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ENGINE MECHANICAL — Diesel Engine Diagnosis

DIESEL ENGINE DIAGNOSIS

1. GENERAL

Diesel engine problems are usually caused by the engine or fuel system. The injection pump is very rarely the cause of fuel system problems.

Before beginning fuel system tests, first check that the engine compression, valve timing and other major systems are within specifications.

2. PRELIMINARY CHECKS

- (a) Before performing fuel system checks, insure that the engine is in good running condition. If necessary, first check the compression, timing and major components or systems.
- (b) Check the air filter and clean or replace as necessary.
- (c) Check for sufficient fuel in the tank.
- (d) Check if the fuel is contaminated with gasoline or other foreign elements. Only high-quality diesel fuel should be used.
- (e) Bleed air from the system by pumping the priming pump.
- (f) Check for water in the sedimenter and fuel tank, and drain as necessary.
- (g) If the engine will not crank or if it cranks slowly, troubleshoot the electrical system.

ENGINE MECHANICAL — Diesel Engine Diagnosis EM-3

PRECAUTION:

1. The basic troubleshooting procedures for the diesel engine (valve clearance, compression, bearings, valves, pistons, etc.) are the same checks you would make for a gasoline engine.
2. The repair of the injection pump requires considerable skill and use of a special test bench.

ENGINE WILL NOT CRANK

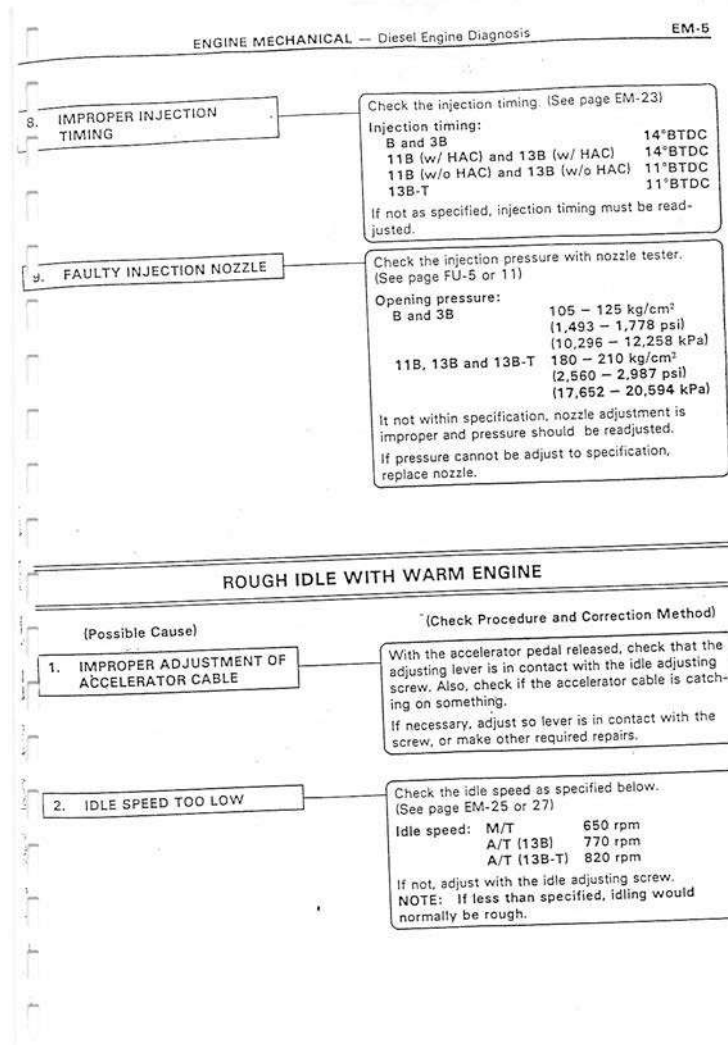
(Possible Cause)	(Check Procedure and Correction Method)
1. LOOSE OR CORRODED BATTERY CABLES	Check cables from battery to starter and make necessary repairs.
2. DISCHARGED BATTERY	Check the alternator output and the drive belt. Repair as necessary. (See page CH-6)
3. INOPERATIVE STARTER	Check for battery voltage at starter terminals 30 and 50. If Okay, see STARTING SYSTEM page (ST-15) for repair procedure.

ENGINE CRANKS SLOWLY-WILL NOT START

NOTE: Minimum cranking speed: Cold M/T 100 rpm
A/T 110 rpm
Hot 150 rpm

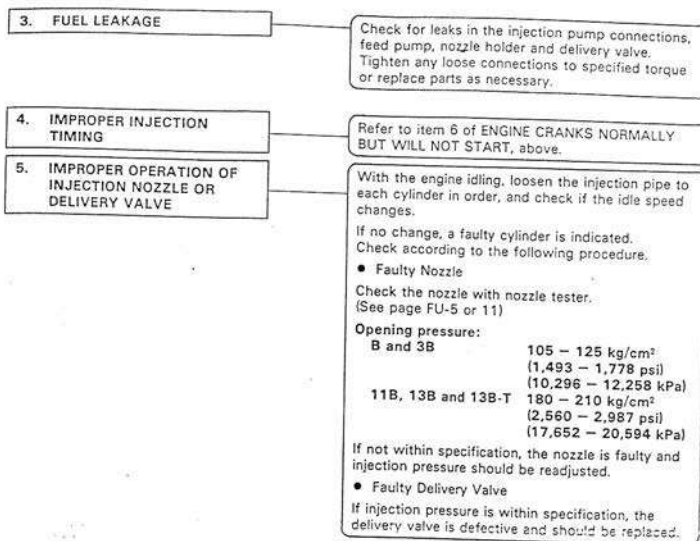
(Possible Cause)	(Check Procedure and Correction Method)
1. LOOSE OR CORRODED BATTERY CABLES	Refer to items 1 and 2 of ENGINE WILL NOT CRANK.
2. DISCHARGED BATTERY	
3. IMPROPER ENGINE OIL	Check engine oil. If improper viscosity, drain and refill with oil of a viscosity recommended by manufacturer. (See page LU-3)

EM-4 ENGINE MECHANICAL -- Diesel Engine Diagnosis	
ENGINE CRANKS NORMALLY BUT WILL NOT START	
(Possible Cause)	(Check Procedure and Correction Method)
1. NO FUEL TO INJECTION NOZZLE	Loosen any one injection pipe union nut from its nozzle. Crank the engine for about 5 seconds while confirming that fuel is being discharged from the pipe. If fuel is coming out, begin diagnosis from item 4. If not, begin from item 2.
2. NO FUEL INTO INJECTION PUMP	Disconnect inlet hoses to the feed pump and feed clean fuel from separate container directly into feed pump. If engine starts, either the sedimenter or fuel line between the fuel tank and feed pump is clogged and should be repaired. If the engine still does not start, check the fuel filter or line between feed pump and injection pump. If normal, the feed pump or injection pump is faulty and should be repaired. NOTE: When feeding fuel directly into pump, keep container at same level as vehicle fuel tank.
3. FUEL LEAKAGE FROM INJECTION PIPE	Check for loose unions or cracks. If leaking, tighten to specified torque or, if necessary, replace pipe(s).
4. [B AND 3B] INOPERATIVE PRE-HEATING OPERATION	With the ignition switch turned ON and the glow plug indicator light illuminated, check that there is voltage applied to the glow plug. If not, refer to ELECTRICAL DIAGNOSIS and repair as necessary. (See page EM-11)
5. [11B, 13B AND 13B-T] INOPERATIVE PRE-HEATING OPERATION	With the ignition switch turned ON and the intake heater indicator light illuminated, check that there is voltage applied to the intake heater. If not, refer to ELECTRICAL DIAGNOSIS and repair as necessary. (See page EM-13)
6. [B AND 3B] FAULTY GLOW PLUG OPERATION	Check the glow plug for continuity. (See page ST-5) If no continuity, a broken wire is indicated and the glow plug should be replaced.
7. [11B, 13B AND 13B-T] FAULTY INTAKE HEATER OPERATION	Check the intake heater continuity. (See page ST-13) If no continuity, a broken wire is indicated and intake heater should be replaced.

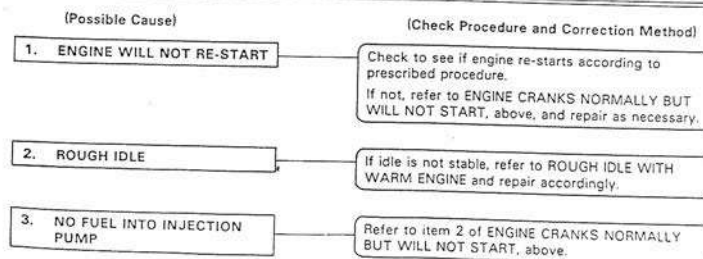


EM-6

ENGINE MECHANICAL — Diesel Engine Diagnosis



ENGINE SUDDENLY STOPS



ENGINE MECHANICAL — Diesel Engine Diagnosis		EM-7
LACK OF POWER		
NOTE: 1. First check that the air cleaner is not clogged or the engine overheating. 2. Not applicable if the customer desires an output power higher than specified for that vehicle. For accuracy, adjust with a chassis dynamo.		
(Possible Cause)	(Check Procedure and Correction Method)	
IMPROPER ACCELERATOR CABLE ADJUSTMENT	With accelerator fully depressed, check that the adjusting lever is in contact with the maximum speed adjusting screw. (See page EM-25 or 27) If not, adjust accordingly.	
INSUFFICIENT MAXIMUM SPEED	Start engine, depress the accelerator pedal to the floor and check that maximum speed is as specified below. (See page EM-25 or 27) Maximum speed: 4,100 rpm If not, adjust with the maximum speed adjusting screw.	
3. FUEL LEAKAGE	Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.	
4. CLOGGED FUEL FILTER	Disconnect the injection pump inlet hose and outlet pipe of the feed pump, and connect directly with a suitable pipe. Then pour clean fuel into the inlet side of the feed pump. If the engine condition improves, the fuel filter is clogged and should be replaced. (See page FU-2) NOTE: When feeding fuel directly into the pump, keep container at same level as vehicle fuel tank. If no increase in engine condition after replacing the fuel filter, check the feed pump or perform other necessary repairs.	
5. IMPROPER INJECTION TIMING	Refer to item 8 of ENGINE CRANKS NORMALLY BUT WILL NOT START.	
6. FAULTY INJECTION NOZZLE	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.	

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ENGINE MECHANICAL — Diesel Engine Diagnosis

EXCESSIVE EXHAUST SMOKE**NOTE:**

1. Check that the air cleaner is not clogged.
2. Check with the customer whether or not oil consumption has been excessive.

(Possible Cause)**(Check Procedure and Correction Method)****1. IMPROPER INJECTION TIMING**

Refer to item 8 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
NOTE: Black smoke indicates advanced timing while white smoke indicates retarded timing. Adjustments should be made accordingly.

2. CLOGGED FUEL FILTER

Refer to item 5 of LACK OF POWER.
NOTE: At high speed (2,000 – 3,000 rpm), a clogged filter tends to make the exhaust smoke white.

3. FAULTY INJECTION NOZZLE

Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
NOTE: Excessive exhaust smoke is often caused by nozzle pressure being too low.

EXCESSIVE FUEL CONSUMPTION

NOTE: Check whether the clutch slips, brakes grab, whether the tires are the wrong size or the air filter is clogged.

(Possible Cause)**(Check Procedure and Correction Method)****1. FUEL LEAKAGE**

Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.

2. IDLE SPEED TOO HIGH

After sufficiently warming up engine, check that idle speed is as specified below.
 (See page EM-25 or 27)

Idle speed: M/T 650 rpm
 A/T (13B) 770 rpm
 A/T (13B-T) 820 rpm

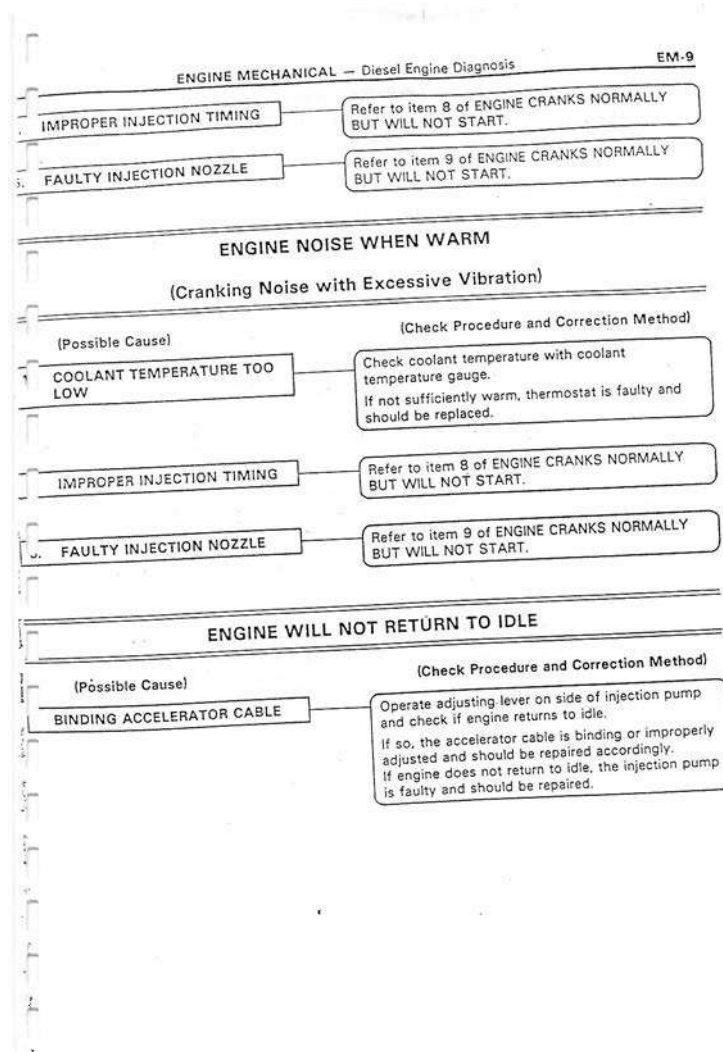
If not, adjust with the idle adjusting screw.

3. MAXIMUM SPEED TOO HIGH

Start engine, depress the accelerator pedal to the floor and check that maximum speed is as specified below. (See page EM-25 or 27)

Maximum speed: 4,100 rpm

If not, adjust with maximum speed adjusting screw.



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ENGINE MECHANICAL — Diesel Engine Diagnosis

ENGINE WILL NOT SHUT OFF WITH STOP BUTTON OR KEY

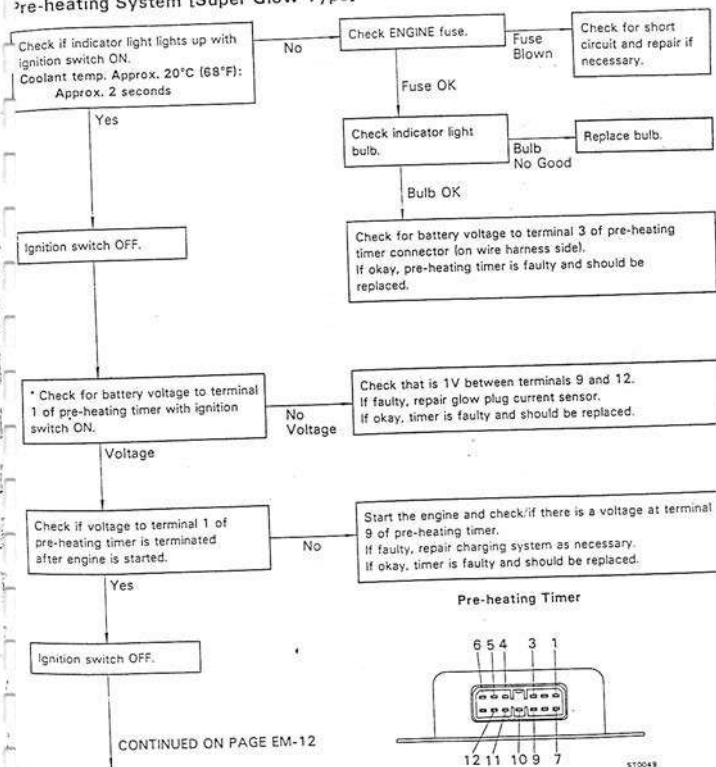
(Possible Cause)

(Check Procedure and Correction Method)

1. [B AND 3B (w/ STOP BUTTON)] BINDING STOP CABLE	Operate stop lever (adjusting lever) on side of injection pump and check if engine stops. If so, stop cable is binding or maladjusted and should be repaired accordingly. If engine does not stop, injection pump is faulty and should be repaired. (See page FU-27)
2. [B AND 3B (w/ EDIC SYSTEM)] IMPROPER EDIC SYSTEM	Operate stop lever (adjusting lever) on side of injection pump and check if engine stops. If so, EDIC system is faulty and should be repaired. (See page ST-26) If engine does not stop, injection pump is faulty and should be repaired. (See page FU-27)
3. [B (w/ FUEL CUT DIAPHRAGM)] IMPROPER FUEL CUT DIAPHRAGM OPERATION	Operate stop lever (adjusting lever) on side of injection pump and check if engine stops. If so, fuel cut diaphragm system is faulty and should be repaired. (See page ST-28) If engine does not stop, injection pump is faulty and should be repaired. (See page FU-27)
4. [11B, 13B AND 13B-T] IMPROPER INTAKE SHUTTER OPERATION	Close the intake shutter and check if engine stops. If it does, the intake shutter system is faulty and should be repaired. (See page EM-30)

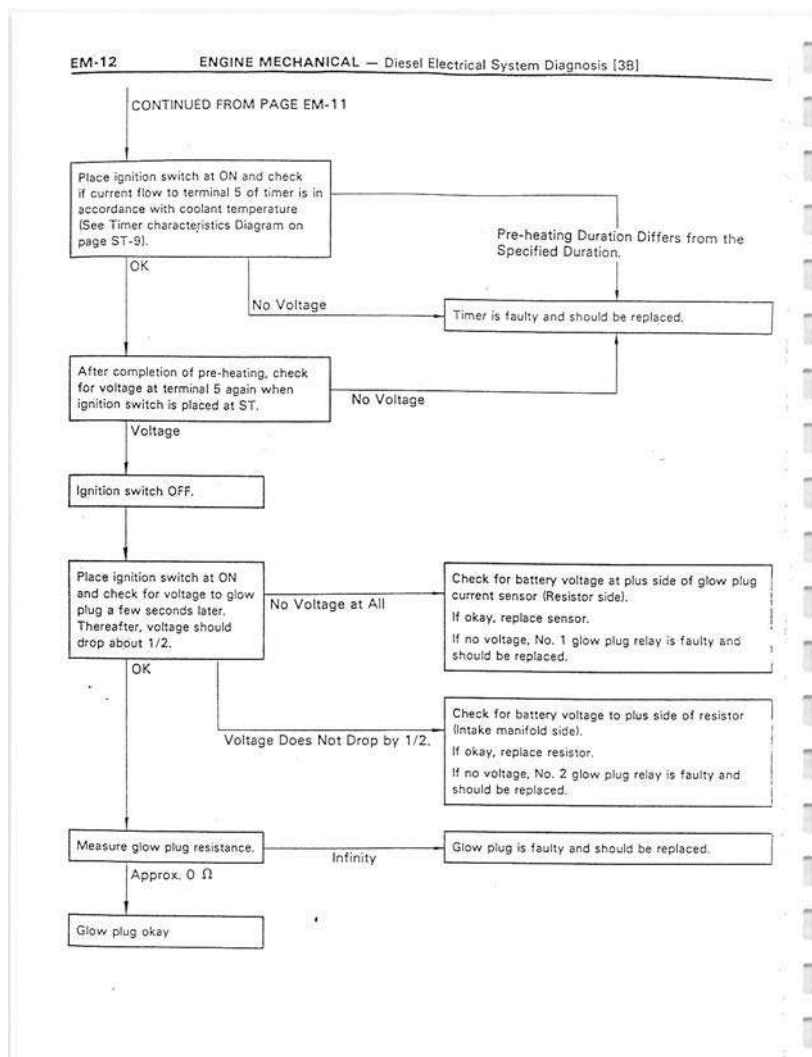
DIESEL ELECTRICAL SYSTEM DIAGNOSIS [3B]**ENGINE DOES NOT START COLD**

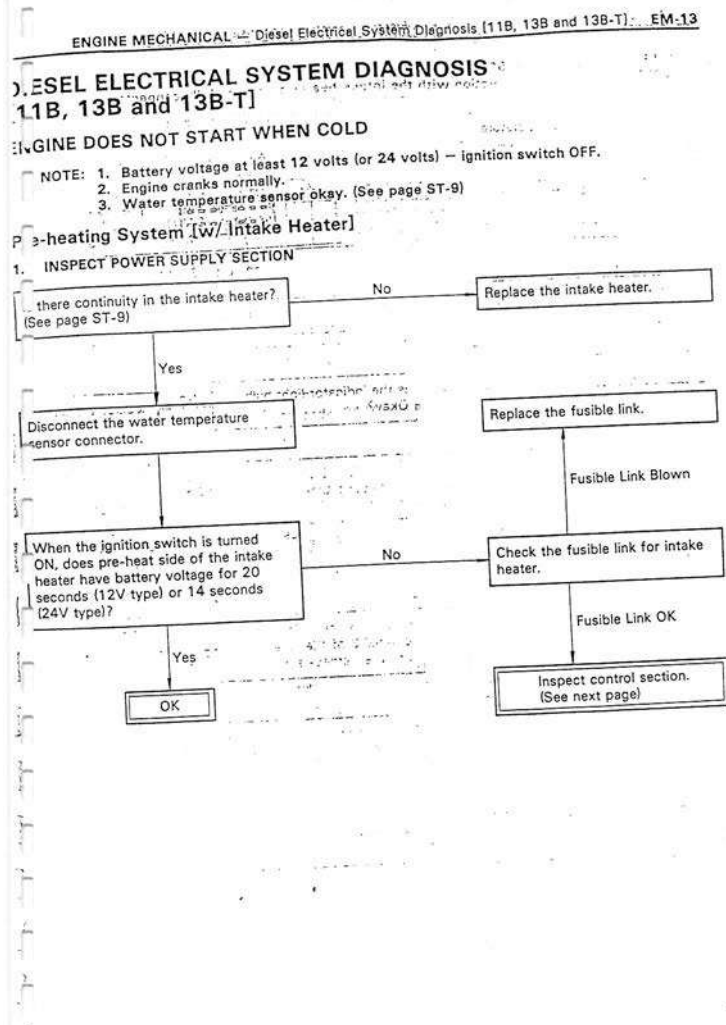
- NOTE: 1. Battery voltage at least 12 volts (or 24 volts) — ignition switch OFF.
 2. Engine cranks normally.
 3. Fusible link okay.
 4. Check the voltage marked with an asterisk(*) just as the ignition switch is placed at ON because the voltage will change with elapse of time.

Pre-heating System [Super Glow Type]

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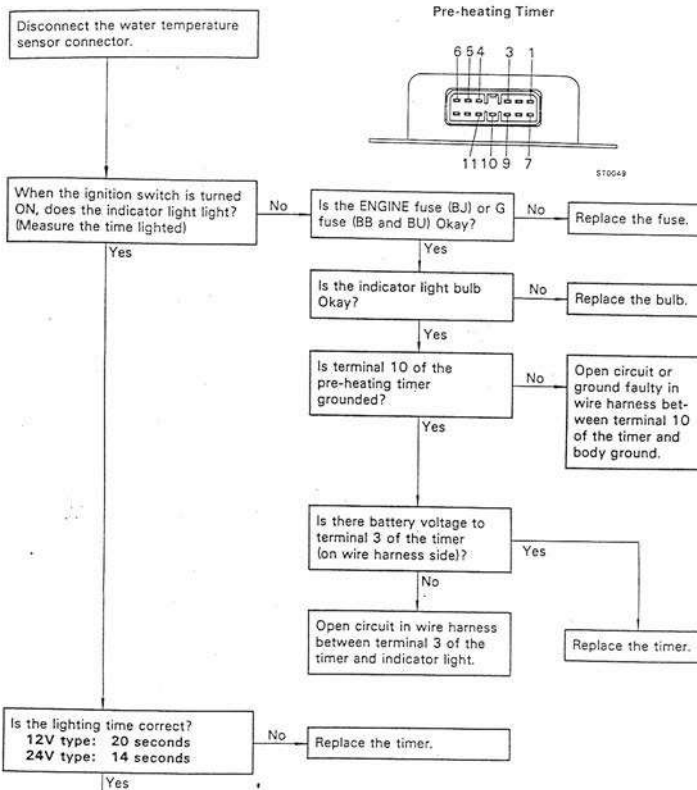




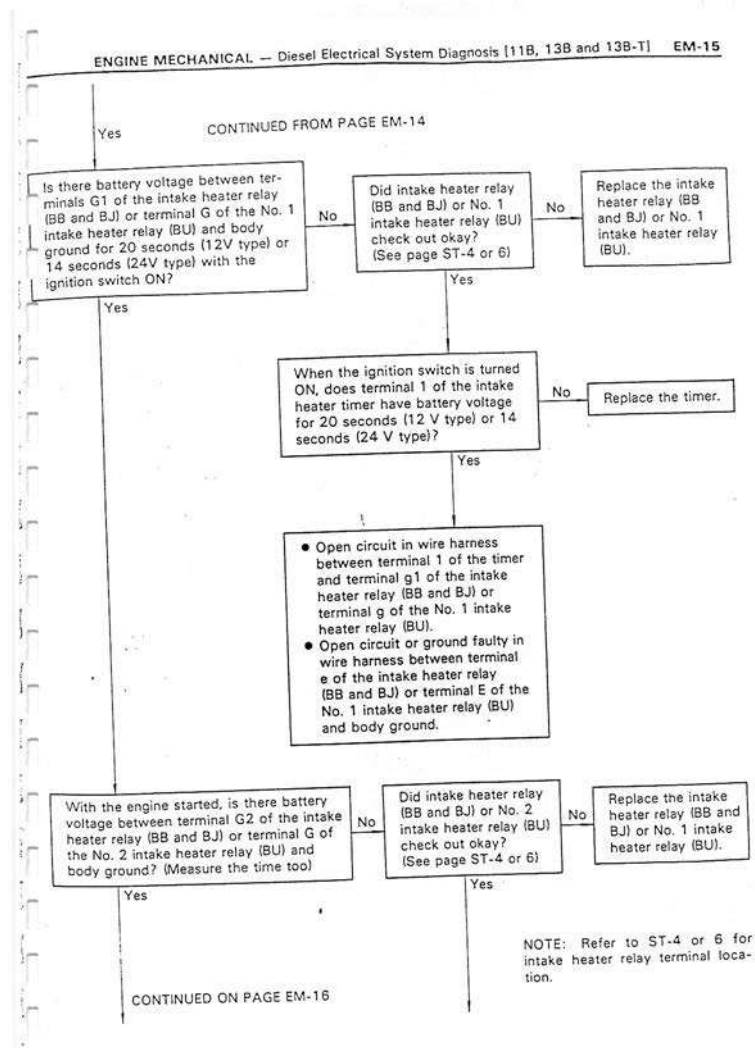
EM-14 ENGINE MECHANICAL — Diesel Electrical System Diagnosis (11B, 13B and 13B-T)

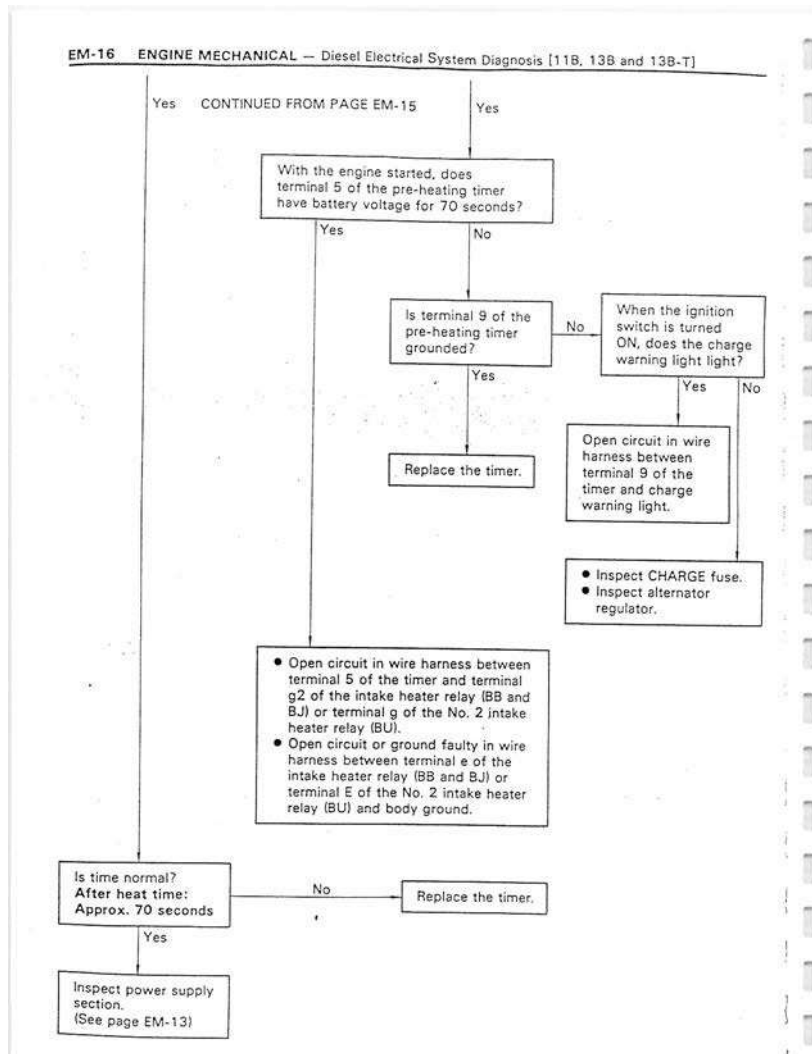
2. INSPECTION CONTROL SECTION

NOTE: Perform this inspection with the intake heater connector fully connected.



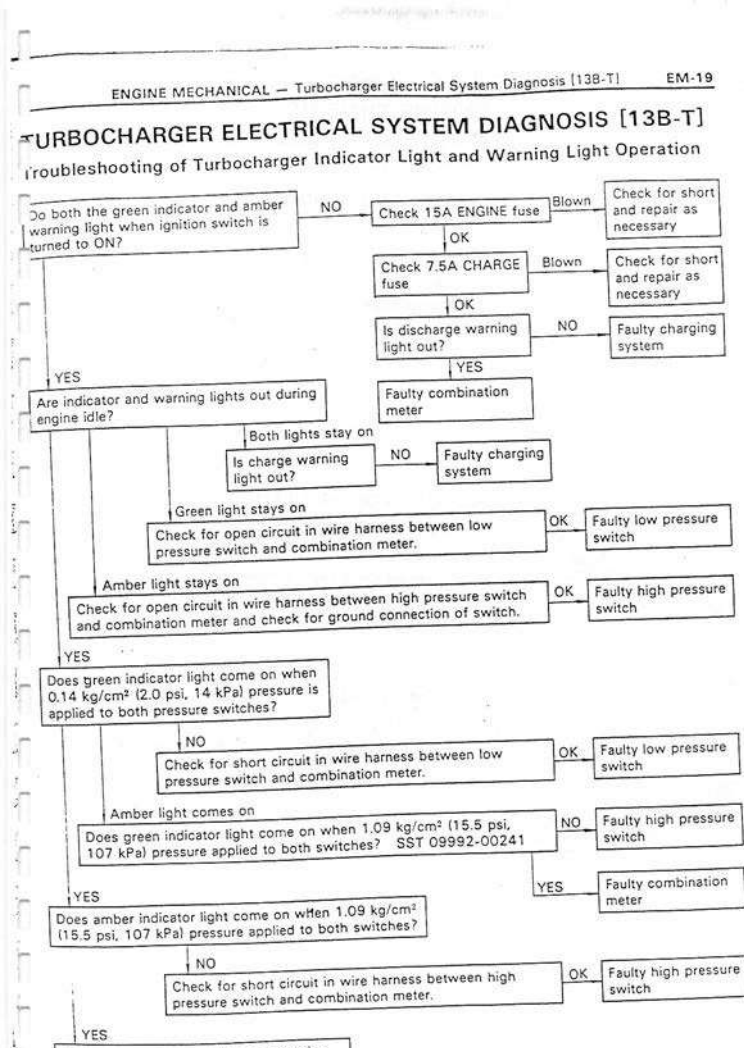
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ENGINE MECHANICAL — Turbocharger Diagnosis [13B-T]		EM-17
TURBOCHARGER DIAGNOSIS [13B-T]		
NOTE: Before troubleshooting the turbocharger, first check the engine itself. (Valve clearance, engine compression, injection timing, etc.)		
INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION		
(Possible Cause)	(Check Procedure and Correction Method)	
1. TURBOCHARGING PRESSURE TOO LOW	Check turbocharging pressure. (See page EM-35) Turbocharging pressure: 0.42 — 0.56 kg/cm ² (6.0 — 8.0 psi, 41 — 55 kPa) If the pressure is below specification, begin diagnosis from item 2.	
2. RESTRICTED INTAKE AIR SYSTEM	Check intake air system, and repair or replace parts as necessary. (See page EM-35)	
3. LEAK IN INTAKE AIR SYSTEM	Check intake air system, and repair or replace parts as necessary. (See page EM-35)	
4. RESTRICTED EXHAUST SYSTEM	Check exhaust system, and repair or replace parts as necessary. (See page EM-35)	
5. LEAK IN EXHAUST SYSTEM	Check exhaust system, and repair or replace parts as necessary. (See page EM-35)	
6. ERRATIC TURBOCHARGER OPERATION	Check rotation of impeller wheel. If it does not turn or turns with a heavy drag, replace the turbocharger assembly. Check axial play of bearing shaft. (See page EM-38) Axial play: 0.13 mm (0.0051 in.) or less If not within specification, replace the turbocharger assembly.	

EM-18 ENGINE MECHANICAL — Turbocharger Diagnosis [13B-T]	
ABNORMAL NOISE	
(Possible Cause)	(Check Procedure and Correction Method)
1. TURBOCHARGING HEAT INSULATOR RESONANCE	Check for loose, improperly installed or deformed insulator mount bolts, and repair or replace as necessary.
2. EXHAUST PIPE LEAKING OR VIBRATING	Check for deformed exhaust pipe, loose mount bolts or damaged gasket, and repair or replace as necessary.
3. ERRATIC TURBOCHARGER OPERATION	Refer to Item 6 of INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION.
EXCESSIVE OIL CONSUMPTION OR WHITE EXHAUST	
(Possible Cause)	(Check Procedure and Correction Method)
FAULTY TURBOCHARGER SEAL	Check for oil leakage in exhaust system. - Remove the turbine elbow from the turbocharger and check for excessive carbon deposits on the turbine wheel. Excessive carbon deposits indicate a faulty turbocharger. Check for oil leakage in intake air system. - Check for axial play in impeller wheel, and replace the turbocharger if necessary. (See page EM-38) Axial play: 0.13 mm (0.0051 in.) or less CAUTION: There is some oil mist from the PCV in the blowby gas so care must be taken not to diagnosis this as an oil leakage from the turbocharger.



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ENGINE MECHANICAL — Engine Tune-up

ENGINE TUNE-UP**INSPECTION OF ENGINE COOLANT**

(See page CO-3)

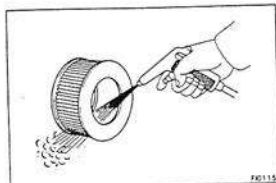
INSPECTION OF ENGINE OIL

(See page LU-3)

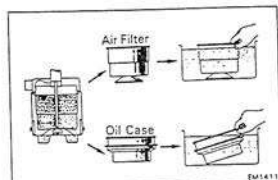
INSPECTION OF BATTERY

(See page CH-6)

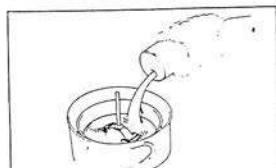
Standard specific gravity:
1.25 — 1.27 when fully charged at 20°C (68°F)

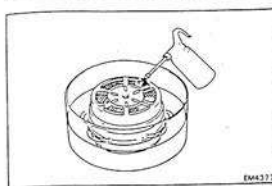
**CLEANING OF AIR FILTER****[Paper Filter Type]****CLEAN AIR FILTER**

Clean the element with compressed air.
First blow from the inside thoroughly. Then blow off the outside of the element.

**[Oil Bath Type]****CLEAN AIR FILTER**

- (a) Wash the oil case and air filter in kerosine by agitating and rubbing.
- (b) Wipe the oil case and air filter with a clean rag.
- (c) Place the oil case on a level work stand.
- (d) Pour in clean engine oil until it reaches the "OIL LEVEL" mark.





- (e) Place the air filter on the tray.
 (f) Saturate the air filter with clean engine oil.

INSPECTION OF ALTERNATOR DRIVE BELT

(See page CH-6)

Drive belt tension (Canada):

New belt 145 ± 25 lb
 Used belt 100 ± 20 lb

Drive belt deflection (Others):

Single belt type

New belt 8 – 12 mm (0.31 – 0.47 in.)
 Used belt 11 – 16 mm (0.43 – 0.63 in.)

Double belt type

New belt 12 – 15 mm (0.47 – 0.59 in.)
 Used belt 14 – 20 mm (0.55 – 0.79 in.)

Drive belt tension (Reference):

Single belt type

New belt 55 – 65 kg
 Used belt 30 – 45 kg

Double belt type

New belt 45 – 55 kg
 Used belt 20 – 35 kg

INSPECTION OF GLOW PLUGS [B and 3B]

(See page ST-6 or 8)

INSPECTION OF INTAKE HEATER

[11B, 13B and 13B-T]

(See page ST-9)

INSPECTION OF INJECTION NOZZLES

(See pages FU-5 and 6) B and 3B

(See pages FU-11 and 12) 11B, 13B and 13B-T

Opening pressure (B and 3B)

New nozzle 115 – 125 kg/cm²
 (1,636 – 1,778 psi)
 (11,278 – 12,258 kPa)

Reused nozzle 105 – 125 kg/cm²
 (1,493 – 1,778 psi)
 (10,296 – 12,258 kPa)

Opening pressure (11B, 13B and 13B-T)

New nozzle 200 – 210 kg/cm²
 (2,845 – 2,987 psi)
 (19,613 – 20,594 kPa)

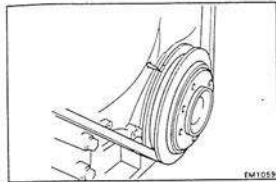
Reused nozzle 180 – 210 kg/cm²
 (2,560 – 2,987 psi)
 (17,652 – 20,594 kPa)

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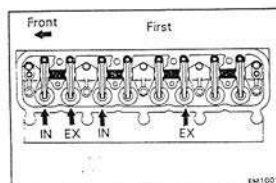
ENGINE MECHANICAL — Engine Tune-up

ADJUSTMENT OF VALVE CLEARANCES**1. WARM UP ENGINE**

Allow the engine to reach normal operating temperature.

2. [13B-T]**REMOVE INTAKE AIR CONNECTOR PIPE**
(See page EM-36)**3. REMOVE CYLINDER HEAD COVER****4. SET NO. 1 CYLINDER TO TDC/COMPRESSION**

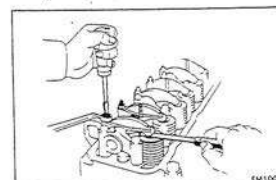
- Align the groove on the pulley with the timing pointer by turning the crankshaft clockwise with a wrench.
 - Check that the rocker arms on the No. 1 cylinder are loose and rocker arms on the No. 4 cylinder are tight.
- If not, turn the crankshaft one revolution (360°) and align the mark as above.

**5. ADJUST VALVE CLEARANCES**

- Measure only those valves indicated by arrows.

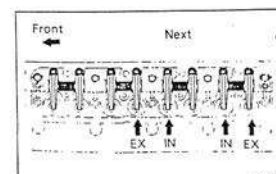
Valve clearance (Hot):

Intake	0.20 mm (0.008 in.)
Exhaust	0.36 mm (0.014 in.)



- Using a feeler gauge, measure the valve clearance between the valve stem and rocker arm. Loosen the lock nut and turn the adjusting screw to set the proper clearance. Hold the adjusting screw in position and tighten the lock nut.
- Recheck the valve clearance. The feeler gauge should slide with a very slight drag.

- Turn the crankshaft one revolution (360°) and align the mark as above. Adjust only the valves indicated by arrows.

6. INSTALL CYLINDER HEAD COVER**7. [13B-T]****INSTALL INTAKE AIR CONNECTOR PIPE**
(See page EM-40)

ENGINE MECHANICAL — Engine Tune-up EM-23

ADJUSTMENT OF INJECTION TIMING

1. **PREPARE INSPECTION PIPE**
Make an inspection pipe with a injection pipe as shown.
2. **[13B-T] REMOVE INTAKE AIR CONNECTOR PIPE**
(See page EM-36)
3. **REMOVE CYLINDER HEAD COVER**
4. **SET NO. 1 CYLINDER TO 14° [B, 3B, 11B (w/ HAC) and 13B (w/ HAC)] or 11° [11B (w/o HAC), 13B (w/o HAC) and 13B-T] BTDC/COMPRESSION**
 - (a) Align the groove on the pulley with the timing pointer by turning the crankshaft clockwise with a wrench.
 - (b) Check that the rocker arms on the No. 1 cylinder are loose and rocker arms on the No. 4 cylinder are tight.

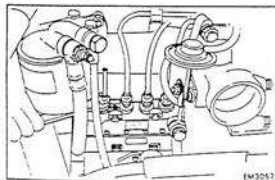
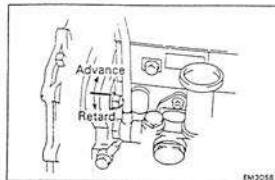
If not turn the crankshaft one revolution (360°) and align the marks as above.
5. **ADJUST INJECTION TIMING**
 - (a) Remove the No. 1 injection pipe and install the inspection pipe on the No. 1 delivery valve holder.
 - (b) Turn the crankshaft slightly to left and right until fuel surfaces from the inspection pipe.
 - (c) Turn the crankshaft counterclockwise, set the No. 1 cylinder just before the 14° [B, 3B, 11B (w/ HAC) and 13B (w/ HAC)] or 11° [11B (w/o HAC), 13B (w/o HAC) and 13B-T] BTDC/compression.
 - (d) Slowly turn the crankshaft clockwise.
 - (e) Check the crankshaft pulley position (injection timing position) when the fuel level in the inspection pipe rises.

Injection timing:	14° BTDC
B and 3B	14° BTDC
11B (w/ HAC) and 13B (w/ HAC)	11° BTDC
11B (w/o HAC) and 13B (w/o HAC)	11° BTDC
13B-T	11° BTDC

NOTE: This operation should be repeated at least two or three times.

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ENGINE MECHANICAL — Engine Tune-up



- (f) Loosen the other injection pipe union nuts, fuel pipe and oil pipe union bolt at the injection pump side.
- (g) [B and 3B]
Loosen the nut holding the injection pump stay to the stay.
- (h) [11B, 13B and 13B-T]
Loosen the nut holding the injection pump to pump stay.
- (i) Loosen the four nuts holding the injection pump to the retainer.

NOTE: If it is difficult to loosen the pump mounting nuts, remove the fuel filter.

- (j) Adjust the injection timing by slightly tilting the injection pump body.

If the injection timing is retarded, advance it by tilting the pump toward the engine.

If the injection timing is advanced, retard it by tilting the pump away from the engine.

- (k) Tighten the four nuts holding the injection pump to the retainer.

Torque: 375 kg-cm (27 ft-lb, 37 N-m)

- (l) [B and 3B]
Tighten the nut holding the injection pump stay to the stay.

Torque: 185 kg-cm (13 ft-lb, 18 N-m)

- (m) [11B, 13B and 13B-T]
Tighten the nut holding the injection pump to pump stay.

Torque: 375 kg-cm (27 ft-lb, 37 N-m)

- (n) Recheck the injection timing.
- (o) Remove the inspection pipe and install the No. 1 injection pipe.
- (p) Tighten the injection pipe union nuts, oil pipe union bolt and fuel pipe union bolt.

Torque:

Injection pipe	250 kg-cm (18 ft-lb, 25 N-m)
Oil pipe	110 kg-cm (8 ft-lb, 11 N-m)
Fuel pipe	375 kg-cm (27 ft-lb, 37 N-m)

6. INSTALL CYLINDER HEAD COVER

- 7. [13B-T]
INSTALL INTAKE AIR CONNECTOR PIPE
(See page EM-40)

8. START ENGINE AND CHECK FOR LEAKS

ENGINE MECHANICAL — Engine Tune-up EM-25

ADJUSTMENT OF IDLE SPEED AND MAXIMUM SPEED [B and 3B]

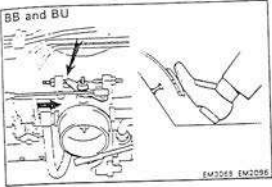
1. INITIAL CONDITIONS
 - (a) Air cleaner installed
 - (b) Normal operating coolant temperature
 - (c) All accessories switched off
 - (d) All vacuum lines connected
 - (e) Valve clearances set correctly
 - (f) Injection timing set correctly
2. CONNECT TACHOMETER
3. ADJUST IDLE SPEED
 - (a) Check that the adjusting lever touches the idle speed (throttle valve) adjusting screw when the accelerator pedal is released.

If not, adjust the accelerator linkage.

 - (b) Start the engine.
 - (c) Check the idle speed.

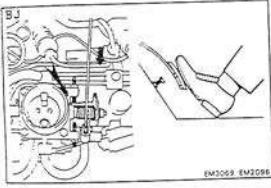
Idle speed: 650 rpm

BB and BU



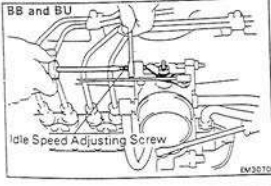
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BU



EM3068 EM3086

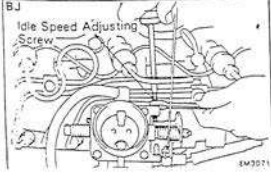
BB and BU



Idle Speed Adjusting Screw

EM3070

BU



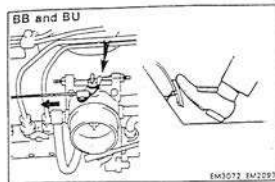
Idle Speed Adjusting Screw

EM3071

- (d) Adjust the idle speed.
 - Disconnect the accelerator linkage.
 - Loosen the lock nut of the idle speed (throttle valve) adjusting screw.
 - Adjust the idle speed by turning the IDLE SPEED ADJUSTING SCREW.
 - Securely tighten the lock nut and recheck the idle speed.
 - Connect the accelerator linkage.
 - After adjustment, adjust the accelerator linkage.

EM-26

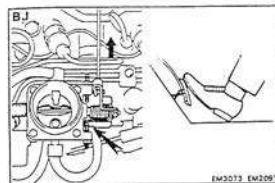
ENGINE MECHANICAL — Engine Tune-up



4. ADJUST MAXIMUM SPEED

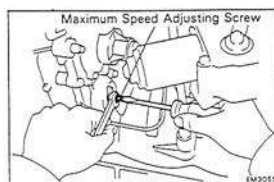
- (a) Check that the adjusting lever touches the throttle valve adjusting screw when the accelerator pedal is depressed all the way.

If not, adjust the accelerator linkage.



- (b) Start the engine.
 (c) Depress the accelerator pedal all the way.
 (d) Check the maximum speed.

Maximum speed: 4,100 rpm



- (e) Adjust the maximum speed.
- Disconnect the accelerator linkage.
 - Cut out the maximum speed speed adjusting (speed control) screw seal wire.
 - Loosen the lock nut of the maximum speed adjusting screw.
 - Adjust the maximum speed by turning the MAXIMUM SPEED ADJUSTING SCREW.

NOTE: Adjust at idle speed. Then, raise engine speed and recheck the maximum speed.

- Securely tighten the lock nut and recheck the maximum speed.
- Seal the maximum speed adjusting screw with a new seal wire.

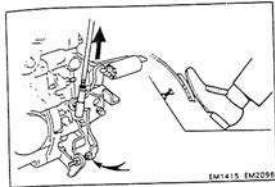


ENGINE MECHANICAL — Engine Tune-up

EM-27

**ADJUSTMENT OF IDLE SPEED AND
MAXIMUM SPEED [11B, 13B and 13B-T]****1. INITIAL CONDITIONS**

- (a) Air cleaner installed
- (b) Normal operating coolant temperature
- (c) All accessories switched off
- (d) All vacuum lines connected
- (e) Valve clearances set correctly
- (f) Injection timing set correctly
- (g) Transmission in N range

**2. CONNECT TACHOMETER****3. ADJUST IDLE SPEED**

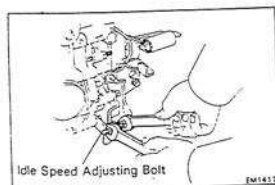
- (a) Check that the adjusting lever touches the idle speed adjusting bolt when the accelerator pedal is released. If not, adjust the accelerator linkage.

- (b) Start the engine.

- (c) Check the idle speed.

Idle speed:

M/T	650 rpm
A/T (13B)	770 rpm
A/T (13B-T)	820 rpm



- (d) Adjust the idle speed.

- Disconnect the accelerator linkage.
- Loosen the lock nut of the idle speed adjusting bolt.
- Adjust the idle speed by turning the IDLE SPEED ADJUSTING BOLT.
- Securely tighten the lock nut and recheck the idle speed.
- Connect the accelerator linkage.
- After adjustment, adjust the accelerator linkage.

4. ADJUST MAXIMUM SPEED

- (a) Check that the adjusting lever touches the maximum speed adjusting bolt when the accelerator pedal is depressed all the way.

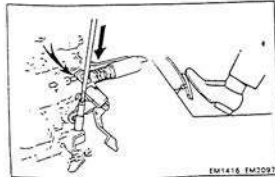
If not, adjust the accelerator linkage.

- (b) Start the engine.

- (c) Depress the accelerator pedal all the way.

- (d) Check the maximum speed.

Maximum speed: 4,100 rpm



EM-28

ENGINE MECHANICAL — Engine Tune-up



- (e) Adjust the maximum speed.
- Disconnect the accelerator linkage.
 - Cut out the seal wire of the maximum speed adjusting screw.
 - Loosen the lock nut of the maximum speed adjusting bolt.
 - Adjust the maximum speed by turning the MAXIMUM SPEED ADJUSTING SCREW.

NOTE: Adjust at idle speed. Then, raise engine speed and recheck the maximum speed.

- Securely tighten the lock nut and recheck the maximum speed.
- Seal the maximum speed adjusting screw with a new seal wire.

ADJUSTMENT OF AIR CONDITIONER IDLE-UP SETTING SPEED [B and 3B]

1. INITIAL CONDITIONS

- (a) Air cleaner installed
- (b) Normal operating coolant temperature
- (c) All accessories switched off
- (d) All vacuum lines connected
- (e) Valve clearances set correctly
- (f) Injection timing set correctly
- (g) Idle speed set correctly

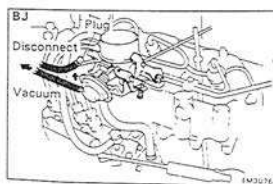
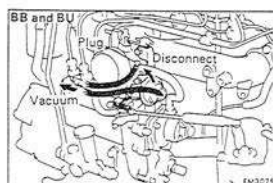
2. CONNECT TACHOMETER

3. ADJUST AIR CONDITIONER (A/C) IDLE-UP SETTING SPEED

- (a) Start the engine.
- (b) Disconnect the vacuum hose from the idle-up actuator and plug the hose end.
- (c) Apply vacuum to the idle-up actuator.
- (d) Race the engine to 2,500 rpm a few seconds, release throttle and check the A/C idle-up setting speed.

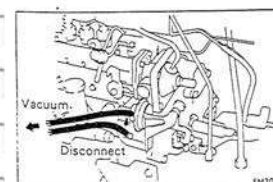
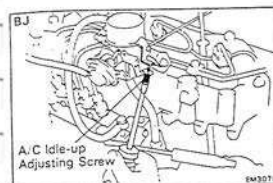
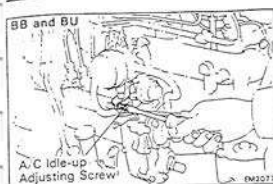
A/C idle-up setting speed:

- BB 750 rpm
BJ and BU 950 rpm



ENGINE MECHANICAL — Engine Tune-up

EM-29



- (e) Adjust the A/C idle-up setting speed by turning the A/C IDLE-UP ADJUSTING SCREW.
- (f) Race the engine to 2,500 rpm a few seconds, release the throttle and recheck the A/C idle-up setting speed.
- (g) Reconnect the vacuum hose to the idle-up actuator.

ADJUSTMENT OF AIR CONDITIONER IDLE-UP SETTING SPEED [11B, 13B and 13B-T]

1. INITIAL CONDITIONS

- (a) Air clear installed
- (b) Normal operating coolant temperature
- (c) All accessories switched off
- (d) Valve clearances set correctly
- (e) Injection timing set correctly
- (f) Idle speed set correctly
- (g) Transmission in N range

2. CONNECT TACHOMETER

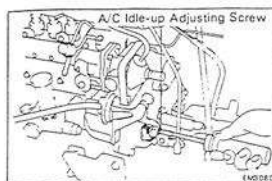
3. ADJUST AIR CONDITIONER (A/C) IDLE-UP SETTING SPEED

- (a) Start the engine.
- (b) Disconnect the vacuum hose from the idle-up actuator and plug the hose end.
- (c) Apply vacuum to the idle-up actuator.
- (d) Race the engine to 2,500 rpm a few seconds, release the throttle and check the A/C idle-up setting speed.

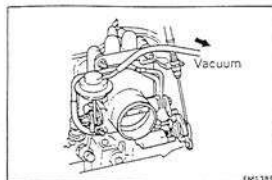
A/C idle-up setting speed:
 BB 750 rpm
 BJ and BU 950 rpm

EM-30

ENGINE MECHANICAL — Engine Tune-up



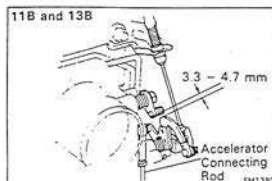
- (e) Adjust the A/C idle-up setting speed by turning the A/C IDLE-UP ADJUSTING SCREW.
- (f) Race the engine to 2,500 rpm a few seconds, release the throttle and recheck the A/C idle-up setting speed.
- (g) Reconnect the vacuum hose to the idle-up actuator.



INSPECTION AND ADJUSTMENT OF INTAKE SHUTTER [11B, 13B and 13B-T]

1. INSPECT AND ADJUST INTAKE SHUTTER

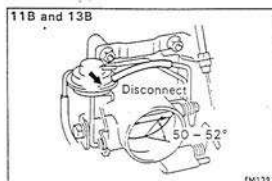
- (a) Apply at least 300 mmHg (11.81 in.Hg, 40.0 kPa) of vacuum to the actuator.
- (b) Check that the throttle valve moves smoothly to the fully closed position.



- (c) [11B and 13B]
Measure the clearance between the throttle lever and intake shutter lever.

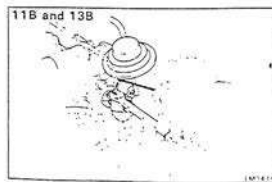
Clearance: 3.3 - 4.7 mm (0.130 - 0.185 in.)

- (d) [11B and 13B]
Adjust by turning the accelerator connecting rod.



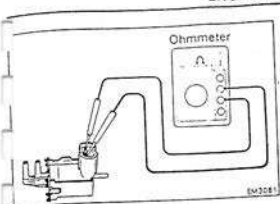
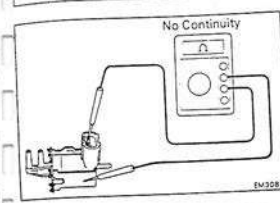
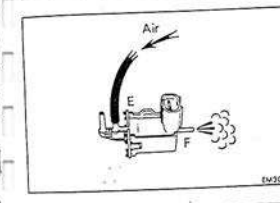
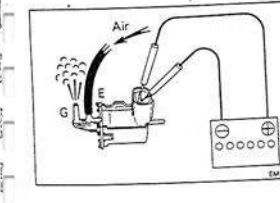
- (e) [11B and 13B]
Disconnect the vacuum hose of the actuator.
- (f) [11B and 13B]
Check the throttle valve angle.

Standard angle: 50 - 52° from horizontal



- (g) [11B and 13B]
Using a hexagon wrench, adjust by turning the adjusting screw.

ENGINE MECHANICAL — Engine Tune-up EM-31

2. INSPECT VACUUM SWITCHING VALVE (VSV)

A. Inspect VSV for open circuit
Using an ohmmeter, check that there is continuity between the terminals.

Resistance:

12V type	33 — 39 Ω	at 20°C (68°F)
24V type	135 — 155 Ω	at 20°C (68°F)

If there is no continuity, replace the VSV.

B. Inspect VSV for ground
Using an ohmmeter, check that there is no continuity between each terminal and the VSV body.
If there is continuity, replace the VSV.

C. Inspect VSV operation

(a) Check that air flows from pipe E to pipe F.

(b) Apply battery voltage (12V or 24V) across the terminals.

(c) Check that air flows from pipe E to pipe G.
If operation is not as specified, replace the VSV.

EM-32

ENGINE MECHANICAL — Compression Check [B and 3B]

COMPRESSION CHECK [B and 3B]

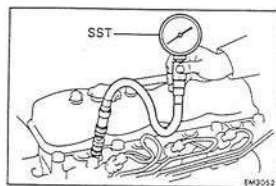
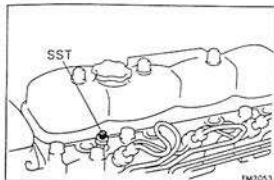
NOTE: If there is lack of power, excessive oil consumption or poor fuel economy, measure the cylinder compression pressure.

1. WARM UP AND STOP ENGINE**2. REMOVE GLOW PLUGS (See page EM-44)**

CAUTION: Make sure the load wire is not grounded.

3. CHECK CYLINDER COMPRESSION PRESSURE

(a) Install SST (gauge adapter) to the glow plug hole.
SST 09992-00023



(b) Connect SST (compression gauge) to SST (gauge adapter).
SST 09992-00023

(c) Fully open the throttle valve.

(d) While cranking the engine with the starter, measure the compression pressure.

NOTE: Always use a fully charged battery to obtain engine revolutions of more than 250 rpm.

(e) Repeat steps (a) through (d) for each cylinder.

Compression pressure:

30.0 kg/cm² (427 psi, 2,942 kPa) or more

Minimum pressure:

20.0 kg/cm² (284 psi, 1,961 kPa)

Difference between each cylinder:

2.0 kg/cm² (28 psi, 196 kPa) or less

(f) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the glow plug hole and repeat steps (a) through (d) for the cylinder with low compression.

• If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.

• If pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.

4. INSTALL GLOW PLUGS (See page EM-62)

ENGINE MECHANICAL — Compression Check [11B, 13B and 13B-T]

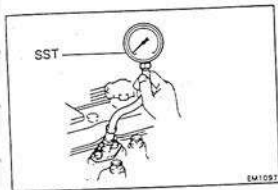
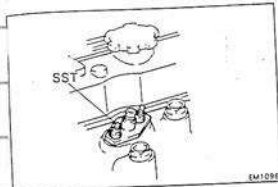
EM-33

**COMPRESSION CHECK
[11B, 13B and 13B-T]**

NOTE: If there is lack of power, excessive oil consumption or poor fuel economy, measure the cylinder compression pressure.

1. WARM UP AND STOP ENGINE
2. REMOVE INJECTION NOZZLES (See page FU-10)
3. CHECK CYLINDER COMPRESSION PRESSURE
 - (a) Install SST (gauge adapter) to the injection nozzle hole.

SST 09992-00023



- (b) Connect SST (compression gauge) to SST (gauge adapter).

SST 09992-00023

- (c) Fully open the throttle valve.
- (d) While cranking the engine with the starter, measure the compression pressure.

NOTE: Always use a fully charged battery to obtain engine revolutions of more than 250 rpm.

- (e) Repeat steps (a) through (d) for each cylinder.

Compression pressure:
30.0 kg/cm² (427 psi, 2,942 kPa) or more

Minimum pressure:
20.0 kg/cm² (284 psi, 1,961 kPa)

Difference between each cylinder:
2.0 kg/cm² (28 psi, 196 kPa) or less

- (f) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the injection nozzle hole and repeat steps (a) through (d) for the cylinder with low compression.
 - If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
 - If pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.

4. INSTALL INJECTION NOZZLES (See page FU-15)

EM-34

ENGINE MECHANICAL -- Turbocharger [13B-T]

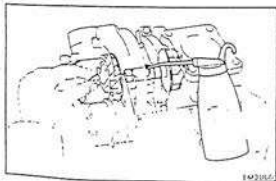
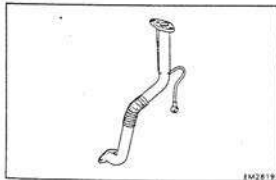
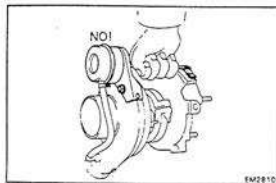
TURBOCHARGER [13B-T]**CAUTION:**

- Do not stop the engine immediately after pulling a trailer or high speed or uphill driving. Idle the engine 20 – 120 seconds, depending on the severity of the driving condition.
- Avoid sudden racing or acceleration immediately after starting a cold engine.
- If the engine is run with the air cleaner removed, foreign material entering will damage the wheels which run at extremely high speed.
- If the turbocharger is defective and must be replaced, first check for the cause of the defect in reference to the following items and replace parts if necessary:

Engine oil level and quality

Conditions under which the turbocharger was used

Oil lines leading to the turbocharger



- Use caution when removing and reinstalling the turbocharger assembly. Do not drop it or bang it against anything or grasp it by easily-deformed parts, such as the actuator or rod, when moving.
- Before removing the turbocharger, plug the intake and exhaust ports and oil inlet to prevent entry of dirt or other foreign material.
- If replacing the turbocharger, check for accumulation of sludge particles in the oil pipes and, if necessary, replace the oil pipes.
- Completely remove the gaskets adhered to the lubrication oil pipe flange and turbocharger oil flange.
- If replacing bolts or nuts, do so only with the specified new ones to guard against breakage or deformation.
- If replacing the turbocharger, put 20 cc (1.2 cu in.) of oil into the turbocharger oil inlet and turn the impeller wheel by hand to spread oil to the bearing.
- If overhauling or replacing the engine, cut the fuel supply after reassembly and crank the engine for 30 seconds to distribute oil throughout the engine. Then allow the engine to idle for 60 seconds.

ENGINE MECHANICAL — Turbocharger (13B-T)

EM-35

ON-VEHICLE INSPECTION OF TURBOCHARGER

1. INSPECT INTAKE AIR SYSTEM

Check for leakage or clogging between the air cleaner and turbocharger inlet and between the turbocharger outlet and cylinder head.

- Clogged air cleaner Clean or replace the element
- Hoses collapsed or deformed Check each connection and repair
- Cracks in components Check and replace

2. INSPECT EXHAUST SYSTEM

Check for leakage or clogging between the cylinder head and turbocharger inlet and between the turbocharger outlet and exhaust pipe.

- Deformed components Repair or replace
- Foreign material in passages Remove
- Leakage from components Repair or replace
- Cracks in components Check and replace

3. INSPECT OPERATION OF ACTUATOR AND WASTE GATE VALVE

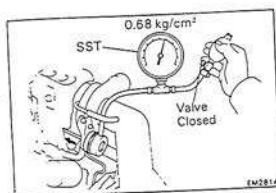
(a) Disconnect the actuator hose.

(b) Using SST (turbocharger pressure gauge), apply about 0.68 kg/cm² (9.7 psi, 67 kPa) of pressure to the actuator and check that the rod moves.

SST 09992-00240 or 09992-00241

CAUTION: Never apply more than 0.8 kg/cm² (11.4 psi, 78 kPa) of pressure to the actuator.

If the rod does not move, replace the turbocharger assembly.



4. INSPECT TURBOCHARGING PRESSURE

(a) Warm up the engine.

(b) Using a 3-way union, connect SST (turbocharger pressure gauge) to the hose leading to the air intake connector.

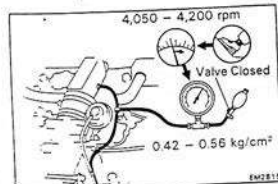
SST 09992-00240 or 09992-00241

(c) Press in the clutch pedal, then press the accelerator pedal down as far as it will go. Measure the turbocharging pressure at maximum speed (4,050 – 4,200 rpm).

Turbocharging pressure: 0.42 – 0.56 kg/cm²
(6.0 – 8.0 psi, 41 – 55 kPa)

If the pressure is less than that specified, check the intake air and exhaust systems for leakage. If there is no leakage, replace the turbocharger assembly.

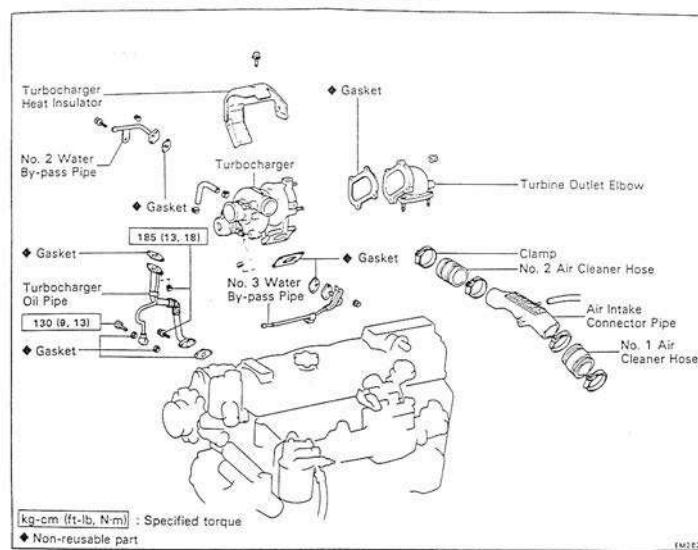
If the pressure is above specification, check if the actuator hose is disconnected or cracked. If not, replace the turbocharger assembly.

5. INSPECT IMPELLER WHEEL ROTATION
(See page EM-38)

EM-36

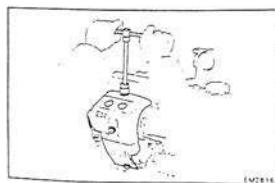
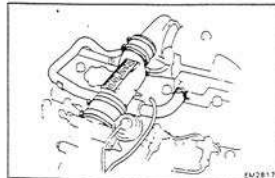
ENGINE MECHANICAL — Turbocharger [13B-T]

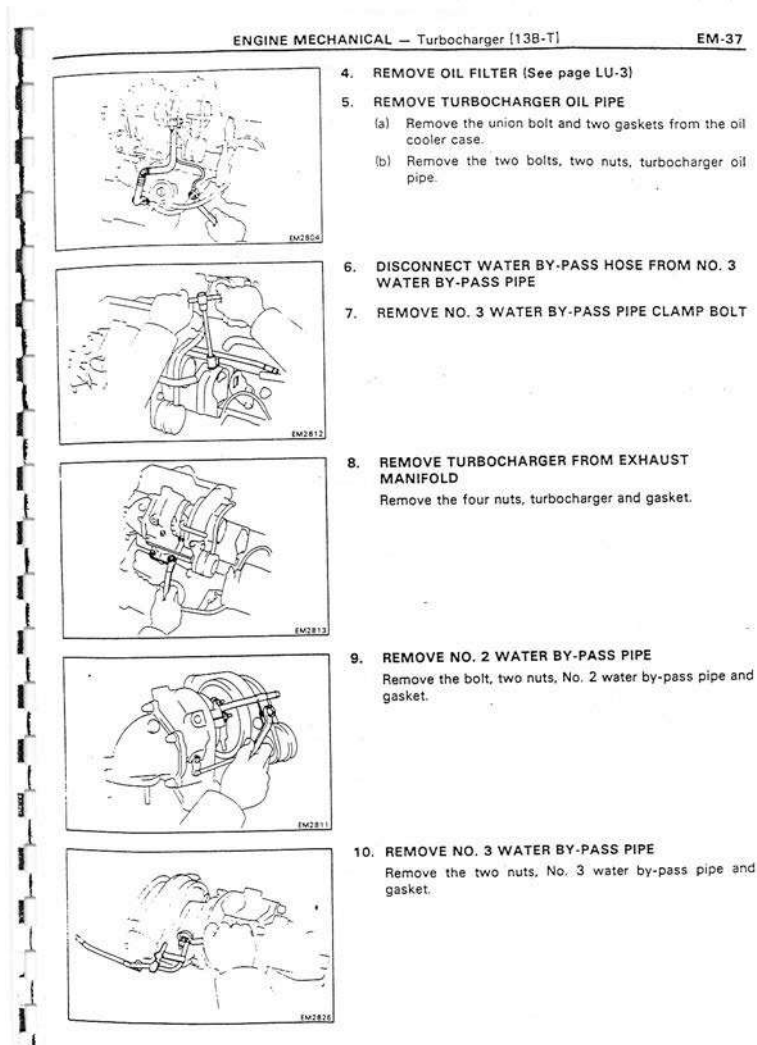
COMPONENTS



REMOVAL OF TURBOCHARGER

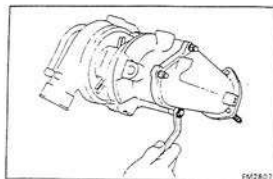
1. DRAIN ENGINE COOLANT (See page CO-3)
2. REMOVE POSITIVE CRANKCASE VENTILATION (PCV) HOSE AND INTAKE AIR CONNECTOR PIPE
 - (a) Disconnect the PCV hose from the cylinder head.
 - (b) Disconnect the vacuum hose from the intake air connector.
 - (c) Loosen the four clamps, and remove the intake air connector pipe, No. 1 air cleaner hose, No. 2 air cleaner hose and PCV hose.
3. REMOVE TURBOCHARGER HEAT INSULATOR
Remove the four bolts and heat insulator.



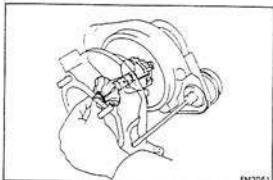


EM-38

ENGINE MECHANICAL — Turbocharger (13B-T)

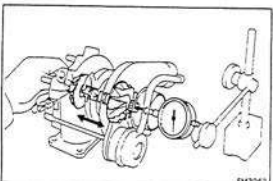
**11. REMOVE TURBINE OUTLET ELBOW**

Remove the four nuts, turbine outlet elbow and gasket.

12. REMOVE ACTUATOR HOSE**INSPECTION OF TURBOCHARGER****1. INSPECT IMPELLER WHEEL ROTATION**

Grasp the edge of the turbine wheel and turn it. Check that the impeller wheel turns smoothly.

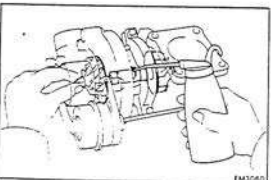
If the impeller wheel does not turn or if it turns with a drag, replace the turbocharger assembly.

**2. INSPECT AXIAL PLAY OF IMPELLER WHEEL**

Insert a dial indicator into the exhaust side, hold the turbine wheel edge by hand and check the axial play.

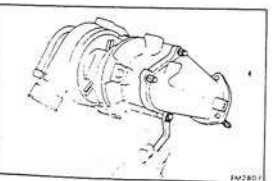
Axial play: 0.13 mm (0.0051 in.) or less

If the axial play is not within specification, replace the turbocharger assembly.

**INSTALLATION OF TURBOCHARGER**

(See page EM-36)

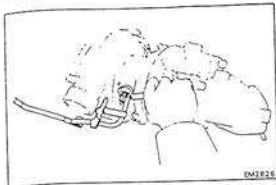
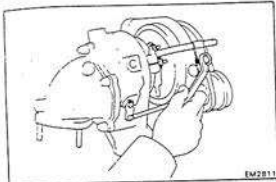
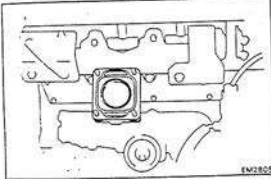
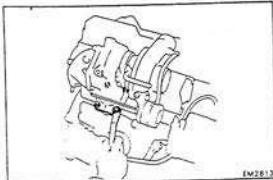
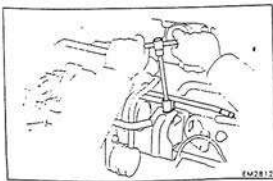
CAUTION: After replacing a turbocharger assembly, pour about 20 cc (1.2 cu in.) of new oil into the oil inlet and then turn the impeller wheel by hand to splash oil on the bearing.

1. INSTALL ACTUATOR HOSE**2. INSTALL TURBINE OUTLET ELBOW**

Install the gasket and turbine outlet elbow with the four nuts.

Torque: 375 kg-cm (27 ft-lb, 37 N-m)

ENGINE MECHANICAL — Turbocharger [13B-T] **EM-39**

3. INSTALL NO. 3 WATER BY-PASS PIPE
Install a new gasket and No. 3 water by-pass pipe with the two nuts.
Torque: 75 kg-cm (65 in.-lb, 7.1 N-m)

4. INSTALL NO. 2 WATER BY-PASS PIPE
Install a new gasket and No. 2 water by-pass pipe with the bolt and two nuts.
Torque:
Bolt 185 kg-cm (13 ft-lb, 18 N-m)
Nut 75 kg-cm (65 ft-lb, 7.1 N-m)

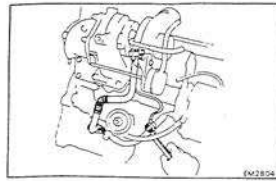
5. INSTALL TURBOCHARGER TO EXHAUST MANIFOLD
(a) Place a new gasket on the manifold with the groove of the gasket facing upward (turbocharger side).
(b) Install the turbocharger with the four nuts.
Torque: 465 kg-cm (34 ft-lb, 46 N-m)

6. INSTALL NO. 3 WATER BY-PASS PIPE CLAMP BOLT

7. CONNECT WATER BY-PASS HOSE TO NO. 3 WATER BY-PASS PIPE
Torque: 185 kg-cm (13 ft-lb, 18 N-m)

EM-40

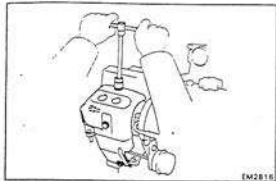
ENGINE MECHANICAL — Turbocharger [13B-T]

**8. INSTALL TURBOCHARGER OIL PIPE**

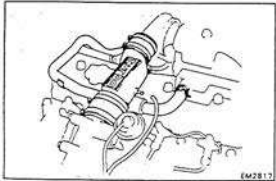
Install the turbocharger oil pipe with the two bolts, two nuts, union bolt and gaskets. Torque the bolts and nuts.

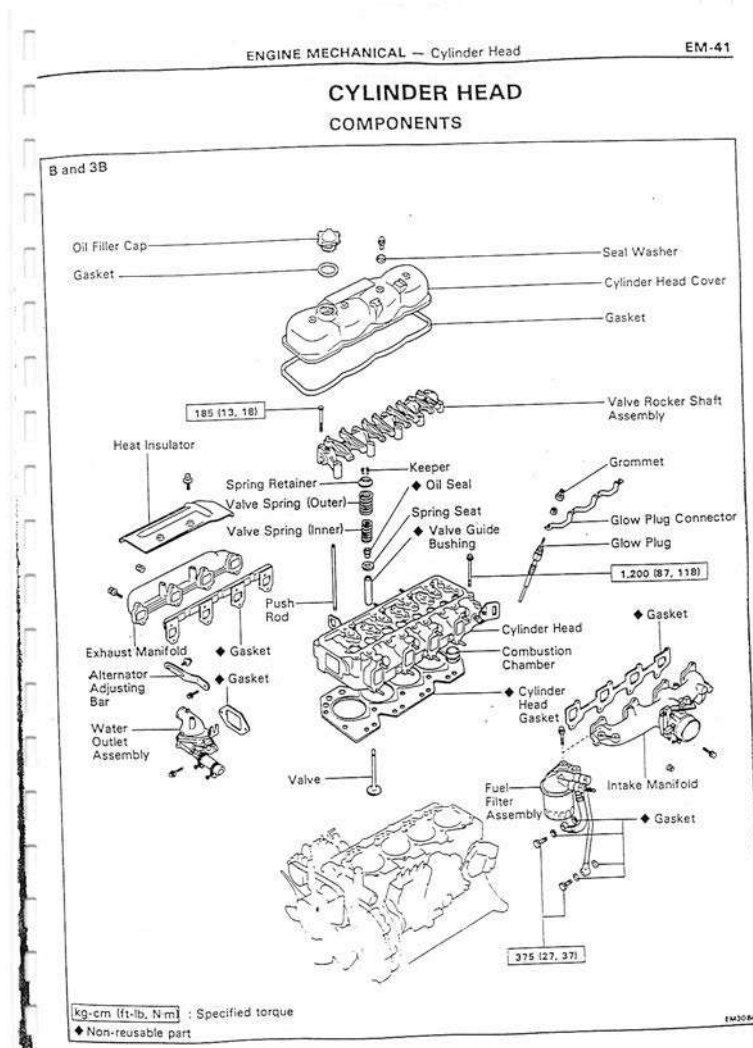
Torque:

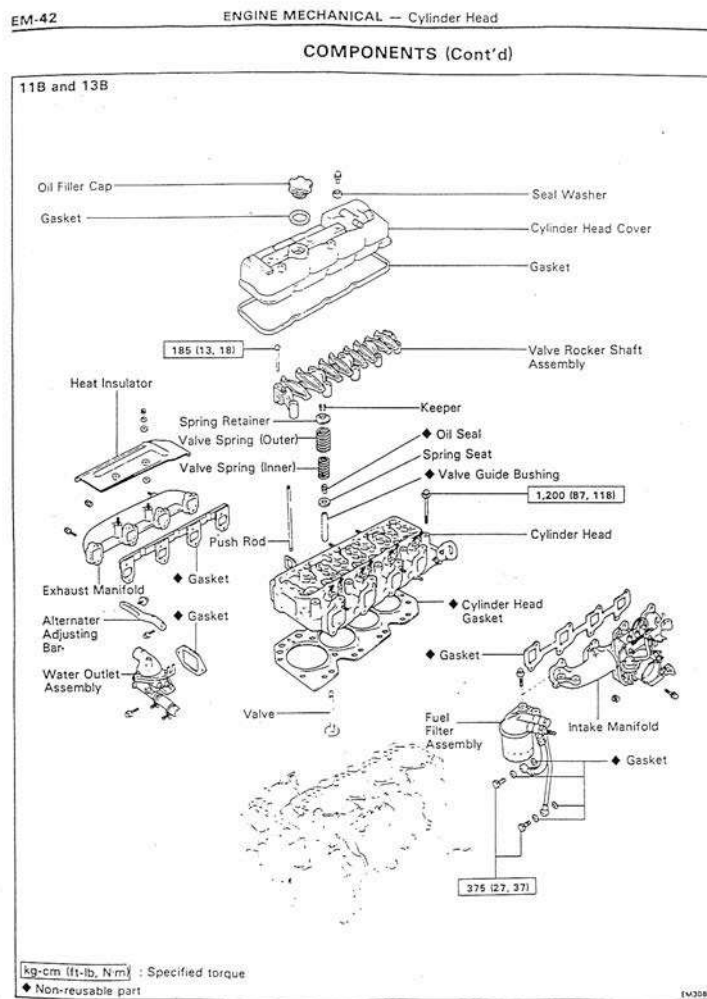
Bolt and nut 185 kg-cm (13 ft-lb, 18 N-m)
Union bolt 130 kg-cm (9 ft-lb, 13 N-m)

9. INSTALL OIL FILTER (See page LU-3)**10. INSTALL TURBOCHARGER HEAT INSULATOR**

Install the heat insulator with the four bolts.

**11. INSTALL POSITIVE CRANKCASE VENTILATION (PCV) HOSE AND INTAKE AIR CONNECTOR PIPE****12. FILL WITH ENGINE COOLANT (See page CO-3)****13. START ENGINE AND CHECK FOR LEAKS****14. CHECK ENGINE OIL LEVEL (See page LU-2)**



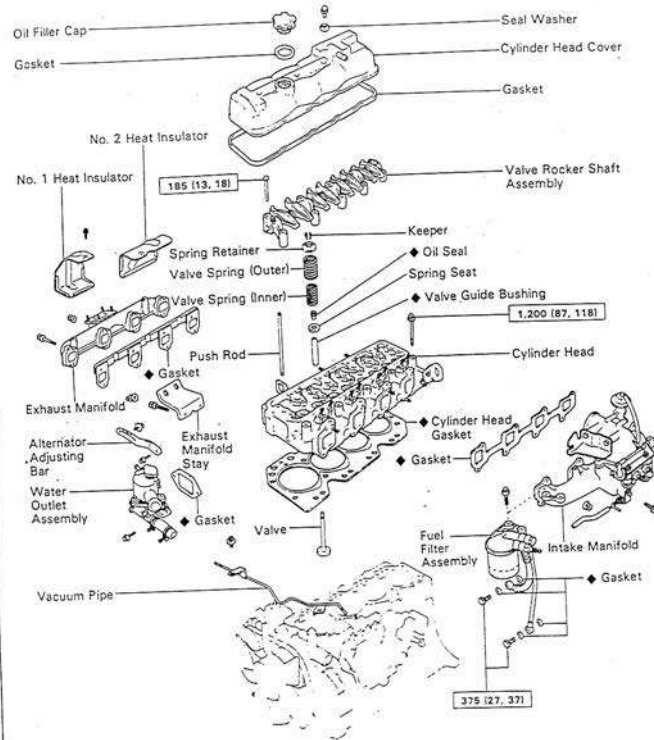


ENGINE MECHANICAL – Cylinder Head

EM-43

COMPONENTS (Cont'd)

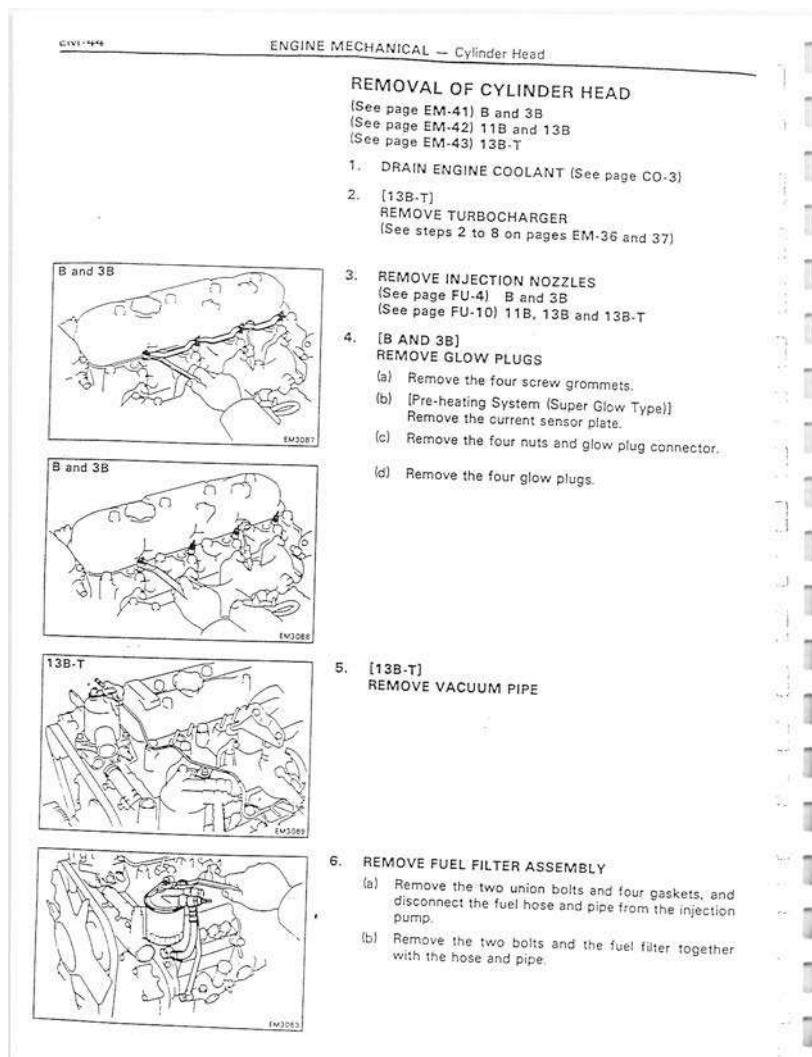
13B-T



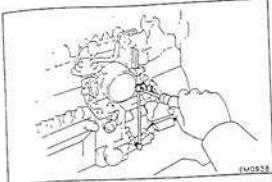
(kg-cm (ft-lb, N-m)) : Specified torque

◆ Non-reusable part

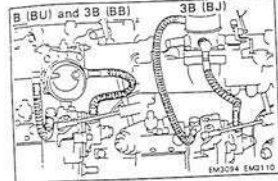
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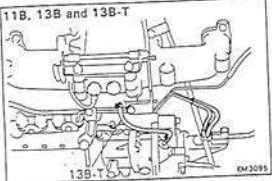
ENGINE MECHANICAL — Cylinder Head EM-45



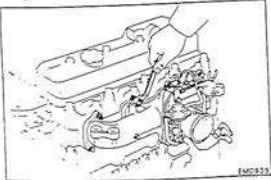
EM0538



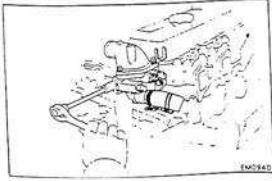
EM0304 EM0110



EM0305



EM0935



EM0940

**7. [11B, 13B AND 13B-T]
REMOVE ACCELERATOR CONNECTING ROD**

8. REMOVE INTAKE MANIFOLD

(a) Remove the vacuum hoses.

(b) Remove the five bolts and three nuts holding the level gauge clamp, No. 2 leakage pipe clamps and intake manifold to the cylinder head.

NOTE: If necessary, remove the union bolt of the No. 2 leakage pipe.

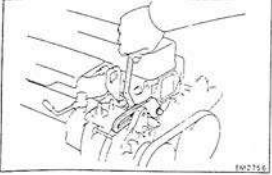
(c) Remove the intake manifold and gasket.

9. REMOVE WATER OUTLET ASSEMBLY

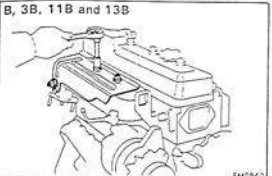
(a) Remove the two bolts holding the water outlet housing to the cylinder head.

(b) Disconnect the water by-pass hose from the water pump, and remove the water outlet assembly and gasket together with the by-pass hose.

EM-46 ENGINE MECHANICAL — Cylinder Head



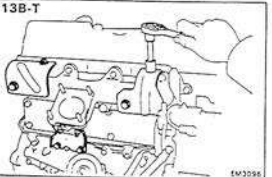
10. REMOVE DRIVE BELT ADJUSTING BAR
Remove the two bolts and adjusting bar.



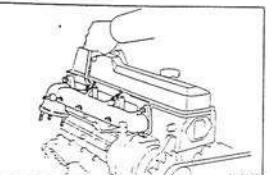
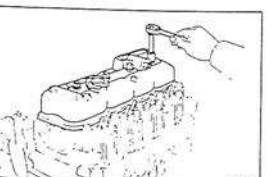
B, 3B, 11B and 13B

11. REMOVE EXHAUST MANIFOLD

- (a) [B, 3B, 11B and 13B (Bolt tightening type)]
Remove the three bolts and heat insulator.
- (b) [11B and 13B (Nut tightening type)]
Remove the three nuts, plate washers, heat insulator and six spacers.
- (c) [13B-T]
Remove the four bolts, No. 1 and No. 2 heat insulators.
- (d) [13B-T]
Remove the two bolts, nuts and exhaust manifold stay.
- (e) Remove the six bolts, two nuts, exhaust manifold and gasket.

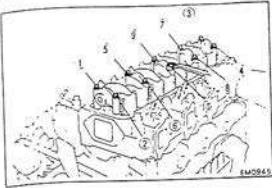
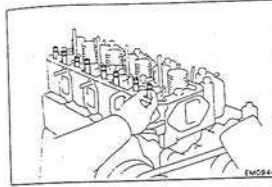
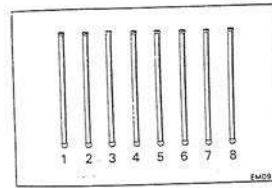
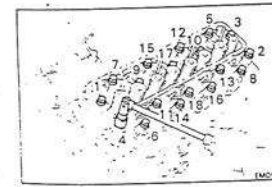
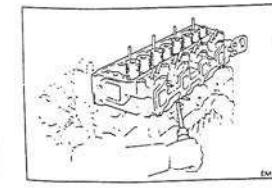


13B-T

12. REMOVE CYLINDER HEAD COVER
Remove the four cap nuts, seal washers, cylinder head cover and gasket.

ENGINE MECHANICAL — Cylinder Head EM-47

13. REMOVE VALVE ROCKER SHAFT ASSEMBLY

- Uniformly loosen and remove the ten bolts in several passes, in the sequence shown.
- Remove the rocker shaft assembly.

14. REMOVE PUSH RODS

Remove the eight push rods in order, beginning from the No. 1 push rod.

NOTE: Arrange the push rods in correct order.

15. REMOVE CYLINDER HEAD

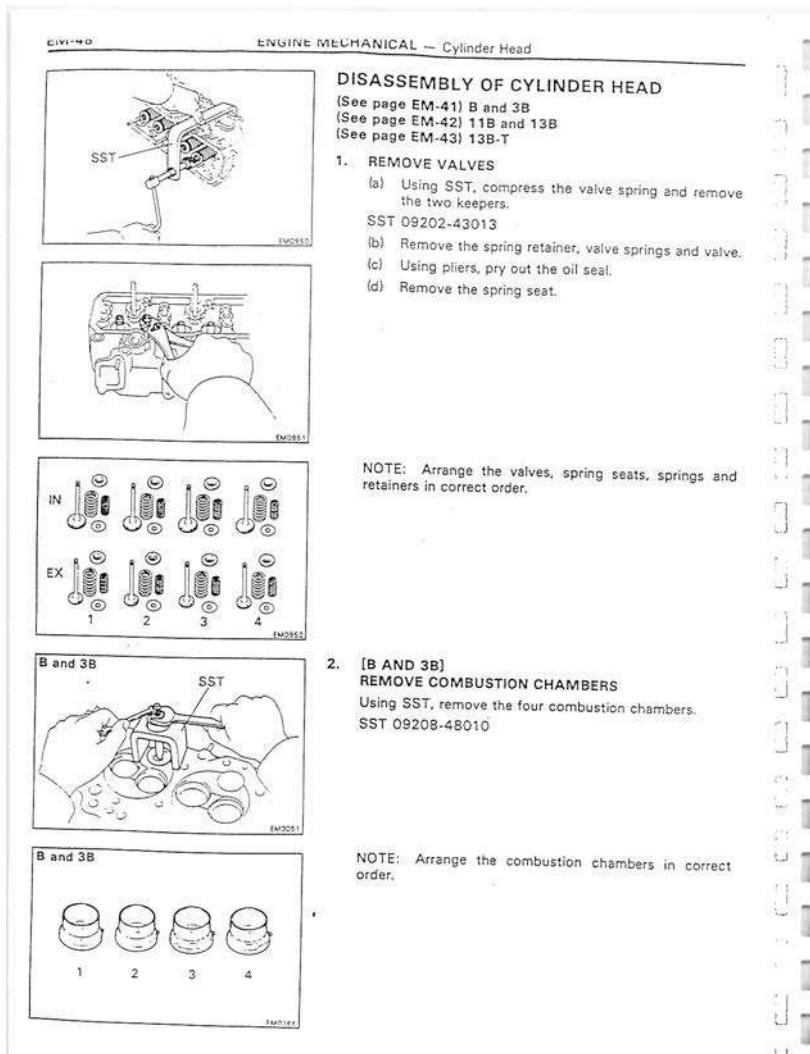
- Uniformly loosen and remove the eighteen head bolts in several passes, in the sequence shown.

CAUTION: Head warpage or cracking could result from removing bolts in incorrect order.

- Lift the cylinder head from the dowels on the cylinder block and place the head on wooden blocks on a bench.

NOTE: If the cylinder head is difficult to lift off, pry with a screwdriver between the cylinder head and block saliences.

CAUTION: Be careful not to damage the cylinder head and block surface on the cylinder and head gasket sides.



ENGINE MECHANICAL — Cylinder Head

EM-49

INSPECTION, CLEANING AND REPAIR OF CYLINDER HEAD COMPONENTS**1. CLEAN TOP OF PISTONS AND TOP OF BLOCK**

- (a) Turn the crankshaft and bring each piston to top dead center. Using a gasket scraper, remove all the carbon from the piston top.
- (b) Remove all the gasket material from the top of the block.
- (c) Blow carbon and oil from the bolt holes.

WARNING: Protect your eyes when using high pressure air.

2. REMOVE GASKET MATERIAL

Using a gasket scraper, remove all the gasket material from the manifold and head surface.

CAUTION: Be careful not to scratch the surfaces.

3. CLEAN COMBUSTION CHAMBERS

Using a wire brush, remove all the carbon from the combustion chambers.

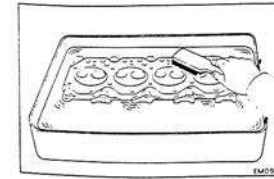
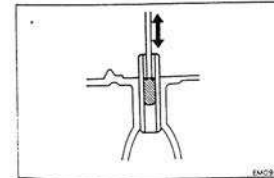
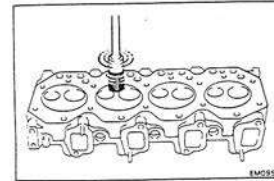
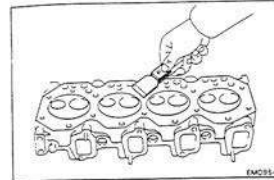
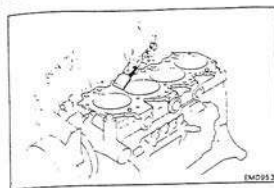
CAUTION: Be careful not to scratch the head gasket contact surface.

4. CLEAN VALVE GUIDE BUSHINGS

Using a valve guide bushing brush and solvent, clean all the guide bushings.

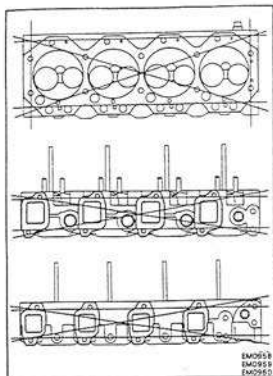
5. CLEAN CYLINDER HEAD

Using a soft brush and solvent, thoroughly clean the head.



EM-50

ENGINE MECHANICAL — Cylinder Head

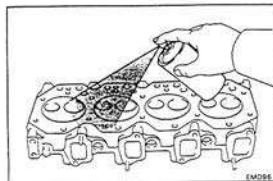
**6. INSPECT CYLINDER HEAD FOR FLATNESS**

Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder block and manifolds for warpage.

Maximum warpage:

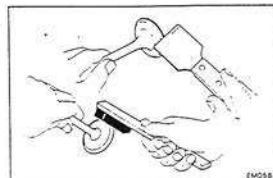
Cylinder block side 0.20 mm (0.0079 in.)
Manifold side 0.20 mm (0.0079 in.)

If warpage is greater than maximum, replace the head.

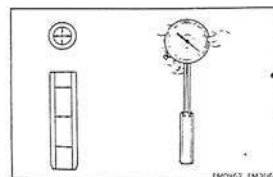
**7. INSPECT CYLINDER HEAD FOR CRACKS**

Using a dye penetrant, check the combustion chamber, intake and exhaust ports, head surface and the top of the head for cracks.

If cracked, replace the head.

**8. CLEAN VALVES**

- (a) Using a gasket scraper, chip any carbon from the valve head.
- (b) Using a wire brush, thoroughly clean the valve.

**9. INSPECT VALVE STEM AND VALVE GUIDE BUSHING**

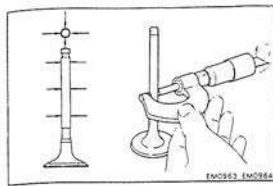
- (a) Using a caliper gauge or telescoping gauge, measure the inside diameter of the valve guide bushing.

Bushing inside diameter:

9.010 – 9.030 mm (0.3547 – 0.3555 in.)

ENGINE MECHANICAL — Cylinder Head

EM-51



(b) Using a micrometer, measure the diameter of the valve stem.

Stem diameter:

Intake	8.968 – 8.984 mm (0.3531 – 0.3537 in.)
Exhaust B, 3B, 11B and 13B	8.954 – 8.970 mm (0.3525 – 0.3531 in.)
13B-T	8.940 – 8.956 mm (0.3520 – 0.3526 in.)

(c) Subtract the valve stem diameter measurement from the valve guide bushing inside diameter measurement.

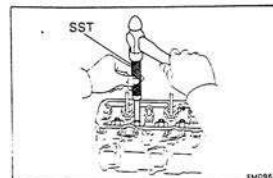
Standard oil clearance:

Intake	0.026 – 0.062 mm (0.0010 – 0.0024 in.)
Exhaust B, 3B, 11B and 13B	0.040 – 0.076 mm (0.0016 – 0.0030 in.)
13B-T	0.054 – 0.090 mm (0.0021 – 0.0035 in.)

Maximum oil clearance:

Intake	0.10 mm (0.0039 in.)
Exhaust B, 3B, 11B and 13B	0.12 mm (0.0047 in.)
13B-T	0.13 mm (0.0051 in.)

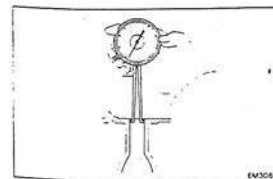
If the clearance is greater than maximum, replace the valve and guide bushing.



10. IF NECESSARY, REPLACE VALVE GUIDE BUSHING

(a) Using SST and a hammer, tap out the valve guide bushing.

SST 09201-60011

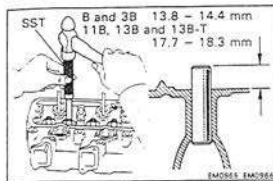


(b) Using a caliper gauge, measure the bushing bore diameter of the cylinder head.

If the bushing bore diameter of cylinder head is more than 14.018 mm (0.5519 in.), replace the cylinder head.

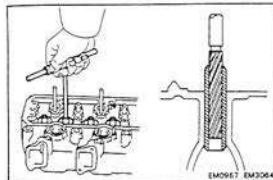
EM-52

ENGINE MECHANICAL — Cylinder Head

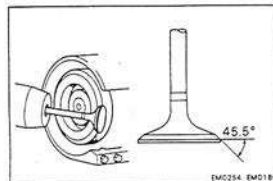


- (c) Using SST and a hammer, drive in a new valve guide bushing to where there is 13.8 - 14.4 mm (0.543 - 0.567 in.) or 17.7 - 18.3 mm (0.697 - 0.720 in.) protruding from the cylinder head.

SST 09201-60011



- (d) Using a sharp 9.0 mm reamer, ream the valve guide bushing to obtain the standard specified clearance (See page EM-59) between the valve guide bushing and new valve stem.



11. INSPECT AND GRIND VALVES

- (a) Grind the valve only enough to remove pits and carbon.
(b) Check that the valve is ground to the correct valve face angle.

Valve face angle: 45.5°

- (c) Check the valve head margin thickness.

Standard margin thickness:

Intake	1.4 mm (0.055 in.)
Exhaust B and 3B	1.8 mm (0.071 in.)
11B	1.3 mm (0.051 in.)
13B and 13B-T	1.7 mm (0.067 in.)

Minimum margin thickness:

Intake	0.9 mm (0.035 in.)
Exhaust B and 3B	1.3 mm (0.051 in.)
11B	0.8 mm (0.031 in.)
13B and 13B-T	1.2 mm (0.047 in.)

If the valve head margin thickness is less than minimum, replace the valve.

- (d) Check the valve overall length.

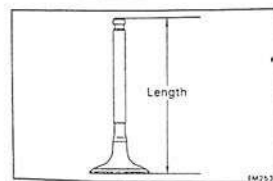
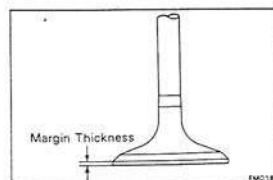
Standard overall length:

Intake	127.95 mm (5.0374 in.)
Exhaust B and 3B	127.75 mm (5.0295 in.)
11B, 13B and 13B-T	127.95 mm (5.0374 in.)

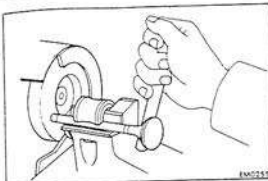
Minimum overall length:

Intake	127.45 mm (5.0177 in.)
Exhaust B and 3B	127.25 mm (5.0098 in.)
11B, 13B and 13B-T	127.45 mm (5.0177 in.)

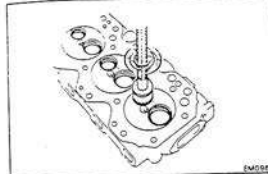
If the valve overall length is less than minimum, replace the valve.



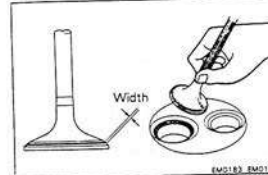
ENGINE MECHANICAL — Cylinder Head EM-53



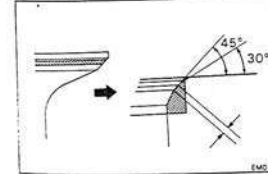
EM0553



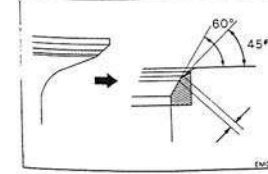
EM0563



EM0583, EM0584



EM0585



EM0586

(e) If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.

CAUTION: Do not grind off more than the minimum amount.

12. INSPECT AND CLEAN VALVE SEATS

(a) Using a 45° carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.

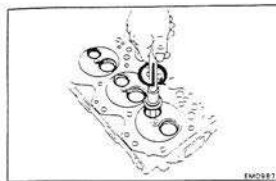
(b) Check the valve seating position.
Apply a thin coat of prussian blue (or white lead) to the valve face. Install the valve. Lightly press the valve against the seat. Do not rotate the valve.

(c) Check the valve face and seat for the following:

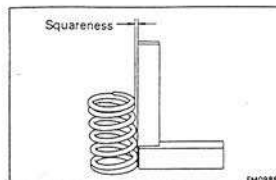
- If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and seat are concentric. If not, resurface the seat.
- Check that the seat contact is on the middle of the valve face with the following width:
1.9 – 2.3 mm (0.075 – 0.091 in.)
If not, correct the valve seat as follows:
 - (1) If the seating is too high on the valve face, use 30° and 45° cutters to correct the seat.
 - (2) If seating is too low on the valve face, use 60° and 45° cutters to correct the seat.

EM-54

ENGINE MECHANICAL — Cylinder Head



- (d) Hand-lap the valve and valve seat with an abrasive compound.
- (e) After hand-lapping, clean the valve and valve seat.

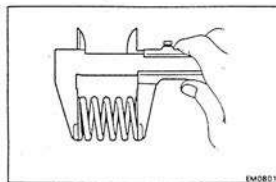


13. INSPECT VALVE SPRINGS

- (a) Using a steel square, check the squareness of the valve spring.

Maximum squareness: 2.0 mm (0.079 in.)

If squareness is greater than maximum, replace the valve spring.



- (b) Using calipers, measure the free length of the valve spring.

Free length:**Inner spring**

B and 3B 45.50 mm (1.7913 in.)

11B, 13B and 13B-T 54.84 mm (2.1591 in.)

Outer spring

B and 3B 47.52 mm (1.8709 in.)

11B, 13B and 13B-T 58.30 mm (2.2953 in.)

If the free length is not as specified, replace the valve spring.

- (c) Using a spring tester, measure the tension of the valve spring at the specified installed length.

Installed tension:**Inner spring**

B and 3B 5.95 kg (13.1 lb, 58 N)

at 36.05 mm (1.4193 in.)

11B, 13B and 13B-T 14.2 kg (31.3 lb, 139 N)

at 42.25 mm (1.6634 in.)

Outer spring

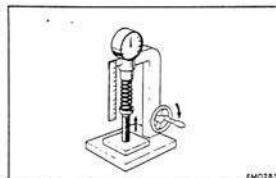
B and 3B 25.53 kg (56.3 lb, 250 N)

at 39.55 mm (1.5571 in.)

11B, 13B and 13B-T 27.8 kg (61.2 lb, 273 N)

at 44.75 mm (1.7618 in.)

If the installed tension is not as specified, replace the valve spring.



ENGINE MECHANICAL — Cylinder Head EM-55

14. INSPECT VALVE ROCKER SHAFT ASSEMBLY

(a) Check the valve stem contacting surface of the rocker arm for wear.
If the valve stem contact surface is worn, disassemble and replace the rocker arm.

(b) Check the clearance between the rocker arms and shaft by moving the rocker arms as shown. Little or no movement should be felt.
If movement is felt, disassemble and check the oil clearance.

(c) Disassemble the rocker shaft assembly.
NOTE: Arrange the rocker arms, spring and rocker supports in correct order.

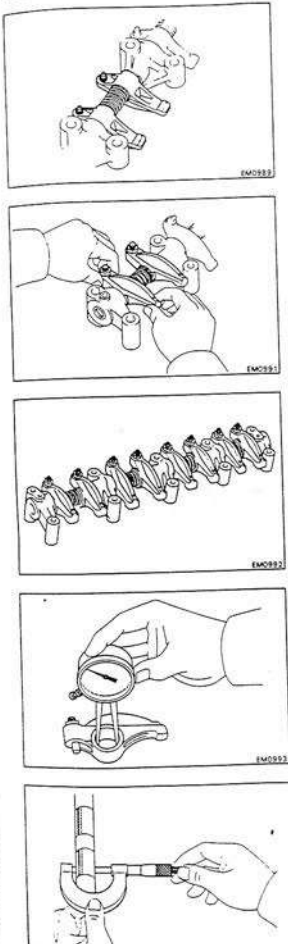
(d) Check the oil clearance between the rocker arm and shaft.

- Using a caliper gauge, measure the inside diameter of the rocker arm.

Rocker arm inside diameter:
18.512 – 18.533 mm (0.7288 – 0.7296 in.)

- Using a micrometer, measure the diameter of the rocker shaft.

Rocker shaft diameter:
18.472 – 18.493 mm (0.7272 – 0.7281 in.)



EM-56

ENGINE MECHANICAL — Cylinder Head

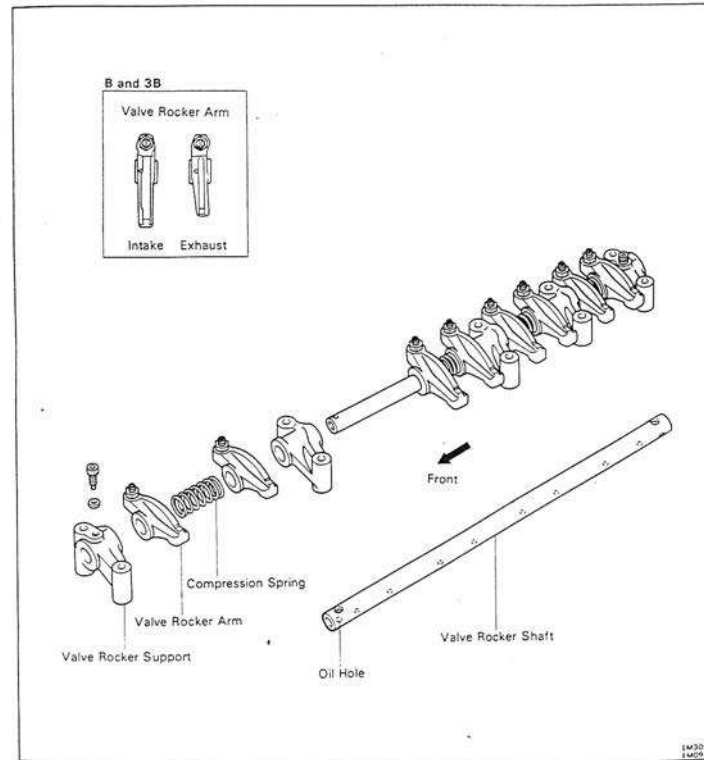
- Subtract the rocker shaft diameter measurement from the inside diameter measurement of the rocker arm.

Standard oil clearance: 0.019 – 0.061 mm
(0.0007 – 0.0024 in.)

Maximum oil clearance: 0.10 mm (0.0039 in.)

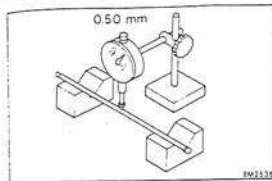
If the clearance is greater than maximum, replace the rocker arm and shaft.

(e) Assemble the valve rocker shaft assembly as shown.



ENGINE MECHANICAL — Cylinder Head

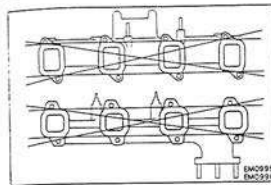
EM-57

**15. INSPECT PUSH RODS**

- Place the push rod on V-blocks.
- Using a dial indicator, measure the circle runout at the center of the push rod.

Maximum circle runout: 0.50 mm (0.0197 in.)

If the circle runout is greater than maximum, replace the push rod.

**16. INSPECT INTAKE AND EXHAUST MANIFOLDS**

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head for warpage.

Maximum warpage: 0.20 mm (0.0079 in.)

If warpage is greater than maximum, replace the manifold.

ASSEMBLY OF CYLINDER HEAD

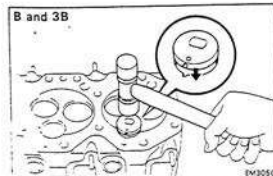
(See page EM-41) B and 3B

(See page EM-42) 11B and 13B

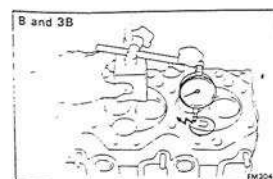
(See page EM-43) 13B-T

NOTE:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new ones.

**1. [B AND 3B]****INSTALL COMBUSTION CHAMBERS**

- Align the combustion chamber knock pin with the cylinder head notch.
- Using a plastic-faced hammer, tap in the combustion chamber.

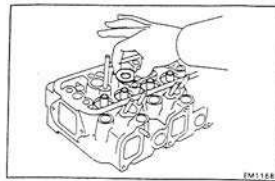


- Using a dial indicator, check the combustion chamber protrusion.

Combustion chamber protrusion:
Minus 0.05 – Plus 0.05 mm
(Minus 0.0020 – Plus 0.0020 in.)

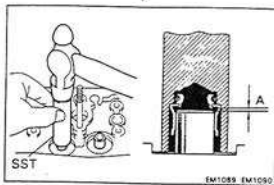
EM-58

ENGINE MECHANICAL — Cylinder Head



2. INSTALL VALVES

- (a) Place the spring seat on the cylinder head.



- (b) Apply engine oil to a new oil seal lip.

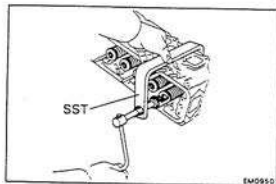
- (c) Using SST and a hammer, tap in a new oil seal.

SST B and 3B 09201-56010

11B, 13B, 13B-T 09201-58010

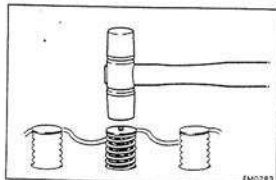
NOTE: There should be clearance A in the figure.

- (d) Install the valve, valve springs and spring retainer.



- (e) Using SST, compress the valve springs and place the two keepers around the valve stem.

SST 09202-43013



- (f) Using a plastic-faced hammer, lightly tap the stem to assure proper fit.

ENGINE MECHANICAL — Cylinder Head EM-59

INSTALLATION OF CYLINDER HEAD

(See page EM-41) B and 3B
(See page EM-42) 11B and 13B
(See page EM-43) 13B-T

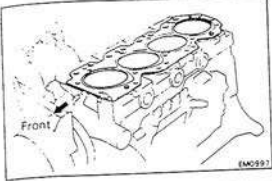
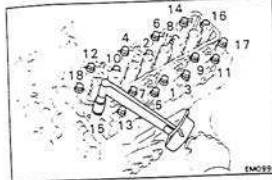
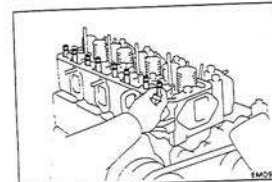
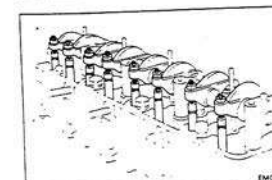
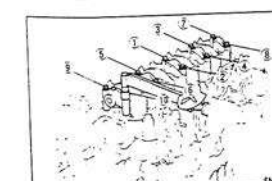
1. **INSTALL CYLINDER HEAD**
 - (a) Place a new cylinder head gasket on the cylinder block.

CAUTION: Be careful of the installation direction.

 - (b) Place the cylinder head on the cylinder head gasket.
 - (c) Apply a light coat of engine oil on the threads and under the cylinder head bolts.
 - (d) Install and uniformly tighten the eighteen cylinder head bolts in several passes, in the sequence shown.

Torque: 1,200 kg-cm (87 ft-lb, 118 N-m)
2. **INSTALL PUSH RODS**
Install the eight push rods.
3. **INSTALL VALVE ROCKER SHAFT ASSEMBLY**
 - (a) Place the rocker shaft assembly on the cylinder head.
 - (b) Align the rocker arm adjusting screws with the heads of the push rods.
 - (c) Install and uniformly tighten the fourteen bolts in several passes, in the sequence shown.

Torque: 185 kg-cm (13 ft-lb, 18 N-m)

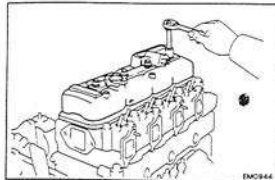
EM-60

ENGINE MECHANICAL — Cylinder Head

4. ADJUST VALVE CLEARANCES
(See steps 4 and 5 on page EM-22)

Valve clearance (Cold):

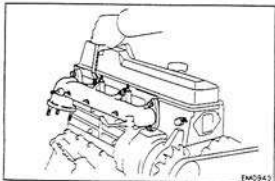
Intake	0.25 mm (0.010 in.)
Exhaust	0.40 mm (0.016 in.)



5. INSTALL CYLINDER HEAD COVER

- (a) Install a new gasket to the cylinder head cover.
- (b) Install the cylinder head cover with the four seal washers and cap nuts.

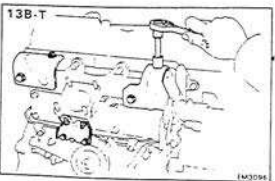
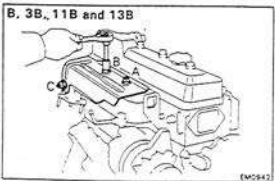
Torque: 125 kg-cm (9 ft-lb, 12 N·m)



6. INSTALL EXHAUST MANIFOLD

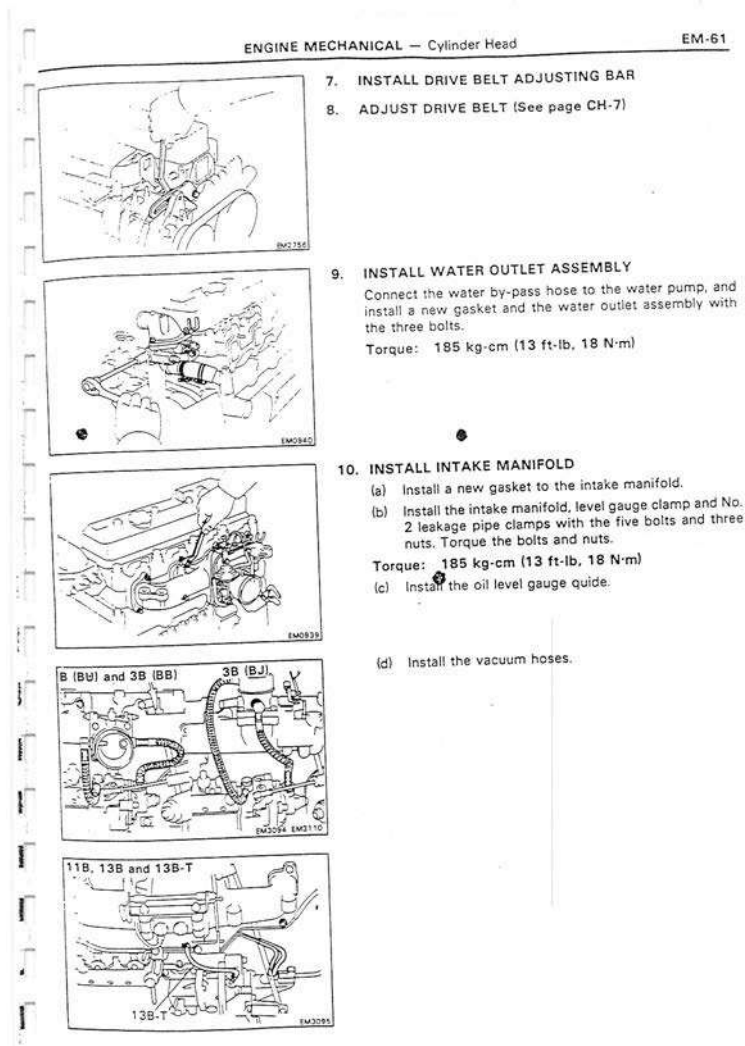
- (a) Install a new gasket, the exhaust manifold and No. 2 heat insulator (BU) with the six bolts and two nuts. Torque the bolts and nuts.

Torque: 475 kg-cm (34 ft-lb, 47 N·m)



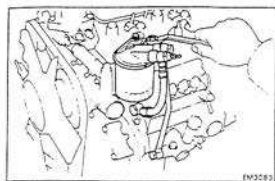
- (b) [11B and 13B (Nut tightening type)]
Place the three spacers, heat insulator, three spacers and three plate washers on the exhaust manifold.
- (c) [B, 3B, 11B and 13B (Bolt tightening type)]
Place the heat insulator on the exhaust manifold.
- (d) [B, 3B, 11B and 13B]
Install and tighten the three nuts or bolts with the following order.
First, temporarily tighten nuts or bolts A and B. Then fully tighten nuts or bolts C, A and B.
- (e) [13B-T]
Install the exhaust manifold stay with the two bolts and nuts.
- (f) [13B-T]
Install the No. 1 and No. 2 heat insulators with the four bolts.

Torque: 185 kg-cm (13 ft-lbs, 18 N·m)



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ENGINE MECHANICAL — Cylinder Head



**11. [11B, 13B AND 13B-T]
INSTALL ACCELERATOR CONNECTING ROD**

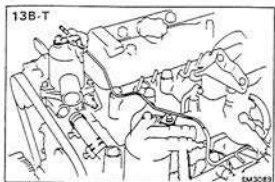
12. INSTALL FUEL FILTER ASSEMBLY

- (a) Install the fuel filter assembly with the two bolts.

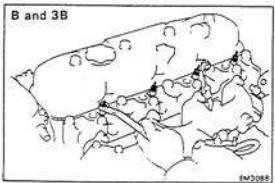
Torque: 375 kg-cm (27 ft-lb, 37 N·m)

- (b) Connect the fuel pipe and hose to the injection pump with new four gaskets and the two union bolts. Torque the union bolts.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)



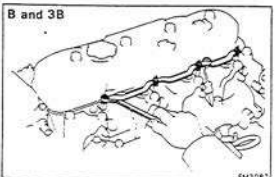
**13. [13B-T]
INSTALL VACUUM PIPE**



**14. [B AND 3B]
INSTALL GLOW PLUGS**

- (a) Install the four glow plugs.

Torque: 125 kg-cm (9 ft-lb, 12 N·m)



- (b) Install the glow plug connector with the four nuts.
(c) [Pre-heating System (Supper Glow Type)]
Install the current sensor plate.
(d) Install the four screw grommets.

15. INSTALL INJECTION NOZZLES
(See page FU-9) B and 3B
(See page FU-15) 11B, 13B and 13B-T

**16. [13B-T]
INSTALL TURBOCHARGER**
(See steps 5 to 11 on pages EM-39 and 40)

17. FILL WITH ENGINE COOLANT (See page CO-3)

18. START ENGINE AND CHECK FOR LEAKS

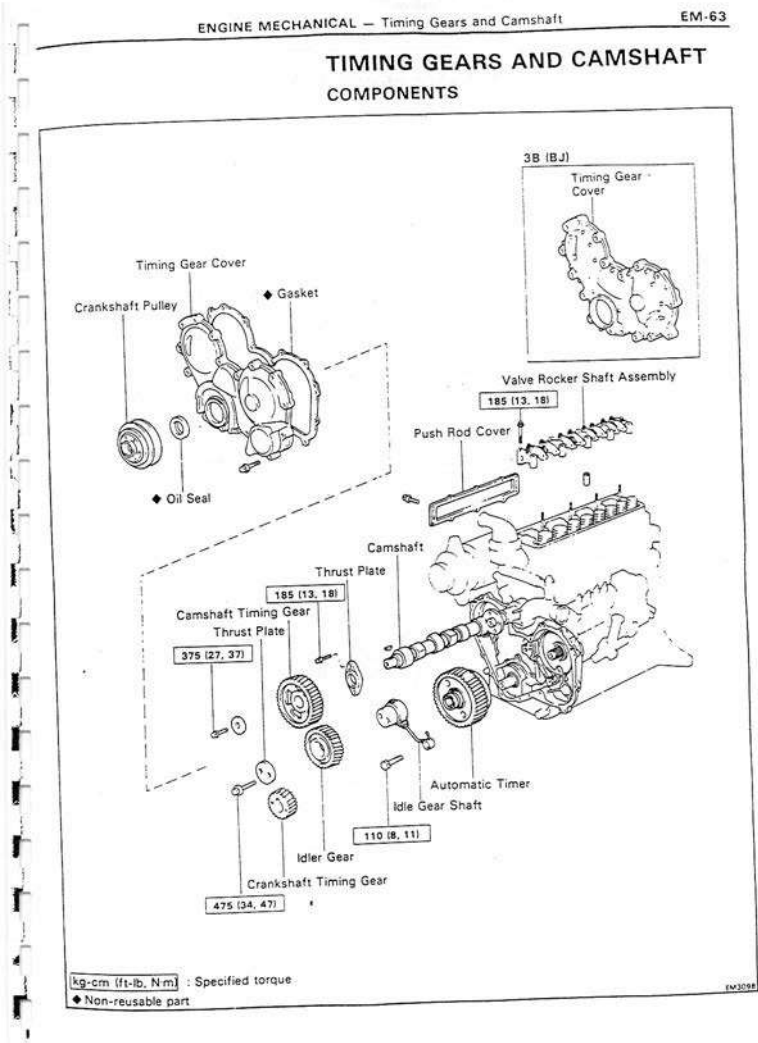
19. CHECK ENGINE OIL LEVEL (See page LU-3)

20. READJUST VALVE CLEARANCES (See page EM-22)

Valve clearance (Hot):

Intake 0.20 mm (0.008 in.)

Exhaust 0.36 mm (0.014 in.)



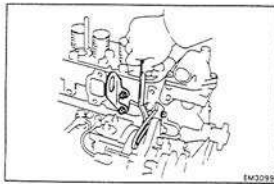
EM-64

ENGINE MECHANICAL — Timing Gears and Camshaft

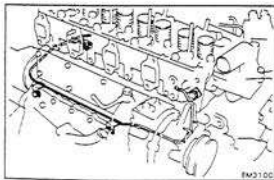
REMOVAL OF TIMING GEARS AND CAMSHAFT

(See page EM-63)

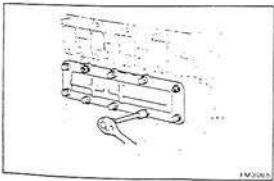
1. SET NO. 1 CYLINDER TO TDC/COMPRESSION
(See page EM-22)
2. REMOVE DRIVE BELT
3. REMOVE FAN AND WATER PUMP PULLEY
(See page CO-5)
4. [13B-T]
REMOVE TURBOCHARGER
(See steps 2 to 8 on page EM-36 and 37)
5. REMOVE VALVE ROCKER SHAFT ASSEMBLY
(See steps 12 to 14 on pages EM-46 and 47)
6. REMOVE EXHAUST MANIFOLD (See page EM-46)



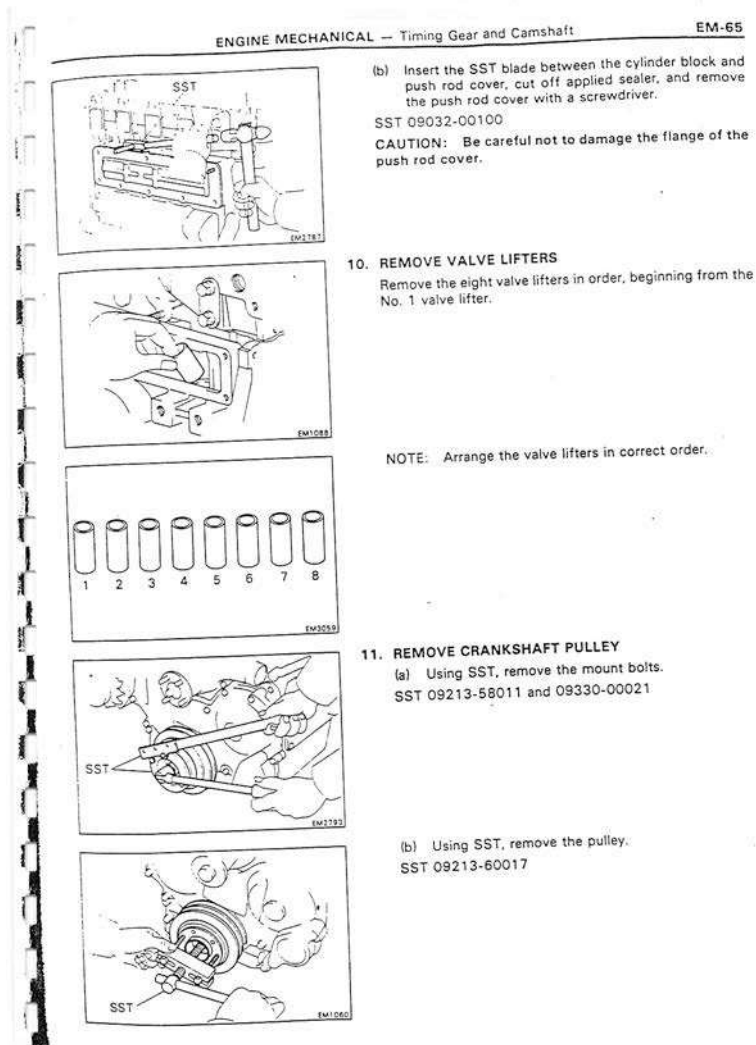
7. REMOVE NO. 1 ENGINE HANGER AND DRIVE BELT ADJUSTING BAR



8. [11B, 13B AND 13B-T]
REMOVE VACUUM PIPE

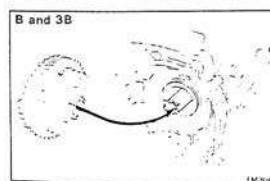
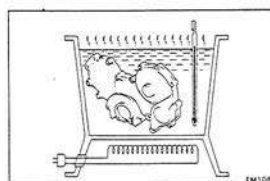
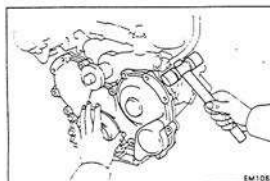
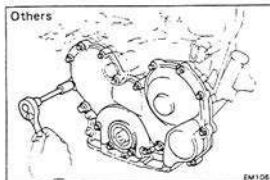
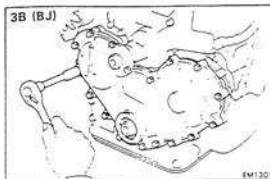


9. REMOVE PUSH ROD COVER
(a) Remove the eight bolts and two nuts.



EM-66

ENGINE MECHANICAL — Timing Gears and Camshaft

**12. REMOVE TIMING GEAR COVER**

- (a) Remove the seventeen mount bolts.

- (b) Using a plastic-faced hammer, lightly tap out the gear cover.
- (c) Remove the cover gasket.

13. REMOVE AUTOMATIC TIMER FROM TIMING GEAR COVER

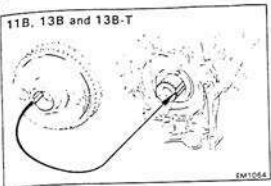
Heat the timing gear cover with the automatic timer to about 60°C (140°F) and remove the timer.

NOTE: For disassembly and assembly of the automatic timer, refer to the FUEL SYSTEM section. (See page FU-21)

14. CHECK TIMING GEAR BACKLASH

- (a) [B and 3B]
Align the marks of the automatic timer hub and injection pump spline, and install the timer.

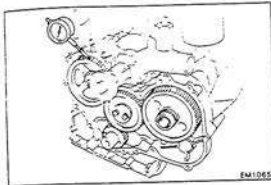
ENGINE MECHANICAL — Timing Gears and Camshaft **EM-67**



11B, 13B and 13B-T

EM1064

(b) [11B, 13B and 13B-T]
Align the spline toothless portions of the automatic timer hub and injection pump, and install the timer.



EM1065

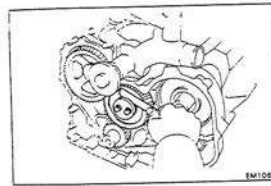
(c) Using a dial indicator, measure the backlash between each gear.

Standard backlash: 0.058 – 0.162 mm
(0.0023 – 0.0064 in.)

Maximum backlash: 0.30 mm (0.0118 in.)

If the backlash is greater than maximum, replace the gears as a set.

(d) Remove the automatic timer.



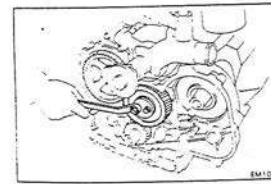
EM1066

15. CHECK IDLE GEAR THRUST CLEARANCE
Using a feeler gauge, measure the idle gear thrust clearance.

Standard thrust clearance: 0.06 – 0.17 mm
(0.0024 – 0.0067 in.)

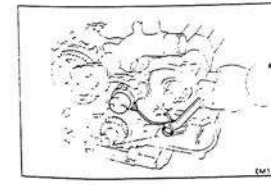
Maximum thrust clearance: 0.30 mm (0.0118 in.)

If the thrust clearance is greater than maximum, replace the thrust plate.



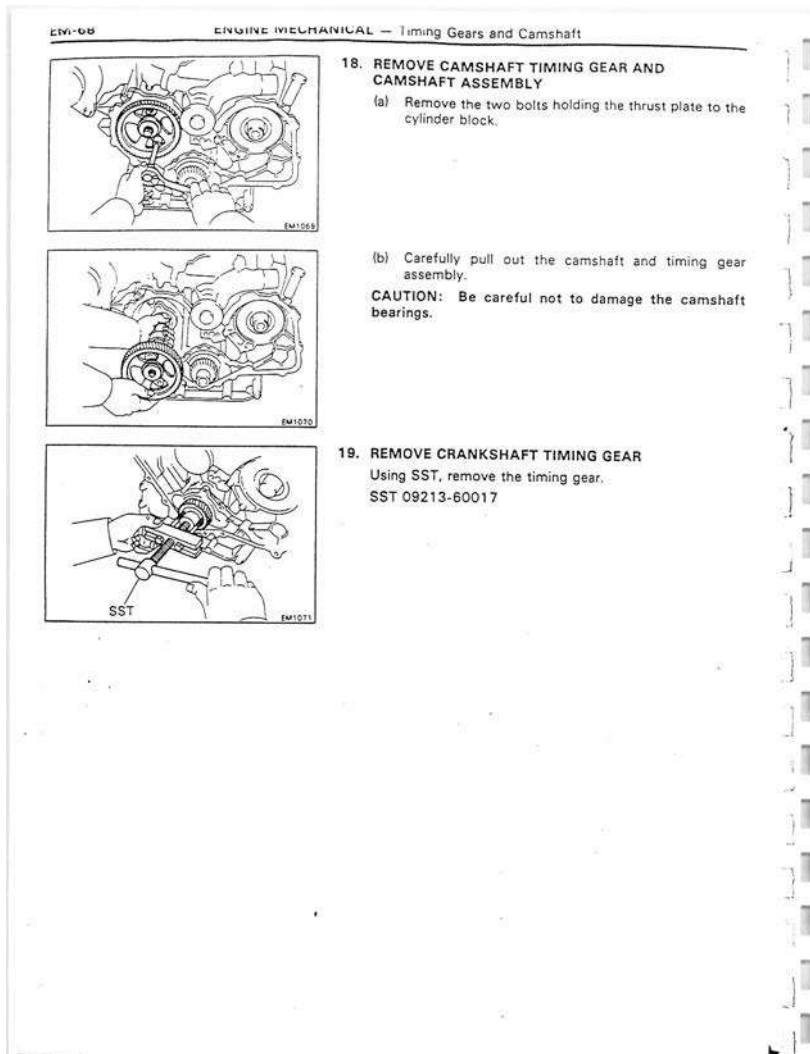
EM1067

16. REMOVE IDLE GEAR
Remove the two bolts, thrust plate and idle gear.



EM1068

17. REMOVE IDLE GEAR SHAFT
Remove the union bolt and idle gear shaft.



ENGINE MECHANICAL — Timing Gears and Camshaft EM-69

INSPECTION OF TIMING GEARS AND CAMSHAFT

1. INSPECT CAMSHAFT

(a) Place the camshaft on V-blocks and, using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.06 mm (0.0024 in.)

If the circle runout is greater than maximum, replace the camshaft.

(b) Using a micrometer, measure the cam lobe height.

Standard cam lobe height:

Intake	B and 3B	45.067 – 45.157 mm (1.7743 – 1.7778 in.)
	11B and 13B	44.705 – 44.795 mm (1.7600 – 1.7636 in.)
	13B-T	44.909 – 44.999 mm (1.7681 – 1.7716 in.)
Exhaust	B and 3B	45.065 – 45.155 mm (1.7742 – 1.7778 in.)
	11B, 13B and 13B-T	44.774 – 44.864 mm (1.7628 – 1.7663 in.)

Minimum cam lobe height:

Intake	B and 3B	44.63 mm (1.7571 in.)
	11B and 13B	44.27 mm (1.7429 in.)
	13B-T	44.47 mm (1.7508 in.)
Exhaust	B and 3B	44.63 mm (1.7571 in.)
	11B, 13B and 13B-T	44.34 mm (1.7457 in.)

If the lobe height is less than minimum, replace the camshaft.

(c) Using a micrometer, measure the journal diameter.

Journal diameter (from front side):

No. 1	53.459 – 53.475 mm (2.1047 – 2.1053 in.)
No. 2	53.209 – 53.225 mm (2.0948 – 2.0955 in.)
No. 3	52.959 – 52.975 mm (2.0850 – 2.0856 in.)
No. 4	52.709 – 52.725 mm (2.0752 – 2.0758 in.)
No. 5	52.459 – 52.475 mm (2.0653 – 2.0659 in.)

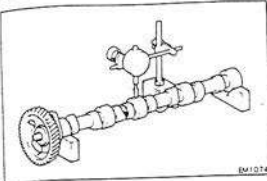
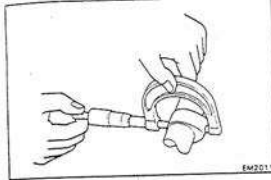
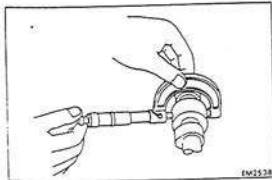
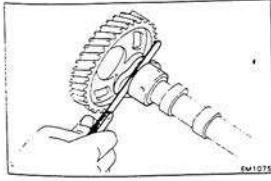
If the journal diameter is not within specification, check the oil clearance. (See page EM-97)

(d) Using a feeler gauge, measure the thrust clearance between the camshaft and thrust plate.

Standard clearance: 0.06 – 0.13 mm
(0.0024 – 0.0051 in.)

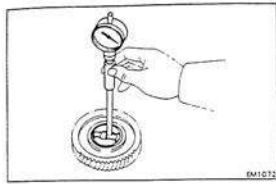
Maximum clearance: 0.30 mm (0.0118 in.)

If the thrust clearance is greater than maximum, replace the thrust plate. If necessary, replace the camshaft. (See page EM-71)

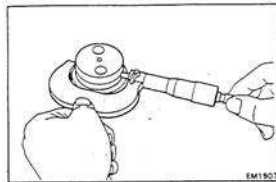
EM-70

ENGINE MECHANICAL — Timing Gears and Camshaft

**2. INSPECT IDLE GEARS**

- (a) Using a cylinder gauge, measure the inside diameter of the idle gear.

Idle gear inside diameter: 44.969 – 44.995 mm
(1.7704 – 1.7715 in.)



- (b) Using a micrometer, measure the diameter of the idle gear shaft.

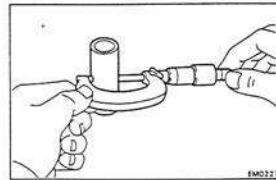
Idle gear shaft diameter: 44.935 – 44.955 mm
(1.7691 – 1.7699 in.)

- (c) Subtract the idle gear shaft diameter measurement from the idle gear inside diameter measurement.

Standard oil clearance: 0.014 – 0.060 mm
(0.0006 – 0.0024 in.)

Maximum oil clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than maximum, replace the gear and shaft.

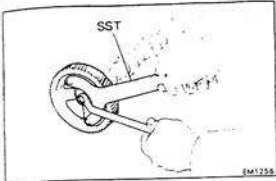
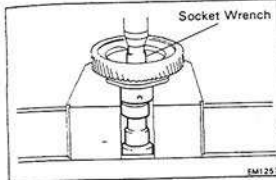
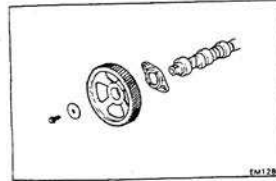
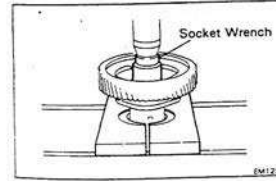
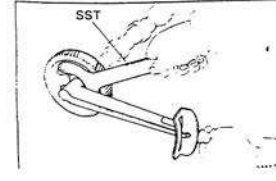
**3. INSPECT VALVE LIFTERS**

- Using a micrometer, measure the valve lifter diameter.

Lifter diameter: 26.972 – 26.985 mm
(1.0619 – 1.0624 in.)

If the diameter is not within specification, check the oil clearance. (See page EM-98)

ENGINE MECHANICAL — Timing Gears and Camshaft
EM-71

REPLACEMENT OF CAMSHAFT (OR CAMSHAFT TIMING GEAR)

1. REMOVE CAMSHAFT
 - (a) Using SST, remove the bolt and plate washer.
SST 09278-54012
 - (b) Using a 19 mm socket wrench and press, press out the camshaft.
2. INSTALL NEW CAMSHAFT
 - (a) Install the timing gear set key to the camshaft.
 - (b) Assemble the camshaft, thrust plate and timing gear as shown.
 - (c) Using a 29 mm socket wrench and press, align the timing gear set key with the key groove of the timing gear, and press in the camshaft timing gear.
 - (d) Using SST, install the plate washer and bolt. Torque the bolt.
SST 09278-54012
Torque: 375 kg-cm (27 ft-lb, 37 N·m)
3. CHECK CAMSHAFT THRUST CLEARANCE
(See page EM-69)

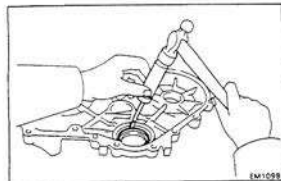
Standard thrust clearance:	0.06 – 0.13 mm (0.0024 – 0.0051 in.)
Maximum thrust clearance:	0.30 mm (0.0118 in.)

EM-72

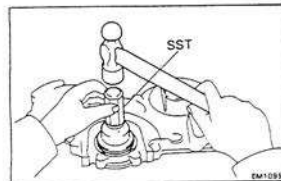
ENGINE MECHANICAL — Timing Gears and Camshaft

REPLACEMENT OF CRANKSHAFT FRONT OIL SEAL**REPLACE CRANKSHAFT FRONT OIL SEAL**

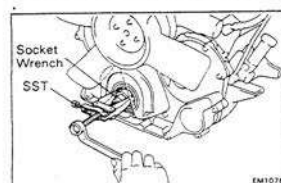
NOTE: There are two methods (A and B) to replace the oil seal as follows.



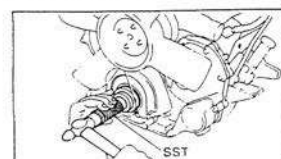
- A. If timing gear cover is removed from cylinder block:**
 (a) Using a screwdriver and hammer, tap out the oil seal.



- (b) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.
 SST 09223-46011
 (c) Apply MP grease to the oil seal lip.



- B. If timing gear cover is installed to cylinder block:**
 (a) Using SST and a socket wrench, remove the oil seal.
 SST 09308-10010



- (b) Apply MP grease to a new oil seal lip.
 (c) Using SST and a hammer, tap in the oil seal until its surface is flush with the timing gear cover edge.
 SST 09223-46011

ENGINE MECHANICAL — Timing Gears and Camshaft EM-73

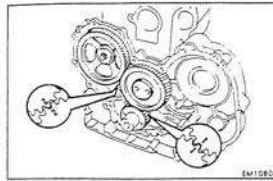
INSTALLATION OF TIMING GEARS AND CAMSHAFT

(See page EM-63)

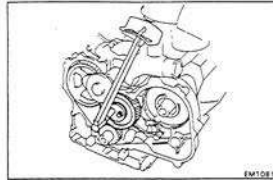
1. **INSTALL CRANKSHAFT TIMING GEAR**
 - (a) Check the set key on crankshaft facing upward.
If not, then turn the crankshaft with a crankshaft pulley mount bolt.
 - (b) Put the timing gear on the crankshaft with the "1" timing mark of the timing gear facing forward.
 - (c) Align the timing gear set key with the key groove of the timing gear.
 - (d) Using SST and a hammer, tap in the timing gear.
SST 09608-35014 (09608-06040)
2. **INSTALL CAMSHAFT TIMING GEAR AND CAMSHAFT ASSEMBLY**
 - (a) Insert the camshaft into the cylinder block.
CAUTION: Be careful not to damage the camshaft bearings.
 - (b) Install and torque the two bolts.
Torque: 185 kg-cm (13 ft-lb, 18 N·m)
3. **INSTALL IDLE GEAR SHAFT**
Temporarily install the idle gear with the union bolt.
CAUTION: Do not tighten the union bolt.

EM-74

ENGINE MECHANICAL — Timing Gears and Camshaft

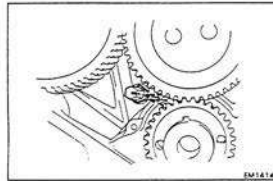
**4. INSTALL IDLE GEAR**

- (a) Align the idle gear timing marks "1" and "2" with the crankshaft gear timing mark "1" and camshaft gear timing mark "2" respectively, and mesh the gears.

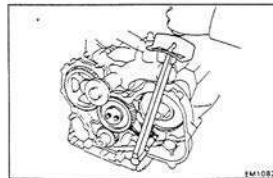


- (b) Apply a light coat of engine oil on the threads and under the bolt heads.
 (c) Install the thrust plate with the two bolts. Torque the bolts.

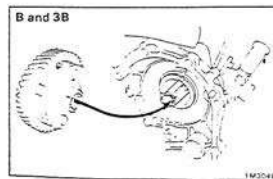
Torque: 475 kg-cm (34 ft-lb, 47 N-m)



- (d) Check that the oil nozzle is in the position shown.

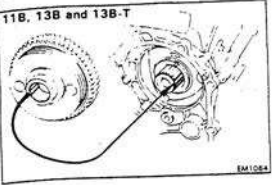
**5. TORQUE IDLE GEAR SHAFT UNION BOLT**

Torque: 110 kg-cm (8 ft-lb, 11 N-m)

**6. INSTALL AUTOMATIC TIMER**

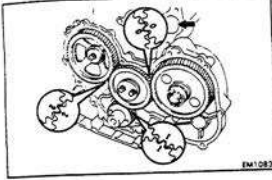
- (a) Apply MP grease to the timer hub spline, bearing and injection pump spline.
 (b) [B and 3B]
 Align the marks of the automatic timer hub and injection pump spline, and install the timer.

ENGINE MECHANICAL — Timing Gears and Camshaft **EM-75**

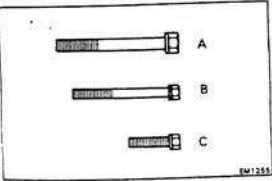


11B, 13B and 13B-T

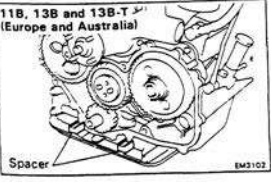
EM1084



EM1083



EM1255



11B, 13B and 13B-T
(Europe and Australia)

Spacer

EM3102

(c) [11B, 13B and 13B-T]
Align the spline toothless portions of the automatic timer hub and injection pump, and install the timer.

(d) Align the idle gear timing mark O with the timer drive gear timing mark O, and mesh the gears.

7. CHECK TIMING GEAR BACKLASH
(See page EM-67)
Standard backlash: 0.058 – 0.162 mm
(0.0023 – 0.0064 in.)
Maximum backlash: 0.30 mm (0.0118 in.)

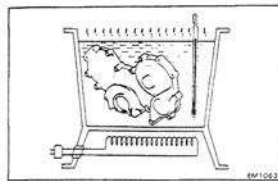
8. CHECK IDLE GEAR THRUST CLEARANCE
(See page EM-67)
Standard thrust clearance: 0.06 – 0.17 mm
(0.0024 – 0.0067 in.)
Maximum thrust clearance: 0.30 mm (0.0118 in.)

9. INSTALL TIMING GEAR COVER
NOTE: Use the bolts indicated by A, B and C.

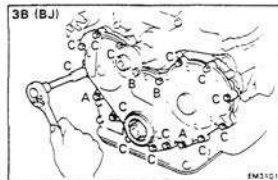
(a) [11B, 13B and 13B-T (Europe and Australia)]
Place the spacer in position on the timing gear case. Apply adhesive to the contacting surfaces of the timing gear case or cover.

EM-76

ENGINE MECHANICAL — Timing Gears and Camshaft

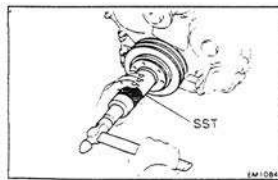
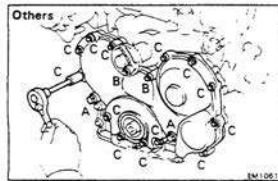


- (a) Gradually heat the timing gear cover to about 60°C (140°F).



- (b) Install a new gasket and the warmed gear cover with seventeen bolts.

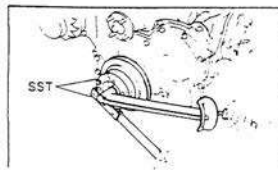
Torque: A 375 kg-cm (27 ft-lb, 37 N-m)
B and C 185 kg-cm (13 ft-lb, 18 N-m)



10. INSTALL CRANKSHAFT PULLEY

- (a) Align the pulley set key with the key groove of the pulley.

- (b) Using SST and a hammer, tap in the pulley.
SST 09608-35014 (09608-06040)

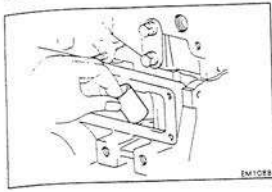


- (c) Apply a light coat of engine oil on the threads and under the bolt head.

- (d) Using SST, install and torque the pulley mount bolt.
SST 09213-58011 and 09330-00021

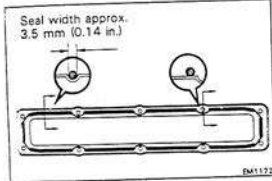
Torque: 2,450 kg-cm (177 ft-lb, 240 N-m)

ENGINE MECHANICAL — Timing Gears and Camshaft EM-77

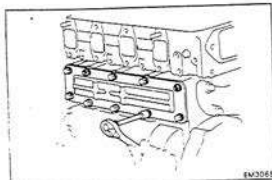


EM1088

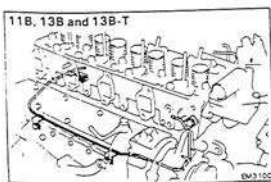
11. INSTALL VALVE LIFTERS
Carefully insert the eight lifters into the lifter bores.



EM1122



EM3065



EM3100

12. INSTALL PUSH ROD COVER

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the push rod cover and cylinder block.

- Using a razor blade and gasket scraper, remove all the residual packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Clean both sealing surfaces with a non-residue solvent.

CAUTION: Do not use a solvent which will affect the painted surfaces.

(b) Apply seal packing to the push rod cover as shown in the figure.

Seal packing: Part No. 08826-00080 or equivalent

- Install a nozzle that has been cut to a 3 mm (0.12 in.) opening.

NOTE: Avoid applying an excess amount to the surface.

- Parts must be assembled within 3 minutes of application. Otherwise, the material must be removed and reapplied.
- Immediately remove nozzle from tube and reinstall cap.

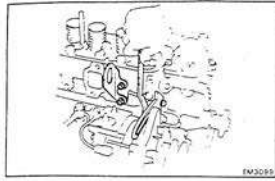
(c) Install the push rod cover with the eight bolts and two nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N-m)

**13. [11B, 13B AND 13B-T]
INSTALL VACUUM PIPE**

EM-78

ENGINE MECHANICAL — Timing Gears and Camshaft



14. INSTALL NO. 1 ENGINE HANGER AND DRIVE BELT ADJUSTING BAR

15. INSTALL EXHAUST MANIFOLD (See page EM-60)

16. INSTALL VALVE ROCKER SHAFT ASSEMBLY
(See steps 2 to 5 on pages EM-59 and 60)

17. (13B-T)
INSTALL TURBOCHARGER
(See steps 5 to 11 on pages EM-39 and 40)

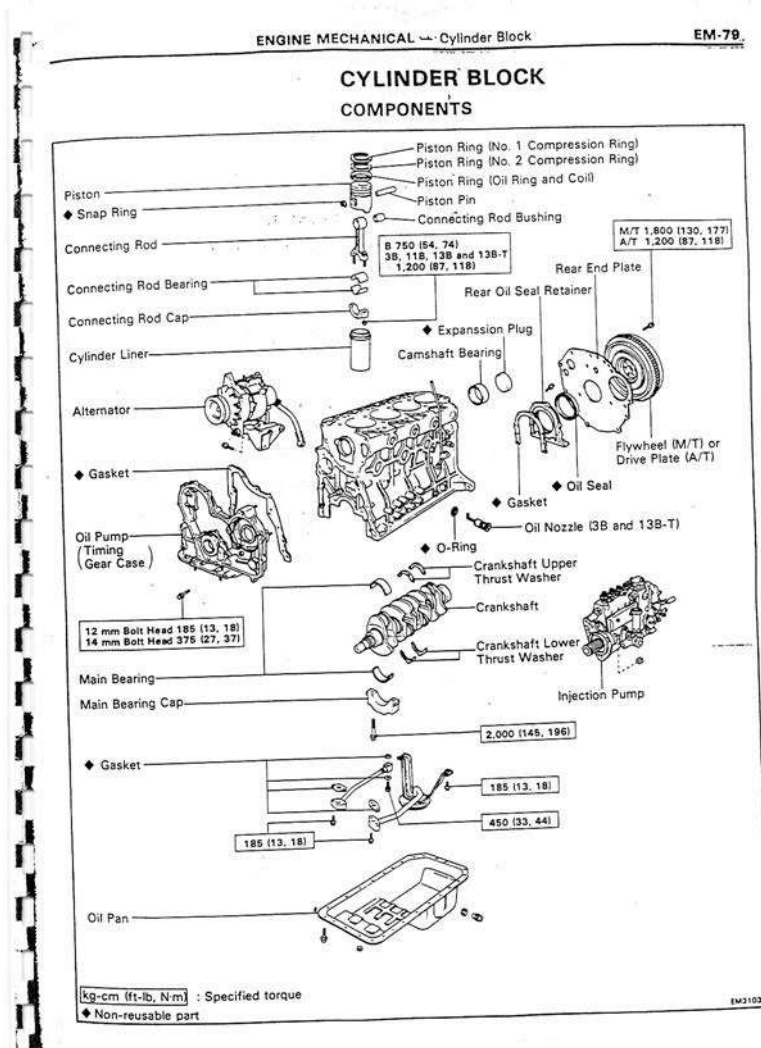
18. INSTALL WATER PUMP PULLEY AND FAN
(See page CO-10)

19. INSTALL AND ADJUST DRIVE BELT
(See page CH-7)

20. START ENGINE AND CHECK FOR LEAKS

21. CHECK ENGINE OIL LEVEL (See page LU-2)

22. READJUST VALVE CLEARANCES (See page EM-22)



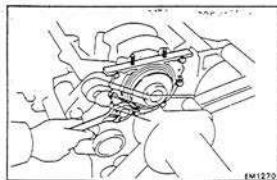
EM-80

ENGINE MECHANICAL — Cylinder Block

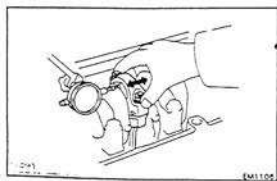
DISASSEMBLY OF CYLINDER BLOCK

(See page EM-79)

1. [M/T]
REMOVE FLYWHEEL
2. [A/T]
REMOVE DRIVE PLATE
3. REMOVE REAR END PLATE
4. INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY
5. [13B-T]
REMOVE TURBOCHARGER (See page EM-36)
6. REMOVE INJECTION PIPES
(See page FU-4) B and 3B
(See page FU-10) 11B, 13B and 13B-T
7. REMOVE ALTERNATOR
8. REMOVE CYLINDER HEAD (See page EM-44)
9. REMOVE TIMING GEARS AND CAMSHAFT
(See pages EM-64)
10. REMOVE INJECTION PUMP (See page FU-27)
11. REMOVE OIL PAN AND OIL PUMP (See page LU-5)



12. REMOVE REAR OIL SEAL RETAINER
Remove the six bolts, retainer and gasket.



13. CHECK CONNECTING ROD THRUST CLEARANCE
Using a dial indicator, measure the thrust clearance while moving the rod back and forth.
Standard thrust clearance: 0.200 – 0.320 mm
(0.0079 – 0.0126 in.)
Maximum thrust clearance: 0.40 mm (0.0157 in.)
If the clearance is greater than maximum, replace the connecting rod assembly. If necessary, replace the crankshaft.

ENGINE MECHANICAL — Cylinder Block EM-81

14. REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE

(a) Using a punch or numbering stamp, place match-marks on the connecting rod and cap to ensure correct reassembly.

(b) Remove the connecting rod cap nuts.

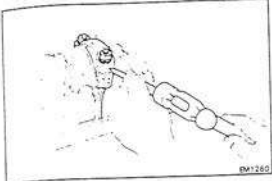
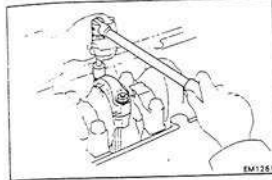
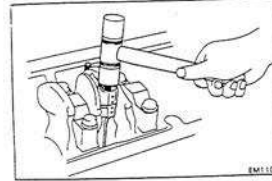
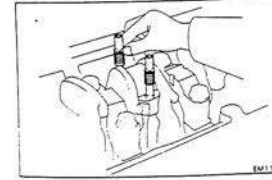
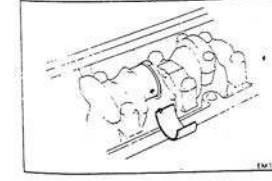
(c) Using a plastic-faced hammer, lightly tap the connecting rod bolts and lift off the connecting rod cap.
NOTE: Keep the lower bearing inserted with the connecting rod cap.

(d) Cover the connecting rod bolts with a short piece of hose to protect the crankshaft from damage.

(e) Clean the crank pin and bearing.

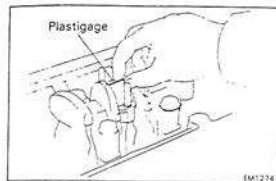
(f) Check the crank pin and bearing for pitting and scratches.

If the crank pin or bearing are damaged, replace the bearings. If necessary, grind or replace the crankshaft.

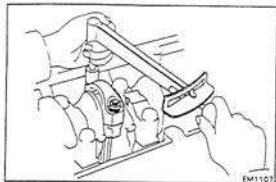






EM-82

ENGINE MECHANICAL — Cylinder Block



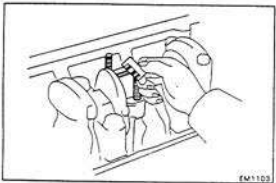
(g) Lay a strip of Plastigage across the crank pin.



(h) Install the connecting rod cap. (See page EM-103)

Torque: **B** 750 kg-cm (54 ft-lb, 74 N-m)
3B, 11B, 13B and 13B-T
 1,200 kg-cm (87 ft-lb, 118 N-m)

NOTE: Do not turn the crankshaft.



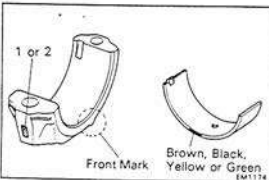
(i) Remove the connecting rod cap.

(j) Measure the Plastigage at its widest point.

Standard oil clearance: 0.030 – 0.070 mm
 (0.0012 – 0.0028 in.)

Maximum oil clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than maximum, replace the bearing. If necessary, grind or replace the crankshaft.



NOTE: There are two sizes of standard bearings, colored brown and black (B), yellow and green (3B, 11B, 13B and 13B-T). If using a standard bearing, select one having the color corresponding to the number on the bearing cap:

1 with Brown (B) or Yellow (3B, 11B, 13B and 13B-T)

2 with Black (B) or Green (3B, 11B, 13B and 13B-T)

Standard bearing thickness (at center wall):

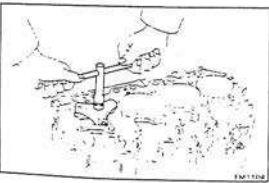
STD size Brown or Yellow

1.480 – 1.485 mm (0.0583 – 0.0585 in.)

STD size Black or Green

1.485 – 1.490 mm (0.0585 – 0.0587 in.)

(k) Completely remove the Plastigage.



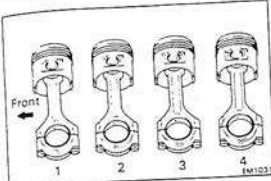
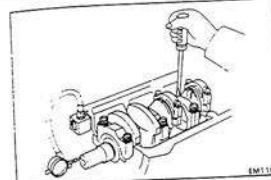
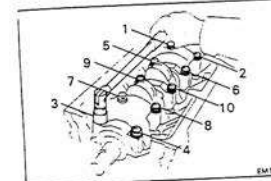
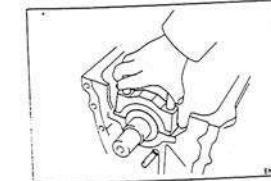
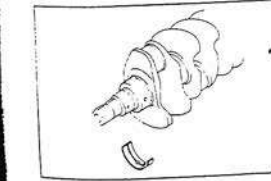
15. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

(a) Remove all the carbon from the piston ring ridge.

(b) Cover the connecting rod bolts. (See page EM-96)

(c) Push the piston, connecting rod assembly and upper bearing out through the top of the cylinder.

ENGINE MECHANICAL — Cylinder Block EM-83

NOTE:

- Keep the bearings, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in correct order.

16. CHECK CRANKSHAFT THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Standard thrust clearance: 0.040 – 0.250 mm (0.0016 – 0.0098 in.)

Maximum thrust clearance: 0.40 mm (0.0157 in.)

If the clearance is greater than maximum, replace the thrust washers as a set.

Thrust washer thickness:

STD size	2.430 – 2.480 mm (0.0957 – 0.0976 in.)
O/S 0.125	2.493 – 2.543 mm (0.0981 – 0.1001 in.)
O/S 0.250	2.555 – 2.605 mm (0.1006 – 0.1026 in.)

17. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

(a) Remove the main bearing cap bolts.

(b) Using the removed main bearing cap bolts, pry the cap back and forth, and remove the main bearing caps, lower bearings and lower thrust washers (No. 3 main bearing cap only).

NOTE:

- Keep the lower bearing and main bearing cap together.
- Arrange the main bearing cap and lower thrust washers in correct order.

(c) Lift out the crankshaft.

NOTE: Keep the upper bearing and upper thrust washers together with the cylinder block.

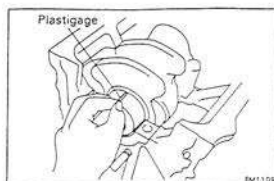
(d) Clean each main journal and bearing.

(e) Check each main journal and bearing for pitting and scratches.

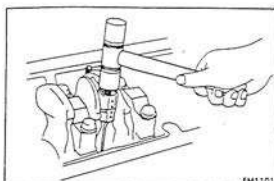
If the journal or bearing are damaged, replace the bearing. If necessary, grind or replace the crankshaft.

EM-84

ENGINE MECHANICAL — Cylinder Block



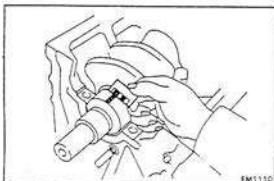
- (f) Place the crankshaft on the cylinder block.
 (g) Lay a strip of Plastigage across each of the main journal.



- (h) Install the main bearing caps. (See page EM-102)

Torque: 2,000 kg-cm (145 ft-lb, 196 N-m)

NOTE: Do not turn the crankshaft.



- (i) Remove the main bearing caps.

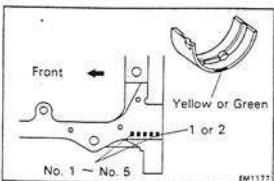
- (j) Measure the Plastigage at its widest point.

Standard oil clearance: 0.030 – 0.074 mm

(0.0012 – 0.0029 in.)

Maximum oil clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than maximum, replace the main bearing. If necessary, grind or replace the crankshaft.



NOTE: There are two sizes of standard bearings, colored yellow and green. If using a standard bearing, select one having the color corresponding to the number on the cylinder block:

1 with Yellow

2 with Green

Standard bearing thickness (at center wall):

STD size Yellow 2.480 – 2.485 mm

(0.0976 – 0.0978 in.)

STD size Green 2.485 – 2.490 mm

(0.0978 – 0.0980 in.)

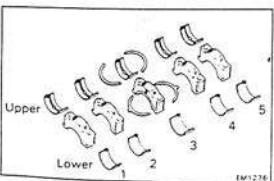
- (k) Completely remove the Plastigage.

18. REMOVE CRANKSHAFT

- (a) Lift out the crankshaft.

- (b) Remove the upper bearings and upper thrust washers from the cylinder block.

NOTE: Arrange the main bearing caps, bearings and thrust washers in correct order.



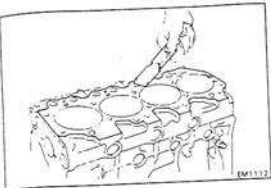
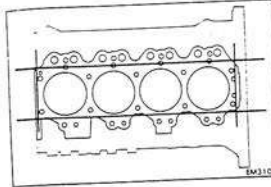
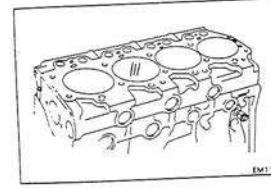
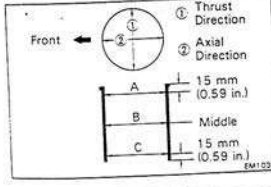
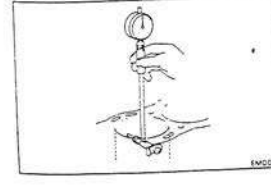
ENGINE MECHANICAL — Cylinder Block EM-85

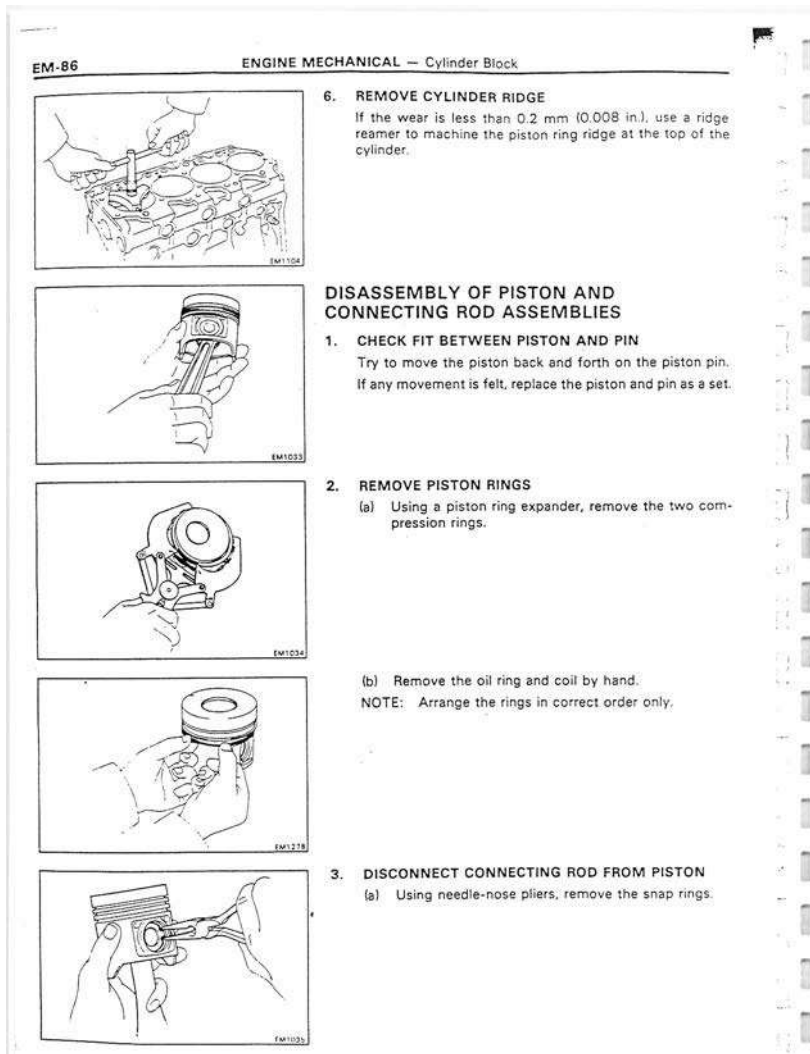
INSPECTION OF CYLINDER BLOCK

1. **REMOVE GASKET MATERIAL**
Using a gasket scraper, remove all the gasket material from the cylinder block surface.
2. **CLEAN CYLINDER BLOCK**
Using a soft brush and solvent, clean the block.
3. **INSPECT TOP OF CYLINDER BLOCK FOR FLATNESS**
Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder head gasket for warpage.
Maximum warpage: 0.20 mm (0.0079 in.)
If warpage is greater than maximum, replace the cylinder block.
4. **INSPECT CYLINDER FOR VERTICAL SCRATCHES**
Visually check the cylinder for vertical scratches.
If deep scratches are present, replace the all four cylinder liners.
5. **INSPECT CYLINDER BORE DIAMETER**
Using a cylinder gauge, measure the cylinder bore diameter at positions A, B and C in the thrust and axial directions.

Standard diameter:		95.00 – 95.03 mm
B and 11B		(3.7402 – 3.7413 in.)
3B, 13B and 13B-T		102.00 – 102.03 mm
		(4.0157 – 4.0169 in.)
Maximum diameter:		95.23 mm (3.7492 in.)
B and 11B		
3B, 13B and 13B-T		102.23 mm (4.0248 in.)

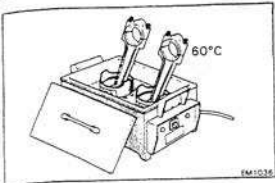
If the diameter is greater than maximum, replace all four cylinder liners.



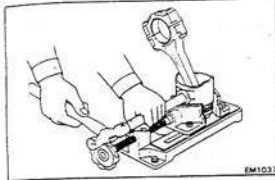
ENGINE MECHANICAL — Cylinder Block

EM-87

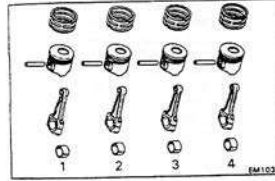


60°C

EM1035

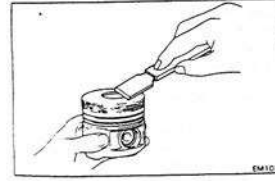


EM1037

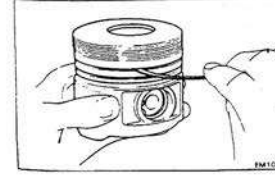


1 2 3 4

EM1038



EM1039



EM1040

(b) Gradually heat the piston to approx. 60°C (140°F).

(c) Using a plastic-faced hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.

NOTE:

- The piston and pin are a matched set.
- Arrange the pistons, pins, rings, connecting rods and bearings in correct order.

INSPECTION AND REPAIR OF PISTON AND CONNECTING ROD ASSEMBLIES

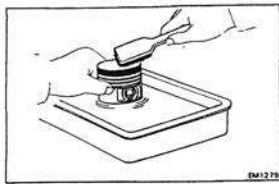
1. CLEAN PISTON

(a) Using a gasket scraper, remove the carbon from the piston top.

(b) Using a groove cleaning tool or broken ring, clean the ring grooves.

EM-88

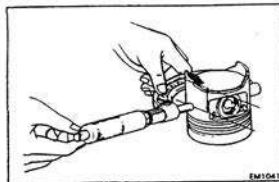
ENGINE MECHANICAL — Cylinder Block



EM1279

- (c) Using solvent and a brush, thoroughly clean the piston.

CAUTION: Do not use a wire brush.



EM1041

2. INSPECT PISTON DIAMETER AND OIL CLEARANCE

- (a) Using a micrometer, measure the piston diameter at a right angle to the piston pin hole center line, the indicated distance below the skirt bottom edge.

Distance:

B and 3B	15.5 – 30.5 mm (0.610 – 1.201 in.)
11B and 13B-T	14.0 mm (0.551 in.)
13B	20.0 mm (0.787 in.)

Piston diameter:

B	94.90 – 94.93 mm (3.7362 – 3.7374 in.)
3B	101.90 – 101.93 mm (4.0118 – 4.0130 in.)
11B	94.94 – 94.97 mm (3.7378 – 3.7390 in.)
13B	101.93 – 101.96 mm (4.0130 – 4.0142 in.)
13B-T	101.92 – 101.95 mm (4.0126 – 4.0138 in.)

- (b) Measure the cylinder bore diameter in the thrust directions (See page EM-85) and subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard oil clearance:

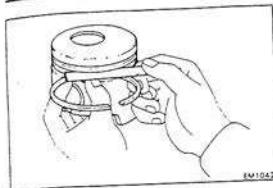
B and 3B	0.09 – 0.11 mm (0.0035 – 0.0043 in.)
11B	0.05 – 0.07 mm (0.0020 – 0.0028 in.)
13B	0.06 – 0.08 mm (0.0024 – 0.0031 in.)
13B-T	0.07 – 0.09 mm (0.0028 – 0.0035 in.)

Maximum oil clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than maximum, replace all four pistons. If necessary, replace all four cylinder liners.

ENGINE MECHANICAL — Cylinder Block

EM-89



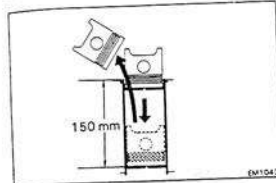
3. INSPECT CLEARANCE BETWEEN WALL OF PISTON RING GROOVE AND NEW PISTON RING

Using a feeler gauge, measure the clearance between new piston ring and the wall of the piston ring groove.

Ring groove clearance:

No. 1 (11B and 13B)	0.08 – 0.12 mm (0.0031 – 0.0047 in.)
No. 2 B, 3B, 11B and 13B	0.04 – 0.08 mm (0.0016 – 0.0031 in.)
13B-T	0.06 – 0.10 mm (0.0024 – 0.0039 in.)
Oil	0.03 – 0.07 mm (0.0012 – 0.0028 in.)

If the clearance is not within specification, replace the piston.



4. INSPECT PISTON RING END GAP

- Insert the piston ring into the cylinder bore.
- Using a piston, push the piston ring a little beyond the bottom of the ring travel, 150 mm (5.91 in.) from the top of the cylinder block.
- Using a feeler gauge, measure the end gap.

Standard end gap:

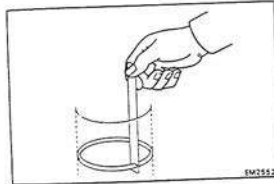
No. 1 B	0.35 – 0.64 mm (0.0138 – 0.0252 in.)
3B, 11B, 13B and 13B-T	0.30 – 0.54 mm (0.0118 – 0.0213 in.)
No. 2 B and 11B	0.35 – 0.64 mm (0.0138 – 0.0252 in.)
3B, 13B and 13B-T	0.45 – 0.69 mm (0.0177 – 0.0272 in.)
Oil B and 11B	0.35 – 0.64 mm (0.0138 – 0.0252 in.)
3B, 13B and 13B-T	0.40 – 0.69 mm (0.0157 – 0.0272 in.)

Maximum end gap:

No. 1 B	1.44 mm (0.0567 in.)
3B, 11B, 13B and 13B-T	1.34 mm (0.0528 in.)
No. 2 B and 11B	1.44 mm (0.0567 in.)
3B, 13B and 13B-T	1.49 mm (0.0587 in.)
Oil B and 11B	1.44 mm (0.0567 in.)
3B, 13B and 13B-T	1.49 mm (0.0587 in.)

If the gap is greater than maximum, replace the piston ring.

If the gap is greater than maximum, even with a new piston ring, replace the cylinder liner.



EM-90

ENGINE MECHANICAL — Cylinder Block

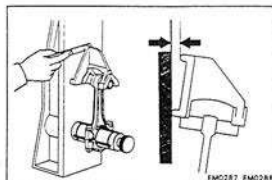


EM1244

5. CHECK PISTON PIN FIT

At 60°C (140°F) you should be able to push the pin into the piston with thumb.

If the pin can be installed at a lower temperature, replace the piston and pin as a set.



EM0287 EM0288

6. INSPECT CONNECTING RODS

(a) Using a rod aligner, check the connecting rod alignment.

- Check for bend.

Maximum bend:

0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

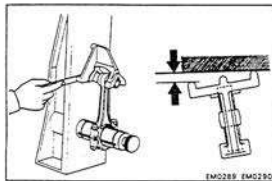
If bend is greater than maximum, replace the connecting rod assembly.

- Check for twist.

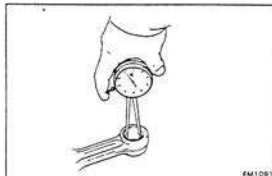
Maximum twist:

0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

If twist is greater than maximum, replace the connecting rod assembly.



EM0289 EM0290



EM1081

(b) Using a caliper gauge, measure the inside diameter of the connecting rod bushing.

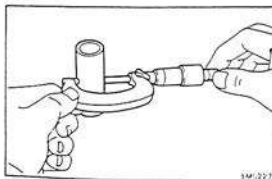
Bushing inside diameter:

B	29.009 – 29.019 mm (1.1421 – 1.1425 in.)
3B	32.009 – 32.019 mm (1.2602 – 1.2606 in.)
11B, 13B and 13B-T	34.009 – 34.019 mm (1.3389 – 1.3393 in.)

(c) Using a micrometer, measure the diameter of the piston pin.

Piston pin diameter:

B	29.000 – 29.010 mm (1.1417 – 1.1421 in.)
3B	32.000 – 32.010 mm (1.2598 – 1.2602 in.)
11B, 13B and 13B-T	34.000 – 34.010 mm (1.3386 – 1.3390 in.)



EM-227

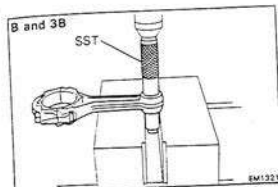
ENGINE MECHANICAL — Cylinder block

- (d) Subtract the piston pin diameter measurement from the bushing inside diameter measurement.

Standard oil clearance: 0.004 – 0.014 mm
(0.0002 – 0.0006 in.)

Maximum oil clearance: 0.05 mm (0.0020 in.)

If the clearance is greater than maximum, replace the connecting rod bushing. If necessary, replace the piston and piston pin assembly.

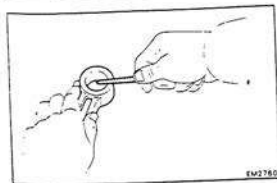
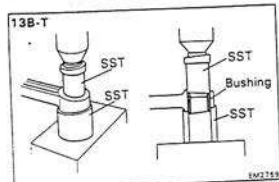
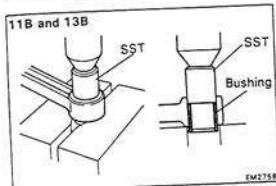


7. IF NECESSARY, REPLACE CONNECTING ROD BUSHINGS

A. Remove connecting rod bushing

Using SST and a press, press out the bushing.

SST B and 3B 09222-66010
11B and 13B 09222-76012
13B-T 09222-58010
(09222-01020, 09222-01040)

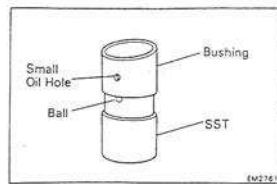


B. Install new connecting rod bushings

- (a) Using a round file, lightly file off any roughness from the small end of the connecting rod as shown in the illustration.

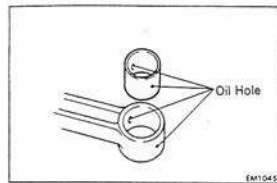
EM-92

ENGINE MECHANICAL — Cylinder Block

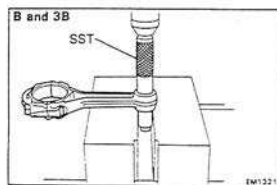


(b) [13B-T]

Attach the bushing to the SST with the ball of the SST inside the small oil hole of the bushing.
SST 09222-58010 (09222-01030)

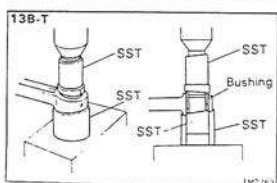
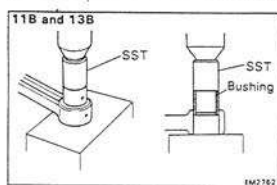


(c) Align the oil holes of the bushing and connecting rod.



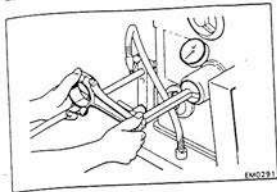
(d) Using SST and a press, press in the bushing.

SST B and 3B 09222-66010
11B and 13B 09222-76012
13B-T 09222-58010 (09222-01020,
09222-01030, 09222-01040)

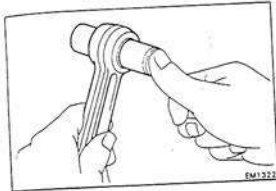


ENGINE MECHANICAL — Cylinder Block

EM-93

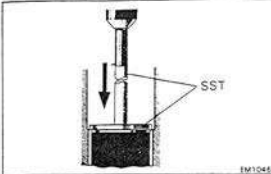
**C. Hone connecting rod bushing and check piston pin fit in connecting rod**

- (a) Using a pin hole grinder, hone the bushing to obtain the standard specified clearance (See page EM-105) between the bushing and piston pin.



- (b) Check the piston pin fit at normal room temperature. Coat the piston pin with engine oil and push it into the rod with your thumb.

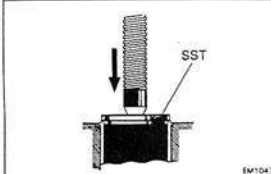
EM-94 ENGINE MECHANICAL — Cylinder Block



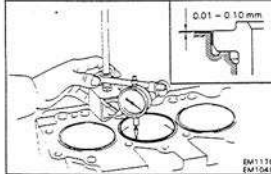
EM1045



EM10293



EM1043



EM1116
EM1048

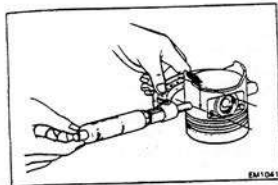
REPLACEMENT OF CYLINDER LINERS

- [3B AND 13B-T]**
REMOVE OIL NOZZLE (See page LU-21)
- REMOVE CYLINDER LINER**
Using SST and a press, press out the liner with 2,000 – 3,000 kg (4,409 – 6,614 lb, 19,613 – 29,420 N) pressure.
SST B and 11B 09218-56040 and 09608-12010 (09608-00020)
3B, 13B and 13B-T 09218-56030 and 09608-12010 (09608-00020)
- INSTALL NEW CYLINDER LINER**
 - Apply engine oil to the outside surface of the cylinder liner.
 - Using SST and a press, press in the cylinder liner with the shim using 2,000 – 3,000 kg (4,409 – 6,614 lb, 19,613 – 29,420 N) of pressure.
SST B and 11B 09218-56040
3B, 13B and 13B-T 09218-56030
- CHECK CYLINDER LINER RIDGE PROTRUSION**
Using a dial indicator, measure the ridge protrusion of the cylinder liner.
Ridge protrusion: 0.01 – 0.10 mm^{*}
(0.0004 – 0.0039 in.)
- BORE CYLINDER LINER** (See page EM-95)
- [3B AND 13B-T]**
INSTALL OIL NOZZLE (See page LU-22)

BORING OF CYLINDER LINERS**1. KEEP NEW PISTON**

Piston diameter:

B	94.90 – 94.93 mm (3.7362 – 3.7374 in.)
3B	101.90 – 101.93 mm (4.0118 – 4.0130 in.)
11B	94.94 – 94.97 mm (3.7378 – 3.7390 in.)
13B	101.93 – 101.96 mm (4.0130 – 4.0142 in.)
13B-T	101.92 – 101.95 mm (4.0126 – 4.0138 in.)

**2. CALCULATE AMOUNT TO BORE CYLINDER LINER**

- (a) Using a micrometer, measure the piston diameter at a right angle to the piston pin hole center line, the indicated distance below the skirt bottom edge.

Distance:

B and 3B	15.5 – 30.5 mm (0.610 – 1.201 in.)
11B and 13B-T	14.0 mm (0.551 in.)
13B	20.0 mm (0.787 in.)

- (b) Calculate the amount each cylinder is to be rebored as follows:

$$\text{Size to be rebored} = P + C - H$$

P = Piston diameter

C = Piston clearance

B and 3B	0.09 – 0.11 mm (0.0035 – 0.0043 in.)
11B	0.05 – 0.07 mm (0.0020 – 0.0028 in.)
13B	0.06 – 0.08 mm (0.0024 – 0.0031 in.)
13B-T	0.07 – 0.09 mm (0.0028 – 0.0035 in.)

H = Allowance for honing

0.02 mm (0.0008 in.) or less

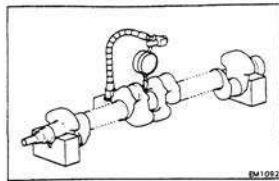
3. BORE AND HONE CYLINDERS TO CALCULATED DIMENSIONS

Maximum honing: 0.02 mm (0.0008 in.)

CAUTION: Excess honing will destroy the finished roundness.

EM-96

ENGINE MECHANICAL — Cylinder Block

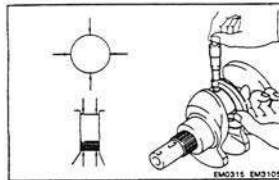
**INSPECTION AND REPAIR OF CRANKSHAFT****1. INSPECT CRANKSHAFT FOR RUNOUT**

- Place the crankshaft on V-blocks.
- Using a dial indicator, measure the circle runout at the center journal.

NOTE: Use a long spindle on the dial indicator.

Maximum circle runout: 0.08 mm (0.0031 in.)

If the circle runout is greater than maximum, replace the crankshaft.

**2. INSPECT MAIN JOURNALS AND CRANK PINS**

- Using a micrometer, measure the diameter of the main journal and crank pin.

Main journal diameter:

STD size	69.98 – 70.00 mm (2.7551 – 2.7559 in.)
U/S 0.25	69.74 – 69.75 mm (2.7457 – 2.7461 in.)
U/S 0.50	69.49 – 69.50 mm (2.7358 – 2.7362 in.)
U/S 1.00	68.99 – 69.00 mm (2.7161 – 2.7165 in.)

Crank pin diameter:

B STD size	58.98 – 59.00 mm (2.3220 – 2.3228 in.)
U/S 0.25	58.74 – 58.75 mm (2.3126 – 2.3130 in.)
U/S 0.50	58.49 – 58.50 mm (2.3028 – 2.3031 in.)
U/S 1.00	57.99 – 58.00 mm (2.2831 – 2.2835 in.)

3B, 11B, 13B and 13B-T

STD size	60.98 – 61.00 mm (2.4008 – 2.4016 in.)
U/S 0.25	60.74 – 60.75 mm (2.3913 – 2.3917 in.)
U/S 0.50	60.49 – 60.50 mm (2.3815 – 2.3819 in.)
U/S 1.00	59.99 – 60.00 mm (2.3618 – 2.3622 in.)

If the diameter is not within specification, check the oil clearance. If necessary, grind or replace the crankshaft.

- Check each main journal and crank pin for taper and out-of-round as shown.

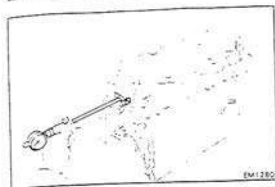
Maximum taper and out-of-round: 0.02 mm (0.0008 in.)

If taper and out-of-round is greater than maximum, replace the crankshaft.

3. IF NECESSARY, GRIND AND HONE MAIN JOURNALS AND/OR CRANK PINS

Grind and hone the main journals and or crank pins to the undersized finished diameter. (See procedure step 2)

Install new main journal and or crank pin undersize bear-



INSPECTION AND REPAIR OF CAMSHAFT BEARINGS AND CAMSHAFT

1. INSPECT CAMSHAFT OIL CLEARANCE

- (a) Using a cylinder gauge, measure the inside diameter of the camshaft bearing.

Bearing inside diameter (from front side):

No. 1	53.495 – 53.568 mm (2.1061 – 2.1090 in.)
No. 2	53.245 – 53.318 mm (2.0963 – 2.0991 in.)
No. 3	52.995 – 53.068 mm (2.0864 – 2.0893 in.)
No. 4	52.745 – 52.818 mm (2.0766 – 2.0794 in.)
No. 5	52.495 – 52.568 mm (2.0667 – 2.0696 in.)

- (b) Subtract the journal diameter measurement (See page EM-69) from the bearing inside diameter measurement.

Standard oil clearance: 0.020 – 0.109 mm
(0.0008 – 0.0043 in.)

Maximum oil clearance: 0.15 mm (0.0059 in.)

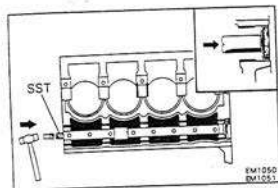
If the clearance is greater than maximum, replace the camshaft bearings. If necessary, replace the camshaft.

2. IF NECESSARY, REPLACE CAMSHAFT BEARINGS

A. Remove expansion plug

Using SST and a hammer, tap out the expansion plug.

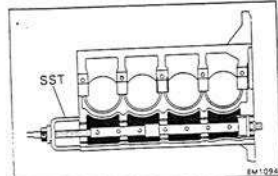
SST 09215-00100 (09215-00130, 09215-00150, 09215-00210)



B. Remove camshaft bearings

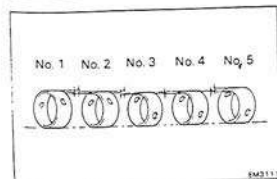
Using SST, remove the camshaft bearings.

SST 09215-00012 (09215-00020, 09215-00440, 09215-00470) and 09215-00100 (09215-00130, 09215-00140, 09215-00150, 09215-00160)



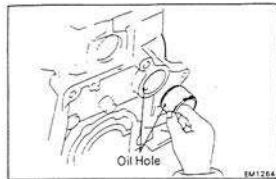
C. Install new camshaft bearings

- (a) Install new bearings in their proper location.

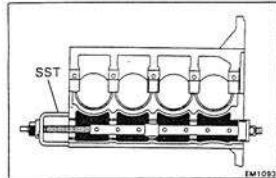


EM-98

ENGINE MECHANICAL — Cylinder Block

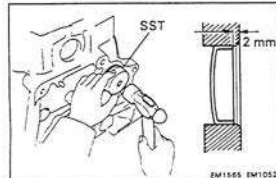


(b) Align the oil holes of the bearing and cylinder block.



(c) Using SST, install the camshaft bearings.

SST 09215-00012 (09215-00020, 09215-00440,
09215-00470) and
09215-00100 (09215-00130, 09215-00140,
09215-00150, 09215-00160)



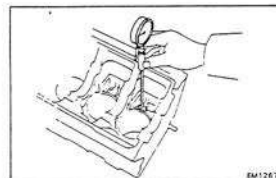
D. Check camshaft oil clearance (See page EM-79)

E. Install expansion plug

(a) Apply liquid sealer to the expansion plug surface of the cylinder block.

(b) Using SST and a hammer, drive in the expansion plug to a distance of 2 mm (0.08 in.) from the cylinder block edge.

SST 09215-00012 (09215-00470)



INSPECTION OF VALVE LIFTERS AND VALVE LIFTER BORES

INSPECT VALVE LIFTER OIL CLEARANCE

(a) Using a cylinder gauge, measure the valve lifter bore diameter.

Bore diameter: 27.010 – 27.030 mm
(1.0634 – 1.0642 in.)

(b) Subtract the valve lifter diameter measurement (See page EM-70) from the valve lifter bore diameter measurement.

Standard oil clearance: 0.025 – 0.065 mm
(0.0010 – 0.0026 in.)

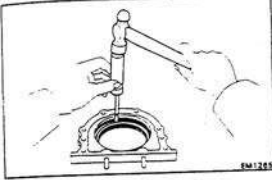
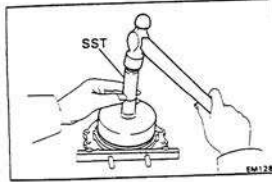
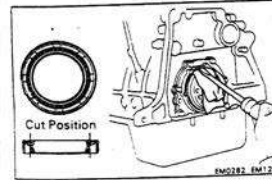
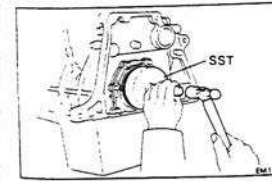
Maximum oil clearance: 0.10 mm (0.0039 in.)

If the oil clearance is greater than maximum, replace the valve lifters.

ENGINE MECHANICAL — Cylinder block EM-99

REPLACEMENT OF CRANKSHAFT REAR OIL SEAL

NOTE: There are two methods (A and B) to replace the oil seal as follows.

REPLACE CRANKSHAFT REAR OIL SEAL

A. If rear oil seal retainer is removed from cylinder block:

- (a) Using a screwdriver and hammer, tap out the oil seal.
- (b) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.
SST 09223-56010
- (c) Apply MP grease to the oil seal lip.

B. If rear oil seal retainer is installed to cylinder block:

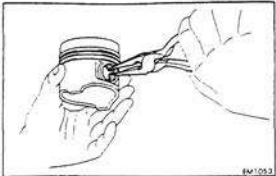
- (a) Using a knife, cut off the oil seal lip.
- (b) Using a screwdriver, pry out the oil seal.

CAUTION: Be careful not to damage the crankshaft. Tape the screwdriver.

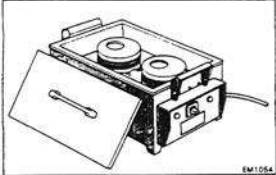
- (c) Apply MP grease to a new oil seal.
- (d) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.
SST 09223-56010

EM-100

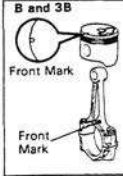
ENGINE MECHANICAL — Cylinder Block



EM1053

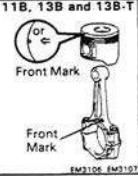


EM1054



B and 3B

Front Mark



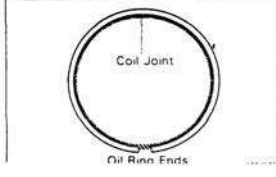
11B, 13B and 13B-T

Front Mark

EM9108 EM9107



EM1278



Coil Joint

Oil Ring Ends

ASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLIES

1. ASSEMBLE PISTON AND CONNECTING ROD

(a) Install a new snap ring on one side of the piston pin hole.

(b) Gradually heat the piston to about 60°C (140°F).

(c) Align the front marks of the piston and connecting rod, and push in the piston pin with your thumb.

(d) Install a new snap ring on the other side of the piston hole.

2. INSTALL PISTON RINGS

(a) Install the coil and oil ring by hand.

NOTE: Face the end gap of the oil ring in the opposite direction of the coil joint.

ENGINE MECHANICAL — Cylinder Block

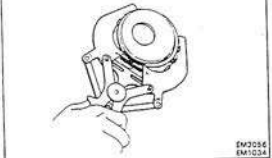
EM-101

No. 1 (B and 3B)
Code Mark (T)

No. 1 (11B and 13B)
Code Mark (T)

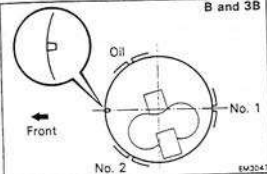
No. 1 (13B-T)
Code Mark (TT)

No. 2 (T or T2)
Code Mark



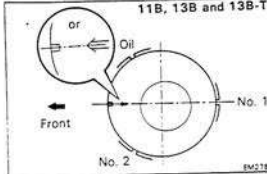
EM2026
EM1024

B and 3B

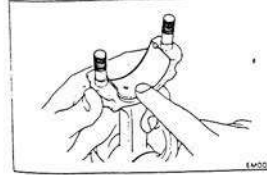


EM2047

11B, 13B and 13B-T



EM2189



EM2085

(b) Using a piston ring expander, install the two compression rings with the code mark facing upward.

(c) Position the piston rings so that the ring end gaps are as shown.
CAUTION: Do not align the end gaps.

3. INSTALL BEARINGS

(a) Align the bearing claw with the claw groove of the connecting rod or connecting rod cap.

(b) Install the bearings in the connecting rod and connecting rod cap.

<https://cardiagn.com/engine-mechanical-b-engine/>

101/104

EM-102

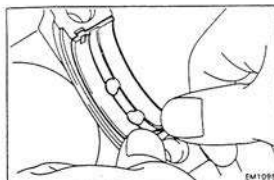
ENGINE MECHANICAL — Cylinder Block

ASSEMBLY OF CYLINDER BLOCK

(See page EM-79)

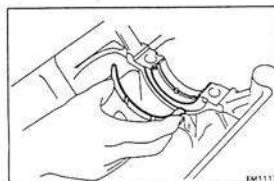
NOTE:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets, and oil seals with new parts.

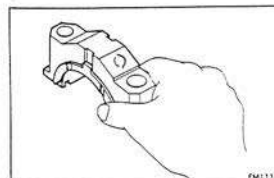
**1. INSTALL MAIN BEARINGS**

- Align the bearing claw with the claw groove of the main bearing cap or cylinder block.
- Install the bearing in the cylinder block and main bearing caps in the proper location.

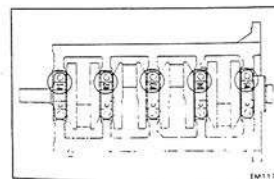
CAUTION: Install the bearing with the oil hole in the cylinder block.

**2. INSTALL UPPER THRUST WASHERS**

Install the thrust washers under the No. 3 main bearing cap position of the block with the oil grooves facing outward.

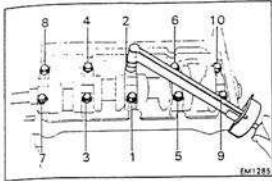
3. PLACE CRANKSHAFT ON CYLINDER BLOCK**4. INSTALL MAIN BEARING CAPS AND LOWER THRUST WASHERS**

- Install the lower thrust washers on the No. 3 main bearing cap with the oil grooves facing outward.

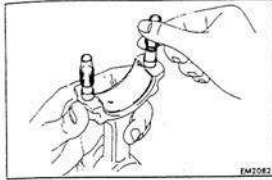


- Install the main bearing caps in their proper locations.

ENGINE MECHANICAL — Cylinder Block **EM-103**

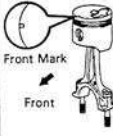


EM1285



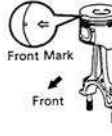
EM1282

B and 3B

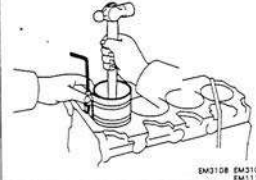


Front Mark
Front

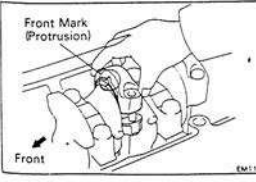
11B, 13B and 13B-T



Front Mark
Front



EM3108 EM3109 EM1115



EM1118

(c) Apply a light coat of the engine oil on the threads and under the bolt heads of the main bearing caps.

(d) Install and uniformly tighten the fourteen bolts of the main bearing caps in several passes, in the sequence shown.

Torque: 2,000 kg-cm (145 ft-lb, 196 N-m)

(e) Check that the crankshaft turns smoothly.

(f) Check the crankshaft thrust clearance.
(See page EM-83)

5. INSTALL PISTON AND CONNECTING ROD ASSEMBLIES

(a) Cover the connecting rod bolts with a short piece of hose to protect the crankshaft and cylinder bore from damage.

(b) Using a piston ring compressor, push the correctly numbered piston and connecting rod assembly into the cylinder with the front mark of the piston facing forward.

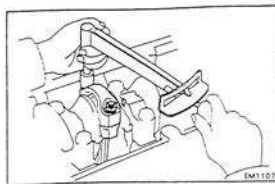
6. INSTALL CONNECTING ROD CAPS

(a) Match the numbered cap with the numbered connecting rod.

(b) Install the connecting rod cap with the front mark facing forward.

EM-104

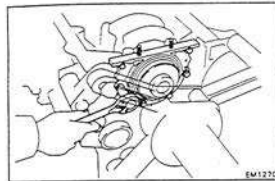
ENGINE MECHANICAL — Cylinder Block



- (c) Apply a light coat of engine oil on the threads and under the nuts of the connecting rod cap.
- (d) Install and alternately tighten the nuts of the connecting rod cap in several passes.

Torque: B 750 kg-cm (54 ft-lb, 74 N·m)
 3B, 11B, 13B and 13B-T
 1,200 kg-cm (87 ft-lb, 118 N·m)

- (e) Check that the crankshaft turns smoothly.
- (f) Check the connecting rod thrust clearance. (See page EM-80)



7. INSTALL REAR OIL SEAL RETAINER

Install a new gasket and the retainer with the six bolts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

8. INSTALL OIL PUMP AND OIL PAN (See page LU-13)

9. INSTALL INJECTION PUMP (See page FU-99)

10. INSTALL TIMING GEARS AND CAMSHAFT (See page EM-73)

11. INSTALL CYLINDER HEAD (See page EM-59)

12. INSTALL ALTERNATOR

13. INSTALL INJECTION PIPES

(See page FU-9) B and 3B

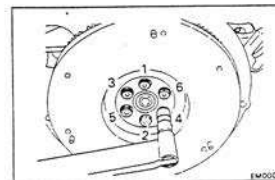
(See page FU-15) 11B, 13B and 13B-T

14. [13B-T]

INSTALL TURBOCHARGER (See page EM-39)

15. REMOVE ENGINE STAND

16. INSTALL REAR END PLATE



17. [M/T]

INSTALL FLYWHEEL

- (a) Apply a light coat of engine oil on the threads and under the bolt heads.
- (b) Install the flywheel on the crankshaft.
- (c) Install and uniformly tighten the six bolts in several passes, in the sequence shown.

Torque: 1,800 kg-cm (130 ft-lb, 177 N·m)

18. [A/T]

INSTALL DRIVE PLATE (See procedure step 16)

Torque: 1,200 kg-cm (87 ft-lb, 118 N·m)