

LU-1

LUBRICATION SYSTEM

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LU

LU-2 LUBRICATION SYSTEM — Troubleshooting, Oil Pressure Check

TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Oil leakage	Cylinder head, cylinder block or oil pump body damaged or cracked	Repair as necessary	EM-72 or EM-99
	Oil seal faulty	Replace oil seal	
	Gasket faulty	Replace gasket	
Low oil pressure	Oil leakage	Repair as necessary	LU-5
	Relief valve faulty	Repair relief valve	
	Oil pump faulty	Repair oil pump	LU-5
	Engine oil poor quality	Replace engine oil	LU-3
	Crankshaft bearing faulty	Replace bearing	EM-79
	Connecting rod bearing faulty	Replace bearing	EM-79
	Oil filter clogged	Replace oil filter	LU-3
High oil pressure	Relief valve faulty	Repair relief valve	LU-5

OIL PRESSURE CHECK

1. CHECK ENGINE OIL QUALITY

Check the oil for deterioration, entry of water, discoloring or thinning.

If the quality is poor, replace the oil.

Use API grade CC, CD or better and recommended viscosity oil.

NOTE: Be sure to use CD type or better for vehicles with turbocharger.

2. CHECK ENGINE OIL LEVEL

The oil level should be between the "L" and "F" marks on the level gauge.

If low, check for leakage and add oil up to the "F" mark.

3. REMOVE OIL PRESSURE SWITCH OR SCREW PLUG

4. INSTALL OIL PRESSURE GAUGE

5. START ENGINE

Start the engine and warm it up to normal operating temperature.

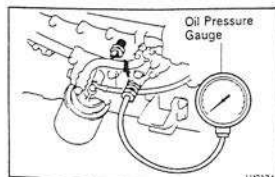
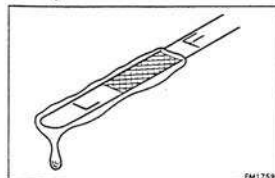
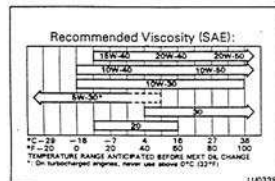
6. CHECK OIL PRESSURE

Oil pressure:

At idle 0.3 kg/cm² (4.3 psi, 29 kPa) or more

At 3,000 rpm 2.5 – 6.0 kg/cm²
(36 – 85 psi, 245 – 588 kPa)

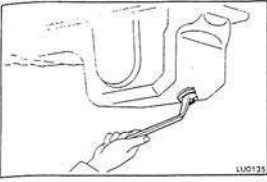
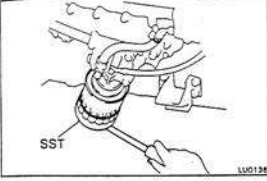
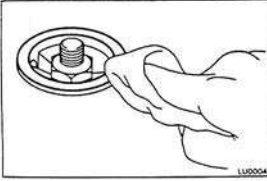
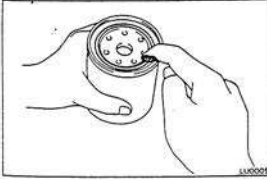
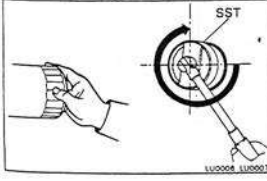
NOTE: Check for oil leakage after reinstalling the pressure switch or screw plug.



LUBRICATION SYSTEM — Replacement of Engine Oil and Oil Filter LU-3

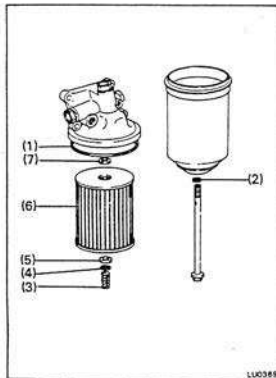
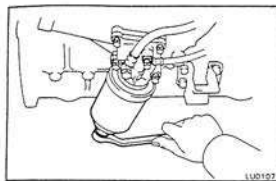
REPLACEMENT OF ENGINE OIL AND OIL FILTER

1. DRAIN ENGINE OIL
 - (a) Remove the oil filler cap.
 - (b) Remove the oil drain plug and drain the oil into a container.
2. REPLACE OIL FILTER [Cartridge Type]
 - (a) Using SST, remove the oil filter.
SST 09228-44011
 - (b) Inspect and clean the oil filter installation surface.
 - (c) Apply clean engine oil to the gasket of a new oil filter.
 - (d) Lightly screw in the oil filter until you feel resistance.
 - (e) Using SST, tighten the oil filter an extra 3/4 turn.
SST 09228-44011

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LUBRICATION SYSTEM — Replacement of Engine Oil and Filter

**[Paper Element Type]**

- (a) Remove the guide bolt and oil filter assembly.
- (b) Remove the rubber gasket, element, rubber gasket, plate washer and spring from the oil filter case.
- (c) Remove the O-ring from the guide bolt.
- (d) Remove the oil filter bracket gasket from the oil filter bracket.
- (e) Clean the filter case and guide bolt.
- (f) Install a new oil filter bracket gasket (1) to the oil filter bracket.
- (g) Install a new O-ring (2) to the guide bolt.
 - Put a light coat of engine oil on the O-ring.
- (h) Install the spring (3), plate washer (4), new rubber gasket (5), element (6) and rubber gasket (7) to the oil filter case.
- (i) Install the oil filter assembly with the guide bolt.

3. FILL WITH ENGINE OIL

- (a) Clean and install the oil drain plug with a new gasket. Torque the drain plug.

Torque: 350 kg-cm (25 ft-lb, 34 N-m)

- (b) Fill the engine with new oil, API grade CC, CD or better.

NOTE: Be sure to use CD type or better for vehicles with turbocharger.

Capacity:**Drain and refill**

w/o Oil filter change
5.8 liters (6.1 US qts, 5.1 imp. qts)

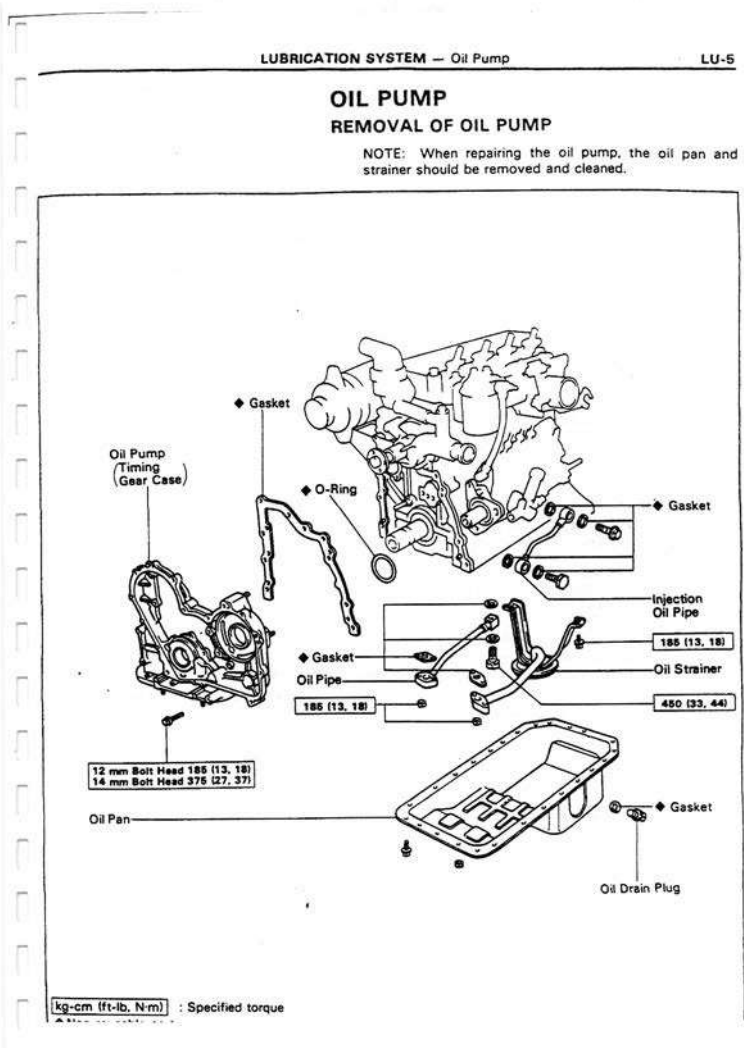
w/ Oil filter change
6.7 liters (7.1 US qts, 5.9 imp. qts)

Dry fill 7.3 liters (7.7 US qts, 6.4 imp. qts)

- (c) Install the oil filler cap with the gasket.

4. START ENGINE AND CHECK FOR LEAKS**5. RECHECK OIL LEVEL**

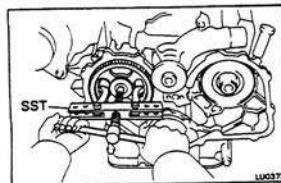
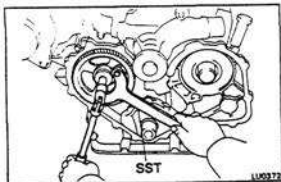
Recheck the engine oil level and refill as necessary.



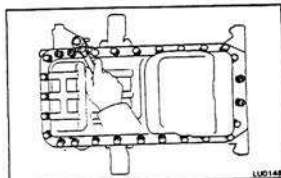
LU-6

LUBRICATION SYSTEM — Oil Pump

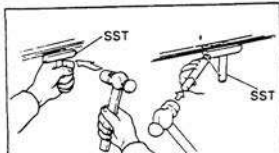
1. SET NO. 1 CYLINDER TO TDC/COMPRESSION
(See page EM-22)
2. DRAIN ENGINE OIL (See page LU-3)
3. REMOVE DRIVE BELT
4. REMOVE FAN AND WATER PUMP PULLEY
(See page CO-5)
5. REMOVE CRANKSHAFT PULLEY AND TIMING GEAR COVER
(See steps 11 to 13 on pages EM-65 and 66)
6. REMOVE IDLE GEAR AND CRANKSHAFT TIMING GEAR
(See steps 16, 17 and 19 on pages EM-67 and 68)
7. REMOVE CAMSHAFT TIMING GEAR
 - (a) Using SST, remove the mount bolt and plate was
SST 09278-54012



- (b) Using SST, remove the timing gear.
SST 09950-20017



8. REMOVE OIL PAN
 - (a) Remove the twenty-three bolts and four nuts.



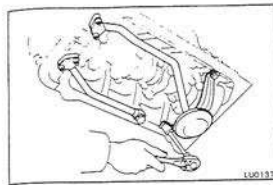
- (b) Insert the SST blade between the cylinder block oil pan, cut off applied sealer and remove the oil
SST 09032-00100

CAUTION:

- Do not use SST for the timing gear case side rear oil seal retainer side.
- Be careful not to damage the oil pan flange.

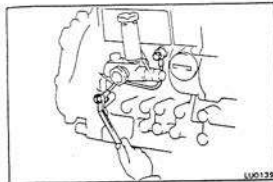
LUBRICATION SYSTEM — Oil Pump

LU-7



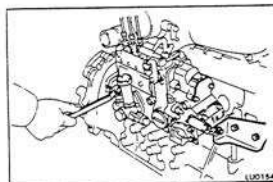
9. REMOVE OIL STRAINER AND OIL PIPE

- (a) Remove the two bolts, two nuts, oil strainer and gasket.
- (b) Remove the union bolt, two nuts, oil pipe and three gaskets.

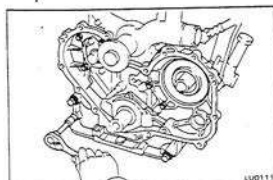


10. REMOVE OIL PUMP (TIMING GEAR CASE)

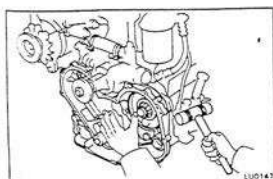
- (a) Remove the union bolt and two gaskets, and disconnect the injection oil pipe from the timing gear case.



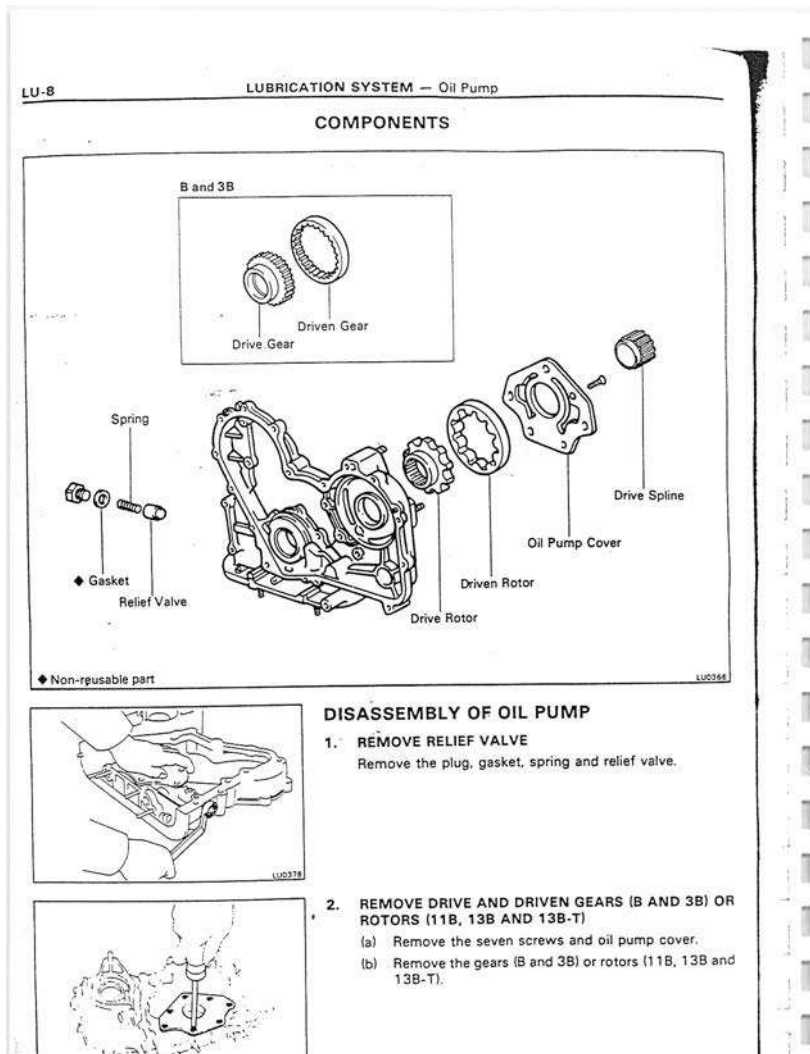
- (b) Before removing the three nuts holding the injection pump flange to the timing gear case, check if the matchmarks are aligned. If not, place new matchmarks for reinstallation.
- (c) Remove the three nuts.



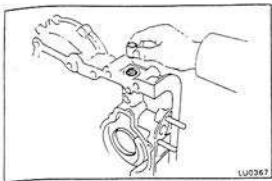
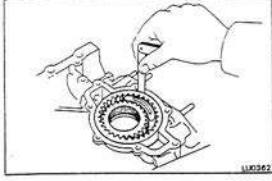
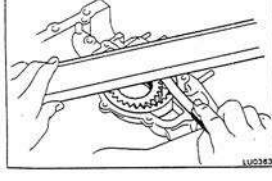
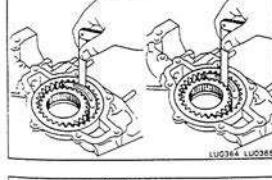
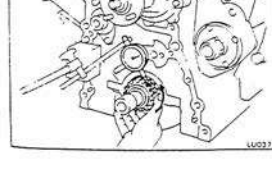
- (d) Remove the eight bolts.



- (e) Using a plastic-faced hammer, lightly tap out the timing gear case and gasket.



LUBRICATION SYSTEM — Oil Pump
LU-9

INSPECTION OF OIL PUMP [B and 3B]

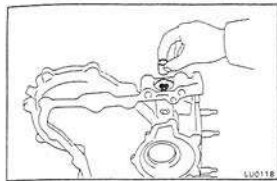
1. **INSPECT RELIEF VALVE**
 Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.
 If it is not, replace the relief valve. If necessary, replace the oil pump assembly.
2. **INSPECT DRIVE AND DRIVEN GEARS**
 - A. **Inspect Gear Body Clearance**
 Using a feeler gauge, measure the clearance between the driven gear and body.
 Standard body clearance: 0.090 – 0.150 mm (0.0035 – 0.0059 in.)
 Maximum body clearance: 0.30 mm (0.0118 in.)
 If the clearance is greater than maximum, replace gears. If necessary, replace the oil pump assembly.
 - B. **Inspect Gear Side Clearance**
 Using a feeler gauge and precision straight edge, measure the clearance between the gear and precision straight edge.
 Standard side clearance: 0.030 – 0.095 mm (0.0012 – 0.0037 in.)
 Maximum side clearance: 0.15 mm (0.0059 in.)
 If the clearance is greater than maximum, replace the gears.
 - C. **Inspect Gear Tip Clearance**
 Using a feeler gauge, measure the clearance between the gear and crescent.
 Standard clearance:
 Driven gear to crescent 0.393 – 0.476 mm (0.0155 – 0.0187 in.)
 Drive gear to crescent 0.477 – 0.567 mm (0.0188 – 0.0223 in.)
 Maximum clearance:
 Driven gear to crescent 0.55 mm (0.0217 in.)
 Drive gear to crescent 0.65 mm (0.0256 in.)
 If the clearance is greater than maximum, replace the gears. If necessary, replace the oil pump assembly.
3. **INSPECT DRIVE SPLINE**
 Using a dial indicator, measure the backlash while turning the drive gear clockwise and counterclockwise in several places.
 Standard backlash: 0.541 – 0.790 mm (0.0213 – 0.0311 in.)
 Maximum backlash: 1.00 mm (0.0394 in.)
 If the backlash is greater than maximum, replace the gear and spline.

LU-10

LUBRICATION SYSTEM — Oil Pump

**INSPECTION OF OIL PUMP
[11B, 13B and 13B-T]****1. INSPECT RELIEF VALVE**

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.
If it is not, replace the relief valve. If necessary, replace the oil pump assembly.

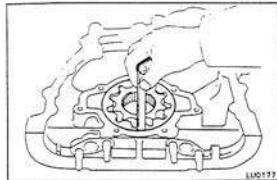
**2. INSPECT DRIVE AND DRIVEN ROTORS****A. Inspect Rotor Body Clearance**

Using a feeler gauge, measure the clearance between the driven rotor and body.

Standard body clearance: 0.140 – 0.220 mm
(0.0055 – 0.0087 in.)

Maximum body clearance: 0.40 mm (0.0157 in.)

If the clearance is greater than maximum, replace rotors. If necessary, replace the oil pump assembly.

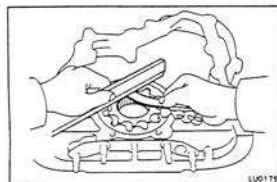
**B. Inspect Rotor Side Clearance**

Using a feeler gauge and precision straight edge, measure the clearance between the rotor and precision straight edge.

Standard side clearance: 0.035 – 0.090 mm
(0.0014 – 0.0035 in.)

Maximum side clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than maximum, replace the rotors. If necessary, replace the oil pump assembly.

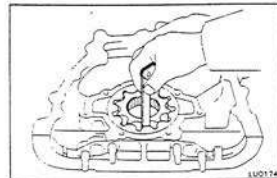
**C. Inspect Rotor Tip Clearance**

Using a feeler gauge, measure the clearance between the drive and driven rotors.

Standard tip clearance: 0.110 – 0.240 mm
(0.0043 – 0.0094 in.)

Maximum tip clearance: 0.30 mm (0.0118 in.)

If the clearance is greater than maximum, replace the rotors.

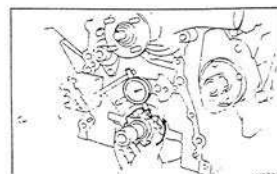
**3. INSPECT DRIVE SPLINE**

Using a dial indicator, measure the backlash while turning the drive rotor clockwise and counterclockwise in several places.

Standard backlash: 0.541 – 0.790 mm
(0.0213 – 0.0311 in.)

Maximum backlash: 1.00 mm (0.0394 in.)

If the backlash is greater than maximum, replace the rotor and spline.



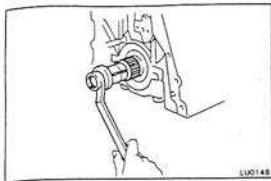
LUBRICATION SYSTEM — Oil Pump

LU-11

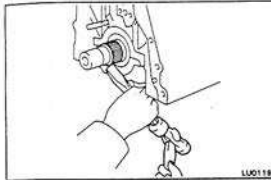
REPLACEMENT OF DRIVE SPLINE**1. REMOVE DRIVE SPLINE**

- (a) Remove the two set keys.
- (b) Set the drive spline with the hole facing downward by turning the crankshaft.

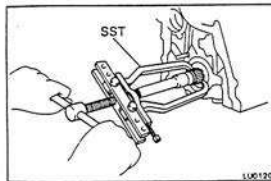
CAUTION: Do not turn the crankshaft more than 1/4 revolution.



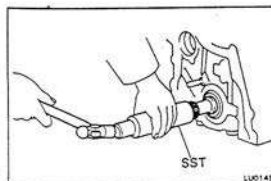
- (c) Using a chisel and hammer, tap the drive spline out of the hole until SST can be hooked to spline's end.



- (d) Using SST, remove the drive spline.
SST 09950-20017

**2. INSTALL NEW DRIVE SPLINE**

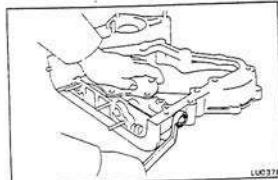
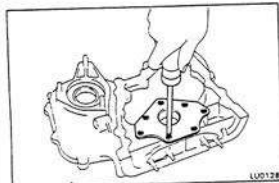
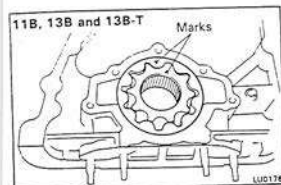
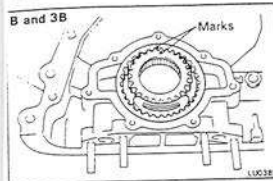
- (a) Using SST and a hammer, tap in the drive spline.
SST 09608-35014 (09608-06040)



- (b) Install the two set keys.

U-12

LUBRICATION SYSTEM — Oil Pump

**ASSEMBLY OF OIL PUMP**

(See page LU-8)

1. INSTALL DRIVE AND DRIVEN GEAR (BAND 3B) OR ROTORS (11B, 13B AND 13B-T)

- (a) Insert the gear (B and 3B) or rotors (11B, 13B and 13B-T) into the oil pump body with the marks facing the oil pump cover side.

- (b) Install the oil pump cover with the seven screws.

2. INSTALL RELIEF VALVE

Install the relief valve and spring with a new gasket and the plug.

Torque: 500 kg-cm (36 ft-lb, 49 N·m)

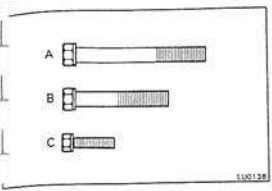
LUBRICATION SYSTEM — Oil Pump LU-13

INSTALLATION OF OIL PUMP

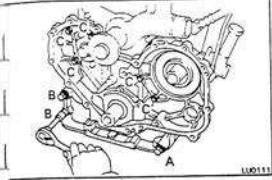
(See page LU-5)

1. INSTALL OIL PUMP (TIMING GEAR CASE)

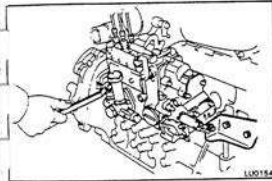
NOTE: Use the bolts indicated "A," "B," and "C."



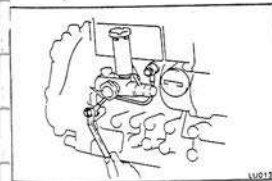
LU0128



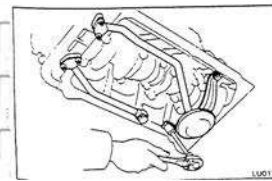
LU0133



LU0154



LU0172



LU0173

(a) Place a new gasket and the timing gear case in position.

(b) Install and uniformly tighten the eight bolts in several passes.

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

(c) Align the matchmarks on the injection pump and timing gear case.

(d) Install the three nuts holding the injection pump flange to the timing gear case.

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

(e) Connect the injection oil pipe with the union bolt and new two gaskets.

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

2. INSTALL OIL STRAINER AND OIL PIPE

(a) Install a new gasket and oil strainer with the two bolts and two nuts. Torque the bolts and nuts.

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

(b) Install new three gaskets and oil pipe with the union bolt and two nuts. Torque the union bolt and nuts.

Torque:
Union bolt 450 kg-cm (33 ft-lb, 44 N-m)
Nut 185 kg-cm (13 ft-lb, 18 N-m)

LU-14

LUBRICATION SYSTEM — Oil Pump

3. INSTALL OIL PAN

- (a) Remove any oil packing material and be careful not to drop any oil on the contacting surfaces of the oil pan and cylinder block.

- Using a razor blade and gasket scraper, remove all the old 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 oil pan as shown in the figure.

Seal packing: Part No. 08826-00080 or equivalent

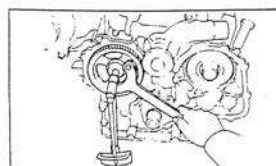
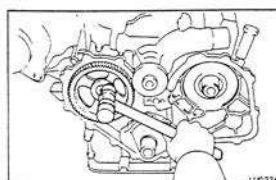
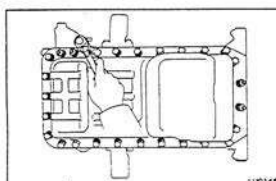
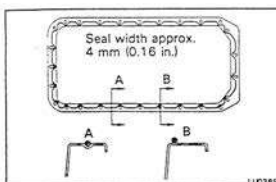
- Install a nozzle that has been cut to the 4 mm (0.16 in.) opening.

NOTE: Avoid applying an excess amount to the surface. Be especially careful near oil passages.

- Parts must be assembled within 15 minutes of application. Otherwise, the material must be removed and resupplied.
- Immediately remove nozzle from tube and reinstall cap.

- (c) Install the oil pan with the twenty-three and four nuts.

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



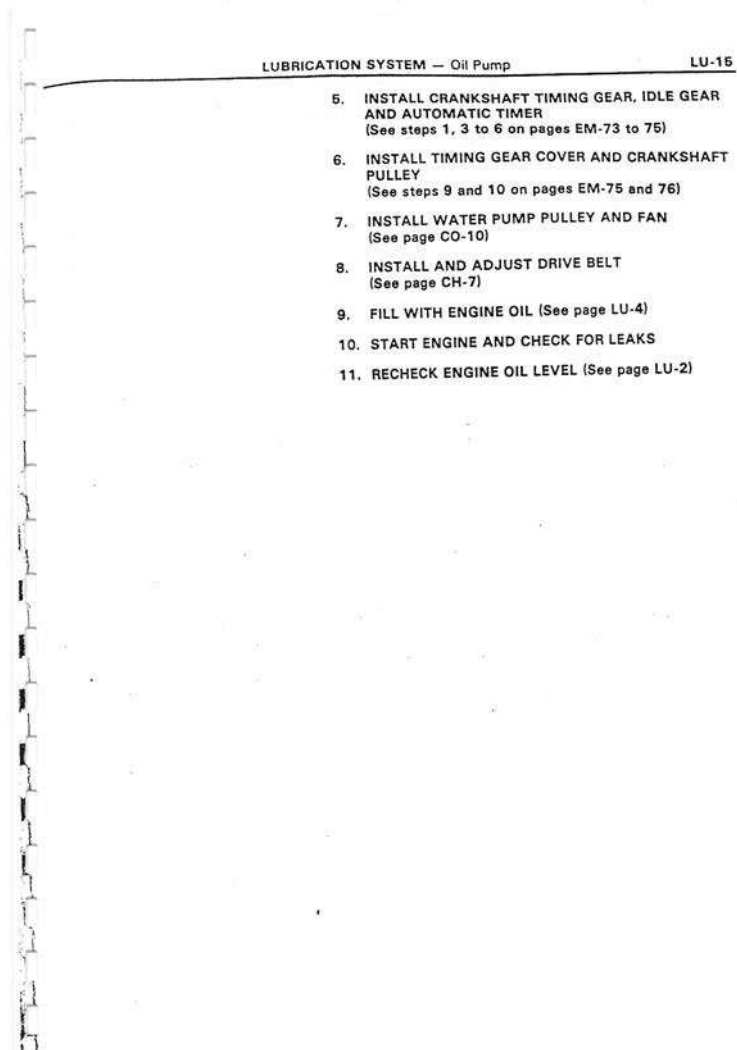
4. INSTALL CAMSHAFT TIMING GEAR

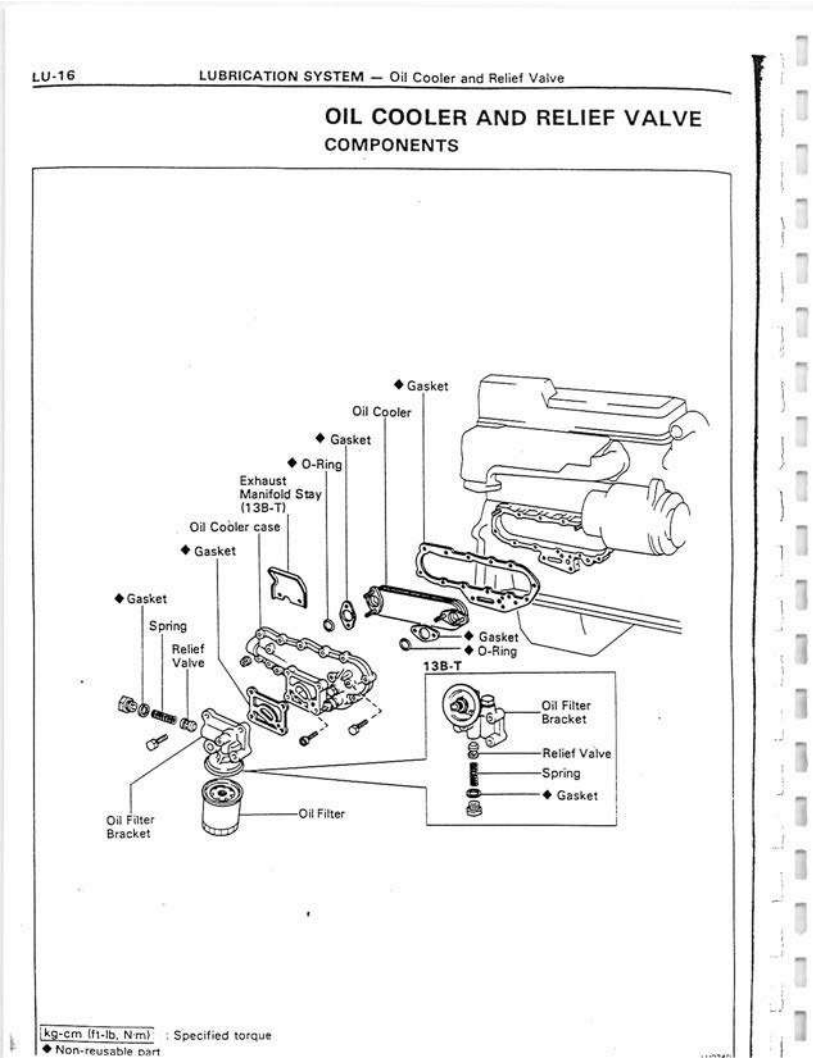
- (a) Align the timing gear set key with the key groove of the timing gear.
- (b) Using a plastic-faced hammer, lightly tap in the timing gear.

- (c) Using SST, install the plate washer and mount bolt. Torque the bolt.

SST 09278-54012

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





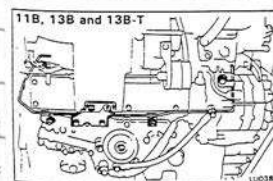
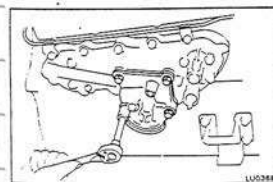
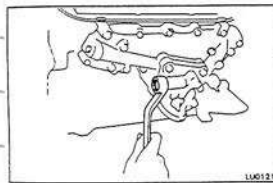
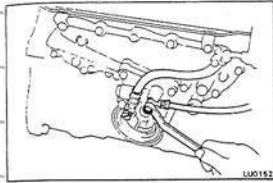
LUBRICATION SYSTEM — Oil Cooler and Relief Valve

LU-17

REMOVAL OF OIL COOLER AND RELIEF VALVE

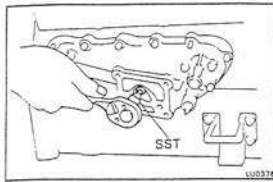
(See page LU-16)

1. DRAIN ENGINE COOLANT (See page CO-3)
2. REMOVE OIL FILTER (See pages LU-3 or 4)
3. [13B-T]
REMOVE TURBOCHARGER OIL PIPE
(See page EM-37)
4. DISCONNECT ALTERNATOR OIL HOSES
Remove the two union bolts and four gaskets from the oil filter bracket.
5. REMOVE RELIEF VALVE
Remove the plug, gasket, spring and relief valve.
6. REMOVE OIL FILTER BRACKET
Remove the four bolts, bracket and gasket.
7. [13B-T]
REMOVE EXHAUST MANIFOLD STAY
8. [11B, 13B AND 13B-T]
REMOVE VACUUM PIPE

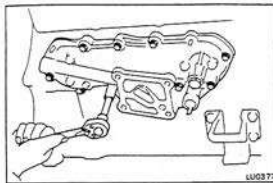


LU-18

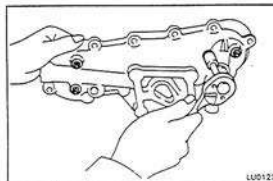
LUBRICATION SYSTEM — Oil Cooler and Relief Valve

**9. REMOVE OIL COOLER COVER WITH OIL COOLER**

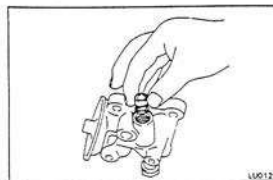
- (a) Using SST, remove the bolt holding the oil cooler cover to cylinder block as shown.
SST 09313-30021



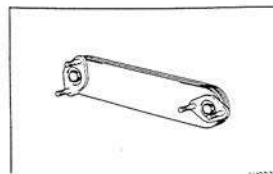
- (b) Remove the nine bolts, two nuts, oil cooler cover with the oil cooler and gasket.

**10. SEPARATE OIL COOLER AND OIL COOLER CASE**

Remove the four nuts, oil cooler, two O-rings and gaskets.

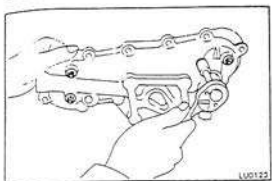
**INSPECTION OF OIL COOLER AND RELIEF VALVE****1. INSPECT RELIEF VALVE**

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.
If it is not, replace the relief valve. If necessary, replace the oil filter bracket.

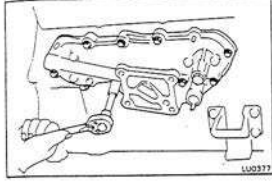
**2. INSPECT OIL COOLER**

Check the oil cooler for damage or clogging.

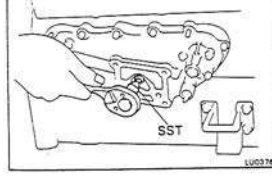
LUBRICATION SYSTEM — Oil Cooler and Relief Valve LU-19



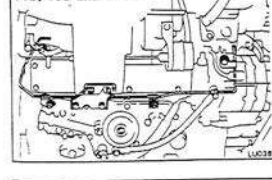
LU0122



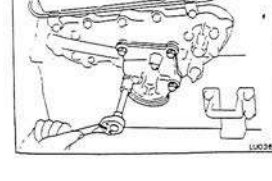
LU0377



LU0378



11B, 13B and 13B-T
LU0381



LU0388

INSTALLATION OF OIL COOLER AND RELIEF VALVE

(See page LU-16)

1. **ASSEMBLE OIL COOLER AND OIL COOLER CASE**
 Assemble the oil cooler and oil cooler case together with new two gaskets and O-rings. Install the four nuts.
 Torque: 130 kg-cm (9 ft-lb, 13 N·m)

2. **INSTALL OIL COOLER CASE AND OIL COOLER ASSEMBLY**
 - (a) Install a new gasket, the oil cooler case and oil cooler assembly with the nine bolts and two nuts.
 Torque: 185 kg-cm (13 ft-lb, 18 N·m)

 - (b) Using SST, install the bolt holding the oil cooler case to the cylinder block.
 SST 09313-30021
 Torque: 185 kg-cm (13 ft-lb, 18 N·m)

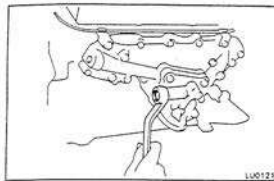
3. **[11B, 13B AND 13B-T] INSTALL VACUUM PIPE**

4. **[13B-T] INSTALL EXHAUST MANIFOLD STAY**

5. **INSTALL OIL FILTER BRACKET**
 Install a new gasket, the oil filter bracket with the four bolts.
 Torque: 375 kg-cm (27 ft-lb, 37 N·m)

LU-20

LUBRICATION SYSTEM — Oil Cooler and Relief Valve

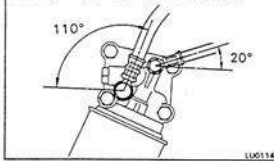


6. INSTALL RELIEF VALVE

Install the relief valve and spring with a new gasket and the plug.

Torque: 500 kg-cm (36 ft-lb, 49 N-m)

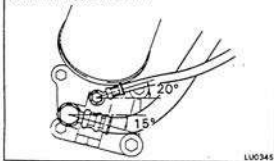
Cartridge Type (B, 3B, 11B and 13B)



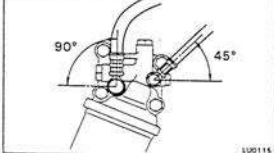
7. CONNECT ALTERNATOR OIL PIPES

Connect the alternator oil pipes with new four gaskets and two union bolts as shown.

Cartridge Type (13B-T)



Paper Element Type



8. [13B-T]

INSTALL TURBOCHARGER OIL PIPE (See page EM-40)

9. INSTALL OIL FILTER (See page LU-3 or 4)

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

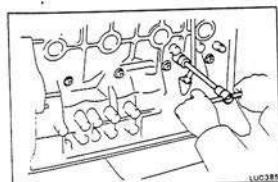
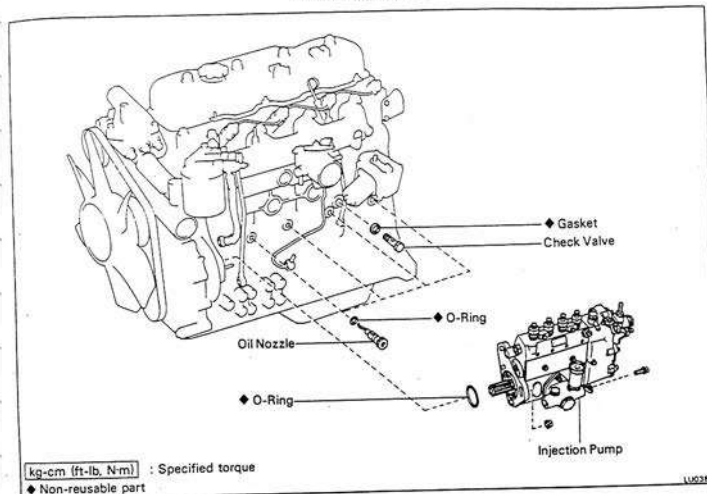
11. START ENGINE AND CHECK FOR LEAKS

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

LUBRICATION SYSTEM — Oil Nozzles and Check Valve [3B and 13B-T]

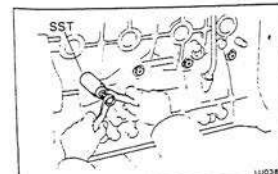
LU-21

OIL NOZZLES AND CHECK VALVE [3B and 13B-T] COMPONENTS



REMOVAL OF OIL NOZZLES AND CHECK VALVE

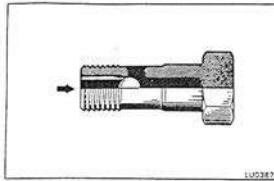
1. REMOVE INJECTION PUMP (See page FU-27)
2. REMOVE CHECK VALVE



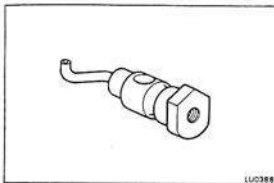
3. REMOVE OIL NOZZLES
Using SST, remove the oil nozzles.
SST 09219-56010

LU-22

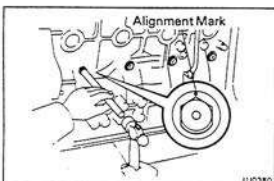
LUBRICATION SYSTEM — Oil Nozzles and Check Valve [3B and 13B-T]

**INSPECTION OF OIL NOZZLE AND CHECK VALVE****1. INSPECT CHECK VALVE**

Push the valve with a wooden stick to check if it is stuck. If stuck, replace the check valve.

**2. INSPECT OIL NOZZLES**

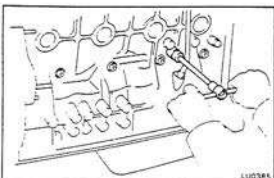
Check the oil nozzle for damage or clogging.

**INSTALLATION OF OIL NOZZLES AND CHECK VALVE**

(See page LU-21)

1. INSTALL OIL NOZZLES

- Install a new O-ring to the oil nozzle.
- Apply a light coat of engine oil on the O-ring.
- Align the head point of the oil nozzle with the alignment mark of the cylinder block.
- Using a brass bar and hammer, tap in the four nozzles.

**2. INSTALL CHECK VALVE**

Install a new gasket and the check valve.
Torque: 350 kg-cm (25 ft-lb, 34 N-m)