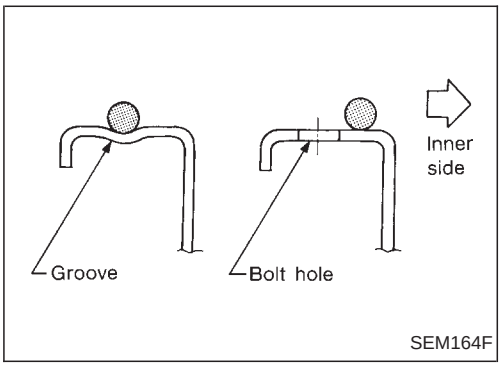
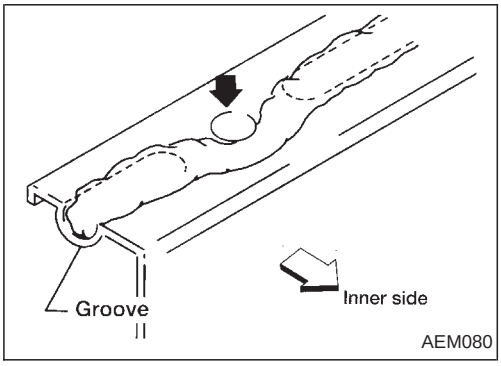
ENGINE LUBRICATION & COOLING SYSTEMS

SECTION LC

CONTENTS



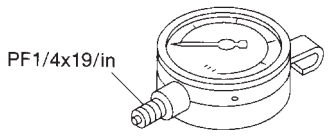
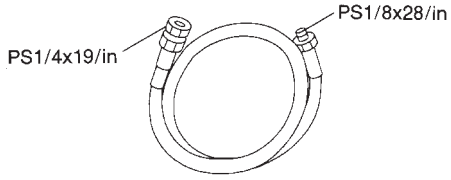
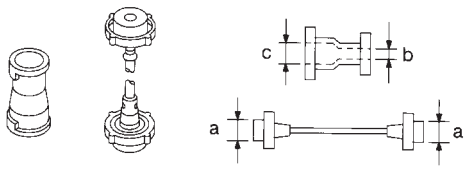


Liquid Gasket Application Procedure

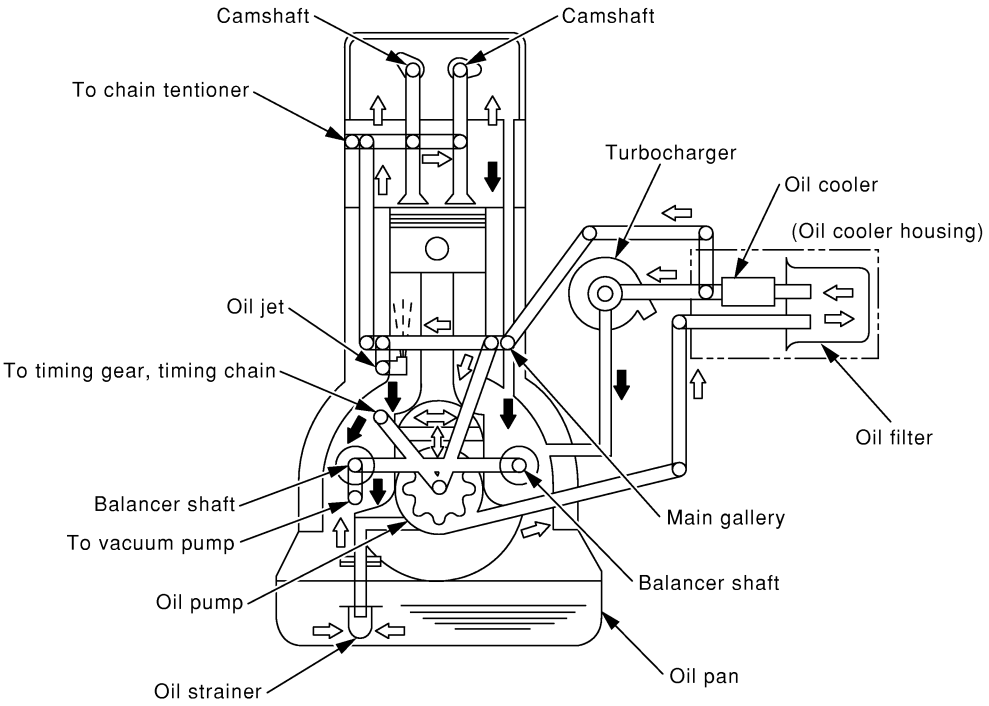
a. Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
b. Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)
   - For oil pan, be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in).
   - For areas except oil pan, be sure liquid gasket diameter is 2.0 to 3.0 mm (0.079 to 0.118 in).
c. Apply liquid gasket around the inner side of bolt holes (unless otherwise specified).
d. Assembly should be done within 5 minutes after coating.
e. Wait at least 30 minutes before refilling engine oil and engine coolant.

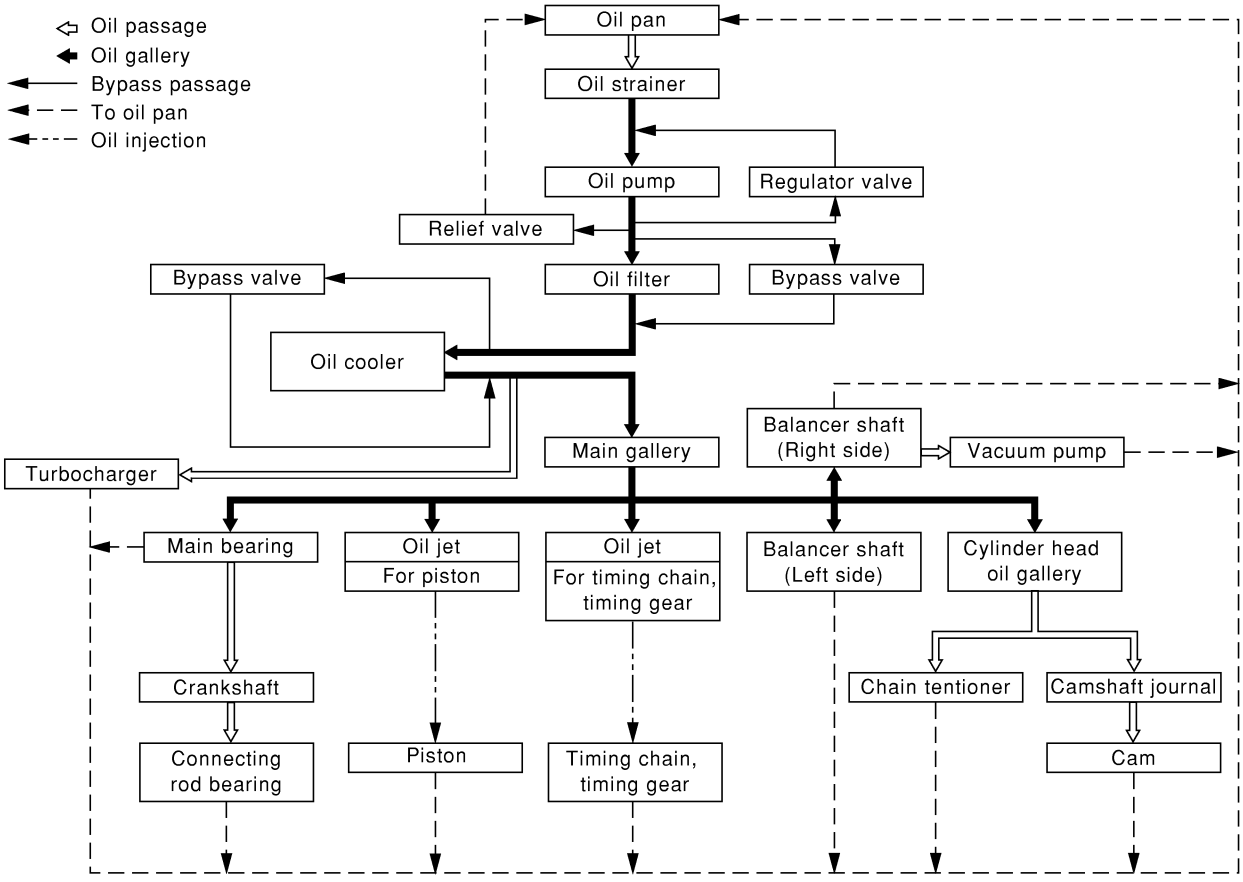
Special Service Tools

*: Special tool or commercial equivalent

Tool number Tool name	Description	
ST25051001* Oil pressure gauge	 NT558	Measuring oil pressure **Maximum measuring range: 2,452 kPa (24.5 bar, 25 kg/cm^2, 356 psi)**
ST25052000* Hose	 NT559	Adapting oil pressure gauge to cylinder block
EG17650301 Radiator cap tester adapter	 NT564	Adapting radiator cap tester to radiator filler neck and reservoir tank cap **a: 28 (1.10) dia.** **b: 31.4 (1.236) dia.** **c: 41.3 (1.626) dia.** Unit: mm (in)

Lubricating Circuit





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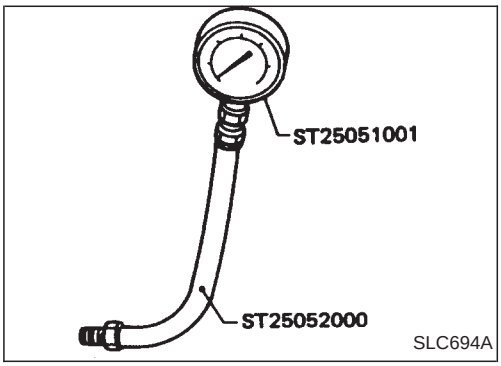
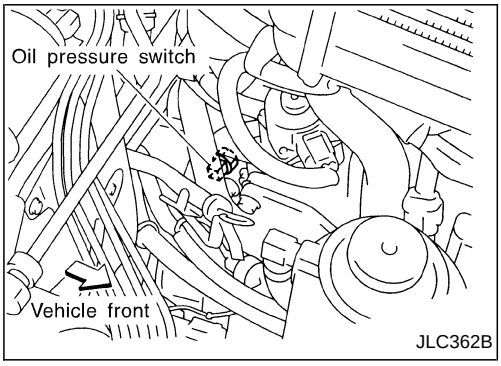




Oil Pressure Check

WARNING:

- **Be careful not to burn yourself, as the engine and oil may be hot.**
- **Oil pressure check should be done in “Neutral” gear position.**

1. Check oil level.
2. Remove oil pressure switch.
3. Install pressure gauge.
4. Start engine and warm it up to normal operating temperature.
5. Check oil pressure with engine running under no-load.

Engine speed rpm	Approximate discharge pressure kPa (bar, kg/cm^2, psi)
Idle speed	More than 147 (1.47, 1.5, 21)
2,000	More than 539 (5.39, 5.5, 78)
4,000	More than 736 (7.36, 7.5, 107)

If difference is extreme, check oil passage and oil pump.

6. Install oil pressure switch with sealant.

Oil pressure switch:

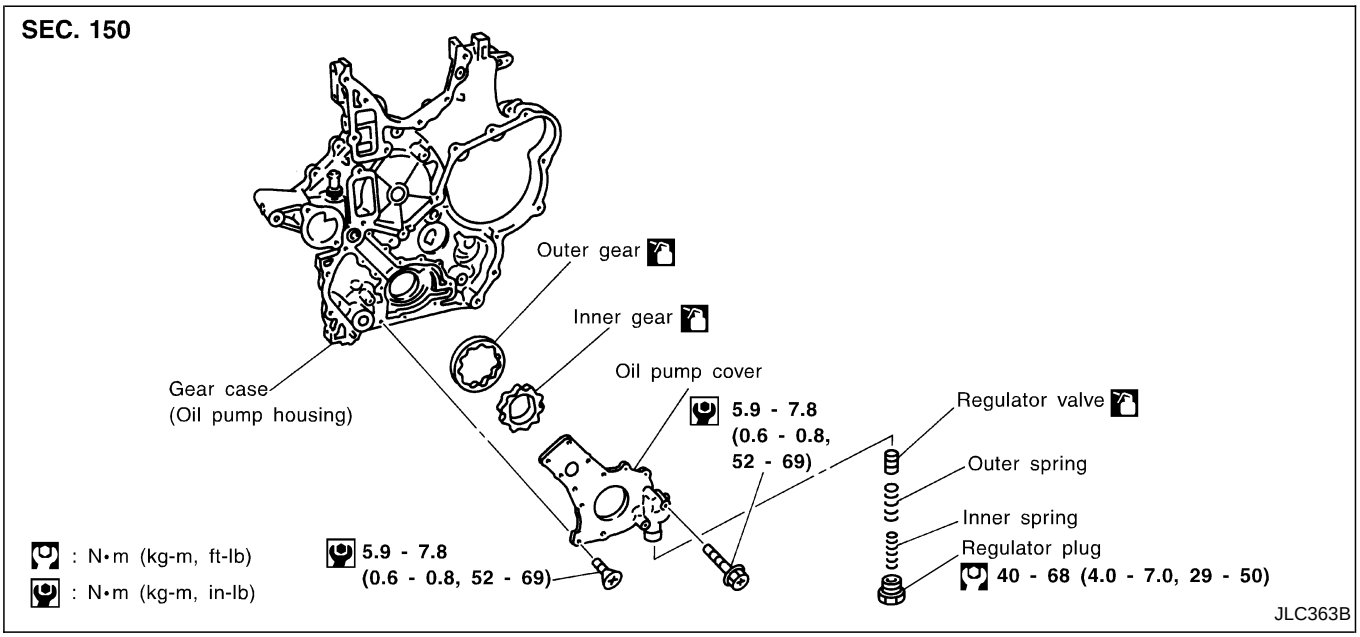
: 13 - 17 N·m (1.25 - 1.75 kg-m, 9 - 12 ft-lb)

Oil Pump

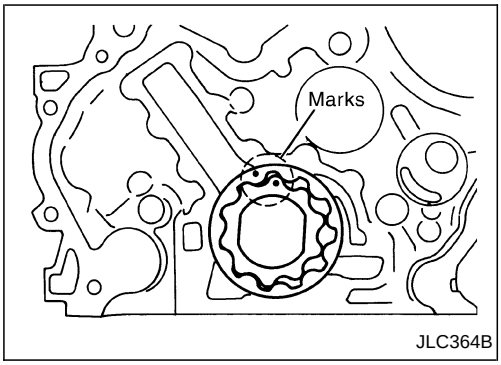
REMOVAL AND INSTALLATION

Refer to “TIMING GEAR” in EM section.

DISASSEMBLY AND ASSEMBLY



- **When installing oil pump, apply new engine oil to gears.**



- **When installing the inner and outer gear, face mating mark toward the oil pump cover as shown (left).**

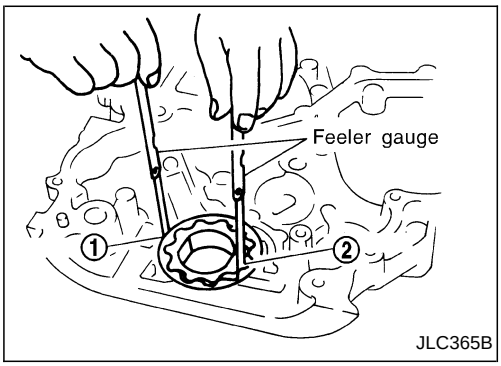
Oil Pump (Cont'd)

OIL PUMP INSPECTION

Using a feeler gauge, straightedge and micrometers, check the following clearances:

Unit: mm (in)

Body to outer gear radial clearance ①	0.114 - 0.200 (0.0045 - 0.0079)
Inner gear to outer gear tip clearance ②	Less than 0.180 (0.0071)
Body to inner gear axial clearance ③	0.05 - 0.09 (0.0020 - 0.0035)
Body to outer gear axial clearance ④	0.050 - 0.105 (0.0020 - 0.0041)
Inner gear to brazed portion of housing clearance ⑤	0.045 - 0.091 (0.0018 - 0.0036)
Regulator valve to oil pump cover clearance ⑥	0.040 - 0.097 (0.0016 - 0.0038)



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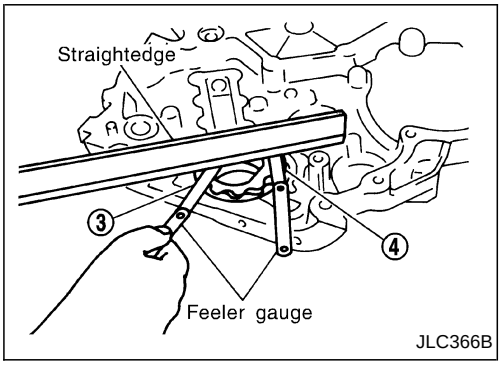

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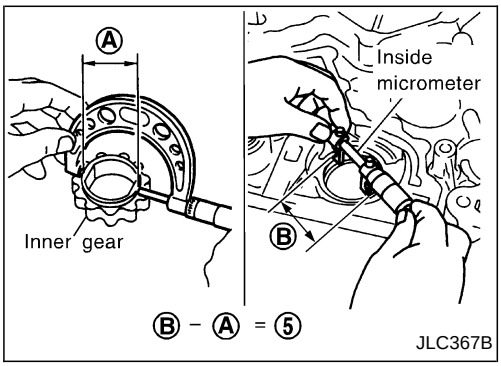

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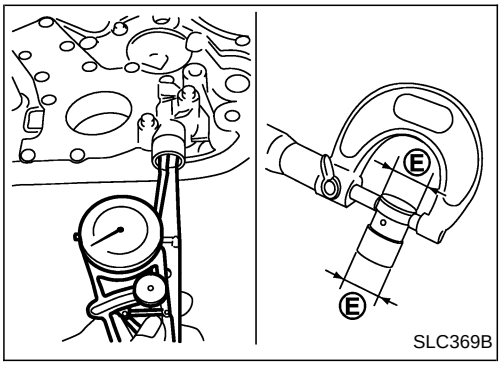
- **If the tip clearance (②) exceeds the limit, replace gear set.**
- **If body to gear clearances (① , ③ , ④ , ⑤) exceed the limit, replace oil pump body assembly.**

REGULATOR VALVE INSPECTION

1. Visually inspect components for wear and damage.
2. Check oil pressure regulator valve sliding surface and valve spring.
3. Coat regulator valve with engine oil. Check that it falls smoothly into the valve hole by its own weight.

If damaged, replace regulator valve set or oil pump cover.



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4. Check regulator valve to oil pump cover clearance.

Clearance:

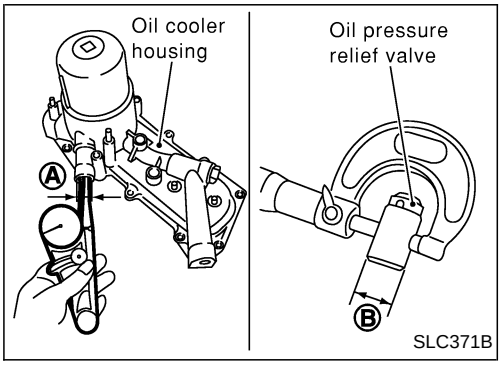
⑥ : 0.040 - 0.097 mm (0.0016 - 0.0038 in)

If it exceeds the limit, replace oil pump cover.

Oil Pump (Cont'd)

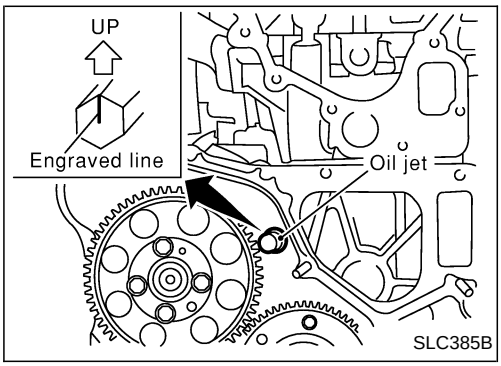
OIL PRESSURE RELIEF VALVE AND BYPASS VALVE INSPECTION (For oil cooler)

1. Inspect oil pressure relief valve for movement, cracks and breaks by pushing the ball. If replacement is necessary, remove valve by prying it out with suitable tool.
   Install a new valve in place by tapping it.



2. Check oil pressure relief valve to oil cooler housing clearance.
   Clearance:
   Ⓒ: 0.032 - 0.068 mm (0.0013 - 0.0027 in)

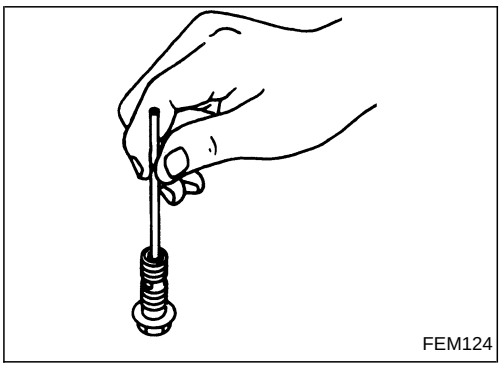
If it exceeds the limit, replace oil cooler housing.



Oil Jet

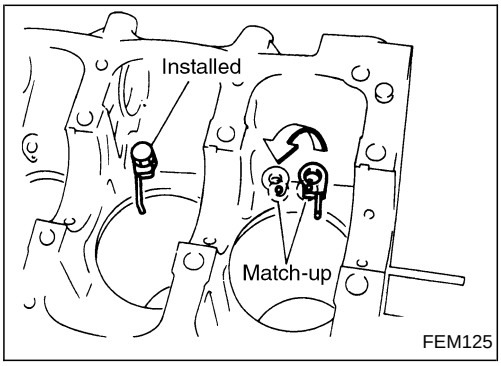
INSPECTION (For timing chain)

Make sure that the holes are not clogged. Clean them with a wire if necessary.
Drive oil jet into place after positioning alignment mark on.



INSPECTION (For piston)

1. Push cut-off valve of oil jet bolt with a clean resin or brass rod and make sure that cut-off valve moves smoothly with proper repulsion.
2. Make sure that the oil jet passage is not clogged. Clean with a wire if necessary.



When installing oil jet, align oil jet's boss with hole on cylinder block.

Oil jet:

: 30 - 39 N·m (3.0 - 4.0 kg-m, 22 - 28 ft-lb)

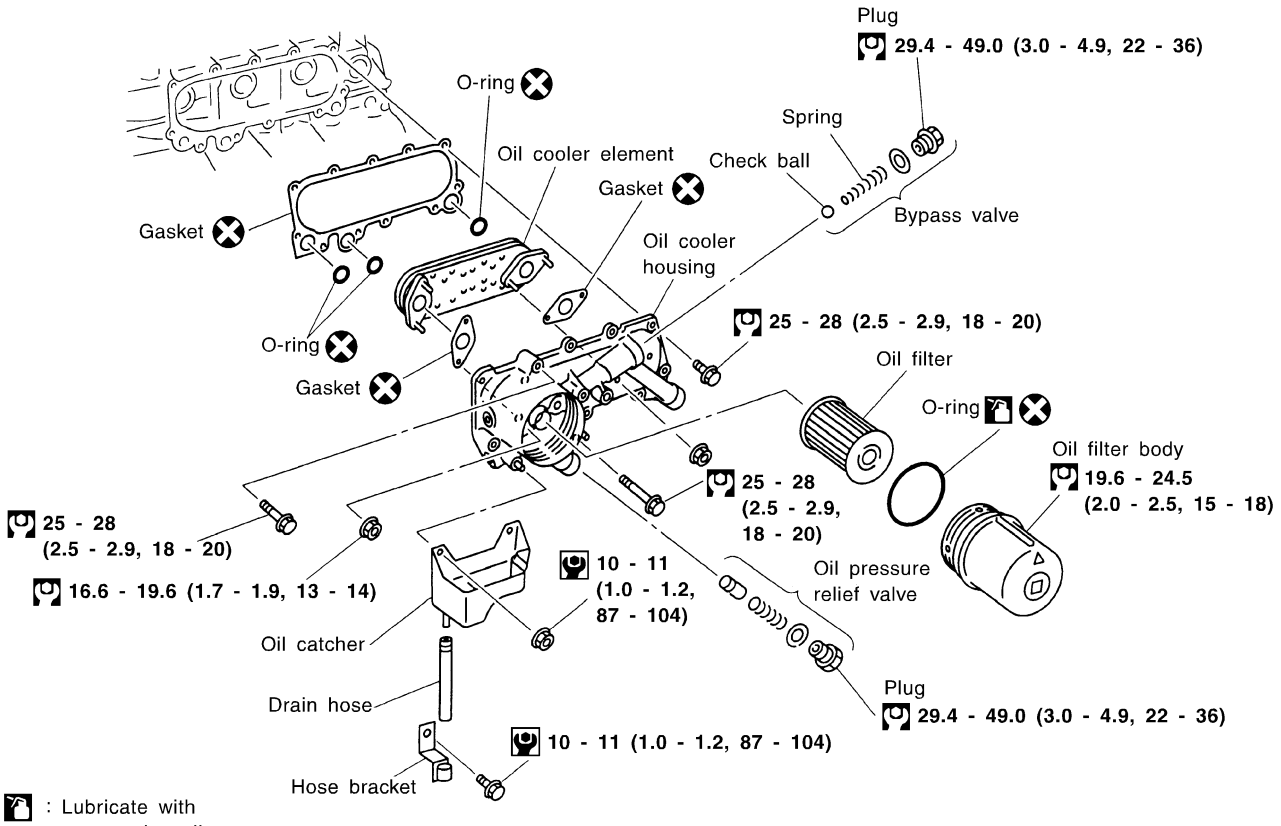
Oil Jet (Cont'd)

OIL FILTER

The oil filter is an element type. Refer to "Changing Oil Filter" in MA section.

Oil Cooler

SEC. 213



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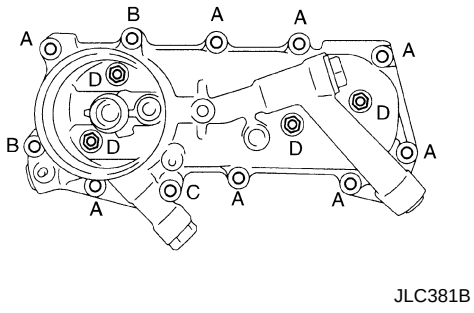

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REMOVAL AND INSTALLATION

1. Drain engine oil and coolant.
   Remove catalyst and turbocharger. Refer to "CATALYST AND TURBOCHARGER" in EM section.
2. Remove bolts A to C then remove oil cooler assembly.

- **Do not remove "D" nuts when removing oil cooler assembly.**

  Bolt length:
  A: 20 mm (0.79 in)
  B: 45 mm (1.77 in)
  C: 65 mm (2.56 in)

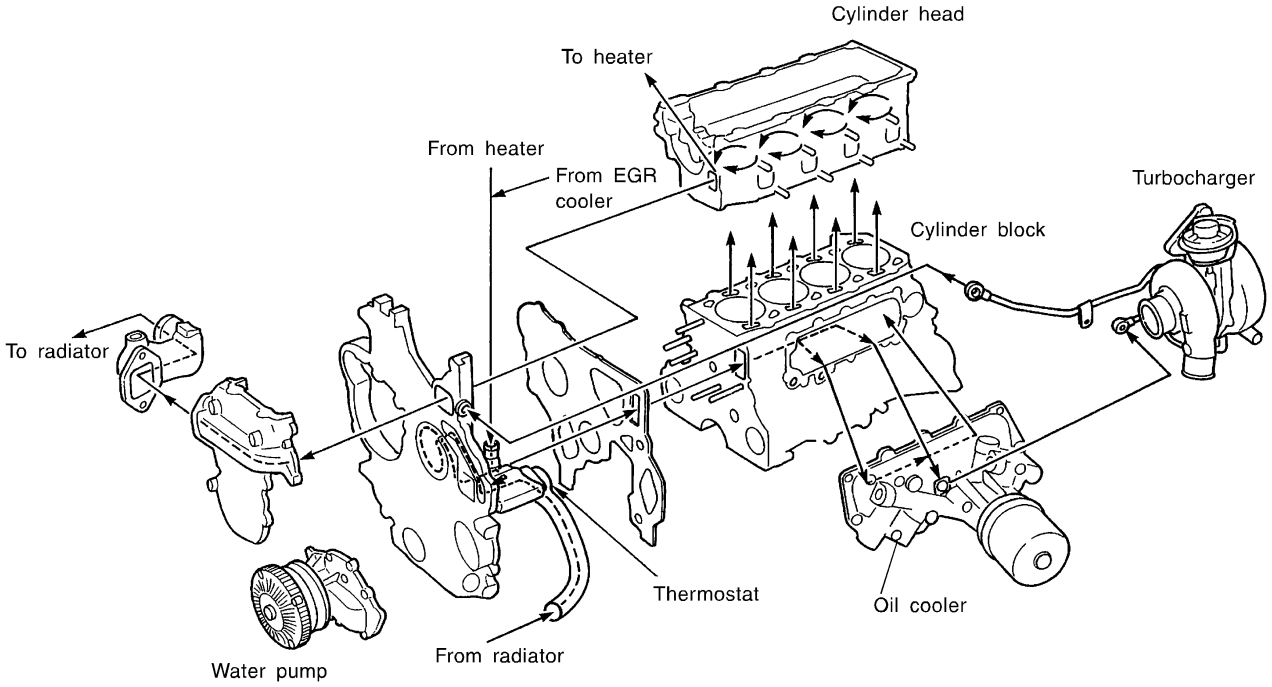
3. Installation is in reverse order of removal.

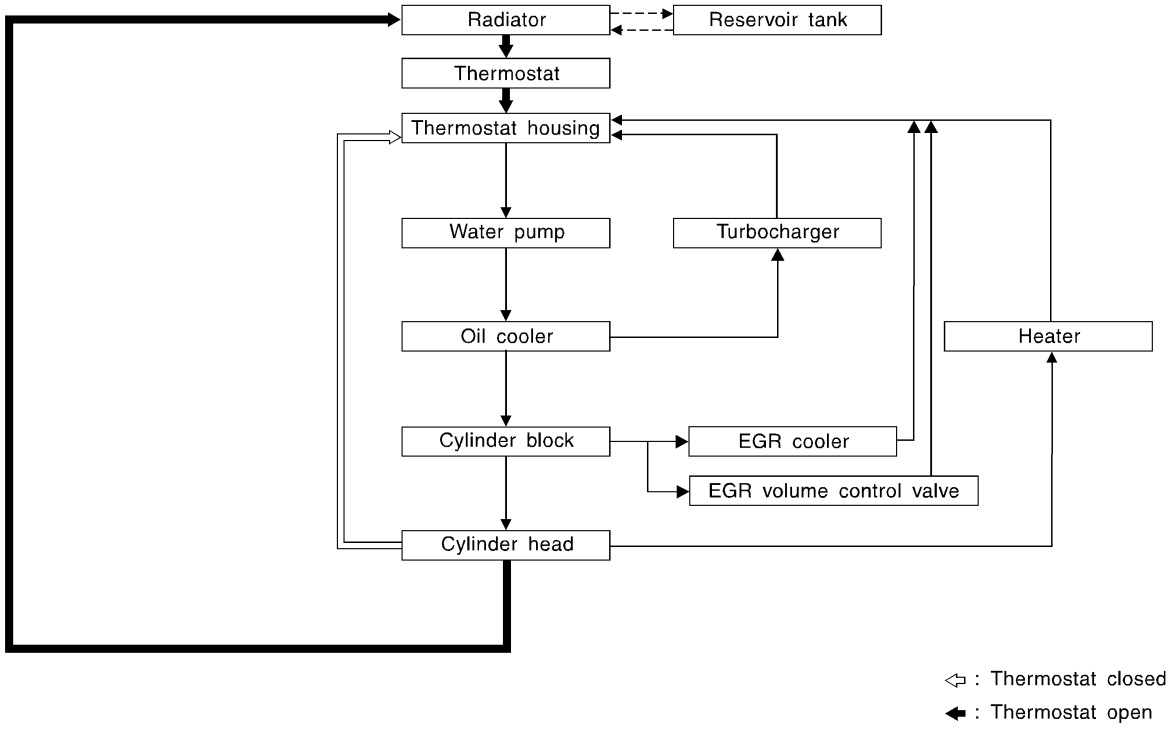
- **Do not spill coolant on the drive belt.**

INSPECTION

1. Check oil cooler for cracks.
2. Check oil cooler for clogging by blowing through coolant inlet. If necessary, replace oil cooler assembly.

Cooling Circuit





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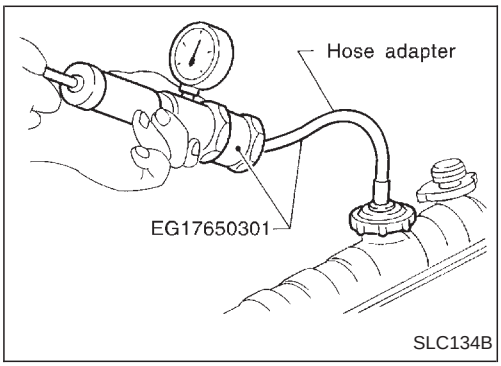
System Check

WARNING:
Never remove the radiator cap when the engine is hot. Serious burns could occur from high pressure coolant escaping from the radiator.
Wrap a thick cloth around the cap. Slowly turn it a quarter turn to allow built-up pressure to escape. Carefully remove the cap by turning it all the way.

CHECKING COOLING SYSTEM HOSES

Check hoses for the following:

- Improper attachment
- Leaks
- Cracks
- Damage
- Chafing
- Deterioration

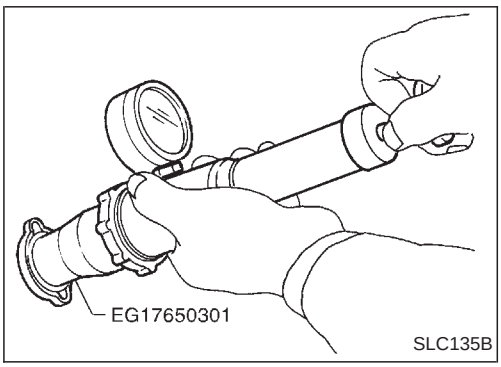


CHECKING COOLING SYSTEM FOR LEAKS

To check for leakage, apply pressure to the cooling system with a tester.

Testing pressure:
157 kPa (1.57 bar, 1.6 kg/cm^2, 23 psi)

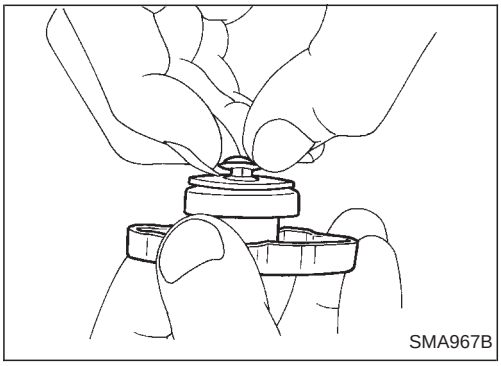
CAUTION:
Higher pressure than specified may cause radiator damage.



CHECKING RADIATOR CAP

To check radiator cap, apply pressure to cap with a tester.

Radiator cap relief pressure:
Standard
78 - 98 kPa
(0.78 - 0.98 bar, 0.8 - 1.0 kg/cm^2, 11 - 14 psi)

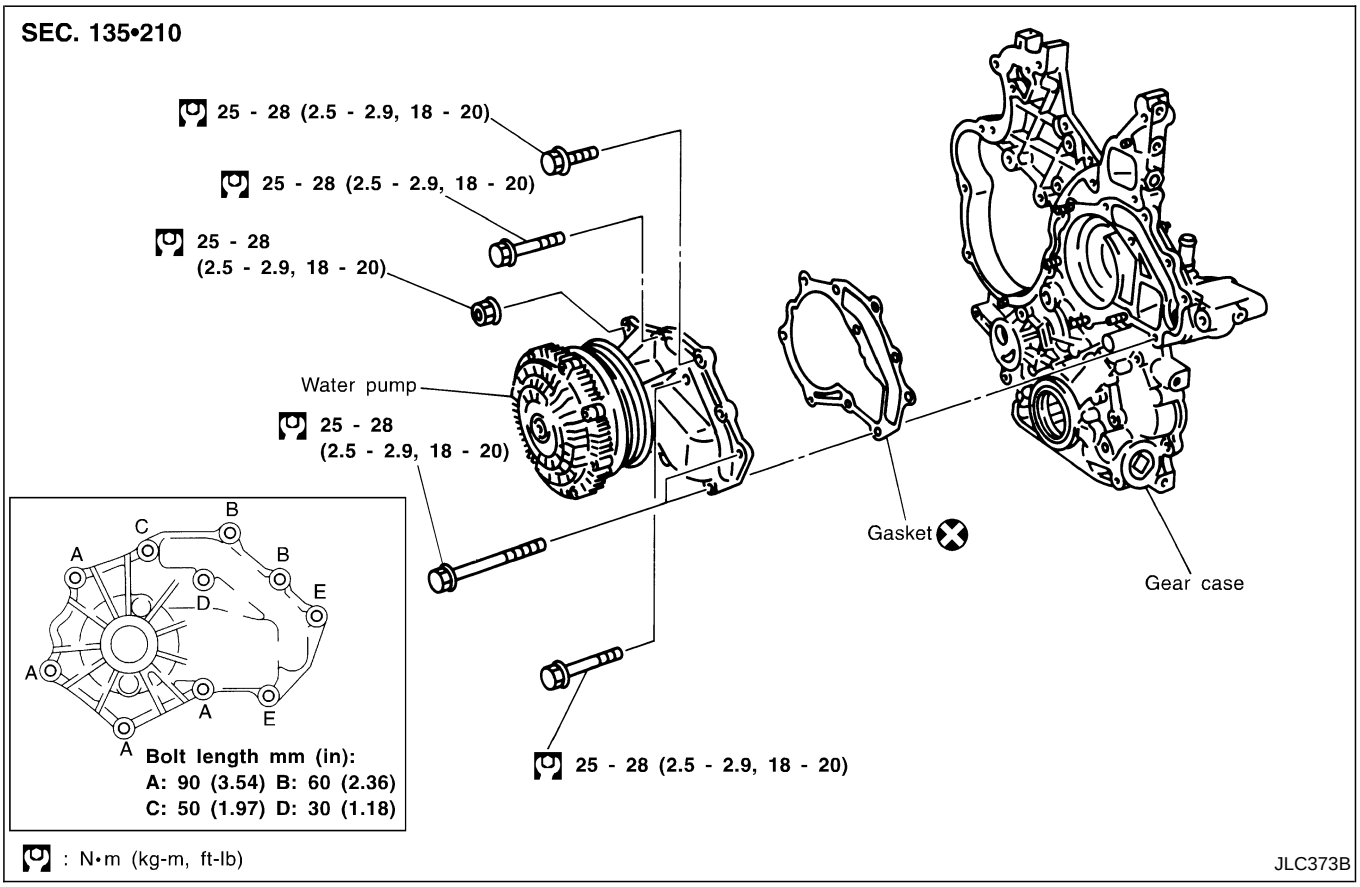


Pull the negative pressure valve to open it.
Check that it closes completely when released.

Water Pump

CAUTION:

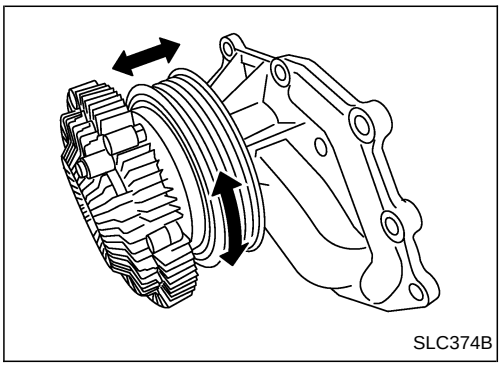
- **When removing water pump assembly, be careful not to get coolant on drive belt.**
- **Water pump cannot be disassembled and should be replaced as a unit.**
- **Always replace with new gasket.**
- **After installing water pump, connect hose and clamp securely, then check for leaks using radiator cap tester. Refer to MA section.**



REMOVAL AND INSTALLATION

1. Drain coolant from radiator and cylinder block. Refer to MA section (“Changing Engine Coolant”, “ENGINE MAINTENANCE”).
2. Remove radiator upper hose.
3. Remove radiator shroud.
4. Remove cooling fan.
5. Remove drive belt. Refer to MA section, “Checking Drive Belt”.
6. Remove insulator.
7. Remove vacuum pipe.
8. Remove TDC sensor. Refer to EM section, “TDC sensor removal and installation” in “TIMING GEAR”.
9. Remove fan coupling with water pump.
10. Install in the reverse order of removal.

Water Pump (Cont'd)


SLC374B

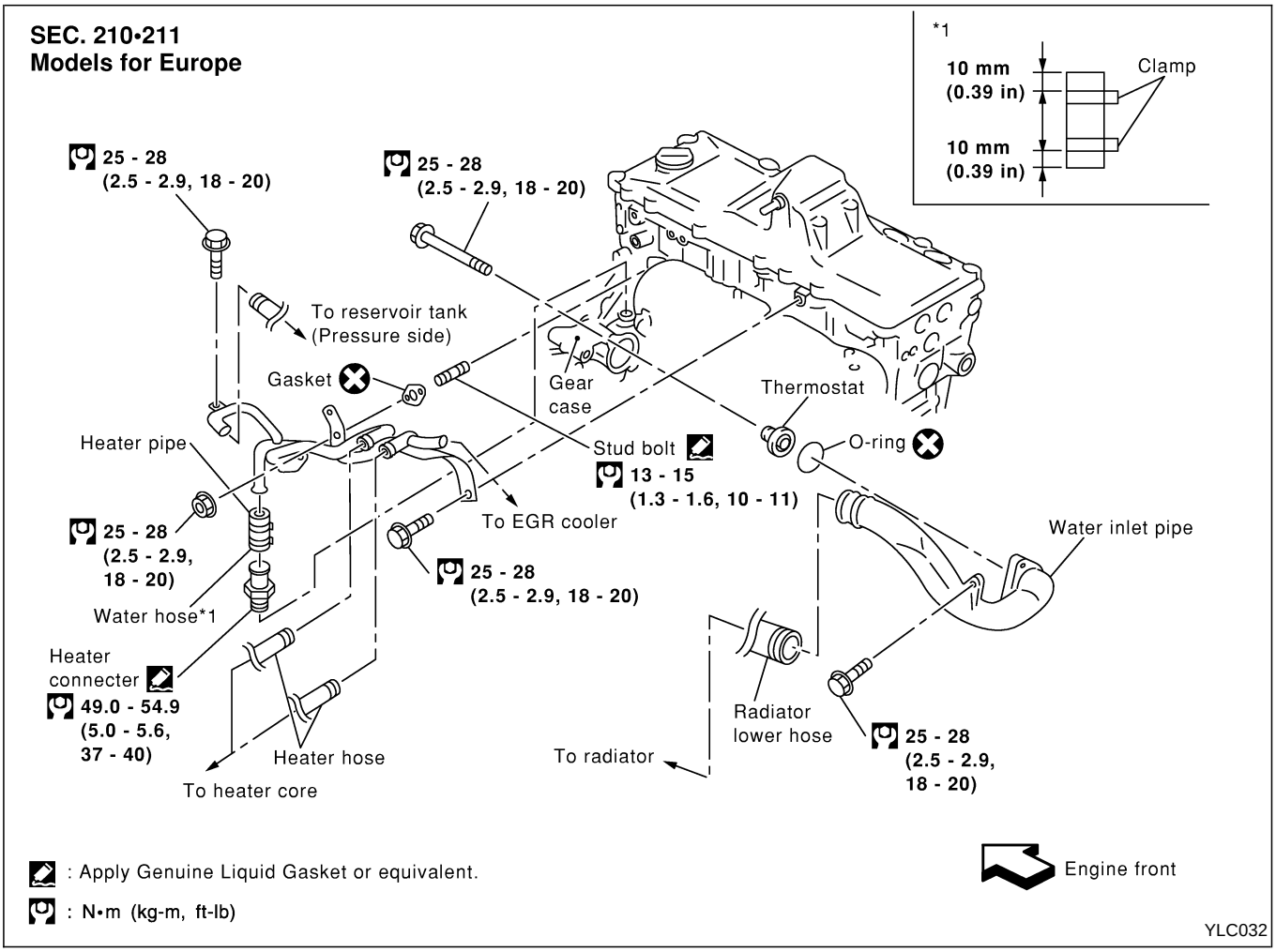
INSPECTION

1. Check for badly rusted or corroded body assembly and vane.
2. Check for rough operation due to excessive end play.

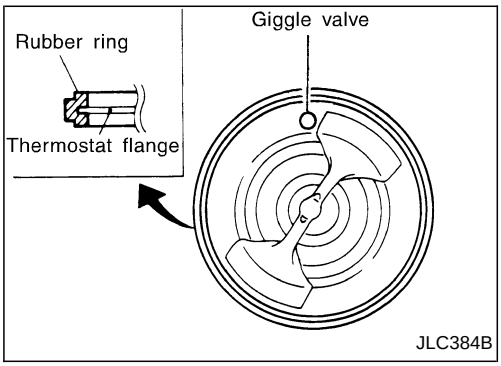
CAUTION:

Do not disassemble water pump coupling assembly.

Thermostat



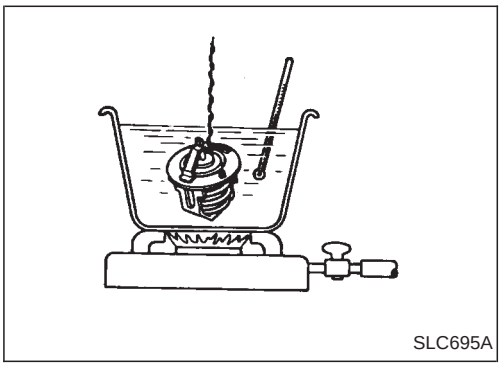
Thermostat (Cont'd)



REMOVAL AND INSTALLATION

1. Drain engine coolant. Refer to MA section, "Changing Engine Coolant".
2. Remove left side battery. (If so equipped)
3. Remove radiator upper hose.
4. Remove radiator shroud.
5. Remove intake air duct, inlet pipe.
6. Remove harness and connectors.
7. Install in reverse order of removal.

- **After installation, run engine for a few minutes and check for leaks.**
- **Be careful not to spill coolant in engine compartment. Use a rag to absorb coolant.**

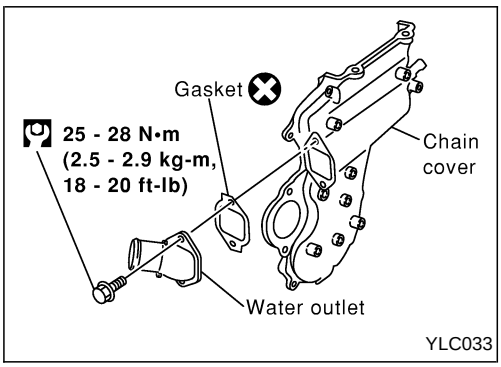


INSPECTION

1. Check valve seating condition at ordinary temperatures. It should seat tightly.
2. Check valve opening temperature and maximum valve lift.

Valve opening temperature	°C (°F)	82 (180)
Maximum valve lift	mm/°C (in/°F)	10/95 (0.39/203)

3. Then check if valve closes at 5°C (9°F) below valve opening temperature.

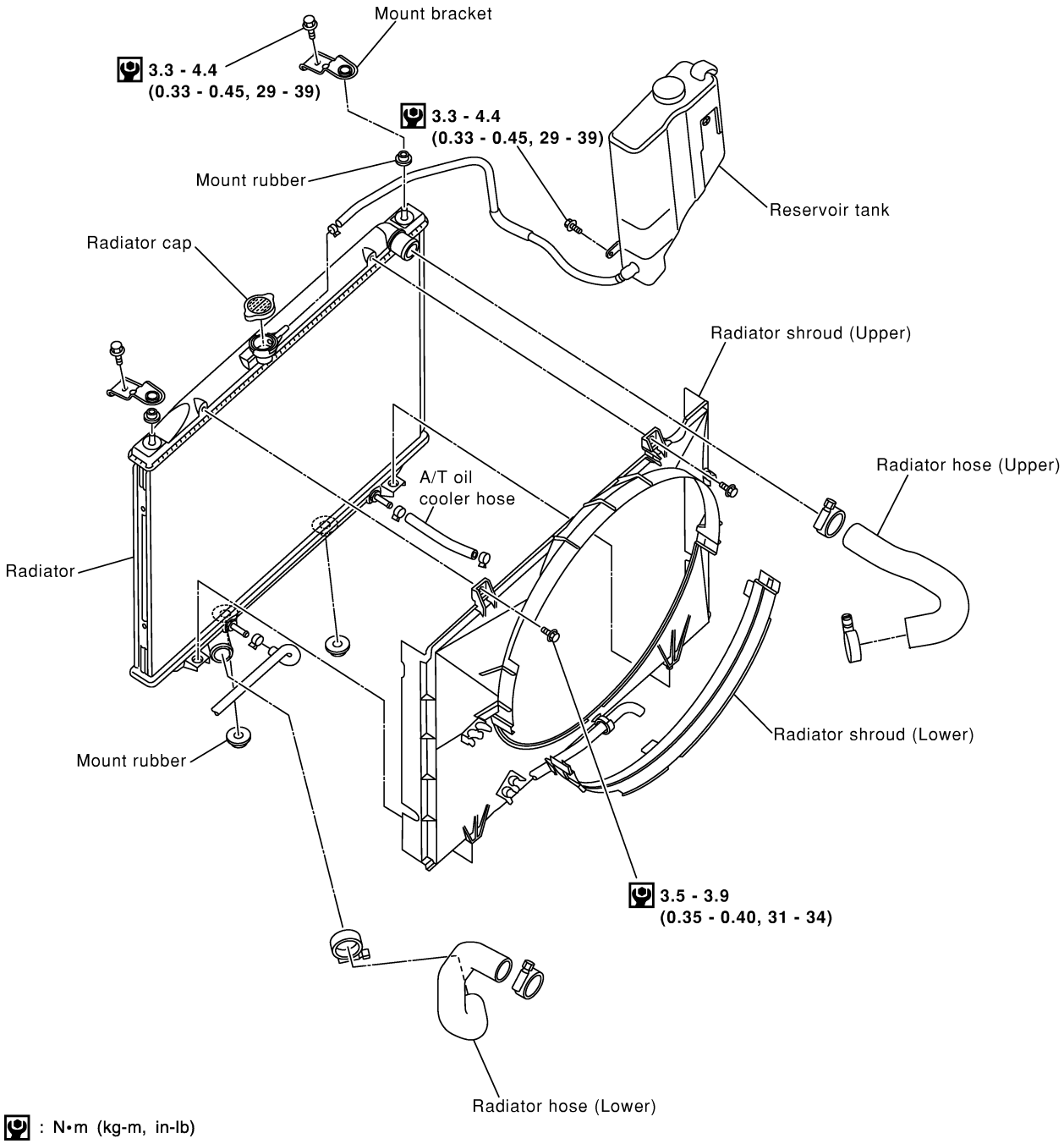


Water Outlet

INSPECTION

Visual inspection for water leaks. If there is leakage, replace gasket.

Radiator



: N•m (kg-m, in-lb)

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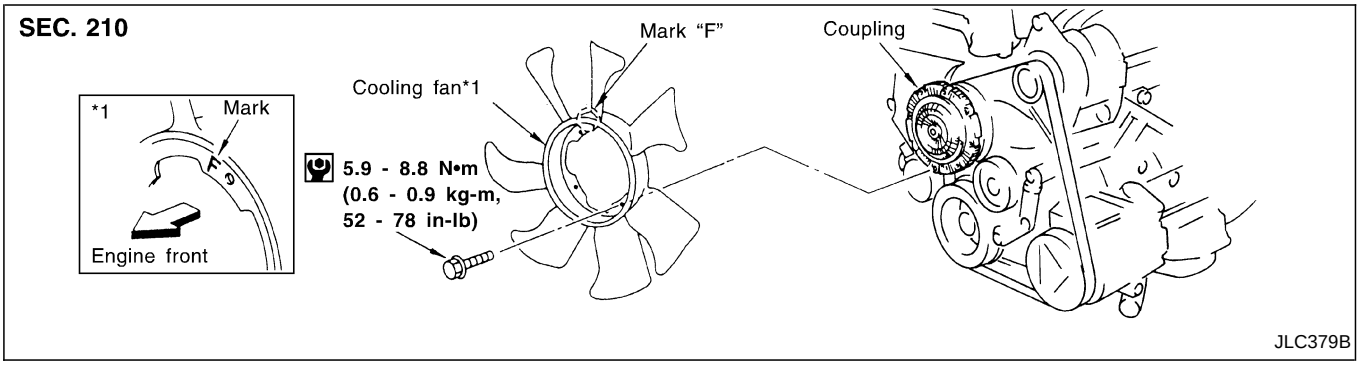
Radiator (Cont'd)

REMOVAL AND INSTALLATION

1. Remove under cover.
2. Drain engine coolant. Refer to MA section, "Changing Engine Coolant".
3. Remove air cleaner case, air duct and resonator.
4. Remove battery (right side).
5. Remove radiator shroud (lower).
6. Remove radiator shroud (front).
7. Disconnect radiator hose (upper and lower).
8. Disconnect reservoir tank hose.
9. Disconnect A/T oil cooler hose (Only A/T models).
10. Remove radiator.
11. After repairing or replacing radiator, install all removed parts in reverse order of removal.

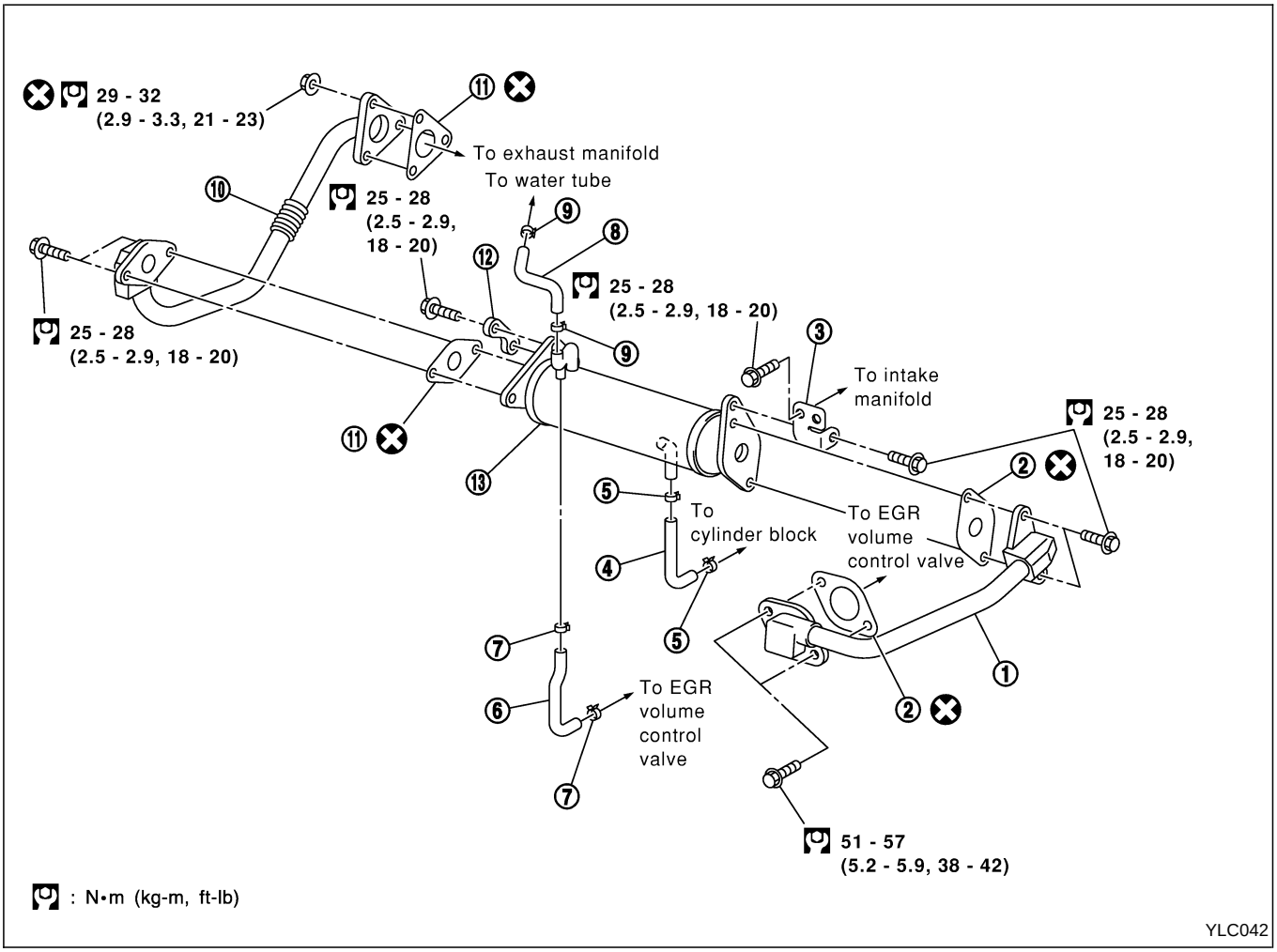
Cooling Fan (Crankshaft driven)

DISASSEMBLY AND INSTALLATION



- Do not release the drive belt tension by removing the fan/water pump pulley.
- Fan coupling cannot be disassembled and should be replaced as a unit. If front mark Ⓕ is present, install fan so that side marked Ⓕ faces the front.
- Proper alignment of these components is essential. Improper alignment will cause them to wobble and may eventually cause the fan to separate from the water pump causing extensive damage.

EGR Cooler



① EGR tube assembly
② Gasket
③ EGR cooler bracket
④ Water hose
⑤ Clamp
⑥ Water hose
⑦ Clamp
⑧ Water hose
⑨ Clamp
⑩ EGR tube
⑪ Gasket
⑫ EGR cooler bracket
⑬ EGR cooler

Engine Lubrication System

Oil pressure check

Engine speed rpm	Approximate discharge pressure kPa (bar, kg/cm^2, psi)
Idle speed	More than 147 (1.47, 1.5, 21)
2,000	More than 539 (5.39, 5.5, 78)
4,000	More than 736 (7.36, 7.5, 107)

Oil pump

Unit: mm (in)

Body to outer gear radial clearance ①	0.114 - 0.200 (0.0045 - 0.0079)
Inner gear to outer gear tip clearance ②	Less than 0.180 (0.0071)
Body to inner gear axial clearance ③	0.05 - 0.09 (0.0020 - 0.0035)
Body to outer gear axial clearance ④	0.050 - 0.105 (0.0020 - 0.0041)
Inner gear to brazed portion of housing clearance ⑤	0.045 - 0.091 (0.0018 - 0.0036)
Regulator valve to oil pump cover clearance ⑥	0.040 - 0.097 (0.0016 - 0.0038)

Engine Cooling System

Radiator

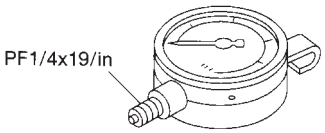
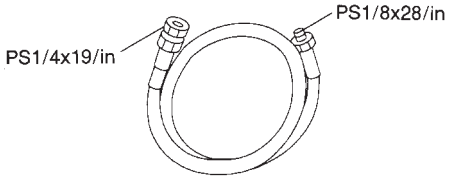
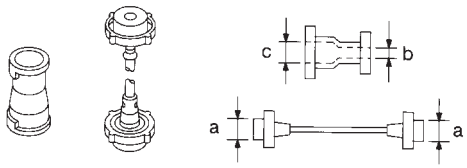
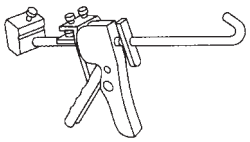
Unit: kPa (bar, kg/cm^2, psi)

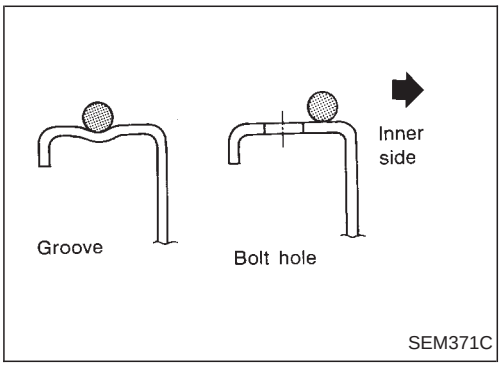
Cap relief pressure	78 - 98 (0.78 - 0.98, 0.8 - 1.0, 11 - 14)
Leakage test pressure	157 (1.57, 1.6, 23)

Thermostat

Valve opening temperature	°C (°F)	82 (180)
Valve lift	mm/°C (in/°F)	More than 10/95 (0.39/203)

SPECIAL SERVICE TOOLS

Tool number Tool name	Description	
ST25051001 Oil pressure gauge	 NT558	Measuring oil pressure **Maximum measuring range:** **2,452 kPa (24.5 bar, 25 kg/cm^2, 356 psi)**
ST25052000 Hose	 NT559	Adapting oil pressure gauge to cylinder block
EG17650301 Radiator cap tester adapter	 NT564	Adapting radiator cap tester to radiator filler neck **a: 28 (1.10) dia.** **b: 31.4 (1.236) dia.** **c: 41.3 (1.626) dia.** Unit: mm (in)
WS39930000 Tube presser	 NT052	Pressing the tube of liquid gasket

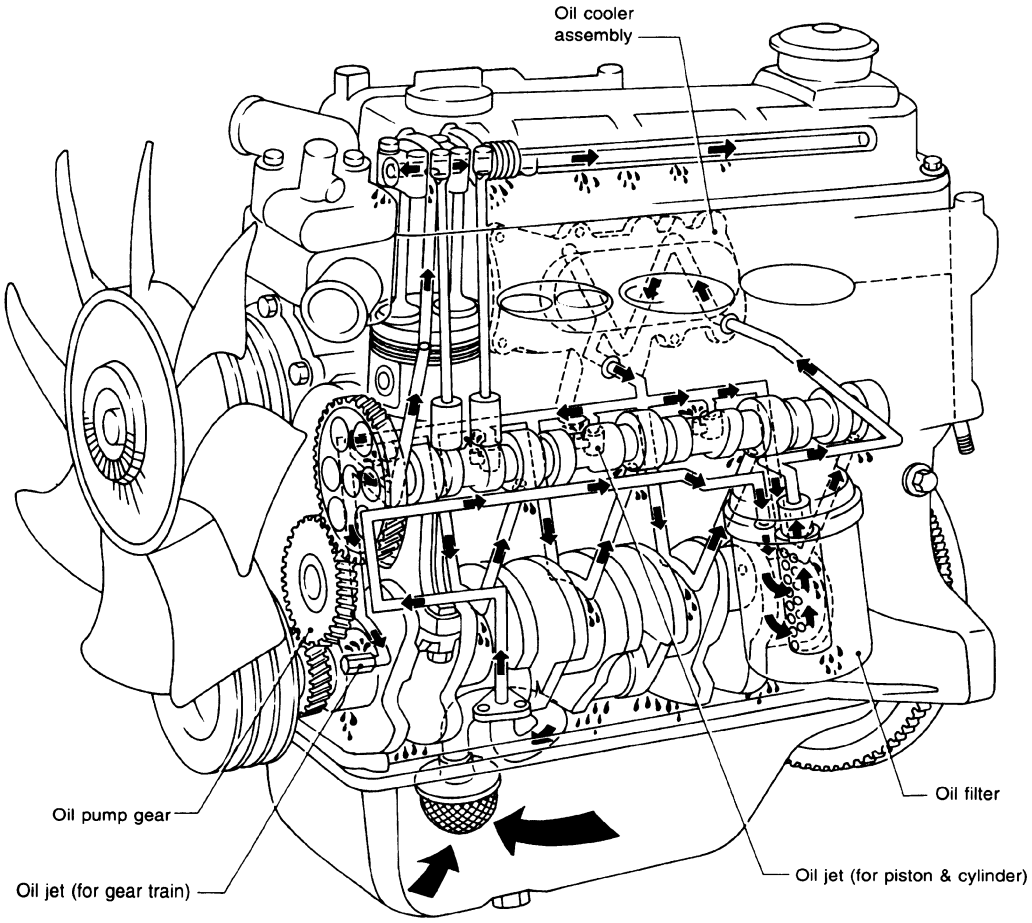


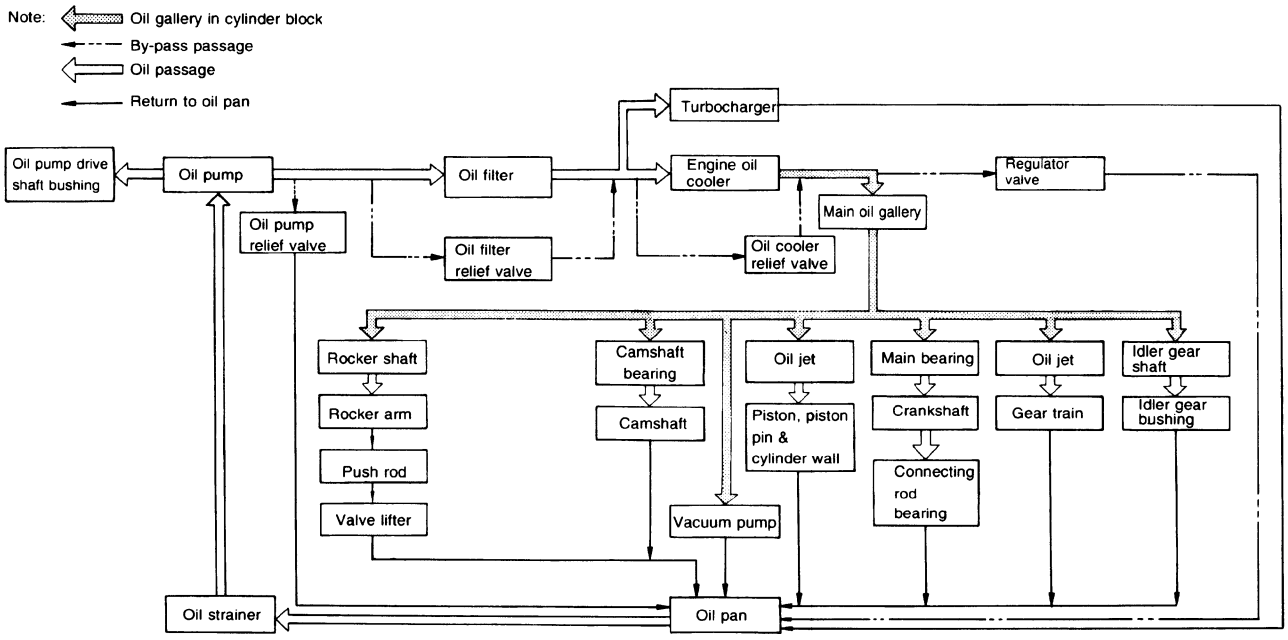
LIQUID GASKET APPLICATION PROCEDURE

a. Before applying liquid gasket, use a scraper to remove all traces of old liquid gasket from mating surface.
b. Apply a continuous bead of liquid gasket to mating surfaces.
(Use Genuine Liquid Gasket or equivalent.)
   - Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide (for oil pan).
   - Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) wide (in areas except oil pan).

c. Apply liquid gasket to inner sealing surface around hole perimeter area.
(Assembly should be done within 5 minutes after coating.)
d. Wait at least 30 minutes before refilling engine oil and engine coolant.

Lubrication Circuit



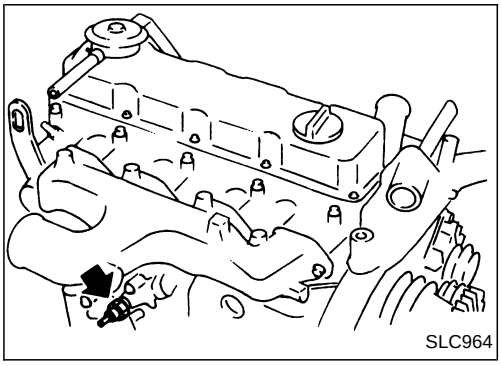


ELC037

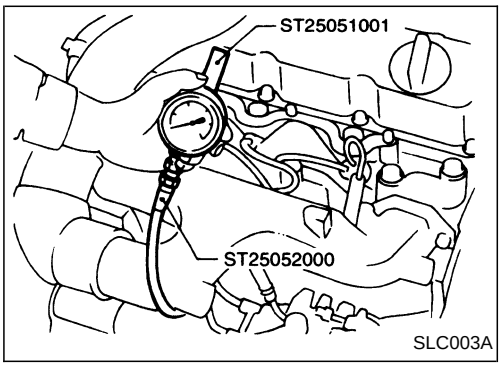
Oil Pressure Check

WARNING:

- **Be careful not to burn yourself, as the engine and oil may be hot.**
- **Oil pressure check should be done in "Neutral" gear position.**


SLC964

1. Check oil level.
2. Remove oil pressure switch.



SLC003A

3. Install pressure gauge.
4. Start engine and warm it up to normal operating temperature.
5. Check oil pressure with engine running under no-load.

Engine rpm	Approximate discharge pressure kPa (bar, kg/cm^2, psi)
Idle speed	More than 78 (0.78, 0.8, 11)
3,000	294 - 392 (2.94 - 3.92, 3.0 - 4.0, 43 - 57)

If difference is extreme, check oil passage and oil pump for oil leaks.

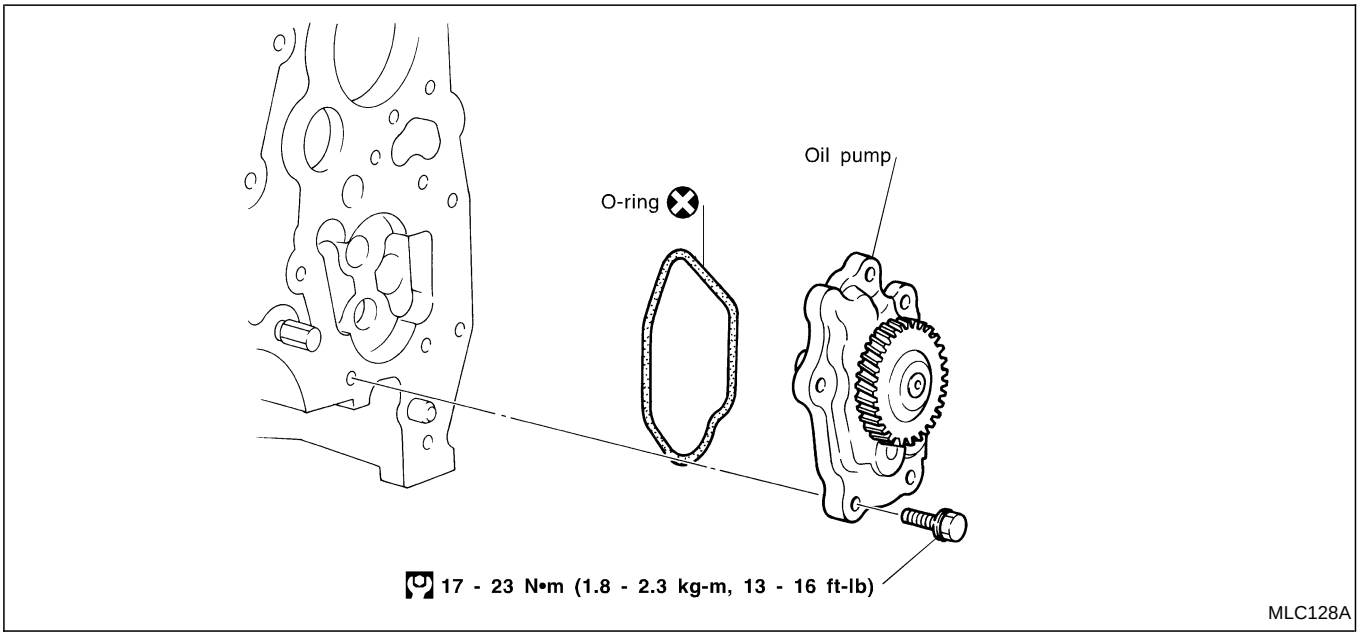
6. Install oil pressure switch.

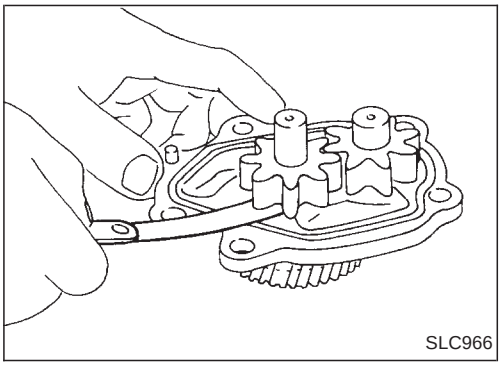
Use proper liquid sealant.

Oil pressure switch:

: 10 - 13 N·m (1.0 - 1.3 kg-m, 87 - 113 in-lb)

Oil Pump

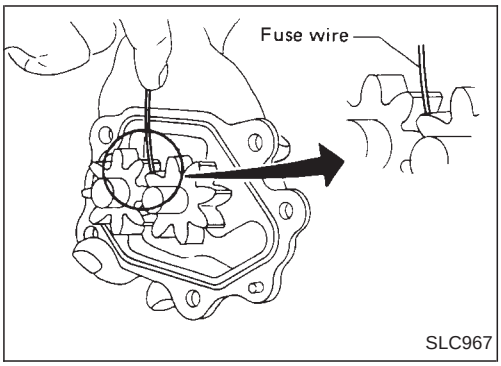




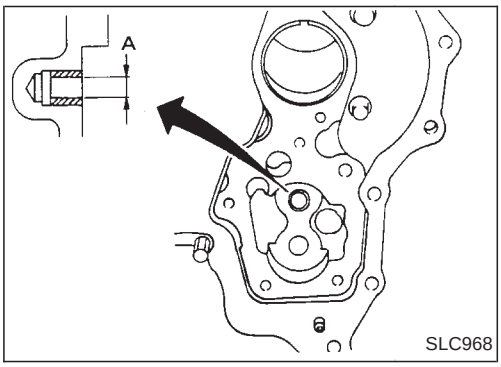
OIL PUMP INSPECTION

1. Inspect pump body, gears and drive shaft for wear and damage.
2. Using a feeler gauge and fuse wire, check the following clearances.

Gear side clearance:
Less than 0.13 mm (0.0051 in)

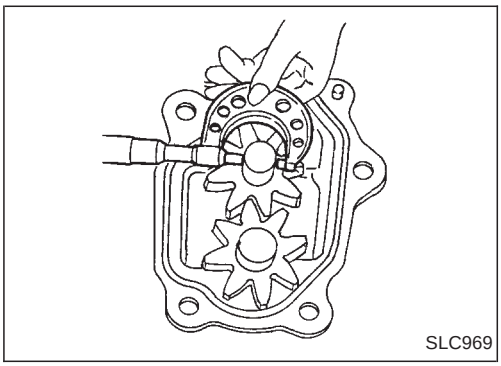


Gear backlash:
Less than 0.43 mm (0.0169 in)



3. Measure inside diameter “A” of bushing.
A: 13.012 - 13.098 mm (0.5123 - 0.5157 in)

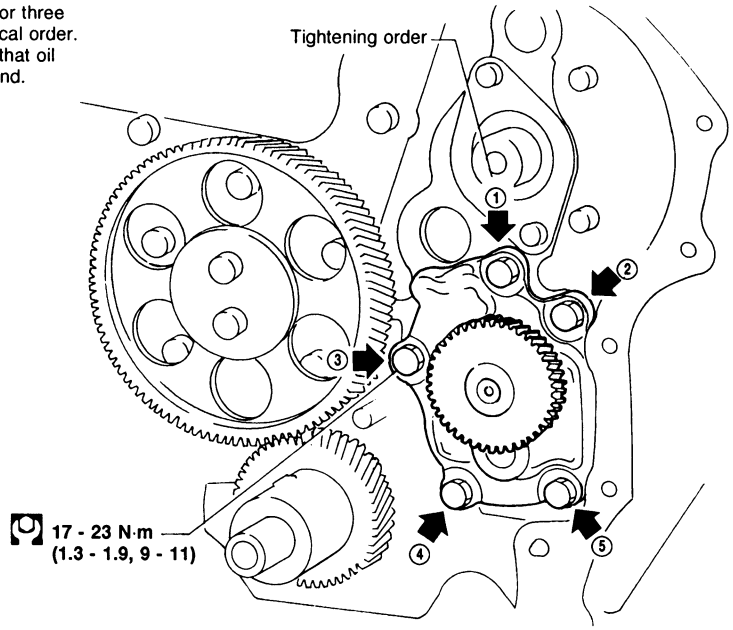
Oil Pump (Cont'd)


SLC969

4. Measure outside diameter "B" of drive gear shaft.
   B: 12.974 - 12.992 mm (0.5108 - 0.5115 in)
5. Calculate oil pump bushing clearance.
   Oil pump bushing clearance (A − B):
   Less than 0.15 mm (0.0059 in)

If it exceeds the limit replace oil pump bushing or entire oil pump assembly.

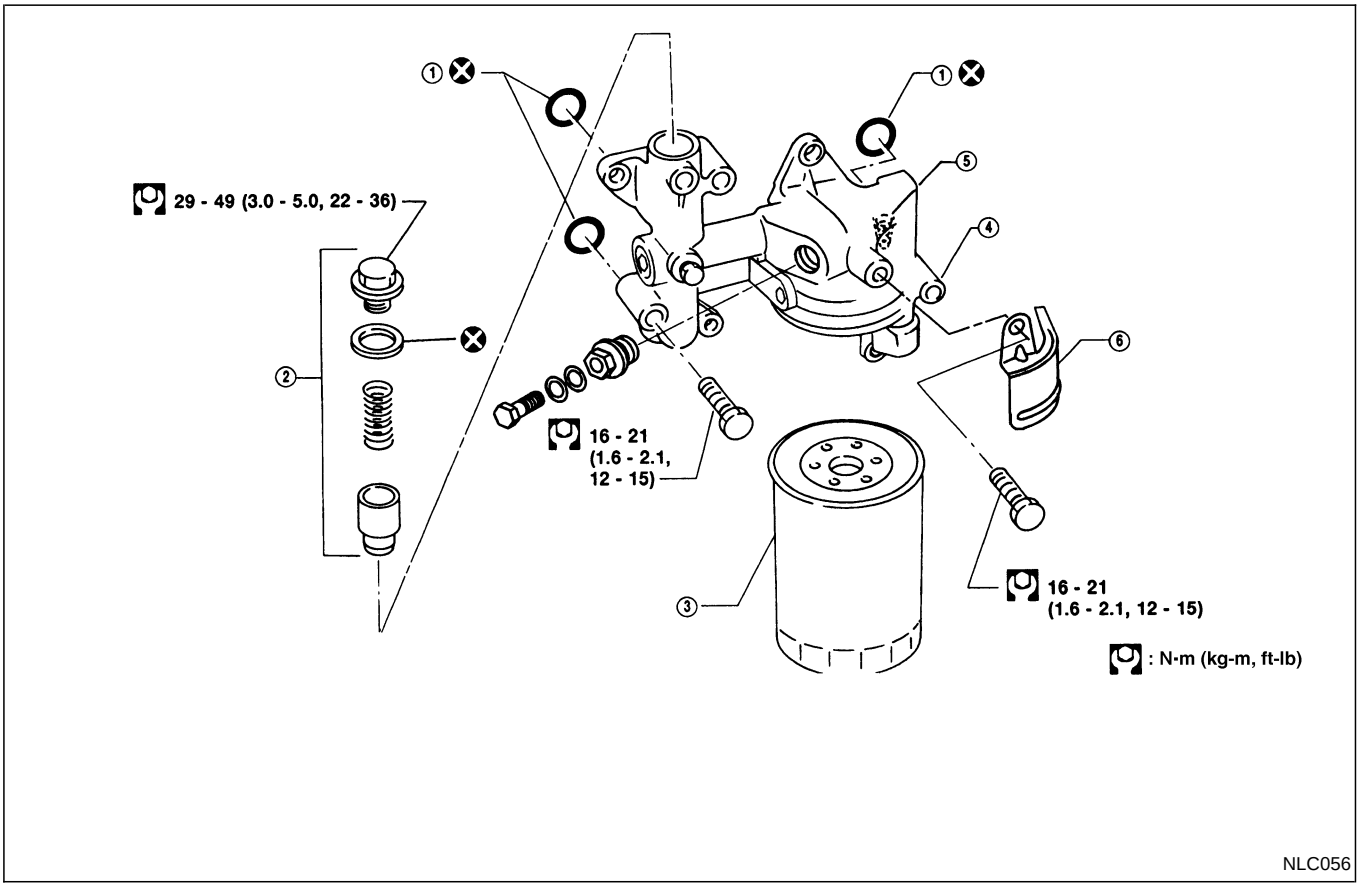
- When installing oil pump, the bolt should be tightened in two or three stages according to numerical order.
- After installation, ascertain that oil pump turns smoothly by hand.



N·m (kg-m, ft-lb)

NLC057

Oil Filter Bracket



① O-ring
② Oil pump relief valve
③ Oil filter
④ Oil filter bracket
⑤ Oil filter relief valve
⑥ Protection shield

OIL PUMP RELIEF VALVE INSPECTION

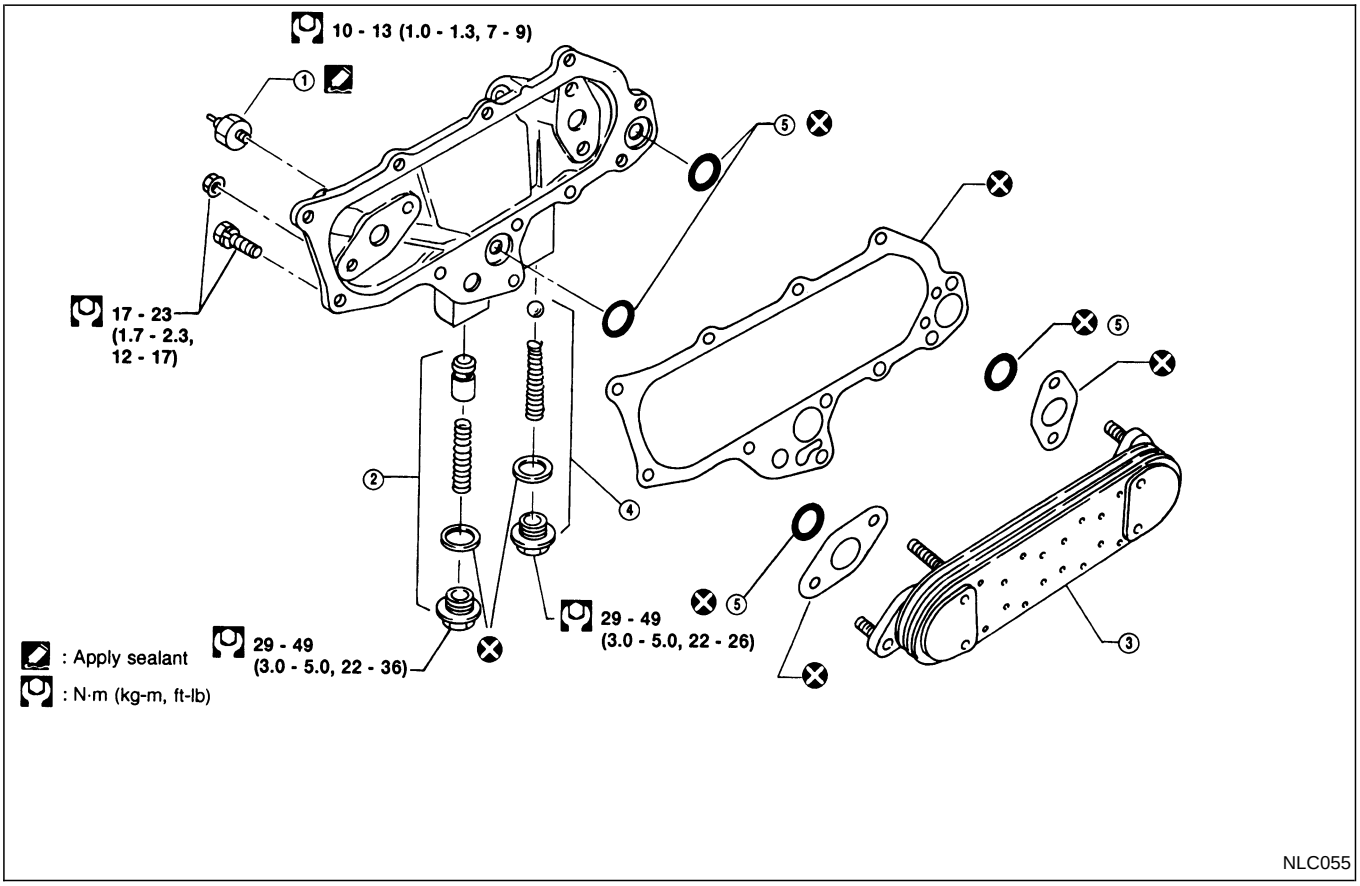
1. Visually inspect components for wear and damage.
2. Coat relief valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If damaged, replace oil pump relief valve set.

OIL FILTER RELIEF VALVE INSPECTION

Inspect oil filter short valve for movement, cracks and breaks by pushing the ball.
If damaged, replace oil filter bracket assembly.

Oil Cooler



① Oil pressure switch
② Regulator valve
③ Oil cooler element
④ Oil filter relief valve
⑤ O-ring

OIL COOLER RELIEF VALVE INSPECTION

Inspect oil cooler relief valve for movement, cracks and breaks by pushing the ball.
If damaged, replace oil cooler relief valve set.

REGULATOR VALVE INSPECTION

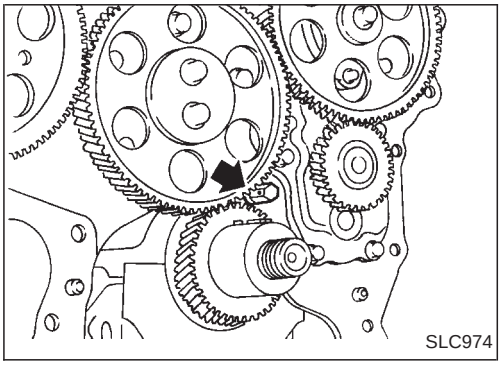
1. Visually inspect components for wear and damage.
2. Coat regulator valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If damaged, replace regulator valve set.

Oil Jet

INSPECTION (For gear train)

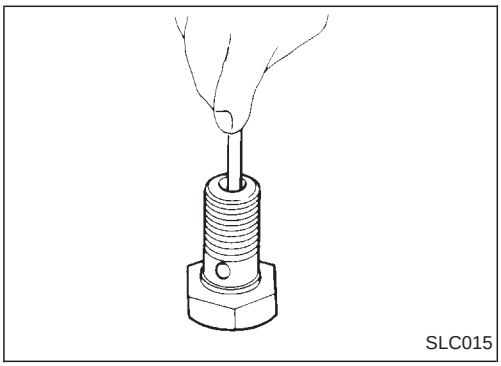
Make sure that the holes are not clogged. Clean them with a wire if necessary.

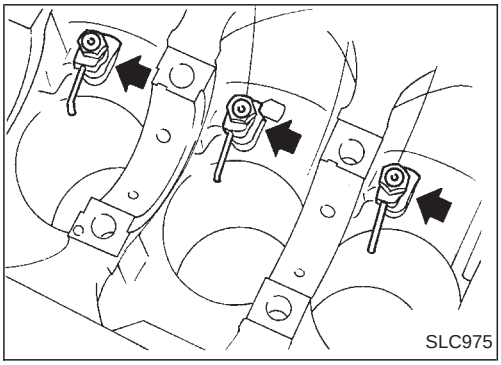

SLC974

Oil jet has to be installed with oil hole facing crank gear and idler gear.

INSPECTION (For piston)

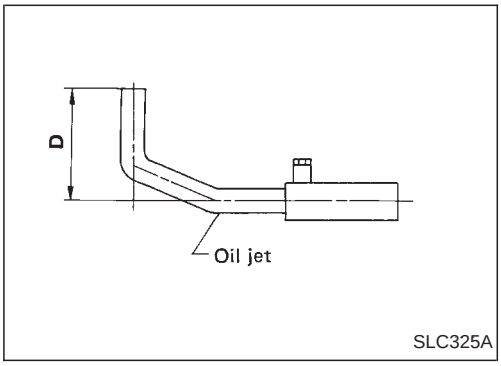
1. Blow through outlet of oil jet and make sure that air comes out of inlet.
2. Push cut-off valve of oil jet bolt with a clean resin or brass rod and make sure that cut-off valve moves smoothly with proper repulsion.


SLC015


SLC975

When installing oil jet, align oil jet's boss with hole on cylinder block.

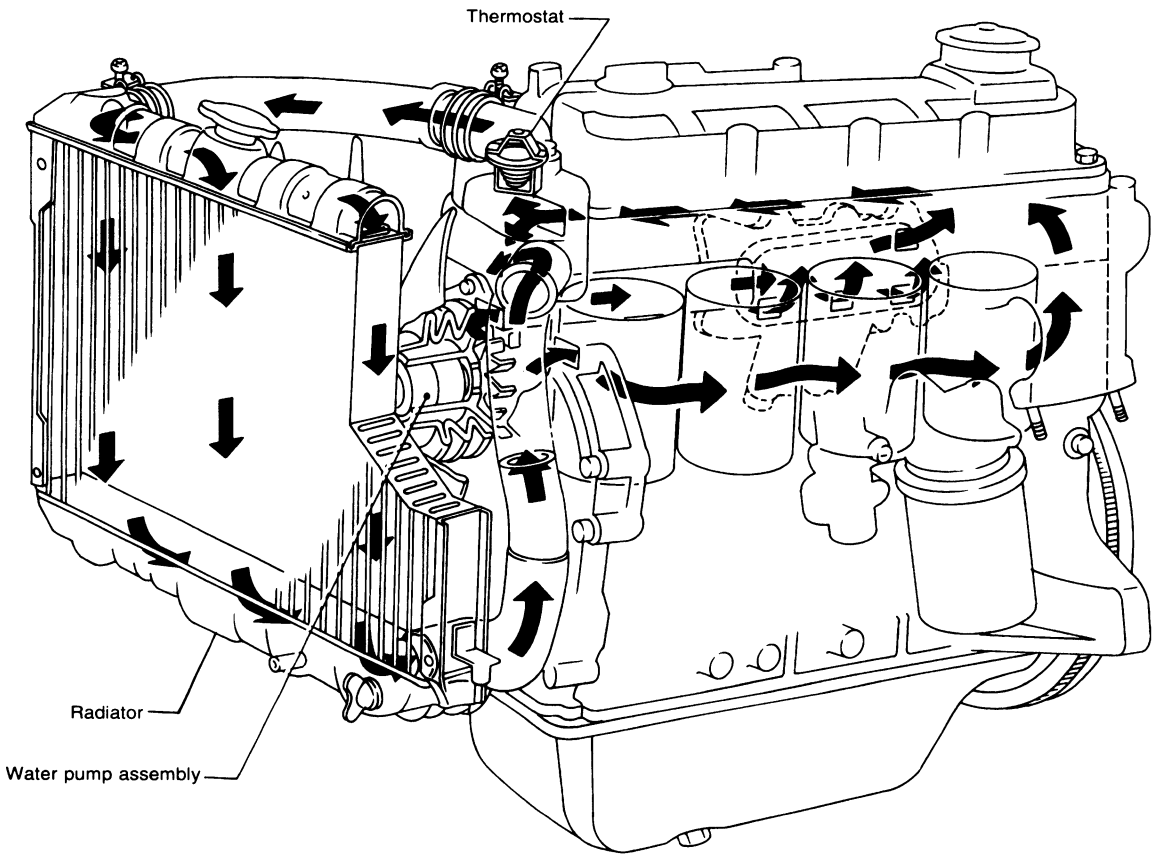
Oil jet bolt:
: 29 - 39 N·m
(3.0 - 4.0 kg-m, 22 - 29 ft-lb)

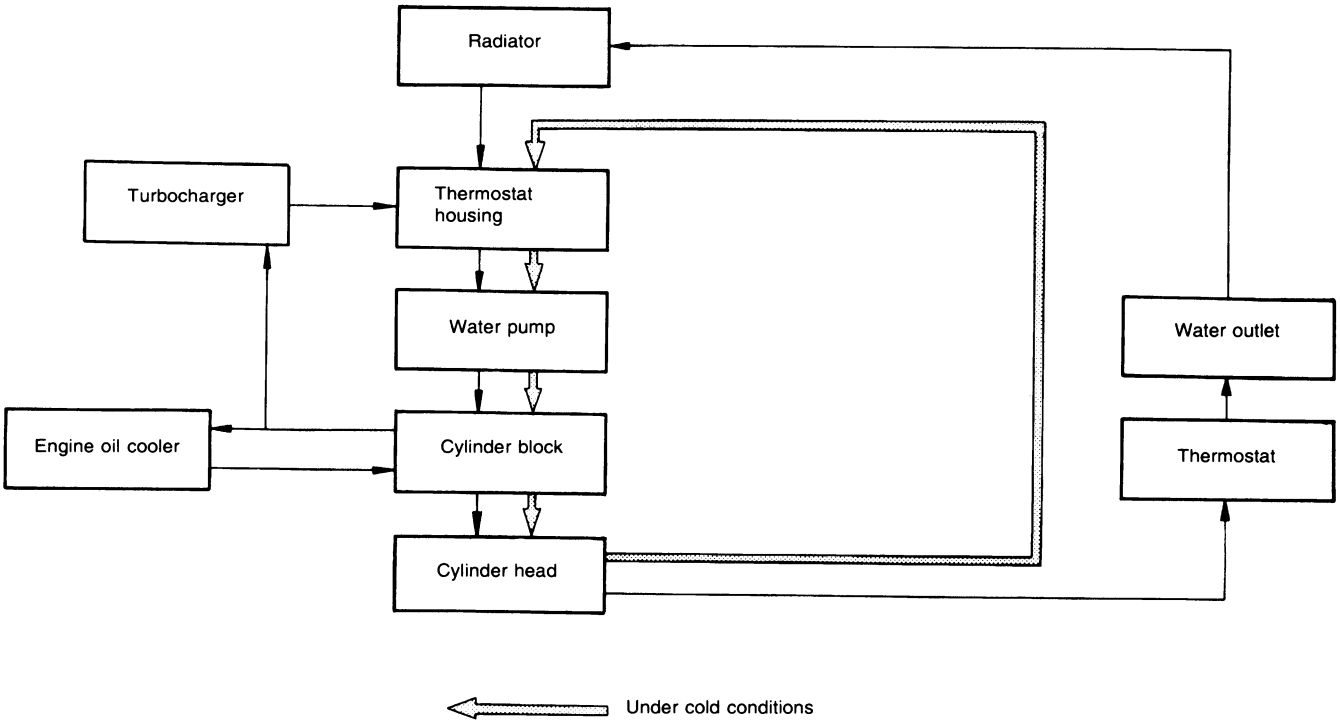


SLC325A

Dimension "D":
22 mm (0.87 in)

Cooling Circuit



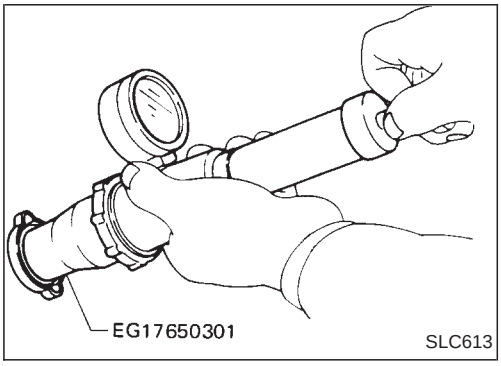


NLC011

System Inspection

CHECKING HOSES

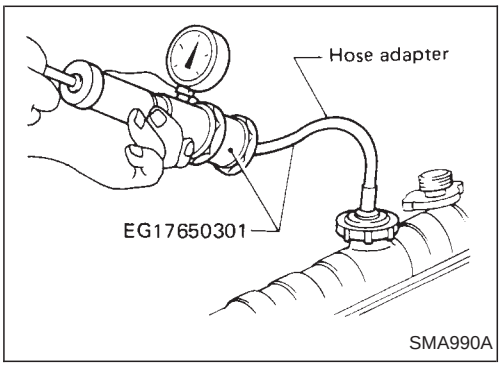
Check hoses for proper attachment, leaks, cracks, damage, loose connections, chafing and deterioration.



CHECKING RADIATOR CAP

To check radiator cap, apply pressure to the cap with a cap tester.

Radiator cap relief pressure:
78 - 98 kPa
(0.78 - 0.98 bar, 0.8 - 1.0 kg/cm^2, 11 - 14 psi)

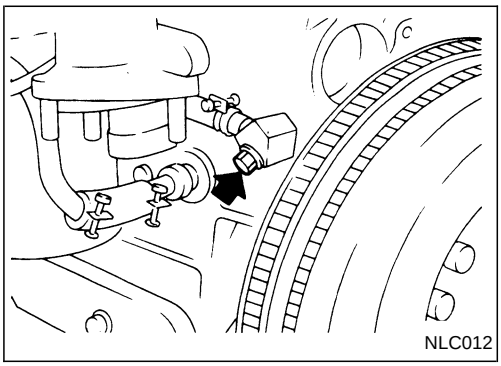


CHECKING COOLING SYSTEM FOR LEAKS

Appear pressure to the cooling system by means of a tester to check for leakage.

Testing pressure:
157 kPa (1.57 bar, 1.6 kg/cm^2, 23 psi)

CAUTION:
Higher than the specified pressure may cause radiator damage.

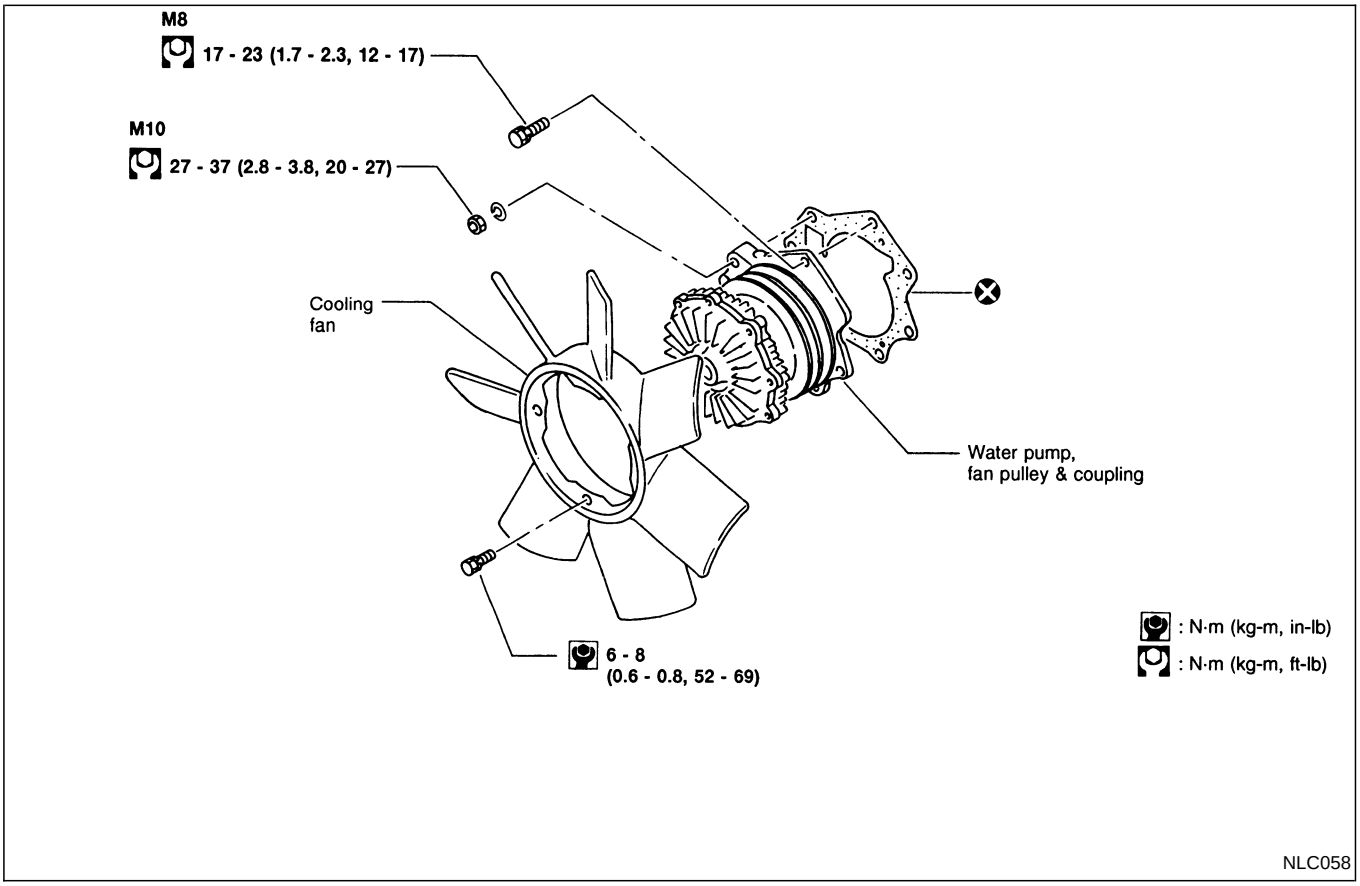


Water Pump

REMOVAL AND INSTALLATION

Drain coolant from drain plugs on cylinder block and radiator.

Cylinder block drain plug:
(Use proper sealant)
: 20 - 29 N·m (2.0 - 3.0 kg-m, 14 - 22 ft-lb)

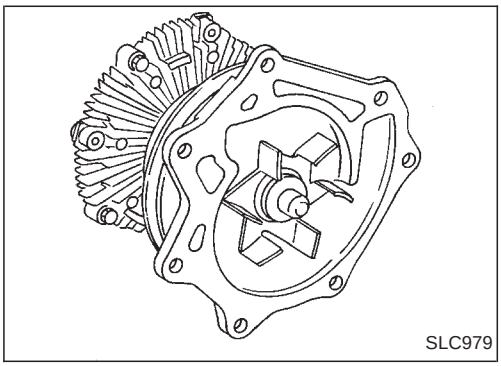


CAUTION:

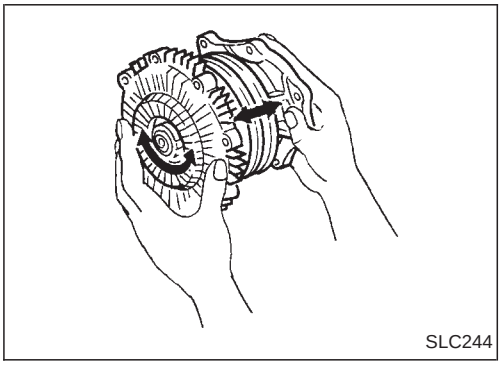
- **When removing water pump assembly, be careful not to spill coolant on drive belt.**
- **Water pump cannot be disassembled and should be replaced as a unit.**
- **Always replace with new gasket.**
- **After installing water pump, connect hose and clamp securely, then check for leaks using radiator cap tester.**

Water Pump (Cont'd)

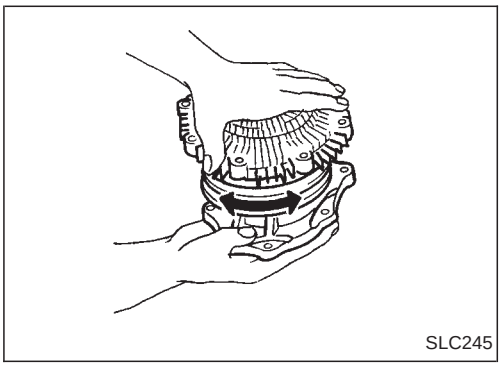
INSPECTION


SLC979

1. Check for badly rusted or corroded body assembly and vane.


SLC244

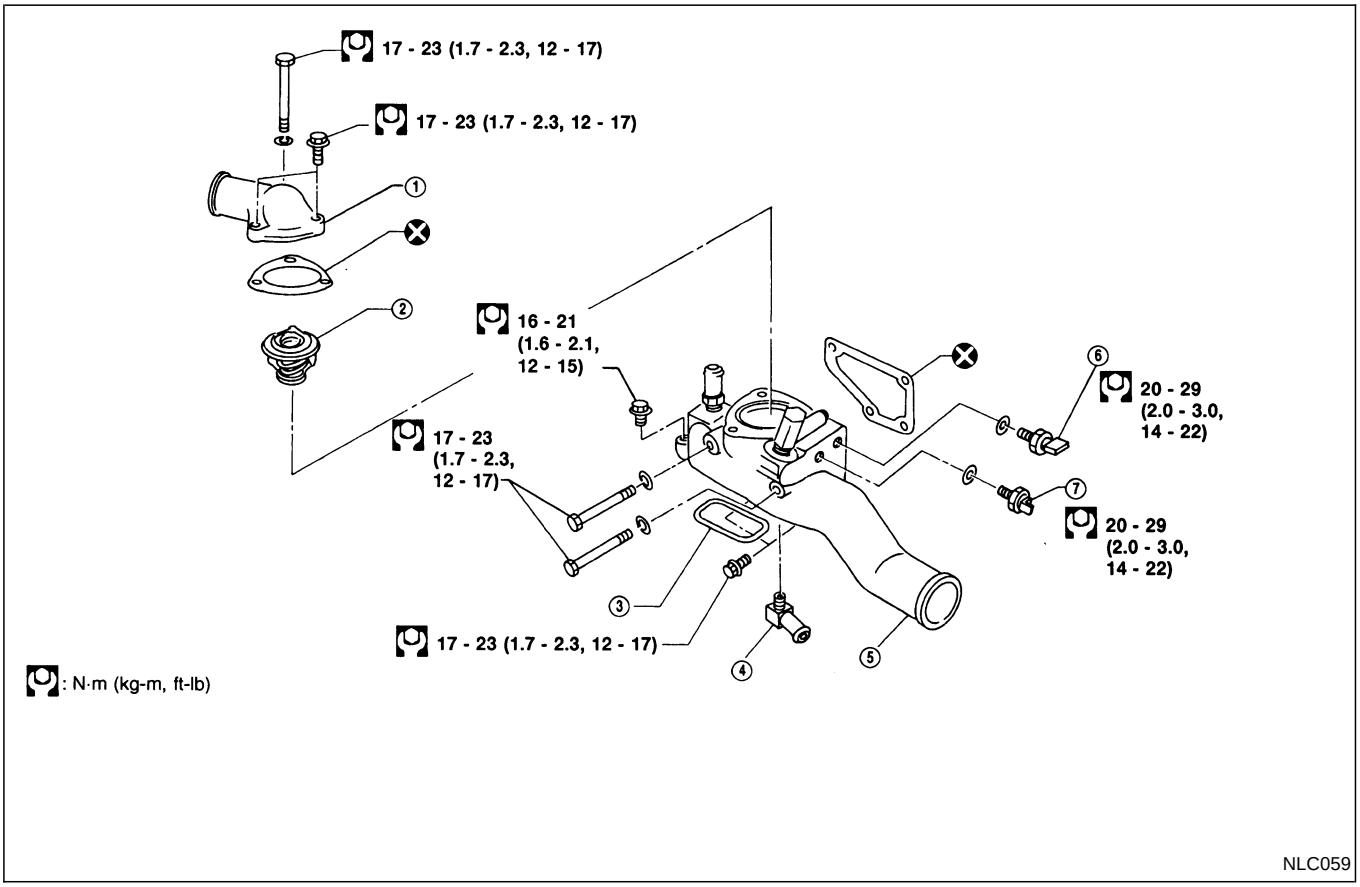
2. Check the water pump bushing for excessive end play and irregular movement.


SLC245

3. Check fan coupling for rough operation, oil leakage or bent bimetal.

The water pump and fan coupling cannot be disassembled and should be replaced as a unit.

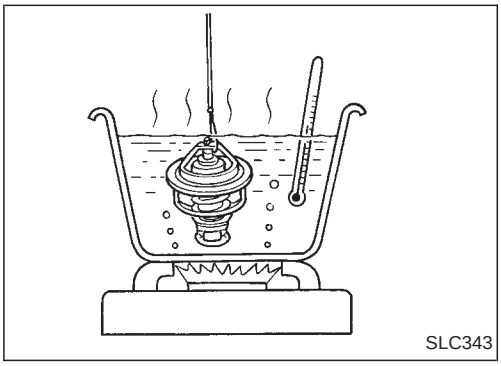
Thermostat



① Water outlet
② Thermostat with jiggle valve
③ Rubber seal
④ Water connector
⑤ Thermostat housing
⑥ Engine coolant temperature sensor
⑦ Thermal transmitter

CAUTION:

- **After installation, run engine for a few minutes, and check for leaks.**
- **Be careful not to spill coolant over engine compartment. Place a rag to absorb coolant.**



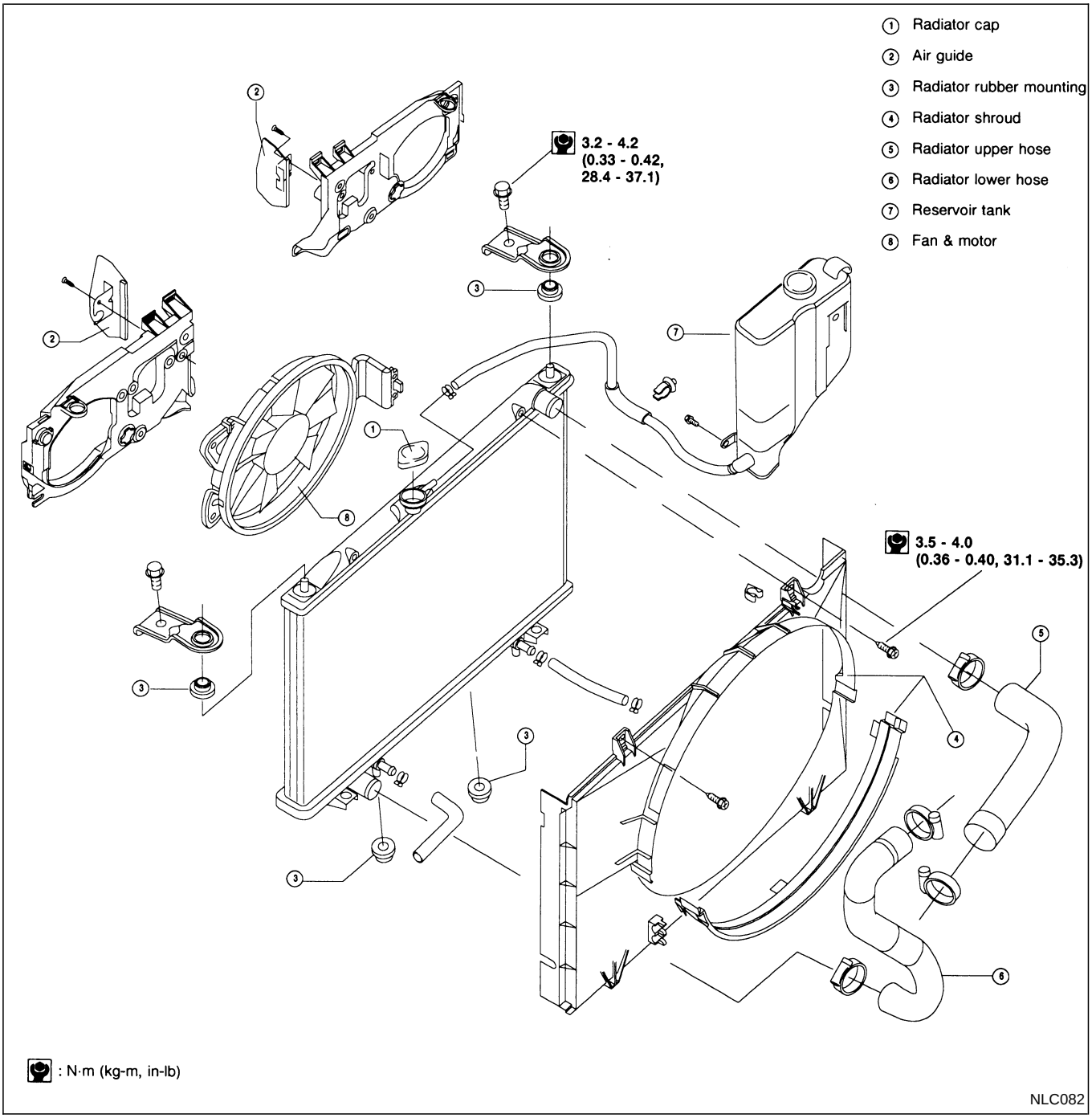
INSPECTION

1. Check for valve seating condition at ordinary temperatures. It should seat tightly.
2. Check valve opening temperature and maximum valve lift.

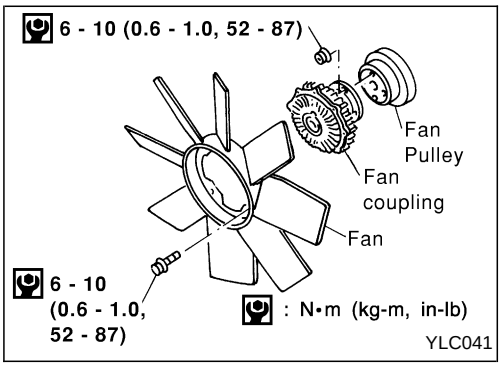
	Standard type	Optional type
Valve opening temperature °C (°F)	82 (180)	88 (190)
Max. valve lift mm/°C (in/°F)	8/95 (0.315/203)	8/100 (0.315/212)

3. Then check if valve closes at 5°C (9°F) below valve opening temperature.

Radiator

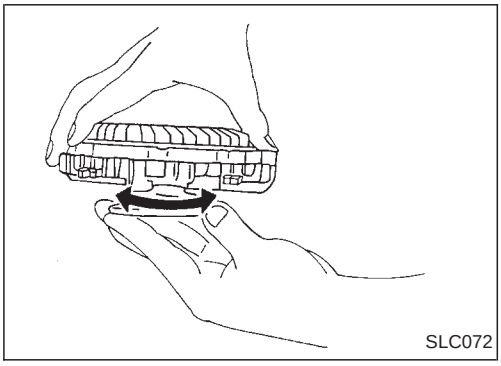


CAUTION:
When filling radiator with coolant, refer to MA section.



Cooling Fan

DISASSEMBLY AND ASSEMBLY



INSPECTION

Check fan coupling for irregular operation, oil leakage or bent bimetal.

Engine Lubrication System

Oil pressure check

Engine rpm	Approximate discharge pressure kPa (bar, kg/cm^2, psi)
Idle speed	More than 78 (0.78, 0.8, 11)
3,000	294 - 392 (2.94 - 3.92, 3.0 - 4.0, 43 - 57)

Oil pump

Unit: mm (in)

Gear side clearance	Less than 0.13 (0.0051)
Gear backlash	Less than 0.43 (0.0169)
Oil pump bushing clearance	Less than 0.15 (0.0059)
Oil pump bushing inside diameter	13.012 - 13.098 (0.5123 - 0.5157)
Drive gear shaft outside diameter	12.974 - 12.992 (0.5108 - 0.5115)

Engine Cooling System

Thermostat

	Standard type	Optional type
Valve opening temperature °C (°F)	82 (180)	88 (190)
Max. Valve lift mm/°C (in/°F)	8/95 (0.315/203)	8/100 (0.315/212)

Radiator

Unit: kPa (bar, kg/cm^2, psi)

Cap relief pressure	78 - 98 (0.78 - 0.98, 0.8 - 1.0, 11 - 14)
Leakage test pressure	157 (1.57, 1.6, 23)