

# ENGINE LUBRICATION & COOLING SYSTEMS

## SECTION **LC**

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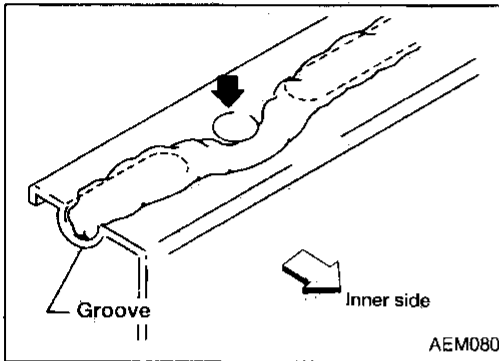
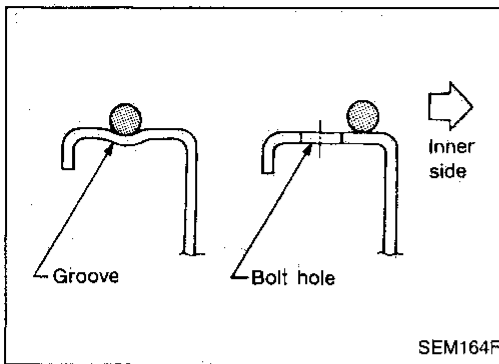
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## PRECAUTIONS AND PREPARATION



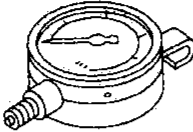
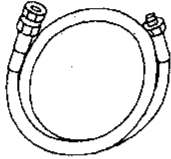
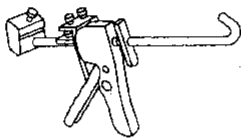
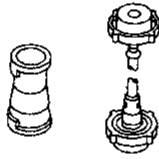

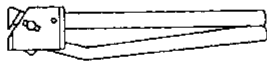
### Liquid Gasket Application Procedure

- Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
- Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine RTV silicone sealant Part No. 999MP-A7007, Three Bond TB1207D or equivalent.)
- Apply liquid gasket around the inner side of bolt holes (unless otherwise specified).
- Assembly should be done within 5 minutes after coating.
- Wait at least 30 minutes before refilling engine oil and engine coolant.

# PRECAUTIONS AND PREPARATION

## Special Service Tools

The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

Tool number (Kent-Moore No.) Tool name	Description	
ST25051001 (J25695-1) Oil pressure gauge	 NT050	GI MA EM
ST25052000 (J25695-2) Hose	 NT051	<div style="background-color: black; color: white; padding: 2px; display: inline-block;">LC</div> EC FE
WS39930000 ( — ) Tube pressure	 NT052	CL MT
EG17650301 (J33984-A) Radiator cap tester adapter	 NT053	AT FA
KV99103510 ( — ) Radiator plate pliers A	 NT224	RA BR
KV99103520 ( — ) Radiator plate pliers B	 NT225	ST RS BT

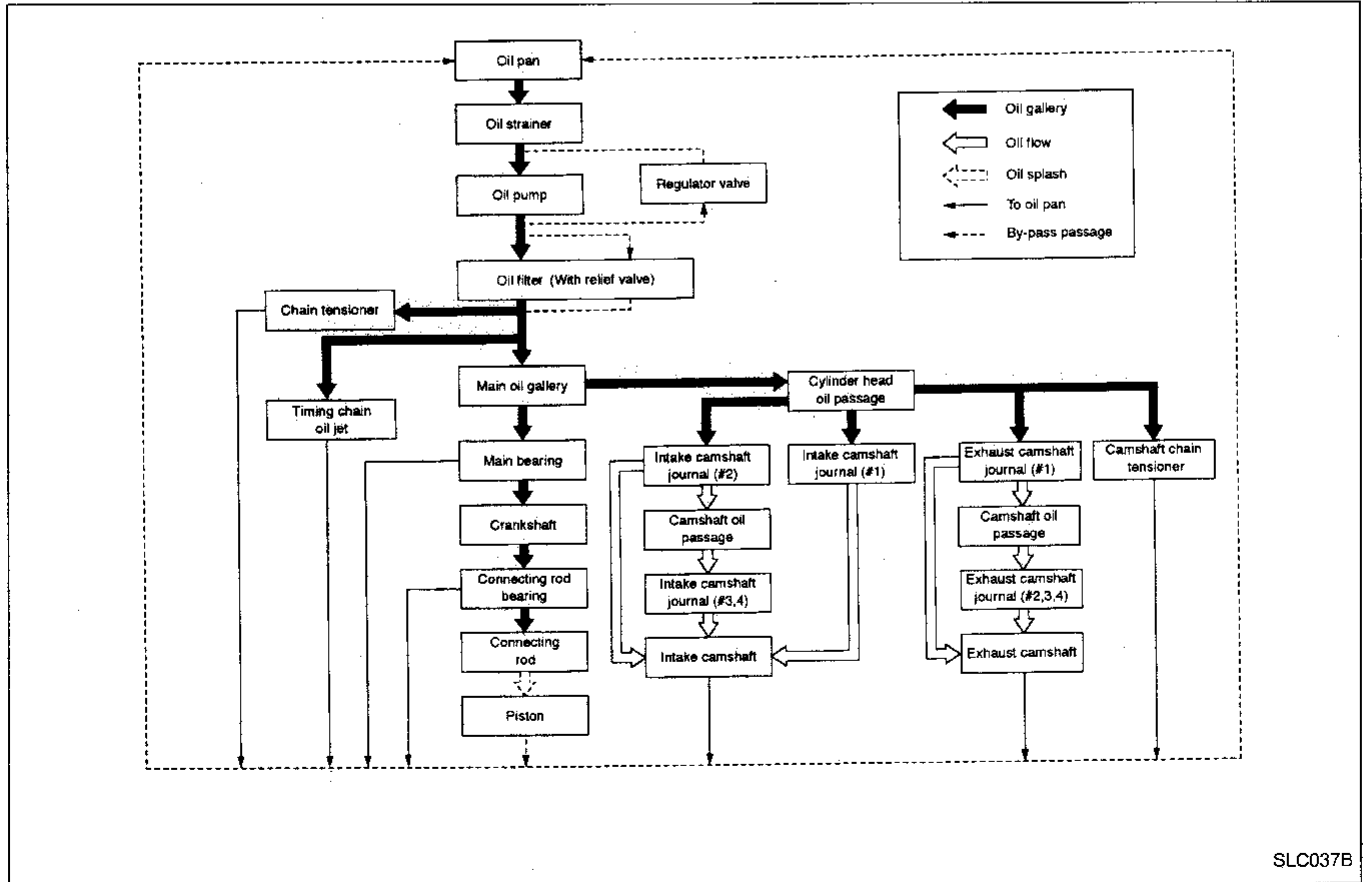
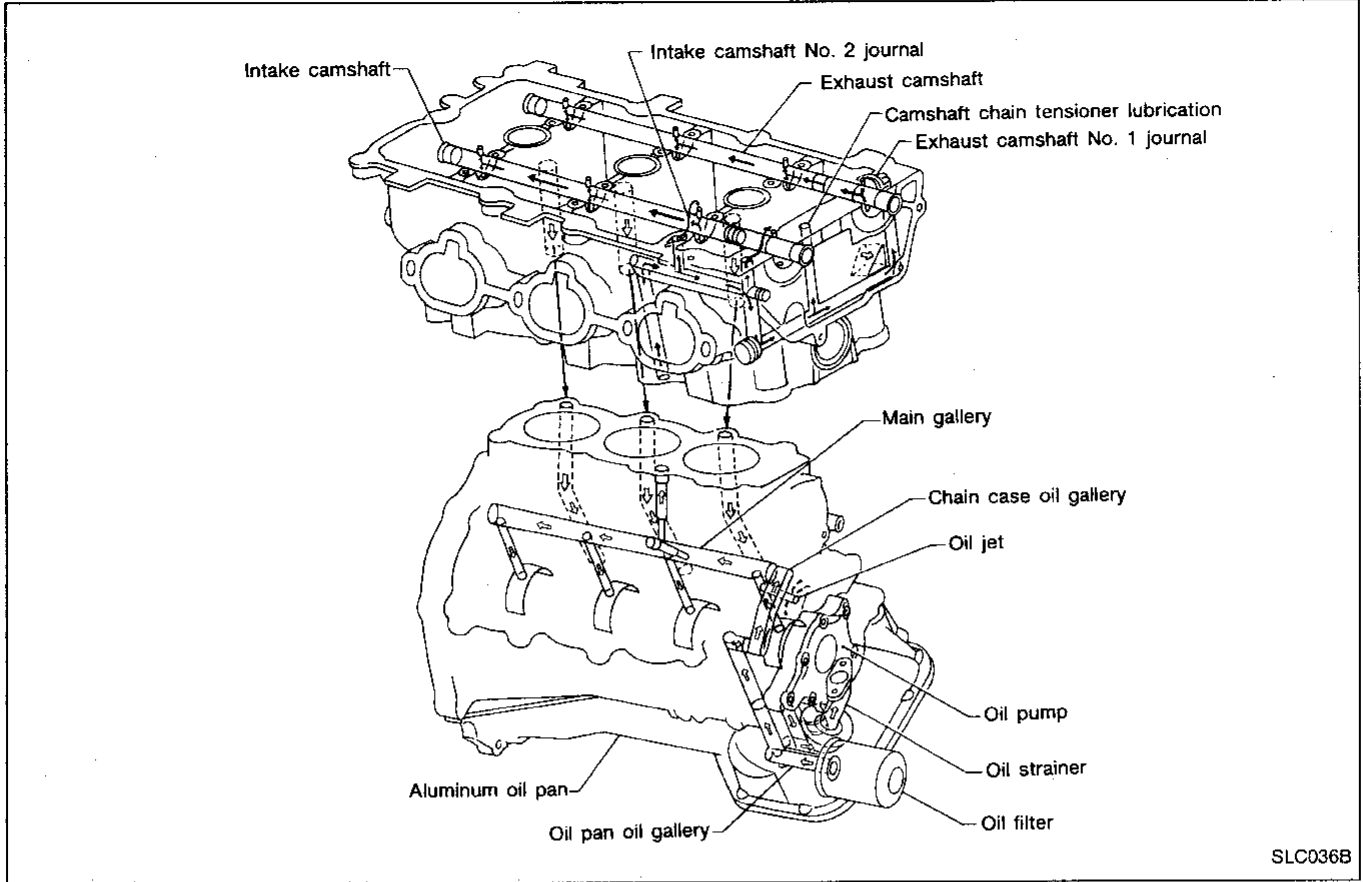
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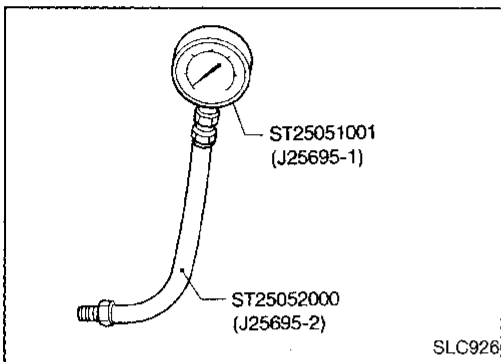
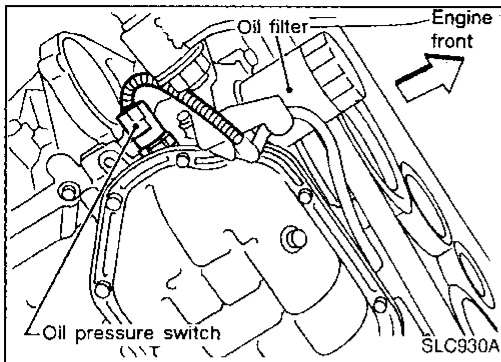
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# ENGINE LUBRICATION SYSTEM

## Lubrication Circuit



# ENGINE LUBRICATION SYSTEM



## 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 position" (M/T) or "Parking position" (A/T).
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.

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Engine speed rpm	Approximate discharge pressure kPa (kg/cm <sup>2</sup> , psi)
Idle speed	More than 69 (0.70, 10.0)
3,000	435 - 551 (4.44 - 5.62, 63.1 - 79.9)

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

6. Install oil pressure switch with sealant.

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## Oil Pump

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### REMOVAL AND INSTALLATION

#### CAUTION:

When removing the oil pans, oil pump assembly and timing chain from engine, first remove the camshaft position sensor (PHASE) and the crankshaft position sensor (REF)/(POS) from the assembly.

AT

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Be careful not to damage sensor edge.

1. Drain engine oil.
2. Remove drive belts.
3. Remove camshaft position sensor (PHASE), and crankshaft position sensor (REF)/(POS).
4. Remove engine lower covers.
5. Remove crankshaft pulley.
6. Remove front exhaust tube and its support.
7. Support engine at right and left side engine slingers with a suitable hoist.
8. Remove engine right side mounting insulator and bracket bolts and nuts.
9. Remove center member assembly.
10. Remove air compressor assembly and bracket.
11. Remove oil pans. (Refer to "Removal" of "OIL PAN" in EM section.)
12. Remove water pump cover.
13. Remove front cover assembly.
14. Remove timing chain. (Refer to "Removal" of "TIMING CHAIN" in EM section.)
15. Remove oil pump assembly.
16. Reinstall any parts removed in reverse order of removal.

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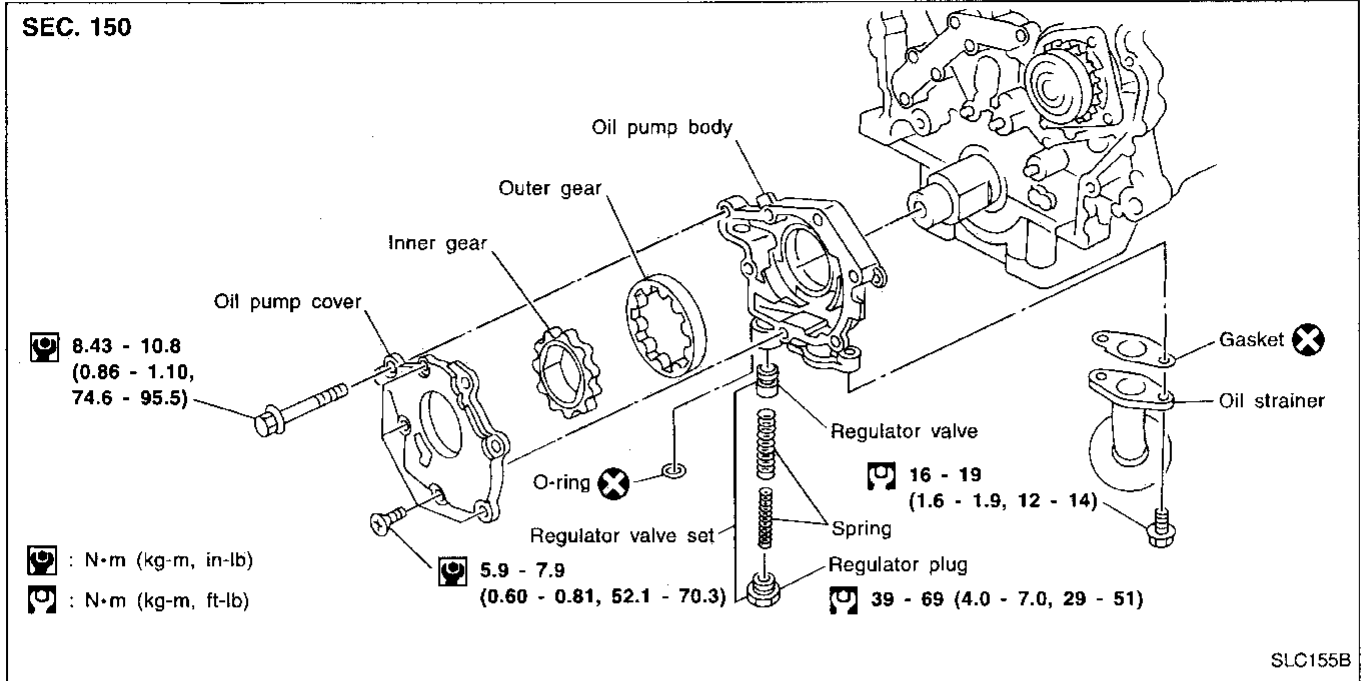
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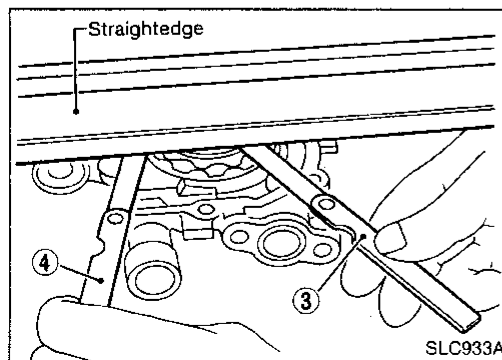
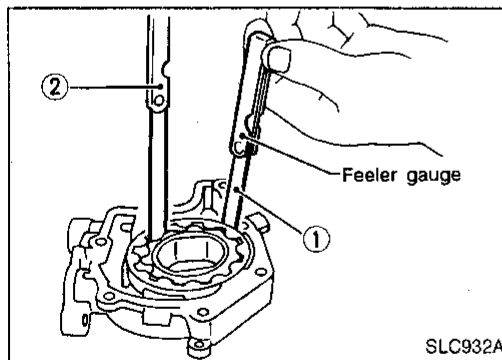
# ENGINE LUBRICATION SYSTEM

## Oil Pump (Cont'd)

### DISASSEMBLY AND ASSEMBLY



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



### OIL PUMP INSPECTION

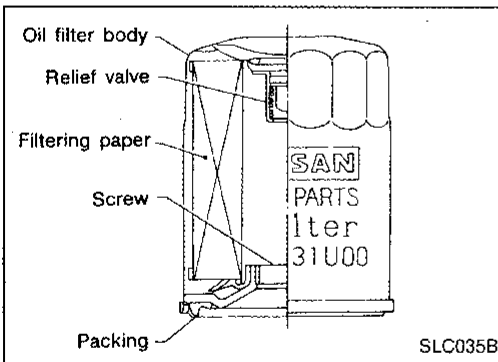
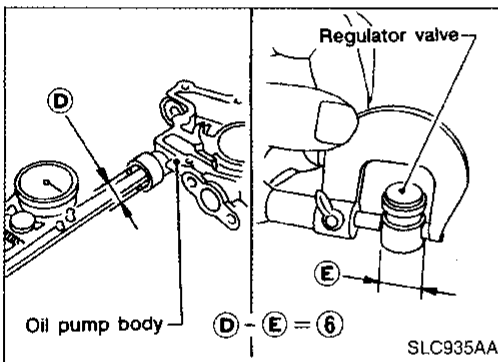
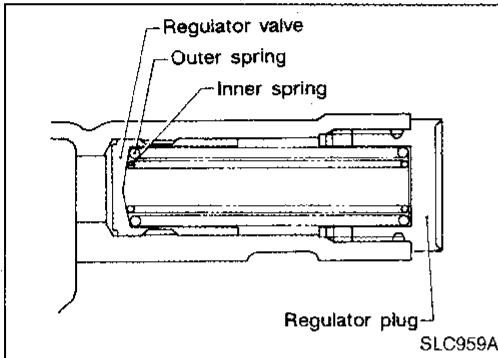
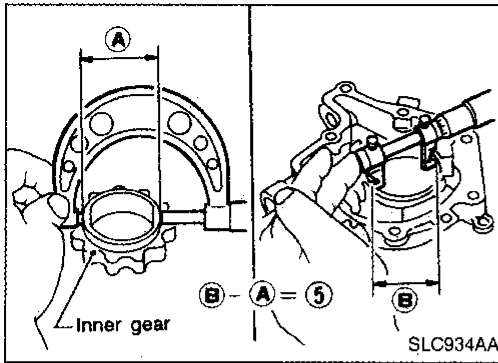
Using a feeler gauge, straightedge and micrometers, check the following clearances:

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	Below 0.18 (0.0071)
Body to inner gear axial clearance ③	0.030 - 0.070 (0.0012 - 0.0028)
Body to outer gear axial clearance ④	0.050 - 0.110 (0.0020 - 0.0043)
Inner gear to brazed portion of housing clearance ⑤	0.045 - 0.091 (0.0018 - 0.0036)

- 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.

## Oil Pump (Cont'd)



### 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 body.**

4. Check regulator valve to oil pump body clearance.

**Clearance:**

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

**If it exceeds the limit, replace oil pump body.**

### OIL FILTER

The oil filter is a small, full-flow cartridge type and is provided with a relief valve.

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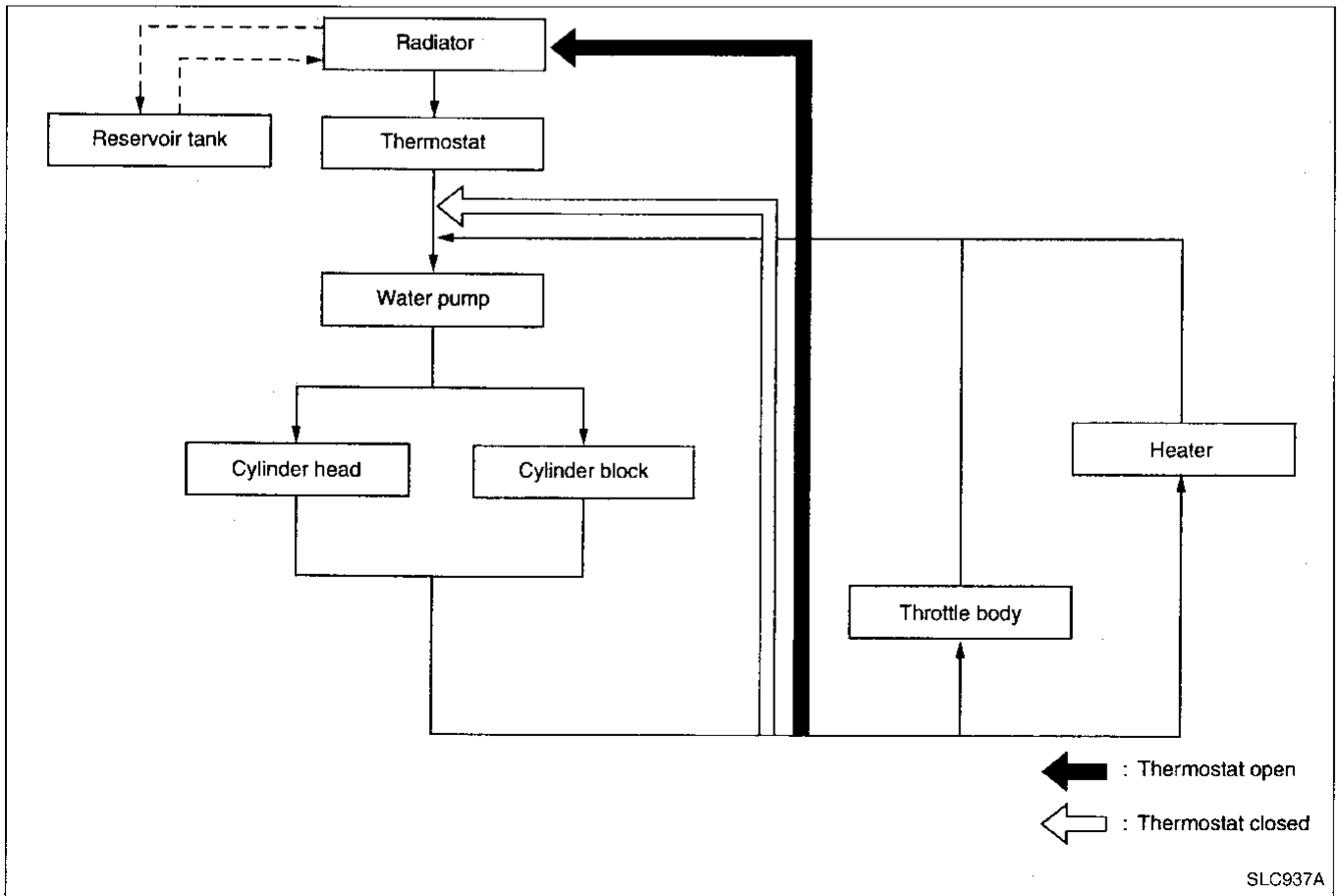
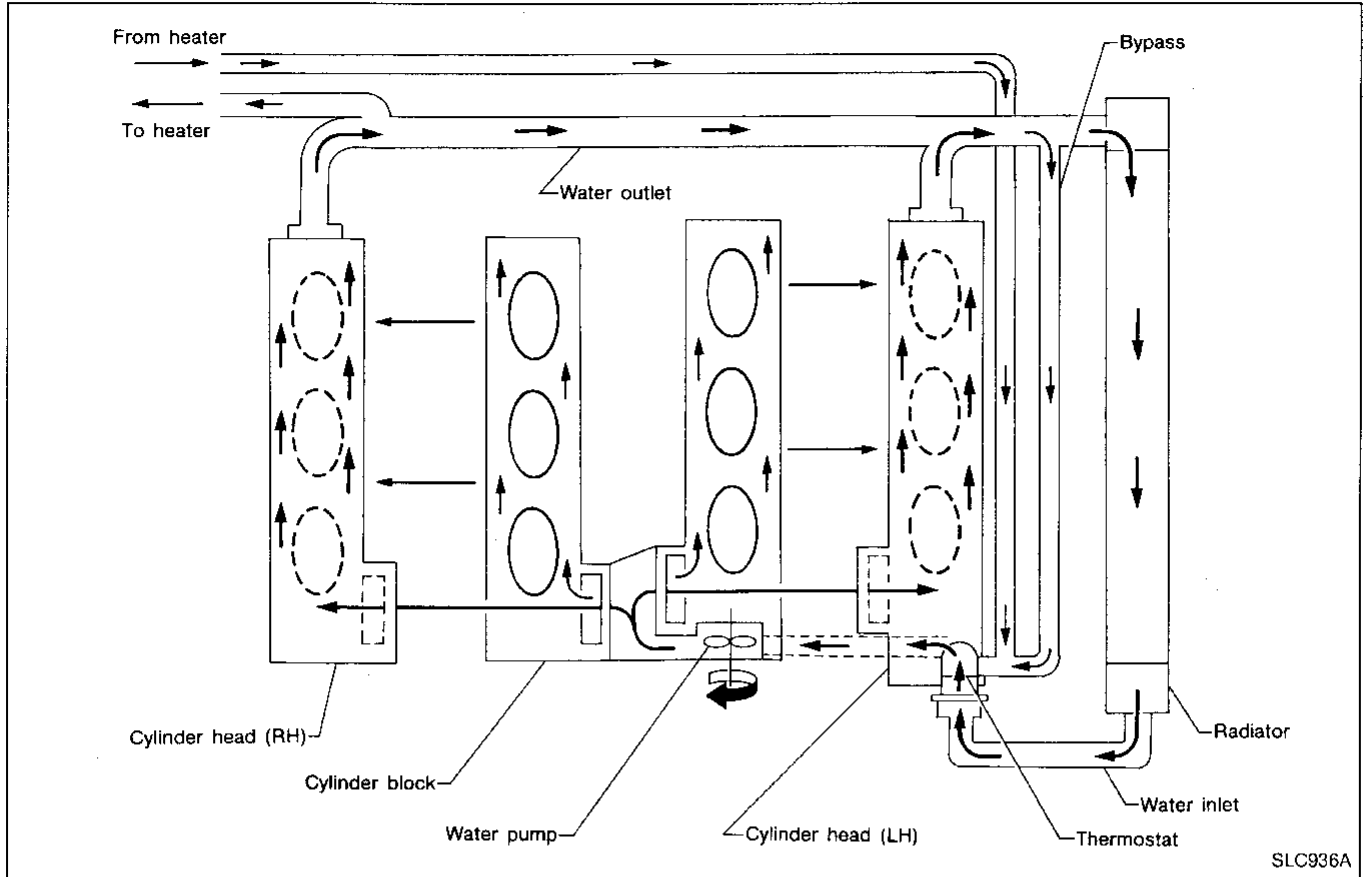
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# ENGINE COOLING SYSTEM

## Cooling Circuit





## System Check

### WARNING:

Never remove the radiator cap when the engine is hot; serious burns could be caused by high pressure fluid escaping from the radiator.

Wrap a thick cloth around the cap and carefully remove it by turning it a quarter turn to allow built-up pressure to escape and then turn the cap all the way off.

### CHECKING COOLING SYSTEM HOSES

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

### CHECKING RADIATOR CAP

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

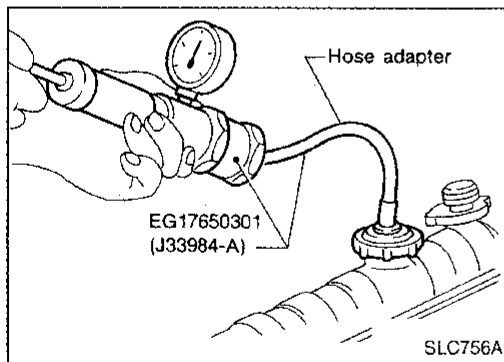
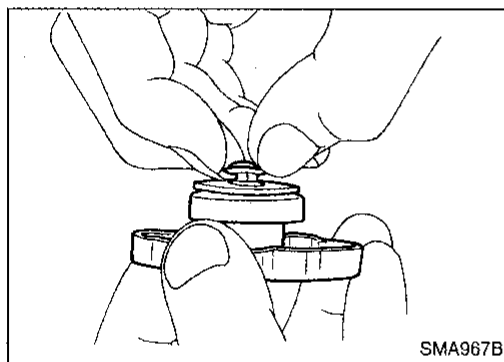
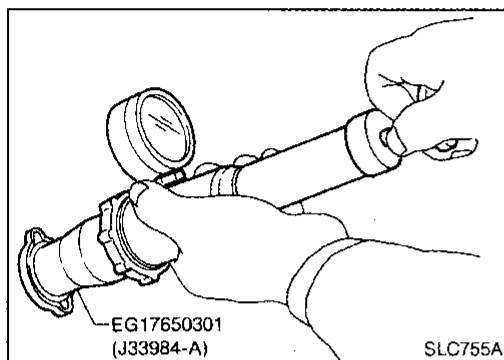
#### Radiator cap relief pressure:

##### Standard

78 - 98 kPa  
(0.8 - 1.0 kg/cm<sup>2</sup>, 11 - 14 psi)

##### Limit

59 - 98 kPa  
(0.6 - 1.0 kg/cm<sup>2</sup>, 9 - 14 psi)



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

### CHECKING COOLING SYSTEM FOR LEAKS

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

#### Testing pressure:

157 kPa (1.6 kg/cm<sup>2</sup>, 23 psi)

### CAUTION:

Higher than the specified pressure may cause radiator damage.

## 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.
- After installing water pump, connect hose and clamp securely, then check for leaks using radiator cap tester.

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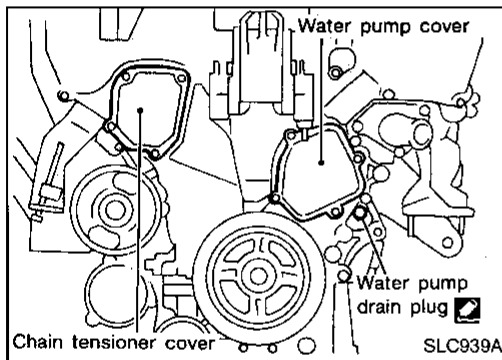
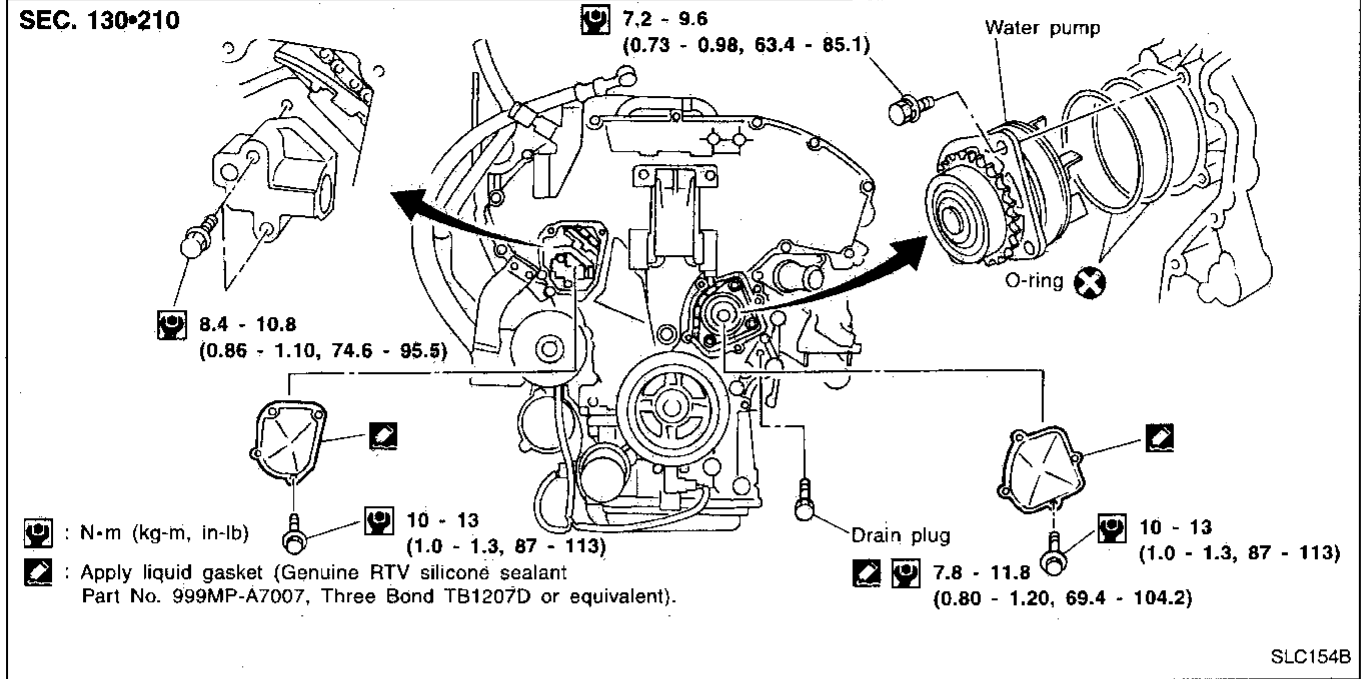
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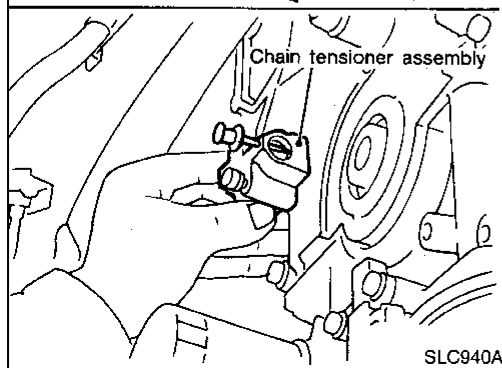
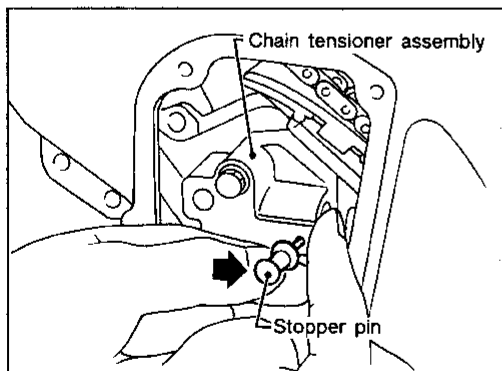
# ENGINE COOLING SYSTEM

## Water Pump (Cont'd)

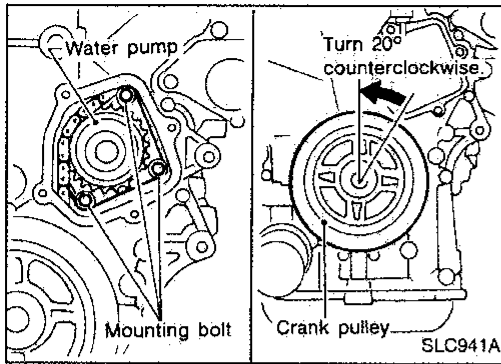


### REMOVAL

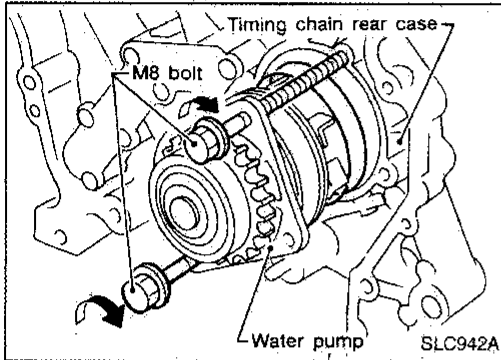
1. Drain coolant from drain plugs on radiator and both sides of cylinder block.  
Refer to "Changing Engine Coolant" in MA section.
2. Remove right side engine mounting, mounting bracket and nuts.
3. Remove drive belts and idler pulley bracket.
4. Remove water pump drain plug.
5. Remove chain tensioner cover and water pump cover.
6. Pushing timing chain tensioner sleeve, apply a stopper pin so it does not return. Then remove the chain tensioner assembly.



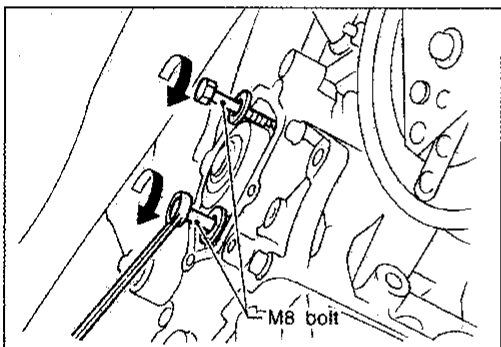
## Water Pump (Cont'd)



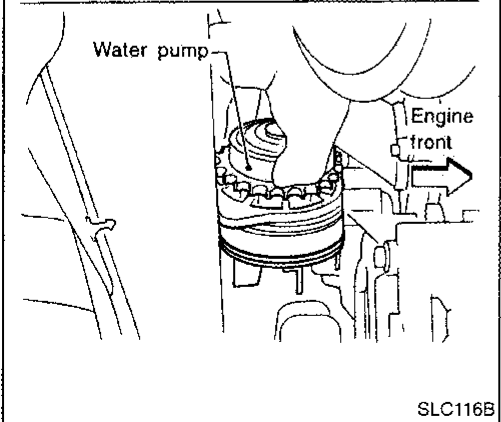
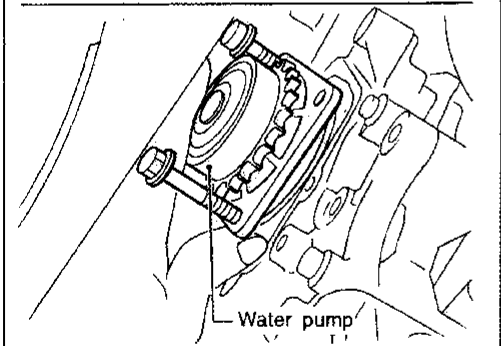
- Remove the 3 water pump fixing bolts. Secure a gap between water pump gear and timing chain, by turning crankshaft pulley 20° backwards.



- Put M8 bolts to two M8-threaded holes out of 3 water pump fixing bolt holes.



- Tighten M8 bolts by turning half turn alternately until they reach timing chain rear case.
  - In order to prevent damages to water pump or timing chain rear case, do not tighten one bolt continuously. Always turn each bolt half turn each time.
- Lift up water pump and remove it.
  - When lifting up water pump, do not allow water pump gear to hit timing chain.



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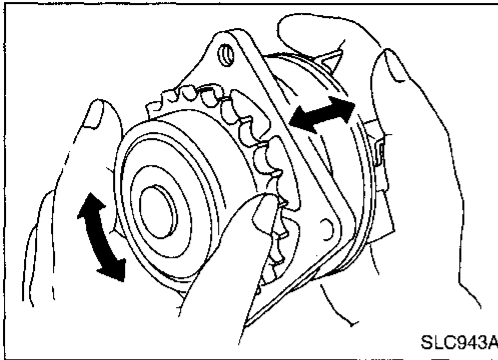
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# ENGINE COOLING SYSTEM

## Water Pump (Cont'd)

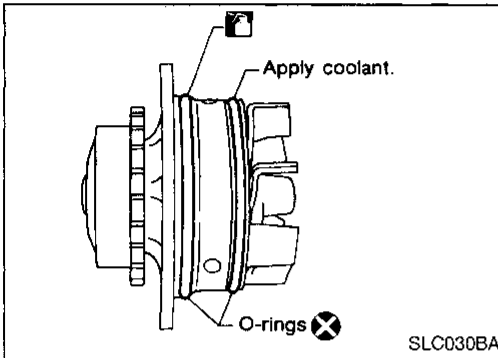
### INSPECTION

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

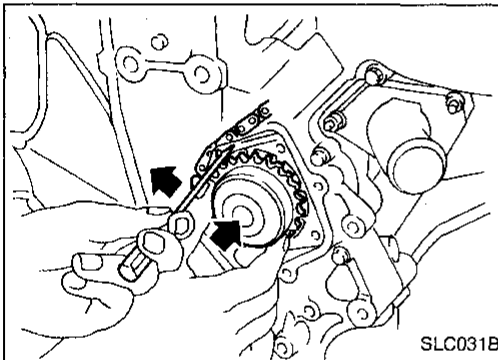


### INSTALLATION

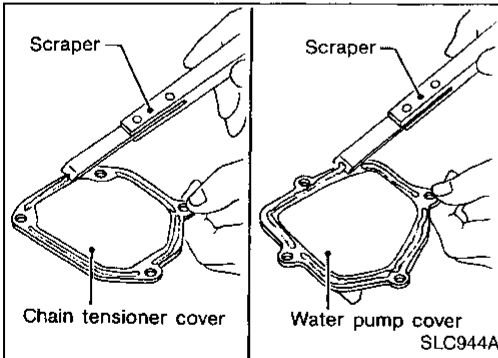
1. Apply engine oil and coolant to O-rings as shown in the figure.



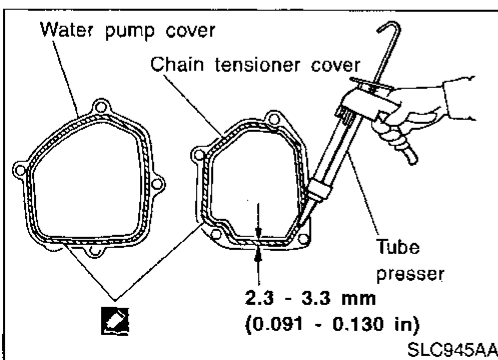
2. Install water pump.
  - Do not allow cylinder block to nip O-rings when installing water pump.



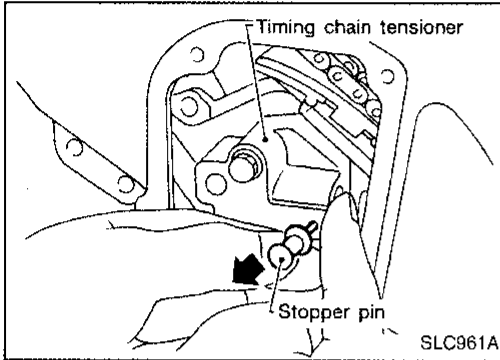
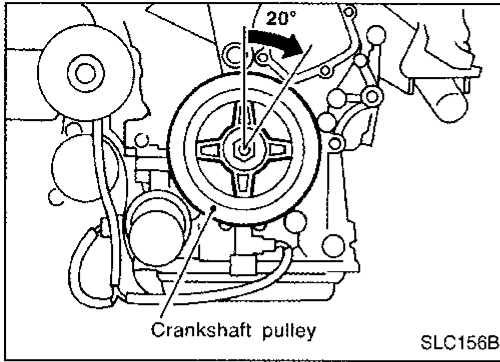
3. Before installing, remove all traces of liquid gasket from mating surface of water pump cover and chain tensioner cover using a scraper. Also remove traces of liquid gasket from mating surface of front cover.



4. Apply a continuous bead of liquid gasket to mating surface of chain tensioner cover and water pump cover.



## Water Pump (Cont'd)



5. Return the crankshaft pulley to its original position by turning it 20° forward.

6. Install timing chain tensioner, then remove the stopper pin.  
• **After installing the tensioner, race the engine at about 3,000 rpm under no load to purge air from the high-pressure chamber. The engine may produce a rattling noise. This indicates that air still remains in the chamber and is not a matter of concern.**

7. Install drain plug on cylinder block.

8. Reinstall any parts removed in reverse order of removal.

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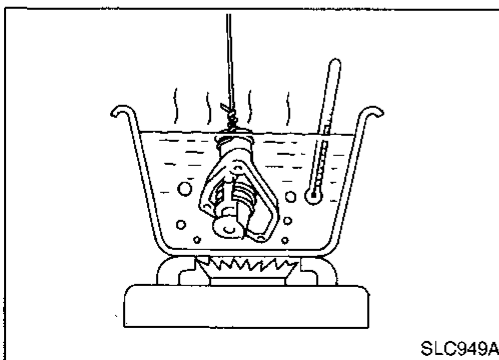
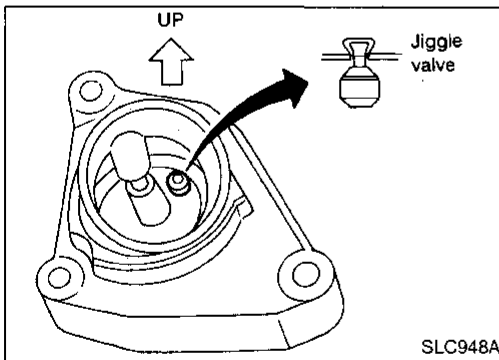
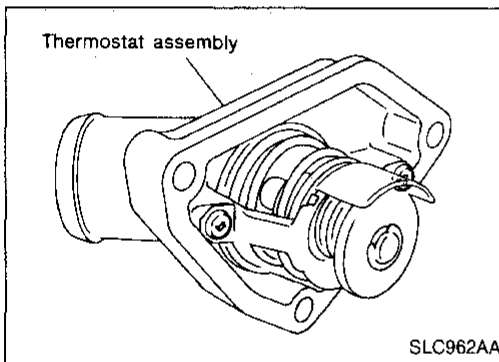
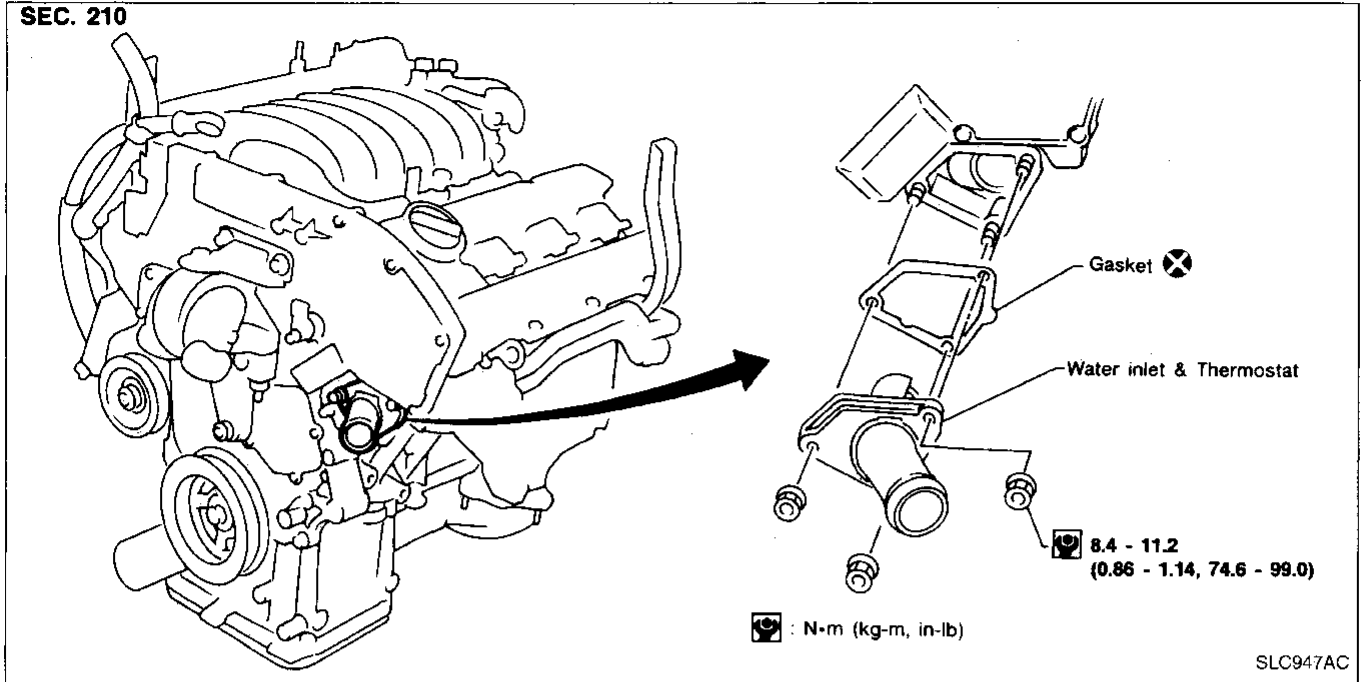
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# ENGINE COOLING SYSTEM

## Thermostat



### REMOVAL AND INSTALLATION

1. Drain coolant from drain plugs on radiator and both sides of cylinder block.
2. Remove drive belts and idler pulley bracket.
3. Remove water pump drain plug on pump side of cylinder block.
4. Remove lower radiator hose.
5. Remove water inlet and thermostat assembly.
  - **Do not disassemble water inlet and thermostat. Replace them as a unit, if necessary.**
6. Install thermostat with jiggle valve facing upward.
  - **After installation, run engine for a few minutes, and check for leaks.**
  - **Be careful not to spill coolant over engine compartment. Use a rag to absorb coolant.**

### INSPECTION

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

		Standard
Valve opening temperature	°C (°F)	82 (180)
Valve lift	mm/°C (in/°F)	More than 8.6/95 (0.339/203)

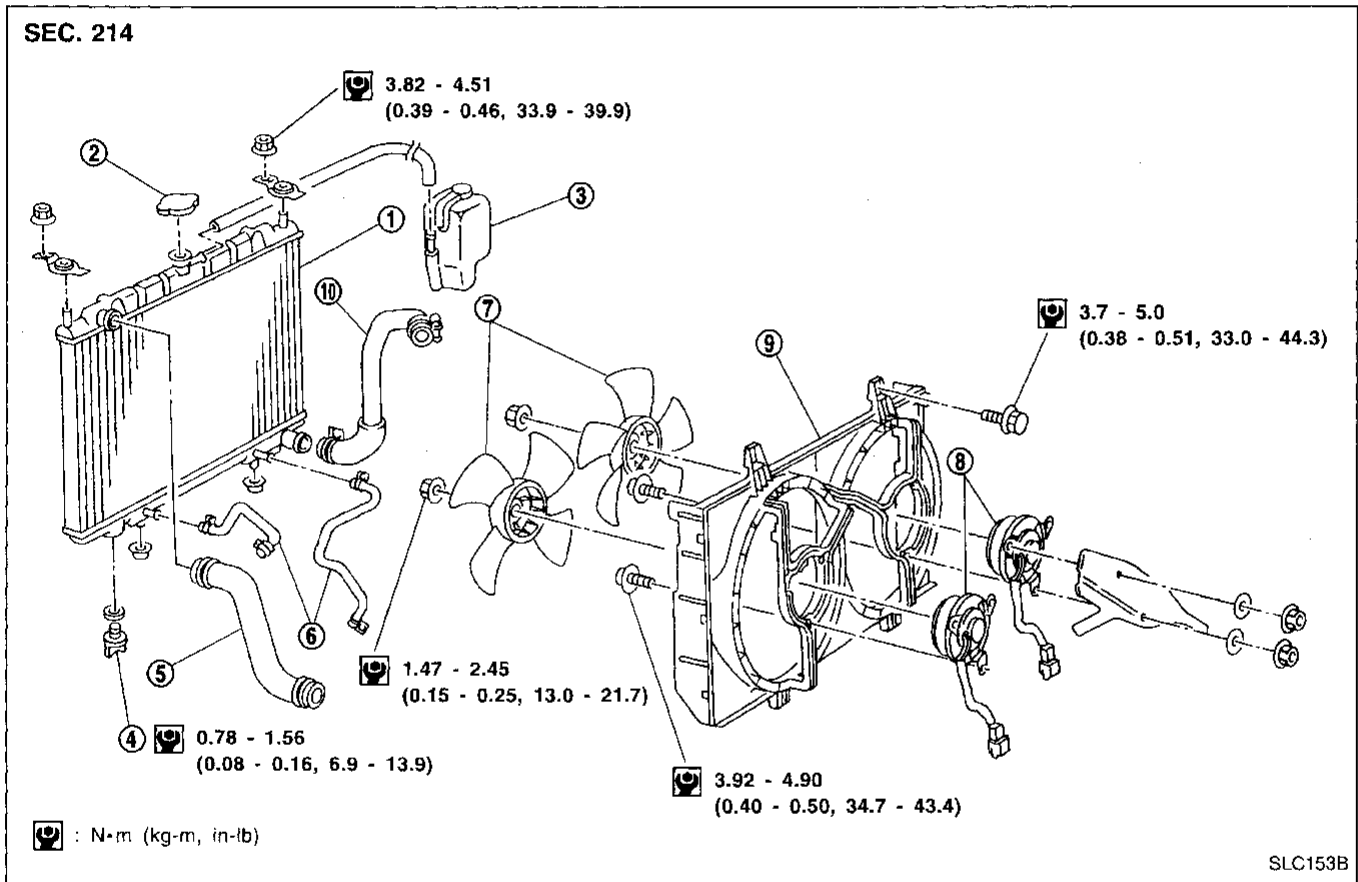
3. Then check if valve closes at 5°C (9°F) below valve opening temperature.

## Radiator

### REMOVAL AND INSTALLATION

1. Remove under cover.
2. Drain coolant from radiator.
3. Disconnect radiator upper and lower hoses.
4. Remove radiator shroud.
5. Remove A/T oil cooler hoses. (A/T models only)
6. Disconnect reservoir tank hose.
7. Remove radiator mounting bracket.
8. Remove radiator.
9. After repairing or replacing radiator, install any part removed in reverse order of removal.

When filling radiator with coolant, refer to "Changing Engine Coolant" in MA section.



- |                       |                                 |                       |
|-----------------------|---------------------------------|-----------------------|
| ① Radiator            | ⑤ Lower radiator hose           | ⑧ Cooling fan motors  |
| ② Radiator filler cap | ⑥ Oil cooler hoses (A/T models) | ⑨ Radiator shroud     |
| ③ Reservoir tank      | ⑦ Cooling fans                  | ⑩ Upper radiator hose |
| ④ Radiator drain cock |                                 |                       |

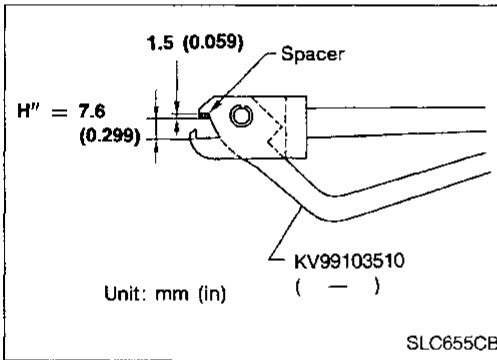
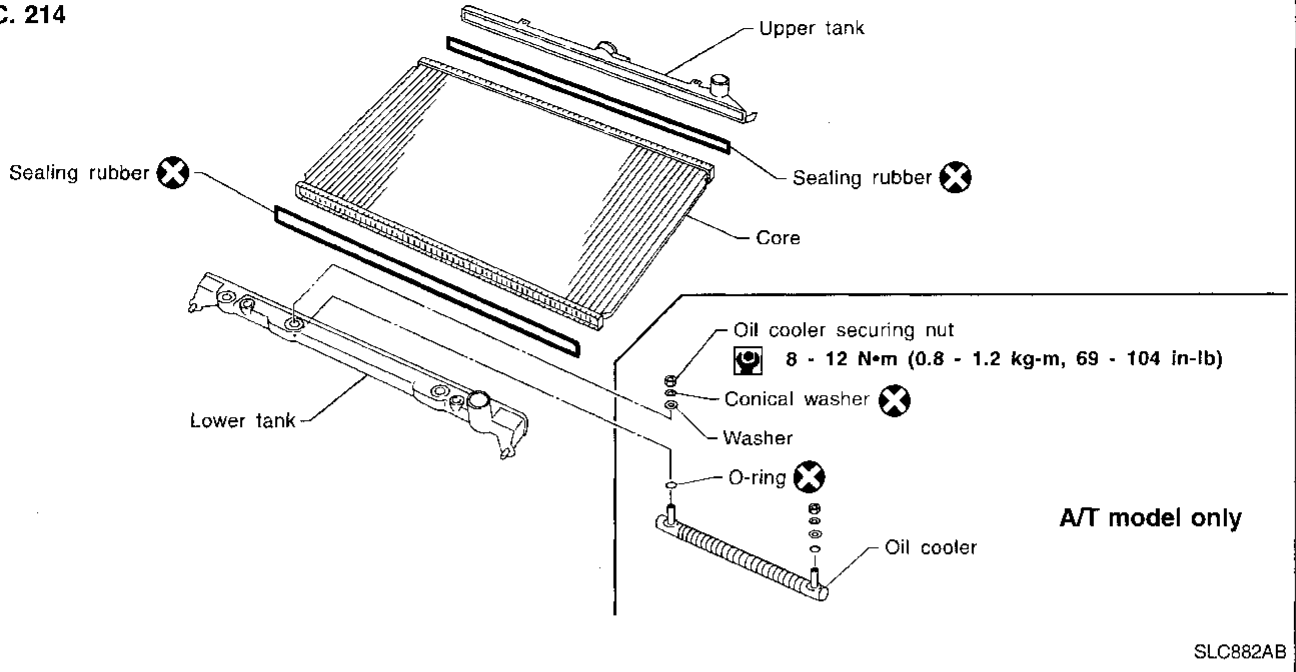
### Cooling Fan Control System

Cooling fans are controlled by ECM (ECCS control module). For details, refer to EC section ("Cooling Fan", "TROUBLE DIAGNOSIS FOR DTC P1900").

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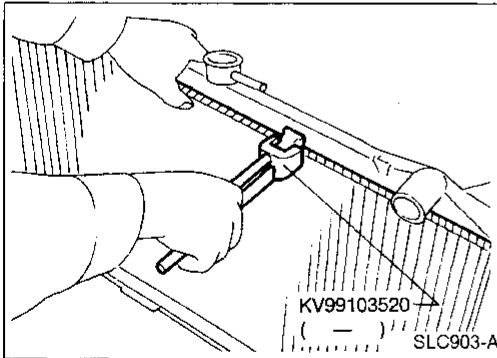
## Radiator (Aluminum type)

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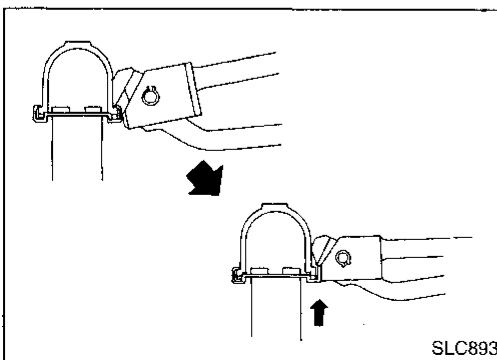
### PREPARATION

1. Attach the spacer to the tip of the radiator plate pliers A. Spacer specification: 1.5 mm (0.059 in) thick x 18 mm (0.71 in) wide x 8.5 mm (0.335 in) long.
2. Make sure that when radiator plate pliers A are closed dimension H'' is approx. 7.6 mm (0.299 in).
3. Adjust dimension H'' with the spacer, if necessary.



### DISASSEMBLY

1. Remove tank with Tool.



- Grip the crimped edge and bend it upwards so that Tool slips off.

**Do not bend excessively.**

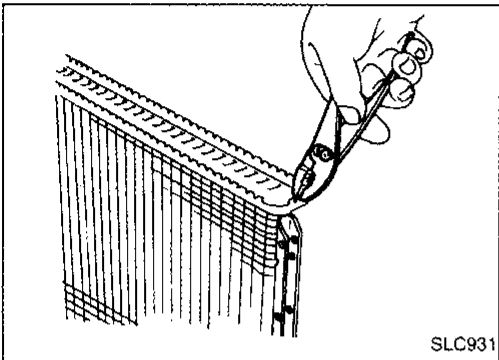
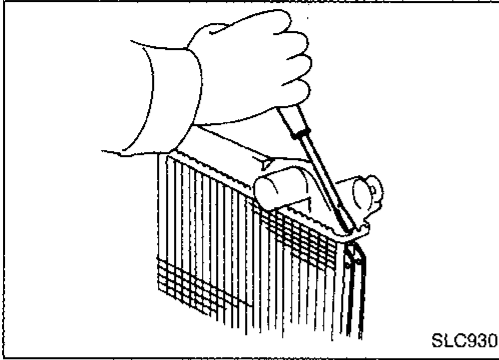


# ENGINE COOLING SYSTEM

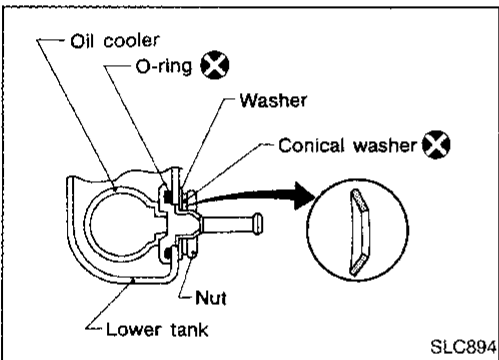
## Radiator (Aluminum type) (Cont'd)

- In areas where Tool cannot be used, use a screwdriver to bend the edge up.

**Be careful not to damage tank.**

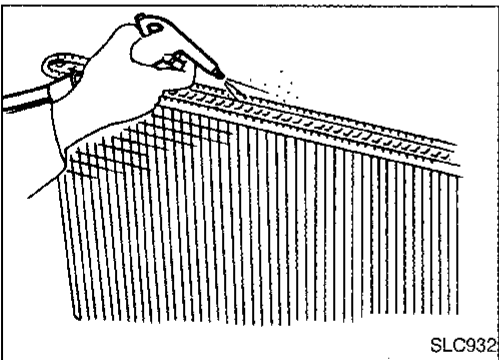


2. Make sure the edge stands straight up.
3. Remove oil cooler from tank. (A/T models only)

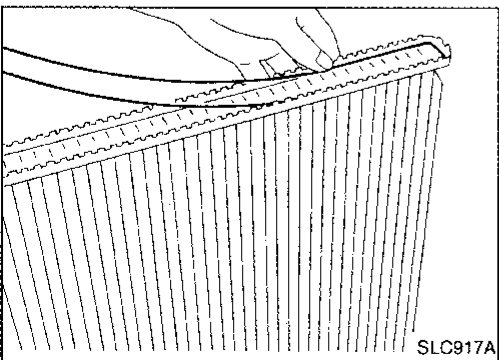


### ASSEMBLY

1. Install oil cooler. (A/T models only)  
**Pay attention to direction of conical washer.**



2. Clean contact portion of tank.



3. Install sealing rubber.  
**Push it in with fingers.**  
**Be careful not to twist sealing rubber.**

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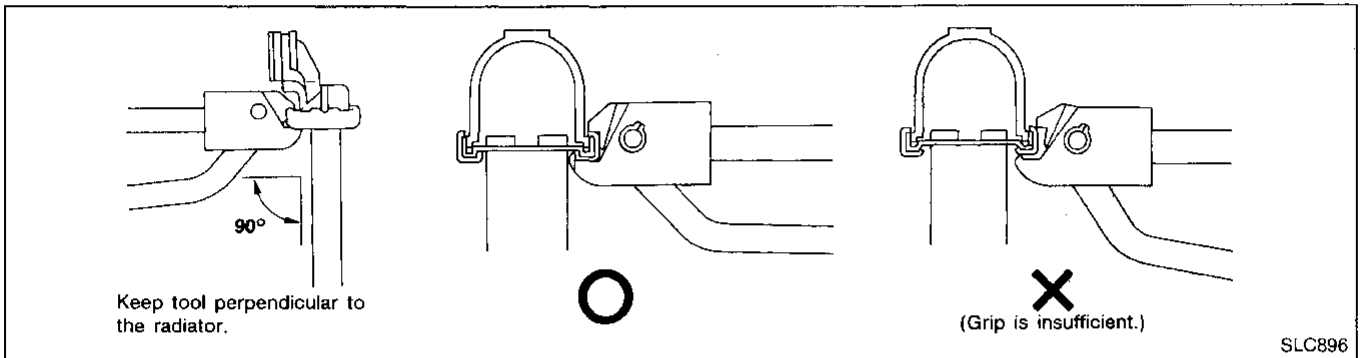
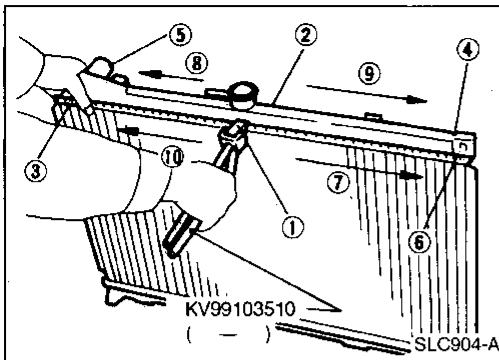
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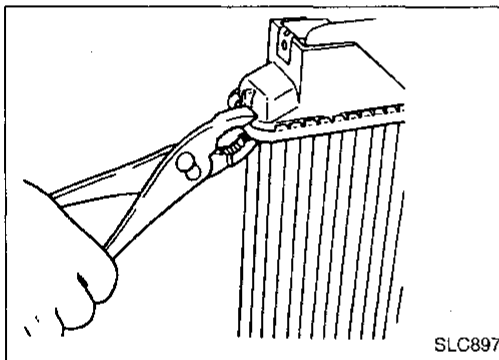
# ENGINE COOLING SYSTEM

## Radiator (Aluminum type) (Cont'd)

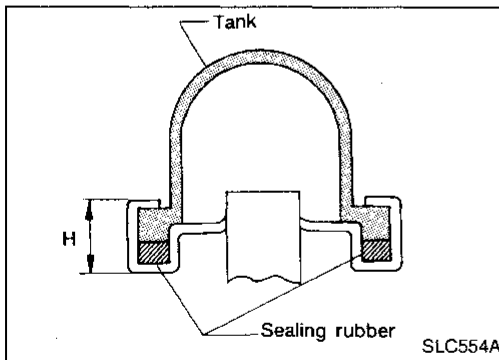
4. Caulk tank in specified sequence with Tool.



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- Use pliers in the locations where Tool cannot be used.

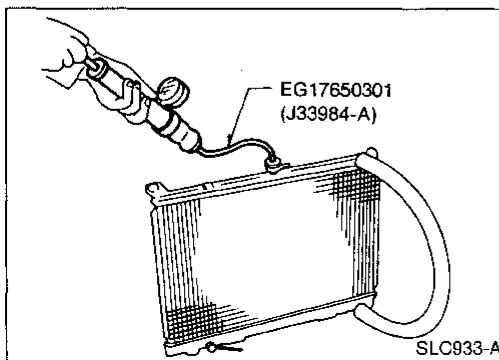


5. Make sure that the rim is completely crimped down.

**Standard height "H":**  
8.0 - 8.4 mm (0.315 - 0.331 in)

6. Confirm that there is no leakage.

**Refer to Inspection.**



### INSPECTION

Apply pressure with Tool.

**Specified pressure value:**  
157 kPa (1.6 kg/cm<sup>2</sup>, 23 psi)

### WARNING:

To prevent the risk of the hose coming undone while under pressure, securely fasten it down with a hose clamp. Attach a hose to the oil cooler as well. (A/T models only)

# ENGINE COOLING SYSTEM

## Overheating Cause Analysis

	Symptom		Check items			
Cooling system parts malfunction	Poor heat transfer	Water pump malfunction	Worn or loose drive belt	—	—	
		Thermostat stuck closed	—			
		Damaged fins	Dust contamination or paper clogging			—
			Mechanical damage			
		Clogged radiator cooling tube	Excess foreign material (rust, dirt, sand, etc.)			
	Reduced air flow	Cooling fan does not operate.	—	—		
		High resistance to fan rotation				
		Damaged fan blades				
		Damaged radiator shroud	—	—		
		Improper coolant mixture ratio	—	—	—	
		Poor coolant quality	—	—	—	
	Insufficient coolant	Coolant leaks	Cooling hose	Loose clamp	—	—
				Cracked hose		
			Water pump	Poor sealing		
			Radiator cap	Loose	—	
Poor sealing						
Radiator		O-ring for damage, deterioration or improper fitting	—			
		Cracked radiator tank				
		Cracked radiator core				
	Reservoir tank	Cracked reservoir tank				
Overflowing reservoir tank	Exhaust gas leaks into cooling system	Cylinder head deterioration	—			
		Cylinder head gasket deterioration				
Except cooling system parts malfunction	—	Overload on engine	Abusive driving	High engine rpm under no load	—	
				Driving in low gear for extended time		
				Driving at extremely high speed		
		Powertrain system malfunction	—			
		Installed improper size wheels and tires				
	Dragging brakes					
	Improper ignition timing					
	Blocked or restricted air flow	Blocked bumper	—	—		
Blocked radiator grille		Installed car brassiere				
		Mud contamination or paper clogging				
Blocked radiator		—				
Blocked condenser		—				
	Installed large fog lamp	—				

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# SERVICE DATA AND SPECIFICATIONS (SDS)

## Engine Lubrication System

### Oil pressure

Engine speed rpm	Approximate discharge pressure kPa (kg/cm <sup>2</sup> , psi)
Idle speed 3,000	More than 69 (0.70, 10.0) 435 - 551 (4.44 - 5.62, 63.1 - 79.9)

### Regulator valve

Unit: mm (in)	
Regulator valve to oil pump cover clearance	0.040 - 0.097 (0.0016 - 0.0038)

### Oil pump

Unit: mm (in)	
Body to outer gear radial clear- ance	0.114 - 0.200 (0.0045 - 0.0079)
Inner gear to outer gear tip clear- ance	Below 0.18 (0.0071)
Body to inner gear axial clearance	0.030 - 0.070 (0.0012 - 0.0028)
Body to outer gear axial clearance	0.050 - 0.110 (0.0020 - 0.0043)
Inner gear to brazed portion of housing clearance	0.045 - 0.091 (0.0018 - 0.0036)

## Engine Cooling System

### Thermostat

Valve opening temperature	°C (°F)	82 (180)
Valve lift	mm/°C (in/°F)	More than 8.6/95 (0.339/203)

### Radiator

Unit: kPa (kg/cm <sup>2</sup> , psi)		
Cap relief pressure	Standard	78 - 98 (0.8 - 1.0, 11 - 14)
	Limit	59 - 98 (0.6 - 1.0, 9 - 14)
Leakage test pressure		157 (1.6, 23)