



GROUP 07

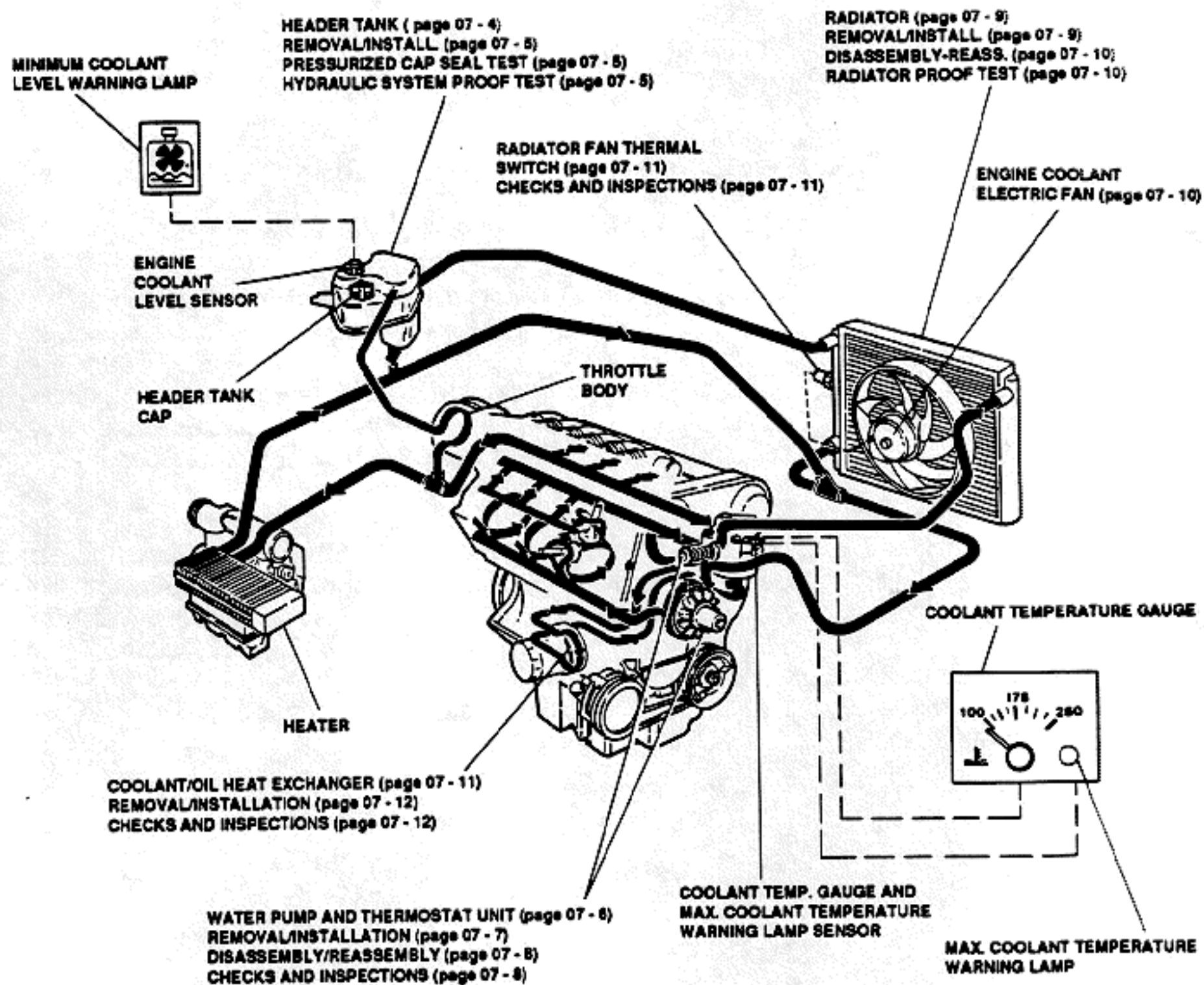
COOLING SYSTEM

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ILLUSTRATED INDEX





COOLING SYSTEM

DESCRIPTION

The cooling system is of the sealed type. The coolant flow is forced by a centrifugal pump driven by the crankshaft through a poly-V type belt.

A thermostat maintains the engine temperature within optimum values; the thermostat opens when the coolant temperature reaches about 87°C (188°F).

The coolant is cooled in the radiator by means of ram air effect and by a two-speed electric fan controlled by a radiator mounted thermal switch; an additional resistor and a relay select the higher speed of the electric fan in case of excessive temperature.

The header tank tops-up the cooling system in case of low coolant level, and absorbs the changes of coolant volume due to changes in temperature; the header tank also enables to bleed the air from the system.

The cooling system also includes a coolant temperature sensor which controls the maximum temperature warning lamp on the instrument panel. The warning lamp turns on when the coolant temperature increases above 115°C (239°F).

A further sensor on the header tank monitors the coolant minimum level and directs level signals to the relevant warning lamp on the instrument panel.

SYSTEM OPERATION

After the engine has been cooled, the coolant flows to the thermostat unit. If the temperature is below 87°C (188°F) the coolant is directed to the pump; if the temperature is above the limit value, the coolant is directed to the radiator. After cooling, the coolant returns to the pump and is then directed to the engine.

Moreover, a cooling system offtake maintains the throttle body to a constant temperature; a second offtake is also provided to cool the engine oil through a heat exchanger located below the oil filter.

Two vent pipes connect the highest points of the system (radiator and throttle body) to the header tank, and allow bleeding in the header tank of any air that could be trapped in the system.

A further offtake supplies the air conditioning heater, which provides heating of the vehicle interior (refer to Group 80).



CAUTION:

The anti-freezing mixture is harmful for the paintwork. Avoid any contact with painted surfaces.

DRAINING OF THE HYDRAULIC SYSTEM

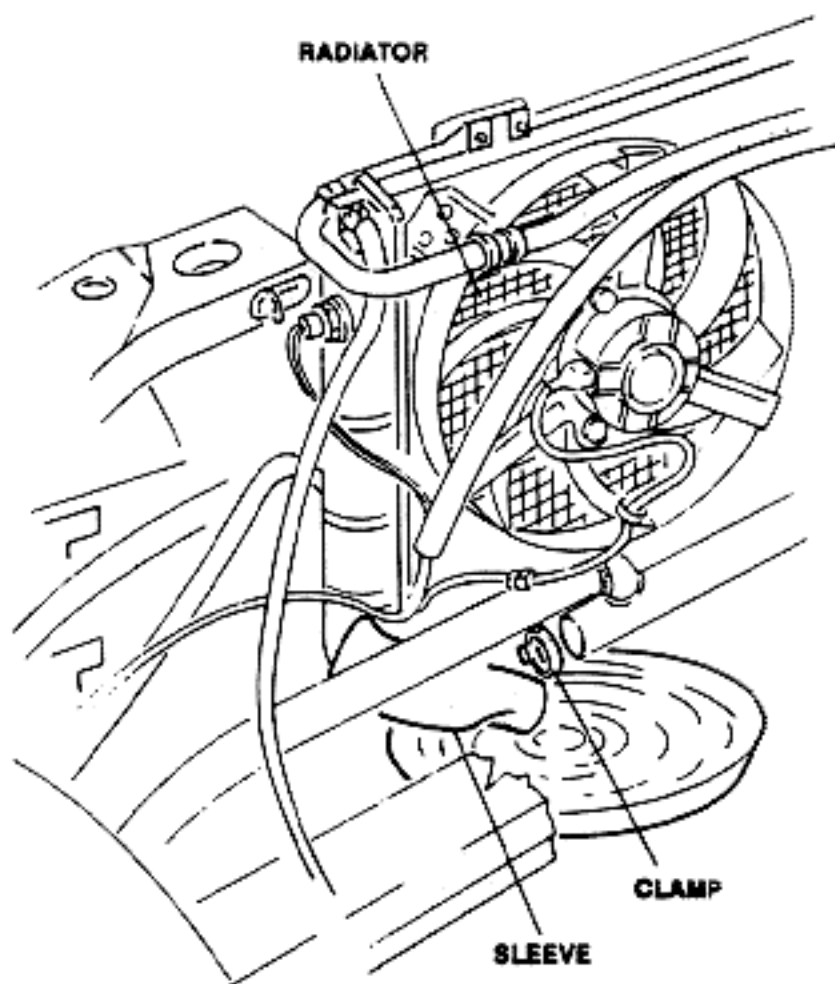
1. Disconnect (-) lead from the battery.
2. Unscrew and remove header tank cap.



WARNING:

Do not absolutely remove the header tank cap while the engine is warm.

3. Loosen clamp fixing the radiator outlet sleeve, and disconnect sleeve from the radiator; drain and collect coolant in a suitable container located underneath the vehicle.





SERVICING OF THE HYDRAULIC SYSTEM

1. Connect radiator sleeve and any other hose previously disconnected; check that all clamps are properly tightened.
2. Service the system to the MAX level mark on the header tank.

The type and approximate quantity of coolant are indicated in the table below:

Minimum outside temperature	°C °F	-20 -4	-40 -40
Concentrated Anti-freeze	liters Gals.	4.3 1.15	7.1 1.9
Distilled water (Dilution)	liters Gals.	8.7 2.35	5.9 1.6
Anti-freeze mixture (Ready for use)	liters Gals.	13 3.5	- -

NOTE: The quantities shown in the above table are referred to the total capacity of the cooling system. Note that servicing capacity is 9.5 liters (2.55 Gals.).

3. Start engine and bring to normal operating temperature range, so that opening of thermostat will vent any air trapped in the system.
4. With cold engine, top-up coolant to the MAX level mark on the header tank.
5. Screw and tighten the header tank pressurized cap.

NOTE: To increase protection from -20°C (-4°F) to -40°C (-40°F) without draining the system completely, replace about 4 liters (1.1 gals) of freezing mixture with the same quantity of the specified concentrated anti-freeze.



CAUTION:

It is recommended not to mix anti-freeze fluids of different types or brands.

Do not use anti-rust additives, which could be not compatible with the anti-freeze used in system.

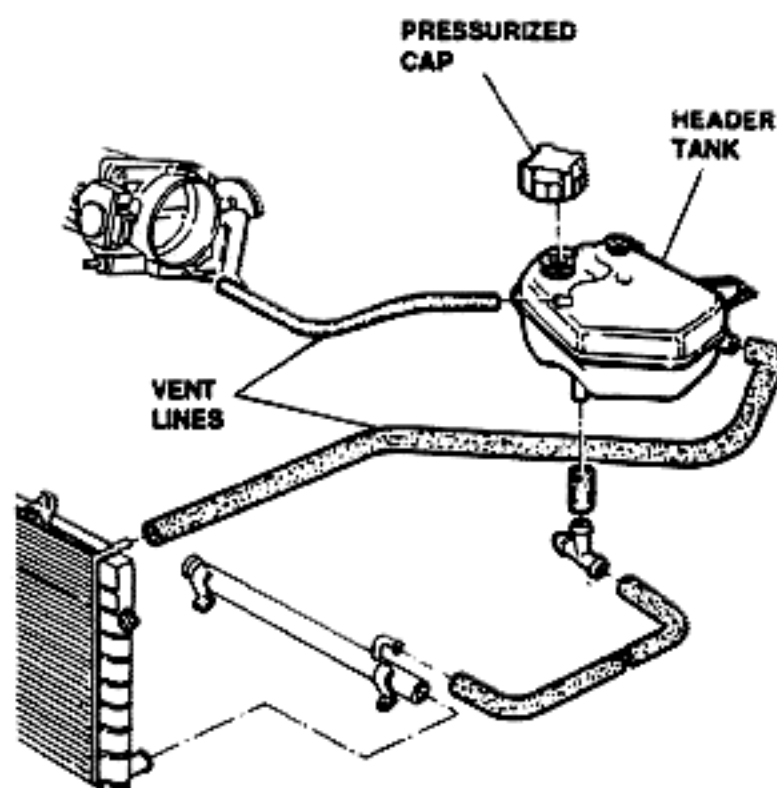
HEADER TANK

The header tank provides the following functions:

- Supply the system with coolant in case the level decreases.
- Expansion box for the absorption of coolant changes of volume due to the variations of temperature during engine operation.
- Bleeding of air bubbles trapped in the system by means of two lines connected to the highest points of the system.

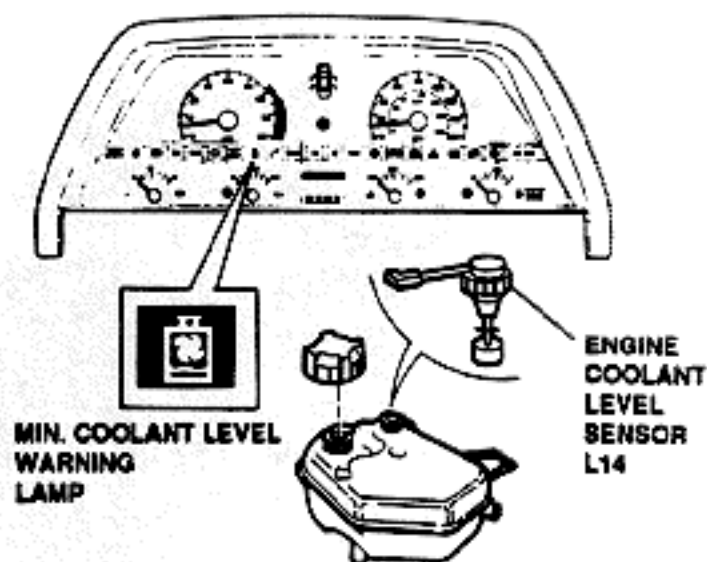
A pressurized cap allows sealing of the header tank; anyway, if excessive pressure builds-up in the tank, a relief valve opens and discharges the excess pressure. Relief valve setting: 100 kPa (14.5 p.s.i.)

The header tank is made of plastic.



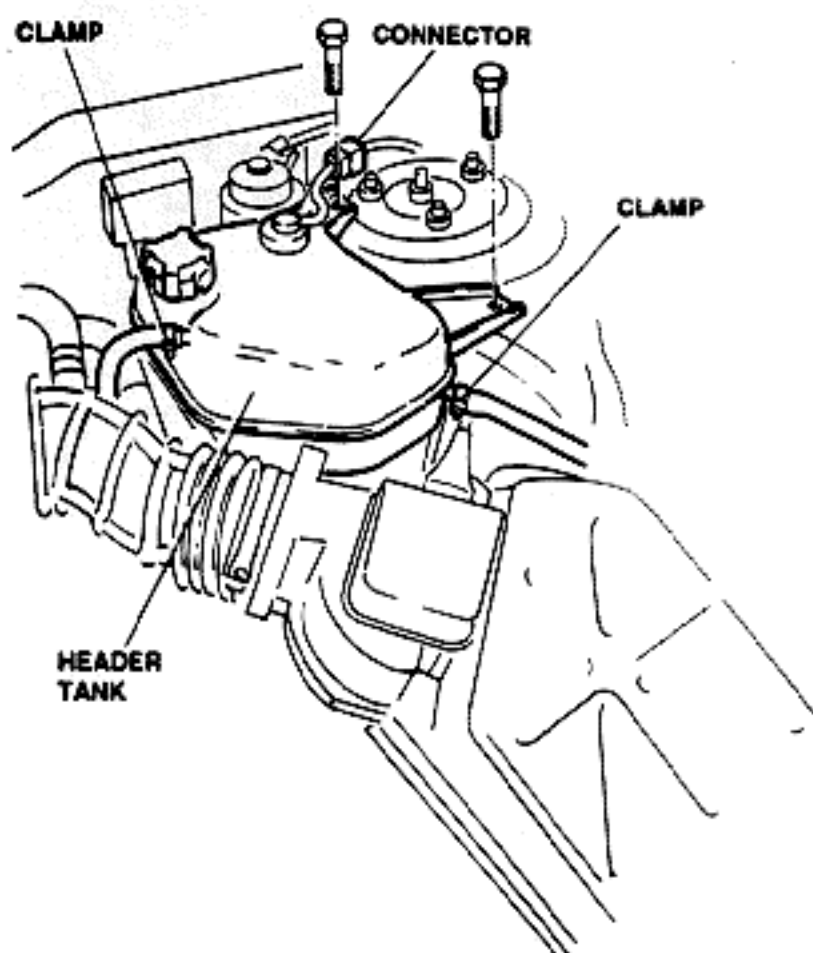


A sensor installed on the header tank controls a warning lamp on the instrument panel to alert when the level of coolant in the tank is insufficient.



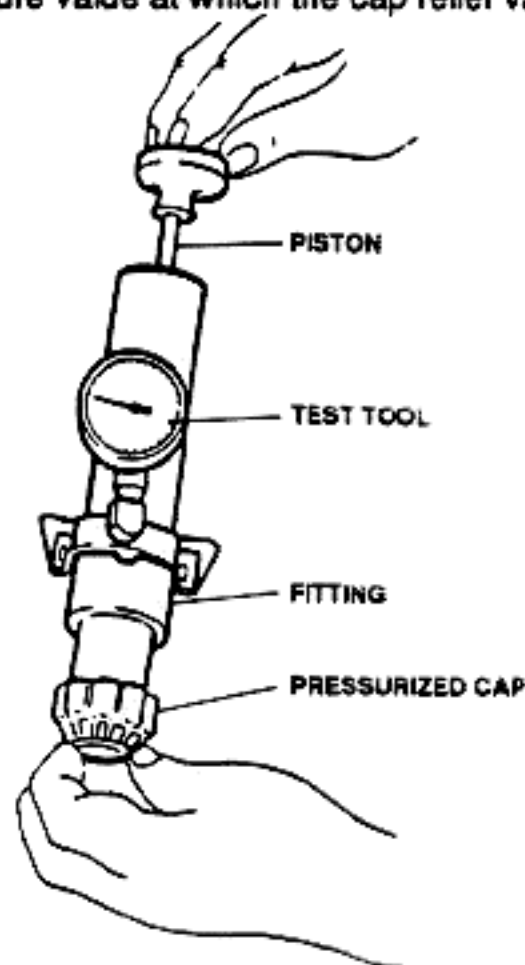
REMOVAL/INSTALLATION

1. Drain the hydraulic system (refer to page 7-3).
2. Disconnect electric connector from the engine coolant level sensor.
3. Loosen clamps and disconnect all lines from the header tank.
4. Remove header tank.



PRESSURIZED CAP SEAL TEST

1. Perform test using the seal test tool.
2. Screw fitting to lower end of test tool.
3. Install the pressurized cap of header tank on test tool fitting.
4. Manually actuate the test tool piston and pressurize the pressurized cap; read on the test tool gauge the pressure value at which the cap relief valve opens.

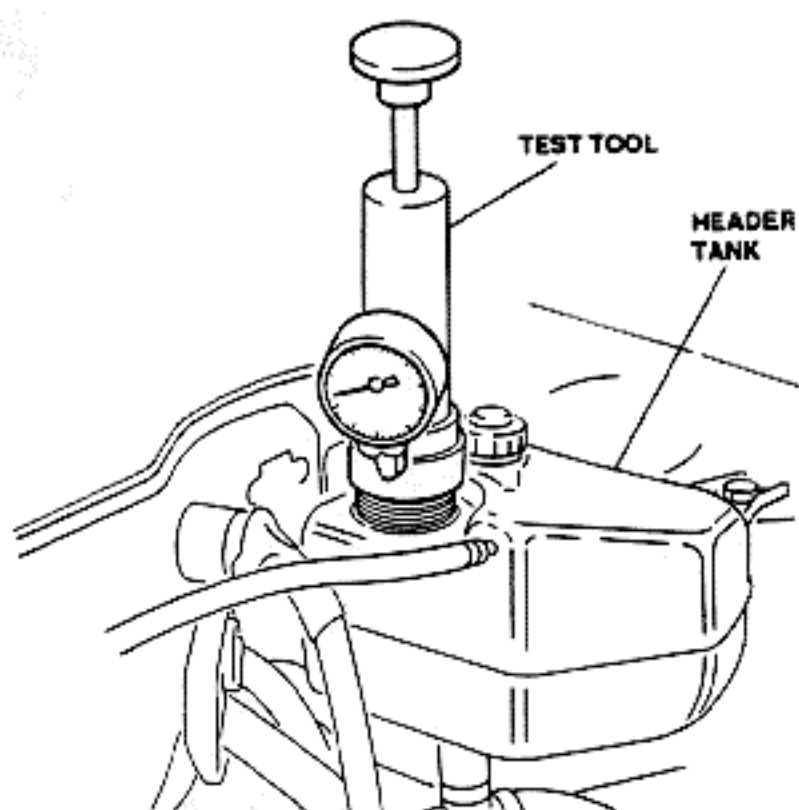


Pressurized cap setting

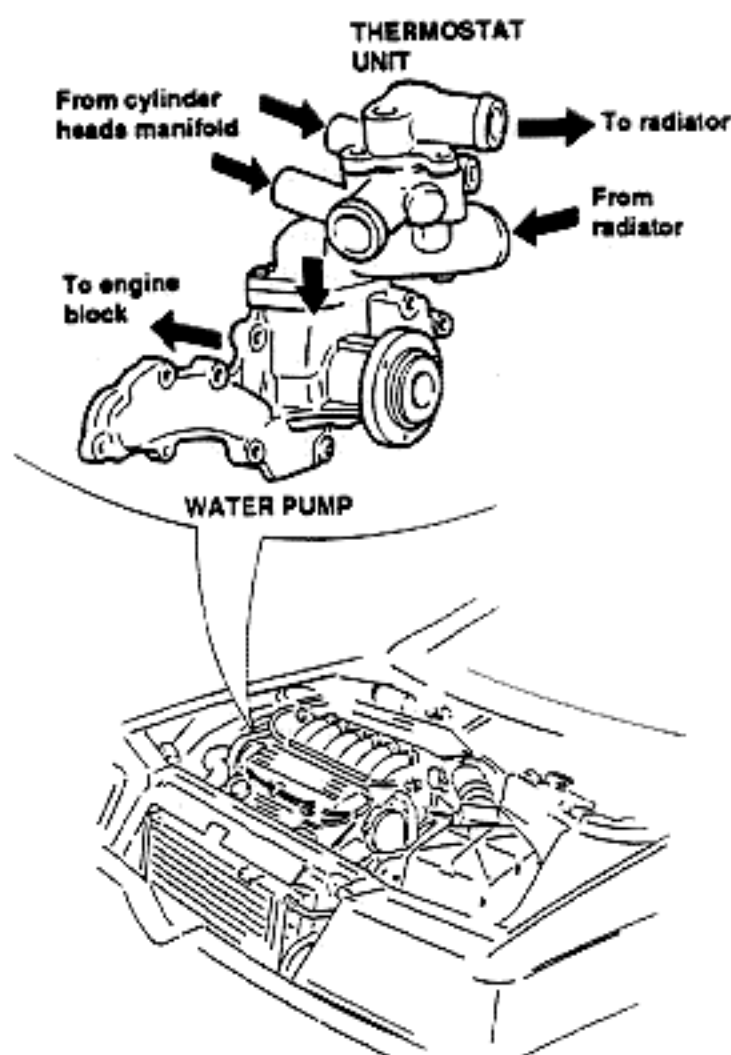
100 kPa (14.5 p.s.i.)

HYDRAULIC SYSTEM PROOF TEST

1. Unscrew and remove pressurized cap from header tank.
2. Screw hydraulic system proof test tool and relevant fitting onto header tank filler.
3. Manually pressurize the system and check on proof test tool gauge that pressure remains to the prescribed value. If pressure decreases, check for leaks through the sleeves or radiator.

**Hydraulic system test pressure****107.9 kPa (15.6 p.s.i.)**

the normal operating limits; the thermostat valve directs the coolant to the pump when the coolant temperature is below 87°C (188°F); when the coolant temperature exceeds the above limit, the thermostat valve opens and directs the coolant to the radiator.



The thermostat unit includes a coolant temperature sensor which supplies temperature signals to the coolant temperature gauge and coolant maximum temperature warning lamp on the instrument panel.

PUMP AND THERMOSTAT UNIT

The water pump is of the vane centrifugal type; the pump body is made of a special aluminum alloy, and the impeller is made of cast iron.

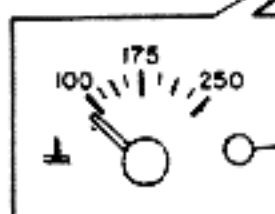
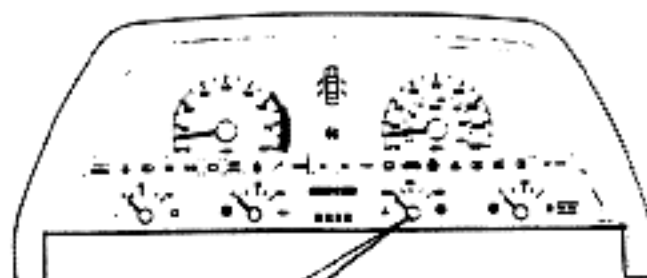
The pump is fixed to the engine block front side by means of nine screws.

A gasket is installed between the engine block and the pump.

The pump is driven by the crankshaft through a "poly-V" type belt; continuous operation of the pump ensures a continuous flow of coolant.

The thermostat unit is located just above the pump body.

The thermostat maintains the engine temperature within

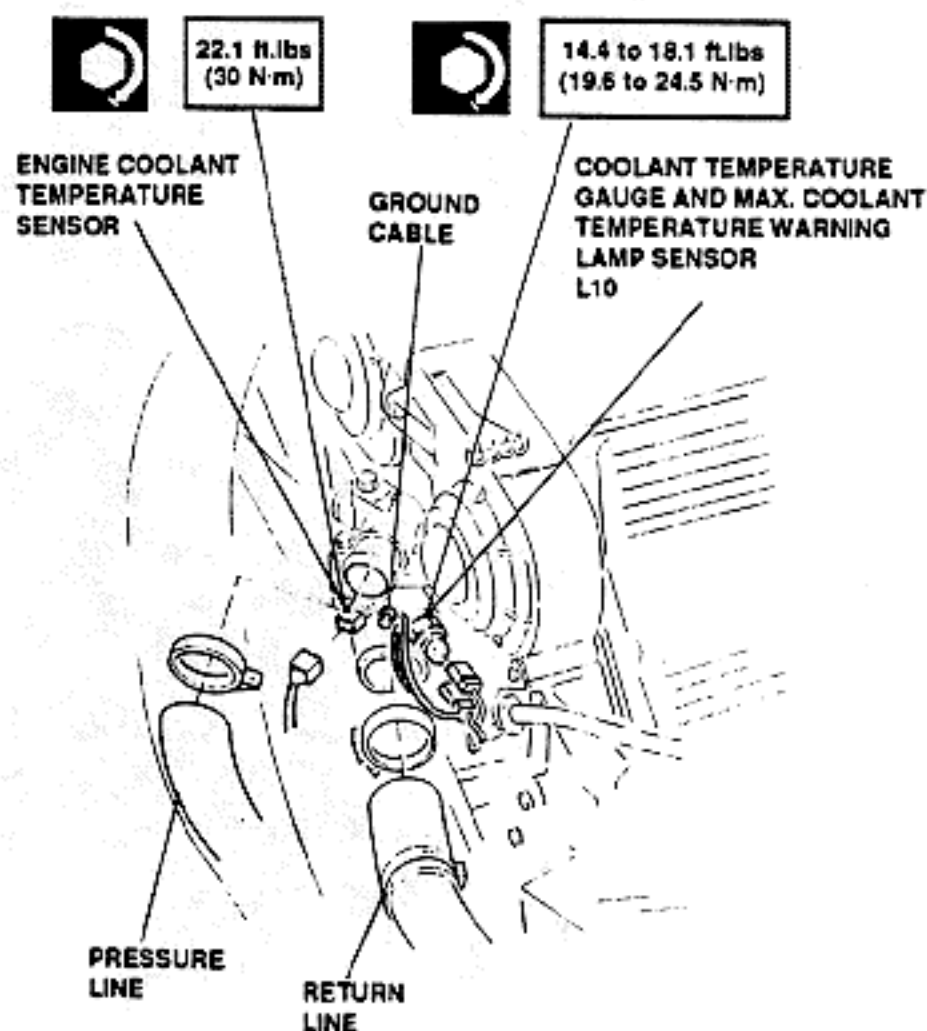


COOLANT
TEMPERATURE GAUGE
MAX. COOLANT TEMPERATURE
WARNING LAMP

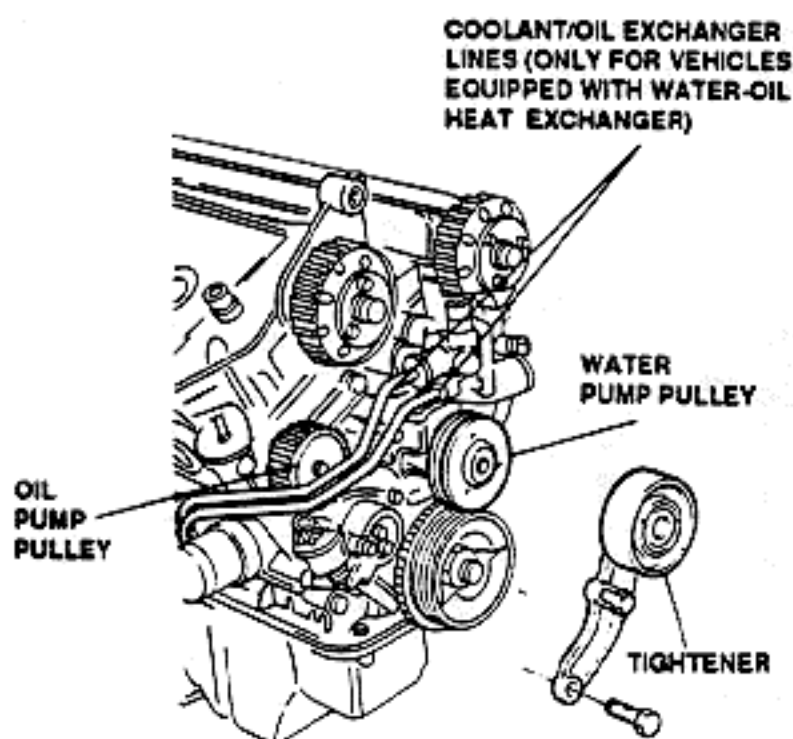


REMOVAL/INSTALLATION

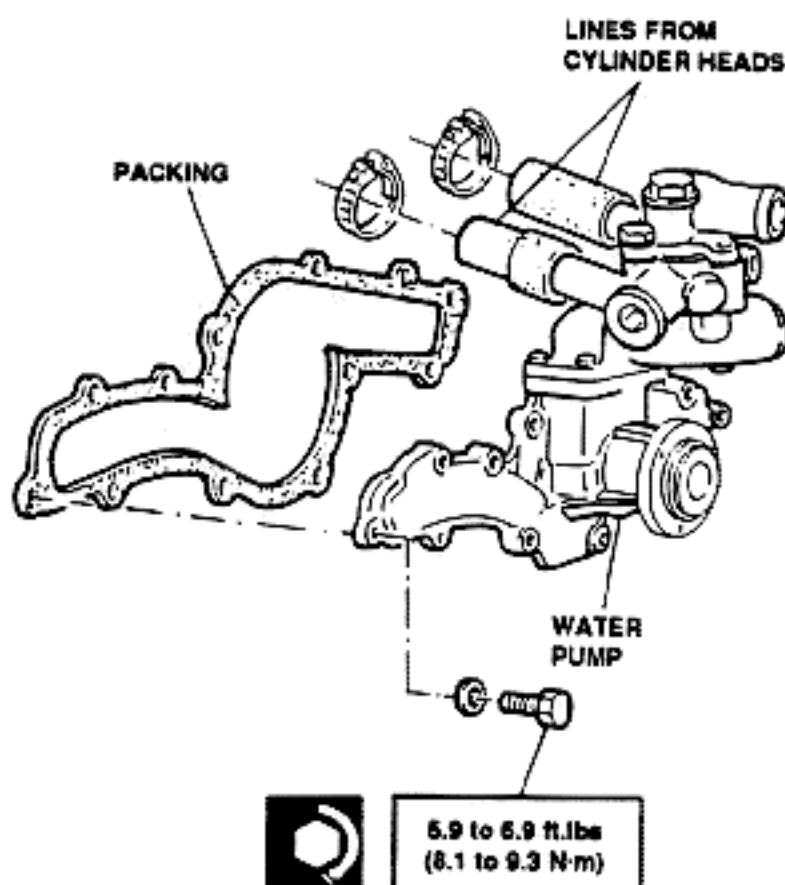
1. Disconnect (-) lead from battery.
2. Drain hydraulic system (refer to page 7-3).
3. Disconnect pressure line from thermostat unit.
4. Disconnect the engine coolant temperature sensor connector (for signals to the control unit).
5. Disconnect ground cable.
6. Remove gauge and warning lamp temperature sensor (for signals to the instrument panel).
7. Disconnect the return line from the pump.
8. Remove the water pump and air conditioning compressor drive belt (refer to Group 00).
9. Remove the engine timing belt (refer to Group 00).



10. Disconnect coolant/oil exchanger lines (only for vehicles equipped with water-oil heat exchanger).
11. Using the torque reactor N. 1.820.051.000, remove the oil pump pulley.
12. Remove the coolant pump and air conditioning compressor belt tightener.
13. Remove water pump pulley.



14. Remove clamps from lines from cylinder heads to thermostat unit.
15. Remove the water pump complete of thermostat unit.
16. Remove the gasket.
17. Reinstall the parts by reversing the order of the above steps; torque fixing parts to the prescribed values.

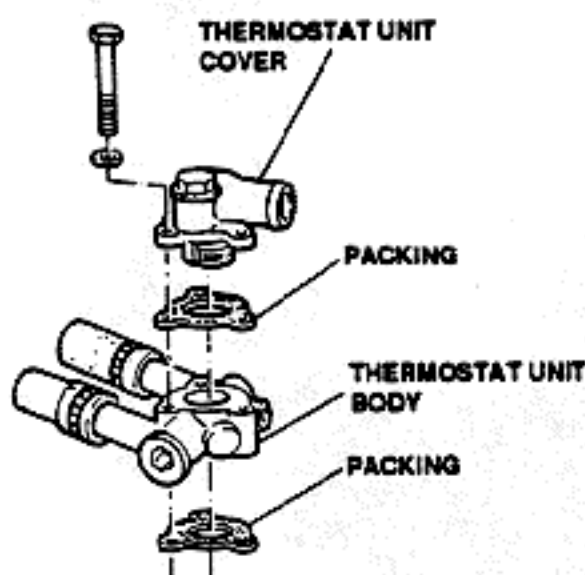


When the installation is completed, check belt tension (refer to Group 00); service the hydraulic system (refer to page 07-4) and check for absence of leaks

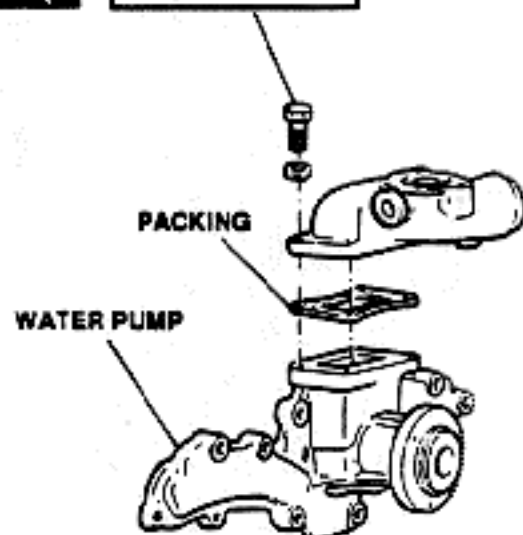


DISASSEMBLY/REASSEMBLY

1. Disassembly the pump and thermostat unit into parts shown in the figure below.



5.9 to 7.4 ft.lbs
(8.1 to 10 N·m)



2. Reassembly the pump and thermostat unit by reversing the order of disassembly procedure; replace all packings and torque parts to the prescribed values.

CHECKS AND INSPECTIONS

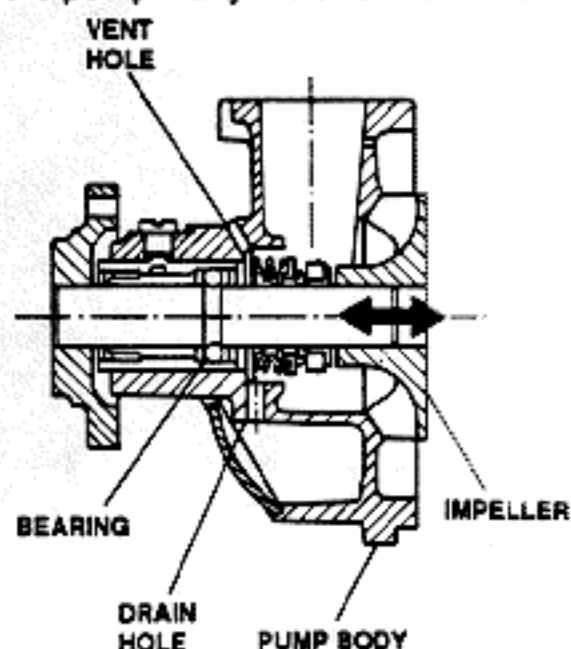
Water Pump

1. Check pump body and impeller for proper conditions and absence of oxidation and corrosion traces.
2. Check for excessive axial play of impeller.
3. Check pump front packing for proper conditions and sealing.

NOTE: Light leaks through the drain holes are normal.

4. Check bearing for wear of races, balls and rollers.

Replace the pump if any the above defects is detected.



Thermostat unit

Check thermostat setting as follows:

1. Suspend thermostat in a container filled with water; heat the water.
2. Using a thermometer, check that beginning of opening, and completion of opening, happen at the values shown in the table below.



CAUTION:

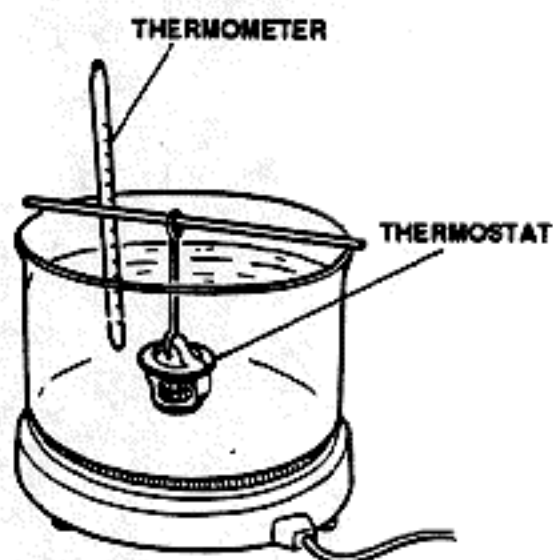
Ensure that both the thermometer and the thermal switch do not contact the bottom of container

Check that the total bulb travel ranges within the values shown in the table below.

Thermostat setting		
Beginning of opening	$87 \pm 2 \text{ C}^\circ$	$188 \pm 4^\circ\text{F}$
Fully opening	99 C°	210°F
Total bulb travel	$\geq 7.5 \text{ mm}$	$\geq 0.3 \text{ In}$



Replace thermostat if correct values are not obtained.

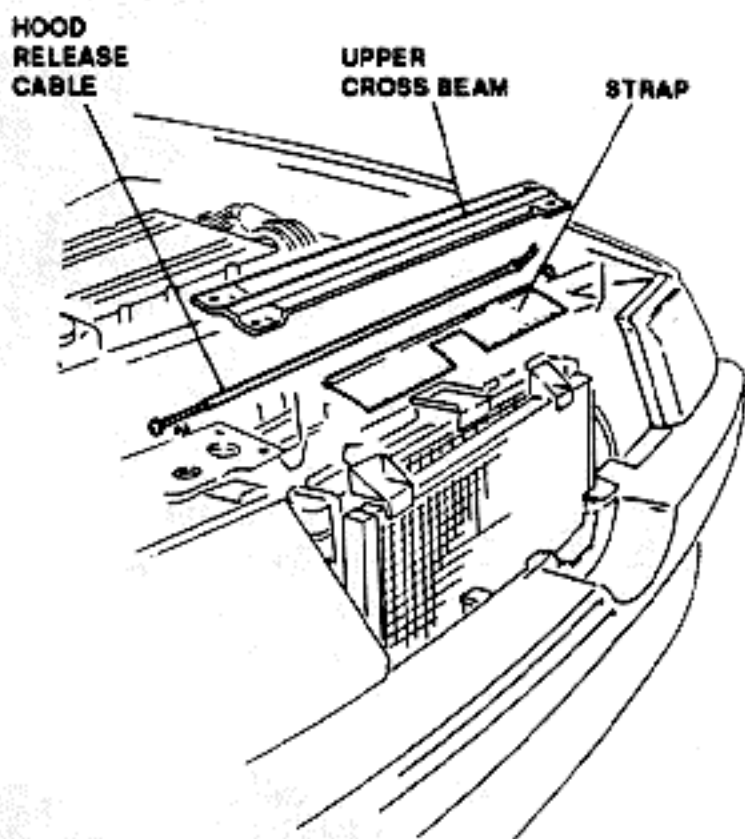


RADIATOR

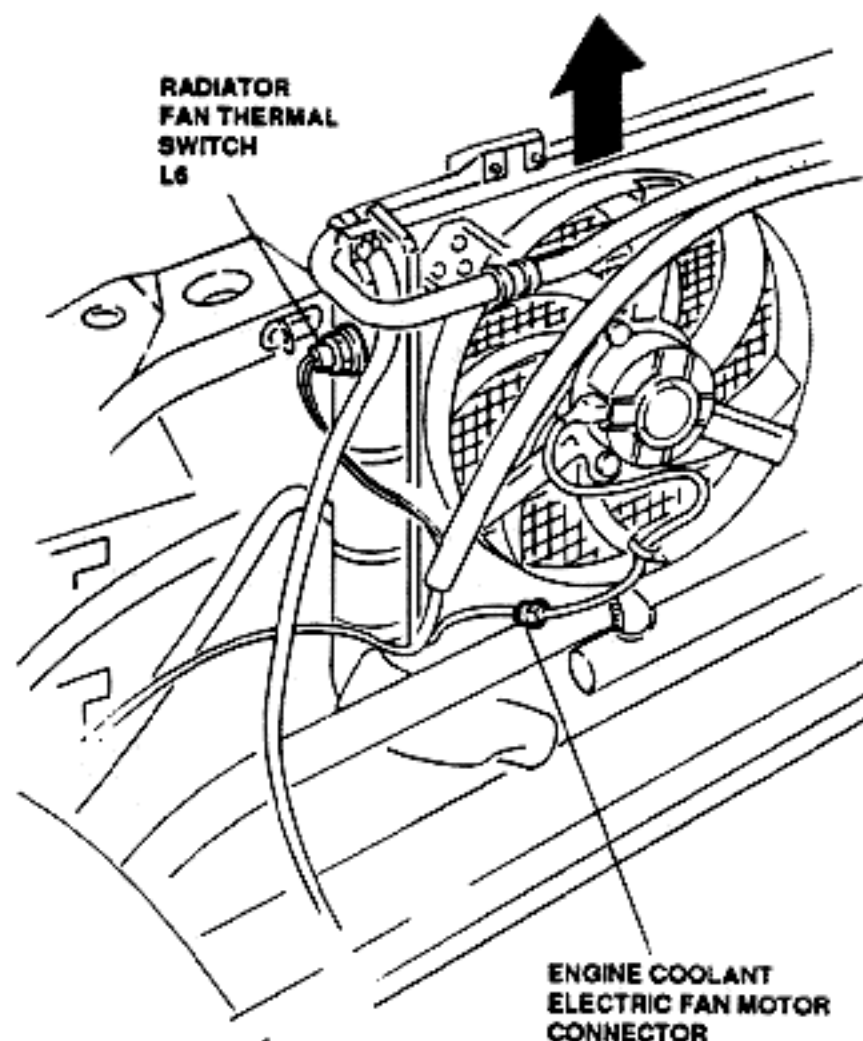
The radiator capability is such that proper cooling of the engine is ensured in the various operating conditions. The radiator consists of a heat exchange unit (total heat exchange surface 21.5 sq. dm (333 sq. in)) and of two lateral chambers, each provided with fittings for the inlet and outlet of coolant. Pipes and fins of the heat exchange unit are made of aluminum; the lateral chambers are made of plastic.

REMOVAL/INSTALLATION

1. Disconnect (-) lead from battery.
2. Drain the hydraulic system (refer to page 7-3).
3. Disconnect engine hood release cable.
4. Remove upper cross beam.
5. Remove strap.



6. Disconnect lines from radiator.
7. Disconnect radiator fan thermal switch connector.
8. Disconnect engine coolant electric fan motor power supply connector.
9. Remove radiator by sliding it upwards.
10. Remove and retain shims between radiator and support frame (only for vehicles equipped with spacers between engine support frame and bodywork).
11. Reinstall the radiator by reversing the order of the above procedure.



After radiator has been reinstalled, service the hydraulic system (refer to page 7-4) and check for absence of leaks.



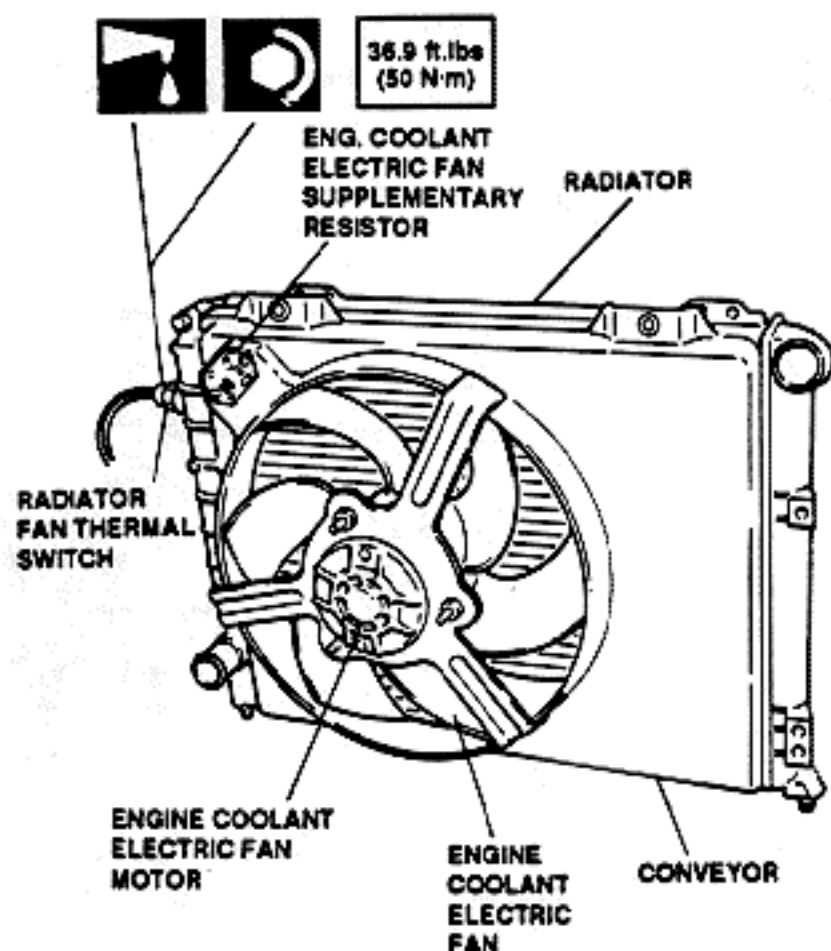
CAUTION:

Torque line clamps carefully to avoid damaging of the lateral chambers. Avoid hitting the radiator and the lateral chambers with wrenches or other tools.



DISASSEMBLY/REASSEMBLY

1. Remove the air conveyor and the engine coolant electric fan from the radiator, if required, as illustrated below.



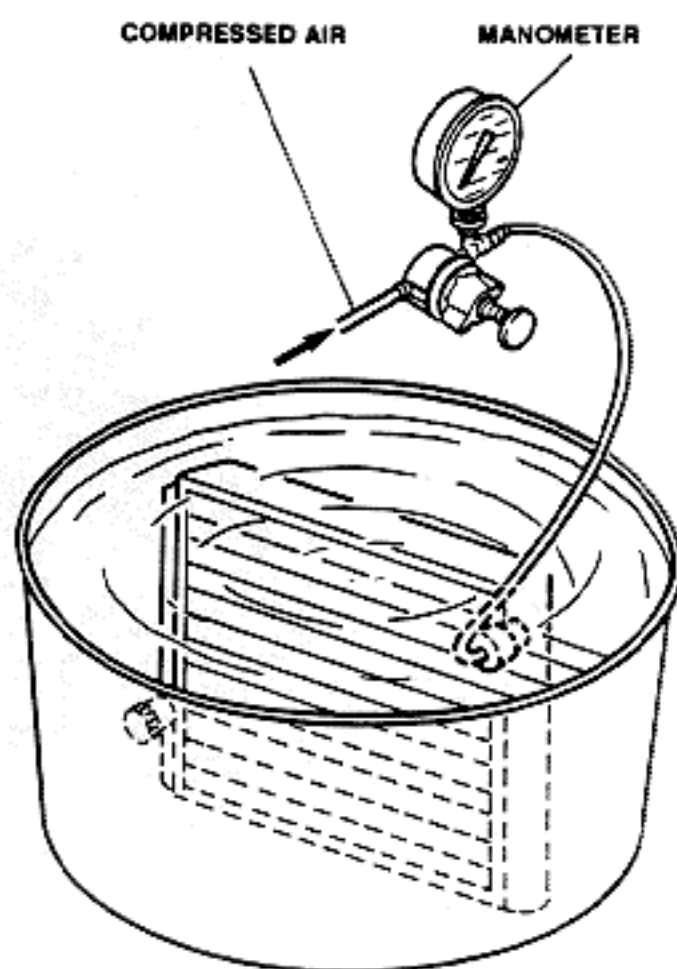
2. Reassembly the parts by reversing the order of disassembly procedure; torque parts to the prescribed values.



Wipe radiator fan thermal switch thread with anti-seizure compound (R. GORI Never Seez) at reassembly.

RADIATOR PROOF TEST

1. Carefully cap all coolant inlet and outlet fittings.
2. Dip radiator in a container filled with water.
3. Pressurize the radiator to 111 KPa (16.2 p.s.i.) with compressed air through a suitable fitting installed on one of the filler caps.
4. If air bubbles are noted, the radiator is not serviceable and must be replaced since repair is not allowed.



Radiator test pressure

111 kPa (16.2 p.s.i.)

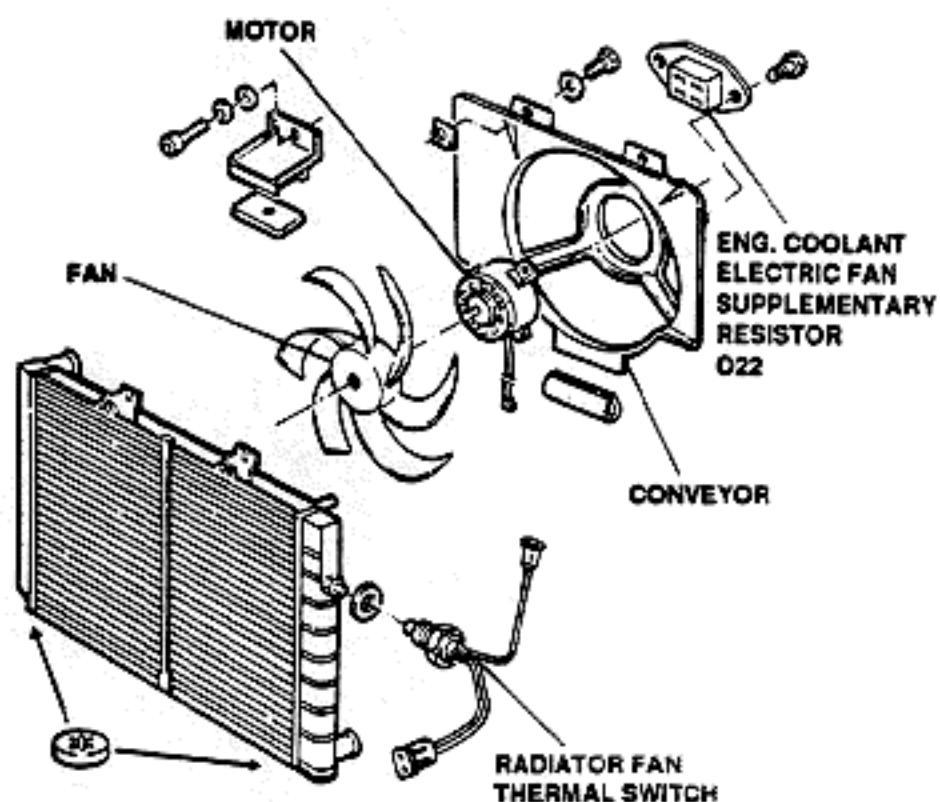
ENGINE COOLANT ELECTRIC FAN

The two-speed electric fan increases the radiator heat exchange capability; when the temperature in the radiator reaches a pre-set value (92°C/198°F) a thermal switch actuates the electric fan.

An additional contact on the thermal switch and resistor will select the fan high speed if the temperature tends to increase furtherly (above 97°C/206°F).

NOTE: For the troubleshooting in case of a malfunction of the electric fan, and for the checks and inspections of the other components (supplementary resistor, relays, etc...) refer to the "WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS".

The thermal switch setting check is however indicated in the following paragraph.



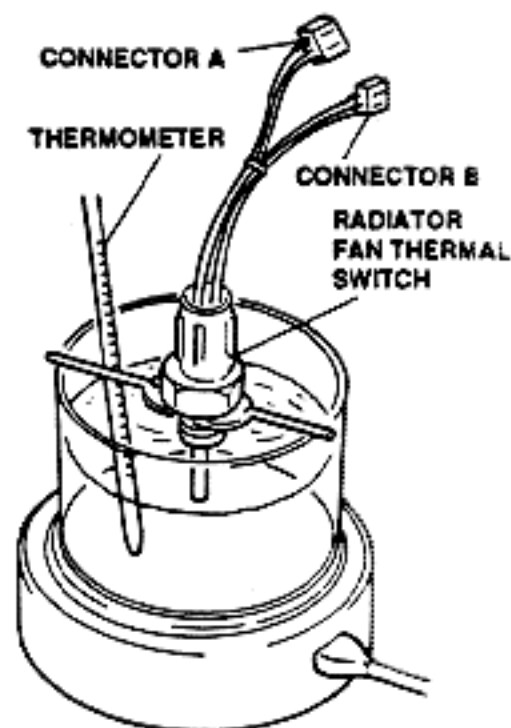
RADIATOR FAN THERMAL SWITCH

CHECKS AND INSPECTIONS

Check the thermal switch setting as follows:

1. Suspend the thermal switch in a container filled with water; heat the water.
2. Using a thermometer and a multimeter, check that thermal switch triggers (the circuit closes at the two pins of connector A) at the temperature corresponding to the first speed of the electric fan.
3. Check in analogy that the thermal switch triggers (the circuit closes between a pin of connector A and pin of connector B) at the temperature corresponding to the second speed of the electric fan.

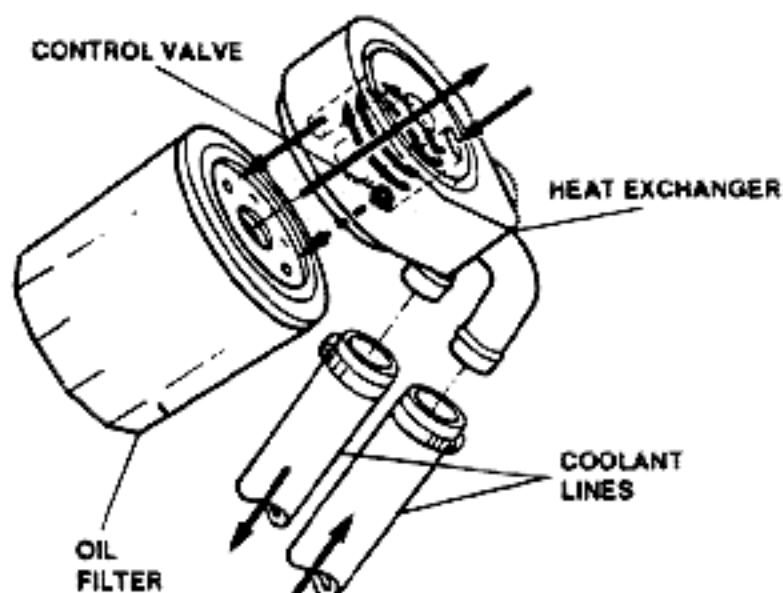
Replace thermal switch if correct values are not obtained.



COOLANT/OIL HEAT EXCHANGER

On "S" version vehicles the increased engine power demands a better cooling of the engine. Improvement of engine cooling has been obtained with several devices and modifications that include a heat exchanger for the engine oil cooling.

The coolant/oil exchanger, located below the oil filter, provides a noticeable cooling of engine oil, thus increasing the oil cooling and lubricating characteristics.



CAUTION:

Ensure that both the thermometer and the thermal switch do not contact the bottom of container.

Electric fan actuation temperatures

1st speed:	92°C (198°F)
2nd speed:	97°C (206°F)



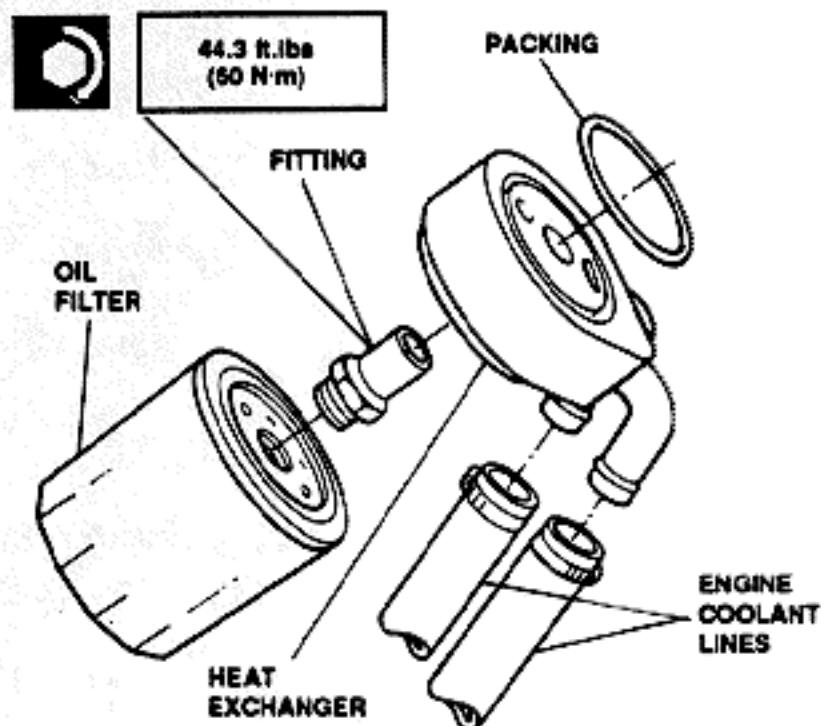
The oil cools up flowing through a series of passages in the heat exchanger before reaching the oil filter, and returns directly in flow through the central passage.

When the engine is cold, and oil density is higher, the control valve opens and allows a higher oil flow, that does not cross the exchanger passages, but reaches the oil filter directly.

REMOVAL/INSTALLATION

1. Remove oil filter using the relevant tool.
2. Unscrew fitting between filter and heat exchanger.
3. Disconnect engine coolant supply and return lines.
4. Remove the heat exchanger.

5. Remove and retain packing.
6. Reinstall by reversing the order of the above steps; torque fixing parts to the prescribed values.



CHECKS AND INSPECTIONS

Thoroughly clean the heat exchanger from any trace of dirt and oil; carefully inspect the cooling passages for obstructions.



TECHNICAL CHARACTERISTICS AND SPECIFICATIONS

COOLING SYSTEM

Hydraulic system test pressure	107.9 kPa	15.6 p.s.i.
Pressurized cap pressure setting	100 kPa	14.5 p.s.i.
Radiator proof test pressure	111 kPa	16.2 p.s.i.

THERMOSTAT

Temperature at beginning of opening	87±2 °C	188±4 °F
Temperature at full opening	99 °C	210 °F
Total bulb travel	7.5 mm	0.3 in

ELECTRIC FAN

Actuating temperature, 1st speed	92 °C	198 °F
Actuating temperature, 2nd speed	97 °C	206 °F

COOLANT

Minimum outside temperature	-20 °C (-4 °F)		-40 °C (-40 °F)	
Concentrated anti-freeze	4.3 liters	1.15 gals	7.1 liters	1.9 gals
Dilution distilled water	8.7 liters	2.35 gals	5.9 liters	1.6 gals
Ready-for-use anti-freeze mixture	13 liters	3.5 gals	—	—

NOTE: Servicing capacity 9.5 liters (2.55 Gals)

FLUIDS AND LUBRICANTS

Application	Type	Name
Thermal switch thread	Anti-seizure compound	R. GORI Never Seez

**TIGHTENING TORQUES**

Water pump to engine block attaching screws	5.9 to 6.9 ft.lbs	8.1 to 9.3 Nm
Thermostat to pump attaching screws	5.9 to 7.4 ft.lbs	8.1 to 10 Nm
Radiator fan thermal switch to radiator attachments	36.9 ft.lbs	50 Nm
Coolant temperature sensor attachments	14.4 to 18.1 ft.lbs	19.6 to 24.5 Nm
Engine coolant temperature sensor attachments	21.1 ft.lbs	30 Nm
Oil filter fitting attachments	44.3 ft.lbs	60 Nm

SPECIAL TOOLS

Tool number	Description
1.820.051.000	Tool, oil pump pulley removal/installation



TROUBLESHOOTING PROCEDURE

TROUBLES AND SYMPTOMS	FAULT ISOLATION	TEST REFERENCE
LEAKS OF COOLANT - (If evidenced by low coolant level and white-green sediments in the leaking area).	- If the leak is not evident carry-out the "HYDRAULIC SYSTEM PROOF TEST".	A
ENGINE OVERHEATING	- Start engine and bring to normal operating temperature. - Excessive temperature is indicated by the temperature warning lamp and gauge on instrument panel. NOTE: In case of malfunction of the temperature warning lamp and gauge, a valve is provided on the header tank to relief the high pressure steam generated within the cooling system.  CAUTION: Frequent operation on dusty or muddy roads, or in presence of flower pollen or small insects, can cause excessive obstruction of the engine cooler front area, thus reducing its cooling capability and causing consequent engine overheating.	B



LEAKAGE OF COOLANT

TEST A

TEST STEPS		RESULTS	REMEDY
A1	CLAMPS CHECK		
- Check that clamps are not loose, damaged, improperly installed or of a size different from that required		 ►	Carry-out step A2
		 ►	Tighten or replace affected clamps
A2	PUMP AND THERMOSTAT UNIT CHECK		
- Check pump and thermostat unit body for cracks or other defects		 ►	Carry-out step A3
		 ►	Replace defective items
A3	OIL CONTAMINATION CHECK		
- Check that the coolant has not contaminated the engine oil; such faulty condition is confirmed by traces of a whitish substance in the engine oil		 ►	Carry-out step A4
		 ►	Tighten the cylinder head screws to the prescribed torque; should malfunction be recurring, replace the cylinder head gas-kets
A4	GAS PRESENCE CHECK INSIDE THE CIRCUIT		
- Using a special instrument applied to the expansion tank, check for absence of gas (Co + HC) inside the cooling circuit		 ►	Tighten the cylinder head screws to the prescribed torque; should malfunction be recurring, replace the cylinder head gas-kets

End of test A



ENGINE OVERHEATING

TEST B

TEST STEPS		RESULTS	REMEDY
B1	WARNING LAMP AND GAUGE CHECK		
- Check proper operation of coolant temperature warning lamp and gauge on instrument panel, and of transmitters on engine (refer to WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS)		OK ► ~~OK~~ ►	Carry-out step B2 Repair or replace affected items
B2	COOLANT LEVEL CHECK		
- Check level of coolant		OK ► ~~OK~~ ►	Carry-out step B3 Service coolant to proper level; proof test the system
B3	ENGINE OIL LEVEL CHECK		
- Check level of engine oil		OK ► ~~OK~~ ►	Carry-out step B4 Service engine oil to proper level (refer to Group 00)
B4	BELT CHECK		
- Check water pump drive belt for proper tension and condition		OK ► ~~OK~~ ►	Carry-out step B5 Tighten belt to proper value, or replace belt if damaged or excessively worn (refer to Group 00)

(Cont.d)



ENGINE OVERHEATING

TEST B

TEST STEPS		RESULTS	REMEDY
B5	ENGINE COOLANT ELECTRIC FAN CHECK		
- Check operation of engine coolant electric fan wiring system (refer to WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS)		 	Carry-out step B6
		 	Replace electric fan or unserviceable parts of relevant wiring system
B6	THERMAL SWITCH CHECK		
- Check setting of cooling fan thermal switch (contacts close at 198°F; 92°C)		 	Carry-out step B7
		 	Replace thermal switch
B7	HOSE CHECK		
- Check coolant hoses for obstructions, visually inspect that sleeves are not squeezed or bent		 	Carry-out step B8
		 	Replace hoses
B8	COOLANT FLOW CHECK		
- Check that coolant flows freely through the hoses by manually pumping the hoses, and noting swashing in the header tank		 	Carry-out step B9
		 	Replace hoses

(Cont.d)



ENGINE OVERHEATING

TEST B

TEST STEPS		RESULTS	REMEDY
B9	RADIATOR CHECK		
- Check radiator for absence of fouling or foreign matter		OK ► ~~OK~~ ►	Carry-out step B10 Wash radiator with specific cleaners; make sure the engine radiator is of the approved type
B10	WATER PUMP CHECK		
- Check water pump for condition and proper operation		OK ► ~~OK~~ ►	Carry-out step B11 Replace water pump and gasket
B11	THERMOSTAT UNIT CHECK		
- Bring engine to normal temperature range, then touch hose between thermostat unit and radiator: verify the duct warms up gradually		OK ► ~~OK~~ ►	Carry-out step B12 Replace thermostat unit and relevant gaskets
B12	THERMOSTAT UNIT SETTING CHECK		
- Check thermostat unit for proper setting (refer to CHECKS AND INSPECTIONS - Thermostat unit)		OK ► ~~OK~~ ►	Carry-out step B13 Replace thermostat unit and relevant gaskets

(Cont.d)



ENGINE OVERHEATING

TEST B

TEST STEPS		RESULTS	REMEDY
B13	ENGINE IGNITION TIMING CHECK		Adjust engine ignition timing
- Check engine ignition timing			

End of test B