SECTION 03-03 Engine Cooling

VEHICLE APPLICATION

Capri.

DESCRIPTION

WARNING: KEEP HANDS AND OTHER OBJECTS CLEAR OF THE RADIATOR FAN BLADES! THE ELECTRIC COOLING FAN IS MOUNTED BEHIND THE RADIATOR AND CAN START TO OPERATE AT ANY TIME WHEN THE IGNITION IS SWITCHED ON. CARE SHOULD BE TAKEN TO ENSURE THAT THE IGNITION IS OFF WHEN WORKING IN THE FAN AREA.

WARNING: THE COOLING FAN WILL COME ON IF THE WIRE IS DISCONNECTED FROM THE COOLANT TEMPERATURE SWITCH WITH THE IGNITION SWITCH IN THE RUN POSITION. IF THE WIRE IS DISCONNECTED FROM THE SWITCH FOR ANY REASON, MAKE SURE THE IGNITION SWITCH IS IN THE OFF POSITION.

CAUTION: If during service or diagnostic procedures it is necessary for the cooling fan to be off while the engine is running, disconnect the wiring at the fan motor terminal. Do not disconnect the wires at the thermal switch. With the fan disconnected, the engine may be run for a maximum of two minutes only. The wiring must then be reconnected or overheating and engine damage may occur. Never drive with a disconnected water pump belt or inoperative cooling fan system.

In addition to basic cooling system components:

- Radiator
- Water pump
- Thermostat
- Electric cooling fan

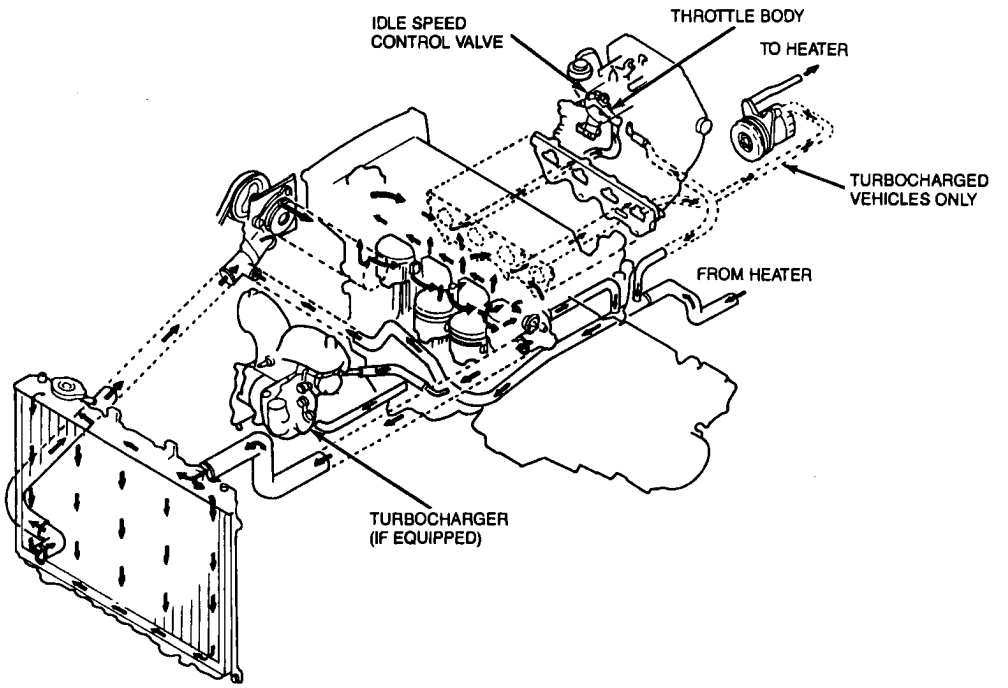
The cooling system also includes:

- Coolant recovery bottle
- Automatic transaxle oil cooler, if so equipped

A thermostat bypass circuit reroutes part of the coolant flow, when the engine is cold and the thermostat is closed. This circuit is the primary flow path distributing combustion heat throughout the engine for quick, uniform warm-up. As the coolant approaches operating temperature the two-stage thermostat begins to open. This routes enough of the coolant flow through the radiator to limit coolant temperature to the operating value of the thermostat. A two-stage thermostat is used for better coolant temperature control with less fluctuation and quicker warm up.

DESCRIPTION (Continued)

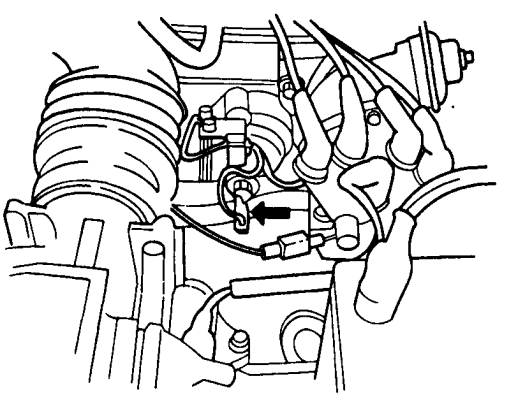
Coolant circulation is by conventional centrifugal pump, discharging into the front of the engine block. It is driven by the crankshaft pulley through a V-belt which also drives the alternator.



Q2991-A

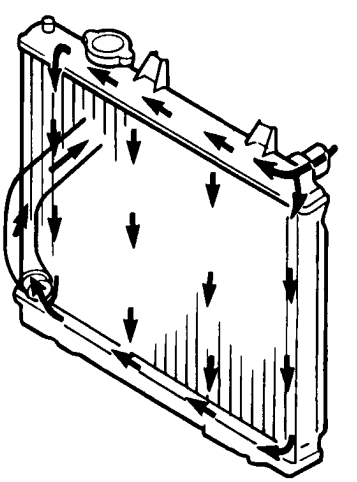
The cooling fan is separately driven by an electric motor controlled by coolant temperature. A thermostatic switch in the thermostat housing opens, to actuate the fan whenever coolant temperature reaches 100°C (212°F).

WARNING: STAY CLEAR OF FAN AT ALL TIMES AS AN INCREASE IN COOLANT TEMPERATURE MAY CAUSE THE FAN TO SUDDENLY OPERATE EVEN THOUGH THE ENGINE IS NOT RUNNING.



Q2996-A

The radiator is of the downflow-type with plastic tanks. System connections differ depending on transaxle equipment.



Q2986-A

DESCRIPTION (Continued)

From behind the radiator, the electric cooling fan draws air through the radiator fins to dissipate engine heat absorbed by the engine coolant. The fan will operate only when a specific heat load is present in the radiator. Matching fan operation to heat load is accomplished through the use of a temperature sensitive switch in the control circuit. The switch is threaded into the thermostat housing where the sensing element is exposed to coolant leaving the engine. At 100°C (212°F) the switch will be open. If coolant temperature drops below 93°C (199°F) the switch will be in the closed position.

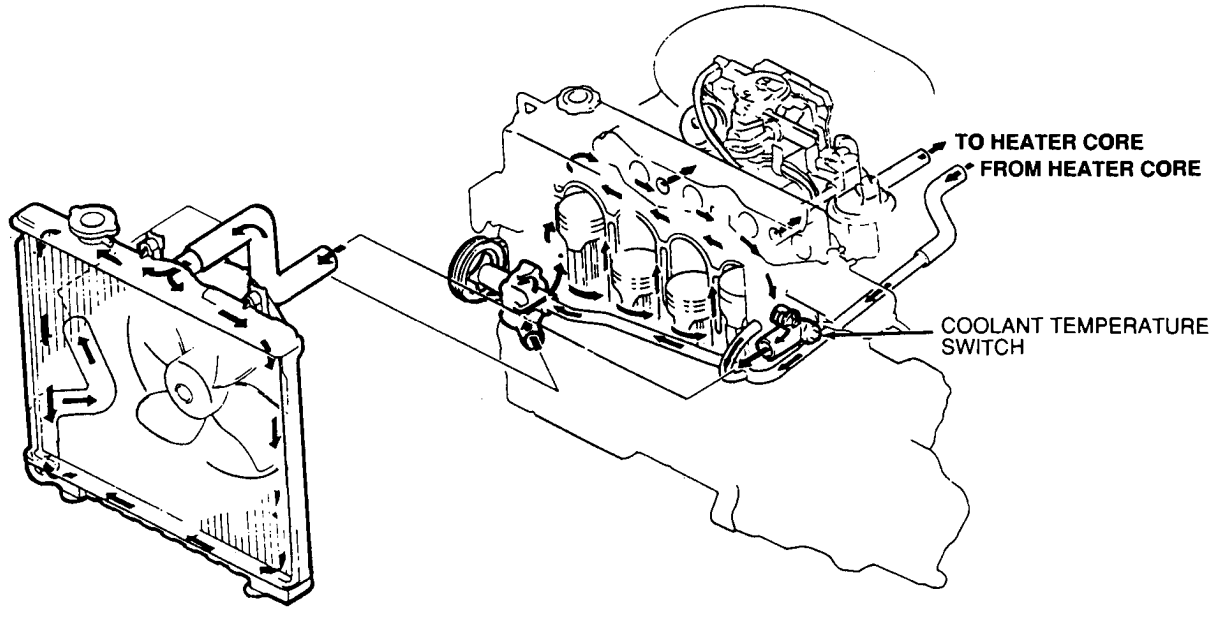
The coolant temperature switch is wired in series with the cooling fan relay coil. When the switch is closed, the coil circuit is complete and the relay points are open. Opening of the switch de-energizes the relay coil, allowing the relay points to close.

When the relay points move to their normally closed position, a ground path is provided for the fan motor circuit. Battery feed to the motor is routed through the ignition switch and the 80 amp power fuse. The relay coil is wired back to the 10 amp meter fuse which is also fed from the ignition switch.

The cooling fan relay is mounted in the LH front corner of the engine compartment behind the headlamp. The fan is attached to an airflow shroud which also acts as a mounting bracket. The fan, relay and temperature switch are serviced only as assemblies.

On vehicles equipped with air conditioning, there is an auxiliary condenser fan in addition to the electric cooling fan. Both operate continuously while the compressor magnetic clutch is engaged. Refer to Section 12-00 for information on the condenser fan.

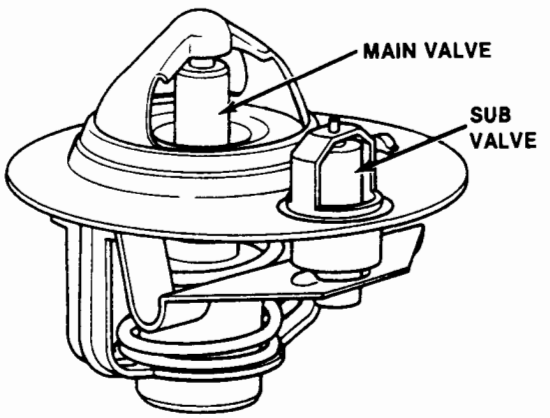
Coolant Flow



Q2643-B

DESCRIPTION (Continued)

Two-Stage Thermostat



DIAGNOSIS AND TESTING

Symptoms of cooling system trouble fall into three categories:

- Loss of coolant
- Overheating
- Failure to reach normal operating temperature

A careful systematic approach to diagnosis is essential if results are to be conclusive. The possible causes and corrective actions for each type of condition are detailed in the charts.

The first step in cooling system diagnosis is a thorough inspection of the entire system. The engine should be warmed up to normal operating temperature and pressure. The upper radiator hose will become warm and firm as the engine warms. Then, shut the engine off.

WARNING: STAY CLEAR OF COOLING FAN, SINCE INCREASED COOLANT TEMPERATURE MAY CAUSE IT TO START AT ANY TIME.

With the system under pressure, check for leaks at:

- All hose connections, radiator, water pump, thermostat housing, heater lines, heater core connections, transmission oil cooler, and intake manifold hose nipple.
- Gasket joints at water pump, thermostat housing, cylinder head, intake manifold, and radiator tanks.
- Threaded water jacket fittings--intake manifold nipple, fan switch, temperature sensor, temperature gauge sender, and automatic transaxle oil cooler fittings in radiator tank, if applicable.

Also, check all hoses for cracks, bulges, soft spots or evidence of chafing or scorching due to improper routing. Check the dipstick for coolant in the engine oil supply.

If the upper hose does not noticeably harden on warm-up, the system is not pressurizing, most likely due to improper pressure cap sealing or a worn or damaged cap. To check the cap, the engine must be stopped and the cap removed.

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY.

TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN CERTAIN ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

DIAGNOSIS AND TESTING (Continued)

CONDITION CHART—COOLING SYSTEM

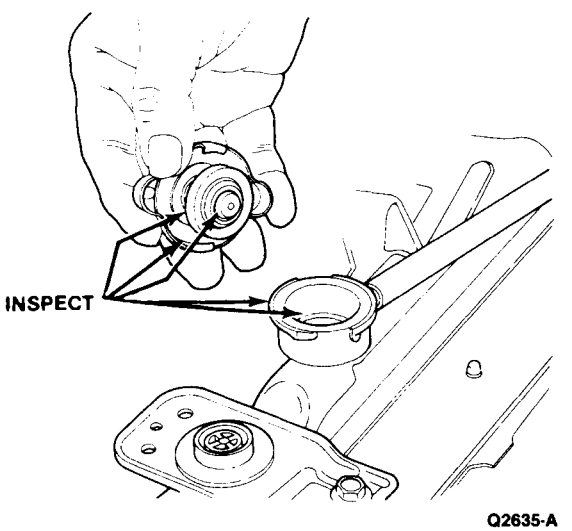
CONDITION	POSSIBLE SOURCE	ACTION
• Coolant Loss	• Pressure cap not pressurizing.	• Inspect cap. Wash both surfaces of rubber cap seal and sealing surfaces of vacuum valve. Inspect and clean sealing surface in expansion tank filler neck. • Pressure test cap and replace it if relief pressure is not within 13 kPa (2 psi) of cap rating.
	• System leakage (external).	• Pressure test system. Refer to test procedure in this section. • If system will not hold pressure, inspect all system connections for external leakage while maintaining pressure with test pump. Check all hose connections, edges of pump, thermostat housing, intake manifold and cylinder head gaskets, radiator core-to-tank joints, drain cock, core plugs, expansion tank, heater valve, and transmission oil cooler line connections, if applicable. Service or replace leaking components as required.
	• System leakage (internal).	• Check dipstick for signs of coolant in engine oil supply. • Check head bolt torque and tighten as required. Refer to Section 03-01 for torque specifications. • Disassemble engine and check for blown gaskets, warped head or block surfaces, or cracks in intake manifold, head or block castings. Refer to Section 03-01 for engine disassembly and inspection procedures.
• Failure to Reach Normal Operating Temperature	• Thermostat not closing.	• Test thermostat and replace if not satisfactory, as outlined in this section.
	• False temp gauge reading.	• Check instrument circuits and service as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
• Overheating	• Low coolant level.	• Fill as required. Check possible causes for coolant loss. Refer to coolant replacement procedure in this section.
	• Excessive rust in coolant.	• Drain and flush system and refill with new coolant. Refer to flushing and coolant replacement procedures in this section.
	• Pressure cap not pressurizing.	• Pressure test cap and replace if relief pressure is not within 13 kPa (2 psi) of cap rating. Refer to test procedure in this section.
	• Radiator or A/C condenser obstructed.	• Remove debris from air passages.
	• Thermostat not opening.	• Test thermostat and if not satisfactory, replace it. Refer to test procedure in this section.
	• Fan drive motor inoperative.	• Test motor and control circuit and service as required as outlined.
	• Ignition timing off.	• Check timing and advance, and adjust as required. Refer to Section 03-07.
	• False temp gauge reading.	• Check instrument circuits and service as required.
	• Engine coolant passages obstructed.	• Check head, block, intake manifold and pump for blockage and remove or flush clear. Refer to Section 03-01.
	• Exhaust system restricted.	• Inspect exhaust system for damage or obstructions, and service as required. Refer to Section 09-00.

Cleaning and Inspection Pressure Cap Testing

Inspect both sides of the pressure cap rubber seal and the vacuum valve seat. Check for particles of rust or dirt that could impair sealing. Flush away any foreign matter with warm tap water. Also check the sealing shoulder on the filler neck and wipe out any foreign matter.



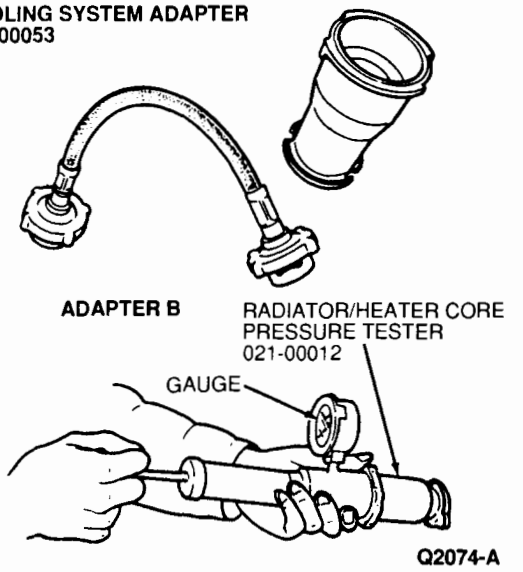
Pressure Test

Make sure pressure cap seal surfaces are clean. Install the cap on Rotunda Cooling System Adapter 021-00053 of Rotunda Radiator / Heater Core Pressure Tester 021-00012 or equivalent.

The adapter is reversible to accept either deep or shallow neck caps.

DIAGNOSIS AND TESTING (Continued)

Install the filler neck seal on the filler neck adapter with it seated in the deepneck end of the cap adapter. Connect the pump hose quick-disconnect fitting to the nipple on the filler neck adapter. Slowly pump the plunger while observing the pressure gauge. When the pressure stops increasing, note the reading obtained.



NOTE: Applying pressure too quickly can cause incorrect readings. Release pressure with the pressure relief screw. Repeat the test at least twice to verify that the pressure reading is repeatable and consistent. If the cap pressure is less than 103 kPa (15 psi) or more than 131 kPa (19 psi), replace the cap.

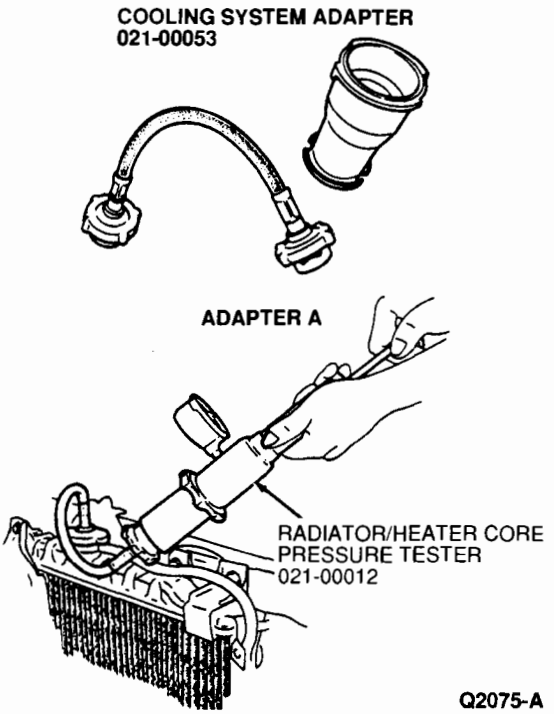
Cooling System Pressure Test

System pressure testing is necessary when inspection and pressure cap testing do not identify the cause of coolant loss.

With system warm and pressure cap removed, install the test kit filler neck seal on the filler neck adapter, large end first. Install the adapter on the radiator filler neck in place of the pressure cap. Connect the test pump quick-disconnect fitting to the nipple on the filler neck adapter. Pressurize the system, if possible, to the relief pressure of the cap 103 kPa (15 psi).

CAUTION: Do not, in any case, pressurize the system in excess of 103 kPa (15 psi). If cap relief pressure is greater than 131 kPa (19 psi), replace the cap.

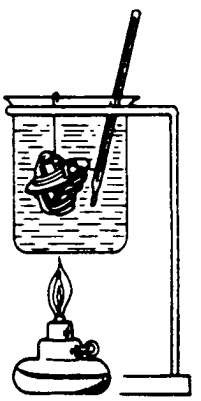
If the system can be pressurized to within 13 kPa (2 psi) of the cap pressure rating, let it stand for two minutes while watching the gauge. If the pressure holds, the system is not leaking. If pressure drops, check for leaks at all external cooling system connections as outlined. Maintain pressure with the test pump. If no external leaks are found, refer to Section 03-01 for engine disassembly and inspection procedures.



DIAGNOSIS AND TESTING (Continued)

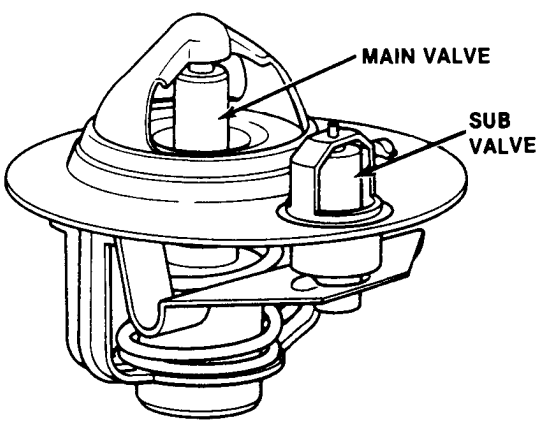
Thermostat Testing

If overheating or failure to reach normal operating temperature occur, the thermostat must be removed as outlined and temperature-tested. Suspend the thermostat and an accurate thermometer in a pan of water so that they do not touch the bottom of the pan. Heat water to boiling while observing the temperature. The thermostat sub valve should just begin to open at 88°C±1.5°C (192°F±1.5°F), and the main valve should begin opening at 91°C±1.5°C (198°F±1.5°F). Both valves should be fully open at 100°C (212°F). Fully open means that the sub valve opens 1.5mm (0.06 inch) or more, and the main valve opens 8mm (0.31 inch) or more. The sub valve should be closed at 83°C (181°F), while the main valve should be closed at 86°C (188°F).



Q2632-A

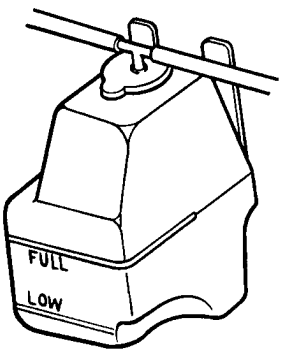
To check for low temperature leakage, cool the thermostat to room temperature. Hold thermostat up against a lighted background. Check for light between valve and seat. If any light is visible, replace the thermostat with an approved original equipment replacement of the same temperature rating.



Q2642-A

Coolant Level Check

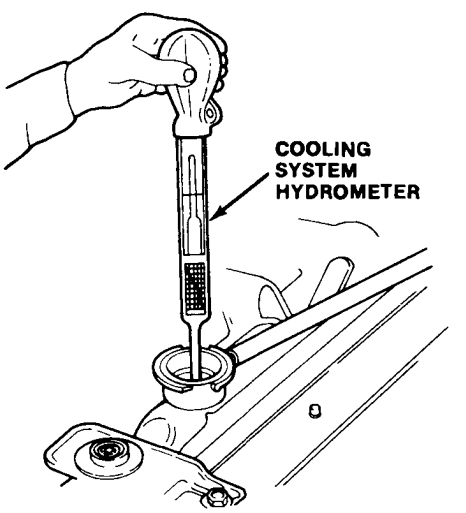
Coolant level should be checked at least once a month. With a cold engine, the coolant level should be even with the FULL mark on the coolant expansion tank.



Q2987-A

Coolant Condition Check

With pressure cap off, examine the coolant in the upper tank. Draw a sample with a hydrometer or Rotunda Battery / Anti-Freeze Tester 021-00046 or equivalent. Check for rust, dirt or oil. Then check the freezing point. It should be approximately -37°C (-35°F) if the mixture has not been diluted by adding plain water. Dilution of the mixture below the recommended 50 / 50 concentration reduces the effectiveness of the corrosion inhibitors in the anti-freeze formula. If the mixture is diluted but not rusty or discolored, full protection may be restored by partially draining the system and adding 100 percent anti-freeze coolant Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A or ESE-M97B43-A) or equivalent.



Q2636-A

DIAGNOSIS AND TESTING (Continued)

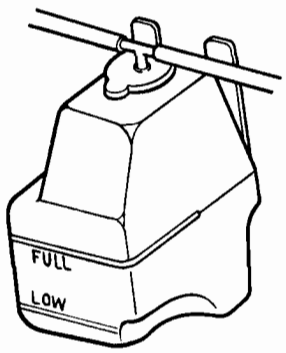
Coolant Draining and Replacement

If coolant is discolored or dirty, or if inspection revealed hoses, gaskets, or other components requiring service or replacement, the coolant must be drained and discarded, or saved for reuse depending on its condition. Remove the pressure cap. Observe all safety precautions if the system is hot and pressurized. Position a drain pan under the radiator and open the drain cock. Drain the system.

Clean the cooling system by flushing with clear water. If excessively rusty or dirty, reverse pressure flush or use an approved flushing compound. Refer to the flushing procedures as outlined.

Refill the system with equal parts of water and Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A or ESE-M97B43-A) or equivalent. Fill to the FULL mark on the reservoir. Install the pressure cap only to the first stop (non-pressurizing). Start the engine. Run at fast idle only until the radiator upper hose feels warm. This indicates the thermostat has opened.

Then stop the engine. Check the coolant level in the radiator. Add coolant mixture if necessary. Fully install the pressure cap on the radiator, and fill the recovery bottle to the FULL mark.



Q2987-A

Cooling System Flush Procedure

When replacing coolant because of excessive rust or dirt, the system should be vigorously flushed to break up and remove deposits of sludge, rust, and foreign matter.

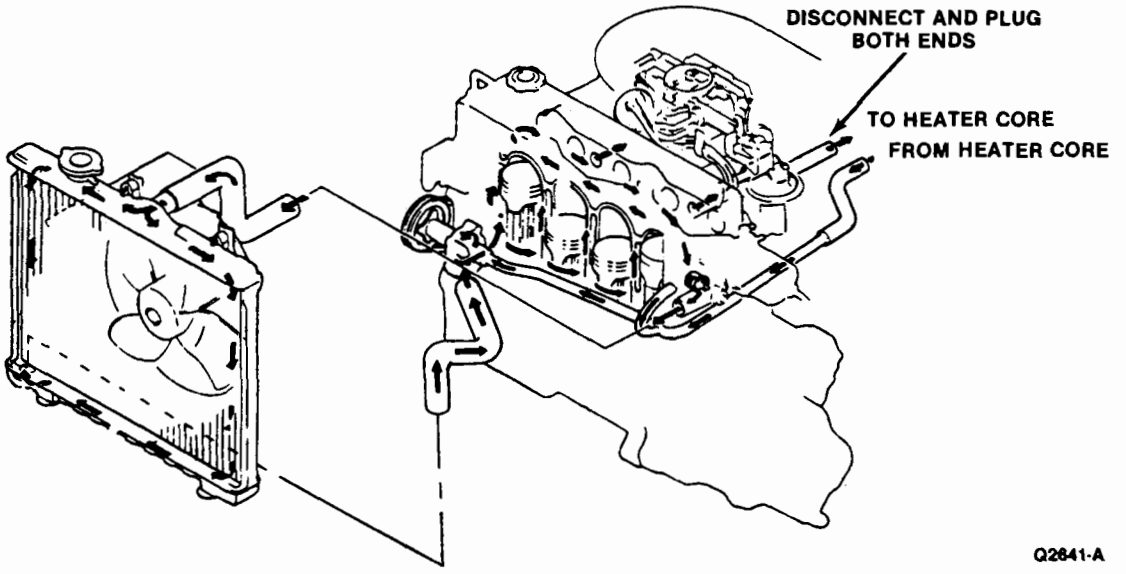
If closed-circuit pressure flushing equipment is not available, the cooling system may be reverse-pressure flushed with plain water as follows:

1. Drain the cooling system. Remove the thermostat and re-install the thermostat housing on the cylinder head as outlined.
2. Disconnect the radiator overflow hose from the expansion tank. Plug the end of the hose.
3. Disconnect the intake manifold outlet hose from the manifold nipple. Plug or cap both nipple and hose.
4. Disconnect the radiator lower hose from the radiator. Position the hose to drain clear of the vehicle.
5. Connect a high-pressure hose to the radiator lower hose outlet. Back-flush the radiator and engine until water runs clear. Turn water on and off several times, pulsing the flow to help break loose sludge deposits.

   CAUTION: Flushing water flow must be limited so that pressure inside the radiator does not exceed 103 kPa (15 psi).

DIAGNOSIS AND TESTING (Continued)

6. When the system drains clear, unplug the radiator overflow hose. When water flows clear from the hose, replug it.



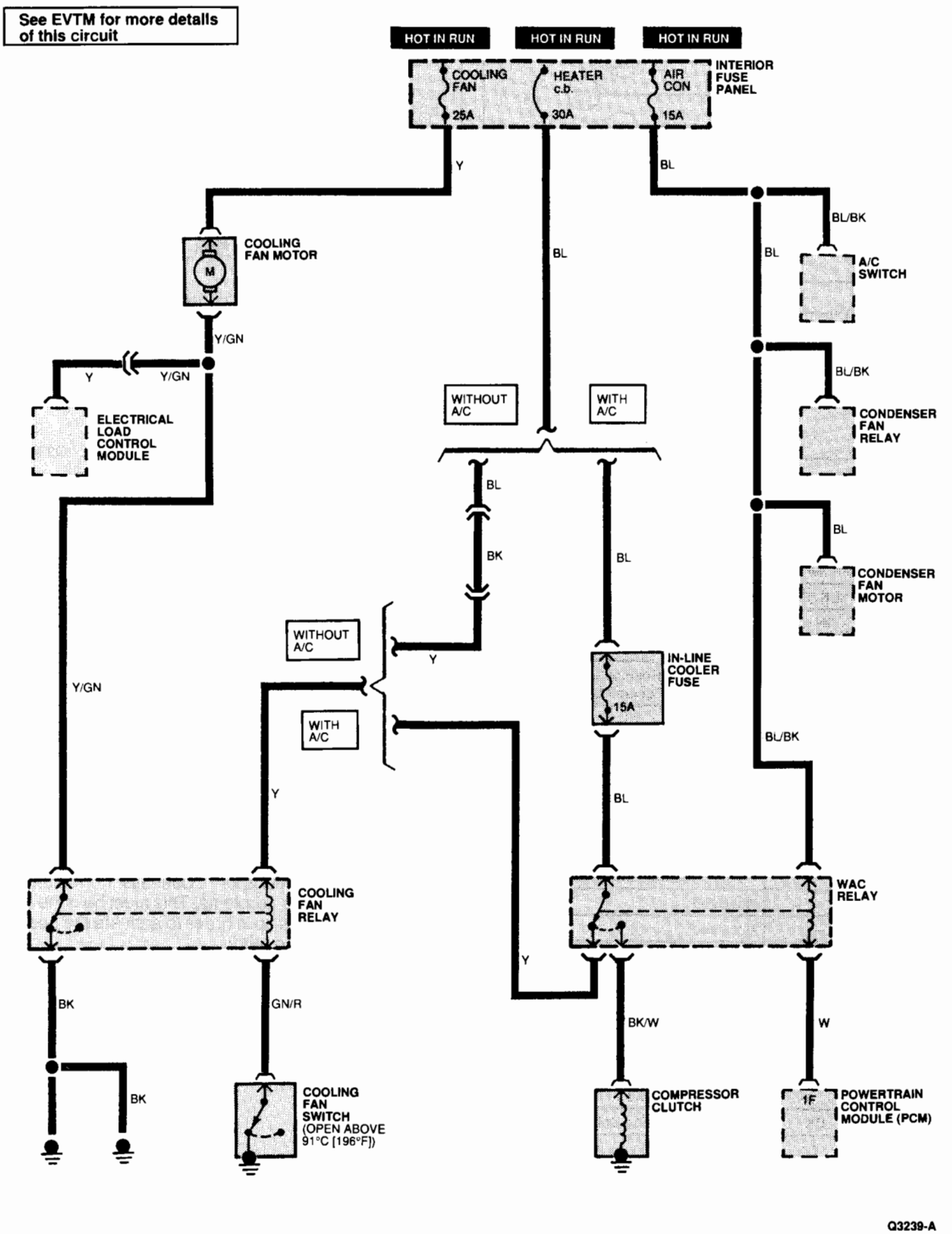
7. Before reconnecting the cooling system hoses the heater core loop must be back-flushed separately to prevent loosened sediment from lodging in the heater core as follows:
   a. Install and clamp a garden hose female end fitting in the heater return hose, disconnected from the bypass nipple.
   b. Connect a garden hose to the hose fitting in the heater return hose. Flush the heater core circuit until the drain water runs clear. Pulse the flow by turning the water on and off several times. Allow full flow for approximately five minutes.
   c. Shut off the flushing water supply. Remove the adapters, caps, and plugs installed for the flushing operation. Connect all cooling system connections. Tighten all screw-type hose clamps to 2.5-3.5 N·m (22-31 lb-in).

      NOTE: Spring-type clamps should be installed into the same position as removed.

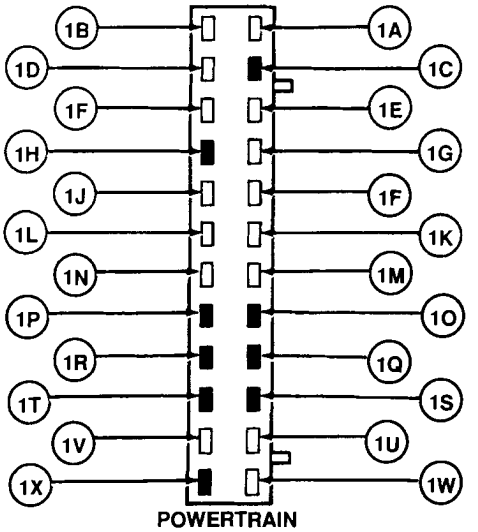
8. Install the thermostat with a new housing gasket as outlined.
9. Refill cooling system with approved anti-freeze coolant mixture as outlined.
10. With cooling system warmed up and pressurized, inspect all system connections for leaks and tighten as necessary.

DIAGNOSIS AND TESTING (Continued)

Electrical Schematic—Engine Cooling System



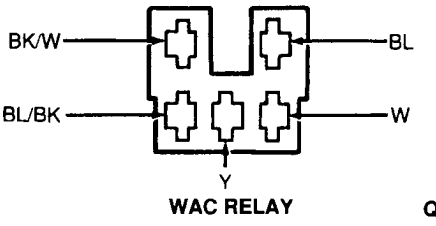
DIAGNOSIS AND TESTING (Continued)



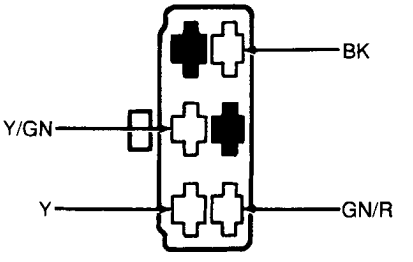
POWERTRAIN CONTROL MODULE Q3240-A

Pin Number	Wire Color	Circuit Function
1A	LG/R	MIL Lamp
1B	GN/BK	Self Test Output
1C	—	Not Used
1D	BK/BL	Switch Monitor Lamp
1E	GN/O	Idle Switch
1F	W	WAC Relay
1G	R/BL	Park/Neutral Position Switch, Clutch Pedal Position Switch
1H	—	Not Used
1I	BL	Electrical Load Control Module
1J	W/GN	Brake On/Off (BOO) Switch
1K	GN/R	Power Steering Pressure Switch
1L	R	A/C Control Switch
1M	Y/BL	Ignition Diagnostic Monitor
1N	Y	Cylinder Identification Sensor
1O	—	Not Used
1P	—	Not Used
1Q	—	Not Used
1R	—	Not Used
1S	—	Not Used
1T	—	Not Used
1U	LG/Y	Ignition Control Module (Non-Turbo) Knock Control Unit 1 (Turbo)
1V	BK	Ground (Non-Turbo Only)
1W	Y	Self Test Input
1X	—	Not Used

TQ3240A



WAC RELAY Q3241-A



COOLING FAN RELAY Q3242-A

System Inspection — Engine Cooling System

1. Visually inspect the components of the engine cooling system.

VISUAL INSPECTION CHART

Mechanical	Electrical

• Fan turns freely
• Noisy Fan
	• Blown fuses:
	  • 15 amp air conditioning
	  • Cooling fan*
	• Set (popped out) 30 amp heater circuit breaker
	• Damage to wiring harness
	• Loose or corroded connections

* 20 amp on non-turbo manual, 25 amp on all other applications.

2. Wiggle the wiring and connectors for the fan, fan relay, and cooling fan switch. Check for intermittent operation, looseness, corrosion or other obvious problems. This must be done as the engine warms up in order to activate the cooling fan switch and relay.
3. If an obvious cause for a malfunction can be found, correct the cause of malfunction, if possible, before proceeding to the next step.
4. If the cause of the malfunction cannot be found by visual inspection, refer to the following chart.

DIAGNOSIS AND TESTING (Continued)

CONDITION CHART—ENGINE COOLING SYSTEM

CONDITION	POSSIBLE SOURCE	ACTION
• Overheating	• Fuse(s) and/or circuit breaker. • Cooling fan switch. • Cooling fan relay. • Cooling fan motor. • WAC relay. • Circuit.	• Go to **A1.** • Go to **A17.** • Go to **A15.** • Go to **A12.** • Go to **A7.** • Go to **A4.**
• Fan Runs Erratically or Intermittently	• Cooling fan switch. • Cooling fan relay. • Cooling fan motor. • WAC relay. • Circuit.	• Go to **A17.** • Go to **A15.** • Go to **A12.** • Go to **A7.** • Go to **A4.**
• Fan Runs Continuously	• Cooling fan relay. • Cooling fan switch. • WAC relay. • Circuit.	• Go to **A15.** • Go to **A17.** • Go to **A7.** • Go to **A4.**
• Fan Does Not Run When A/C is ON	• WAC relay. • Cooling fan relay. • Cooling fan motor. • Circuit.	• Go to **A7.** • Go to **A15.** • Go to **A12.** • Go to **A4.**

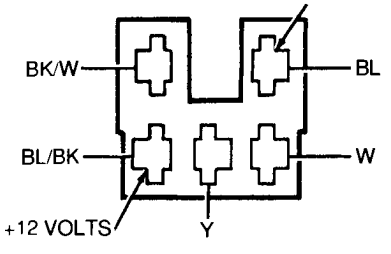
PINPOINT TEST A—ENGINE COOLING SYSTEM

TEST STEP		RESULT ▶	ACTION TO TAKE
A1	CHECK FUSES		
	• Locate interior fuse panel. • Key OFF. • Check the 30 amp heater circuit breaker, 15 amp A/C and the COOLING FAN fuses[1] • **Are fuses and circuit breaker OK?**	Yes ▶ No ▶	GO to **A4.** GO to **A2.**
A2	CHECK SYSTEM		
	• Replace blown fuse(s) and/or reset the 30 amp heater circuit breaker. • Key ON. • **Did circuit breaker pop out again and/or fuse(s) fail again?**	Yes ▶ No ▶	GO to **A3.** GO to **A4.**
A3	CHECK FOR SHORTS TO GROUND		
	• Key OFF. • Locate and disconnect interior fuse panel connectors. • Measure the resistance between the BL wires and then the Y wire at the interior fuse panel connectors and ground. • **Are resistances less than 5 ohms?**	Yes ▶ No ▶	SERVICE wire(s) in question. GO to **A4.**
A4	CHECK POWER SUPPLY TO COOLING FAN MOTOR		
	• Locate and disconnect cooling fan motor connector. • Key ON. • Measure voltage on the Y wire at the cooling fan motor connector. • **Is voltage greater than 10 volts?**	Yes ▶ No ▶	GO to **A5.** (A/C only). GO to **A11.** (non A/C only) SERVICE Y wire.
A5	CHECK POWER SUPPLY TO WAC RELAY (A/C ONLY)		
	• Locate and disconnect WAC relay connector. • Key ON. • Measure voltage on the BL/BK and BL wires at the WAC relay connector. • **Is voltage greater than 10 volts?** NOTE: If there is no voltage on the BL wire, check for a blown 15 amp INLINE COOLER fuse before servicing the wire.	Yes ▶ No ▶	GO to **A6.** SERVICE wire in question.

1 20 amp on non-turbo manual, 25 amp on all other applications.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A—ENGINE COOLING SYSTEM (Continued)

TEST STEP		RESULT ▶	ACTION TO TAKE
A6	CHECK THE WIRE TO CONDENSER FAN RELAY (A/C ONLY)		
	• Key OFF. • Measure the resistance of the BL/BK wire between the WAC relay and the condenser fan relay. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **A7.** SERVICE BL/BK wire.
A7	CHECK WAC RELAY (A/C ONLY)		
	• Disconnect WAC relay. • Measure resistance between the following wire terminals at the WAC relay and verify resistances: From / To / Resistances: BL / Y / Less than 5 ohms; BL / BK/W / Greater than 10,000 ohms • Apply 12 volts to the BL/BK wire terminal as shown below. • Ground the W wire terminal. • Measure the resistance between the following wire terminals at the WAC relay and verify the resistances: From / To / Resistances: BL / Y / Greater than 10,000 ohms; BL / BK/W / Less than 5 ohms **A/C RELAY** MEASURE RESISTANCE FROM THIS BL TERMINAL TO EITHER THE Y OR THE BK/W TERMINAL AS DIRECTED ABOVE.  Q3029-A • **Are resistances correct?**	Yes ▶ No ▶	GO to **A8.** REPLACE WAC relay.
A8	CHECK WIRE BETWEEN WAC RELAY AND COOLING FAN RELAY (A/C ONLY)		
	• Disconnect cooling fan relay connector and WAC relay connector. • Measure resistance of the Y wire between the WAC relay and the cooling fan relay. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **A9.** SERVICE Y wire.
A9	CHECK WIRE BETWEEN WAC RELAY AND PCM (A/C ONLY)		
	• Disconnect PCM connector. • Measure resistance of the W wire between the WAC relay and the PCM. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **A10.** SERVICE W wire.
A10	CHECK WIRE BETWEEN WAC RELAY AND COMPRESSOR CLUTCH (A/C ONLY)		
	• Disconnect compressor clutch connector. • Measure resistance of the BK/W wire between the WAC relay and the compressor clutch. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **A11.** SERVICE BK/W wire.

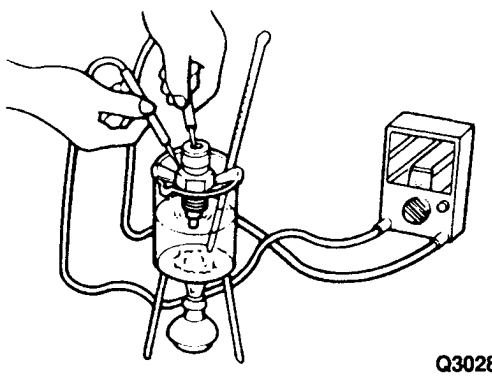
DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A—ENGINE COOLING SYSTEM (Continued)

TEST STEP		RESULT ▶	ACTION TO TAKE
A11	CHECK POWER SUPPLY TO COOLING FAN RELAY (NON-A/C ONLY)		
	• Locate and disconnect cooling fan relay connector. • Key ON. • Measure voltage on the Y wire at the cooling fan relay. • **Is voltage greater than 10 volts?**	Yes ▶ No ▶	GO to **A12.** SERVICE Y wire.
A12	CHECK COOLING FAN MOTOR		
	• Locate cooling fan motor connector. • Key ON. • Ground the Y/GN wire at cooling fan motor connector. • **Does cooling fan motor run?**	Yes ▶ No ▶	GO to **A13.** SERVICE/REPLACE cooling fan motor.
A13	CHECK WIRE BETWEEN COOLING FAN RELAY AND COOLING FAN MOTOR		
	• Key OFF. • Measure resistance of the Y/GN wire between the cooling fan relay and the cooling fan motor. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **A14.** SERVICE Y/GN wire.
A14	CHECK COOLING FAN RELAY GROUND		
	• Measure resistance between the BK wire at the cooling fan relay and ground. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **A15.** SERVICE BK wire.
A15	CHECK COOLING FAN RELAY		
	• Disconnect the cooling fan relay connector. • Measure resistance of the Y/GN wire terminal and the BK wire terminal on the relay. • **Is resistance less than 5 ohms?** • Apply 12 volts to the Y wire terminal on the relay. • Ground the GN/R wire terminal on the relay. • Measure resistance of the Y/GN wire terminal and the BK wire terminal on the relay. • **Is the resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to **A16.** REPLACE cooling fan relay.
A16	CHECK WIRE BETWEEN COOLING FAN RELAY AND COOLING FAN SWITCH		
	• Measure resistance of the GN/R wire between the cooling fan relay and the cooling fan switch. • **Is the resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **A17.** SERVICE GN/R wire.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A—ENGINE COOLING SYSTEM (Continued)

TEST STEP		RESULT	ACTION TO TAKE
A17	CHECK COOLING FAN SWITCH FUNCTION		
	• Disconnect the cooling fan switch connector. • Using a VOM, check the continuity of the switch from GN/R wire terminal to ground. • Start up the engine and observe the continuity of the switch on the VOM as engine warms up. • If continuity is still present in the switch by the time the engine is hot, remove the cooling fan switch from the engine. • Place the cooling fan switch in a 50% water and glycol mixture with a 150°C (250°F) range thermometer. • Heat the water and monitor the switch continuity, using a VOM, and verify the opening and closing temperature as the water is heated and then cooled.  Q3028-A • **Does the switch operate at the approximate specified temperatures?** Refer to specifications.	Yes ▶ No ▶	RETURN TO condition chart. For A/C only GO to **A18.** REPLACE cooling fan switch.
A18	CHECK SYSTEM FOR OPERATION WHEN A/C IS TURNED ON (A/C ONLY)		
	• Turn the A/C on. • **Does the cooling fan motor turn on?**	Yes ▶ No ▶	RETURN to condition chart. REFER to Section 12-00.

Leak Testing

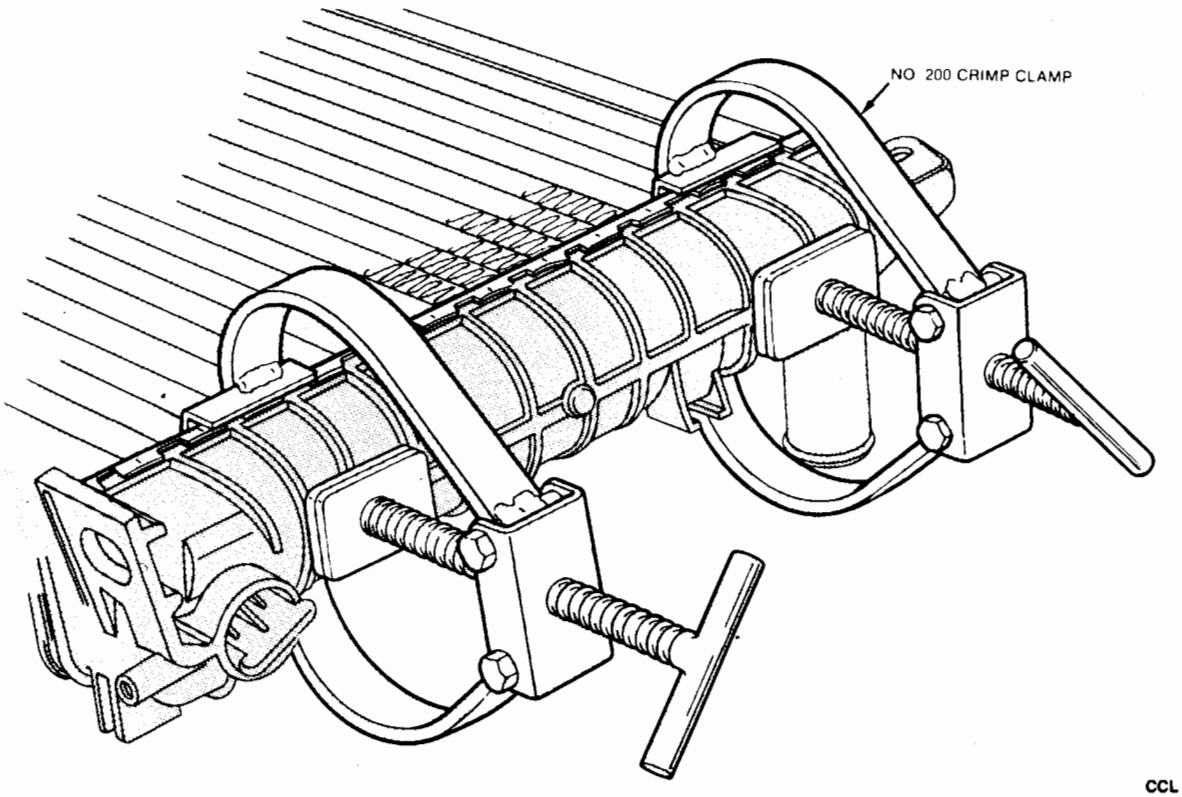
Transmission Oil Cooler Connection Leaks

Check to see that the fitting nut is fully tightened. If the leak persists, apply a thin, even coat of Dow Corning 1200 primer using a brush. Allow to dry for 10 minutes at room temperature. Apply Dow Corning "Silastic 734 RTV" or equivalent in undiluted form around the leaking connection and allow it to dry for one hour.

Clean the radiator before leak testing to prevent contaminating the test tank. Then, leak test the radiator in **clean** water with 117 kPa (17 psi) air pressure. **Do not** leak test an aluminum radiator in the same water that copper/brass radiators are tested in. Flux and caustic cleaners may be present in the tank and they will attack aluminum. A separate clean test tank is necessary for aluminum radiators. If conditions do not allow a separate tank for aluminum radiator leak testing, thoroughly clean the test tank each time before testing an aluminum radiator in the tank.

DIAGNOSIS AND TESTING (Continued)

When a tank is removed to service a tube-to-header leak, the core can be leak tested by clamping the tank (with an O-ring gasket in place) to the core and leak testing with air under water. When service is completed, install the tank. Refer to Radiator Tank Installation.



CCL 2059-A

Always install plugs in the oil cooler fittings before leak testing or cleaning any radiator equipped with an oil cooler.

REMOVAL AND INSTALLATION

Radiator

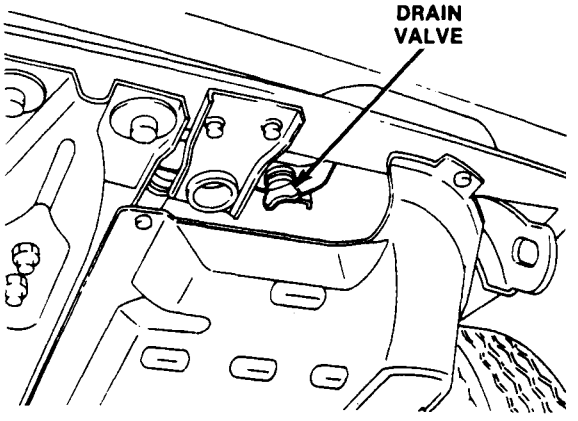
Removal

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED; THEN, WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN CERTAIN ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

1. Disconnect the battery ground cable. Disconnect cooling fan wiring harness connector.

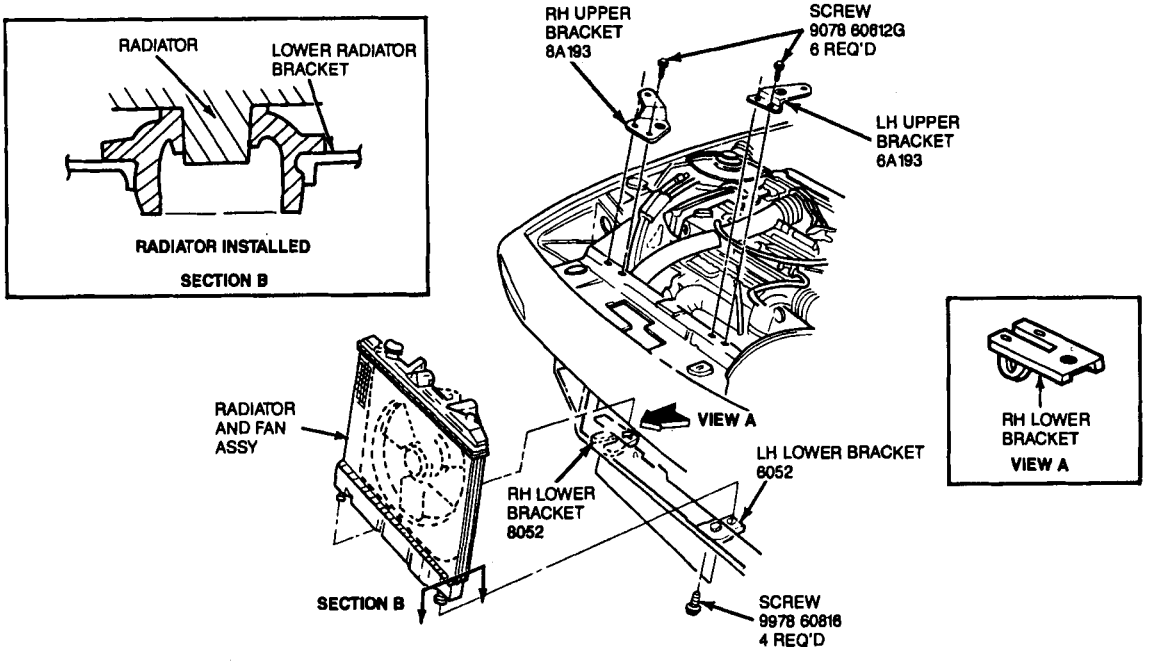
REMOVAL AND INSTALLATION (Continued)

2. Remove the radiator pressure cap from the filler neck. If the system is hot and pressurized, be careful to release pressure before fully opening it.
3. Drain the system. The drain valve is located at the bottom of the radiator left end.



Q2569-A

4. Disconnect the radiator upper and lower hoses from the radiator inlet and outlet.
5. Disconnect the overflow tube from the filler neck.
6. Disengage wiring harness from routing clips attached to cooling fan shroud.
7. On automatic transaxle equipped vehicles, disconnect and plug the cooler lines.
8. Remove six bolts retaining radiator upper tank brackets to the radiator core support.

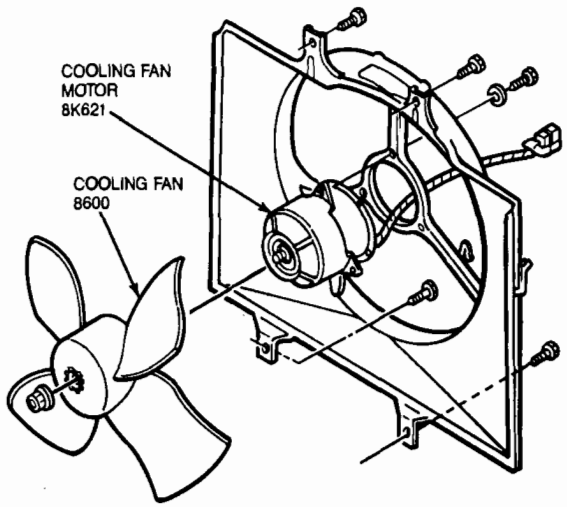


Q2995-A

9. Remove the radiator and cooling fan, as an assembly, from vehicle.

REMOVAL AND INSTALLATION (Continued)

10. Remove two bolts at the top and two bolts at the bottom of the fan shroud assembly, and remove the fan and shroud assembly.



Q2064-A

Installation

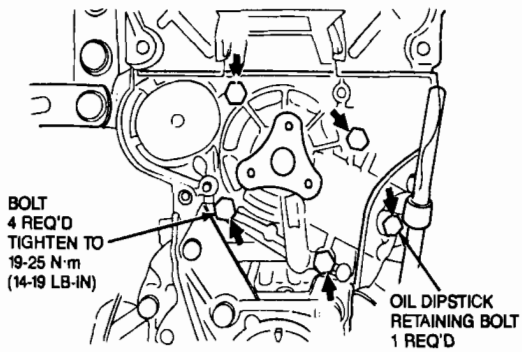
1. Place the fan and shroud assembly against the rear of the radiator, and secure with four bolts. Tighten the retaining bolts to 31-46 N·m (23-33 lb-ft).
2. Be sure the radiator insulators are positioned on the radiator supports. Position the radiator, making sure the lower tank engages the insulators.
3. Install the six radiator retaining bolts through the top tank mounting brackets into the vehicle core support. Make sure that the insulators are aligned. Tighten the bolts securely.
4. Unplug and connect the automatic transaxle oil cooler lines, if equipped.
5. Secure the wiring harness in routing clips.
6. Connect the upper and lower hoses to the radiator inlet and outlet.
7. Connect the overflow tube to the radiator fill neck.
8. Close the radiator drain valve, in the lower tank.
9. Fill the system with specified coolant as outlined and install the pressure cap.
10. Connect the cooling fan harness connector.
11. Warm up the engine to pressurize the system and check for leaks.

Water Pump

Removal

1. Remove timing belt. Refer to Section 03-01.
2. Drain cooling system as outlined.
3. Remove timing belt tension and idler pulleys.
4. Remove engine oil dipstick bracket retaining bolt.
5. Remove power steering pump from retaining bracket (leave hoses attached). Refer to Section 11-02.
6. Remove power steering pump bracket. Position power steering pump aside.
7. Remove water pump outlet.
8. Remove water pump retaining bolts and water pump.

   NOTE: Raise engine slightly with floor jack, if required, to gain clearance for removal.



Q2993-A

Installation

1. Clean all gasket surfaces. Transfer rubber belt cover seal to new water pump, if required.
2. Position water pump with new gasket. Install retaining bolts. Tighten to 19-25 N·m (14-19 lb-ft).
3. Install pump outlet with new gasket and O-ring. Tighten retaining bolts to 19-25 N·m (14-19 lb-ft).
4. Install oil dipstick retaining bolt.
5. Install timing belt tension and idler pulleys. Tighten idler bolt only to 37-52 N·m (27-38 lb-ft).
6. Install power steering pump bracket. Tighten nut and bolts to 47-66 N·m (35-48 lb-ft).
7. Install power steering pump. Refer to Section 11-02.
8. Install timing belt. Refer to Section 03-01.
9. Fill cooling system as outlined.
10. Star engine. Check for leaks and proper operation.

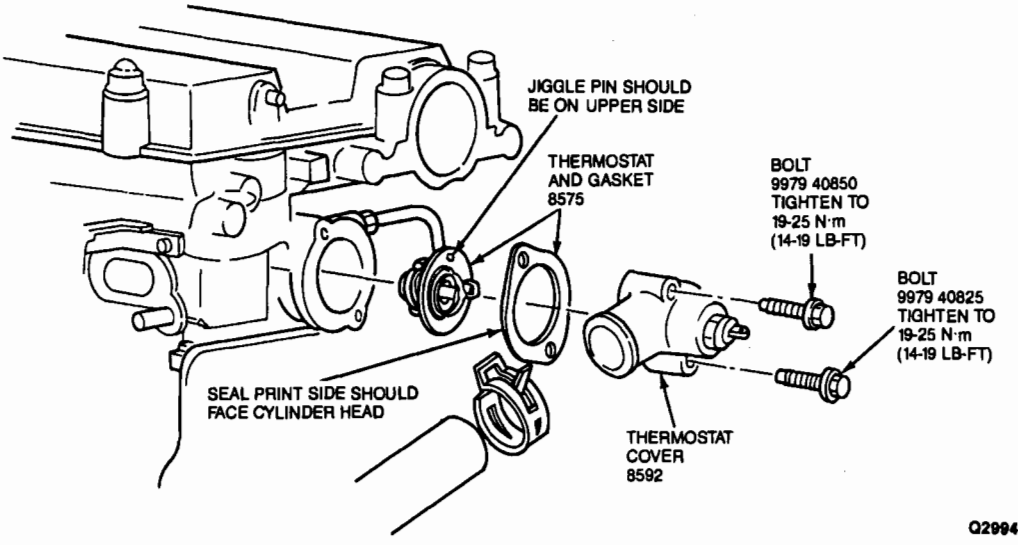
Thermostat

Removal

1. Disconnect the wire from the engine cooling fan switch on thermostat housing.

REMOVAL AND INSTALLATION (Continued)

2. Remove the pressure cap, observing precautions if system is warm and pressurized, to release pressure before fully opening.
3. Partially drain the cooling system by opening the drain valve in the radiator lower tank. Close the drain valve.
4. Disconnect the radiator upper hose from the thermostat housing.
5. Remove bolts retaining thermostat housing to the cylinder head, and remove the housing.
6. Remove thermostat and gasket.



Installation

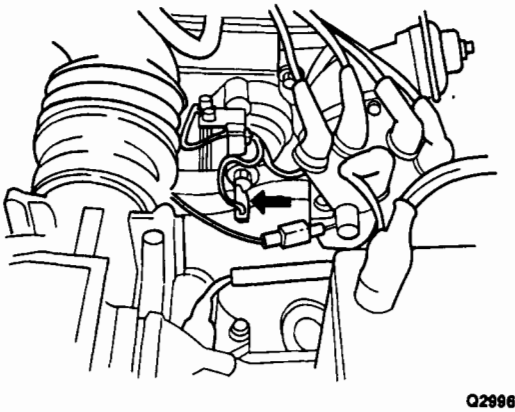
1. Scrape all traces of gasket material from the mounting surfaces of the cylinder head and thermostat housing.
2. Install the thermostat in the head, valve end first, with the jiggle valve at the top.
3. Coat a new housing gasket with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent, and position it on the cylinder head with the bolt holes correctly aligned.

   NOTE: The painted side of the gasket must face to the thermostat.
4. Carefully position the thermostat housing to align the bolt holes without shifting the gasket and install the two retaining bolts. Tighten to 19-25 N·m (14-19 lb-ft).
5. Connect the radiator upper hose to the thermostat housing, and install hose clamp.
6. Fill the system with coolant as outlined and install pressure cap.
7. Connect the wire from the engine cooling fan to switch on thermostat housing.
8. Warm up the engine to pressurize the system and check for leaks.

Cooling Fan

Removal

1. Disconnect the battery ground cable.
2. Disengage the fan wiring harness from the routing clamps.
3. Separate the cooling fan wiring connector.
4. Remove the four screws retaining fan shroud to radiator and remove the fan and shroud.



REMOVAL AND INSTALLATION (Continued)

Installation

1. Position the fan and shroud and install four retaining screws. Tighten to 31-46 N·m (23-34 lb-ft).
2. Connect the cooling fan wiring.
3. Position the wiring and secure in place using the routing clamps.
4. Connect the battery ground cable.

Cooling Fan Motor

Removal

1. Remove the cooling fan assembly as outlined.
2. Remove retaining nut and washer.
3. Remove the fan from the motor shaft.
4. Remove three retaining screws and washers, and separate the fan motor from the shroud.

Installation

1. Position the cooling fan on the shroud and install three retaining screws and washers. Tighten to 4-6 N·m (3-4 lb-ft).
2. Install the fan on the motor shaft.
3. Install the retaining washer and nut.
4. Install the cooling fan assembly as outlined.

Coolant Temperature Switch

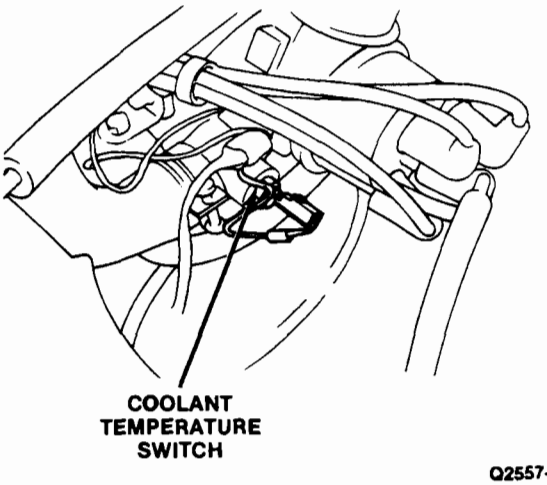
Removal

WARNING: THE COOLING FAN WILL COME ON IF THE WIRE IS DISCONNECTED FROM THE COOLANT TEMPERATURE SWITCH WITH THE IGNITION SWITCH IN THE RUN POSITION. BEFORE DISCONNECTING THE WIRE FROM THE SWITCH, MAKE SURE THE IGNITION SWITCH IS IN THE OFF POSITION.

1. Drain cooling system as outlined.
2. Disconnect switch connector.
3. Remove switch from thermostat housing.

Installation

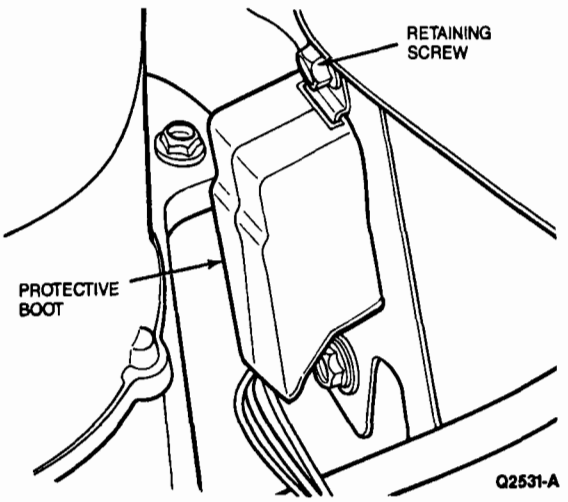
1. Coat the threads with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent.
2. Install switch into thermostat housing.
3. Connect switch connector.
4. Fill cooling system as outlined.



Cooling Fan Relay

Removal and Installation

The cooling fan relay is located in the LH front corner of the engine compartment behind the headlamp. A single screw retains the relay. After removing the screw, remove the protective boot and separate the relay from the wiring connector. To install, reverse Removal procedure.



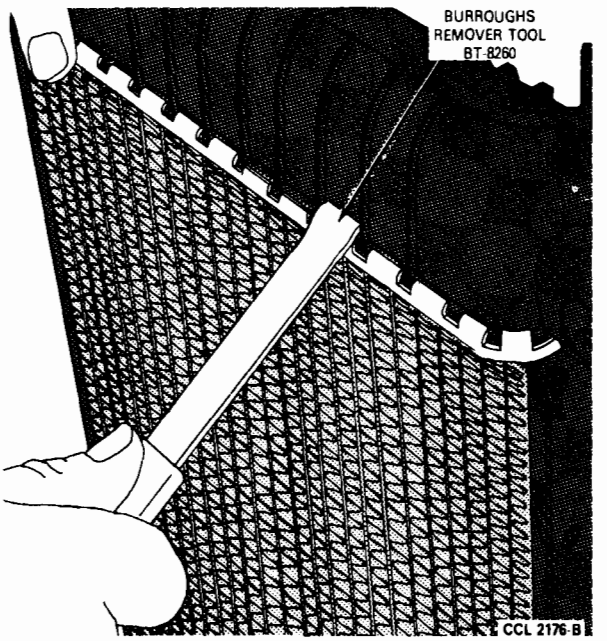
Radiator Tank

Removal

The radiator tanks are moulded, glass-filled nylon and have integral radiator and shroud mounting brackets. The tanks, which are available in two different widths, are attached to the core header by bending the header tabs over the foot (edge) of the tank.

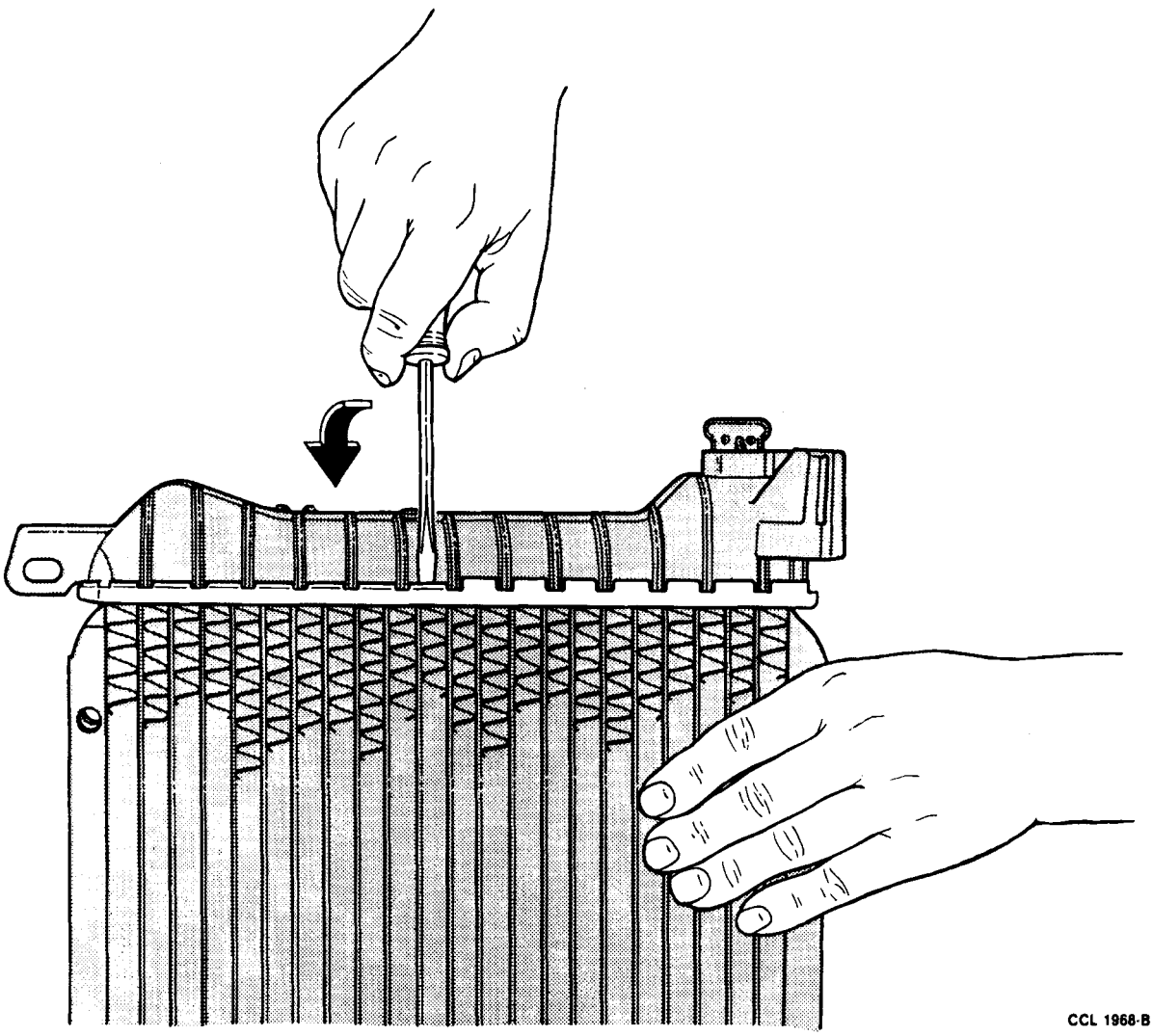
REMOVAL AND INSTALLATION (Continued)

1. Insert end of Borroughs Remover Tool BT-8260-A or equivalent between end of header tab and tank. Then, push tool handle down toward core to bend tab away from radiator tank. **Do not open tabs more than necessary for tank removal.**



REMOVAL AND INSTALLATION (Continued)

NOTE: If Borroughs tool is not available, insert end of medium tip screwdriver between radiator tank and end of header tab. Then, pivot screwdriver toward tank to bend tab away from tank foot (edge). Repeat this procedure for each tab.



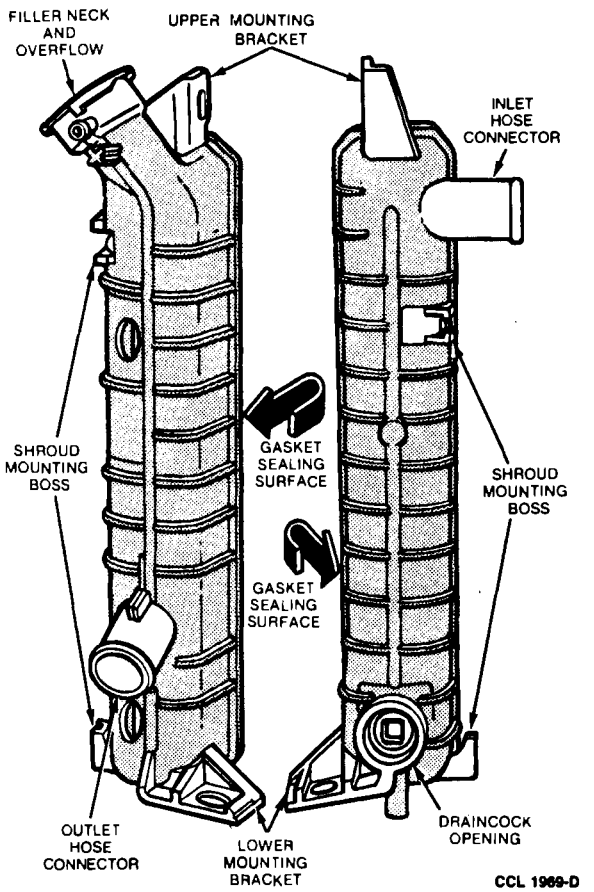
CCL 1968-B

2. Repeat Step 1 for each header tab. Then lift tank from header.

REMOVAL AND INSTALLATION (Continued)

Inspection

Carefully examine the radiator tank for cracks, damage to the upper and lower mounting brackets, the fan shroud bosses and the gasket sealing surface. Replace any damaged radiator tanks.

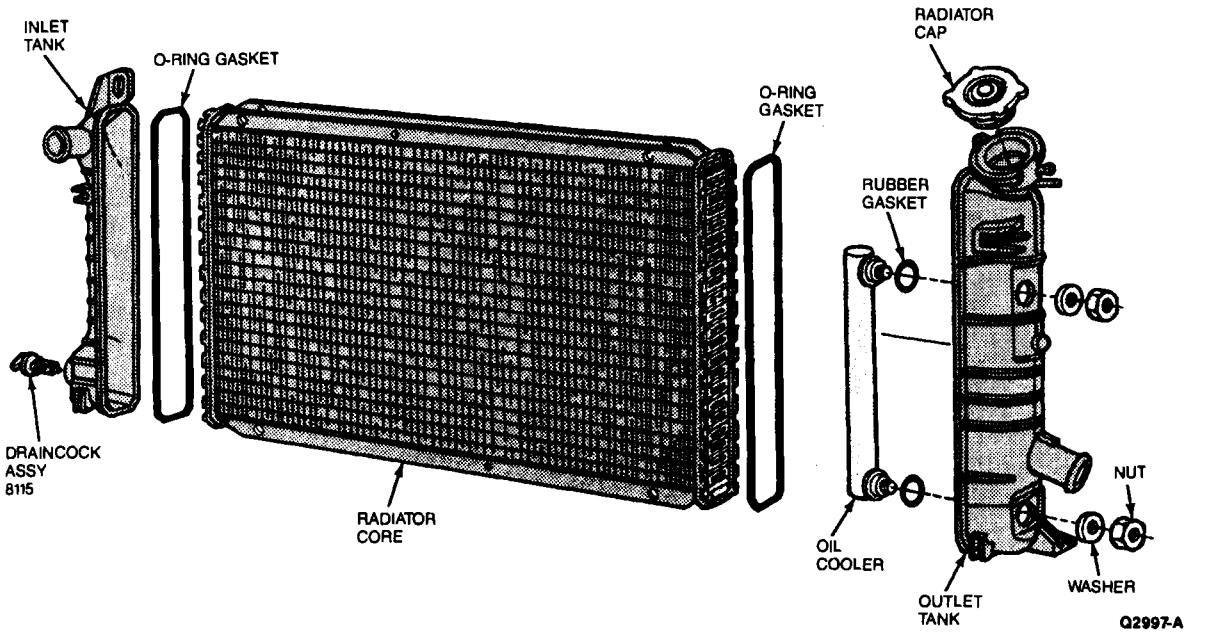


Installation

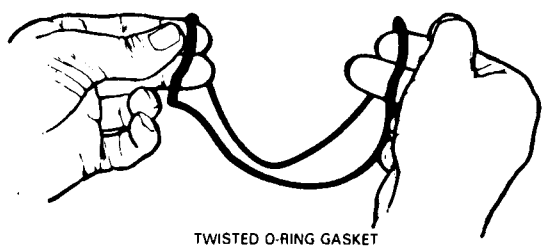
NOTE: If any header tabs are missing from an aluminum core, the core should be replaced.

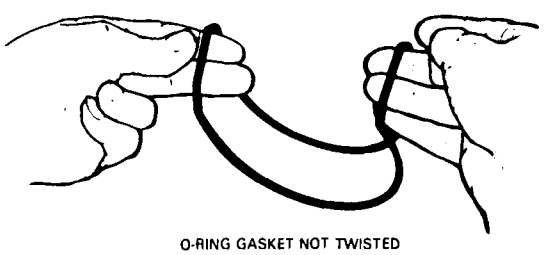
REMOVAL AND INSTALLATION (Continued)

1. Inspect gasket surface of radiator core header to ensure it is clean and free of foreign material or damage.



2. Check for O-ring gasket as shown to ensure it is not twisted. If gasket is twisted, it will distort. Rotate one end of gasket until it is not twisted.

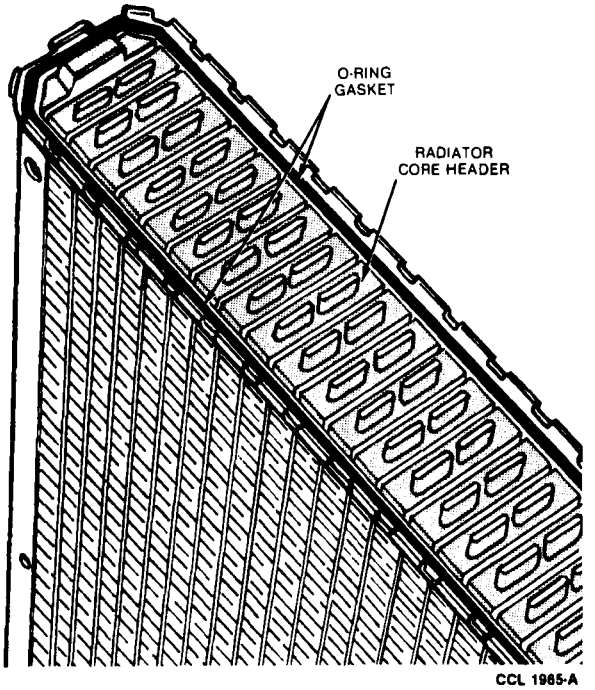

TWISTED O-RING GASKET


O-RING GASKET NOT TWISTED

CCL 2286-A

REMOVAL AND INSTALLATION (Continued)

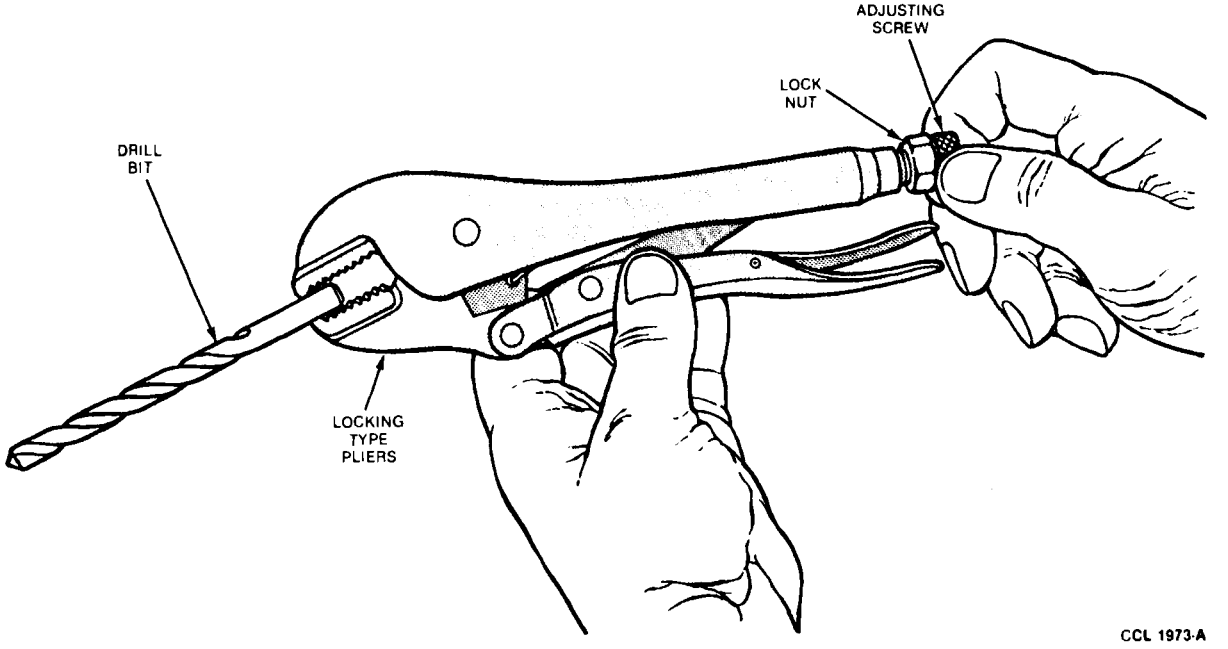
3. Place a new O-ring gasket dipped in Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A) or equivalent in groove of header.



CCL 1965-A

4. If outlet tank is being replaced and is equipped with an oil cooler, transfer oil cooler from replaced tank to new tank. Refer to Oil Cooler Transfer or Replacement.
5. Position tank to header using care not to scratch tank sealing surfaces with header tabs. Make sure top and bottom of tank is positioned properly with other tank.

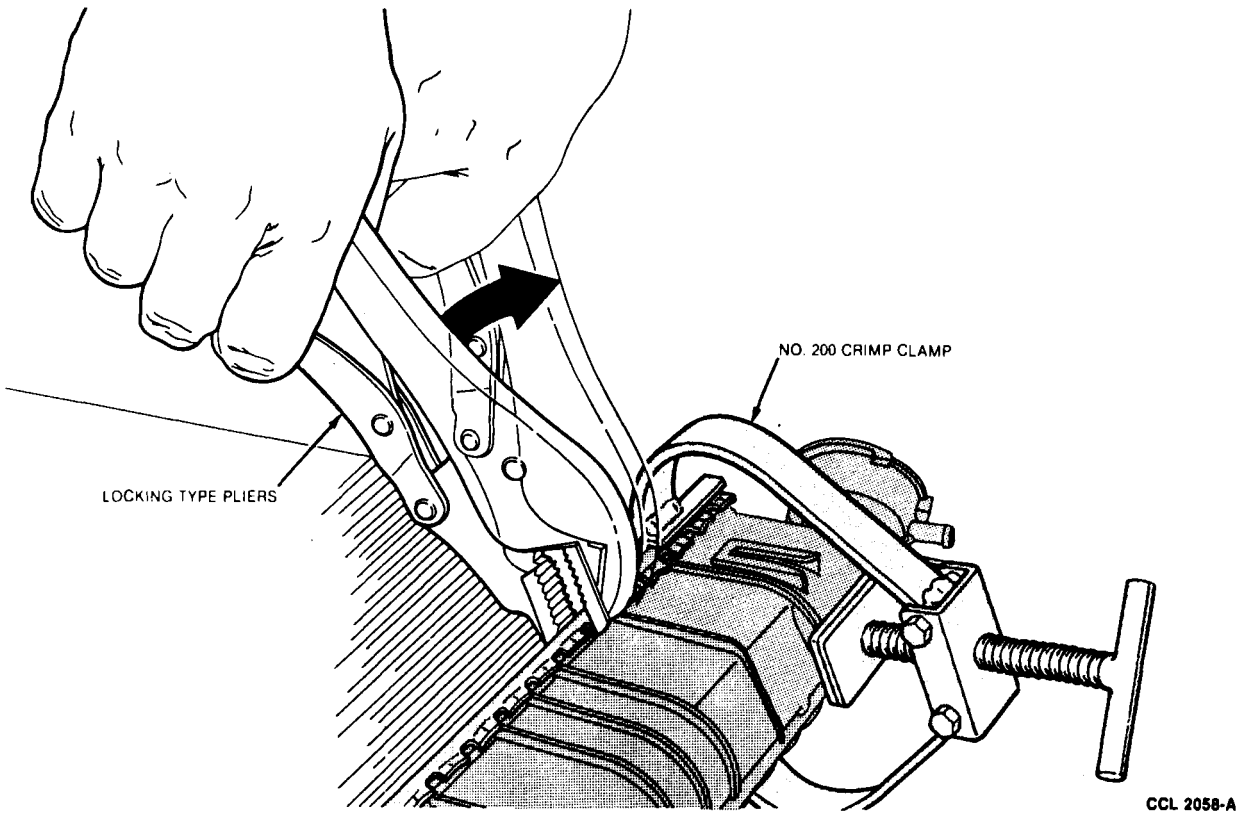
   NOTE: The mechanically assembled radiator must be assembled so tabs of header marked FRONT will be toward front of vehicle when installed.
6. Clamp tank in position on header with two header clamps. Tighten header clamps to compress O-ring gasket.
7. If locking-type pliers are used to squeeze header tabs against tank, install a hex nut on pliers adjusting screw.
8. With jaws of locking-type pliers closed and locked, turn adjusting screw to position jaws against shank of an 10.9mm (27 / 64-inch) drill bit. Tighten hex nut on adjusting screw against handle to lock adjustment in place.



CCL 1973-A

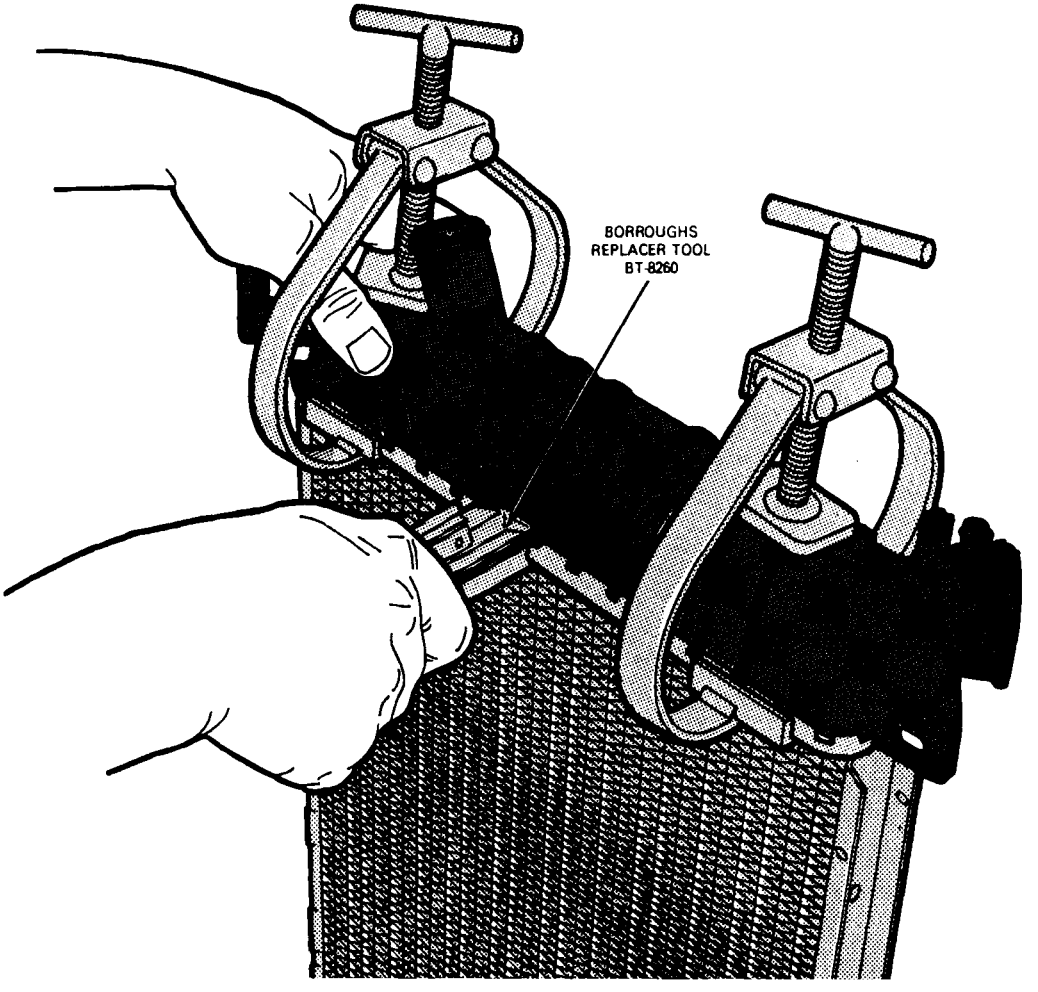
REMOVAL AND INSTALLATION (Continued)

9. Squeeze aluminum header tabs down against lip of tank base with locking-type pliers while rotating pliers toward tank.

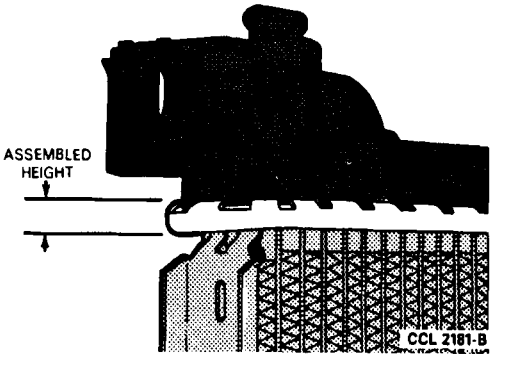


REMOVAL AND INSTALLATION (Continued)

10. If a special crimping tool such as Borroughs Tool is used, follow manufacturer's instructions. It is important that the tool be adjusted to obtain correct assembled height of crimp.



11. Remove header clamps and squeeze header tabs (behind clamps) down.
12. Leak test radiator at 145 kPa (21 psi). Most minor leaks at header to tank seal can be corrected by squeezing header tabs down against tank tip area of indicated leak.



REMOVAL AND INSTALLATION (Continued)

Oil Cooler Transfer or Replacement

Removal

1. Remove outlet tank from radiator.
2. Remove retaining nuts and washers from oil cooler inlet and outlet connections. Then, lift oil cooler from radiator outlet tank.
3. Remove rubber gasket from oil cooler inlet and outlet connections if oil cooler is to be reused.

Installation

1. Install new rubber gasket on oil cooler inlet and outlet connections.
2. Position oil cooler to radiator outlet tank and insert inlet and outlet connections through holes in outlet tank.
3. Install flatwasher and nut on each oil cooler connection to retain oil cooler in radiator outlet tank.
4. Tighten oil cooler retaining nuts to 12-15 N·m (9-11 lb-ft).
5. Install outlet tank on radiator core header. Refer to Radiator Tank Installation.

CLEANING

External

The aluminum core can be cleaned externally with a soft bristle brush, warm water and a mild household liquid detergent. Rinse with clear water.

If the radiator is equipped with an oil cooler, install steel or brass plugs in the oil cooler fittings before cleaning and keep them installed during the entire service operation.

Internal

NOTE: Do not use caustic cleaning solutions or cooper/brass radiator cleaning agents on aluminum radiators. Internal cleaning of the aluminum tubes can be accomplished with sonic cleaning equipment, or by removing one end tank to gain access to tubes. Then, clean the tubes with a mild household liquid detergent. Rinse the core with clean water when completed. Do not use a metal brush to clean an aluminum core. Use only horsehair, bristle or nylon brushes.

SERVICE PROCEDURES

Radiator Core

NOTE: Do not allow zinc chloride flux to come in contact with the nylon end tanks. To do so could cause delayed stress cracking of the tank.

Aluminum

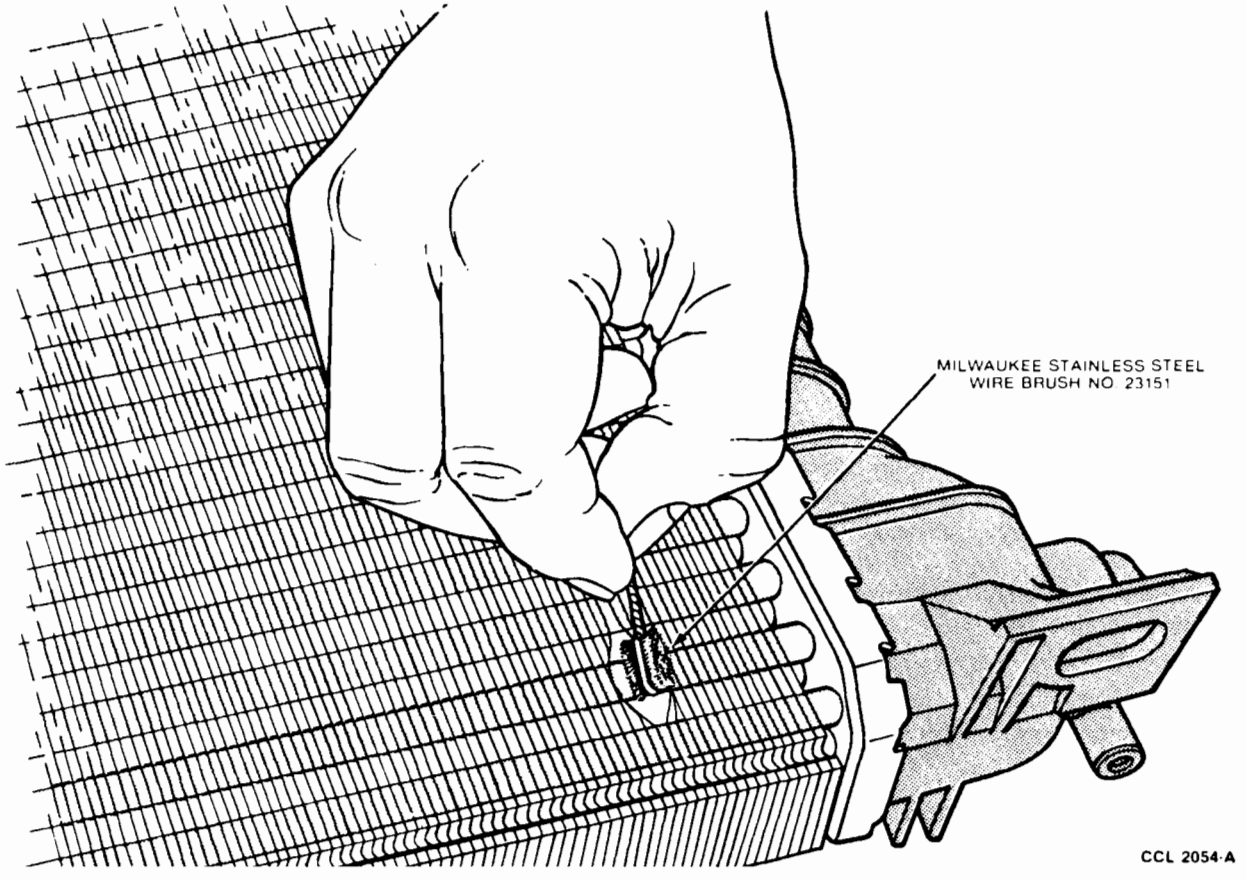
The only approved repair method for the aluminum radiator core is to use a two component epoxy material. The materials and supplies necessary to repair the aluminum core are:

- EPOXI-PATCH No. 6 Aluminum. Hysol Division of the Dexter Corporation, Olean, New York 14760.
- Sandpaper and/or emery paper: 80 or 100 grit.
- Stainless steel wire brush No. 23151. The Milwaukee Brush Manufacturing Co., Menomonee Falls, Wisconsin 53501.
- 375 watt heat lamp.
- Methylene chloride solvent.
- Mixing card and spatulas.

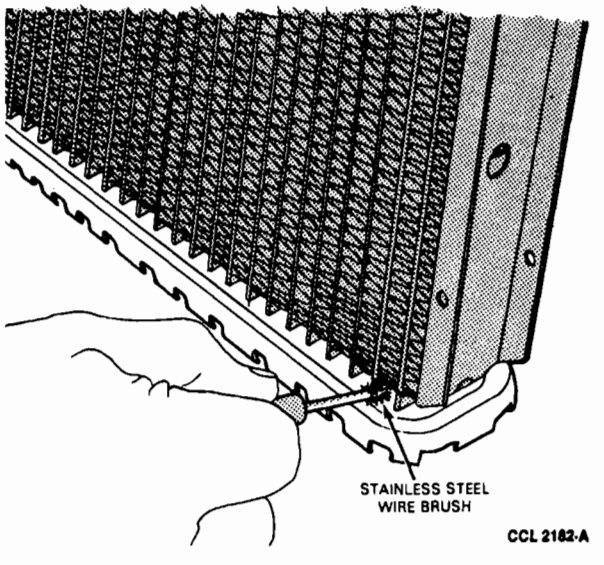
1. Clean and leak test core. Refer to Leak Testing.
2. Mark leak(s) and dry core with compressed air in area of leak(s).
3. If leak is in fin area of core, spread fins away from leak before cleaning area.
4. Clean area around leak with 80 or 100 grit sandpaper or emery cloth and/or with a small stainless steel wire brush. **DO NOT USE WIRE BRUSHES THAT ARE NOT STAINLESS STEEL.**

SERVICE PROCEDURES (Continued)

Tube Cleaning



Tube to Header Cleaning

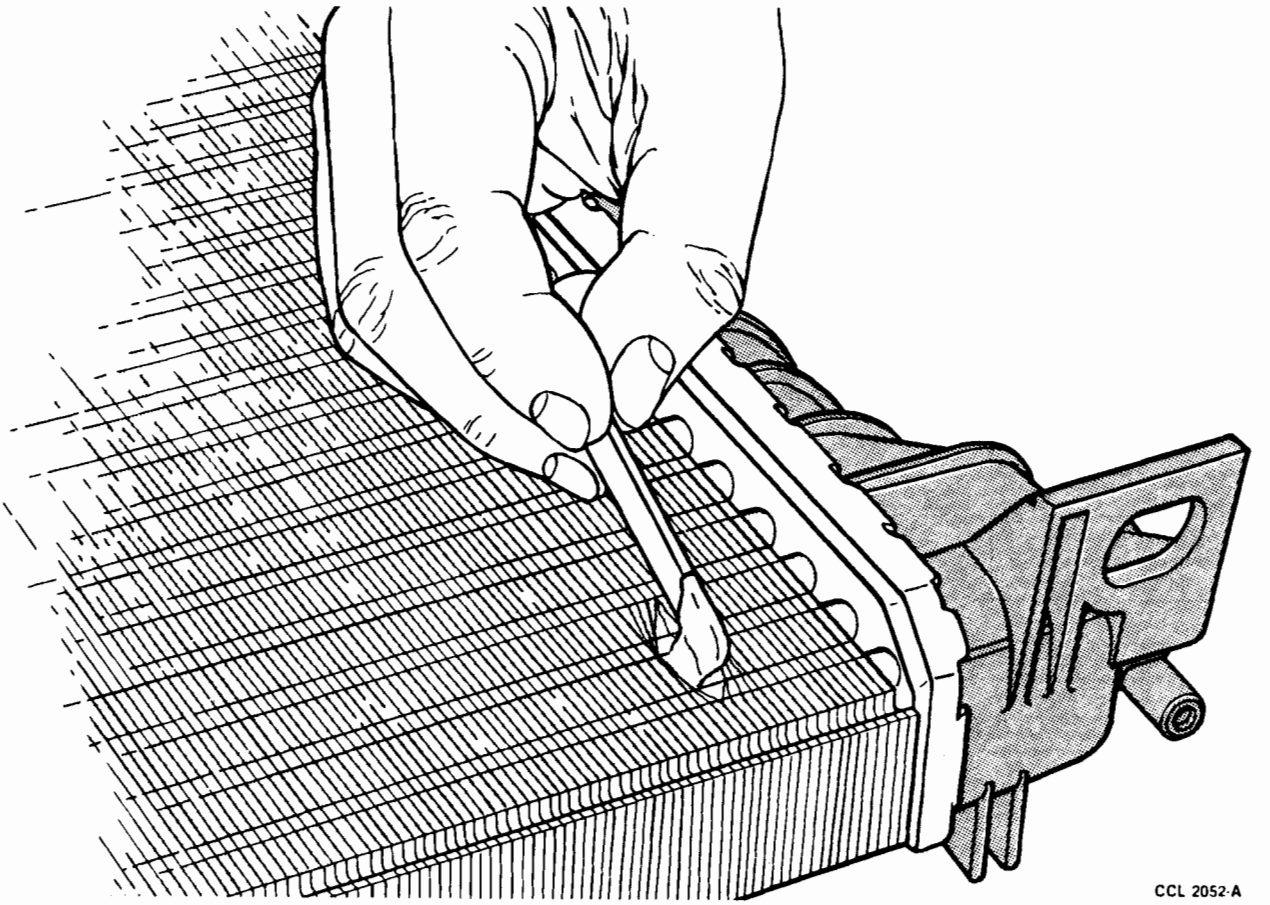


5. Squeeze a bead (length-enough material to service the leak) of resin Part A on a clean, dry, disposable flat mixing surface. Use uniform pressure to obtain an even bead.

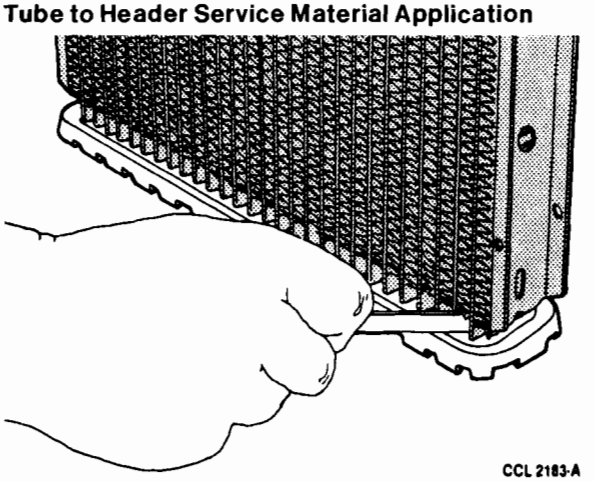
   NOTE: Observe all cautions and warnings printed on service material containers.
6. Squeeze an equal length bead of hardener (Part B) parallel to Part A bead.
7. Mix Parts A and B together.
8. Clean area around leak with methylene chloride.
9. Warm core around leak with a 375 watt heat lamp. Then, apply servicing material to leak.

SERVICE PROCEDURES (Continued)

Tube Service Material Application

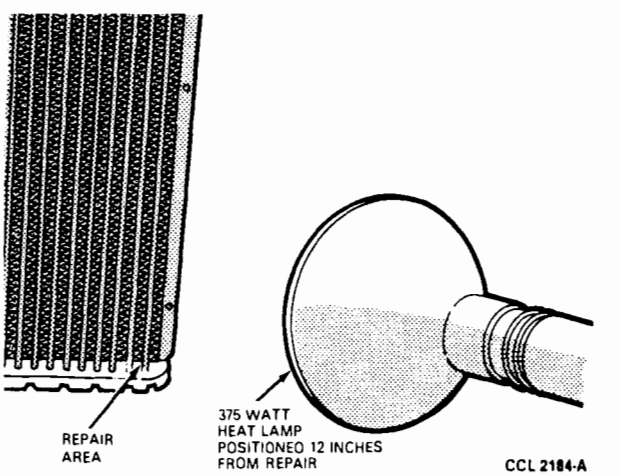


Tube to Header Service Material Application



10. Position 375 watt heat lamp 30cm (12 inch) from area and allow to cure for two hours. **DO NOT** position heat lamp closer to area being serviced than 30cm (12 inch). **DO NOT** use a heat gun or overheat material.

11. When area being serviced is cured, leak test and paint areas, if required. Use crimp clamps to hold tank to header during leak testing if tank was removed for service.



SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft
Cooling Fan Shroud to Radiator	31-46	23-34
Cooling Fan to Shroud	4-6	3-4
Water Pump Bolts	19-25	14-19
Water Pump Outlet Bolts	19-25	14-19
Idler Bolt	37-52	27-38
Power Steering Pump Bracket	47-66	35-48
Thermostat Cover	19-25	14-19
Oil Cooler Nuts	12-15	9-11

Description	Specification
Cooling Fan Switch Resistance as the temperature rises above 91°C (196°F)	Greater than 10,000 ohms
Resistance as the temperature falls below 91°C (196°F)	Less than 5 ohms

CQ2070-A

SPECIAL SERVICE TOOLS

- No. 200 Crimp Clamp: The Barbee Company P.O. Box 323 Louisville, Kentucky 40201.
- No. 23151 Stainless Steel Wire Brush: The Milwaukee Brush Manufacturing Co. P.O. Box 830 Menomonee Falls, Wisconsin 53051.
- Heat Lamp and Socket: 375 Watt
- Sandpaper or Emery Paper 80 or 100 Grit.
- Methylene Chloride Solvent.
- Mixing Card.
- Spatulas, Wood.
- Epoxi-Patch Kit No. 6 Aluminum: Hysol Division of the Dexter Corporation Olean, New York 14760.
- Tool BT8260 and 8260-A Radiator Core Remover and Replacer. Borroughs Tool and Equipment Corporation: 2429 North Burdick St. Kalamazoo, Michigan 49007.

ROTUNDA EQUIPMENT

Model	Description
021-00012	Radiator/Heater Core Pressure Tester
021-00053	Cooling System Adapter
014-00407	Digital Volt-Ohmmeter
021-00046	Battery/Anti-Freeze Tester