SECTION 6B

COOLING AND RADIATOR

CAUTION: This vehicle is equipped with Supplemental Inflatable Restraint (SIR). Refer to CAUTIONS in Section 9J under ON-VEHICLE SERVICE and the SIR component and wiring location view in Section 9J before performing service on or around SIR components or wiring. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound, will be called out. The correct torque values must be used when installing fasteners that require them. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The cooling system consists of the radiator, radiator cap, reservoir, hoses, water pump, two electric motor-driven cooling fans, thermostat, and suitable passages for water circulation through the engine.

RADIATOR

A cross-flow lightweight aluminum/plastic radiator is used with the transverse 4.9L engine. The radiator incorporates a brazed aluminum cross-flow tube and center core. Plastic end tanks are fastened to the core with clinch tabs and sealed with a high temperature rubber gasket. The end tanks house a transmission oil cooler in the right side and an engine oil cooler in the left side. Oil cooler fittings are sealed to the tank with rubber gaskets and nuts. The radiator drain cock is plastic and is located at the bottom of the left side plastic tank. The radiator is fully serviceable.

Radiator Cap

Refer to Figure 1

A pressure-vent cap is used on the cross-flow radiator to allow a build up of 103 kPa (15 psi) in the cooling system. This pressure raises the boiling point of coolant to approximately 129°C (265°F) at sea level. Do not remove radiator cap to check engine coolant level; check coolant visually at the see-through coolant reservoir. Coolant should be added only to the reservoir.

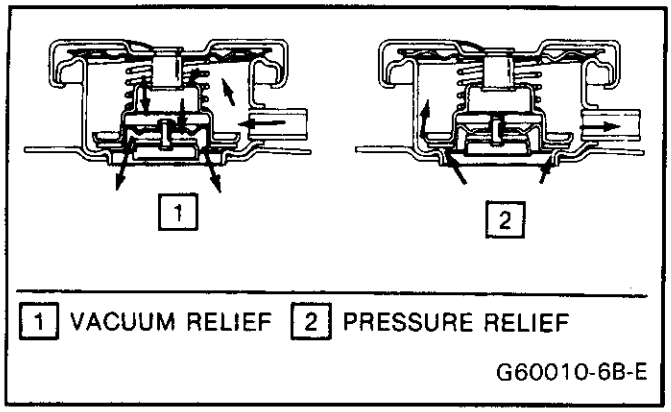


Figure 1 - Closed System Pressure Cap

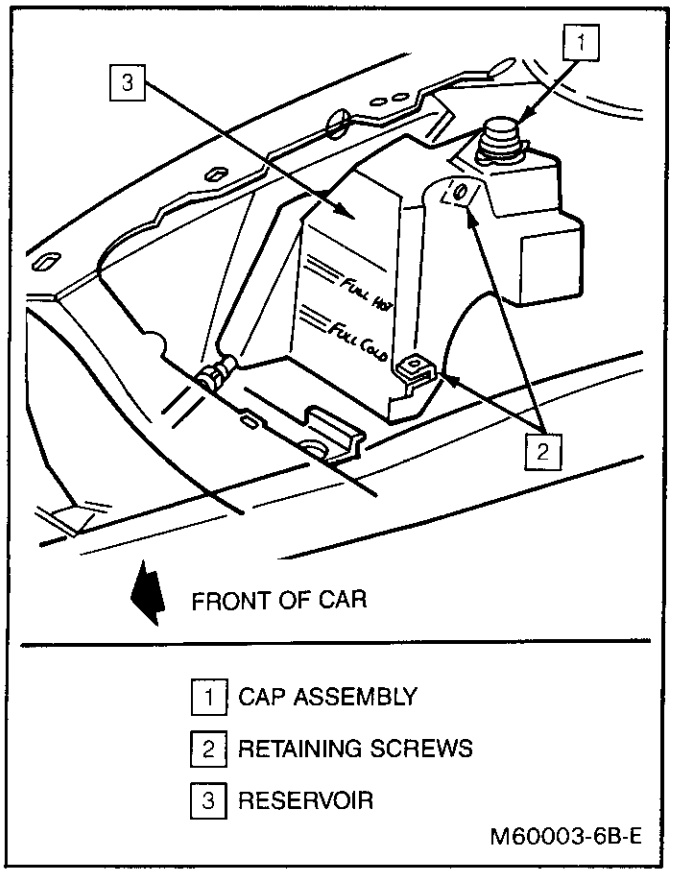


Figure 2 - Coolant Recovery Reservoir

CAUTION: With a pressurized cooling system, coolant temperature in the radiator can be considerably higher than the boiling point of the solution at atmospheric pressure. Removal of the radiator cap, while the cooling system is hot and under high pressure, will cause the solution to boil instantaneously with explosive force, spewing the solution over engine, fenders and persons nearby. If the solution contains flammable anti-freeze such as alcohol (not recommended for use at any time), there is also the possibility of causing a serious fire and severe injury.

The pressure-type radiator filler cap contains a blow-off (or pressure valve) and a vacuum (or atmospheric valve). The pressure valve is held against its seat by a calibrated spring and protects the radiator by relieving any internal pressure exceeding design specification.

The radiator cap is designed to prevent accidental removal. The finger grips have been removed so that the cap is round in shape. It must be pushed downward before it can be removed. A rubber/asbestos gasket is added to the diaphragm spring at the top of the cap. Also, embossed on the cap is a caution against its being opened and arrows indicating the proper closed position.

CAUTION: If there is evidence of steam, do not open hood until steam is dispersed as bodily injury could occur.

COOLANT RECOVERY RESERVOIR

Refer to Figure 2

A see-through plastic recovery reservoir, similar to the windshield washer solvent container, is connected to the radiator with a hose. As the car is driven, the coolant is heated and expands. Fluid displaced by this expansion flows from the radiator into the reservoir. When the car is stopped and the coolant cools and contracts, the displaced coolant is drawn back into the radiator by vacuum. Consequently, the radiator is filled with coolant to the desired level at all times, resulting in increased cooling efficiency. The coolant level should be maintained between the 'Full Hot' and 'Full Cold' indicators on the reservoir.

WATER PUMP

The water pump is a centrifugal type pump consisting of an impeller, impeller drive shaft, pulley flange and a stamped steel housing. The pulley which attaches to the pump is driven by the back side of the serpentine drive belt.

THERMOSTAT

The thermostat is located in the thermostat housing at the right rear of the engine.

A pellet-type thermostat is used in the coolant outlet passage to control the flow of engine coolant, to provide fast engine warmup and to regulate coolant temperatures. A wax pellet element in the thermostat expands when heated and contracts when cooled. The pellet is connected through a piston to a valve. When the pellet is heated, pressure is exerted against a rubber diaphragm which forces the valve to open. as the pellet is cooled, the contraction allows a spring to close the valve. Thus, the valve remains closed while the coolant is cold, preventing circulation of coolant through the radiator. At this point, coolant is allowed to circulate through the engine, heater core, and bypass.

As the engine warms, the pellet expands and the thermostat valve opens, permitting coolant to flow through the radiator where heat is dissipated. This opening and closing of the thermostat permits enough coolant to enter the radiator to keep the engine within operating limits.

COOLING FANS

The cooling system utilizes two plastic fans. The front fan is 310 mm (12.20 in.) in diameter and the rear fan is 415 mm (16.20 in.) in diameter.

The fans are driven by individual electric motors which are controlled electronically by the Powertrain Control Module (PCM). Fan speed is variable and is controlled based on engine coolant and A/C high-pressure refrigerant temperature.

Both fans are commanded 'ON' with half power at a calibrated engine coolant or A/C high-pressure refrigerant

temperature increases and reaches full power at a higher calibrated engine coolant or A/C high-pressure refrigerant temperature. Undesirable on-off operation of the fans is eliminated by utilizing turn-off temperatures lower than the turn-on temperatures.

A cooling fan control module is no longer used on this vehicle. The module has been replaced by three relays, located in the relay center near the left front fender shroud. Two of the relays operate in parallel at low fan speed, and in series at high fan speed. The third relay discriminates between the two primary fan control relays.

ACCESSORY DRIVE BELT

Refer to Figures 3 And 4

The engine employs a single serpentine belt which drives each of the engine-mounted accessories. The belt is wider than conventional belts due to its 'Poly-V' design, similar to six narrow V-belts joined at their sides.

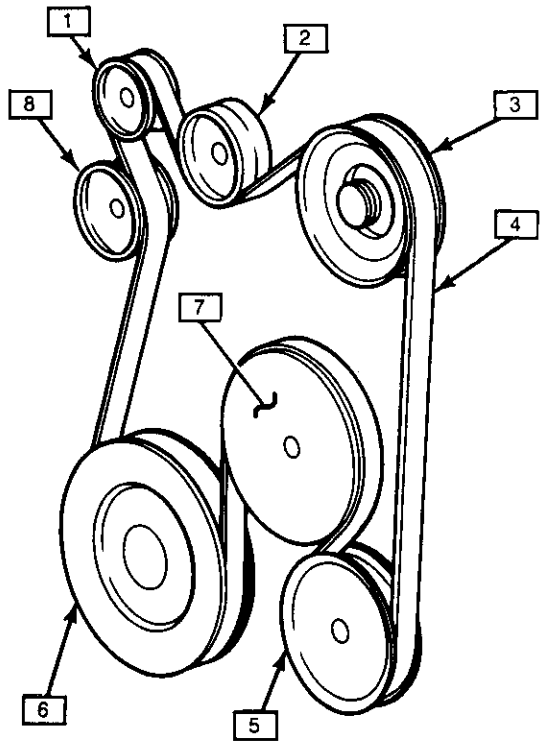
Encircling each accessory pulley are six grooves which mate with the contours of the belt face. The exception to this is the water pump pulley which is driven by the back side of the serpentine belt and, consequently, does not require grooves.

An engine-mounted belt automatic tensioner mechanism is designed to maintain 534 N (120 lbs.) of belt tension. Tool J 23600-B can be used to check the belt tension. Throughout its functional travel, the mechanism will maintain this tension while compensating for increases in belt length resulting from normal belt wear and stretch which will occur with time. When the cast arrow indicates the belt has stretched (which causes the tensioner to operate outside of its design range), belt replacement is necessary. When the indicator lug bottoms against the housing stop, the tensioner no longer maintains any belt tension.

COOLING SYSTEM CIRCULATION

The front engine-mounted water pump is belt driven. Coolant from the radiator outlet (lower right side of radiator) flows to the water pump inlet and is pumped through coolant passages in the crankcase and into the cavities surrounding the cylinder liners. Coolant then flows through holes in the cylinder head gaskets into the cylinder head coolant passages. Passages in the intake manifold direct the coolant to the thermostat at the right rear of the manifold. When the thermostat is closed (cold engine), the coolant is prevented from returning to the radiator and is recirculated for quick engine warmup.

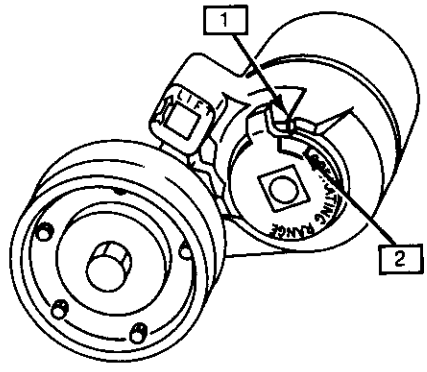
Once the engine has warmed sufficiently, the thermostat opens and coolant flows to the inlet tank on the top left side of the radiator. It is cooled as it flows across the horizontal core tubes to the outlet tank on the right side of the radiator, completing the cycle.



1 GENERATOR PULLEY
2 TENSIONER
3 STEERING PUMP PULLEY
4 SERPENTINE BELT
5 A/C COMPRESSOR PULLEY
6 CRANKSHAFT PULLEY
7 WATER PUMP PULLEY
8 IDLER PULLEY

M60002-6B-EK

Figure 3 - Serpentine Drive Belt



1 CAST ARROW
2 RANGE INDICATOR

L60030-6B-EK

Figure 4 - Serpentine Belt Tensioner

MAINTENANCE RECOMMENDATIONS

At least once a year, the front face of the radiator should be cleaned. In northern climates, spring is a good time of year to do this cleaning, as road salt residue on the radiator can cause corrosion. Insects, leaves, and other debris can be removed by blowing compressed air through the radiator core from the back. Water can also be used on both sides of the radiator.

CAUTION: Never spray cold water on a hot radiator. The resulting steam could cause personal injury.

NOTICE: The radiator fins are necessary for good heat transfer and should not be brushed as this could damage the fins.

For other maintenance recommendations and system capacities, refer to 'MAINTENANCE AND LUBRICATION' (Section 0B).

COOLING SYSTEM CARE

The radiator cap should not be removed to check coolant level. Check the coolant level visually at the see-through coolant recovery reservoir or tank. The level should be near the appropriate mark when the system is cold. At normal operating temperature the coolant level in the recovery reservoir should increase. Use a $^{50}/_{50}$ mixture of high-quality ethylene glycol antifreeze and water for coolant additions.

Every 12 months the cooling system should be serviced as follows:

1. Wash the radiator cap with clean water.
2. Check the coolant for proper level and freeze protection.
3. Pressure test the system and radiator cap for proper pressure holding capacity of 103 kPa (15 psi). If a replacement cap is required, use the proper cap specified for this vehicle.
4. Tighten hose clamps to specifications and inspect all hoses. Replace cracked, swollen or deteriorated hoses.
5. Clean the front of the radiator and air conditioner condenser.
6. Every 2 years or 48,000 kilometers (30,000 miles), whichever comes first, the cooling system should be drained and refilled. Refer to 'DRAINING AND REFILLING THE COOLING SYSTEM' later in this section.

   NOTICE: The 4.9 Liter V-8 uses a coolant solution and GM coolant supplement (sealant) Part #3634621 or equivalent specifically designed for use in aluminum engines. Failure to use the engine coolant supplement (sealant) and the approved coolant antifreeze could result in major engine damage. When refilling the engine cooling system, add engine coolant supplement sealant, Part #3634621 or equivalent and coolant antifreeze meeting GM specification 1825-M.

DIAGNOSIS

ENGINE OVERHEAT (CODE B450)

Refer to Figure 5

The normal operating temperature for engine coolant is between 85°C (185°F) and 110°C (230°F). Should the coolant exceed these temperatures and reach 126°C (259°F), the A/C compressor clutch will disengage and a Code B450 will set. As the engine coolant temperature drops below 120°C (248°F), the A/C compressor clutch will re-engage and the Code B450 for Coolant Temperature Too High becomes stored in history. This feature is designed to protect the engine from damage which might occur during overheat in long idle or slow, stop and go traffic conditions. Refer to 'SYSTEM DIAGNOSIS' chart (Figure 5) in this section and Code B450 Chart in Section 8D2 for further diagnosis.

THERMOSTAT TEST

This test involves removing the thermostat from the vehicle. Refer to 'THERMOSTAT' in ON-VEHICLE SERVICE later in this section for removal procedures.

1. Suspend the thermostat and a thermometer in a pan in a $^{50}/_{50}$ mixture of ethylene glycol and water. Do not let the thermostat or thermometer rest on the bottom of the pan because of the uneven concentration of heat at that point in the pan.
2. Heat and measure the temperature of the solution using a thermometer.
3. The thermostat valve should begin to open when the temperature of the solution reaches 89° to 93°C (192° to 199°F). When the coolant solution reaches 104°C (219°F), the valve should be fully open--approximately 11 mm (0.43-inch).
4. If the thermostat does not perform to these specifications, replace it with a new one.

RADIATOR CAP

Inspect

- Radiator cap for a weak spring washer or damage to the gasket. If the spring washer is weak, replace the radiator cap.
- Relief valve gasket in the cap and the inner sealing surface of the filler neck for damage or debris.
- Coolant recovery hose fitting on the radiator filler neck for cracks. If the fitting is loose or cracked, replace the radiator end tank.

RADIATOR CAP LEAK TEST

Tool Required:

J 24460-01 Cooling System Tester

1. Clean the radiator cap.
2. Install the radiator cap on J 24460-01 cooling system tester.
3. Pump the pressure tester slowly to obtain the minimum holding pressure.
4. If the radiator cap fails to hold 83 kPa (12 psi), replace the cap. Wet new cap with coolant before installing.
5. Install J 24460-01 on the radiator. Pump the cooling system to 110 kPa (16 psi). Check for leaks and watch for a pressure drop on the tester gage. Repair as necessary.

SYMPTOM DIAGNOSIS

CONDITION	CAUSE	CORRECTION
ENGINE OVERHEATS (I.E., COOLANT AND/OR ENGINE TEMP LIGHT COMES ON AND STAYS ON, OR COOLANT OVERFLOWS FROM RESERVOIR ONTO GROUND WHILE ENGINE IS RUNNING). **NOTE:** 'SELF DIAGNOSTIC SYSTEM CHECK' (SECTION 8D) SHOULD BE PERFORMED FIRST AND ANY TROUBLE CODES (IN PARTICULAR E014 FOR SHORTED COOLANT SENSOR) SHOULD BE DIAGNOSED AND CORRECTED FIRST.	LOSS OF COOLANT.	SEE 'LOSS OF COOLANT' CONDITION BELOW.
	LOSS OF SYSTEM PRESSURE.	INSPECT SYSTEM. CHECK HOSE CONNECTIONS AND TIGHTEN AS NECESSARY.
	LOW COOLANT PROTECTION (SHOULD BE -37 °C/-34 °F).	TEST SOLUTION.
	BELT TENSION TOO LOW.	REPLACE TENSIONER.
	SPARK TIMING INCORRECT.	SET TIMING.
	WATER PUMP INOPERATIVE.	REPAIR AS REQUIRED.
	RADIATOR FINS OBSTRUCTED.	CLEAN AWAY BUGS, LEAVES, ETC.
	COOLING SYSTEM PASSAGES BLOCKED BY RUST OR SCALE.	FLUSH SYSTEM - ADD FRESH COOLANT.
		RELIEVE KINKS BY RE-ROUTING. REPLACE HOSE IF NECESSARY.
	LOWER RADIATOR HOSE COLLAPSES.	CHECK FOR HOSE SPRING POSITION BY SQUEEZING LOWER END OF HOSE. REPLACE AS NECESSARY.
	DEFECTIVE ENGINE METAL TEMP SWITCH.	REPLACE SWITCH.
	COOLING FANS INOPERATIVE	CHECK ELECTRICAL CONNECTOR & CHECK FOR PROPER ROTATION
	EXHAUST SYSTEM RESTRICTION.	CHECK MUFFLER AND EXHAUST PIPE FOR COLLAPSE.
	THERMOSTAT STUCK IN CLOSED POSITION.	REPLACE THERMOSTAT.
LOSS OF COOLANT.	LEAKING RADIATOR.	INSPECT COOLING SYSTEM AS DESCRIBED.
	LEAKING COOLANT RESERVOIR OR HOSE.	REPLACE RESERVOIR OR HOSE.
	LOOSE OR DAMAGED HOSES OR CONNECTIONS.	RESEAT OR REPLACE HOSES OR CLAMPS.
	WATER PUMP SEAL LEAKING.	REPAIR WATER PUMP.
	WATER PUMP GASKET LEAKING.	REPLACE GASKET.
	SURGE TANK CAP DAMAGED, OR FILLER NECK DISTORTED.	REPLACE END TANK.
	CYLINDER HEAD GASKET LEAKING.	REPLACE GASKET.
	IMPROPER CYLINDER HEAD SCREW TORQUE.	TIGHTEN SCREWS TO PROPER TORQUE.
	CYLINDER BLOCK CORE PLUG LEAKING.	REPLACE CORE PLUG.
	CRACKED CYLINDER HEAD OR BLOCK OR WARPED CYLINDER HEAD OR BLOCK GASKET SURFACE.	RESURFACE OR REPLACE.
	LEAKING HEATER CORE.	REPAIR OR REPLACE.
	LOOSE INTAKE MANIFOLD BOLTS.	RETORQUE MANIFOLD BOLTS.
	LEAKING INTAKE MANIFOLD GASKET.	REPLACE GASKET.
ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE. (COOL AIR FROM HEATER.)	THERMOSTAT STUCK OPEN OR WRONG TYPE THERMOSTAT.	INSTALL NEW THERMOSTAT OF CORRECT TYPE AND HEAT RANGE.
	COOLANT BELOW ADD MARK.	ADD COOLANT.
WATER IN OIL.	CRACKED CYLINDER LINER.	REPLACE PISTON/LINER ASSEMBLY.
	CYLINDER LINER O-RING LEAKING.	REPLACE O-RING.
	LOOSE INTAKE MANIFOLD BOLTS.	RETORQUE MANIFOLD BOLTS.
	LEAKING INTAKE MANIFOLD GASKET.	REPLACE GASKET. N60007-6B-EK-I

Figure 5 - Cooling System Diagnosis

Radiator Core Leaks

If a leak is detected in the aluminum core use the aluminum radiator repair kit Part #1052536 or equivalent. This kit contains the hot melt adhesive system, considered the best method for repairing small tube leaks in aluminum radiators. For more severe leaks, use conventional repair techniques such as epoxy adhesive, soldering, brazing or welding.

Aluminum radiator leaks can sometimes be repaired on-vehicle. However, it is generally necessary and desirable to remove the radiator prior to attempting a repair.

Follow the manufacturer's instructions when working with a hot melt adhesive system. A brief summary of the repair kit procedure follows:

1. Thoroughly clean the area around the leak. The adhesive will not stick to a dirty surface.
2. If the leak is near one of the plastic end tanks, cover the tank with a wet cloth to prevent the tank from overheating.
3. Slightly heat the area of the leak with a small torch or a heat gun. **Do not use a blow torch.**
4. Apply the primer provided in the kit to the affected area. **Do not heat the primer.**

   CAUTION: The primer contains trichlorethane. It could be harmful or fatal if swallowed. Keep away from eyes. Flush eyes with water and seek immediate medical attention if eye contact occurs. Wash primer from body with soap and water. Do not mix the primer with water.
5. Scrub the area with a cotton swab until a fresh swab stays clean. A clear, yellow-brown coating does not have to be removed.
6. Heat the primed area with a heat gun, or by using a small torch in circular pattern. Use a soft, small blue flame (like a gas stove flame).
7. Withdraw the torch and rub the adhesive stick on the repair area. The adhesive will flow at approximately 260°C (500°F). **Do not heat the stick directly. High heat will burn and char the adhesive.**
8. Continue heating until the adhesive flows, wetting the entire area and filling the joint. The force of the flame or heat gun will tend to guide the adhesive toward the hole.
9. Heat the repair area until the adhesive is bubble-free and smooth, with a slight yellow color. Curing is not required.
10. Leak test the core after it has cooled. If the leak persists, repeat the procedure.

Radiator End Tank Leaks

Before removing the end tank suspected of leaking, re-clinch all of the tabs securing the end tank to the core. Frequently this is all that is required to eliminate the leak.

If the leak persists, it will be necessary to remove the end tank from the core. Inspect the end tank for cracks, flaws or a rough sealing edge and replace as necessary. Inspect the core sealing surface for flaws, dents or cracks and repair as necessary. Replace the old gasket with a new one which has been dipped in coolant. Reinstall the end tank and test for leaks.

COOLANT CONCENTRATION TEST

Due to a worldwide shortage of 'Ethylene Glycol' in 1988, some coolant manufacturers have started to mix other types of glycol in their coolant formulations; propylene glycol is the most common new ingredient. A hydrometer will not always provide a correct measurement of freeze protection when anything other than ethylene glycol and water is being tested. The degree of inaccuracy will vary depending on the proportion of other glycols present in the coolant.

All 1991 GM vehicles are produced with coolant that can be accurately measured with a hydrometer; however, when the type and quality of coolant being measured is unknown, such as a customer vehicle that has accumulated mileage, use of a refractometer is recommended.

Coolant testers J 26568 (Centigrade Scale), J23688 (Fahrenheit Scale) or J 38633 (Expanded Fahrenheit Scale) can be used to check the antifreeze protection of the coolant. Make sure the refractometer markings are correct. Unless J 26568, J 23688 or J 38633 has a provision for temperature correction, test the temperature at which J 26568, J 23688 or J 38633 is calibrated. If the coolant is warmer or cooler, the reading may be incorrect. Follow the manufacturers directions on using J 26568, J 23688 or J 38633.

Clean

- Before each use, swing the plastic cover at the slanted end of J 26568, J 23688 or J 38633 exposing the measuring window and the bottom of the plastic cover (Figure 6).
- Wipe dry with a tissue or a clean soft cloth.
- Close the plastic cover.

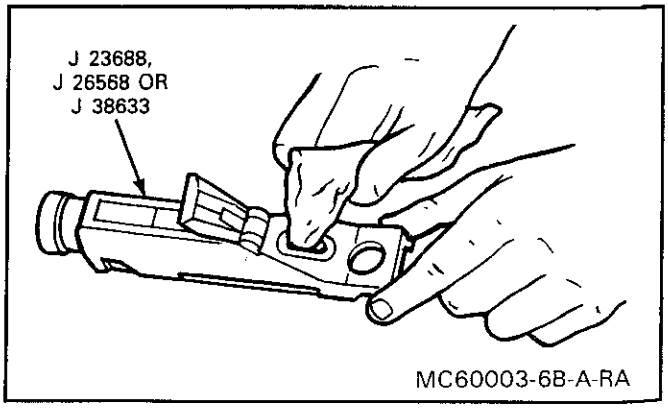


Figure 6 - Cleaning the Coolant Tester

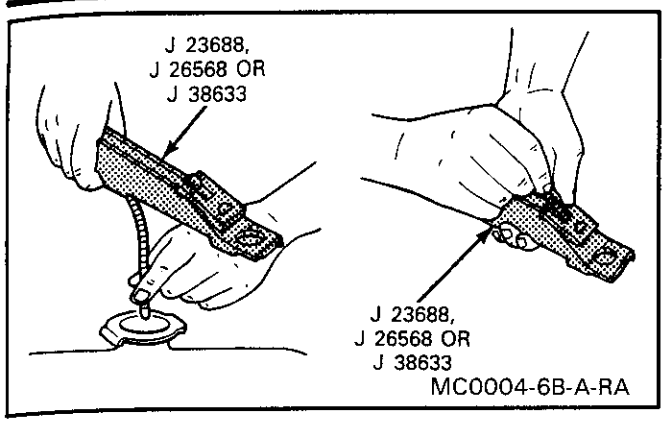


Figure 7 - Collecting the Coolant

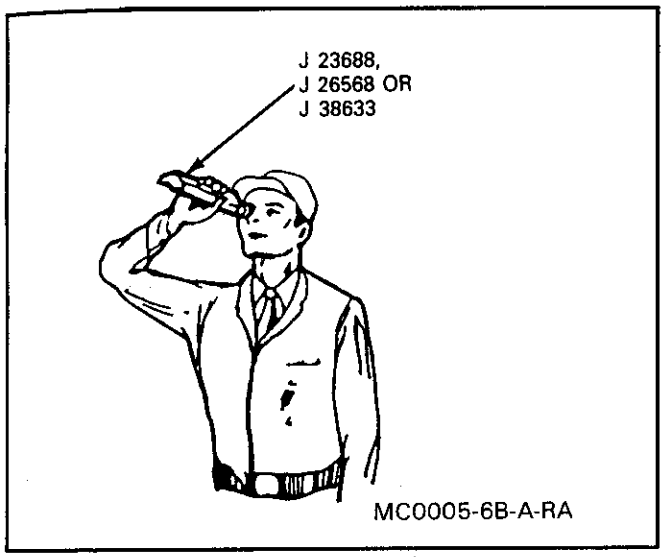


Figure 8 - Reading the Coolant Tester

Testing

Refer to Figures 6, 7, and 8

Tool Required:

J 26568, J 23688, or J 38633 Coolant Tester

- Do not remove the clear plastic pump from J 26568, J 23688 or J 38633

1. Release the tip of the pump from J 26568, J 23688 or J 38633.
2. Insert the tip of the pump into the radiator filler neck.
   - Make sure the tip of the pump is below the level of the coolant.
3. Press and release the bulb to get a sample.
4. Insert the tip of the pump into the cover plate opening.
5. Press the bulb and allow a few drops to fall onto the measuring surface.
   - Do not open the plastic cover when taking readings because water evaporation can change the readings.
6. Point J 26568, J 23688 or J 38633 toward any light and look into the eyepiece.
   - Coolant protection reading is at the point where the dividing line between light and dark crosses the scale (antifreeze protection is the scale on the right).
   - Temperature scale is reversed from a standard thermometer scale.
   - Below zero readings are on the upper half of the scale.
   - If the readings are not clear, the measuring surface was not cleaned and dried properly. Wipe dry and make a new test.

COMPUTER DIAGNOSTICS

For a detailed explanation of the self-diagnostic features available to the service technician, refer to COMPUTER SYSTEM DIAGNOSIS (Section 8D). Refer to 'PCM TROUBLE CODE DIAGNOSIS' (Section 8D1) for cooling fan trouble code diagnosis of Code B441.

SERPENTINE BELT REPLACEMENT DIAGNOSIS

Refer to Figures 9, 10, and 11

When checking the serpentine belt for wear, the condition of the belt ribs if best judged as the belt is bent back over the water pump pulley. Belt stretch, as indicated by the belt tensioner, also affects the belt replacement decision (see Figure 9).

SERPENTINE BELT NOISE

Serpentine belt noise is most noticeable at idle. **Various other drive system components (tensioner, A/C compressor, generator) may appear to be the cause of the noise which is the result of the belt. For vehicles that exhibit this condition. The service belt can be easily identified by a six inch orange band along its outside perimeter. This belt is not used in production.**

Before replacing the belt to resolve a noise condition, inspect all of the pulleys in the accessory drive system for misalignment. This can be accomplished by observing the various pulleys with the engine running. Runout or wobble will identify pulleys requiring attention. Observe particularly the crankshaft, AIR pump and water pump pulleys for runout that may be induced by loose pulley fasteners.

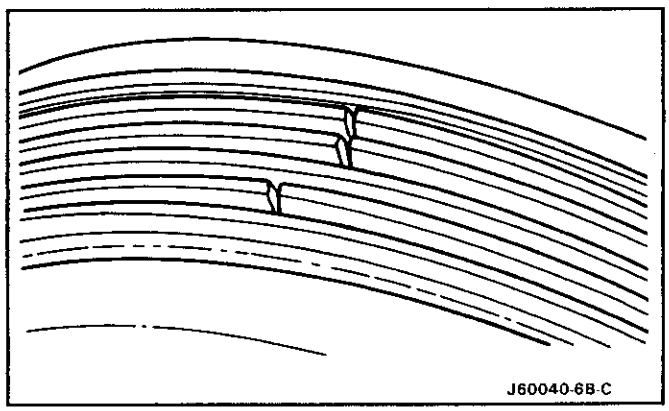


Figure 9 - Serpentine Belt- Moderately Used

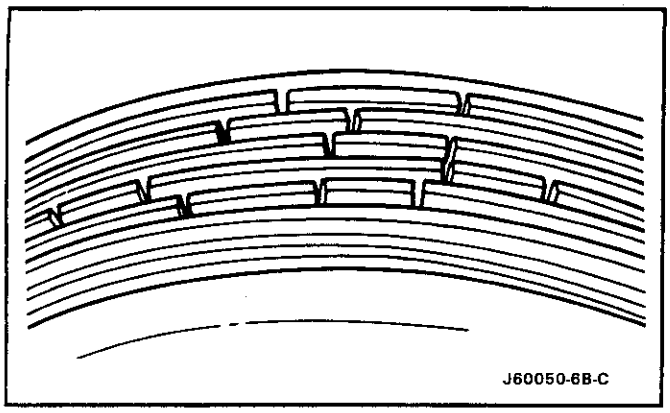


Figure 10 - Serpentine Belt-Severely Used

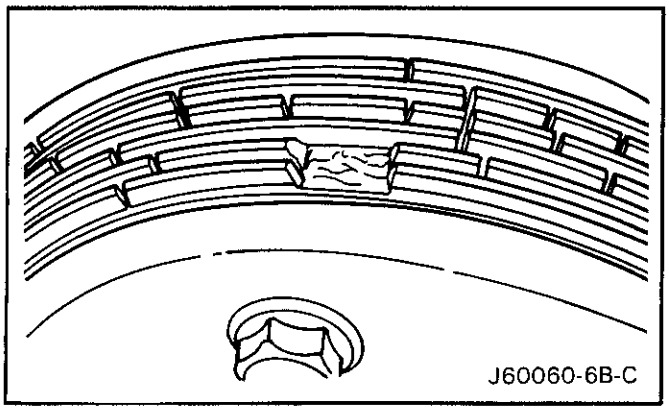


Figure 11 - Serpentine Belt-chunking

Once alignment of the belt drive system is confirmed, the service belt should be installed and the noise re-evaluated even if replacement of other components appears to be required. Frequently, a belt tensioner which appears excessively 'jumpy' can be fixed by belt replacement only. This is also true for belt noise which appears only with the A/C compressor engaged. If belt replacement fails to correct the condition, continue diagnosis of accessory components. Special tool J 36312 serpentine belt assortment kit is available to aid accessory noise diagnosis by providing a series of belts designed to allow engine operation with each of the belt-driven accessories eliminated in turn.

ON-VEHICLE SERVICE

DRAINING AND REFILLING THE COOLING SYSTEM

CAUTION: To avoid the danger of being burned, do not remove the radiator cap while the engine and radiator are still hot. Scalding fluid and steam will be blown out under pressure.

1. Remove the radiator cap when engine is completely cool.
   - Turn cap in a counterclockwise direction until it reaches the 'stop'. Do not press down on the cap.
   - Wait until any remaining pressure (indicated by a 'hissing' sound) is relieved.
   - After all pressure is released, press down on the cap and continue to rotate in a counterclockwise direction and remove.
2. Open the radiator drain cock, located on the bottom of the right radiator tank.

Important

- Dispose of used coolant in a proper fashion, i.e., in a used coolant holding tank which is picked up along with used oil. **NEVER POUR USED COOLANT DOWN THE DRAIN!** Ethylene glycol antifreeze is a very toxic chemical; disposing of it into the sewer system or ground water is ecologically unsound!

3. Remove, clean and reinstall the coolant recovery reservoir.
4. When all the coolant has drained, close the radiator drain cock .
5. Fill the cooling system with water.
6. Run the engine until the thermostat opens.
7. Stop the engine. Repeat steps one through seven until the drained fluid is clear and free of coolant and/or rust.
8. Close drain cock.
9. Fill the cooling system with at least a $^{50}/_{50}$ mixture of ethylene glycol antifreeze and water—but no more than $^{70}/_{30}$ mixture of antifreeze and water.
   - Fill the radiator to just below the filler neck.
   - Fill the coolant recovery reservoir to the COLD FILL mark.

   NOTICE: Use Ethylene Glycol antifreeze meeting GM specification 1825-M, to provide the required freezing and corrosion protection, -37°C (-34°F).
10. Run the engine with the radiator cap removed until normal operating temperature is reached (radiator inlet hose becomes hot).

    CAUTION: Under some conditions, ethylene glycol in engine coolant is flammable. To avoid being burned when adding coolant, do not spill it on the exhaust system or on hot engine parts.
11. With the engine idling, add the coolant to the radiator until it reaches the bottom of the filler neck.
12. Install the radiator cap.
    - The arrows on the cap must line up with the coolant recovery reservoir hose.

    NOTICE: Alcohol or methanol-based coolants are not recommended at any time. Use of these coolants could cause system failure.

    NOTICE: A solution of higher than a $^{70}/_{30}$ mixture of antifreeze to water should never be used. The solution freezing point increases after this point.

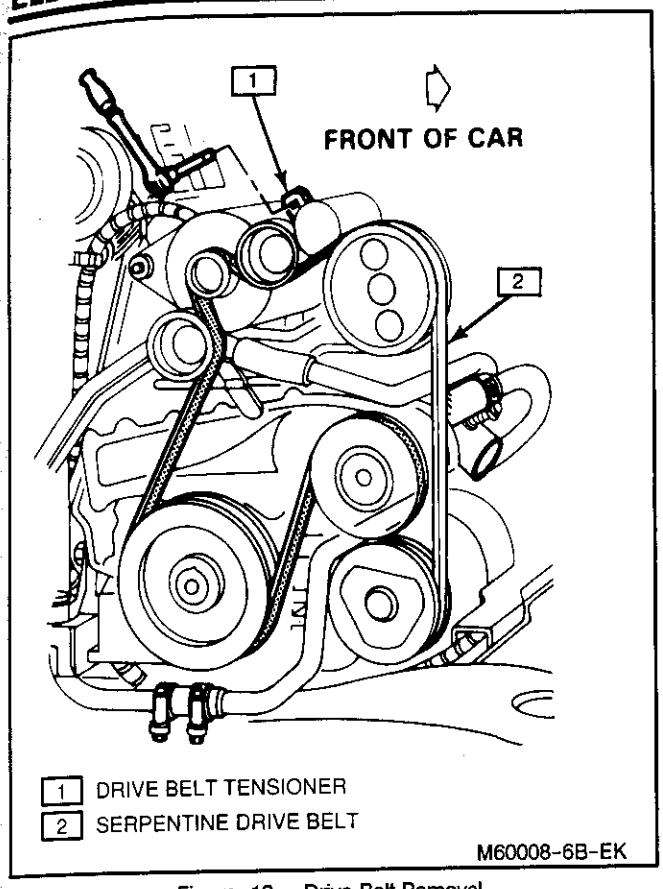


Figure 12 - Drive Belt Removal

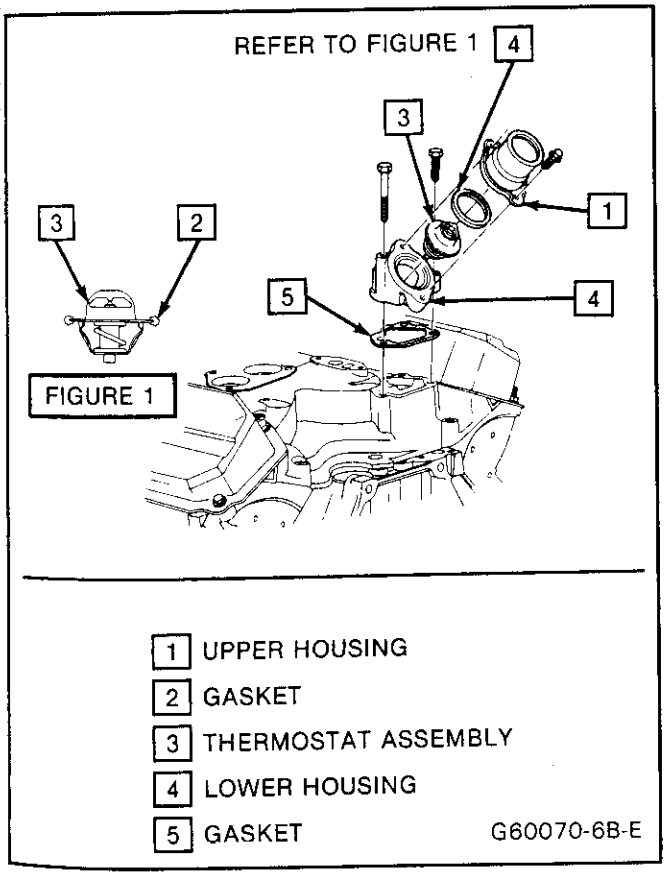


Figure 13 - Thermostat and Housing

ACCESSORY DRIVE BELT

Refer to Figure 12

Remove or Disconnect

1. Rotate drive belt tensioner mechanism upward, away from drive belt using a $^1/_2$ inch drive breaker bar.
2. Drive belt from vehicle.

Install or Connect

1. Drive belt loosely.

Important

- Be sure that the belt is aligned properly into the grooves of all accessory pulleys.

2. Rotate tensioner mechanism upward with breaker bar and thread belt under tensioner pulley.
3. Return tensioner to normal position.

THERMOSTAT

Refer to Figure 13

Remove or Disconnect

- Drain coolant to a level below that of the thermostat housing.

1. Upper air filter assembly.
2. Two screws fastening upper and lower thermostat housing together.
3. Upper thermostat housing.
4. Thermostat and gasket from lower housing.
5. Lower thermostat housing and gasket from intake manifold (only if they need to be removed).

Install or Connect

1. Lower thermostat housing and gasket—if they were removed. Secure with two bolts.

Tighten

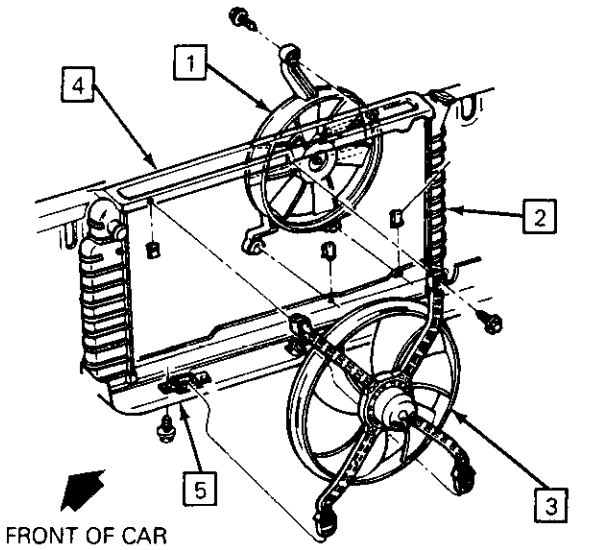
- Lower housing bolts to 27 N•m 20 lb. ft.

2. Thermostat and gasket into lower housing.
3. Upper thermostat housing; securing with two bolts.

Tighten

- Upper-to-lower bolts to 27 N•m 20 lb. ft.

- Refill coolant. Refer to 'DRAINING AND REFILLING COOLANT' earlier in this section.



1 FRONT COOLING RAN
2 RADIATOR
3 REAR COOLING FAN
5 RADIATOR UPPER MOUNTING PANEL
6 RADIATOR SUPPORT LOWER TIE BAR
M66010-6B-EK

Figure 14 - Cooling Fans

COOLING FANS

Refer to Figure 14

Front Cooling Fan

Remove or Disconnect

1. Plastic radiator cover.
2. Fan electrical connector.
3. Right headlamp bracket. Refer to 'LIGHTING SYSTEM AND HORNS' (Section 8B)
4. Front cooling fan from vehicle (three bolts).

Install or Connect

1. Fan to vehicle, securing with three bolts.

Tighten

- Fan mounting bolts to 10 N•m 88 lb.in.

2. Electrical connector.
3. Right headlamp bracket. Refer to 'LIGHTING SYSTEM AND HORNS' (Section 8B)

Rear Cooling Fan

Remove or Disconnect

1. Upper engine-to-radiator support torque strut.
2. Fan electrical connector.
3. Oil cooler line bracket from fan.
4. Fan from vehicle, removing two upper and two lower bolts.

Install or Connect

1. Fan to vehicle, securing with four bolts.

Tighten

- Fan mounting bolts to 10 N•m 88 lb.in.

2. Oil cooler line bracket to fan.
3. Fan electrical connector.
4. Upper engine-to-radiator support torque strut.

Tighten

- Torque strut-to-radiator mounting bolts to 23 N•m 17 lb. ft.

WATER PUMP

Refer to Figures 15 and 16

Remove or Disconnect

- Drain cooling system. Refer to 'DRAINING AND REFILLING COOLANT' earlier in this section.

1. Coolant recovery tank.
2. Water pump pulley (three bolts). Apply tension to drive belt to keep pulley from rotating by forcing the belt tensioner into the drive belt with a breaker bar.
3. Accessory drive belt.
4. Water pump from vehicle.
5. Water pump gasket and discard.

Clean

- Water pump and engine front cover sealing surfaces.

Install or Connect

1. New gasket on water pump cover studs.
2. Water pump.

Tighten

- All pump mounting bolts to the torque specifications in Figure 16.

3. Water pump pulley; install bolts finger-tight.
4. Accessory drive belt.

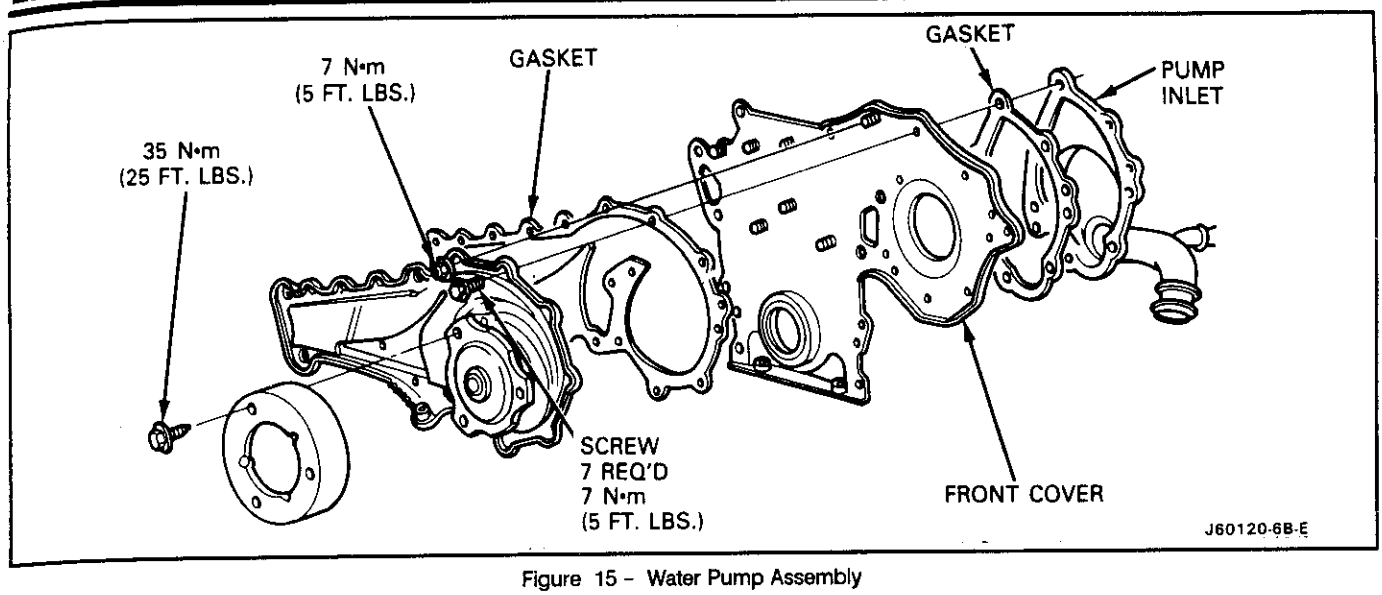
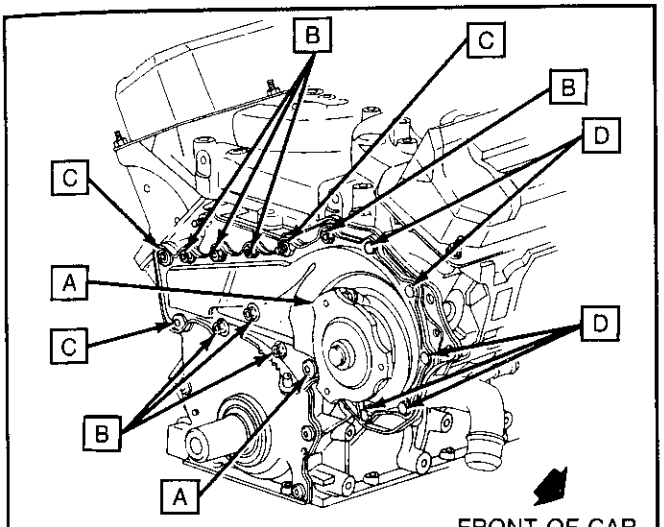


Figure 15 - Water Pump Assembly



KEY	FASTENER TYPE	QTY.	TORQUE	
			N·m	FT. LBS.
A	TORX SCREW	2	40	30
B	NUT	7	7	5
C	HEX SCREW	3	40	30
D	HEX SCREW	5	7	5

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Figure 16 - Water Pump Fasteners

Tighten

- Pump pulley bolts to 30 N•m (22 lb.ft.). Use accessory drive belt drag to keep pulley from moving when tightening pulley bolts. If additional drag is needed, attach a $^1/_2$ inch breaker bar to the belt tensioner and apply a load to the belt.

5. Coolant recovery tank.

- Refill coolant. Refer to 'DRAINING AND REFILLING COOLANT' earlier in this section.

RADIATOR

Refer to Figure 17

Remove or Disconnect

- Drain cooling system. Refer to 'DRAINING AND REFILLING COOLANT' earlier in this section.

1. Plastic radiator support cover.
2. Rear cooling fan. Refer to 'COOLING FANS' earlier in this section.
3. Coolant reservoir hose at filler neck.
4. Upper and lower radiator hoses from radiator.
5. Engine oil cooler lines at radiator.
6. Transaxle oil cooler lines at radiator.
7. Radiator top support.
8. Radiator from vehicle; lift radiator up and out.

Install or Connect

1. Radiator to vehicle.
2. Radiator top support.

Tighten

- Radiator support retaining bolts to 25 N•m 18 lb. ft.

3. Transaxle oil cooler lines at radiator.

Tighten

- Transaxle oil cooler lines to 27 N•m 20 lb. ft.

4. Engine oil cooler lines at radiator.

Tighten

- Engine oil cooler lines to 18 N•m 13 lb. ft.

5. Upper and lower radiator hoses to radiator, securing hose clamps.

Tighten

- Hose clamps to 3 N•m 27 lb. in.

6. Coolant reservoir hose at filler neck.
7. Rear cooling fan. Refer to 'COOLING FANS' earlier in this section.

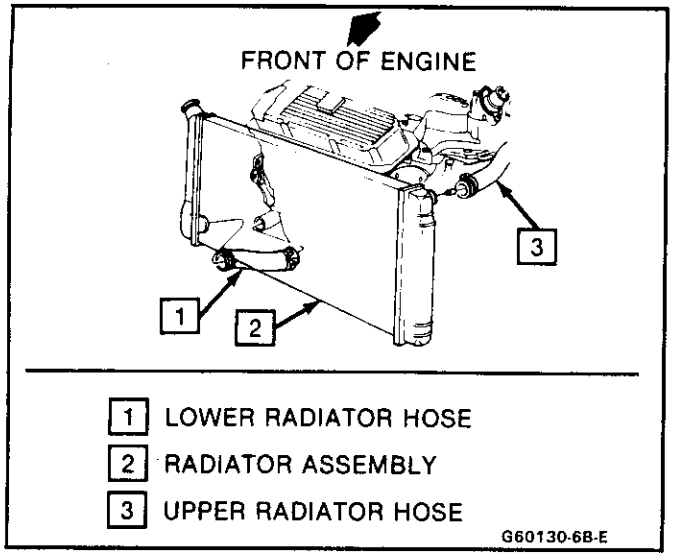


Figure 17 - Radiator Hoses

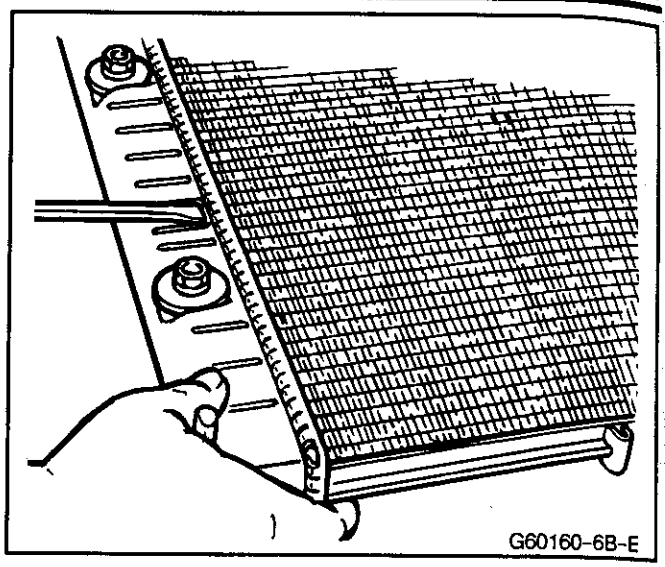


Figure 18 - Removing Radiator End Tank

8. Plastic radiator support cover.

- Refill coolant. Refer to 'DRAINING AND REFILLING COOLANT' earlier in this section.

Radiator End Tank

Refer to Figures 18 and 19

Remove or Disconnect

1. Radiator from vehicle. Refer to 'RADIATOR' earlier in this section.
2. Radiator end tank by prying up clinch tabs with a screwdriver. Tabs should be bent only as far as necessary for tank removal.

   NOTICE: Be careful not to overbend tabs. Excessive bending can result in tab breakage.
3. Old gasket and discard.
4. Oil cooler, if end tank is being replaced.

Clean

- Core and gasket groove of all dirt and gasket material.
- End tank sealing edge of all dirt and gasket material.

Inspect

- Core end for flaws, cracks, bumps or dents. Repair as required.
- Plastic end tank for flaws, cracks or rough sealing edge. If any tank defects are found, replace end tank. Tank leaks can be easily mistaken for tank-to-core sealing leaks.

Install or Connect

1. Oil cooler, if tank is being replaced.
2. New end tank gasket.

Important

- Gasket must be flat to form a good seal. Dip the new gasket in coolant and place it in the gasket seat on the core.
- Use clamps to attach end tank to radiator core.

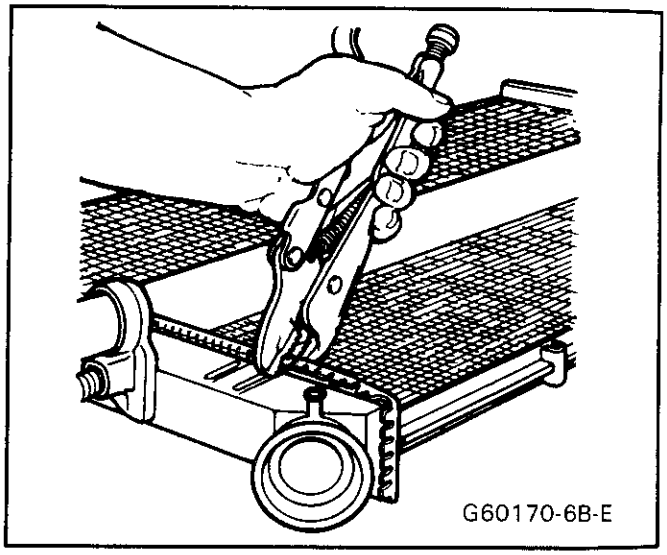


Figure 19 - Installing Radiator End Tank

Important

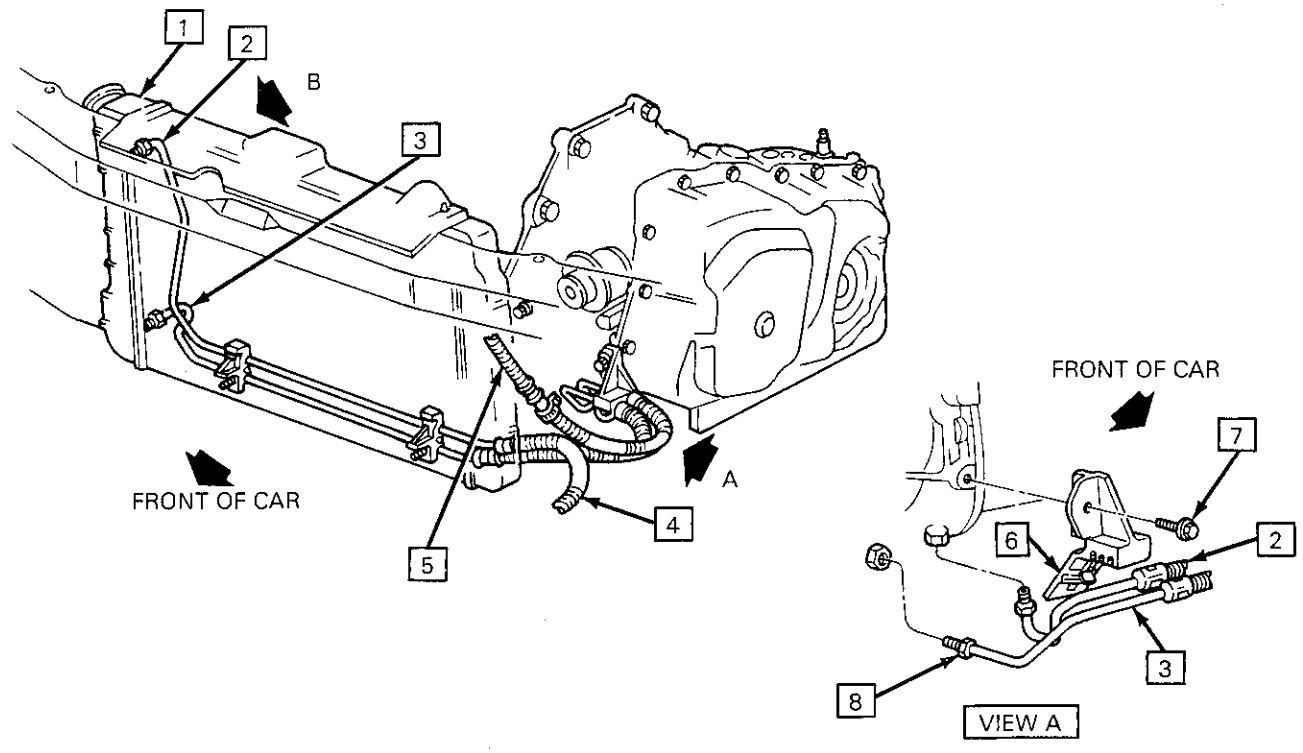
- Clamping the end tank onto the core before clinching the tabs will compress the gasket seal evenly. Use large beam clamps or fixtures. If these tools are not available, a sufficient gasket seal can often be achieved by clinching a tab at each corner of the assembly. This will hold the tank in place for the remainder of the procedure.

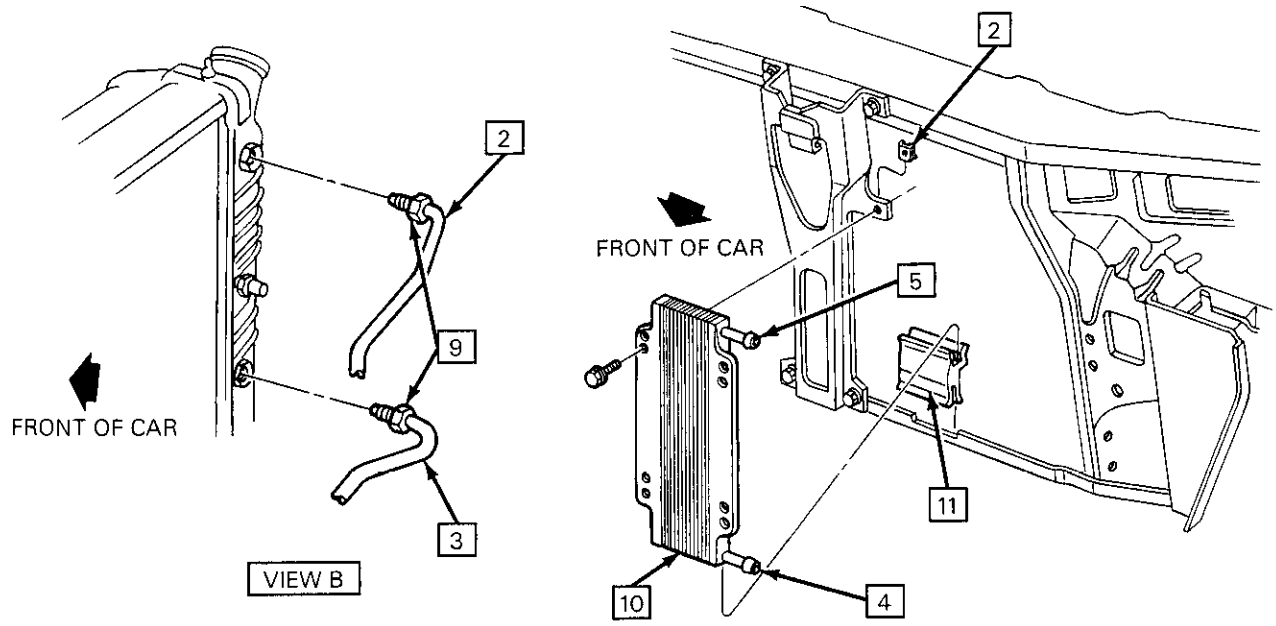
3. End tank securely to radiator core by clinching the tabs around the perimeter of the end tank—use channel locks or vise grips. When clinching tabs, alternate from one side of the tank to the other in order to obtain a good seal. If more than three tabs are broken on one side of the header, or two adjacent tabs, the core must be replaced.

Inspect

- Radiator for leaks and repair as required.

4. Radiator into vehicle. Refer to 'RADIATOR' earlier in this section.





1	RADIATOR AND TRANSAXLE COOLER	7	BOLT
2	OIL SENDING LINE	8	TRANSAXLE INLET AND OUTLET FITTINGS
3	OIL RETURN LINE	9	RADIATOR INLET AND OUTLET FITTINGS
4	TO AUXILIARY COOLER LOWER INLET	10	AUXILIARY TRANSAXLE OIL COOLER
5	TO AUXILIARY COOLER UPPER OUTLET	11	SUPPORT BRACKET
6	CLIP		

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Figure 20 - Transaxle Oil Cooling System

OIL COOLER (ENGINE OR TRANSAXLE)

Refer to Figures 20 and 21

Remove or Disconnect

1. Radiator from vehicle. Refer to 'RADIATOR' earlier in this section.
2. Plastic end tank—right tank for transaxle oil cooler; left tank for engine oil cooler. Refer to 'RADIATOR END TANK' earlier in this section.
3. Nuts from oil cooler fittings.
4. Oil cooler and gaskets from end tank and discard.

Clean

- Gasket seal areas on both oil cooler and end tank.

Install or Connect

1. New oil cooler to tank.
2. New gasket (two) to oil cooler and position in end tank fitting holes.

Important

- **Gaskets must be installed dry.**

3. Cooler line fitting nuts.

Tighten

- Transaxle fitting nuts to 27 N•m 20 lb. ft.
- Oil cooler fitting nuts to 18 N•m 13 lb. ft.

4. Plastic end tank to core. Refer to 'Radiator End Tank' earlier in this section.

Inspect

- Radiator for leaks. Repair as required.

5. Radiator into vehicle. Refer to 'RADIATOR' earlier in this section.

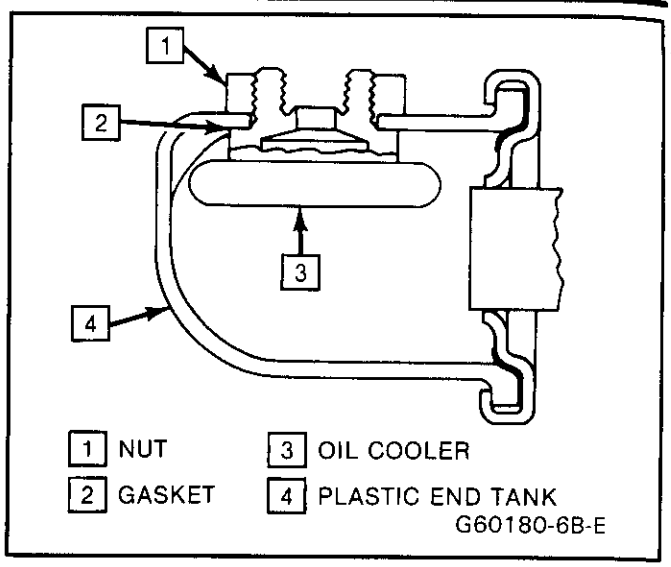


Figure 21 - Oil Cooler Line Fitting

AUXILIARY TRANSAXLE OIL COOLER

Refer to Figure 20

Remove or Disconnect

1. Plastic radiator cover.
2. Front grille (four clips).

- Place a pan below vehicle to catch escaping transaxle fluid.

3. Upper transaxle cooler line from oil cooler unit.
4. Lower cooler line from oil cooler unit.
5. Auxiliary oil cooler unit from vehicle (three bolts).

Install or Connect

1. Auxiliary oil cooler unit to vehicle (three bolts).

Tighten

- Auxiliary cooler mounting bolts to 20 N•m 15 lb. ft.

2. Upper and lower lines to auxiliary oil cooler.

Tighten

- Cooler inlet and outlet fittings to 27 N•m 20 lb. ft.

3. Front grille.
4. Plastic radiator cover.

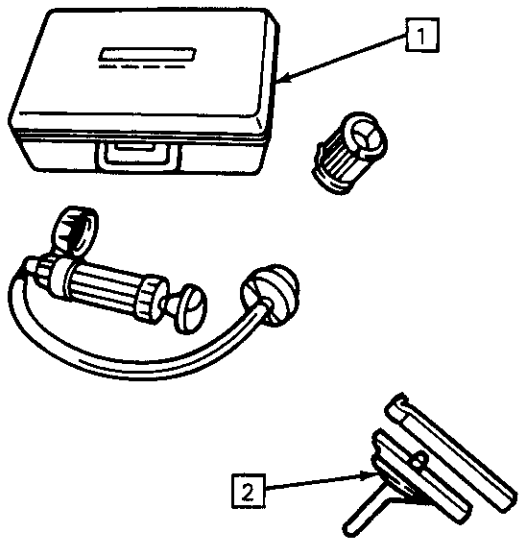
- Check and refill transaxle oil.

SPECIFICATIONS

FASTENER TORQUES

Thermostat Housing Bolts	27 N•m (20 lb. ft.)
Cooling Fan (Front or Rear) Mounting Bolts	11 N•m (97 lb. in.)
Torque Strut-to-Radiator Support Mounting Bolts	23 N•m (17 lb. ft.)
Water Pump Torx-head Screw	40 N•m (30 lb. ft.)
Water Pump Lower Hex-head Screw	7 N•m (62 lb. in.)
Water Pump Upper Hex-head Screw	40 N•m (30 lb. ft.)
Water Pump Stud Nut	7 N•m (62 lb. in.)
Water Pump Pulley Mounting Bolts	30 N•m (22 lb. ft.)
Radiator Support Retaining Screws	25 N•m (20 lb. ft.)
Engine Oil Cooler Line Fittings	18 N•m (13 lb. ft.)
Transaxle Oil Cooler Line Fittings	27 N•m (20 lb. ft.)
Transaxle Auxiliary Cooler Mounting Bolts	20 N•m (15 lb. ft.)

SPECIAL TOOLS



1 COOLING SYSTEM TESTER, J24460-01

2 RADIATOR CORE REMOVER/INSTALLER, J33419-A

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