Section 4 Cooling System

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ENGINE COOLING SYSTEM DESCRIPTION

The cooling system removes excess heat from the engine, engine oil, power steering fluid, transfer case fluid, and the transmission fluid. Some engine heat is beneficial, but excess heat can cause engine oil to break down. If lubrication is significantly reduced, it can cause engine damage. To keep the oil at the proper temperature, the cooling system dissipates some of the heat produced by the engine.

A serpentine belt drives the water pump which pumps coolant through the cooling system. Coolant travels through the engine block and circulates around the parts of the engine which generate heat: the cylinders, cylinder heads, combustion chambers, valve guides, valve seats, etc. As coolant is routed through the engine block, heat is transferred from the engine to the coolant.

The water crossover collects coolant from the cylinder heads and channels it to the thermostat housing. To prevent the engine from being over-cooled, the thermostat monitors the temperature of the coolant and prevents it from being routed to the radiator until it has reached a temperature high enough 190°F (88°C) to require cooling (Figure 4-1).

Like the radiator, the oil cooler also uses a series of fins and baffles to dissipate heat from fluid. The lower half of the oil cooler dissipates heat from the engine oil while the upper half cools transmission fluid.

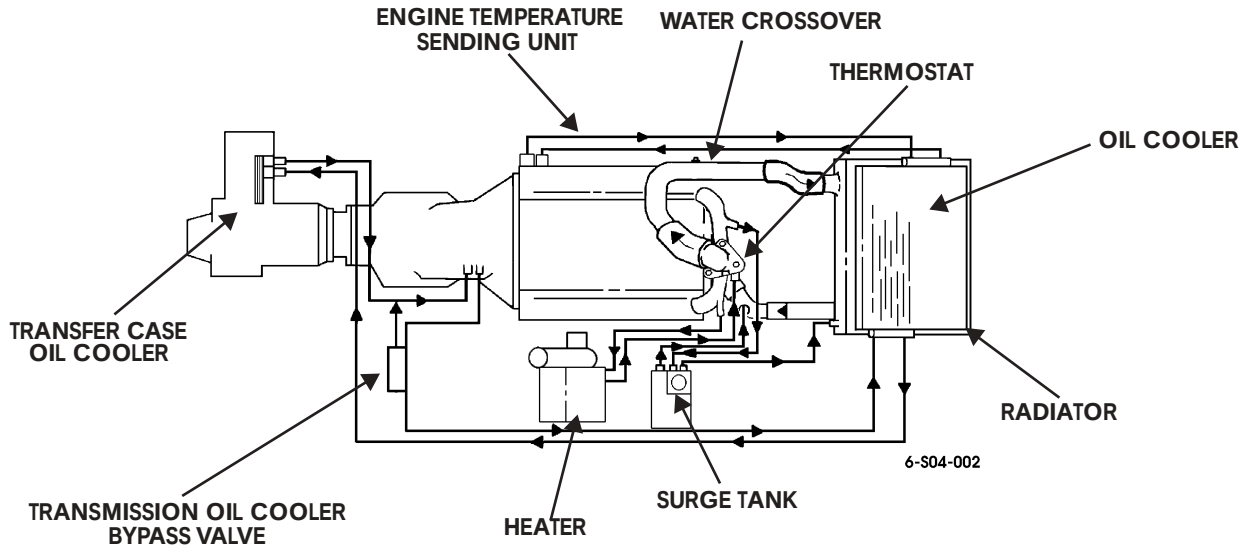

Figure 4-1: Cooling System

If the thermostat detects that the coolant is hot, it is pumped to the radiator where it is routed through a series of fins and baffles. A fan draws in outside air to help dissipate the heat before the coolant is recirculated back through the engine (Figure 4-2).

The heater provides heat to warm the interior of the vehicle for

passenger comfort. Hot coolant leaves the engine and passes through a heater coil. A fan draws air through the heated coil which heats the air. The air is then channeled through a plenum chamber that directs the flow of the heated air into the passenger compartment.

If the engine is generating more heat than the cooling system can effectively dissipate, there may be a problem with coolant or with the system itself. The engine temperature sending unit transmits a signal indicating the coolant temperature to the temperature gauge on the instrument panel to let the driver know that the system should be serviced as soon as possible. Engine coolant is added to the system through the filler cap in the surge tank. After adding or refilling the cooling system, open the valve on the water crossover and bleed the air from the system.

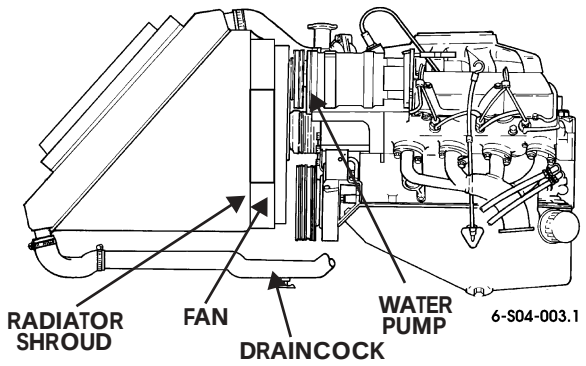

Figure 4-2: Cooling System

ENGINE COOLING SYSTEM DIAGNOSIS AND TROUBLESHOOTING

Loss of Coolant

1. Pressurize system and check for leaks at all cooling system hoses.
   a. Tighten loose clamps, fasteners, or fittings.
   b. Replace leaking hoses.
2. Pressurize coolant system and check for leaks at water pump or around cylinder heads. If any leakage is present, replace cylinder head gaskets, cylinder heads, or water pump.
3. Check cylinder block for cracks. Replace if cylinder block is cracked.
4. Check expansion plugs and block heater for leaks.

Engine Coolant Temperature Gauge Above 230°F (110° C), Engine Overheats

1. Inspect the drivebelt and pulleys for damage.
   a. Replace any damaged parts.
   b. Check belt tension. Replace if necessary.

WARNING: Use caution when testing thermostat. Hot water will cause burns.

2. Check thermostat for proper operation. Remove thermostat and place thermostat in container of water known to be 190°F (88°C). Observe valve. If valve does not open, replace thermostat.
3. Check for clogged or blocked radiator system. Clean and flush as required.
4. Check operation of temperature gauge. Refer to Electrical Troubleshooting (Section 12).
5. Check radiator for bent fins. Straighten fins or replace radiator if damaged beyond repair.
6. Inspect fan blade for damage. Replace fan blade if damaged.
7. Check fan clutch operation.
   a. Check for excessive bearing play. Using fingers only, press tip of fan blade toward and away from engine. Tip of blade total movement should not exceed 0.20 in. (5.1 mm). If movement is more, replace fan drive.
   b. With engine off and ambient temperature of 50°F (10° C) or higher, fan should turn evenly with noticeable drag. If fan turns hard, very easily, or with uneven resistance, replace fan drive.
   c. Fan noise is sometimes evident under the following normal conditions:
      - When the drive is engaged for maximum cooling.
      - During the first 15 seconds to one minute after start-up, until the drive can redistribute the silicone fluid back to its normal disengage operating condition (after overnight settling).

   Fan noise or an excessive roar will generally occur continuously under all engine high speed conditions (2400 RPM and up), if the drive assembly is locked up due to an internal failure. If the fan cannot be rotated by hand or there is a rough, grating feel as the fan is turned, replace the fan drive.
8. Check for leaking or defective water pump. Replace leaking or defective water pump.

WARNING: Do not release surge tank cap when engine is hot. Steam and/or coolant may cause serious injury.

9. Remove surge tank cap. With engine running, check for excessive bubbles in surge tank that may indicate leaking head gaskets or cracked cylinder heads. If bubbles are present, remove cylinder heads and check for defective head gaskets, cracked cylinder heads, or cracked cylinder block. Replace cylinder heads if damaged. Replace engine if cylinder block is cracked.
10. Off-road driving in extremely dusty conditions may result in debris entrapment between the radiator and oil cooler. Debris entrapment may, after a period of engine operation, increase coolant temperature. Cleaning requires the separation of the oil cooler from the radiator and both units thoroughly flushed with water and compressed air.

Fan Runs Continuously (Noisy)

1. Check that all fan capscrews are present and tightened to 45 lb-ft (61 N•m).
2. Perform steps 7a and 7b under *Engine Cooling System Diagnosis And Troubleshooting*.
3. Check for fan cut off (disengagement).
   a. Put tab or mark on fan blade. Use timing light to check RPM.
   b. With coolant temperature between 50° F (10° C) and 140°F (60°C), start engine and set speed to 2000 rpm.

4. Observe fan drive disengagement after 1 to 1-1/2 minutes. If fan speed does not drop and coolant temperature remains below 190° F (88° C), replace fan drive.

RADIATOR AND FAN SHROUD ASSEMBLY MAINTENANCE

Removal

1. Remove hood (Section 10).
2. Drain cooling system.
3. Remove oil cooler (Section 1).
4. Disconnect inlet hose from radiator (Figure 4-3).
5. If equipped with air conditioner, discharge system and remove condenser (Section 11).
6. Remove power steering reservoir (Section 8).
7. Disconnect ambient temperature switch, if equipped.
8. Disconnect surge tank-to-radiator vent hose from adapter.
9. Disconnect lower radiator hose from radiator.
10. Remove strap securing fan shroud to radiator.
11. Remove locknut, washer, capscrew, large washer, washer, and lower mount from radiator and frame bracket. Discard locknut (Figure 4-4).
12. Remove four locknuts, washers, capscrews, and two rear support brackets from airlift brackets. Discard locknuts (Figure 4-3).
13. Remove battery tray, and left splash shield. (Sections 10 and 12).
14. Remove the radiator from vehicle (Figure 4-4).
15. Remove eight capscrews, lockwashers, two retaining strips, and fan shroud from radiator. Discard lockwashers.

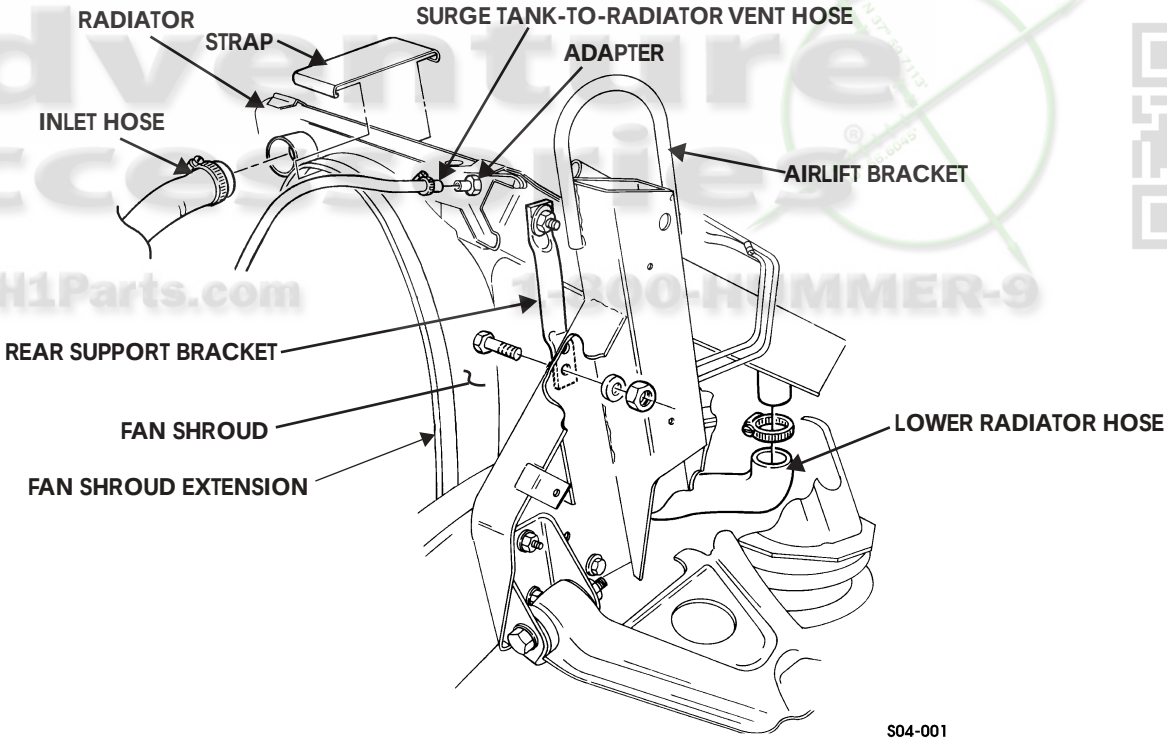

Figure 4-3: Radiator and Fan Shroud Assembly

16. Remove two locknuts, washers, large washers, rear support brackets, and insulators from radiator. Discard locknuts.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Remove debris embedded in radiator fins using water and compressed air.
2. Inspect radiator for breaks, punctures, cracks, or splits.
3. Inspect adapters and fan shroud.

Installation

***CAUTION**: To avoid equipment damage, upper edge of fan shroud must align with radiator top tank seam to ensure proper engine cooling.*

NOTE: Ensure fan shroud edge aligns with tank seam on radiator.

1. Install fan shroud on radiator with two retaining strips, eight lockwashers, and capscrews. Tighten capscrews to 6 lb-ft (8 N•m) (Figure 4-4).
2. Install two rear support brackets and insulators on radiator with two washers, large washers, and locknuts. Tighten locknuts to 26 lb-ft (35 N•m).

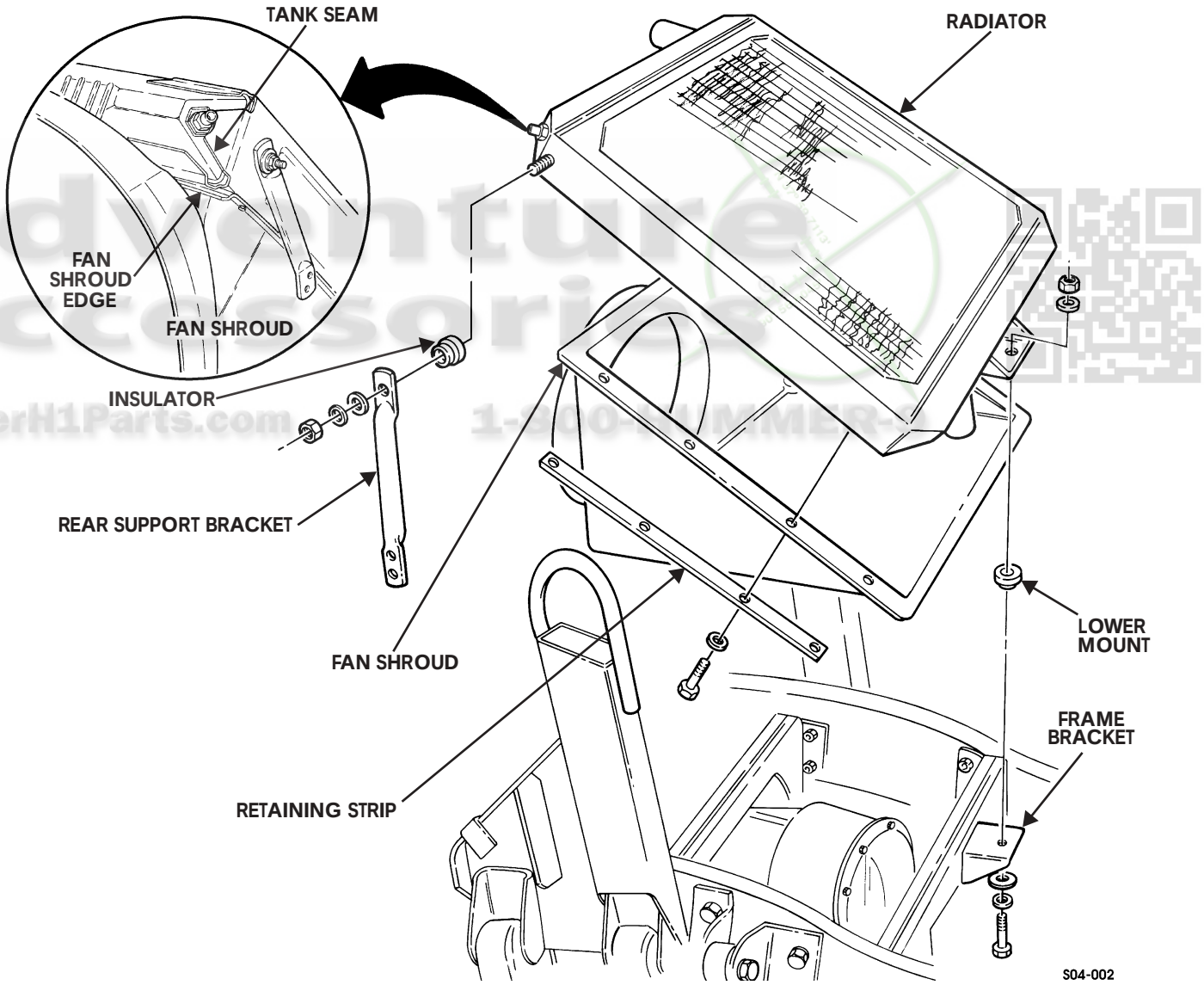

Figure 4-4: Radiator and Fan Shroud Assembly

3. Align radiator with frame bracket, and two rear support brackets with airlift brackets (Figures 4-3, and 4-4).
4. Install two rear support brackets on air lift brackets with four capscrews, washers, and locknuts. Do not tighten locknuts (Figure 4-3).
5. Install lower mount and radiator on frame bracket with washer, large washer, capscrew, washer, and locknut. Do not tighten capscrew (Figure 4-4).
6. Align fan shroud by sliding the radiator/shroud assembly to maintain 1-1/2 ± 1/8 in. (38.1 ± 3 mm) from edge of shroud ring and rear edge of fan. Measure at the 2, 4, 8, and 10 o'clock positions. The distance between the top of the fan blade and fan shroud must not be less than 1/4 in. (6 mm) at any position (Figure 4-5).
7. Tighten rear support bracket locknuts to 26 lb-ft (35 N•m). Tighten frame bracket capscrew to 30 lb-ft (41 N•m) (Figure 4-3) and (Figure 4-4).
8. Install left splash shield and battery tray (Section 12).
9. Install strap on radiator and shroud (Figure 4-3).
10. Connect lower radiator and inlet hoses to radiator.
11. Connect ambient temperature switch, if equipped.
12. Install power steering reservoir (Section 8).
13. Install condenser and charge system, if equipped with air conditioner (Section 11).
14. Connect surge tank-to-radiator vent hose to adapter.
15. Fill cooling system.
16. Install oil cooler (Section 1).
17. Start engine and check cooling system for leaks.
18. Install hood (Section 10).
19. Bleed power steering system (Section 8).

ENGINE COOLING SYSTEM SERVICE

Depressurizing/Draining

WARNING: To avoid injury, do not remove surge tank filler cap before depressurizing cooling system when engine temperature is above 190°F (88°C).

1. If engine is hot, remove surge tank filler cap by placing a thick cloth over cap. Turn counterclockwise to first stop to release internal pressure (Figure 4-6).
2. After pressure has escaped, remove cap.
3. Open draincock and drain system (Figure 4-7).
4. Close draincock.

Replenishing

NOTE: Ensure surge tank coolant level is 3/4 full before securing filler cap.

1. Ensure draincock is closed and heater control valve is open (Figure 4-6) and (Figure 4-7).
2. Fill system with proper antifreeze solution. See Antifreeze Preparation Guide table.
3. Install filler cap on surge tank (Figure 4-6).
4. Start engine and run at fast idle (1500 rpm) until engine temperature reaches 190° F (88° C). Stop engine.
5. Depressurize system.
6. Fill with proper antifreeze solution until surge tank is 3/4 full. See Antifreeze Preparation Guide table.
7. Install filler cap on surge tank (Figure 4-6).
8. Start engine and run at fast idle (1500 RPM) until engine temperature reaches 190° F (88° C). Stop engine.
9. Depressurize system. Use tester to ensure proper coolant protection is provided.
10. Install filler cap on surge tank.
11. Start engine and check cooling system for leaks.

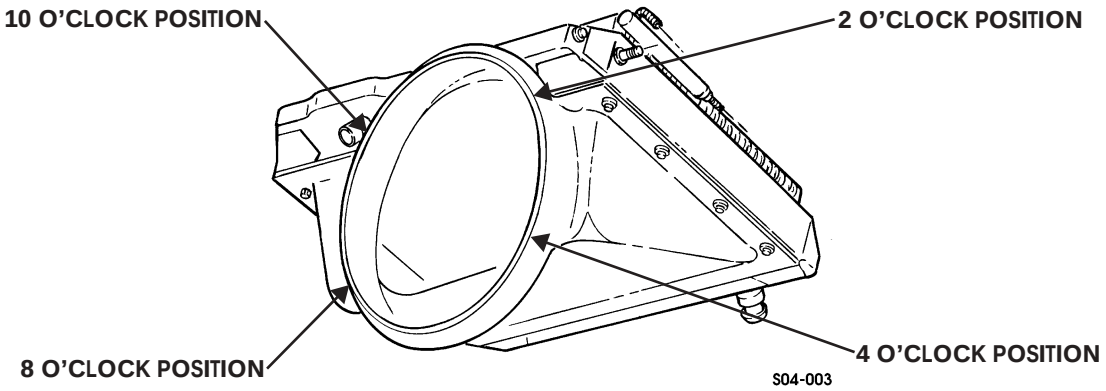

Figure 4-5: Fan Shroud

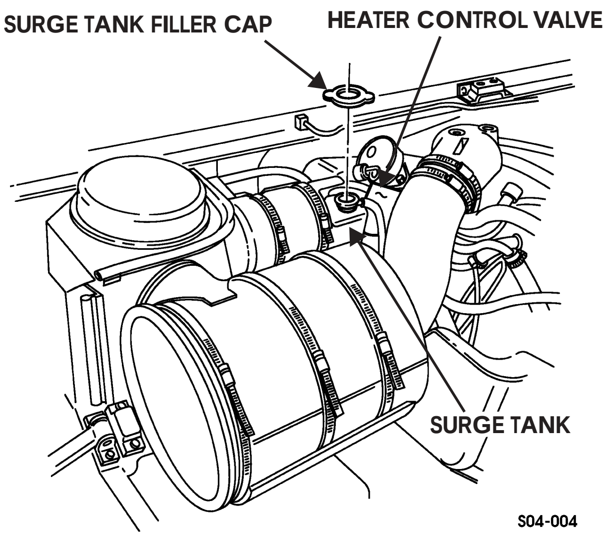

Figure 4-6: Surge Tank and Filler Cap

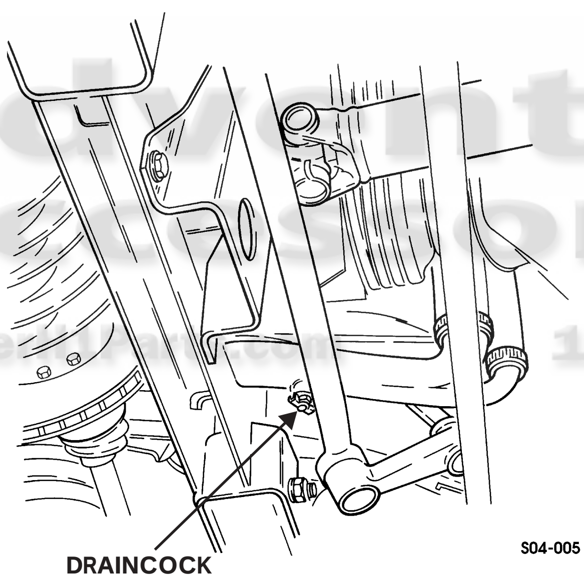

Figure 4-7: Draincock

Expected Temperature	Antifreeze/ Water Mixture
+40° to -65° F (+4° to -54° C)	60% antifreeze/ 40% water

Antifreeze Preparation Guide

SHROUD SHIELD ASSEMBLY REPLACEMENT

Removal

1. Remove radiator and fan shroud.
2. Remove three screws and shroud shield assembly from airlift bracket (Figure 4-8).

Installation

1. Install shroud shield assembly on airlift bracket with three screws (Figure 4-8).
2. Install radiator and fan shroud.

RADIATOR REAR SUPPORT BRACKET REPLACEMENT

Removal

1. Remove left splash shield (Section 10).
2. Remove battery tray and right splash shield (Section 12).
3. Remove locknut, washer, large washer, radiator rear support bracket, and insulator from radiator. Discard locknut (Figure 4-9).
4. Remove two locknuts, washers, capscrews, and support bracket from airlift bracket. Discard locknuts (Figure 4-10).

Installation

1. Install radiator rear support bracket on airlift bracket with two capscrews, washers, and locknuts. Do not tighten locknuts (Figure 4-10).
2. Install insulator and support bracket on radiator with washer, large washer, and locknut (Figure 4-9).
3. Tighten all locknuts to 26 lb-ft (35 N•m).
4. Install left splash shield (Section 10).
5. Install battery tray and right splash shield (Section 12).

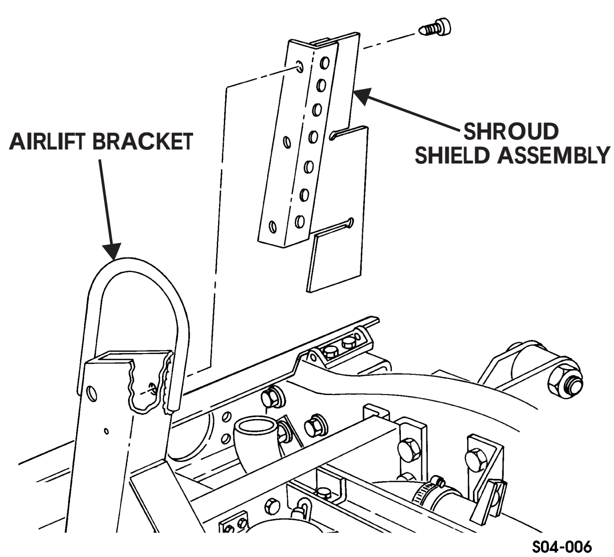

Figure 4-8: Shroud Shield Assembly

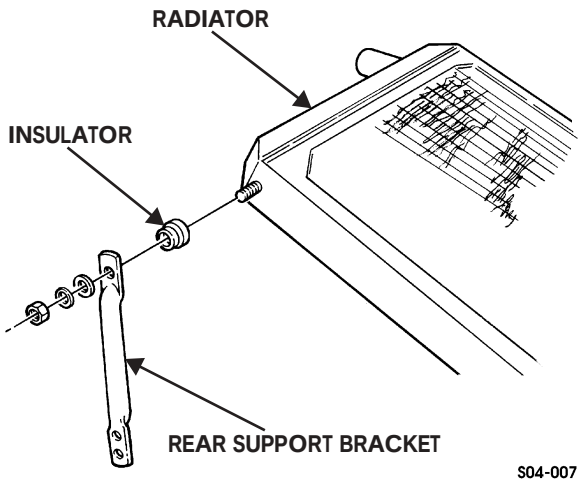

Figure 4-9: Rear Support Bracket to Radiator

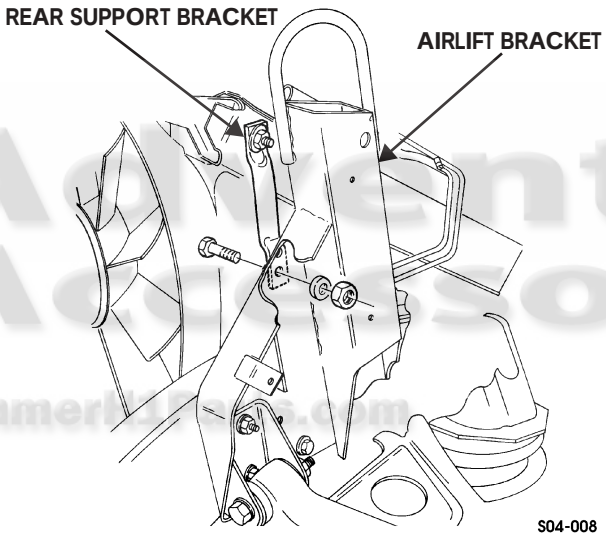

Figure 4-10: Rear Support Bracket to Airlift Bracket

SURGE TANK REPLACEMENT

Removal

1. Drain cooling system.
2. Disconnect radiator vent hose from surge tank (Figure 4-11).
3. Disconnect water crossover vent hose from surge tank.
4. Disconnect lower radiator hose from surge tank.
5. Disconnect overflow hose from surge tank.
6. Loosen two clamps and remove surge tank from bracket.

Installation

1. Install surge tank on bracket and tighten two clamps (Figure 4-11).
2. Connect lower radiator hose to surge tank.
3. Connect water crossover vent hose to surge tank.
4. Connect radiator vent hose to surge tank.
5. Connect overflow hose to surge tank.
6. Fill cooling system.

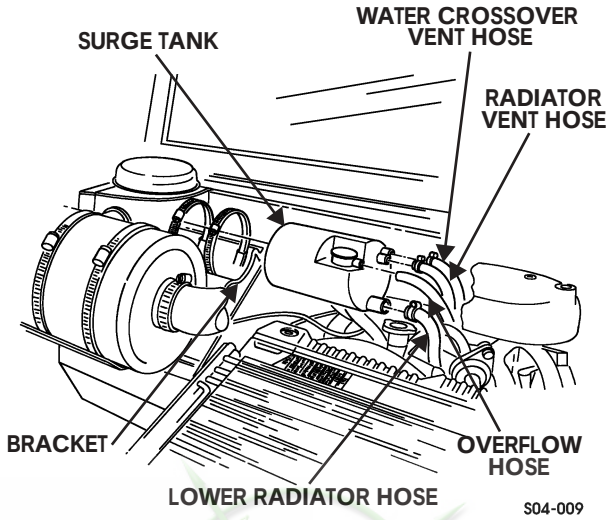

Figure 4-11: Surge Tank

SURGE TANK-TO-RADIATOR VENT HOSE REPLACEMENT

Removal

1. Depressurize cooling system.
2. Remove vent hose from radiator and surge tank (Figure 4-12).

Installation

1. Install vent hose on surge tank and radiator (Figure 4-12).
2. Tighten coolant filler cap.

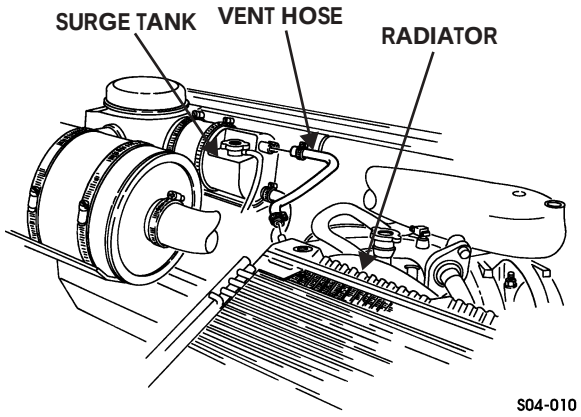

Figure 4-12: Surge Tank-to-Radiator Vent Hose

THERMOSTAT BYPASS HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Loosen two clamps and remove hose from thermostat bypass nipple and heater core adapter (Figure 4-13).

Installation

1. Install hose on heater core adapter and thermostat bypass nipple and tighten two clamps (Figure 4-13).
2. Fill cooling system.

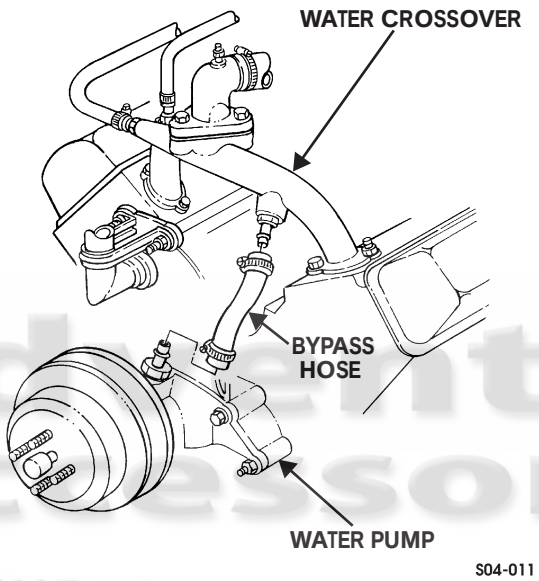

Figure 4-13: Thermostat Bypass Hose

RADIATOR INLET HOSES REPLACEMENT

Removal

1. Depressurize cooling system.
2. Remove inlet hose from inlet tube and water crossover (Figure 4-14).
3. Remove inlet hose from inlet tube and radiator.

Installation

1. Install inlet hose on inlet tube and radiator (Figure 4-14).
2. Install inlet hose on inlet tube and water crossover.
3. Tighten coolant filler cap.

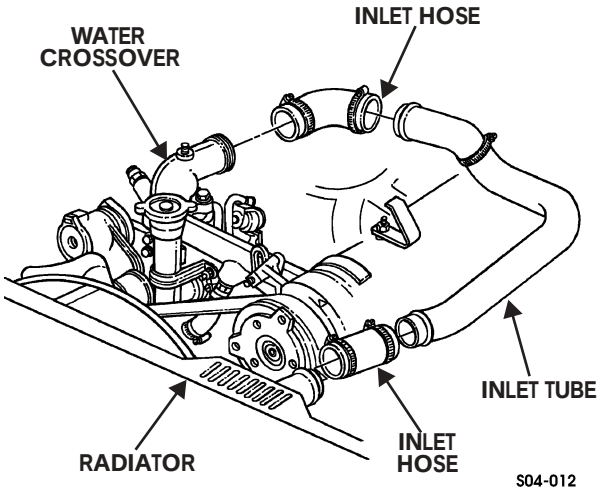

Figure 4-14: Radiator Inlet Hoses

LOWER RADIATOR HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Remove lower radiator hose from radiator and lower tube assembly (Figure 4-15).

Installation

1. Install lower radiator hose on lower tube assembly and radiator (Figure 4-15).
2. Fill cooling system.

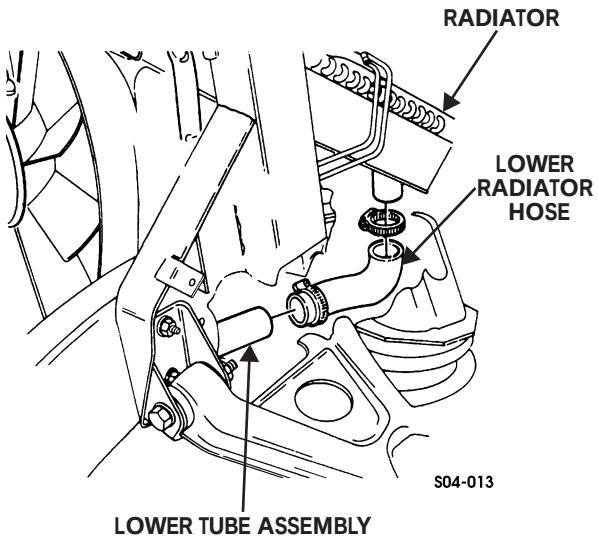

Figure 4-15: Lower Radiator Hose

RADIATOR LOWER TUBE ASSEMBLY REPLACEMENT

Removal

1. Drain cooling system.
2. Remove draincock from radiator lower tube assembly (Figure 4-16).
3. Remove two locknuts, four washers, two capscrews, and radiator lower tube assembly from frame bracket. Discard locknuts.
4. Disconnect water pump inlet hose from lower tube assembly.
5. Disconnect surge tank-to-lower radiator hose from lower tube assembly.
6. Disconnect lower radiator hose from lower tube assembly.
7. Remove lower tube assembly.

Installation

1. Install lower tube assembly on frame bracket with two washers, capscrews, washers, and locknuts. Tighten locknuts to 6 lb-ft (8 N•m) (Figure 4-16).
2. Connect lower radiator hose to lower tube assembly.
3. Connect surge tank-to-lower radiator hose to lower tube assembly.
4. Connect water pump inlet hose to lower tube assembly.
5. Apply sealant tape to threads of draincock and install draincock on lower tube assembly.
6. Fill cooling system.

WATER PUMP INLET HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Remove water pump inlet hose from water pump and lower tube assembly (Figure 4-17).

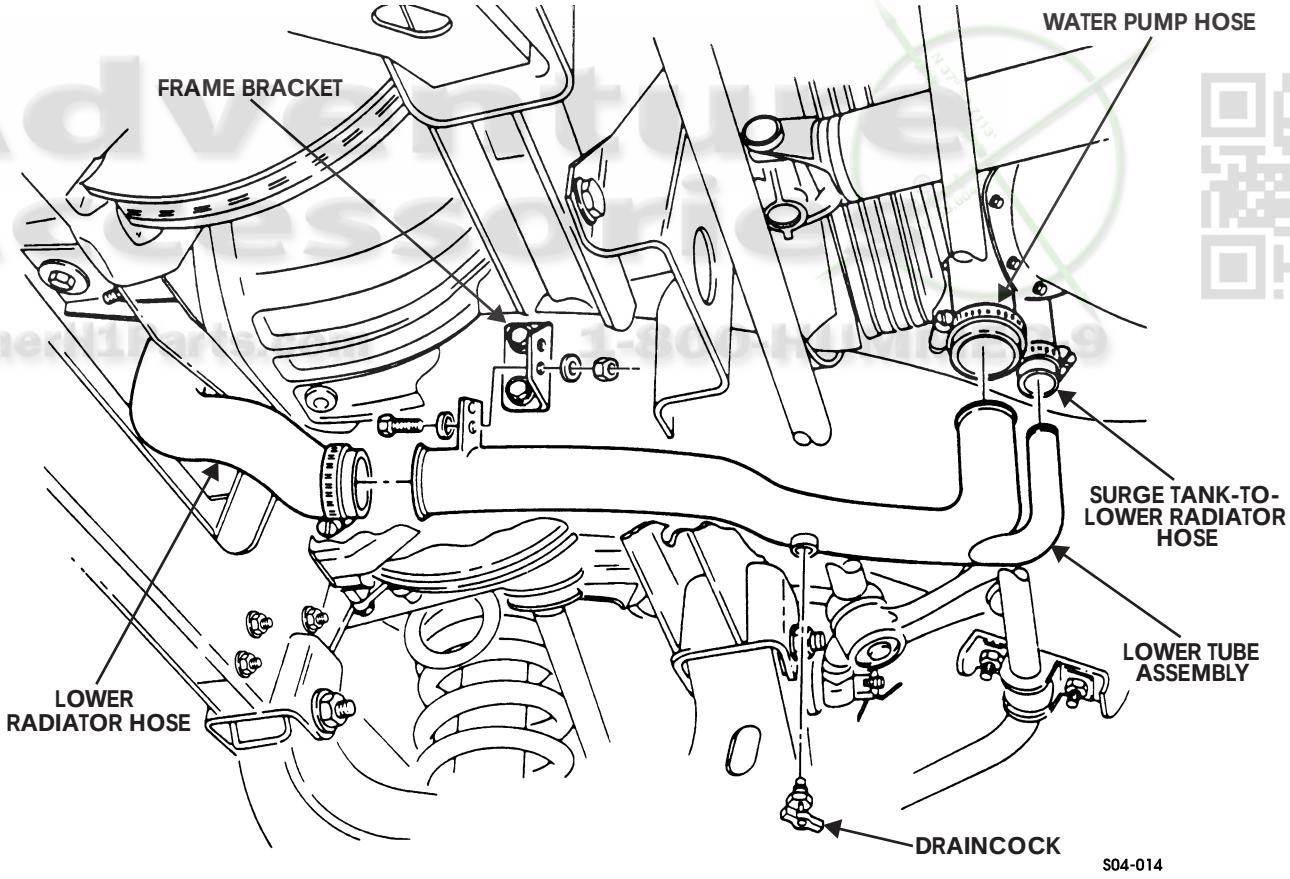

Figure 4-16: Radiator Lower Tube Assembly

Installation

1. Install water pump inlet hose on lower tube assembly and water pump (Figure 4-17).
2. Fill cooling system.

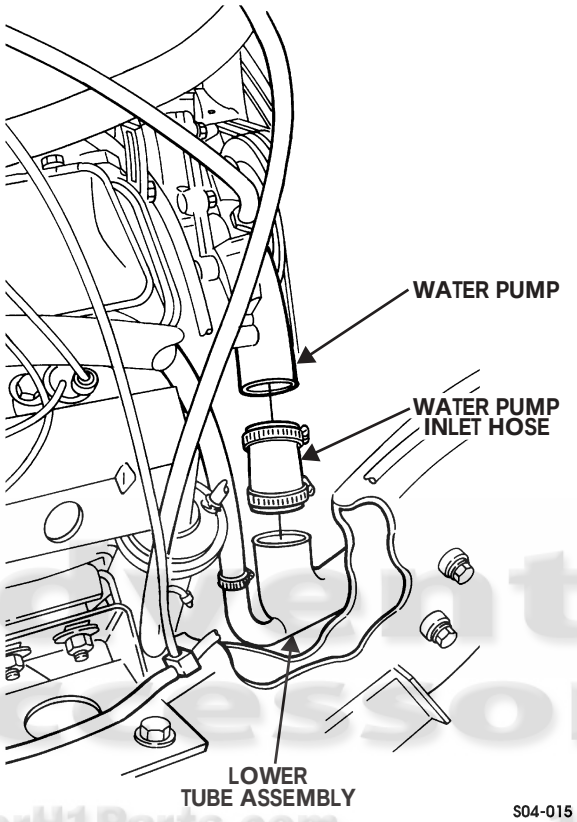

Figure 4-17: Water Pump Inlet Hose

SURGE TANK-TO-WATER CROSSOVER VENT HOSE REPLACEMENT

Removal

1. Depressurize cooling system.
2. Remove vent hose from water crossover and surge tank (Figure 4-18).

Installation

1. Install vent hose on surge tank and water crossover (Figure 4-18).
2. Tighten coolant filler cap.

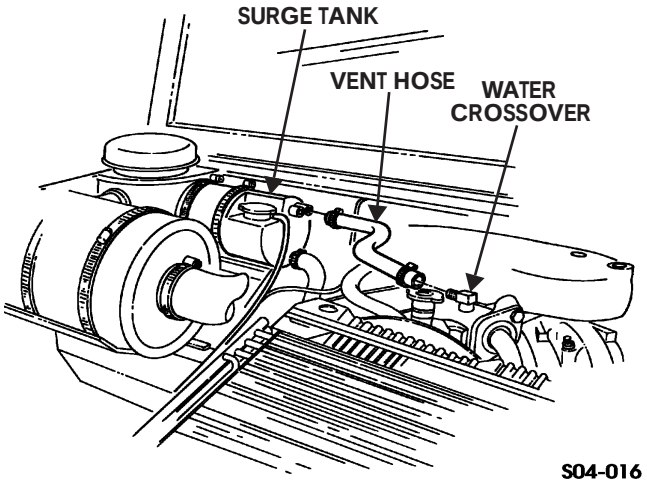

Figure 4-18: Surge Tank-to-Water Crossover Vent Hose

SURGE TANK-TO-LOWER RADIATOR TUBE HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Remove hose from surge tank and lower tube assembly (Figure 4-19).

Installation

1. Install hose on lower tube assembly and surge tank (Figure 4-19).
2. Fill cooling system.

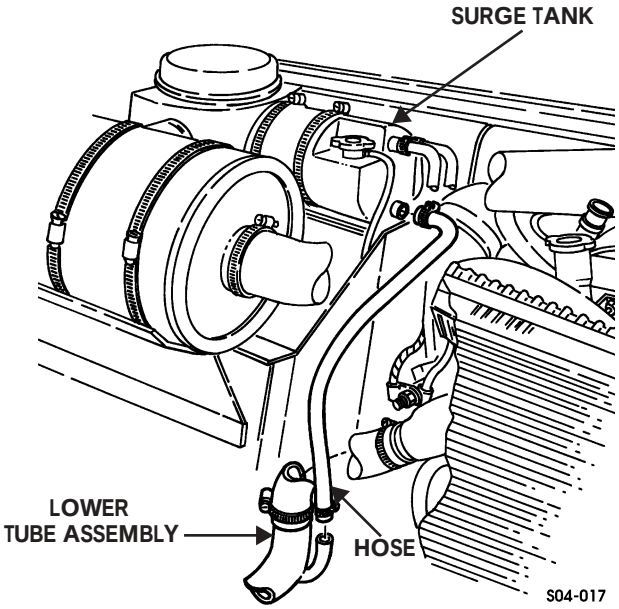

Figure 4-19: Surge Tank-to-Lower Radiator Tube Hose

SURGE TANK OVERFLOW HOSE REPLACEMENT

Removal

1. Remove overflow hose from surge tank filler neck (Figure 4-20).
2. Remove screw, clamp, and overflow hose from body.

Installation

1. Install overflow hose on surge tank filler neck (Figure 4-20).
2. Install overflow hose on body with clamp and screw.

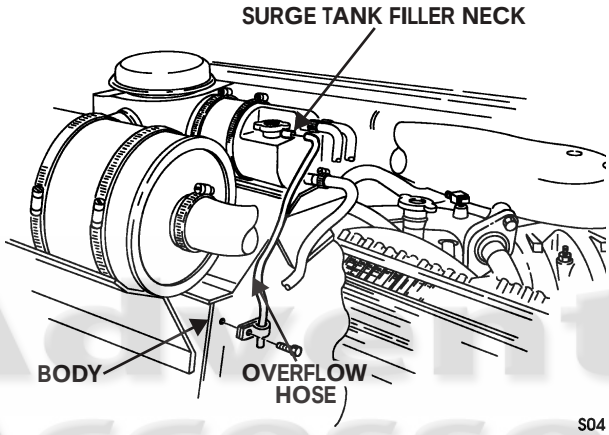

Figure 4-20: Surge Tank Overflow Hose

THERMOSTAT MAINTENANCE

Removal

1. Drain cooling system.
2. Remove three capscrews and thermostat housing from water crossover (Figure 4-21).
3. Remove thermostat and gasket from water crossover. Discard gasket.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Clean gasket surface on water crossover and thermostat housing (Figure 4-21).

Installation

1. Install thermostat into water crossover ensuring valve sensor points toward crossover (Figure 4-21).
2. Apply teflon sealing compound to three capscrew threads, and install gasket on water crossover.
3. Install thermostat housing on water crossover with three capscrews. Tighten capscrews to 20 lb-ft (27 N•m).
4. Fill cooling system.

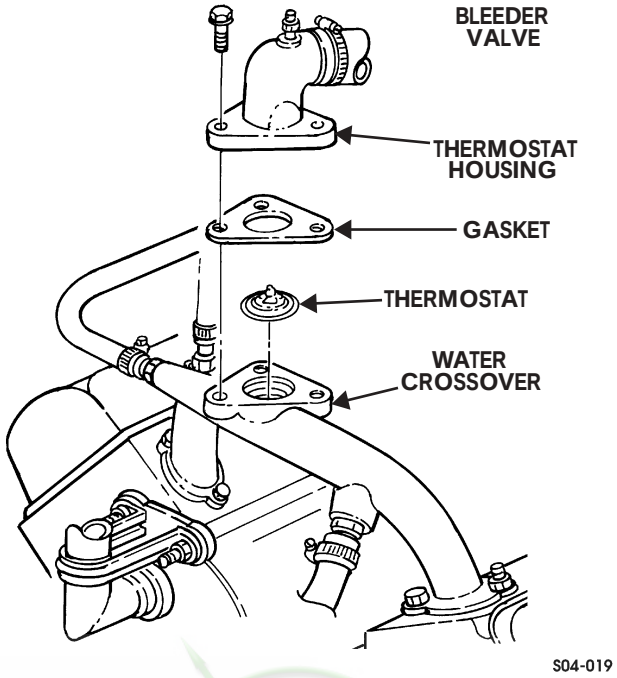

Figure 4-21: Thermostat

WATER CROSSOVER MAINTENANCE

Removal

1. Drain cooling system.
2. Remove thermostat.
3. Disconnect three hoses from water crossover (Figure 4-22).
4. Remove two nuts, wiring harness ground cable, air conditioner ground cable, and stud nuts from water crossover and cylinder head.
5. Remove two capscrews, water crossover, and two gaskets from cylinder heads. Discard gaskets.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean gasket surface on water crossover and cylinder heads (Figure 4-22).
2. Inspect thermostat bypass nipple, surge tank hose nipple, and water pump hose adapter for cracks or breaks.

Installation

1. Install two gaskets and water crossover on cylinder heads with two capscrews and stud nuts. Tighten capscrews to 25-37 lb-ft (34-50 N•m) (Figure 4-22).
2. Install air conditioner ground cable and wiring harness ground cable on stud nuts with two nuts.
3. Connect three hoses to water crossover.
4. Install thermostat.

5. Fill cooling system.

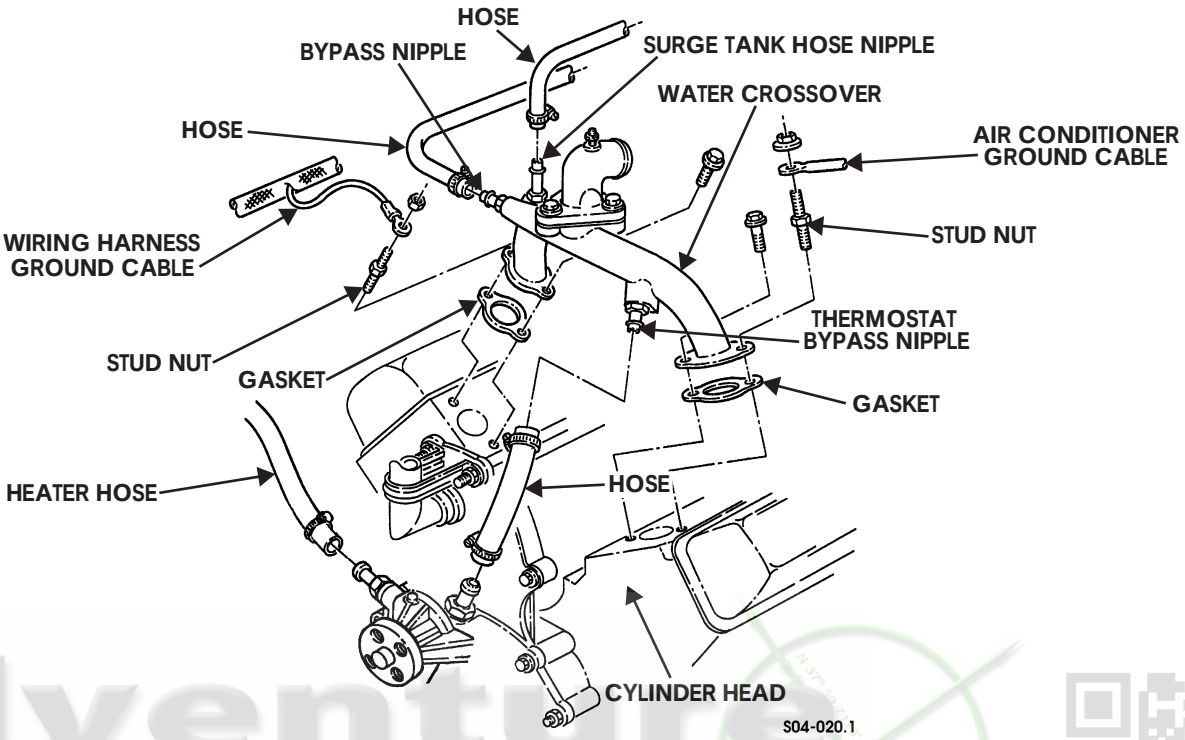

Figure 4-22: Water Crossover

WATER PUMP AND ADAPTER PLATE MAINTENANCE

Removal

1. Drain cooling system.
2. Remove fan drive, fan blade, and water pump pulley.
3. Remove oil fill tube (section 1).
4. Disconnect lower radiator hose at water pump inlet (Figure 4-17).
5. Disconnect heater and bypass hoses from water pump (Figure 4-22).
6. Remove six studs, seven capscrews, water pump and adapter plate from timing gear cover (Figure 4-23).
7. Remove sealant and/or gasket material from adapter plate and water pump.
8. If water pump is being replaced, remove heater and bypass hose adapters from water pump (Figure 4-24).

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean remaining gasket material and sealing compound from adapter plate, water pump, and timing gear cover (Figure 4-23) and (Figure 4-24).
2. Inspect water pump for cracks, breaks, or loose impeller (Figure 4-24).
3. Inspect adapter plate for excessive corrosion (Figure 4-24).
4. Inspect rivet (Figure 4-24).

Installation

1. Install gasket and water pump on adapter plate with seven capscrews. Tighten capscrews to 13-20 lb-ft (18-27 N•m) (Figure 4-24).
2. Apply flange sealant to adapter plate sealing surfaces (Figure 4-25).
3. Apply pipe sealing compound to capscrew to be installed in hole “A” (Figure 4-25).
4. Install adapter plate and water pump on timing gear cover with six studs and seven capscrews (Figure 4-23).
5. If removed, apply pipe sealing compound to threads of bypass hose and heater hose adapters and install in water pump (Figure 4-24).
6. Install bypass hose and heater hose on water pump and tighten clamps.
7. Install water pump pulley, fan blade, and fan drive.
8. Install water pump inlet hose.
9. Install engine oil filler tube (Section 1).
10. Fill cooling system.

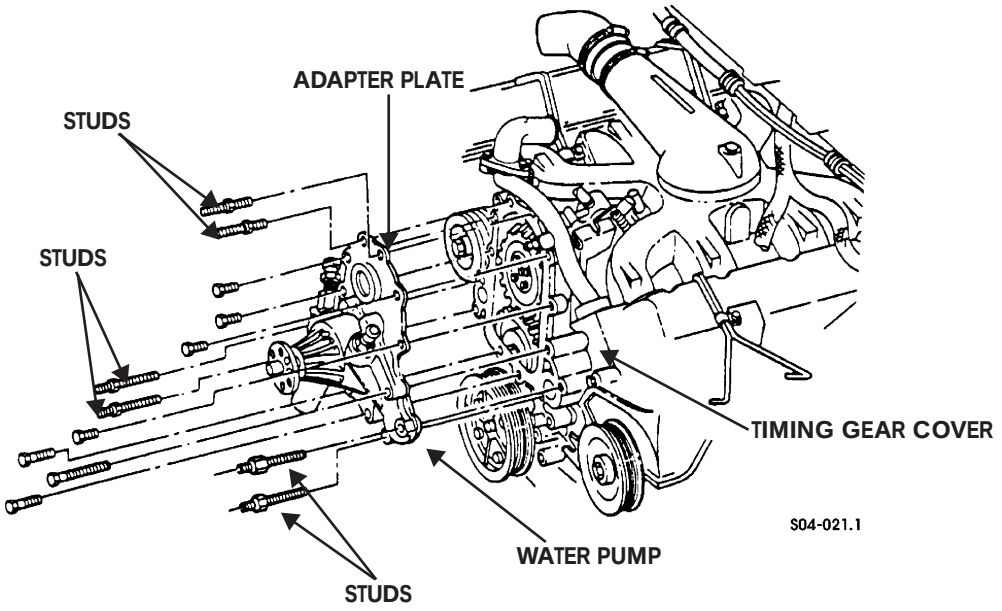

Figure 4-23: Water Pump and Adapter Plate

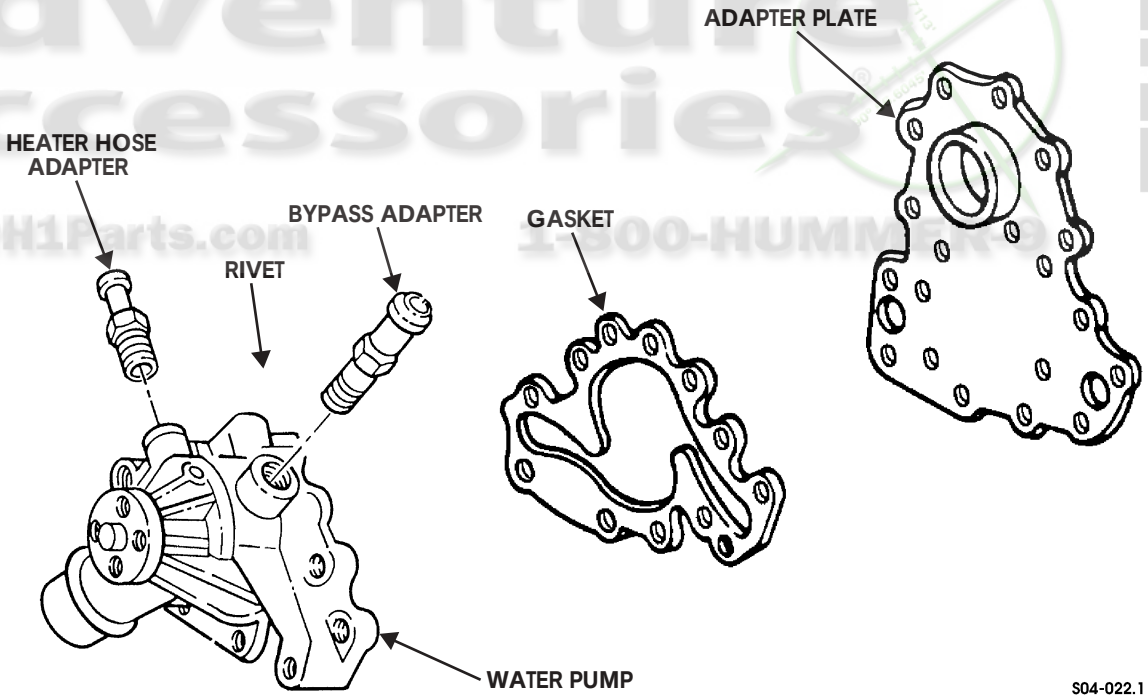

Figure 4-24: Water Pump

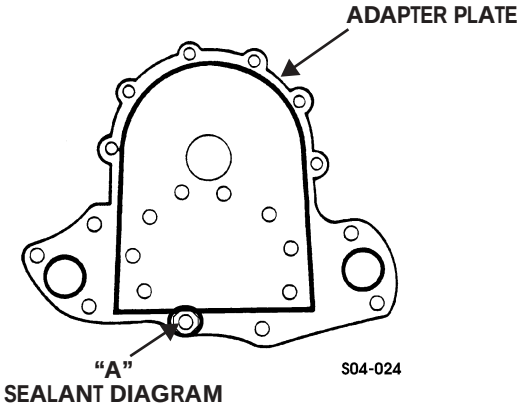

Figure 4-25: Adapter Plate

SERPENTINE BELT REPLACEMENT

Removal

1. Position a half-inch drive breaker bar on belt tensioner and move tensioner counterclockwise to loosen belt (Figure 4-26).
2. Remove belt from pulleys (Figure 4-27).

Installation

1. Position a half-inch drive breaker bar on belt tensioner and move tensioner counterclockwise and position serpentine belt on pulleys as shown (Figure 4-27) and (Figure 4-28).
2. Slowly release half-inch drive breaker bar on belt tensioner until serpentine belt is tight.

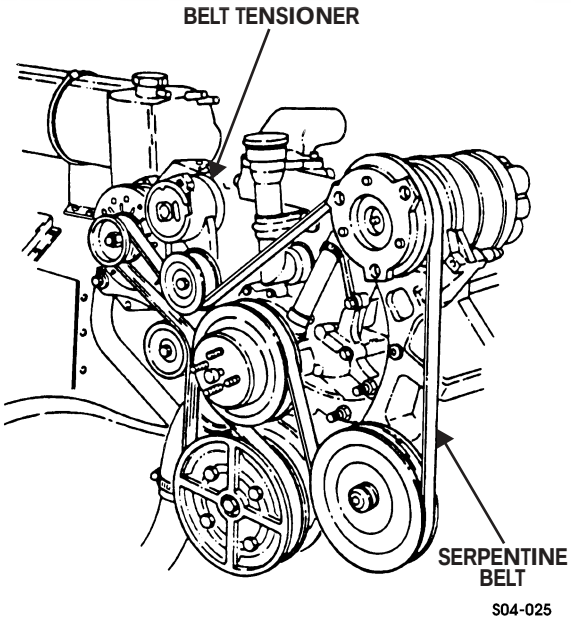

Figure 4-26: Serpentine Belt

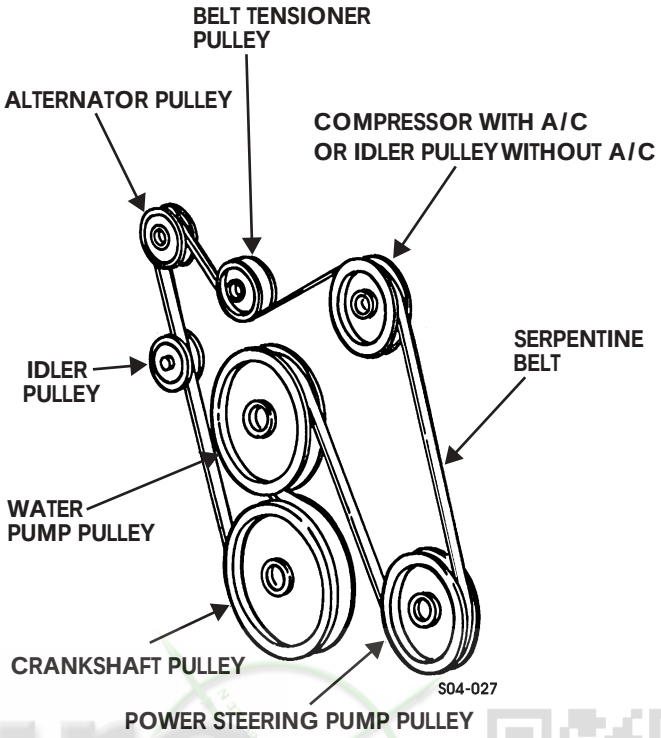

Figure 4-27: Belt Routing

FAN DRIVE, FAN BLADE, AND WATER PUMP PULLEY MAINTENANCE

Removal

1. Remove upper fan shroud extension.
2. Move the A/C hose out of the way, if equipped.
3. Remove serpentine belt.

NOTE: Mark position of fan blade for installation.

4. Remove four nuts, fan drive, fan blade, and water pump pulley from water pump (Figure 4-28).
5. Remove four capscrews, lockwashers, and fan blade from fan drive. Discard lockwashers.
6. Remove four studs from water pump.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect fan blade for cracks, bent blades, or breaks (Figure 4-28).

Installation

1. Apply thread-locking compound to four capscrews and install fan blade on fan drive with four lockwashers and

capscrews. Tighten capscrews to 45 lb-ft (61 N•m) (Figure 4-28).

2. Install four studs on water pump.
3. Install water pump pulley, fan blade, and fan drive on water pump with four nuts. Tighten nuts to 15-20 lb-ft (20-27 N•m).
4. Install serpentine belt.
5. Install upper fan shroud extension.

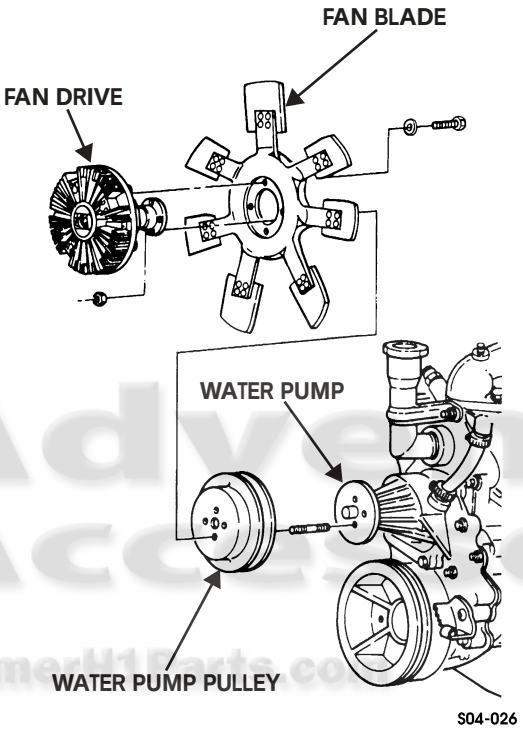

Figure 4-28: Fan Drive, Fan Blade, and Water Pump Pulley