

ENGINE

Engine Cooling System - Corvette

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Engine Coolant Fan Fasteners	7 N.m	60 lb in
Engine Coolant Manifold Fasteners	First Pass - 15 N.m Second Pass - 30 N.m	First Pass - 11 lb ft Second Pass - 22 lb ft
Engine Oil Cooler Adapter Fasteners (Engine Block)	10 N.m	89 lb in
Engine Oil Cooler Adapter Fasteners (Oil Pan)	25 N.m	18 lb ft
Engine Oil Cooler Coolant Inlet Hose Jiffy-Tite® Fastener	35 N.m	26 lb ft
Engine Oil Cooler Coolant Outlet Hose Jiffy-Tite® Fastener	35 N.m	26 lb ft
Engine Oil Cooler Coolant Outlet Hose Fastener	9 N.m	80 lb in
Engine Oil Cooler Fasteners	25 N.m	18 lb ft
Radiator Air Baffle Fasteners	7 N.m	60 lb in
Radiator Air Baffle Extension Retainers	2.5 N.m	22 lb in
Radiator Mounting Fasteners	20 N.m	15 lb ft
Radiator Surge Tank Bolt	7 N.m	60 lb in
Radiator Surge Tank Nut	7 N.m	60 lb in
Water Pump Fasteners	First Pass - 15 N.m Second Pass - 30 N.m	First Pass - 11 lb ft Second Pass - 22 lb ft
Water Pump Outlet Fasteners	10 N.m	89 lb in

ADHESIVES, FLUIDS, LUBRICANTS AND SEALERS

Adhesives, Fluids, Lubricants and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Extended Life Coolant Leak Detection Dye	Dye	89022219	89022220
DEX-COOL	Coolant	12346290	10953464

SCHEMATIC WIRING DIAGRAMS

ENGINE COOLING SYSTEM WIRING SCHEMATICS

Engine Cooling System Wiring Schematics

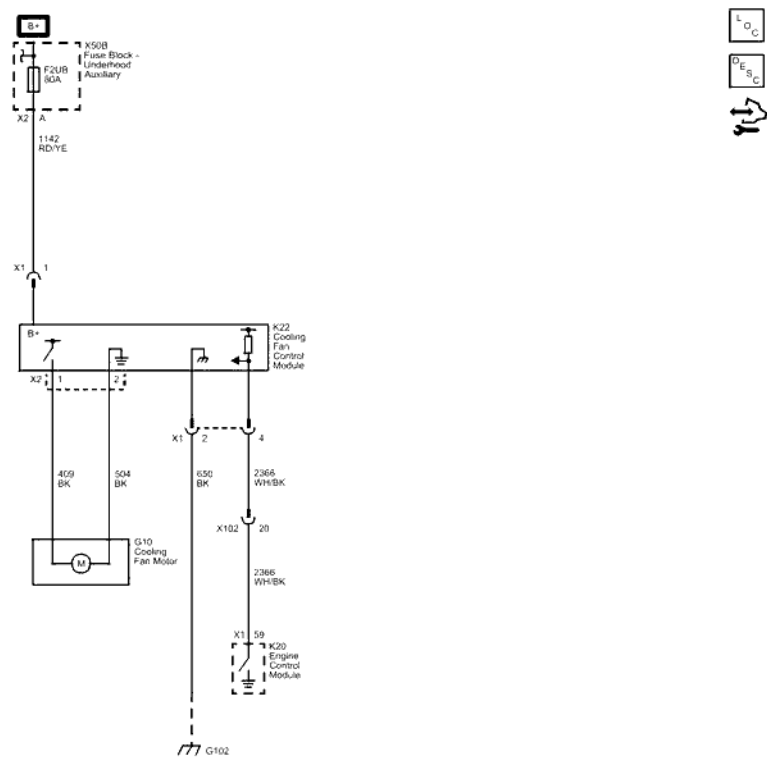


Fig. 1: Engine Cooling System Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0480, P0691 or P0692	DTC P0480 Cooling Fan Speed Control Circuit DTC P0691 Cooling Fan Speed Output Circuit Low Voltage DTC P0692 Cooling Fan Speed Output Circuit High Voltage

DTC P0480, P0691 OR P0692: COOLING FAN SPEED CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480

Cooling Fan Speed Control Circuit

DTC P0691

Cooling Fan Speed Output Circuit Low Voltage

DTC P0692

Cooling Fan Speed Output Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cooling Fan Control Module B+ Supply	P0480, P0691*	P0480	-	-
Cooling Fan Control Module Ground	-	-	-	-
Cooling Fan Control Module Control	P0691	P0480	P0692	-
*Opens cooling fan fuse.				

Circuit/System Description

The engine cooling fan system is composed of one electric cooling fan and a cooling fan control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, which enables cooling fan operation at variable speeds. The ECM will only operate the cooling fan at certain percentages to prevent undesirable noise and vibration. The cooling fan control module is thermally protected to prevent module damage in the case of a short circuit condition in the cooling fan motor.

Conditions for Running the DTC

- The ignition voltage is greater than 11 volts.
- The DTCs run continuously once the above conditions are met.

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0480, P0691 and P0692 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0691 and P0692 are Type B DTCs.

Diagnostic Aids

A delay or ramp up of approximately 12 seconds may occur before the cooling fan activates or changes speed when being commanded with a scan tool.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

NOTE: **A slight delay may occur before the cooling fan activates.**

2. Verify the G10 Cooling Fan Motor activates in each available speed when commanding the cooling fan ON with a scan tool. The cooling fan speed should increase with each command.
 - **The cooling fan does not activate or increase in speed as commanded**

Refer to Circuit/System Testing

- **The cooling fan activates and increases in speed as commanded**

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

4. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector X1 at the K22 Cooling Fan Control Module.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal X1-1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the K22 Cooling Fan Control Module.
 - **If the test lamp illuminates**

NOTE: **The cooling fan speed output circuit is pulled-up to a voltage within the ECM, 2-3 volts on the output circuit is normal.**

3. Connect a DMM, set on the diode setting, between the K22 Cooling Fan Control Module control circuit terminal X1- 4 and ground.
4. Verify the DMM reading is greater than 2.5 V or displays O.L. with the cooling fan commanded OFF.
 - **If 2.5 V or less**
 1. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Disconnect the harness connector X1 at the K20 Engine Control Module.
 3. Test for infinite resistance between the K22 Cooling Fan Control Module control circuit terminal X1- 4 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 2.5 V or displays O.L.**
5. Command the cooling fan ON to 90% with a scan tool.
6. Verify the DMM reading is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF.
 2. Disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.
 3. Test for less than 1 V between the K22 Cooling Fan Control Module control circuit terminal X1- 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 4. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 5. Test for less than 2 ohms in the circuit end to end.
 - If 2 ohms or greater, repair the open in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 1 V**
7. Replace the K20 Cooling Fan Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Fan Replacement** for G10 Cooling Fan Motor or K22 Cooling Fan Control Module replacement.
- **Control Module References** for ECM replacement, setup and programming

SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

- Perform **Diagnostic System Check - Vehicle** and verify all of the following items:
 - Engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
 - There are no diagnostic trouble codes (DTCs) stored.
 - Scan tool data is within a normal operating range.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.
- Locate the correct symptom. Perform the tests and inspections associated with the symptom.

Review the entire cooling system operation in order to familiarize yourself with the system functions. Refer to **Cooling Fan Description and Operation** and **Cooling System Description and Operation**.

Visual/Physical Inspection

CAUTION: Use the connector test adapter kit EL-35616-F for any test that requires probing the following items:

- The control module harness connectors
- The electrical center fuse/relay cavities
- The component terminals
- The component harness connector

Using this kit will prevent damage caused by the improper probing of connector terminals.

Several of the symptom procedures call for a careful visual and physical inspection. This can lead to correcting a condition without further tests and can save time. This inspection should include the following:

- Ensure that the control module grounds are clean, tight and correctly located.
- Inspect cooling system hoses and pipes for splits, kinks and improper connections. Inspect thoroughly for any type of leak or restriction.
- Inspect for a dirty or restricted radiator or HVAC condenser.
- Inspect for aftermarket devices which could affect the operation of the cooling system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the coolant recovery reservoir for proper coolant level.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movement of a component. Refer to the following for a list to help isolate an intermittent condition:

- Water intrusion in connectors, terminals or components
- Poor connector mating
- Terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness' that are routed too tight or chaffed circuits
- High or low ambient temperatures
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in components or circuits due to circuit resistance, poor terminal contact or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surface
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of non-factory, aftermarket or after factory add on accessories

If an intermittent fault is detected, refer to **Testing for Intermittent Conditions and Poor Connections** for specific strategies in diagnosing intermittent conditions.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Cooling Fan Always On**
- **Cooling Fan Inoperative**
- **Engine Overheating**
- **Loss of Coolant**
- **Thermostat Diagnosis**
- **Engine Fails To Reach Normal Operating Temperature**

COOLING FAN ALWAYS ON

Diagnostic Instructions

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system is composed of one electric cooling fan and a cooling fan control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, which enables cooling fan operation at variable speeds. The cooling fan control module is thermally protected to prevent module damage in the case of a short circuit condition in the cooling fan motor.

Diagnostic Aids

- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fan ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the temperature versus resistance tables in the appropriate engine controls subsection.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0691 or P0692, is not set.
 - **If a DTC is set**

Refer to **DTC P0480, P0691 or P0692.**

- **If no DTC is set.**
3. Verify the scan tool Cooling Fan Motor Command parameter is 0 %.
 - **If greater than 0 %**

Refer to Diagnostic Aids and **Symptoms - Engine Cooling** for further diagnosis.

- **If 0 %**
4. Verify that the G10 Cooling Fan Motor is not operating.
 - **If the G10 Cooling Fan Motor is operating**

Refer to Circuit/System Testing.

- **If the G10 Cooling Fan Motor is not operating**
5. All OK.

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the G10 Cooling Fan Motor harness connector X2 at the K22 Cooling Fan Control Module, ignition ON.
3. Verify that the G10 Cooling Fan Motor is not operating.
 - **If the G10 Cooling Fan Motor is operating**
 1. Ignition OFF.
 2. Test for less than 1 V between the G10 Cooling Fan Motor harness connector terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - **If the G10 Cooling Fan Motor is not operating**
4. Replace the K22 Cooling Fan Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Fan Replacement** for G10 Cooling Fan Motor or K22 Cooling Fan Control Module replacement.
- **Control Module References**

COOLING FAN INOPERATIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system is composed of one electric cooling fan and a cooling fan control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, which enables cooling fan operation at variable speeds. The ECM will only operate the cooling fan at certain percentages to prevent undesirable noise and vibration. The cooling fan control module is thermally protected to prevent module damage in the case of a short circuit condition in the cooling fan motor.

Diagnostic Aids

- A delay or ramp up of approximately 12 seconds may occur before the cooling fan activates or changes speed when being commanded with a scan tool.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 36169-HD Heavy Duty Fused Jumper

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0691 or P0692, is not set.

- **If a DTC is set**

Refer to **DTC P0480, P0691 or P0692.**

- **If no DTC is set.**

NOTE: **A slight delay may occur before the cooling fan activates.**

3. Verify the G10 Cooling Fan Motor activates and increases in speed with each command using a scan tool.

- **The cooling fan does not activate or increase in speed**

Refer to Circuit/System Testing

- **The cooling fan activates and increases in speed**

4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector X1 at the K22 Cooling Fan Control Module.
2. Verify that a test lamp illuminates between the ground circuit terminal 2 and B+.
 - **If the test lamp does not illuminate**
 1. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If the test lamp illuminates**
3. Disconnect the G10 Cooling Fan Motor harness connector X2 from the K22 Cooling Fan Control Module.
4. Connect the **EL 36169-HD** between the G10 Cooling Fan Motor terminal 1 and B+. Connect a jumper wire between the G10 Cooling Fan Motor terminal 2 and ground.
5. Verify the G10 Cooling Fan Motor operates.

- **The cooling fan does not operate**

Replace the G10 Cooling Fan Motor.

- **The cooling fan operates**

Replace the K22 Cooling Fan Control Module

Component Testing

1. Ignition OFF.
2. Disconnect the G10 Cooling Fan Motor harness connector X2 from the K22 Cooling Fan Control Module.
3. Connect the **EL 36169-HD** between the G10 Cooling Fan Motor terminal 1 and B+. Connect a jumper wire between the G10 Cooling Fan Motor terminal 2 and ground.
4. Verify the G10 Cooling Fan Motor operates.
 - **The cooling fan does not operate**
Replace the G10 Cooling Fan Motor.
 - **The cooling fan operates**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Fan Replacement** for G10 Cooling Fan Motor or K22 Cooling Fan Control Module replacement.
- **Control Module References**

ENGINE OVERHEATING

Engine Overheating

Step	Action	Yes	No
1	Inspect for a missing or damaged radiator upper or lower baffle and/or radiator air deflector. Is the baffle and/or deflector missing or damaged?	Go to Step 8	Go to Step 2
2	Inspect for a loss of coolant. Is there a loss of coolant?	Go to Step 3	Go to Step 4
3	Fill the system to the specified level. Refer to <u>Loss of Coolant.</u> Does the engine overheat?	Go to Step 4	System OK

4	Is the coolant to the correct concentration?	Go to Step 5	Go to Step 8
5	Inspect for a loss of cooling system pressure. Is there a loss of system pressure?	Go to Step 8	Go to Step 6
6	Inspect for a faulty engine coolant temperature (ECT) sensor. Refer to <u>DTC P0117, P0118 or P0119</u> . Is the sensor operating properly?	Go to Step 7	Go to Step 8
7	Inspect for a cracked coolant surge tank or a leaking hose. Is the coolant surge tank cracked or is the hose leaking?	Go to Step 8	Go to Step 3
8	Repair or install new parts as necessary, then retest. Does the engine overheat?	Go to Step 9	System OK
9	Inspect for incorrect drive belt tension. Is the belt tension correct?	Go to Step 10	Go to Step 8
10	1. Remove the water pump. Refer to <u>Water Pump Replacement</u> . 2. Inspect for a damaged water pump driveshaft. Is the water pump driveshaft damaged or is the seal leaking?	Go to Step 8	Go to Step 11
11	Inspect for obstructed radiator air flow or bent radiator fins. Is the radiator air flow obstructed?	Go to Step 8	Go to Step 12
12	Inspect for blocked cooling system passages. Are the cooling system passages blocked?	Go to Step 8	Go to Step 13
13	Inspect for inoperative cooling fans. Refer to <u>Cooling Fan Inoperative</u> . Are the cooling fans and the motors operating correctly?	Go to Step 14	Go to Step 8
14	Inspect the thermostat. Refer to <u>Water Pump Outlet Replacement</u> . Is the thermostat stuck in the closed position?	Go to Step 15	Go to Step 16
15	Replace the thermostat. Refer to <u>Water Pump Outlet Replacement</u> . Does the engine overheat?	Go to Step 16	System OK
16	Inspect the radiator cooling capacity. Is the proper sized radiator being used on the vehicle?	Go to Step 3	Go to Step 17
17	Consult the current parts catalog and replace the radiator. Refer to <u>Radiator Replacement</u> . Is the repair complete?	System OK	-

LOSS OF COOLANT

Loss of Coolant

Step	Action	Yes	No
DEFINITION: The cooling system is losing coolant either internally or externally.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to Symptoms - Engine Cooling
2	Repair any present DTCs. Refer to Diagnostic System Check - Vehicle . Is the action complete?	Go to Step 3	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to Step 5	Go to Step 4
4	Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) . Is the action complete?	Go to Step 5	-
5	If the engine is suspected to have a coolant leak into a cylinder, the coolant can hydraulically lock the engine. Does the engine crankshaft rotate?	Go to Step 6	Go to Step 23
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to Step 24	Go to Step 7
7	Extended operation with a low coolant level can cause engine internal component failure. Is the engine knocking?	Go to Step 26	Go to Step 8
8	1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust pipe. Is a heavy white smoke present from the exhaust pipe?	Go to Step 9	Go to Step 10
9	Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. Condensation in the exhaust system can cause an odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?	Go to Step 25	Go to Step 10
10	WARNING: Refer to <u>Moving Parts and Hot Surfaces Warning</u> . With the engine idling, inspect the coolant		

	system discharge coolant while the engine is idling?	Go to Step 14	Go to Step 11
11	Visually inspect the hoses, pipes and hose clamps at the following locations: • Coolant surge tank • Water Pump • Throttle Body • Heater core • Radiator Are any of the hoses, clamps or pipes leaking?	Go to Step 20	Go to Step 12
12	Visually inspect the following components: • Coolant pressure cap • Block Heater • Core plugs • Cylinder head gaskets • Engine block • Intake manifold • Radiator • Thermostat housing • Water pump Are any of the listed components leaking?	Go to Step 20	Go to Step 13
13	1. Pressure test the cooling system. Refer to <u>Cooling System Leak Testing</u>. 2. With the cooling system pressurized, visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to Step 20	Go to Step 14
14	Pressure test the coolant pressure cap. Refer to <u>Pressure Cap Testing</u>. Does the coolant pressure cap hold pressure?	Go to Step 15	Go to Step 21
15	Inspect for the following conditions: • A coolant smell inside of the vehicle • Coolant in the HVAC module drain tube • Coolant on the vehicle floor covering near		

	the HVAC module		
	Is coolant present?	Go to Step 22	Go to Step 16
16	1. Add 30 ml (1 oz) of GM Extended Life Coolant Leak Detection Dye to the cooling system for each 15 L (4 gal) of coolant. Refer to <u>Approximate Fluid Capacities</u> . 2. Start the vehicle and allow the engine to reach normal operating temperature. 3. Shut the engine off. 4. Use the J 42220 Universal 12V Leak Detection Lamp to visually inspect the components listed in steps 11 and 12.		
	Are any leaks present?	Go to Step 20	Go to Step 17
17	Use the J 42220 Universal 12V Leak Detection Lamp to inspect for the following conditions: • Coolant dye in the HVAC module drain tube • Coolant dye on the vehicle floor covering near the HVAC module		
	Is coolant dye present?	Go to Step 22	Go to Step 18
18	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is a milky substance under the oil fill cap?	Go to Step 19	Go to Step 19
19	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is a milky substance on the engine oil fluid level indicator?	Go to Step 25	Go to Step 28
20	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to Step 28	-
21	Replace the coolant pressure cap. Is the repair complete?	Go to Step 28	-
22	Replace the heater core. Refer to <u>Heater Core Replacement</u> . Is the repair complete?	Go to Step 28	-
23	Repair the engine no crank condition. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> .		-

24	Repair the engine overheating condition. Refer to <u>Engine Overheating</u> . Is the repair complete?	Go to Step 28	-
25	Repair the engine internal coolant leak. Refer to: • <u>Coolant in Engine Oil</u> • <u>Coolant in Combustion Chamber</u> Is the repair complete?	Go to Step 28	-
26	Repair the engine knock. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u> . Is the repair complete?	Go to Step 28	-
27	Repair the combustion pressure in the cooling system problem. Refer to <u>Cylinder Leakage Test</u> . Is the repair complete?	Go to Step 28	-
28	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

THERMOSTAT DIAGNOSIS

Special Tools

J 24731 Tempil Stick

Use one of the following procedures in testing for a malfunctioning thermostat.

Thermostat Test Procedure Using Tempil Sticks

The coolant thermostat can be tested using a temperature (tempil) stick. The temperature stick is a pencil like device. It has a wax material containing certain chemicals which melt at a given temperature. Take a 87°C (188°F) tempil stick or a 97°C (206°F) tempil stick and rub it on the thermostat housing. Temperature sticks can be used to determine a thermostat's operating range.

1. Use a **J 24731** Tempil Stick in order to find the opening and the closing temperatures of the coolant thermostat.
 - The 188 tempil stick melts at 87°C (188°F). The thermostat should begin to open.
 - The 206 tempil stick melts at 97°C (206°F). The thermostat should be fully open.
2. Replace the coolant thermostat if it does not operate properly between this temperature range.

Thermostat Test Procedure Using Glycol

Inspect the operation of the thermostat by hanging the thermostat on a hook in a 50/50 percent solution of DEX-COOL® and clean drinkable water.

In order to inspect if the thermostat valve is opening properly, perform the following test:

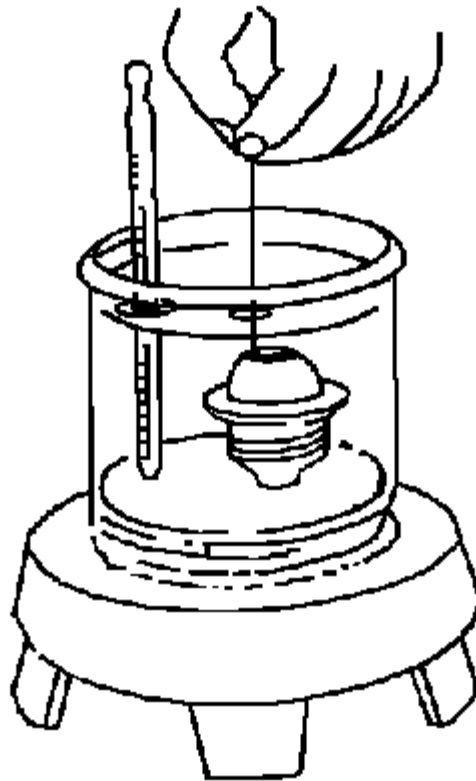


Fig. 2: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS COMPANY

1. Completely submerge the thermostat in the glycol solution. The solution should be 11°C (22°F) above the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should open.

In order to inspect if the thermostat valve is closing properly, perform the following test:

1. Completely submerge the thermostat in a glycol solution. The solution should be 6°C (10°F) below the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should close completely.

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

Special Tools

J 24731 Tempil Stick

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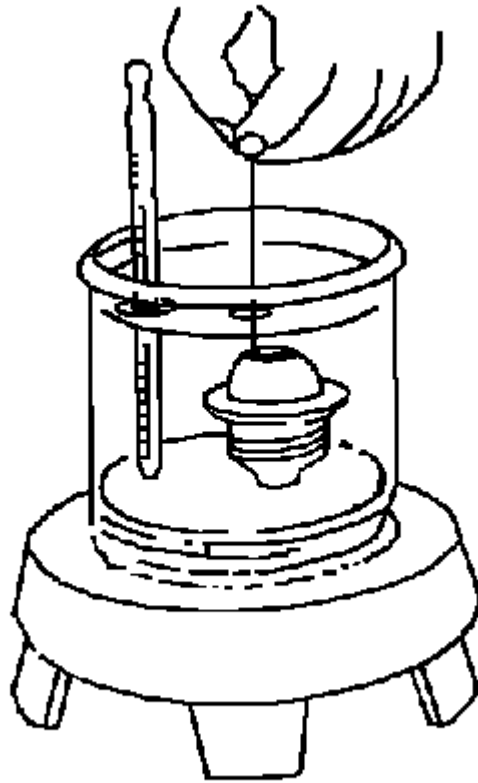


Fig. 3: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS COMPANY

1. Completely submerge the thermostat in the glycol solution. The solution should be 11°C (22°F) above the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should open.

In order to inspect if the thermostat valve is closing properly, perform the following test:

1. Completely submerge the thermostat in a glycol solution. The solution should be 6°C (10°F) below the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should close completely.

PRESSURE CAP TESTING

Special Tools

- **J 24460-01** Cooling System Pressure Tester
- **J 42401** Radiator Cap/Surge Tank Test Adapter

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the pressure cap.
2. Wash the pressure cap sealing surface with water.

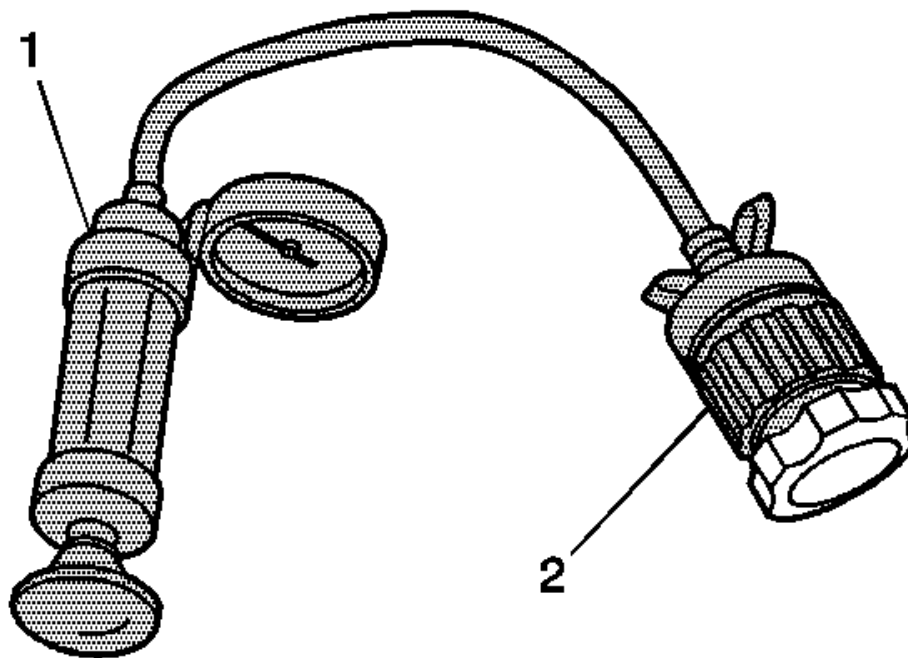


Fig. 4: Identifying Pressure Cap Testing Tool J 42401
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate J-42401 and pressure cap o-rings with coolant and press cap to seat o-ring on J-42401 before turning to engage threads.

3. Use the **J 24460-01** Cooling System Pressure Tester (1) with **J 42401** Radiator Cap/Surge Tank Test Adapter (2) in order to test the pressure cap.
4. Test the pressure cap for the following conditions:

pressure rating of the pressure cap.

- Maintain the rated pressure for at least 10 seconds.

Note the rate of pressure loss.

5. Replace the pressure cap under the following conditions:

- The pressure cap does not release pressure which exceeds the rated pressure of the cap.
- The pressure cap does not hold the rated pressure.

COOLING SYSTEM LEAK TESTING

Special Tools

- **J-24460-01** Cooling System Pressure Tester
- **J-42401-3** Radiator Cap and Surge Tank Test Adapter

Cooling System Leak Testing

WARNING: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

WARNING: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

1. Remove the pressure cap.
2. Test the operation of the pressure cap. Refer to **Pressure Cap Testing**.
3. Wash the pressure cap mating surface with water.

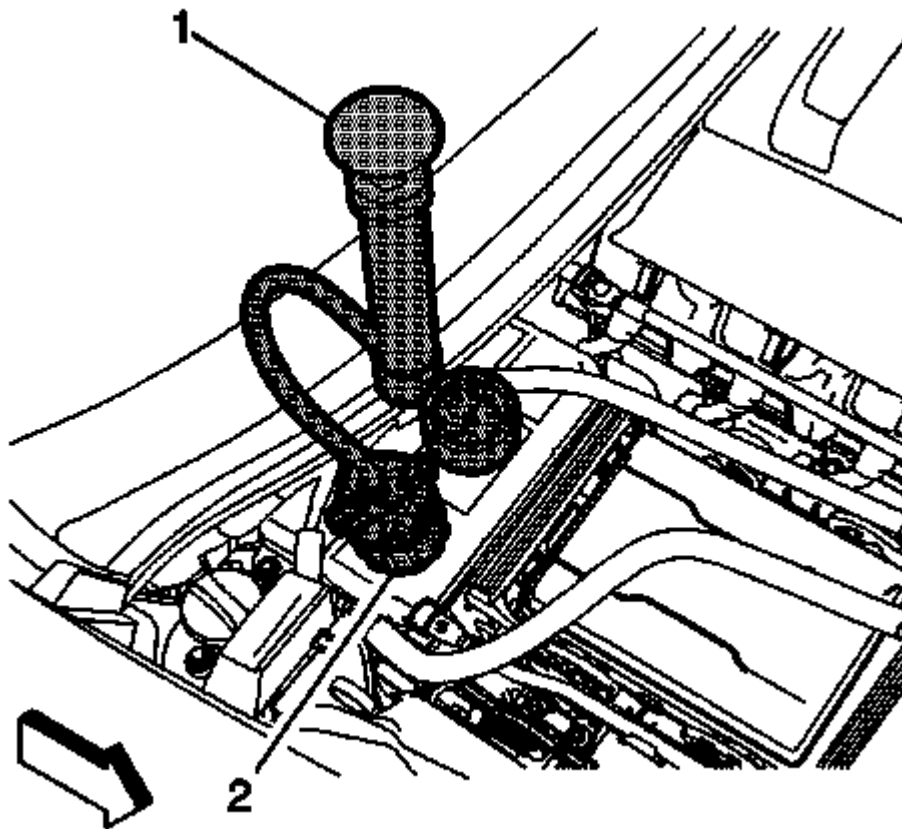


Fig. 5: J-24460-01 Cooling System Pressure Tester And J-42401-3 Radiator Cap and Surge Tank Test Adapter
Courtesy of GENERAL MOTORS COMPANY

4. Use the **J-24460-01** Cooling System Pressure Tester (1) with **J-42401-3** Radiator Cap and Surge Tank Test Adapter (2) in order to apply pressure to the cooling system.

Do not exceed the pressure cap rating.

5. The cooling system should hold the rated pressure for at least 2 minutes.

Observe the gauge for any pressure loss.

6. Repair any leaks as required.

REPAIR INSTRUCTIONS

COOLING SYSTEM DRAINING AND FILLING (STATIC FILL)

Special Tools

J 26568 Coolant and Battery Fluid Tester

Draining Procedure

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the coolant pressure cap.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Place a drain pan under the drain cock.

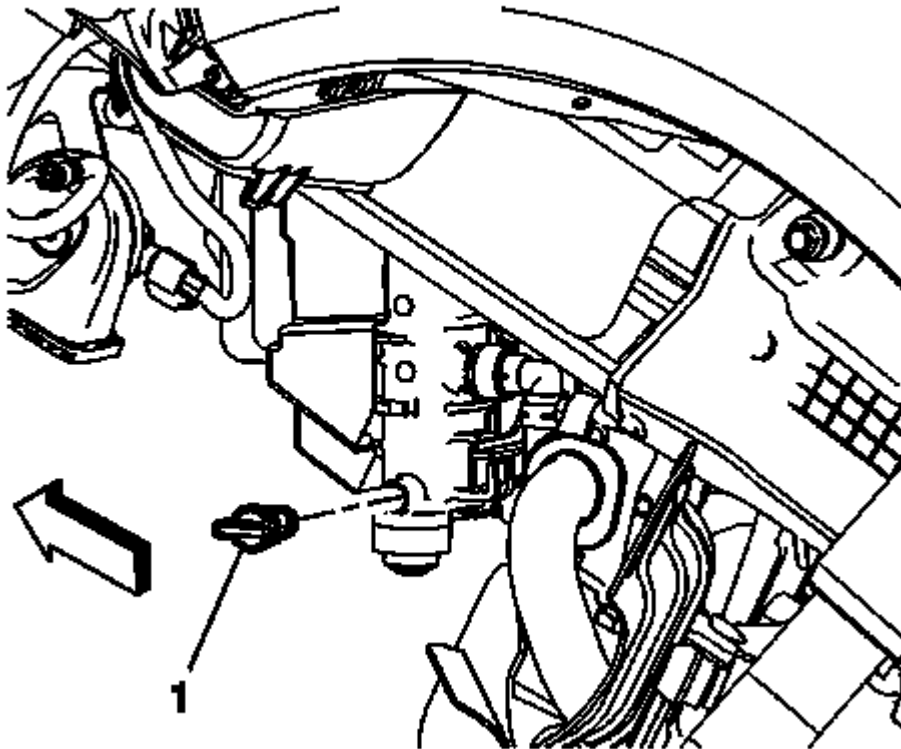


Fig. 6: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator drain cock (1). Refer to Radiator Drain Cock Replacement.
5. Drain the cooling system.
6. Lower the vehicle.
7. Inspect the coolant.

8. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.
 - Discolored-Follow the flush procedure. Refer to **Flushing**.

Filling Procedure

CAUTION: The procedure below must be followed. Improper coolant level could result in a low or high coolant level condition, causing engine damage.

1. Raise and support the vehicle.

NOTE: Inspect the drain cock O-ring for signs of cracks or damage. Replace if necessary.

2. Lubricate the drain cock O-ring with clean coolant prior to installation.

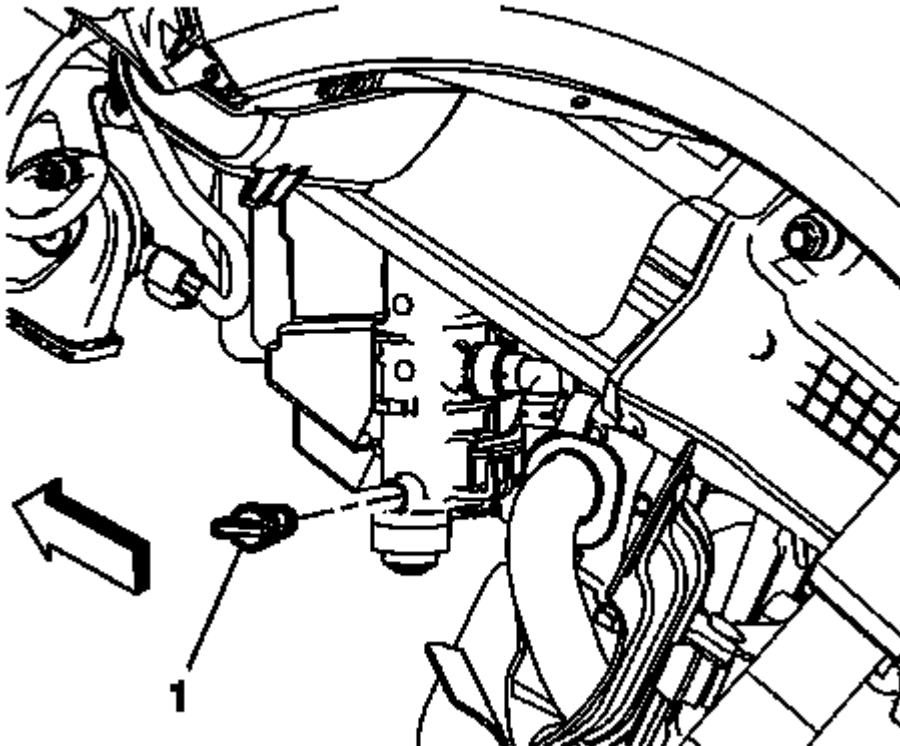


Fig. 7: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the radiator drain cock (1). Refer to Radiator Drain Cock Replacement.
4. Lower the vehicle.

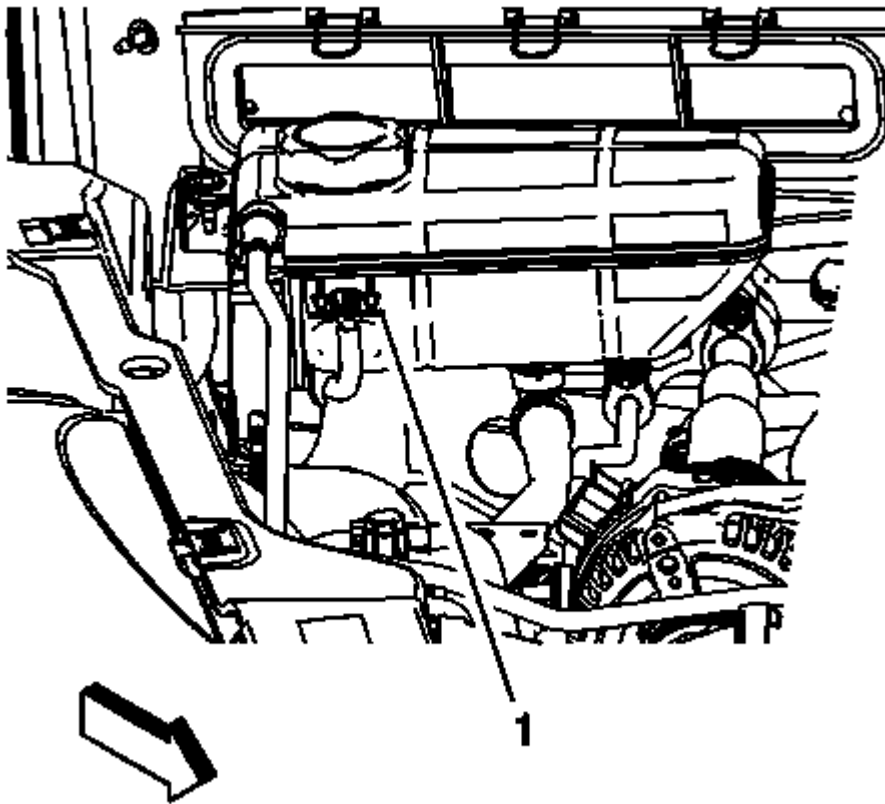


Fig. 8: Filling Surge Tank

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a 40/60 mixture of 40% DEX-COOL antifreeze and 60% clean drinkable water.

5. Slowly fill the surge tank (1) with a 40/60 coolant mixture until the coolant level reaches the base of the surge tank fill neck. Refer to Approximate Fluid Capacities .

NOTE: Monitor the surge tank coolant level closely. The surge tank coolant level will begin to decrease once the engine is started.

6. Start the engine and allow to the engine to idle.

7. Slowly fill the coolant mixture until the level stabilizes at the base of the surge tank fill neck.
8. Run the engine between 2, 000-2, 500 RPM for approximately 2 minutes.
9. Allow engine to idle and add approximately 1 liter (1.1 quarts) of coolant to the surge tank.
10. Install the coolant pressure cap.
11. Shut the engine OFF.
12. Allow the engine to cool.
13. Top off the coolant as necessary.
14. Inspect the concentration of the engine coolant using the **J 26568** Coolant and Battery Fluid Tester.
15. Rinse away any excess coolant from the engine and the engine compartment.
16. Inspect the cooling system for leaks.

COOLING SYSTEM DRAINING AND FILLING (GE 47716)

Special Tools

- **J 26568** Coolant and Battery Fluid Tester
- **J 42401-3** Radiator Cap and Surge Tank Test Adapter
- **GE-47716** Vac-N-Fill Coolant Refill Tool

Draining Procedure

WARNING: With a pressurized cooling system, the coolant temperature in the radiator can be considerably higher than the boiling point of the solution at atmospheric pressure. Removal of the surge tank cap, while the cooling system is hot and under high pressure, causes the solution to boil instantaneously with explosive force. This will cause the solution to spew out over the engine, the fenders and the person removing the cap. Serious bodily injury may result.

1. Remove the coolant pressure cap.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Place a drain pan under the drain cock.

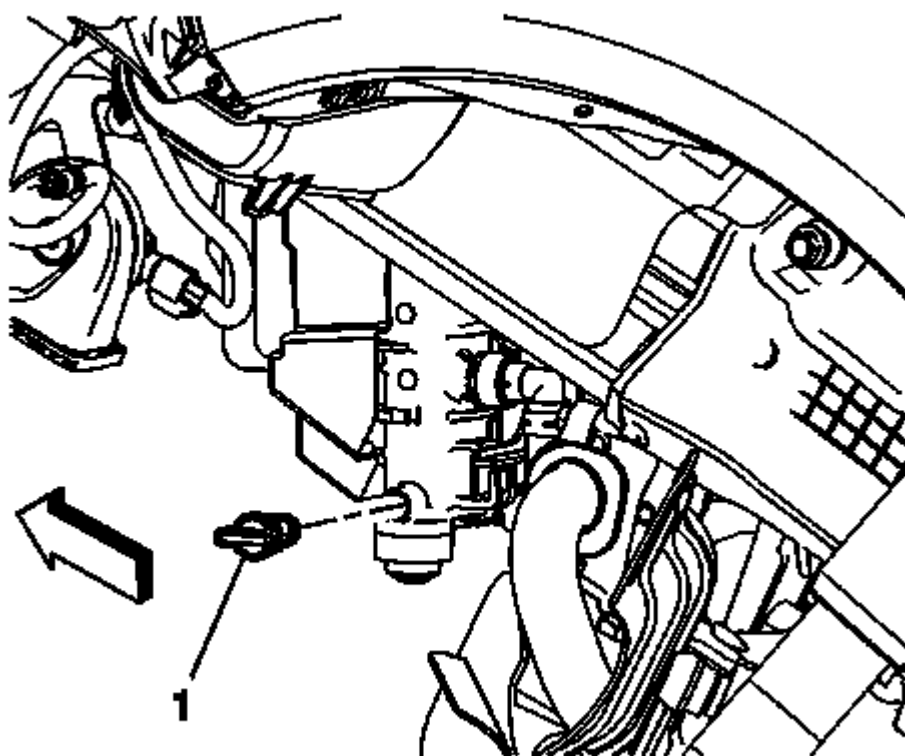


Fig. 9: Radiator Drain Cock

Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator drain cock (1). Refer to **Radiator Drain Cock Replacement**.
5. Drain the cooling system.
6. Lower the vehicle.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.
 - Discolored-Follow the flush procedure. Refer to **Flushing**.
9. Install the radiator drain cock (1). Refer to **Radiator Drain Cock Replacement**.
10. Lower the vehicle.

Vac-N-Fill Procedure

1. Install the **J 42401-3** Radiator Cap and Surge Tank Test Adapter onto the coolant surge tank.

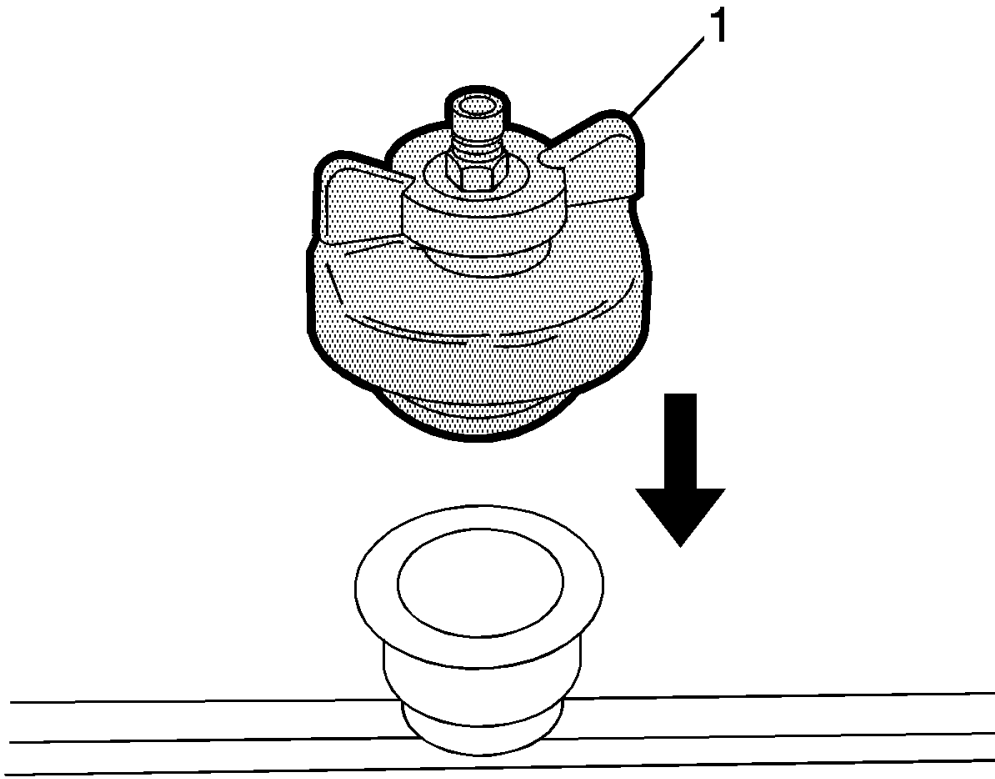


Fig. 10: Radiator Cap & Surge Tank Test Adapter
Courtesy of GENERAL MOTORS COMPANY

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

2. Attach the Vac-N-Fill cap to the **J 42401-3** Radiator Cap and Surge Tank Test Adapter (1).

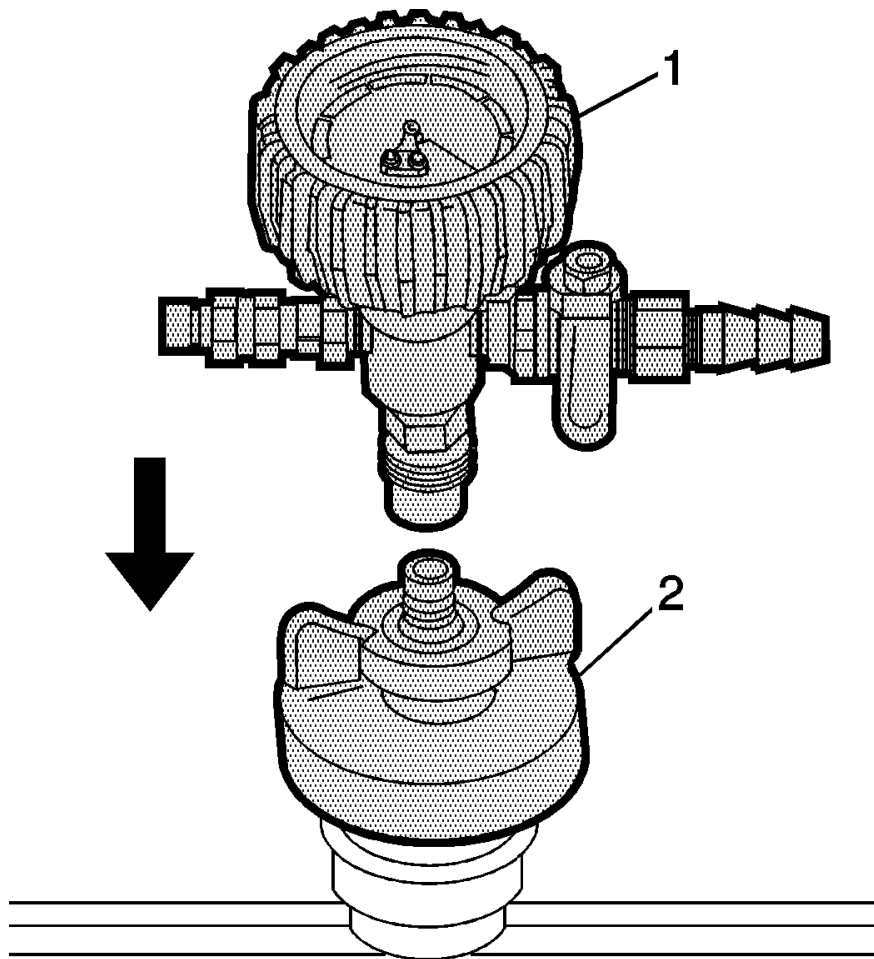


Fig. 11: Vacuum Gauge Assembly & Vac N Fill Cap
Courtesy of GENERAL MOTORS COMPANY

3. Attach the vacuum gauge assembly (1) to the Vac-N-Fill cap (2).

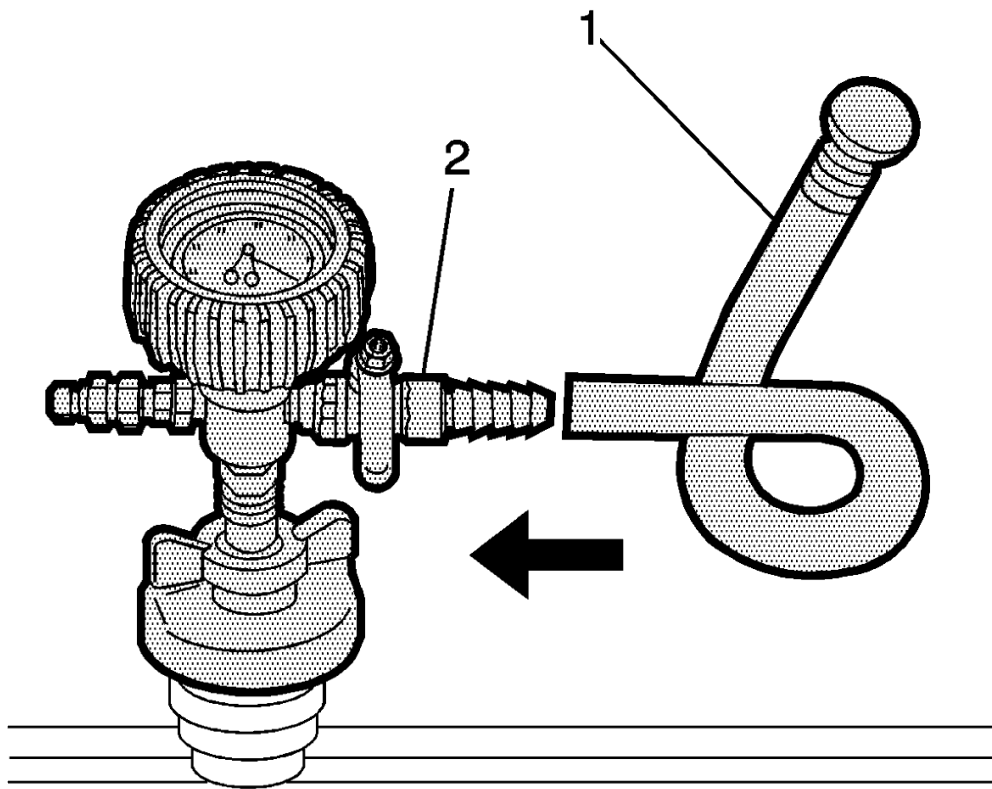


Fig. 12: Vacuum Gauge Assembly & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

4. Attach the fill hose (1) to the barb fitting on the vacuum gauge assembly (2).
Ensure that the valve is closed.

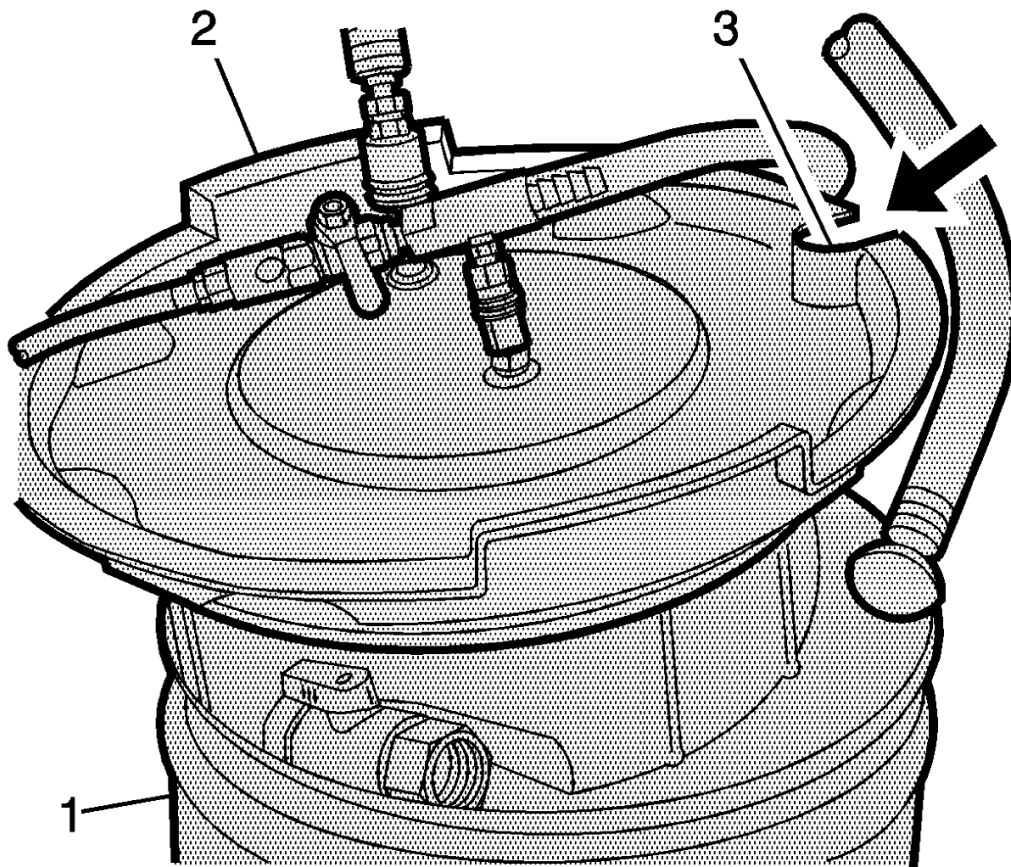


Fig. 13: Graduated Reservoir, Vacuum Tank & Cut-Out Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a 40/60 mixture of 40% DEX-COOL antifreeze and 60% clean, drinkable water.

Always use more coolant than necessary. This will eliminate air from being drawn into the cooling system.

5. Pour the coolant mixture into the graduated reservoir (1).
6. Place the fill hose in the graduated reservoir (1).

NOTE: Prior to installing the vacuum tank onto the graduated reservoir, ensure that the drain valve located on the bottom of the tank is closed.

7. Install the vacuum tank (2) on the graduated reservoir with the fill hose routed through the cut-out area (3) in the vacuum tank.

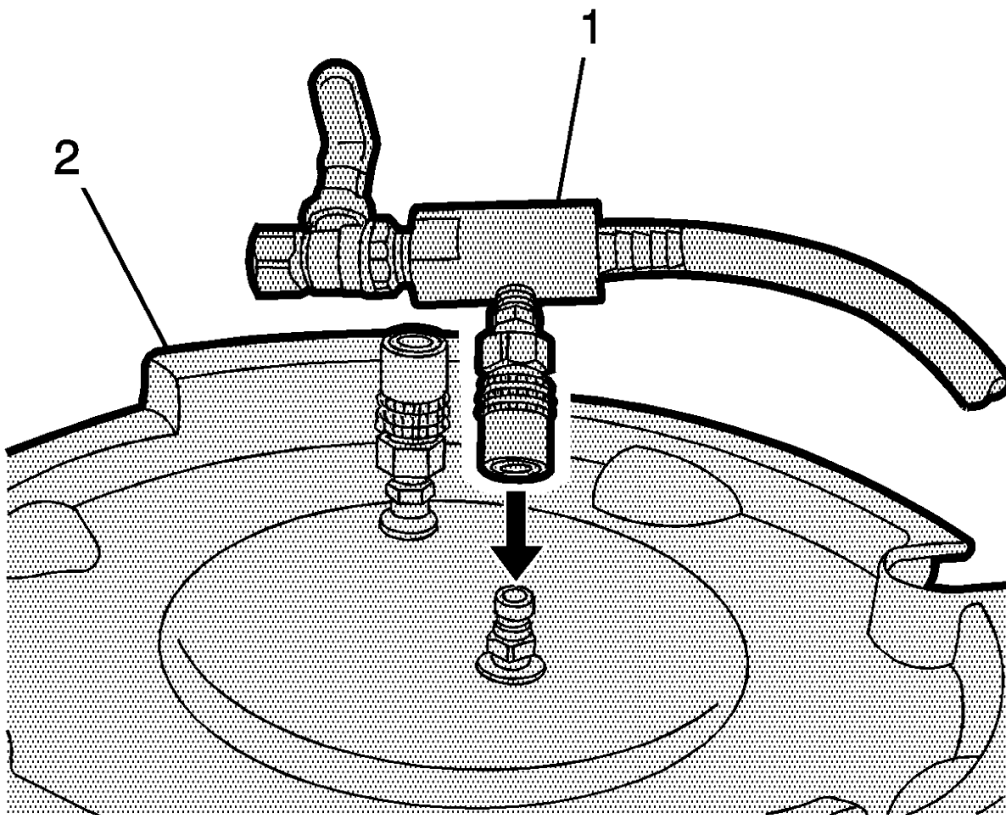


Fig. 14: Vacuum Tank & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Attach the venturi assembly (1) to the vacuum tank (2).

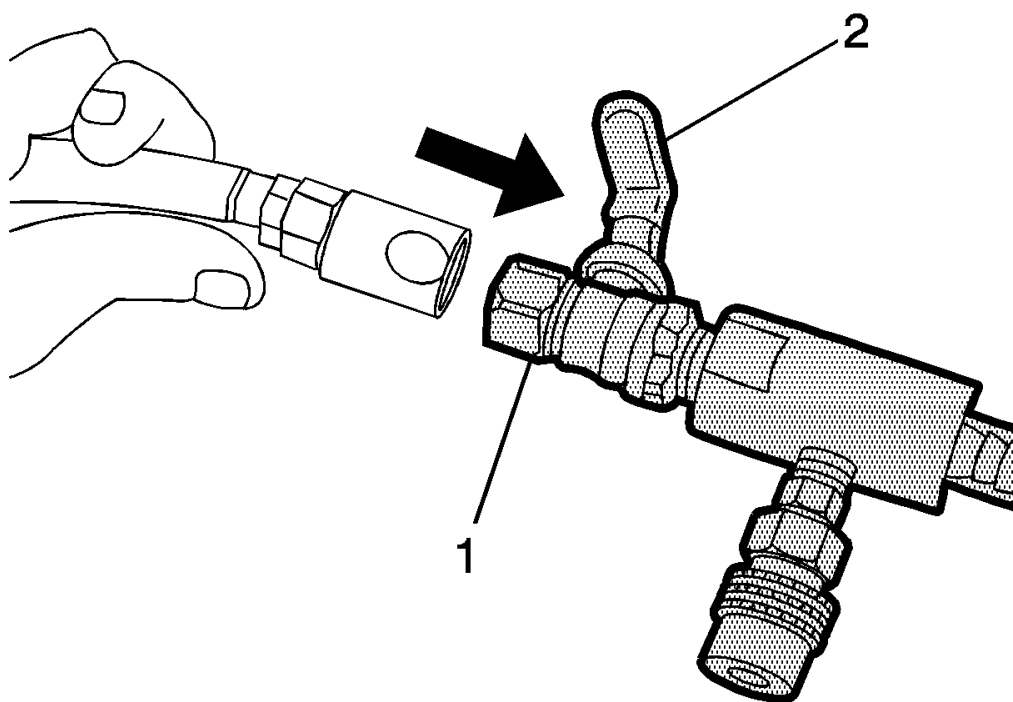


Fig. 15: Venturi Assembly & Valve
Courtesy of GENERAL MOTORS COMPANY

9. Attach a shop air hose to the venturi assembly (1).
Ensure the valve (2) on the venturi assembly is closed.

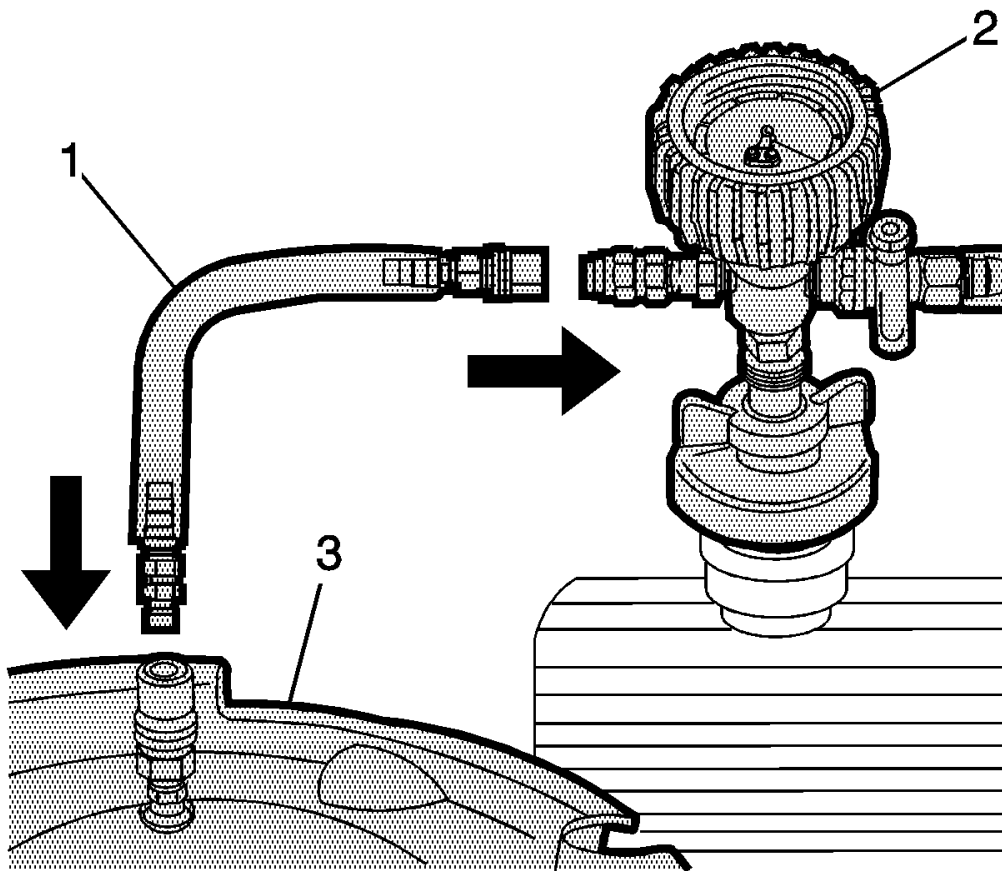


Fig. 16: Vacuum Hose, Gauge Assembly & Tank
Courtesy of GENERAL MOTORS COMPANY

10. Attach the vacuum hose (1) to the vacuum gauge assembly (2) and the vacuum tank (3).

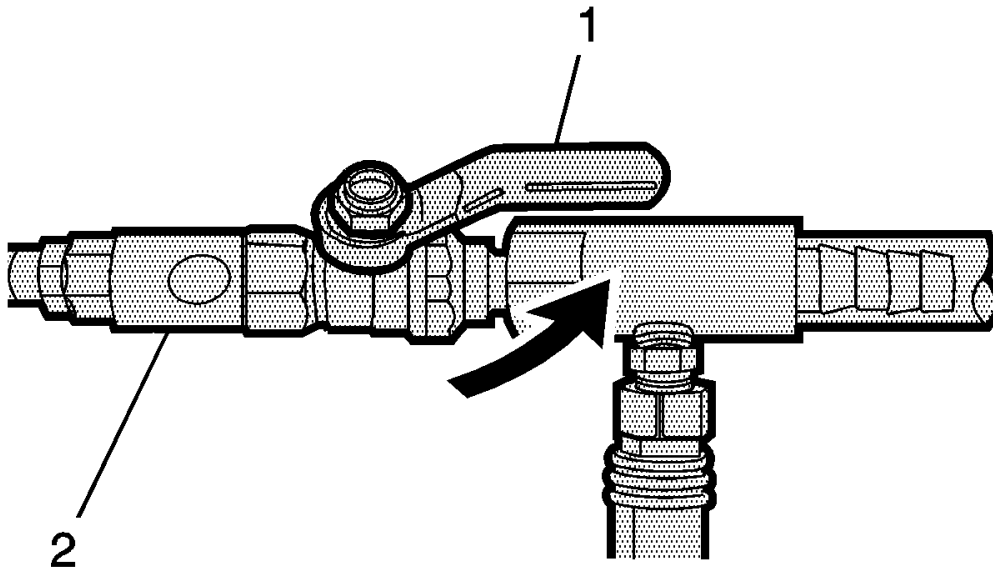


Fig. 17: Valve & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Open the valve (1) on the venturi assembly (2). The vacuum gauge will begin to rise and a hissing noise will be present.

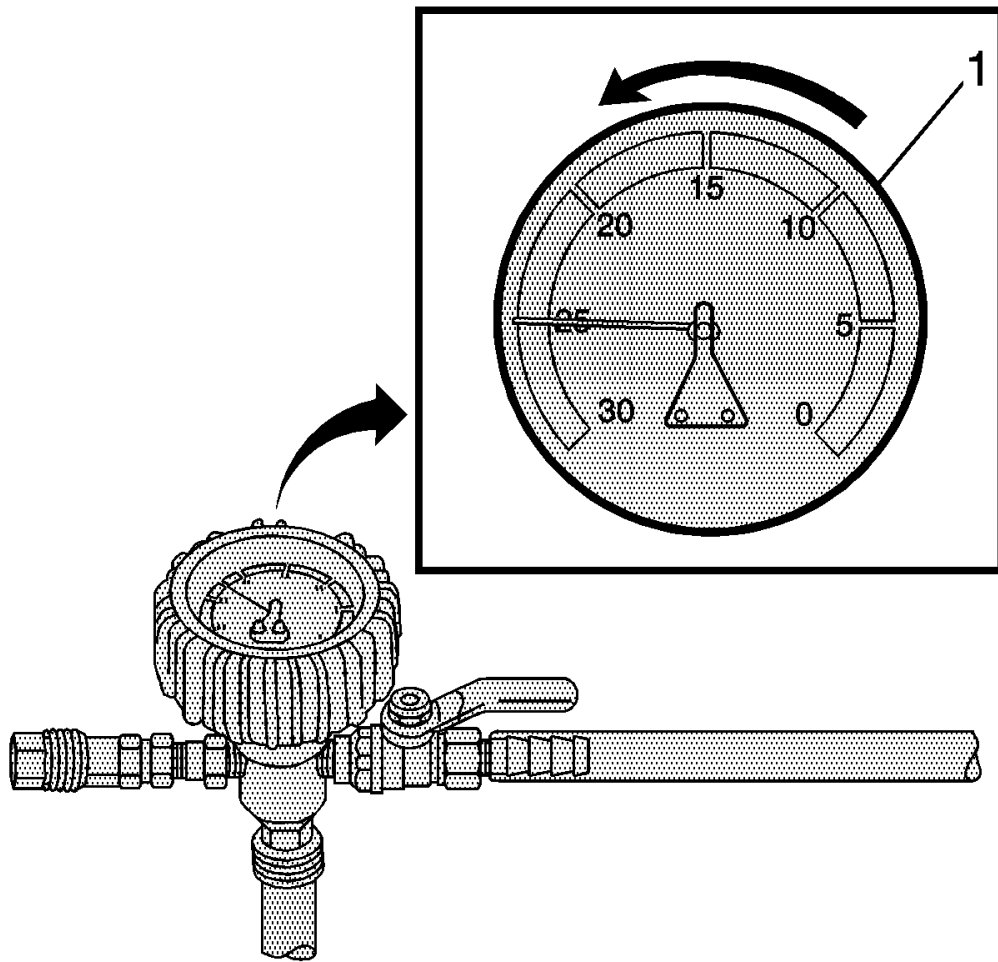


Fig. 18: Vacuum Gauge Needle
Courtesy of GENERAL MOTORS COMPANY

12. Continue to draw vacuum until the needle stops rising (1). This should be 610-660 mm Hg (24-26 in Hg).

Cooling hoses may start to collapse. This is normal due to vacuum draw.

13. To aid in the fill process, position the graduated reservoir above the coolant fill port.

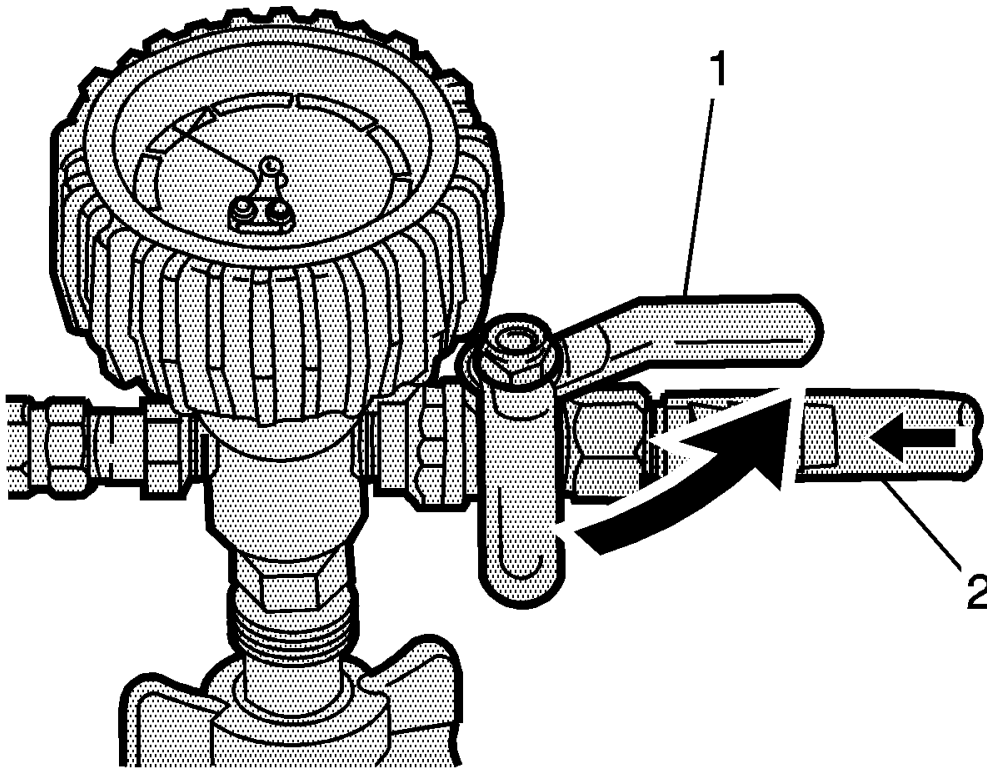


Fig. 19: Vacuum Gauge Assembly & Needle
Courtesy of GENERAL MOTORS COMPANY

14. Slowly open the valve (1) on the vacuum gauge assembly (2). When the coolant reaches the top of the fill hose, close the valve. This will eliminate air from the fill hose.
15. Close the valve on the venturi assembly.
16. If there is a suspected leak in the cooling system, allow the system to stabilize under vacuum and monitor for vacuum loss.

If vacuum loss is observed, refer to **Loss of Coolant**.

17. Open the valve on the vacuum gauge assembly. The vacuum gauge will drop as coolant is drawn into the system.

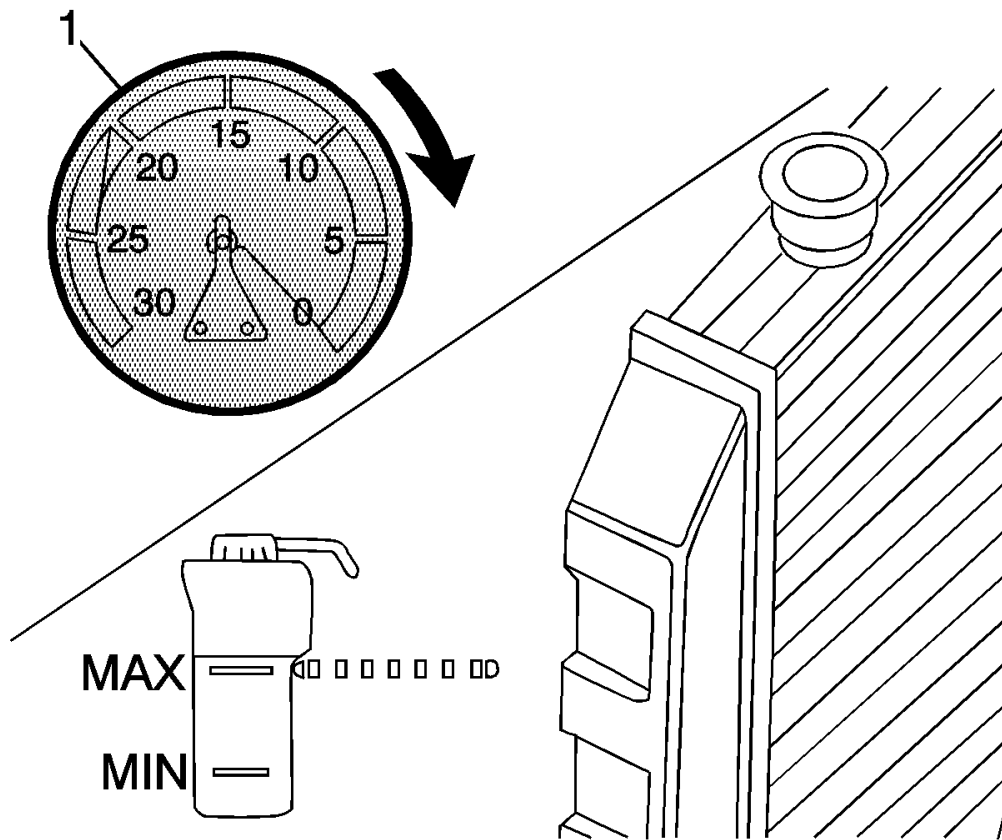


Fig. 20: Vacuum Gauge At Zero
Courtesy of GENERAL MOTORS COMPANY

18. Once the vacuum gauge reaches zero (1), close the valve on the vacuum gauge assembly and repeat steps 11-17.
19. Detach the Vac-N-Fill cap from the **J 42401-3** Radiator Cap and Surge Tank Test Adapter.
20. Remove the **J 42401-3** Radiator Cap and Surge Tank Test Adapter from the coolant surge tank.
21. Add coolant to the system as necessary.
22. Inspect the concentration of the coolant mixture using **J 26568** Coolant and Battery Fluid Tester.

NOTE: After filling the cooling system, the extraction hose can be used to remove excess coolant to achieve the proper coolant level.

23. Detach the vacuum hose from the vacuum gauge assembly.

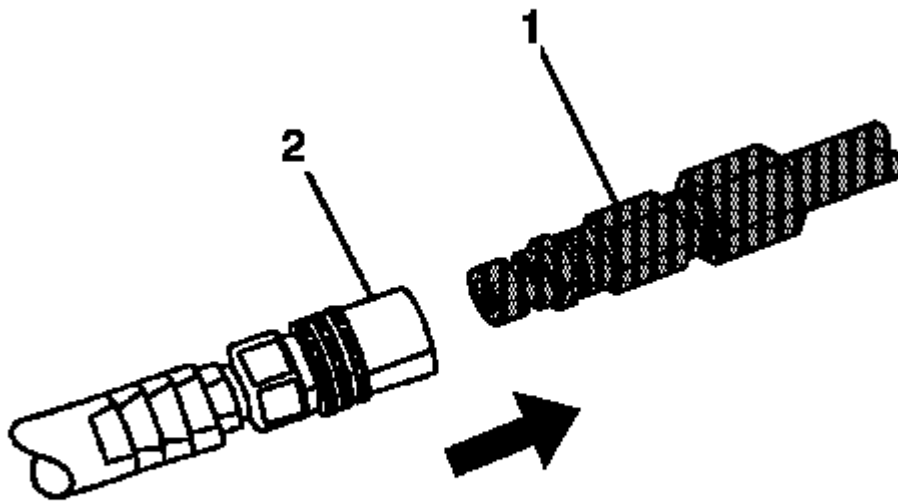


Fig. 21: Vacuum Hose & Extraction Hose
Courtesy of GENERAL MOTORS COMPANY

24. Attach the extraction hose (1) to the vacuum hose (2).

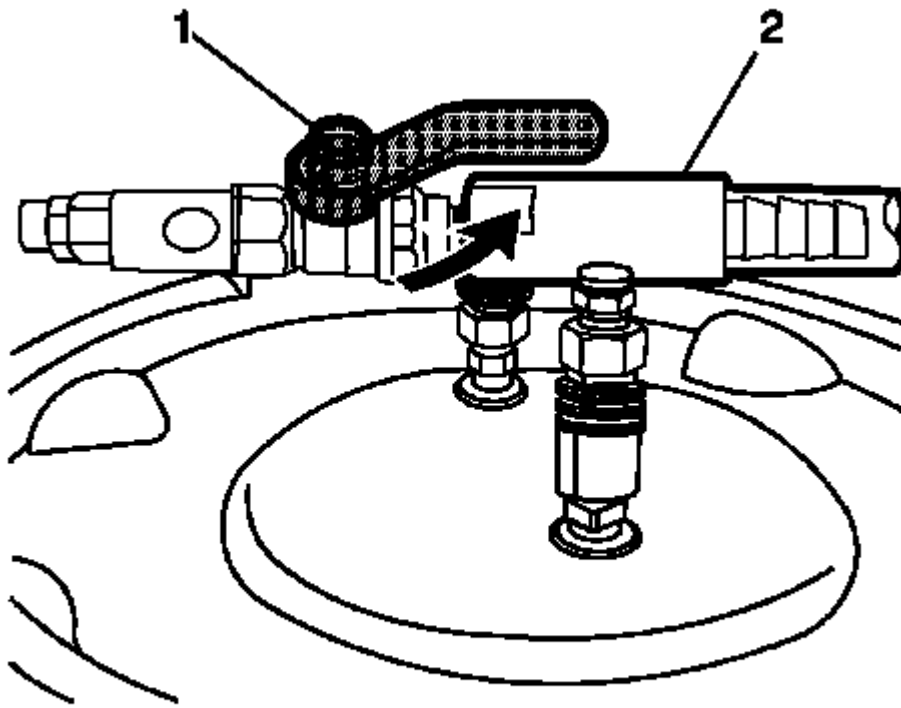


Fig. 22: Venturi Assembly & Valve
Courtesy of GENERAL MOTORS COMPANY

25. Open the valve (1) on the venturi assembly (2) to start a vacuum draw.

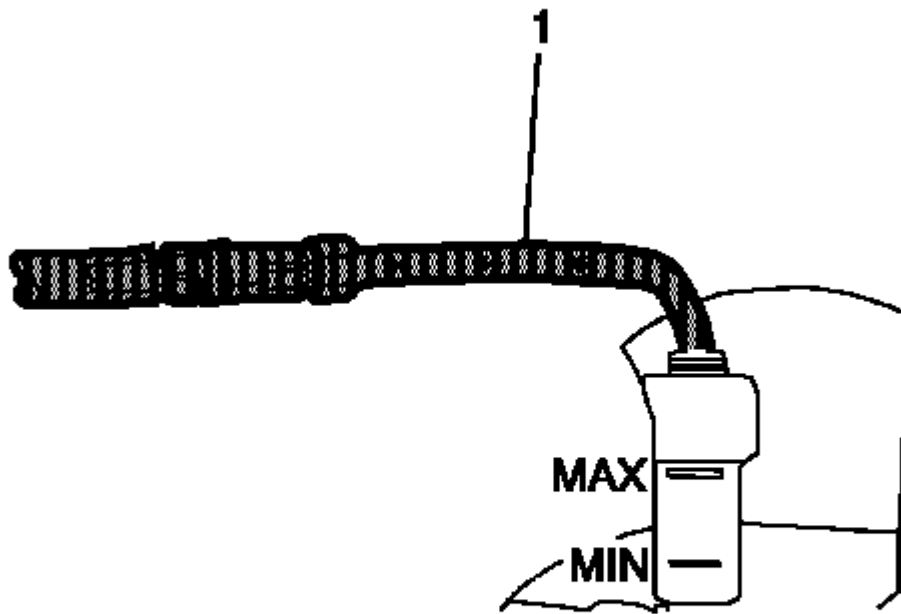


Fig. 23: Coolant Extraction Hose
Courtesy of GENERAL MOTORS COMPANY

26. Use the extraction hose (1) to draw out coolant to the proper level.
27. The vacuum tank has a drain valve on the bottom of the tank. Open the valve to drain coolant from the vacuum tank into a suitable container for disposal.
28. Install the surge tank cap.

FLUSHING

NOTE: Do not use a chemical flush.

Store used coolant in the proper manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.

Various methods and equipment can be used to flush the cooling system. If special equipment is used, such as a back flusher, follow the manufacturer's instruction. Always remove the thermostat before flushing the cooling system.

When the cooling system becomes contaminated, the cooling system should be flushed thoroughly to remove the contaminants before the engine is seriously damaged.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).
2. Remove the surge tank. Refer to Radiator Surge Tank Replacement.
3. Clean and flush the surge tank with clean, drinkable water.
4. Install the surge tank. Refer to Radiator Surge Tank Replacement.
5. Follow the drain and fill procedure using only clean, drinkable water. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).
6. Run the engine for 20 minutes.
7. Stop the engine.
8. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).
9. Repeat the procedure if necessary, until the fluid is nearly colorless.
10. Fill the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).

RADIATOR CLEANING

WARNING: NEVER spray water on a hot heat exchanger. The resulting steam could cause personal injury.

CAUTION: The heat exchanger fins are necessary for good heat transfer. Do not brush the fins. This may cause damage to the fins, reducing heat transfer.

NOTE: Remove bugs, leaves, dirt and other debris by blowing compressed air through the engine side of the radiator.

- Some conditions may require the use of warm water and a mild detergent.
- Clean the A/C condenser fins.
- Clean between the A/C condenser and radiator.
- Clean the radiator cooling fins.
- Straighten any damaged cooling fins.

RADIATOR SURGE TANK REPLACEMENT

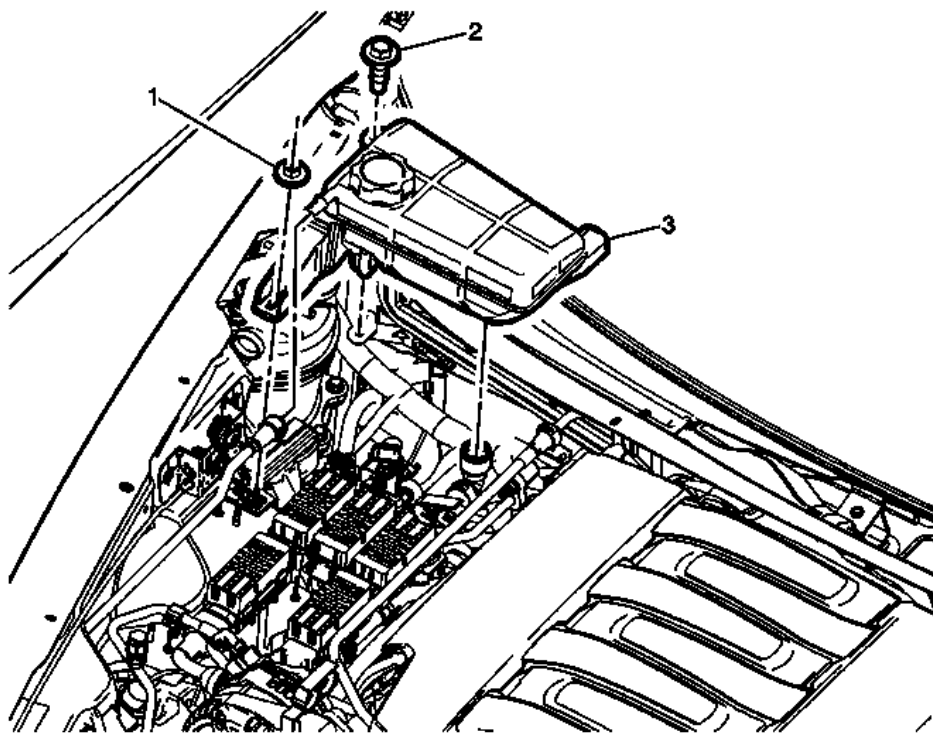


Fig. 24: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Replacement

Callout	Component Name
Preliminary Procedures	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .
2.	Disconnect the positive crankcase ventilation hose/pipe/tube above the radiator surge tank. Refer to <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Positive Crankcase Ventilation Tube)</u> , <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Oil Tank to RH Rocker Arm Cover)</u> , <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Air Duct To Oil Tank)</u> , <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Fresh Air)</u> .
3.	Remove the radiator surge tank inlet hose from the radiator surge tank. Refer to <u>Radiator Surge Tank Inlet Hose Replacement (Radiator Surge Tank to Radiator)</u> , <u>Radiator Surge Tank Inlet Hose Replacement (Radiator Surge Tank Hose Connector to Water Outlet)</u> .
4.	Remove the fasteners securing the underhood electrical center junction block bracket and reposition the underhood electrical center junction block and bracket out of the way. Refer to <u>Underhood Electrical Center or Junction Block Replacement</u> .
5.	Remove the heater inlet and outlet hose from the radiator surge tank. Refer to <u>Heater Inlet and Outlet Hose Replacement</u> .

1	Radiator Surge Tank Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7 (62 lb in)
2	Radiator Surge Tank Bolt Tighten 7 (62 lb in)
3	Radiator Surge Tank Procedures 1. Fill the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Check the cooling system for leaks.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (RADIATOR SURGE TANK TO RADIATOR)

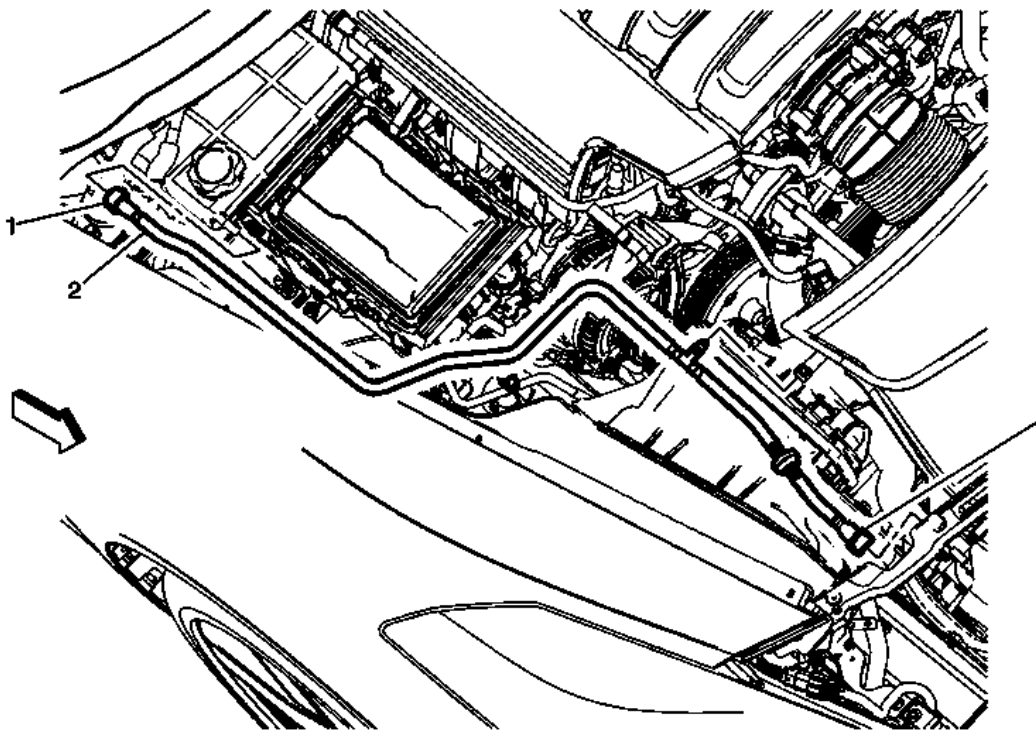


Fig. 25: Radiator Surge Tank Inlet Hose And Radiator
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (Radiator Surge Tank to Radiator)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u>. 3. Remove the radiator surge tank inlet hose connector to water outlet from the radiator surge tank inlet hose.	
1	Radiator Surge Tank Inlet Hose Quick Connect Fitting (Qty: 2) Procedure Release the radiator surge tank inlet hose quick connect fittings. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .
2	Radiator Surge Tank Inlet Hose Procedures 1. Fill the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Check the cooling system for leaks.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (RADIATOR SURGE TANK HOSE CONNECTOR TO WATER OUTLET)

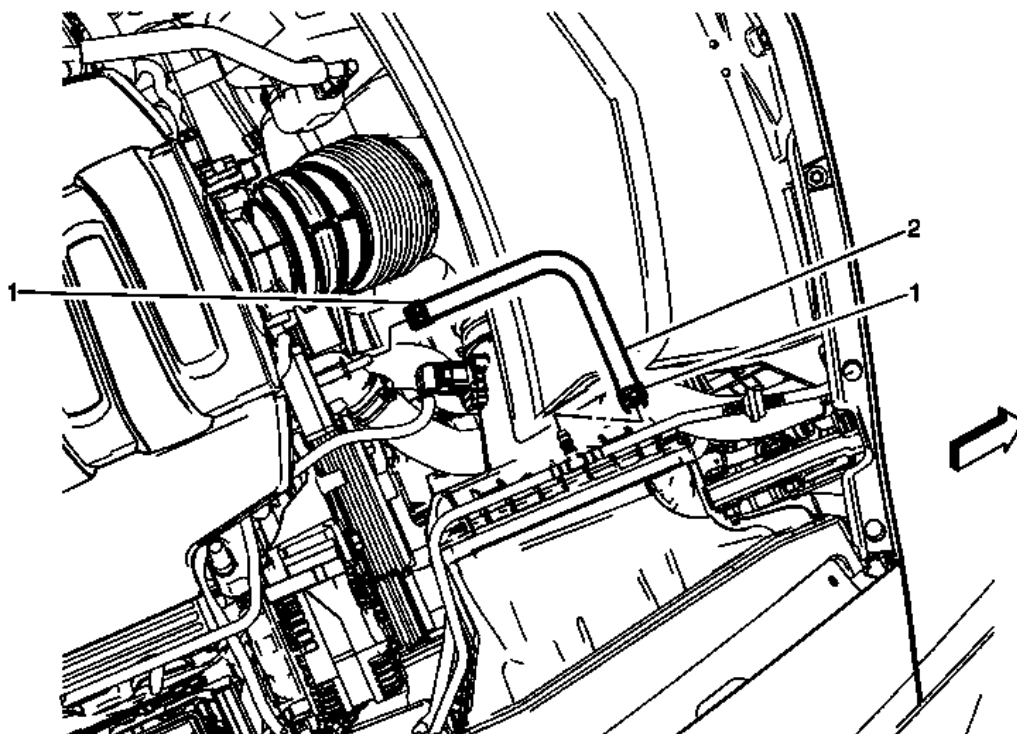


Fig. 26: Radiator Surge Tank Inlet Hose (Radiator Surge Tank Hose Connector to Water Outlet)
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (Radiator Surge Tank Hose Connector to Water Outlet)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 2) Procedure Reposition the radiator surge tank inlet hose clamps using BO 38185 hose clamp pliers. Special Tools BO 38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Surge Tank Inlet Hose Procedures 1. Fill the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Check the cooling system for leaks.

RADIATOR INLET HOSE REPLACEMENT

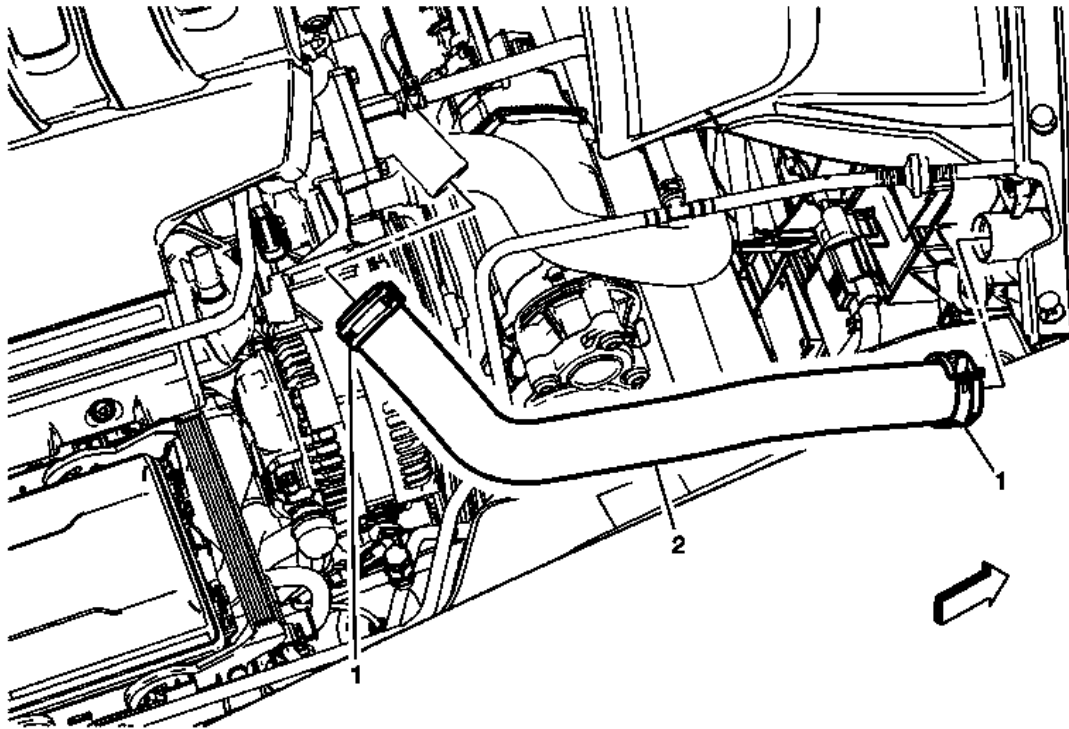


Fig. 27: Radiator Inlet Hose
 Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716). 2. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.	
1	Radiator Inlet Hose Clamp (Qty: 2) Procedure Reposition the radiator inlet hose clamps using BO 38185 hose clamp pliers. Special Tools BO 38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Inlet Hose Procedures 1. Fill the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716). 2. Check the cooling system for leaks.

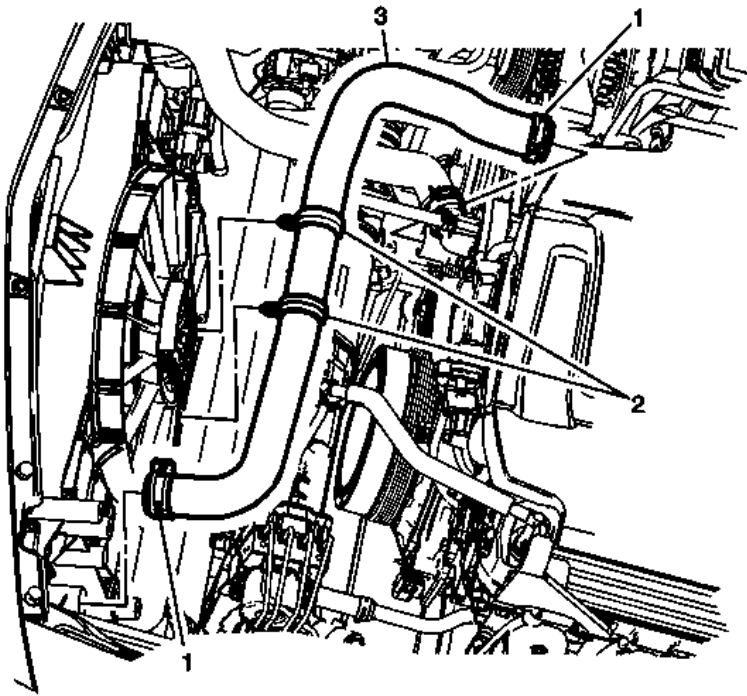


Fig. 28: Radiator Outlet Hose
 Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) . 2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Radiator Outlet Hose Clamp (Qty: 2) Procedure Reposition the radiator outlet hose clamps using BO 38185 hose clamp pliers. Special Tools BO 38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Outlet Hose Retainer (Qty: 2) Procedure Remove the radiator outlet hose retainers from the cooling fan and shroud.
3	Radiator Outlet Hose Procedures 1. Fill the cooling system. Refer to Cooling System Draining and Filling

2. Check the cooling system for leaks.

ENGINE OIL COOLER REPLACEMENT

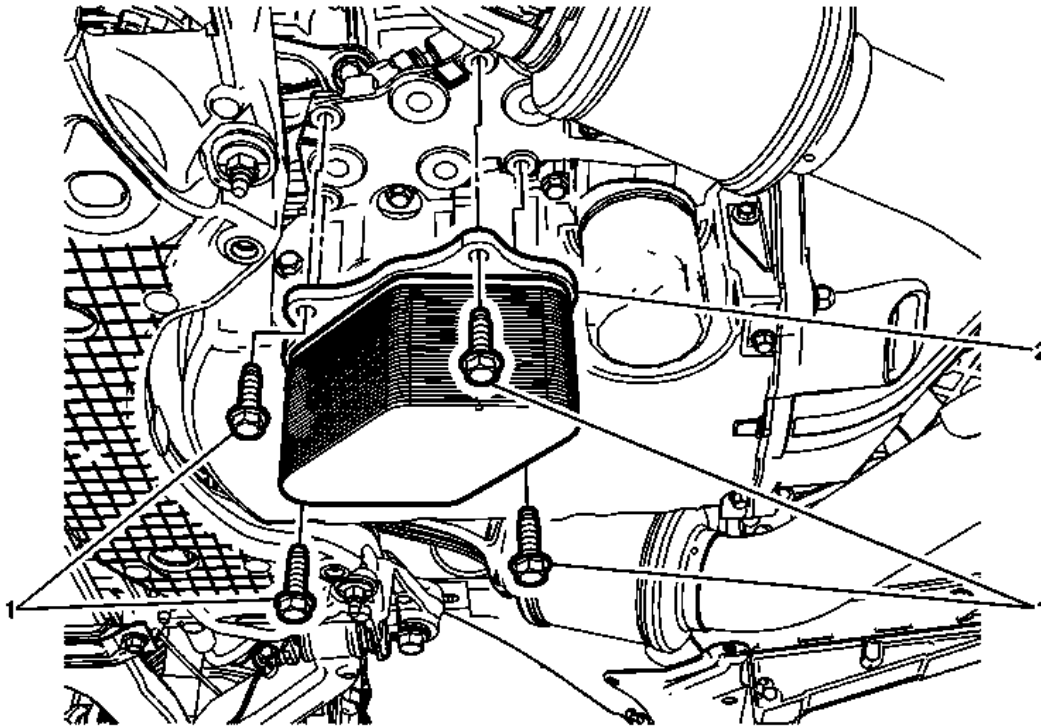


Fig. 29: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Replacement

Callout	Component Name
Preliminary Procedure	
1. Drain the engine oil. Refer to <u>Engine Oil and Oil Filter Replacement (With Z52 Option)</u> , <u>Engine Oil and Oil Filter Replacement (Without Z52 Option)</u> . 2. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>.	
1	Engine Oil Cooler Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Engine Oil Cooler

ENGINE OIL COOLER ADAPTER REPLACEMENT

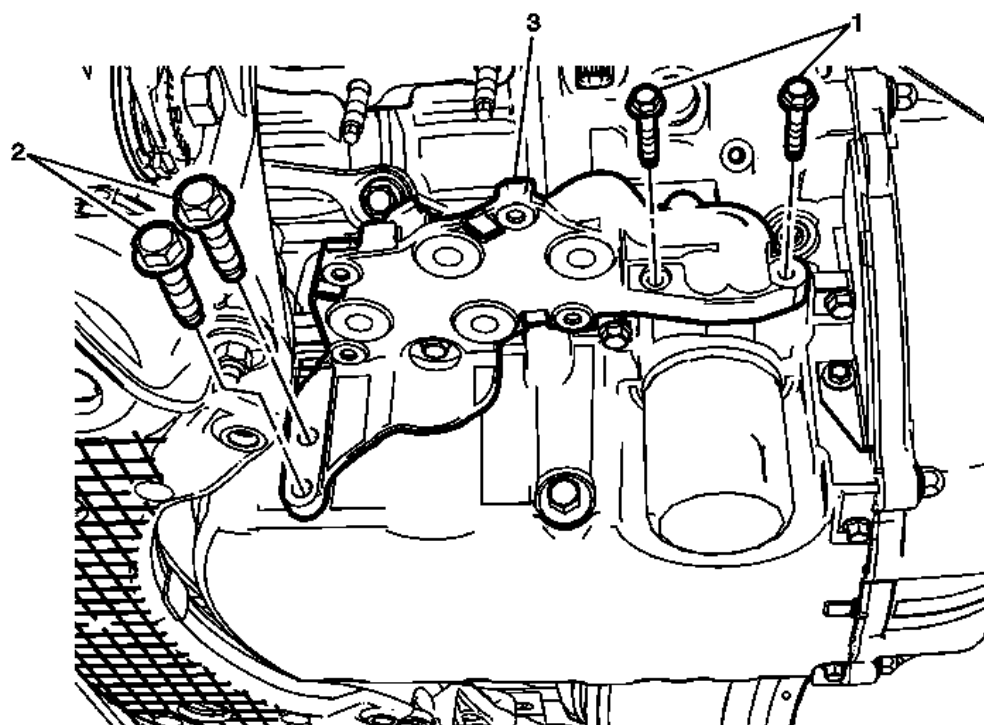


Fig. 30: Engine Oil Cooler Adapter
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Adapter Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the engine oil cooler. Refer to <u>Engine Oil Cooler Replacement</u>. 2. Disconnect the engine oil cooler coolant inlet hose. Refer to <u>Engine Oil Cooler Coolant Inlet Hose Replacement</u>. 3. Disconnect the engine oil cooler coolant outlet hose. Refer to <u>Engine Oil Cooler Coolant Outlet Hose Replacement</u>.	
1	Engine Oil Cooler Adapter Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Engine Oil Cooler Adapter Fastener (Qty: 2)

	25 (18 lb ft)
3	Engine Oil Cooler Adapter

ENGINE OIL COOLER COOLANT INLET HOSE REPLACEMENT

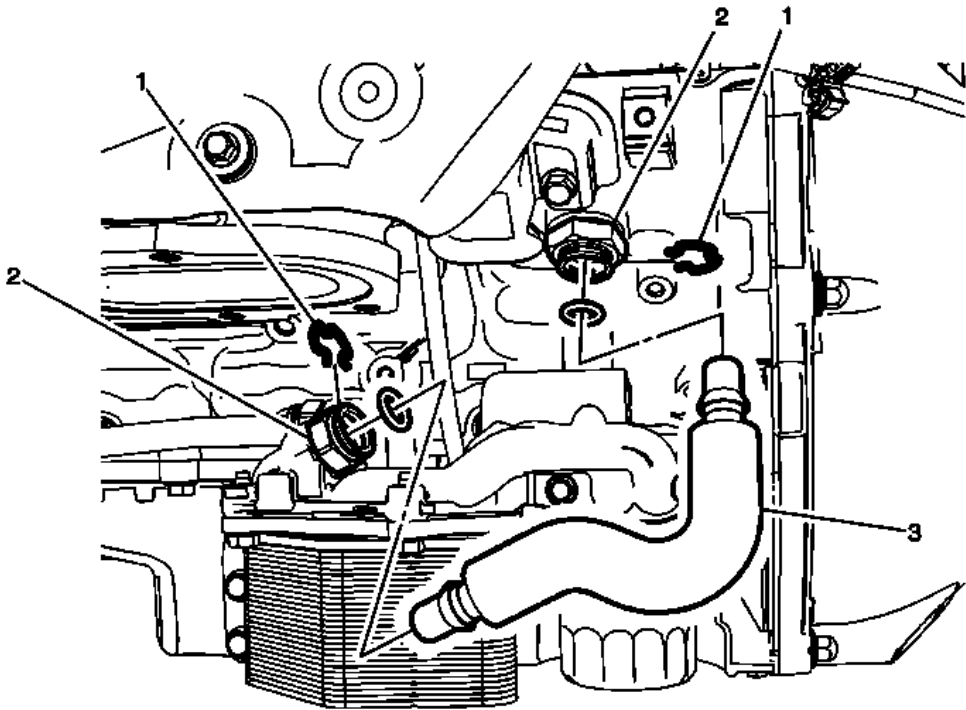


Fig. 31: Engine Oil Cooler Coolant Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Coolant Inlet Hose Replacement

Callout	Component Name
Preliminary Procedures Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .	
1	Turbocharger Coolant Return Pipe Retaining Clip (Qty: 2)
2	Engine Oil Cooler Coolant Inlet Hose Jiffy-Tite® Fastener (Qty: 2) CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure 1. Remove and DISCARD the Jiffy-Tite® fastener.

	Tighten 35 (26 lb ft)
3	Engine Oil Cooler Coolant Inlet Hose

ENGINE OIL COOLER COOLANT OUTLET HOSE REPLACEMENT

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

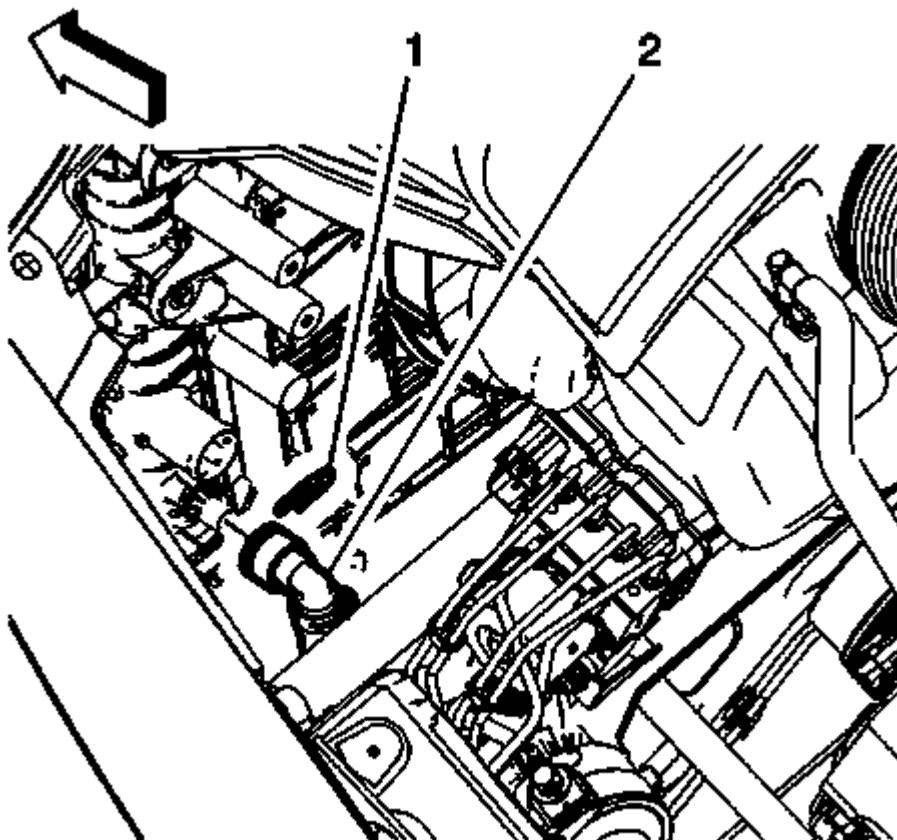


Fig. 32: Retaining Ring And Engine Oil Cooler Coolant Outlet Hose Connector
Courtesy of GENERAL MOTORS COMPANY

2. Remove the retaining ring (1) from the engine oil cooler coolant outlet hose connector at the radiator.
3. Remove the engine oil cooler coolant outlet hose (2) from the radiator.

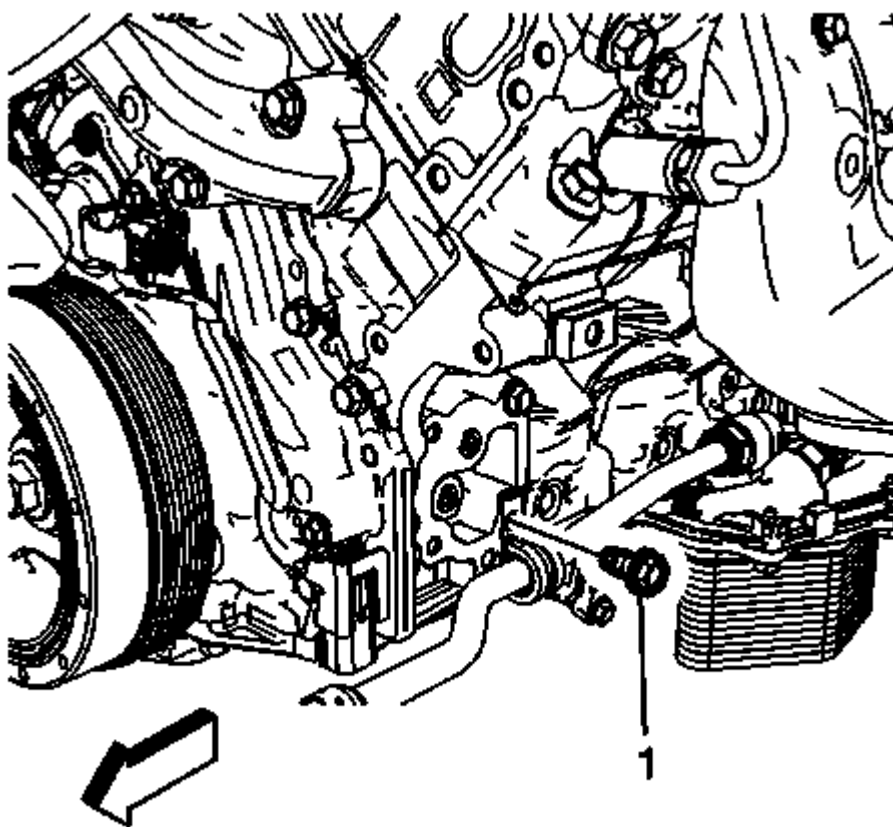


Fig. 33: Engine Oil Cooler Coolant Outlet Hose Bolt And Engine Block
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil cooler coolant outlet hose bolt (1) from the engine block.

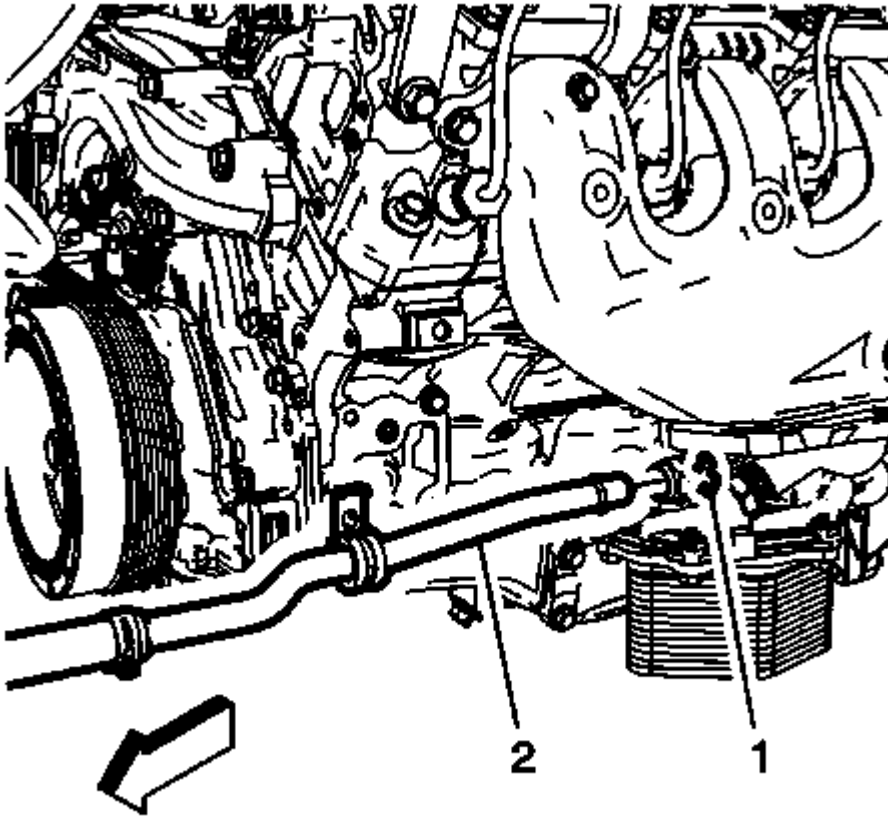


Fig. 34: Retaining Ring And Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

5. Remove the retaining ring (1) from the engine oil cooler.
6. Remove the engine oil cooler coolant outlet hose (2) from the engine oil cooler.
7. Remove the engine oil cooler coolant outlet hose (2) from the vehicle.

Installation Procedure

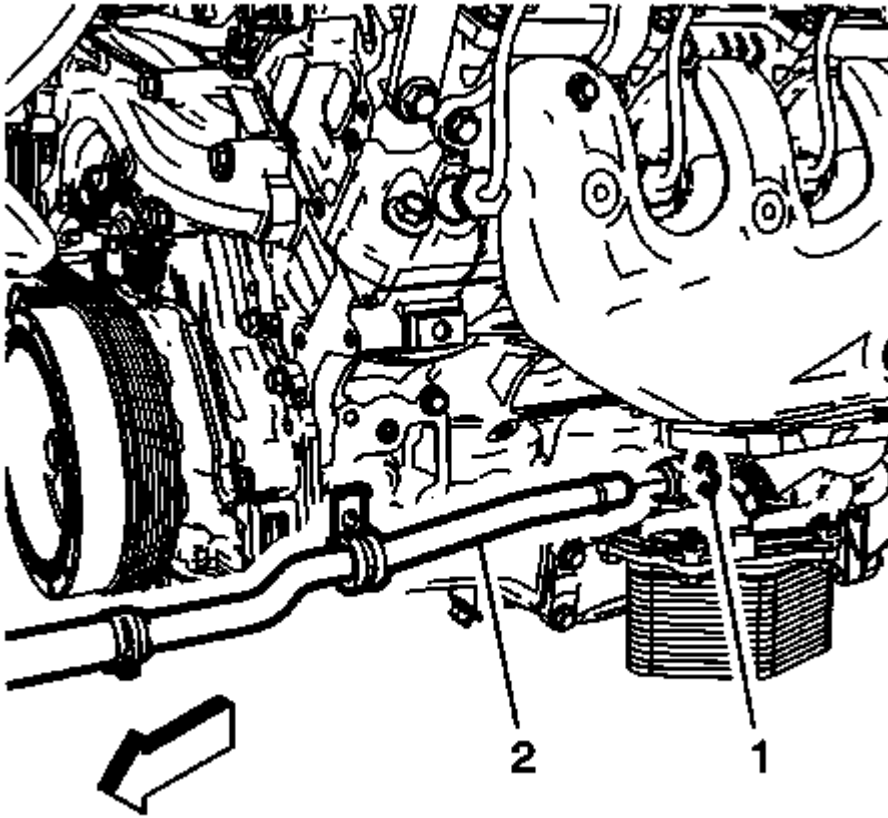


Fig. 35: Retaining Ring And Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil cooler coolant outlet hose (2) to the engine oil cooler.
2. Install the retaining ring (1) to the engine oil cooler.

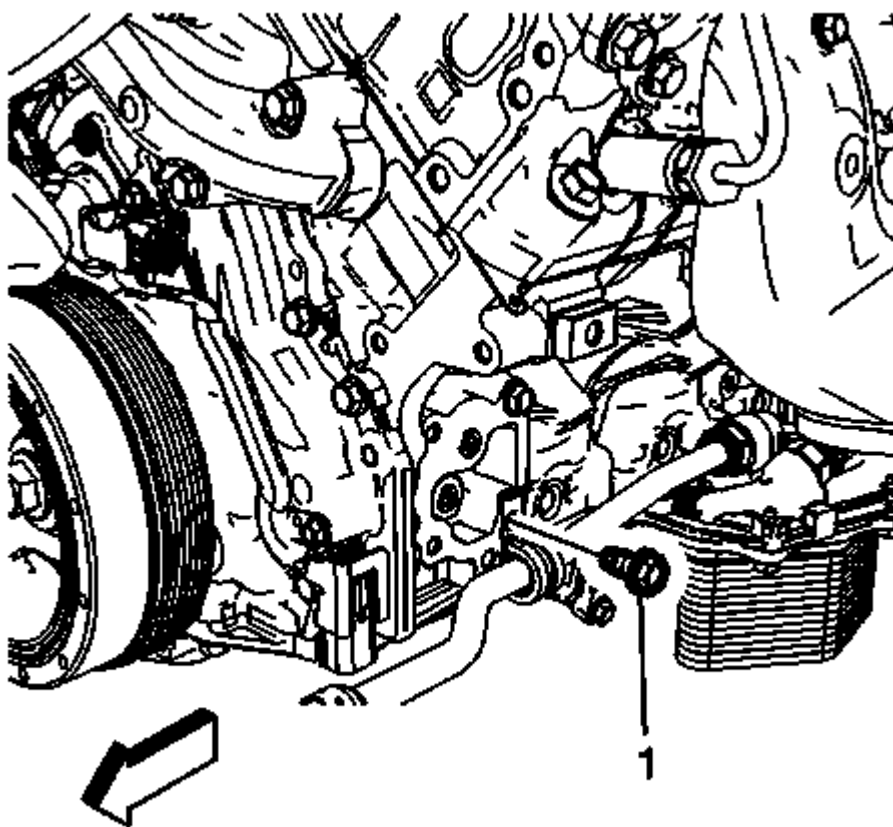


Fig. 36: Engine Oil Cooler Coolant Outlet Hose Bolt And Engine Block
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the engine oil cooler coolant outlet hose bolt (1) to the engine block and tighten to 9 (80 lb in).

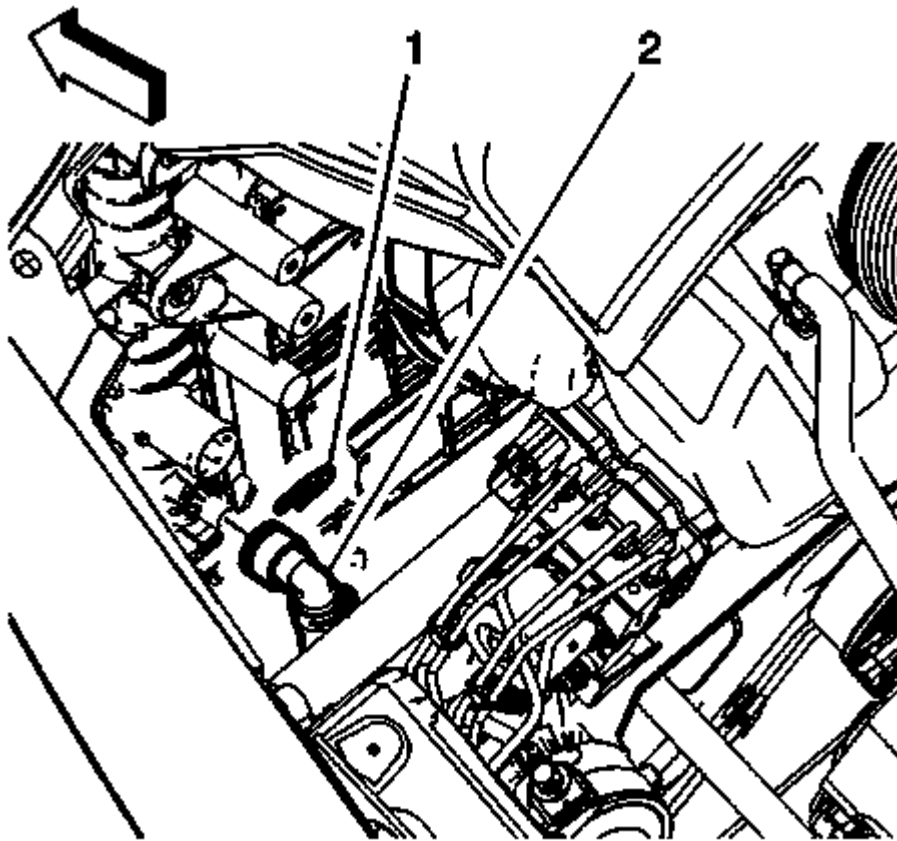


Fig. 37: Retaining Ring And Engine Oil Cooler Coolant Outlet Hose Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine oil cooler coolant outlet hose (2) to the radiator.
5. Install the retaining ring (1) to the engine oil cooler coolant outlet hose connector at the radiator.
6. Lower the vehicle.
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
8. Check the cooling system for leaks.

ENGINE COOLANT FAN REPLACEMENT

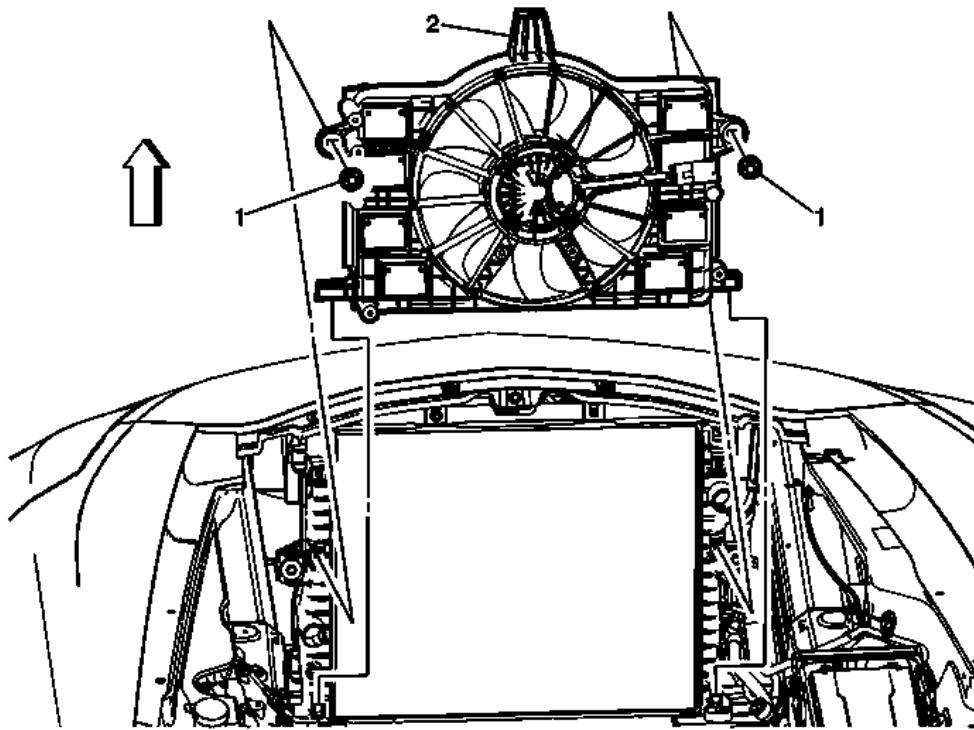


Fig. 38: Engine Coolant Fan And Radiator
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the radiator air upper baffle. Refer to <u>Radiator Air Baffle Replacement</u>. 2. Remove the radiator outlet hose retainers from the shroud. Refer to <u>Radiator Outlet Hose Replacement</u>. 3. Disconnect the engine coolant fan motor electrical connector. 4. Remove the electrical wiring harness from the shroud.	
1	Engine Coolant Fan Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7 (62 lb in)
2	Engine Coolant Fan Procedure Transfer all necessary parts.

ENGINE COOLANT MANIFOLD REPLACEMENT

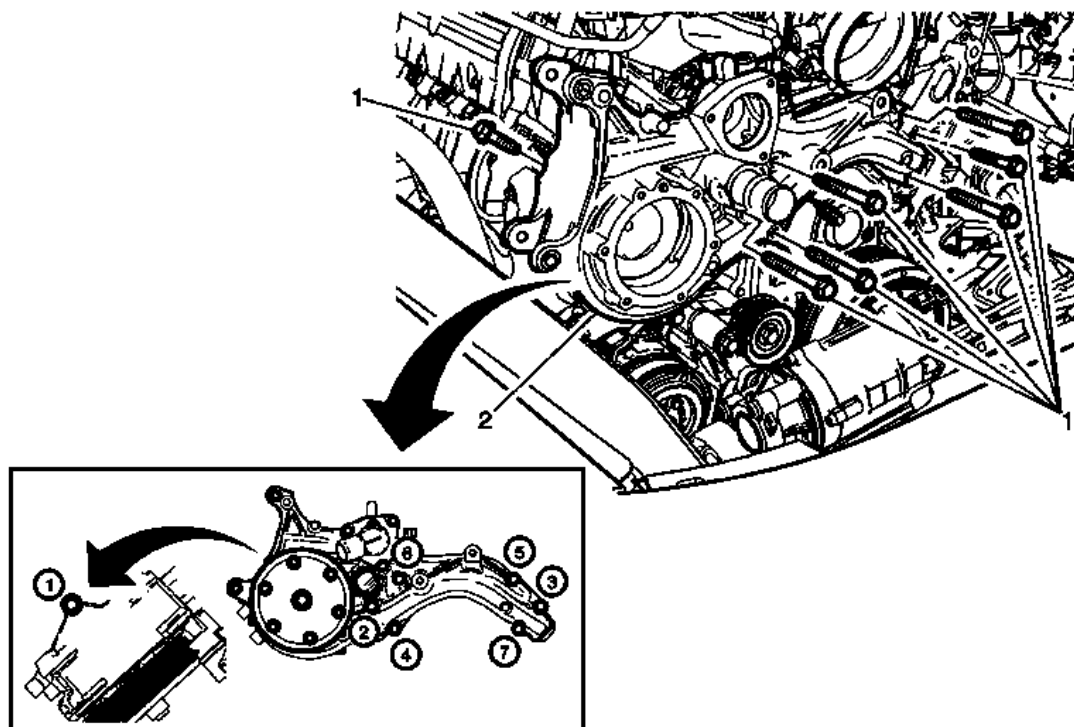


Fig. 39: Engine Coolant Manifold
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Manifold Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the accessory drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> . 3. Remove the generator from the engine coolant manifold and set aside. Refer to <u>Generator Replacement (LT1)</u> . 4. Remove the water pump outlet. Refer to <u>Water Pump Outlet Replacement</u>. 5. Remove the water pump. Refer to <u>Water Pump Replacement</u>. 6. Disconnect the radiator outlet hose. Refer to <u>Radiator Outlet Hose Replacement</u>.	
	Engine Coolant Manifold Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> .

1	1. Clean all fastener threads and apply threadlocker. Refer to <u>Adhesives, Fluids, Lubricants and Sealers</u> . 2. Torque fasteners in sequence shown. Tighten • First Pass - 15 (11 lb ft) • Second Pass - 30 (22 lb ft)
2	Engine Coolant Manifold Procedure 1. Clean and inspect the engine coolant manifold and engine gasket surfaces. 2. Install NEW engine coolant manifold gaskets.

WATER PUMP REPLACEMENT

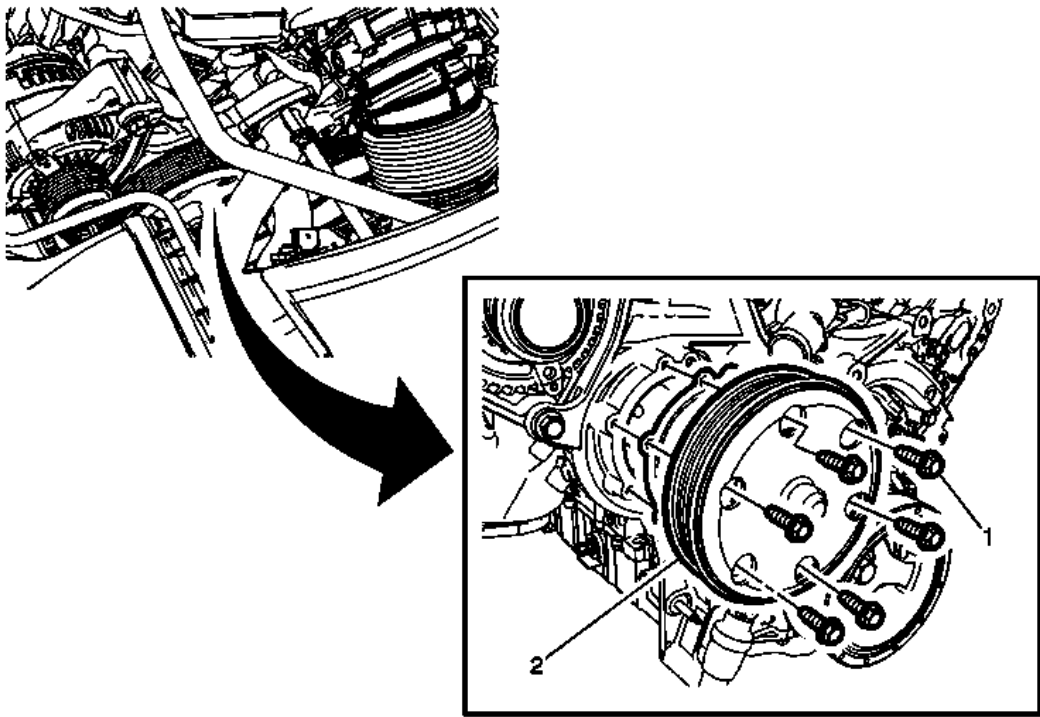


Fig. 40: Water Pump
 Courtesy of GENERAL MOTORS COMPANY

Water Pump Replacement

Callout	Component Name

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

1	Water Pump Fastener (Qty: 6) CAUTION: Refer to Fastener Caution. Tighten • First Pass - 15 (11 lb ft) • Second Pass - 30 (22 lb ft)
2	Water Pump Procedure 1. Clean and inspect the water pump and pump housing. 2. Install a NEW water pump gasket.

WATER PUMP OUTLET REPLACEMENT

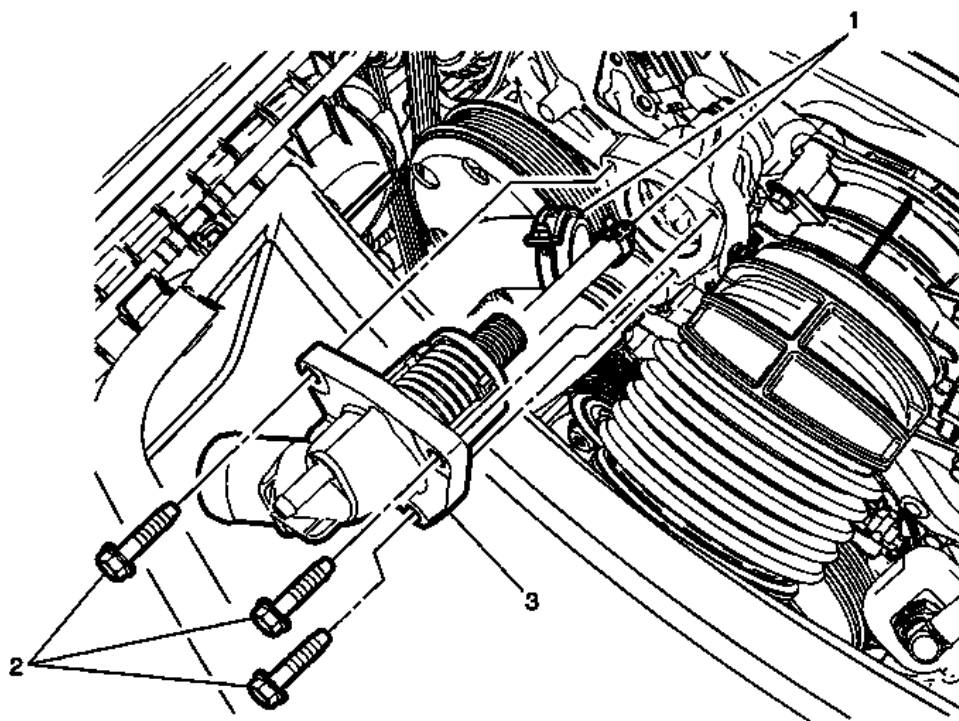


Fig. 41: Water Pump Outlet

Water Pump Outlet Replacement

Callout	Component Name
Preliminary Procedures Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Coolant Hose Clamps (Qty: 2)
2	Water Pump Outlet Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
3	Water Pump Outlet

RADIATOR DRAIN COCK REPLACEMENT

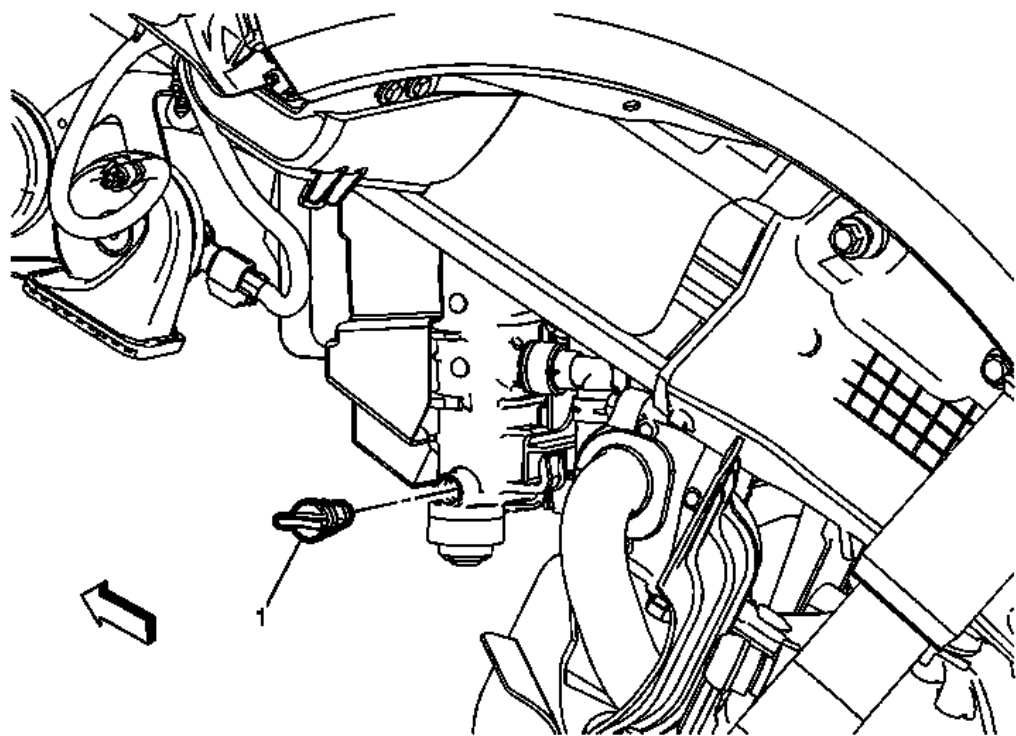


Fig. 42: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

Radiator Drain Cock Replacement

Callout	Component Name

1. Remove the left front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
2. Place a drain pan under the radiator drain cock.
3. Drain the engine coolant. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

1

Radiator Drain Cock

CAUTION:
Refer to **Fastener Caution** .

Tighten
2 (18 lb in)

RADIATOR REPLACEMENT

Removal Procedure

1. Recover the refrigerant from the A/C system. Refer to **Refrigerant Recovery and Recharging (LT1)** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

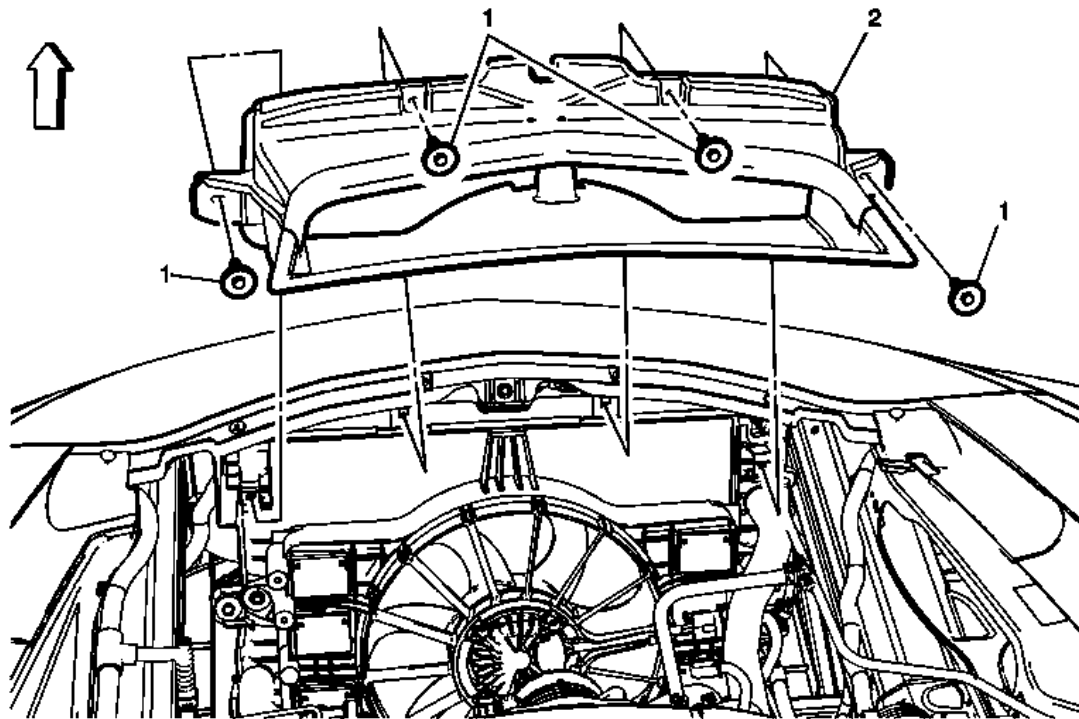


Fig. 43: Radiator Air Upper Baffle Extension

Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator air upper baffle extension (2). Refer to **Radiator Air Upper Baffle Extension Replacement**.

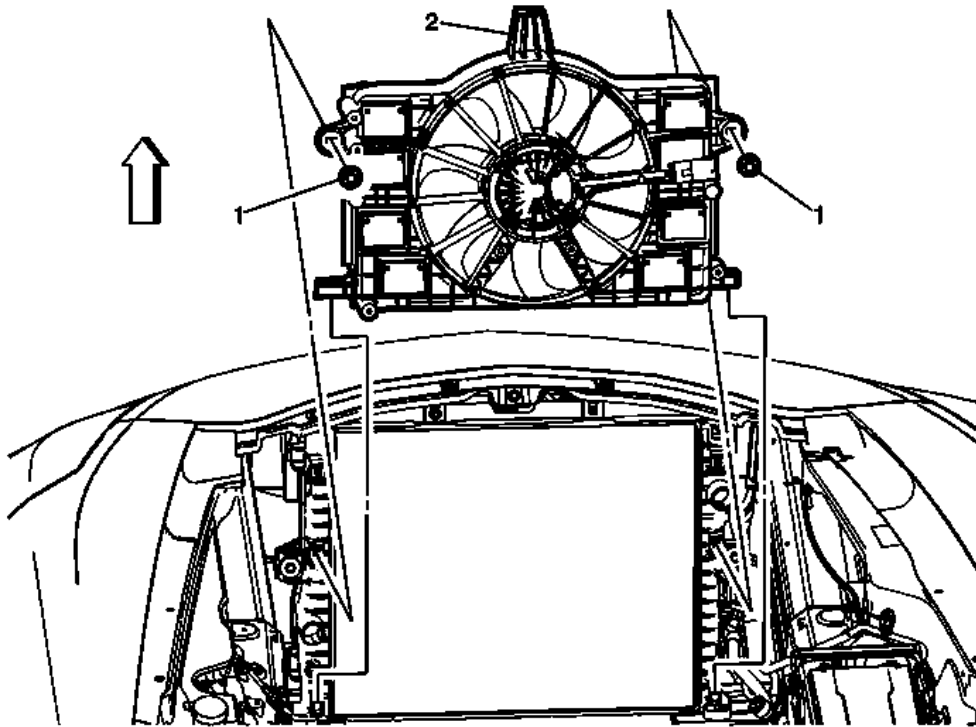


Fig. 44: Engine Coolant Fan And Radiator
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine coolant fan (2) from the radiator and remove from the vehicle. Refer to **Engine Coolant Fan Replacement**.

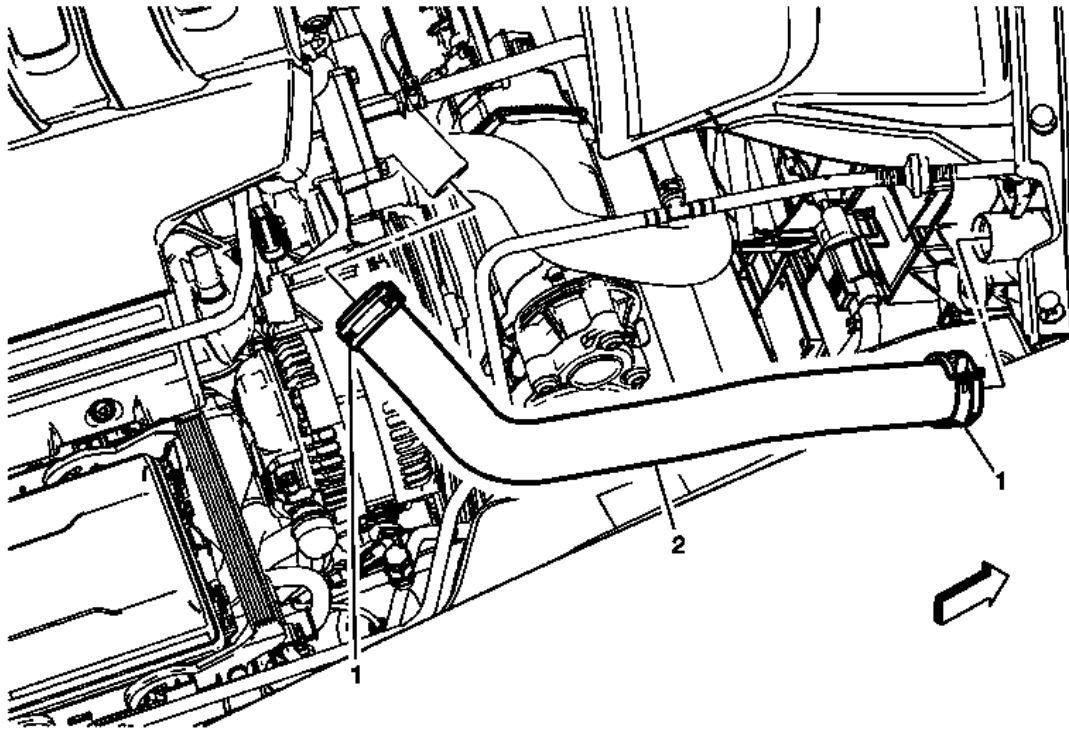


Fig. 45: Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Removed the radiator inlet hose (2) from the radiator. Refer to **Radiator Inlet Hose Replacement**.

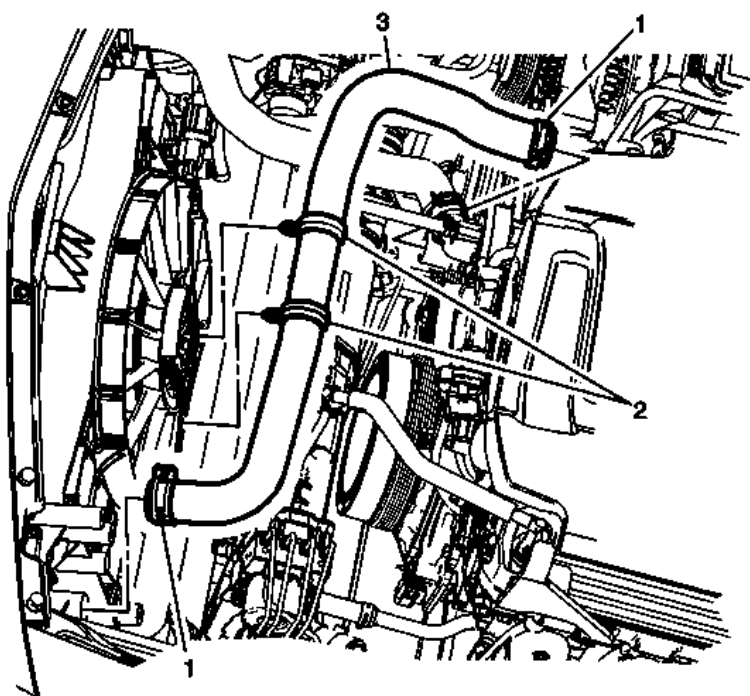


Fig. 46: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Removed the radiator outlet hose (2) from the radiator. Refer to **Radiator Outlet Hose Replacement**.

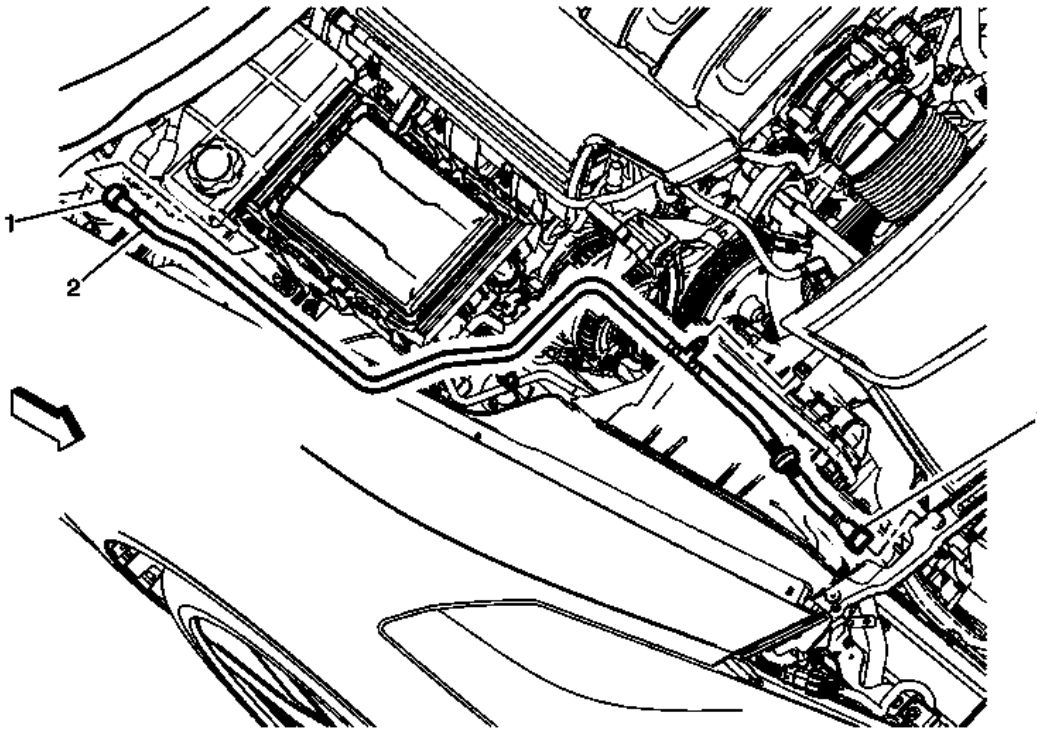


Fig. 47: Radiator Surge Tank Inlet Hose And Radiator
Courtesy of GENERAL MOTORS COMPANY

7. Remove the radiator surge tank inlet hose (2) from the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (Radiator Surge Tank to Radiator)**, **Radiator Surge Tank Inlet Hose Replacement (Radiator Surge Tank Hose Connector to Water Outlet)**.

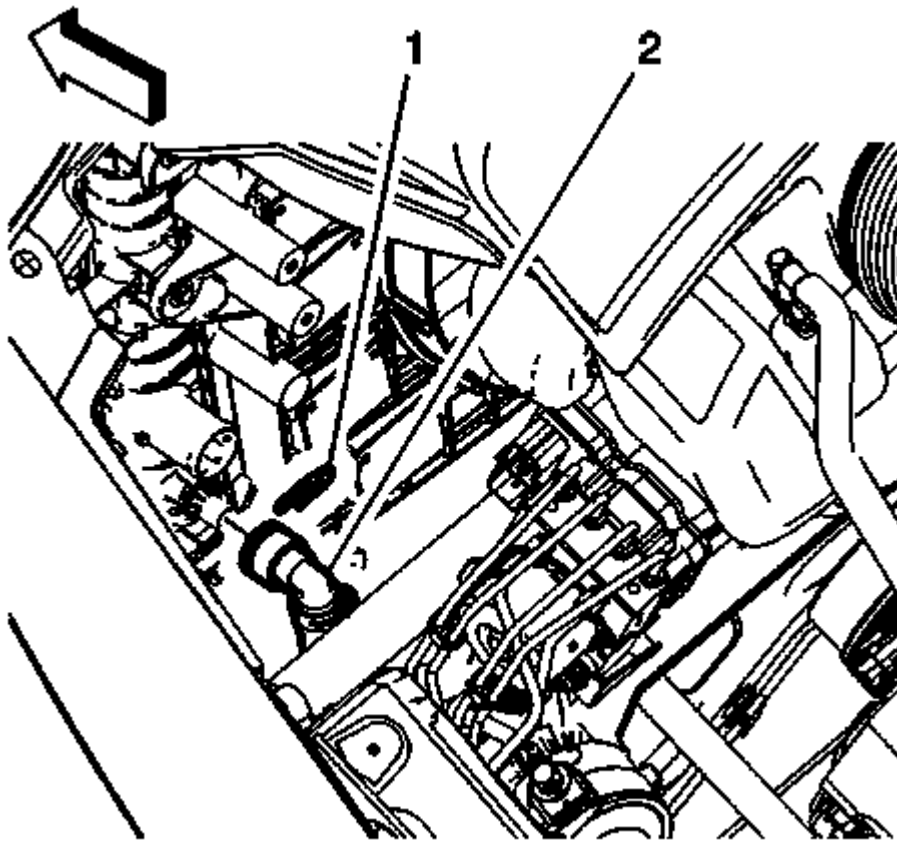


Fig. 48: Retaining Ring And Engine Oil Cooler Coolant Outlet Hose Connector
Courtesy of GENERAL MOTORS COMPANY

8. Remove the engine oil cooler coolant outlet hose (2) from the radiator. Refer to **Engine Oil Cooler Coolant Outlet Hose Replacement**.

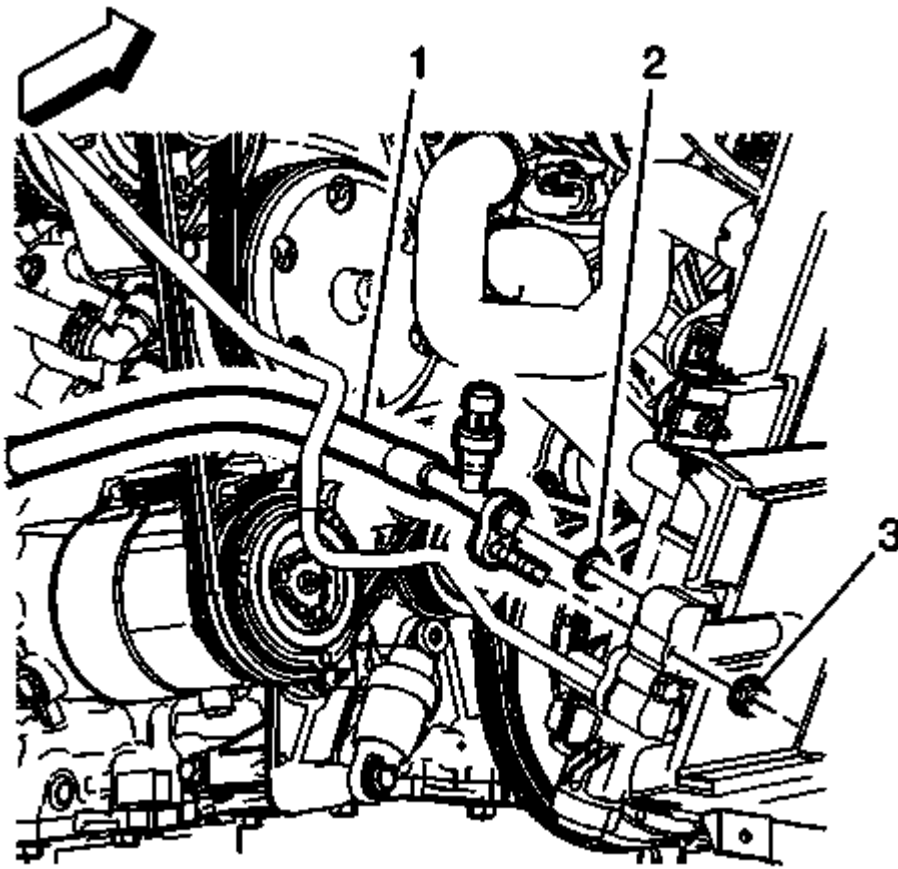


Fig. 49: Air Conditioning Compressor And Condenser
Courtesy of GENERAL MOTORS COMPANY

9. Remove the air conditioning compressor and condenser hose (1) from the condenser. Refer to **Air Conditioning Compressor and Condenser Hose Replacement** .

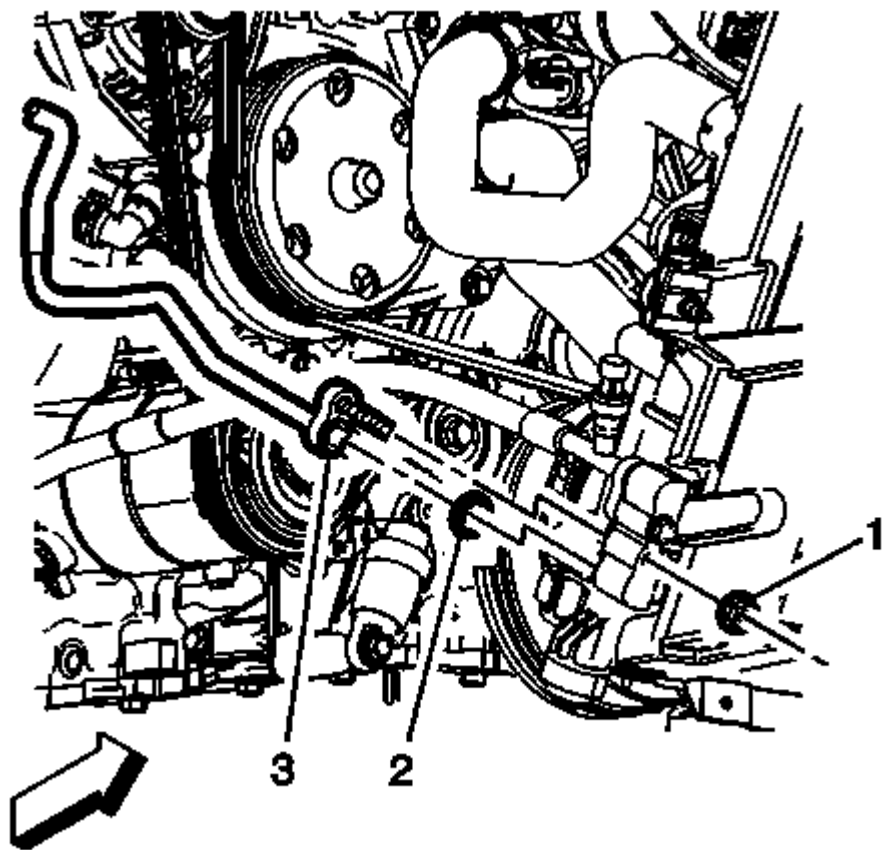


Fig. 50: Air Conditioning Evaporator Thermal Expansion Valve Front Tube
Courtesy of GENERAL MOTORS COMPANY

10. Remove the air conditioning evaporator thermal expansion valve front tube (3) from the condenser. Refer to **Air Conditioning Evaporator Thermal Expansion Valve Front Tube Replacement**.

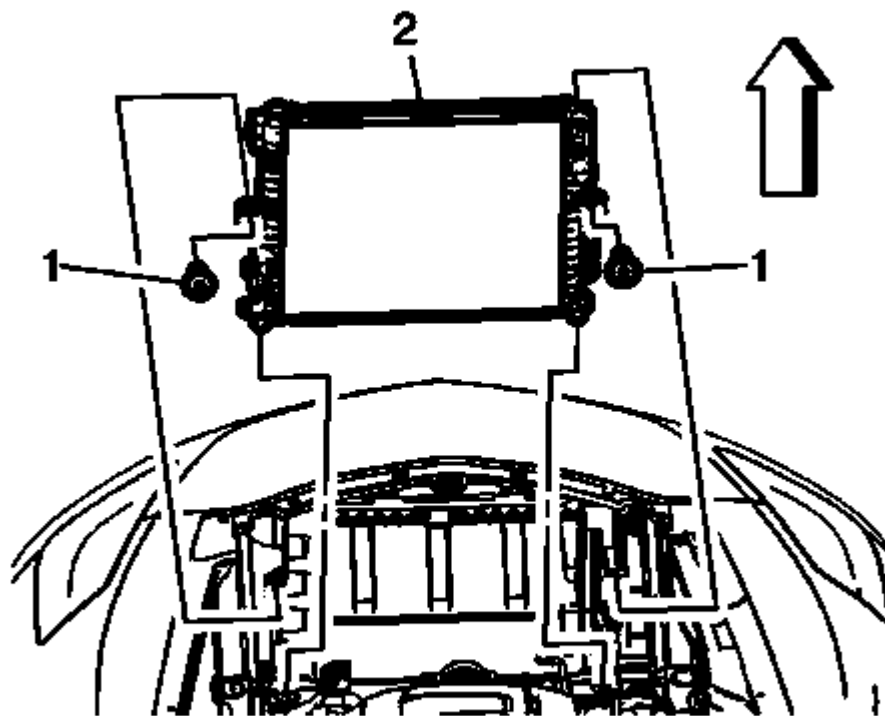


Fig. 51: Radiator Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the radiator mounting bolts (1).
12. Tilt the radiator and air conditioning condenser (2) rearward and remove the radiator and condenser from the vehicle as an assembly.

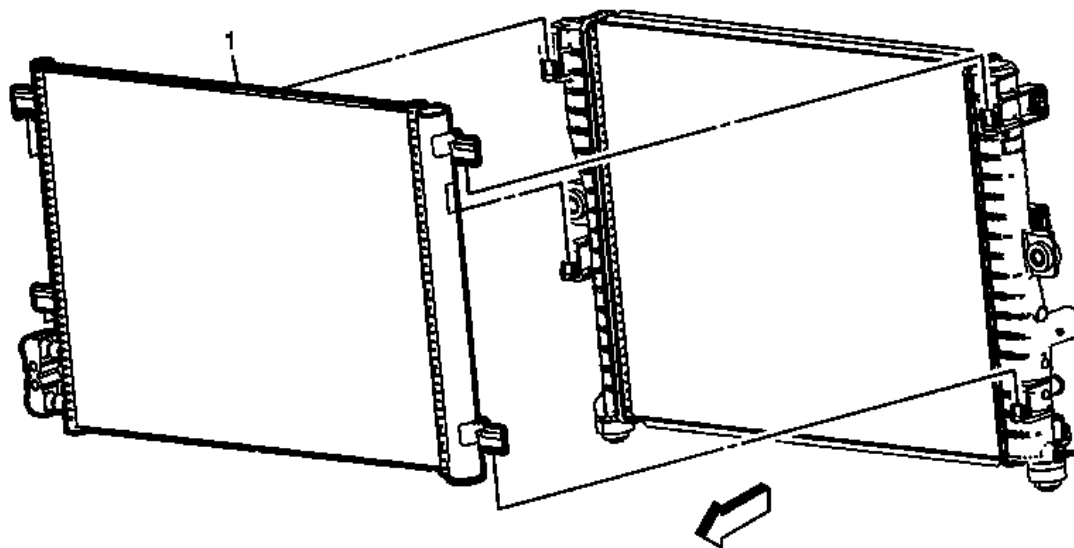


Fig. 52: Air Conditioning Condenser
Courtesy of GENERAL MOTORS COMPANY

13. Remove the air conditioning condenser (1) from the radiator if replacing the air conditioning condenser or radiator. Refer to **Air Conditioning Condenser Replacement** .

Installation Procedure

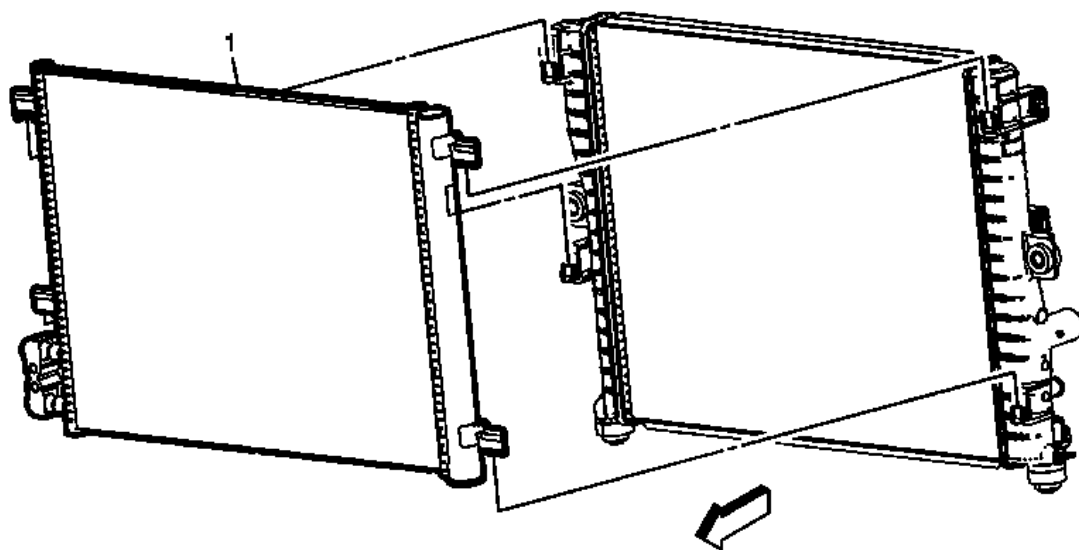


Fig. 53: Air Conditioning Condenser
Courtesy of GENERAL MOTORS COMPANY

1. If replacing the air conditioning condenser or radiator install the air conditioning condenser (1) to the radiator. Refer to **Air Conditioning Condenser Replacement** .

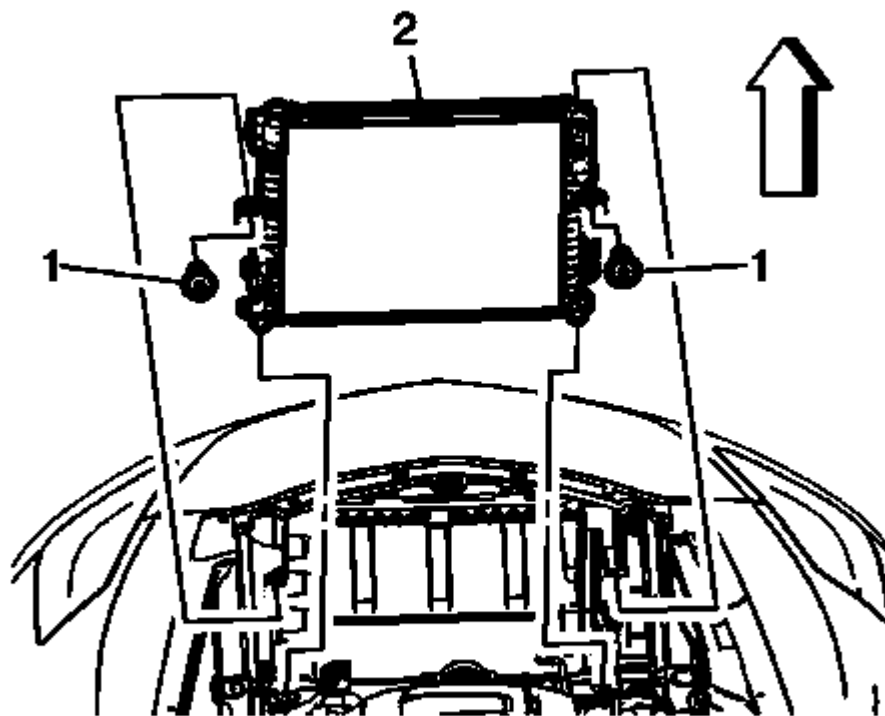


Fig. 54: Radiator Mounting Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Tilt the radiator and air conditioning condenser (2) rearward and install the radiator and air conditioning condenser to vehicle as an assembly.
3. Install the radiator mounting bolts (1) to the radiator air baffle and tighten to 20 (15 lb ft).

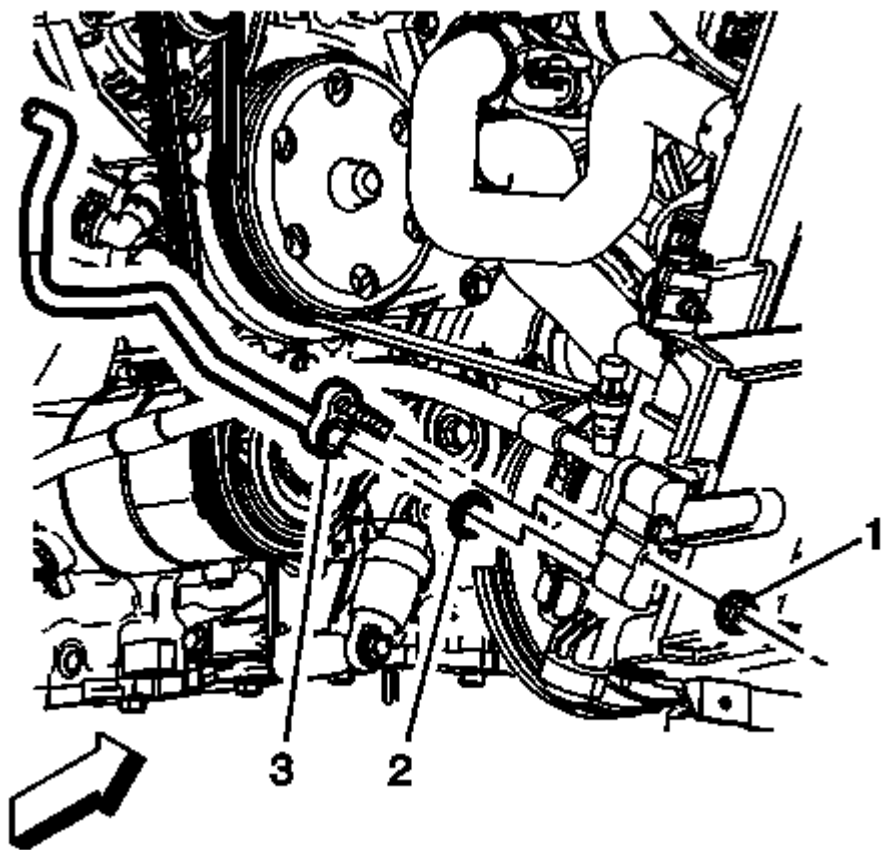


Fig. 55: Air Conditioning Evaporator Thermal Expansion Valve Front Tube
Courtesy of GENERAL MOTORS COMPANY

4. Install the air conditioning evaporator thermal expansion valve front tube (3) to the condenser. Refer to **Air Conditioning Evaporator Thermal Expansion Valve Front Tube Replacement**.

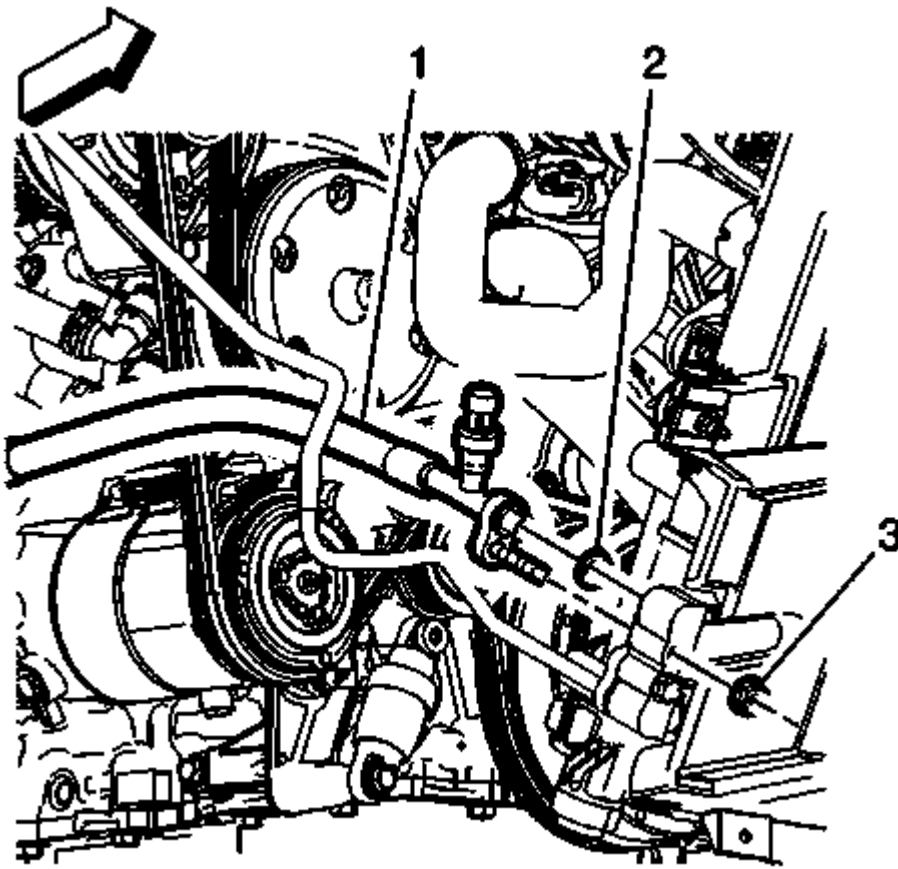


Fig. 56: Air Conditioning Compressor And Condenser
Courtesy of GENERAL MOTORS COMPANY

5. Install the air conditioning compressor and condenser hose (1) to the condenser. Refer to **Air Conditioning Compressor and Condenser Hose Replacement** .

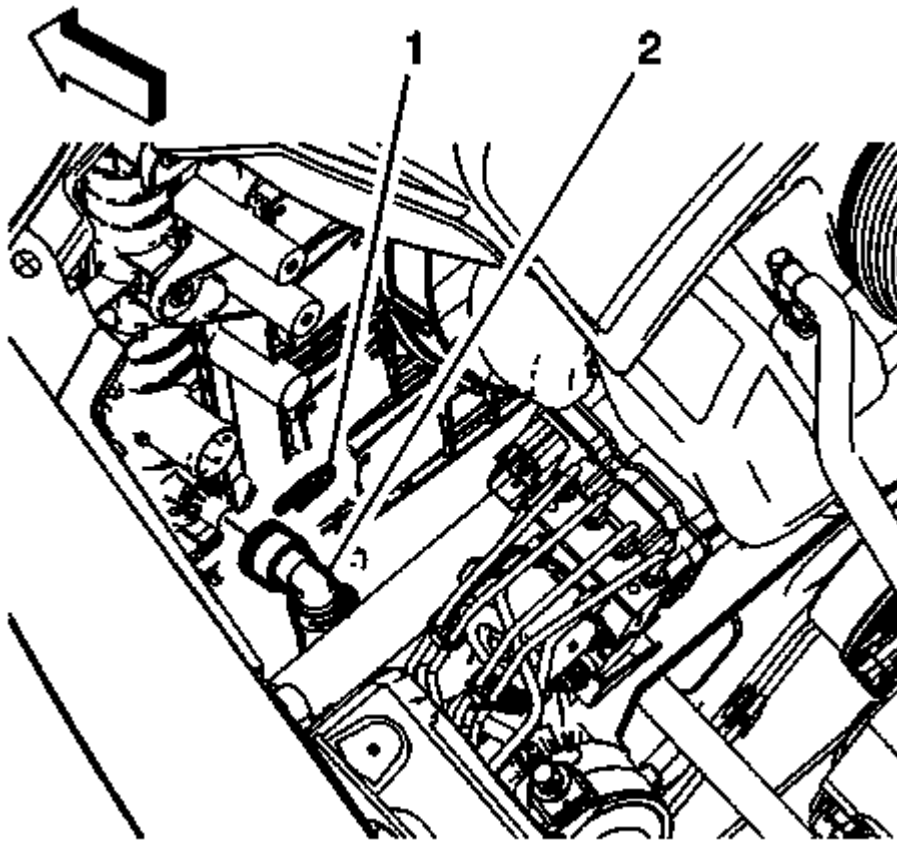


Fig. 57: Retaining Ring And Engine Oil Cooler Coolant Outlet Hose Connector
Courtesy of GENERAL MOTORS COMPANY

6. Install the engine oil cooler coolant outlet hose (2) to the radiator. Refer to **Engine Oil Cooler Coolant Outlet Hose Replacement**.

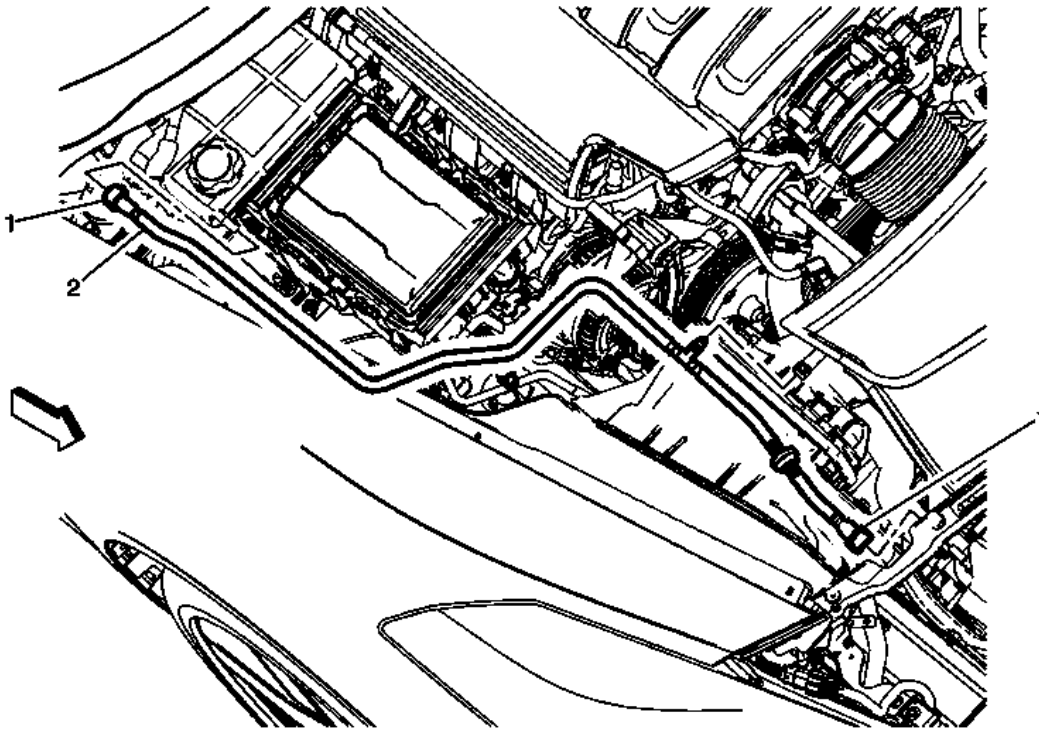


Fig. 58: Radiator Surge Tank Inlet Hose And Radiator
Courtesy of GENERAL MOTORS COMPANY

7. Install the radiator surge tank inlet hose (2) to the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (Radiator Surge Tank to Radiator)**, **Radiator Surge Tank Inlet Hose Replacement (Radiator Surge Tank Hose Connector to Water Outlet)**.

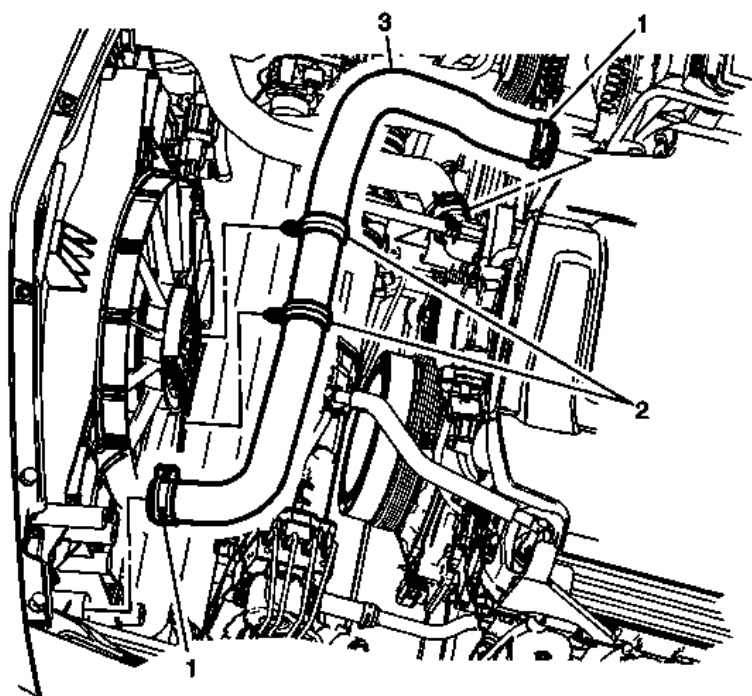


Fig. 59: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

8. Install the radiator outlet hose (2) to the radiator. Refer to **Radiator Outlet Hose Replacement**.

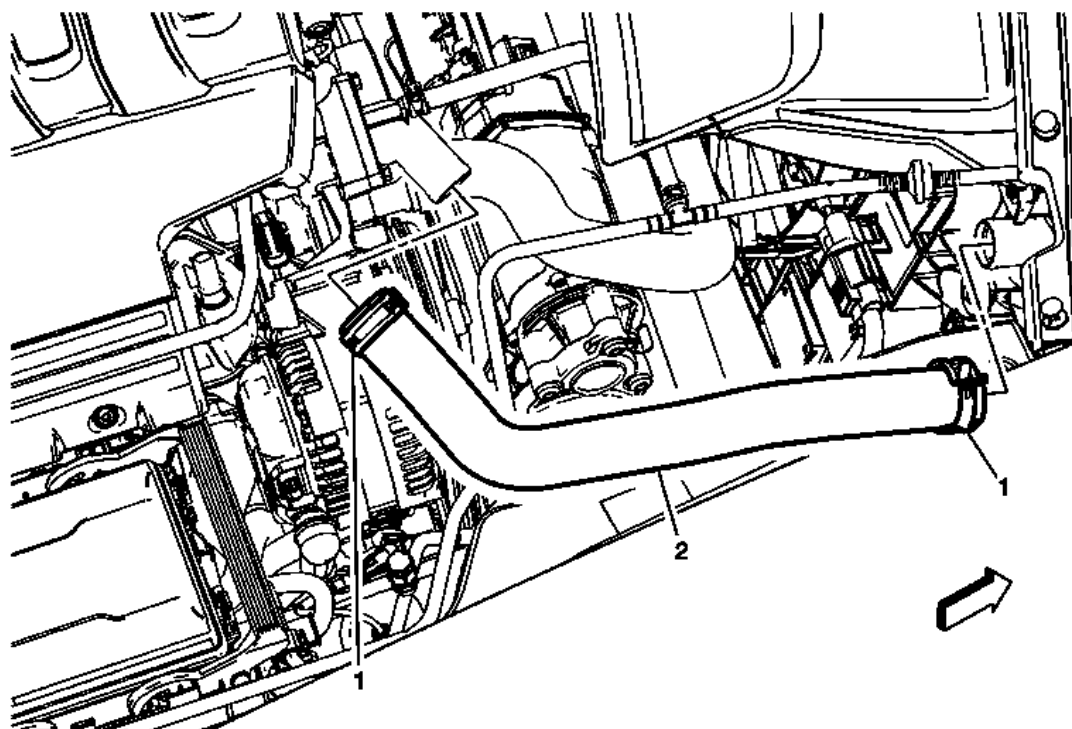


Fig. 60: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

9. Install the radiator inlet hose (2) to the radiator. Refer to Radiator Inlet Hose Replacement.

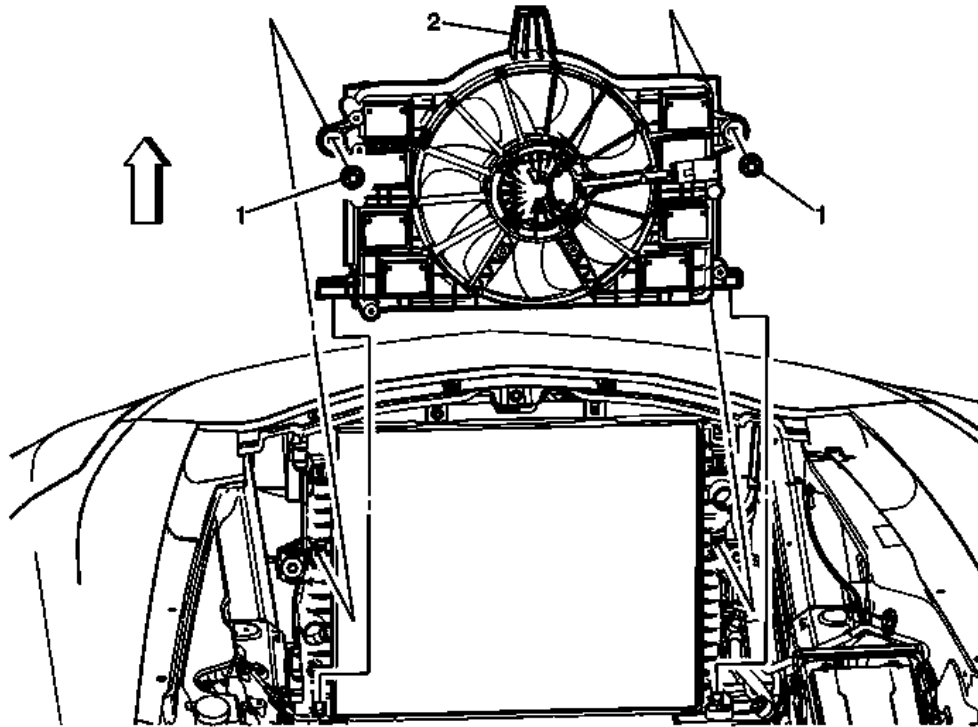


Fig. 61: Engine Coolant Fan And Radiator

Courtesy of GENERAL MOTORS COMPANY

10. Install the cooling fan and shroud (2) to the radiator. Refer to Engine Coolant Fan Replacement.

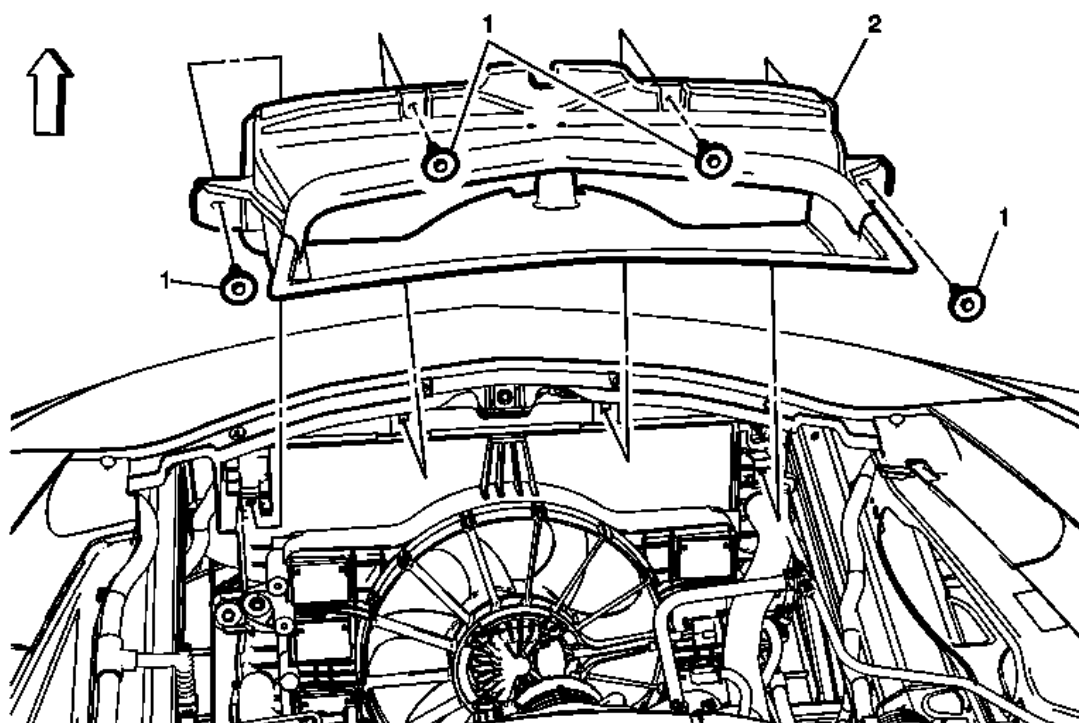


Fig. 62: Radiator Air Upper Baffle Extension
Courtesy of GENERAL MOTORS COMPANY

11. Install the radiator air upper baffle extension (2). Refer to **Radiator Air Upper Baffle Extension Replacement**.
12. Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
13. Check the cooling system for leaks.
14. Evacuate and recharge the A/C system. Refer to **Refrigerant Recovery and Recharging (LT1)**.

RADIATOR LOWER INSULATOR REPLACEMENT

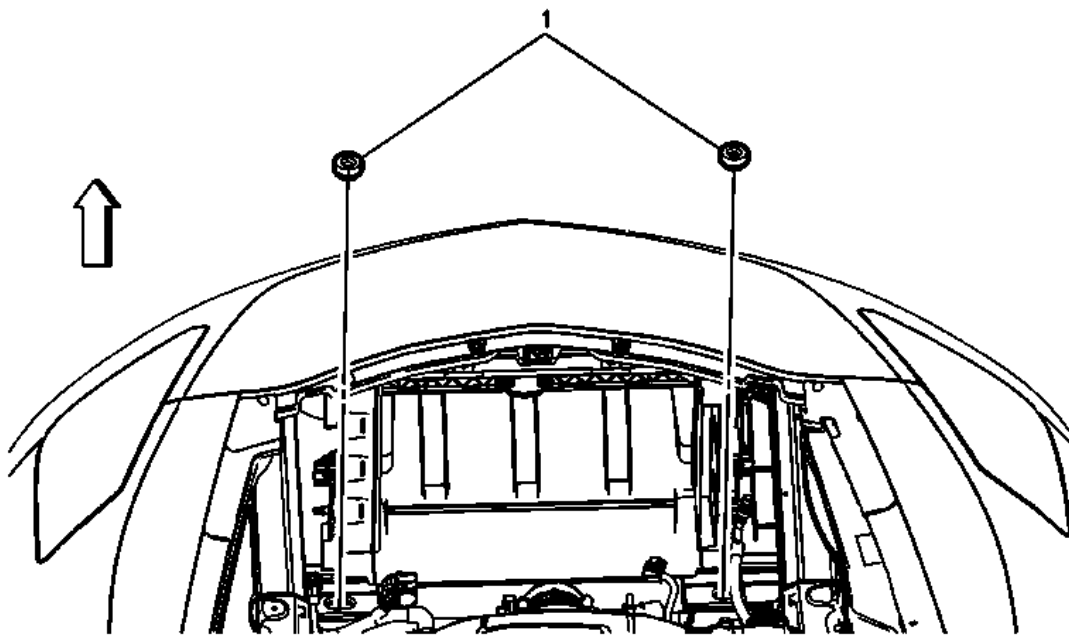


Fig. 63: Radiator Lower Insulator
Courtesy of GENERAL MOTORS COMPANY

Radiator Lower Insulator Replacement

Callout	Component Name
Preliminary Procedure	
Remove the radiator and condenser as an assembly. Refer to Radiator Replacement .	
1	Radiator Lower Insulator (Qty: 2)

RADIATOR AIR BAFFLE REPLACEMENT

Removal Procedure

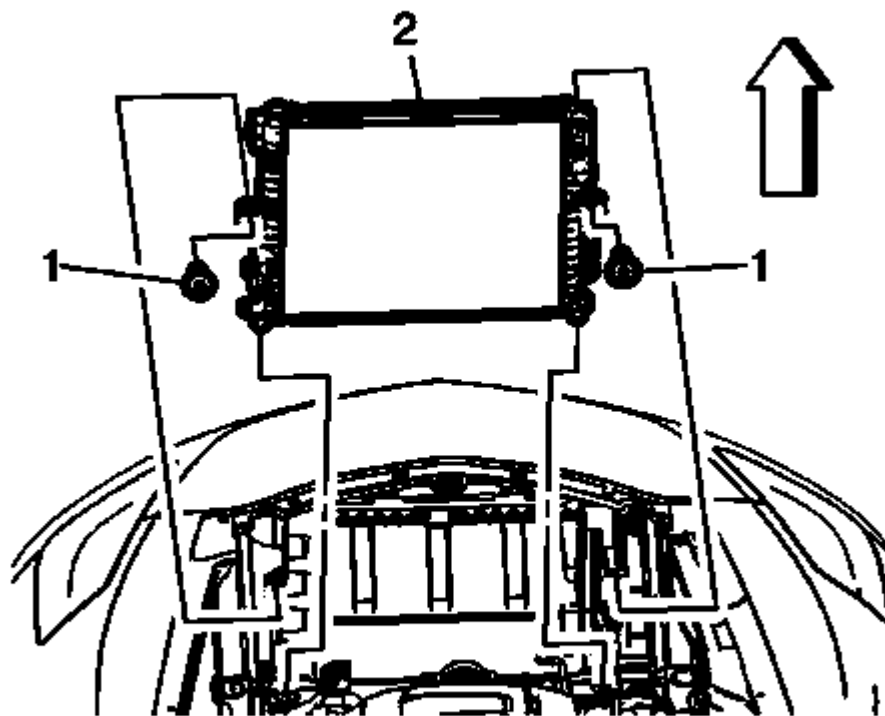


Fig. 64: Radiator Mounting Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the radiator and condenser (2) from the vehicle as an assembly. Refer to **Radiator Replacement**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

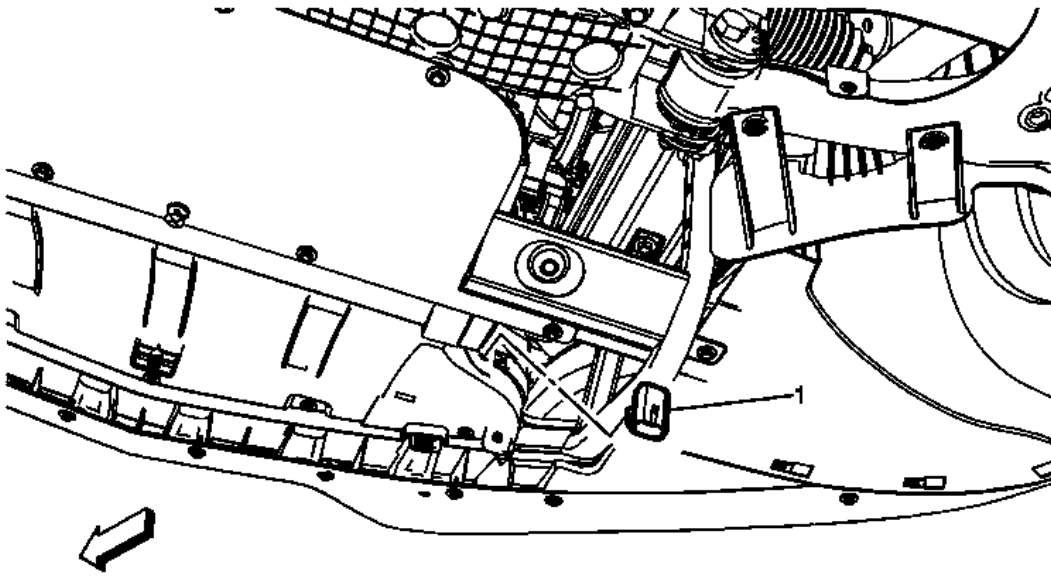


Fig. 65: Ambient Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ambient air temperature sensor (1) from the radiator air baffle and reposition out of the way. Refer to **Radiator Air Baffle Replacement**.

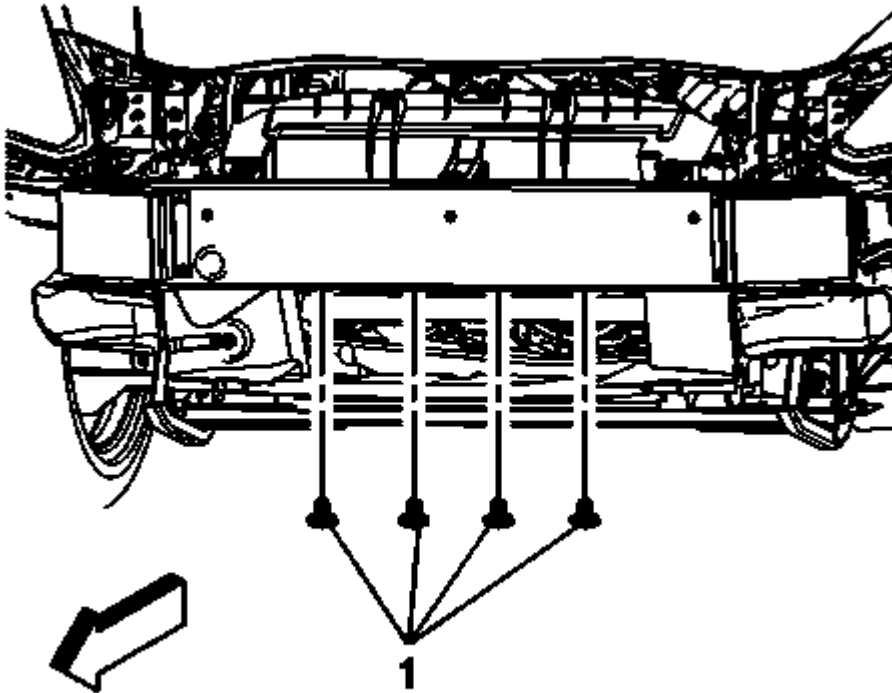


Fig. 66: Radiator Air Baffle Retainers
Courtesy of GENERAL MOTORS COMPANY

5. Remove the radiator air baffle retainers (1) from the front end lower body rail cross bar.

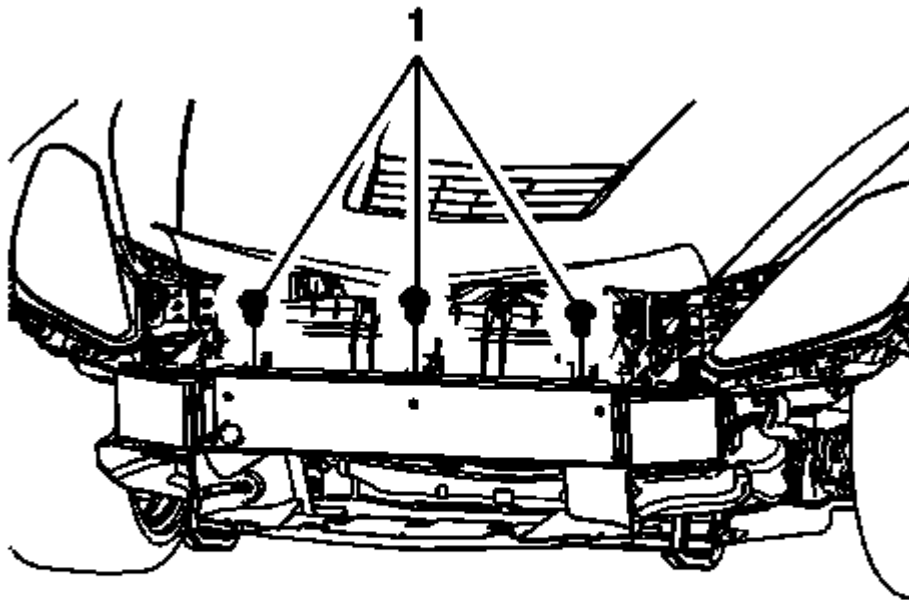


Fig. 67: Radiator Air Baffle Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the radiator air baffle bolts (1) from the front end lower body rail cross bar.
7. Lower the vehicle.

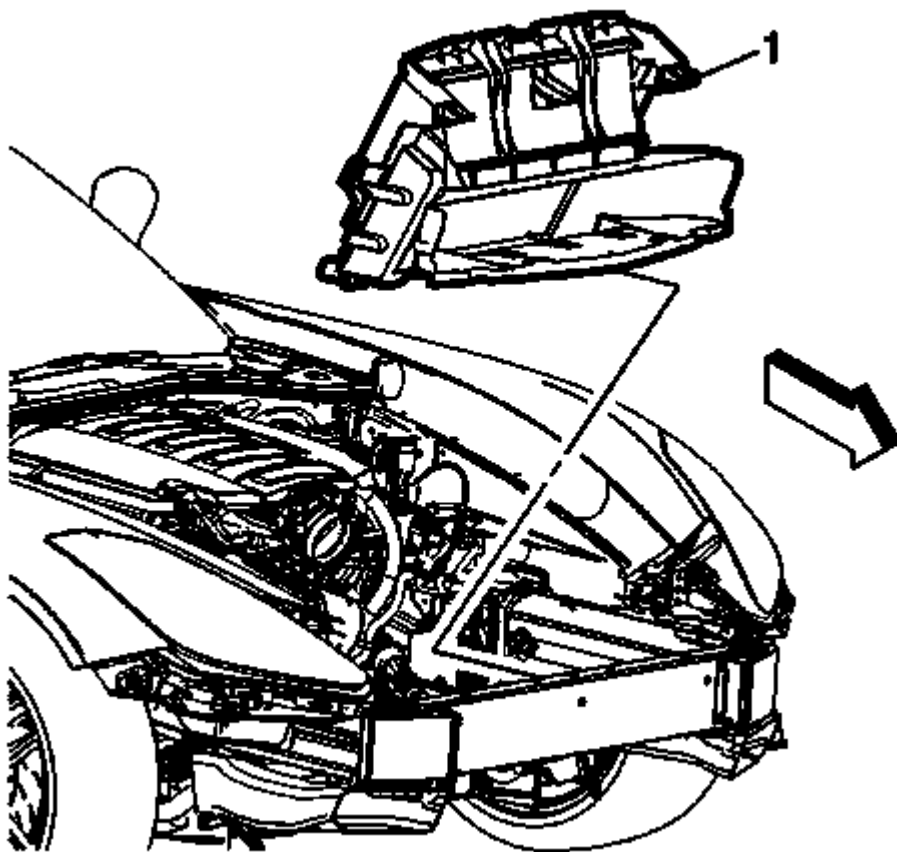


Fig. 68: Radiator Air Baffle

Courtesy of GENERAL MOTORS COMPANY

8. Remove the radiator air baffle (1) from the vehicle.

Installation Procedure

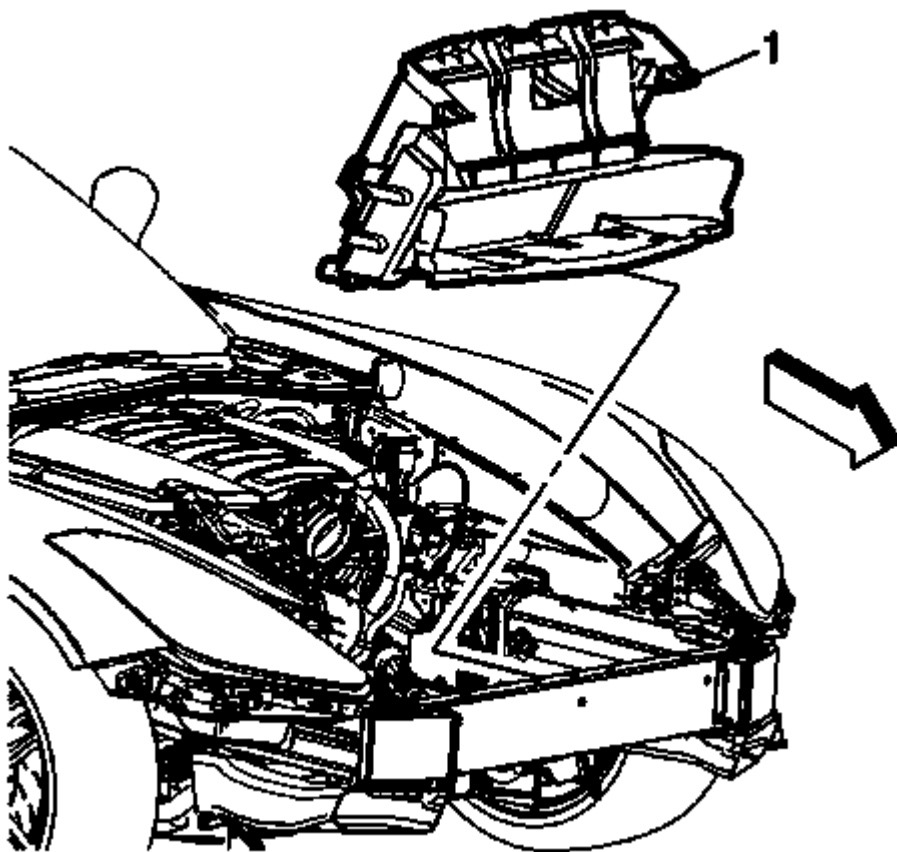


Fig. 69: Radiator Air Baffle

Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator air baffle (1) to the vehicle.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

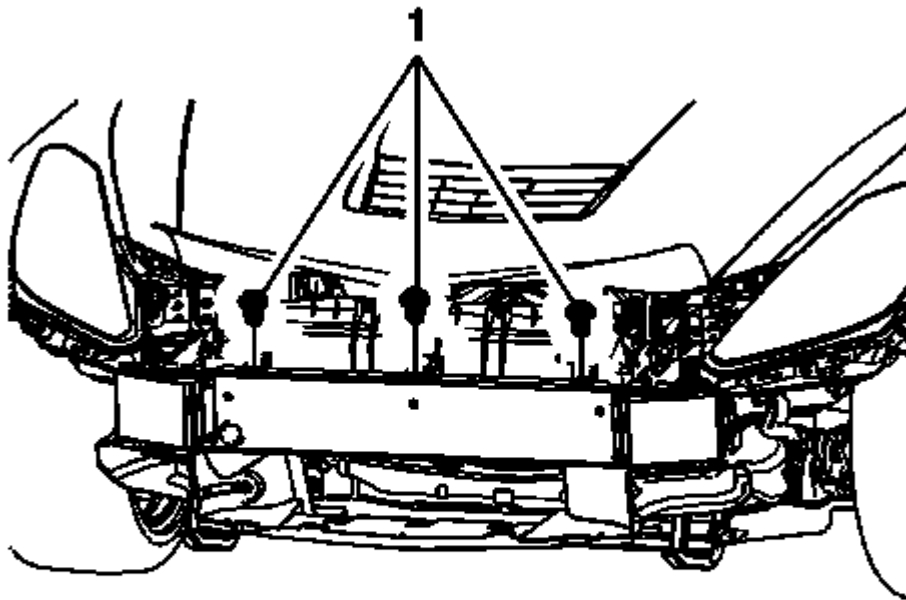


Fig. 70: Radiator Air Baffle Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the radiator air baffle bolts (1) to the front end lower body rail cross bar and tighten to 7 (62 lb in).

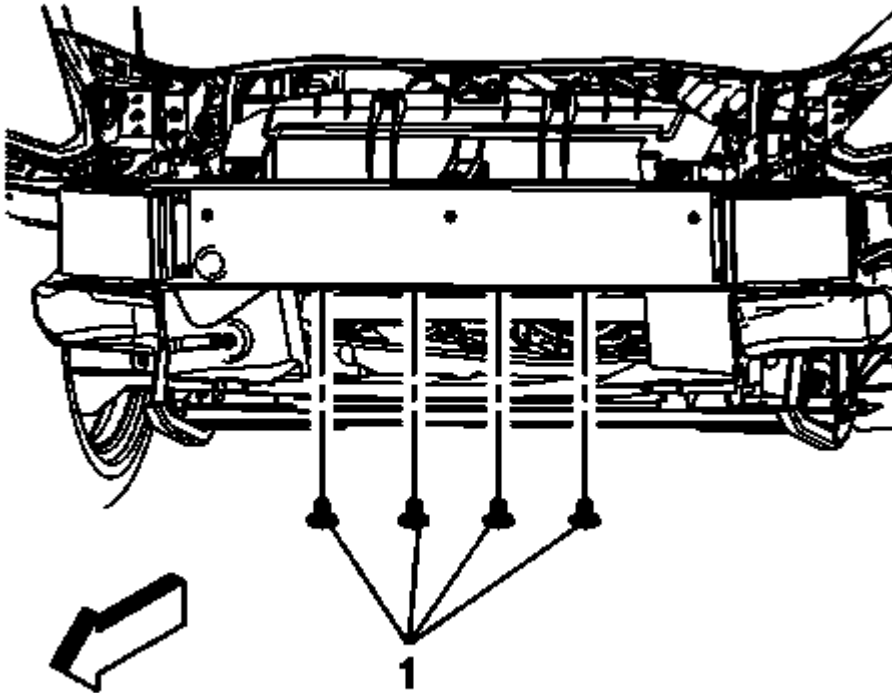


Fig. 71: Radiator Air Baffle Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Install the radiator air baffle retainers (1) to the front end lower body rail cross bar.

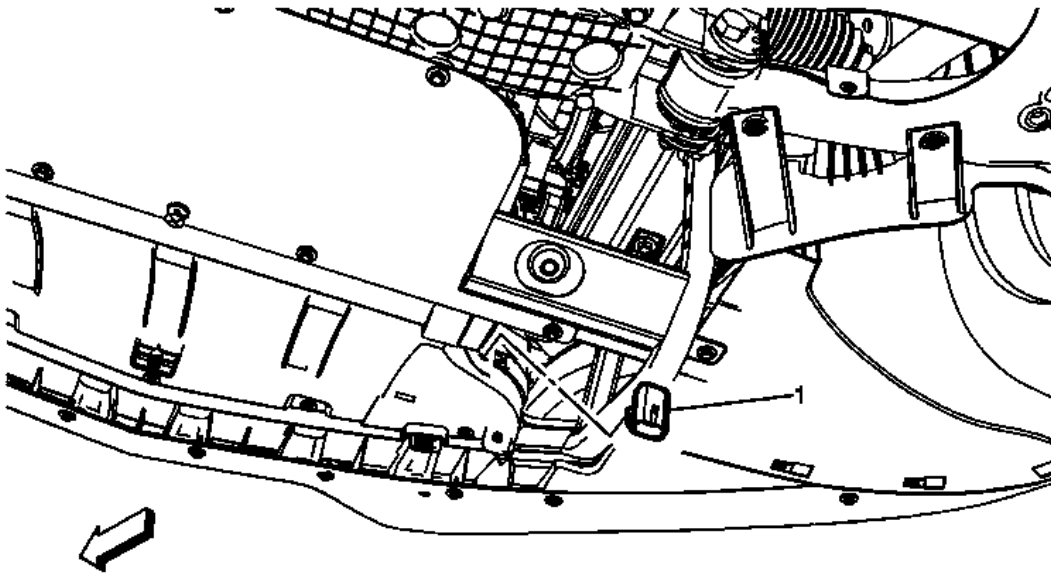


Fig. 72: Ambient Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Install the ambient air temperature sensor (1) to the radiator air baffle and reposition out of the way. Refer to **Radiator Air Baffle Replacement**.
6. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .
7. Lower the vehicle.

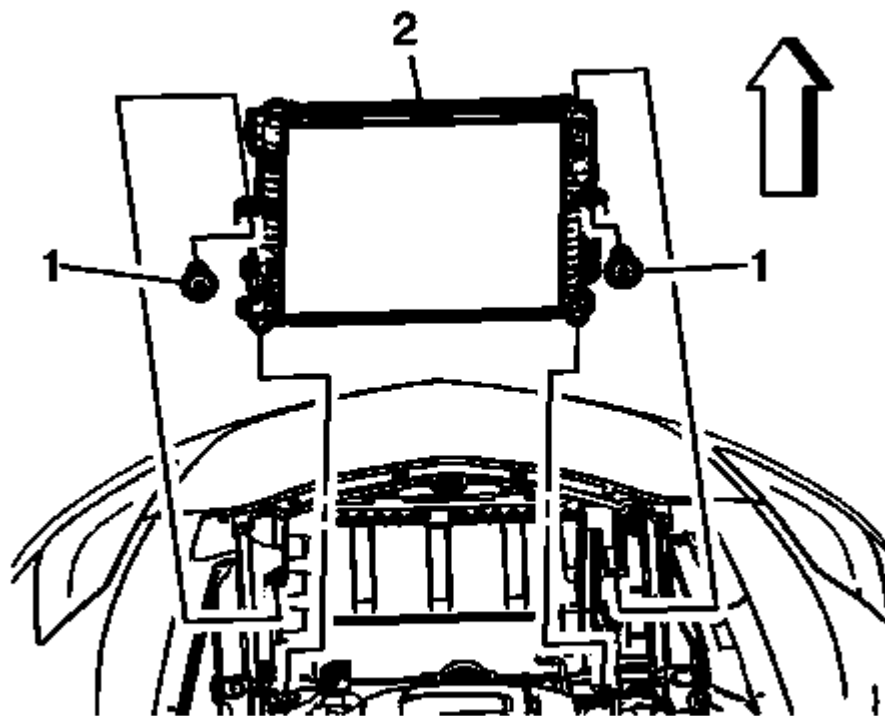


Fig. 73: Radiator Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the radiator and condenser (2) to the vehicle as an assembly. Refer to **Radiator Replacement**.

RADIATOR AIR UPPER BAFFLE EXTENSION REPLACEMENT

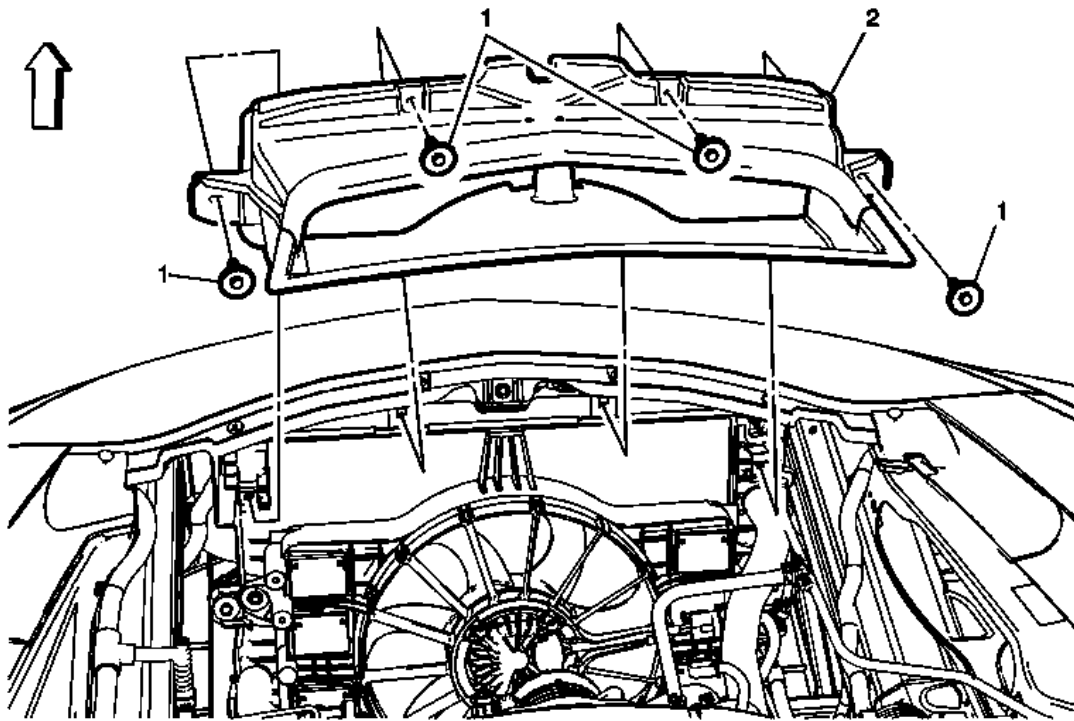


Fig. 74: Radiator Air Upper Baffle Extension
Courtesy of GENERAL MOTORS COMPANY

Radiator Air Upper Baffle Extension Replacement

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Radiator Air Upper Baffle Extension Retainers (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 2.5 (22 lb in)
2	Radiator Air Upper Baffle Extension

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

Cooling Fan Control

The engine cooling fan system is composed of 1 electric cooling fan, fan motor and 1 control module.

signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, which allows the cooling fan to operate at variable speeds.

The cooling fan speed is effected by many different conditions and the ECM will adjust the duty cycle from 0-100 percent based on cooling system requirements. The scan tool output control is only capable of operating the cooling fan increments, between 10-90 percent. 90 percent is considered high speed fan. When multiple cooling fan speed requests are received, the ECM operates the fan at the highest of speed requests. The ECM commands the fans ON under the following conditions:

- The engine coolant temperature is warmer than a predetermined temperature.
- The engine oil temperature is warmer than a predetermined temperature.
- The A/C pressure reaches a predetermined pressure.
- If the engine coolant temperature at key-off is warmer than a predetermined value or the A/C pressure is greater than a predetermined value, the cooling fan will operate at a low speed. The fan will shut OFF if the temperature or pressure drops below the predetermined value, but will only operate for 2 minutes, regardless of the coolant temperature or A/C pressure.

COOLING SYSTEM DESCRIPTION AND OPERATION

Cooling Fan Control - Variable Speed Single Fan System

The engine cooling fan is a variable speed fan. The engine control module (ECM) controls the fan speed by sending a pulse width modulated signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal.

Cooling fan speed is effected by many different conditions and can be adjusted from 10% to 90% duty cycle (PWM), 90% is considered high speed fan. When multiple cooling fan speed requests are received the ECM uses the highest cooling fan speed of all the requests. The ECM commands the cooling fan ON under the following conditions:

- Cooling fan duty cycle starts when engine coolant temperature reaches approximately 95°C (204°F) and reaches high speed at temperatures above 113°C (235°F).
- Cooling fan duty cycle starts when A/C pressure reaches approximately 1100 kPa (160 psi) and reaches high speed at A/C pressures above 2480 kPa (360 psi).
- At engine oil temperatures above approximately 150°C (302°F) the cooling fan duty cycle will be commanded to high speed.
- At transmission oil temperatures above approximately 132°C (270°F) the cooling fan duty cycle will be commanded to high speed.
- After the vehicle is shut OFF if the engine coolant temperature at key-off is greater than 113°C (235°F) or the A/C pressure is greater than 1720 kPa (249 psi) the cooling fan duty cycle is set to 50%, low speed. If the coolant temperature drops below 110°C (230°F) and the A/C pressure drops below 1660 kPa (241 psi) the fan will shut OFF. The fans will automatically shut OFF after 2 min. regardless of coolant temperature.

Low Coolant Message

The engine cooling system utilizes an algorithm based low coolant level system which eliminates the need for the coolant level sensor previously positioned inside the surge tank. The algorithm measures the difference in engine coolant temperature readings over time as a function of engine speed, to determine if the cooling system has a low coolant condition. After vehicle start up, the engine control module (ECM) sends an engine RPM and engine coolant temperature message through the body control module (BCM) to the HVAC control module. The HVAC control module uses engine coolant temperature and engine RPM to determine if an increase in engine coolant temperature is due to a low coolant level condition. This system is capable of losing 2 full liters of coolant before triggering the Low Coolant indicator. Because the surge tank holds approximately 0.8 liters when filled to the proper level, its possible that the Low Coolant indicator will not be triggered, even though the surge tank is completely dry.

Engine Coolant Indicator(s)

COOLANT OVER TEMP

The IPC illuminates the COOLANT OVER TEMP indicator in the message center when the following occurs:

- The PCM detects that the engine coolant temperature exceeds 124°C (256°F). The IPC receives a class 2 message from the PCM indicating the high coolant temperature.
- The IPC will also illuminate the CHECK GAGES indicator and a chime sounds when this condition exists.

Cooling System

The cooling system's function is to maintain an efficient engine operating temperature during all engine speeds and operating conditions. The cooling system is designed to remove approximately one-third of the heat produced by the burning of the air-fuel mixture. When the engine is cold, the system cools slowly or not at all. This allows the engine to warm quickly.

Cooling Cycle

Coolant is drawn from the radiator outlet and into the water pump inlet by the water pump. Some coolant will then be pumped from the water pump, to the heater core, then back to the water pump. This provides the passenger compartment with heat and defrost.

Coolant is also pumped through the water pump outlet and into the engine block. In the engine block, the coolant circulates through the water jackets surrounding the cylinders where it absorbs heat.

The coolant is then forced through the cylinder head gasket openings and into the cylinder heads. In the cylinder heads, the coolant flows through the water jackets surrounding the combustion chambers and valve seats, where it absorbs additional heat.

Coolant is also directed to the throttle body. There it circulates through passages in the casting.

During initial start up, the coolant assists in warming the throttle body. During normal operating temperatures, the coolant assists in keeping the throttle body cool.

From the cylinder heads, the coolant is then forced to the thermostat. The flow of coolant will either be stopped at the thermostat until the engine is warmed or it will flow through the thermostat and into the radiator where it is cooled and the coolant cycle is completed.

Operation of the cooling system requires proper functioning of all cooling system components. The cooling system consists of the following components:

Coolant

The engine coolant is a solution made up of a 40-60 mixture of 40% DEX-COOL and 60% clean drinkable water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger. It consists of a core and two tanks. The aluminum core is a crossflow tube and fin design. This is a brazed tube with convoluted louvered fin design. Separate tubes and fins are stacked together with a manifold at each end. The entire assembly is then brazed forming a homogeneous unified structure. The fins allow for efficient heat transfer from the coolant to the atmosphere. The inlet and outlet tanks are molded with a high temperature, glass reinforced nylon plastic. The tank and gasket is supplied as an assembly with silicone gasket attached to the tank. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminum header at each end of the core. The radiator also has a drain cock which is located in the bottom of the passenger side tank. The drain cock includes the drain cock and drain cock seal.

The radiator removes heat from the coolant passing through it. The fins on the core absorb heat from the coolant passing through the tubes. As air passes between the fins, it transfer heat to the atmosphere and cools the coolant.

During vehicle use, the coolant heats and expands. The coolant that is displaced by this expansion flows into the surge tank. As the coolant circulates, air is allowed to exit. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Pressure Cap

The pressure cap is a cap that seals and pressurizes the cooling system. It contains a blow off or pressure valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring and protects the radiator by relieving pressure if it exceeds 20 psi. The vacuum valve is held against its seat by a spring, which permits opening of the valve to relieve vacuum created in the cooling system as it cools off. The vacuum, if not relieved, could cause the radiator hoses to collapse.

The pressure cap allows pressure in the cooling system to build up. As the pressure builds, the boiling point of the coolant goes up as well. Therefore, the coolant can be safely run at a temperature higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant is, the

faster the heat moves from the radiator to the cooler passing air. However, if the pressure exceeds the strength of the spring, the pressure valve rises so that the excess pressure can escape. When the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing outside air into the cooling system. This equalizes the pressure in the cooling system with atmospheric pressure, thus preventing the radiator hoses from collapsing.

Surge Tank

The surge tank is a plastic tank with a pressure cap mounted to it. The tank is mounted at a point higher than all other coolant passages. The surge tank provides an air space in the cooling system. The air space allows the coolant to expand and contract. The surge tank also provides a coolant fill point and a central air bleed location.

During vehicle use, the coolant heats and expands. The coolant that is displaced by this expansion flows into the surge tank. As the coolant circulates, air is allowed to exit. This is an advantage to the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Air Baffles and Seals

The cooling system uses deflectors, air baffles and air seals to increase system cooling. Deflectors are installed under the vehicle to redirect airflow beneath the vehicle to flow through the radiator and increase cooling. Air baffles are also used to direct airflow into the radiator and increase cooling. Air seals prevent air from bypassing the radiator and A/C condenser. Air seals also prevent recirculation of the air for better hot weather cooling and A/C condenser performance.

Water Pump

The water pump is a centrifugal vane impeller type pump. The pump consists of a housing with coolant inlet and outlet passages and an impeller. The impeller is a flat plate mounted on the pump shaft with a series of flat or curved blades or vanes. When the impeller rotates, the coolant between the vanes is thrown outward by centrifugal force. The impeller shaft is supported by one or more sealed bearings. These sealed bearings never need to be lubricated. With a sealed bearing, grease cannot leak out and dirt and water cannot get in.

The purpose of the water pump is to circulate coolant throughout the cooling system. The water pump is driven by the crankshaft via the drive belt.

Thermostat

The thermostat is a coolant flow control component. Its purpose is to regulate the operating temperature of the engine. It utilizes a temperature sensitive wax-pellet element. The element connects to a valve through a piston. When the element is heated, it expands and exerts pressure against a rubber diaphragm. This pressure forces the valve to open. As the element is cooled, it contracts. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 87°C (187°F), the thermostat valve remains closed. This

prevents circulation of the coolant from the radiator to the water pump and allows the engine to warm up quickly. After the coolant temperature reaches 87°C (187°F), the thermostat valve will begin to open. The coolant is then allowed to circulate from the radiator return hose, through the thermostat and back into the water pump where the engine heat is dissipated to the atmosphere. The thermostat provides a restriction in the cooling system, even after it has opened. This restriction creates a pressure difference which prevents cavitation at the water pump and forces coolant to circulate through the engine block.

Engine Oil Cooler (Base LT1)

The engine oil cooler is a heat exchanger located inside the LH side end tank of the radiator. The engine oil temperature is controlled by the temperature of the engine coolant that surrounds the oil cooler in the radiator.

The engine oil pump, pumps the oil through the engine oil cooler line to the oil cooler. The oil then flows through the cooler where the engine coolant absorbs heat from the oil. The oil is then pumped through the oil cooler return line, to the engine block system.

Transmission Oil Cooler

The transmission oil cooler is an air-to-oil heat exchanger that is located in the rear of the vehicle on the driver side. The cooling of transmission fluid is accomplished by forcing ducted outside air across the heat exchanger. Coupe models also use an auxiliary electric cooling fan to assist with transmission cooling under aggressive driving or low airflow conditions.

The transmission oil pump pumps the fluid through the transmission oil cooler feed line to the oil cooler. Incoming air passes through the cooler transferring heat from the cooler to the atmosphere, reducing oil temperature. Fluid returns to the transmission.

Coolant Heater

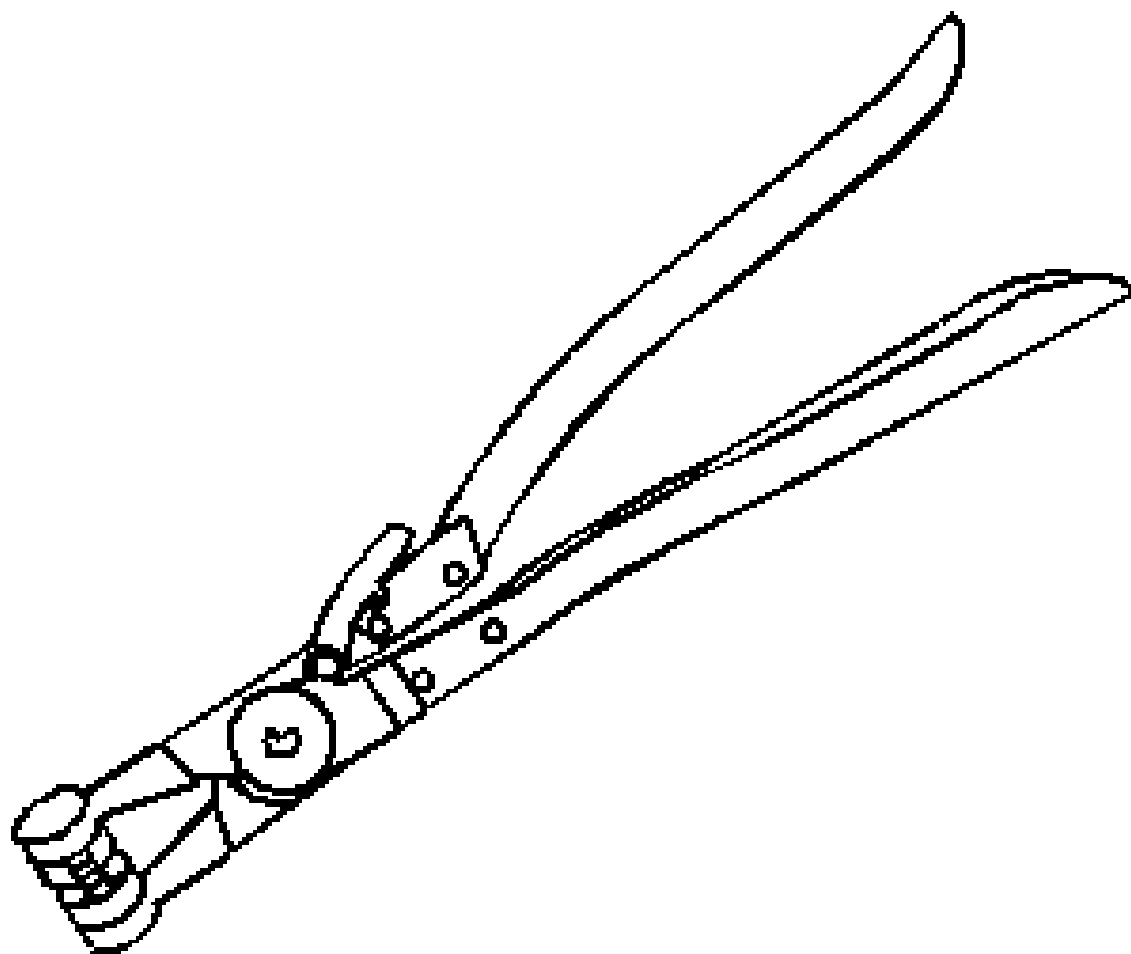
The optional engine coolant heater (RPO K05) is rated at 400 watts and supplies 1365 btu/hr. The engine coolant heater operates using 110-volt AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather -29°C (-20°F). The coolant heater helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. A weather shield on the cord is provided to protect the plug when not in use.

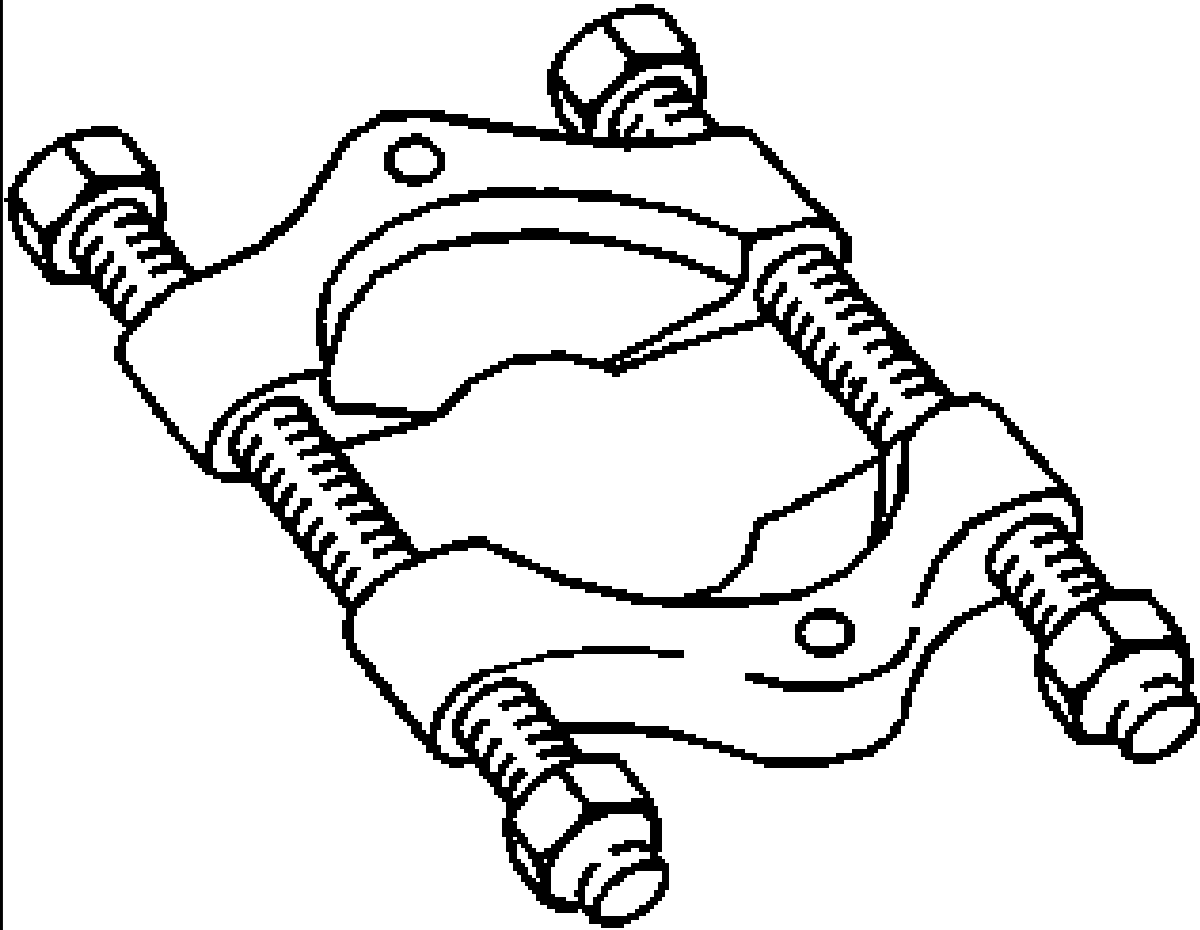
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

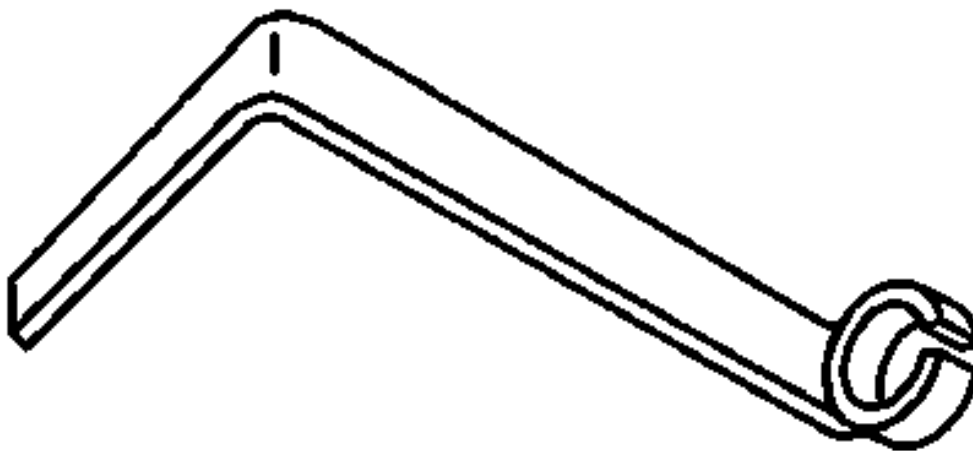
Illustration	Tool Number/ Description

BO 38185
J 38185
Hose
Clamp
Pliers

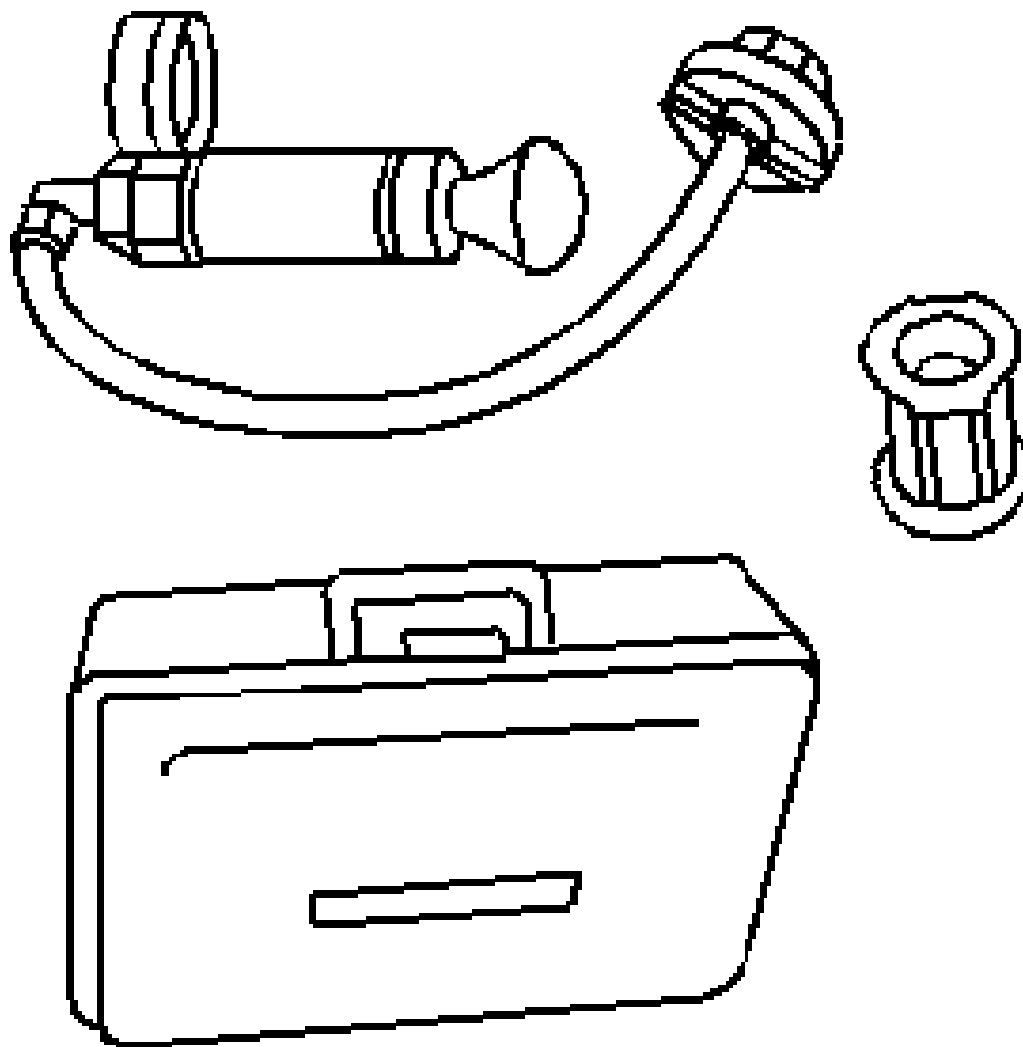




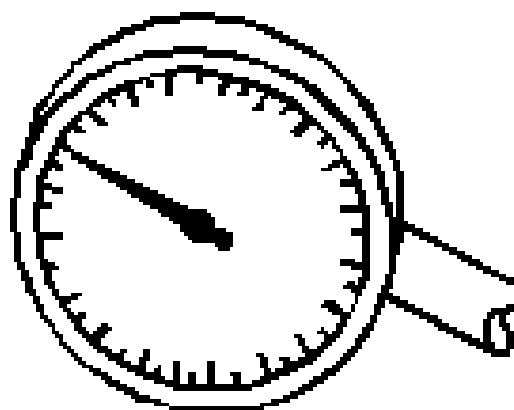
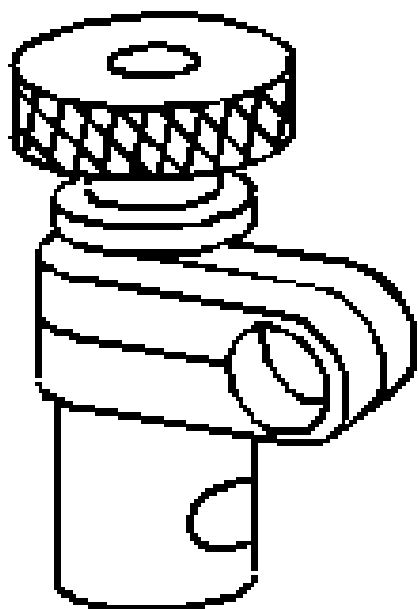
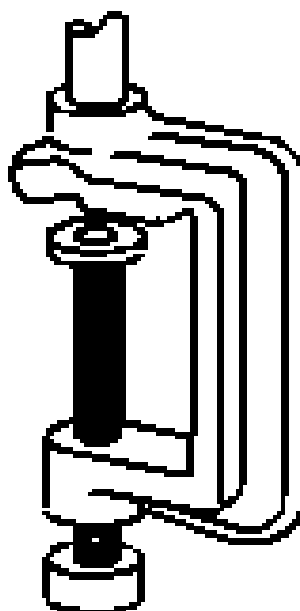
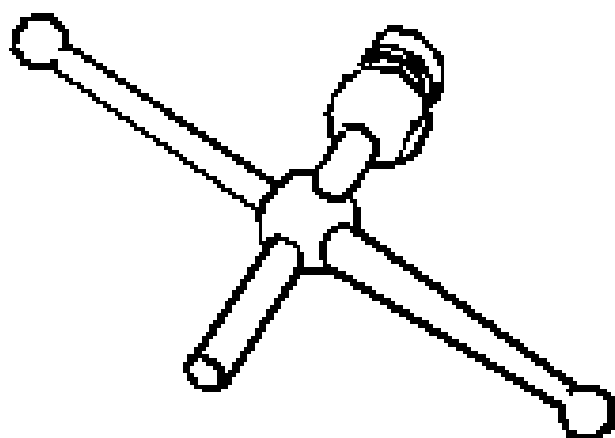
EL 35616-F
J 35616-F
Connector
Test
Adapter Kit



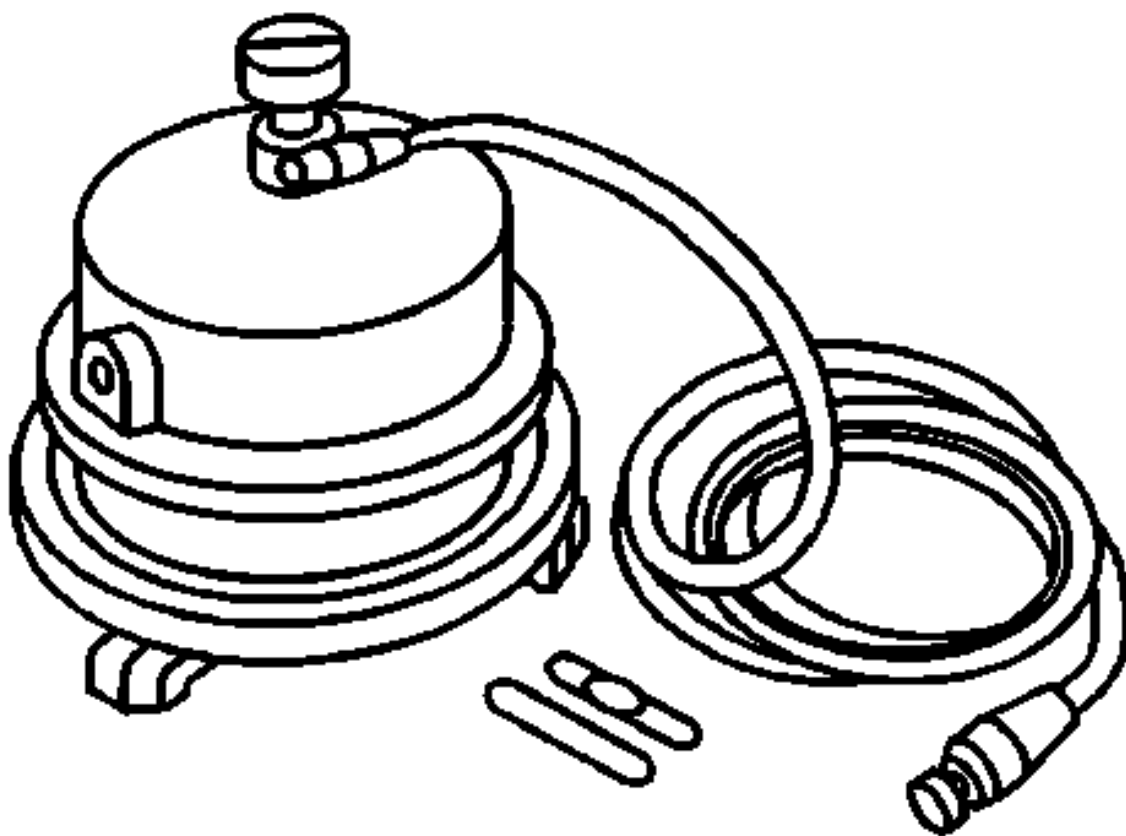
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HD
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Heavy Duty
Fused
Jumper



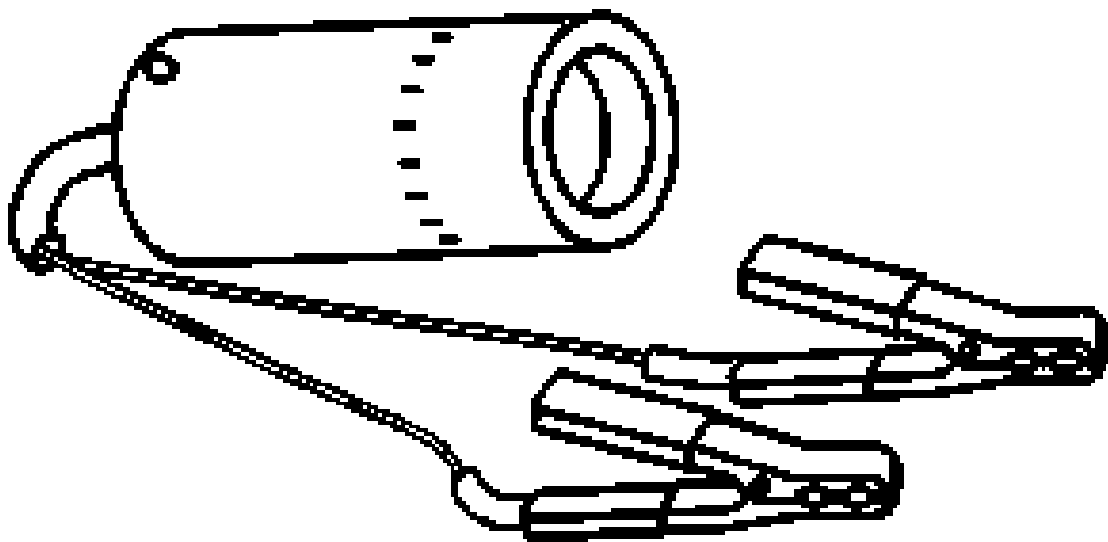
EN 24460-A
J 24460-01
Cooling
System
Pressure
Tester



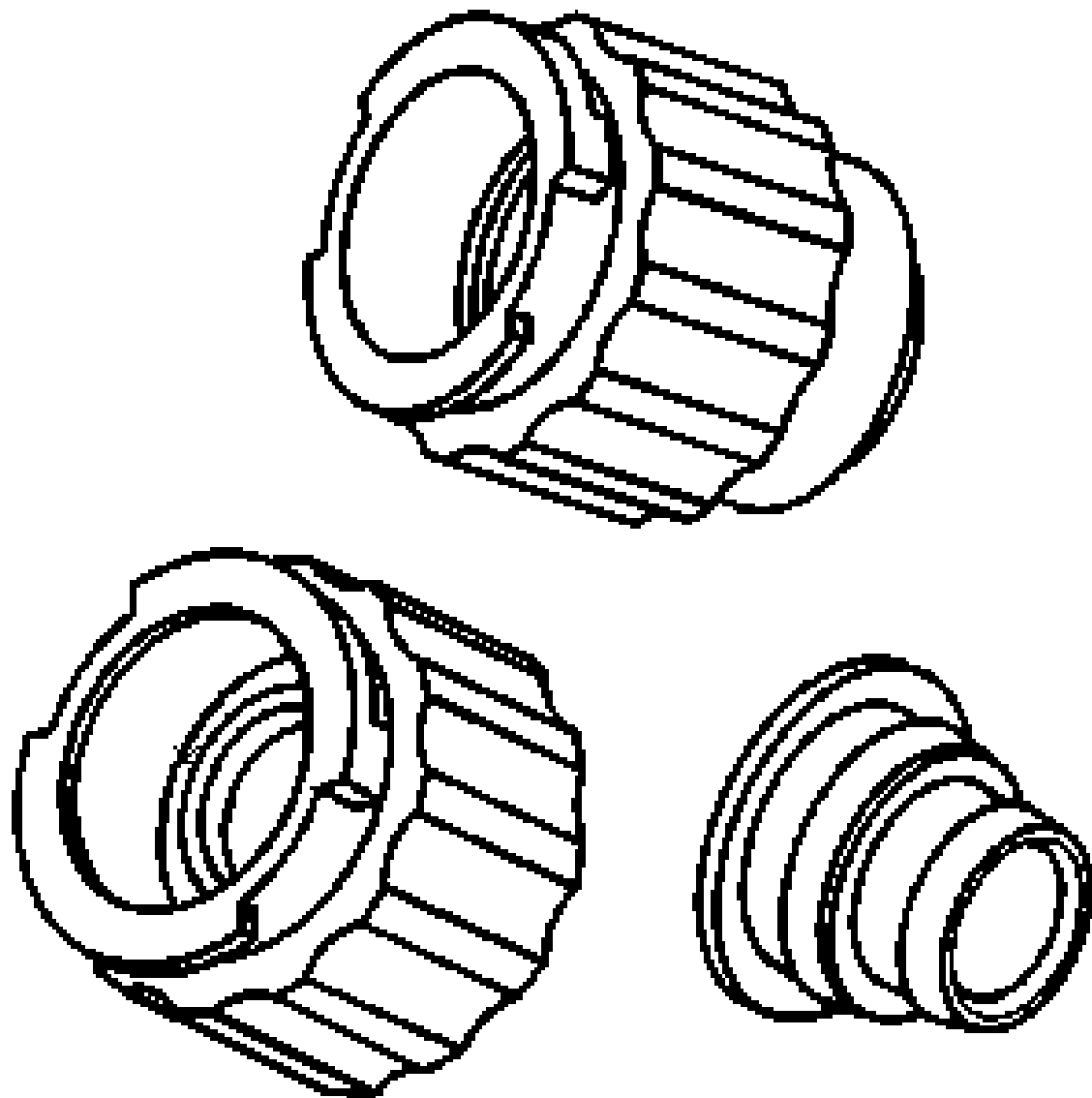
GE 24731
J 24731
Tempil Stick



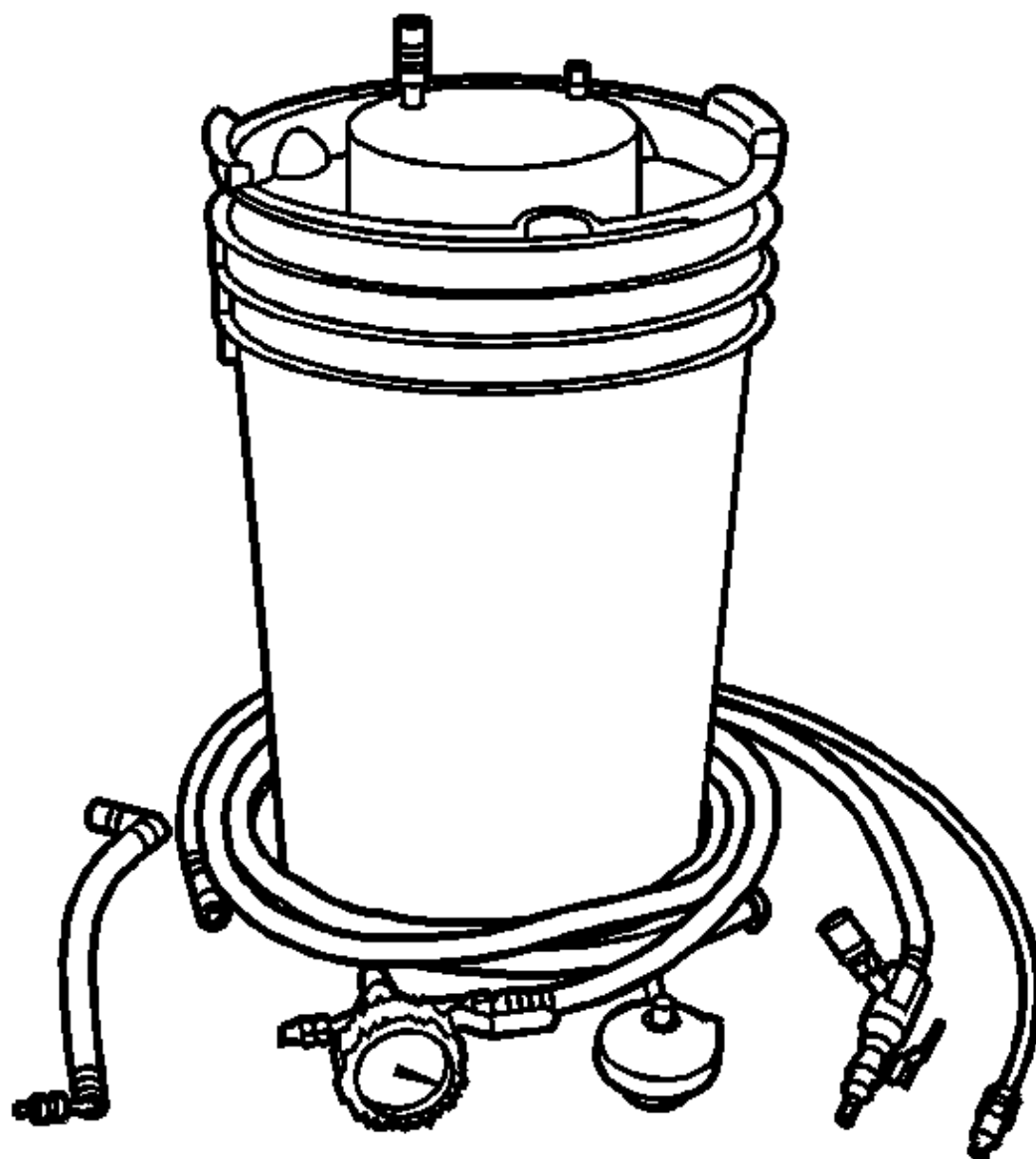
GE 26568
J 26568
Coolant and
Battery
Fluid Tester



GE 42220
J 42220
Universal
12V Leak
Detection
Lamp



GE 42401-3
J 42401
Radiator
Cap and
Surge Tank
Test
Adapter



GE 47716
Vac N Fill
Coolant
Refill Tool