

2010 ENGINE

Engine Cooling - Equinox & Terrain

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Condenser to Radiator Bolts	9 N.m	80 lb in
Coolant Heater	50 N.m	37 lb ft
Cooling Fan Motor Nuts	6 N.m	53 lb in
CRFM Bracket Bolts	20 N.m	15 lb ft
Fan Shroud to Radiator Bolts	9 N.m	80 lb in
Heater Inlet Housing Bolts	10 N.m	89 lb in
Heater Inlet Pipe Nut	25 N.m	18 lb ft
Heater Outlet Pipe to Throttle Body Bolt	10 N.m	89 lb in
Heater Outlet Pipe to Throttle Body Nut	10 N.m	89 lb in
Heater Outlet Pipe to Upper Intake Manifold Nut	25 N.m	18 lb ft
Manifold Absolute Pressure (MAP) Sensor Bracket Bolt	10 N.m	89 lb in
Surge Tank to Body Bolts	9 N.m	80 lb in
Thermal Bypass Fitting Bolt	12 N.m	106 lb in
Thermal Bypass Pipe Bolt	10 N.m	89 lb in
Thermostat Housing Bolt	10 N.m	89 lb in
Water Outlet Housing Bolt	10 N.m	89 lb in
Water Pump Bolt	10 N.m	89 lb in
Water Pump Pulley Bolt	10 N.m	89 lb in

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE COOLING SCHEMATICS

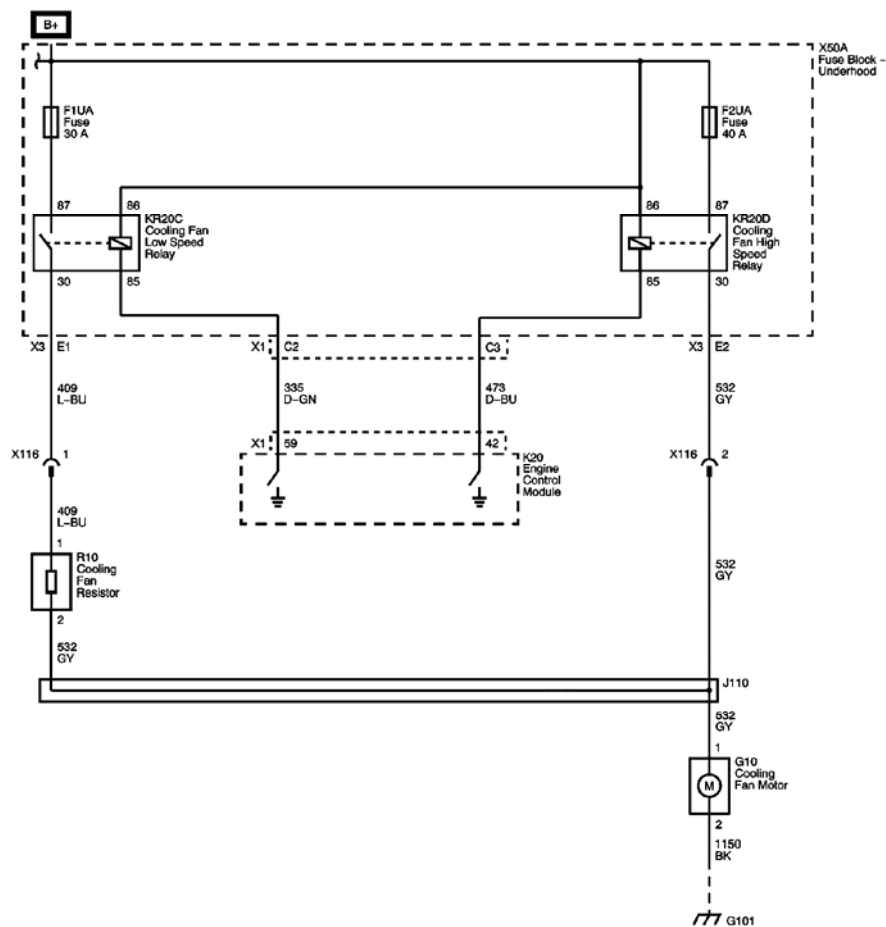


Fig. 1: Engine Cooling Fans (LAF)
 Courtesy of GENERAL MOTORS CORP.

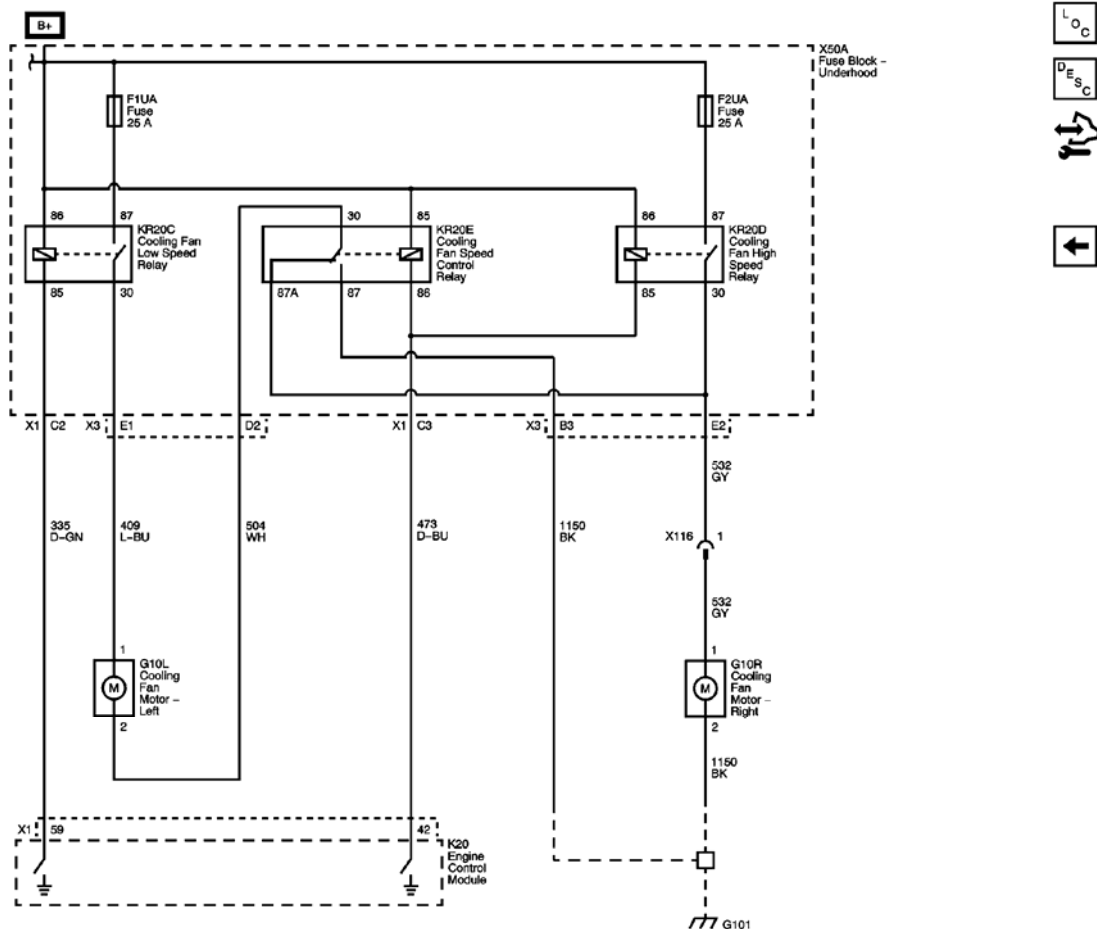


Fig. 2: Engine Cooling Fans (LF1)
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0480 or P0481 (w/LF1)	P0480: Cooling Fan Relay 1 Control Circuit P0481: Cooling Fan Relays 2 and 3 Control Circuit
DTC P0480 or P0481 (w/LAF)	P0480: Cooling Fan Relay 1 Control Circuit P0481: Cooling Fan Relay 2 Control Circuit
DTC P1258	P1258: Engine Coolant Overtemperature - Protection Mode Active

DTC P0480 OR P0481 (W/LF1)

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 Relay 1 Control Circuit

DTC P0481

Cooling Fan Relays 2 and 3 Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480, P0481	P0480, P0481	-	-
Relay Switch Ignition Circuit			-	-
Fan Relay 1 Control Circuit	P0480	P0480	P0480	-
Fan Relay 2 and Fan Relay 3 Control Circuit	P0481	P0481	P0481	-
Relay Controlled Output Circuit				-
Fans inoperative without a DTC. Fans always ON without a DTC.				

Typical Scan Tool Data

Cooling Fan Relays

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating in closed loop			
Parameter Normal Operation: Cooling Fan Relay Control Circuit Test Status: OK, or Not Run			
Cooling Fan Relay 1 Control Circuit Open Test Status	OK or Not Run	Malfunction or Not Run	OK or Not Run
Cooling Fan Relay 1 Control Circuit Low Voltage Test Status	Malfunction or Not Run	OK or Not Run	OK or Not Run
Cooling Fan Relay 1 Control Circuit High Voltage Test Status	OK or Not Run	OK or Not Run	Malfunction or Not Run
Cooling Fan Relay 2 and 3 Control Circuit Open Test Status	OK or Not Run	Malfunction or Not Run	OK or Not Run
Cooling Fan Relay 2 and 3 Control Circuit Low Voltage Test Status	Malfunction or Not Run	OK or Not Run	OK or Not Run
Cooling Fan Relay 2 and 3 Control	OK or Not Run	OK or Not Run	Malfunction or Not

Circuit High Voltage Test Status			Run
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Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Conditions for Running the DTC

- The ignition voltage is between 11-18 volts.
- The engine speed is greater than 400 RPM.
- The ECM driver transitions from ON to OFF or from OFF to ON.
- DTC P0480 and P0481 run continuously when the conditions above are met.

Conditions for Setting the DTC

P0480

The ECM detects an open circuit, short to ground, or a short to voltage on the low speed cooling fan 1 relay control circuit, for greater than 200 mS.

P0481

The ECM detects an open circuit, short to ground, or a short to voltage on the high speed cooling fan relay 2 and 3 control circuit, for greater than 200 mS.

Action Taken When the DTC Sets

DTCs P0480 and P0481 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480 and P0481 are Type B DTCs.

Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates both fans at a low speed
 - Cooling Fan Relay 2 and 3 operates the right fan at a high speed
 - Cooling Fan Relay 1, 2 and 3 operates both fans at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component

electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (3.0L) or Cooling Fan Description and Operation (2.4L)

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, command the KR20 cooling fan relays ON and OFF with a scan tool. Listen or feel the relay click.
2. Ignition ON, observe the scan tool Cooling Fan Relay 1 and the Cooling Fan Relay 2 and 3 Control Circuit Test Status parameters. Command the cooling fans ON and OFF with a scan tool. Verify all of the Cooling Fan Relay Control Circuit Test Status parameters display OK or Not Run in each of the commanded states.
3. Engine operating, observe the DTC information with a scan tool. DTC P0480 or P0481 should not set.
4. 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.

Circuit/System Testing

1. Ignition OFF, disconnect all of the KR20 cooling fan relays.

NOTE: The following test must be performed on all three fan relay circuits.

2. Ignition ON, verify that a test lamp illuminates between ground and the relay coil ignition circuit terminal listed below:
 - KR20C cooling fan low speed relay 1 terminal 85
 - KR20D cooling fan high speed relay 3 terminal 85
 - KR20E cooling fan speed control relay 2 terminal 85
 - If the test lamp does not illuminate, test the relay coil ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the relay coil ignition circuit fuse is open, test all components connected to the ignition circuit and replace as necessary.

NOTE: The following tests must be performed on all three fan relay control circuits.

3. Connect the red lead of the DMM to a control circuit terminal listed below. Connect the black lead to ground. Set the DMM on the diode setting. The DMM should display OL.
 - KR20C cooling fan low speed relay 1 terminal 86
 - KR20D cooling fan high speed relay 3 terminal 86
 - KR20E cooling fan speed control relay 2 terminal 86
 - If less than the specified range, test the appropriate relay coil control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: The following tests must be performed on all three fan relay control circuits.

4. Command the cooling fan relay ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
 - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the appropriate KR20 relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.
 - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display OL.
 - 30 and 86
 - 30 and 87
 - 30 and 85

- 85 and 87
 - If less than the specified range, replace the KR20 cooling fan relay.
- 4. Test for less than 2 ohms between terminals 30 and 87A.
 - If greater than the specified range, replace the KR20E cooling fan relay.
- 5. Connect a 20 A fused jumper wire between relay terminal 85 and B+. Connect a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
 - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

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

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0480 OR P0481 (W/LAF)

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 Relay 1 Control Circuit

DTC P0481

Cooling Fan Relay 2 Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480, P0481	P0480, P0481	-	-
Relay Switch Ignition Circuit	1	1	-	-
Fan Relay 1 Control Circuit	P0480	P0480	P0480	-
Fan Relay 2 Control Circuit	P0481	P0481	P0481	-
Relay Controlled Output Circuit	1	1	2	-
1. Fan inoperative without a DTC.				

2. Fan always ON without a DTC.

Typical Scan Tool Data

Cooling Fan Relays

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating in closed loop			
Parameter Normal Operation: Cooling Fan Relay Control Circuit Test Status: OK, or Not Run			
Cooling Fan Relay 1 Control Circuit Open Test Status	OK or Not Run	Malfunction or Not Run	OK or Not Run
Cooling Fan Relay 1 Control Circuit Low Voltage Test Status	Malfunction or Not Run	OK or Not Run	OK or Not Run
Cooling Fan Relay 1 Control Circuit High Voltage Test Status	OK or Not Run	OK or Not Run	Malfunction or Not Run
Cooling Fan Relay 2 Control Circuit Open Test Status	OK or Not Run	Malfunction or Not Run	OK or Not Run
Cooling Fan Relay 2 Control Circuit Low Voltage Test Status	Malfunction or Not Run	OK or Not Run	OK or Not Run
Cooling Fan Relay 2 Control Circuit High Voltage Test Status	OK or Not Run	OK or Not Run	Malfunction or Not Run

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, 2 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes 1 resistor mounted in the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 2 speeds using two fan control circuits. The ECM will operate the cooling fan at either Low or High speed based on the cooling requirements.

Conditions for Running the DTC

- The ignition voltage is between 11-18 volts.
- The engine speed is greater than 400 RPM.
- The ECM driver transitions from ON to OFF or from OFF to ON.
- DTC P0480 and P0481 run continuously when the conditions above are met.

Conditions for Setting the DTC

P0480

The ECM detects an open circuit, short to ground, or a short to voltage on the low speed cooling fan 1 relay control circuit, for greater than 200 mS.

P0481

The ECM detects an open circuit, short to ground, or a short to voltage on the high speed cooling fan relay 2 control circuit, for greater than 200 mS.

Action Taken When the DTC Sets

DTCs P0480 and P0481 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480 and P0481 are Type B DTCs.

Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates the fan at low speed
 - Cooling Fan Relay 2 operates the fan at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (3.0L) or Cooling Fan Description and Operation (2.4L)

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, command the KR20 cooling fan relays ON and OFF with a scan tool. Listen or feel the relay click.
2. Ignition ON, observe the scan tool Cooling Fan Relay 1 and the Cooling Fan Relay 2 Control Circuit Test Status parameters. Command the cooling fan ON and OFF with a scan tool. Verify all of the Cooling Fan Relay Control Circuit Test Status parameters display OK or Not Run in each of the commanded states.
3. Engine operating, observe the DTC information with a scan tool. DTC P0480 or P0481 should not set.
 - If a DTC is set, refer to **DTC P0480 or P0481 (w/LF1)** or **DTC P0480 or P0481 (w/LAF)**.
4. 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.

Circuit/System Testing

1. Ignition OFF, disconnect both of the KR20 cooling fan relays.

NOTE: **The following test must be performed on all three fan relay circuits.**

2. Ignition ON, verify that a test lamp illuminates between ground and the relay coil ignition circuit terminal listed below:
 - KR20C COOL FAN LOW Relay Terminal 85
 - KR20D COOL FAN HI Relay Terminal 85
 - If the test lamp does not illuminate, test the relay coil ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the relay coil ignition circuit fuse is open, test all components connected to the ignition circuit and replace as necessary.

NOTE: **The following tests must be performed on both fan relay control circuits.**

3. Connect the red lead of the DMM to a control circuit terminal listed below. Connect the black lead to ground. Set the DMM on the diode setting. The DMM should display OL:
 - KR20C COOL FAN LOW Relay Terminal 86
 - KR20D COOL FAN HI Relay Terminal 86
 - If less than the specified range, test the appropriate relay coil control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: **The following tests must be performed on both fan relay control circuits.**

4. Command the cooling fan relay ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
 - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to voltage. If the circuit tests normal, replace the K20 ECM.

5. If all circuits test normal, test or replace the appropriate KR20 relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.
 - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display OL:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - If less than the specified range, replace the KR20 cooling fan relay.
4. Connect a 20 A fused jumper wire between relay terminal 85 and B+. Connect a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
 - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

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

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P1258

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 P1258

Engine Coolant Overtemperature - Protection Mode Active

Circuit/System Description

The engine control module (ECM) uses the engine coolant temperature sensor to monitor the engine for an over-temperature condition. This condition occurs when the coolant temperature is above a calibrated value. The ECM will alternately disable 2 groups of cylinders by turning OFF the fuel injectors. By switching between

the 2 groups of cylinders, the ECM is able to reduce the temperature of the coolant.

Conditions for Running the DTC

- DTCs P0116, P0117, P0118, P0128 are not set.
- The engine is operating for greater than 30 seconds.
- DTC P1258 runs continuously once the conditions above have been met.

Conditions for Setting the DTC

3.0L - LF1

The ECM detects that engine coolant temperature is warmer than 129°C (264°F) for greater than 2 seconds.

3.6L - LLT

The ECM detects that engine coolant temperature is warmer than 136°C (277°F) for greater than 1 second.

Action Taken When the DTC Sets

- DTC P1258 is a Type A DTC.
- The engine will operate in the Overheated Engine Protection Operating Mode.
- The IP will illuminate the coolant temperature indicator lamp and the driver information center (DIC), if equipped, may display a message.

Conditions for Clearing the MIL/DTC

DTC P1258 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- **Cooling Fan Description and Operation (3.0L)** or **Cooling Fan Description and Operation (2.4L)**
- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information (LF1,LFW) or Engine Control Module Scan Tool Information (LAF) for scan tool information

Circuit/System Verification

1. If DTC P0480, P0481, P0691, P0692, P0693, or P0694 is set, diagnose that DTC first.
2. Observe the engine coolant level. The engine coolant level should be within the operating range. Refer to Capacities - Approximate Fluid, and Engine Coolant in the Owner's Manual.
3. Ensure that the vehicle has the correct engine coolant with correct concentration and is not old, contaminated, or contains additives. Refer to Recommended Fluids and Lubricants in the Owner's Manual.
4. Inspect the cooling system for the following:
 - Leaks
 - Kinked or pinched hoses, especially at the radiator
 - Loose, missing, or damaged radiator air seals or deflectors
 - Air flow obstructions or bent fins at the radiator or the A/C condenser-Refer to Symptoms - Engine Cooling.

NOTE: **A small delay occurs before the ECM changes the cooling fan speed.**

5. Command the cooling fans ON and OFF, low and high speed. The engine cooling fans should turn ON and OFF with each command.
 - If the cooling fans do not function as indicated, refer to Cooling Fan Inoperative (LF1 or LFW) or Cooling Fan Inoperative (LAF).

Circuit/System Testing

1. Test the thermostat for correct operation. Refer to Thermostat Diagnosis.
2. Test the engine cooling system for overheating. Refer to Engine Overheating.
3. Inspect the water pump and coolant flow for correct operation. Refer to Water Pump Cleaning and Inspection.
4. Inspect the engine mechanical for worn, leaking, cracked cylinder heads or engine block. Refer to Coolant in Engine Oil.

Repair Procedures

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

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:
 - Ensure that the engine control module (ECM) and indicator lamp are operating correctly.
 - Ensure that there are no diagnostic trouble codes (DTCs) that are 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 (3.0L)** or **Cooling Fan Description and Operation (2.4L)** and **Cooling System Description and Operation**.

Visual/Physical Inspection

CAUTION: Use the connector test adapter kit J 35616-A 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 areas:

- Ensure that the control module grounds are clean, tight, and correctly located.
- Inspect cooling system hoses and pipes for splits, kinks, and proper connections. Inspect thoroughly for any type of a leak or a restriction.
- Inspect for a dirty or restricted radiator and 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 surge tank reservoir for the 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:

- Moisture and water intrusion in connectors, terminals, and components
- 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 temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit 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, and after factory add on accessories

If an intermittent 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 (3.0L LF1 w/Dual Fans)** or **Cooling Fan Always On (2.4L)**
- **Cooling Fan Inoperative (LF1 or LFW)** or **Cooling Fan Inoperative (LAF)**
- **Engine Overheating**
- **Loss of Coolant**
- **Thermostat Diagnosis**
- **Engine Fails To Reach Normal Operating Temperature**

COOLING FAN ALWAYS ON (3.0L LF1 W/DUAL FANS)

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 consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates both fans at a low speed
 - Cooling Fan Relay 2 and 3 operates the right fan at a high speed
 - Cooling Fan Relay 1, 2 and 3 operates both fans at a high speed
- KR20 cooling fan relay identification:
 - KR20C cooling fan low speed relay
 - KR20D cooling fan high speed relay
 - KR20E cooling fan speed control relay
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (3.0L) or **Cooling Fan Description and Operation (2.4L)**

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, observe the DTC information with a scan tool. Verify that DTC P0480 or P0481 is not set.
 - If a DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition ON, observe the scan tool Cooling Fan Relay 1 and Cooling Fan Relays 2 and 3 Command parameters. The parameters should display OFF.
3. Ignition ON, observe that the fan is not activated.

Circuit/System Testing

NOTE: The following tests must be performed on each cooling fan relay.

1. Ignition OFF, disconnect each KR20 cooling fan relay one at a time.
2. Ignition ON, observe that the cooling fans are not activated.
 - If the fans are activated, test for a short to voltage in the relay controlled output circuit of the appropriate cooling fan.
 - If the fans are not activated, test or replace the appropriate KR20 cooling fan relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.
 - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display OL.
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - If not the specified range, replace the KR20 cooling fan relay.
4. Test the KR20E relay for less than 2 ohms between terminals 30 and 87A.
 - If greater than the specified range, replace the KR20E cooling fan relay.
5. Install a 20 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

- If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

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

Relay Replacement (Attached to Wire Harness) or **Relay Replacement (Within an Electrical Center)**

COOLING FAN ALWAYS ON (2.4L)

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 cooling fan, 2 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes 1 resistor mounted in the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 2 speeds using two fan control circuits. The ECM will operate the cooling fan at either Low or High speed based on the cooling requirements.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates the fan at a low speed
 - Cooling Fan Relay 2 the fan at a high speed
- KR20 cooling fan relay identification:
 - KR20C COOL FAN LOW Relay
 - KR20D COOL FAN HI Relay
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (3.0L) or Cooling Fan Description and Operation (2.4L)

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, observe the DTC information with a scan tool. Verify that DTC P0480 or P0481 is not set.
 - If a DTC is set, refer to **DTC P0480 or P0481 (w/LF1)** or **DTC P0480 or P0481 (w/LAF)**.
2. Ignition ON, observe the scan tool Cooling Fan Relay 1 and Cooling Fan Relays 2 Command parameters. The parameters should display OFF.
3. Ignition ON, observe that the fan is not activated.

Circuit/System Testing

NOTE: The following tests must be performed on each cooling fan relay.

1. Ignition OFF, disconnect the KR20 cooling fan relays one at a time.
2. Ignition ON, observe that the cooling fans are not activated.
 - If the fan is activated, test for a short to voltage in the relay controlled output circuits of the engine cooling fan.
 - If the fans are not activated, test or replace the appropriate KR20 cooling fan relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.
 - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display OL.
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87

- If not the specified range, replace the KR20 cooling fan relay.
- 4. Install a 20 A fused jumper wire between relay terminal 85 and B+. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
 - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

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

Relay Replacement (Attached to Wire Harness) or **Relay Replacement (Within an Electrical Center)**

COOLING FAN INOPERATIVE (LF1 OR LFW)

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 consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates both fans at a low speed
 - Cooling Fan Relay 2 and 3 operates the left fan at a high speed
 - Cooling Fan Relay 1, 2 and 3 operates both fans at a high speed
- KR20 cooling fan relay identification:
 - KR20C cooling fan low speed relay
 - KR20D cooling fan high speed relay
 - KR20E cooling fan speed control relay
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (3.0L) or Cooling Fan Description and Operation (2.4L)

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. Verify that DTC P0480 or P0481 is not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, command the appropriate fan relay ON and OFF with a scan tool. Verify that the fans turn ON and OFF when changing between the commanded states.

Circuit/System Testing

1. Ignition OFF, disconnect the KR20 cooling fan relays.
2. Connect a 30 A fused jumper between the KR20E cooling fan speed control relay switch circuit terminal 30 and the ground circuit terminal 87. This completes the left side fan ground circuit. Leave this jumper in place for the remainder of this procedure.

NOTE: **The following test must be performed on both the high speed fan relay circuit and the low speed fan relay circuit.**

3. Ignition ON, verify that a test lamp illuminates between ground and the relay switched ignition circuit terminal listed below:
 - KR20C cooling fan low speed relay terminal 87
 - KR20D cooling fan high speed relay terminal 87
 - If the test lamp does not illuminate, test the appropriate relay switch B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the relay switch B+ circuit fuse is open, test the relay controlled output circuit for a short to ground. If the circuit tests normal, test or replace the appropriate KR20 relay.

NOTE: **The following test must be performed first on the high speed fan relay circuit and next on the low speed fan relay circuit. Leave the jumper connected to the low speed fan relay circuit for the next test.**

4. Connect a 30 A fused jumper between the KR20 cooling fan relay circuit terminals listed below. Verify the appropriate fan is activated.
 - KR20D cooling fan high speed relay terminals 87 and 30
 - KR20C cooling fan low speed relay terminals 87 and 30
 - If the corresponding cooling fan does not activate, test the relay controlled output circuit and the cooling fan ground circuit for an open/high resistance. If the circuits tests normal, replace the appropriate G10 cooling fan motor.
 - If the corresponding cooling fan activates, replace the appropriate KR20 cooling fan relay.
5. Install the KR20E cooling fan speed control relay. Verify both fans activate at low speed.
 - If both fans do not activate, test the relay controlled output circuit terminal 87A of the KR20E fan relay for a short to ground or an open/high resistance.
6. If the circuits test normal, test or replace the KR20E cooling fan speed control relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.
 - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display OL.
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - If not the specified range, replace the KR20 cooling fan relay.
4. Test the KR20E relay for less than 2 ohms between terminals 30 and 87A.
 - If greater than the specified range, replace the KR20E cooling fan relay.
5. Install a 20 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
 - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

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

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Engine Coolant Fan Replacement (LF1)** or **Engine Coolant Fan Replacement (LAF)**

COOLING FAN INOPERATIVE (LAF)

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 cooling fan, 2 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes 1 resistor mounted in the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 2 speeds using two fan control circuits. The ECM will operate the cooling fan at either Low or High speed based on the cooling requirements.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates the fan at a low speed
 - Cooling Fan Relay 2 the fan at a high speed
- KR20 cooling fan relay identification:
 - KR20C COOL FAN LOW Relay
 - KR20D COOL FAN HI Relay
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (3.0L) or **Cooling Fan Description and Operation (2.4L)**

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, observe the DTC information with a scan tool. Verify that DTC P0480 or P0481 is not set.
 - If a DTC is set, refer to **DTC P0480 or P0481 (w/LF1)** or **DTC P0480 or P0481 (w/LAF)**.
2. Command the cooling fan ON and OFF at Low and High speed with a scan tool. The cooling fan should turn ON and OFF in each of the commanded states.

Circuit/System Testing

1. Ignition OFF, Disconnect the G10 cooling fan jumper harness connector X116.
2. Ignition ON, connect a test lamp between ground and the G10 cooling fan circuit terminals listed below. Command the cooling fan ON at Low and High speed with a scan tool. The test lamp should illuminate at each terminal as commanded:
 - Low speed circuit terminal 1-X116
 - High speed circuit terminal 2-X116
 - If the test lamp does not illuminate, test the appropriate KR20 relay controlled output circuit and B+ supply circuit for a short to ground or for an open/high resistance. If the circuits test normal, test or replace the appropriate KR20 cooling fan relay.
3. Ignition OFF, connect G10 cooling fan jumper harness connector X116.
4. Disconnect the harness connector at the G10 engine cooling fan.
5. Test for less than 1.0ohms between the G10 cooling fan ground circuit terminal 2 and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
6. Ignition ON, connect a test lamp between ground and the G10 cooling fan circuit terminal 1. Command the cooling fan ON at Low and High speed with a scan tool. The test lamp should illuminate as commanded.
 - If the test lamp does not illuminate, test the circuits between the X116 connector and the G10 fan for an open/high resistance. If the jumper harness circuits/connections test normal, replace the R10 cooling fan resistor.
7. If all of the circuits and components test normal, test or replace the G10 cooling fan.

Component Testing

KR20 Cooling Fan Relay

1. Ignition OFF, disconnect the cooling fan relay.
2. Test for 70-110ohms between terminals 85 and 86.

- If not within the specified range, replace the KR20 cooling fan relay.
- 3. Measure the resistance between the terminals listed below. The DMM should display OL.
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
- If not the specified range, replace the relay.
- 4. Install a 20 A fused jumper wire between relay terminal 86 and B+. Install a jumper wire between relay terminal 85 and ground. Test for less than 2ohms between terminals 30 and 87.
 - If greater than the specified range, replace the relay.

G10 Engine Cooling Fan

1. Ignition OFF, disconnect the harness connector at the G10 engine cooling fan.
2. Connect a jumper wire between ground and the G10 ground circuit terminal 2.
3. Connect a 30 A fused jumper wire between B+ and the G10 B+ supply circuit terminal 1. The cooling fan should operate at a High speed.
 - If the cooling fan does not operate, replace the G10 engine cooling fan.

Repair Procedures

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

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Engine Coolant Fan Resistor Replacement (LAF)**
- **Engine Coolant Fan Replacement (LF1)** or **Engine Coolant Fan Replacement (LAF)**

ENGINE OVERHEATING

Step	Action	Yes	No
DEFINITION: The engine temperature lamp comes on and stays on, or temperature gauge shows hot, or coolant overflows from the surge tank onto the ground while the engine is running.			
1	Check the condenser, radiator, and auxiliary coolers for any obstructions or bent fins that would prevent air flow through the radiator. Is there any airflow obstruction or bent fins?	Go to Step 2	Go to Step 3
2	1. Remove any debris that may cause an air flow obstruction. 2. Remove or relocate aftermarket add-on components that block air flow to the radiator. Does the engine still overheat?	Go to Step 3	System OK

3	Check for loose, missing, or damaged radiator air seals or deflectors. Are there any loose, missing, or damaged radiator air seals or deflectors?	Go to Step 4	Go to Step 5
4	Repair or replace any loose, missing, or damaged radiator air seals or deflectors. Does the engine still overheat?	Go to Step 5	System OK
5	Check for an inoperative cooling fan. Refer to <u>Cooling Fan Inoperative (LF1 or LFW)</u> or <u>Cooling Fan Inoperative (LAF)</u> Is the cooling fan inoperative?	Go to Step 6	Go to Step 7
6	Repair or replace the cooling fan(s) as necessary. Refer to <u>Engine Coolant Fan Replacement (LF1)</u> or <u>Engine Coolant Fan Replacement (LAF)</u> Does the engine still overheat?	Go to Step 7	System OK
7	Check for a loss of coolant. Refer to <u>Loss of Coolant</u> . Does the engine still overheat?	Go to Step 8	System OK
8	Check for kinked or pinched cooling hoses. Are any cooling hoses kinked or pinched?	Go to Step 9	Go to Step 10
9	1. Relieve any kinks by rerouting the hoses. 2. Replace the hoses, if necessary. Does the engine still overheat?	Go to Step 10	System OK
10	Using J-26568 : Coolant and Battery Fluid Tester, check the coolant concentration. Does the coolant concentration test correctly?	Go to Step 12	Go to Step 11
11	Replace the coolant, if necessary. Refer to <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System Draining and Filling (GE 47716)</u> Does the engine still overheat?	Go to Step 12	System OK
12	Check for any blocked cooling system passages. Are there blocked cooling system passages?	Go to Step 13	Go to Step 14
13	Remove any obstructions by flushing the cooling system. Refer to <u>Flushing</u> Does the engine still overheat?	Go to Step 14	Go to Step 19
14	Inspect the accessory drive belt tensioner. Refer to for 2.4L engine and for 3.0L engine. Does the engine still overheat?	Go to Step 15	System OK
15	Check for a faulty thermostat. Refer to <u>Thermostat Diagnosis</u> Does the engine still overheat?	Go to Step 16	System OK
16	Replace the radiator. Refer to <u>Radiator Replacement</u> Does the engine still overheat?	Go to Step 17	System OK
17	Check for a faulty water pump. The impeller blades may be eroded or broken.		-

	Is the water pump faulty?	Go to Step 18	
18	Replace the water pump. Refer to <u>Water Pump Replacement (LF1)</u> or <u>Water Pump Replacement (LAF)</u> Did you complete the repair?	Go to Step 19	-
19	Operate the system to verify the repair. Did you correct the condition?	System OK	-

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 <u>Symptoms - Engine Cooling</u>
2	Repair any present DTCs. Refer to <u>Diagnostic System Check - Vehicle</u> . 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 <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System Draining and Filling (GE 47716)</u> . Is the action complete?	Go to Step 5	-
5	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to Step 19	Go to Step 6
6	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 7	Go to Step 8
7	1. Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. 2. 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 20	Go to Step 8
8	Visually inspect the hoses, pipes and hose clamps. Are any of the hoses, clamps or pipes leaking?	Go to Step 21	Go to Step 9
	Visually inspect the following components: • Block heater • Coolant pressure cap • Core plugs		

9	• Throttle body • Engine block • Intake manifold • Radiator • Thermostat housing • Water pump Are any of the listed components leaking?	Go to Step 21	Go to Step 10
10	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 7 and 8. Are any leaks present?	Go to Step 21	Go to Step 11
11	Pressure test the coolant pressure cap. Refer to <u>Pressure Cap Testing</u>. Does the coolant pressure cap hold pressure?	Go to Step 12	Go to Step 16
12	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 21	Go to Step 13
13	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is there a milky substance under the oil fill cap?	Go to Step 14	Go to Step 15
14	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is there a milky substance on the engine oil fluid level indicator?	Go to Step 17	Go to Step 15
15	Inspect the automatic transmission oil fluid level indicator, if equipped, for a gray/white milky substance. Is there a milky substance on the automatic transmission fluid level indicator?	Go to Step 18	Go to Step 22
16	Replace the coolant pressure cap. Is the repair complete?	Go to Step 22	-
	1. Replace the radiator. Refer to <u>Radiator Replacement</u>.		

17	2. Replace the oil and filter. Refer to <u>Engine Oil and Oil Filter Replacement</u> For 2.4L engine or <u>Engine Oil and Oil Filter Replacement (LF1)</u> for 3.0L engine. Is the repair complete?	Go to Step 22	-
18	1. Replace the radiator. Refer to <u>Radiator Replacement</u> . 2. Service the automatic transmission. Refer to the following: <u>Engine Coolant/Water in Transmission</u> . Is the repair complete?	Go to Step 22	-
19	Repair the engine overheating condition. Refer to <u>Engine Overheating</u> . Is the repair complete?	Go to Step 22	-
20	Repair the engine internal coolant leak. Refer to <u>Coolant in Combustion Chamber</u> for 2.4L engine or <u>Coolant in Combustion Chamber</u> for 3.0L engine. or, <u>Coolant in Engine Oil</u> for 2.4L engine or <u>Coolant in Engine Oil</u> for 3.0L engine. Is the repair complete?	Go to Step 22	-
21	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to Step 22	-
22	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:

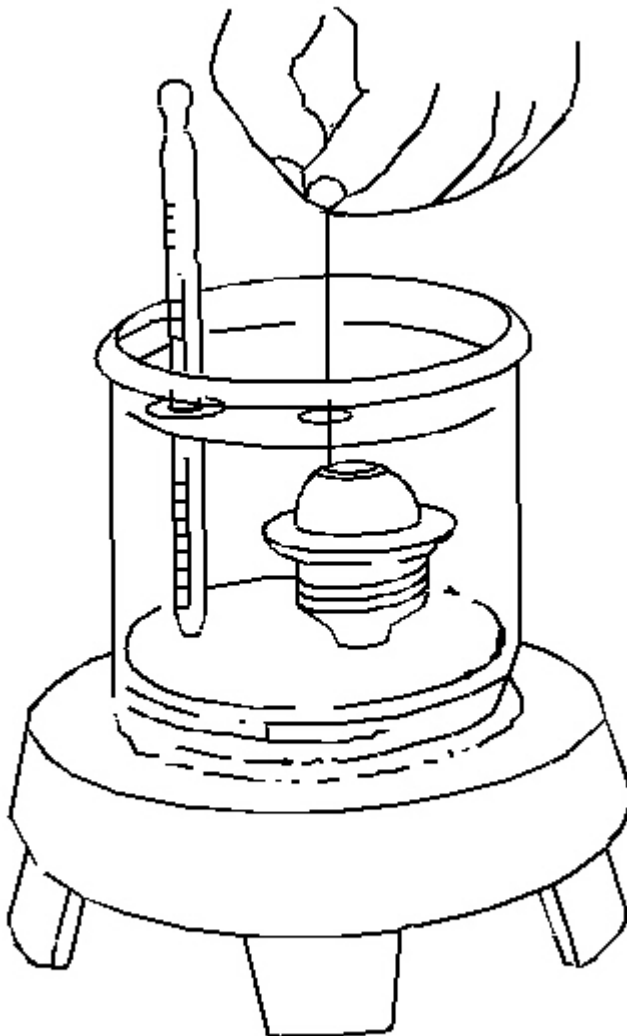


Fig. 3: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS CORP.

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.

COOLANT HEATER 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 optional 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. There is an internal thermal switch in the power cord that prevents operation above -18°C (0°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.

Reference Information

Electrical Information Reference

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

Circuit/System Testing

NOTE: **The power supply cord will read open due to an internal thermal switch if the ambient temperature is above -18°C (0°F).**

1. Test the engine coolant heater for an open or short to ground.
 - If open or shorted, replace the heater.

2. If the heater tests normal, replace the coolant heater power cord.

Repair Procedures

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

- **Coolant Heater Replacement (LF1)** or **Coolant Heater Replacement (LAF)**
- **Coolant Heater Cord Replacement (LAF)** or **Coolant Heater Cord Replacement (LF1)**

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

Step	Action	Yes	No
1	1. Ensure that the cooling system is full. 2. Allow the engine to cool. 3. Start the engine. 4. Turn the air conditioning system off. 5. Inspect the engine cooling fan(s). Is the electric cooling fan on?	Go to Step 2	Go to Step 3
2	1. Diagnose and repair the cooling fan system. Refer to <u>Engine Coolant Fan Replacement (LF1)</u> or <u>Engine Coolant Fan Replacement (LAF)</u> . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 3	System OK
3	Install the Scan Tool to the DLC. Compare the Scan Tool coolant temperature reading to the I/P cluster coolant temperature. Is the I/P cluster coolant temperature close to the reading on the Scan Tool?	Go to Step 5	Go to Step 4
4	1. Diagnose and repair the coolant temperature gauge system. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 5	System OK
5	Inspect the thermostat for correct operation. Refer to <u>Thermostat Diagnosis</u> . Is the thermostat operating correctly?	System OK	Go to Step 6
	1. Replace the thermostat. Refer to <u>Engine Coolant Thermostat Replacement (LF1)</u> or <u>Engine</u>		

6	<u>Coolant Thermostat Replacement (LAF).</u>		
	2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 1	System OK

PRESSURE CAP TESTING

Special Tools

- **J 24460-01:** Cooling System Pressure Tester
- **J 42401-1:** Radiator Cap / Surge Tank Test Adapter

Pressure Cap Testing

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.

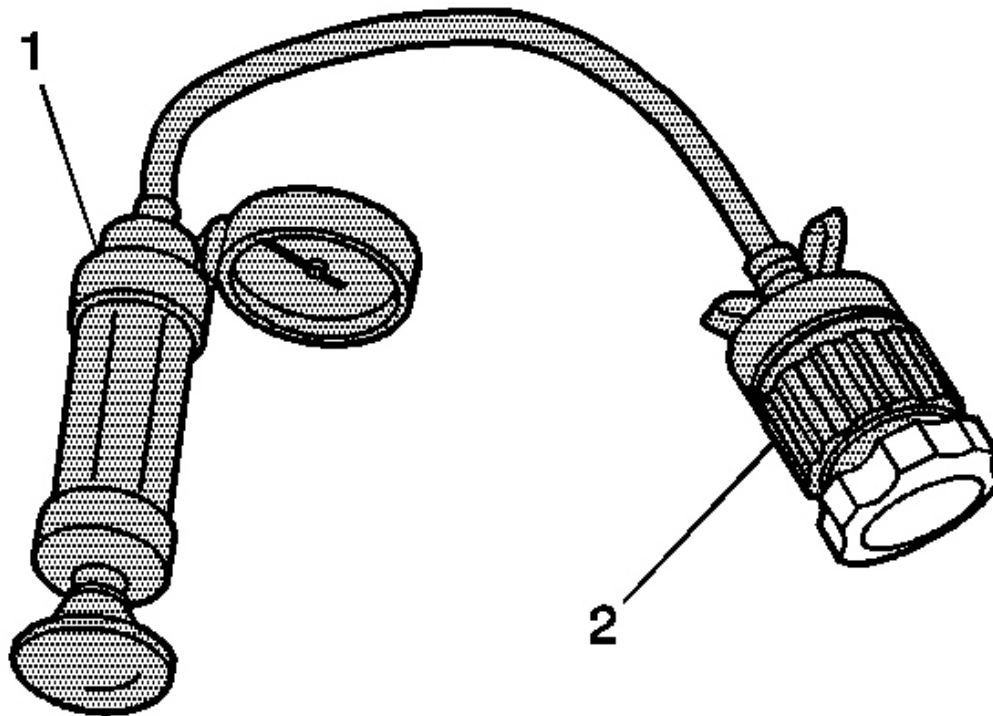


Fig. 4: Pressure Testing Radiator Cap
Courtesy of GENERAL MOTORS CORP.

NOTE: Lubricate J-42401-1 and pressure cap o-rings with coolant and press cap to seat o-ring on J-42401-1 before turning to engage threads.

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

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.

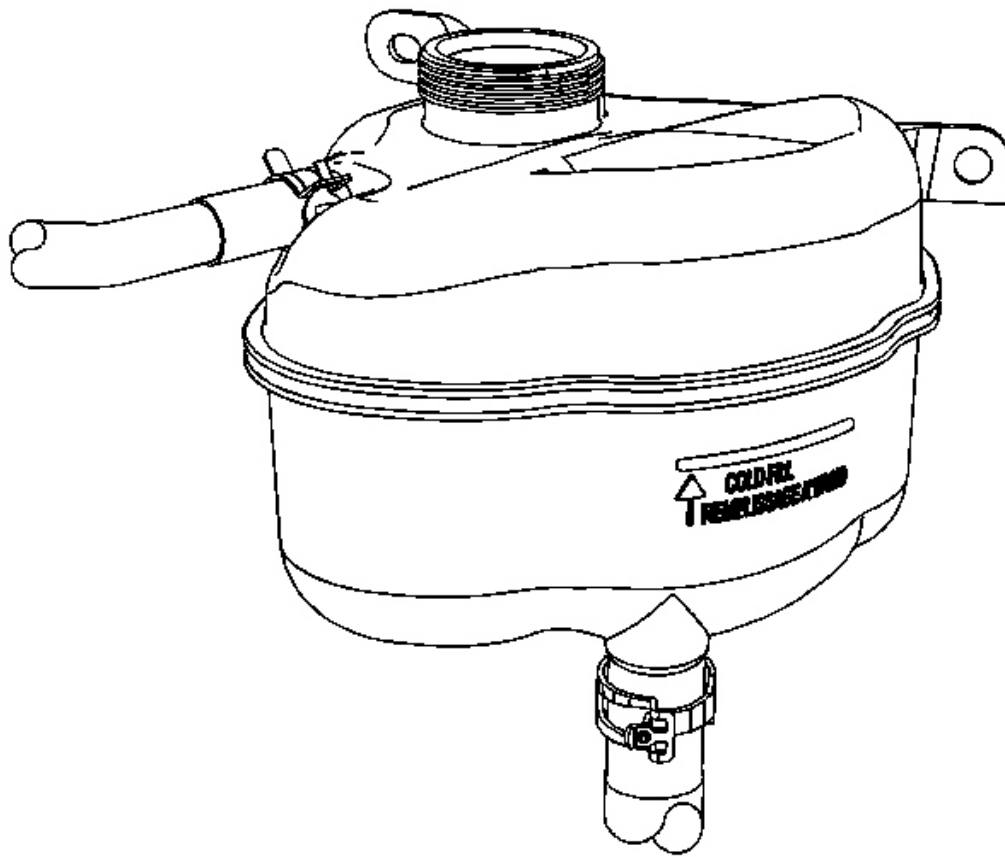


Fig. 5: Applying Pressure To Cooling System
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 24460-01: Cooling System Pressure Tester** with the **J 42401: Radiator Cap/Surge Tank Test Adapter** 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)

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 from the radiator surge tank.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Place a drain pan under the drain cock.

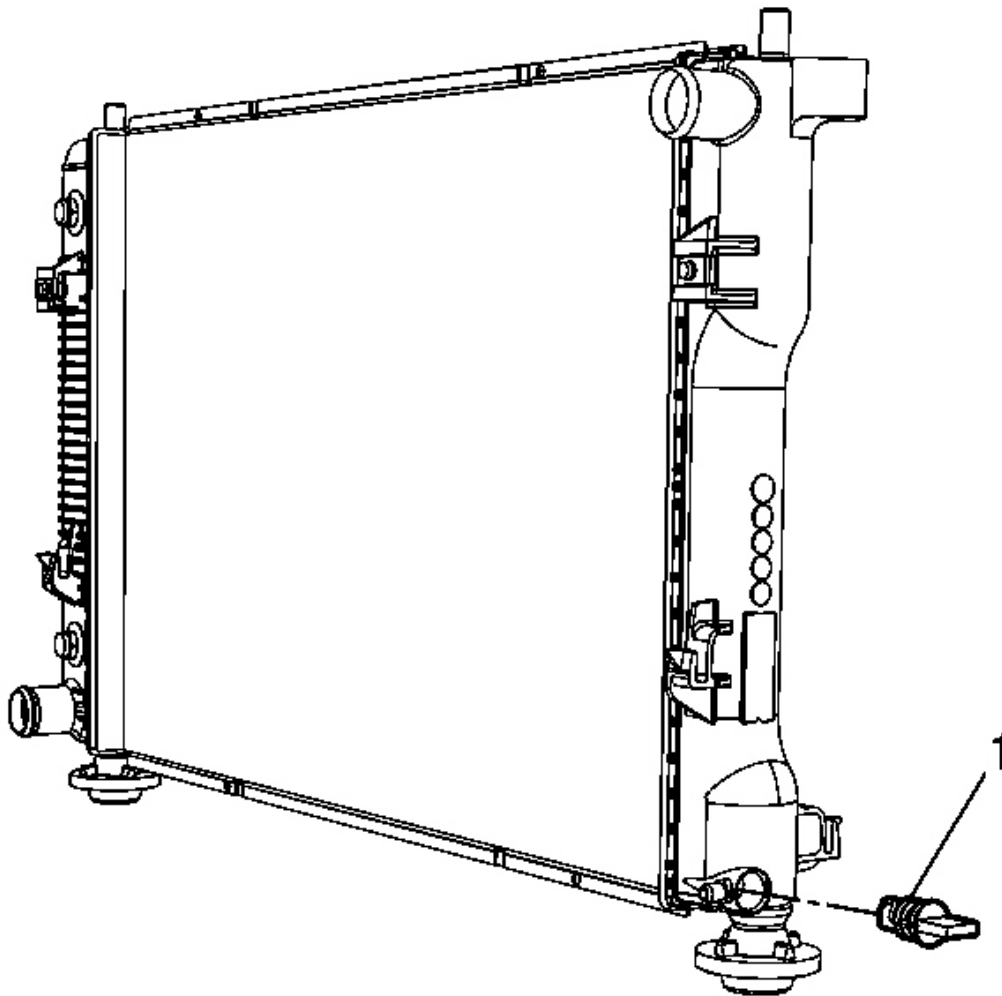


Fig. 6: Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

4. Loosen the radiator drain cock.
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.

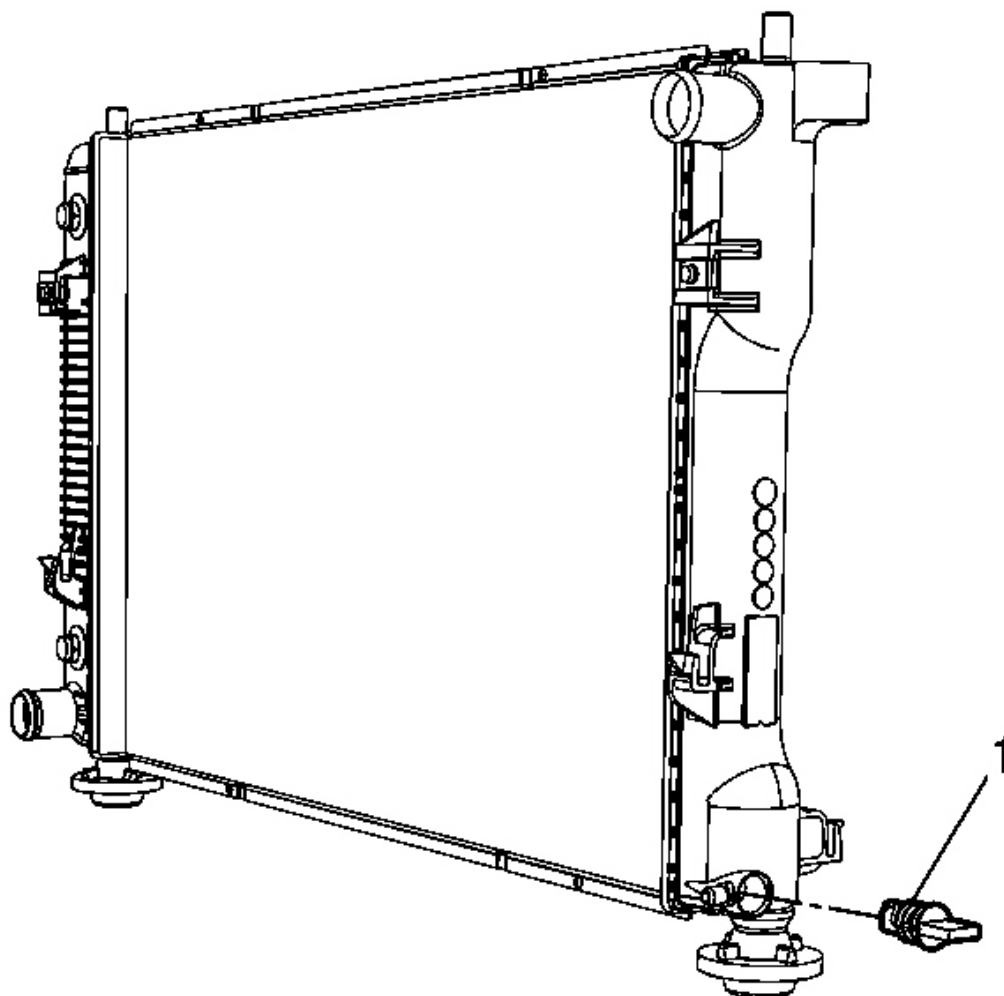


Fig. 7: Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Tighten the radiator drain cock to 2 N.m (18 lb in).
3. Lower the vehicle.

NOTE: Use a 50/50 mixture of DEX-COOL antifreeze and clean drinkable water.

4. Slowly fill the radiator with a 50/50 coolant mixture until the coolant level reaches the base of the radiator surge tank. Refer to **Approximate Fluid Capacities**.
5. Allow 30 seconds for the coolant level to stabilize and continue to fill the coolant filler neck until the level stabilizes for at least 2 minutes.
6. Start the engine and allow the engine to idle in PARK or NEUTRAL with the parking brake engaged.
7. Slowly fill the coolant mixture until the level stabilizes at the base of the radiator surge tank.
8. Install the coolant pressure cap.
9. Raise the engine RPM to 2500rpm for 30-40 seconds.
10. Shut the engine OFF.
11. Allow the engine to cool, remove coolant fill cap and repeat steps 4-10 until the coolant level has completely stabilized within the radiator surge tank.
12. Inspect the concentration of the engine coolant using the **J 26568: Coolant and Battery Fluid Tester**.
13. Inspect and if necessary, fill the coolant reservoir bottle as necessary.
14. Rinse away any excess coolant from the engine and the engine compartment
15. Inspect the cooling system for leaks.
16. Top off the radiator surge tank if necessary.

COOLING SYSTEM DRAINING AND FILLING (GE 47716)

Special Tools

- **J 26568:** Coolant and Battery Fluid Tester
- **J 42401:** 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.
4. Remove the radiator drain cock.

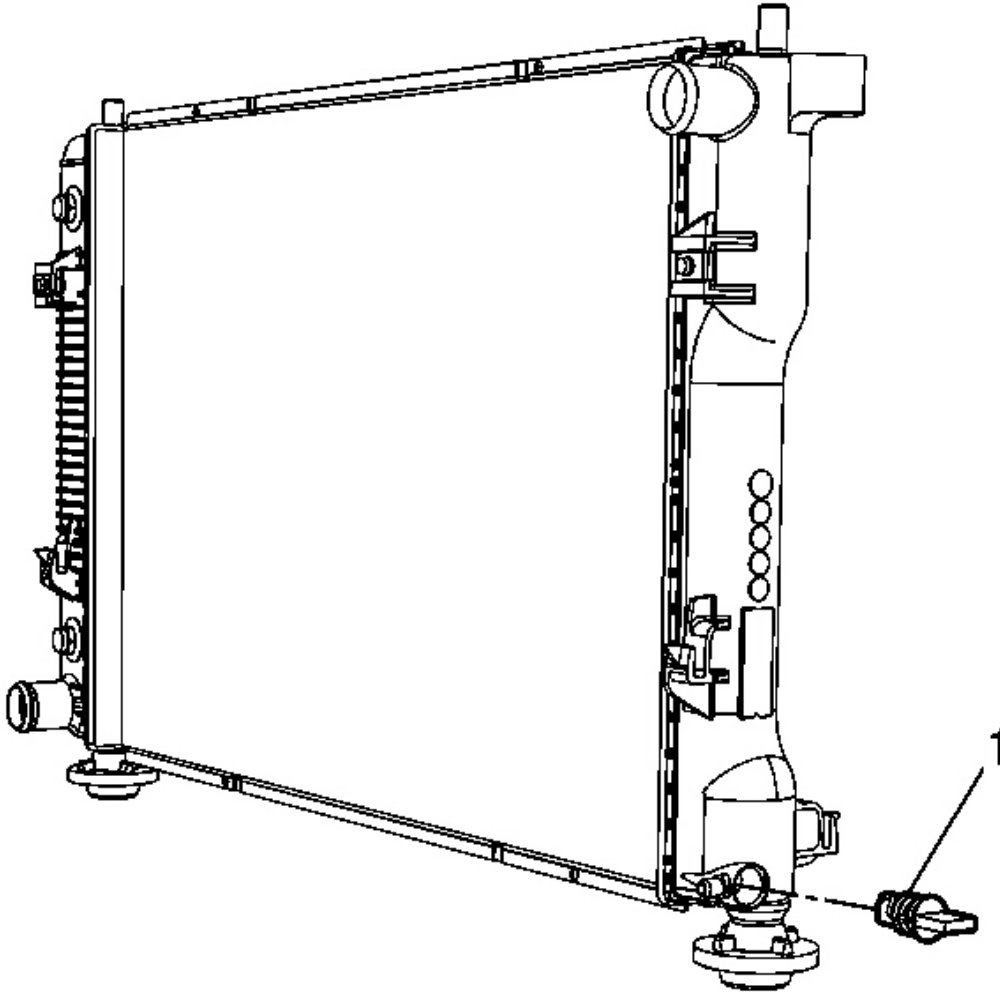


Fig. 8: Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

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** .

Vac-N-Fill Procedure

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

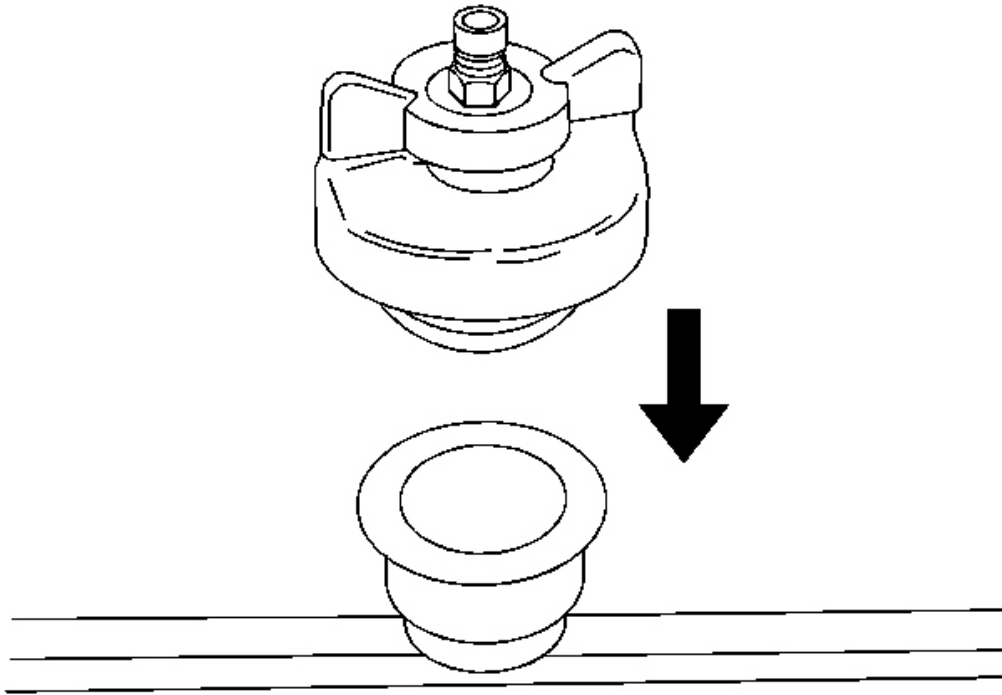


Fig. 9: Vac-N-Fill Cap
Courtesy of GENERAL MOTORS CORP.

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: Radiator Cap and Surge Tank Test Adapter**.

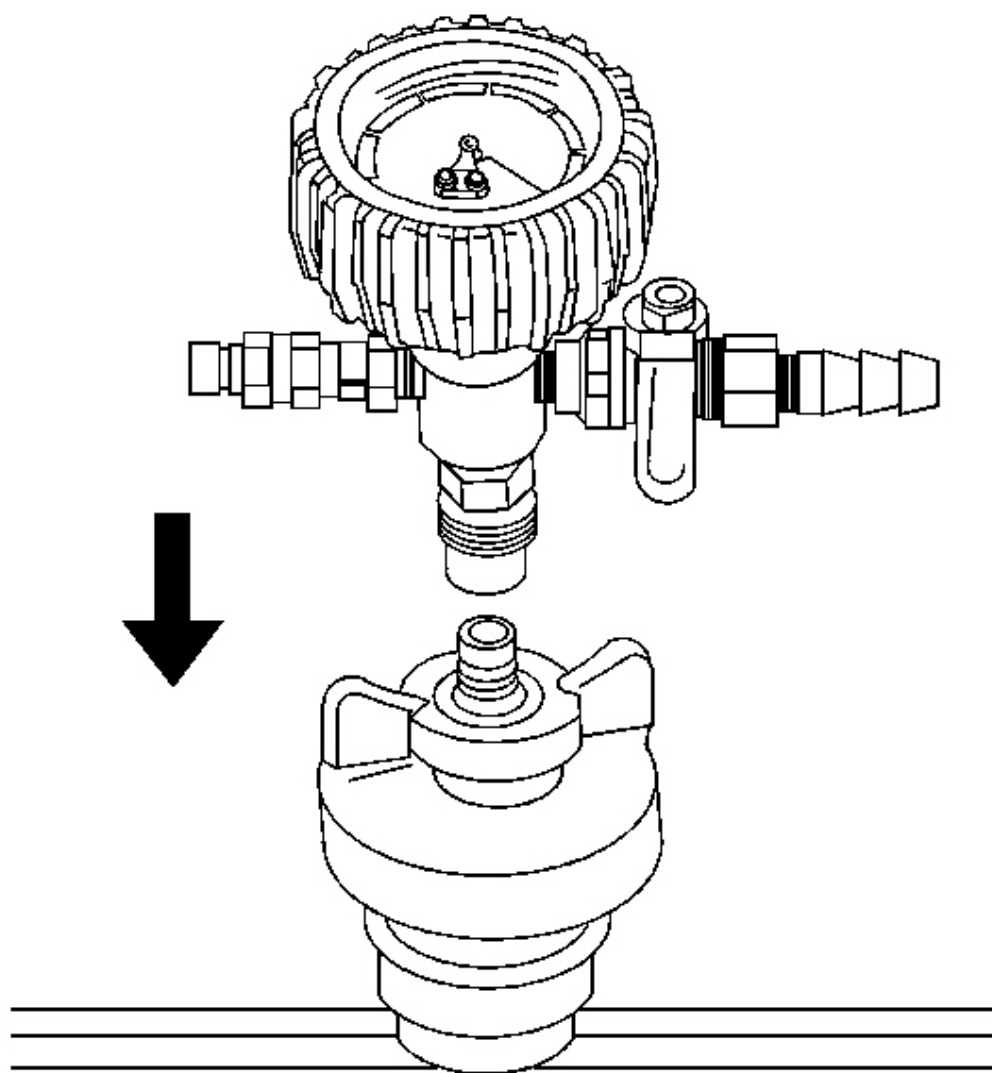


Fig. 10: Attaching Vacuum Gage Assembly To Vac-N-Fill Cap
Courtesy of GENERAL MOTORS CORP.

3. Attach the vacuum gauge assembly to the Vac N Fill cap.

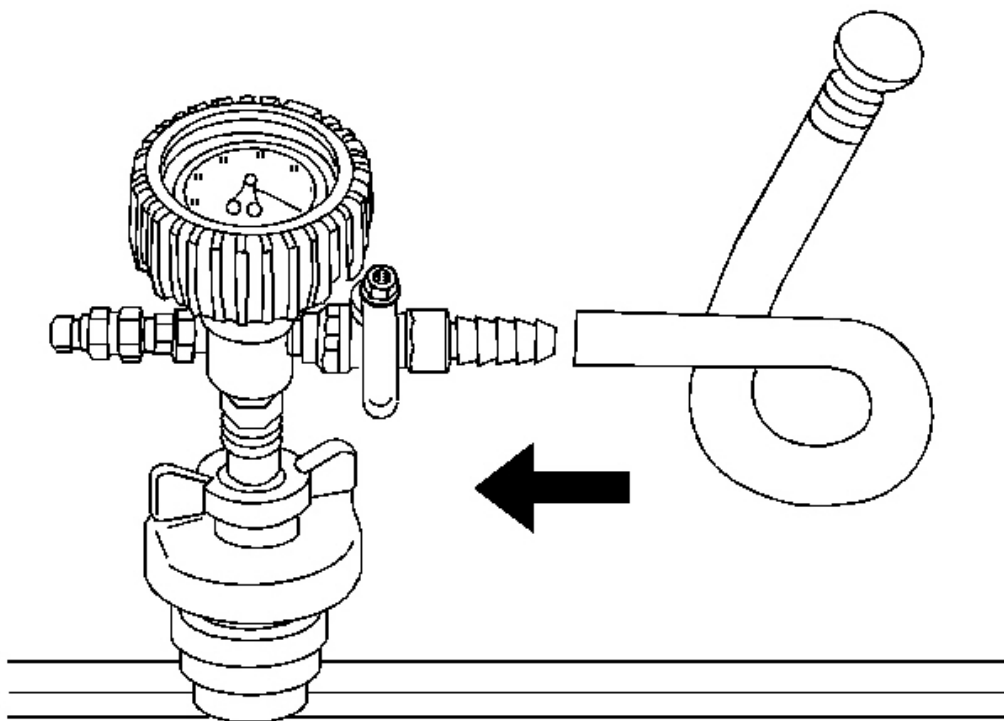


Fig. 11: Attaching Fill Hose To Barb Fitting On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

4. Attach the fill hose to the barb fitting on the vacuum gauge assembly.

Ensure that the valve is closed.

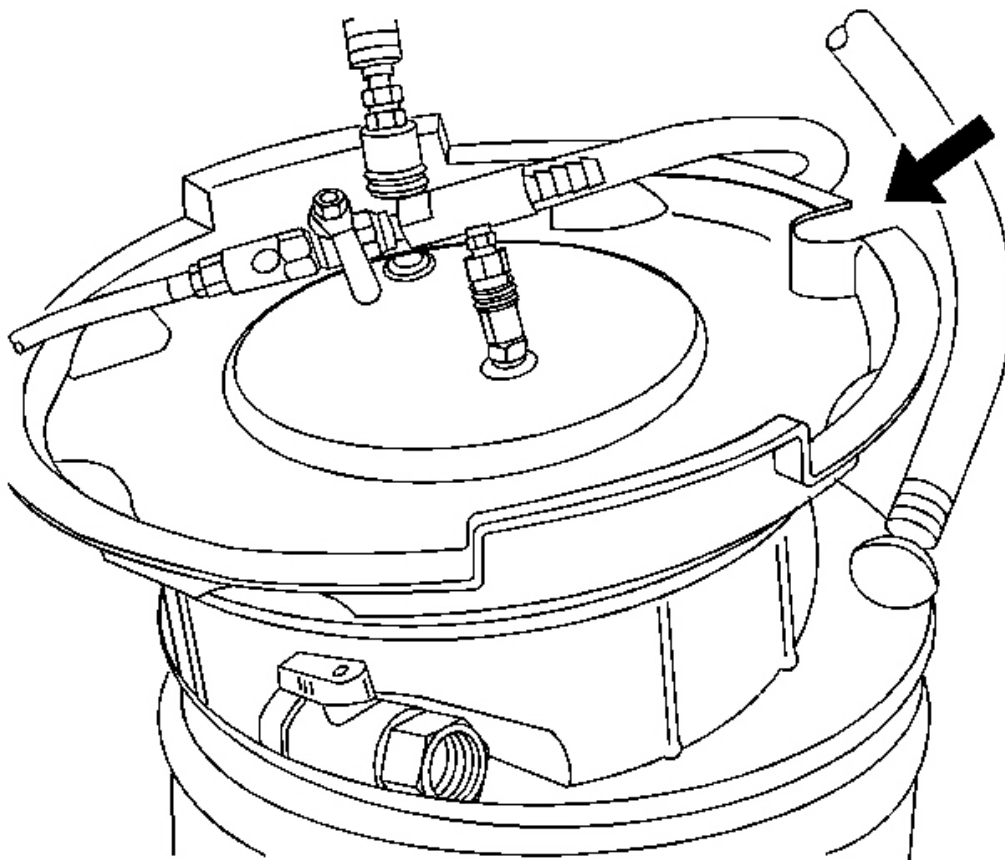


Fig. 12: View Of Graduated Reservoir & Hose
Courtesy of GENERAL MOTORS CORP.

NOTE: Use a 50/50 mixture of DEX-COOL antifreeze and 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.
6. Place the fill hose in the graduated reservoir.

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 on the graduated reservoir with the fill hose routed through the cut-out area in the vacuum tank.

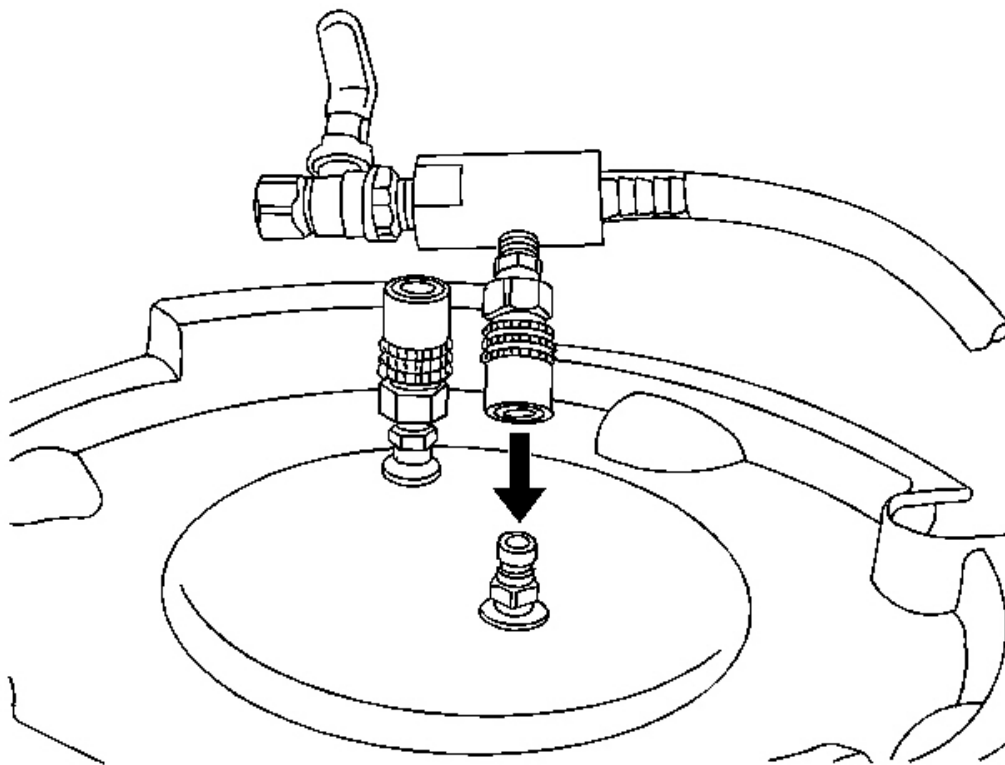


Fig. 13: Connecting Venturi Assembly To Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

8. Attach the venturi assembly to the vacuum tank.

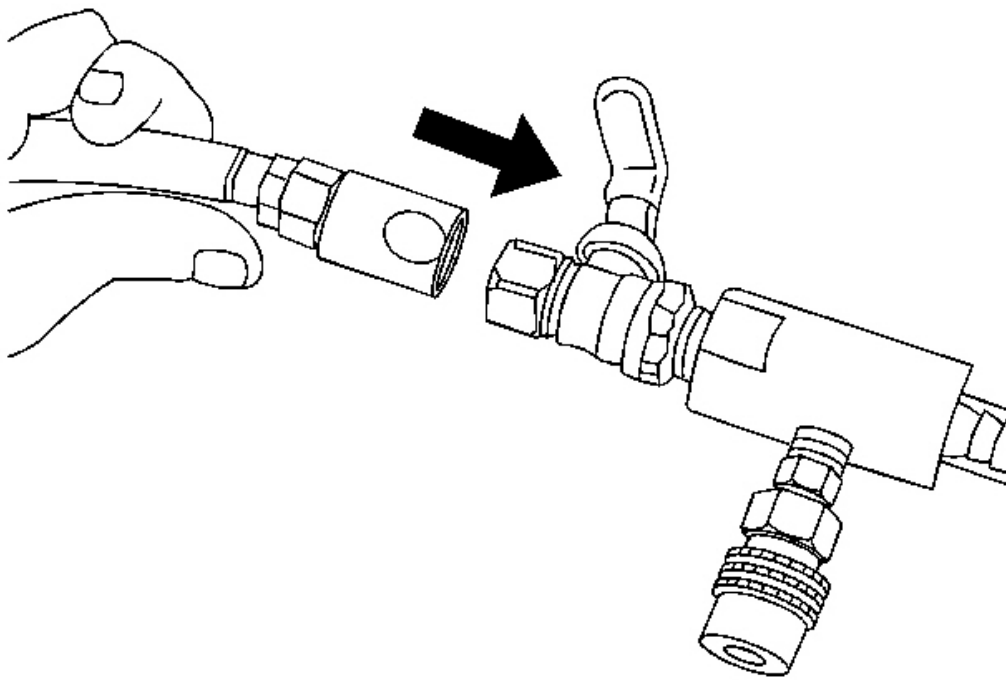


Fig. 14: Attaching Shop Air Hose To Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

9. Attach a shop air hose to the venturi assembly.

Ensure the valve on the venturi assembly is closed.

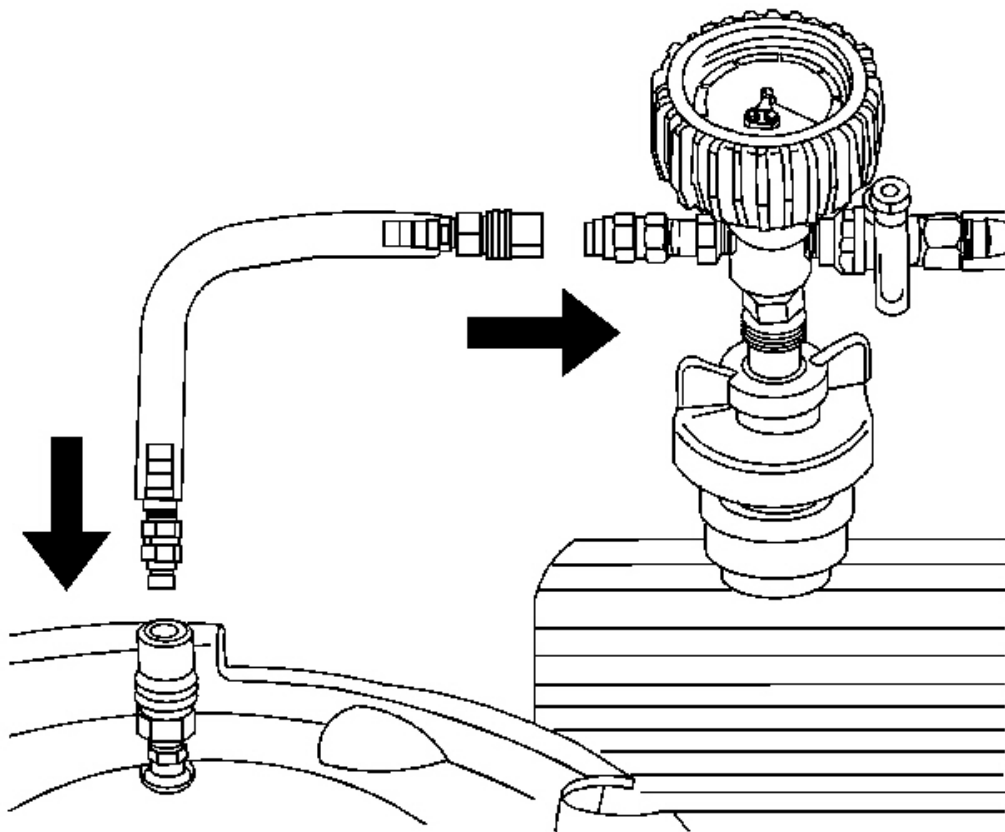


Fig. 15: Attaching Vacuum Hose To Vacuum Gauge Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

10. Attach the vacuum hose to the vacuum gauge assembly and the vacuum tank.

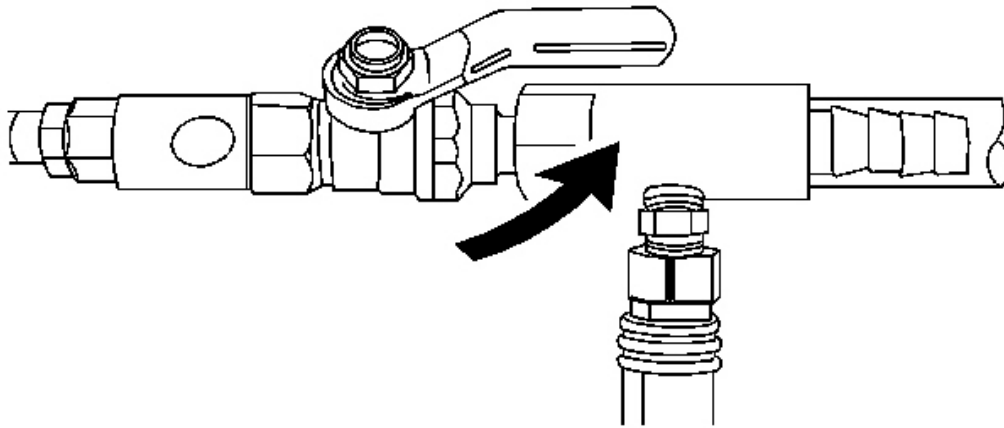


Fig. 16: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

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

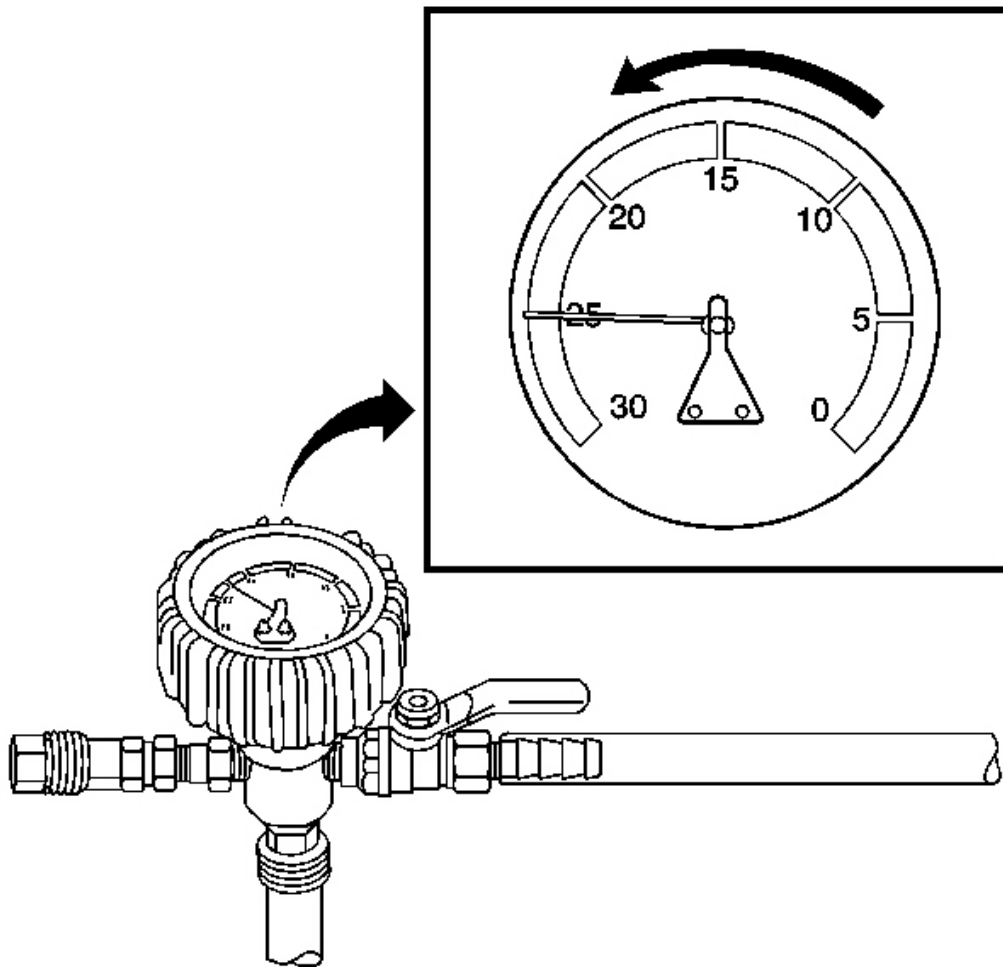


Fig. 17: View Of Vacuum Gauge
Courtesy of GENERAL MOTORS CORP.

12. Continue to draw vacuum until the needle stops rising. 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.

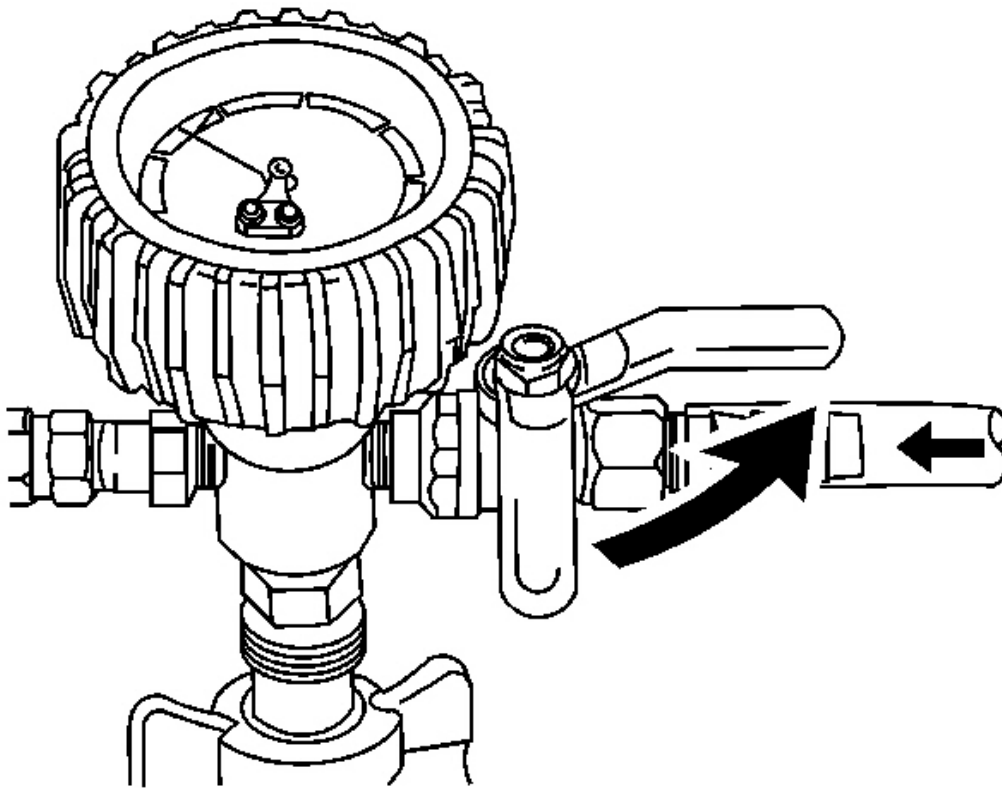


Fig. 18: Identifying Valve On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

14. Slowly open the valve on the vacuum gage assembly. 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 gage assembly. The vacuum gauge will drop as coolant is drawn into the system.

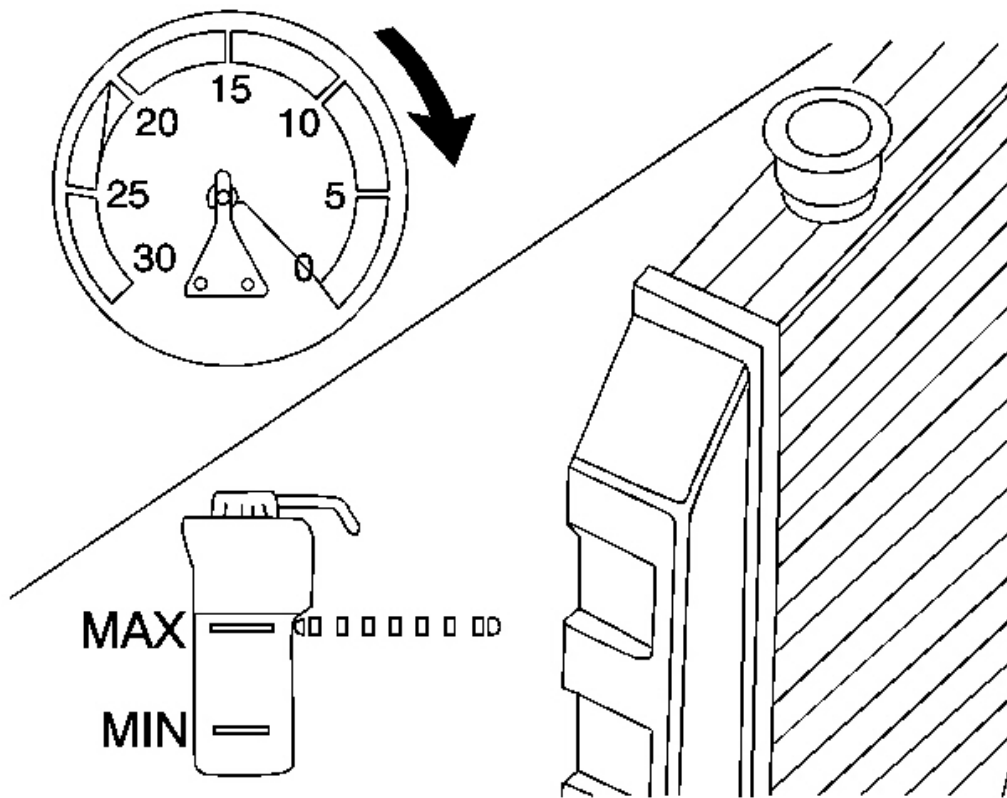


Fig. 19: View Of Vacuum Gauge & Radiator
Courtesy of GENERAL MOTORS CORP.

18. Once the vacuum gauge reaches zero, close the valve on the vacuum gauge assembly and repeat steps 11-17.
19. Detach the Vac N Fill cap from the **J 42401: Radiator Cap and Surge Tank Test Adapter**.
20. Remove the **J 42401: 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.

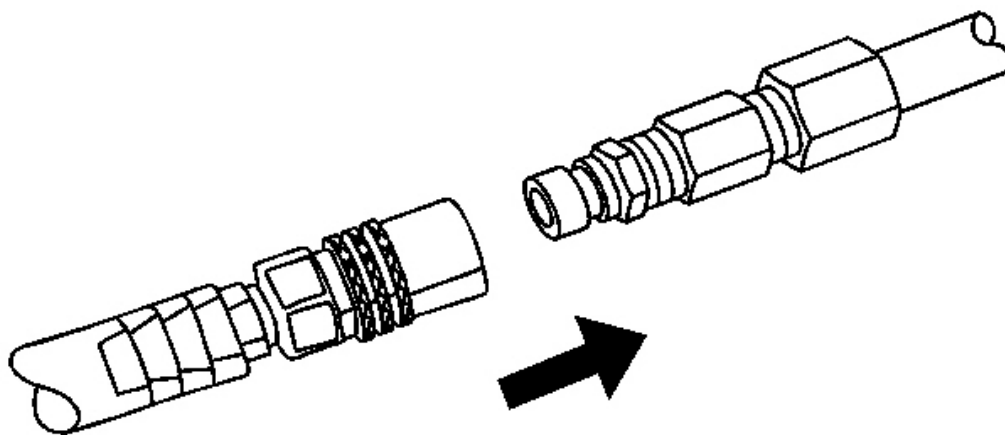


Fig. 20: Attaching Extraction Hose To Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

24. Attach the extraction hose to the vacuum hose.

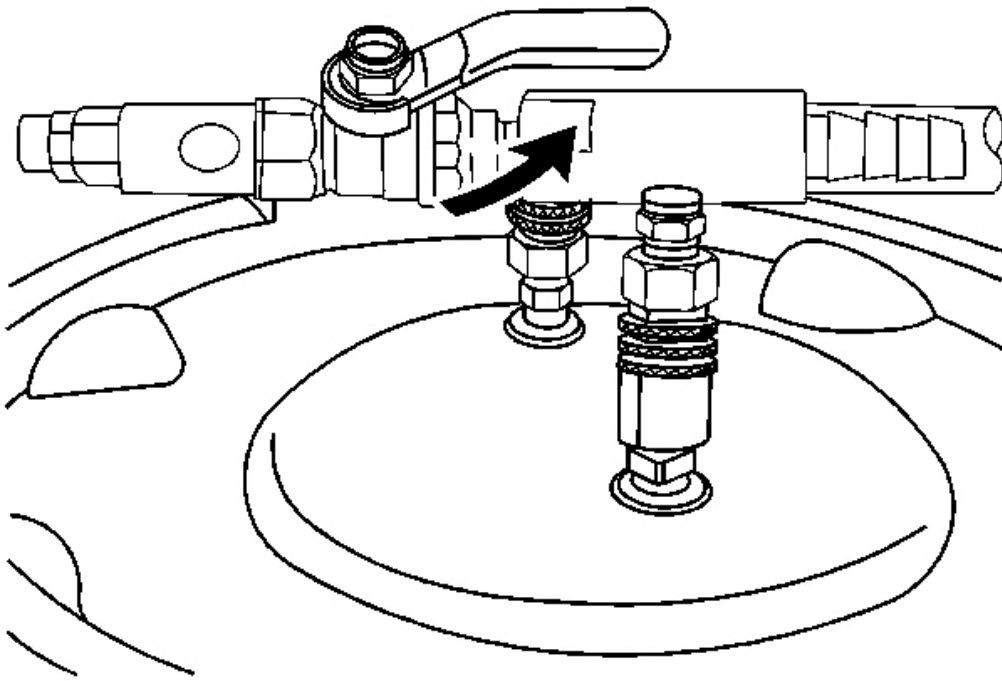


Fig. 21: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

25. Open the valve on the venturi assembly to start a vacuum draw.

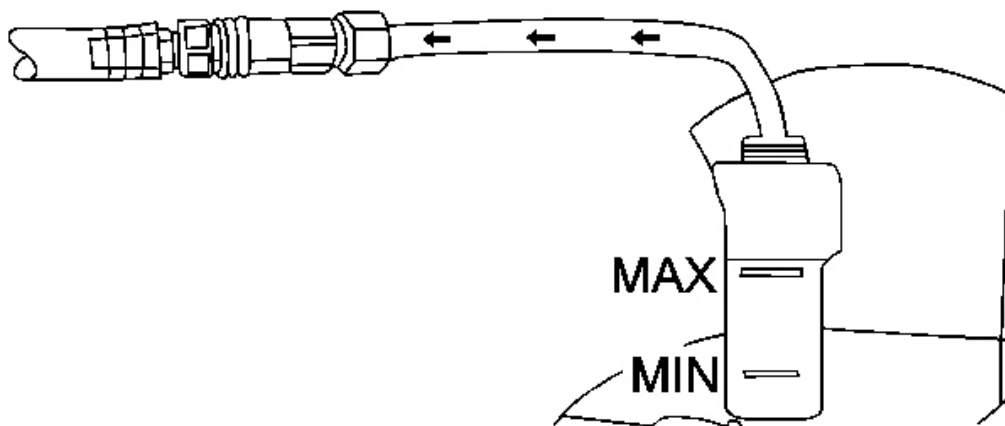


Fig. 22: Using Extraction Hose To Draw Out Coolant
Courtesy of GENERAL MOTORS CORP.

26. Use the extraction hose 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)** or **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)** or **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)** or **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)** or **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

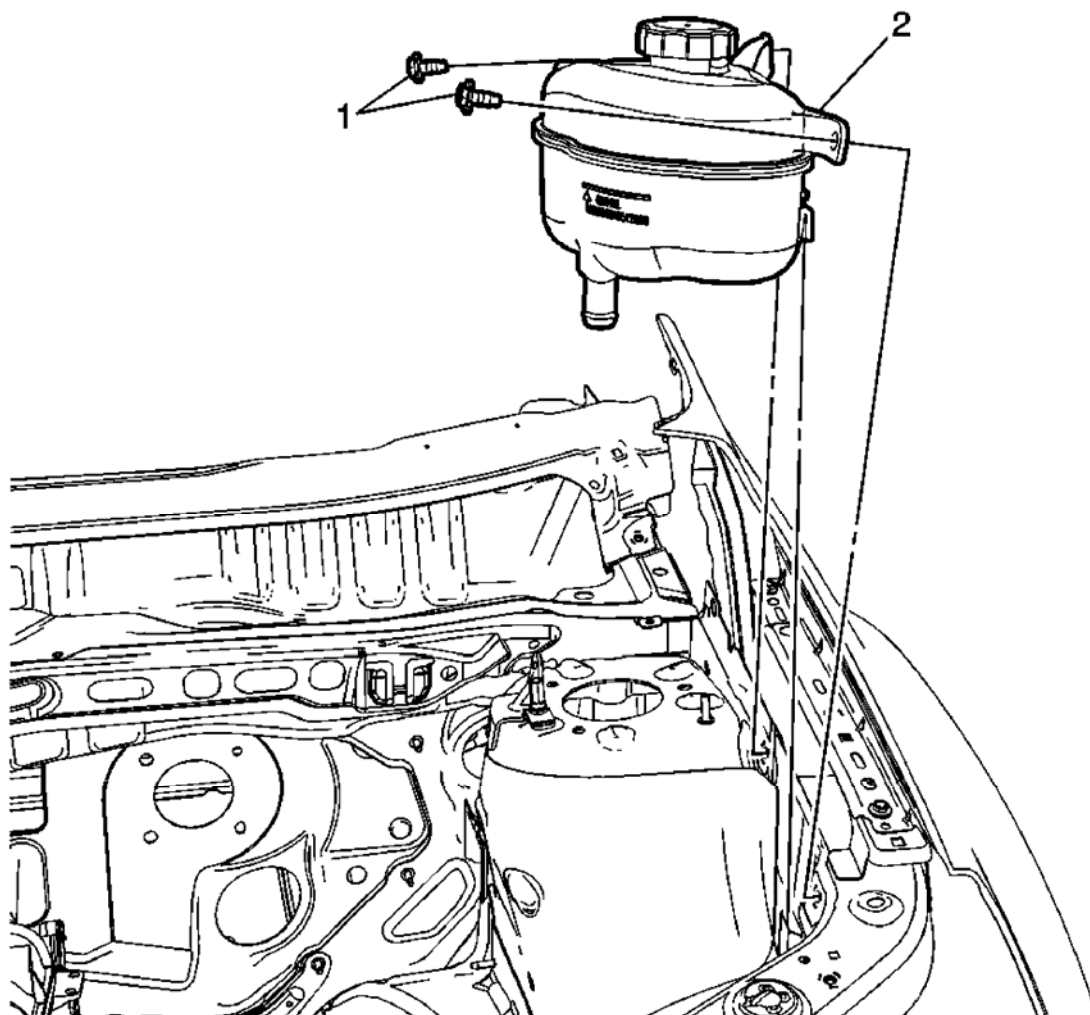


Fig. 23: Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Drain the coolant. Refer to <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System Draining and Filling (GE 47716)</u> .
2.	Remove front bumper fascia opening cover. Refer to <u>Front Bumper Fascia Opening Cover Replacement (Equinox)</u> or <u>Front Bumper Fascia Opening Cover Replacement (Terrain)</u> .
3.	Remove the coolant recovery reservoir vent hose. Refer to <u>Coolant Recovery Reservoir Vent Hose Replacement (LAF)</u> or <u>Coolant Recovery Reservoir Vent Hose Replacement (LF1)</u> .
4.	Remove the coolant recovery reservoir outlet hose. Refer to <u>Coolant Recovery Reservoir Outlet Hose Replacement (LAF)</u> or <u>Coolant Recovery Reservoir Outlet Hose Replacement (LF1)</u> .
	Radiator Surge Tank Bolt (Qty: 2)

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 9 N.m (80 lb in)
2	Radiator Surge Tank

RADIATOR INLET HOSE REPLACEMENT (LAF)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

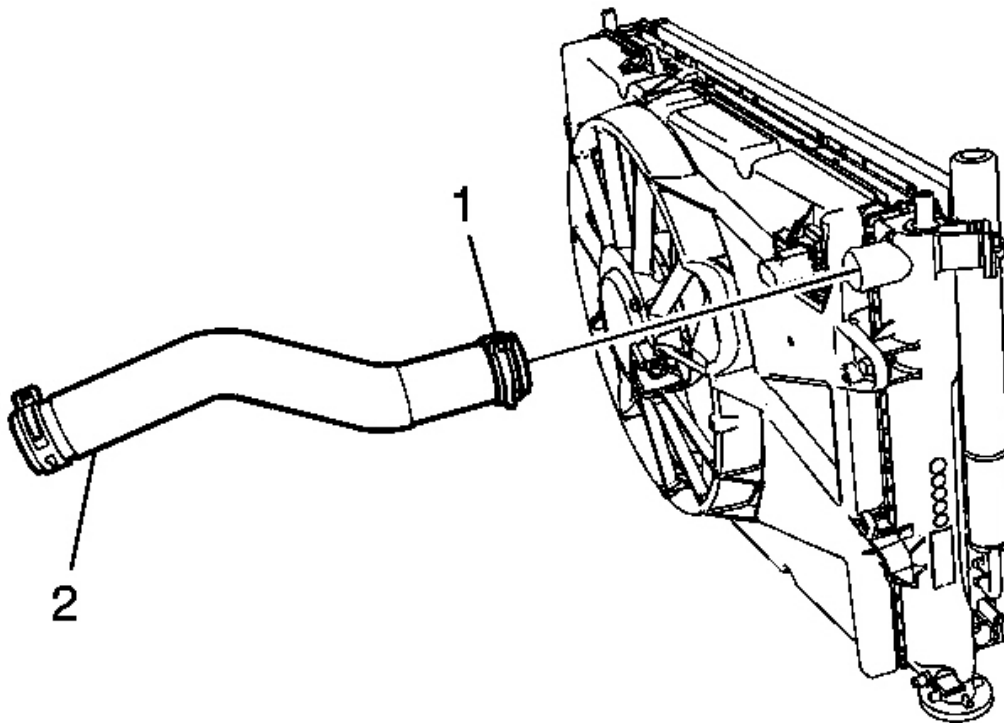


Fig. 24: Radiator Inlet Hose At Radiator

Courtesy of GENERAL MOTORS CORP.

3. Disengage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185: Hose Clamp Pliers**.
4. Remove the radiator inlet hose (2) from the radiator.

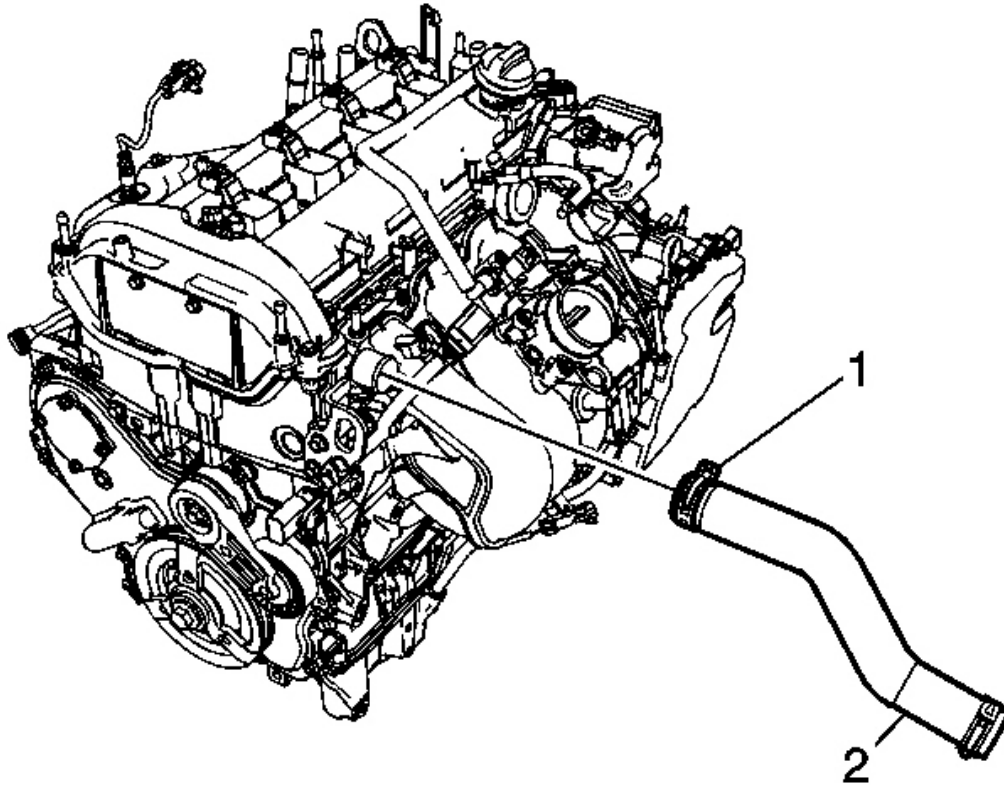


Fig. 25: Radiator Inlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

5. Disengage tension on the radiator inlet hose clamp (1) at the engine using **J 38185: Hose Clamp Pliers**.
6. Remove the radiator inlet hose (2) from the engine.
7. Remove the radiator inlet hose from the vehicle.

Installation Procedure

1. Install radiator inlet hose to the vehicle.

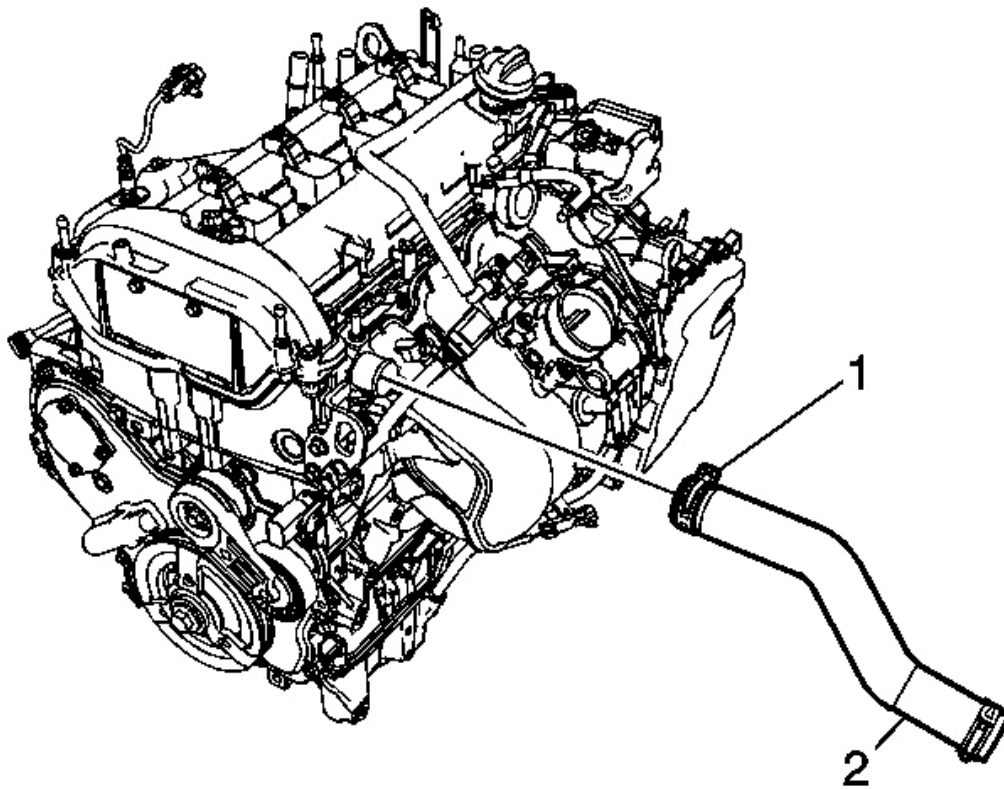


Fig. 26: Radiator Inlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

2. Install the radiator inlet hose (2) to the engine.
3. Engage tension on the radiator inlet hose clamp (1) at the engine using **J 38185: Hose Clamp Pliers**.

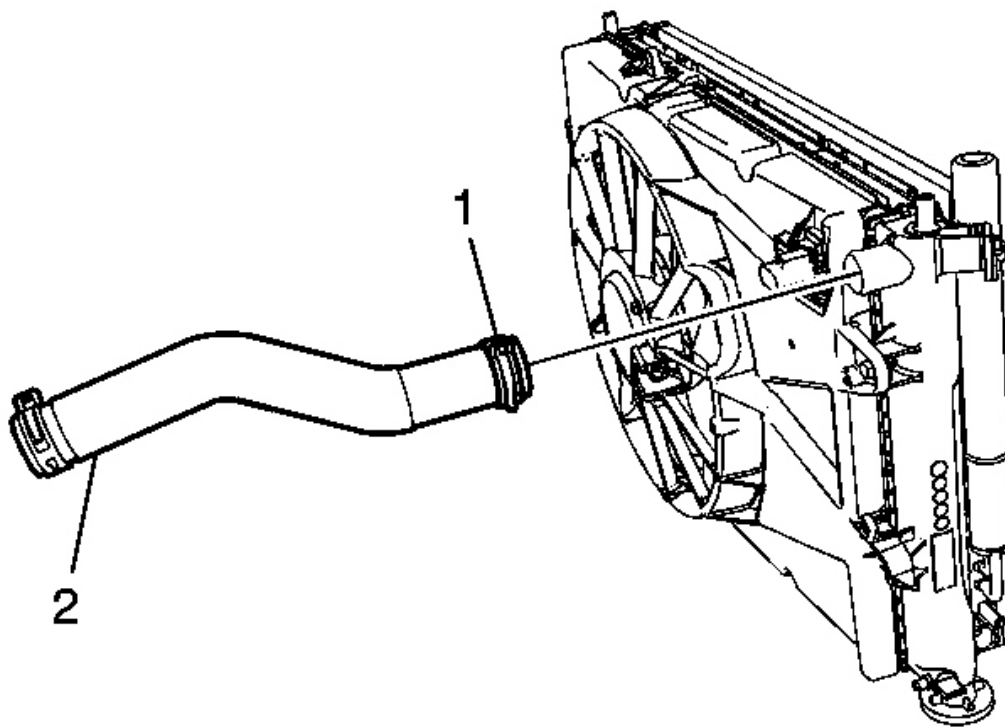


Fig. 27: Radiator Inlet Hose At Radiator
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator inlet hose (2) to the radiator.
5. Engage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185: Hose Clamp Pliers**.
6. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR INLET HOSE REPLACEMENT (LF1)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

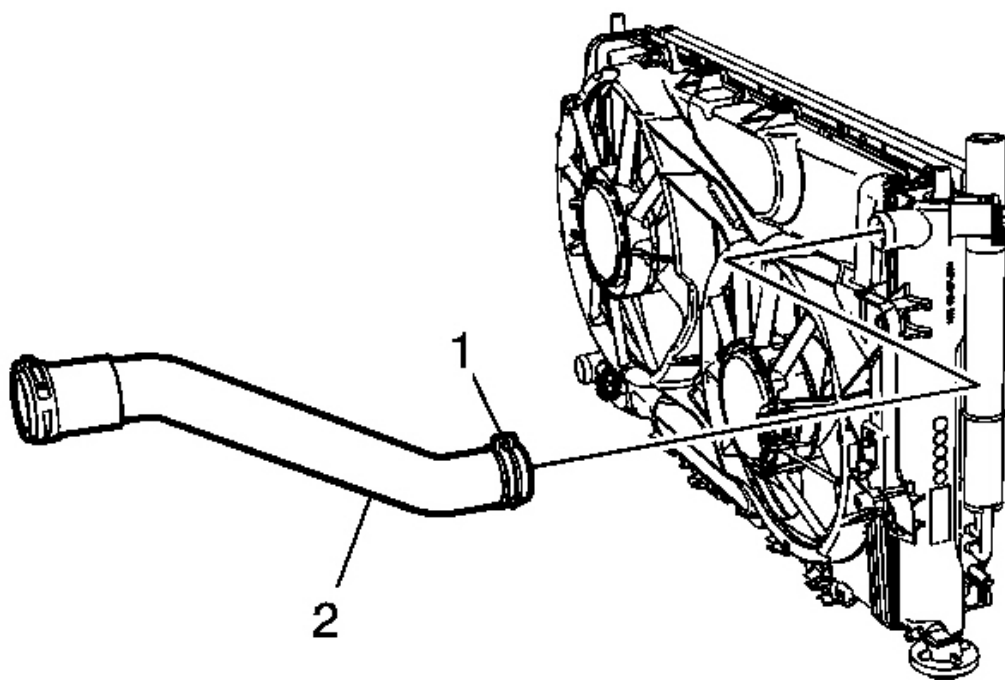


Fig. 28: Radiator Inlet Hose At Radiator
Courtesy of GENERAL MOTORS CORP.

3. Disengage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185: Hose Clamp Pliers**.
4. Remove the radiator inlet hose (2) from the radiator.

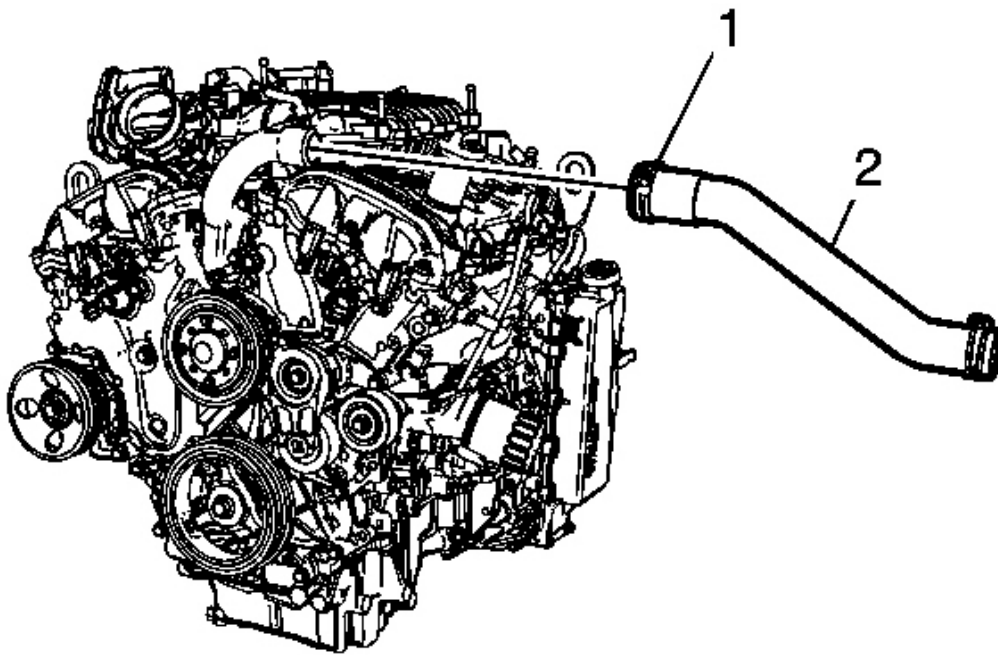


Fig. 29: Radiator Inlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

5. Disengage tension on the radiator inlet hose clamp (1) at the engine using **J 38185: Hose Clamp Pliers**.
6. Remove the radiator inlet hose (2) from the engine.
7. Remove the radiator inlet hose from the vehicle.

Installation Procedure

1. Install radiator inlet hose to the vehicle.

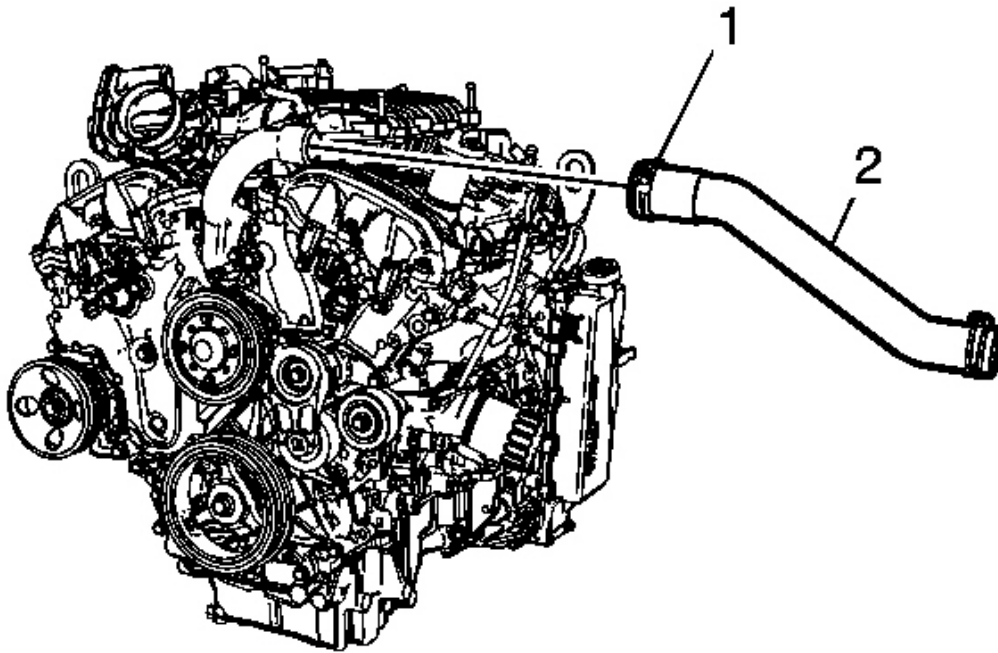


Fig. 30: Radiator Inlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

2. Install the radiator inlet hose (2) to the engine.
3. Engage tension on the radiator inlet hose clamp (1) at the engine using **J 38185: Hose Clamp Pliers**.

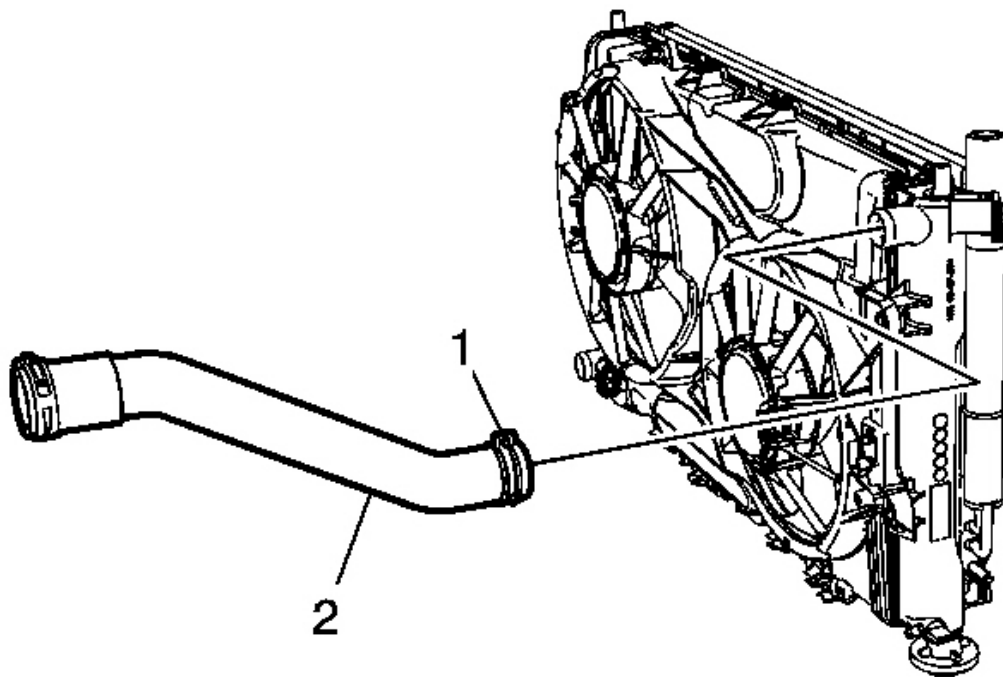


Fig. 31: Radiator Inlet Hose At Radiator
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator inlet hose (2) to the radiator.
5. Engage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185: Hose Clamp Pliers**.
6. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR OUTLET HOSE REPLACEMENT (LAF)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.

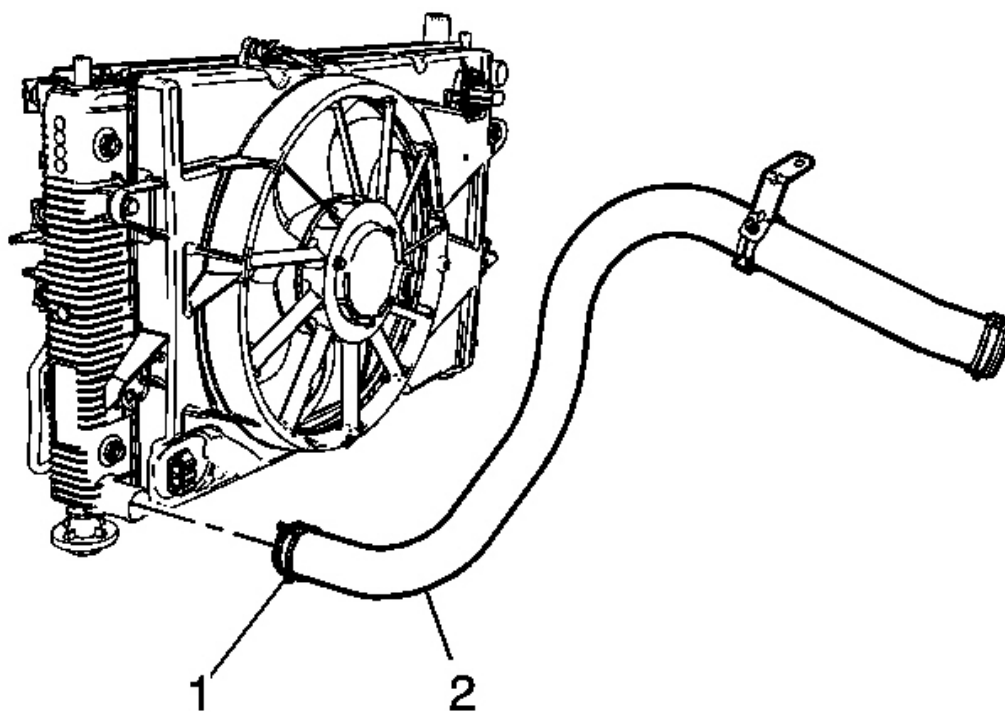


Fig. 32: Radiator Outlet Hose At Radiator
Courtesy of GENERAL MOTORS CORP.

3. Disengage tension on the radiator outlet hose clamp (1) at the radiator using **J 38185: Hose Clamp Pliers**.
4. Remove the radiator outlet hose (2) from the radiator.

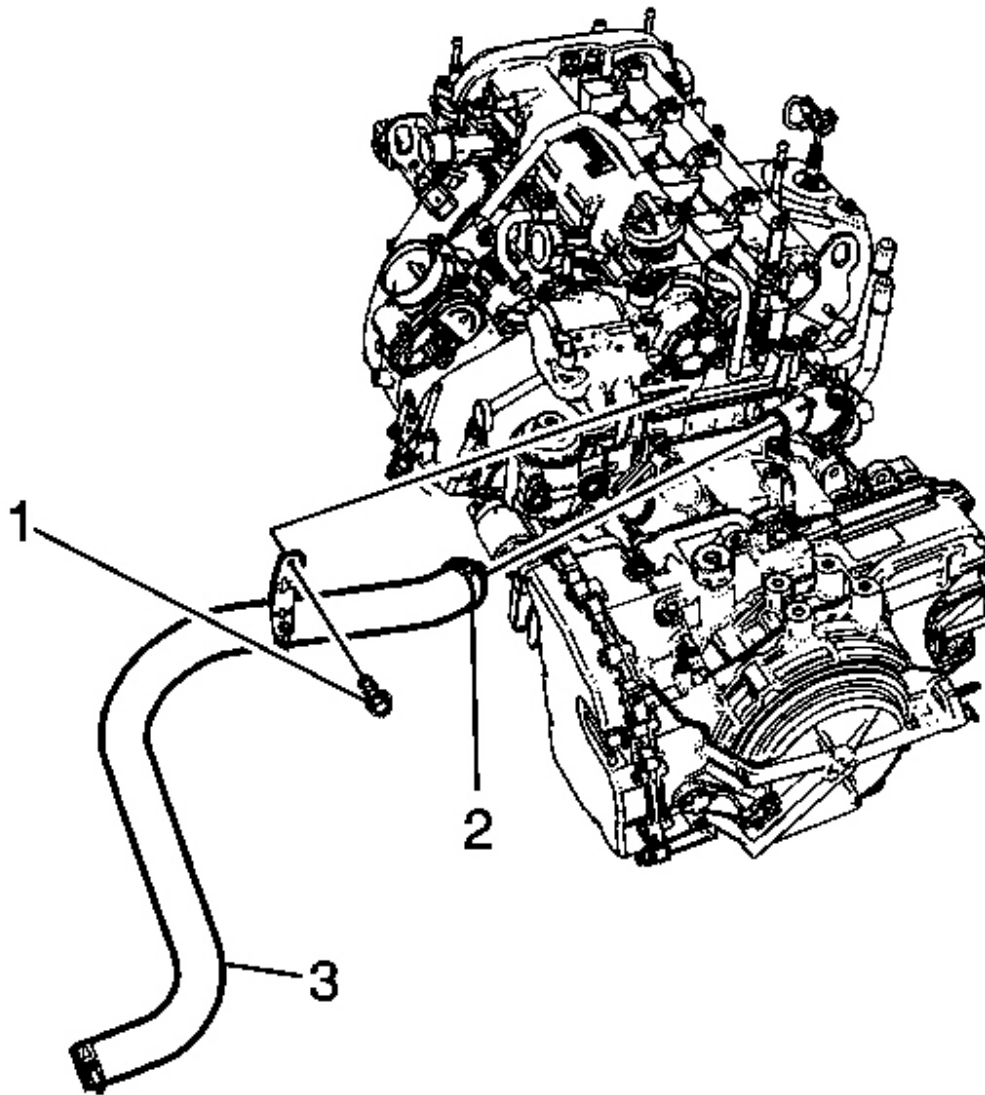


Fig. 33: Radiator Outlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

5. Remove radiator outlet hose bracket retainer (1).
6. Disengage tension on the radiator outlet hose clamp (2) at the thermostat housing using **J 38185: Hose Clamp Pliers**.
7. Remove the radiator outlet hose (4) from the thermostat housing.
8. Disengage tension on the radiator outlet hose clamp (3) at the engine oil cooler using **J 38185: Hose**

Clamp Pliers.

9. Remove the radiator outlet hose (4) from the engine oil cooler.
10. Remove the radiator outlet hose from the vehicle.

Installation Procedure

1. Install radiator outlet hose to the vehicle.

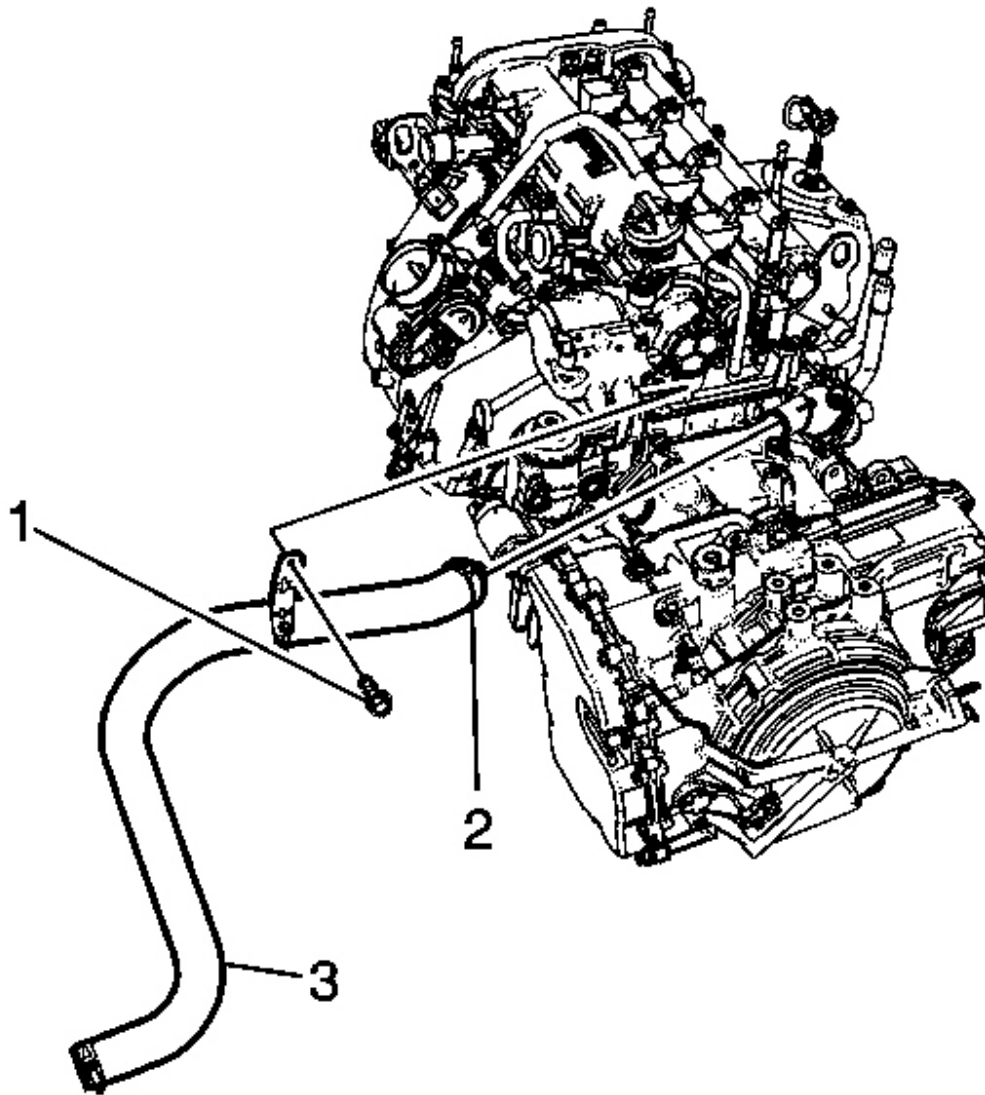


Fig. 34: Radiator Outlet Hose At Engine

Courtesy of GENERAL MOTORS CORP.

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

2. Install the radiator outlet hose (4) to the engine oil cooler.
3. Engage tension on the radiator outlet hose clamp (3) at the engine oil cooler using **J 38185: Hose Clamp Pliers**.
4. Install the radiator outlet hose (4) to the thermostat housing.
5. Engage tension on the radiator outlet hose clamp (2) at the thermostat housing using **J 38185: Hose Clamp Pliers**.
6. Install radiator outlet hose bracket retainer (1).

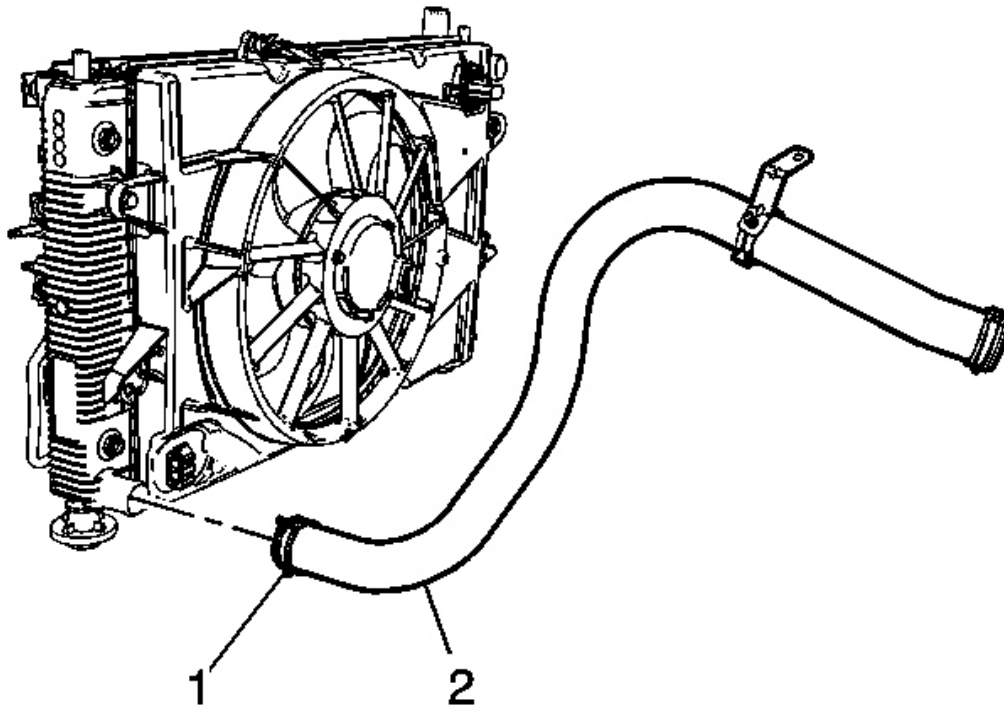


Fig. 35: Radiator Outlet Hose At Radiator
Courtesy of GENERAL MOTORS CORP.

7. Install the radiator outlet hose (2) to the radiator.
8. Engage tension on the radiator outlet hose clamp (1) at the radiator using **J 38185: Hose Clamp Pliers**.
9. Lower the vehicle.

10. Fill the cooling system. Refer to Cooling System Draining and Filling (Static) or Cooling System Draining and Filling (GE 47716).

RADIATOR OUTLET HOSE REPLACEMENT (LF1)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static) or Cooling System Draining and Filling (GE 47716).
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

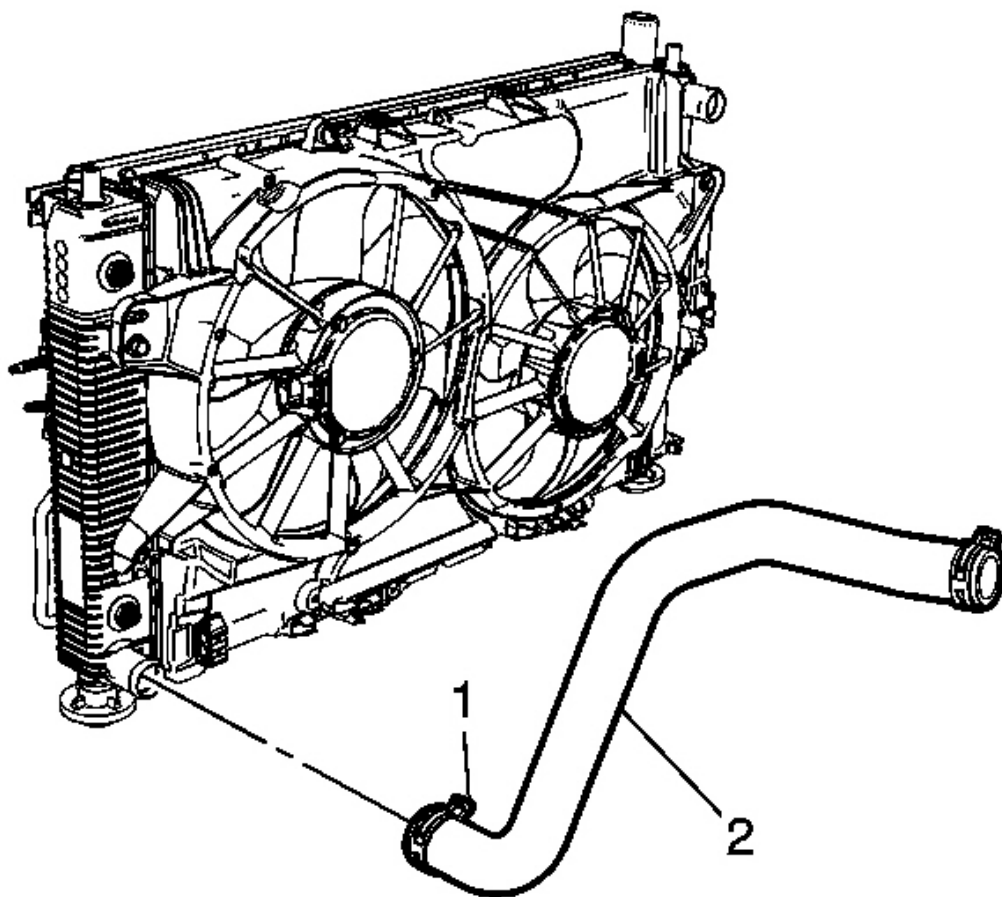


Fig. 36: Radiator Outlet Hose At Radiator
Courtesy of GENERAL MOTORS CORP.

3. Disengage tension on the radiator outlet hose clamp (1) at the radiator using **J 38185: Hose Clamp Pliers**.
4. Remove the radiator outlet hose (2) from the radiator.

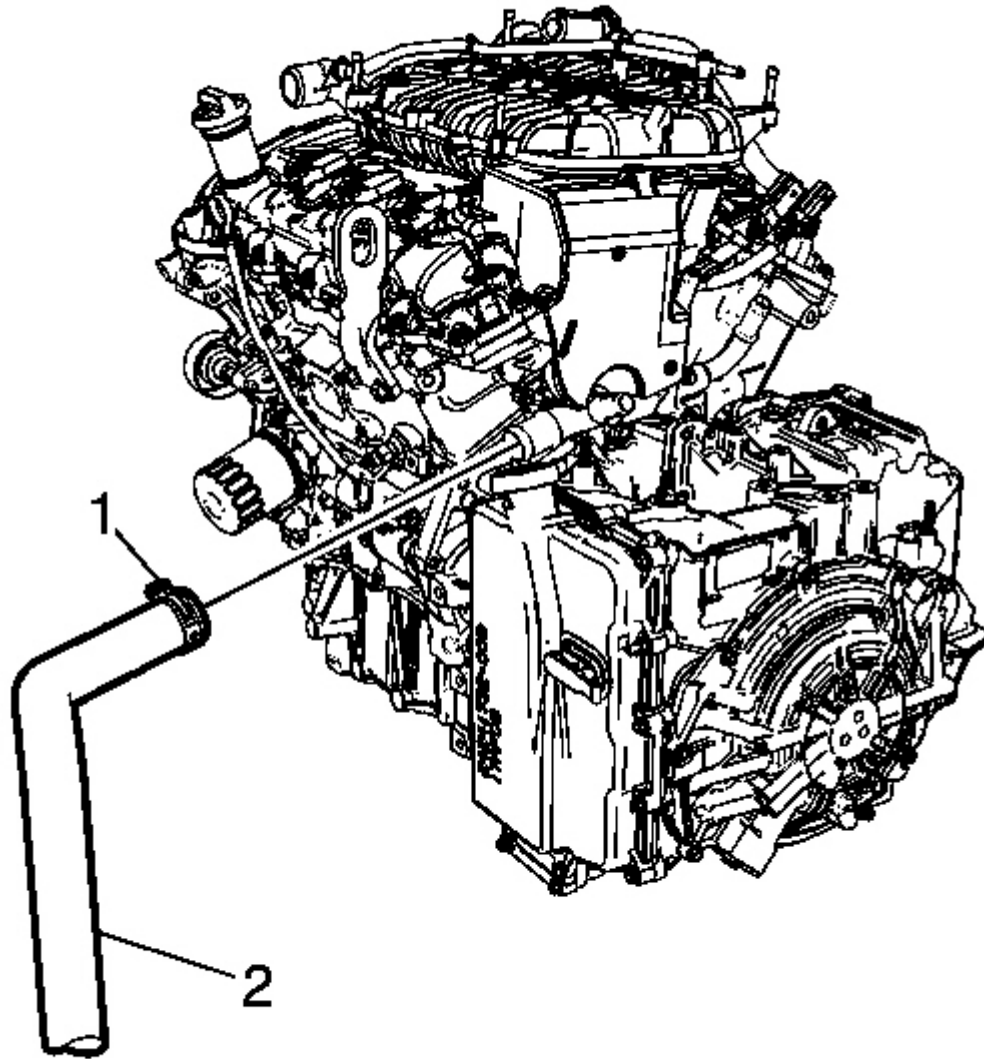


Fig. 37: Radiator Outlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

5. Disengage tension on the radiator outlet hose clamp (1) at the engine using **J 38185: Hose Clamp Pliers**.
6. Remove the radiator outlet hose (2) from the engine.
7. Remove the radiator outlet hose from the vehicle.

Installation Procedure

1. Install radiator outlet hose to the vehicle.

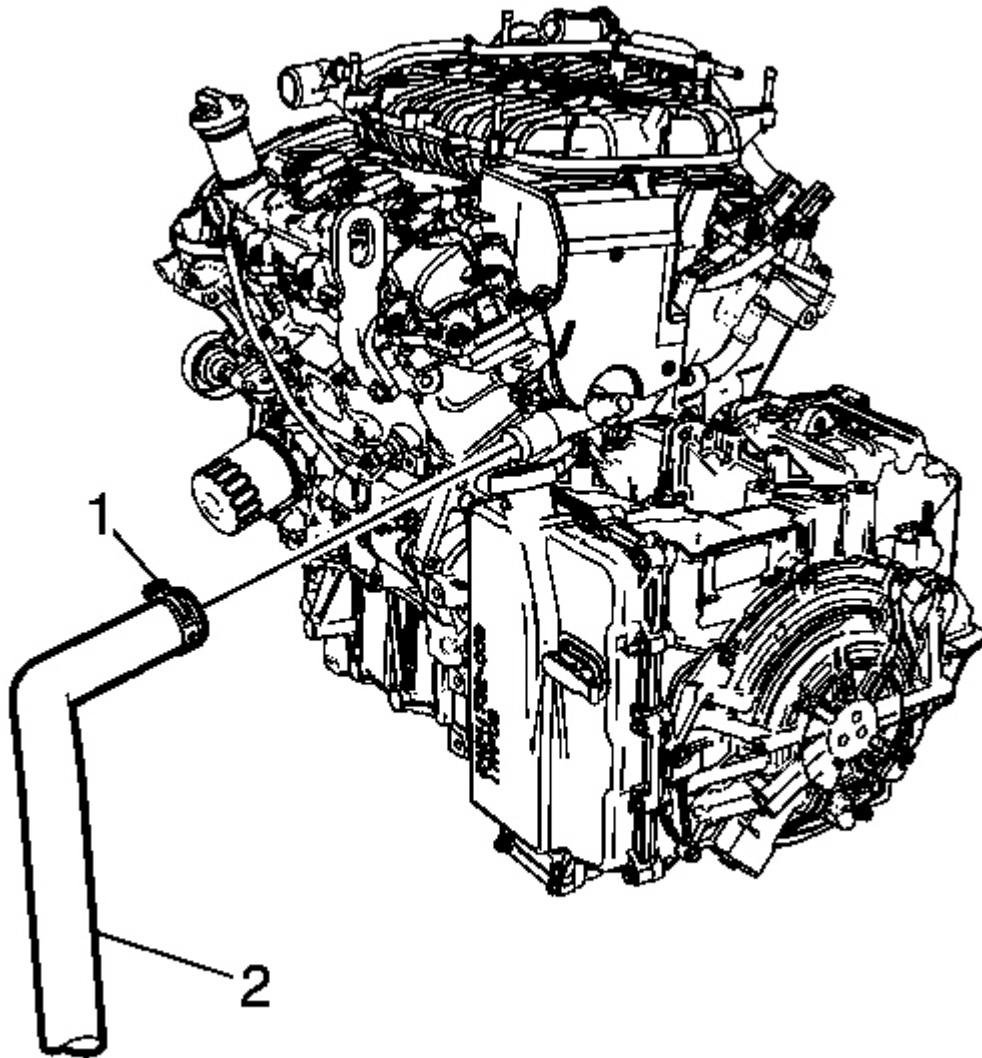


Fig. 38: Radiator Outlet Hose At Engine

Courtesy of GENERAL MOTORS CORP.

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

2. Install the radiator outlet hose (2) to the engine.
3. Engage tension on the radiator outlet hose clamp (1) at the engine using **J 38185: Hose Clamp Pliers**.

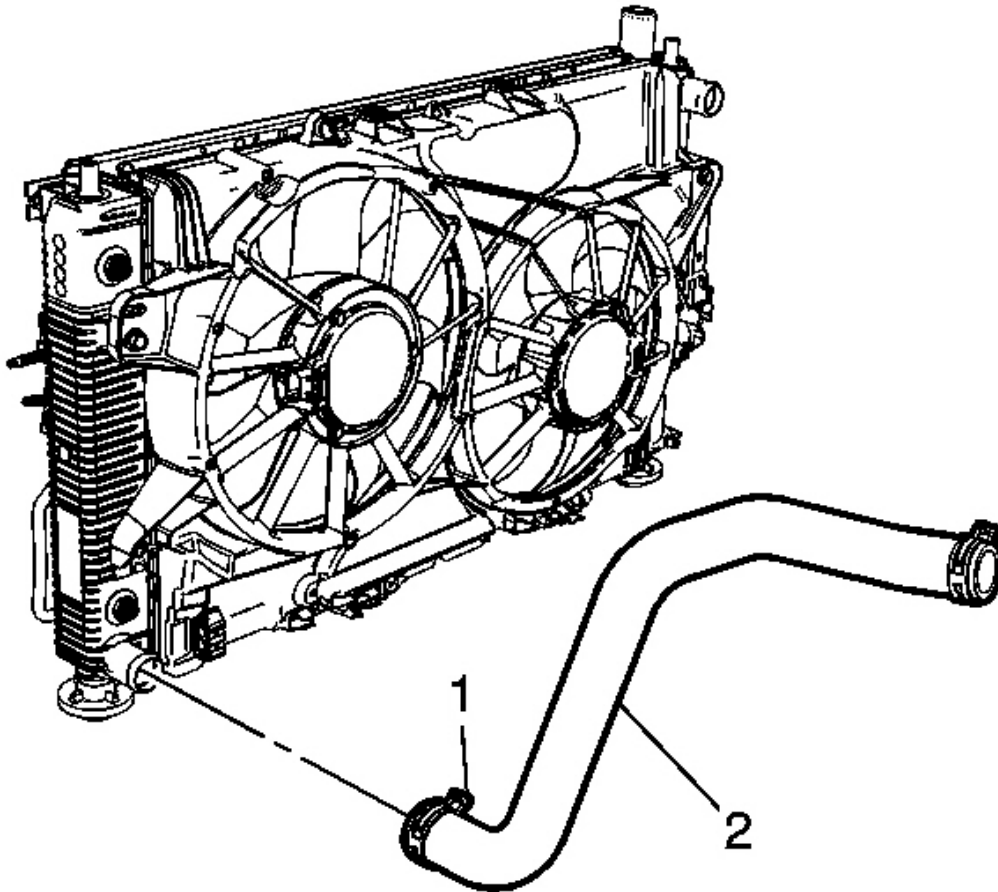


Fig. 39: Radiator Outlet Hose At Radiator
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator outlet hose (2) to the radiator.
5. Engage tension on the radiator outlet hose clamp (1) at the radiator using **J 38185: Hose Clamp Pliers**.
6. Lower the vehicle.

7. Fill the cooling system. Refer to Cooling System Draining and Filling (Static) or Cooling System Draining and Filling (GE 47716).

ENGINE COOLANT FAN REPLACEMENT (LF1)

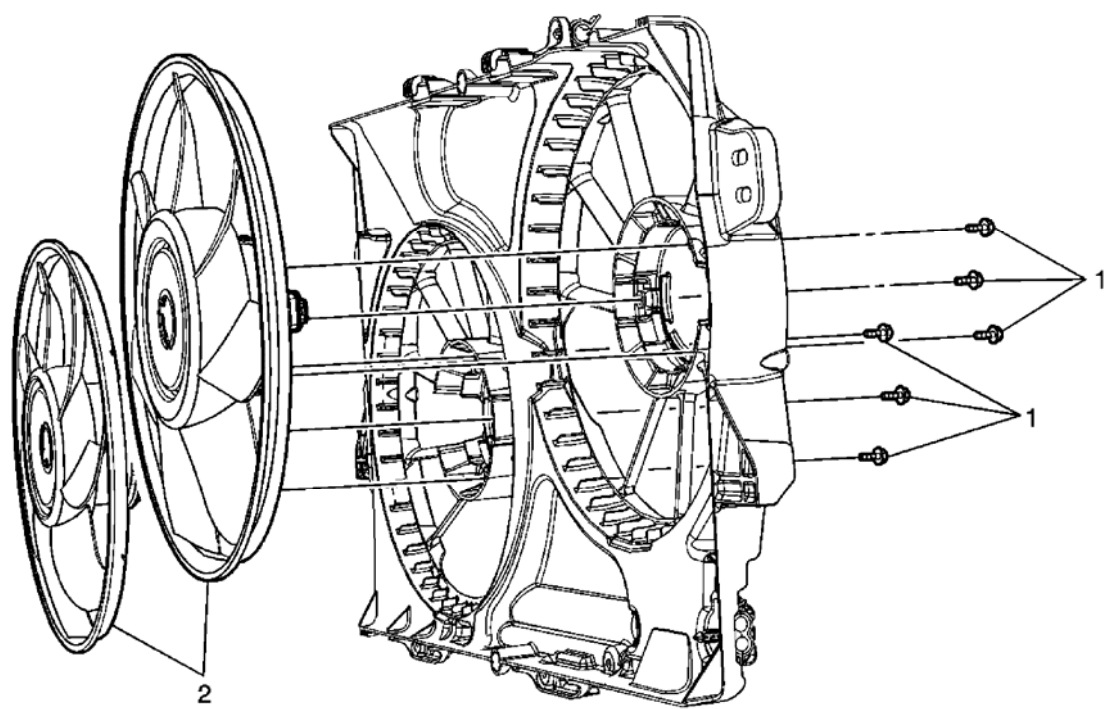


Fig. 40: Engine Coolant Fan (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the engine coolant fan shroud. Refer to <u>Engine Coolant Fan Shroud Replacement (LAF)</u> or <u>Engine Coolant Fan Shroud Replacement (LF1)</u>	
1	Cooling Fan Retainer (Qty 6)
2	Cooling Fan

ENGINE COOLANT FAN REPLACEMENT (LAF)

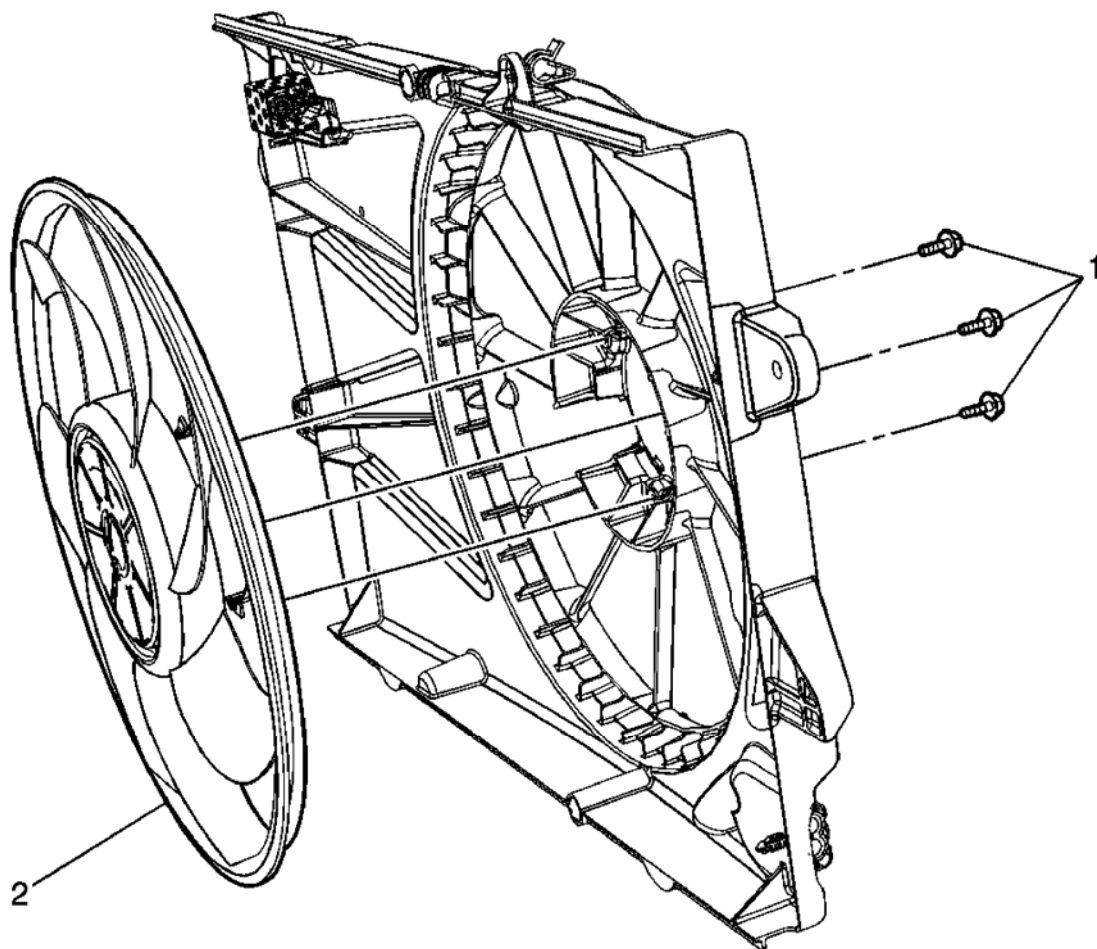


Fig. 41: Engine Coolant Fan (LAF)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the engine coolant fan shroud. Refer to <u>Engine Coolant Fan Shroud Replacement (LAF)</u> or <u>Engine Coolant Fan Shroud Replacement (LF1)</u>	
1	Cooling Fan Retainer (Qty 3)
2	Cooling Fan

ENGINE COOLANT FAN RESISTOR REPLACEMENT (LAF)

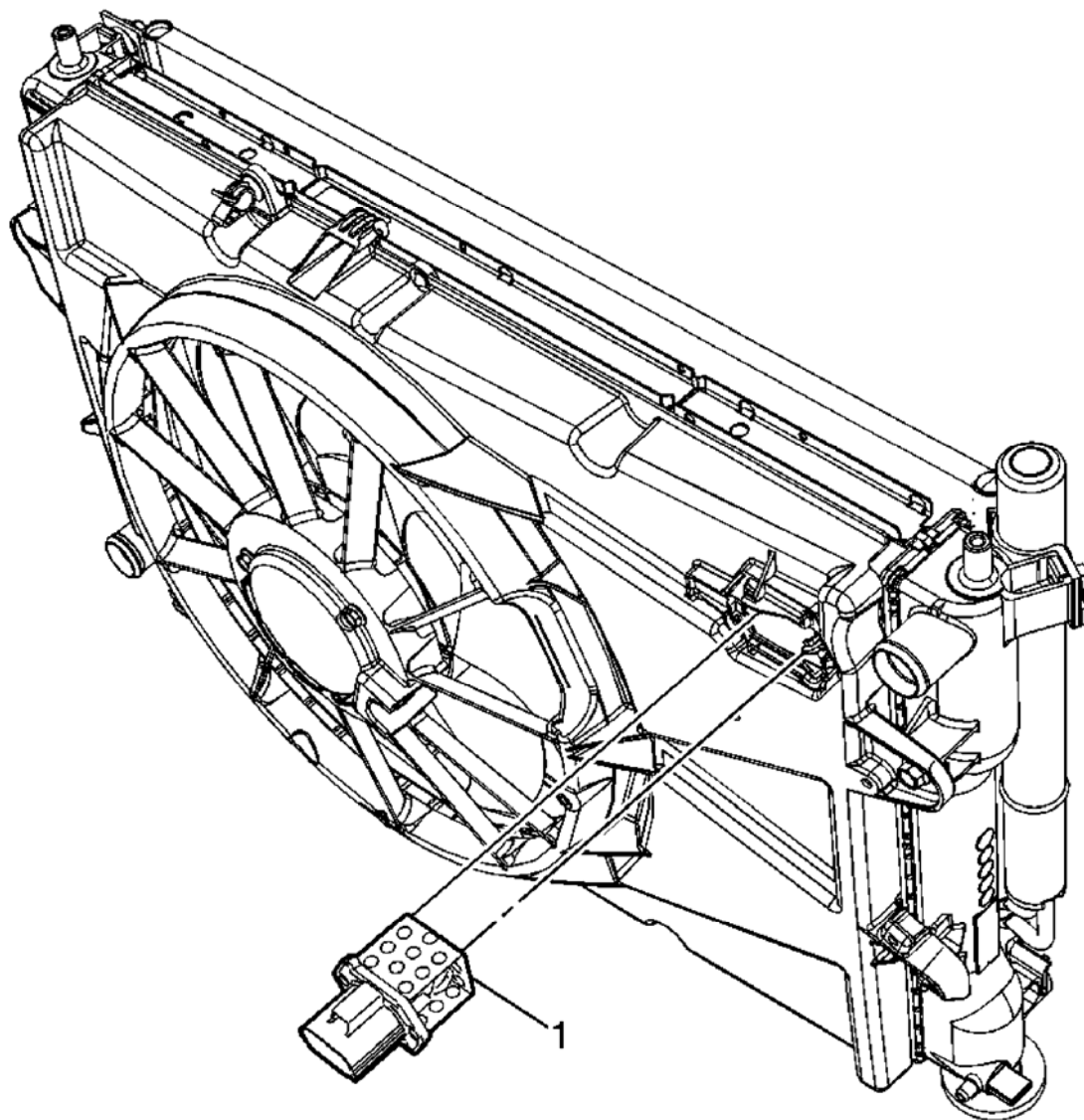


Fig. 42: Engine Coolant Fan Resistor (LAF)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Disconnect the engine coolant fan resistor electrical connector.	
1	Engine Coolant Fan Resistor Procedure: Depress tab on the engine coolant fan shroud to release the engine coolant fan resistor from the engine coolant fan shroud.

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LAF)

Removal Procedure

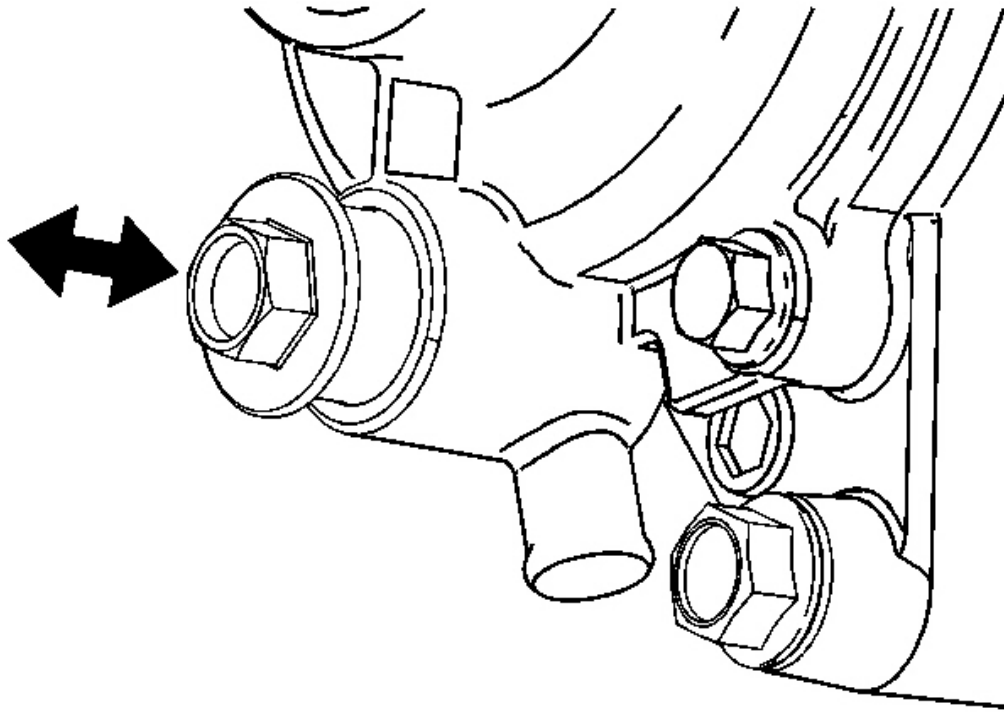


Fig. 43: Water Pump Drain Plug
Courtesy of GENERAL MOTORS CORP.

NOTE: A drain has been provided at the bottom of the water pump for engine block coolant drainage.

1. Drain the coolant from the engine block at the water pump drain. After the coolant has drained, tighten the drain bolt.
2. Lower the vehicle.

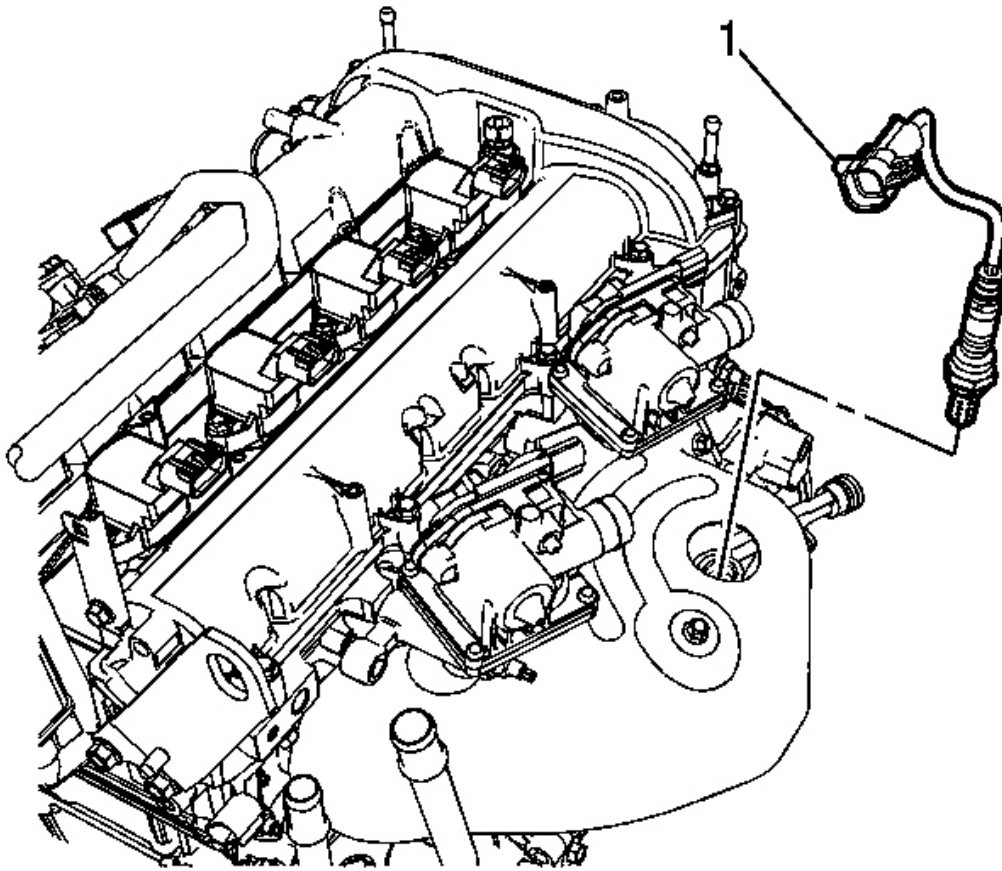


Fig. 44: Engine Coolant Temperature Sensor Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the engine wiring harness electrical connector (1) from the engine coolant temperature (ECT) sensor.
4. Remove the heated oxygen sensor (HO2S) electrical connector rosebud clip from the thermostat housing.

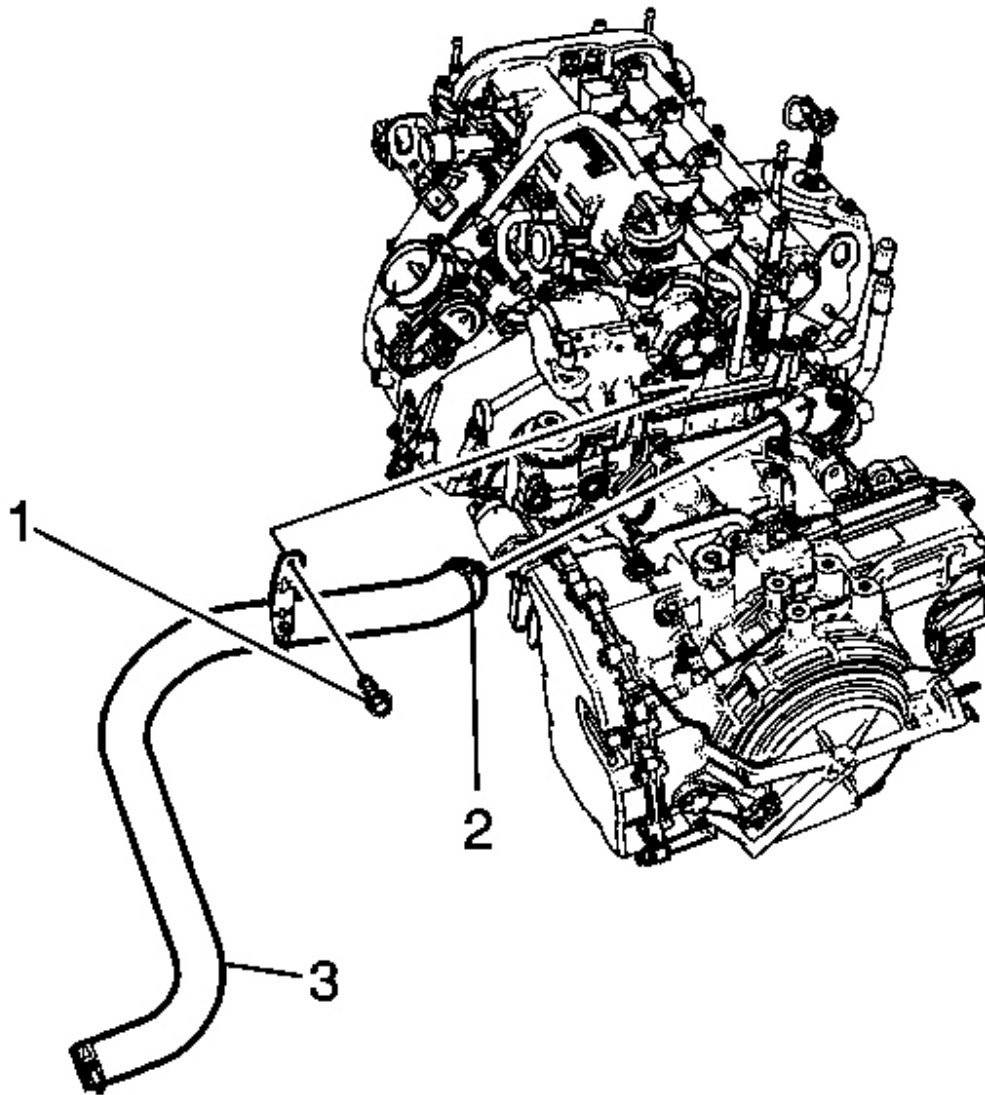


Fig. 45: Radiator Outlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

5. Reposition the radiator outlet hose clamp (2) at the thermostat housing.
6. Remove the radiator outlet hose (4) from the thermostat housing.

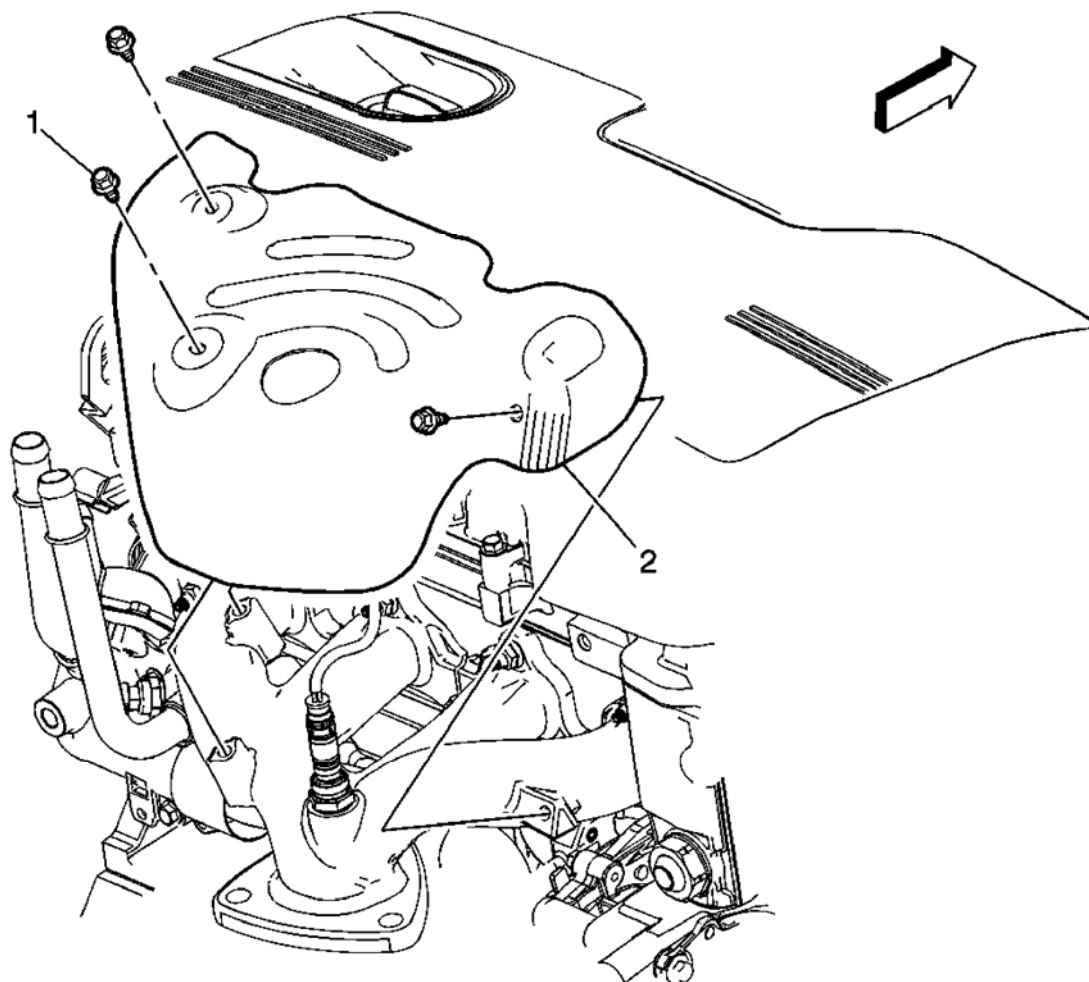


Fig. 46: Exhaust Heat Shield Studs
Courtesy of GENERAL MOTORS CORP.

7. Remove the exhaust heat shield studs (2).
8. Remove the exhaust heat shield.

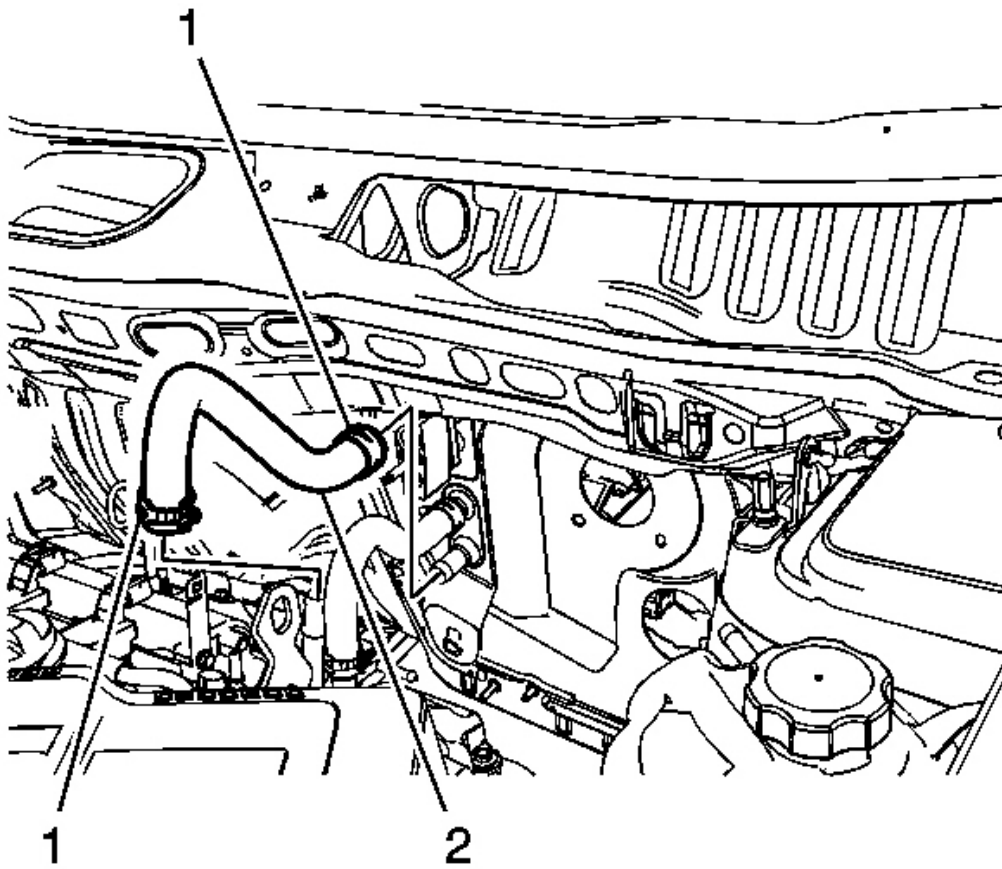


Fig. 47: HVAC Heater Inlet Hose
Courtesy of GENERAL MOTORS CORP.

9. Remove the HVAC heater inlet hose (2) from the thermostat housing.

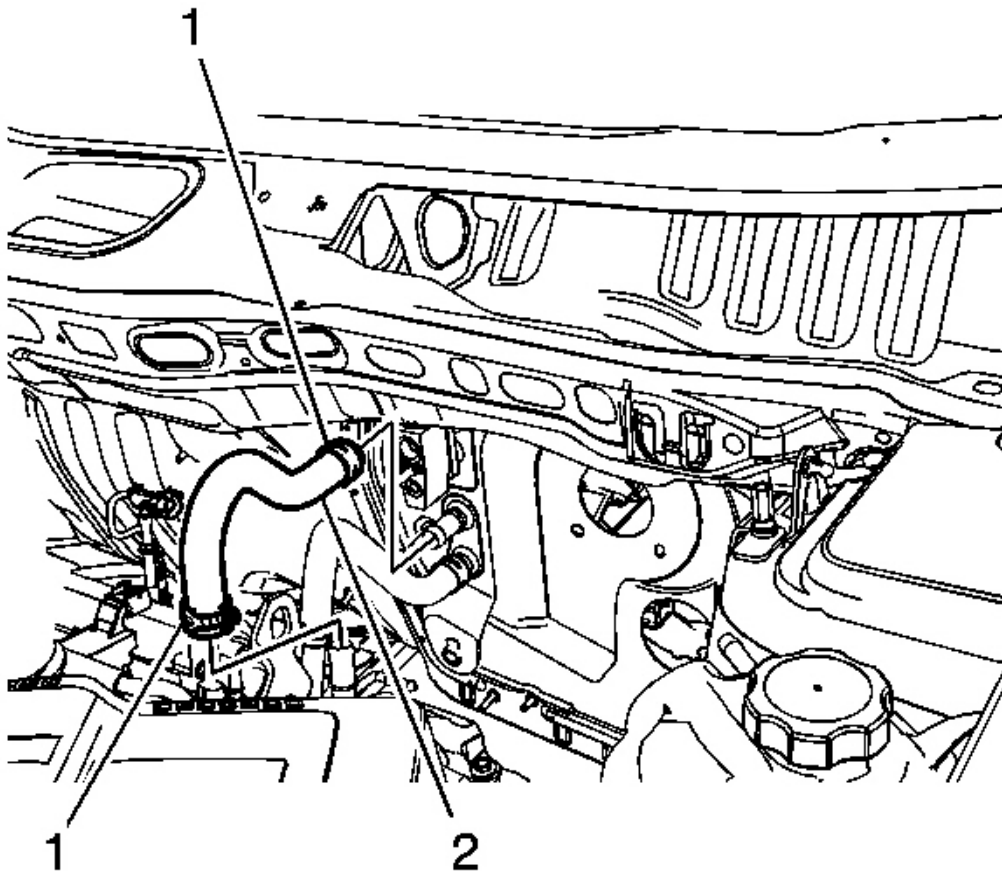


Fig. 48: HVAC Heater Outlet Hose
Courtesy of GENERAL MOTORS CORP.

10. Remove the HVAC heater outlet hose (2) from the thermostat housing.
11. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

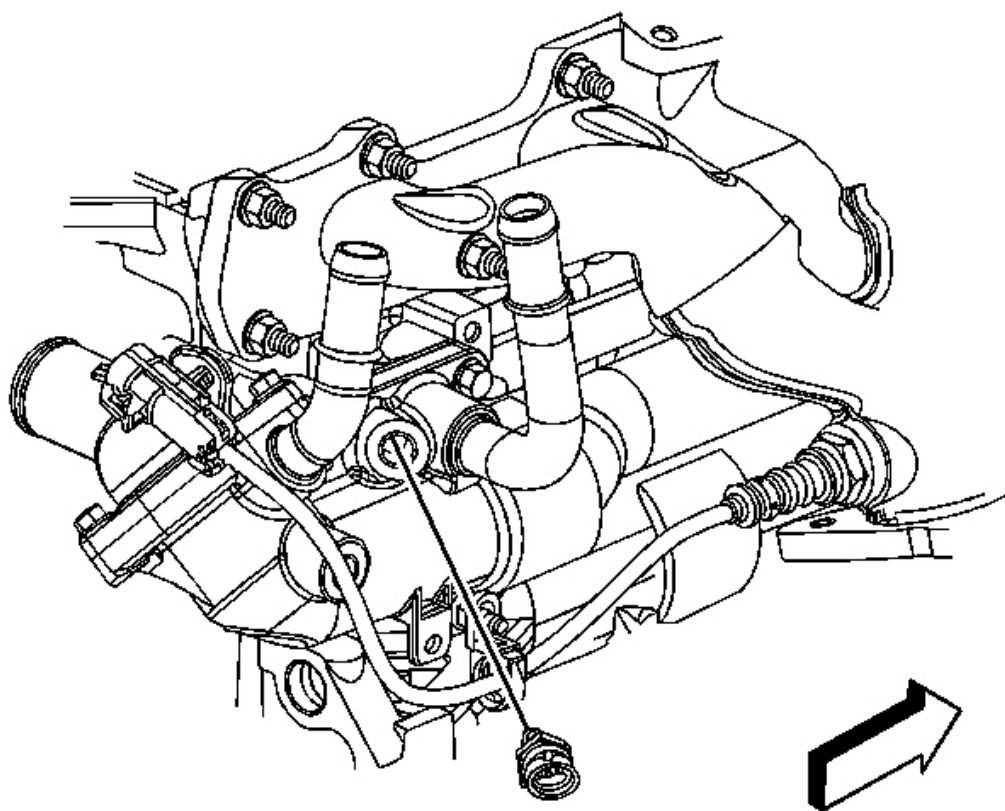


Fig. 49: Locating ECT Sensor
Courtesy of GENERAL MOTORS CORP.

12. Remove the ECT sensor, if necessary.

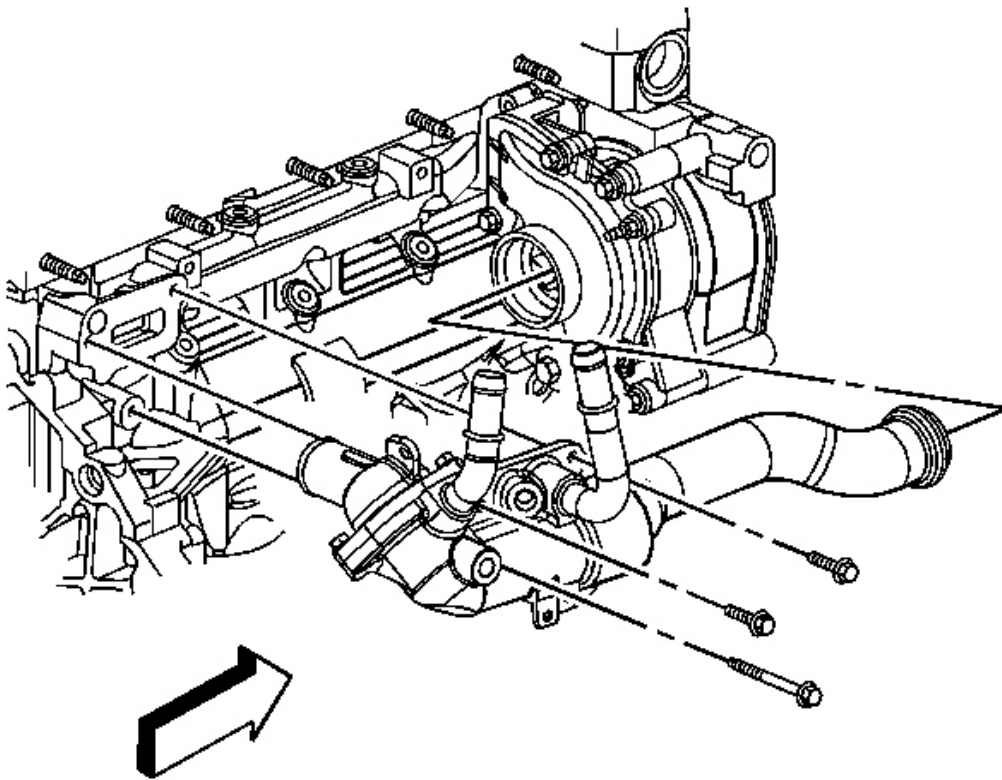


Fig. 50: View Of Thermostat Housing & Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the thermostat housing bolts.

NOTE: **Twist the water transfer pipe while pulling in order to remove it from the water pump.**

14. Remove the thermostat from the vehicle.
15. Remove the water transfer pipe from the thermostat housing, if necessary.
16. Remove and discard the water transfer pipe O-ring seals, if necessary.

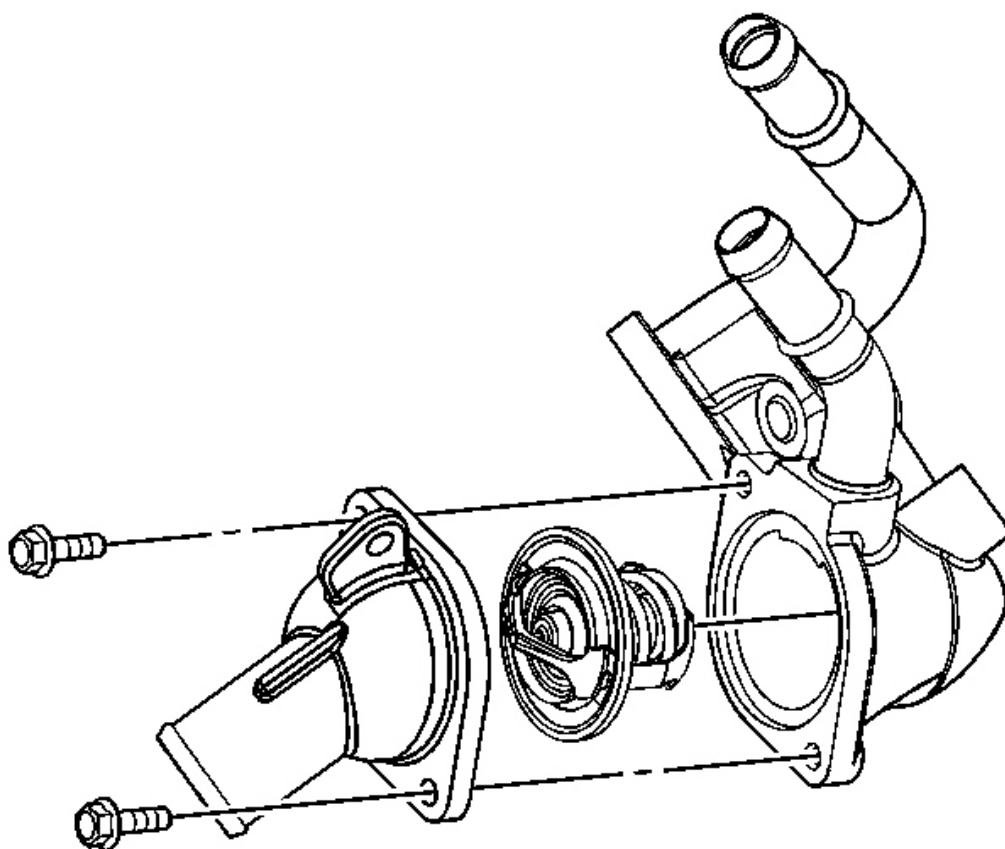


Fig. 51: Identifying Thermostat Housing Cover Bolts & Cover
Courtesy of GENERAL MOTORS CORP.

17. Remove the thermostat cover bolts and cover, if necessary.
18. Remove the thermostat, if necessary.
19. Remove and discard the thermostat cover O-ring seal, if necessary.
20. Remove all debris and thread sealant from the engine coolant temperature (ECT) sensor and bolt holes if the housing is being re-used.

Installation Procedure

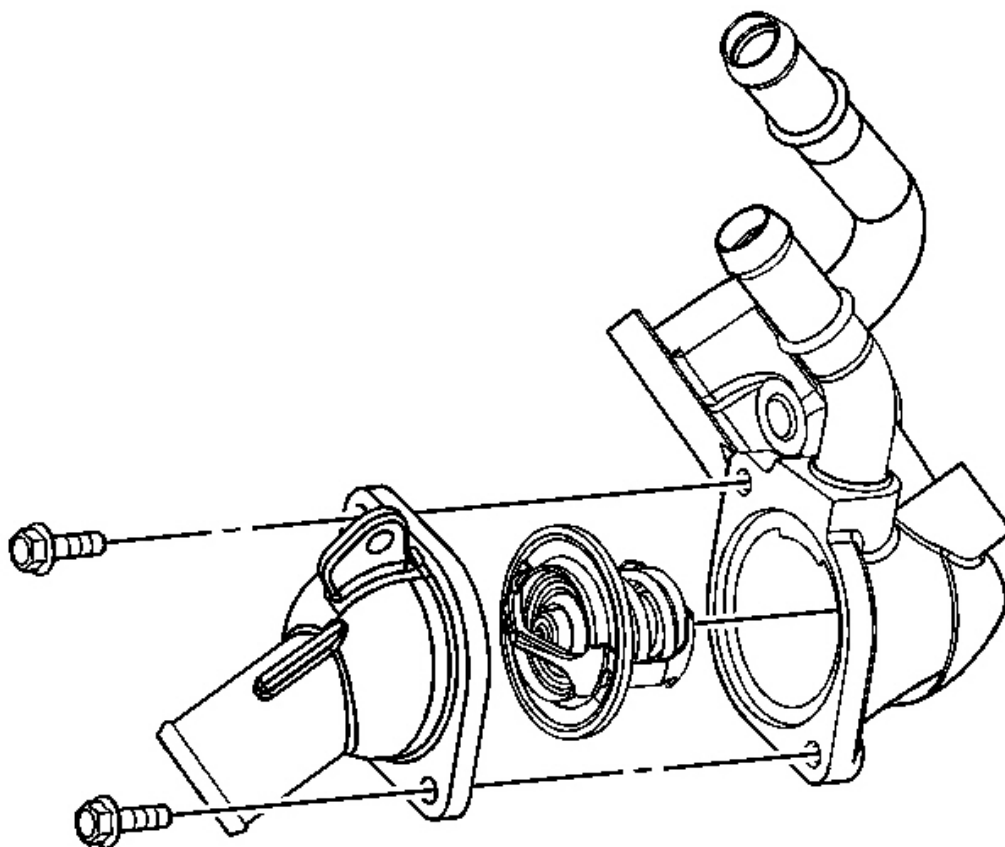


Fig. 52: Identifying Thermostat Housing Cover Bolts & Cover
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW thermostat cover O-ring seal into the recess groove.
2. Install the thermostat, if necessary.

CAUTION: Refer to Fastener Caution .

3. Install the thermostat cover bolts, if necessary and tighten to 10 N.m (89 lb in).
4. Install a NEW thermostat housing to engine gasket onto the thermostat housing.
5. Load the thermostat housing assembly into position.

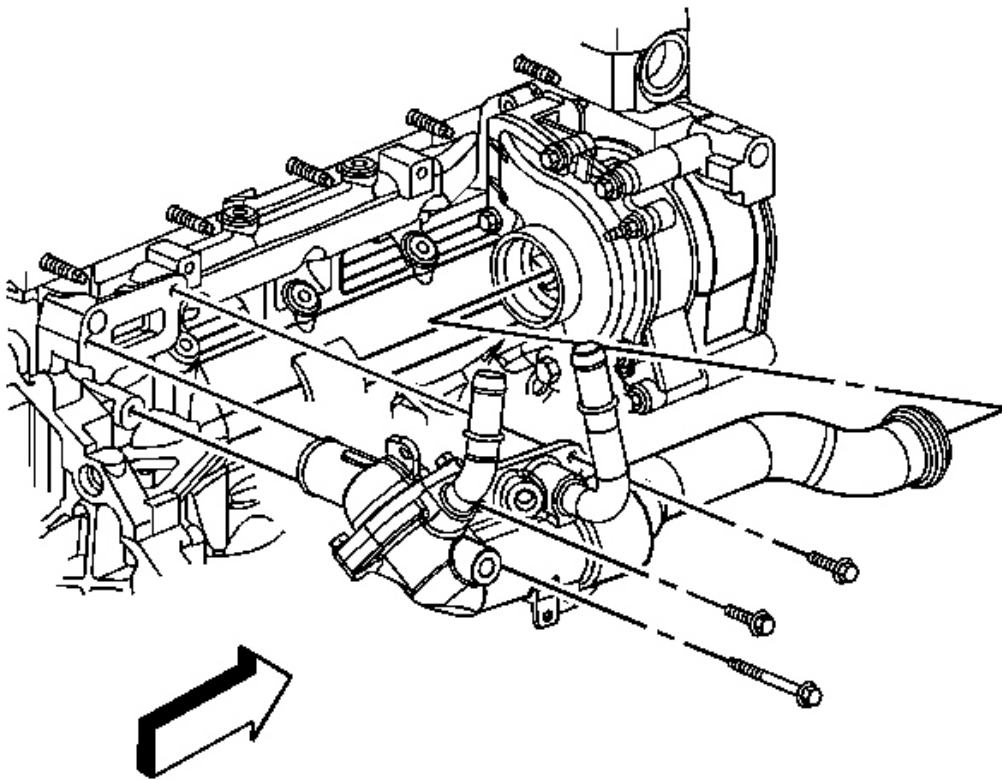


Fig. 53: View Of Thermostat Housing & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The water feed pipe seals can be lightly lubricated with coolant to aid during installation.

6. Install NEW O-ring seals onto the water feed pipe.

NOTE: Lubricate the O-rings with coolant ONLY.

7. Install the water feed pipe into the thermostat housing aligning locator tab.
8. Align the water pipe to water pump.
9. Seat the water feed O-ring seal by pushing inward toward the water pump. Take care not to tear or damage the O-ring.
10. Position the thermostat housing against the engine.
11. Install the thermostat housing bolts and tighten to 10 N.m (89 lb in).

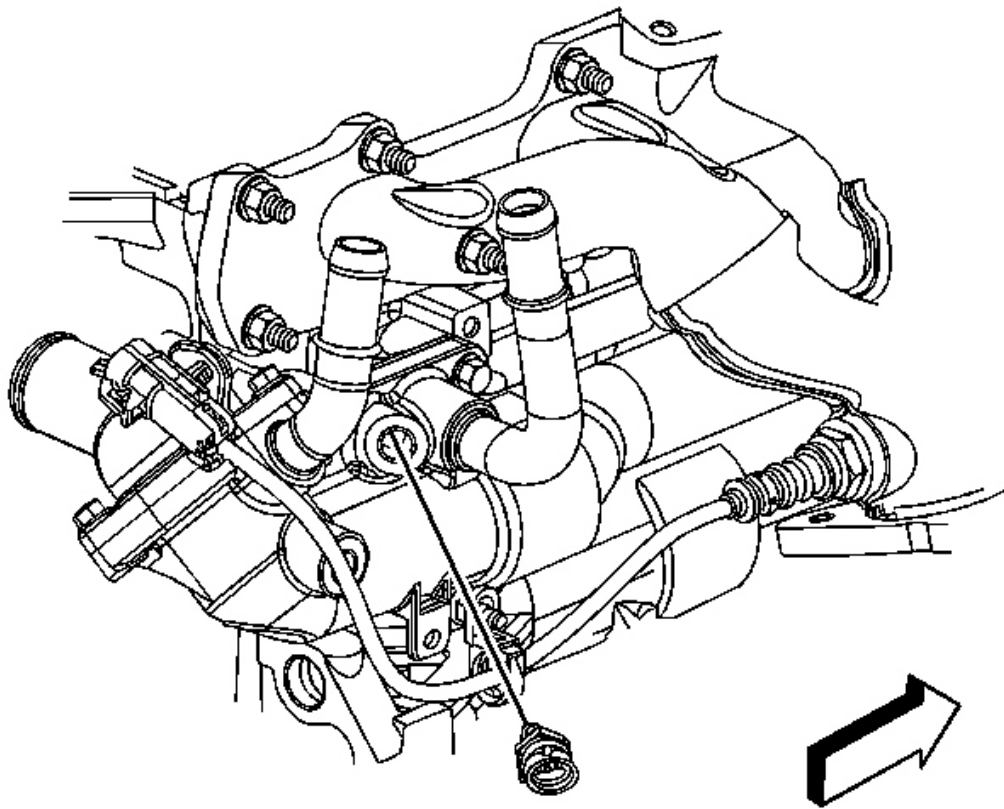


Fig. 54: Locating ECT Sensor
Courtesy of GENERAL MOTORS CORP.

12. If reinstalling the old sensor, coat the threads with sealant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
13. Install the ECT sensor, if necessary and tighten to 20 N.m (15 lb ft).
14. Lower the vehicle.

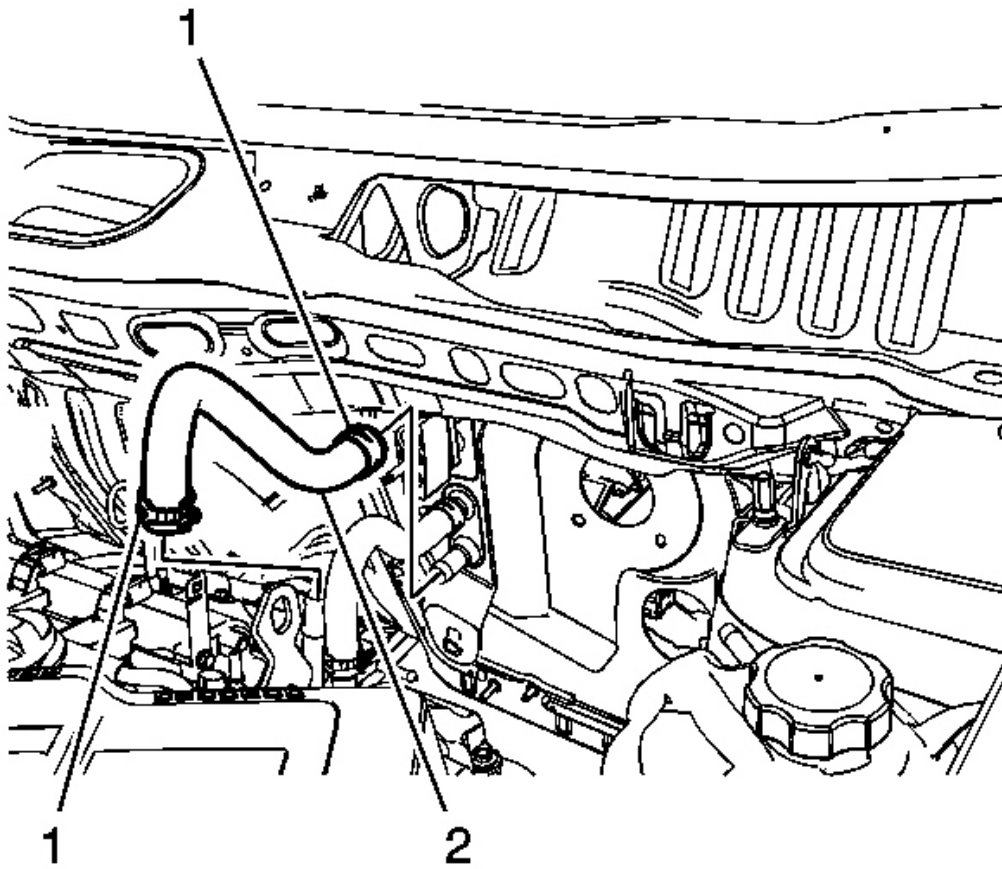


Fig. 55: HVAC Heater Inlet Hose
Courtesy of GENERAL MOTORS CORP.

15. Install the HVAC heater inlet hose (2) to the thermostat housing.

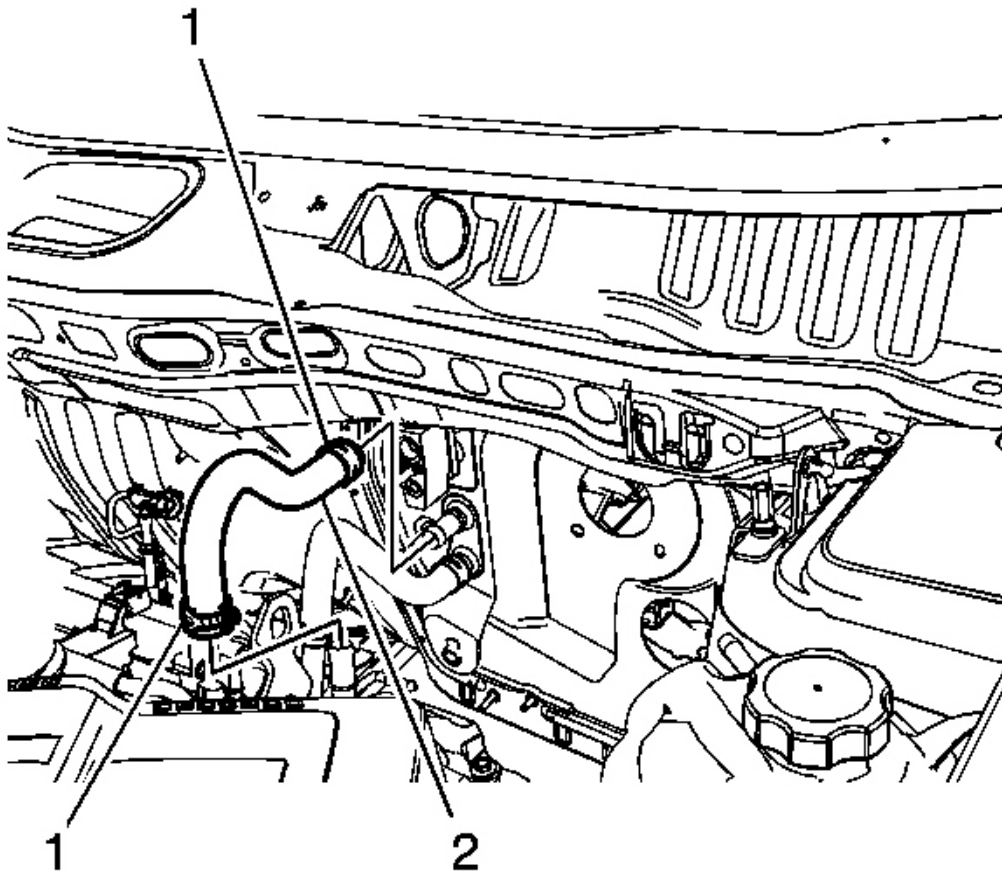


Fig. 56: HVAC Heater Outlet Hose
Courtesy of GENERAL MOTORS CORP.

16. Install the HVAC heater outlet hose to the thermostat housing.
17. Install the exhaust heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LAF)**

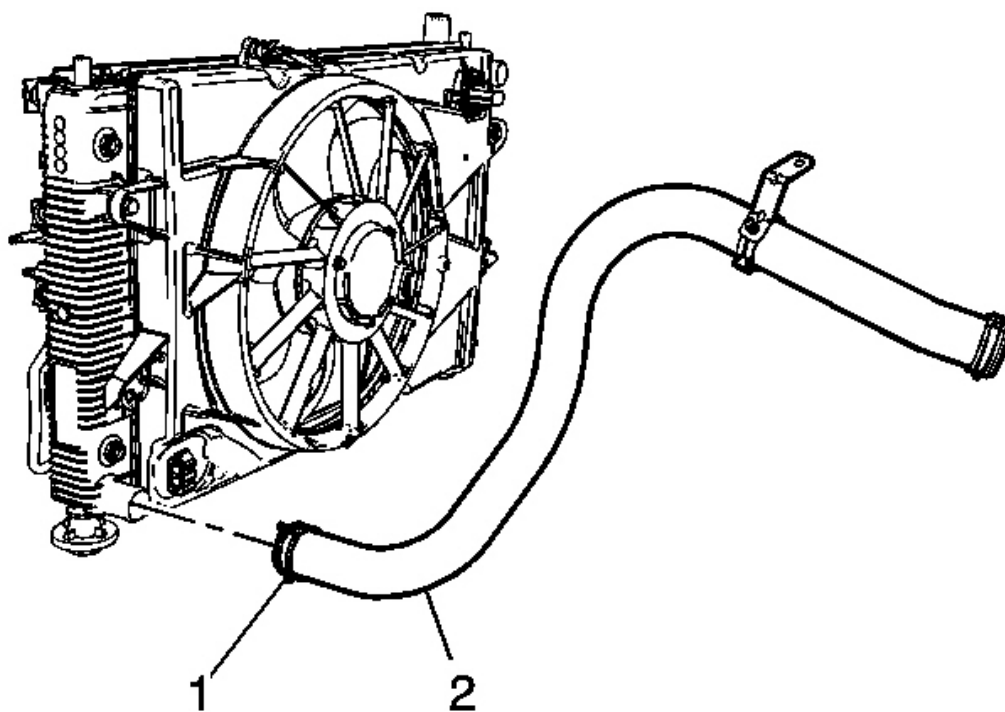


Fig. 57: Radiator Outlet Hose At Radiator
Courtesy of GENERAL MOTORS CORP.

18. Install the radiator outlet hose to the thermostat housing.
19. Position the radiator outlet hose clamp at the thermostat housing.

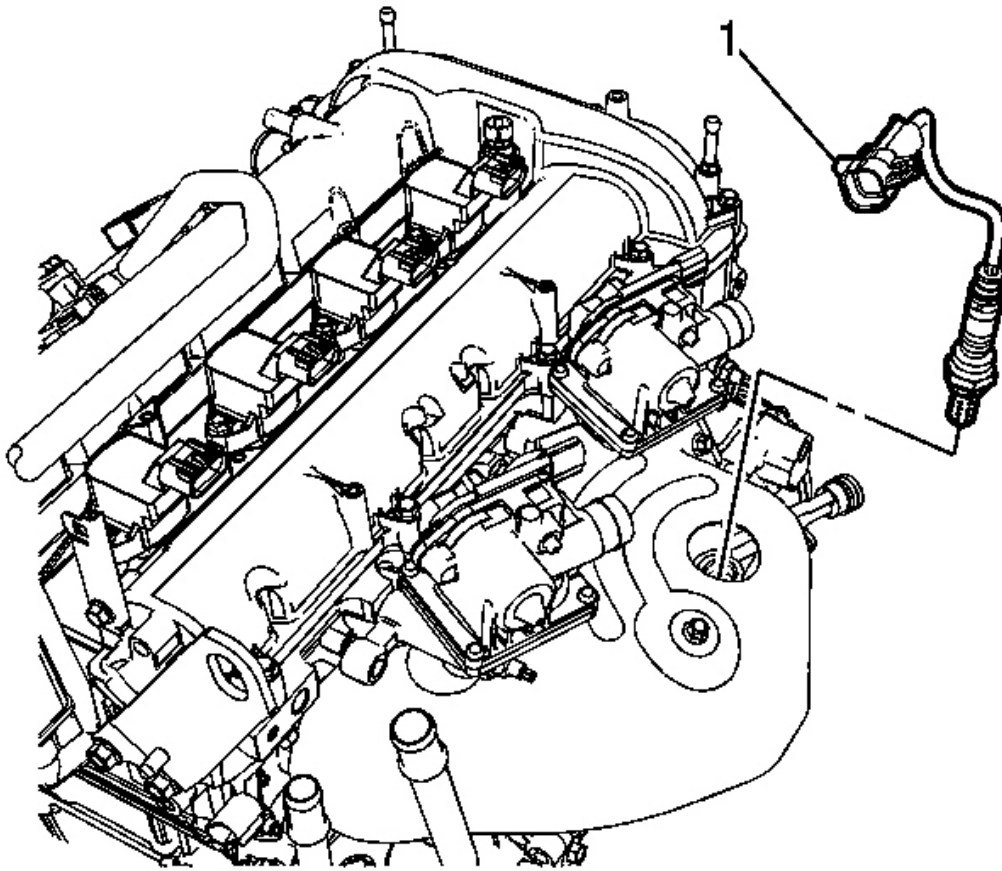


Fig. 58: Engine Coolant Temperature Sensor Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

20. Connect the engine wiring harness electrical connector (1) to the ECT sensor (1).
21. Install the HO2S electrical connector rosebud clip to the thermostat housing.

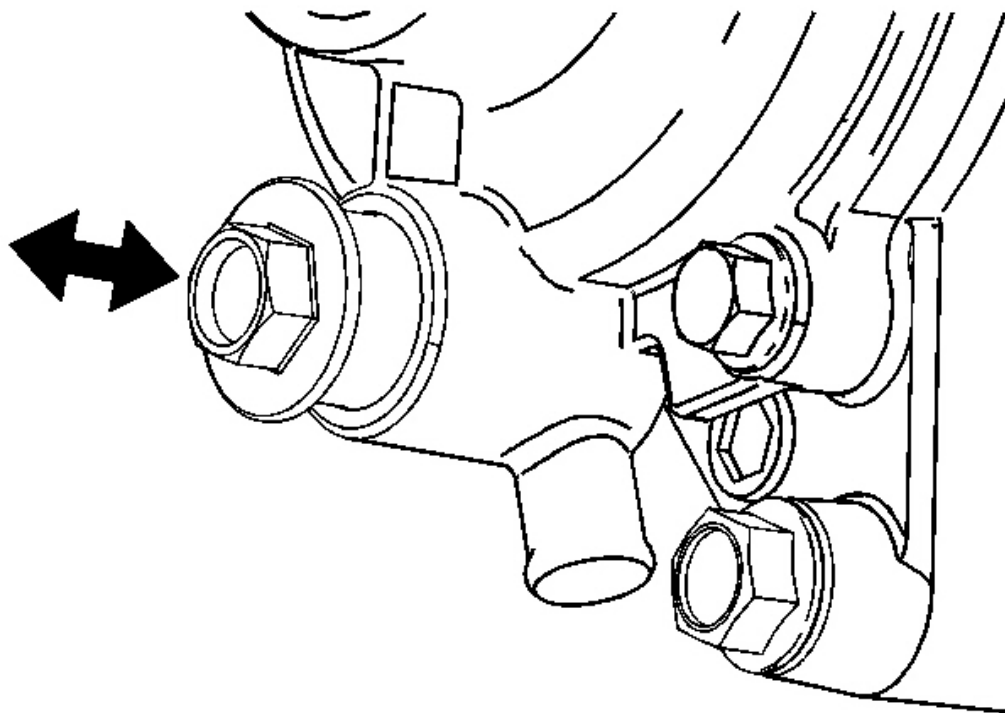


Fig. 59: Water Pump Drain Plug
Courtesy of GENERAL MOTORS CORP.

22. Verify the drain valves at the radiator and water pump are closed.
23. Lower the vehicle.
24. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LF1)

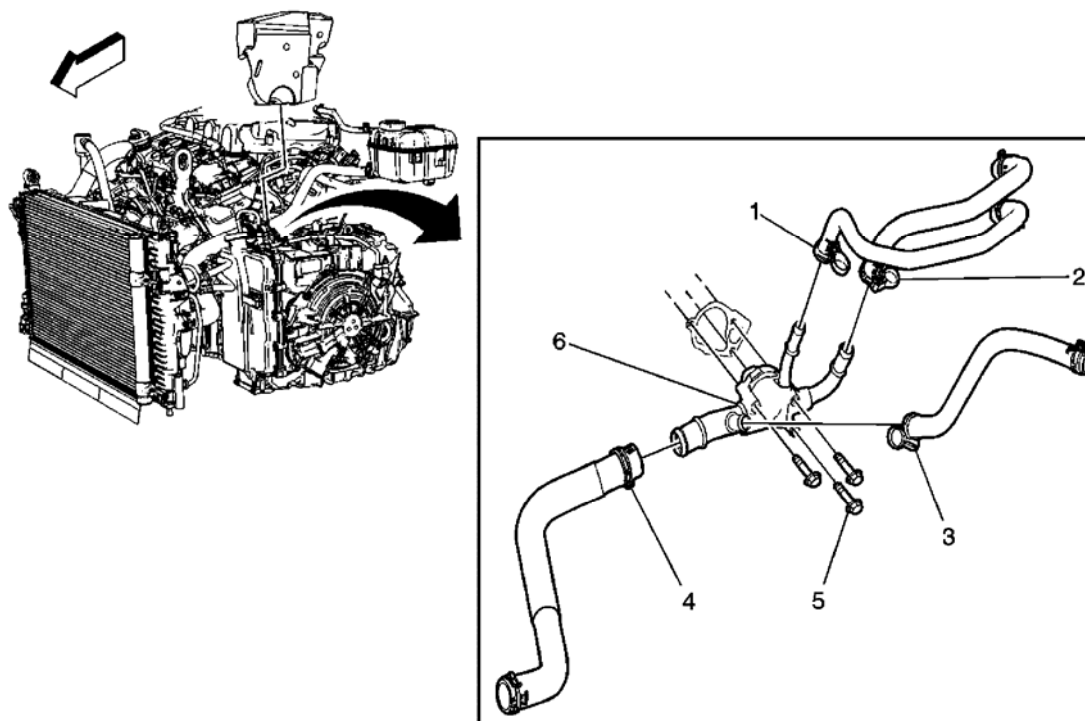


Fig. 60: Engine Coolant Thermostat Housing (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System Draining and Filling (GE 47716)</u> .
2.	Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .
3.	Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement (LF1)</u>
1	Heater Outlet Hose
2	Heater Inlet Hose
3	Surge Tank Hose
4	Radiator Outlet Hose
5	Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (88 lb in)
	Engine Cooling Thermostat Housing Tip:

- Clean the engine block and thermostat gasket surfaces.
- Replace the gasket and any worn hoses.

ENGINE COOLANT THERMOSTAT REPLACEMENT (LF1)

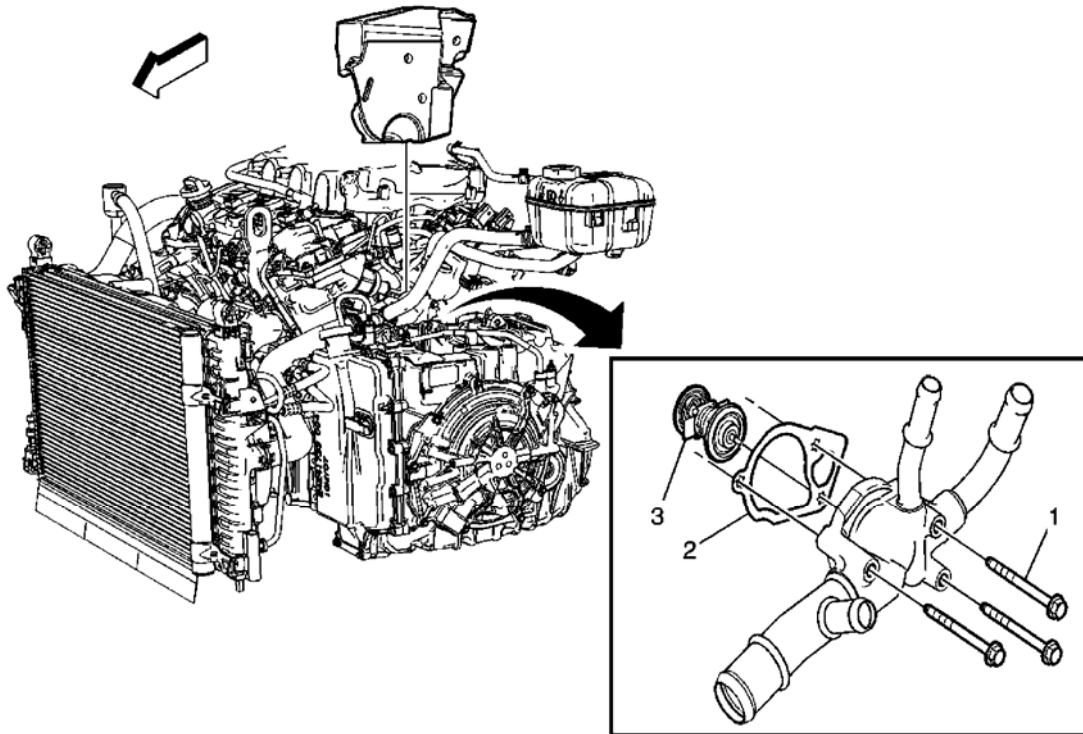


Fig. 61: Engine Coolant Thermostat (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine cooling thermostat housing. Refer to Engine Coolant Thermostat Housing Replacement (LAF) or Engine Coolant Thermostat Housing Replacement (LF1) .	
1	Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (88 lb in)
2	Engine Cooling Thermostat Gasket
3	Engine Cooling Thermostat Tip:

- Clean the engine block and thermostat gasket surfaces.
- Replace gasket and any worn hoses.

ENGINE COOLANT THERMOSTAT REPLACEMENT (LAF)

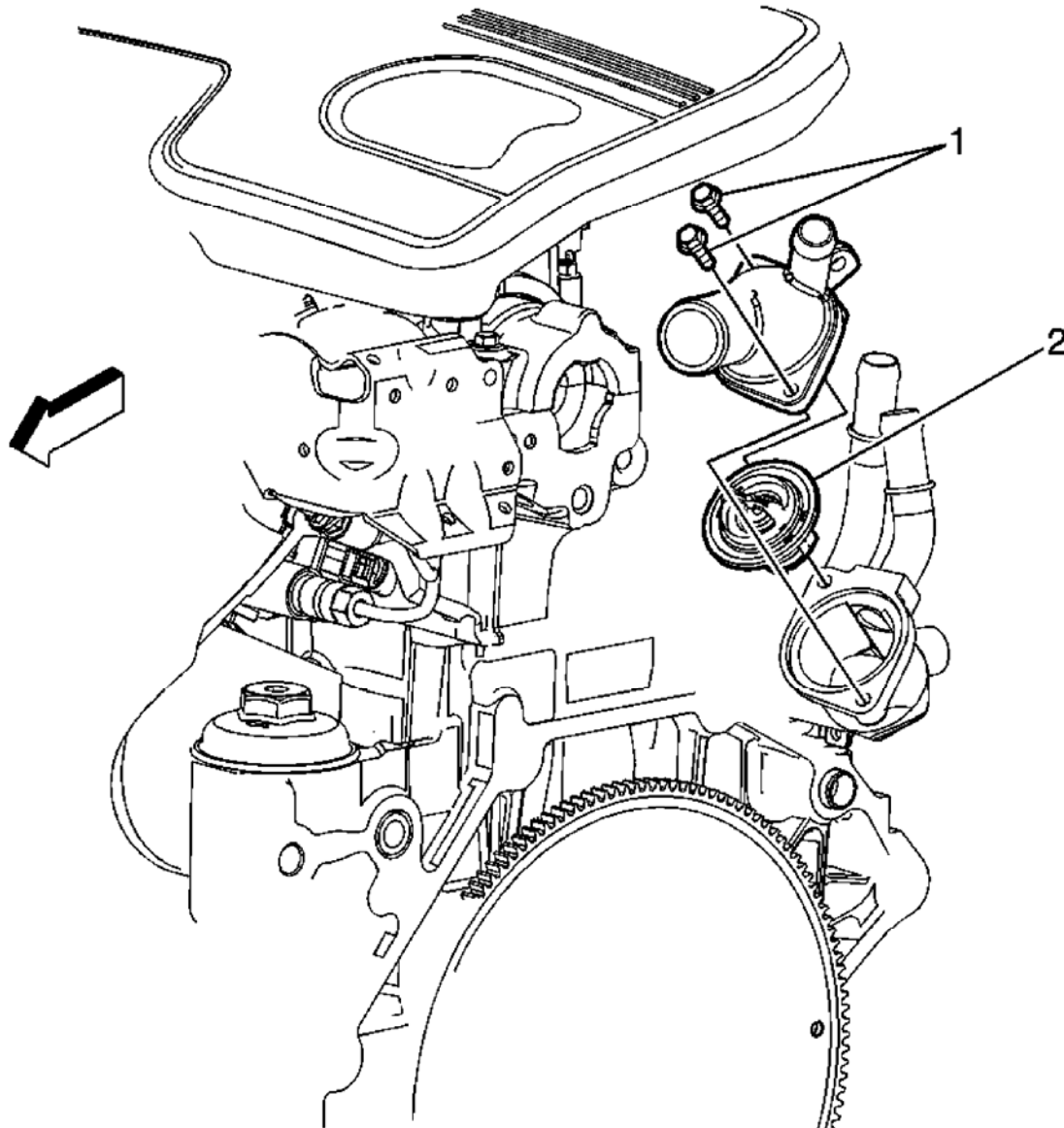


Fig. 62: Engine Coolant Thermostat (LAF)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	

1. Raise the vehicle by its full height. Refer to **Lifting and Jacking the Vehicle** .
2. Draining the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.
3. Disconnect the engine coolant outlet hose and the radiator surge tank outlet hose, from the thermostat housing.

1	Engine Coolant Thermostat Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (88 lb in)
2	Engine Coolant Thermostat Tip: Loosen the drain bolt at the bottom of the water pump and drain the coolant from the engine block.

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LF1)

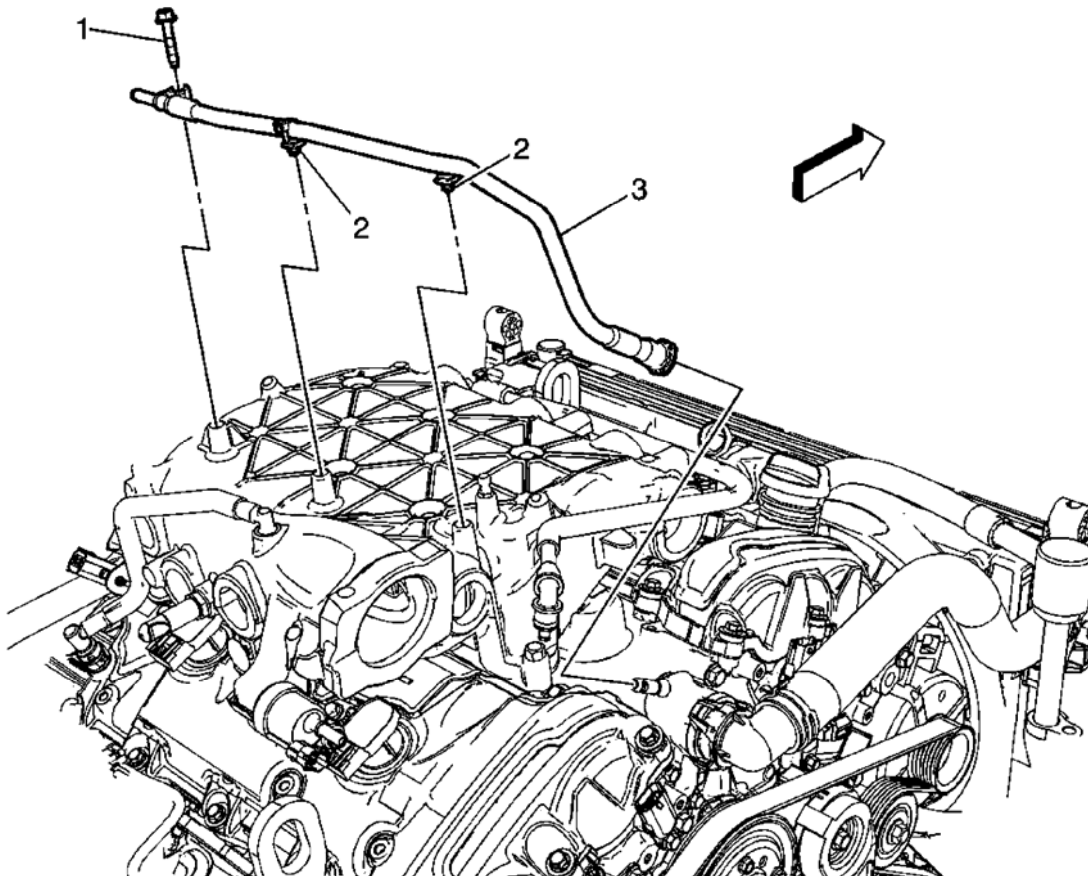


Fig. 63: Engine Coolant Air Bleed Pipe (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Remove the air cleaner. Refer to <u>Air Cleaner Assembly Replacement</u> .	
1	Engine Coolant Air Bleed Pipe Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10N.m (88 lb in)
2	Retainer
3	Engine Coolant Air Bleed Pipe

COOLANT RECOVERY RESERVOIR VENT HOSE REPLACEMENT (LAF)

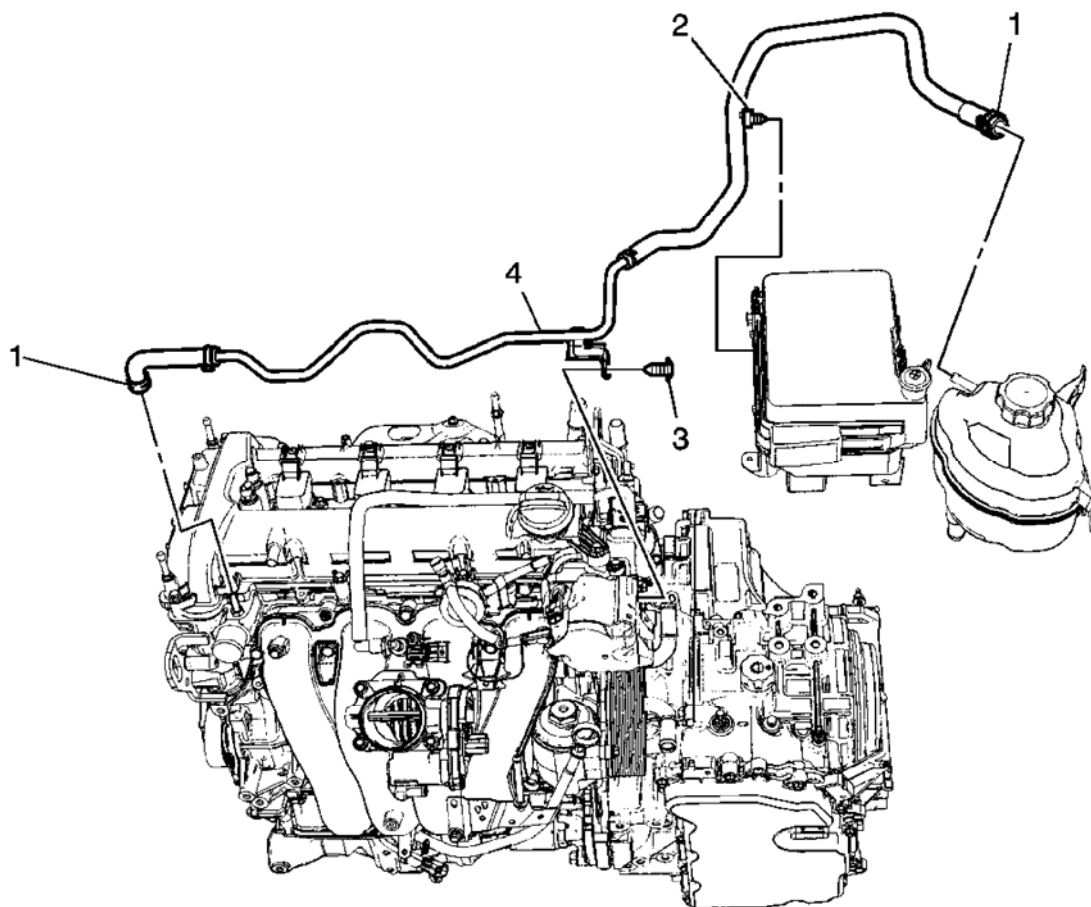


Fig. 64: Coolant Recovery Reservoir Vent Hose (LAF)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the coolant. Refer to Cooling System Draining and Filling (Static) or Cooling System Draining and Filling (GE 47716). 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement	
1	Coolant Recovery Reservoir Vent Hose Clamps (Qty 2) Procedure: Using J 38185: Hose Clamp Pliers reposition the coolant recovery reservoir vent hose. Special Tools: J 38185: Hose Clamp Pliers
2	Coolant Recovery Reservoir Vent Hose Retainer
3	Coolant Recovery Reservoir Vent Hose Retainer
4	Coolant Recovery Reservoir Vent Hose

COOLANT RECOVERY RESERVOIR VENT HOSE REPLACEMENT (LF1)

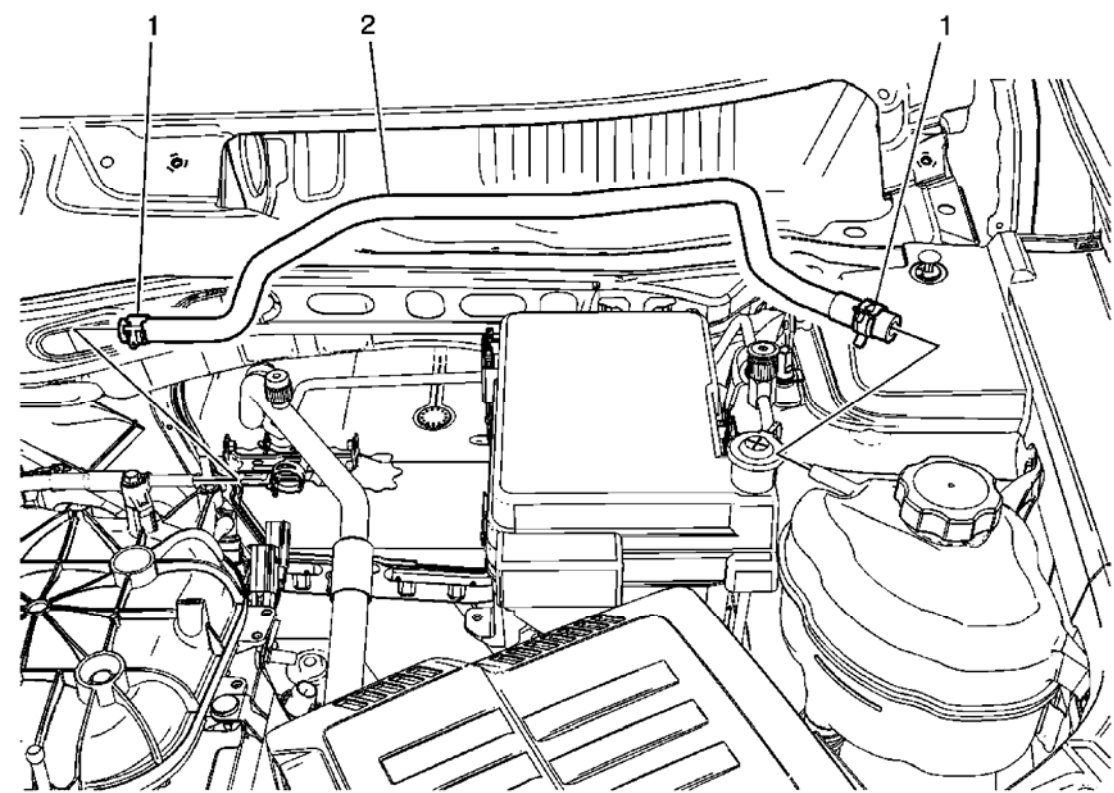


Fig. 65: Coolant Recovery Reservoir Vent Hose (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	

1. Drain the coolant. Refer to Cooling System Draining and Filling (Static) or Cooling System Draining and Filling (GE 47716).
2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement

1	Coolant Recovery Reservoir Vent Hose Clamps (Qty 2) Procedure: Using J 38185 : Hose Clamp Pliers reposition the coolant recovery reservoir vent hose. Special Tools: J 38185 : Hose Clamp Pliers
	2

COOLANT RECOVERY RESERVOIR OUTLET HOSE REPLACEMENT (LAF)

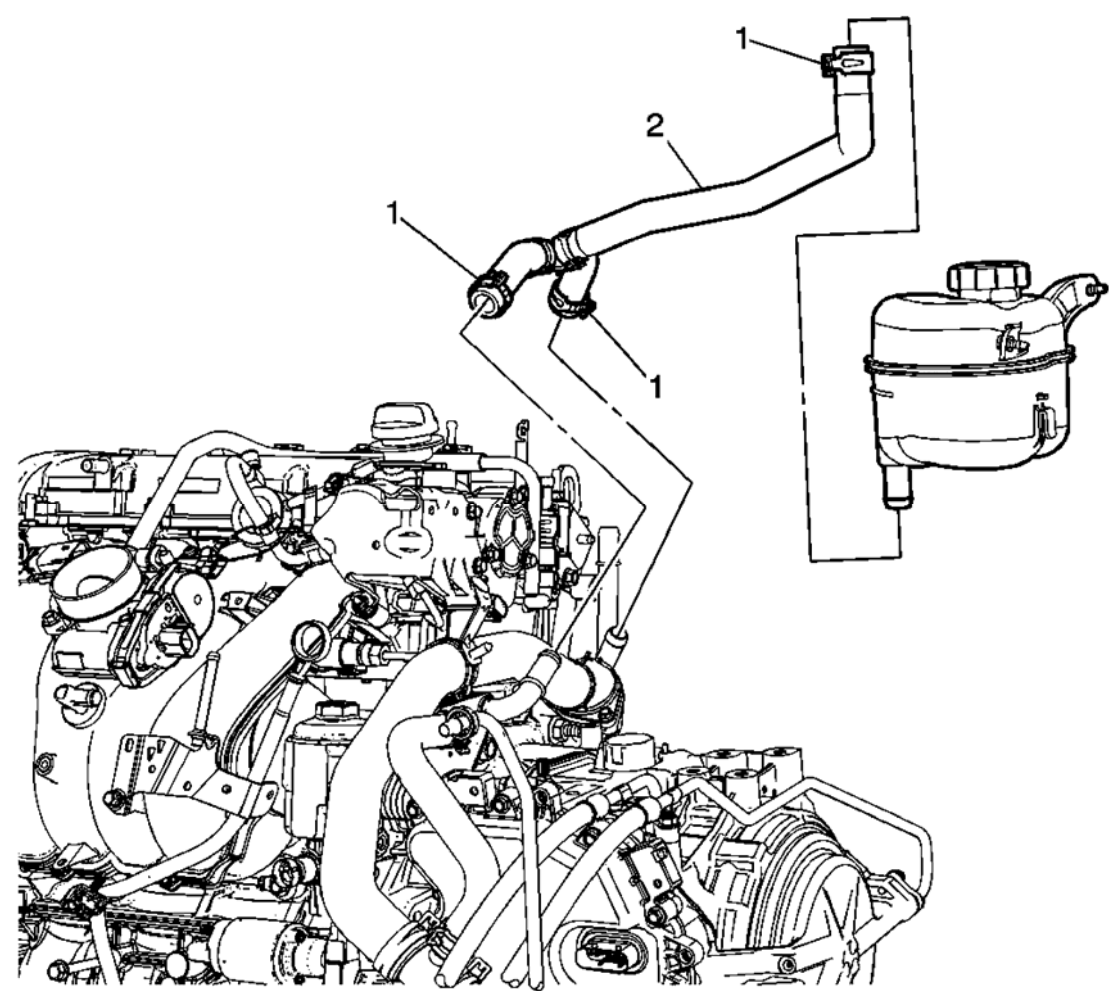


Fig. 66: Coolant Recovery Reservoir Outlet Hose (LAF)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
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Preliminary Procedures

1. Drain the coolant. Refer to <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System Draining and Filling (GE 47716)</u> .	
2. Reposition the accessory wiring junction block. Refer to <u>Accessory Wiring Junction Block Replacement</u>	
	Coolant Recovery Reservoir Outlet Hose Clamps (Qty 3)
1	Procedure: Using J 38185: Hose Clamp Pliers reposition the coolant recovery reservoir outlet hose. Special Tools: J 38185: Hose Clamp Pliers
2	Coolant Recovery Reservoir Outlet Hose

COOLANT RECOVERY RESERVOIR OUTLET HOSE REPLACEMENT (LF1)

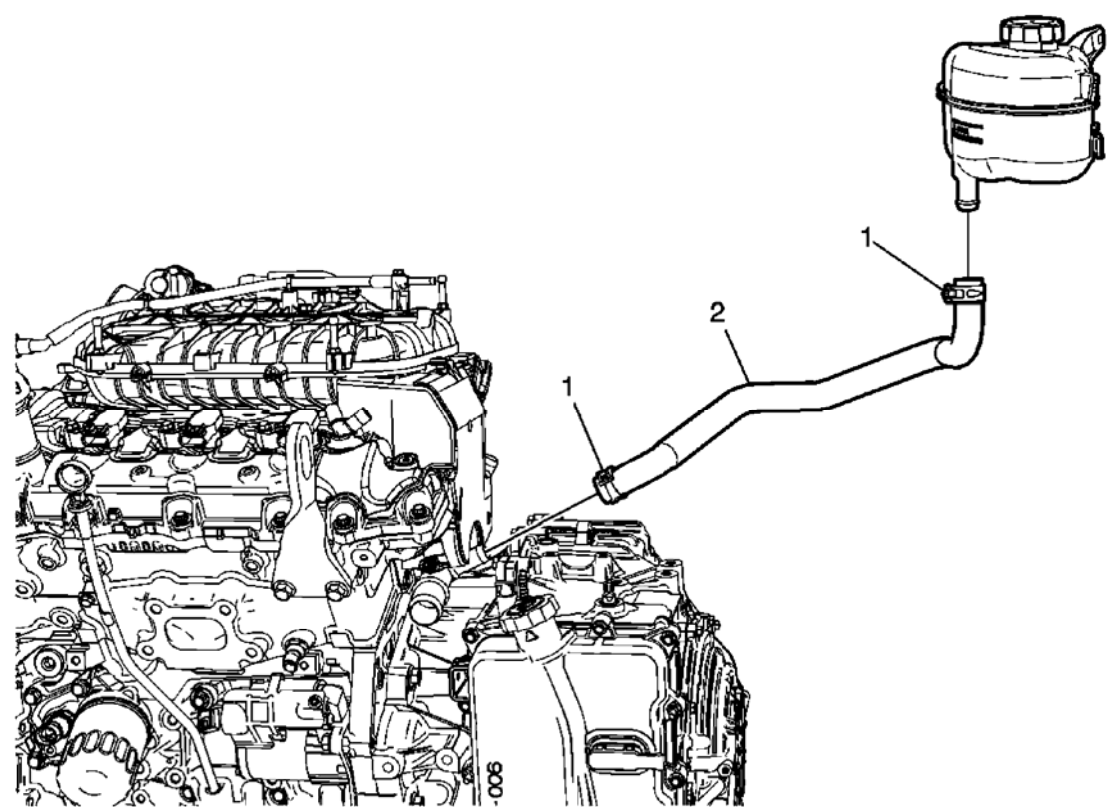


Fig. 67: Coolant Recovery Reservoir Outlet Hose (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the coolant. Refer to <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System</u>	

Draining and Filling (GE 47716).

2. Reposition the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement**

	Coolant Recovery Reservoir Outlet Hose Clamps (Qty 2) Procedure: Using J 38185: Hose Clamp Pliers reposition the coolant recovery reservoir outlet hose. Special Tools: J 38185: Hose Clamp Pliers
1	
2	Coolant Recovery Reservoir Outlet Hose

WATER OUTLET REPLACEMENT (LF1)

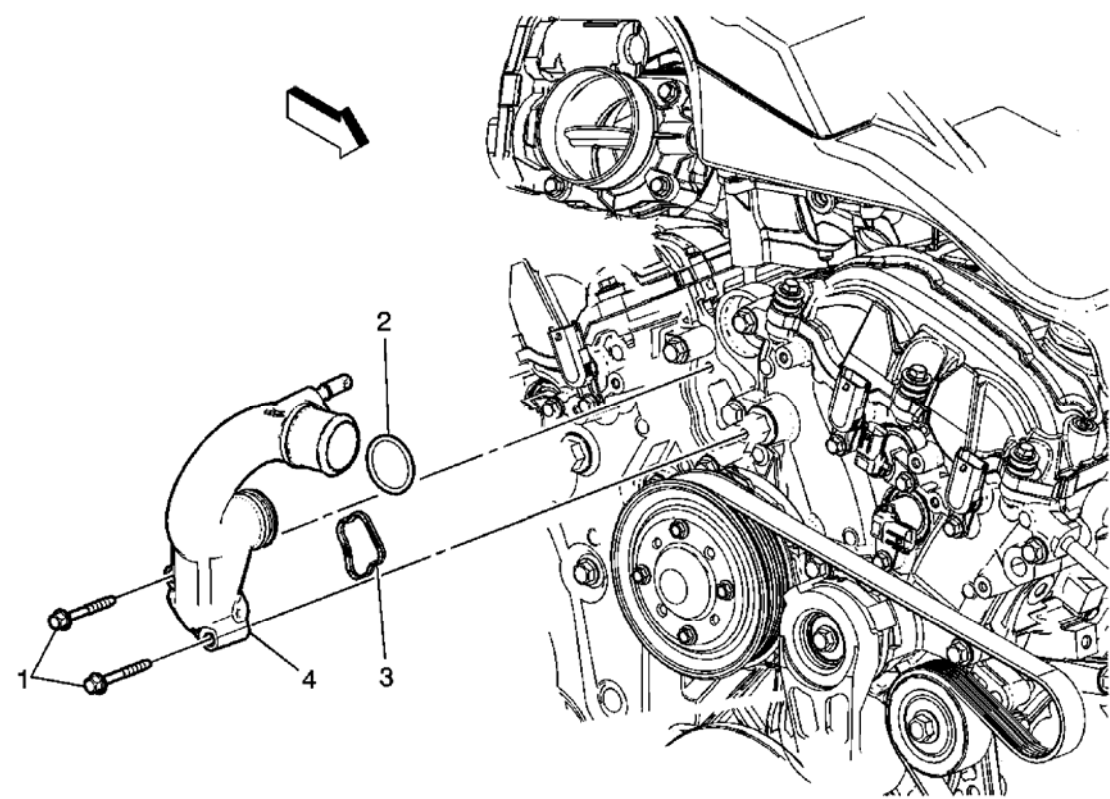


Fig. 68: Water Outlet (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System Draining and Filling (GE 47716)</u> .
2.	Remove the right engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u>

3. Remove the air cleaner. Refer to <u>Air Cleaner Assembly Replacement</u> .	
1	Water Outlet Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10N.m (88 lb in)
2	Seal
3	Gasket
4	Water Outlet Tip: Clean the mating surfaces, replace the seal and gasket

WATER PUMP REPLACEMENT (LF1)

Tools Required

EN 46104: Water Pump Pulley Holder

For equivalent regional tools refer to **Special Tools**

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**
2. Remove the generator drive belt. Refer to **Drive Belt Replacement**

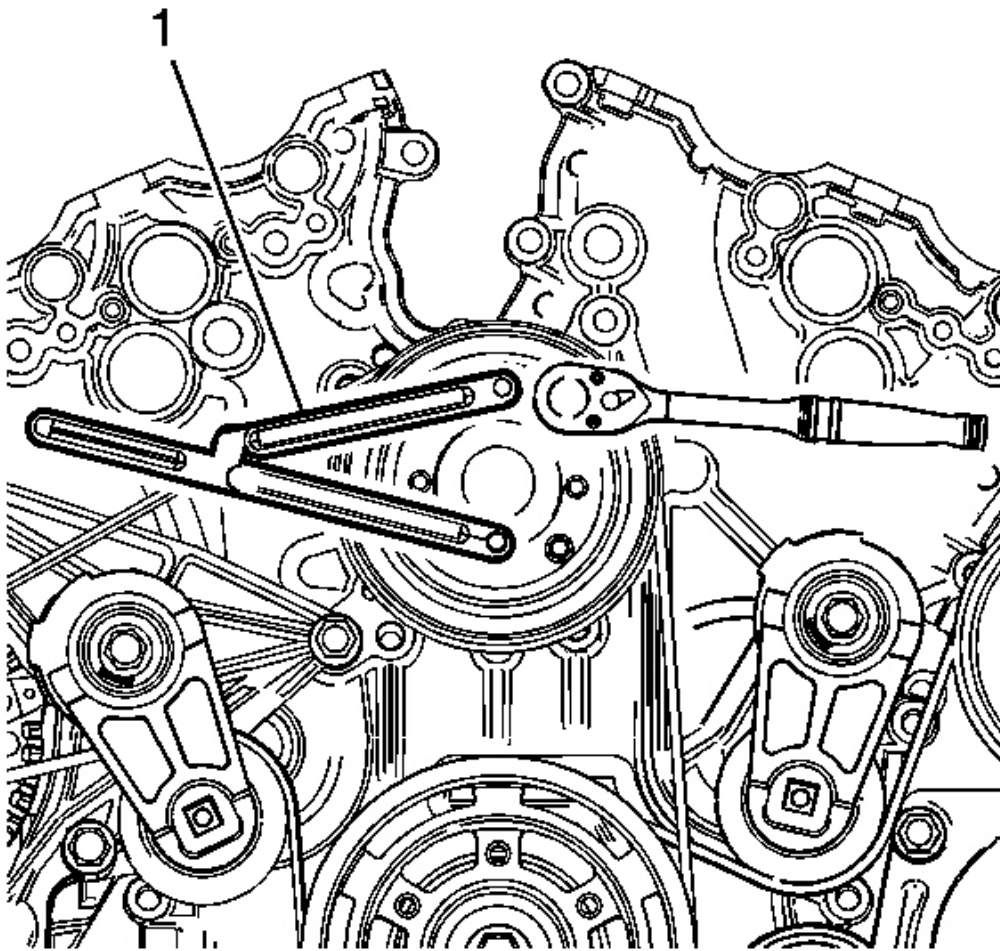


Fig. 69: Securing Water Pump Pulley With EN 46104
Courtesy of GENERAL MOTORS CORP.

3. Use the **EN 46104**: water pump pulley holder to retain the pulley.

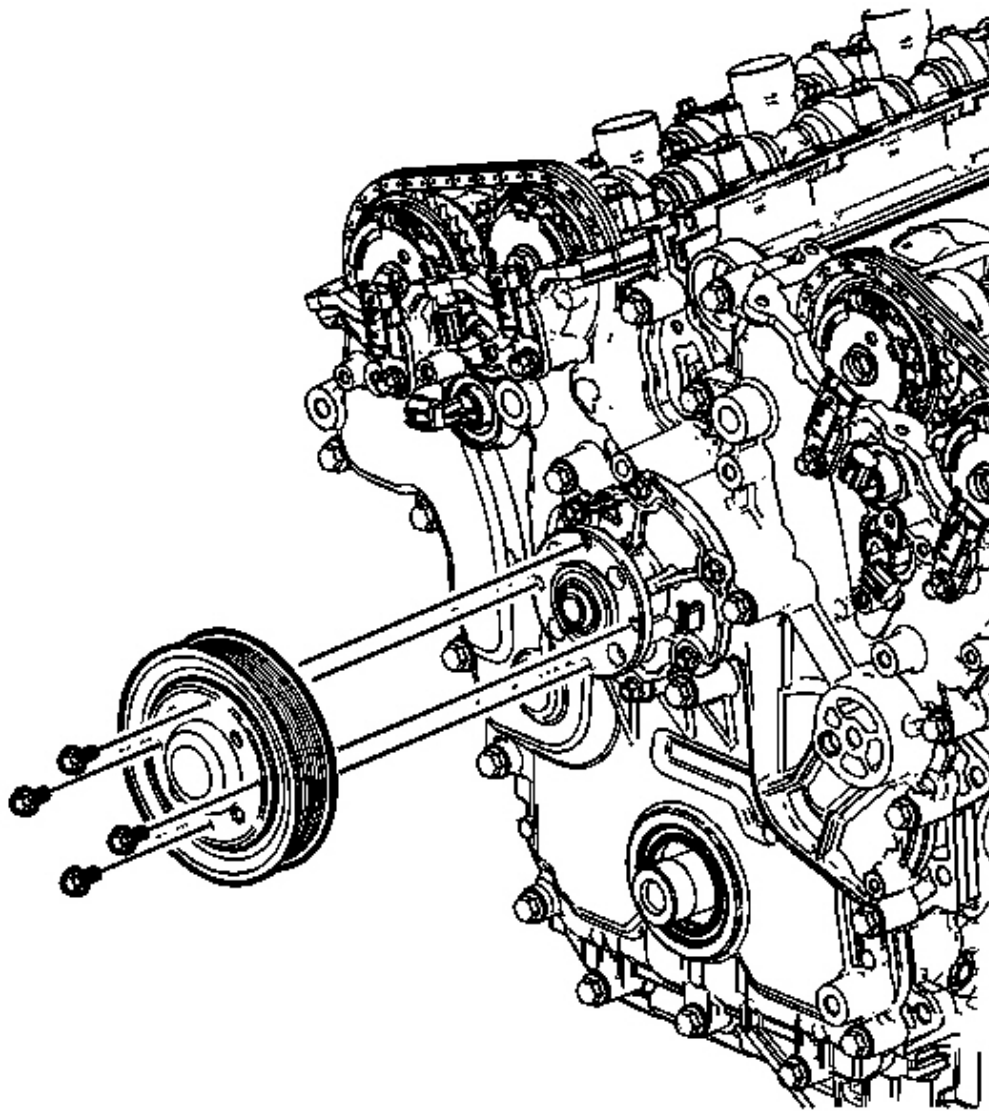


Fig. 70: View Of Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

4. Remove the water pump pulley bolts.
5. Remove the water pump pulley.

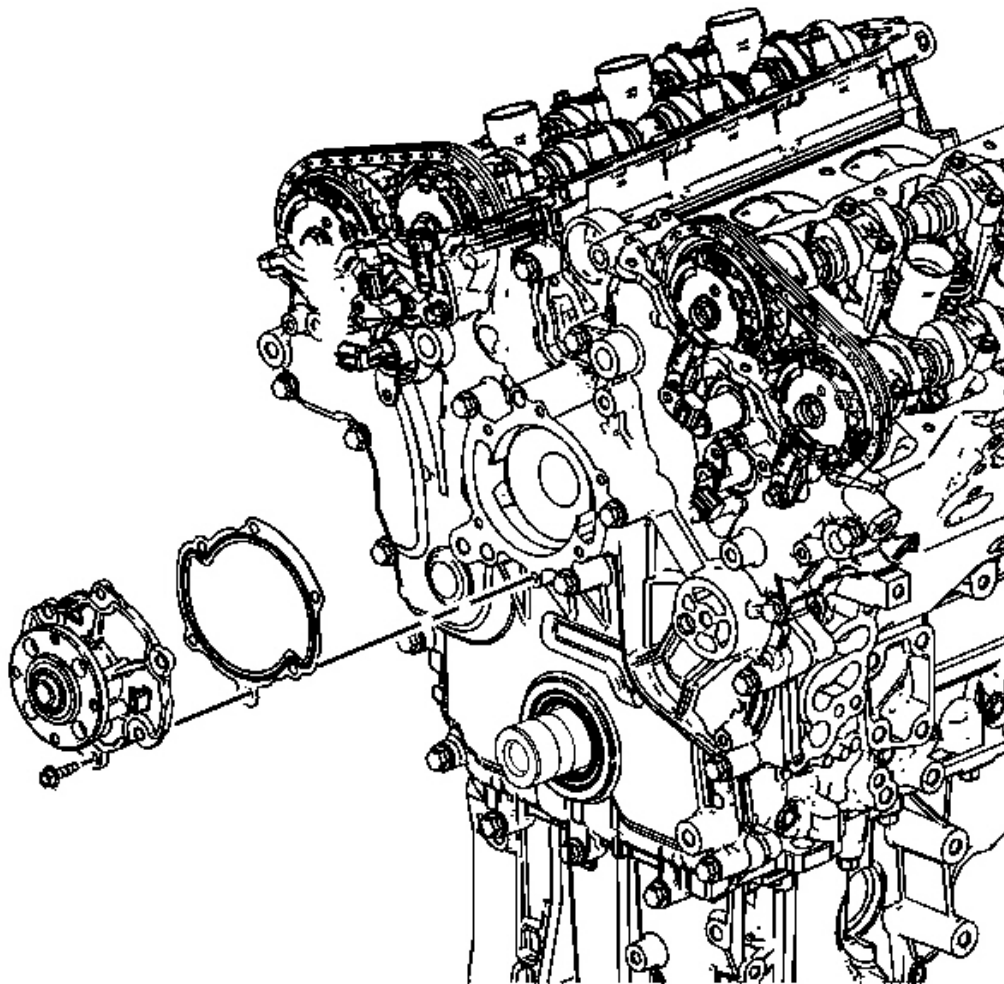


Fig. 71: View Of Water Pump
Courtesy of GENERAL MOTORS CORP.

6. Remove the water pump bolts.
7. Remove the water pump.
8. Remove and DISCARD the water pump seal.
9. Carefully clean the water pump sealing surfaces.

Installation Procedure

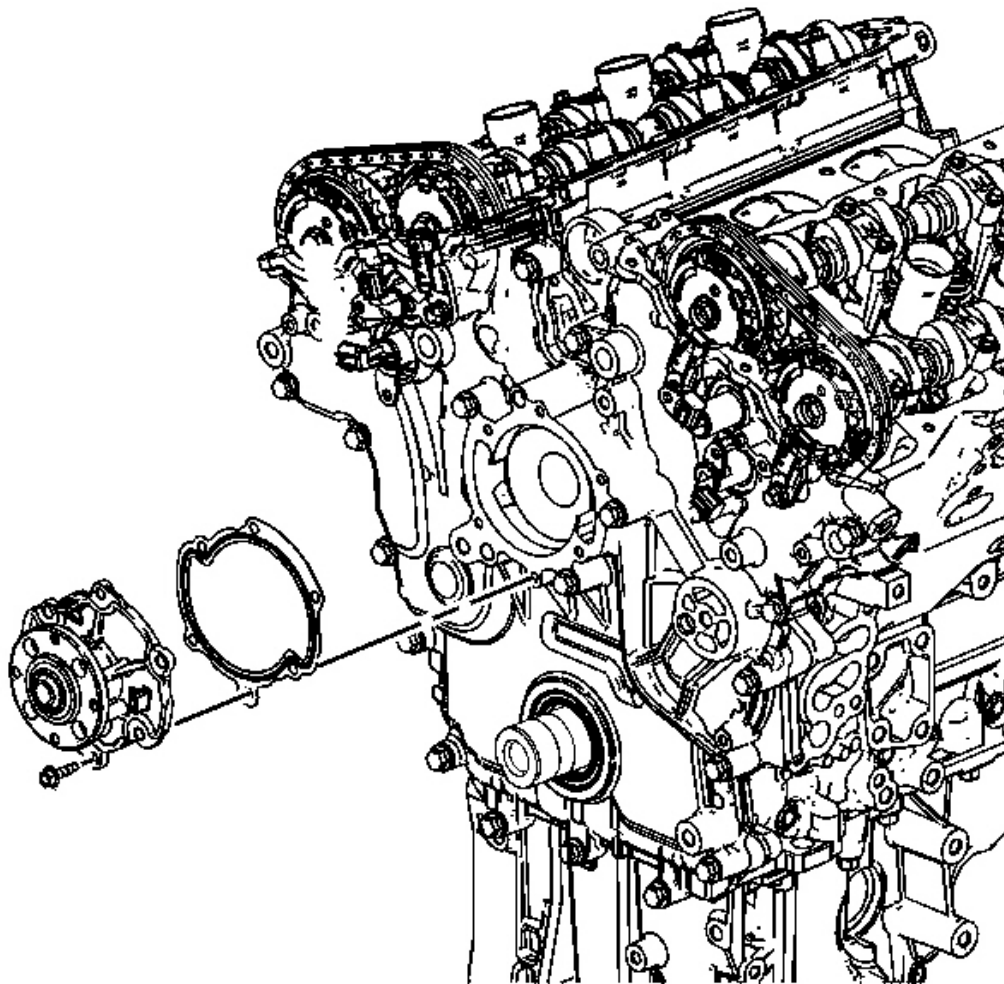


Fig. 72: View Of Water Pump
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW water pump seal.
2. Install the water pump.

CAUTION: Refer to Fastener Caution

3. Install the water pump bolts and tighten to 10 N.m (89 lb in).

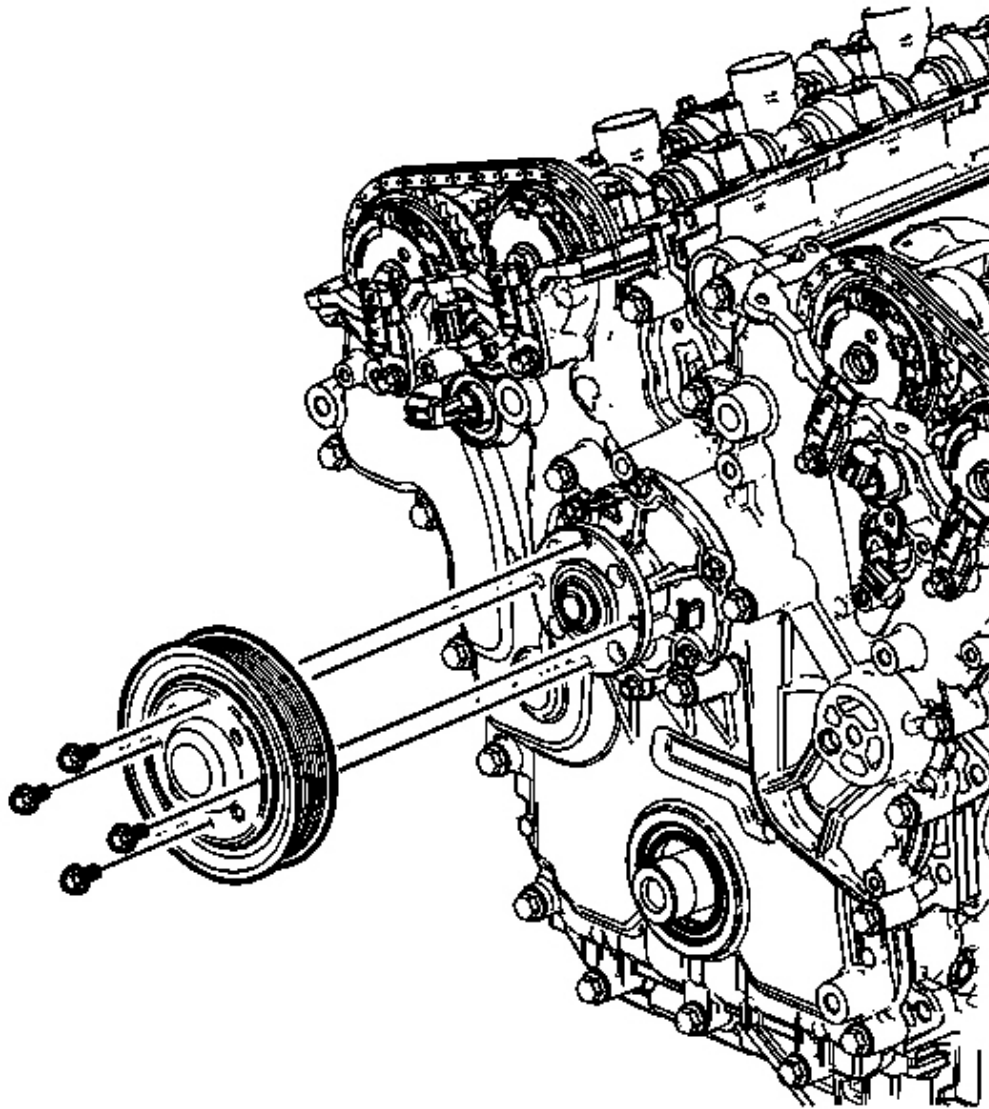


Fig. 73: View Of Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

4. Install the water pump pulley and the water pump pulley bolts.

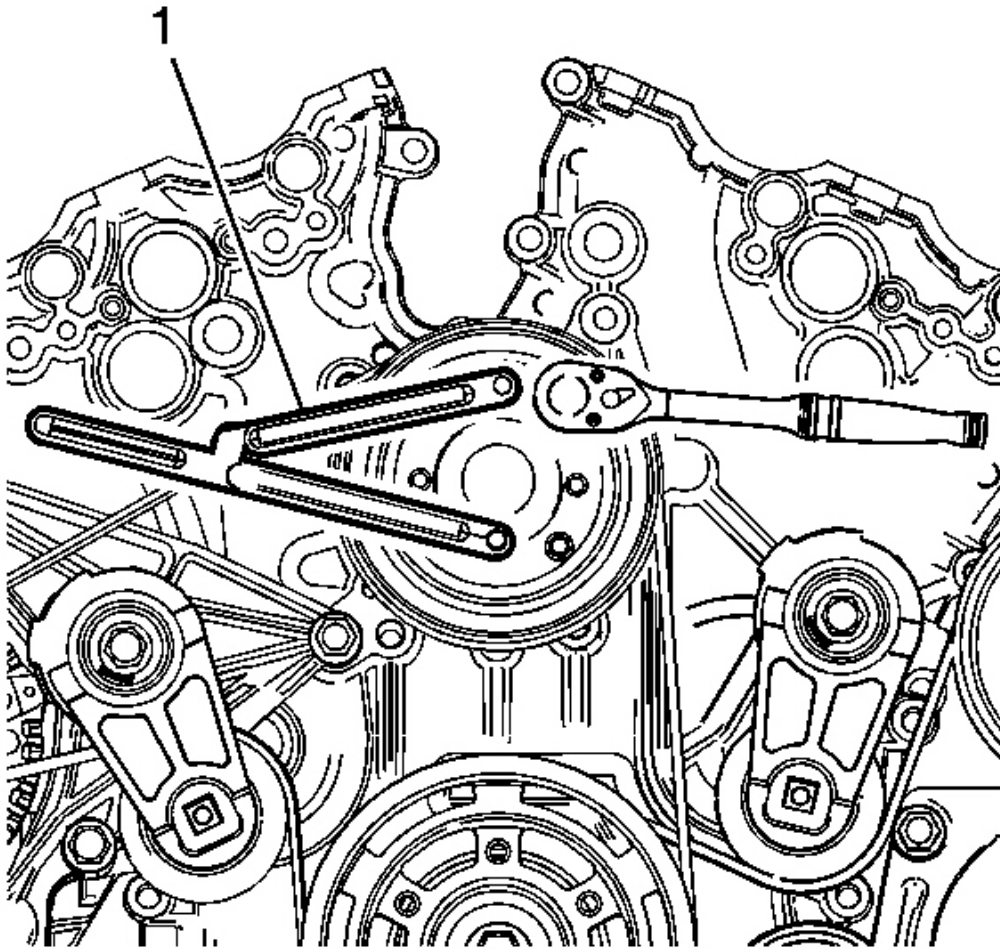


Fig. 74: Securing Water Pump Pulley With EN 46104
Courtesy of GENERAL MOTORS CORP.

5. Use the **EN 46104**: water pump pulley holder to hold the pulley.
6. Install the water pump pulley bolts and tighten to 12 N.m (108 lb in).
7. Install the generator drive belt. Refer to **Drive Belt Replacement**
8. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**

WATER PUMP REPLACEMENT (LAF)

Special Tools

J 43651 Water Pump Holding Tool

Removal Procedure

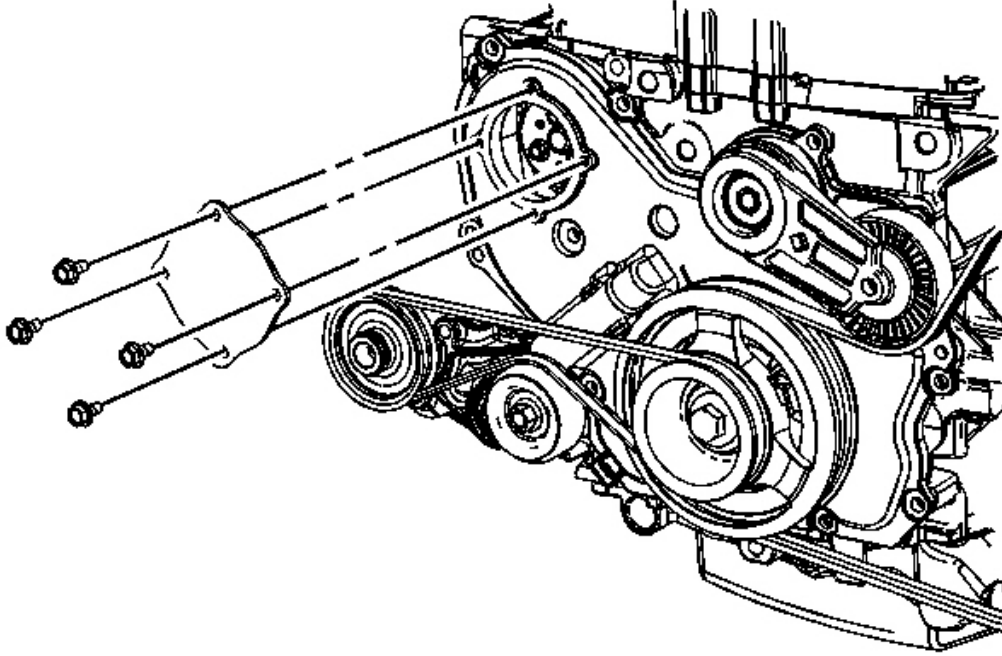


Fig. 75: Water Pump Access Plate
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement (LAF)** or **Engine Coolant Thermostat Housing Replacement (LF1)**.
3. Remove the water pump access plate from the front cover.

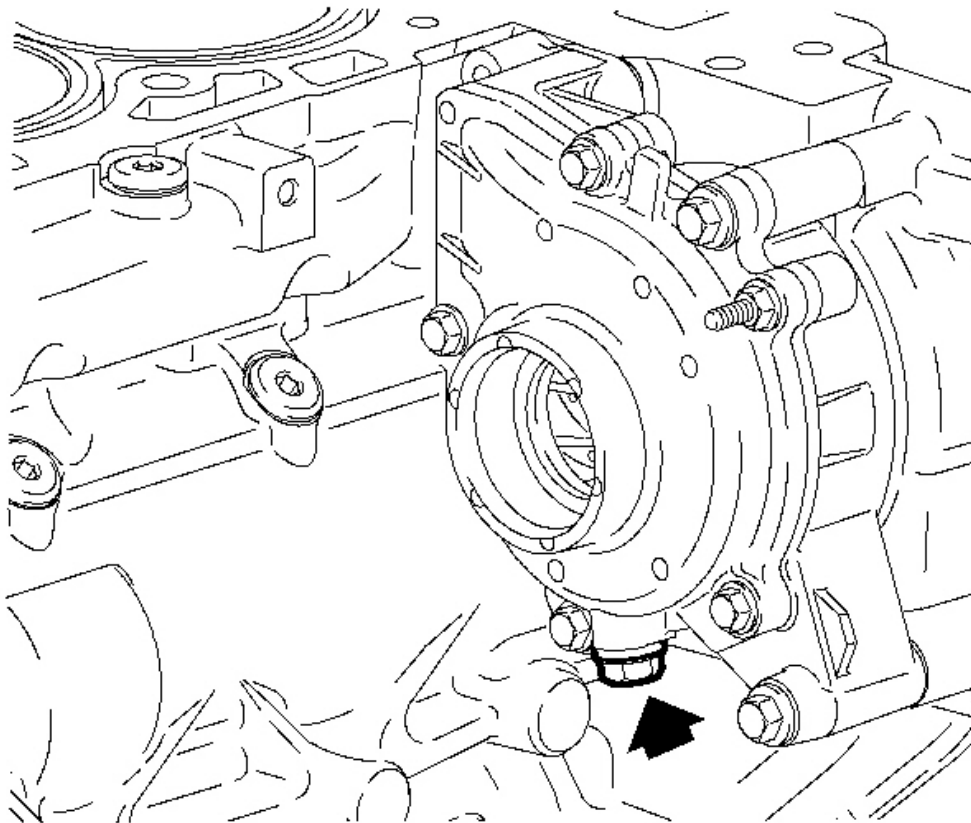


Fig. 76: Locating Water Pump Drain Plug (L61)
Courtesy of GENERAL MOTORS CORP.

NOTE: A drain plug has been provided at the bottom of the water pump assembly for additional coolant drainage from the engine block and water pump.

4. Drain the coolant from the water pump using the plug at the bottom of the pump.

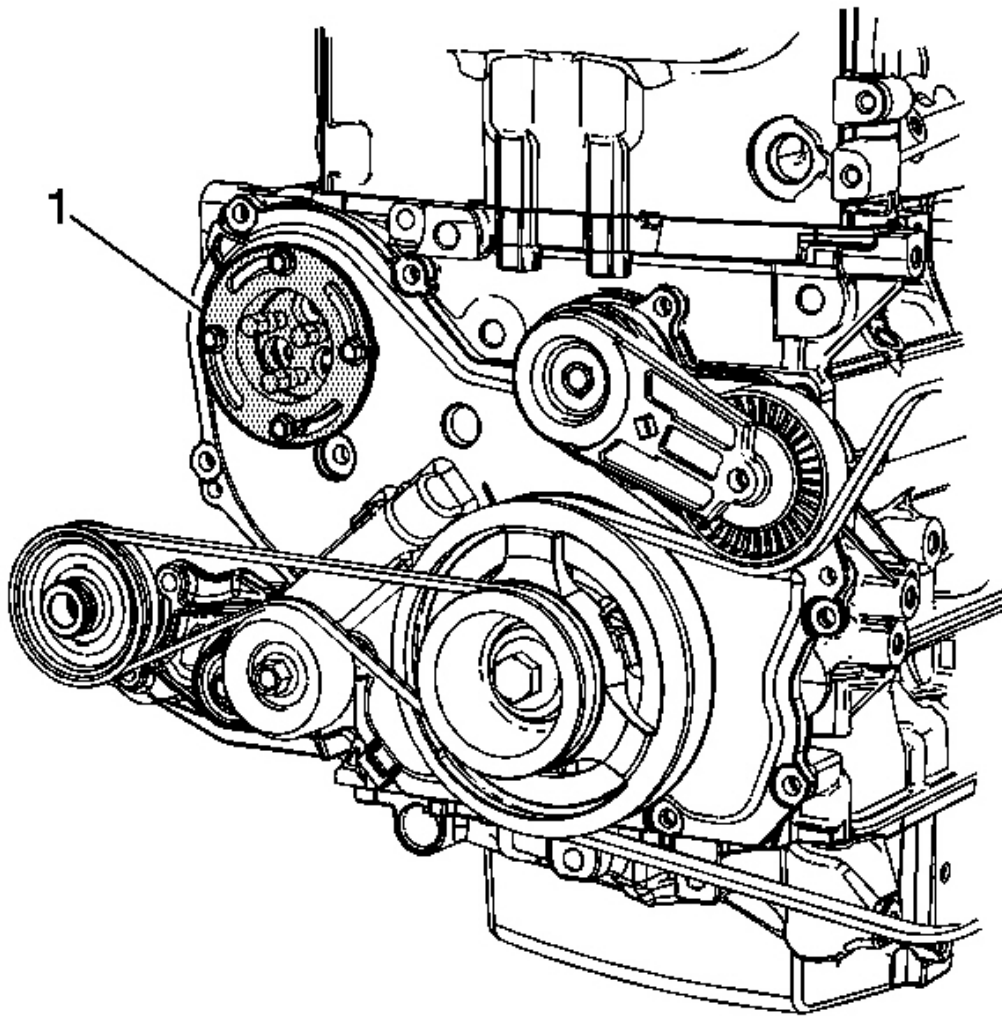


Fig. 77: Using J 43651
Courtesy of GENERAL MOTORS CORP.

NOTE: The water pump holding tool supports the sprocket and chain during water pump service. The tool must be used or the balance shaft must be re-timed.

5. Install the **J 43651** (1) into position.
6. Tighten the bolts on the water pump holding tool into the threads on the water pump sprocket.
7. Install the access cover bolts that were removed earlier to secure the water pump holding tool to the front cover assembly.

8. Remove the 3 inner water pump sprocket to water pump bolts.

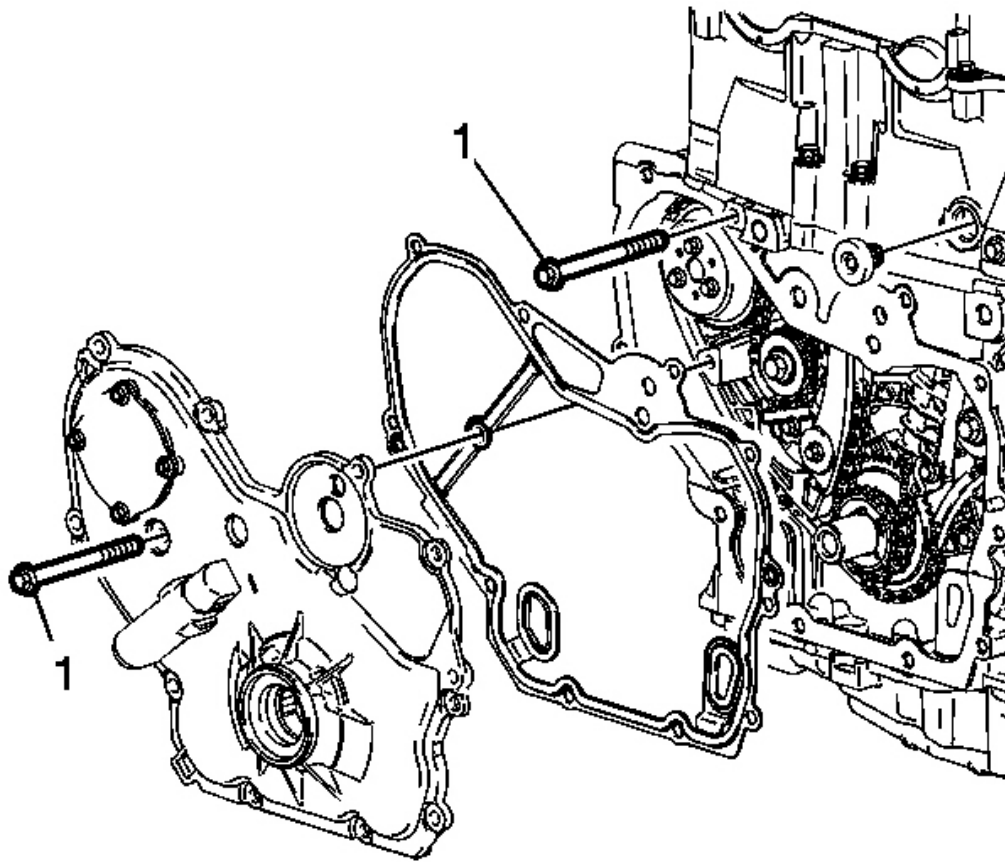


Fig. 78: Water Pump Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Be sure to remove both water pump bolts from the front of the engine block.

9. Remove the 2 water pump bolts (1).

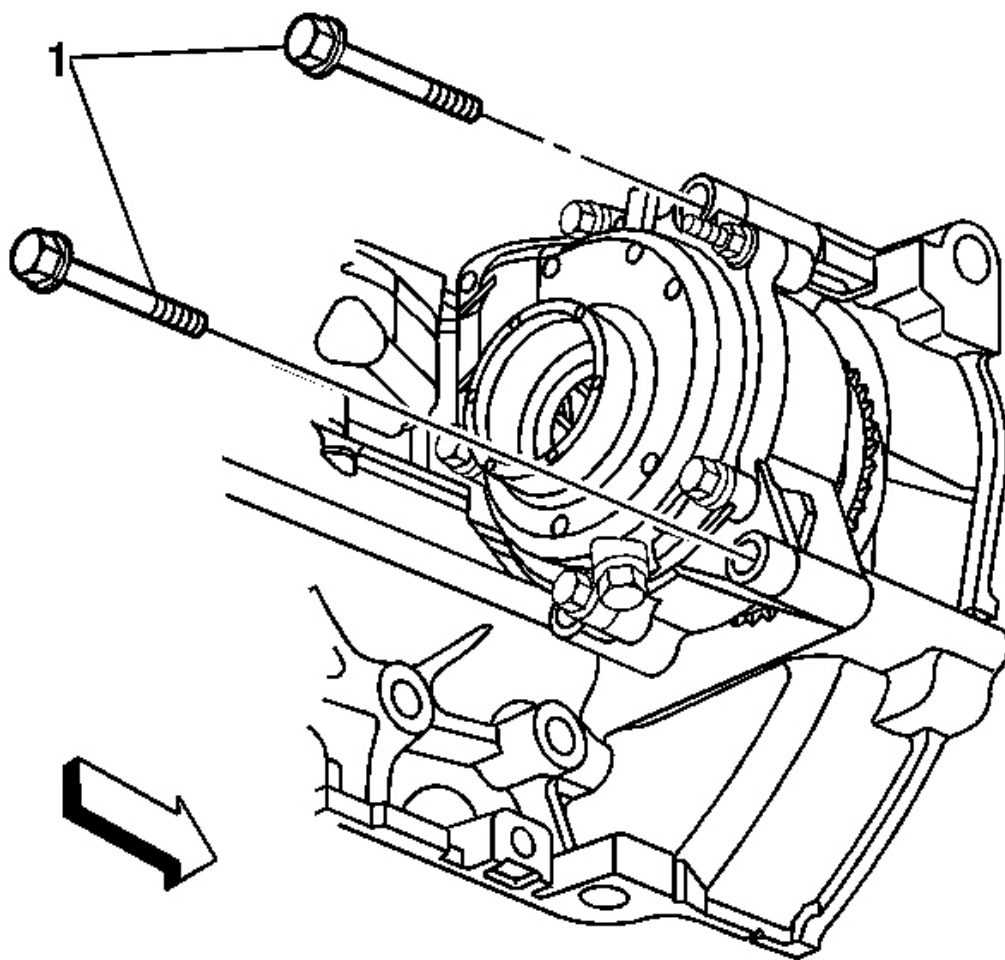


Fig. 79: Identifying Rear Water Pump Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the rear 2 water pump bolts (1).

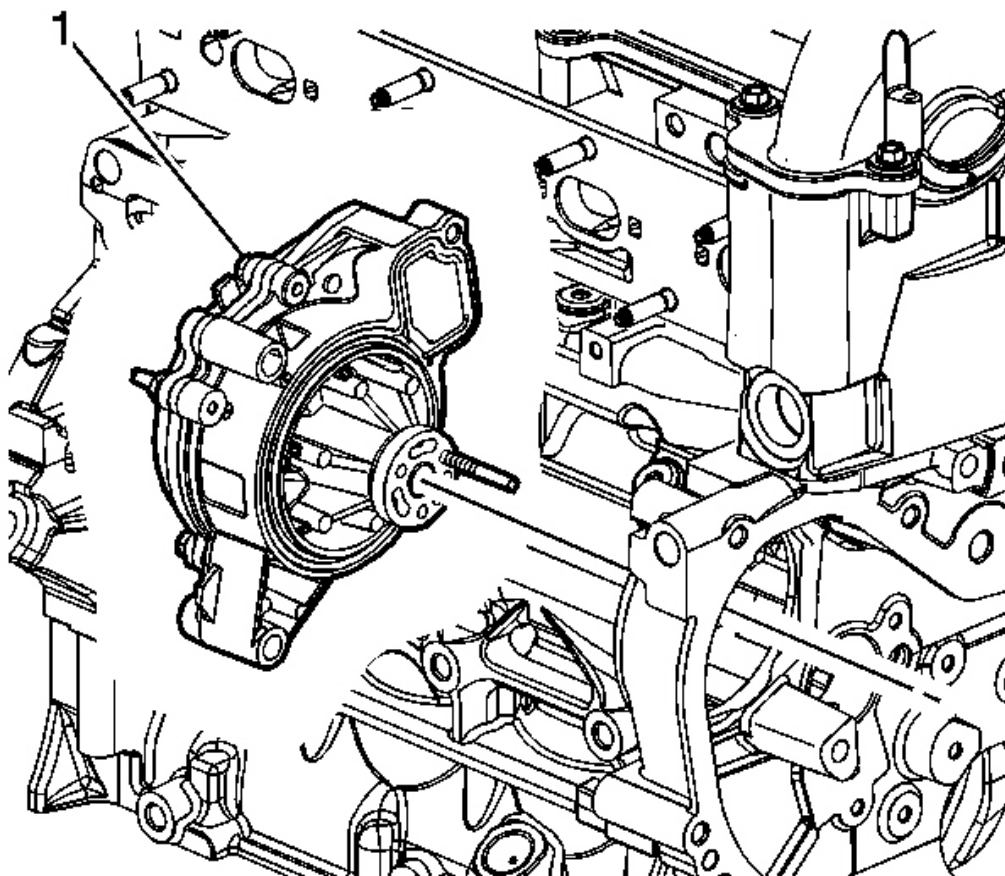


Fig. 80: Removing/Installing Water Pump (L61)
Courtesy of GENERAL MOTORS CORP.

11. Remove the water pump (1).
12. Remove and discard the water pump O-ring seal.

Installation Procedure

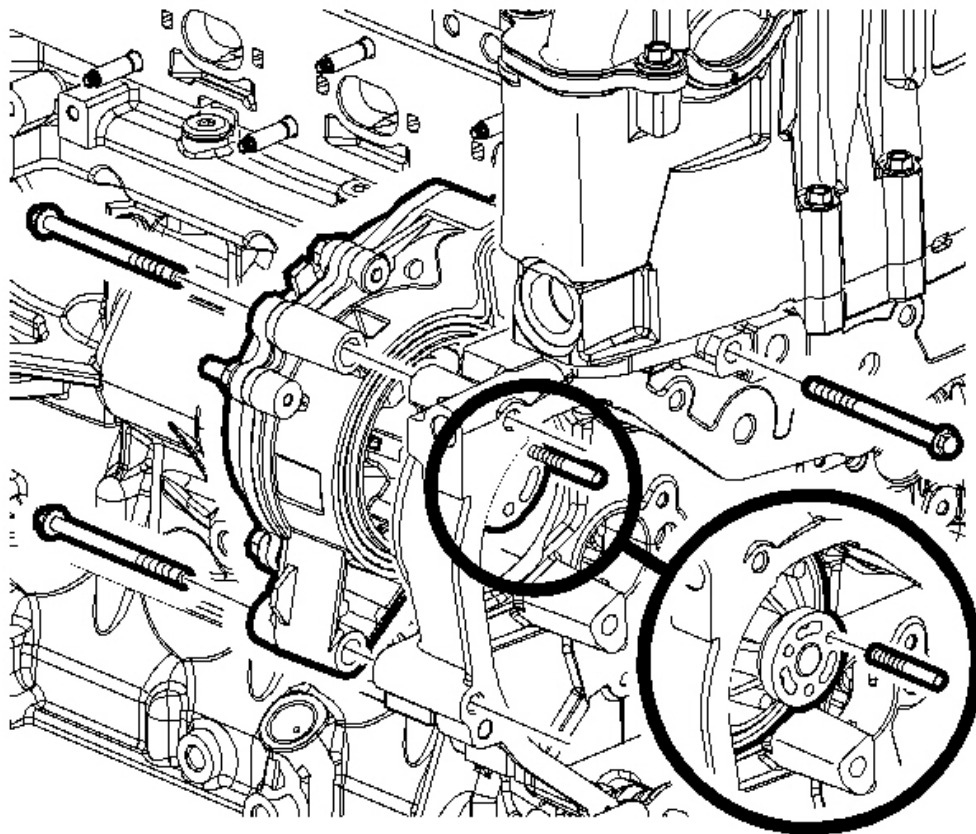


Fig. 81: View Of Water Pump Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Prior to installing the water pump, read the entire procedure. This will help avoid balance shaft chain re-timing and ensure proper sealing.

1. Install a NEW water pump O-ring seal.

NOTE: A guide pin can be created to aid in water pump alignment. Use a M 6 m x 6 mm stud. Thread the pin into the water pump sprocket.

2. Using the guide pin, align the pin with the water pump holding tool.
3. Position the water pump against the engine block and hand tighten the water pump bolts.

CAUTION: Refer to Fastener Caution .

4. Install the inner water pump sprocket bolts. After 2 are snug, remove the guide pin and install the 3rd bolt.

Tighten: Tighten the bolts to 25 N.m (18 lb ft).

5. Tighten the water pump sprocket bolts last.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

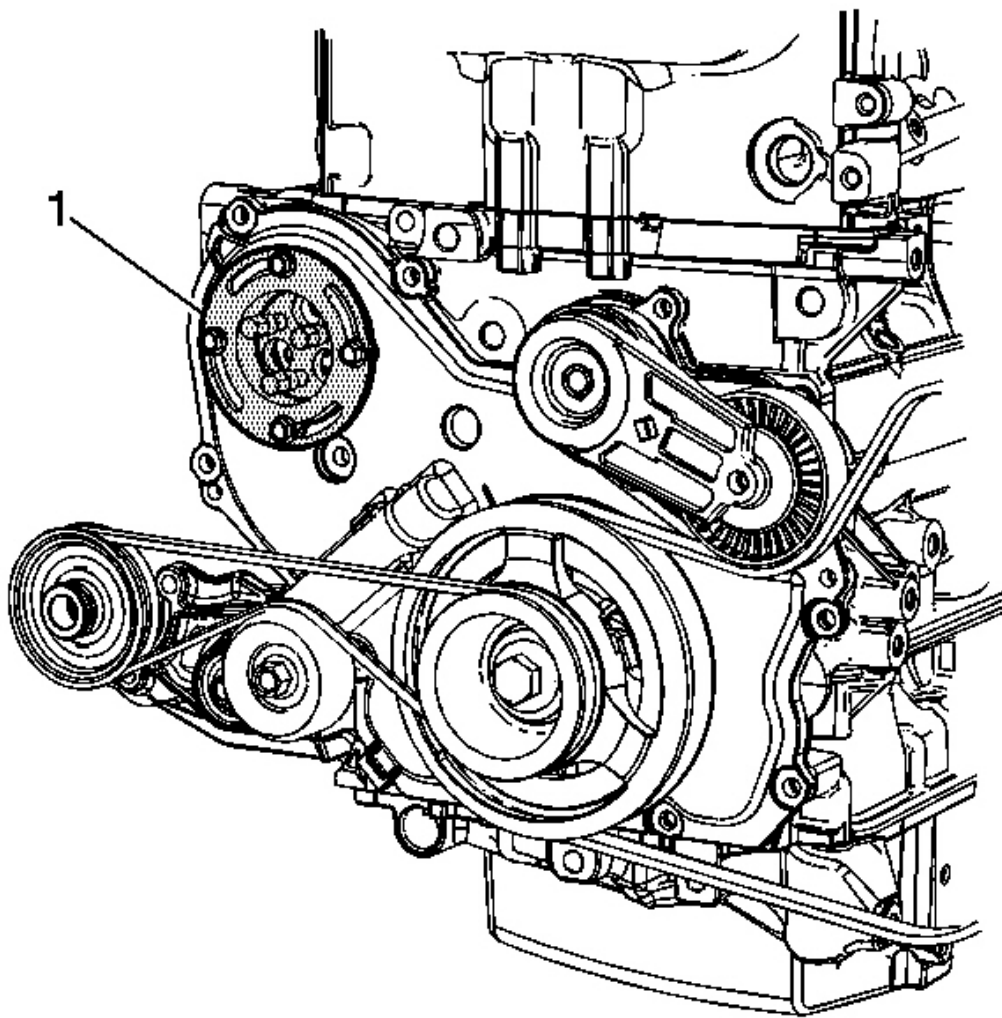


Fig. 82: Using J 43651
Courtesy of GENERAL MOTORS CORP.

6. Remove the J 43651 (1).

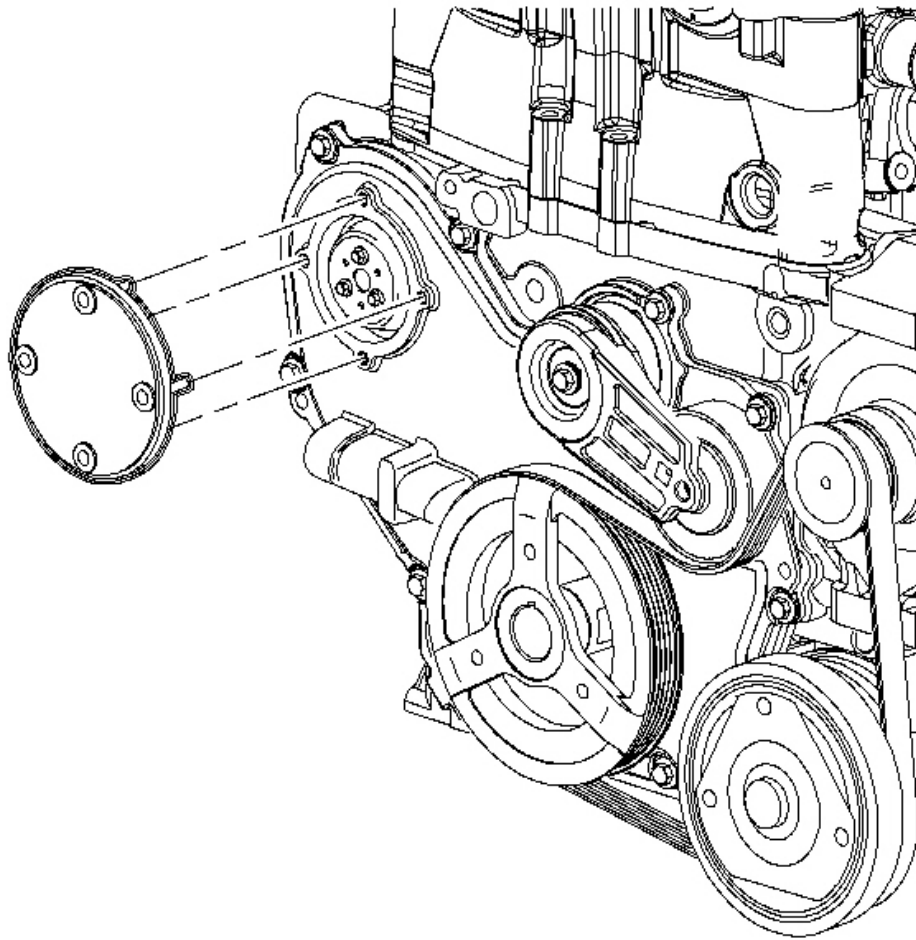


Fig. 83: Removing & Installing Water Pump Access Plate (L61)
Courtesy of GENERAL MOTORS CORP.

7. Install the water pump access plate and bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

8. Install the thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement (LAF)** or **Engine Coolant Thermostat Housing Replacement (LF1)**.
9. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.

RADIATOR DRAIN COCK REPLACEMENT

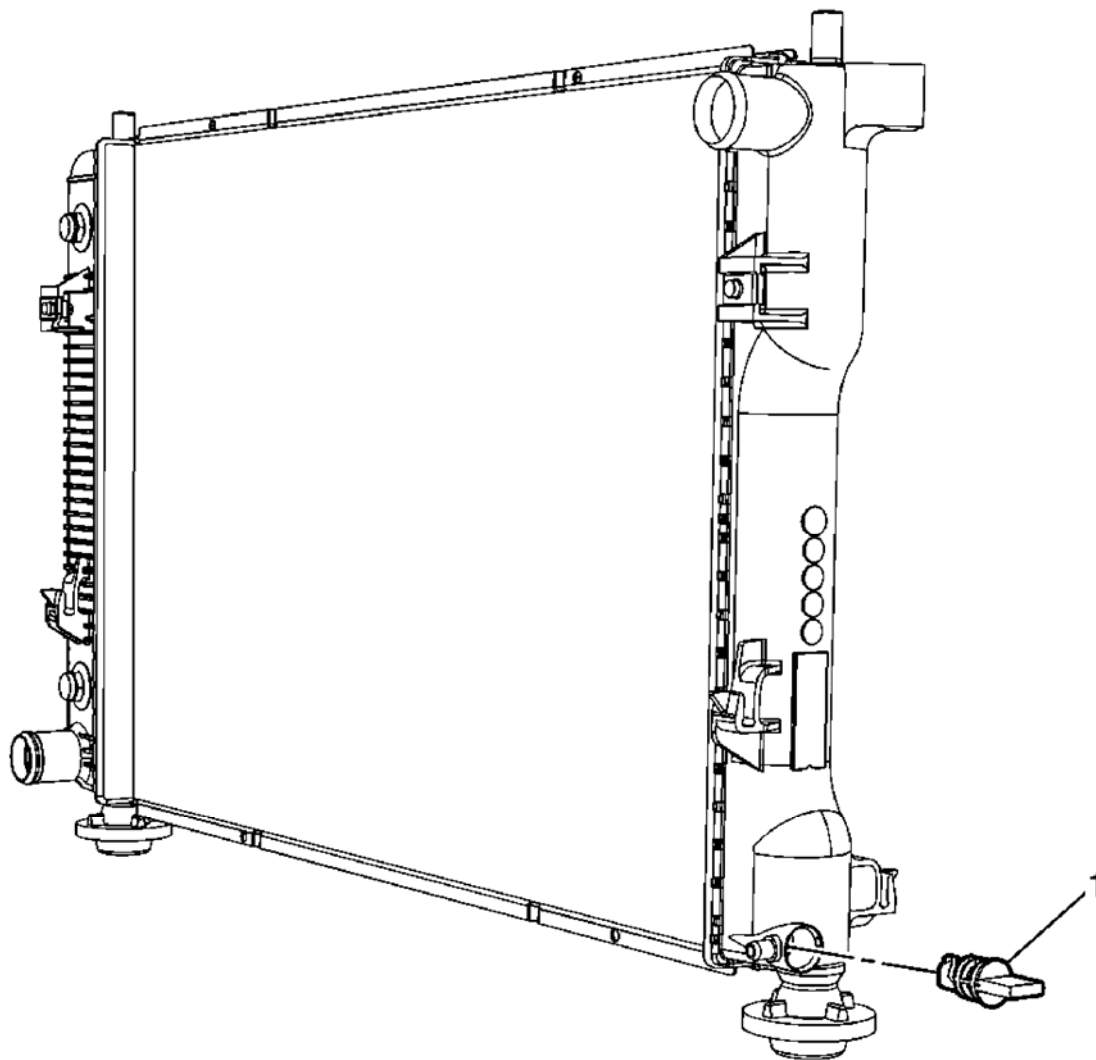


Fig. 84: Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>	
2. Place a drain pan under the right side lower radiator mount.	
1	Radiator Drain Cock

ENGINE COOLANT FAN SHROUD REPLACEMENT (LAF)

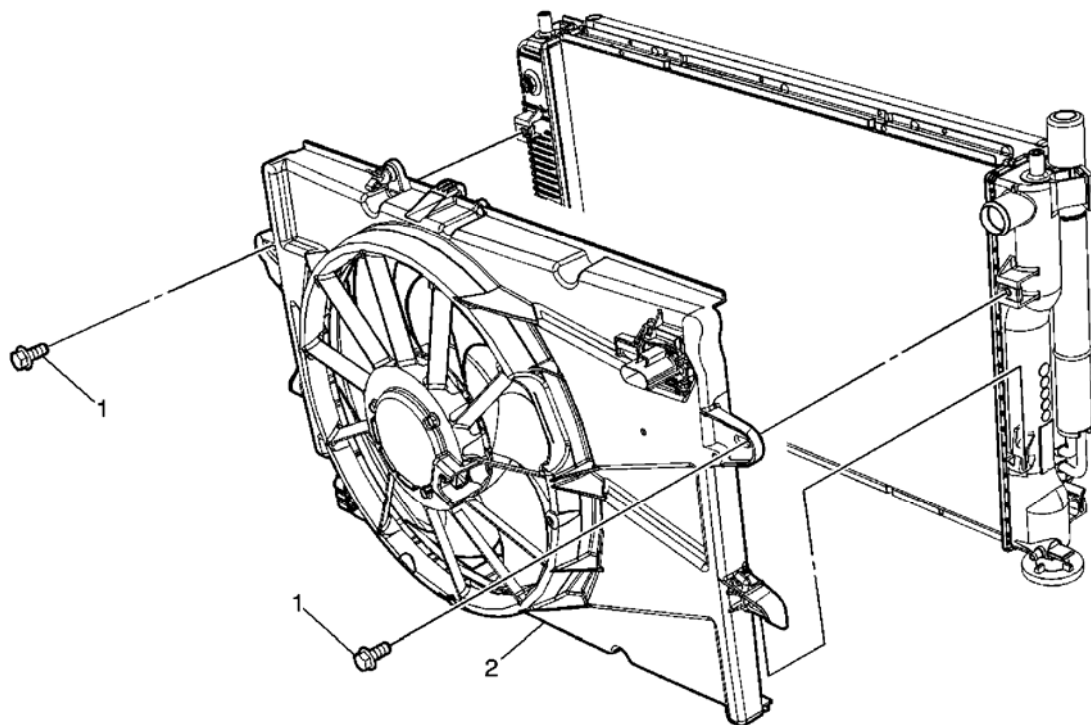


Fig. 85: Engine Coolant Fan Shroud (LAF)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Reposition radiator. Refer to <u>Radiator Replacement</u>. 2. Unclip transmission cooler lines from shroud. 3. Unclip air conditioning lines from shroud. 4. Disconnect engine coolant fan motor electrical connector. 5. Disconnect engine coolant fan resistor electrical connector.	
1	Engine Coolant Fan Shroud Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 9 N.m (80 lb in)
2	Engine Coolant Fan Shroud

ENGINE COOLANT FAN SHROUD REPLACEMENT (LF1)

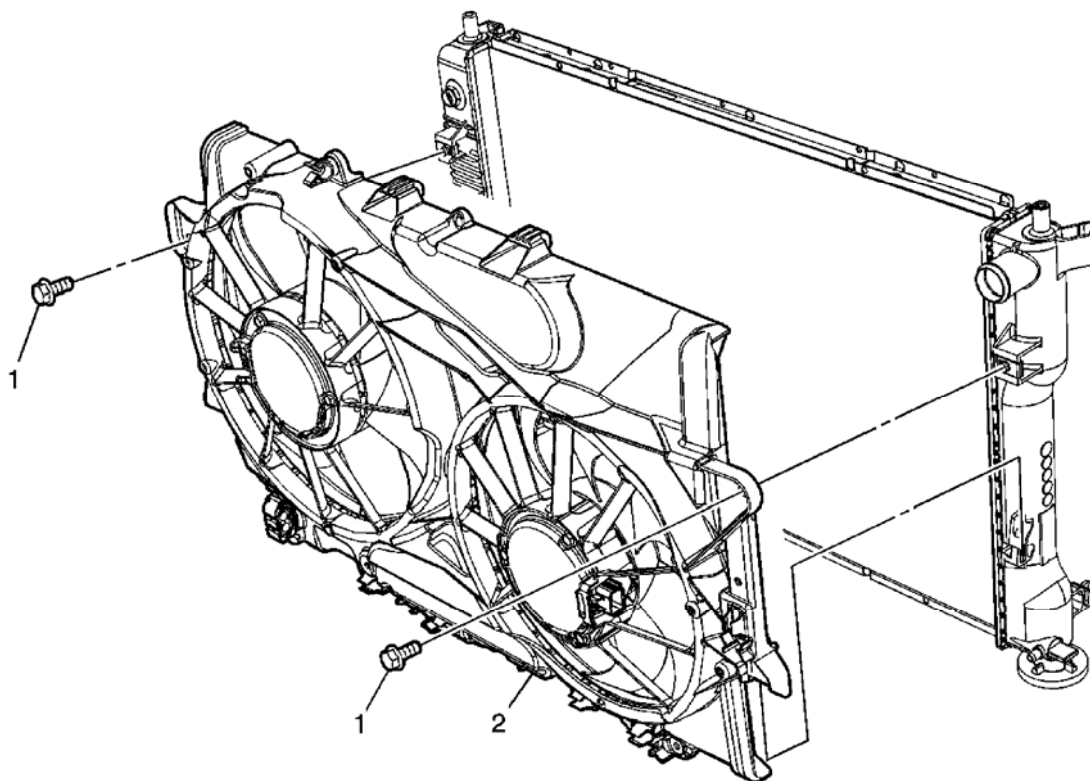


Fig. 86: Engine Coolant Fan Shroud (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia support. Refer to <u>Front Bumper Fascia Support Replacement</u> 2. Remove the radiator inlet hose from radiator. Refer to <u>Radiator Inlet Hose Replacement (LAF)</u> or <u>Radiator Inlet Hose Replacement (LF1)</u> 3. Remove the compressor hose from the condenser. Refer to <u>Air Conditioning Compressor Hose Replacement (LAF)</u> or <u>Air Conditioning Compressor Hose Replacement (LF1)</u> 4. Remove the upper transmission cooler lines from radiator. 5. Remove the radiator mounting bolts and brackets. Refer to <u>Radiator Replacement</u>. 6. Unclip transmission cooler lines from shroud. 7. Unclip air conditioning lines from shroud. 8. Disconnect engine coolant fan motor electrical connector. 9. Position radiator towards front of vehicle.	
1	Engine Coolant Fan Shroud Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten: 9 N.m (80 lb in)
2	Engine Coolant Fan Shroud

RADIATOR REPLACEMENT

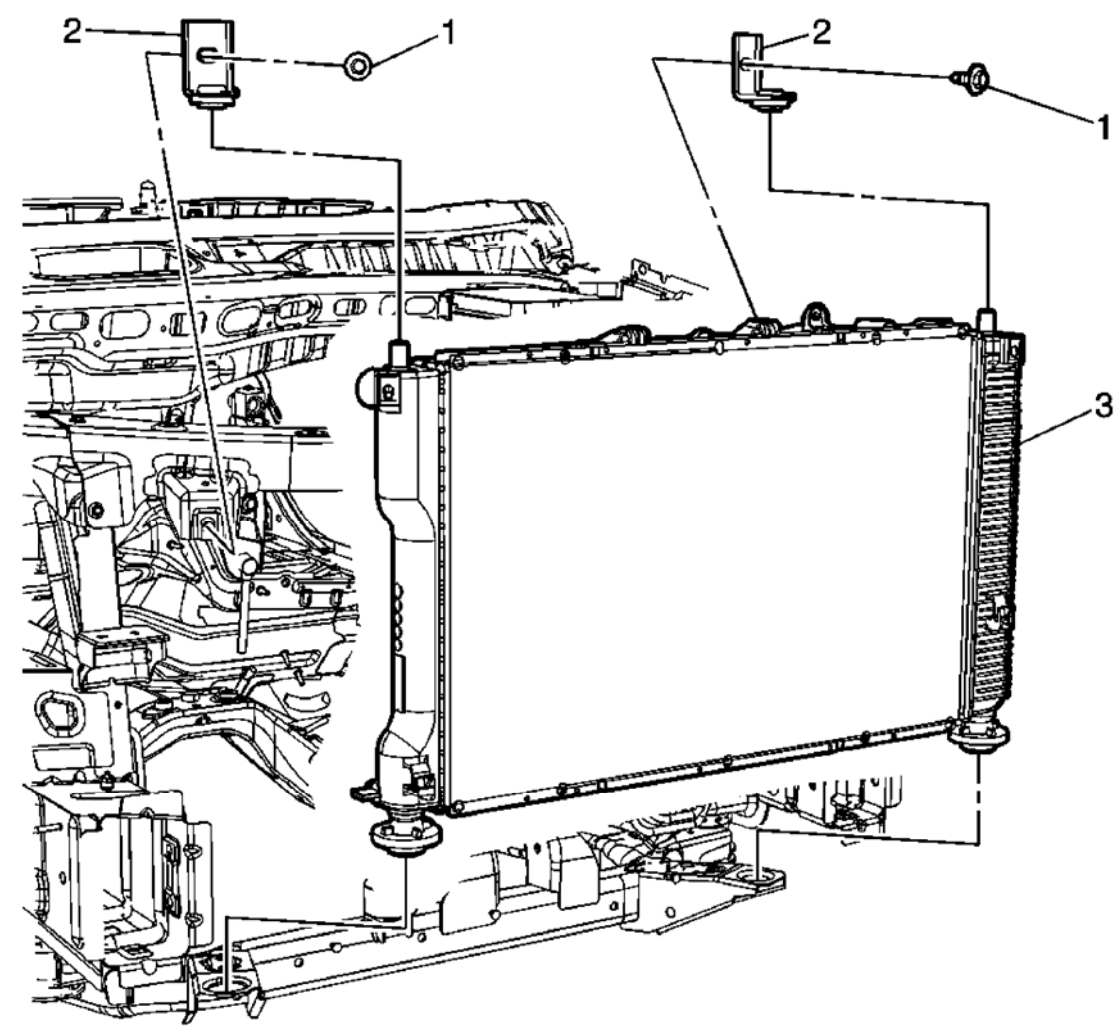


Fig. 87: Radiator
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Drain the cooling system. Refer to Cooling System Draining and Filling (Static) or Cooling System Draining and Filling (GE 47716) .
2.	Remove radiator hose inlet. Refer to Radiator Inlet Hose Replacement (LAF) or Radiator Inlet Hose Replacement (LF1) .

3. Remove radiator hose outlet. Refer to <u>Radiator Outlet Hose Replacement (LAF)</u> or <u>Radiator Outlet Hose Replacement (LF1)</u> . 4. Remove the condenser. Refer to <u>Air Conditioning Condenser Replacement</u> . 5. Remove the engine coolant fan shroud. Refer to <u>Engine Coolant Fan Shroud Replacement (LAF)</u> or <u>Engine Coolant Fan Shroud Replacement (LF1)</u> . 6. Disconnect transmission oil cooler lines from radiator.	
1	Radiator Upper Radiator Bracket Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 25 N.m (18 lb ft)
2	Radiator Upper Radiator Bracket (Qty: 2)
3	Radiator

RADIATOR AIR LOWER BAFFLE AND DEFLECTOR REPLACEMENT

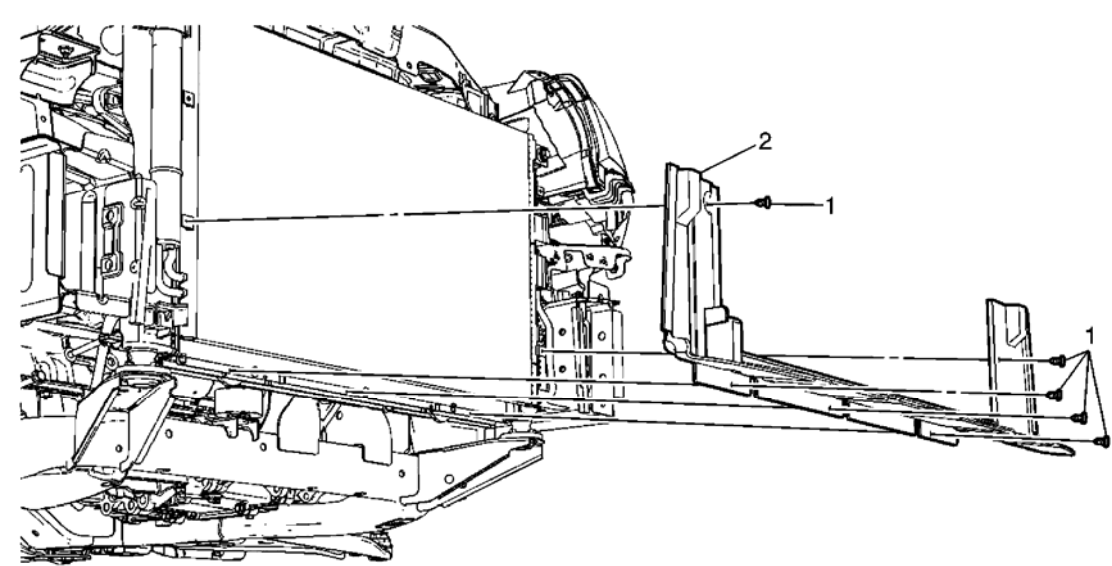


Fig. 88: Radiator Air Lower Baffle & Deflector
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement (Equinox)</u> or <u>Front Bumper Fascia Replacement (Terrain)</u> 2. Remove radiator air upper baffel and deflector. Refer to <u>Radiator Air Upper Baffle and Deflector Replacement</u>	

1	Radiator Air Lower Baffle And Deflector Retainers (Qty 5)
2	Radiator Air Lower Baffle And Deflector

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT

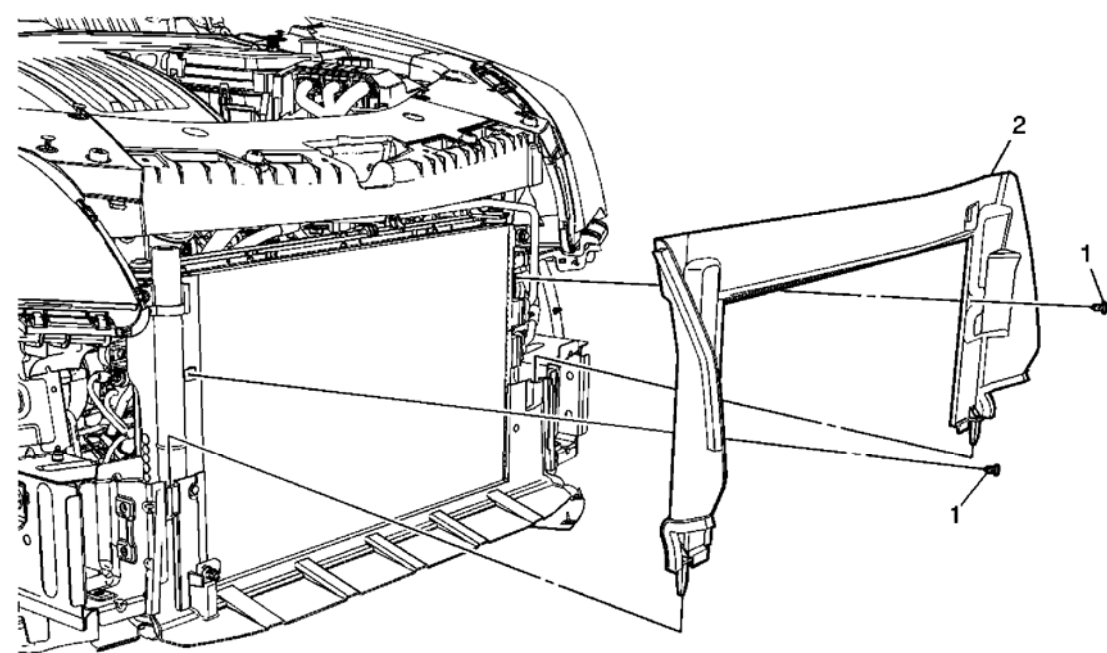


Fig. 89: Radiator Air Upper Baffle & Deflector
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement (Equinox) or Front Bumper Fascia Replacement (Terrain)	
1	Radiator Air Upper Baffle And Deflector Retainers (Qty 2)
2	Radiator Air Upper Baffle And Deflector

COOLANT HEATER REPLACEMENT (LF1)

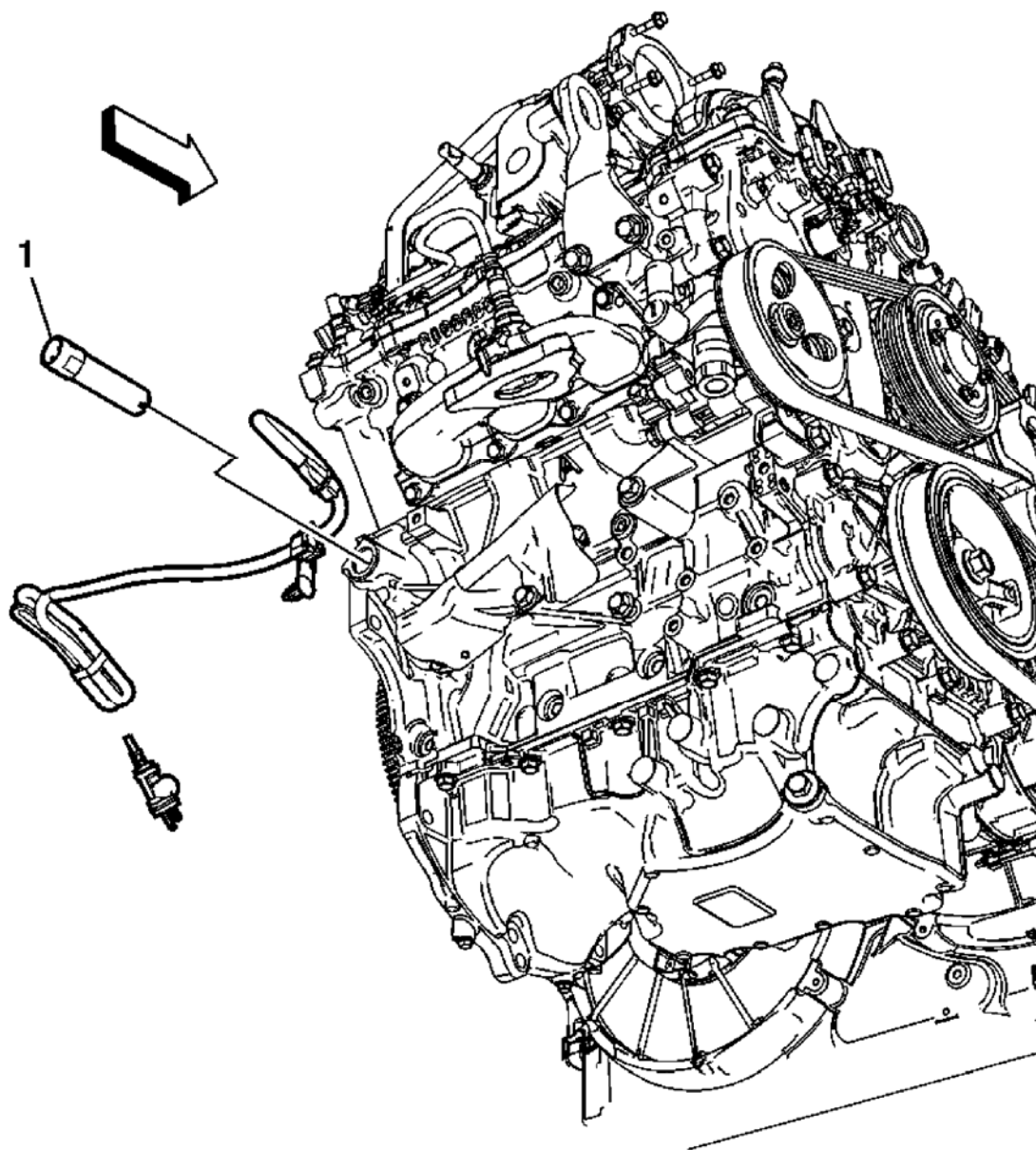


Fig. 90: Coolant Heater (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Coolant Heater Tip: Be careful not to score inner surface of the engine block when removing coolant heater.

COOLANT HEATER REPLACEMENT (LAF)

Removal Procedure

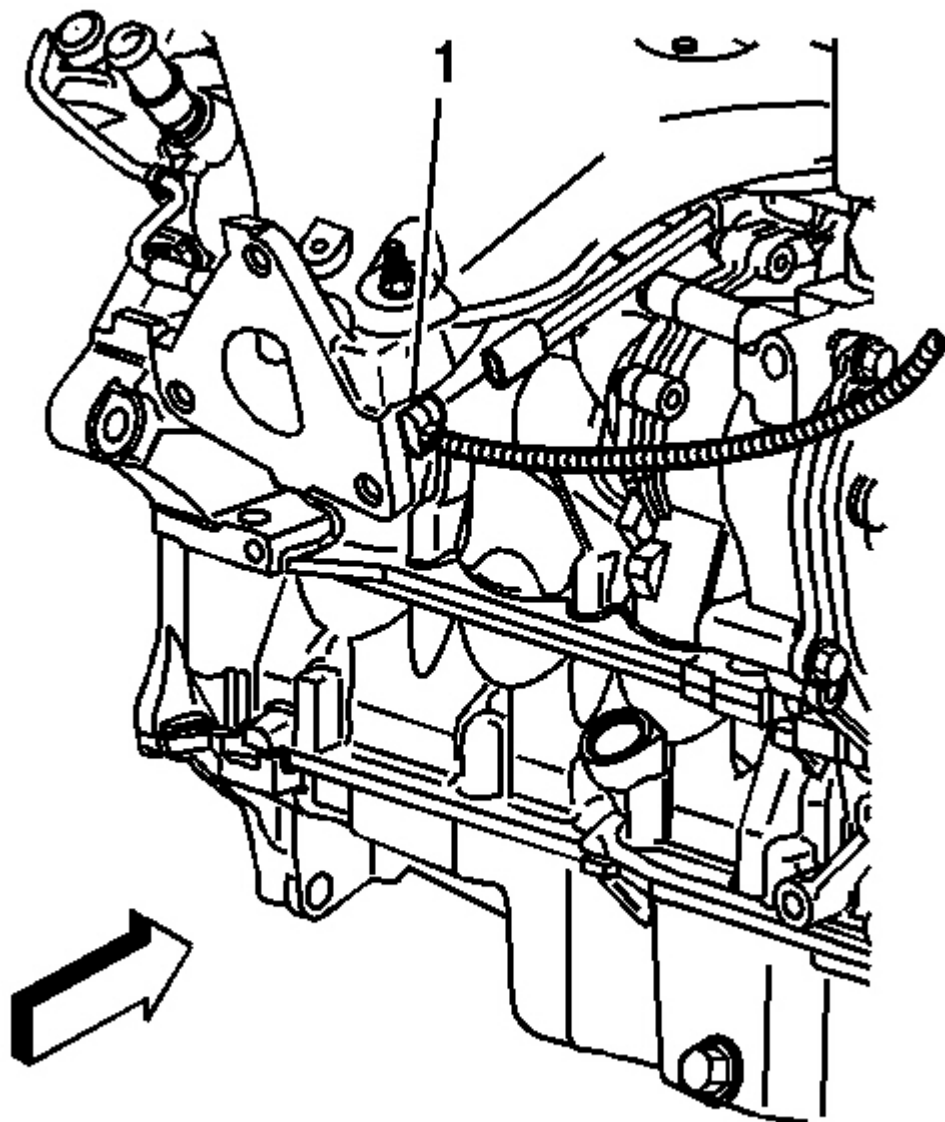


Fig. 91: View Of Coolant Heater Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the coolant heater cord (1).

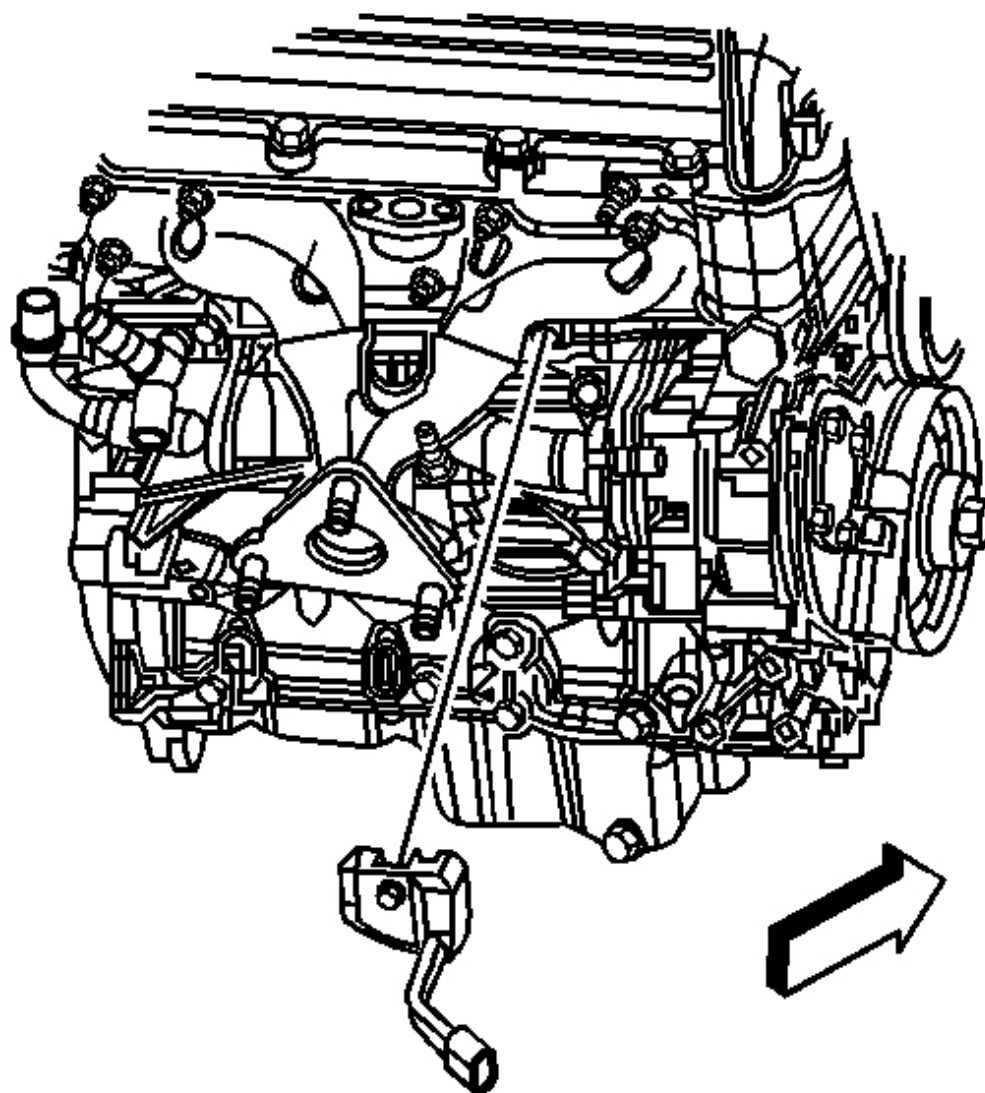


Fig. 92: View Of Coolant Heater
Courtesy of GENERAL MOTORS CORP.

2. Remove the coolant heater bolt.
3. Remove the coolant heater.

Installation Procedure

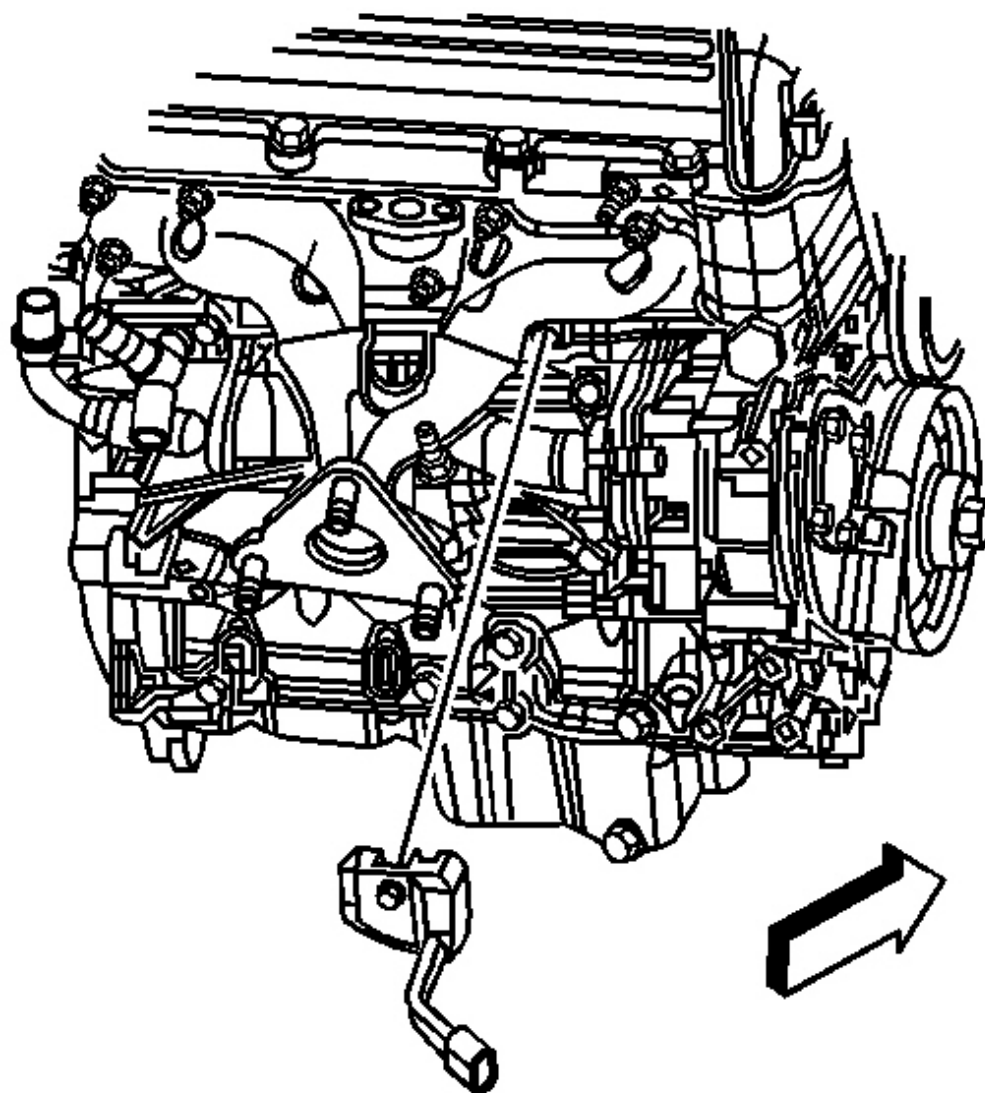


Fig. 93: View Of Coolant Heater
Courtesy of GENERAL MOTORS CORP.

1. Install the coolant heater.

CAUTION: Refer to Fastener Caution .

2. Install the coolant heater bolt and tighten to 10 N.m (89 lb in).

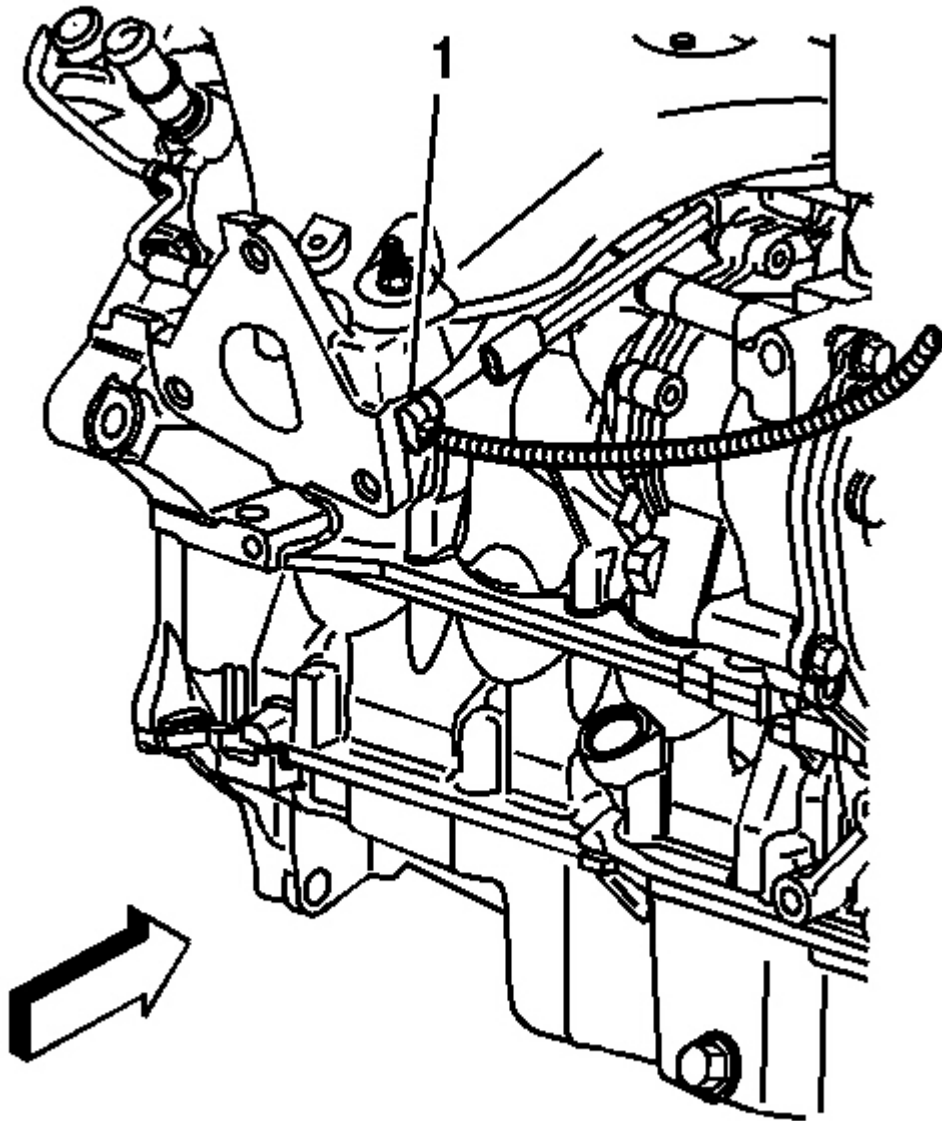


Fig. 94: View Of Coolant Heater Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the coolant heater cord (1).

COOLANT HEATER CORD REPLACEMENT (LAF)

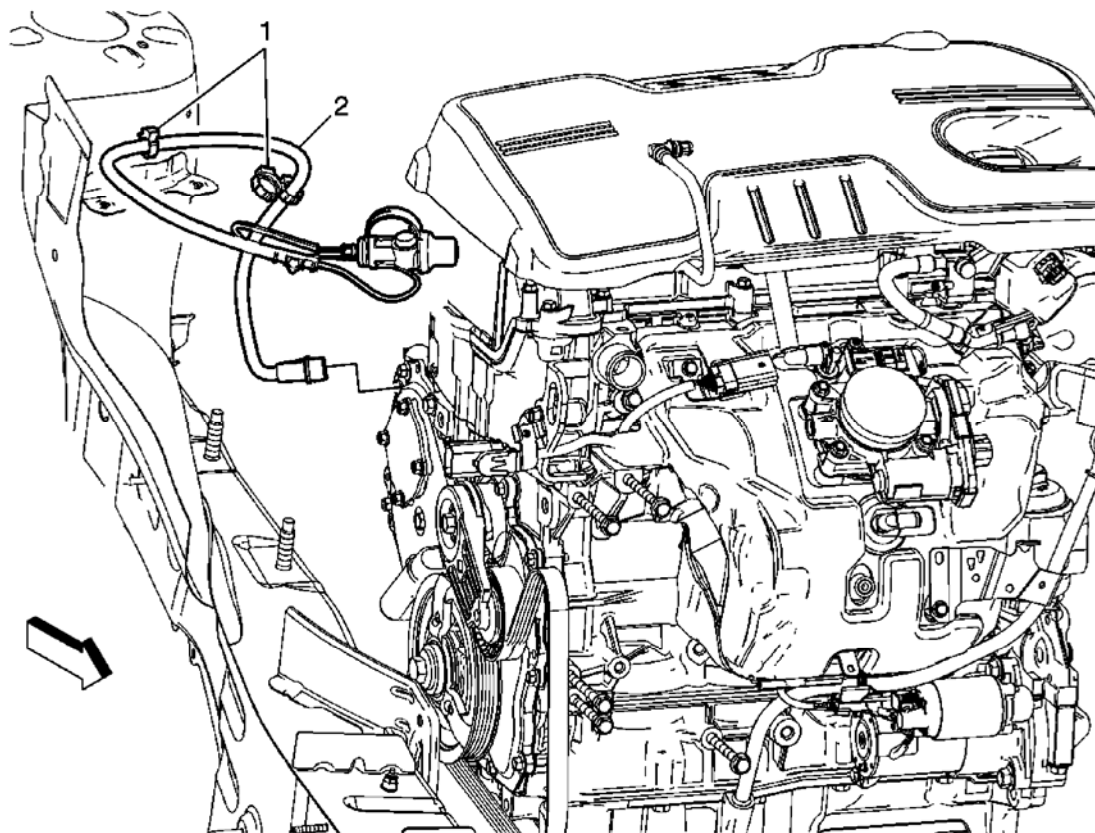


Fig. 95: Coolant Heater Cord (LAF)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Lift and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Retainers
2	Coolant Heater Cord

COOLANT HEATER CORD REPLACEMENT (LF1)

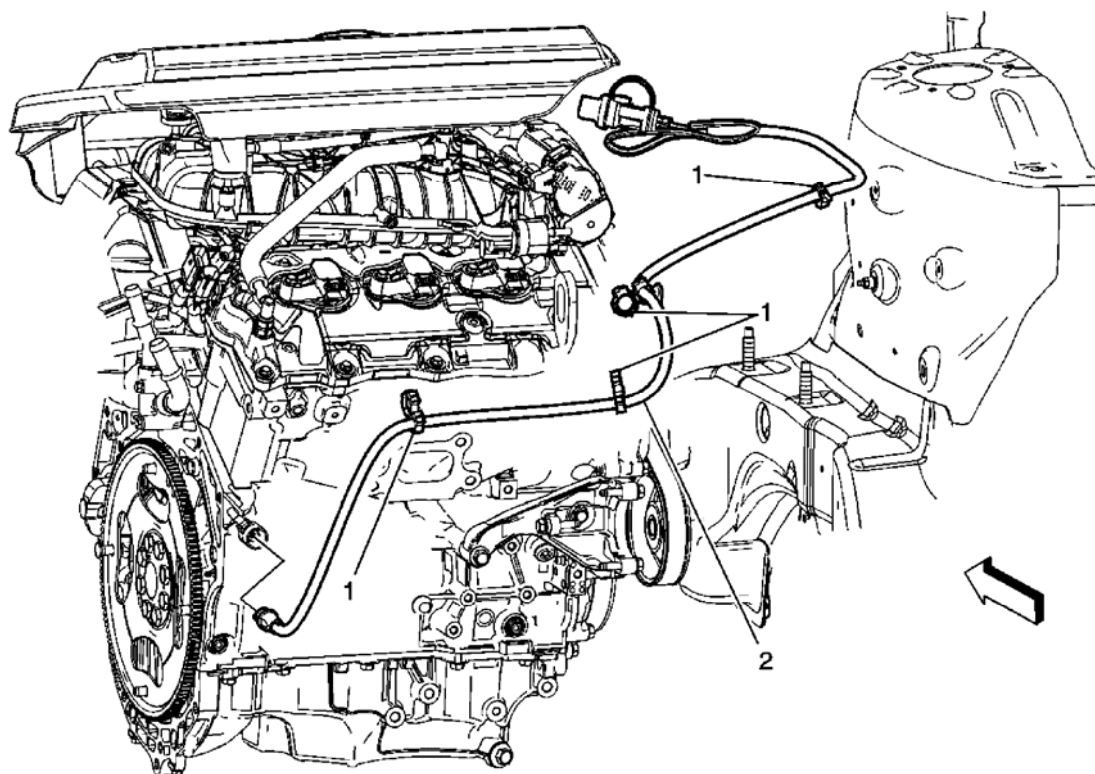


Fig. 96: Coolant Heater Cord (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Lift and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Retainers
2	Coolant Heater Cord

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION (3.0L)

System Overview

The engine cooling fan system consists of 2 electric cooling fans and 3 fan relays. The cooling fan relays are arranged in a series/parallel (S/P) configuration. This allows the engine control module (ECM) to operate both fans together at low or high speeds using 2 fan control circuits. The cooling fans receive positive voltage from the cooling fan relays, which receive battery positive voltage from the underhood fuse block. The cooling fans are supplied a ground at G101.

Low Speed Operation

The ECM applies ground to the coil side of the cooling fan low speed relay. This energizes the coil and applies voltage directly to the left cooling fan through the switch side of the low speed relay. The left cooling fan is connected in series to the right cooling fan through the de-energized series/parallel (S/P) cooling fan speed control relay. The result is a series circuit that operates both fans at low speed.

High Speed Operation

The ECM applies a ground to the coil side of the cooling fan low speed relay, the S/P cooling fan speed control relay, and the cooling fan high speed relay. When energized, the high speed fan relay applies voltage directly to the right cooling fan through the switch side of the relay. Simultaneously, the low speed fan relay and the S/P speed control relay provide ignition voltage and a direct path to ground for the left cooling fan. During high speed fan operation, both engine cooling fans have their own ground path. The result is a parallel circuit with both fans operating at high speed.

COOLING FAN DESCRIPTION AND OPERATION (2.4L)

System Overview

The engine cooling fan system is composed of one cooling fan, 2 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes 1 resistor mounted in the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 2 speeds using two fan control circuits. The ECM will operate the cooling fan at either Low or High speed based on the cooling requirements.

Low Speed Operation

The ECM applies ground at the FAN 1 control circuit for the coil side of the low speed cooling fan relay. The energized low speed relay switch closes to supply B+ through the resistor mounted in the shroud, to the engine cooling fan motor. The result is cooling fan operation at a reduced speed.

High Speed Operation

The ECM applies ground at the FAN 2 control circuit for the coil side of the cooling fan high speed relay. The energized high speed relay switch closes to supply B+ directly to the engine cooling fan motor, by-passing the external resistor. The result is cooling fan operation at full speed.

COOLING SYSTEM DESCRIPTION AND OPERATION

Engine Coolant Indicator(s)

LOW COOLANT LEVEL

The IPC illuminates the low coolant warning indicator when any of the following occur:

- The BCM detects a low coolant level condition for at least 30 seconds. The IPC receives a class 2 message from the BCM requesting illumination.
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

Coolant Heater

The optional engine coolant heater (RPO K05) 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. The power cord has a thermal element in the cord end that does not allow current to the heater until the ambient temperature reaches 0°F or -18°C.

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 coolant does not flow to the radiator until the thermostat opens. This allows the engine to warm quickly.

Cooling Cycle

Coolant flows from the radiator outlet and into the water pump inlet. Some coolant flows from the water pump, to the heater core, then back to the water pump. This provides the passenger compartment with heat and defrost capability as the coolant warms up.

Coolant also flows from 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 then flows 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.

From the cylinder heads, the coolant flows to the thermostat. The flow of coolant will either be stopped at the thermostat until the engine reaches normal operating temperature, or it will flow through the thermostat and into the radiator where it is cooled. At this point, the coolant flow cycle is completed.

Efficient 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 50-50 mixture of DEX-COOL and suitable drinking 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 end tanks. The aluminum core is a tube and fin crossflow design that extends from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer to the atmosphere.

The inlet and outlet end tanks are a molded, high temperature, nylon reinforced plastic material. A high temperature rubber gasket seals the end tank flange edge to the aluminum core. The end 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 utilizes a drain cock for coolant recovery during service. The drain cock is located at the bottom of the right hand or left hand end tank, depending on the powertrain option in the vehicle. The drain cock unit includes the drain cock and drain cock seal.

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

Pressure Cap

The pressure cap seals 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, which protects the radiator from excessive cooling system pressure. 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, might cause the radiator and/or coolant hoses to collapse.

The pressure cap allows cooling system pressure to build up as the temperature increases. As the pressure builds, the boiling point of the coolant increases. Engine coolant can be safely run at a temperature much higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant is, the faster the heat transfers from the radiator to the cooler, passing air.

The pressure in the cooling system can get too high. When the cooling system pressure exceeds the rating of the pressure cap, it raises the pressure valve, venting the excess pressure.

As 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 surge tank. This equalizes the pressure in the cooling system with atmospheric pressure, preventing the radiator and coolant hoses from collapsing.

Surge Tank

The surge tank is a plastic tank that the pressure cap mounts onto. 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 cooling system capability. Deflectors are installed under the vehicle to redirect airflow beneath the vehicle and through the radiator to increase engine cooling. Air baffles are also used to direct airflow through the radiator and increase cooling capability. Air seals prevent air from bypassing the radiator and A/C condenser, and prevent recirculation of hot 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. The sealed bearings never need to be lubricated. Grease cannot leak out, dirt and water cannot get in as long as the seal is not damaged or worn.

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

Thermostat

The thermostat is a coolant flow control component. Its purpose is to help regulate the operating temperature of the engine. It utilizes a temperature sensitive wax-pellet element. The element connects to a valve through a small piston. When the element is heated, it expands and exerts pressure against the small piston. 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 the rated thermostat opening temperature, the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up. After the coolant temperature reaches the rated thermostat opening temperature, the thermostat valve will open. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, 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.

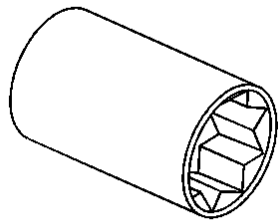
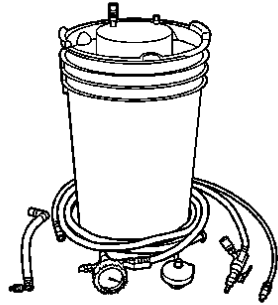
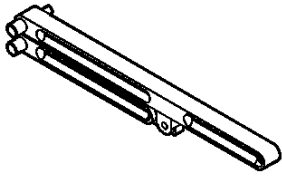
Transmission Oil Cooler

The transmission oil cooler is a heat exchanger. It is located inside one of the radiator end tanks. The transmission fluid temperature is regulated by the temperature of the engine coolant in the radiator. The transmission oil pump, pumps the fluid through the transmission oil cooler line to the transmission oil cooler. The fluid then flows through the cooler where the engine coolant absorbs heat from the fluid. The fluid is then pumped through the transmission oil cooler return line, to the transmission.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number / Description
	EN 46104 Water Pump Pulley Holding Tool

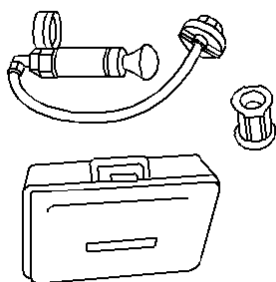


GE 47716
Vac N Fill Coolant Refill Tool

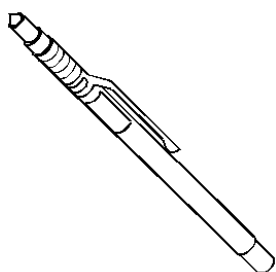
GE 47827
Socket

J 21882
Oil Suction Pipe Installer

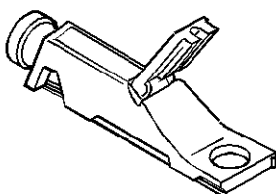
J 24460-01
Cooling System Pressure Tester



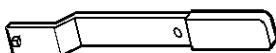
J 24731
Tempil Stick



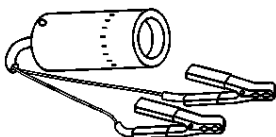
J 26568
Coolant and Battery Fluid Tester

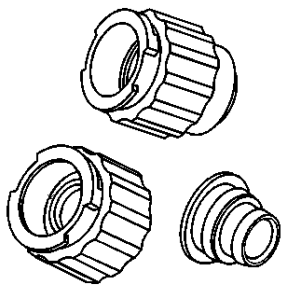


J 39914
Serpentine Belt Tensioner Unloader



J 42220
Universal 12V Leak Detection Lamp





J 42401
Radiator Cap/Surge Tank Test Adapter