2010 ENGINE

Engine Cooling - Camaro

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Air Conditioning (A/C) Condenser Bolt	6.5 N.m	58 lb in
Air Conditioning (A/C) Line Clip to Fan Shroud Screw	1 N.m	9 lb in
Auxiliary Cooling Fan Bolt	6.5 N.m	58 lb in
Brake Master Cylinder Nut	25 N.m	18 lb ft
Clutch Master Cylinder Bolt	50 N.m	37 lb ft
Coolant Air Bleed Pipe Cover Bolt (LSA)	12 N.m	106 lb in
Coolant Air Bleed Stud (LSA)	12 N.m	106 lb in
Coolant Pipe to Cylinder Head Bolt (LLT)	50 N.m	37 lb ft
Coolant Pipe to Generator Bracket Bolt (LLT)	10 N.m	89 lb in
Coolant Pipe to Thermostat Housing Bolt (LLT)	10 N.m	89 lb in
Electric Cooling Fan Blade Nut	7 N.m	62 lb ft
Coolant Recovery Reservior Bolt	17 N.m	13 lb in
Electric Cooling Fan Motor Screw	5 N.m	44 lb in
Electric Cooling Fan Resistor Bolt	5.4 N.m	48 lb in
Electric Cooling Fan Shroud to Plenum Bolt	6.5 N.m	58 lb in
Electric Cooling Fan Shroud to Radiator Bolt	6.5 N.m	58 lb in
Engine Coolant Heater (LSA)	50 N.m	37 lb ft
Engine Coolant Heater Cord Fastener (LSA)	10 N.m	89 lb in
Engine Coolant Heater Ground Wire Bolt (LLT)	12 N.m	106 lb in
Oil Level Indicator Tube Bolt	20 N.m	15 lb ft
Radiator Support Bracket Bolt	9 N.m	80 lb in
Thermostat Bolt (LLT)	10 N.m	89 lb in
Thermostat Housing Bolt (LLT)	20 N.m	15 lb ft
Thermostat Housing Bolt (LSA)	15 N.m	11 lb ft
Water Outlet Housing Bolt (LLT)	10 N.m	89 lb in
Water Pump Bolt (LLT)	10 N.m	89 lb in
Water Pump Bolt (LSA)	30 N.m	22 lb ft
Water Pump Pulley Bolt (LLT)	12 N.m	106 lb in

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE COOLING SCHEMATICS

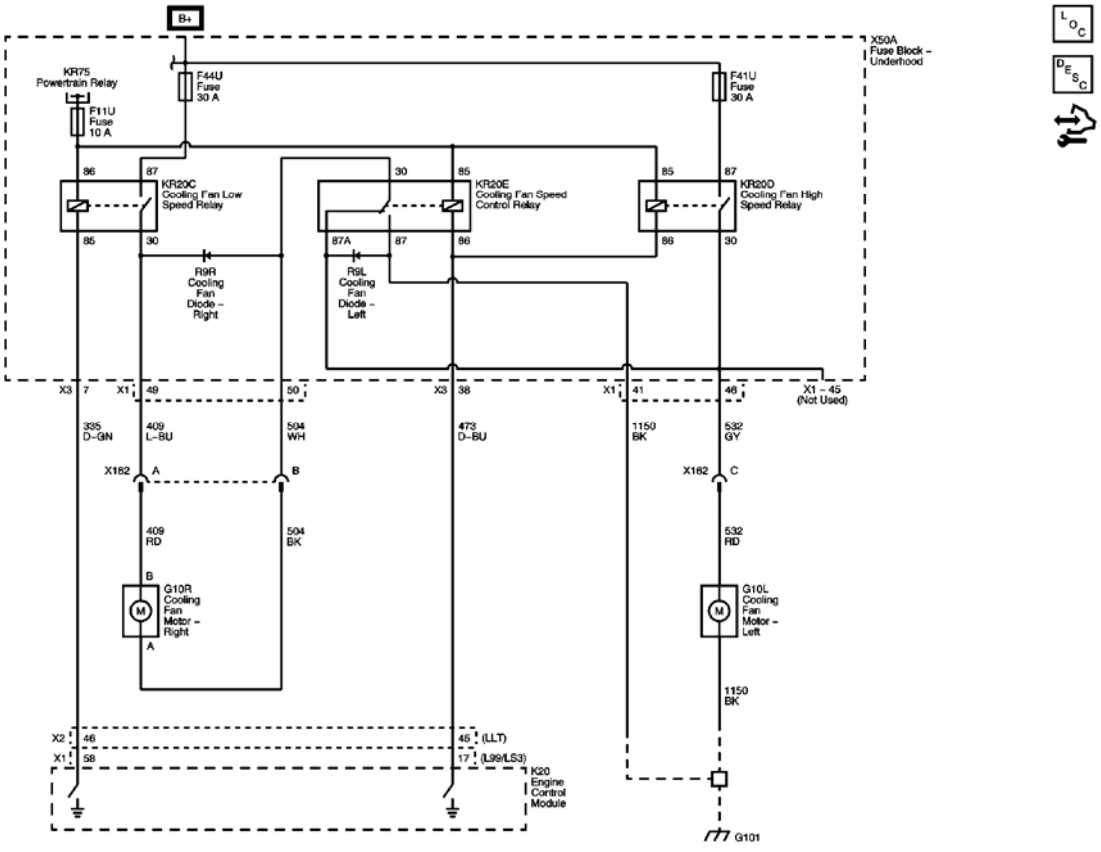


Fig. 1: Engine Cooling
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0480 or P0481	P0480: Cooling Fan Relay 1 Control Circuit P0481: Cooling Fan Relays 2 and 3 Control Circuit
DTC P0480, P0481, P0691, P0692, P0693, or P0694 (w/V6-LLT)	P0480: Cooling Fan Relay 1 Control Circuit P0481: Cooling Fan Relay 2 Control Circuit P0691: Cooling Fan Relay 1 Control Circuit Low Voltage P0692: Cooling Fan Relay 1 Control Circuit High Voltage P0693: Cooling Fan Relay 2 Control Circuit Low Voltage P0694: Cooling Fan Relay 2 Control Circuit High Voltage
DTC P1258	P1258: Engine Coolant Overtemperature - Protection Mode Active

DTC P0480 OR P0481

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	1	1	-	-
Low Speed Cooling Fan Relay Control	P0480	P0480	P0480	-
High Speed Cooling Fan Relay Control	P0481	P0481	P0481	-
Relay Controlled Output Circuit	1	1	2	-

1. Fans inoperative without a DTC.
2. Fans always ON without a DTC.

Typical Scan Tool Data

Cooling Fan Relay 1, and Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status with component OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage	-	Malfunction	-
Low Speed Cooling Fan Relay Control	Malfunction	Malfunction	-
High Speed Cooling Fan Relay Control	Malfunction	Malfunction	Not Run

Cooling Fan Relay 1, and Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status with component ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage	Not Run	Not Run	-
Low Speed Cooling Fan Relay Control	Not Run	Not Run	Malfunction
High Speed Cooling Fan Relay Control	Not Run	Not Run	Malfunction

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.
- DTC P0480 and P0481 run continuously when the conditions above are met.

Conditions for Setting the DTC

P0480

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

P0481

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

Action Taken When the DTC Sets

DTCs P0480 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 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:
  - The KR20C cooling fan low speed relay is COOL FAN LOW Relay K613
  - The KR20E cooling fan speed control relay is COOL FAN CNTRL Relay K614
  - The KR20D cooling fan high speed relay is COOL FAN HI Relay K612
- 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

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. Engine operating, observe the DTC information with a scan tool. DTC P0480 or P0481 should not set.
2. Command the cooling fans ON and OFF at high speed while observing the scan tool circuit test status parameters listed below:
   - Cooling Fan Relay 1 Control Circuit Open, Low Voltage, and High Voltage Test Status
   - Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status

   The parameters should display OK or Not Run in each of the commanded states.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

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 Relay K613, terminal 86
   - KR20D Relay K612, terminal 85
   - KR20E Relay K614, 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 Relay K613, terminal 85
   - KR20D Relay K612, terminal 86
   - KR20E Relay K614, 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 test must be performed on all three fan relay 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 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. 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, P0481, P0691, P0692, P0693, OR P0694 (W/V6-LLT)

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

DTC P0691

Cooling Fan Relay 1 Control Circuit Low Voltage

DTC P0692

Cooling Fan Relay 1 Control Circuit High Voltage

DTC P0693

Cooling Fan Relay 2 Control Circuit Low Voltage

DTC P0694

Cooling Fan Relay 2 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0691, P0693	P0480, P0481	-	-
Relay Switch Ignition	1	1	-	-
Low Speed Cooling Fan Relay Control	P0691	P0480	P0692	-
High Speed Cooling Fan Relay Control	P0693	P0481	P0694	-
Relay Controlled Output	1	1	2	-

1. Fans inoperative without a DTC.
2. Fans always ON without a DTC.

Typical Scan Tool Data

Cooling Fan Relay 1, and Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status with component OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions:			

• Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage	-	Malfunction	-
Low Speed Cooling Fan Relay Control	Malfunction	Malfunction	-
High Speed Cooling Fan Relay Control	Malfunction	Malfunction	Not Run

Cooling Fan Relay 1, and Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status with component ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage	Not Run	Not Run	-
Low Speed Cooling Fan Relay Control	Not Run	Not Run	Malfunction
High Speed Cooling Fan Relay Control	Not Run	Not Run	Malfunction

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 10-18 volts.
- The engine speed is greater than 80 RPM.
- DTC P0480, P0481, P0691, P0692, P0693, and P0694 run continuously when the conditions above are met.

Conditions for Setting the DTC

P0480

The ECM detects an open on the low speed cooling fan relay control circuit for greater than 500 mS.

P0481

The ECM detects an open circuit on the high speed cooling fan relay control circuit for greater than 500 mS.

P0691

The ECM detects a short to ground on the low speed cooling fan relay control circuit for greater than 500 mS.

P0692

The ECM detects a short to voltage on the low speed cooling fan relay control circuit for greater than 500 mS.

P0693

The ECM detects a short to ground on the high speed cooling fan relay control circuit for greater than 500 mS.

P0694

The ECM detects a short to voltage on the high speed cooling fan relay control circuit for greater than 500 mS.

Action Taken When the DTC Sets

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 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 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:
  - The KR20C cooling fan low speed relay is COOL FAN LOW Relay K613
  - The KR20E cooling fan speed control relay is COOL FAN CNTRL Relay K614
  - The KR20D cooling fan high speed relay is COOL FAN HI Relay K612
- 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

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. Engine operating, observe the DTC information with a scan tool. DTC P0480, P0481, P0691, P0692, P0693, or P0694 should not set.
2. Command the cooling fans ON and OFF at high speed while observing the scan tool circuit test status parameters listed below:
   - Cooling Fan Relay 1 Control Circuit Open, Low Voltage, and High Voltage Test Status
   - Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status

   The parameters should display OK or Not Run in each of the commanded states.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

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

NOTE: The following tests 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 Relay K613, terminal 86
- KR20D Relay K612, terminal 85
- KR20E Relay K614, 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 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 Relay K613, terminal 85
   - KR20D Relay K612, terminal 86
   - KR20E Relay K614, 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 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 O.L.
   - 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 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. 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 the diagnostic category.

DTC Descriptor

DTC P1258

Engine Coolant Overtemperature - Protection Mode Active

Circuit/System Description

The engine control module (ECM) uses the engine coolant temperature (ECT) sensor to monitor the engine for an over-termperature condition. This condition occurs when the coolant temperature is above a calibrated value for a calibrated length of time. The ECM will disable half of the cylinders by turning OFF the fuel injectors. By disabling half of cylinders, the ECM is able to reduce the temperature of the coolant.

Conditions for Running the DTC

- The engine is operating for greater than 30 seconds.
- DTC P0116, P0117, P0118, or P0128 is not set.

Conditions for Setting the DTC

- The ECM detects that engine coolant temperature is greater than 136°C (277°F) for greater than 1 second or a cumulative time of 10 seconds, for V6 applications.
- The ECM detects that the engine coolant temperature is greater than 131°C (267.8°F) for greater than 7 seconds, for V8 applications.

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 instrument panel (IP) will illuminate the coolant indicator lamp and the driver information center (DIC), if equipped, may display a message.

Conditions for Clearing the DTC

DTC P1258 is a Type A DTC.

Reference Information

Description and Operation

Cooling System Description and Operation

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: If DTCs P0480, P0481, P0691, P0692, P0693, or P0694 is set, diagnose the DTC first.

1. Observe the engine coolant level. The engine coolant level should be within operating range. Refer to Capacities - Approximate Fluid, and Engine Coolant in the Owner's Manual.
2. 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.
3. Inspect the cooling system for the following:
   - Cooling system leaks
   - Kinked or pinched hoses, especially at the radiator
   - Loose, missing, or damaged radiator air seals or deflectors
   - The radiator and A/C condenser for any air flow obstructions or bent fins-Refer to **Symptoms - Engine Cooling**.

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

4. Command the cooling fans in both low and high speed.
   - If the cooling fans do not operate in both speeds, refer to **Cooling Fan Inoperative**.
5. Test the thermostat for correct operation. Refer to **Thermostat Diagnosis**.
6. Test the engine cooling system for overheating. Refer to **Engine Overheating**.

7. Inspect the water pump and coolant flow for correct operation. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)**.
8. Inspect the engine mechanical for worn/leaking/cracked cylinder heads and engine block. Refer to **Coolant in Combustion Chamber** and **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** 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**
- **Cooling Fan Inoperative**
- **Engine Overheating**

- **Loss of Coolant**
- **Thermostat Diagnosis**
- **Engine Fails To Reach Normal Operating Temperature**

COOLING FAN ALWAYS ON

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.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC P0480, P0481, P0691, P0692, P0693 or P0694 is not set.
    - If any cooling system DTCs are set, repair the DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, verify with a scan tool that the ECM is not commanding fan activation.
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.
    - 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 INOPERATIVE

Diagnostic Instructions

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

Circuit/System Description

The engine cooling fan system 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 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 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:
  - The KR20C cooling fan low speed relay is COOL FAN LOW Relay K613
  - The KR20E cooling fan speed control relay is COOL FAN CNTRL Relay K614
  - The KR20D cooling fan high speed relay is COOL FAN HI Relay K612
- 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

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, P0481, P0691, P0692, P0693 or P0694 is not set.
   - If a DTC is set, refer to **DTC P0480 or P0481** or **DTC P0480, P0481, P0691, P0692, P0693, or P0694 (w/V6-LLT)**.
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 cooling fan relays.
2. Connect a 30 A fused jumper between the KR20E relay K614 switch circuit terminal 30 and the ground circuit terminal 87. This completes the right 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 Relay K613, terminal 87
   - KR20D Relay K612, 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 G10 cooling fan.

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 Relay K612, terminals 87 and 30

- KR20C Relay K613, 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.
  - If the corresponding cooling fan activates, replace the appropriate KR20 cooling fan relay.

5. Install the KR20E relay K614. Verify both fans activate at low speed.
   - If both fans do not activate, test the KR20E relay controlled output circuit terminal 87A, for a short to ground or an open/high resistance.
6. If all 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 O.L.
   - 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 Motor Replacement**

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 coolant recovery reservoir onto the ground while the engine is running. **Special Tools:** **J-26568:** Coolant and Battery Fluid Tester			

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 **Cooling Fan Inoperative**. 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 **Engine Coolant Fan Motor Replacement**. Does the engine still overheat?	Go to **Step 7**	System OK
7	Check for a loss of coolant. Refer to **Loss of Coolant**. Does the engine still overheat?	Go to **Step 8**	System OK
8	Check for kinked or pinched cooling hoses. Does the engine still overheat?	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 **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 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 **Flushing**.		

	Does the engine still overheat?	Go to **Step 14**	Go to **Step 19**
14	Inspect the accessory drive belt tensioner. Refer to **Drive Belt Tensioner Diagnosis** for the 3.6L engine and **Drive Belt Tensioner Diagnosis** for the 6.2L engine. Does the engine still overheat?	Go to **Step 15**	System OK
15	Check for a faulty thermostat. Refer to **Thermostat Diagnosis**. Does the engine still overheat?	Go to **Step 16**	System OK
16	Replace the radiator. Refer to **Radiator Replacement (LLT)** or **Radiator Replacement (LS3, L99)**. 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 **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)**. Does the engine still overheat?	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 loosing coolant either internally or externally.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - Engine Cooling**
2	Repair any present DTCs. Refer to **Diagnostic System Check - Vehicle** . Is the action complete?	Go to **Step 3**	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to **Step 5**	Go to **Step 4**
4	Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. Is the action complete?	Go to **Step 5**	-
5	If the engine is suspected to have a coolant leak into a cylinder, the coolant can hydraulically lock the engine. Does the engine crankshaft rotate?	Go to **Step 6**	Go to **Step 28**
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to **Step 29**	Go to **Step 7**
	Extended operation with a low coolant level can cause		

7	engine internal component failure. Is the engine knocking?	Go to **Step 31**	Go to **Step 8**
8	1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust pipe. Is a heavy white smoke present from the exhaust pipe?	Go to **Step 9**	Go to **Step 10**
9	Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. Condensation in the exhaust system can cause an odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?	Go to **Step 30**	Go to **Step 10**
10	**WARNING:** **Refer to Moving Parts and Hot Surfaces Warning .** With the engine idling, inspect the coolant recovery system.Does the coolant recovery system discharge coolant while the engine is idling?	Go to **Step 15**	Go to **Step 11**
11	Visually inspect the hoses, pipes and hose clamps at the following locations: • Coolant overflow tank • Water Pump • Heater core • Radiator Are any of the hoses, clamps or pipes leaking?	Go to **Step 22**	Go to **Step 12**
12	Visually inspect the following components: • Coolant pressure cap • Block heater • Core plugs • Cylinder head gaskets • Engine block • Intake manifold • Radiator • Thermostat housing • Water pump		

	Are any of the listed components leaking?	Go to **Step 22**	Go to **Step 13**
13	1. Pressure test the cooling system. Refer to **Cooling System Leak Testing**. 2. With the cooling system pressurized, visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to **Step 22**	Go to **Step 14**
14	Pressure test the coolant pressure cap. Refer to **Pressure Cap Testing**. Does the coolant pressure cap hold pressure?	Go to **Step 16**	Go to **Step 23**
15	Pressure test the coolant pressure cap. Refer to **Pressure Cap Testing**. Does the coolant pressure cap hold pressure?	Go to **Step 32**	Go to **Step 23**
16	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 24**	Go to **Step 17**
17	1. Add 30 ml (1 oz) of GM P/N 89022219 (Canadian P/N 89022220) Canada Extended Life Coolant Leak Detection Dye to the cooling system for each 15 L (4 gal) of coolant. Refer to **Approximate Fluid Capacities** . 2. Start the vehicle and allow the engine to reach normal operating temperature. 3. Shut the engine off. 4. Use the **J 42220:** Universal 12V Leak Detection Lamp to visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to **Step 22**	Go to **Step 18**
18	Use the **J 42220:** Universal 12V Leak Detection Lamp to inspect for the following conditions: • Coolant dye in the HVAC module drain tube • Coolant dye on the vehicle floor covering near the HVAC module Is coolant dye present?	Go to **Step 24**	Go to **Step 19**

19	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is a milky substance under the oil fill cap?	Go to **Step 20**	Go to **Step 21**
20	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is a milky substance on the engine oil fluid level indicator?	Go to **Step 30**	Go to **Step 21**
21	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 25**	Go to **Step 33**
22	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to **Step 33**	-
23	Replace the coolant pressure cap. Is the repair complete?	Go to **Step 33**	-
24	Replace the heater core. Refer to **Heater Core Replacement** . Is the repair complete?	Go to **Step 33**	-
25	1. Remove the transmission oil cooler lines from the radiator. 2. Pressure test the cooling system. Refer to **Cooling System Leak Testing**. 3. Inspect the transmission oil cooler for coolant. Is coolant present?	Go to **Step 26**	Go to **Step 27**
26	1. Replace the radiator. Refer to **Radiator Replacement (LLT)** or **Radiator Replacement (LS3, L99)**. 2. Service the automatic transmission. Refer to **Engine Coolant/Water in Transmission** . Is the repair complete?	Go to **Step 33**	-
27	Install the cooler lines to the radiator. Is the action complete?	Go to **Step 33**	-
28	Repair the engine no crank condition. Refer to **Engine Will Not Crank - Crankshaft Will Not Rotate** for 3.6L or **Engine Will Not Crank - Crankshaft Will Not Rotate** for 6.2L engine. Is the repair complete?	Go to **Step 33**	-
29	Repair the engine overheating condition. Refer to **Engine Overheating**. Is the repair complete?	Go to **Step 33**	-

30	Repair the engine internal coolant leak. Refer to **Coolant in Combustion Chamber** for 3.6L or **Coolant in Combustion Chamber** for 6.2L engine. Is the repair complete?	Go to **Step 33**	-
31	Repair the engine knock. Refer to **Lower Engine Noise, Regardless of Engine Speed** for 3.6L or **Lower Engine Noise, Regardless of Engine Speed** for 6.2L engine. Is the repair complete?	Go to **Step 33**	-
32	Repair the combustion pressure in the cooling system problem. Refer to **Coolant in Combustion Chamber** for 3.6L or **Coolant in Combustion Chamber** for 6.2L engine. Is the repair complete?	Go to **Step 33**	-
33	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.

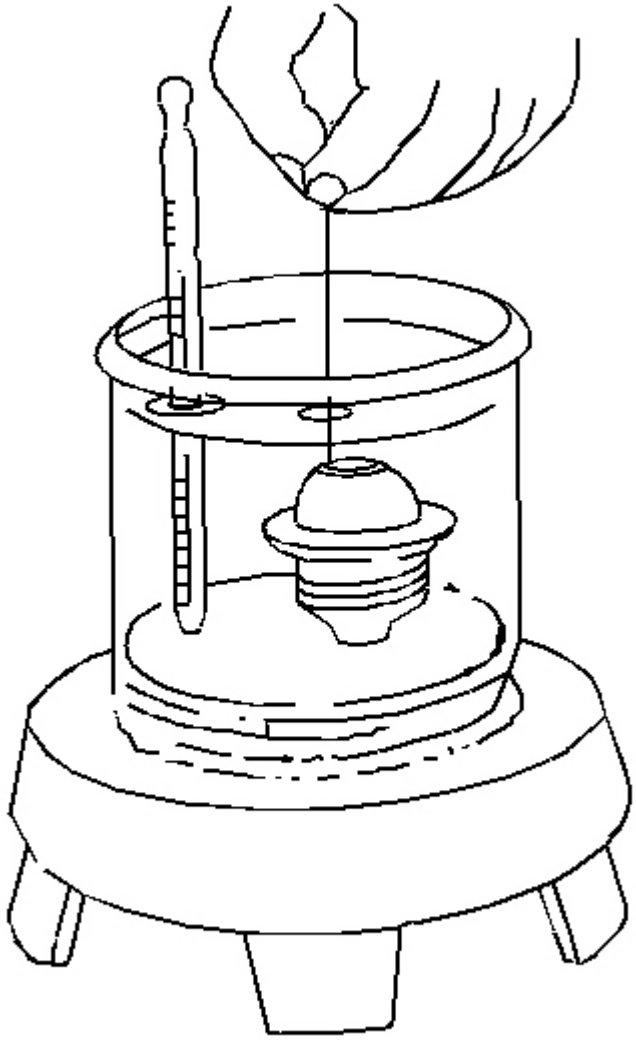


Fig. 2: View Of Thermostat Test
Courtesy of GENERAL MOTORS CORP.

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

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.

- **Engine Coolant Heater Replacement (V6)**
- **Engine Coolant Heater Cord Replacement (V6)**

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 **Cooling Fan Always On**. 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 **Thermostat Diagnosis**. Is the thermostat operating correctly?	System OK	Go to **Step 6**
6	1. Replace the thermostat. Refer to **Engine Coolant Thermostat Replacement (LLT)** or **Engine Coolant Thermostat Replacement (L99/LS3)**. 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.

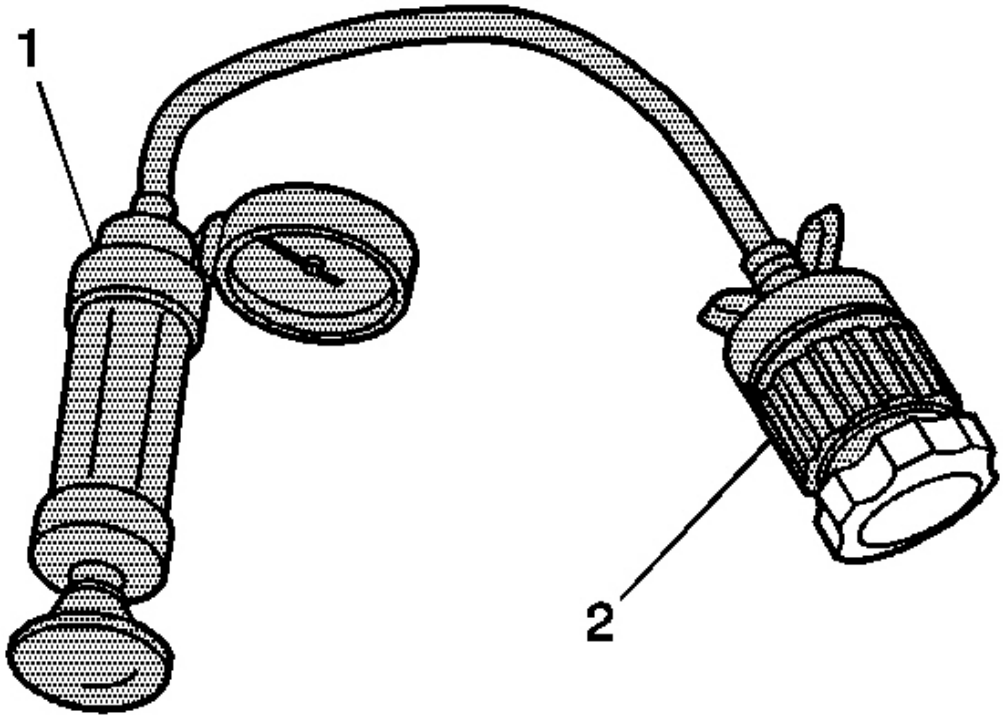


Fig. 3: Testing Pressure Cap
Courtesy of GENERAL MOTORS CORP.

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 42401-3:** Radiator Cap / Surge Tank Test Adapter

Cooling System Leak Testing

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

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

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

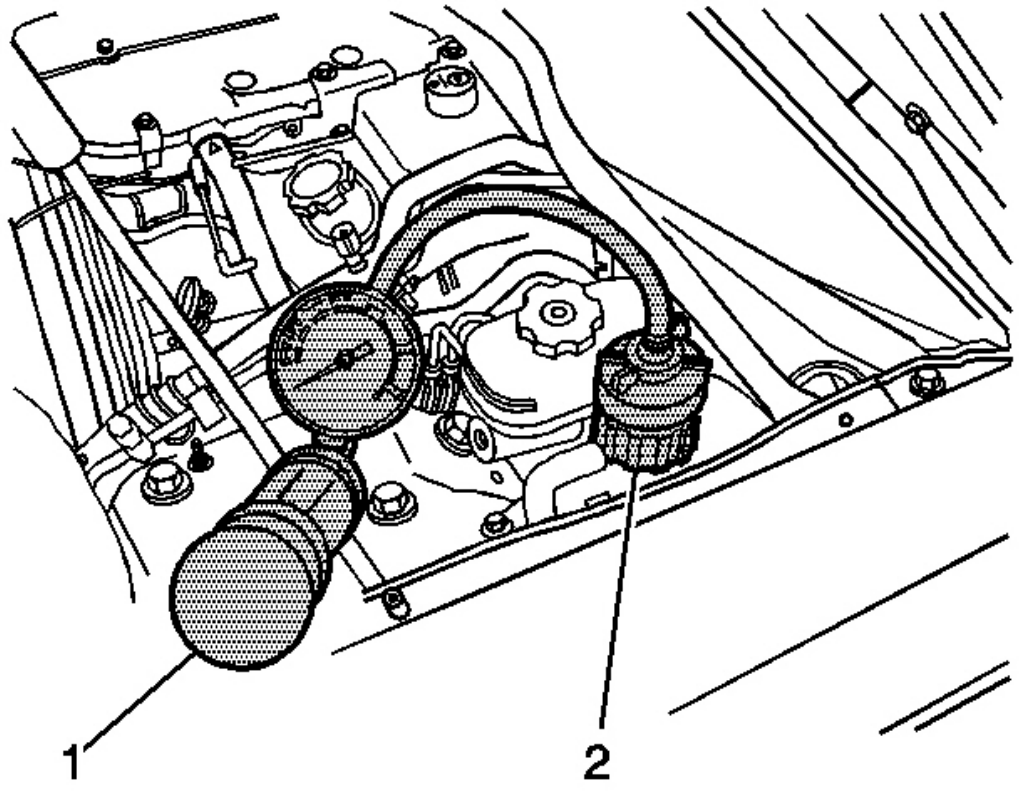


Fig. 4: Applying Pressure To Cooling System
Courtesy of GENERAL MOTORS CORP.

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

   Do not exceed the pressure cap rating.

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

   Observe the gauge for any pressure loss.

6. Repair any leaks as required.

REPAIR INSTRUCTIONS

COOLING SYSTEM DRAINING AND FILLING (LS3, L99 STATIC FILL)

Special Tools

J 26568: Coolant and Battery Fluid Tester

Draining Procedure

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

1. Remove the coolant pressure cap from the radiator.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Place a clean drain pan under the radiator drain cock.
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**.
9. Tighten the radiator drain cock.
10. Lower the vehicle.

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.

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

1. Slowly fill the radiator with a 50/50 coolant mixture until the coolant level is just below the radiator fill neck. Refer to **Approximate Fluid Capacities** .
2. Allow 30 seconds for the coolant level to stabilize and continue to fill the radiator until the level stabilizes for at least 2 minutes.
3. Start the engine and allow to the engine to idle.
4. Slowly fill the coolant mixture until the level stabilizes at the just below the top of radiator fill neck for at least 2 minutes.
5. Install the coolant pressure cap.
6. Allow the engine to idle until the engine reaches normal operating temperature.
7. Shut the engine OFF.

8. Allow the engine to cool.
9. Remove the coolant pressure cap and top off the engine coolant in the radiator.
10. Inspect the concentration of the engine coolant using the **J 26568:** Coolant and Battery Fluid Tester.
11. Install coolant pressure cap.
12. Inspect and if necessary, fill the coolant reservoir bottle.
13. Rinse away any excess coolant from the engine and the engine compartment
14. Inspect the cooling system for leaks.
15. Top off the coolant reservoir if necessary.

COOLING SYSTEM DRAINING AND FILLING (LLT STATIC FILL)

Special Tools

J 26568: Coolant and Battery Fluid Tester

Draining Procedure

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

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Remove the coolant pressure cap from the coolant filler neck.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Place a clean drain pan under the radiator drain cock.
5. Loosen the radiator drain cock.
6. Drain the cooling system.
7. Lower the vehicle.
8. Inspect the coolant.
9. 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**.
10. Tighten the radiator drain cock.
11. Lower the vehicle.

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.

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

1. Slowly fill the coolant filler neck with a 50/50 coolant mixture until the coolant level is just below the top of the coolant filler neck. Refer to **Approximate Fluid Capacities** .
2. 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.
3. Start the engine and allow to the engine to idle in PARK or NEUTRAL with the parking brake engaged.
4. Slowly fill the coolant mixture until the level stabilizes just below the top of the coolant filler neck.
5. Install the coolant pressure cap.
6. Raise the engine RPM to 2500 rpm for 30-40 seconds.
7. Shut the engine OFF.
8. Allow the engine to cool, remove coolant pressure cap and repeat steps 4-10 until the coolant level has completely stabilized within the coolant fill neck.
9. Start the engine and allow the engine to idle until it reaches normal operating temperature.
10. Shut off the engine and allow the engine to cool.
11. Remove the coolant pressure cap.
12. Inspect the concentration of the engine coolant using the **J 26568:** Coolant and Battery Fluid Tester
13. Install the coolant pressure cap.
14. Inspect and if necessary, fill the coolant reservoir bottle as necessary.
15. Rinse away any excess coolant from the engine and the engine compartment
16. Inspect the cooling system for leaks.
17. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

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.
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.

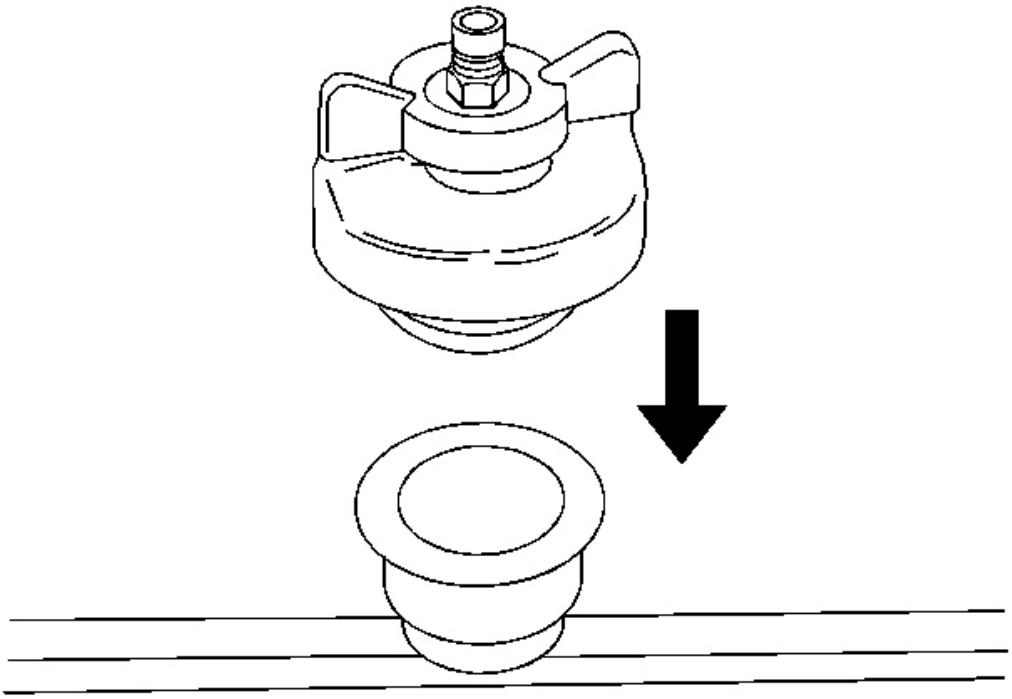


Fig. 5: Identifying Vac-N-Fill Cap
Courtesy of GENERAL MOTORS CORP.

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.

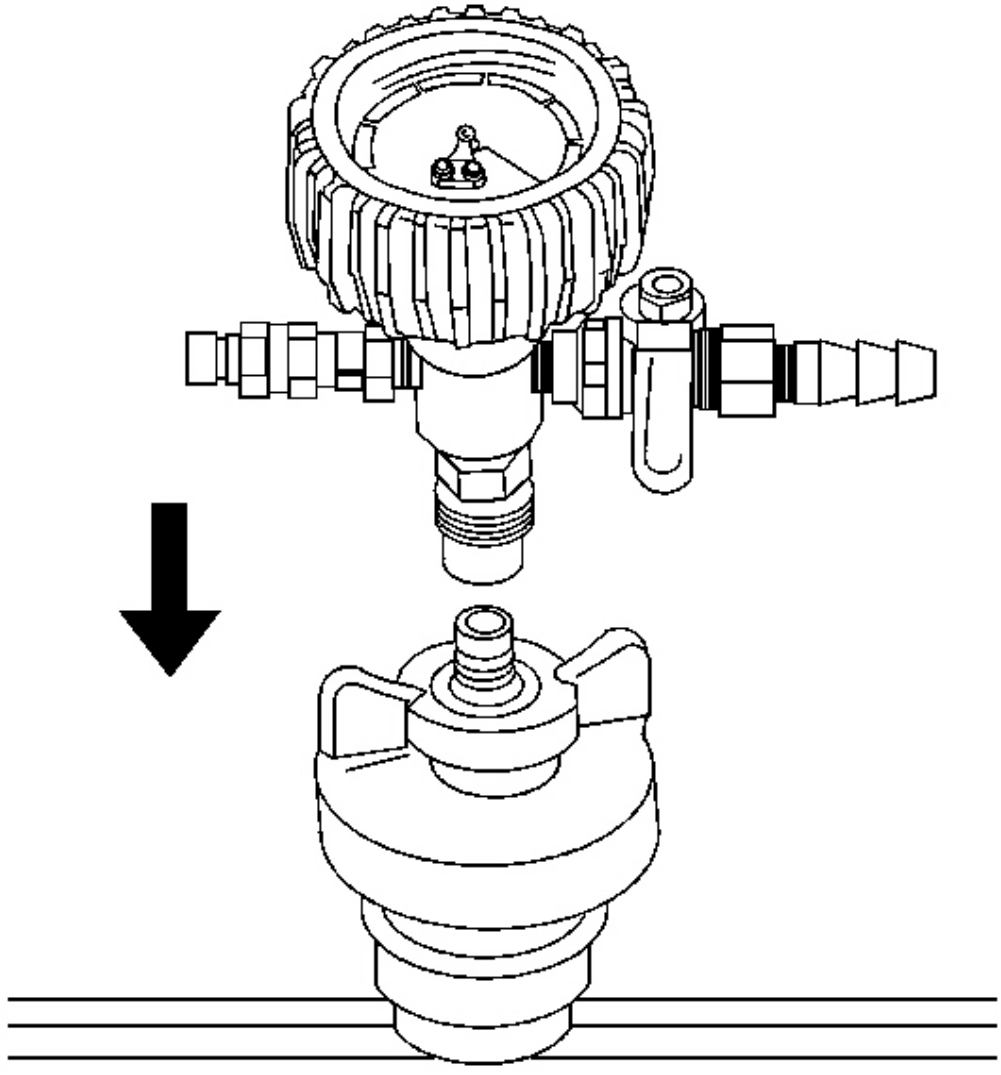


Fig. 6: Attaching Vacuum Gauge Assembly To Vac N Fill Cap
Courtesy of GENERAL MOTORS CORP.

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

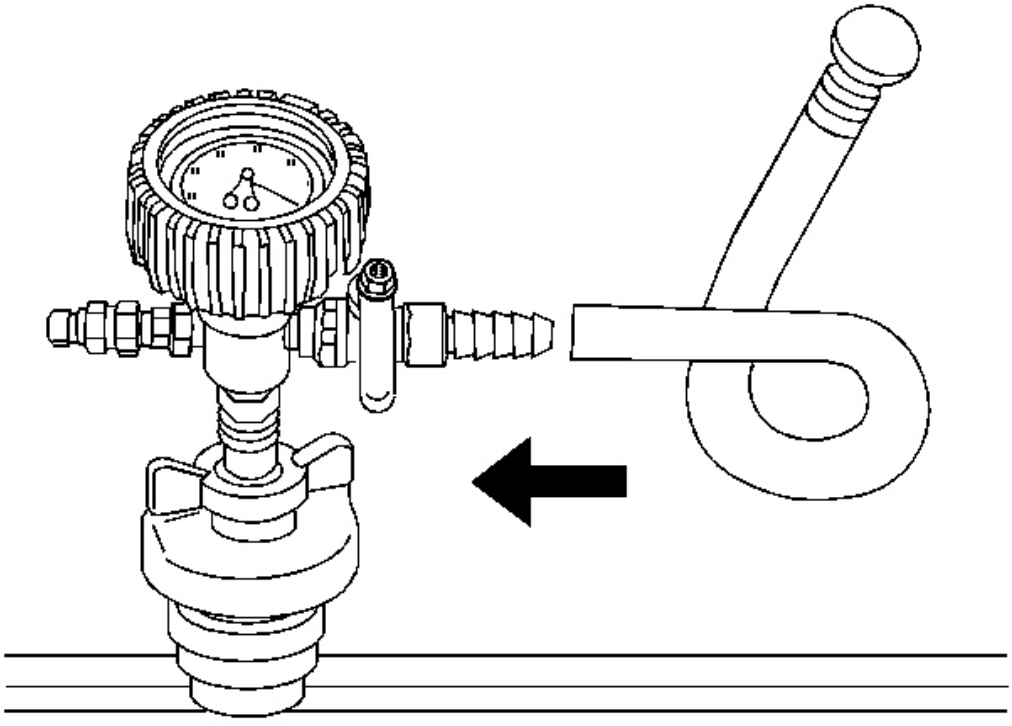


Fig. 7: Attaching Fill Hose To Barb Fitting On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

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

   Ensure that the valve is closed.

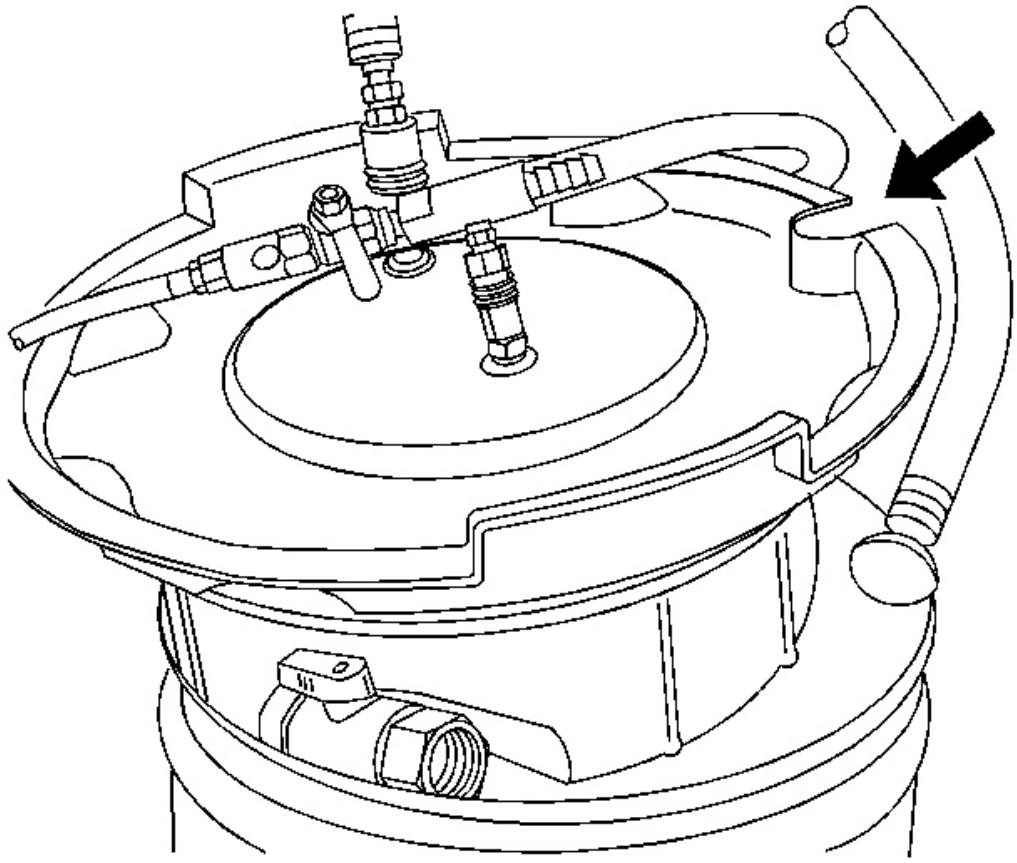


Fig. 8: View Of Graduated Reservoir & Hose
Courtesy of GENERAL MOTORS CORP.

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.

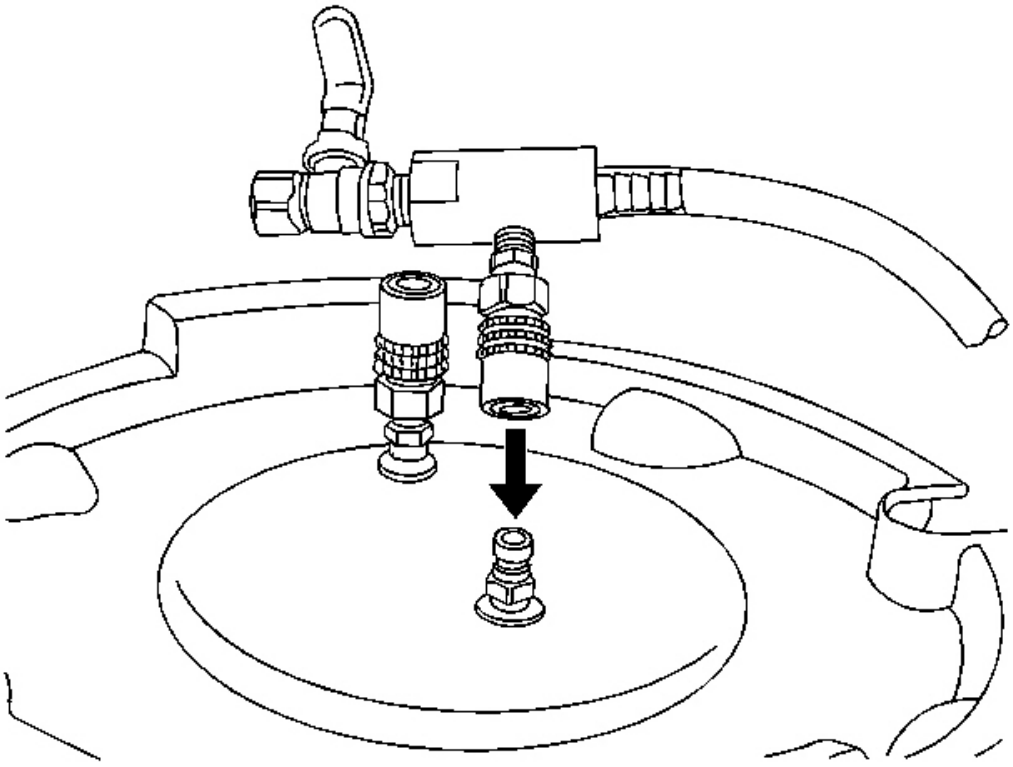


Fig. 9: Connecting Venturi Assembly To Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

8. Attach the venturi assembly to the vacuum tank.

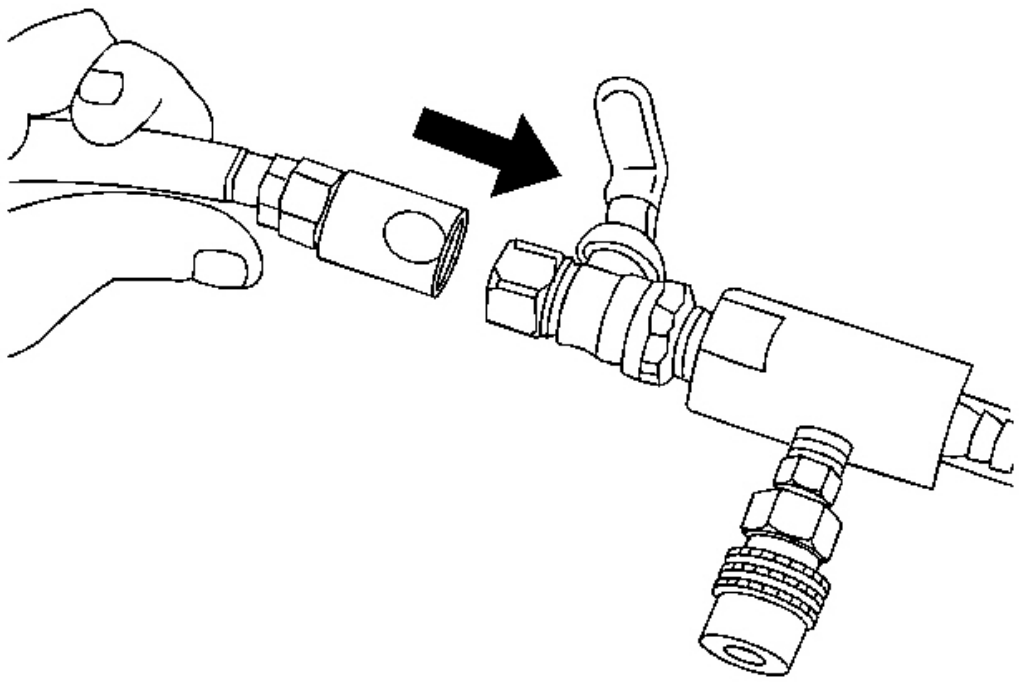


Fig. 10: Attaching Shop Air Hose To Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

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

   Ensure the valve on the venturi assembly is closed.

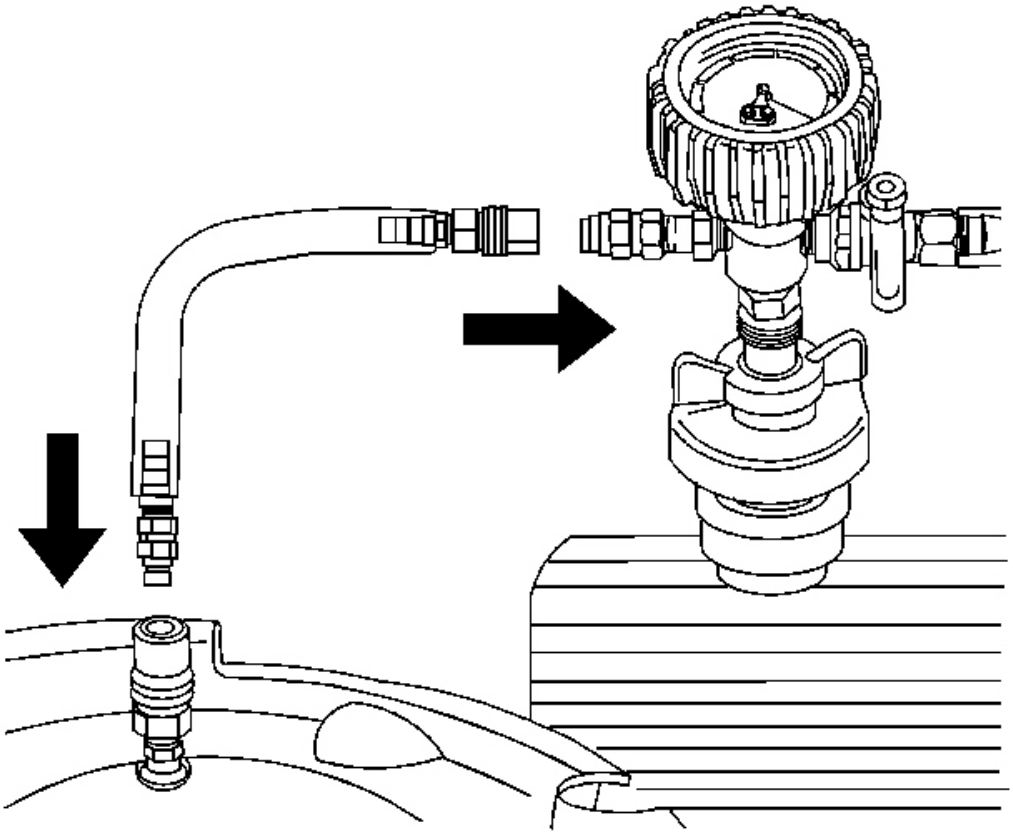


Fig. 11: Attaching Vacuum Hose To Vacuum Gauge Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

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

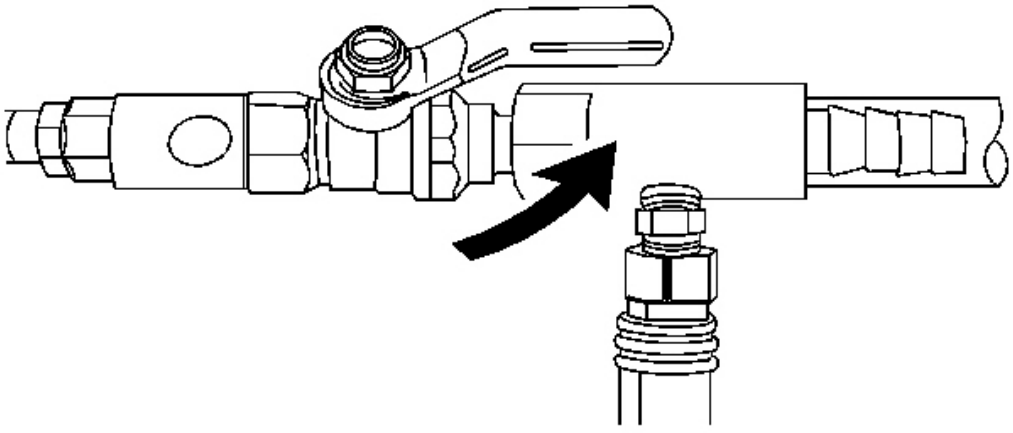


Fig. 12: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

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

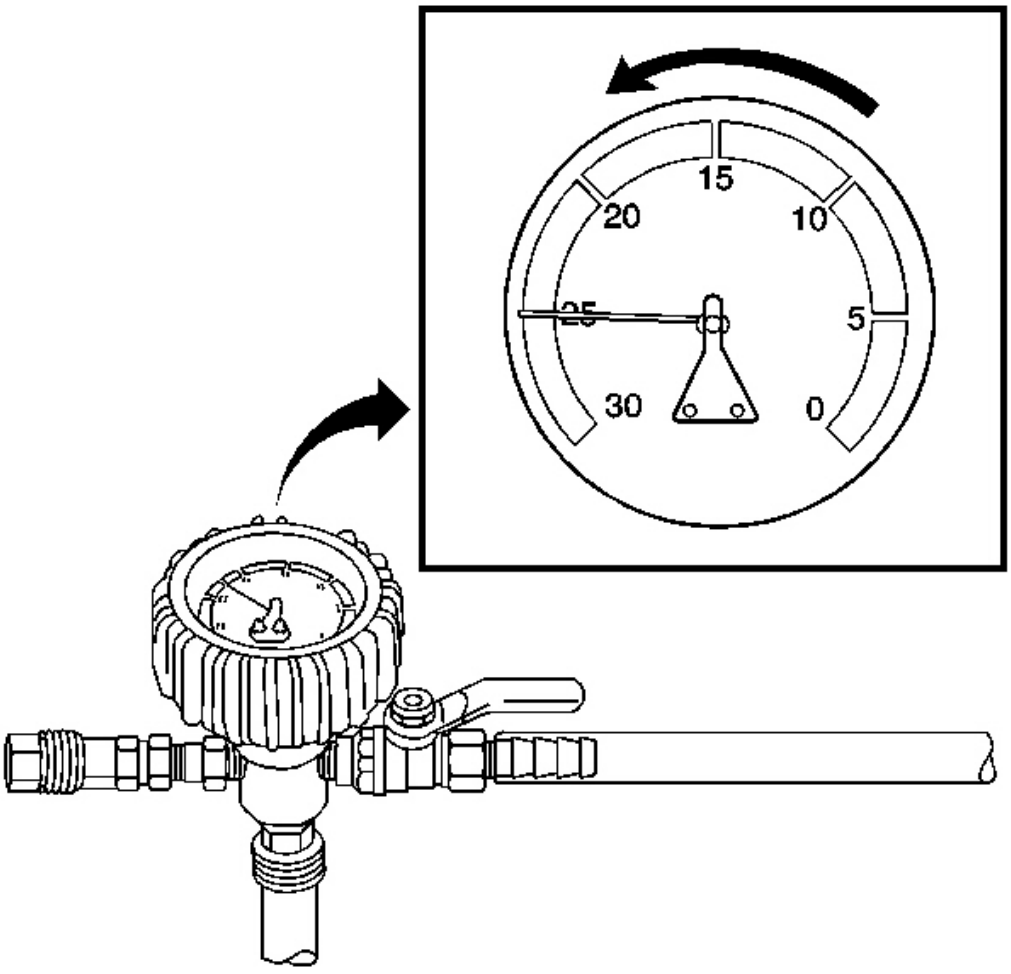


Fig. 13: View Of Vacuum Gauge
Courtesy of GENERAL MOTORS CORP.

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.

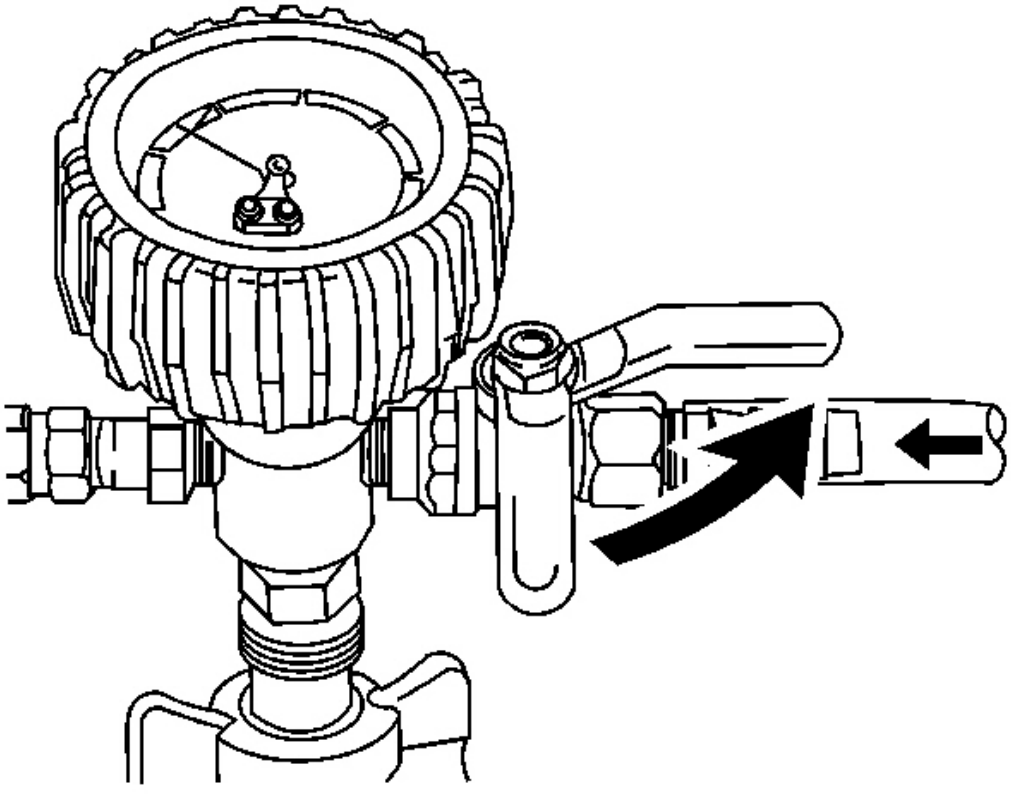


Fig. 14: Identifying Valve On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

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

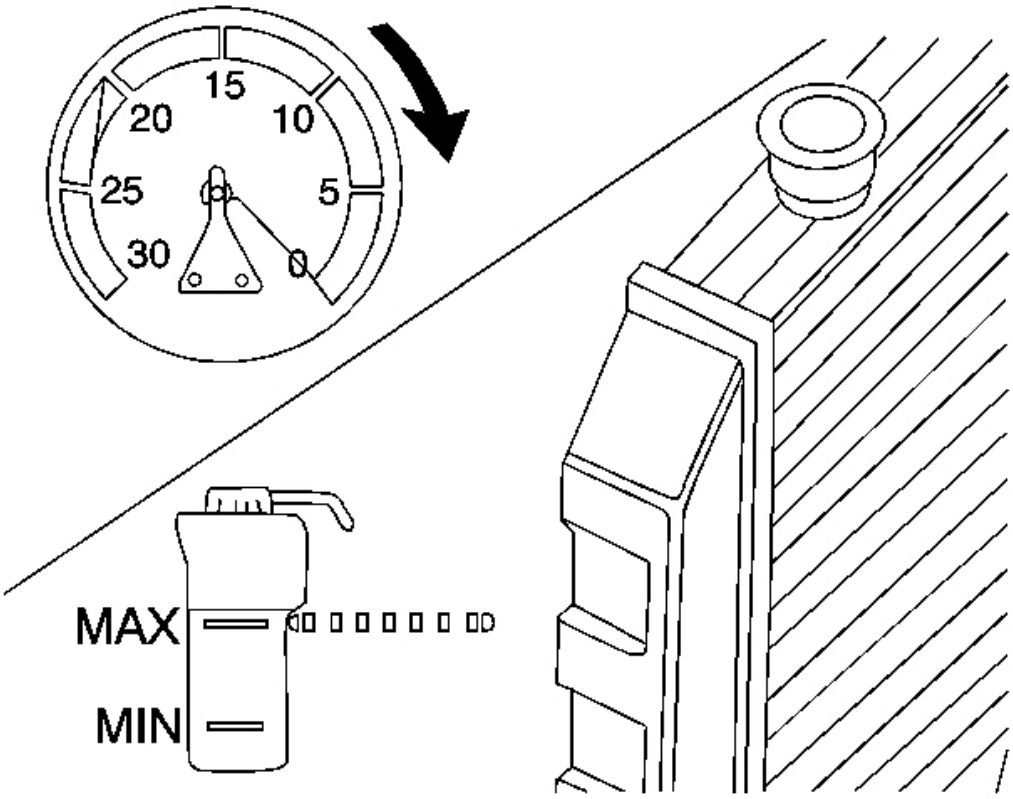


Fig. 15: View Of Vacuum Gauge & Radiator
Courtesy of GENERAL MOTORS CORP.

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.

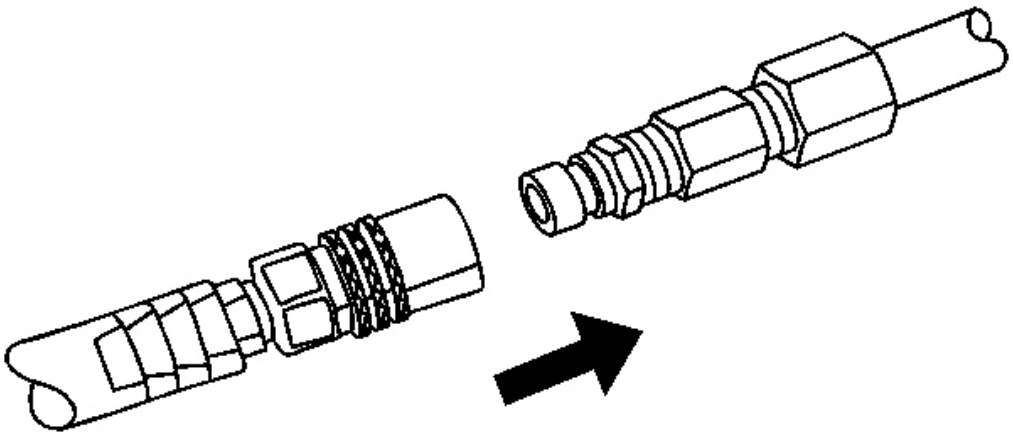


Fig. 16: Attaching Extraction Hose To Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

24. Attach the extraction hose to the vacuum hose.

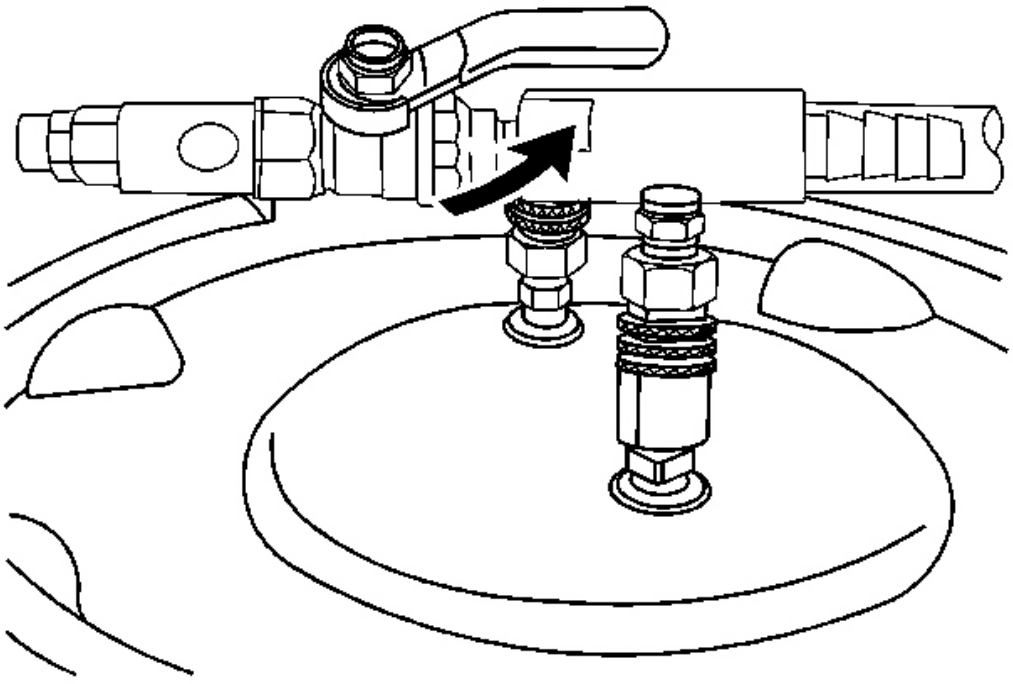


Fig. 17: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

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

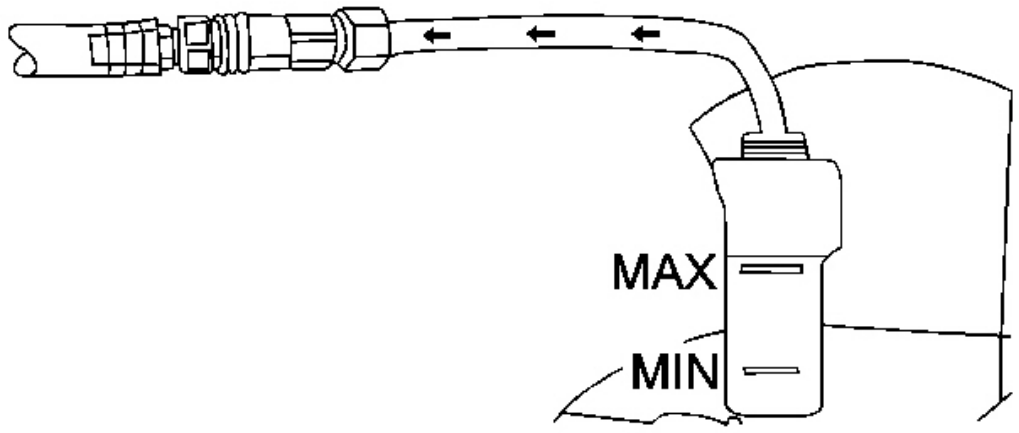


Fig. 18: Using Extraction Hose To Draw Out Coolant
Courtesy of GENERAL MOTORS CORP.

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 (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement**.
3. Clean and flush the coolant recovery reservoir with clean, drinkable water.

4. Install the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement**.
5. Follow the drain and fill procedure using only clean, drinkable water. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** 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 (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** 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 (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

COOLANT RECOVERY RESERVOIR REPLACEMENT

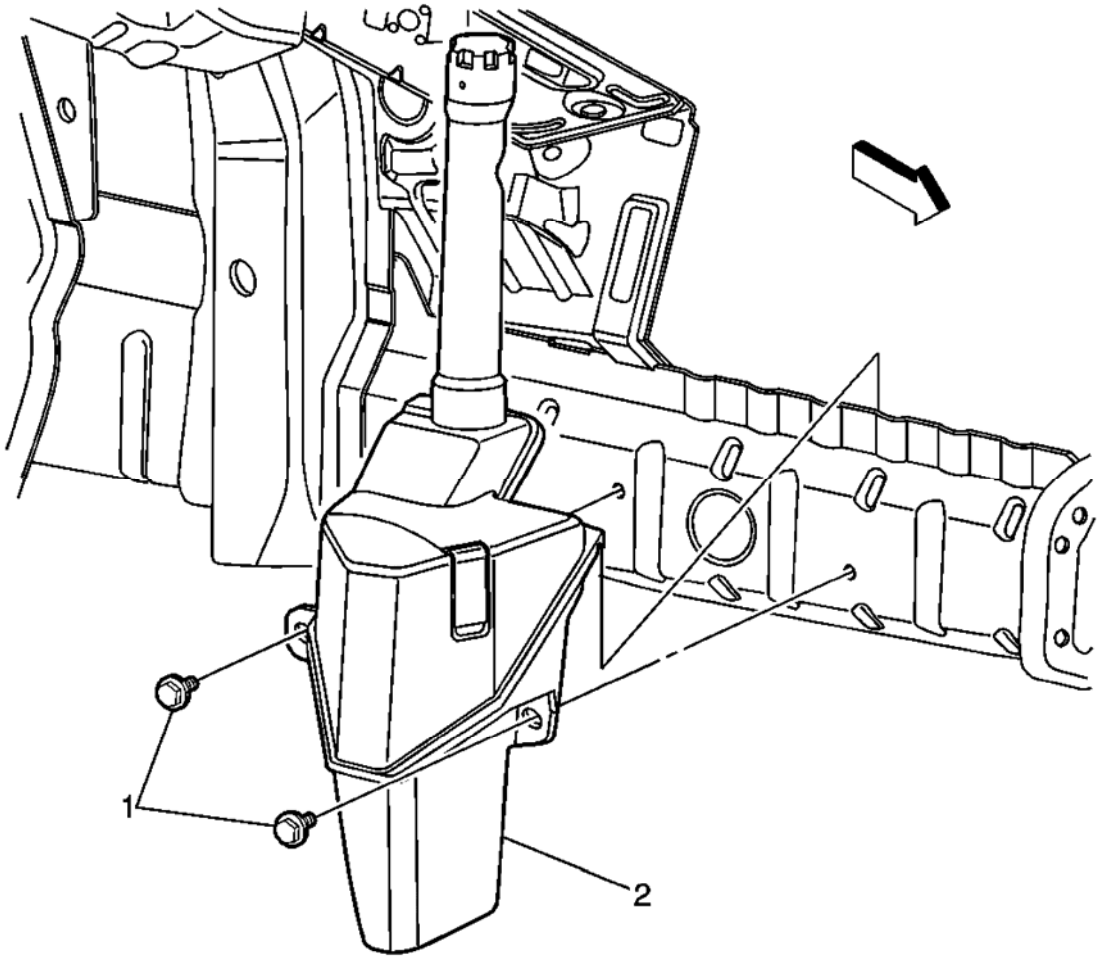


Fig. 19: Coolant Recovery Reservoir
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 3. Remove the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.	
1	Coolant Recovery Reservoir Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 17 N.m (13 lb ft)
2	Coolant Recovery Reservoir

RADIATOR INLET HOSE REPLACEMENT (LLT)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
3. Remove air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

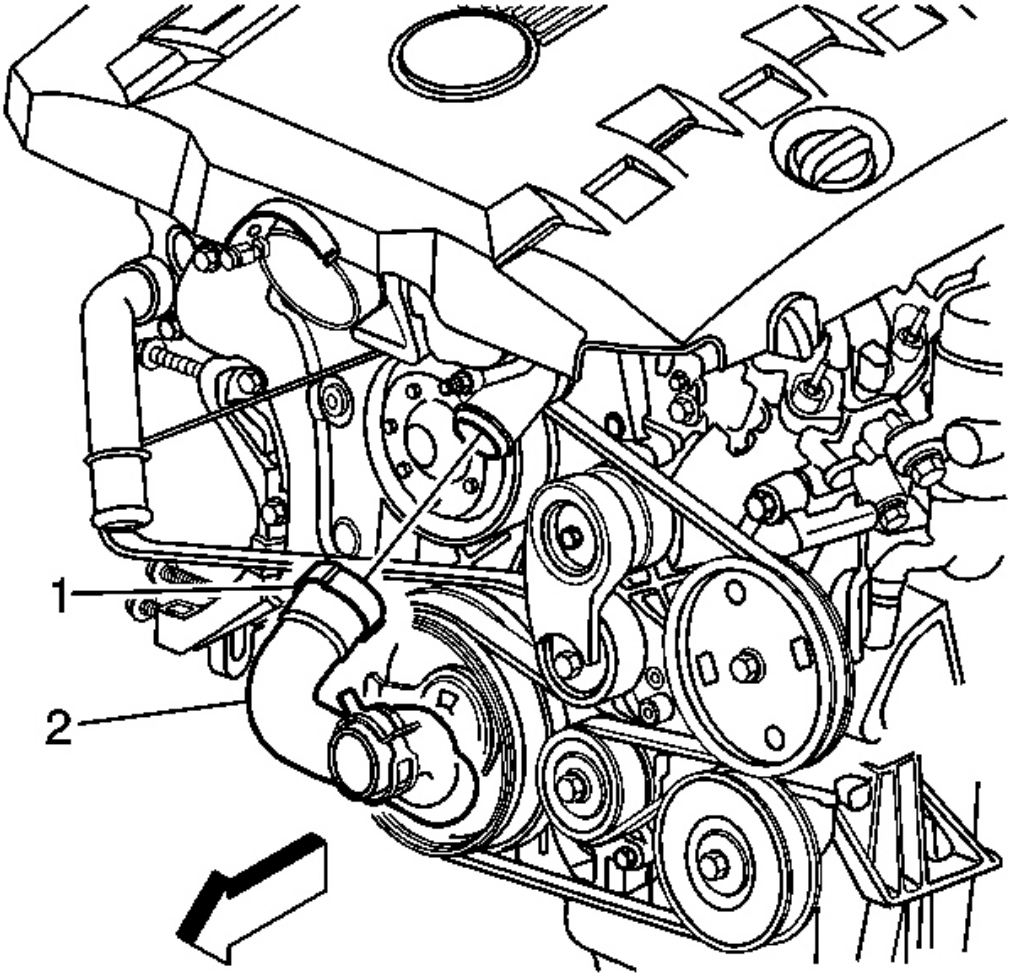


Fig. 20: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

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

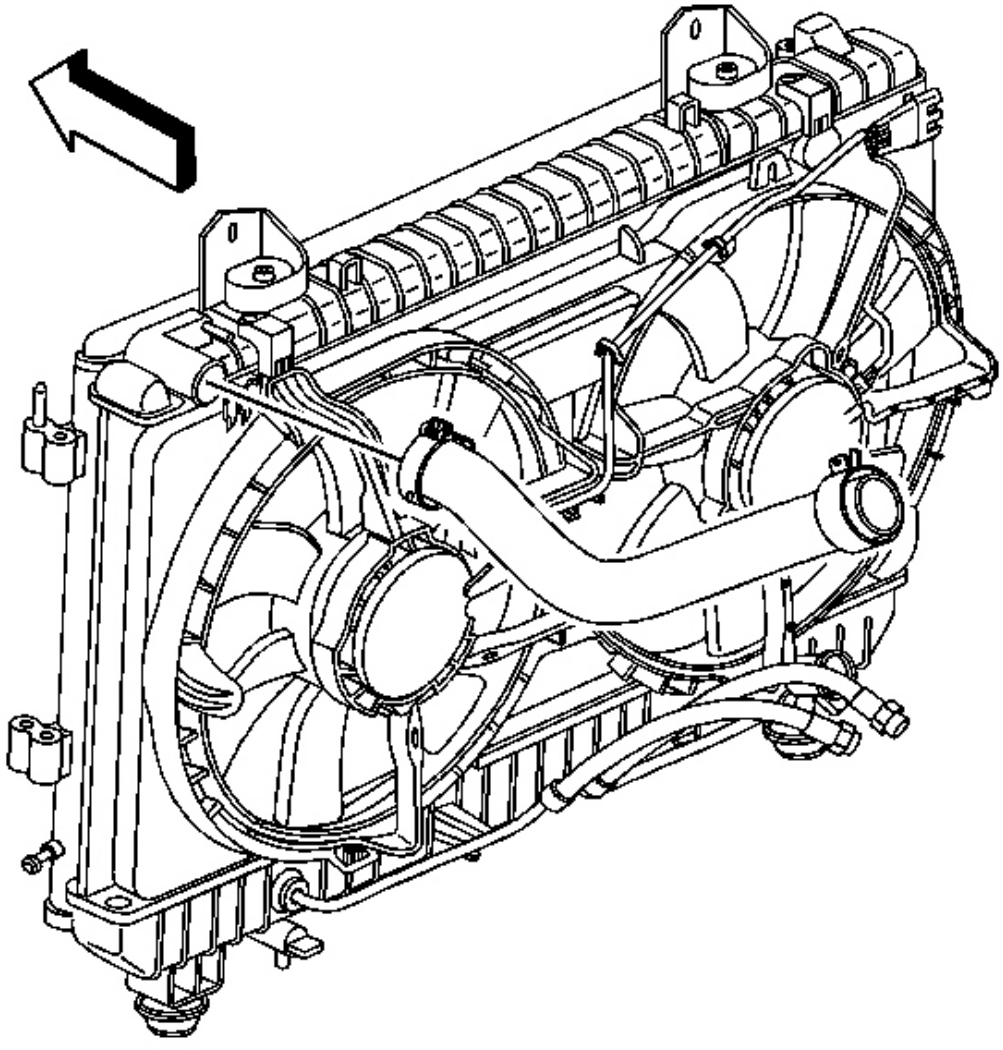


Fig. 21: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

1. Install radiator inlet hose to the vehicle.

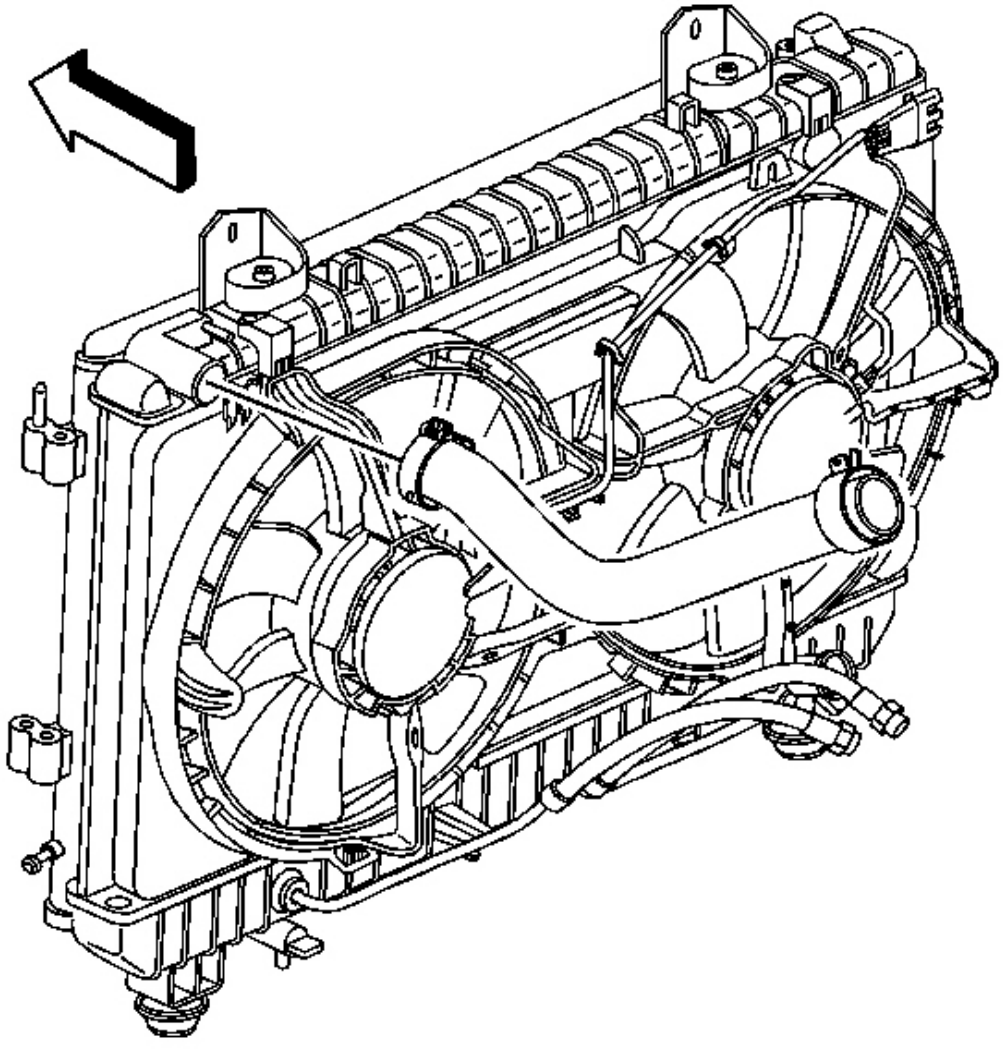


Fig. 22: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

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

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

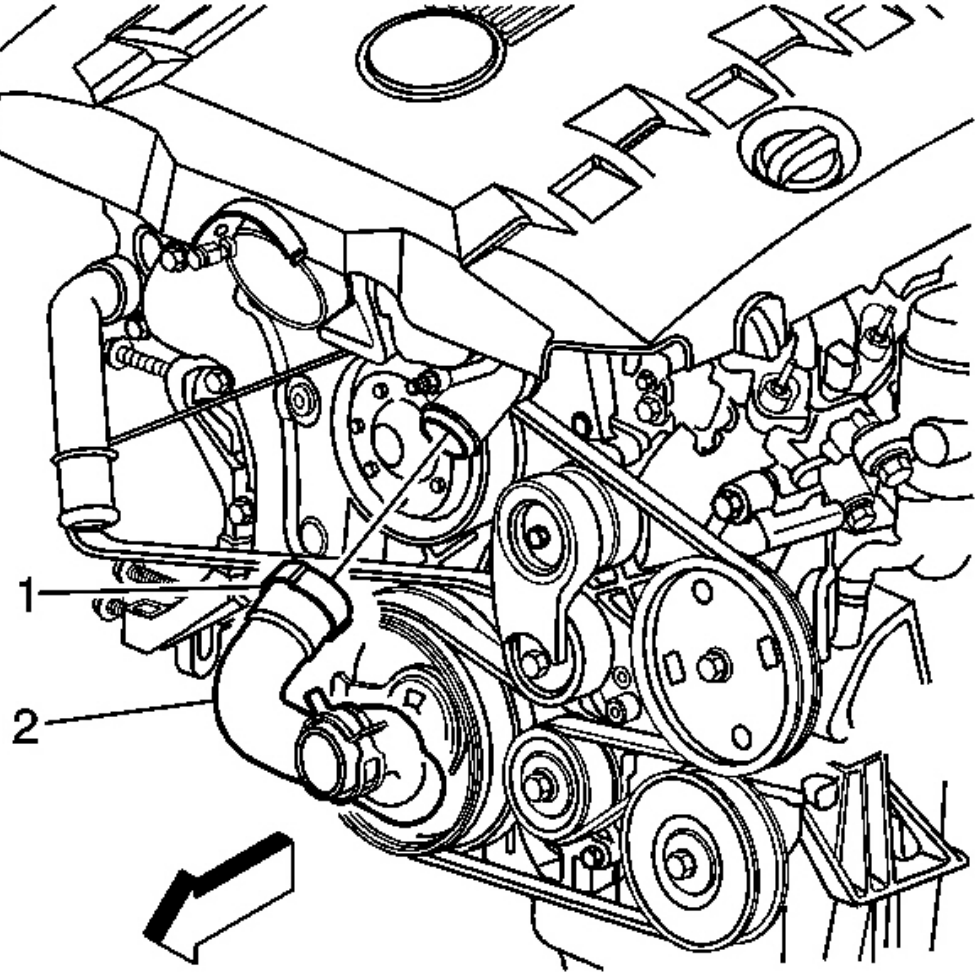


Fig. 23: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator inlet hose (2) to the engine.
5. Engage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Install air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
7. Install the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
8. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or

Cooling System Draining and Filling (LLT Static Fill) or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR INLET HOSE REPLACEMENT (L99)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the engine cover. Refer to **Engine Cover Replacement** .
3. Remove the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .

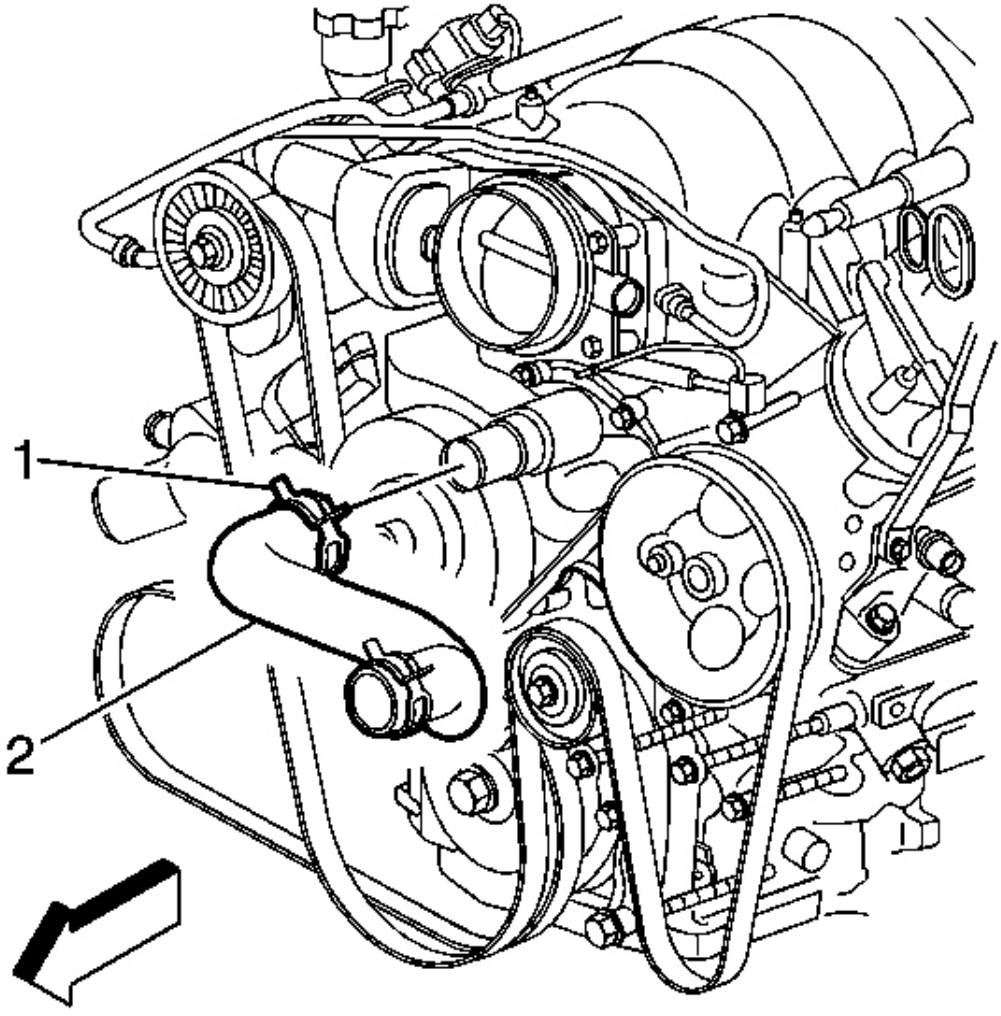


Fig. 24: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

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

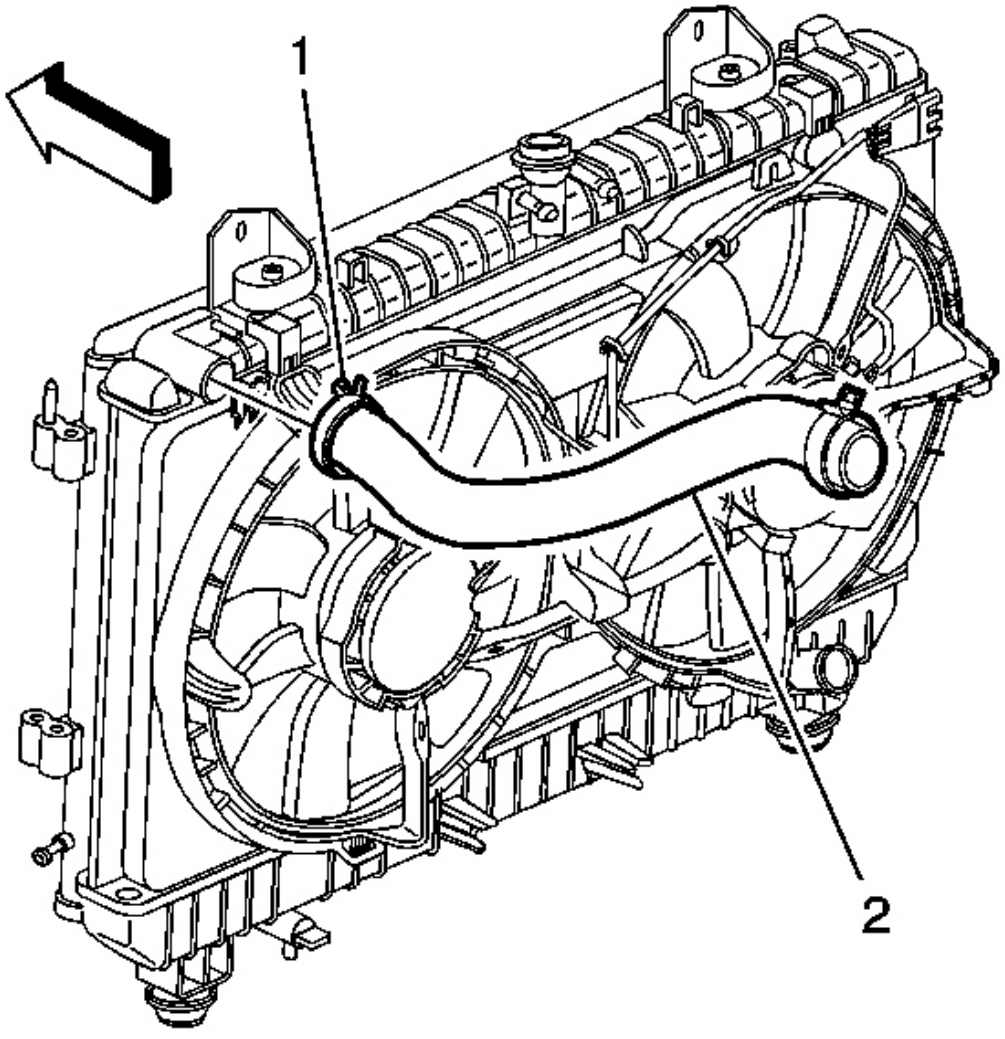


Fig. 25: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

1. Install radiator inlet hose to the vehicle.

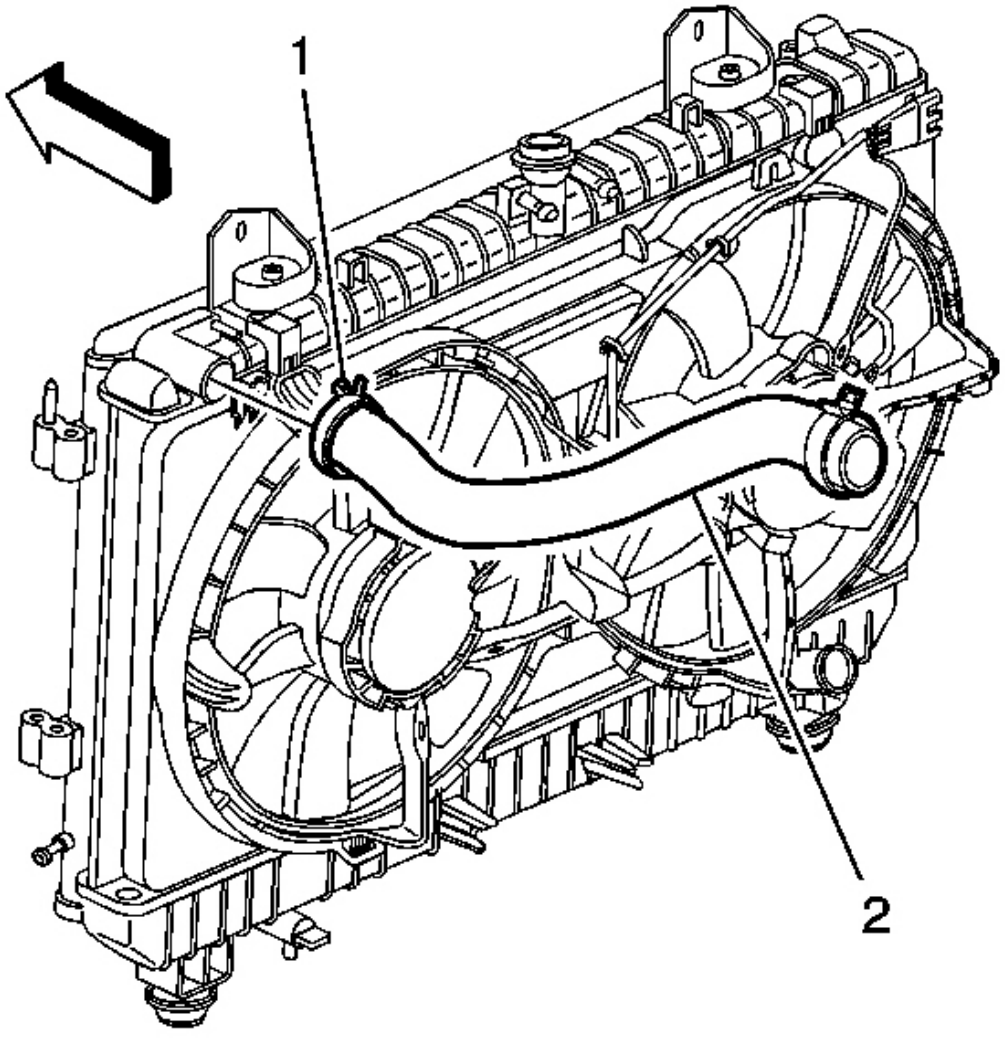


Fig. 26: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

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

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

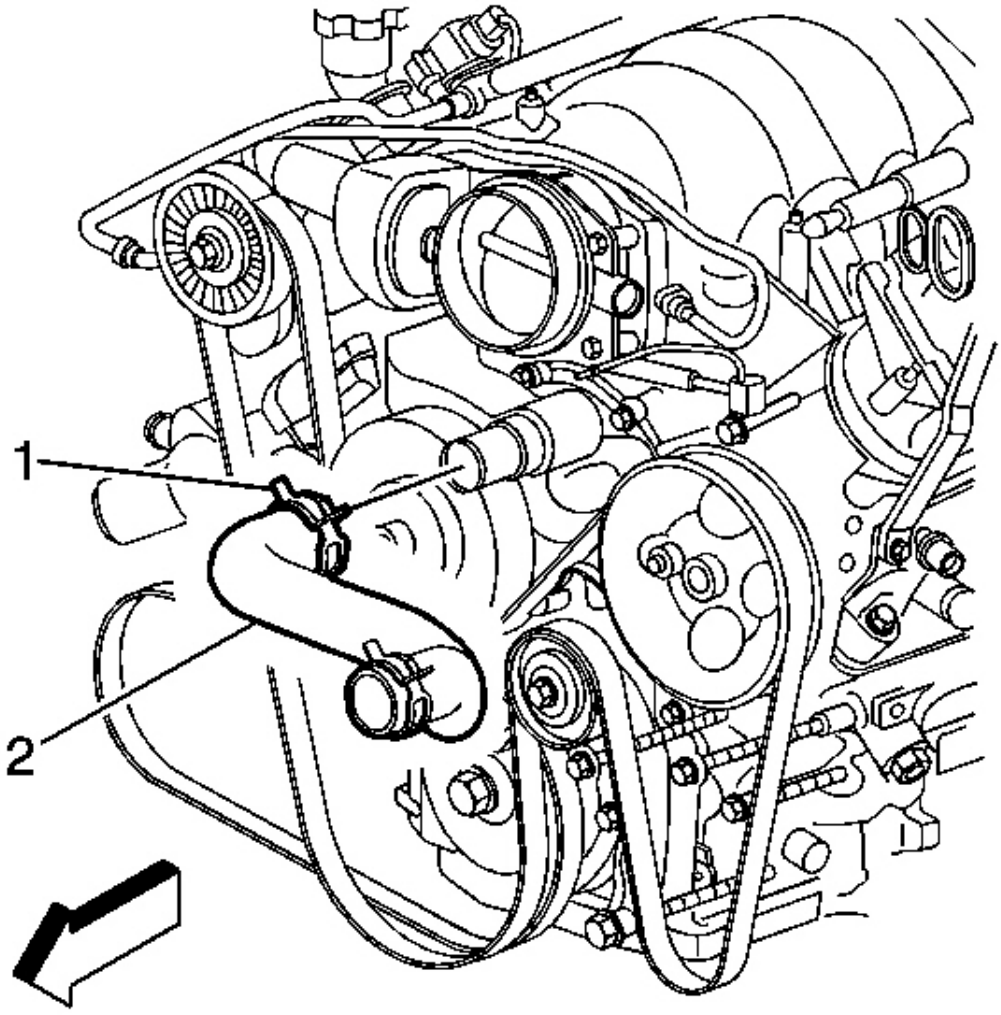


Fig. 27: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator inlet hose (2) to the engine.
5. Engage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Install the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .

7. Install the engine cover. Refer to **Engine Cover Replacement** .
8. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR INLET HOSE REPLACEMENT (LS3)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the engine cover. Refer to **Engine Cover Replacement** .
3. Remove the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .

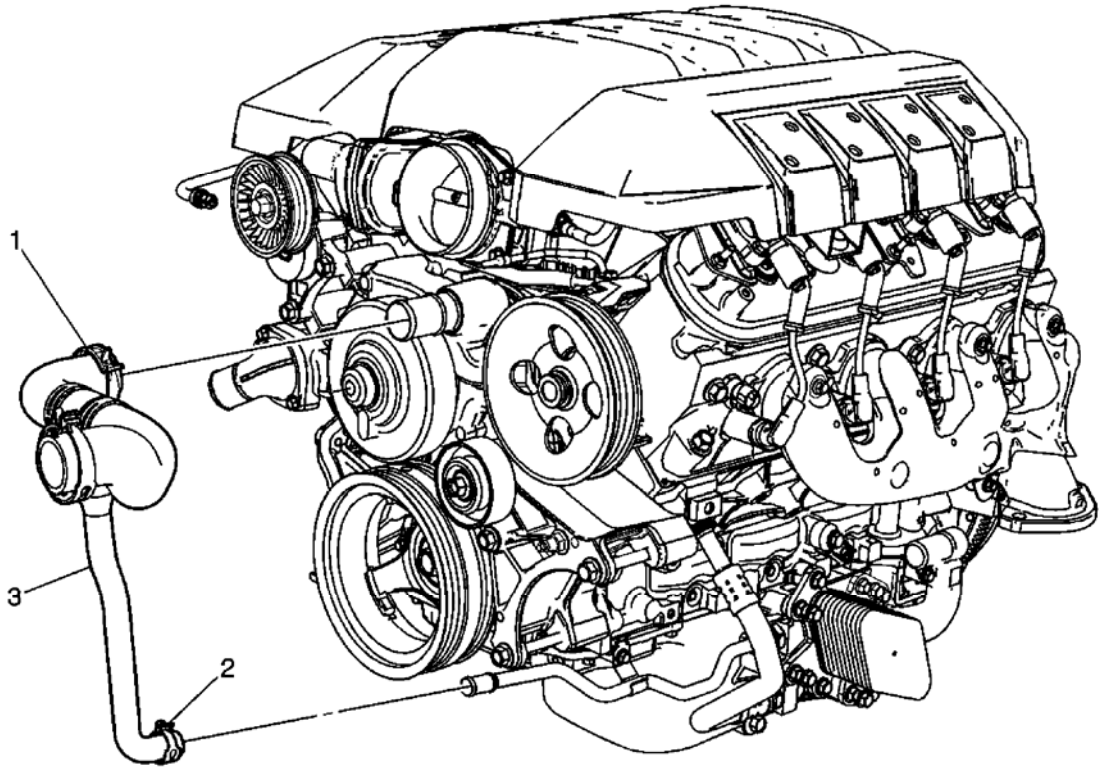


Fig. 28: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Disengage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
5. Remove the radiator inlet hose (3) from the engine.
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
7. Disengage tension on the radiator inlet hose clamp (2) at the engine oil cooler pipe using **J 38185:** Hose Clamp Pliers.
8. Remove the radiator inlet hose (3) from the engine oil cooler pipe.

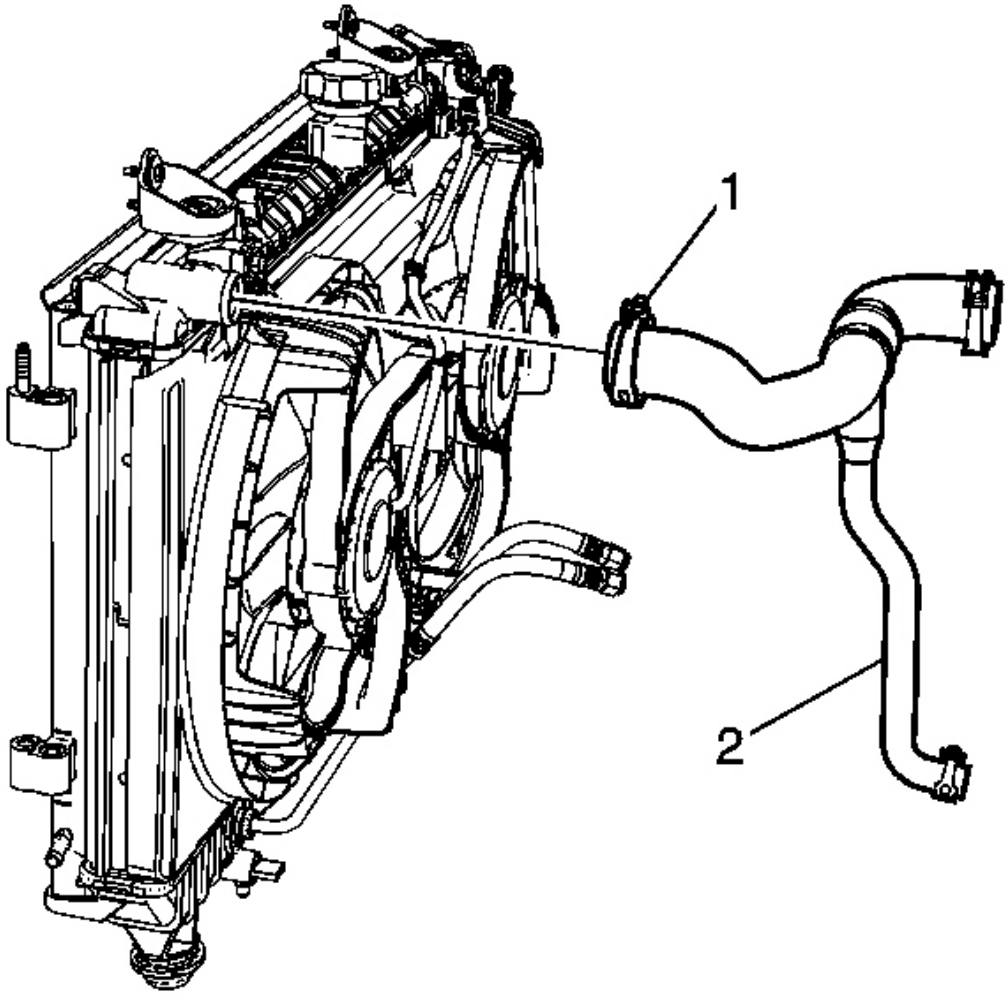


Fig. 29: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

9. Disengage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.

10. Remove the radiator inlet hose (2) from the radiator.
11. Remove the radiator inlet hose from the vehicle (2).

Installation Procedure

1. Install radiator inlet hose to the vehicle.

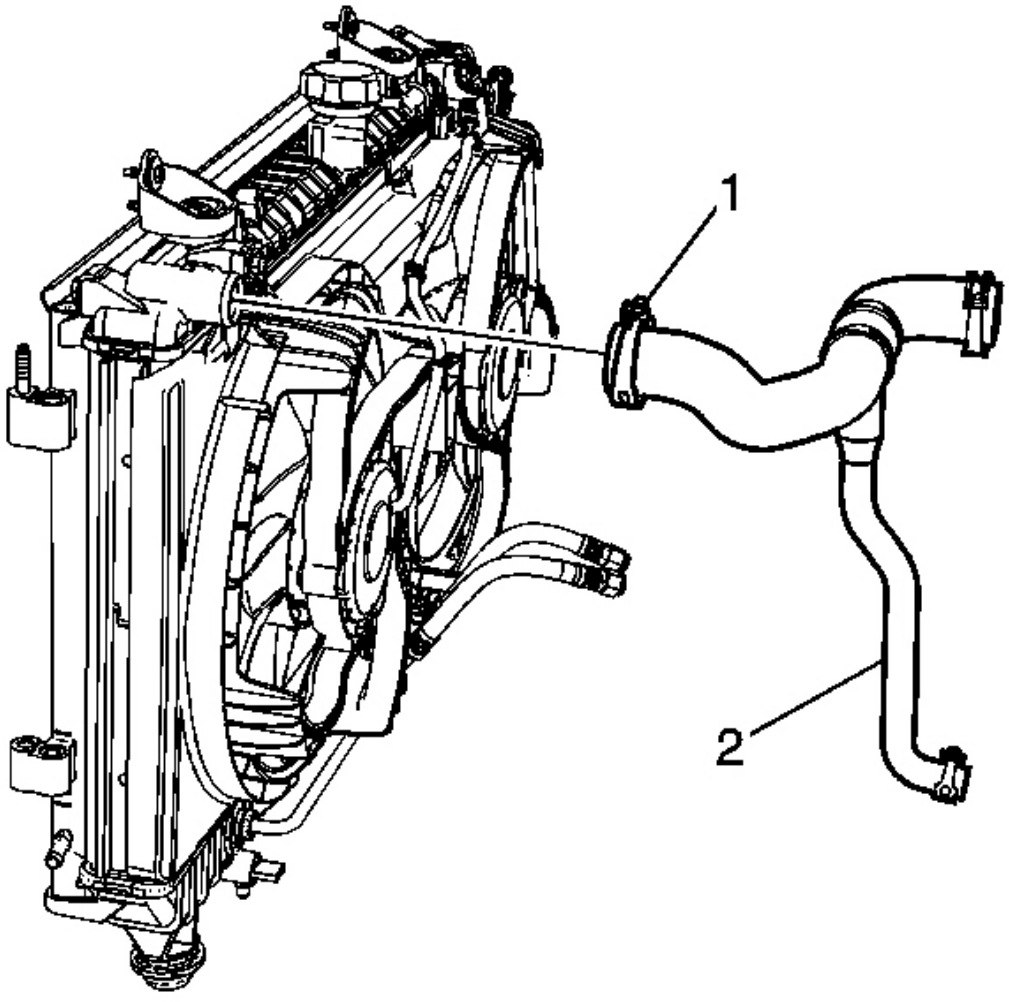


Fig. 30: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are

lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

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

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

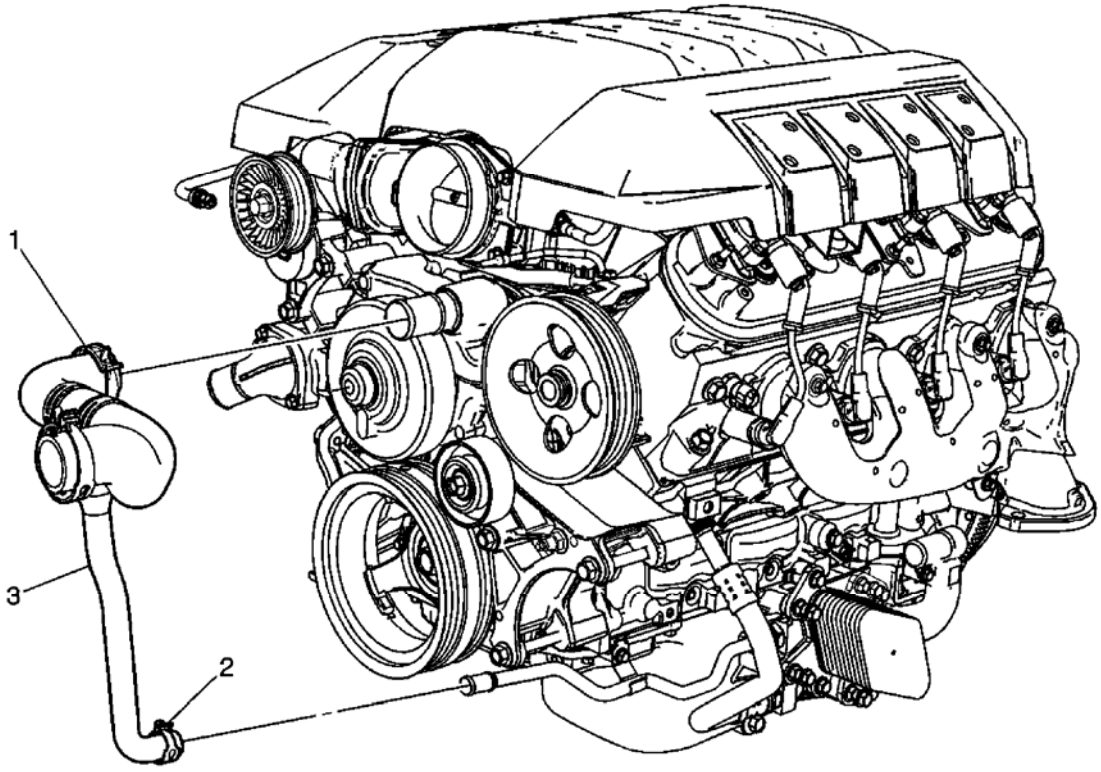


Fig. 31: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator inlet hose (3) to the engine.
5. Engage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Install the radiator inlet hose (3) to the engine oil cooler pipe.
7. Engage tension on the radiator inlet hose clamp (2) at the engine oil cooler pipe using **J 38185:** Hose Clamp Pliers.
8. Lower the vehicle
9. Install the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .
10. Install the engine cover. Refer to **Engine Cover Replacement** .

11. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR OUTLET HOSE REPLACEMENT (LLT)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

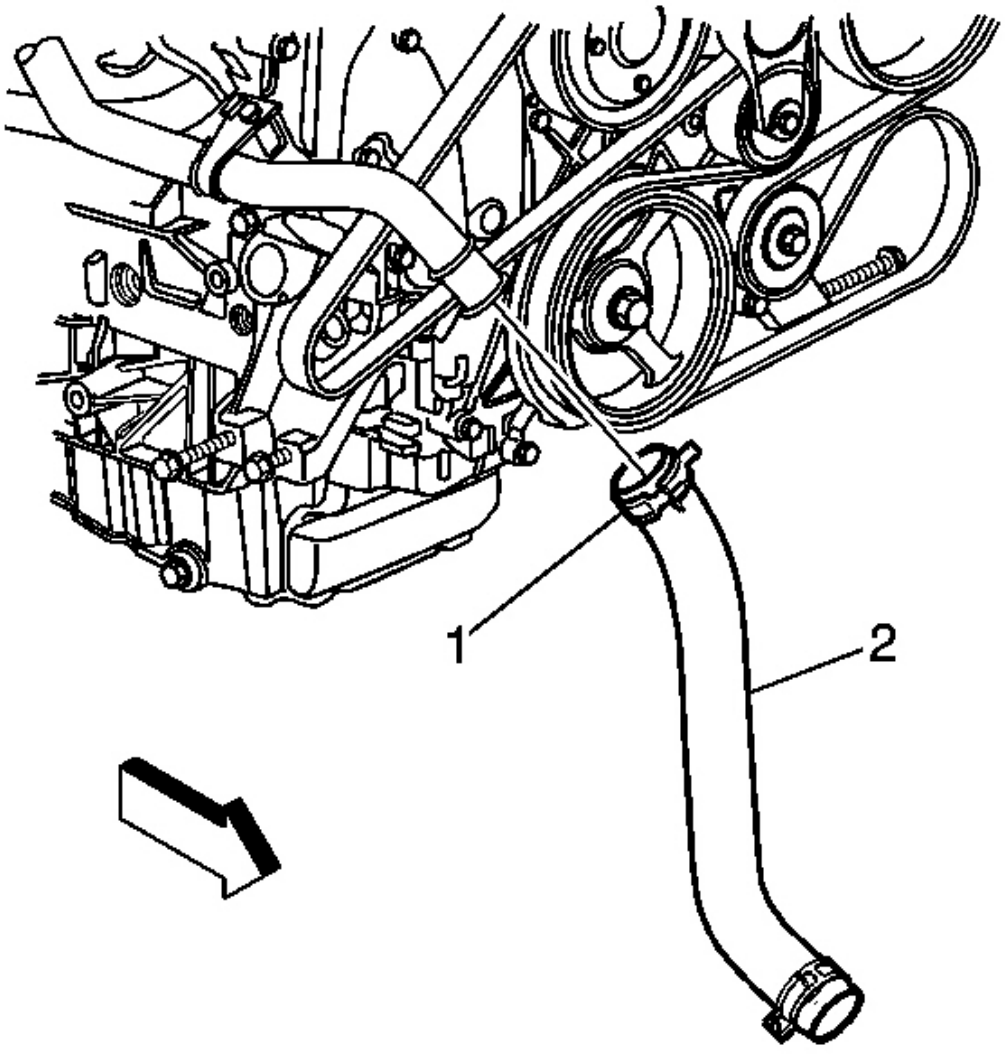


Fig. 32: Radiator Outlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

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

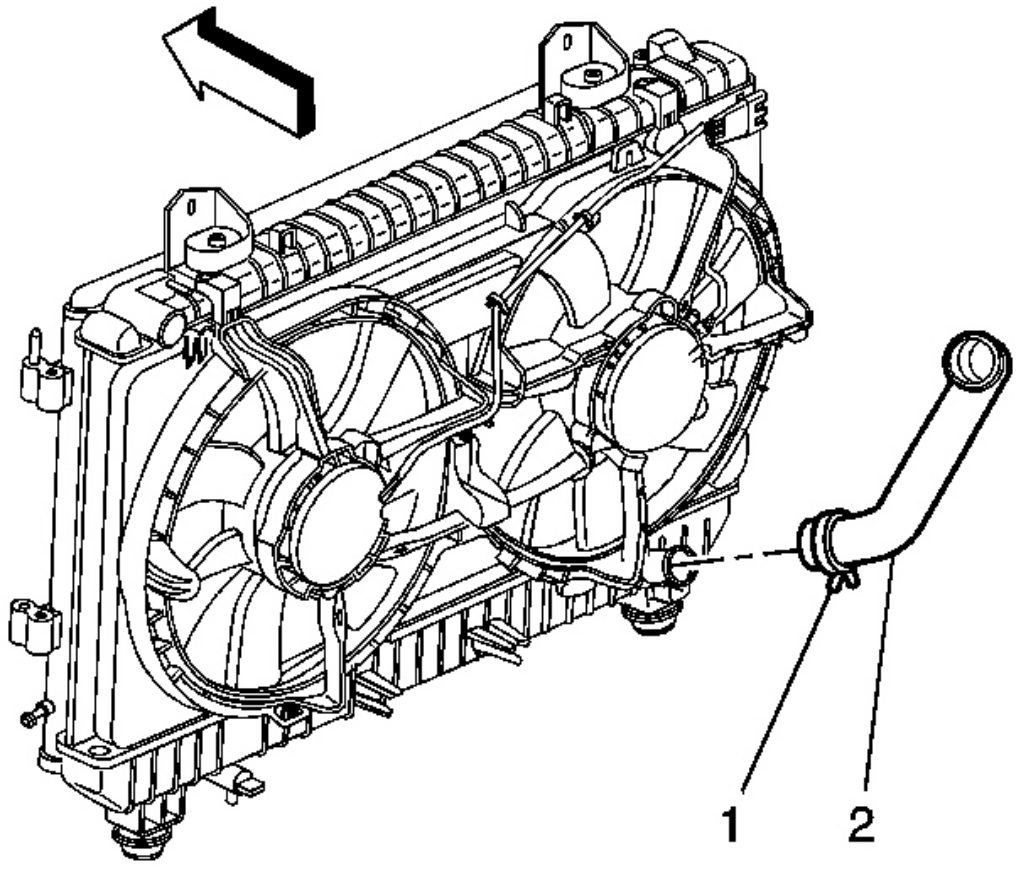


Fig. 33: Radiator Outlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

1. Install radiator outlet hose to the vehicle.

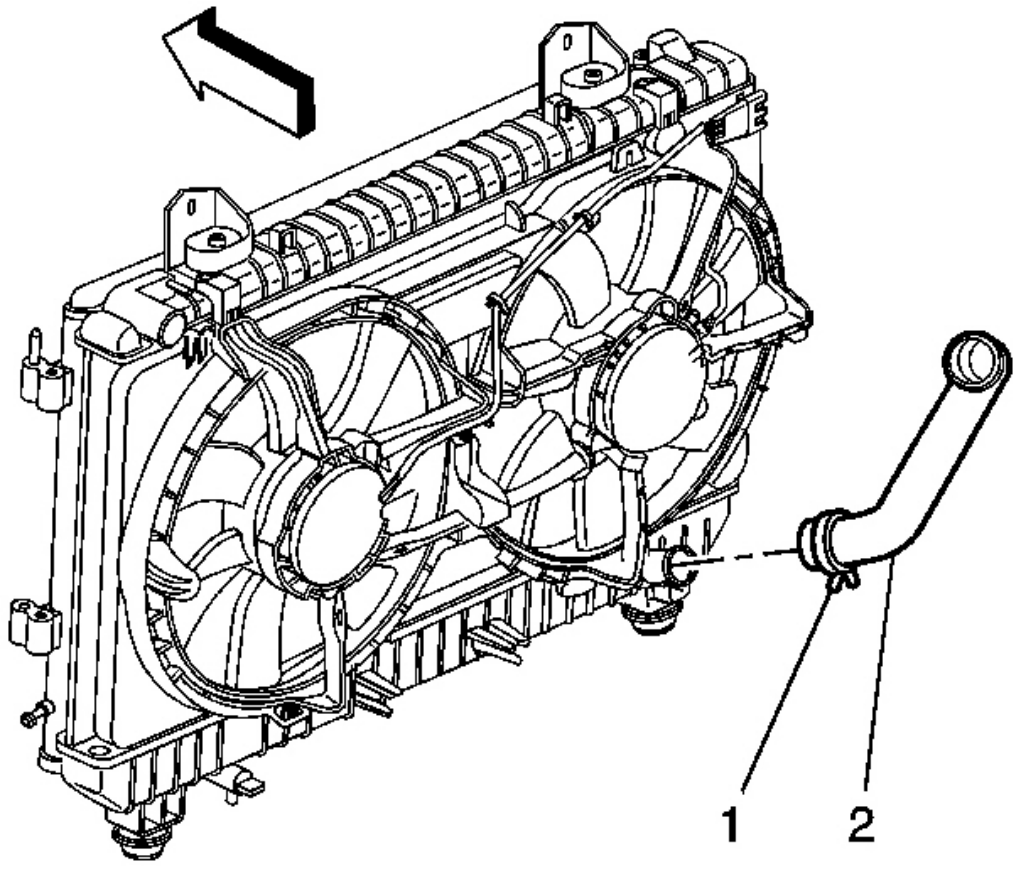


Fig. 34: Radiator Outlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

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

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

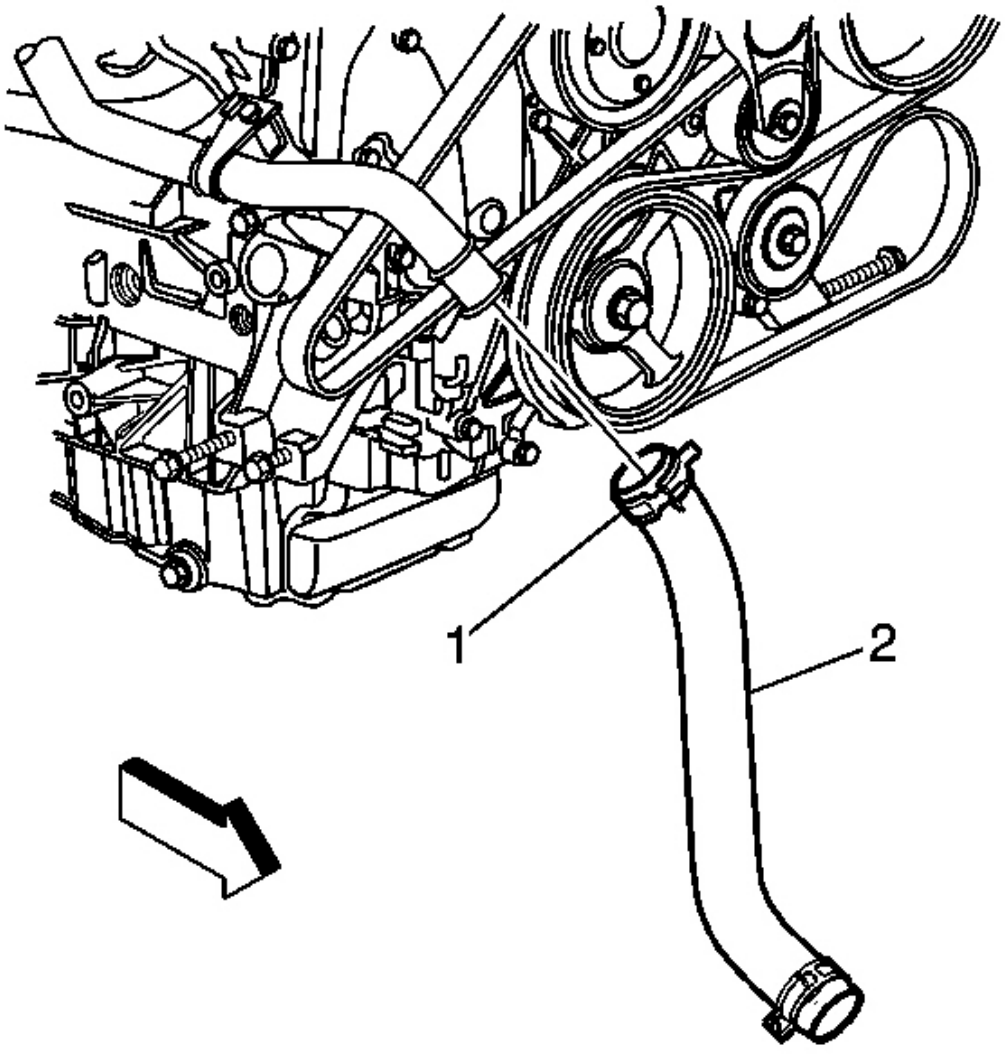


Fig. 35: Radiator Outlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator outlet hose (2) to the engine.
5. Engage tension on the radiator outlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Lower the vehicle.
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR OUTLET HOSE REPLACEMENT (LS3, L99)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

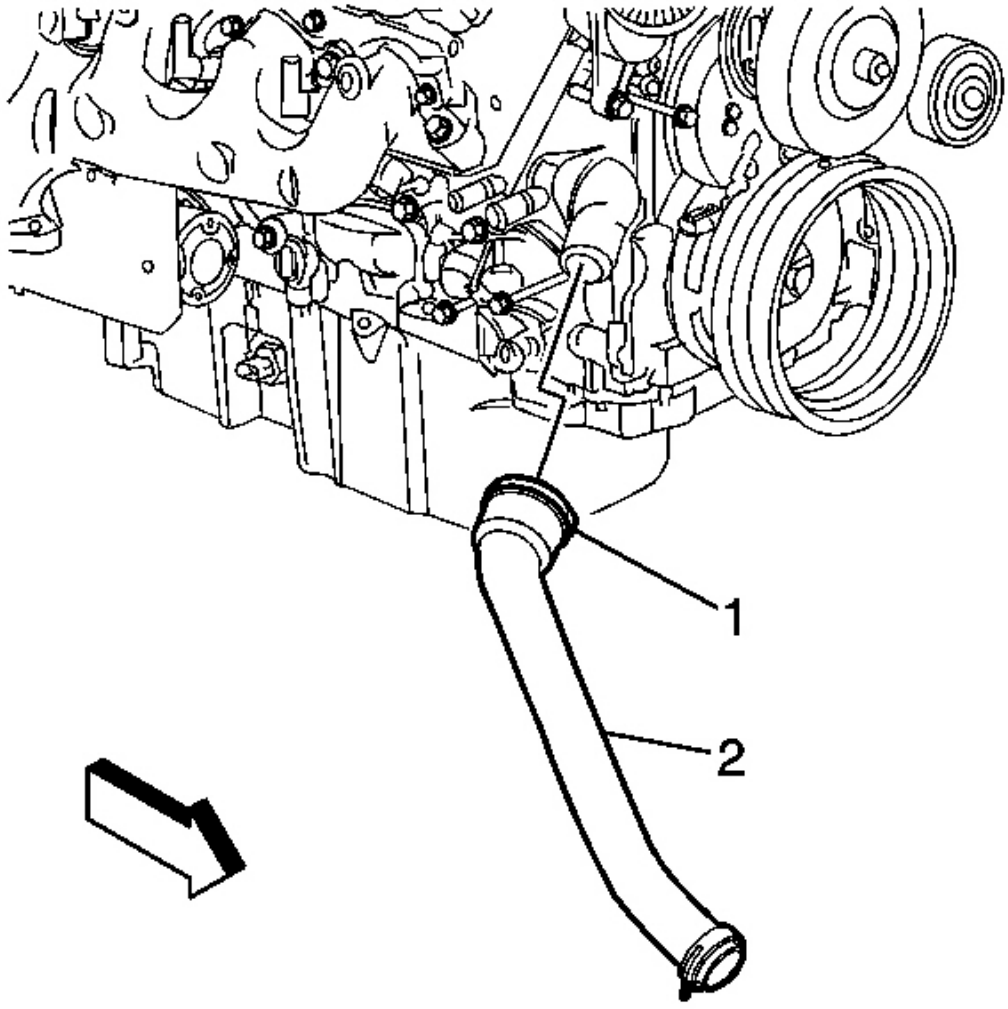


Fig. 36: Radiator Outlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

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

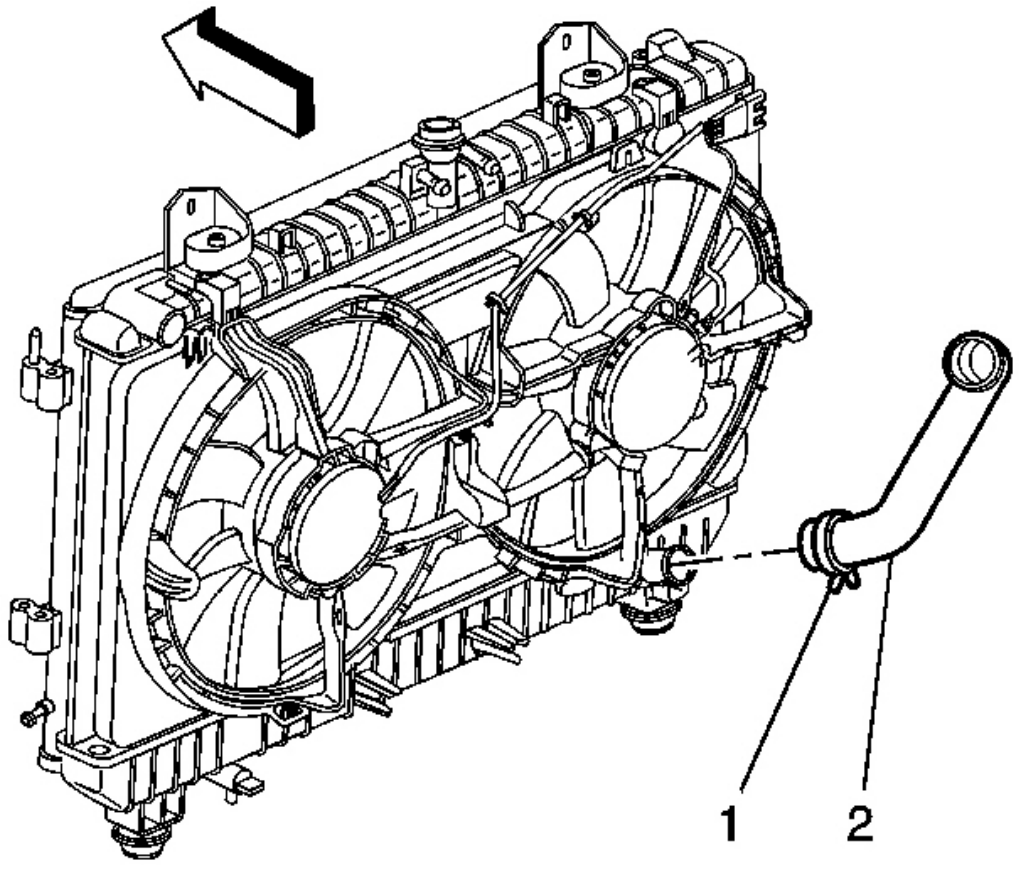


Fig. 37: Radiator Outlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

1. Install radiator outlet hose to the vehicle.

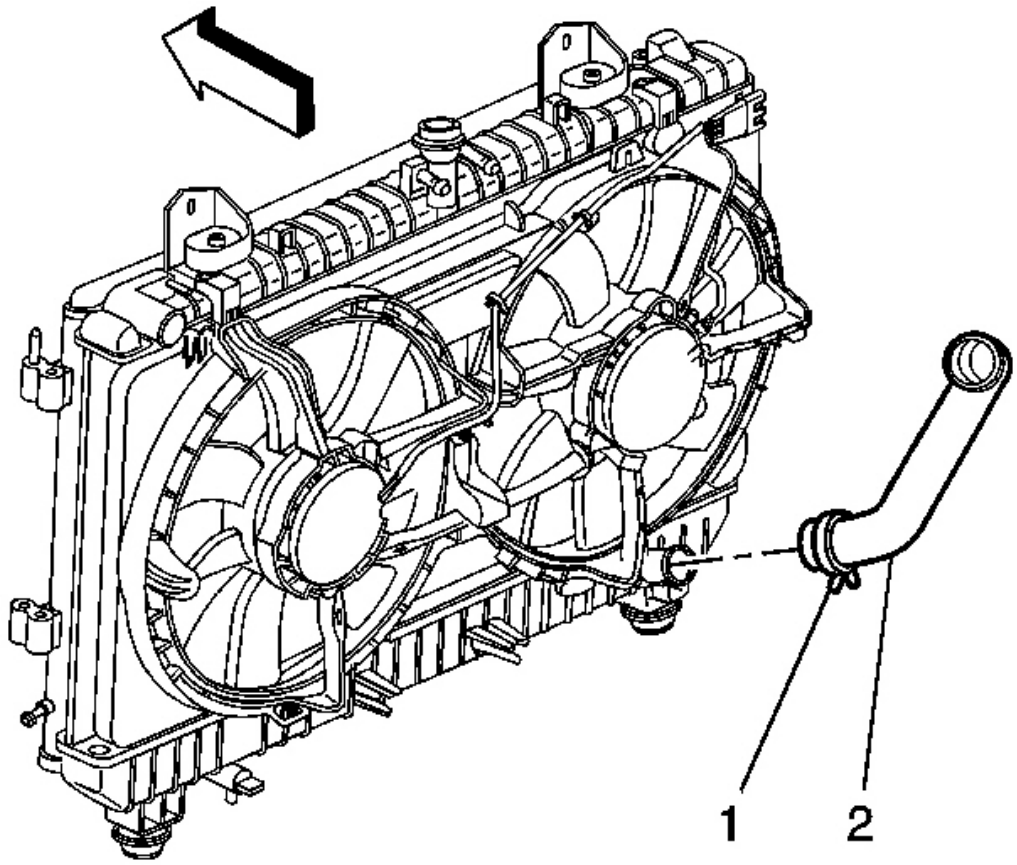


Fig. 38: Radiator Outlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

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

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

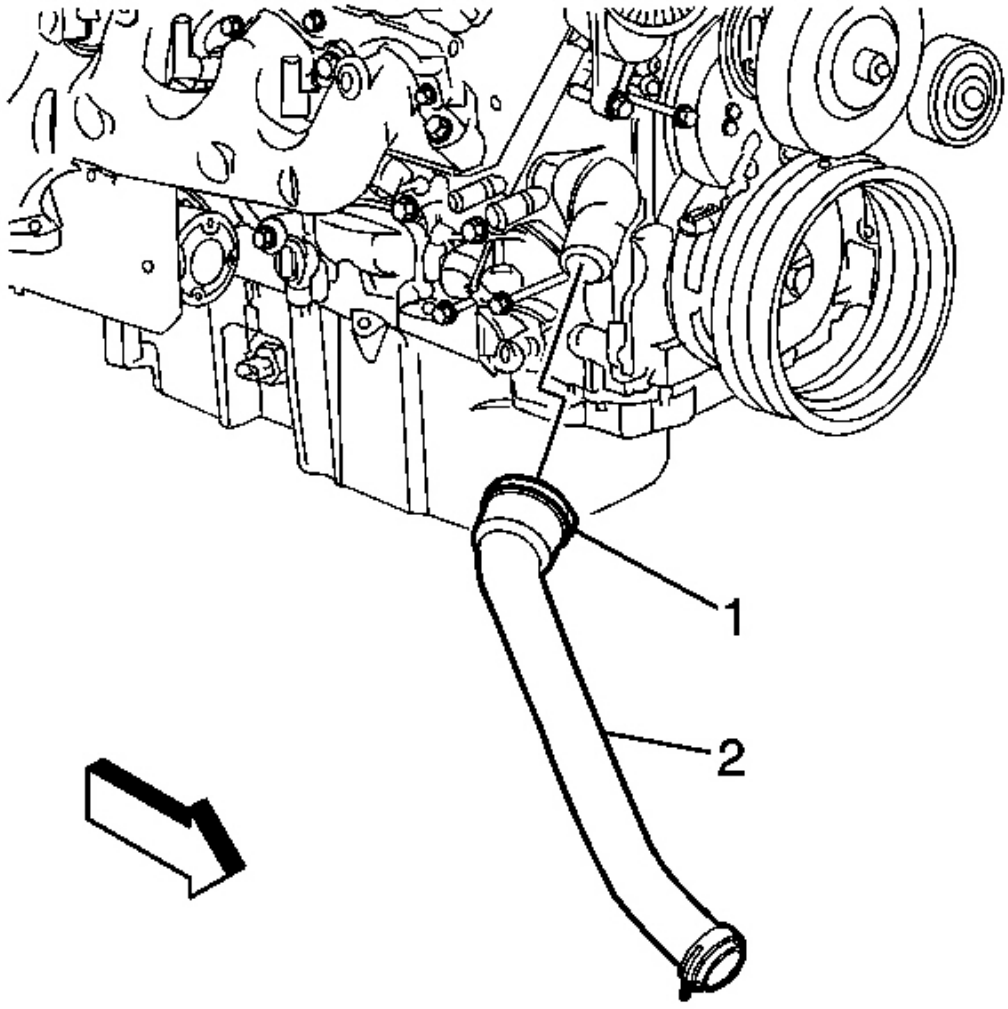


Fig. 39: Radiator Outlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator outlet hose (2) to the engine.
5. Engage tension on the radiator outlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Lower the vehicle.
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR OUTLET PIPE REPLACEMENT (LLT)

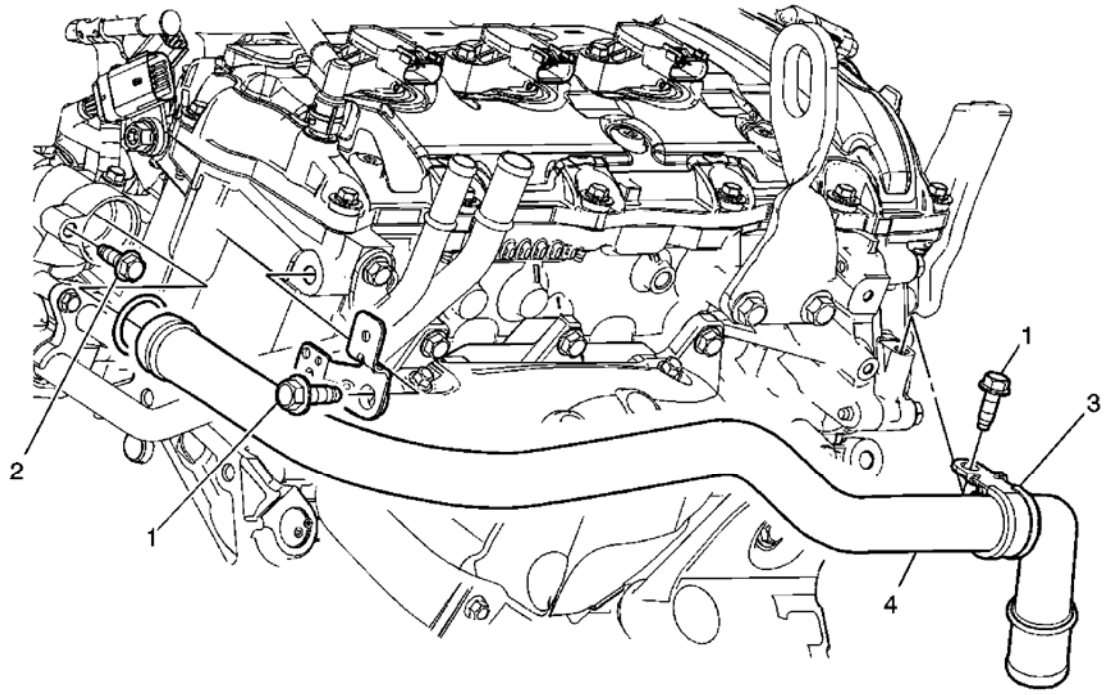


Fig. 40: Radiator Outlet Pipe (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the intake manifold cover. 3. Disconnect the heater hoses from the heater pipes and set aside. 4. Disconnect the radiator outlet hose and set aside.	
1	Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 58 N.m (42 lb ft)
2	Bolt **Tighten:** 58 N.m (42 lb ft)
3	Radiator Outlet Pipe Clip
	Radiator Outlet Pipe

4	**Procedure:** Discard and install a NEW Seal.

RADIATOR OVERFLOW HOSE REPLACEMENT (LLT)

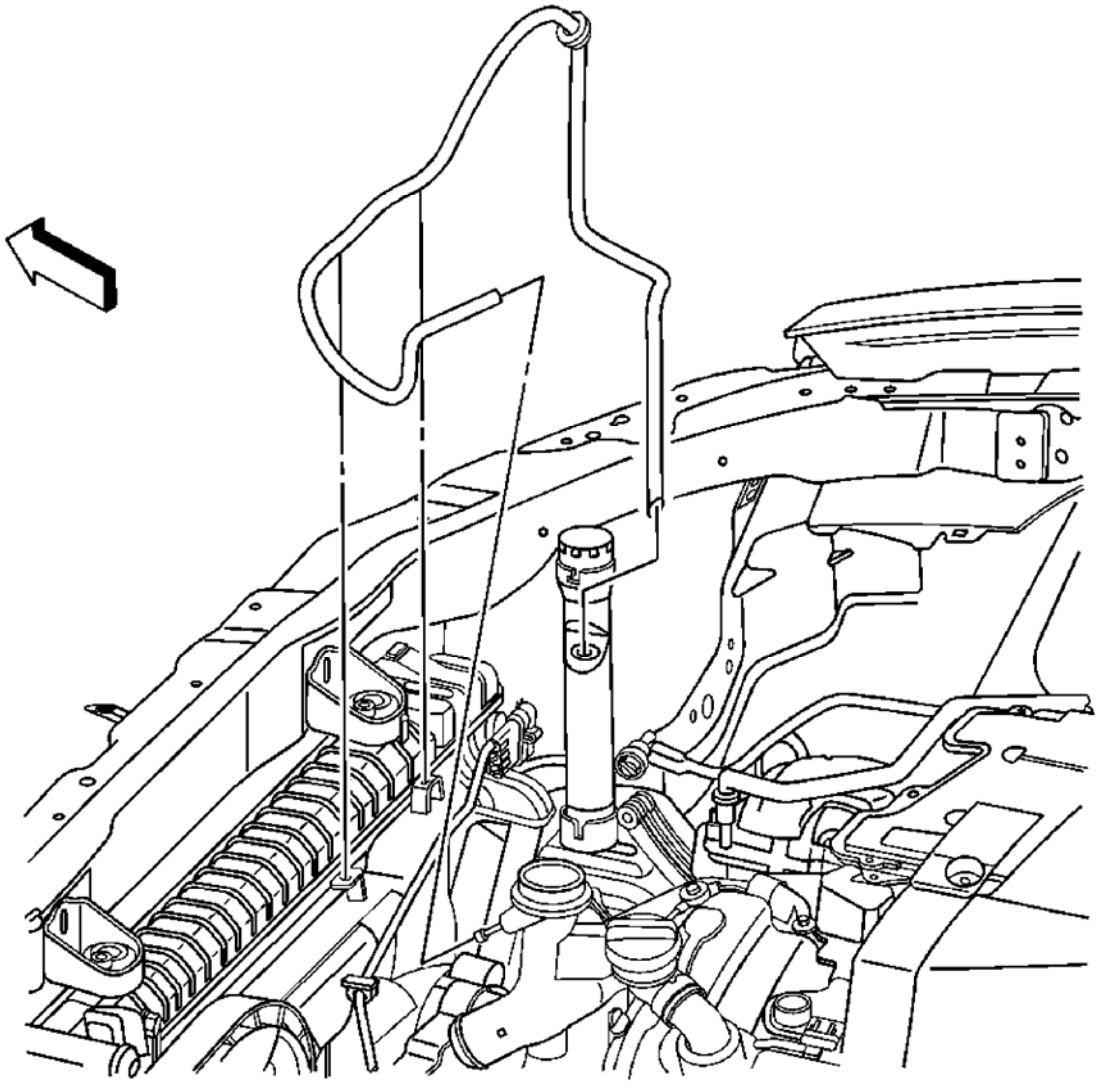


Fig. 41: Radiator Overflow Hose (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Drain the coolant from the radiator overflow hose. 2. Remove front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**	

3. Remove air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**	
1	Radiator Overflow Hose

RADIATOR OVERFLOW HOSE REPLACEMENT (LS3, L99)

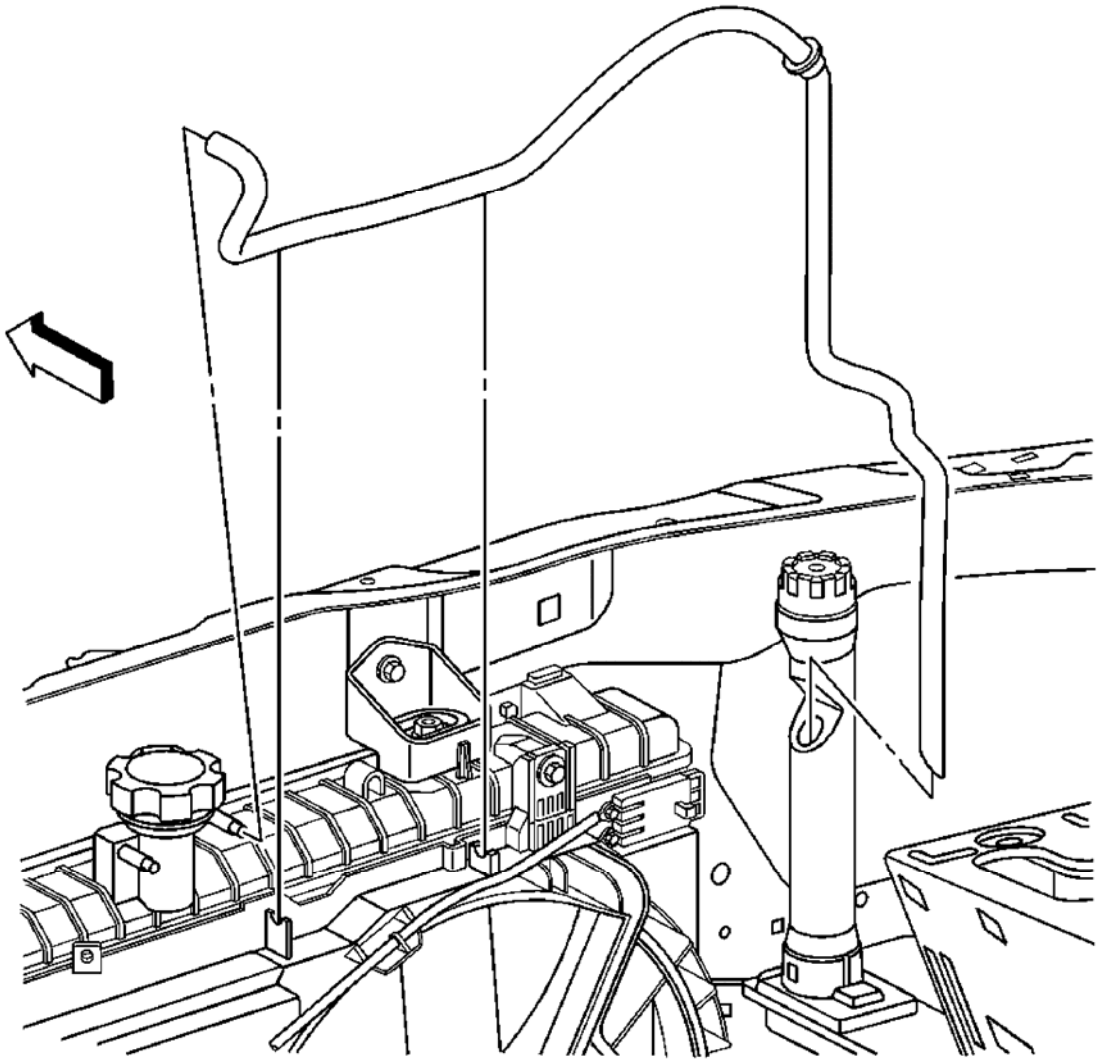


Fig. 42: Radiator Overflow Hose (LS3, L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Drain the coolant from the radiator overflow hose.	
1	Radiator Overflow Hose

ENGINE OIL COOLER REPLACEMENT

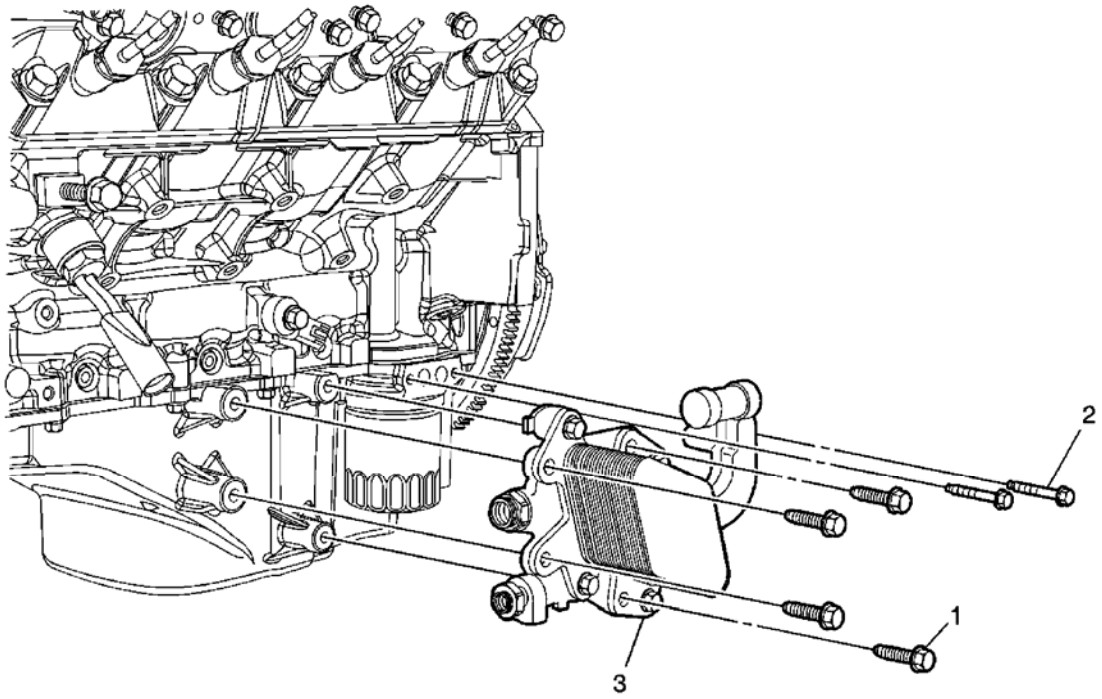


Fig. 43: Engine Oil Cooler
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove engine oil cooler coolant inlet hose. Refer to **Engine Oil Cooler Coolant Inlet Hose Replacement (LS3)**. 2. Remove engine oil cooler pipe. Refer to **Engine Oil Cooler Pipe Replacement (LS3)**.	
1	Engine Oil Cooler Fastener (Qty: 2) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten:** 10 N.m (89 lb in)
2	Engine Oil Cooler Fastener (Qty: 5) **Tighten:** 25 N.m (18 lb ft)
3	Engine Oil Cooler **Procedure** 1. Transfer components as necessary. 2. Ensure the full oil level after installation.

ENGINE OIL COOLER HOSE/PIPE QUICK-CONNECT FITTING DISCONNECTION AND CONNECTION

Special Tools

- **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool
- **DT 47731:** 1/2 Inch Quick Connect Release Tool

Removal Procedure

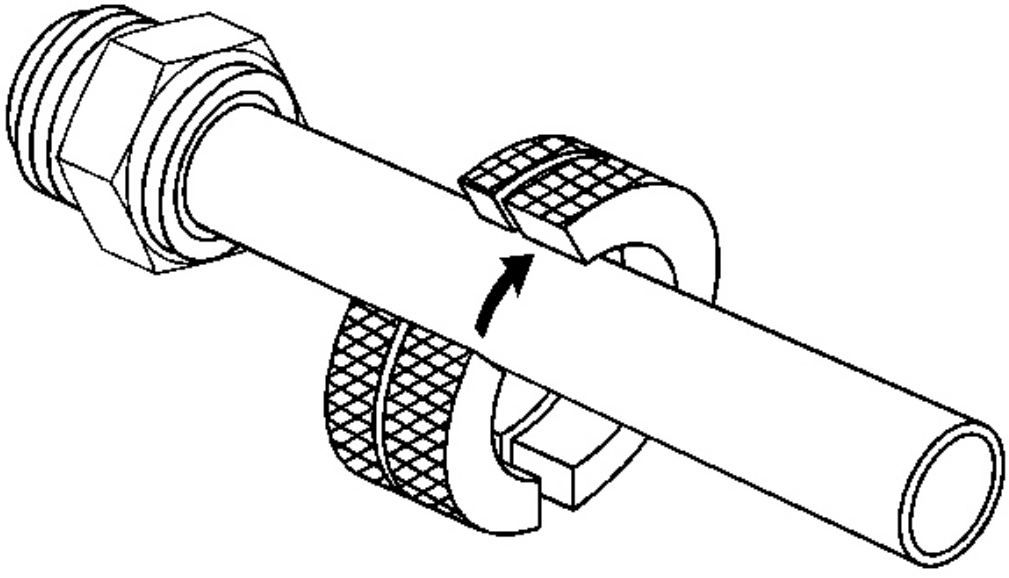


Fig. 44: Installing J 41623-B Onto Generator Cooling Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

1. Install the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool onto the engine oil cooler (EOC) pipe.

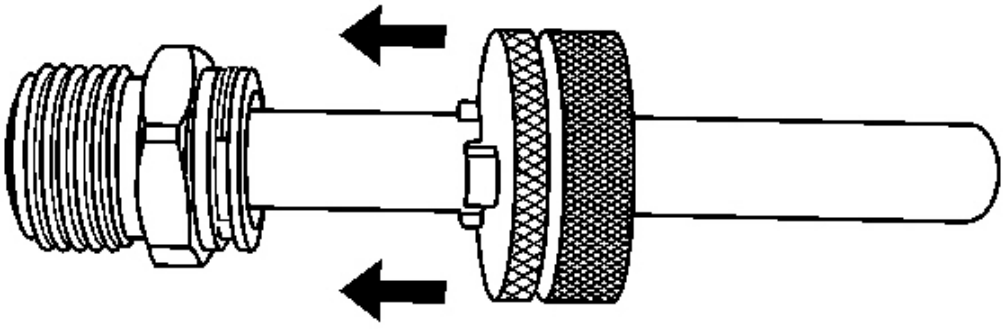


Fig. 45: Sliding J 41623-B Toward Generator Cooling Inlet Pipe Fitting
Courtesy of GENERAL MOTORS CORP.

2. Slide the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool toward the EOC pipe fitting.

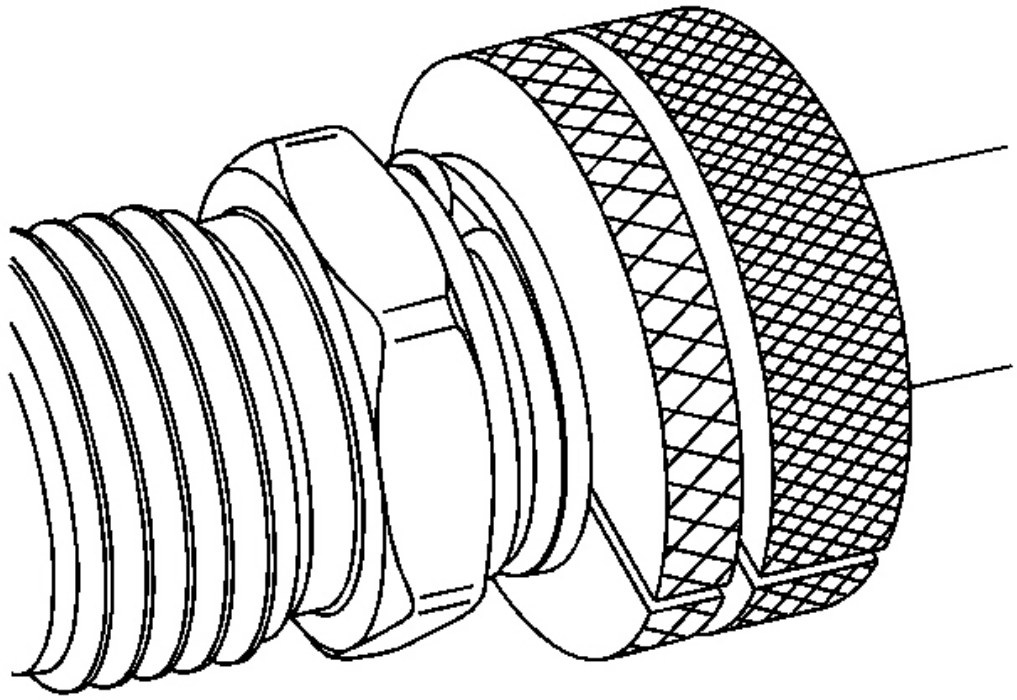


Fig. 46: Rotating J 41623-B On Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

NOTE: **Rotate the J 41623-B: 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool to engage the EOC pipe fitting's retainer slots.**
The J 41623-B: 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool should be nearly flush with the fitting.

3. Connect the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool onto the EOC pipe fitting.

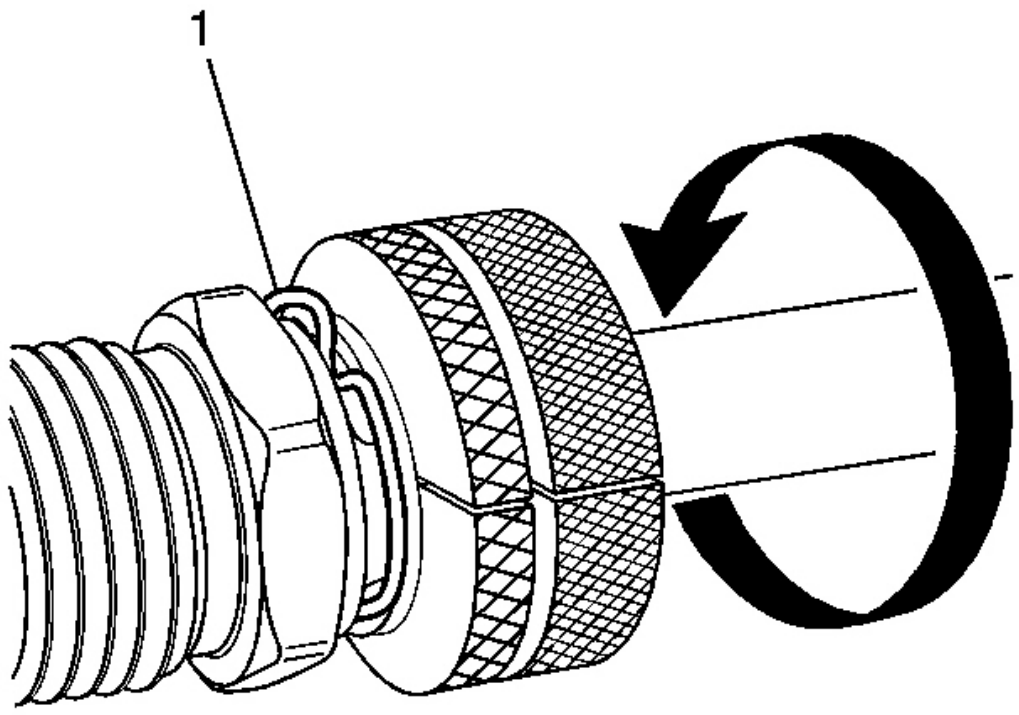


Fig. 47: Identifying Retainer Clip
Courtesy of GENERAL MOTORS CORP.

4. Rotate the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool until the retainer clip (1) rises above the fitting retainer seat.

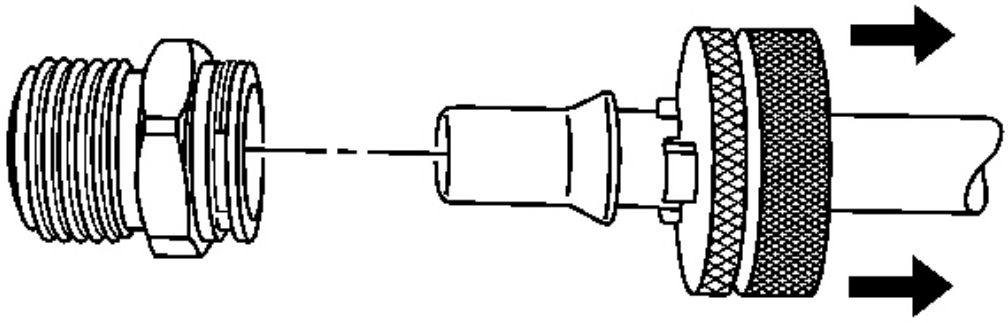


Fig. 48: Disengaging Pipe From EOC Pipe Fitting
Courtesy of GENERAL MOTORS CORP.

5. Pull back on the EOC pipe to disengage the pipe from the EOC pipe fitting.
6. Remove the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool from the EOC pipe.

Installation Procedure

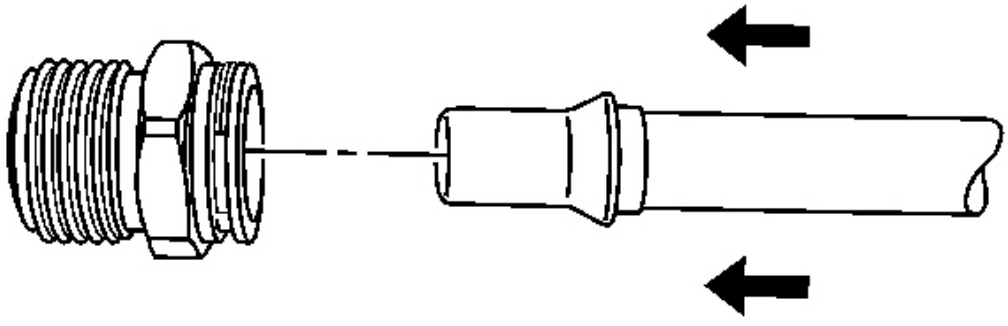


Fig. 49: Installing EOC Pipe Into EOC Pipe Fitting
Courtesy of GENERAL MOTORS CORP.

NOTE: Inspect the EOC pipe fitting and retaining clip for signs of wear or damage. Replace the components if necessary.

1. Install the EOC pipe into the EOC pipe fitting.

   A distinct snap should be heard or felt when assembling the EOC pipe to the fitting.

2. To ensure the cooler line is properly installed, give the cooler pipe a gentle pull.

ENGINE OIL COOLER COOLANT INLET HOSE REPLACEMENT (LS3)

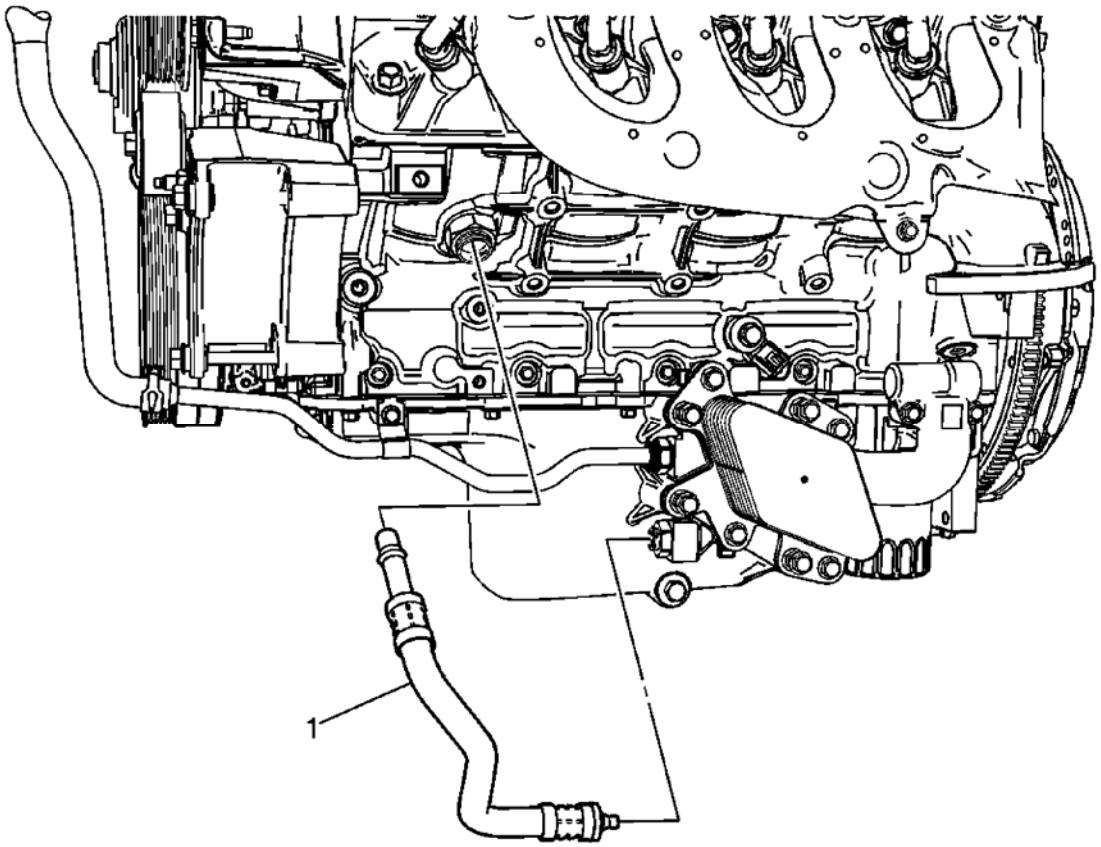


Fig. 50: Engine Oil Cooler Coolant Inlet Hose (LS3)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Install oil drain pan under the vehicle. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**	
1	Engine Oil Cooler Coolant Inlet Hose **Procedure:** Disconnect the engine oil cooler coolant inlet hose from the engine and cooler. Refer to **Engine Oil Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection**

ENGINE OIL COOLER PIPE REPLACEMENT (LS3)

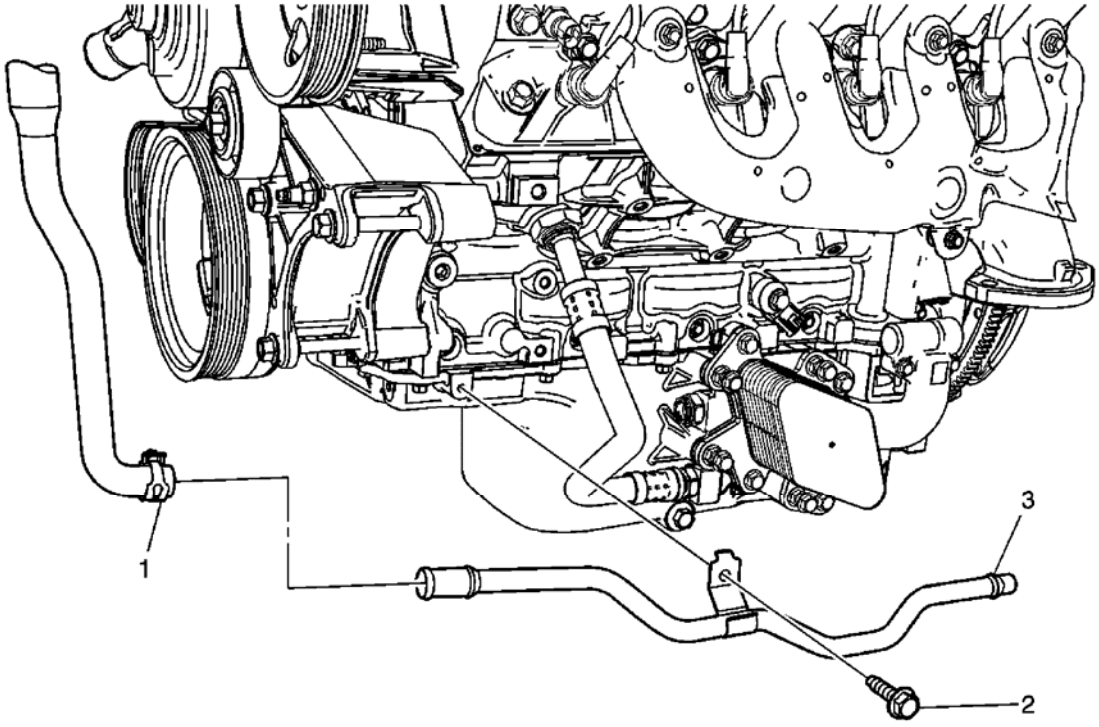


Fig. 51: Engine Oil Cooler Pipe (LS3)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Install oil drain pan under the vehicle. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**	
1	Radiator Inlet Hose Clamp **Procedure:** Using J 38185: Hose Clamp Pliers reposition the radiator inlet hose clamps. **Special Tools:** **J 38185:** Hose Clamp Pliers
2	Engine Oil Cooler Pipe Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
3	Engine Oil Cooler Pipe **Procedure:**

	Disconnect the engine oil cooler pipe from the engine oil cooler. Refer to **Engine Oil Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection**

ENGINE COOLANT FAN REPLACEMENT

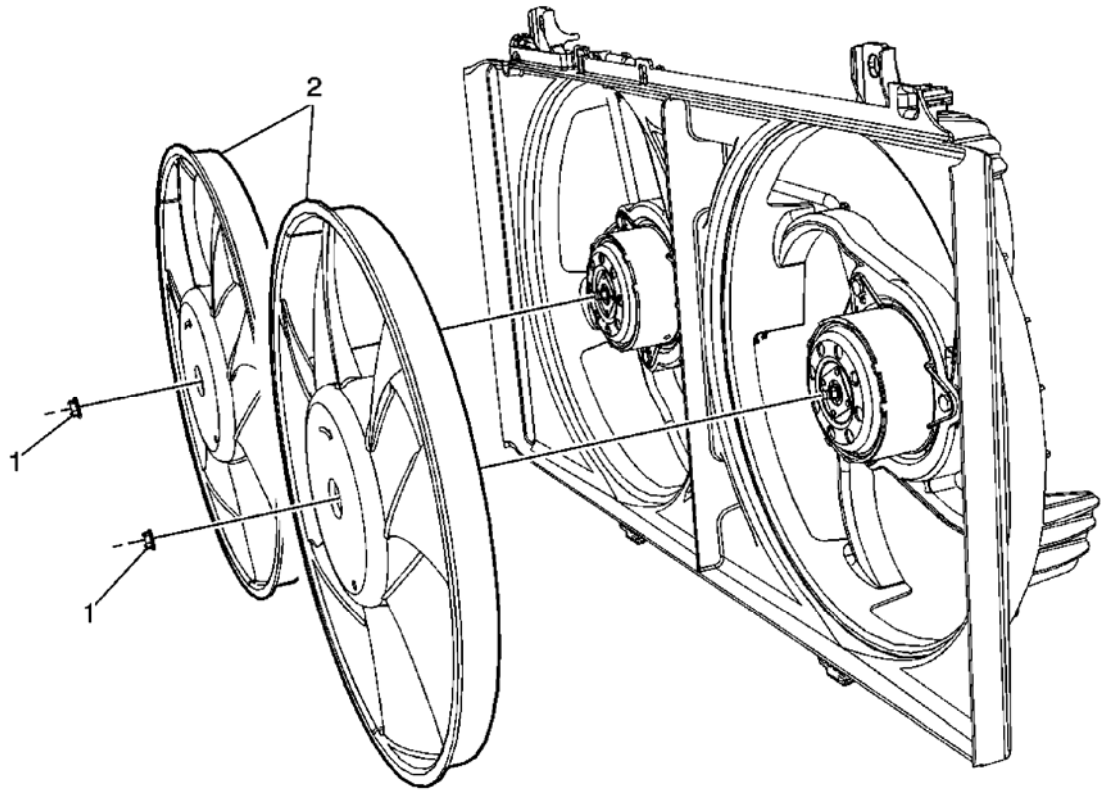


Fig. 52: Engine Coolant Fan
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove engine coolant fan and shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**	
1	Engine Coolant Fan Nuts (Qty 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 6 N.m (53 lb in)
2	Engine Coolant Fan

ENGINE COOLANT FAN MOTOR REPLACEMENT

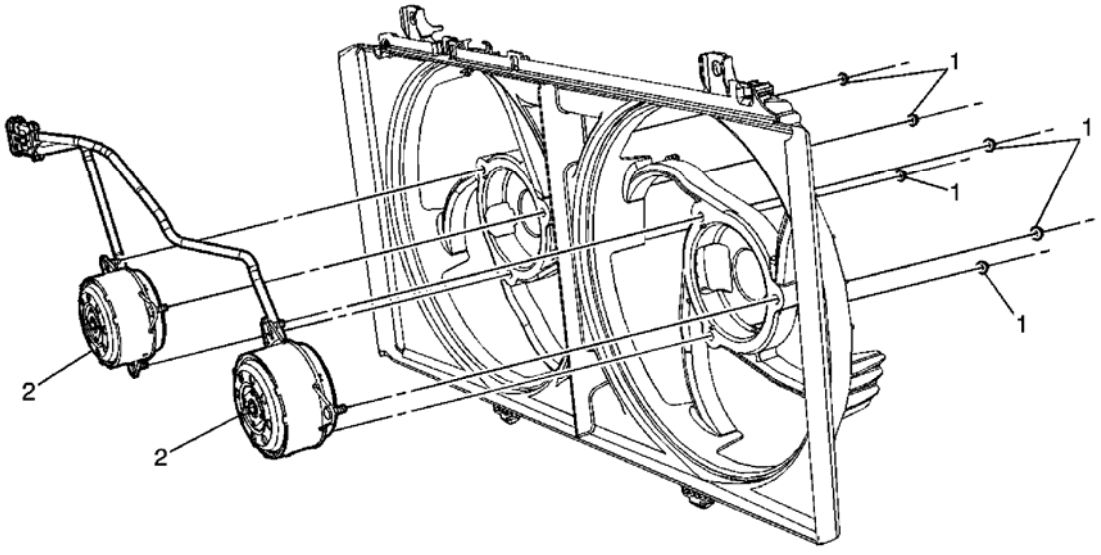


Fig. 53: Engine Coolant Fan Motor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove engine coolant fan. Refer to **Engine Coolant Fan Replacement**	
1	Engine Coolant Fan Motor Nuts (Qty 6) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 6 N.m (53 lb in)
2	Engine Coolant Fan Motor

ENGINE COOLANT THERMOSTAT LOWER HOUSING REPLACEMENT (LLT)

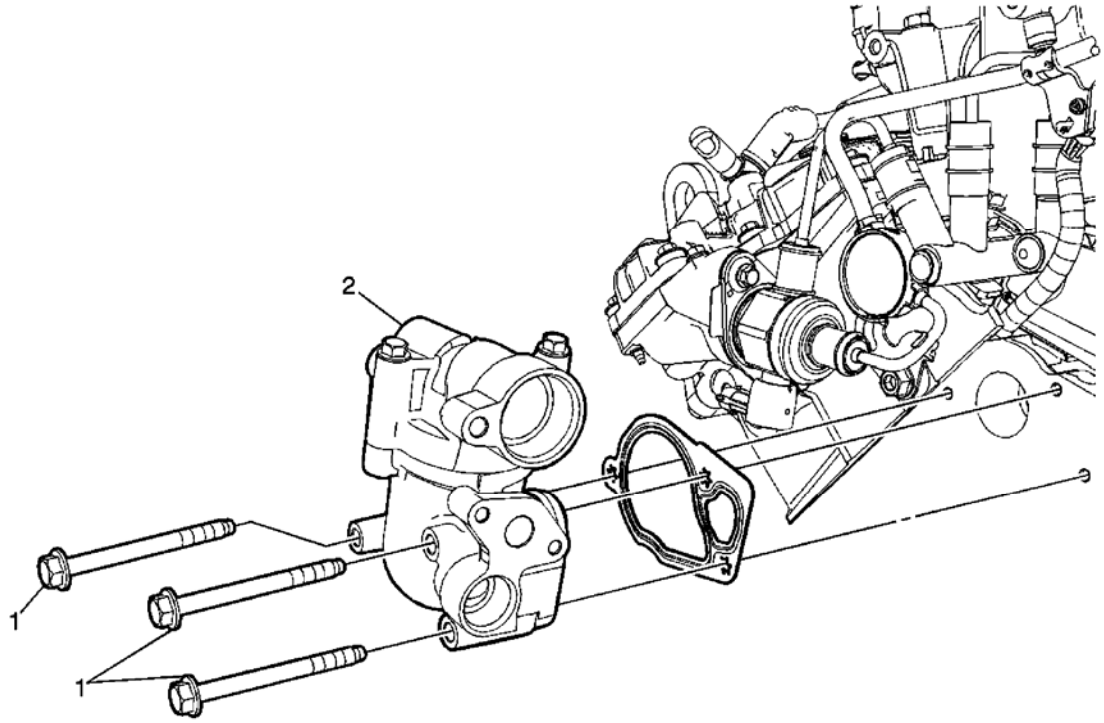


Fig. 54: Engine Coolant Thermostat Lower Housing (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the rear intake manifold cover.Refer to **Intake Manifold Cover Replacement - Rear** 3. Remove the radiator outlet pipe. Refer to **Radiator Outlet Pipe Replacement (LLT)**. 4. Remove the inlet and outlet Heater pipes. Refer to **Heater Inlet And Outlet Pipe Replacement (LLT)**. 5. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .	
1	Lower Thermostat Housing Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Upper and Lower Thermostat Housing **Procedure:** Install NEW lower thermostat housing seals.

ENGINE COOLANT THERMOSTAT REPLACEMENT (LLT)

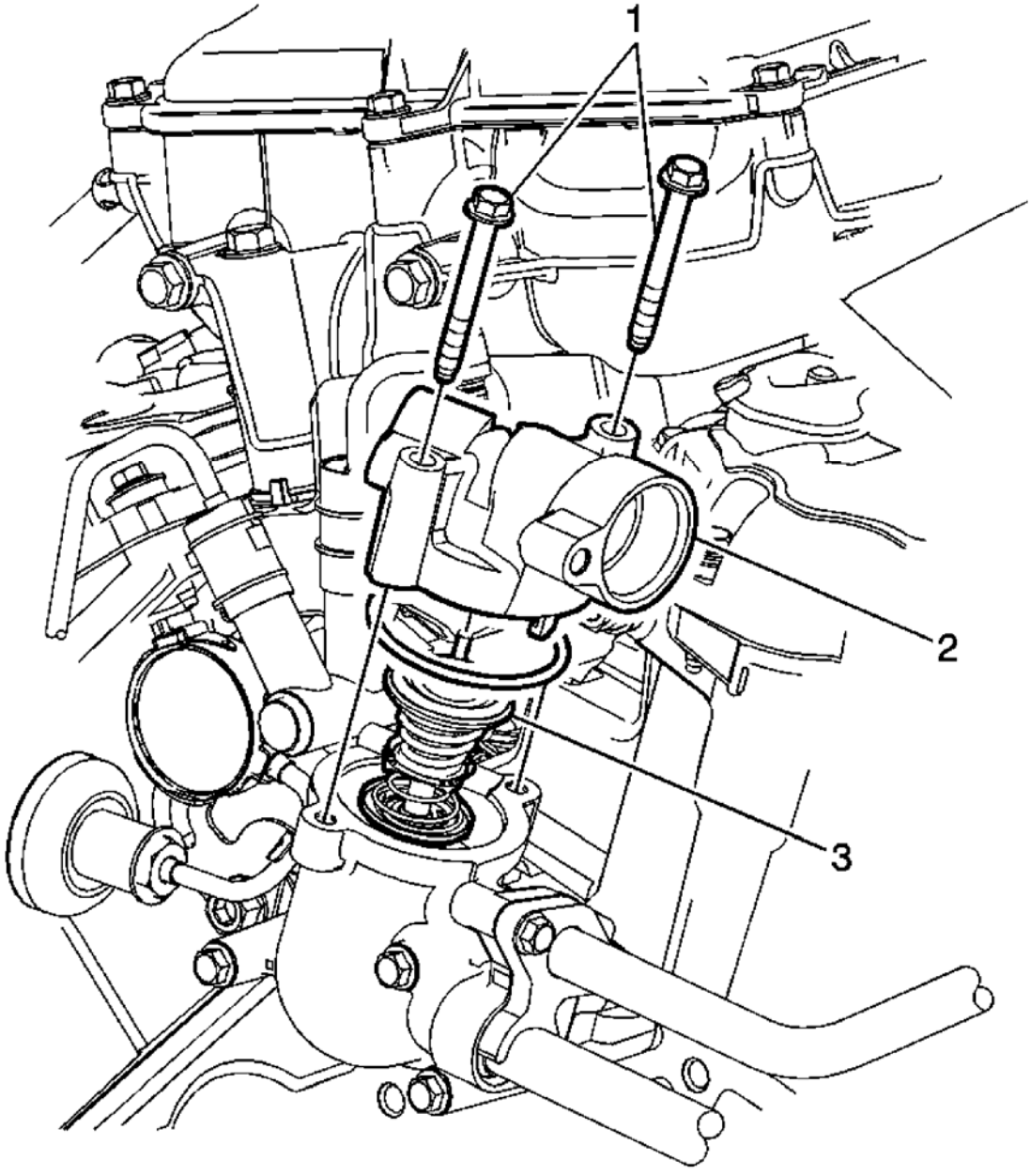


Fig. 55: Engine Coolant Thermostat (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System**	

Draining and Filling (GE 47716).

2. Remove the radiator outlet pipe. Refer to **Radiator Outlet Pipe Replacement (LLT)**.
3. Remove the rear intake manifold cover.Refer to **Intake Manifold Cover Replacement - Rear**

1	Engine Coolant Thermostat Housing Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Upper Engine Coolant Thermostat Housing
3	Thermostat **Procedure:** Install a New thermostat housing seal.

ENGINE COOLANT THERMOSTAT REPLACEMENT (L99/LS3)

Removal Procedure

NOTE: **The engine cooling system thermostat and water pump will not function correctly if oil is present in the cooling system.**
The cooling system MUST be flushed, the water pump and thermostat replaced if oil is found in the cooling system.

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Reposition the outlet hose clamp at the water pump inlet.
3. Remove the outlet hose from the water pump inlet.

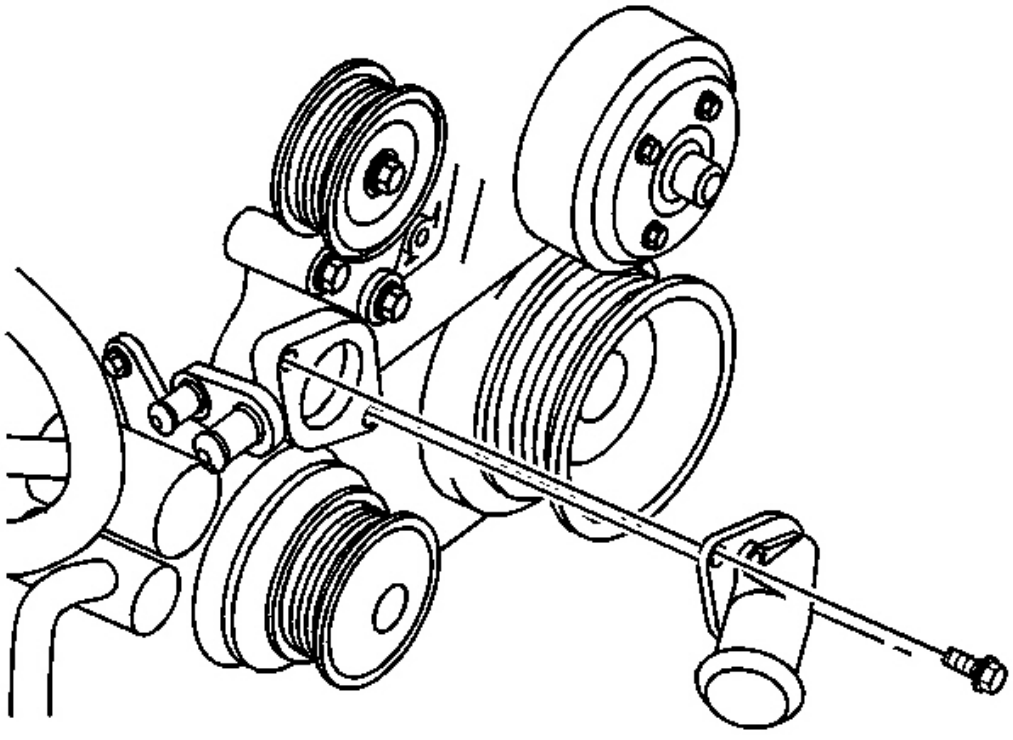


Fig. 56: View Of Water Pump Inlet
Courtesy of GENERAL MOTORS CORP.

4. Remove the water pump inlet bolts.
5. Remove the water pump inlet.
6. The O-ring seal is integral to the thermostat housing.
7. Remove the thermostat housing.

Installation Procedure

1. Install the thermostat housing.
2. Ensure the thermostat housing has an O-ring seal and is in the groove correctly.

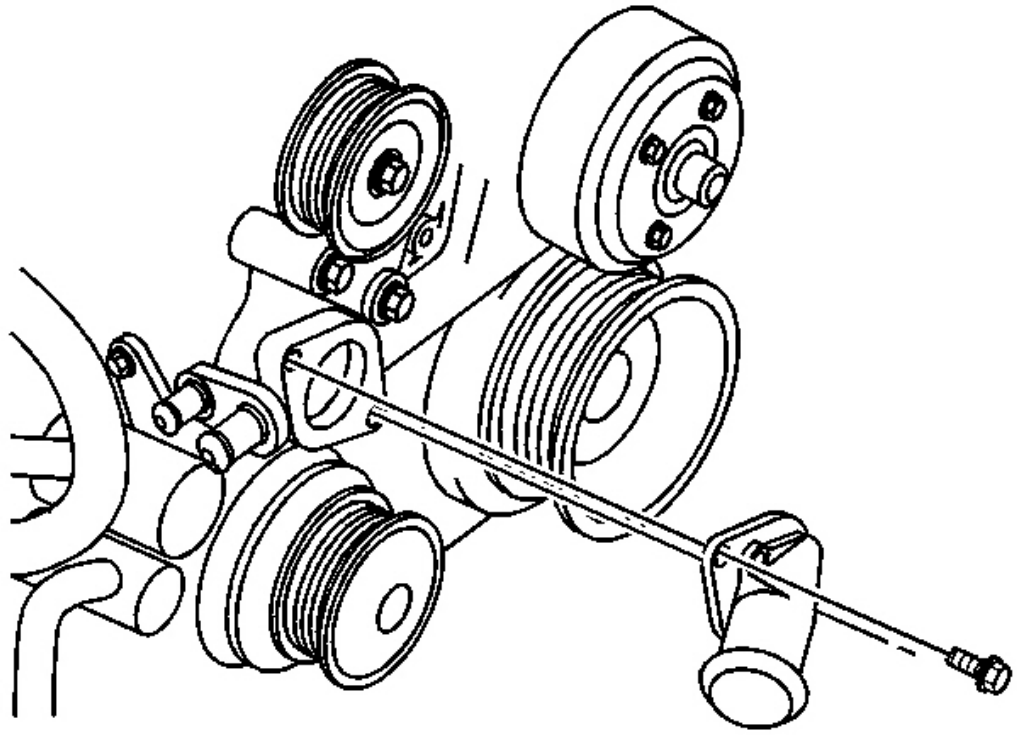


Fig. 57: View Of Water Pump Inlet
Courtesy of GENERAL MOTORS CORP.

3. Install the water pump inlet (with thermostat).

CAUTION: Refer to Fastener Caution .

4. Install the water pump inlet bolts.

   Tighten: Tighten the water pump inlet bolts to 15 N.m (11 lb ft).

5. Install the outlet hose to the water pump inlet.
6. Position the outlet hose clamp at the water outlet.
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (LLT)

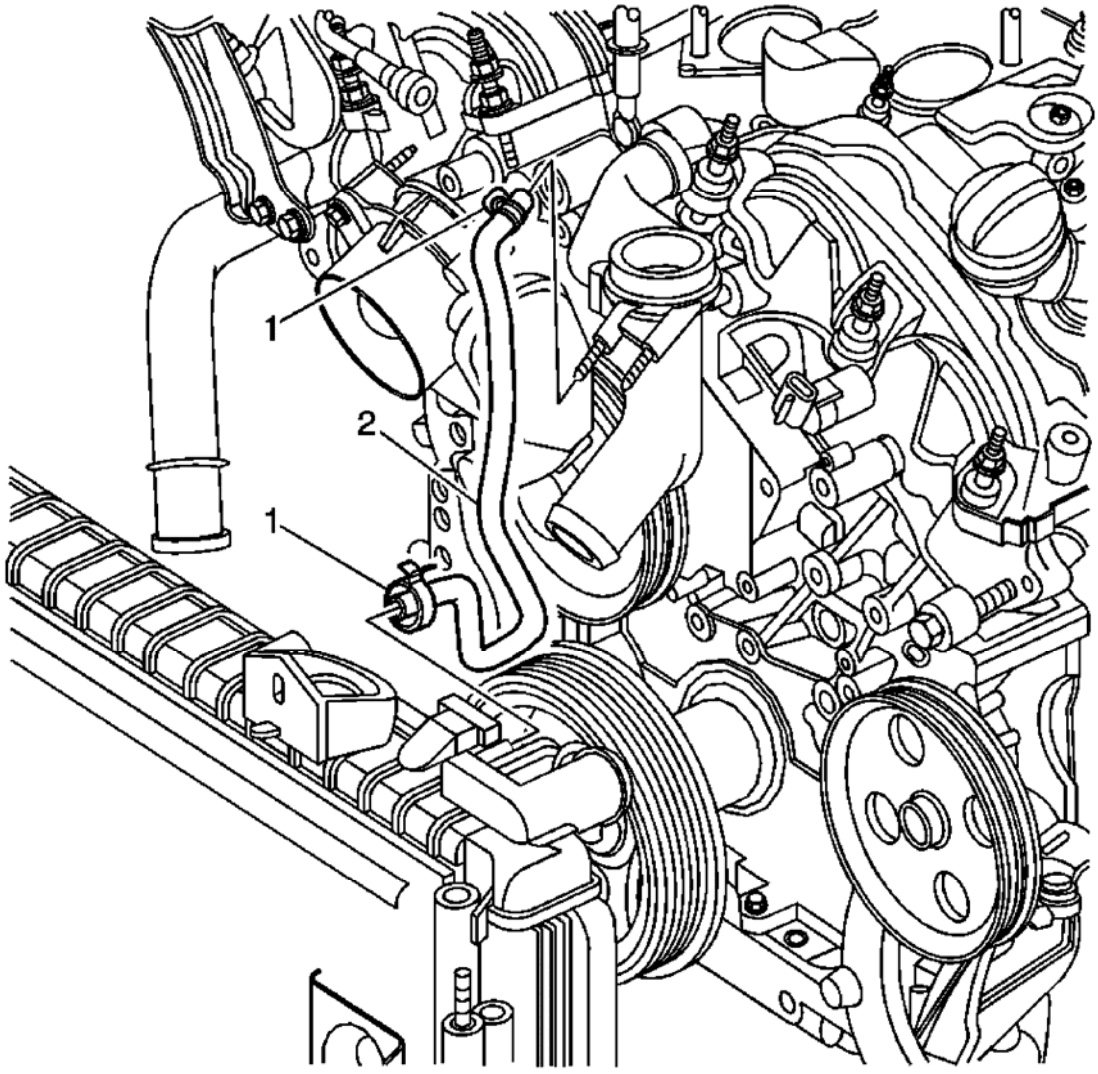


Fig. 58: Engine Coolant Air Bleed Hose (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** 2. Remove front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** 3. Remove air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**	
	Engine Coolant Air Bleed Hose Clamps

1	**Procedure:** Reposition engine coolant air bleed hose clamp using **J 38185:** Hose Clamp Pliers. **Special Tools:** **J 38185:** Hose Clamp Pliers
2	Engine Coolant Air Bleed Hose

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (LS3, L99)

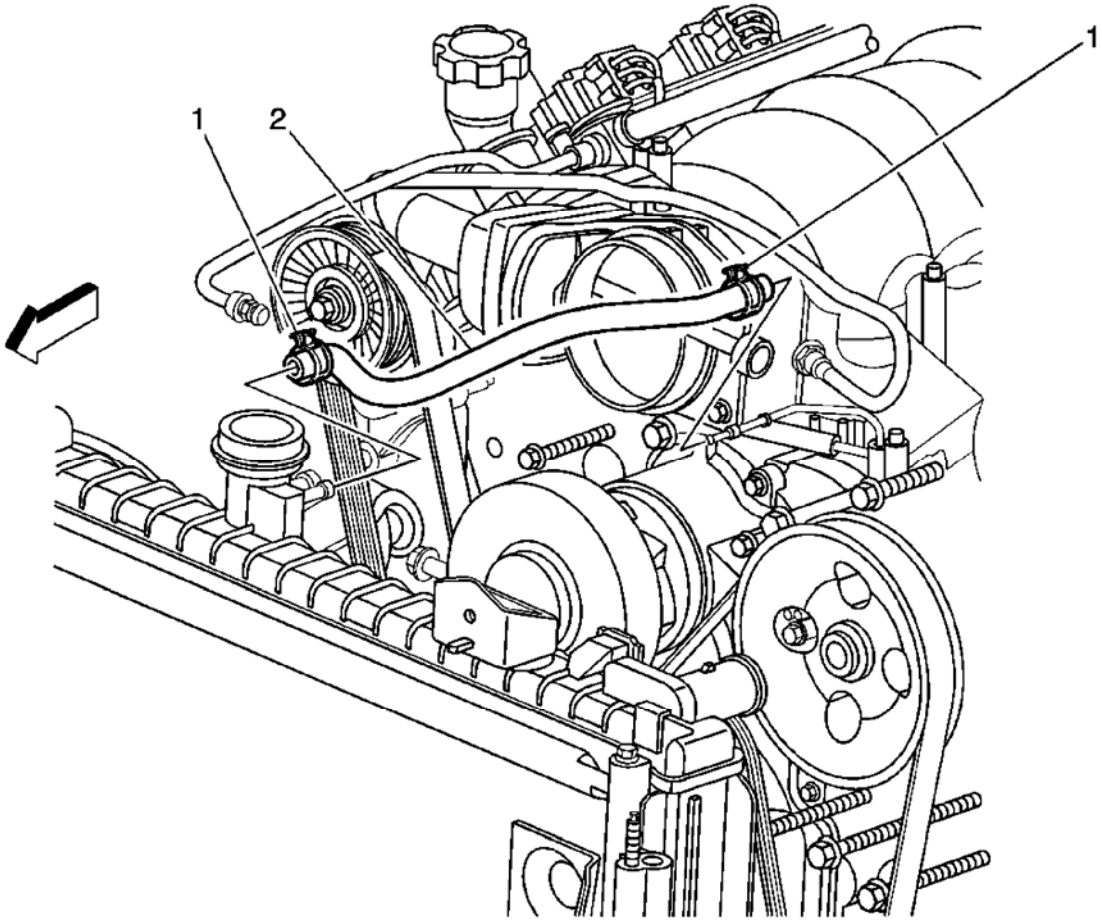


Fig. 59: Engine Coolant Air Bleed Hose (LS3, L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** 2. Remove engine cover. Refer to **Engine Cover Replacement**	

3. Remove air cleaner outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**	
1	Engine Coolant Air Bleed Hose Clamps **Procedure:** Reposition engine coolant air bleed hose clamp using **J 38185:** Hose Clamp Pliers. **Special Tools:** **J 38185:** Hose Clamp Pliers
2	Engine Coolant Air Bleed Hose

WATER OUTLET REPLACEMENT (LLT)

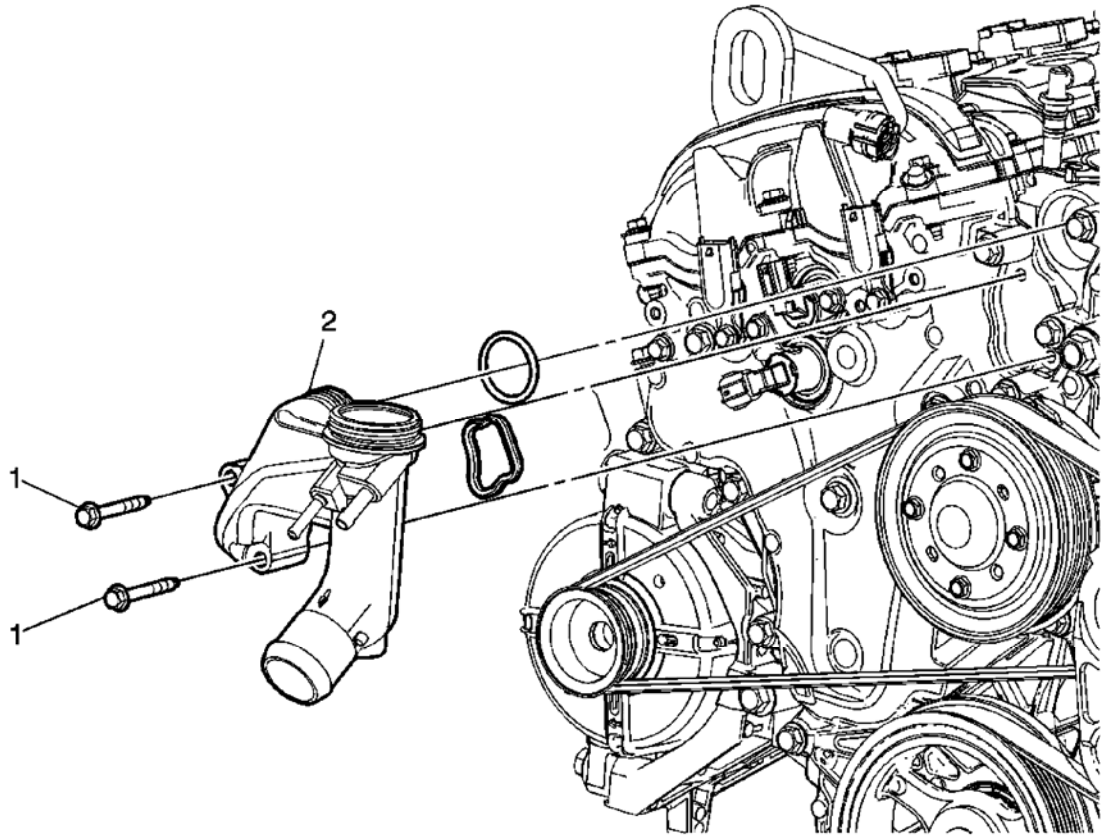


Fig. 60: Water Outlet (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the intake manifold. Refer to **Intake Manifold Replacement**	

1	Bolt, Coolant Outlet Pipe (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Coolant Outlet Pipe **Procedure** 1. Disconnect the outlet radiator hose from the water outlet pipe 2. Disconnect the engine coolant air bleed hoses from the water outlet. 3. Install NEW water outlet seals.

HEATER INLET AND OUTLET PIPE REPLACEMENT (LLT)

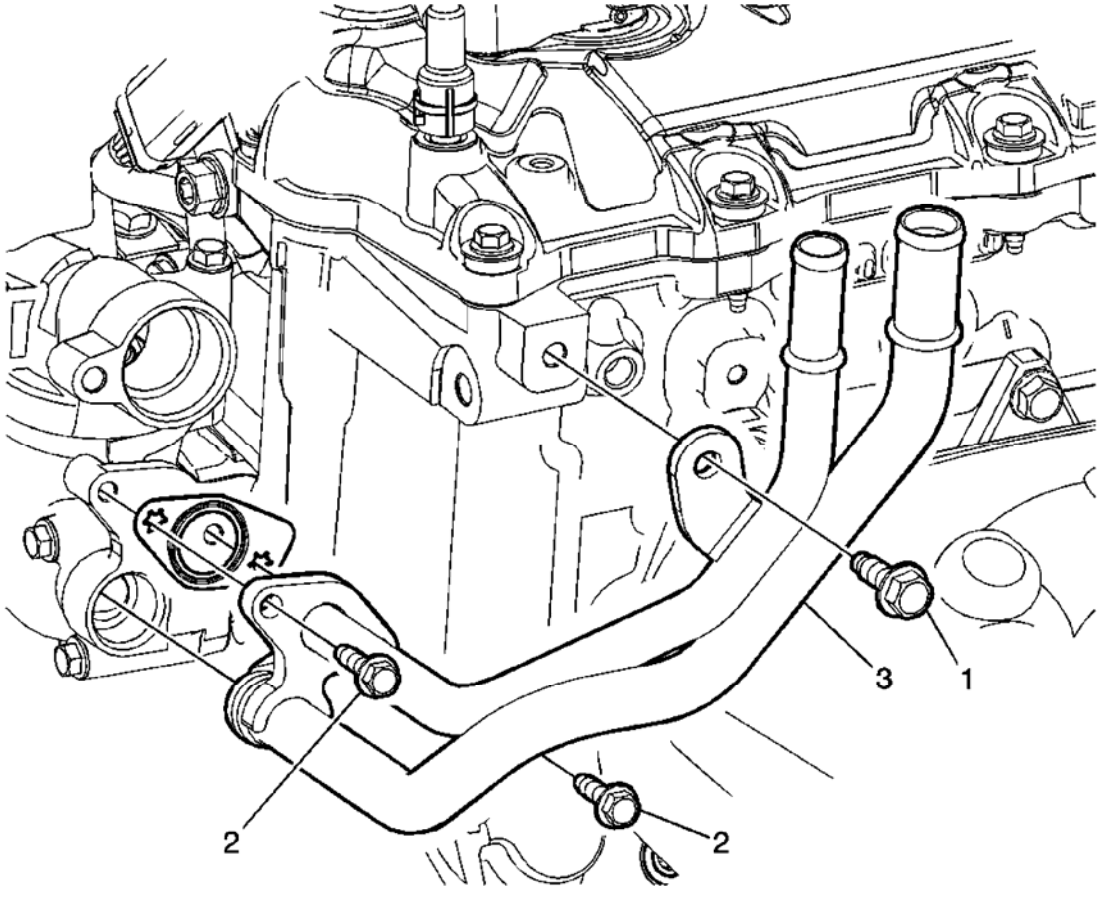


Fig. 61: Heater Inlet & Outlet Pipe (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the rear intake manifold cover.Refer to **Intake Manifold Cover Replacement - Rear** 3. Remove the radiator outlet pipe. Refer to **Radiator Outlet Pipe Replacement (LLT)**. 4. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** . 5. Disconnect the Heater inlet and outer hoses from the heater inlet and outlet pipe.	
1	Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 22 N.m (16 lb ft)
2	Bolt (Qty: 2) **Tighten:** 22 N.m (16 lb ft)
3	Heater Inlet and Outlet Pipe **Procedure:** Install a NEW gasket and seal.

WATER PUMP REPLACEMENT (LLT)

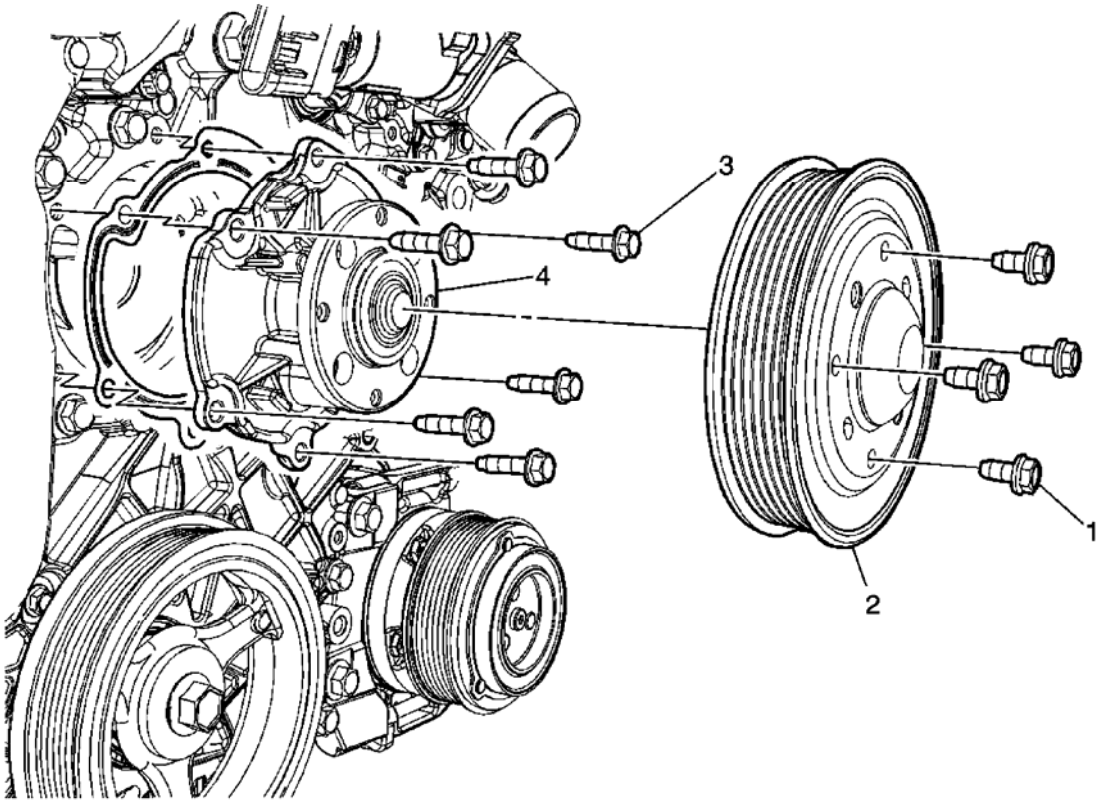


Fig. 62: Water Pump (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** . 3. Remove the water pump drive belt. Refer to **Drive Belt Replacement**	
1	Bolt, Water Pump Pulley **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m(89 lb in)
2	Water Pump Pulley
3	Bolt, Water Pump

	Tighten: 10 N.m(89 lb in)
4	Water Pump **Procedure** • Clean the water pump mating surfaces. • Install a NEW water pump gasket.

WATER PUMP REPLACEMENT (LS3/L99)

Removal Procedure

1. Remove the air cleaner resonator and outlet duct assembly. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
3. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement - Accessory** .
4. Remove the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement** .
5. Disconnect the radiator inlet hose from the water pump. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
6. Disconnect the radiator outlet hose from the water pump. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
7. Disconnect the heater inlet and outlet hose from the water pump. Refer to **Heater Inlet and Outlet Hose Replacement (LS3, L99)** .

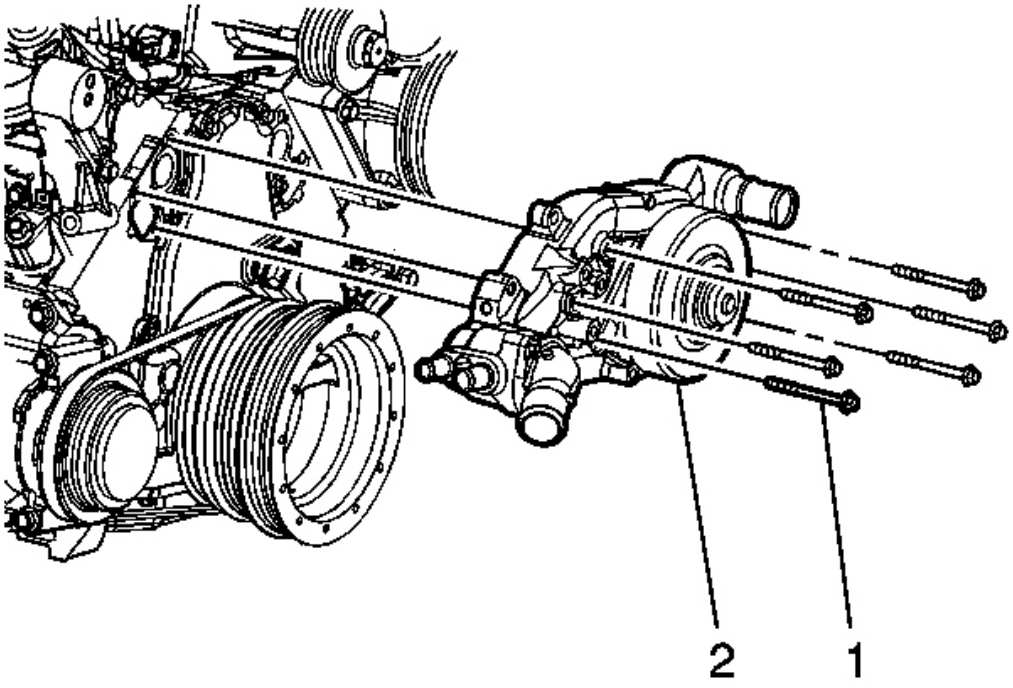


Fig. 63: Identifying Water Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the water pump to block bolts (1).

NOTE: Always clean the water pump and engine block mating surfaces and discard the gaskets.

9. Remove the water pump (2).

Installation Procedure

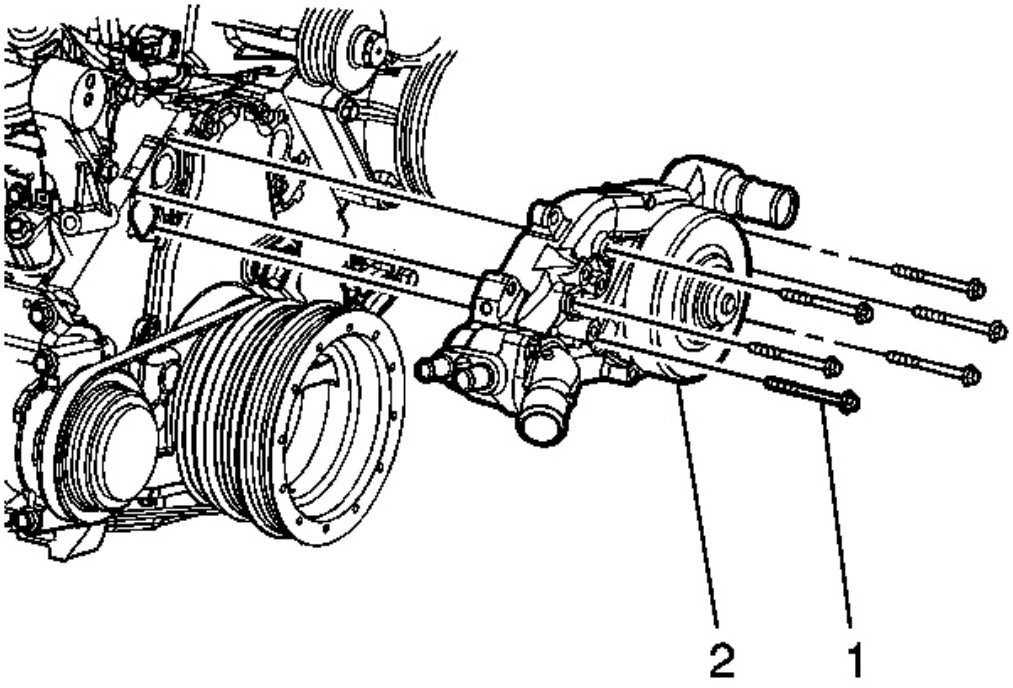


Fig. 64: Identifying Water Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Always install a NEW water pump gasket.

1. Install the water pump (2) to the engine block and tighten the bolts (1) to 30 N.m (22 lb ft).
2. Connect the heater inlet and outlet hose to the water pump. Refer to **Heater Inlet And Outlet Pipe Replacement (LLT)**.
3. Connect the radiator outlet hose to the water pump. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
4. Connect the radiator inlet hose to the water pump. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
5. Install the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement** .
6. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement - Accessory** .
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or

Cooling System Draining and Filling (LLT Static Fill) or **Cooling System Draining and Filling (GE 47716)**.

8. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

RADIATOR DRAIN COCK REPLACEMENT

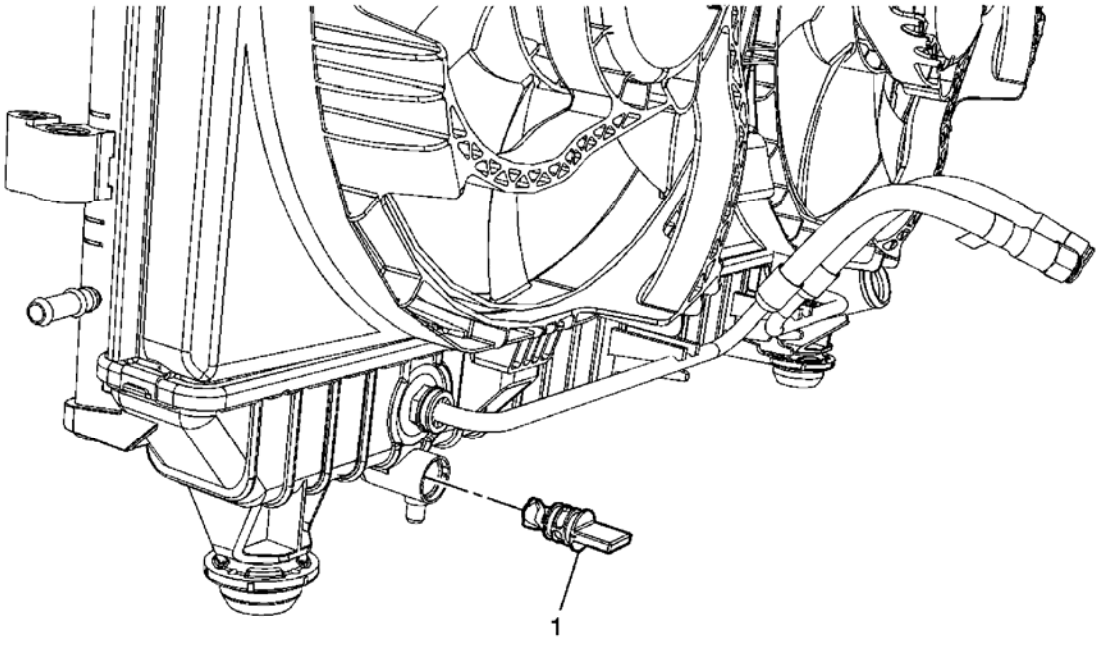


Fig. 65: Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

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

ENGINE COOLANT FAN SHROUD REPLACEMENT (LLT)

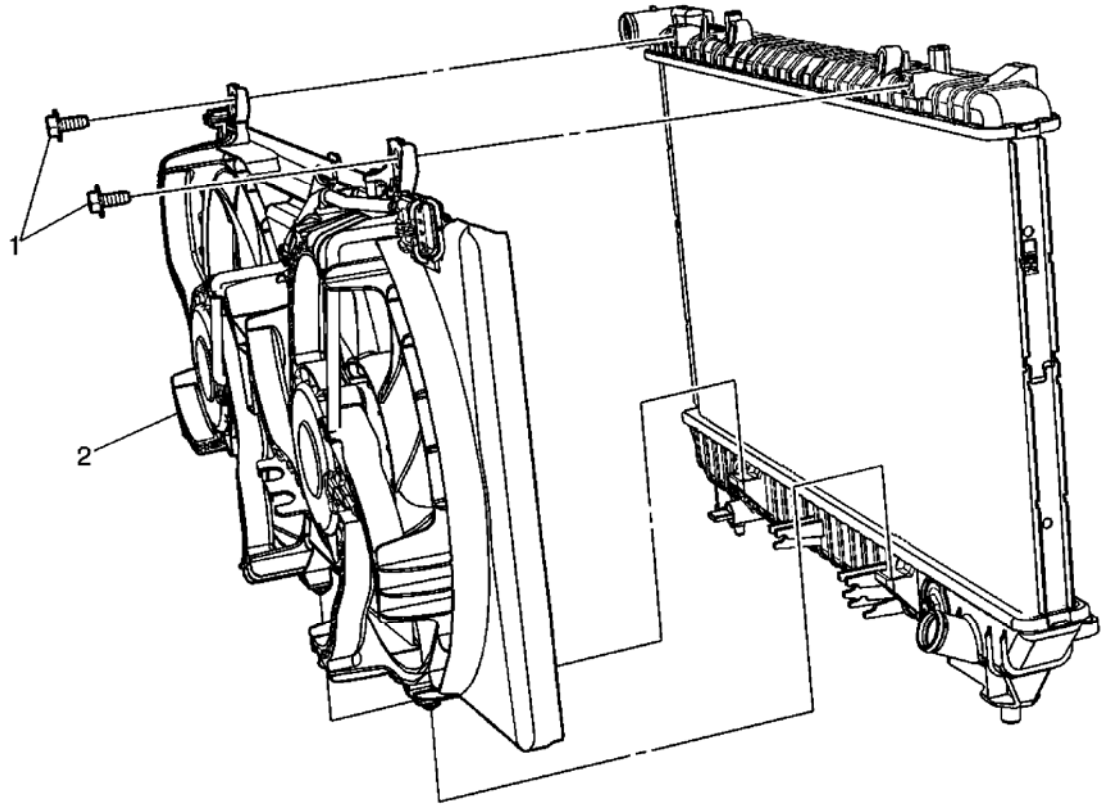


Fig. 66: Engine Coolant Fan Shroud (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove air cleaner resonator and outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** . 2. Reposition radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**. 3. Remove engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**. 4. Remove radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**. 5. Reposition transmission cooler lines. 6. Disconnect the engine coolant fan motor connector.	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .**

	Tighten: 8 N.m (6 lb in)
2	Engine Coolant Fan Shroud

ENGINE COOLANT FAN SHROUD REPLACEMENT (LS3, L99)

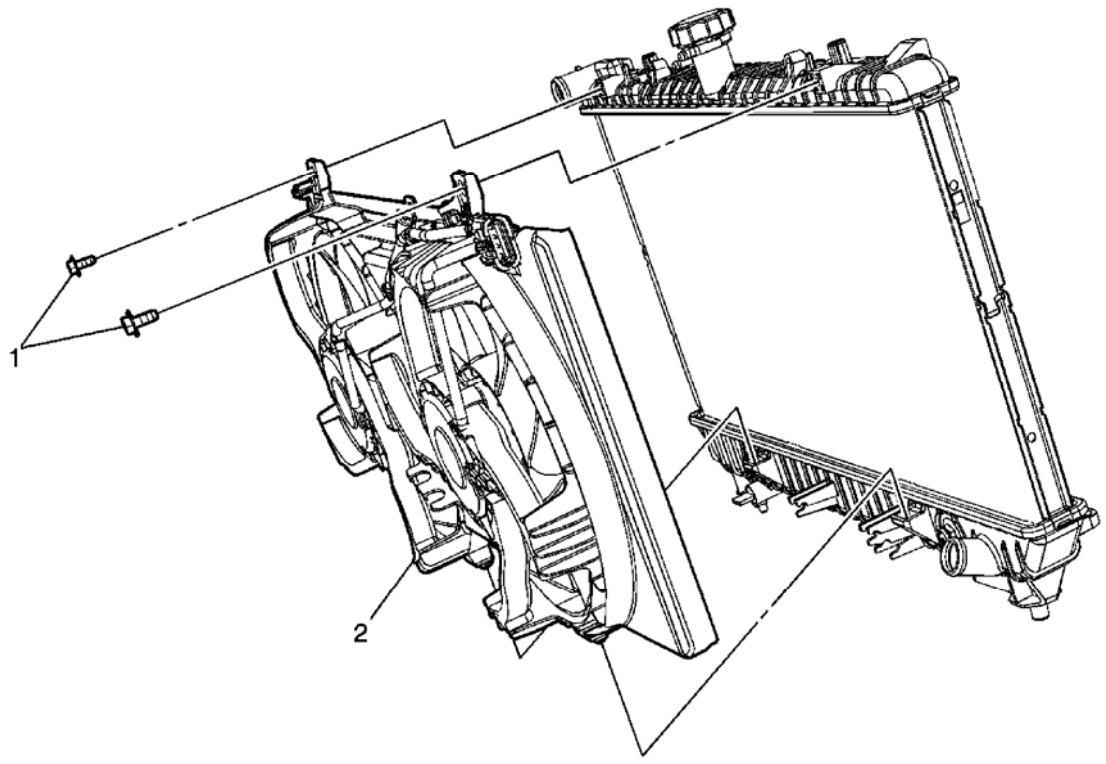


Fig. 67: Engine Coolant Fan Shroud (LS3, L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** . 2. Reposition radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**. 3. Remove engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**. 4. Remove radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**. 5. Reposition transmission cooler lines. 6. Disconnect the engine coolant fan motor connector.	

1	Engine Coolant Fan Shroud Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 8 N.m (6 lb in)
2	Engine Coolant Fan Shroud

RADIATOR REPLACEMENT (LLT)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
3. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
4. Remove the engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**.
5. Remove the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.
6. Remove the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**.
7. Reposition the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
8. Remove transmission oil cooler lines.

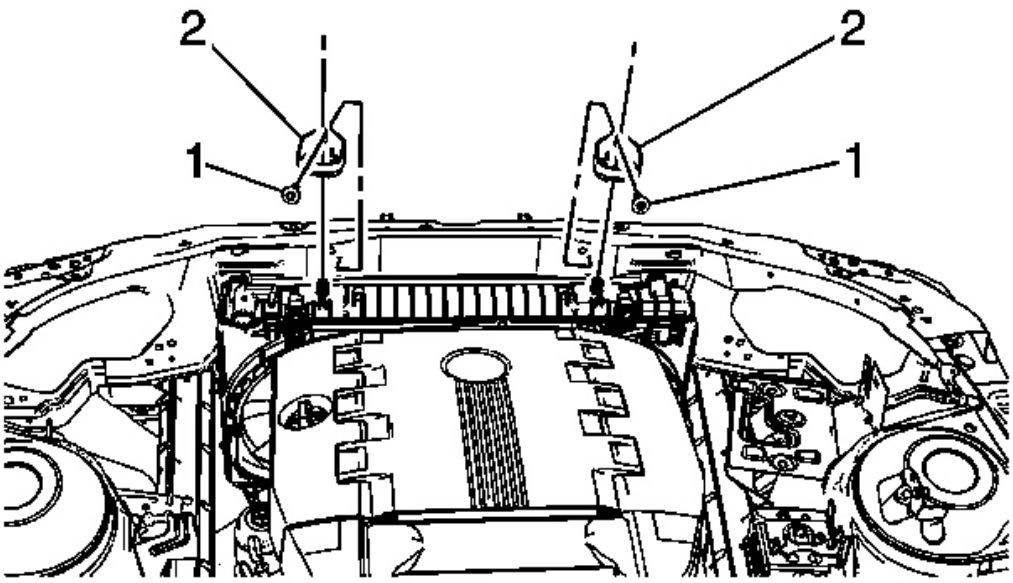


Fig. 68: Radiator Upper Support & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove radiator upper support bolt (1).
10. Remove radiator upper support (2).

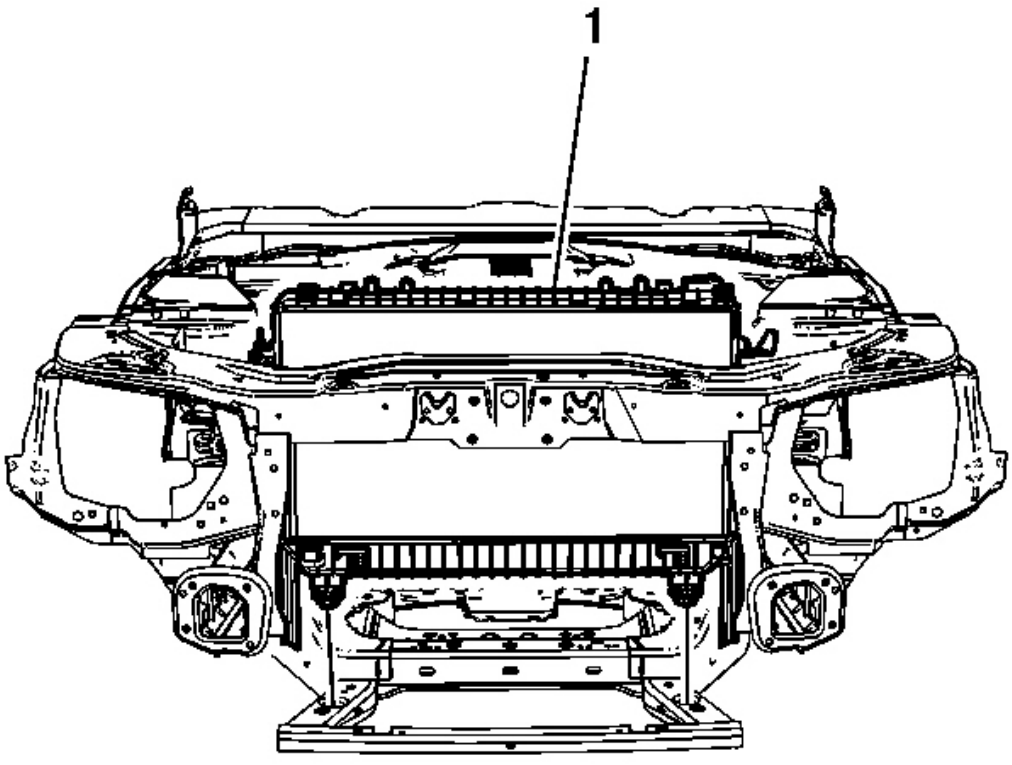


Fig. 69: Radiator
Courtesy of GENERAL MOTORS CORP.

11. Remove radiator (1) from vehicle.

Installation Procedure

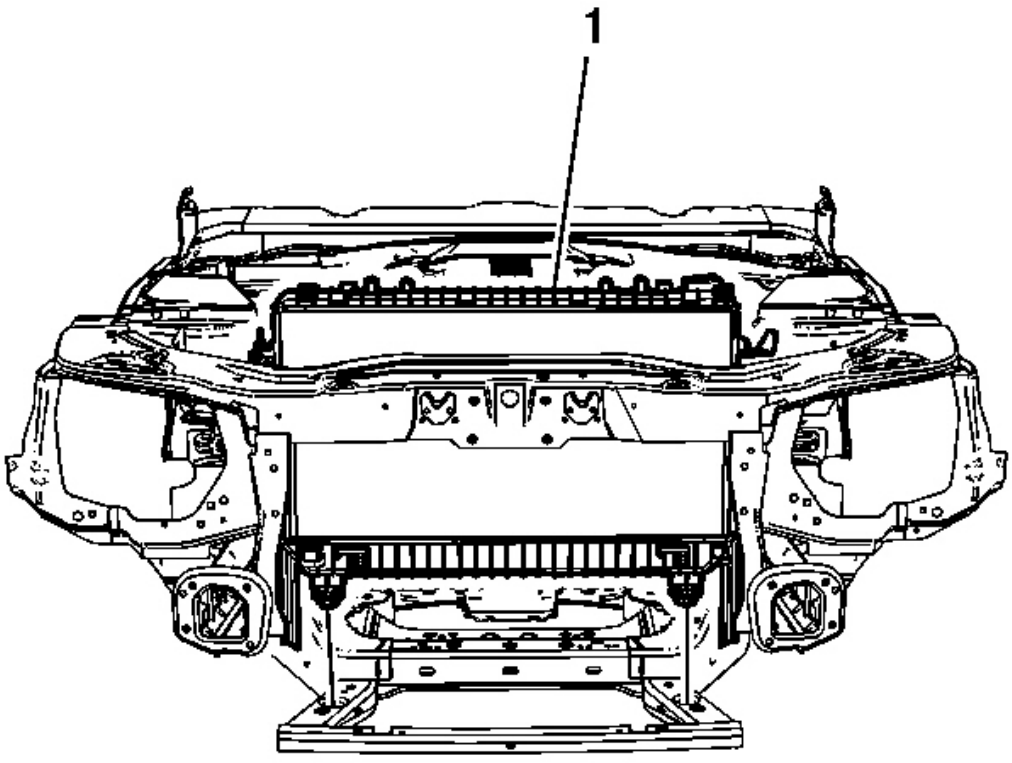


Fig. 70: Radiator
Courtesy of GENERAL MOTORS CORP.

1. Install radiator (1) to vehicle.

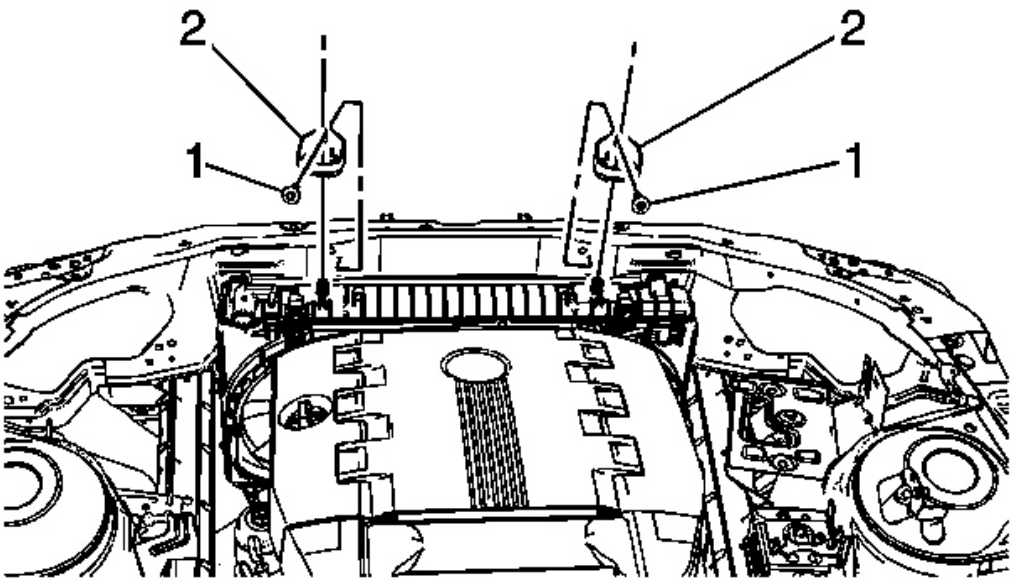


Fig. 71: Radiator Upper Support & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install radiator upper support (2).
3. Install radiator upper support bolt (1) and tighten to 9N.m (80 lb in).
4. Install transmission oil cooler lines.
5. Install the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
6. Install the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**.
7. Install the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.
8. Install the engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**.
9. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
10. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
11. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR REPLACEMENT (LS3, L99)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
3. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
4. Remove the engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**.
5. Remove the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.
6. Remove the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**.
7. Reposition the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
8. Remove transmission oil cooler lines.

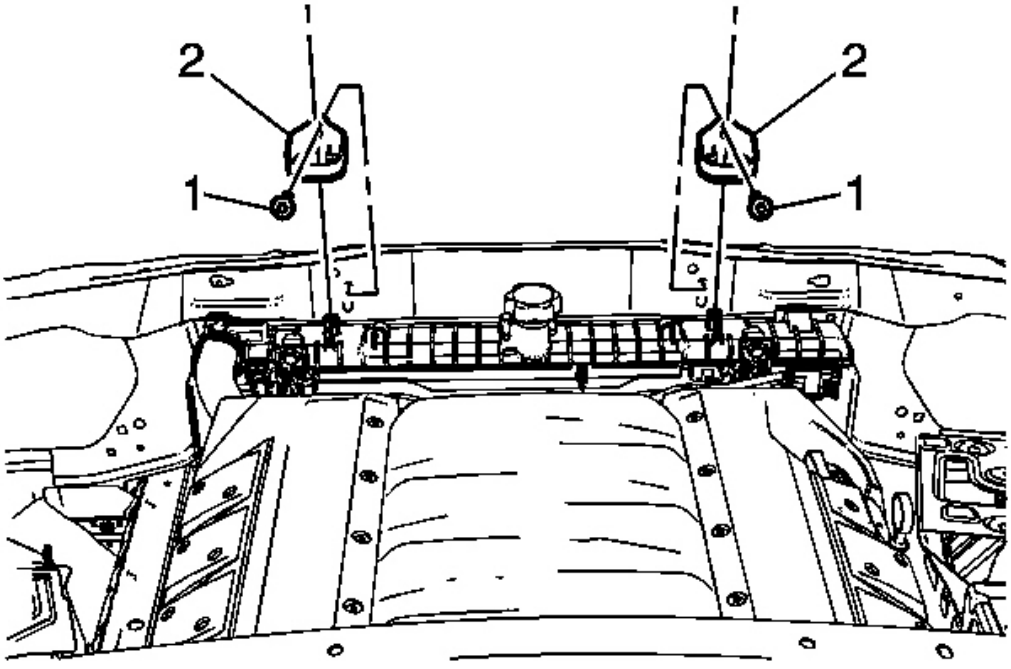


Fig. 72: Radiator Upper Support & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove radiator upper support bolt (1).
10. Remove radiator upper support (2).

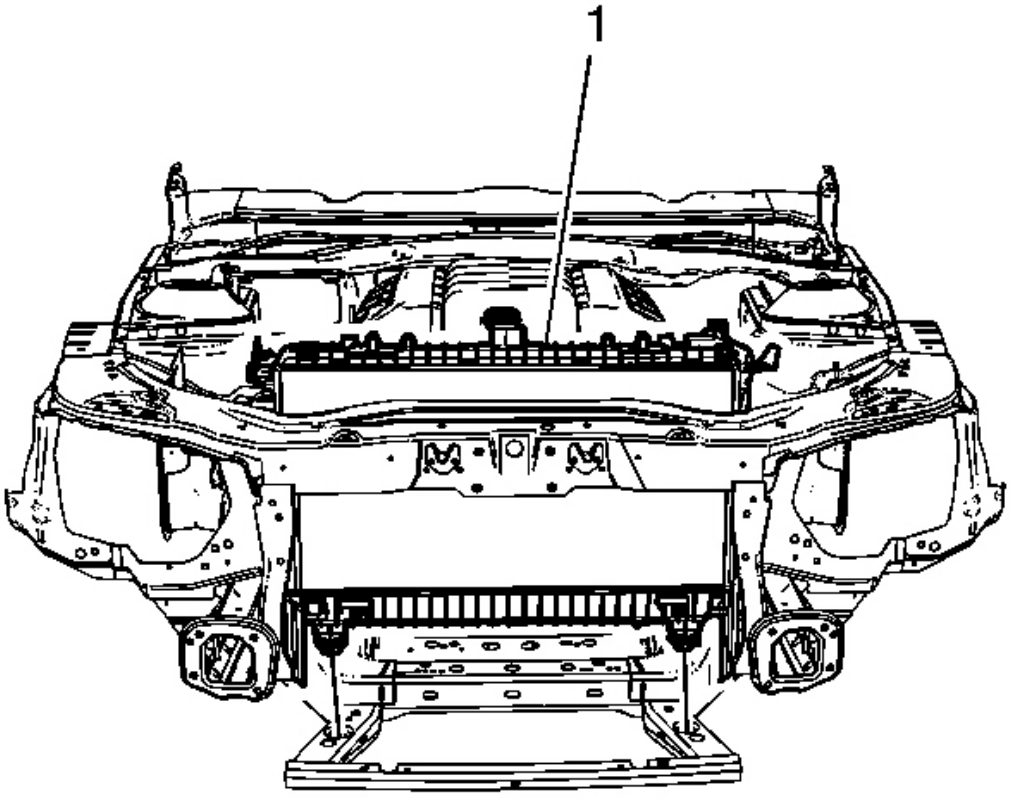


Fig. 73: Radiator
Courtesy of GENERAL MOTORS CORP.

11. Remove radiator (1) from vehicle.

Installation Procedure

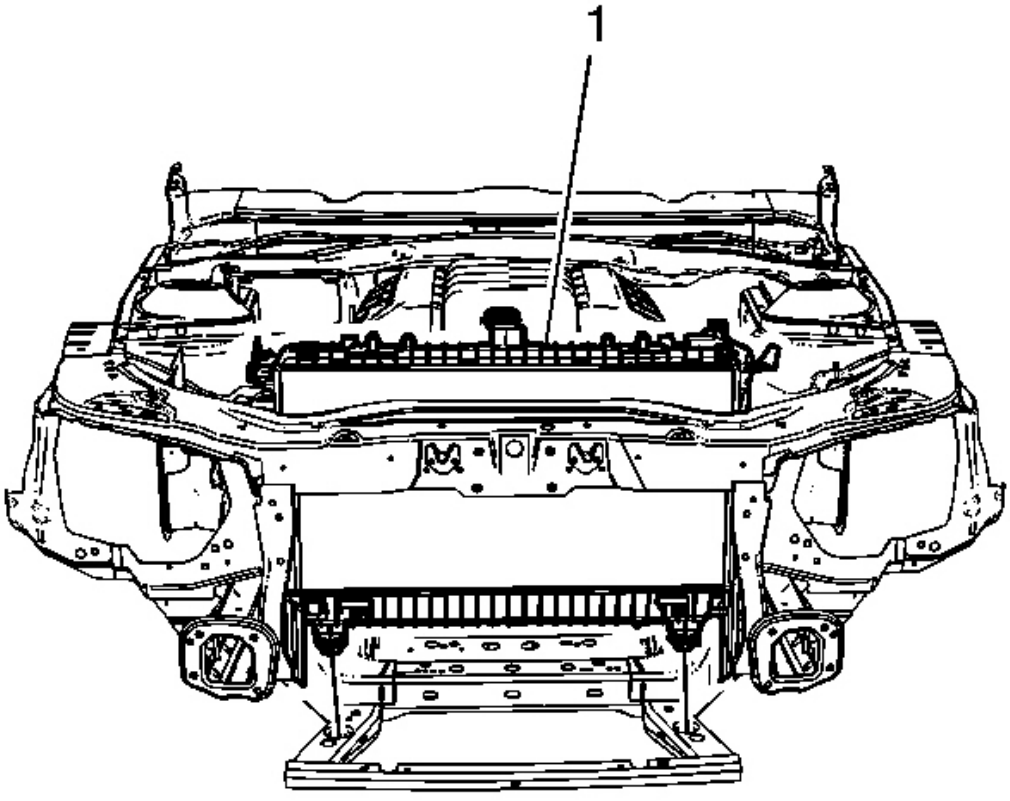


Fig. 74: Radiator
Courtesy of GENERAL MOTORS CORP.

1. Install radiator (1) to vehicle.

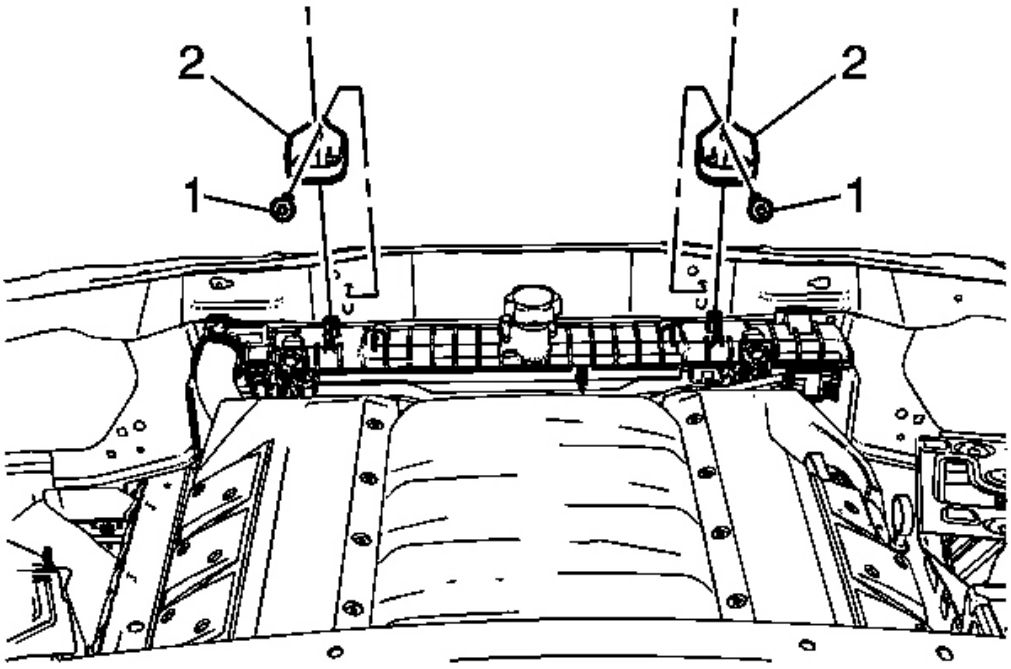


Fig. 75: Radiator Upper Support & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install radiator upper support (2).
3. Install radiator upper support bolt (1) and tighten to 9N.m (80 lb in).
4. Install transmission oil cooler lines.
5. Install the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
6. Install the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**.
7. Install the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.
8. Install the engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**.
9. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
10. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
11. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or

Cooling System Draining and Filling (LLT Static Fill) or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (LEFT)

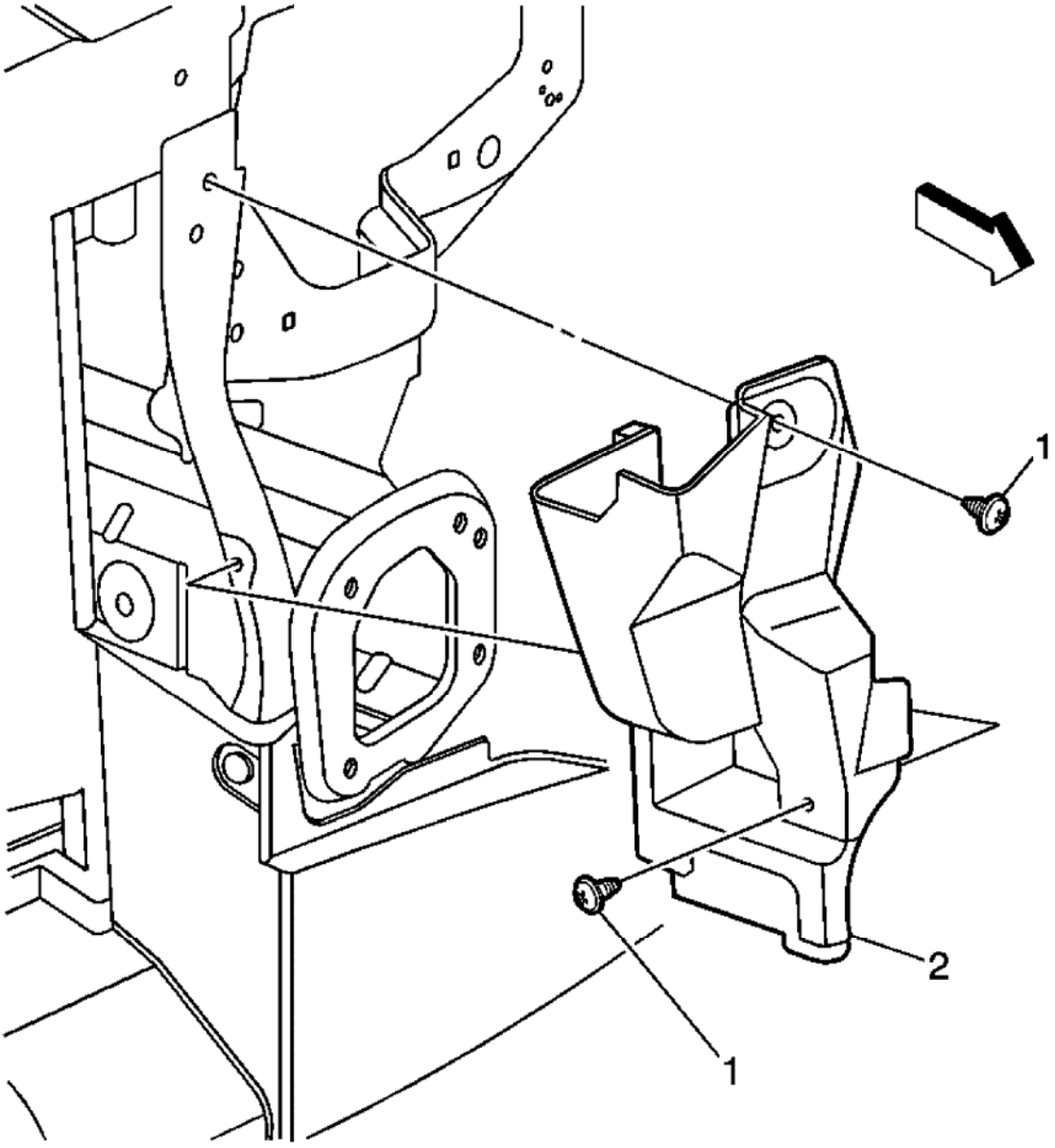


Fig. 76: Radiator Air Side Baffle & Deflector Replacement (Left)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove front bumper fascia. Refer to **Front Bumper Fascia Replacement** .	

1	Radiator Air Side Baffel and Deflector Left Retainer (Qty: 2)
2	Radiator Air Side Baffel and Deflector Left

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (RIGHT)

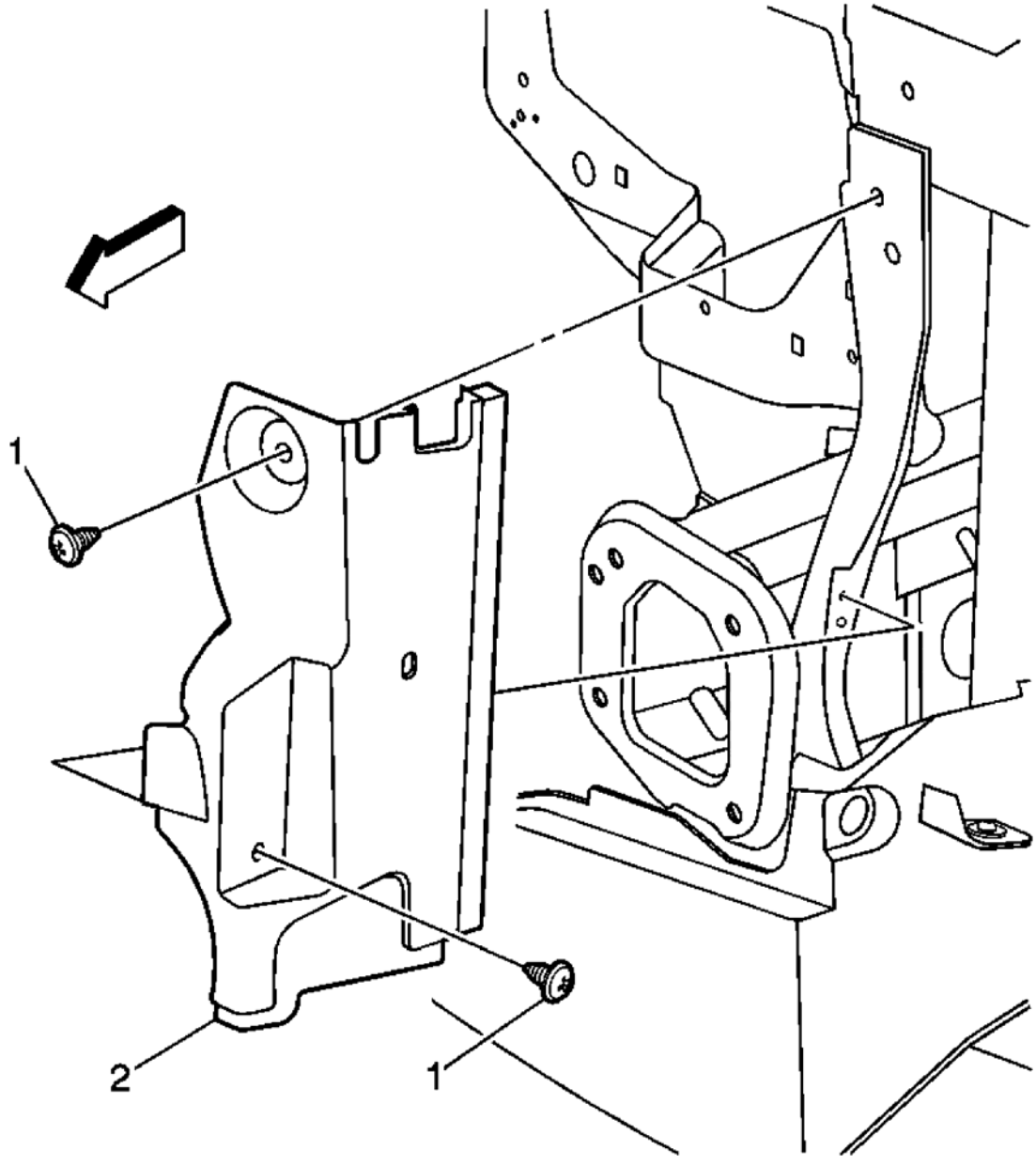


Fig. 77: Radiator Air Side Baffle & Deflector Replacement (Right)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedure: Remove front bumper fascia. Refer to **Front Bumper Fascia Replacement** .	
1	Radiator Air Side Baffel and Deflector Right Retainer (Qty: 2)
2	Radiator Air Side Baffel and Deflector Right

RADIATOR AIR INLET DUCT REPLACEMENT

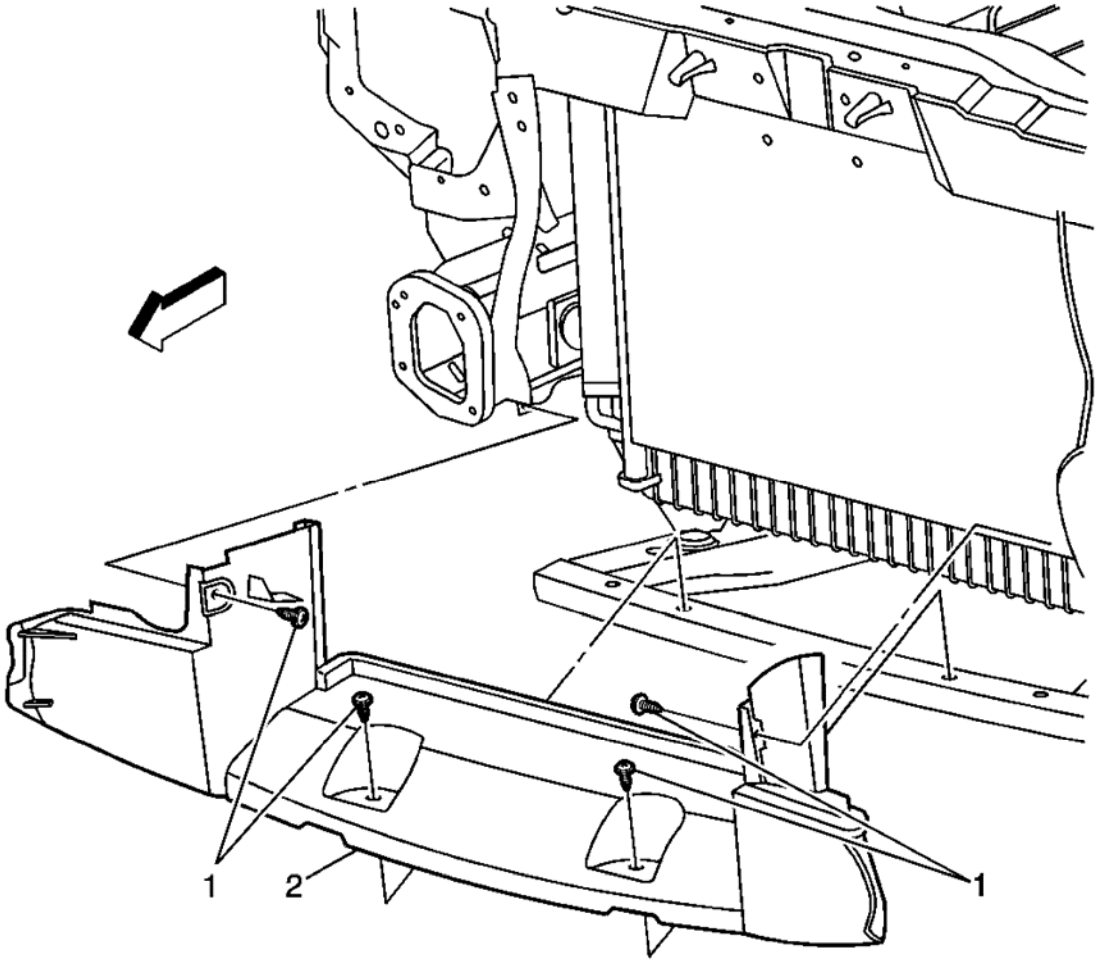


Fig. 78: Radiator Air Inlet Duct
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove front bumper fascia. Refer to **Front Bumper Fascia Replacement** . 2. Remove the ambient air temperature sensor. Refer to **Ambient Air Temperature Sensor Replacement** .	

1	Radiator Air Inlet Duct Retainer (Qty: 4)
2	Radiator Air Inlet Duct

ENGINE COOLANT HEATER REPLACEMENT (V6)

Removal Procedure

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Disconnect the coolant heater cord from the coolant heater.

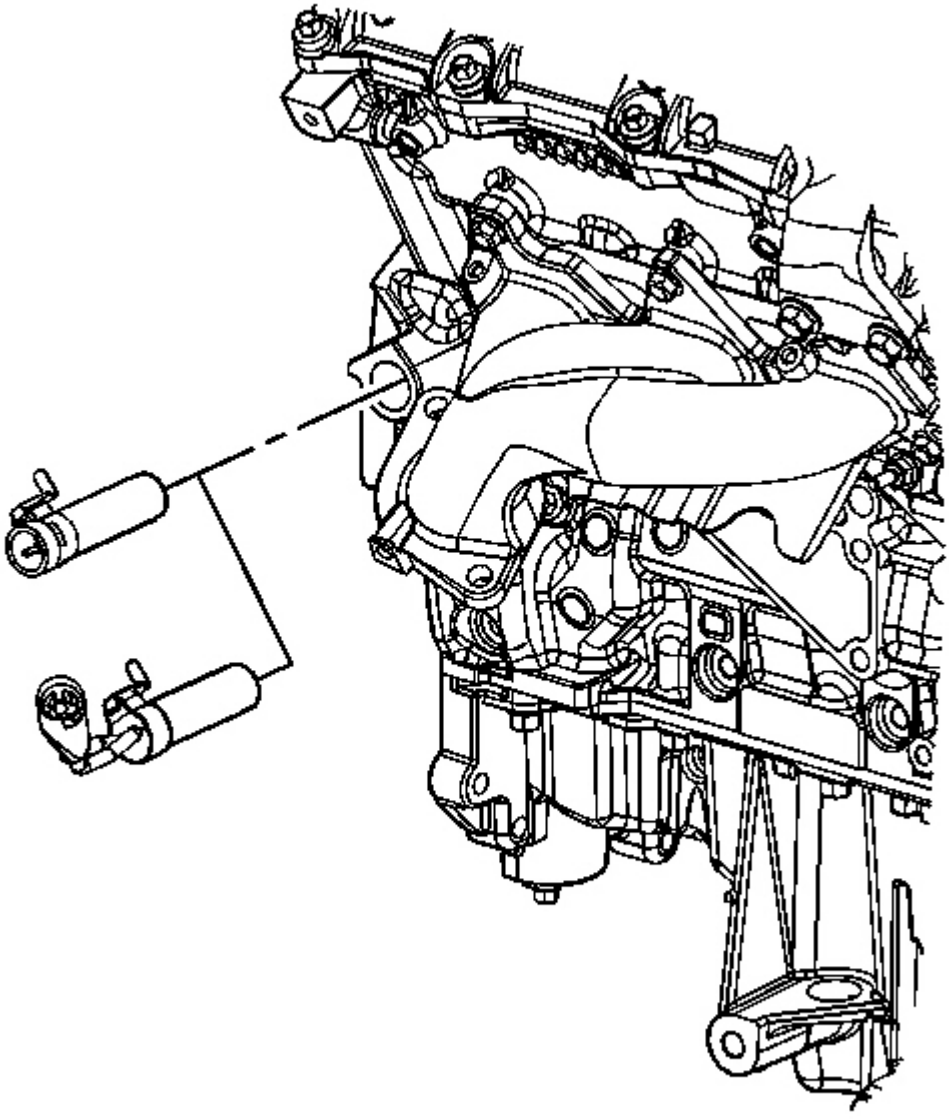


Fig. 79: View Of Coolant Heater (V6)
Courtesy of GENERAL MOTORS CORP.

4. Remove the coolant heater.

Installation Procedure

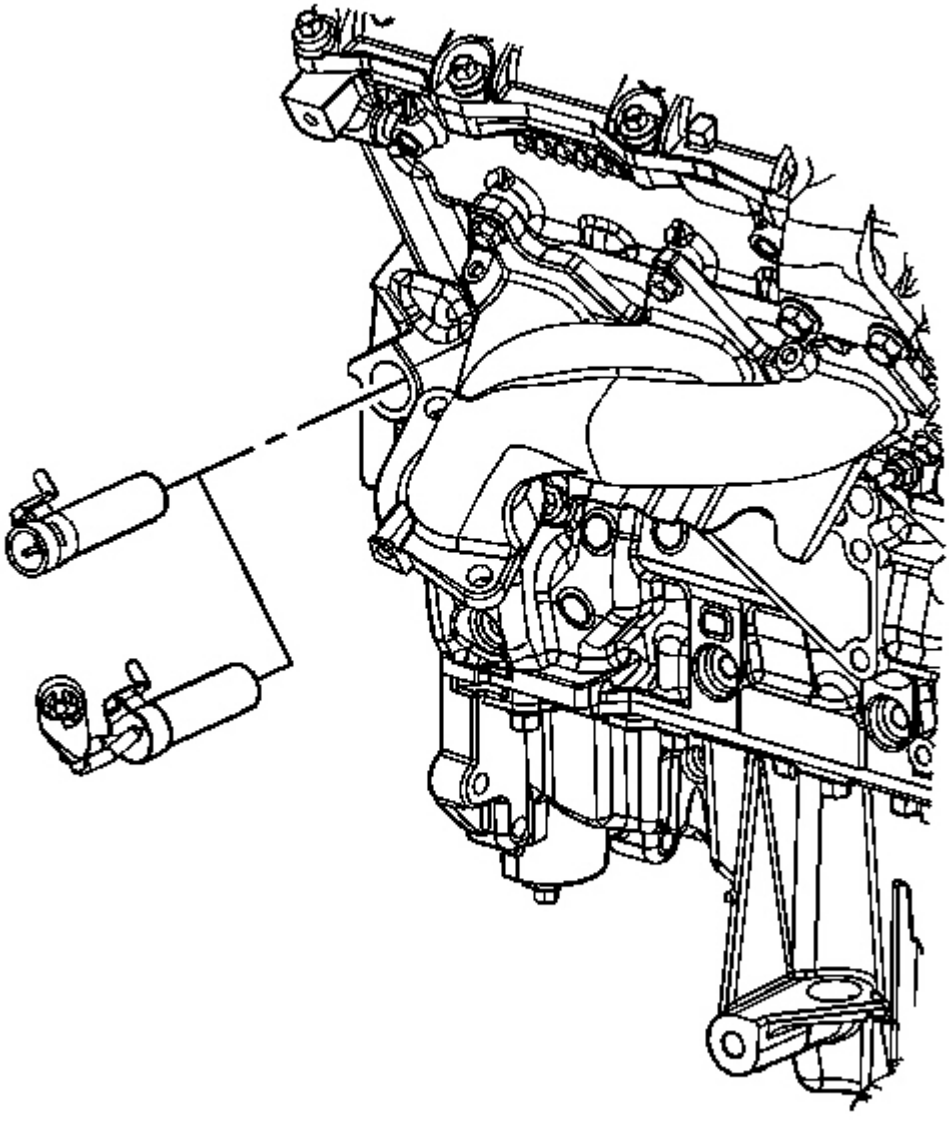


Fig. 80: View Of Coolant Heater (V6)
Courtesy of GENERAL MOTORS CORP.

1. Install the coolant heater.
2. Connect the coolant heater cord to the coolant heater.
3. Lower the vehicle.

ENGINE COOLANT HEATER CORD REPLACEMENT (V6)

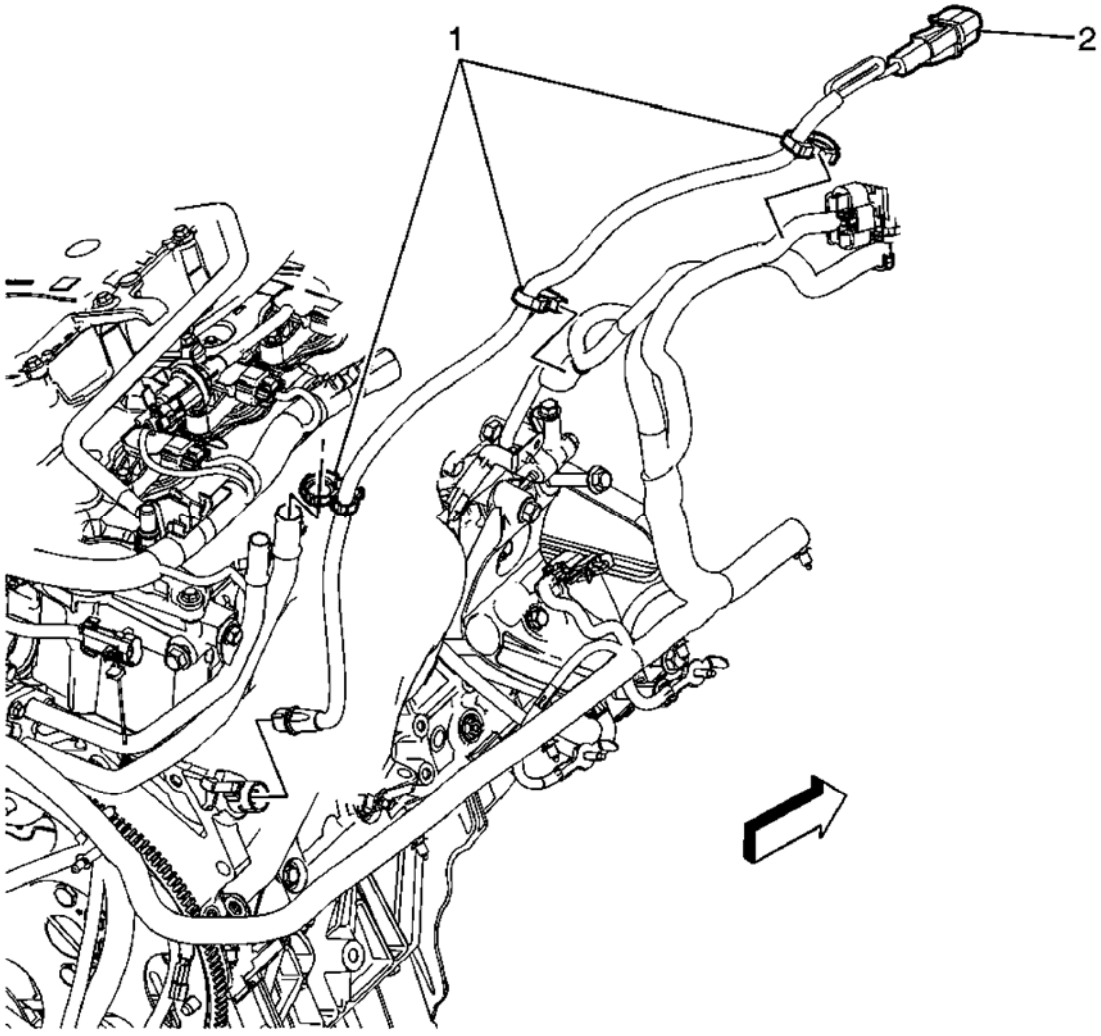


Fig. 81: Engine Coolant Heater Cord (V6)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Coolant Heater Cord Retainers. **Procedure:** Disconnect the coolant heater connector at the engine block and the retainers on the engine coolant heater cord harness.
2	Engine Coolant Heater Cord.

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

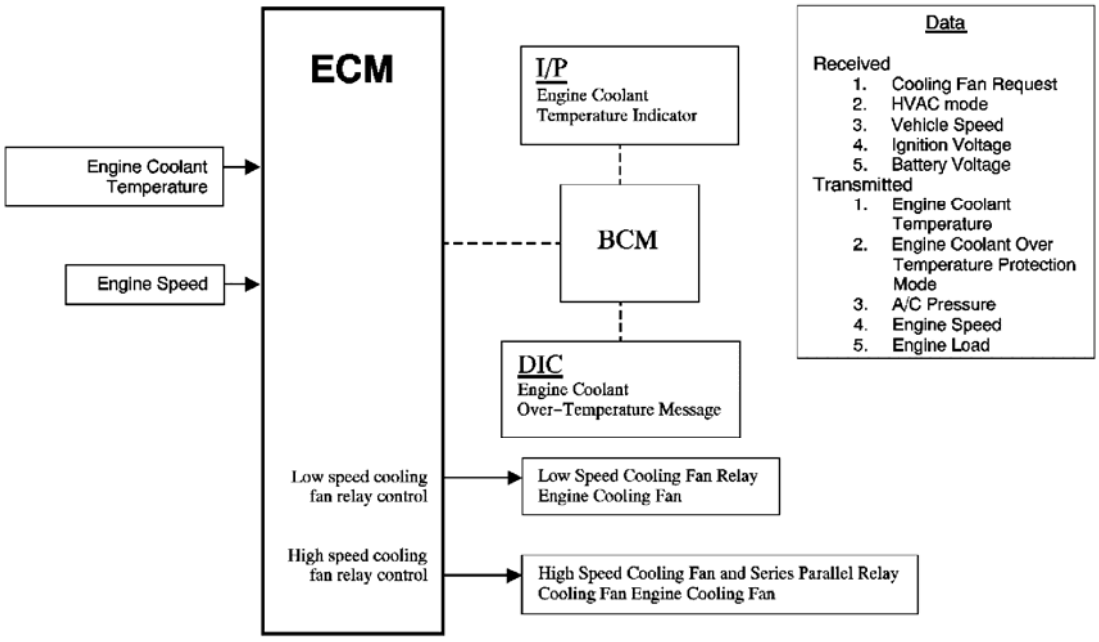


Fig. 82: Cooling Fan Operation
Courtesy of GENERAL MOTORS CORP.

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

In 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 right cooling fan through the switch side of the low speed relay. The right cooling fan is connected in series to the left cooling fan through the de-energized series/parallel (S/P) cooling fan speed control relay. The series circuit operates both fans at low speed.

In 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 left 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 right 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 running at high speed.

COOLING SYSTEM DESCRIPTION AND OPERATION

Cooling System

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

This allows the engine to warm quickly.

Cooling Cycle

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

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

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

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

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

Coolant

The engine coolant is a solution made up of a 50-50 mixture of DEX-COOL and clean drinkable water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

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

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

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

Pressure Cap

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

The pressure cap allows pressure in the cooling system to build up. As the pressure builds, the boiling point of the coolant goes up as well. Therefore, the coolant can be safely run at a temperature higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant is, the faster the heat moves from the radiator to the cooler passing air. However, if the pressure exceeds the strength of the spring, the pressure valve rises so that the excess pressure can escape. When the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing outside air into the cooling system. This equalizes the pressure in the cooling system with atmospheric pressure, thus preventing the radiator hoses from collapsing.

Coolant Recovery System

The coolant recovery system consists of a plastic coolant recovery reservoir and overflow tube. The recovery reservoir is also called a recovery tank or expansion tank. It is partially filled with coolant and is connected to the radiator fill neck with the overflow tube. Coolant can flow back and forth between the radiator and the reservoir.

In effect, a cooling system with a coolant recovery reservoir is a closed system. When the pressure in the cooling system gets too high, it will open the pressure valve in the pressure cap. This allows the coolant, which has expanded due to being heated, to flow through the overflow tube and into the recovery reservoir. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum opens the vacuum valve in the pressure cap, allowing some of the coolant in the reservoir to be siphoned back into the radiator. Under normal operating conditions, no coolant is lost. Although the coolant level in the recovery reservoir goes up and down, the radiator and cooling system are kept full. An advantage to using a coolant recovery reservoir is that it eliminates almost all air bubbles from the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Air Baffles and Seals

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

Transmission Oil Cooler

The transmission oil cooler is a heat exchanger. It is located inside the lower tank of the radiator. The transmission fluid temperature is regulated by the temperature of the engine coolant that surrounds the oil cooler as the transmission fluid passes through the cooler.

The transmission oil pump, pumps the fluid through the transmission oil cooler feed line to the oil cooler. The fluid then flows through the cooler while the engine coolant absorbs heat from the fluid. The fluid is then

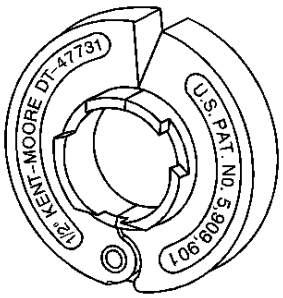
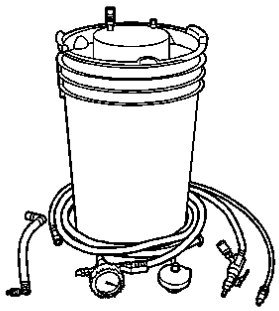
pumped through the transmission oil cooler return line, to the transmission.

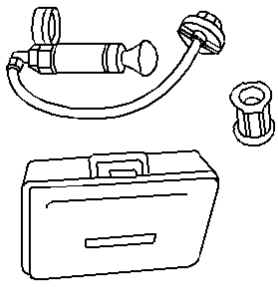
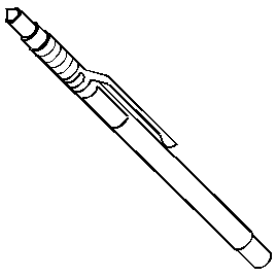
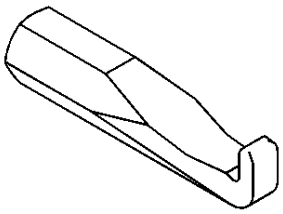
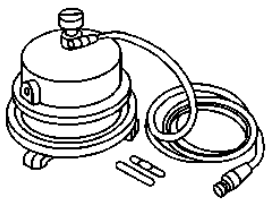
Auxiliary Transmission Oil Cooler

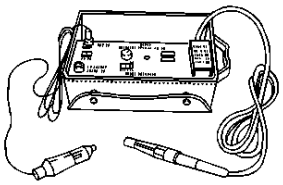
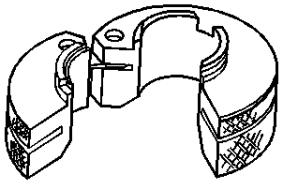
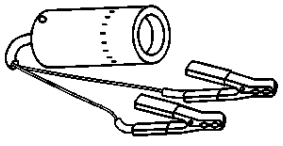
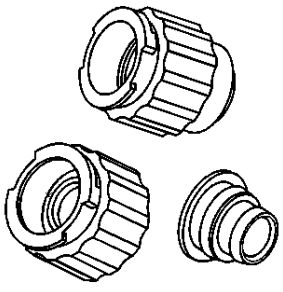
The auxiliary transmission oil cooler used on the L99 automatic transmission, is an oil-to-air heat exchanger located in front of the A/C condenser. The transmission oil temperature is regulated by the airflow passing over this heat exchanger. The oil out of the transmission is plumbed through the TOC lines to the cooler then directed back to the transmission. This cooler helps provided additional cooling for performance driving conditions.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	DT 47731 1/2 Inch Quick Connect Release Tool
	GE 47716 Vac N Fill Coolant Refill Tool
	J 24460-01 Cooling System Pressure Tester

	
	J 24731 Tempil Stick
	J 26568 Coolant and Battery Fluid Tester
	J 38185 Hose Clamp Pliers

	J 39400-A Halogen Leak Detector
	3/8 Inch Cooler Quick Connect Tool
	J 42220 Universal 12V Leak Detection Lamp
	J 42401 Radiator Cap and Surge Tank Test Adapter