2014 ENGINE

Engine Cooling - Regal

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Coolant Crossover Pipe Fastener	10 N.m	89 lb in
Engine Coolant Air Bleed Pipe Fastener LTG)	10 N.m	89 lb in
Engine Coolant Fan Motor Fastener	10 N.m	89 lb in
Engine Coolant Thermostat Fastener (LUK)	10 N.m	89 lb in
Radiator Drain Cock	2 N.m	18 lb in
Thermostat Bypass Pipe Fasteners (LTG)	10 N.m	89 lb in
Thermostat Cover Fastener (LUK)	10 N.m	89 lb in
Thermostat Housing Fastener (LUK, LTG)	10 N.m	89 lb in
Water Inlet Fastener (LDK, LUK)	10 N.m	89 lb in
Water Outlet Fastener (LTG)	12 N.m	9 lb ft
Water Pump Access Hole Cover Fastener (LUK)	25 N.m	18 lb ft
Water Pump Fastener (LUK, LTG)	25 N.m	18 lb ft
Water Pump Sprocket Fasteners (LUK)	10 N.m	89 lb in
Turbocharger Coolant Feed Pipe Banjo Bolt (LTG)	35 N.m	26 lb ft
Turbocharger Coolant Feed Pipe Fastener (LTG)	10 N.m	89 lb in
Turbocharger Coolant Return Pipe Banjo Bolt (LTG)	35 N.m	26 lb ft
Turbocharger Coolant Return Pipe Fastener (LTG)	10 N.m	89 lb in

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

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

SCHEMATIC WIRING DIAGRAMS

ENGINE HEATING/COOLING WIRING SCHEMATICS

Electric Cooling Fans (LUK)

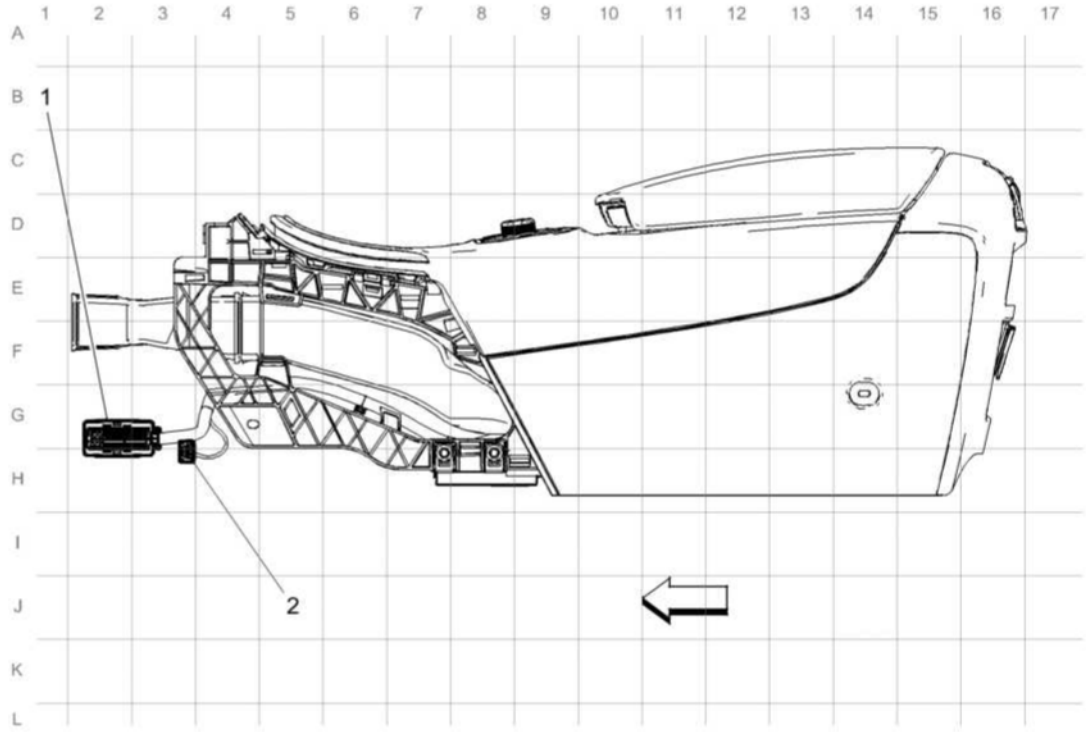


Fig. 1: Electric Cooling Fans (LUK)
Courtesy of GENERAL MOTORS COMPANY

Electric Cooling Fan Controls (LHU)

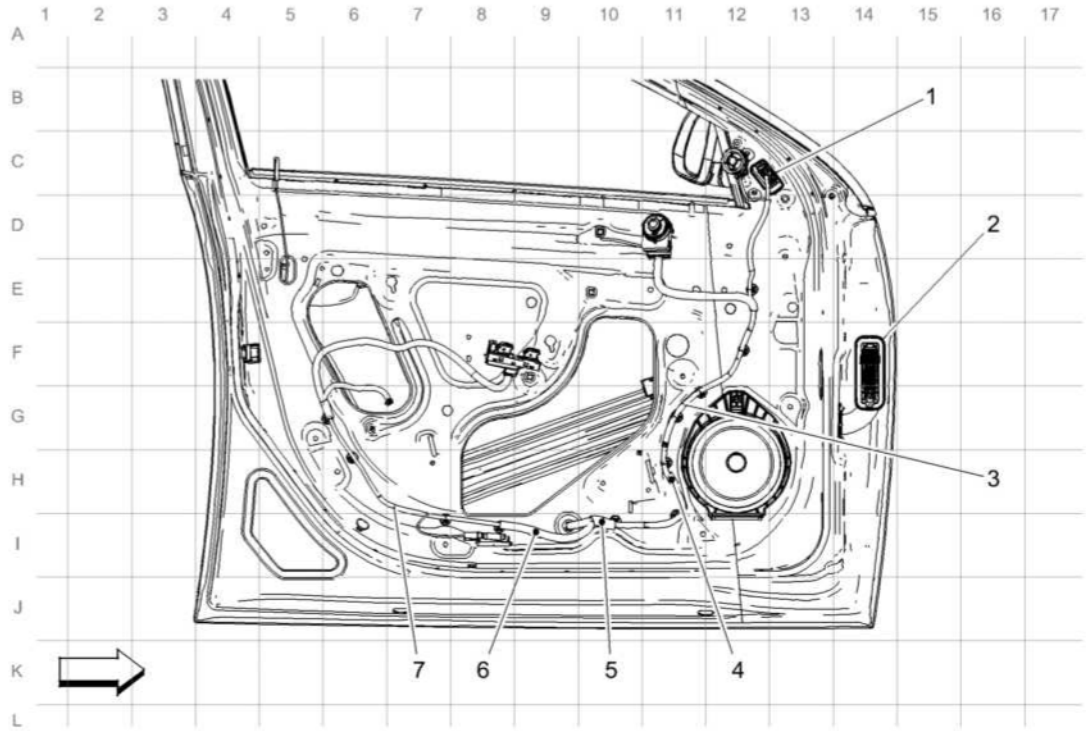


Fig. 2: Electric Cooling Fan Controls (LHU)
Courtesy of GENERAL MOTORS COMPANY

Electric Cooling Fan Motors (LHU)

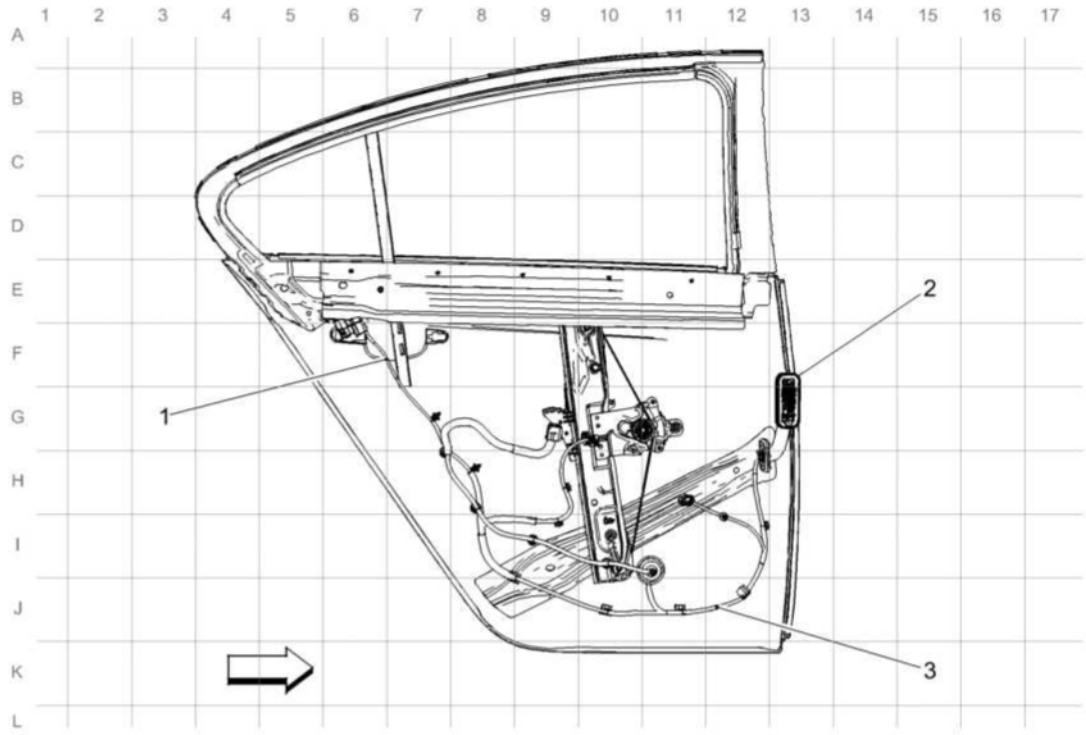


Fig. 3: Electric Cooling Fan Motors (LHU)
Courtesy of GENERAL MOTORS COMPANY

Heater Coolant Pump (HP6)

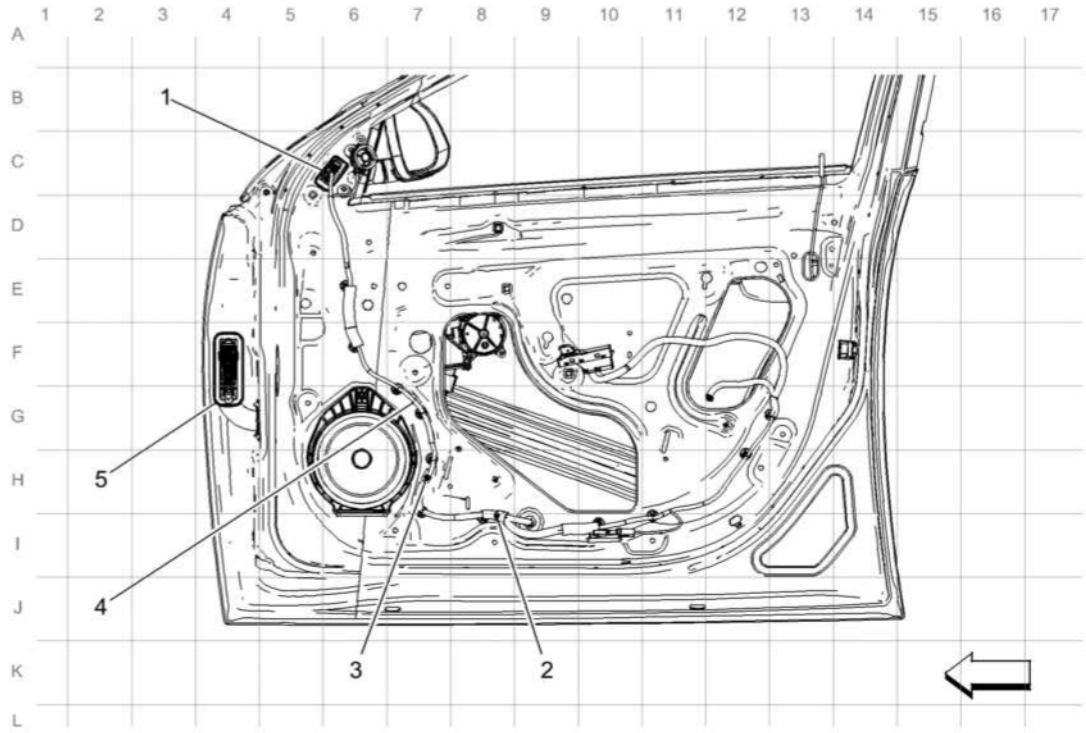


Fig. 4: Heater Coolant Pump (HP6)
Courtesy of GENERAL MOTORS COMPANY

Dual Fan Controls (LDK)

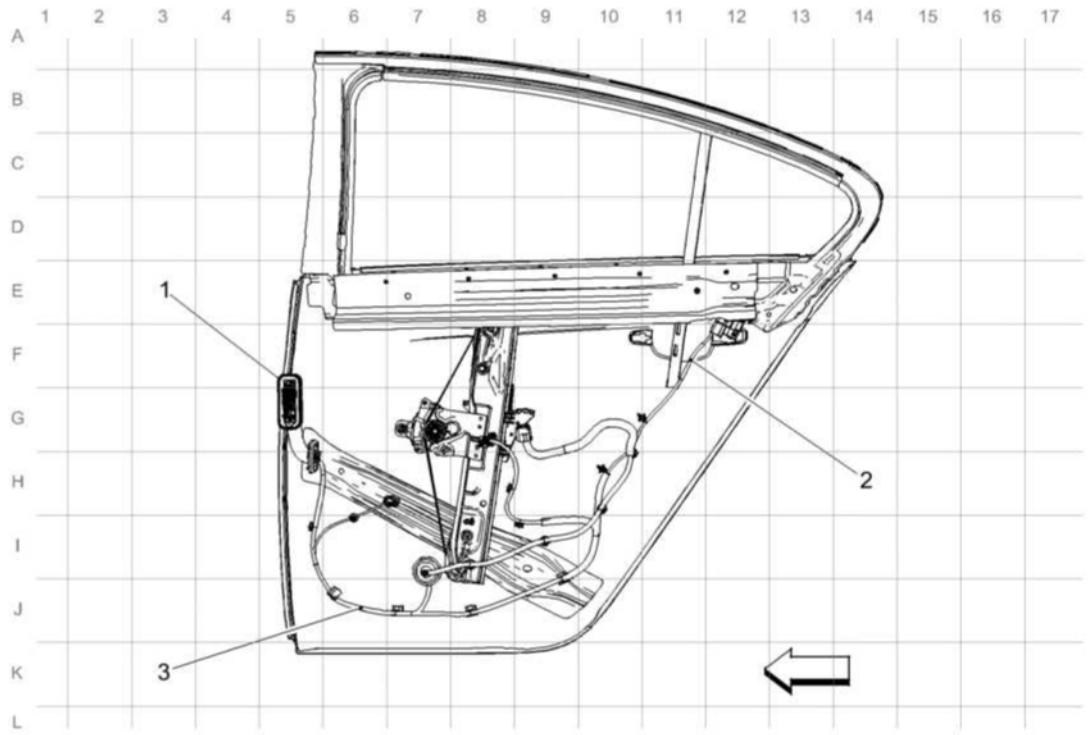


Fig. 5: Dual Fan Controls (LDK)
Courtesy of GENERAL MOTORS COMPANY

Dual Fan Motors (LDK)

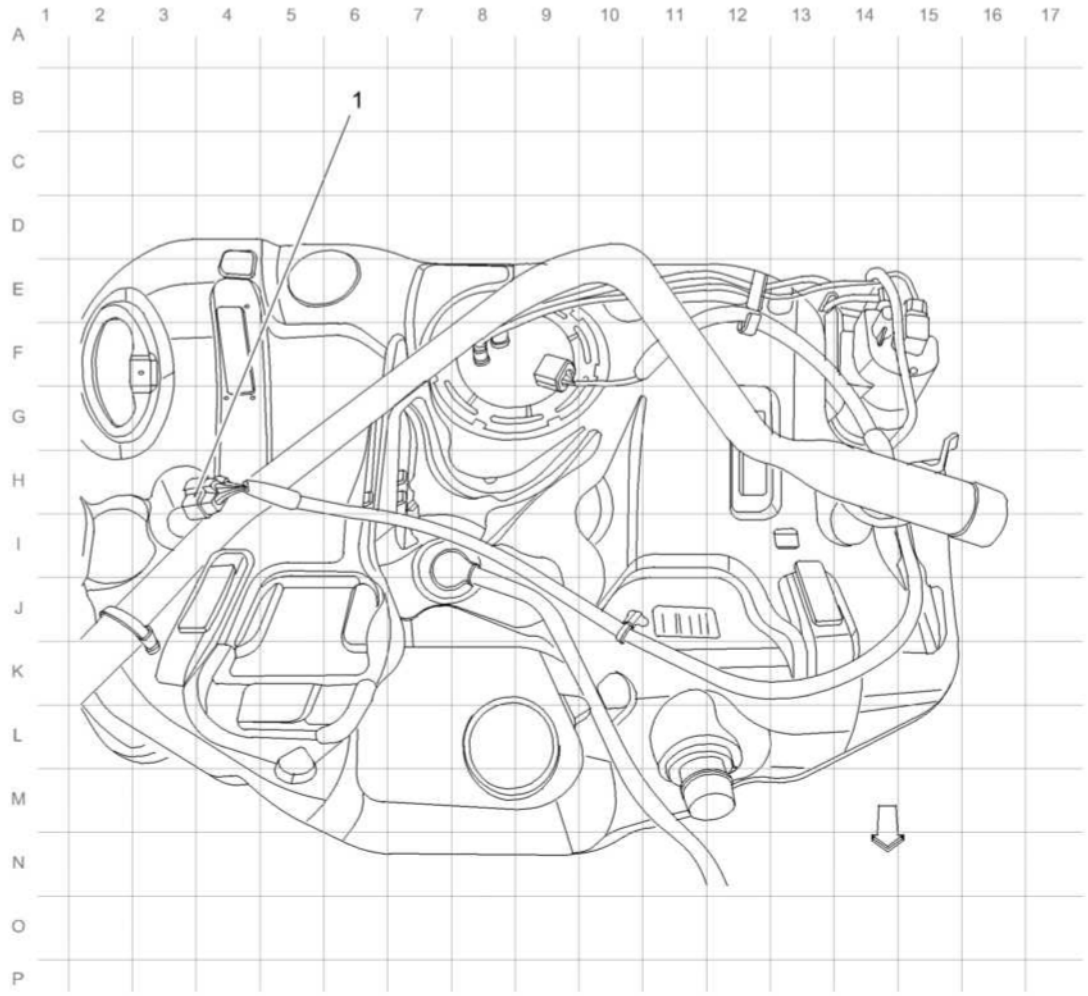


Fig. 6: Dual Fan Motors (LDK)
Courtesy of GENERAL MOTORS COMPANY

Single Fan (LLU/LAF/LTD)

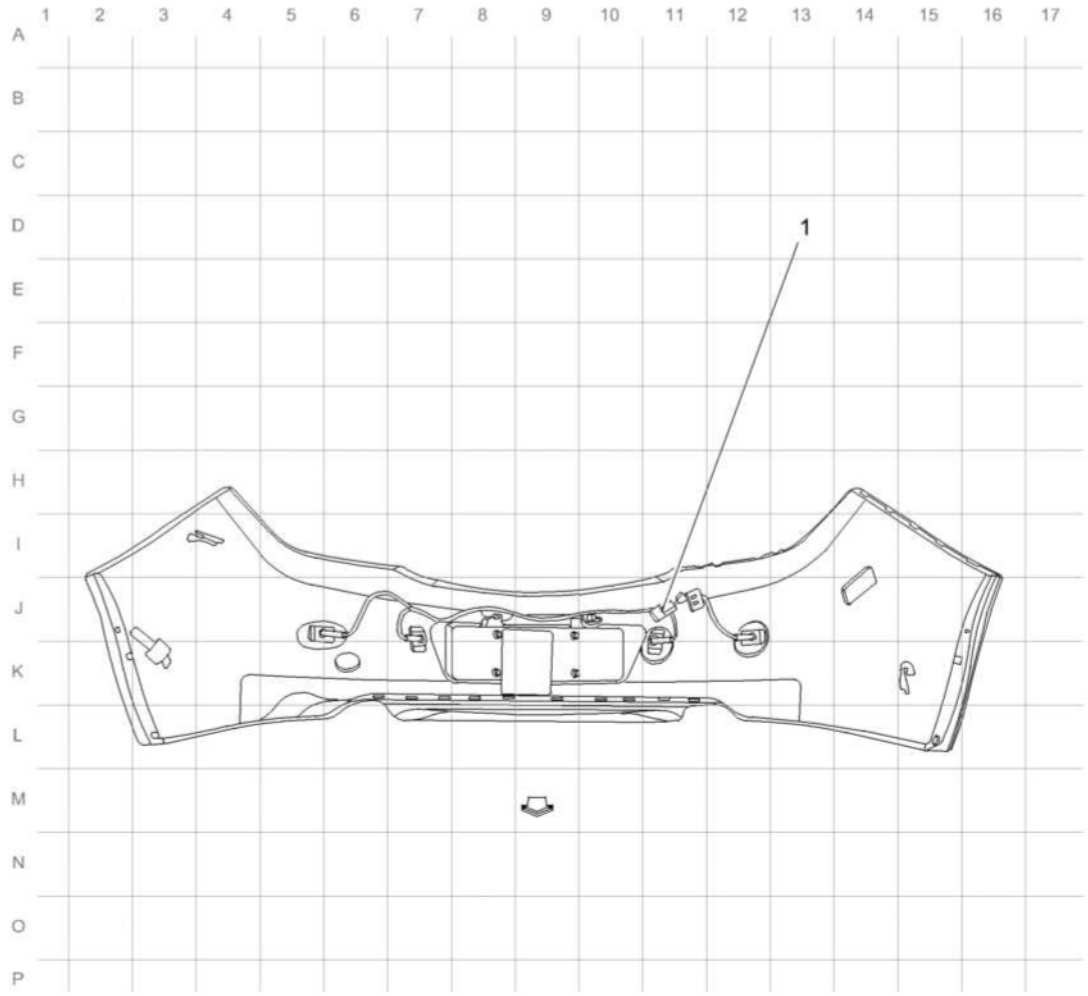


Fig. 7: Single Fan (LLU/LAF/LTD)
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0480, P0481, P0691, P0692, P0693, or P0694	DTC P0480 Cooling Fan Relay 1 Control Circuit DTC P0481 Cooling Fan Relays 2 and 3 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 Relays 2 and 3 Control Circuit Low Voltage DTC P0694 Cooling Fan Relays 2 and 3 Control Circuit High Voltage

DTC P0480, P0481, P0691, P0692, P0693, OR P0694: COOLING FAN RELAY

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

DTC P0691

Cooling Fan Relay 1 Control Circuit Low Voltage

DTC P0692

Cooling Fan Relay 1 Control Circuit High Voltage

DTC P0693

Cooling Fan Relays 2 and 3 Control Circuit Low Voltage

DTC P0694

Cooling Fan Relays 2 and 3 Control Circuit High Voltage

Diagnostic Fault Information

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

1. Fan(s) inoperative without a DTC
2. Fan(s) always ON without a DTC

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. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. 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 greater than 11 volts.
- The ECM driver transitions from ON to OFF or from OFF to ON.
- DTCs P0480, P0481, P0691, P0692, P0693, and P0694 run continuously when the conditions above are met.

Conditions for Setting the DTC

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, 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 Relays 2 and 3 operates one fan at a high speed
  - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification 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. Ignition ON.
2. Verify an audible click is heard or felt from each cooling fan relay when commanding the cooling fans ON and OFF with a scan tool.
    - **If a click is not heard or felt at one or more of the relays**

      Refer to Circuit/System Testing

    - **If a click is heard or felt at each of the relays**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing

    - **If the DTC does not set**
5. All OK.

Circuit/System Testing

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

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

2. Verify that a test lamp illuminates between ground and a relay coil ignition circuit terminal listed below:

- KR20C Cooling Fan Low Speed Relay terminal 85/2
- KR20D Cooling Fan High Speed Relay terminal 86/1
- KR20E Cooling Fan Speed Control Relay terminal 86/1

- **If the test lamp does not illuminate**

1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Remove the test lamp.
2. Test for less than 2 ohms in the ignition circuit of the appropriate cooling fan relay, end to end.
   - If 2 ohms or greater, repair the open/high resistance in the circuit.
   - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Remove the test lamp.
2. Test for infinite resistance between the appropriate cooling fan relay ignition circuit and ground.
   - If less than infinite resistance, repair the short to ground on the circuit.
   - If infinite resistance test or replace the appropriate cooling fan relay.

- **If the test lamp illuminates**

3. Ignition ON.

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

4. Connect a DMM, set on the diode setting, between ground and a relay control circuit terminal listed below:
   - KR20C cooling fan low speed relay terminal 86/1
   - KR20D cooling fan high speed relay terminal 85/2
   - KR20E cooling fan speed control relay terminal 85/2
5. Verify the DMM reading is greater than 2.5 V or displays O.L with the cooling fan relays commanded OFF with a scan tool.
   - **If 2.5 V or less**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the appropriate relay coil control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **If greater than 2.5 V or displays O.L.**
6. Verify the DMM reading is less than 1 V when commanding the cooling fan relays ON with a scan tool.
   - **If greater than 1 V or displays OL.**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the appropriate cooling fan relay control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V.
   3. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems

to power down.

4. Test for less than 2 ohms in the appropriate cooling fan relay control circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.

- **If less than 1 V**

7. Test or replace the appropriate cooling fan relay.

Component Testing

1. Ignition OFF.
2. Disconnect a cooling fan relay.
3. Test for 70-110 ohms between terminals 85/2 and 86/1.
    - **If less than 70 ohms or greater than 110 ohms**

      Replace the cooling fan relay.

    - **If between 70-110 ohms**
4. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87

      OR

    - 3 and 2
    - 3 and 5
    - 3 and 1
    - 1 and 5
    - **If less than infinite resistance**

      Replace the cooling fan relay.

    - **If infinite resistance**

NOTE: This test only applies to the speed control relay.

5. Test for less than 2 ohms between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
    - **If 2 ohms or greater**

      Replace the KR20E Cooling Fan Speed Control Relay.

    - **If less than 2 ohms**
6. Install a 20 A fused jumper wire between relay terminal 85 or 2 and 12 V.

7. Install a jumper wire between relay terminal 86 or 1 and ground.
8. Test for less than 2 ohms between terminals 3/30 and 5/87.
    - **If 2 ohms or greater**

      Replace the cooling fan relay.

    - **If less than 2 ohms**
9. All OK.

Repair Instructions

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

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

SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

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

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

Visual/Physical Inspection

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

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

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

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

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

Identifying Intermittent Conditions

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

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

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

Symptom List

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

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

COOLING FAN ALWAYS ON

Diagnostic Instructions

- 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. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed
  - Cooling Fan Relays 2 and 3 operates one fan at a high speed
  - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed
- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fans ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the temperature versus resistance tables in the appropriate Engine Controls subsection.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification 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. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.
   - **If a DTC is set**

     Refer to **DTC P0480, P0481, P0691, P0692, P0693, or P0694**.

   - **If no DTC is set**
3. Verify the scan tool parameters listed below display OFF:
   - Cooling Fan Relay 1 Command
   - Cooling Fan Relays 2 and 3 Command
     - **If a scan tool parameter displays ON**

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

     - **If both scan tool parameters display OFF**
4. Verify that the fans are not activated.
   - **If a fan is operating**

     Refer to Circuit/System Testing.

   - **If both fans are OFF**
5. All OK

Circuit/System Testing

Both Cooling Fans Always ON

1. Ignition OFF, disconnect KR20C Cooling Fan Low Speed Relay, ignition ON.
2. Verify that both cooling fans are OFF.
   - **If the cooling fans are ON**

1. Ignition OFF, disconnect the harness connector at the G10R Cooling Fan Motor-Right, ignition ON.
2. Test for less than 1 V between KR20C Cooling Fan Low Speed Relay terminal 87/5 and ground.
    - If 1 V or greater, repair the short to voltage in the relay controlled output circuit.
- **If the cooling fans are OFF**

3. Test or replace the KR20C Cooling Fan Low Speed Relay.

One Cooling Fan Always ON

1. Ignition OFF, disconnect the KR20D Cooling Fan High Speed Relay, ignition ON.
2. Verify the cooling fan is OFF.
    - **If the cooling fan is ON**
    1. Ignition OFF, disconnect the harness connector at the G10L Cooling Fan Motor-Left, ignition ON.
    2. Test for less than 1 V between KR20D Cooling Fan High Speed Relay terminal 30/3 and ground.
        - If 1 V or greater, repair the short to voltage in the relay controlled output circuit.
    - **If the cooling fan is OFF**
3. Test or replace the KR20D Cooling Fan High Speed Relay.

Component Testing

1. Ignition OFF.
2. Disconnect a KR20 Cooling Fan Relay.
3. Test for 70-110 ohms between terminals 85/2 and 86/1.
    - **If less than 70 ohms or greater than 110 ohms**

      Replace the KR20 cooling fan relay.

    - **If between 70-110 ohms**
4. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87

      OR

    - 3 and 2
    - 3 and 5
    - 3 and 1
    - 1 and 5
    - **If less than infinite resistance**

Replace the KR20 Cooling Fan Relay.

- **If infinite resistance**

NOTE: This test only applies to the speed control relay.

5. Test for less than 2 ohms between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
   - **If 2 ohms or greater**

     Replace the KR20E Cooling Fan Speed Control Relay.

   - **If less than 2 ohms**
6. Install a 20 A fused jumper wire between relay terminal 85 or 2 and 12 V.
7. Install a jumper wire between relay terminal 86 or 1 and ground.
8. Test for less than 2 ohms between terminals 3/30 and 5/87.
   - **If 2 ohms or greater**

     Replace the KR20 Cooling Fan Relay.

   - **If less than 2 ohms**
9. All OK.

Repair Instructions

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

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

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 scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed

- Cooling Fan Relays 2 and 3 operates one fan at a high speed
- Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification 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. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.
   - **If a DTC is set**

     Refer to **DTC P0480, P0481, P0691, P0692, P0693, or P0694**.

   - **If no DTCs is set**
3. Verify that both cooling fans turn ON and OFF and operate at low and high speed, when commanding the appropriate cooling fan relays ON and OFF with a scan tool.
   - **If a cooling fan does not operate**

     Refer to Circuit/System Testing

   - **If both cooling fans operate**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect all of the KR20 Cooling Fan Relays.
2. Verify a test lamp illuminates between ground and the B+ circuit terminals listed below:
    - KR20C Cooling Fan Low Speed Relay B+ circuit terminal 85/1
    - KR20C Cooling Fan Low Speed Relay B+ circuit terminal 30/3
    - KR20D Cooling Fan High Speed Relay B+ circuit terminal 87/5
    - KR20D Cooling Fan High Speed Relay B+ circuit terminal 86/2
    - KR20E Cooling Fan Speed Control Relay B+ circuit terminal 86/2
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Disconnect the appropriate cooling fan fuse.
    2. Test for less than 2 ohms between the fuse and the appropriate relay B+ circuit terminal, end to end.
        - If 2 ohms or greater, repair the open/high resistance in the B+ circuit.
        - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Connect a DMM to the appropriate relay B+ circuit terminal.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the B+ circuit.
        - If infinite resistance
    3. Disconnect the harness connector at the appropriate G10 Cooling Fan Motor.
    4. Test for infinite resistance between the appropriate relay controlled output circuit terminal and ground.
        - KR20C Cooling Fan Low Speed Relay output circuit terminal 87/5
        - KR20D Cooling Fan High Speed Relay output circuit terminal 30/3
        - KR20E Cooling Fan Speed Control Relay circuit terminal 30/3
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, test or replace the appropriate G10 Cooling Fan Motor.
    - **If the test lamp illuminates**
3. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G10L Cooling Fan Motor-Left. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 5 ohms between the circuits listed below and ground:
    - G10L Cooling Fan Motor-Left terminal A
    - KR20E Cooling Fan Speed Control Relay terminal 87/5
    - **If 5 ohms or greater**
    1. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
    2. Test for less than 2 ohms in the appropriate ground circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, repair the open/high resistance in the ground connection.
    - **If less than 5 ohms**
5. Connect the harness connector at the G10L Cooling Fan Motor-Left.

6. Connect a 50 A fused jumper between the KR20D Cooling Fan High Speed Relay terminals 30/3 and 87/5.
7. Verify the G10L Cooling Fan Motor-Left is activated at high speed.
    - **If the cooling fan does not activate or jumper fuse opens**
    1. Disconnect the harness connector at the G10L Cooling Fan Motor-Left.
    2. Test for less than 2 ohms in the circuit between KR20D Cooling Fan High Speed Relay terminal 30/3 and the G10L Cooling Fan Motor-Left terminal B.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the G10L Cooling Fan Motor-Left.
    - **If the cooling fan activates**
8. Connect a fused jumper between the KR20E Cooling Fan Speed Control Relay switch circuit terminal 30/3 and the ground circuit terminal 87/5.
9. Connect a 40 A fused jumper between the KR20C Cooling Fan Low Speed Relay terminals 30/3 and 87/5.
10. Verify the G10R Cooling Fan Motor-Right is activated at high speed.
    - **If the cooling fan does not activate**
    1. Disconnect the harness connector at the G10R Cooling Fan Motor-Right.
    2. Test for less than 2 ohms in the circuit between KR20C Cooling Fan Low Speed Relay terminal 87/5 and the G10R Cooling Fan Motor-Right terminal B.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms
    3. Test for less than 2 ohms in the circuit between KR20E Cooling Fan Speed Control Relay terminal 30/3 and the G10R Cooling Fan Motor-Right terminal A.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the G10R Cooling Fan Motor-Right.
    - **If the cooling fan activates**
11. Install the KR20E Cooling Fan Speed Control Relay.
12. Verify both fan motors activate at low speed.
    - **If both cooling fans do not activate at low speed**
    1. Disconnect both cooling fan motor harness connectors and the KR20E Cooling Fan Speed Control Relay.
    2. Test for less than 2 ohms in circuit between KR20E Cooling Fan Speed Control Relay terminal 87A/4 and the G10L Cooling Fan Motor-Left terminal B.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms
    3. Test for infinite resistance between KR20E Cooling Fan Speed Control Relay terminal listed below and ground.
        - KR20E Cooling Fan Speed Control Relay terminal 30/3
        - KR20E Cooling Fan Speed Control Relay terminal 87A/4
        - If less than infinite, repair the short to ground in the circuit.
        - If infinite, replace the KR20E cooling fan speed control relay.
    - **If both cooling fans activate**

13. Test or replace the cooling fan relay listed below as appropriate:
    - KR20C Cooling Fan Low Speed Relay
    - KR20D Cooling Fan High Speed Relay

Component Testing

1. Ignition OFF.
2. Disconnect a KR20 Cooling Fan Relay.
3. Test for 70-110 ohms between terminals 85/2 and 86/1.
    - **If less than 70 ohms or greater than 110 ohms**

      Replace the KR20 cooling fan relay.

    - **If between 70-110 ohms**
4. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87

      OR

    - 3 and 2
    - 3 and 5
    - 3 and 1
    - 1 and 5
    - **If less than infinite resistance**

      Replace the KR20 Cooling Fan Relay.

    - **If infinite resistance**

NOTE: This test only applies to the speed control relay.

5. Test for less than 2 ohms between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
    - **If 2 ohms or greater**

      Replace the KR20E Cooling Fan Speed Control Relay.

    - **If less than 2 ohms**
6. Install a 20 A fused jumper wire between relay terminal 85 or 2 and 12 V.
7. Install a jumper wire between relay terminal 86 or 1 and ground.
8. Test for less than 2 ohms between terminals 3/30 and 87/5.
    - **If 2 ohms or greater**

Replace the KR20 Cooling Fan Relay.

- **If less than 2 ohms**

9. All OK.

Repair Instructions

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

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Engine Coolant Fan Shroud Replacement (LUK)**, **Engine Coolant Fan Shroud Replacement (LTG)**, **Engine Coolant Fan Shroud Replacement (LEA)**

ENGINE OVERHEATING

Engine Overheating

Step	Action	Yes	No
DEFINITION: The engine temperature lamp comes on and stays on, or temperature gauge shows hot, or coolant overflows from the surge tank onto the ground while the engine is running.			
1	Check for a loss of coolant. Refer to **Loss of Coolant**. Is there a loss of coolant?	Go to **Step 2**	Go to **Step 3**
2	Fill the system to the specified level. Does the engine still overheat?	Go to **Step 3**	System OK
3	Check for kinked or pinched surge tank hoses, especially at the radiator. Are any surge tank hoses kinked or pinched?	Go to **Step 4**	Go to **Step 5**
4	1. Relieve any kinks by rerouting the hoses. 2. Replace the hoses, if necessary. Does the engine still overheat?	Go to **Step 5**	System OK
5	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 6**	Go to **Step 7**
6	Repair or replace any loose, missing, or damaged radiator air seals or deflectors. Does the engine still overheat?	Go to **Step 7**	System OK
7	Check the coolant concentration. Does the coolant concentration test correctly?	Go to **Step 9**	Go to **Step 8**
8	Replace the coolant, if necessary. Does the engine still overheat?	Go to **Step 9**	System OK
9	**NOTE:** **Use the correct pressure cap.** Check the system for loss of pressure. Refer to **Pressure Cap Testing**.Is there a loss of pressure?	Go to **Step 10**	Go to **Step 11**

10	Repair any leaks, as necessary. Does the engine still overheat?	Go to **Step 11**	System OK
11	Check for a faulty engine coolant temperature sensor. Is the engine coolant temperature sensor faulty?	Go to **Step 12**	Go to **Step 13**
12	Replace the engine coolant temperature sensor. Refer to **Engine Coolant Temperature Sensor Replacement** , for the 2.0L engine or **Engine Coolant Temperature Sensor Replacement** for the 2.4L engine. Does the engine still overheat?	Go to **Step 13**	System OK
13	Check the radiator for any air flow obstructions or bent fins. Is there any airflow obstruction or bent fins?	Go to **Step 14**	Go to **Step 15**
14	1. Remove or relocate add-on parts that block air flow to the radiator. 2. Clean any debris from the radiator core. Does the engine still overheat?	Go to **Step 15**	System OK
15	Check for any blocked cooling system passages. Are there any blocked cooling system passages?	Go to **Step 16**	Go to **Step 17**
16	1. Remove any obstruction. 2. Flush the cooling system, as required. 3. Refill the coolant. Does the engine still overheat?	Go to **Step 17**	System OK
17	Check for an inoperative cooling fan. Is the cooling fan inoperative?	Go to **Step 18**	Go to **Step 19**
18	Replace the cooling fan. Refer to **Engine Coolant Fan Replacement (LUK)**, **Engine Coolant Fan Replacement (LTG)**. Does the engine still overheat?	Go to **Step 19**	System OK
19	Check for a thermostat that is stuck closed. Refer to **Thermostat Diagnosis**. Is the thermostat stuck closed?	Go to **Step 20**	Go to **Step 21**
20	Replace the thermostat. Refer **Engine Coolant Thermostat Replacement (LUK)**. Does the engine still overheat?	Go to **Step 21**	System OK
21	Check for a faulty water pump. The impeller blades may be eroded or broken. Is the water pump faulty?	Go to **Step 22**	-
22	Replace the water pump. Refer to **Water Pump Replacement (LTG)**, **Water Pump Replacement (LUK)**. Does the engine still overheat?	-	System OK

LOSS OF COOLANT

Loss of Coolant

Step	Action	Yes	No
DEFINITION: The cooling system is losing coolant either internally or externally.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - Engine Cooling**
2	Repair any present DTCs. Refer to **Diagnostic System Check - Vehicle** . Is the action complete?	Go to **Step 3**	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to **Step 5**	Go to **Step 4**
4	Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. Is the action complete?	Go to **Step 5**	-
5	If the engine is suspected to have a coolant leak into a cylinder, the coolant can hydraulically lock the engine. Does the engine crankshaft rotate?	Go to **Step 6**	Go to **Step 28**
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to **Step 29**	Go to **Step 7**
7	Extended operation with a low coolant level can cause engine internal component failure. Is the engine knocking?	Go to **Step 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 surge tank.Does the surge tank discharge coolant while the engine is idling?	Go to **Step 15**	Go to **Step 11**
	Visually inspect the hoses, pipes and hose clamps at the following locations:		

11	• Coolant surge tank • 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: • The coolant pressure cap • The core plugs • The cylinder head gaskets • The engine block • The intake manifold • The radiator • The thermostat housing • The 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**
	1. Add 30 ml (1 oz) of Extended Life Coolant Leak Detection Dye to the cooling system for each 15 liters (4 gallons) of coolant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.		

17	and **Approximate Fluid Capacities** . 2. Start the vehicle and allow the engine to reach normal operating temperature. 3. Shut the engine off. 4. Use **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 **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 there a milky substance on 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 there 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 (LHD)** . 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**
	1. Replace the radiator. Refer to **Radiator Replacement (LUK)**, **Radiator**		

26	**Replacement (LTG)**, **Radiator Replacement (LEA)**. 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** 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** , or **Coolant in Engine Oil** Is the repair complete?	Go to **Step 33**	-
31	Repair the engine knock. Refer to **Lower Engine Noise, Regardless of Engine Speed** Is the repair complete?	Go to **Step 33**	-
32	Repair the combustion pressure in the cooling system problem. Refer to **Coolant in Combustion Chamber** 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

Thermostat Diagnosis

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 Inoperative**. 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 **Engine Fails To Reach Normal Operating Temperature**. Is the thermostat operating correctly?	System OK	Go to **Step 6**
6	1. Replace the thermostat. Refer to **Engine Coolant Thermostat Replacement (LUK)**. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to **Step 1**	System OK

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

Special Tools

GE 24731 Tempil Stick

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

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

Thermostat Test Procedure Using Glycol

Inspect the operation of the thermostat by hanging the thermostat on a hook in a 50/50 percent solution of

DEX-COOL® and clean drinkable water.

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

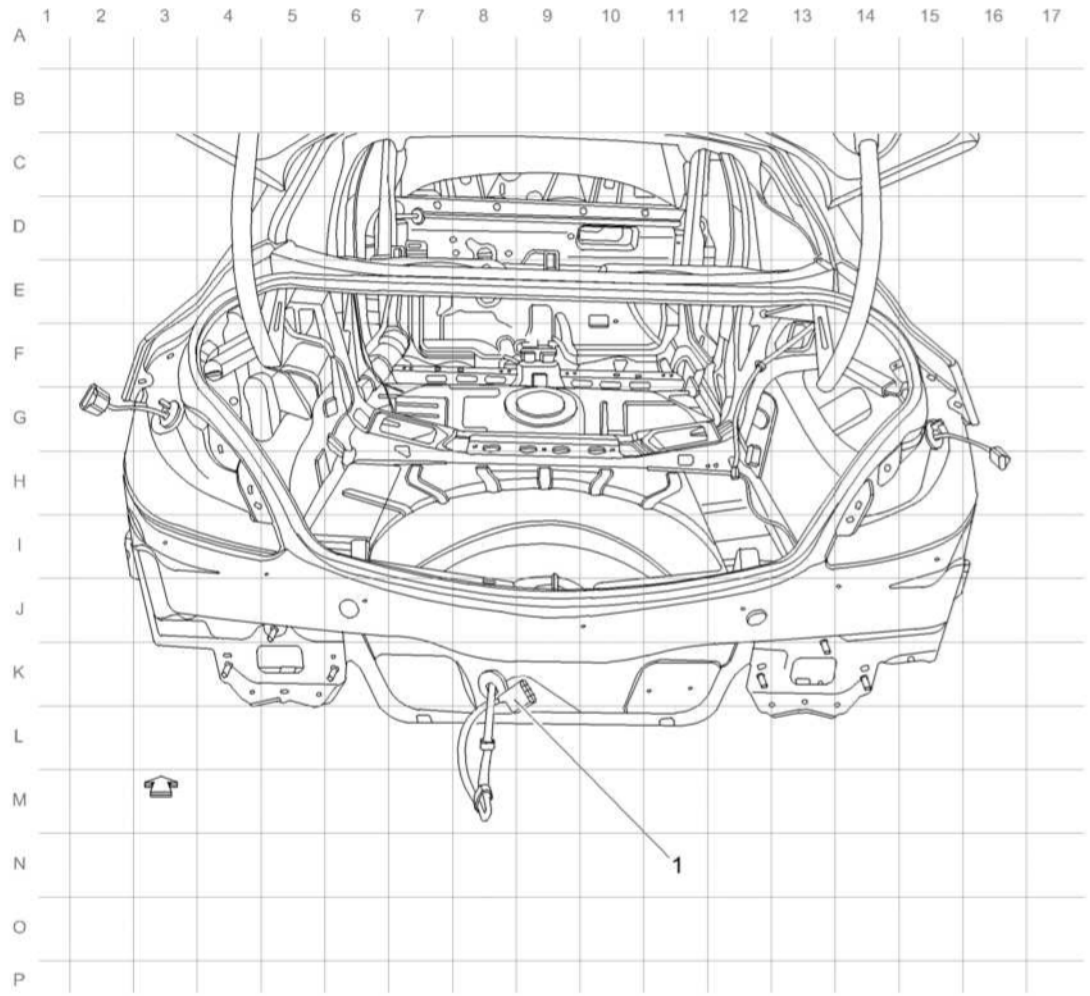


Fig. 8: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS COMPANY

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

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

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

PRESSURE CAP TESTING

Special Tools

- **EN-24460-A** Cooling System Pressure Tester
- **GE-42401-A** Radiator Cap/Surge Tank Test Adapter

For equivalent regional tools, Refer to **Special Tools**

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.

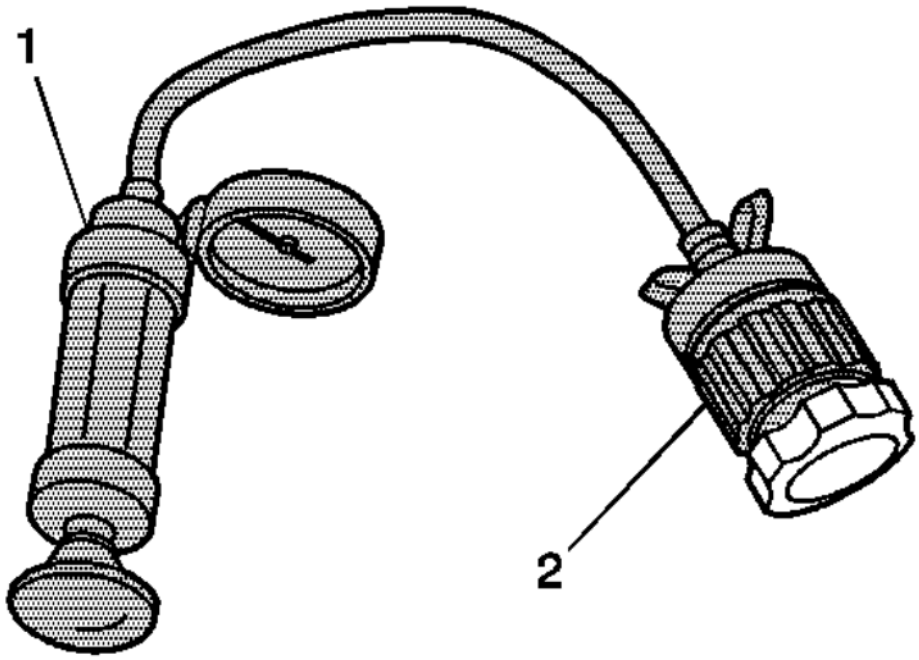


Fig. 9: Identifying Pressure Cap Testing Tool
Courtesy of GENERAL MOTORS COMPANY

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 **EN-24460-A** Cooling System Pressure Tester (1) with **GE-42401-A** 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 **EN-24460-A** 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

- **EN-24460-A** Cooling System Pressure Tester
- **GE-42401-3** Radiator Cap / Surge Tank Test Adapter

For equivalent regional tools, Refer to **Special Tools**

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.

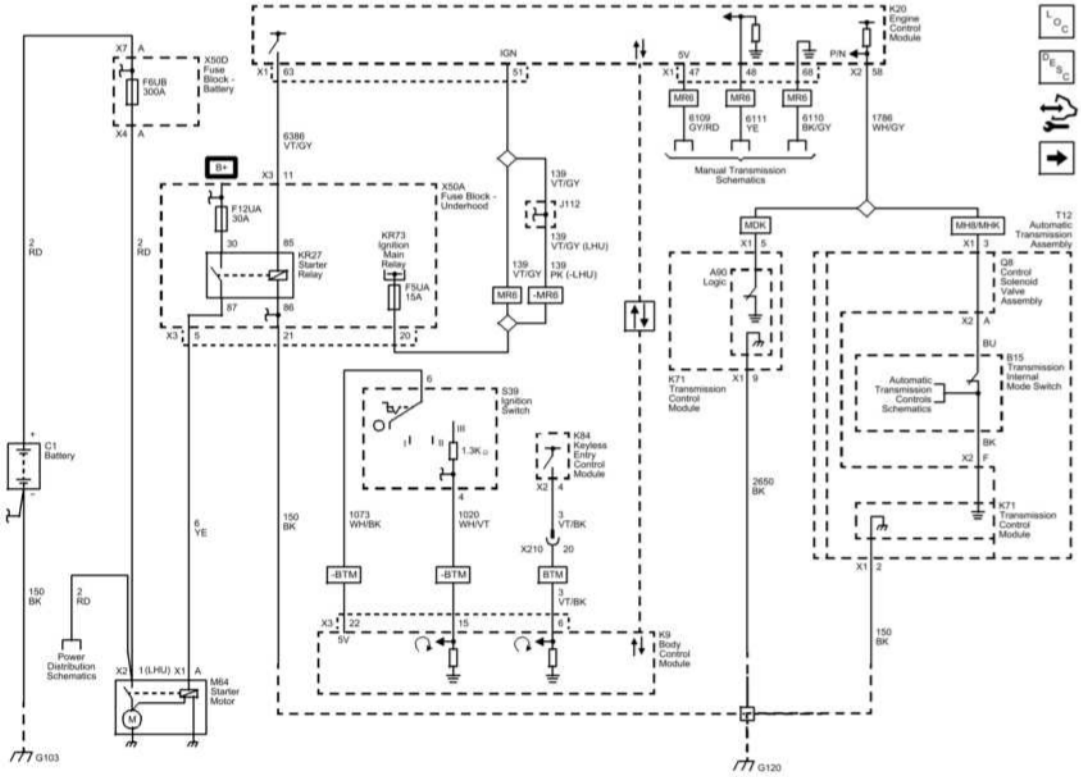


Fig. 10: Applying Pressure To Cooling System
Courtesy of GENERAL MOTORS COMPANY

4. Use the **EN-24460-A** Cooling System Pressure Tester (1) with **GE-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 (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 surge tank.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Place a drain pan under the drain cock.

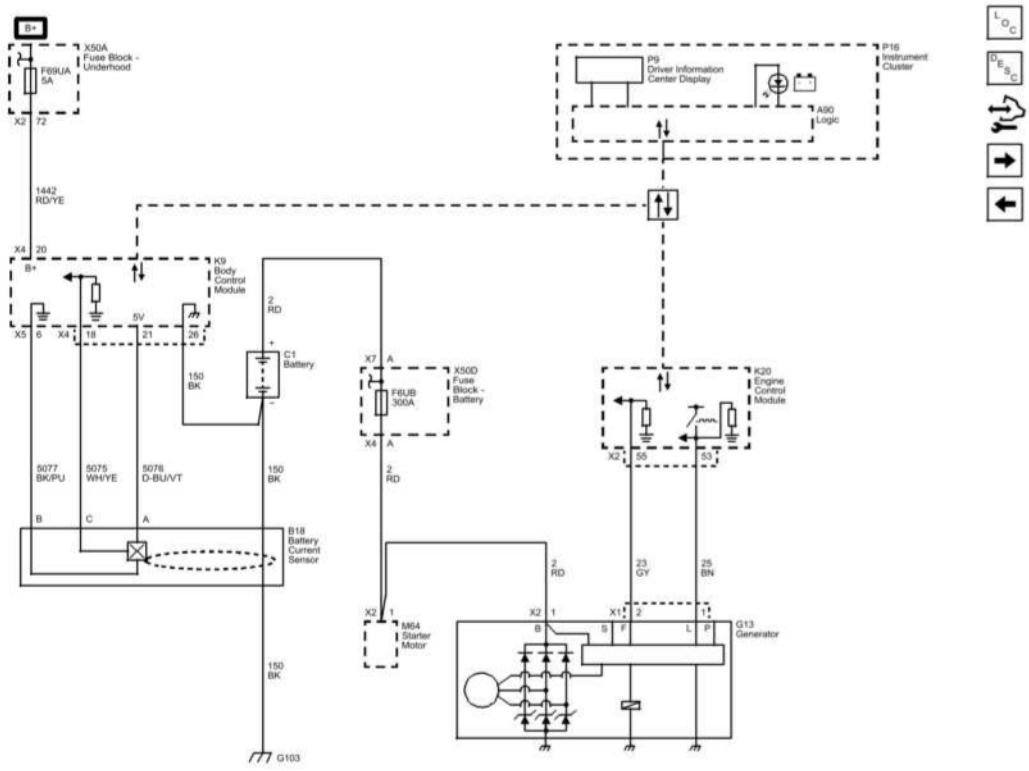


Fig. 11: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the radiator drain cock.
5. Drain the cooling system.
6. Lower the vehicle.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
   - Normal in appearance-Follow the filling procedure.
   - Discolored-Follow the flush procedure. Refer to **Flushing**.

Filling Procedure

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

1. Raise and support the vehicle.

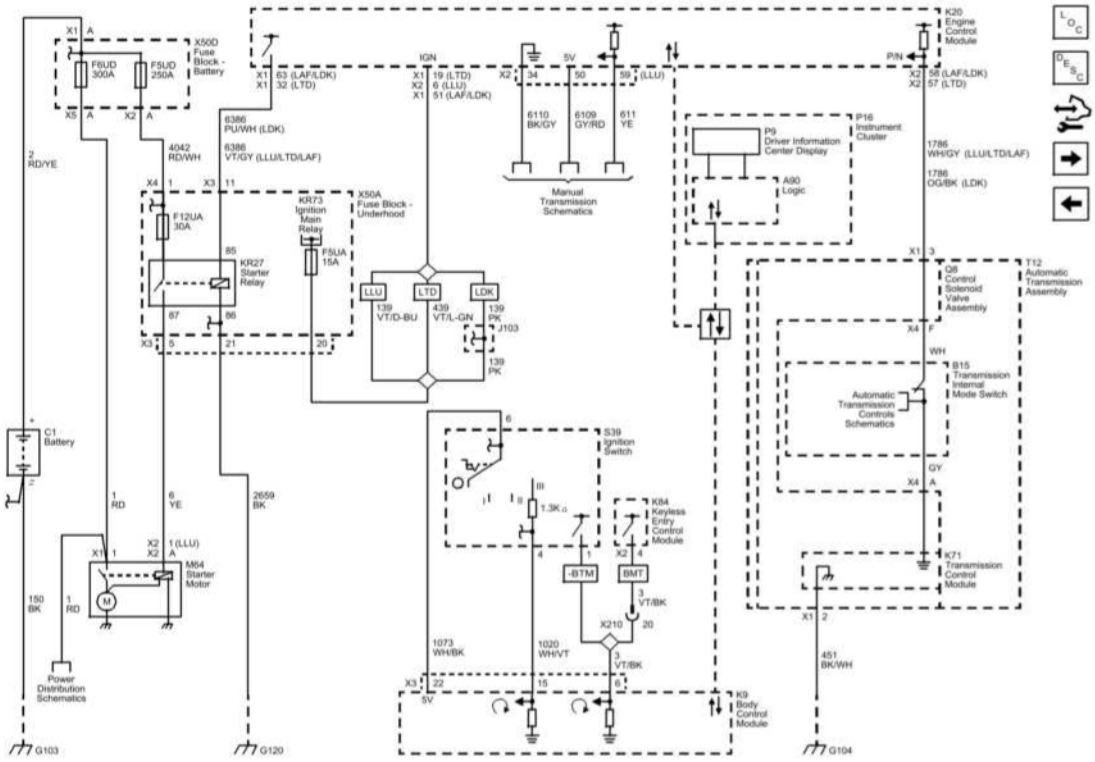


Fig. 12: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

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

4. Slowly fill the radiator with a 50/50 coolant mixture until the coolant level reaches the base of the radiator surge tank. Refer to **Approximate Fluid Capacities** .
5. Allow 30 seconds for the coolant level to stabilize and continue to fill the coolant filler neck until the level stabilizes for at least 2 minutes.
6. Start the engine and allow to the engine to idle in PARK or NEUTRAL with the parking brake engaged.
7. Slowly fill the coolant mixture until the level stabilizes at the base of the radiator surge tank.
8. Install the coolant pressure cap.
9. Raise the engine RPM to 2500 rpm for 30-40 seconds.
10. Shut the engine OFF.

11. Allow the engine to cool, remove coolant fill cap and repeat steps 4-10 until the coolant level has completely stabilized within the radiator surge tank.
12. Inspect the concentration of the engine coolant using the **J 26568** Coolant and Battery Fluid Tester
13. Inspect and if necessary, fill the coolant reservoir bottle as necessary.
14. Rinse away any excess coolant from the engine and the engine compartment
15. Inspect the cooling system for leaks.
16. Top off the radiator surge tank if necessary.

COOLING SYSTEM DRAINING AND FILLING (GE 47716)

Special Tools

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

Draining Procedure

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

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

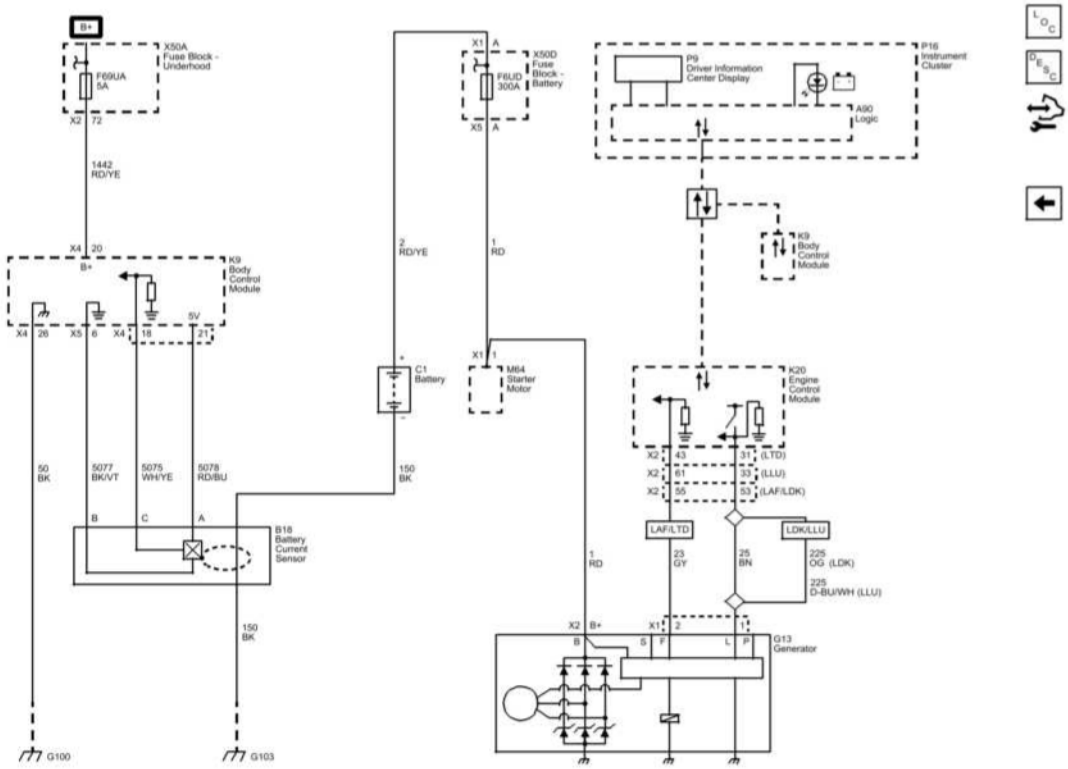


Fig. 13: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

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.

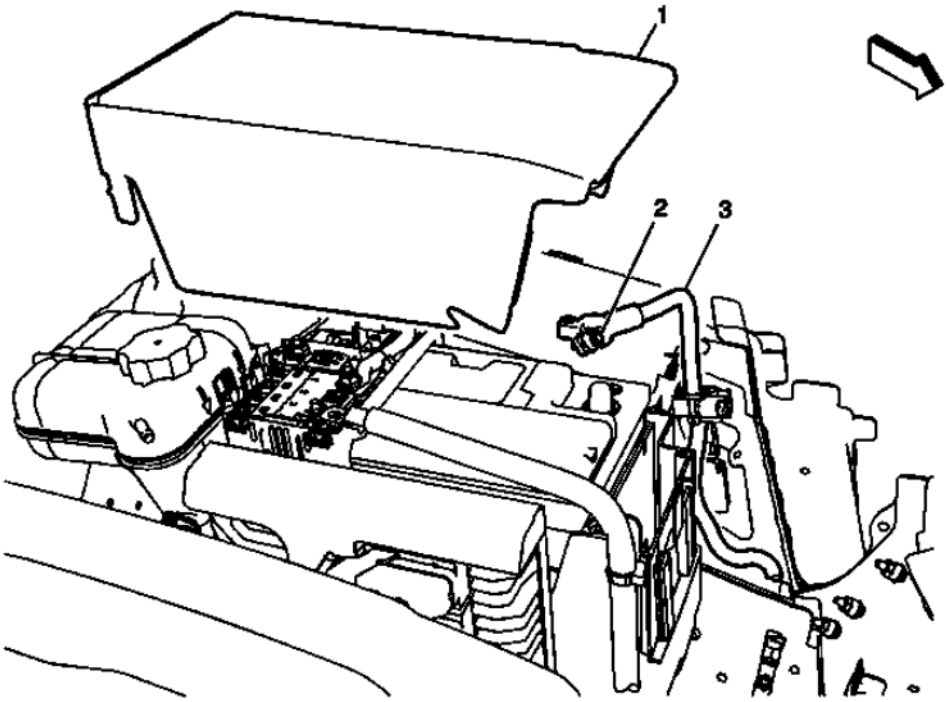


Fig. 14: Identifying Vac-N-Fill Cap
Courtesy of GENERAL MOTORS COMPANY

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

2. Attach the Vac N Fill cap to the **J 42401** Radiator Cap and Surge Tank Test Adapter.

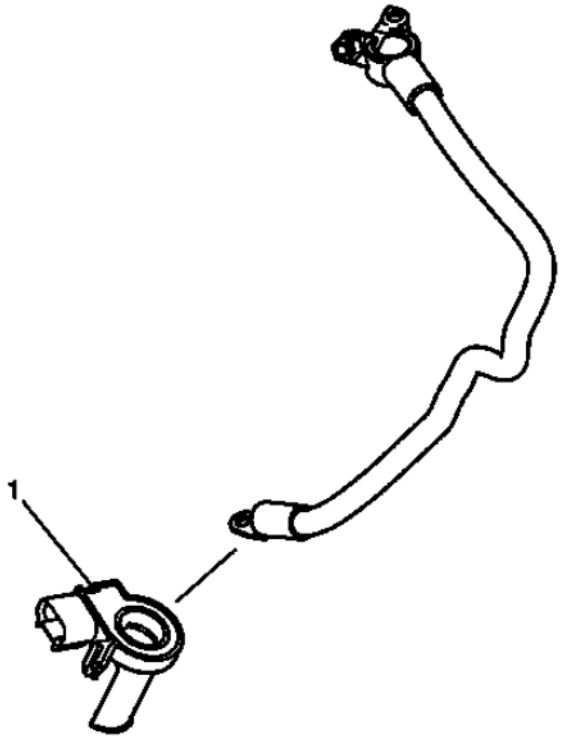


Fig. 15: Attaching The Vacuum Gage Assembly To The Vac-N-Fill Cap
Courtesy of GENERAL MOTORS COMPANY

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

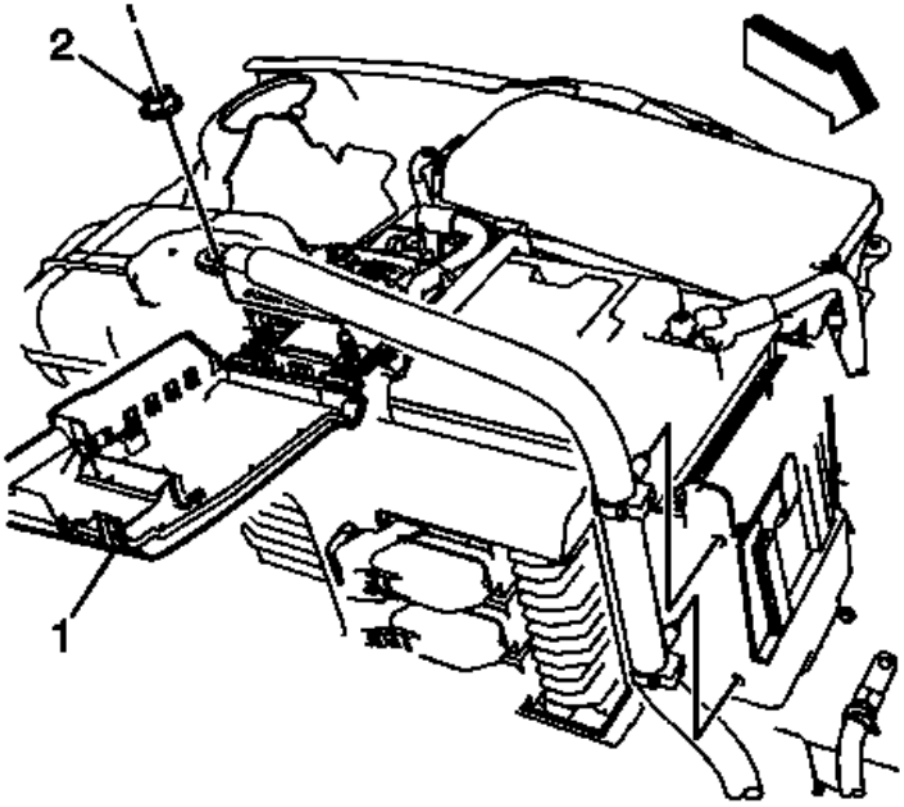


Fig. 16: Attaching Fill Hose To Barb Fitting On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS COMPANY

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

   Ensure that the valve is closed.

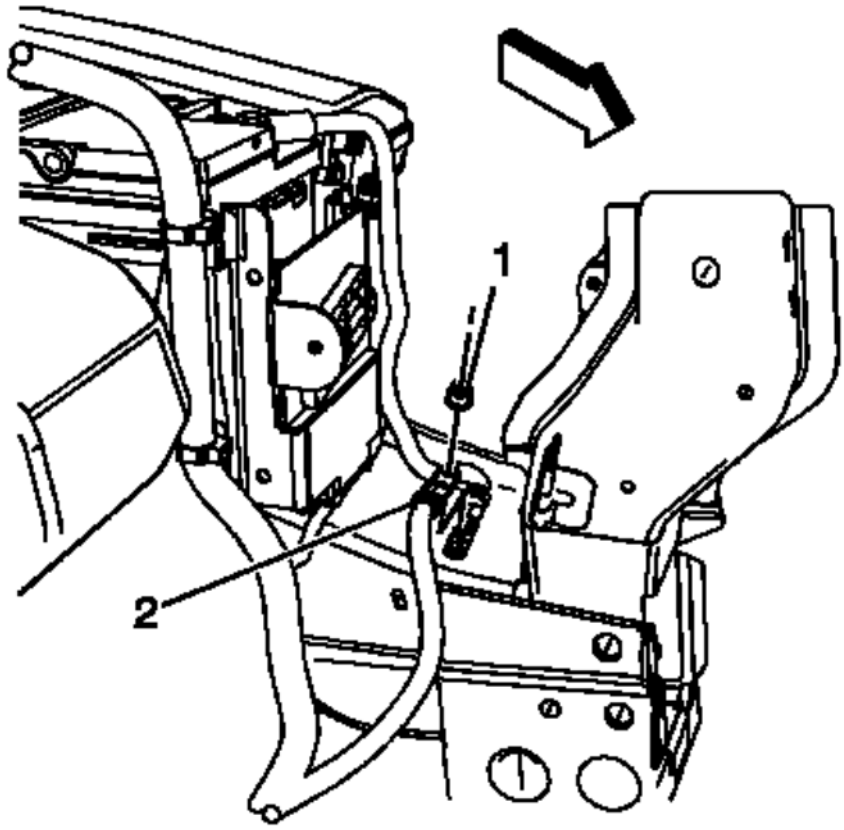


Fig. 17: View Of Graduated Reservoir & Hose
Courtesy of GENERAL MOTORS COMPANY

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.

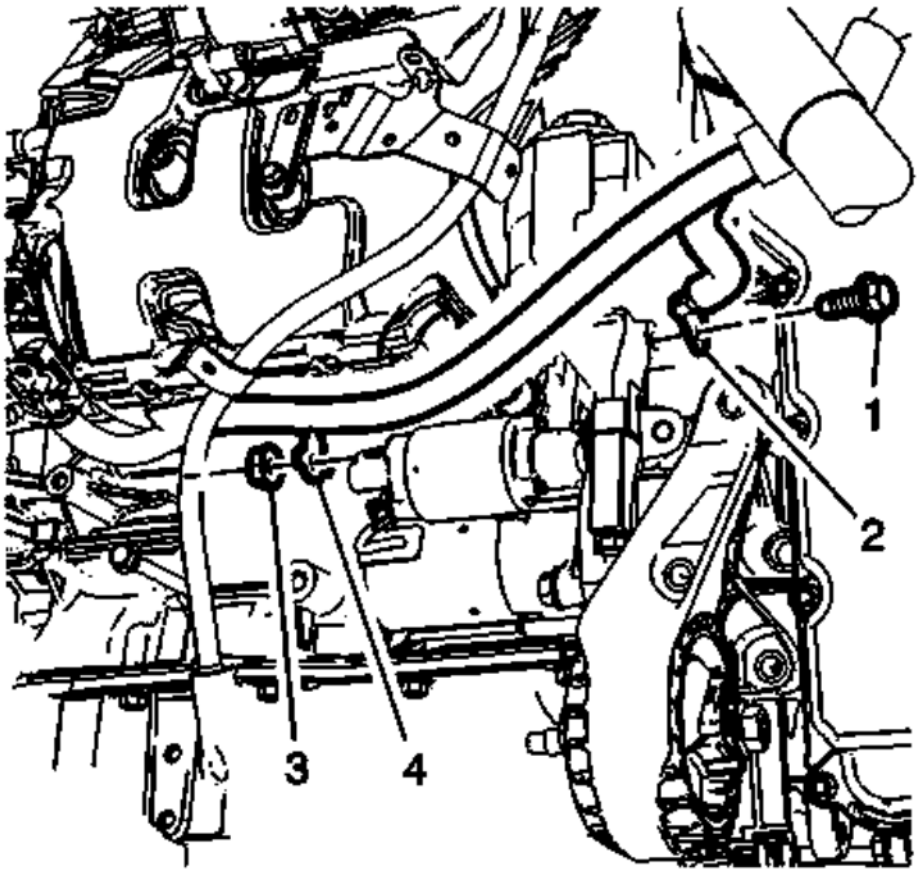


Fig. 18: View Of Venturi Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS COMPANY

8. Attach the venturi assembly to the vacuum tank.

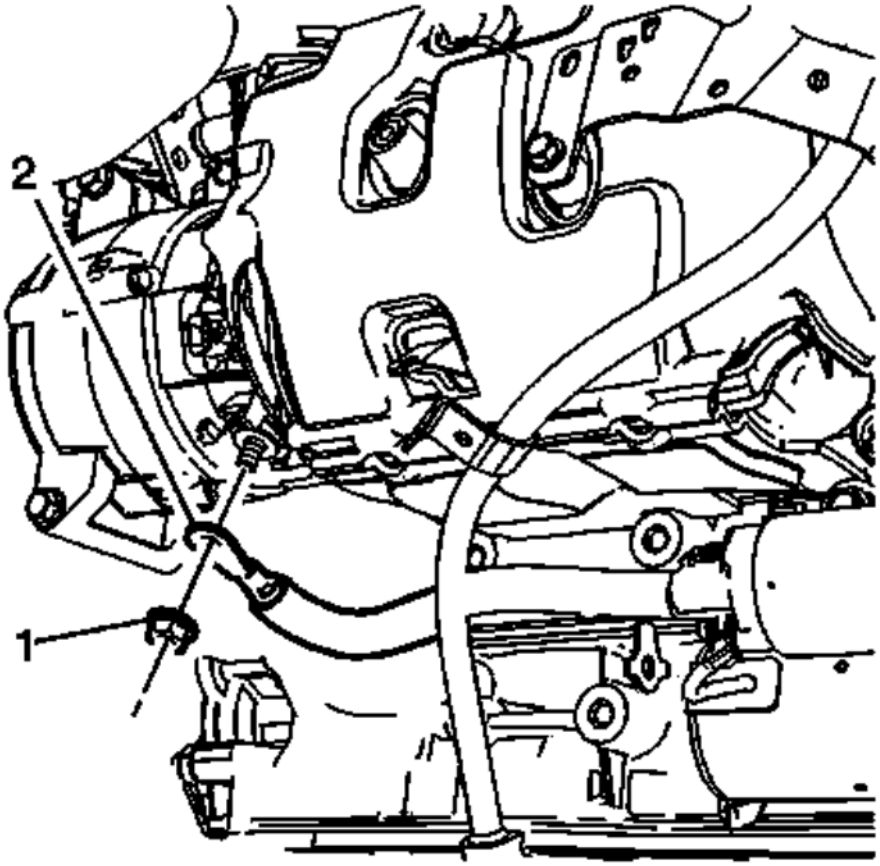


Fig. 19: View Of Shop Air Hose & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

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

   Ensure the valve on the venturi assembly is closed.

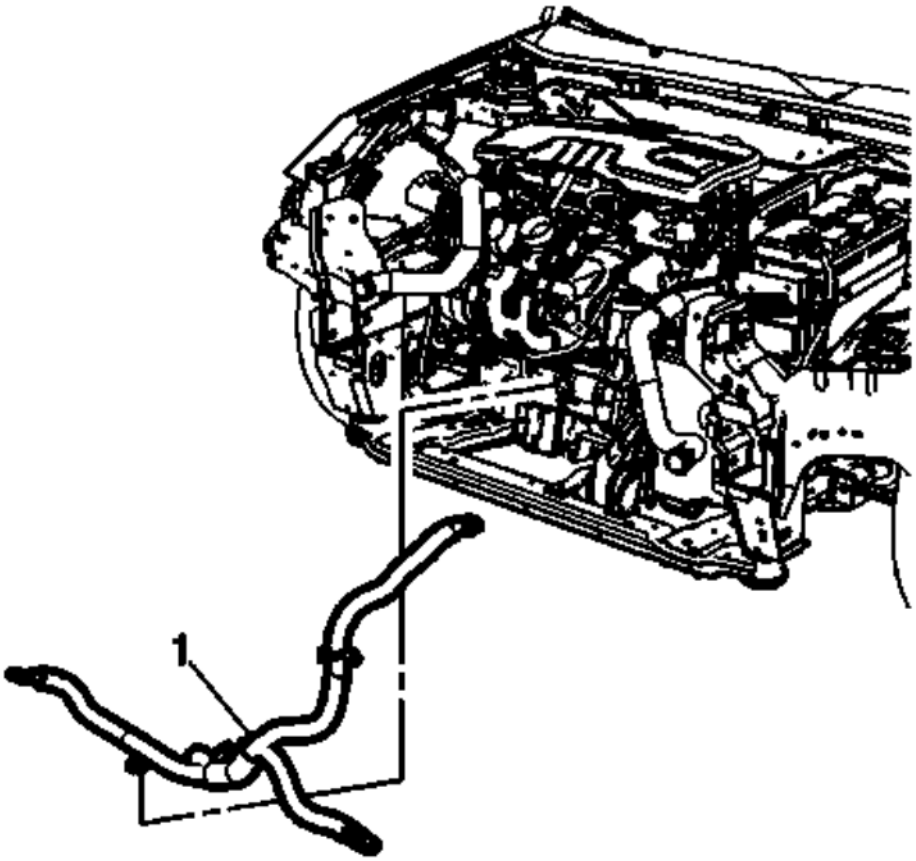


Fig. 20: Attaching Vacuum Hose To Vacuum Gauge Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS COMPANY

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

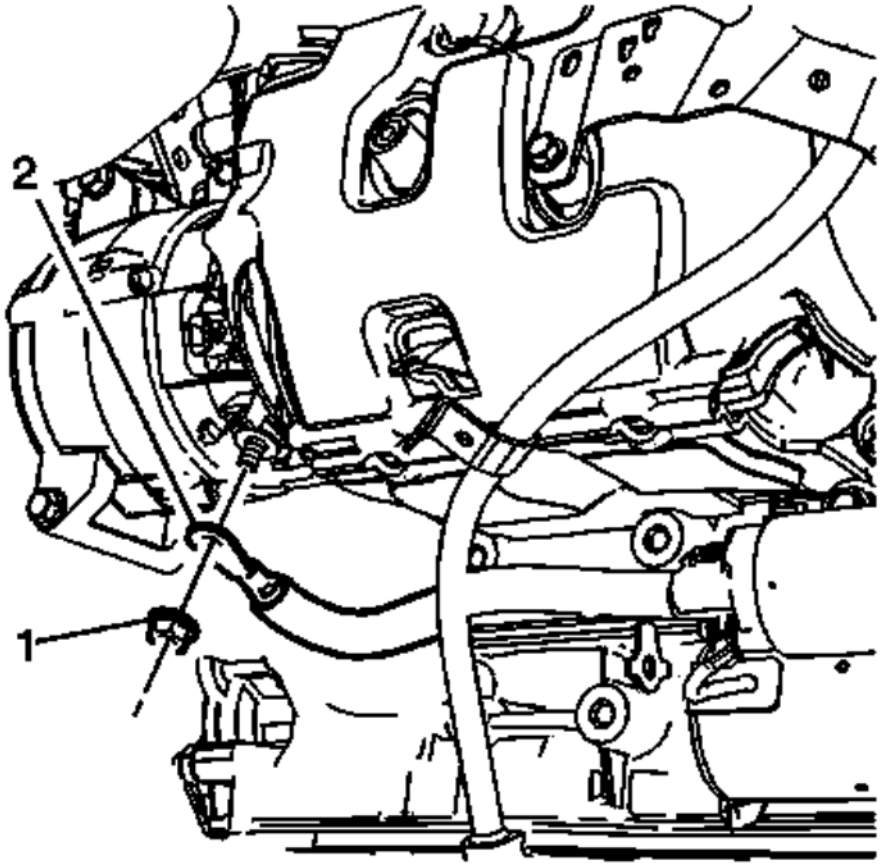


Fig. 21: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

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

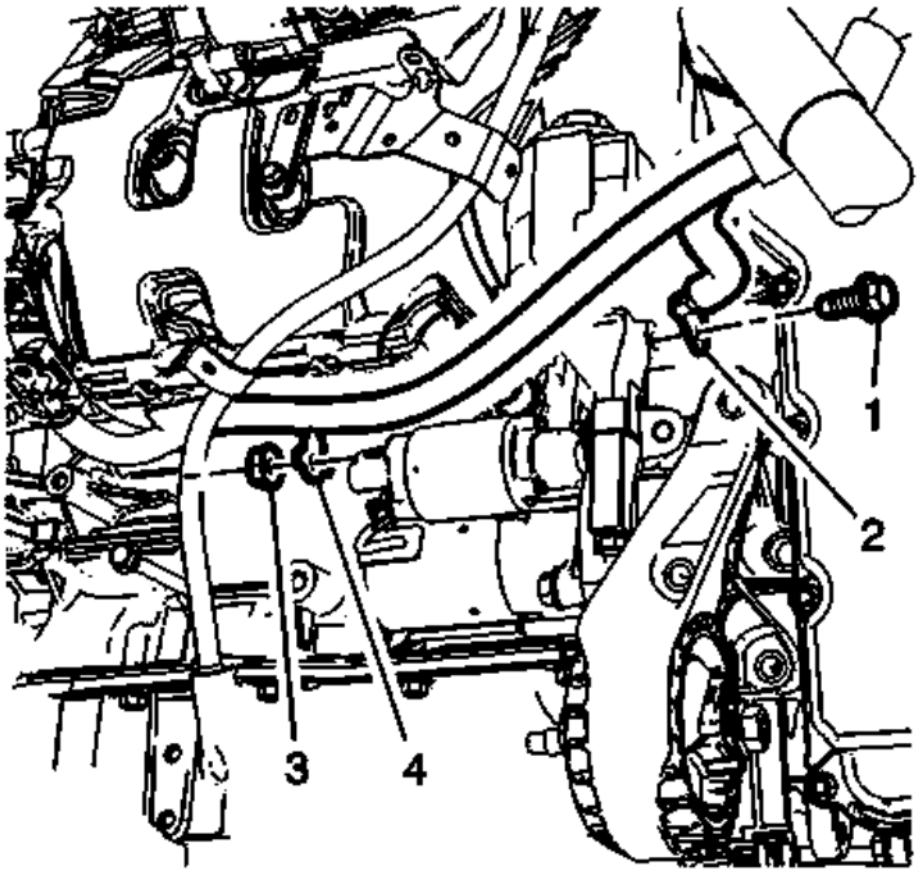


Fig. 22: View Of Vacuum Gauge
Courtesy of GENERAL MOTORS COMPANY

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.

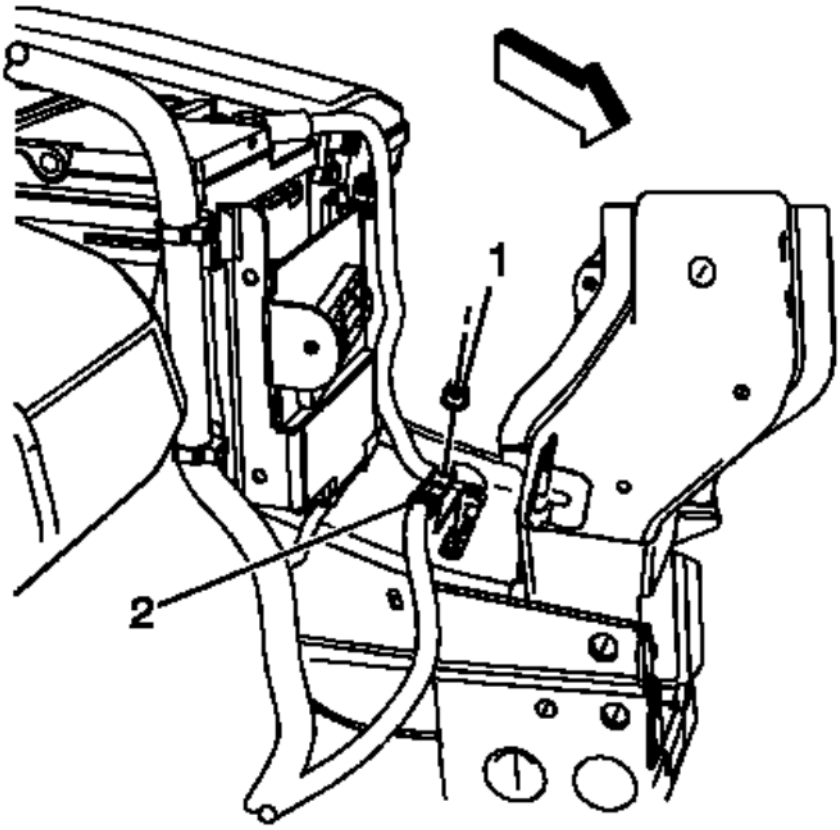


Fig. 23: Identifying Valve On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS COMPANY

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.

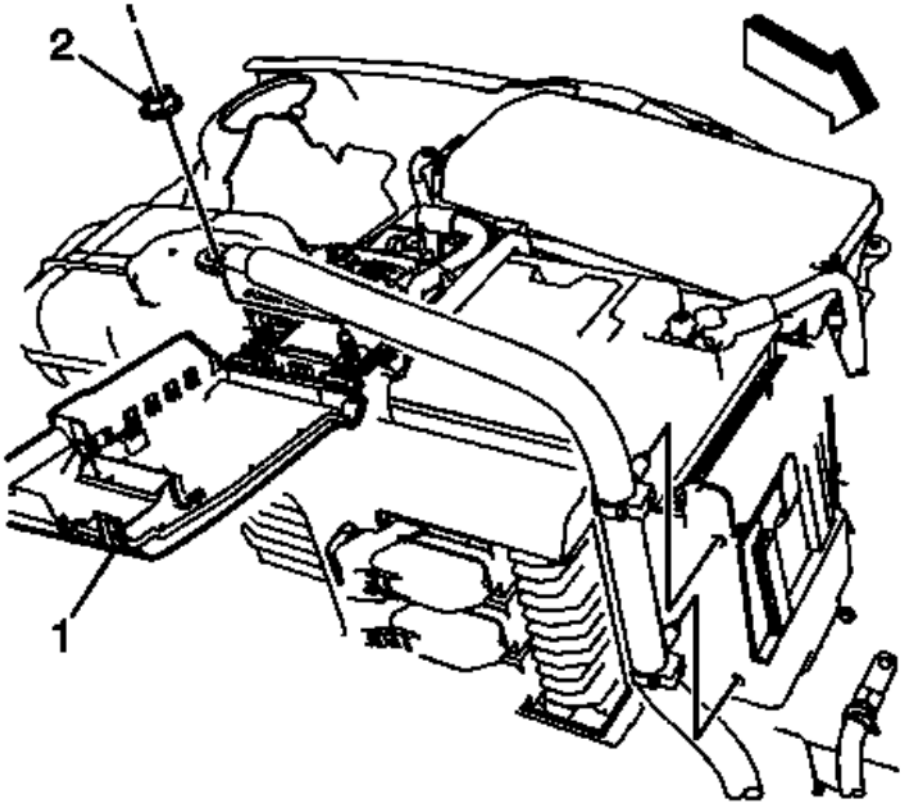


Fig. 24: View Of Vacuum Gauge & Radiator
Courtesy of GENERAL MOTORS COMPANY

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.

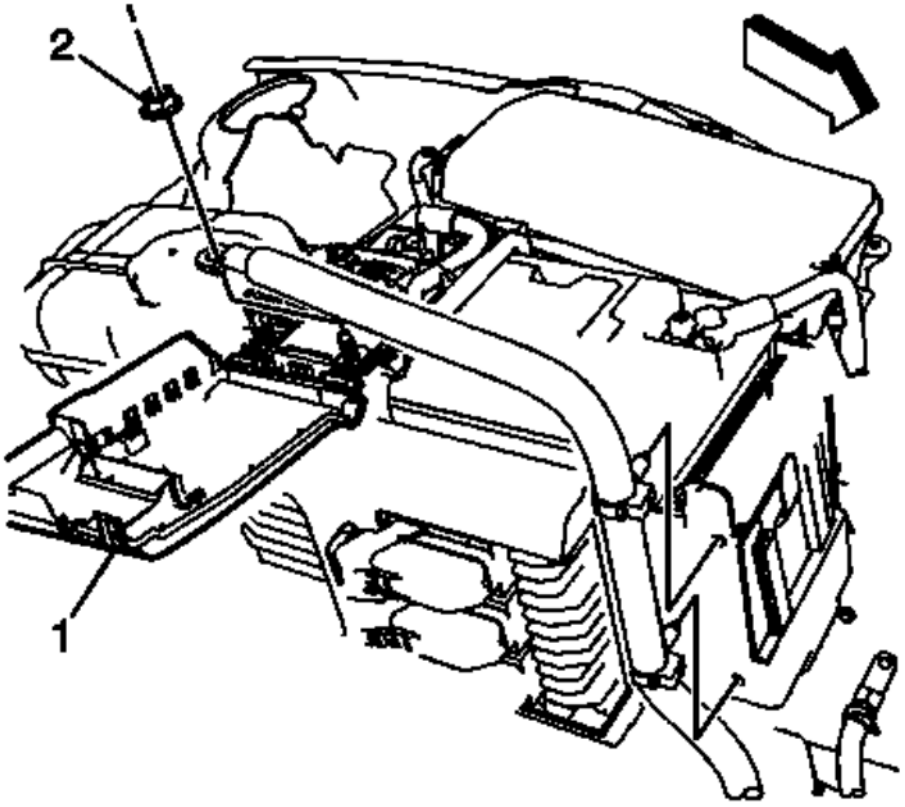


Fig. 25: Attaching Extraction Hose To Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

24. Attach the extraction hose to the vacuum hose.

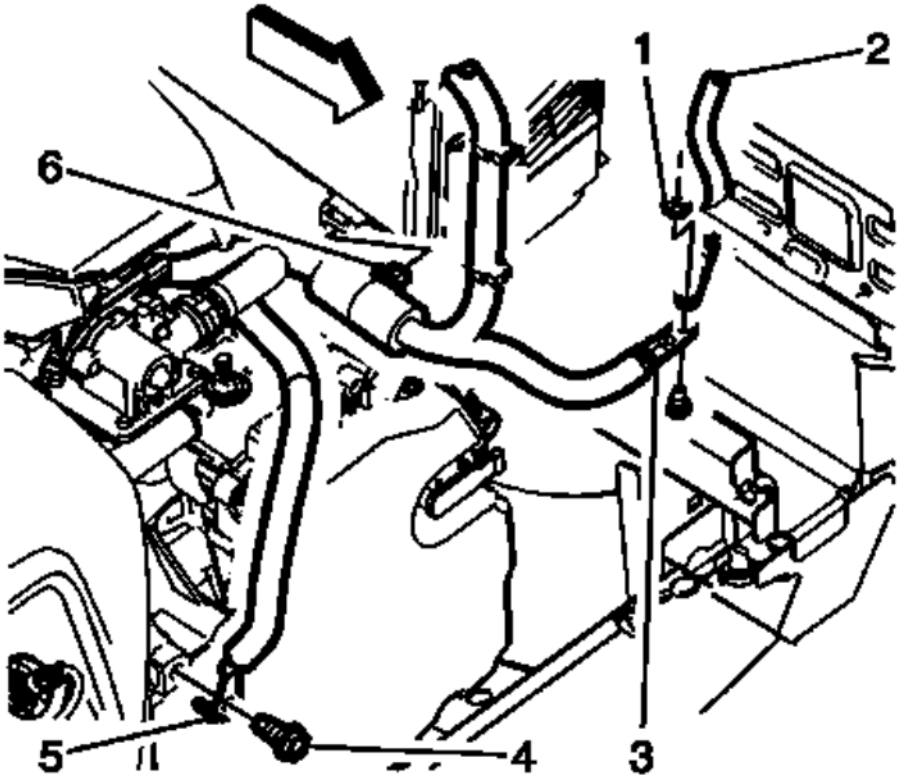


Fig. 26: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

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

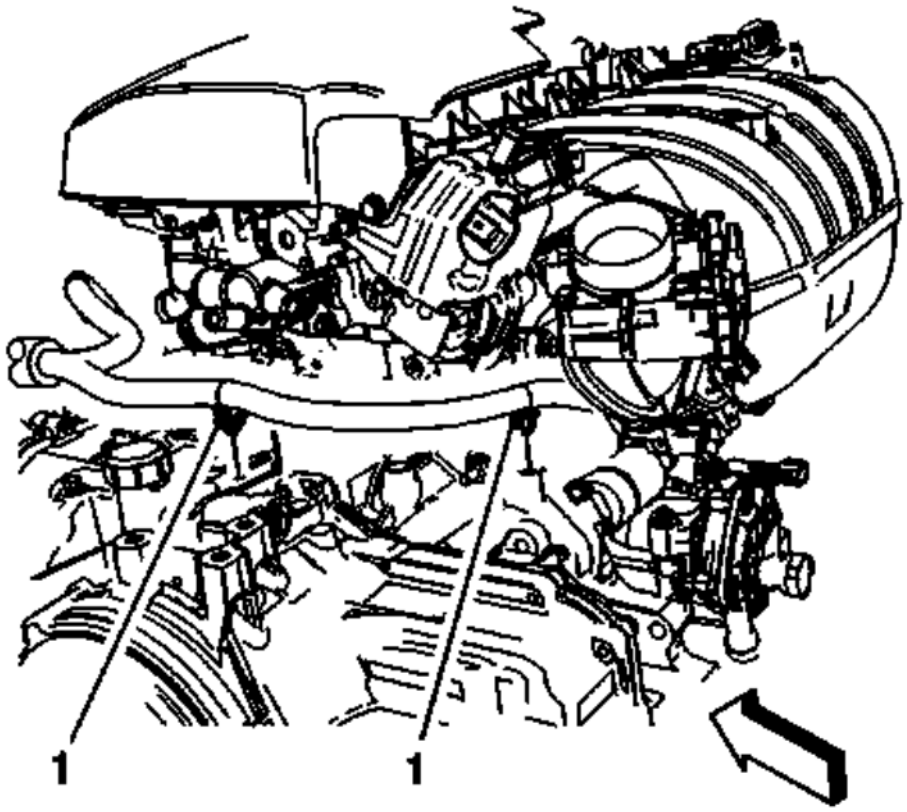


Fig. 27: Using Extraction Hose To Draw Out Coolant
Courtesy of GENERAL MOTORS COMPANY

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

FLUSHING

NOTE: **Do not use a chemical flush.**

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

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

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

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

RADIATOR SURGE TANK REPLACEMENT (LUK)

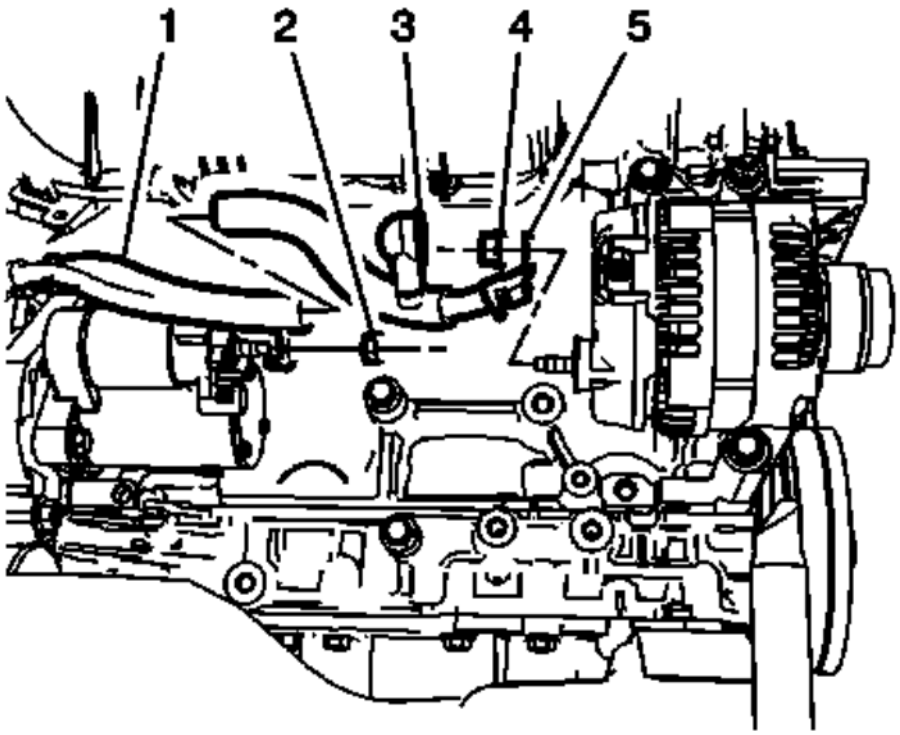


Fig. 28: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Replacement (LUK)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)** 2. Remove the radiator surge tank inlet hose. 3. Remove the radiator surge tank outlet hose. Refer to **Radiator Surge Tank Outlet Hose Replacement (LUK)**	
1	Radiator Surge Tank Retainer
2	Radiator Surge Tank **Procedure** Slide the surge tank forward towards the front of the car to remove from brackets.

RADIATOR SURGE TANK REPLACEMENT (LTG)

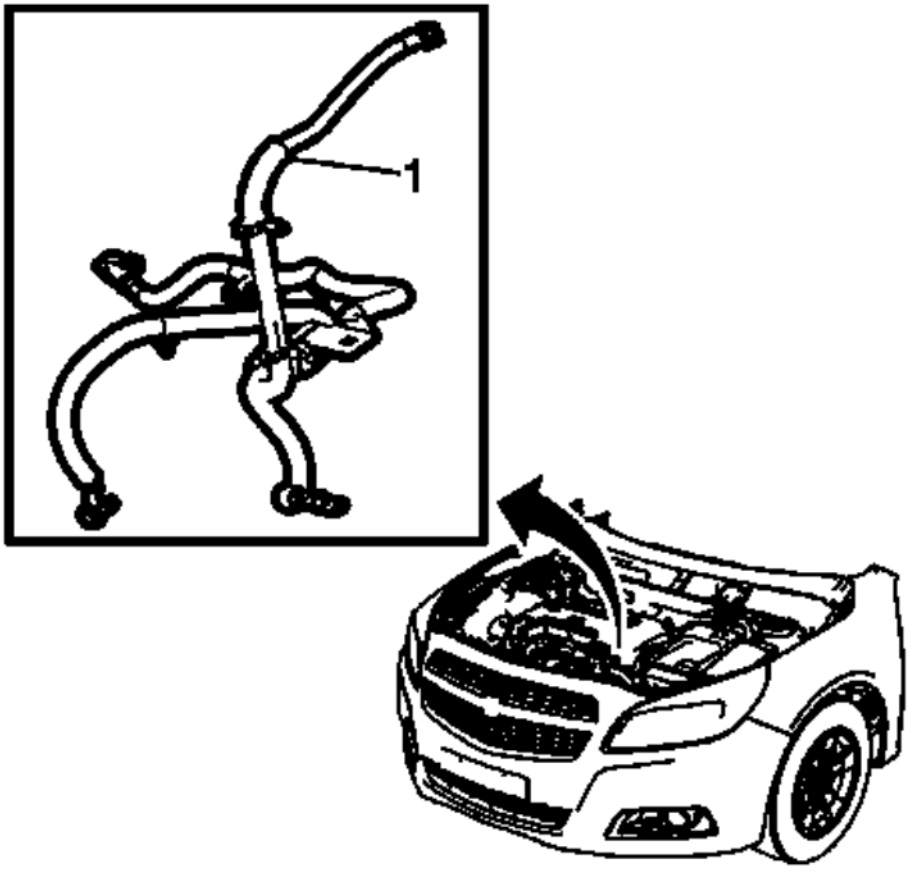


Fig. 29: Radiator Surge Tank (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Replacement (LTG)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling**	

System Draining and Filling (GE 47716).	
1	Radiator Surge Tank Hose Clamp (Qty: 2) **Procedure** Reposition the radiator surge tank hose clamps using **BO-38185** Hose Clamp Pliers. **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools**.
2	Radiator Surge Tank Inlet Hose
3	Heater Outlet Hose
4	Radiator Surge Tank Bracket Clip **Procedure** Lift the surge tank clip from the radiator surge tank and bracket.
5	Radiator Surge Tank **Procedure** 1. Slide the radiator surge tank forward and lift out of the radiator surge tank bracket. 2. After installation, fill the coolant reservoir to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 3. Inspect cooling system for leaks.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LTG)

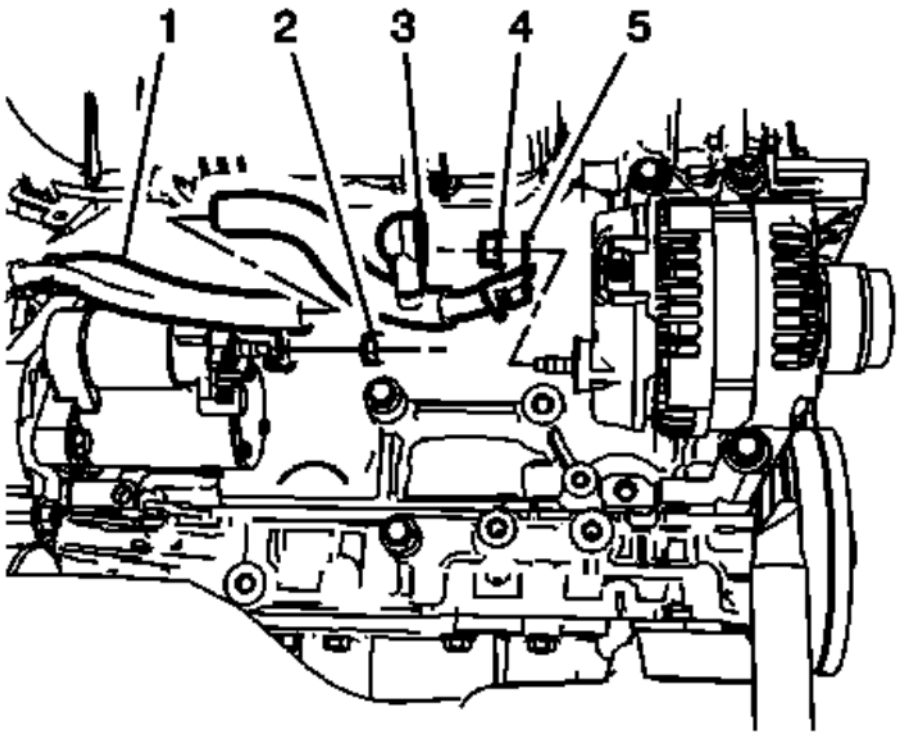


Fig. 30: Radiator Surge Tank Inlet Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 2) **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools**.
2	Radiator Surge Tank Inlet Hose **Procedure** 1. Remove the radiator surge tank inlet hose retaining clips from the fuel feed front pipe. 2. After installation, fill the coolant reservoir to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)** 3. Inspect cooling system for leaks.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LEA)

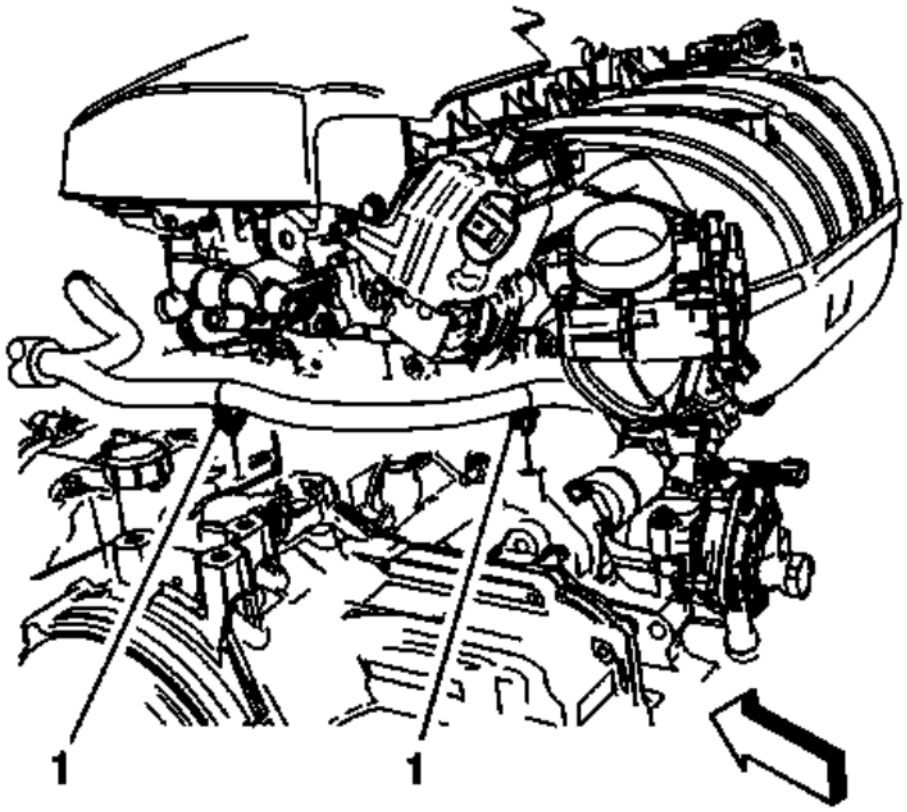


Fig. 31: Radiator Surge Tank Inlet Hose (LEA)
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)** 2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 2) **Procedure** Disengage tension on the radiator surge tank inlet hose clamps using **BO-38185** pliers. **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools**.
2	Radiator Surge Tank Inlet Hose **Procedure** Disconnect the retaining clip holding the radiator surge tank inlet hose to the high pressure fuel pump bracket.

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT (LUK)

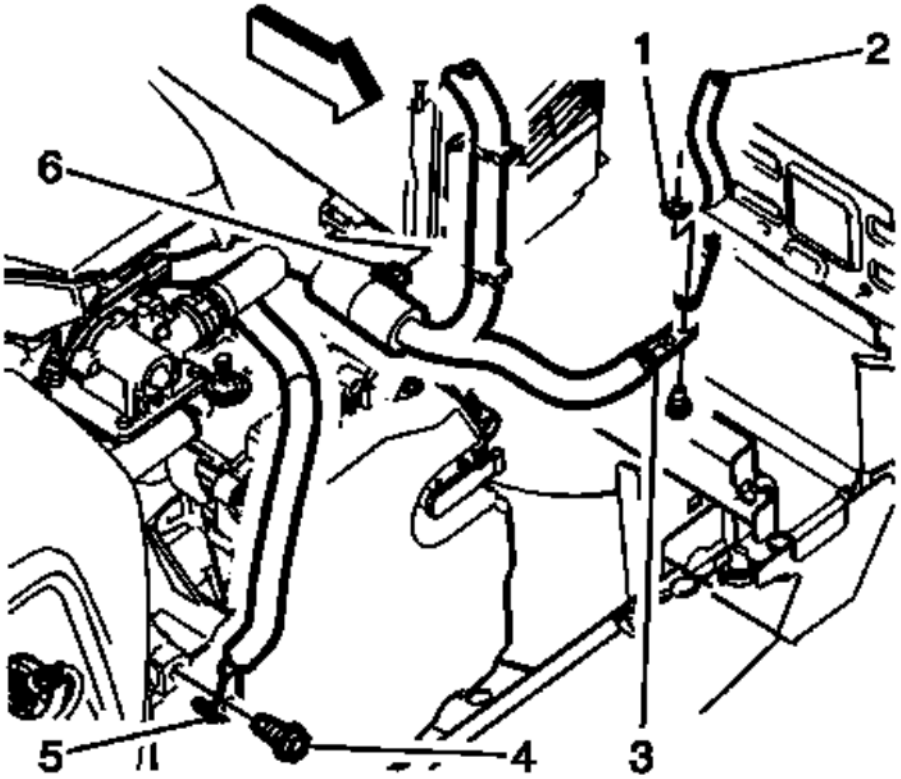


Fig. 32: Radiator Surge Tank Outlet Hose (LUK)
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Outlet Hose Replacement (LUK)

Callout	Component Name
Preliminary Procedures Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.	
1	Radiator Surge Tank Outlet Hose Clamp (Qty: 3)
2	Radiator Surge Tank Outlet Hose

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT (LEA)

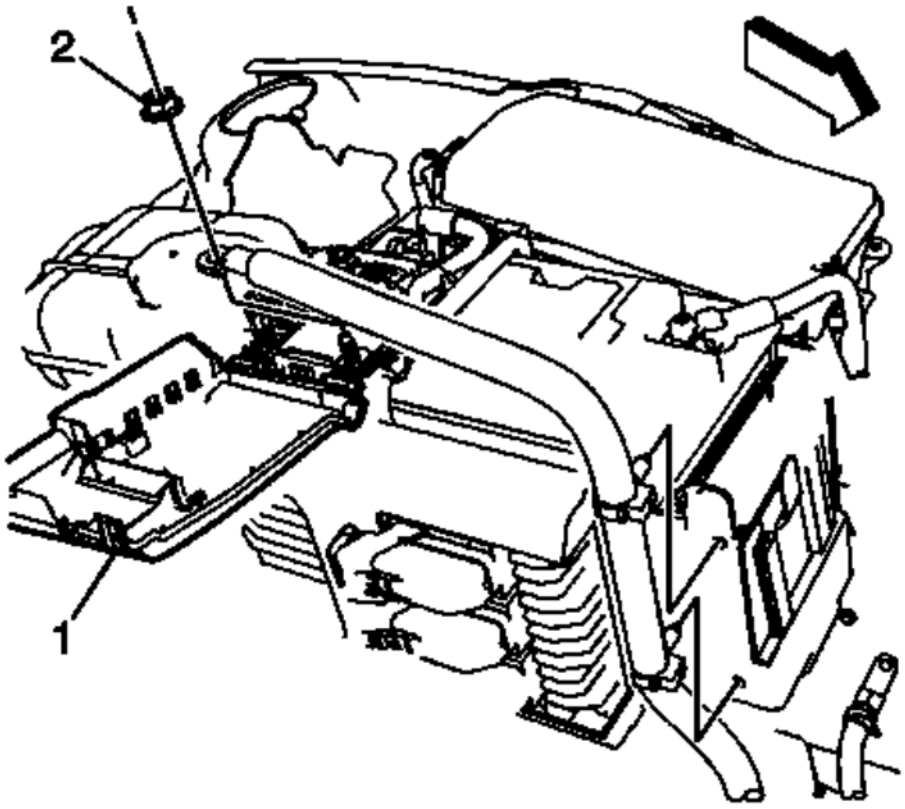


Fig. 33: Radiator Surge Tank Outlet Hose (LEA)
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Outlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.	
1	Radiator Surge Tank Outlet Hose Clamps (Qty: 2) **Procedure** Reposition the radiator surge tank outlet hose clamp using **BO-38185** pliers **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools**.
2	Radiator Surge Tank Outlet Hose

RADIATOR INLET HOSE REPLACEMENT (LUK)

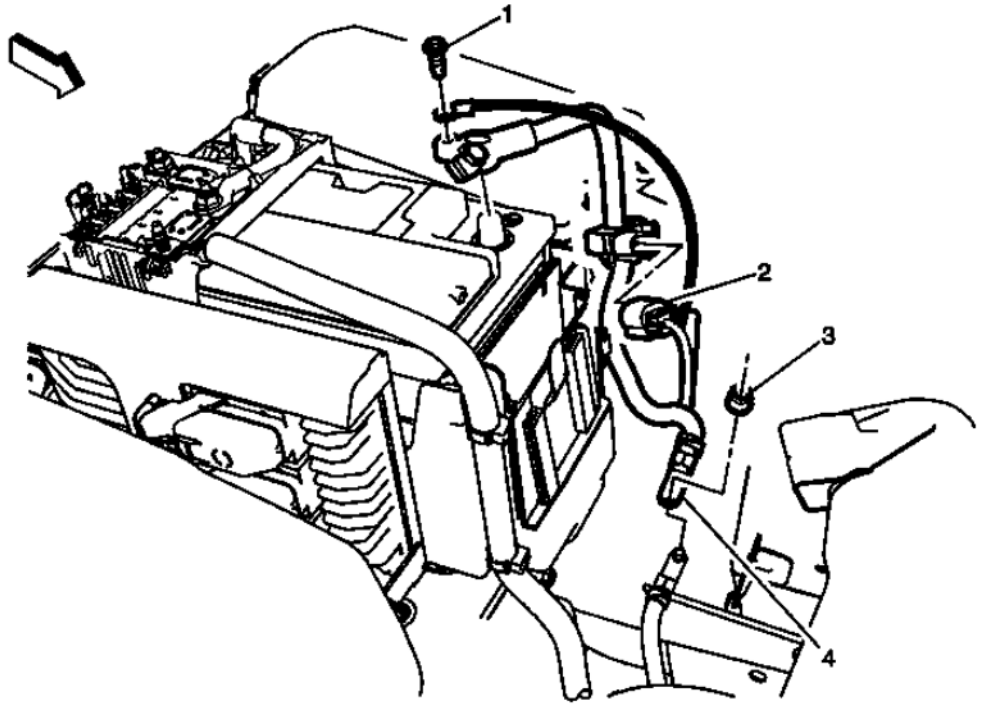


Fig. 34: Radiator Inlet Hose & Clamps (LUK)
Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LUK)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.	
1	Radiator Inlet Hose Clamps (Qty: 2)
2	Radiator Inlet Hose Support Bracket Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 25 (18 lb ft)
3	Radiator Inlet Hose

RADIATOR INLET HOSE REPLACEMENT (LTG)

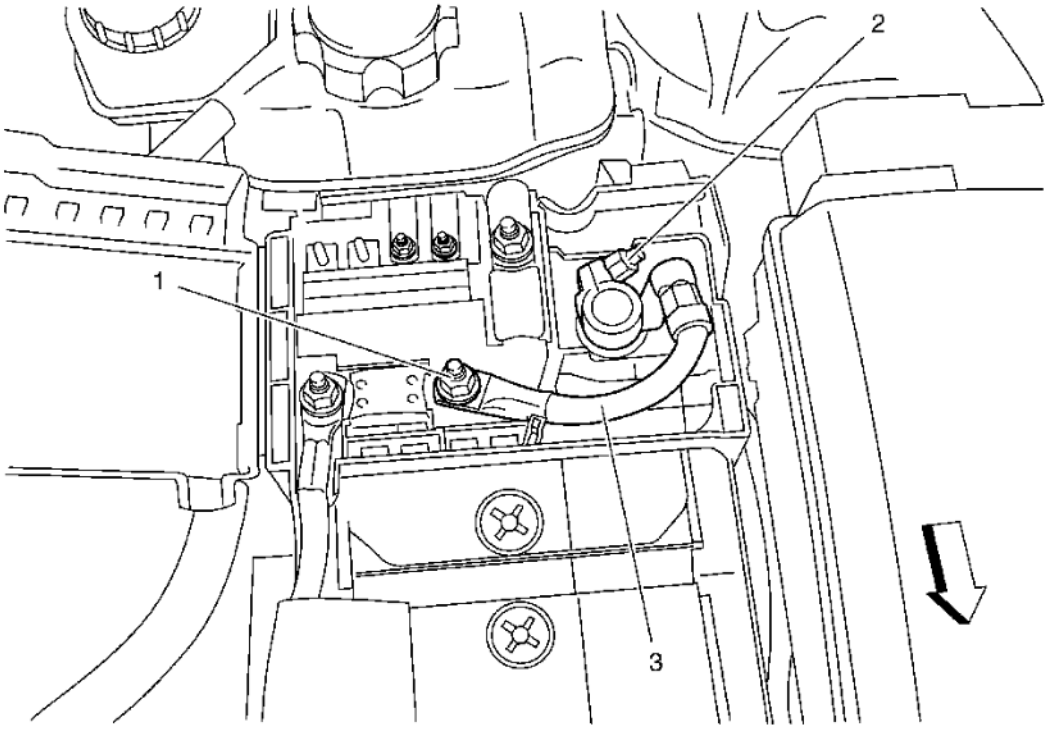


Fig. 35: Radiator Inlet Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** . 2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.	
1	Radiator Inlet Hose Clamp (Qty: 2) **Procedure** Reposition the radiator inlet hose clamps using the **BO-38185** hose clamp pliers. **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools**.
2	Radiator Inlet Hose **Procedure** 1. Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 2. Inspect the cooling system for leaks.

RADIATOR INLET HOSE REPLACEMENT (LEA)

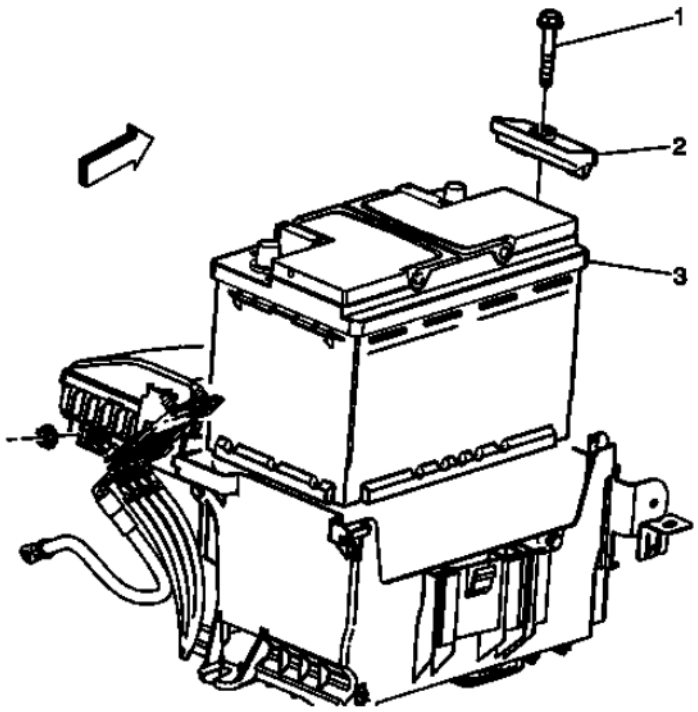


Fig. 36: Radiator Inlet Hose (LEA)
Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LEA)

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

RADIATOR OUTLET HOSE REPLACEMENT (LUK)

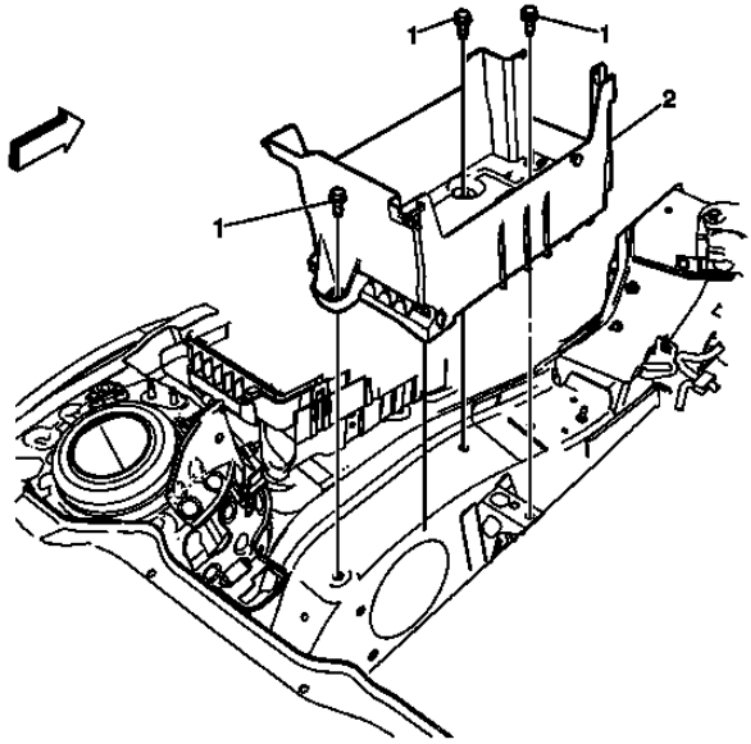


Fig. 37: Radiator Outlet Hose & Clamps (LUK)
Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LUK)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 2. Reposition the engine control module out of the way. Refer to **Engine Control Module Replacement** . 3. Reposition the drive motor battery coolant air separator out of the way. Refer to **Drive Motor Battery Coolant/Air Separator Replacement** .	
1	Radiator Outlet Hose Clamps
2	Radiator Outlet Hose

RADIATOR OUTLET HOSE REPLACEMENT (LTG)

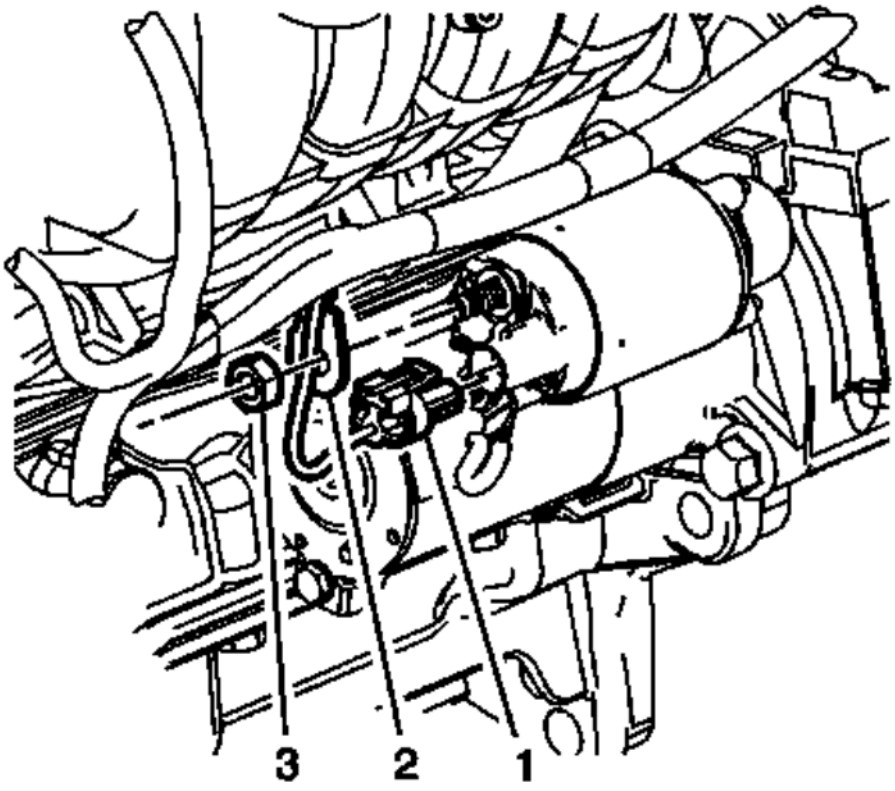


Fig. 38: Radiator Outlet Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedure 1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** . 2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.	
1	Radiator Outlet Hose Clamp (Qty: 2) **Procedure** Reposition the radiator outlet hose clamps using the **BO-38185** hose clamp pliers. **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools**.
2	Radiator Outlet Hose **Procedure** 1. Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 2. Inspect the cooling system for leaks. Refer to **Cooling System Leak Testing**.

RADIATOR OUTLET HOSE REPLACEMENT (LEA)

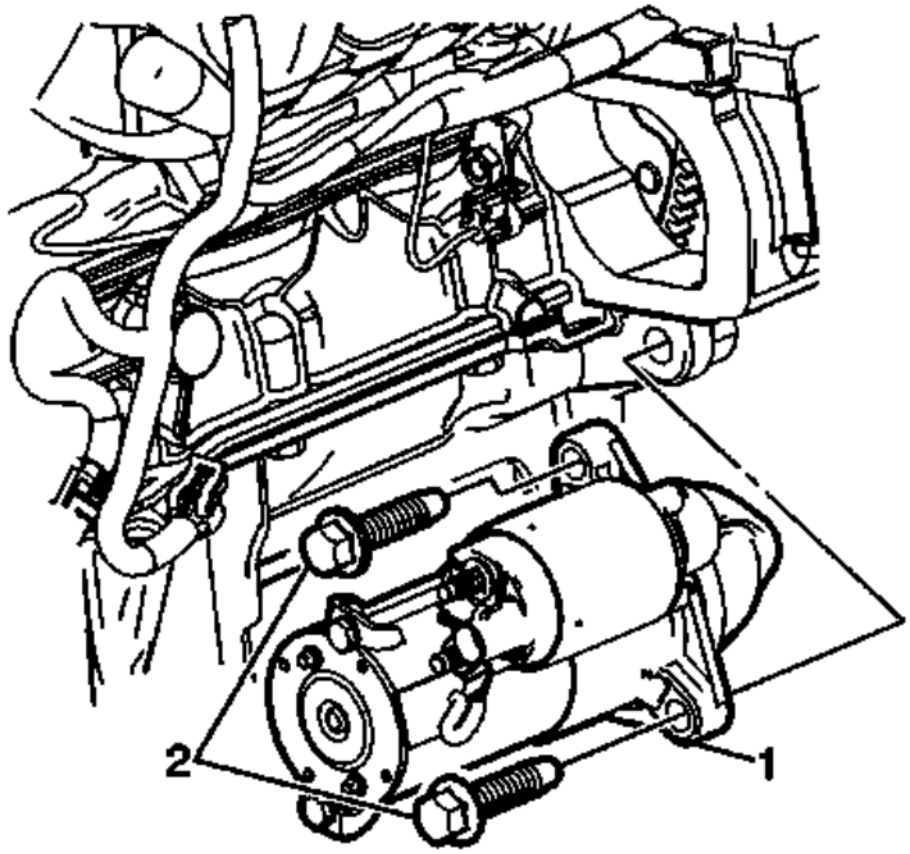


Fig. 39: Radiator Outlet Hose (LEA)
Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 2. Unclip radiator outlet hose from bracket.	
1	Radiator Outlet Hose Clamp **Procedure** Reposition the radiator outlet hose clamp using **BO-38185** pliers. **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools**.
2	Radiator Outlet Hose

RADIATOR LOWER BRACKET REPLACEMENT (LTG)

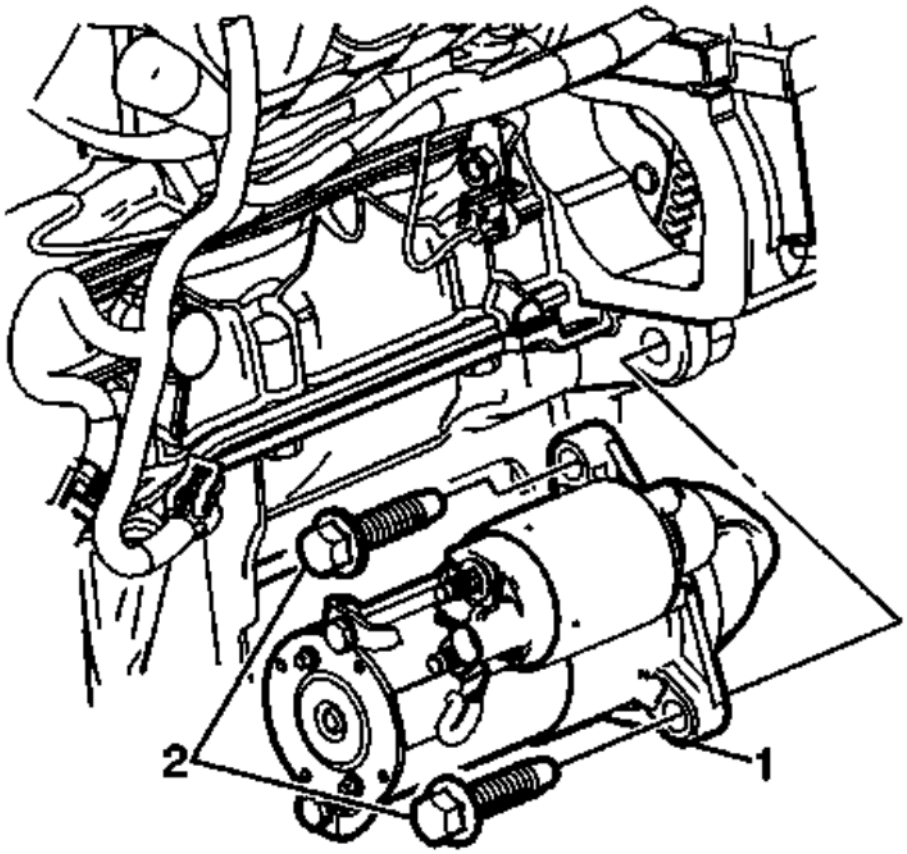


Fig. 40: Radiator Support Bracket (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Lower Bracket Replacement (LTG)

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** . 2. Support the radiator.	
1	Radiator Lower Bracket Fastener (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 22 (16 lb ft)
2	Radiator Lower Bracket (Qty: 2)

RADIATOR UPPER BRACKET REPLACEMENT (LTG)

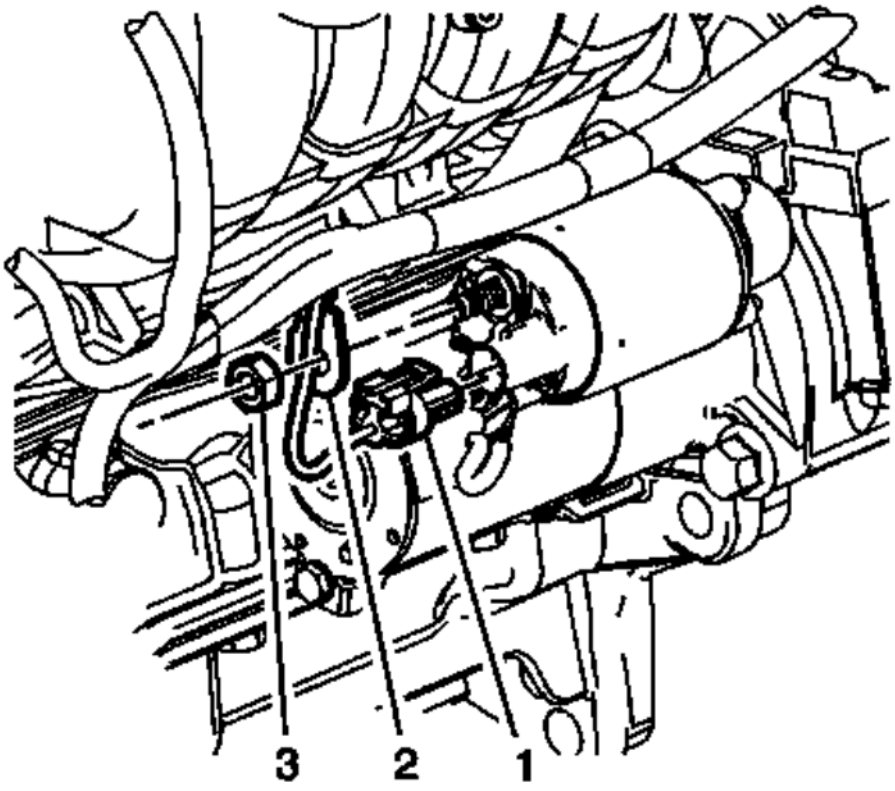


Fig. 41: Radiator Upper Brackets (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Upper Bracket Replacement (LTG)

Callout	Component Name
1	Front End Upper Tie Bar **Procedure** Remove the front end upper tie bar. Refer to **Front End Upper Tie Bar Replacement** .
2	Radiator Upper Bracket Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 22 (16 lb ft)
3	Radiator Upper Bracket (Qty: 2)

ENGINE COOLANT FAN REPLACEMENT (LUK)

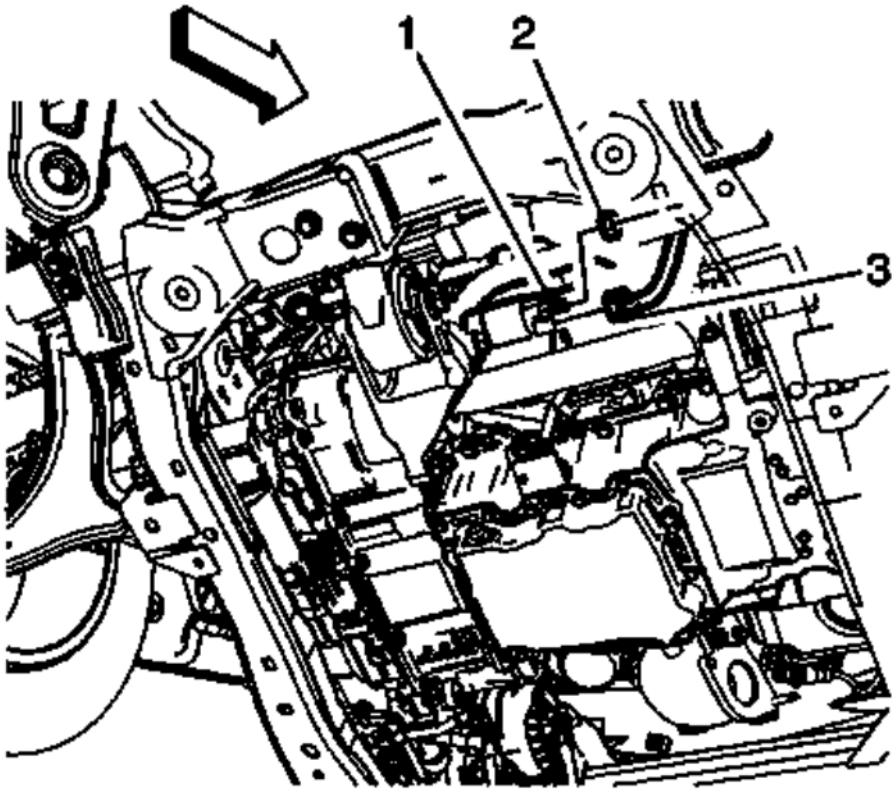


Fig. 42: Engine Coolant Fan (LUK)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Replacement (LUK)

Callout	Component Name
Preliminary Procedures Remove the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LUK)**.	
1	Engine Coolant Fan Retainer (Qty: 2)
2	Engine Coolant Fan (Qty: 2)

ENGINE COOLANT FAN REPLACEMENT (LTG)

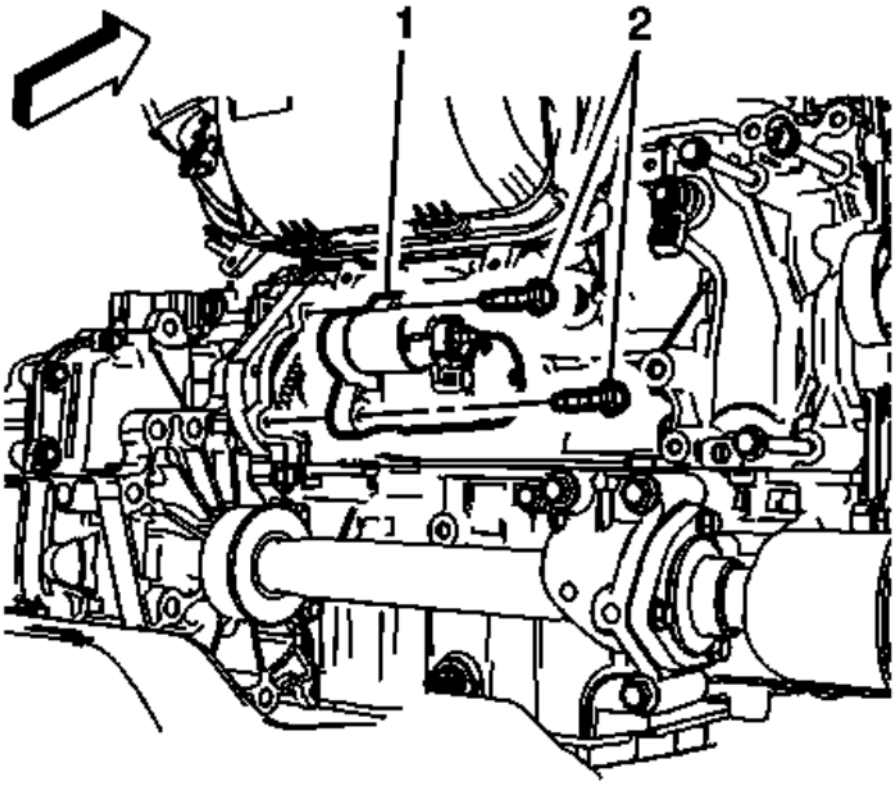


Fig. 43: Engine Coolant Fans & Fasteners (LTG)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Replacement (LTG)

Callout	Component Name
Preliminary Procedure Remove the engine coolant fan shroud from the vehicle. Refer to **Engine Coolant Fan Shroud Replacement (LTG)**.	
1	Engine Coolant Fan Fastener (Qty: 6) (Qty: 3 Per Fan Assembly) **CAUTION:** **Refer to Fastener Caution .**
2	Engine Coolant Fan (Qty: 2)

ENGINE COOLANT FAN MOTOR REPLACEMENT (LUK)

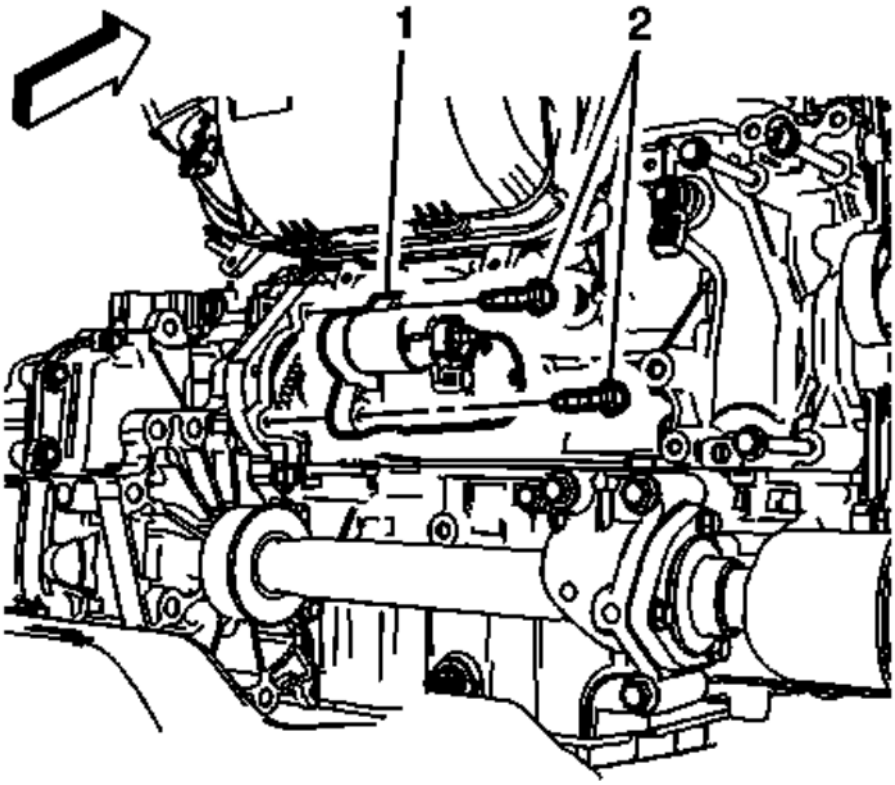


Fig. 44: Engine Coolant Fan Motor (LUK)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Motor Replacement (LUK)

Callout	Component Name
Preliminary Procedures Remove the engine coolant fan. Refer to **Engine Coolant Fan Replacement (LUK)**.	
1	Engine Coolant Fan Motor Bolt (Qty: 6) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Engine Coolant Fan Motor (Qty: 2)

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LTG)

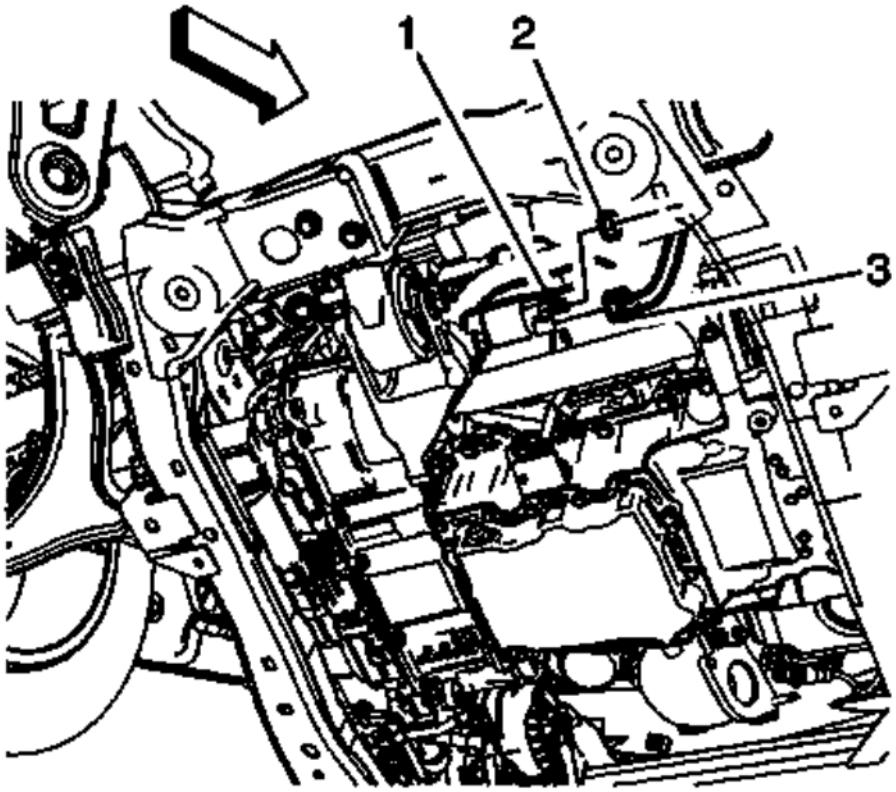


Fig. 45: Turbocharger Coolant Feed Pipe (LTG)
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Feed Pipe Replacement (LTG)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 2. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** . 3. Remove the engine mount bracket heat shield. **NOTE:** **Replace hose clamp if necessary.** **Special Tools BO-38185** Hose Clamp PliersFor equivalent regional tools, refer to **Special Tools** .	
1	Turbocharger Coolant Feed Pipe Bolt **Tighten** 35 (26 lb ft)
2	Turbocharger Coolant Feed Pipe Washer (Qty: 2) **NOTE:** **Install 2 NEW washers.**

3	Turbocharger Coolant Feed Pipe Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 (89 lb in)
4	Gasket
5	Hose Clamp
6	Turbocharger Coolant Feed Pipe

TURBOCHARGER COOLANT RETURN PIPE REPLACEMENT (LTG)

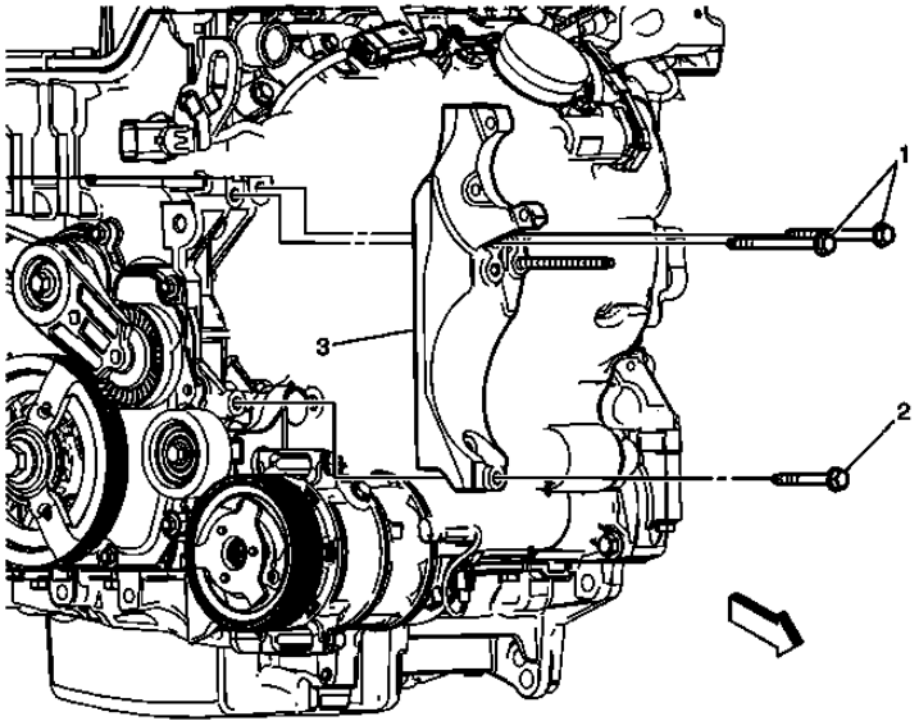


Fig. 46: Turbocharger Coolant Return Pipe (LTG)
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Return Pipe Replacement (LTG)

Callout	Component Name
Preliminary Procedures	

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the turbocharger heat shield. Refer to **Turbocharger Heat Shield Replacement** .

NOTE:

Replace hose clamp if necessary. **Special Tools BO-38185** Hose Clamp PliersFor equivalent regional tools, refer to **Special Tools** .	
1	Engine Coolant Air Bleed Hose
2	Turbocharger Coolant Return Pipe Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 (89 lb in)
3	Turbocharger Coolant Return Pipe Bolt **Tighten** 35 N.m (26 lb ft)
4	Turbocharger Coolant Return Pipe Washer (Qty: 2) **NOTE:** **Install 2 NEW washers.**
5	Turbocharger Coolant Return Pipe

THERMOSTAT BYPASS HOSE REPLACEMENT (LTG)

Special Tools

BO-38185 Hose Clamp Pliers

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

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the battery tray. Refer to **Battery Tray Replacement** .

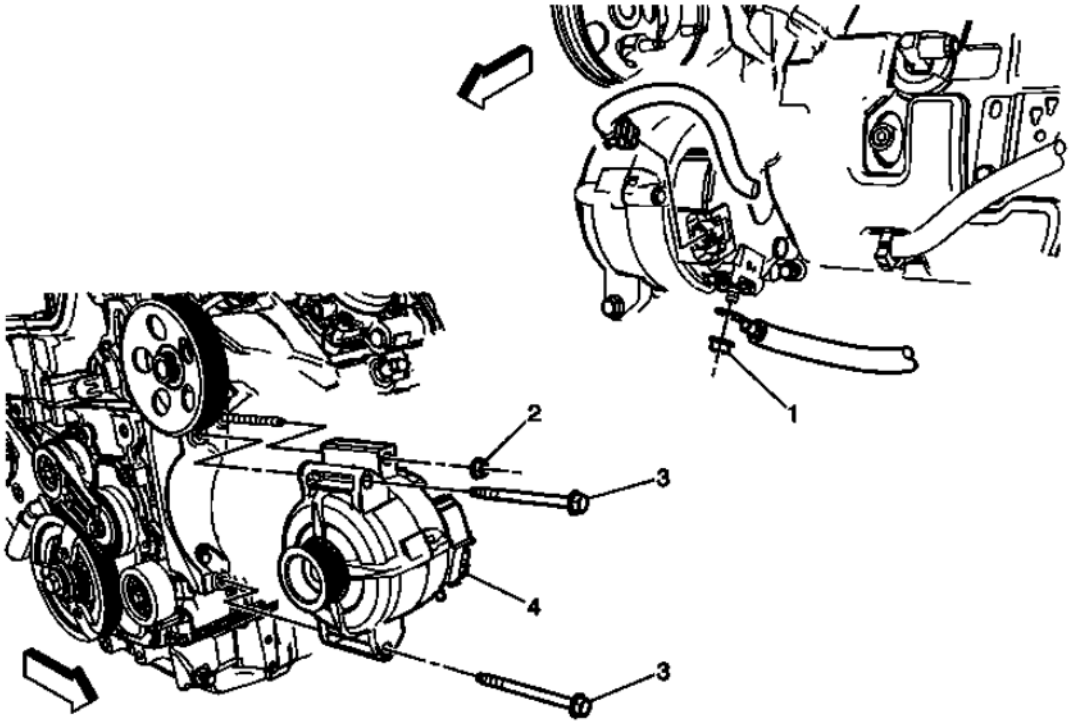


Fig. 47: Radiator Inlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator inlet hose (1) from the water outlet (2).

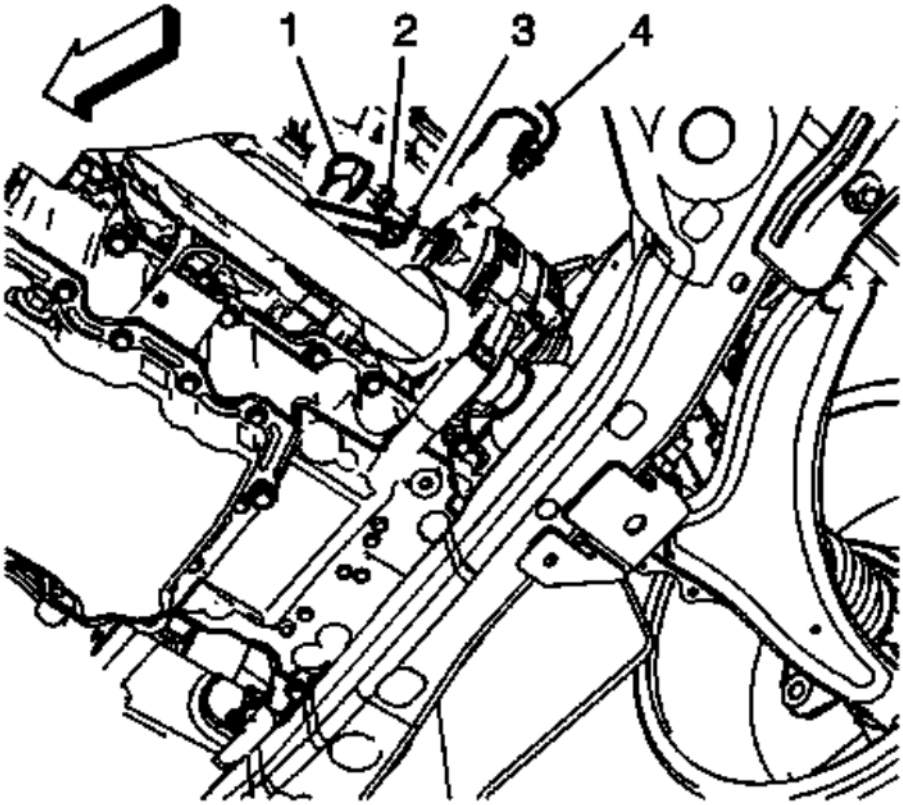


Fig. 48: Thermostat Bypass Hose And Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Remove the thermostat bypass hose (2) from the thermostat bypass pipe (1) and the water outlet (3).

Installation Procedure

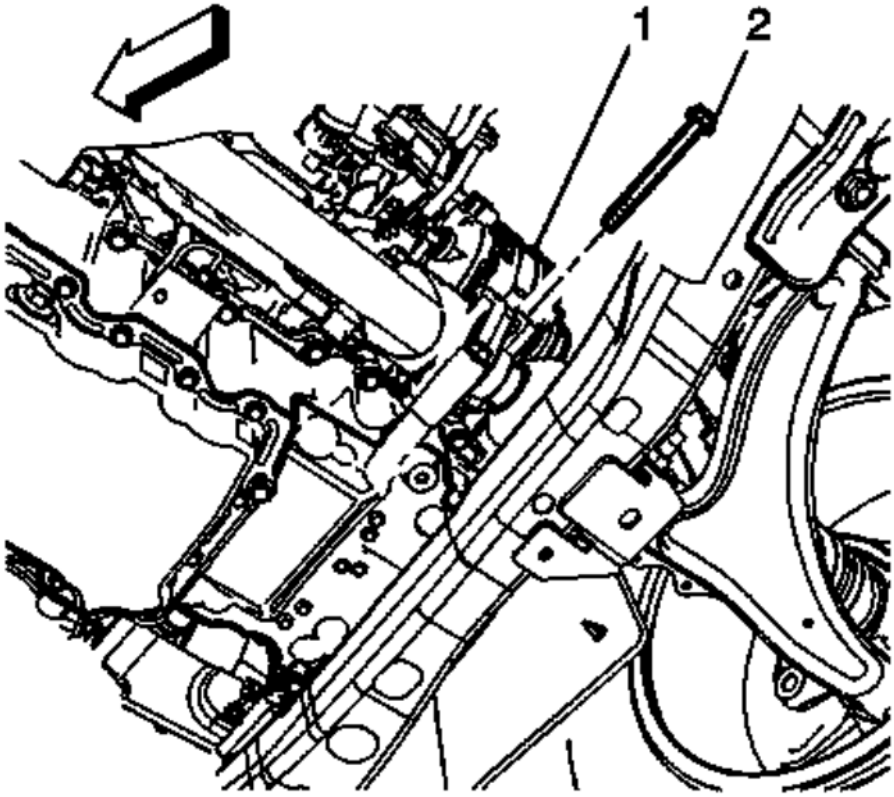


Fig. 49: Thermostat Bypass Hose And Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install the thermostat bypass hose (2) to the thermostat bypass pipe (1) and the water outlet (3).

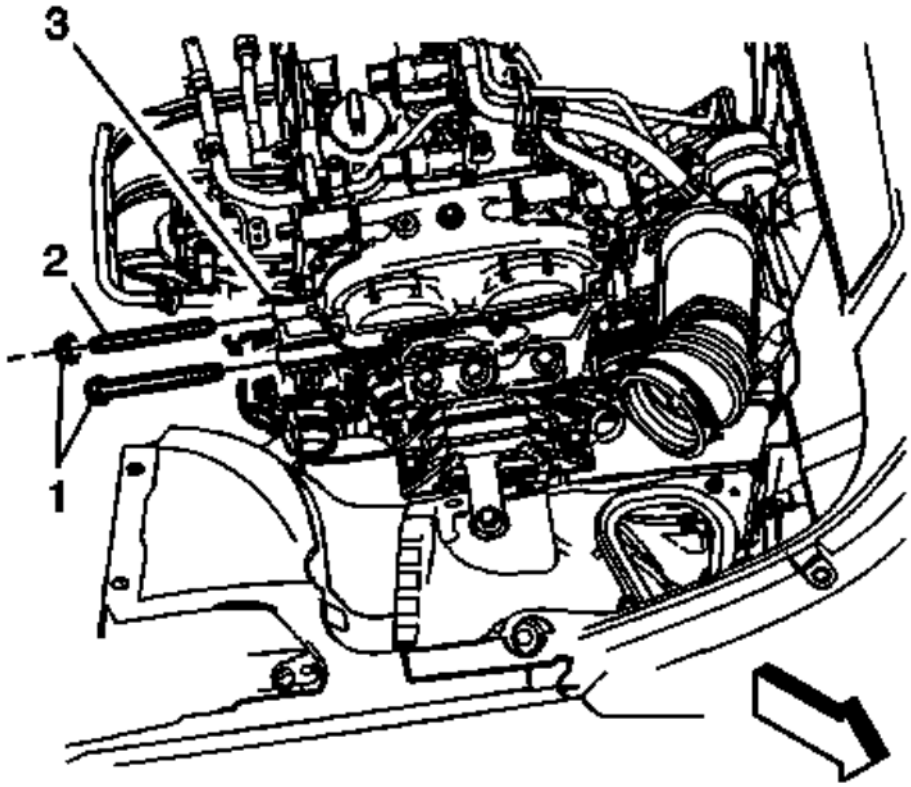


Fig. 50: Radiator Inlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

2. Install the radiator inlet hose (1) to the water outlet (2).
3. Install the battery tray. Refer to **Battery Tray Replacement** .
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
5. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
6. Start the engine and check for coolant leaks.

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LTG)

Removal Procedure

Special Tools

BO-38185 Hose Clamp Pliers

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

NOTE: The thermostat and thermostat housing are serviced as an assembly.

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

System Draining and Filling (GE 47716).

2. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .

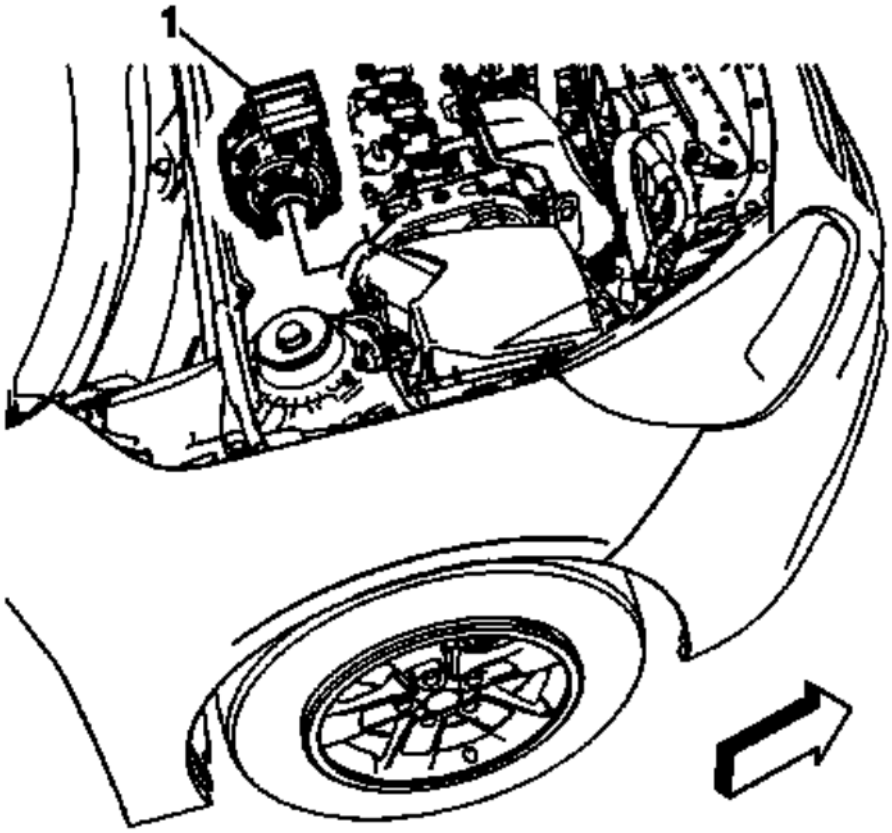


Fig. 51: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose (1) from the engine coolant thermostat housing (2).

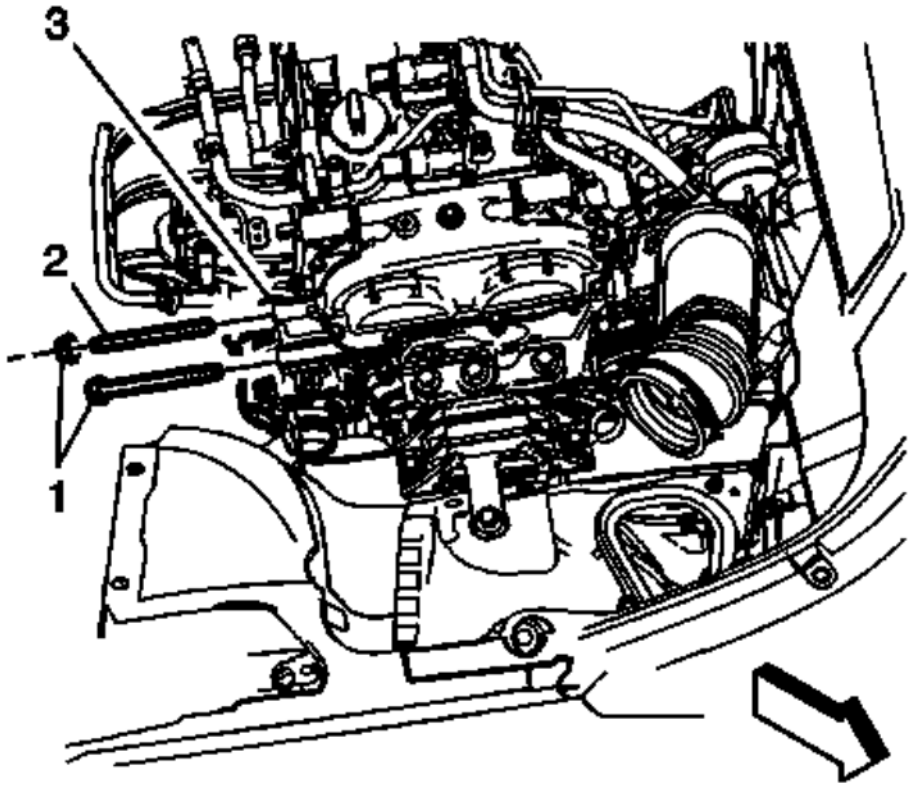


Fig. 52: Engine Coolant Thermostat Housing Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine coolant thermostat housing fasteners (3) and remove the engine coolant thermostat housing (2).
5. Discard the engine coolant thermostat housing seal (1).

Installation Procedure

1. Clean the sealing surfaces.

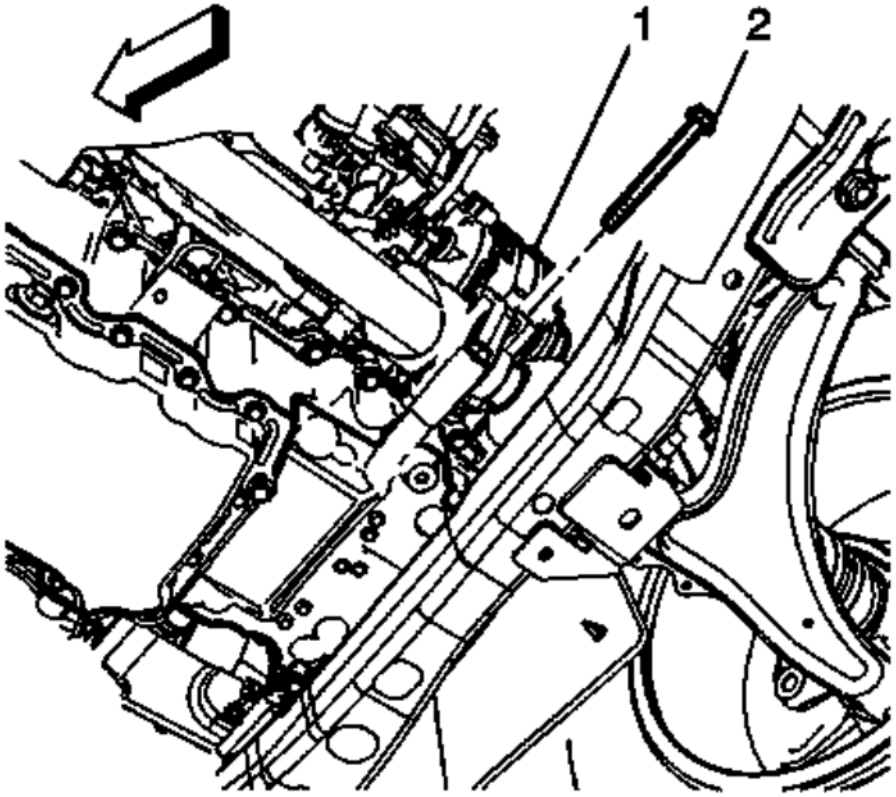


Fig. 53: Engine Coolant Thermostat Housing Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the engine coolant thermostat housing (2) with a NEW seal (1) and tighten the fasteners (3) to 10 (89 lb in).

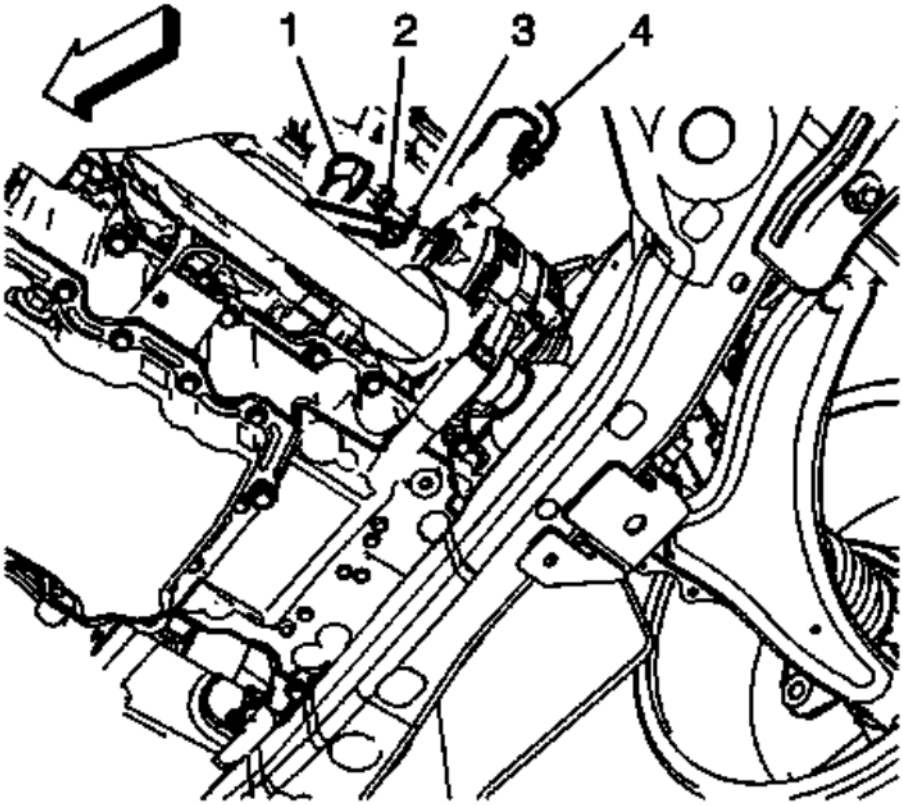


Fig. 54: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

3. Install the radiator outlet hose (1) to the engine coolant thermostat housing (2).
4. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .
5. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
6. Start the engine and check for coolant leaks.

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LUK)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the transmission rear mount. Refer to **Transmission Rear Mount Replacement** .

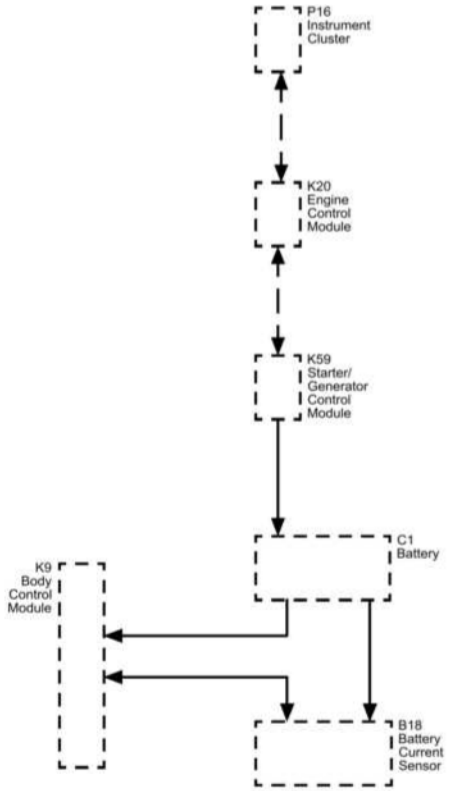


Fig. 55: Opening Water Pump Drain Plug
Courtesy of GENERAL MOTORS COMPANY

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

3. Drain the coolant from the engine block at the water pump drain. After the coolant has drained, tighten the drain bolt.

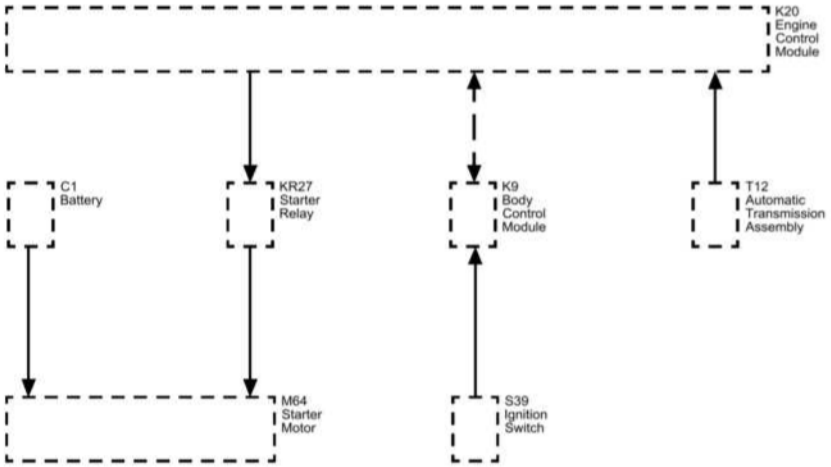


Fig. 56: Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

4. Remove the following hoses from the thermostat housing (6):
    - Radiator Outlet Hose (1)
    - Surge Tank Hose (2)
    - Heater Outlet Hose (3)
    - Heater Inlet Hose (4)
5. Disconnect the Engine Coolant Temperature (ECT) sensor (5).

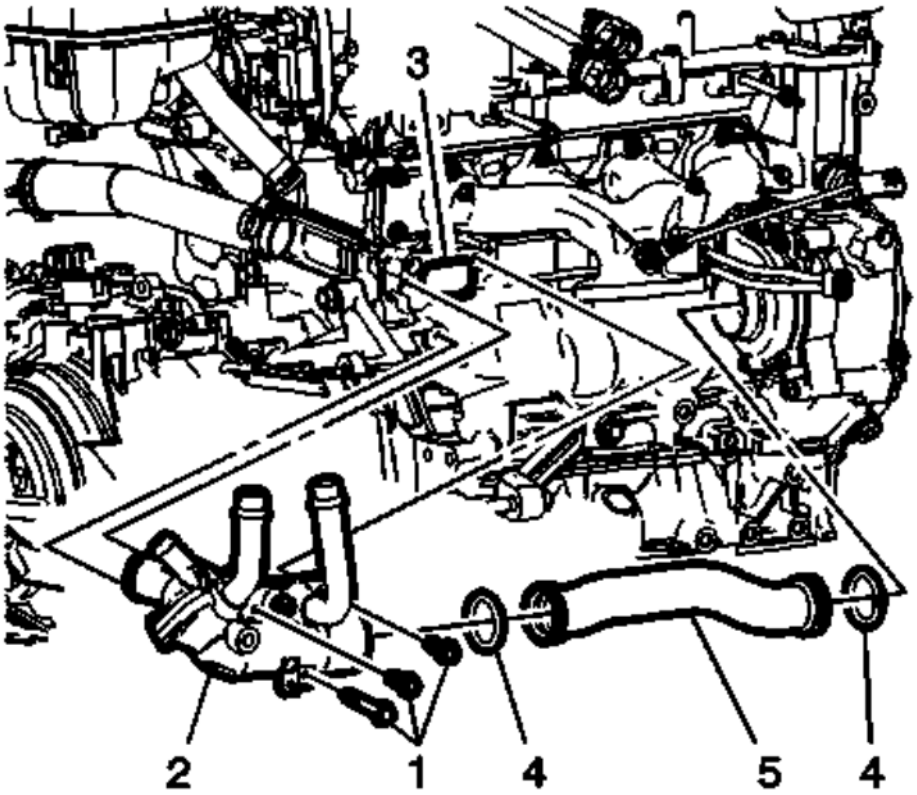


Fig. 57: Thermostat Housing Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the thermostat housing fasteners (1).

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

7. Remove the thermostat housing (2) from the vehicle.
8. Remove the water transfer pipe (5) from the thermostat housing, if necessary.
9. Remove and discard the water transfer pipe O-ring seals (4) and the thermostat housing seal (3).

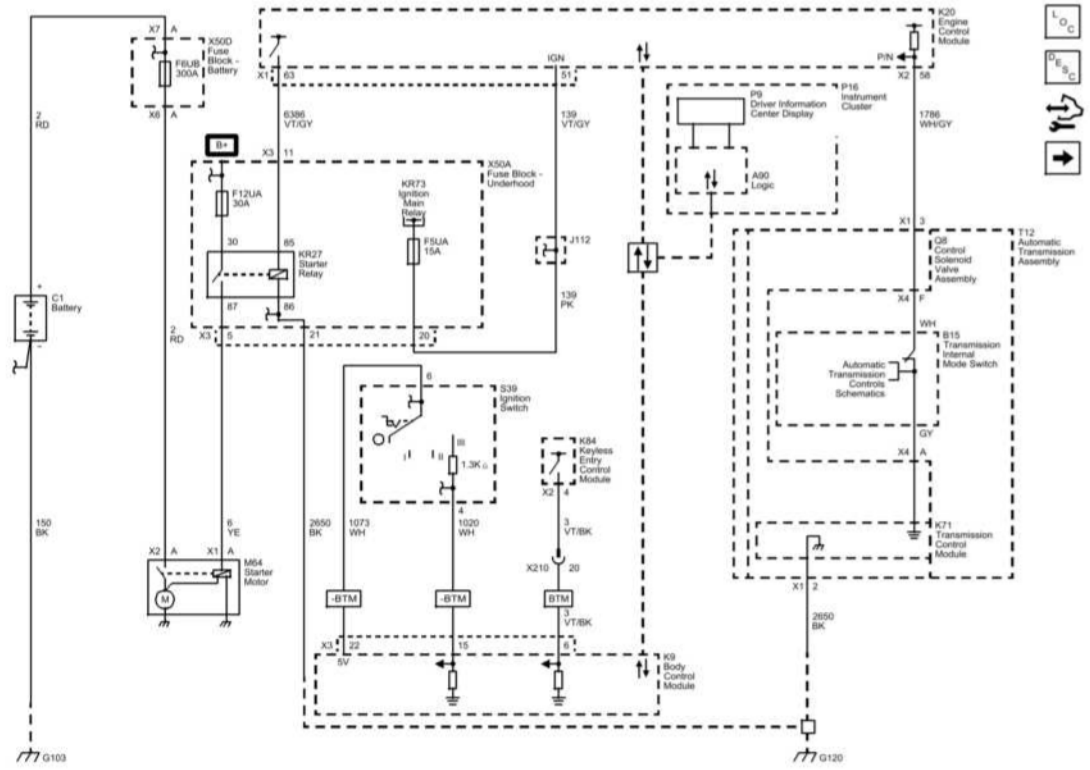


Fig. 58: Thermostat Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the thermostat cover fasteners (1) and cover (2), if necessary.
11. Remove the thermostat (3), if necessary.
12. Remove and discard the thermostat cover O-ring seal, if necessary.
13. Remove all debris and thread sealant from the engine coolant temperature (ECT) sensor and bolt holes if the housing is being re-used.

Installation Procedure

1. If installing a NEW thermostat housing transfer the thermostat, water inlet and the ECT sensor.

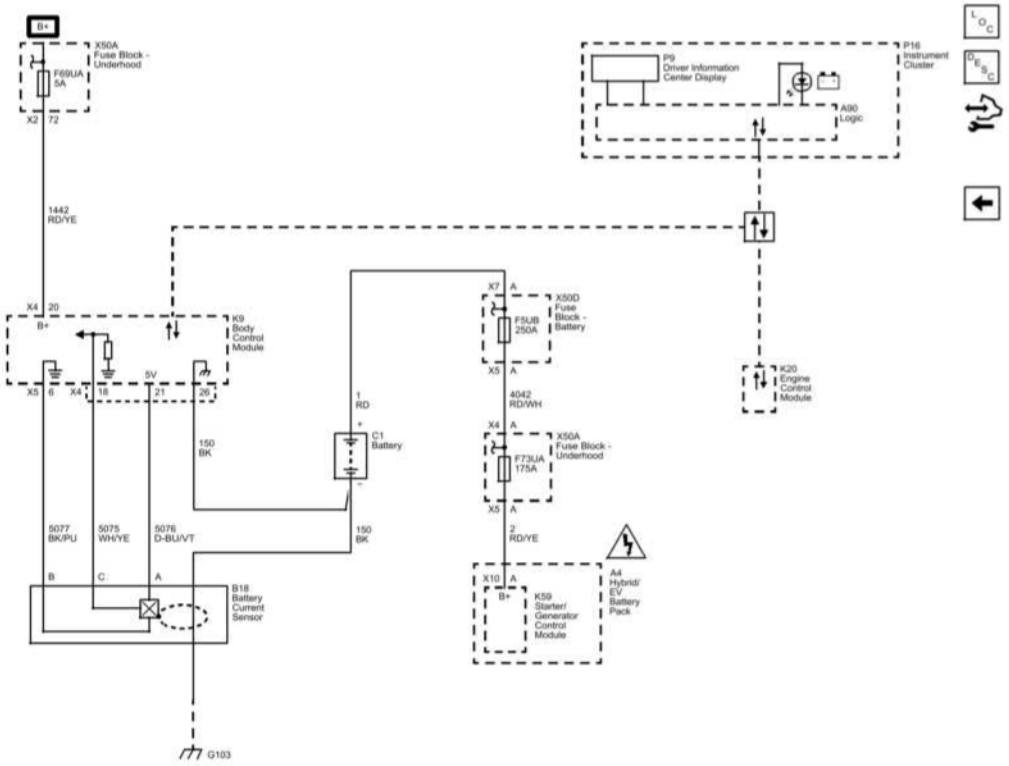


Fig. 59: Thermostat Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW thermostat cover O-ring seal into the recess groove.
3. Install the thermostat (3), if necessary.

CAUTION: Refer to Fastener Caution .

4. Install the thermostat cover fasteners (1), if necessary and tighten to 10 N.m (89 lb in).
5. Install a NEW thermostat housing to engine gasket onto the thermostat housing.
6. Load the thermostat housing assembly into position.

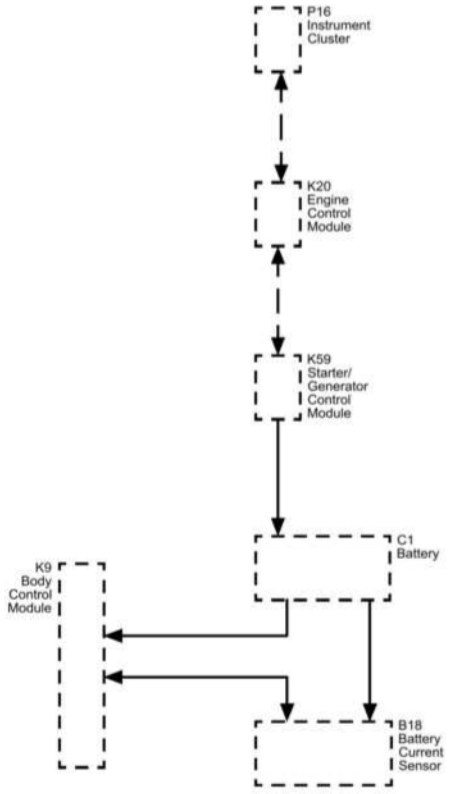


Fig. 60: Thermostat Housing Fasteners
Courtesy of GENERAL MOTORS COMPANY

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

7. Install NEW O-ring seals (4) onto the water feed pipe (5).

NOTE: Lubricate the O-rings with coolant ONLY.

8. Install the water feed pipe (5) into the thermostat housing aligning locator tab.
9. Align the water pipe (5) to water pump.
10. Seat the water feed O-ring seal by pushing inward toward the water pump. Take care not to tear or damage the O-ring.
11. Position the thermostat housing (2) against the engine with a NEW seal (3).
12. Install the thermostat housing fasteners (1) and tighten to 10 N.m (89 lb in).
13. Install the ECT sensor, if necessary and tighten to 20 N.m (15 lb ft).

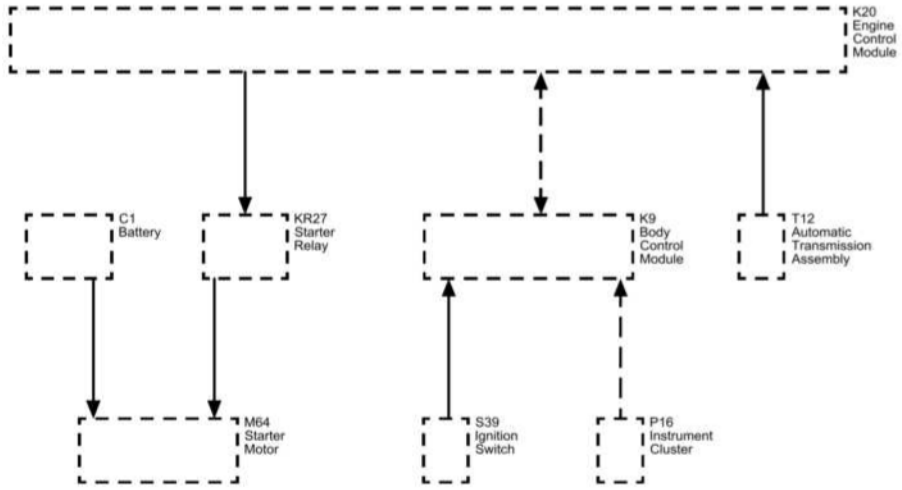


Fig. 61: Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

14. Install the following hoses from the thermostat housing (6):
    - Radiator Outlet Hose (1)
    - Surge Tank Hose (2)
    - Heater Outlet Hose (3)
    - Heater Inlet Hose (4)
15. Connect the Engine Coolant Temperature (ECT) sensor (5).

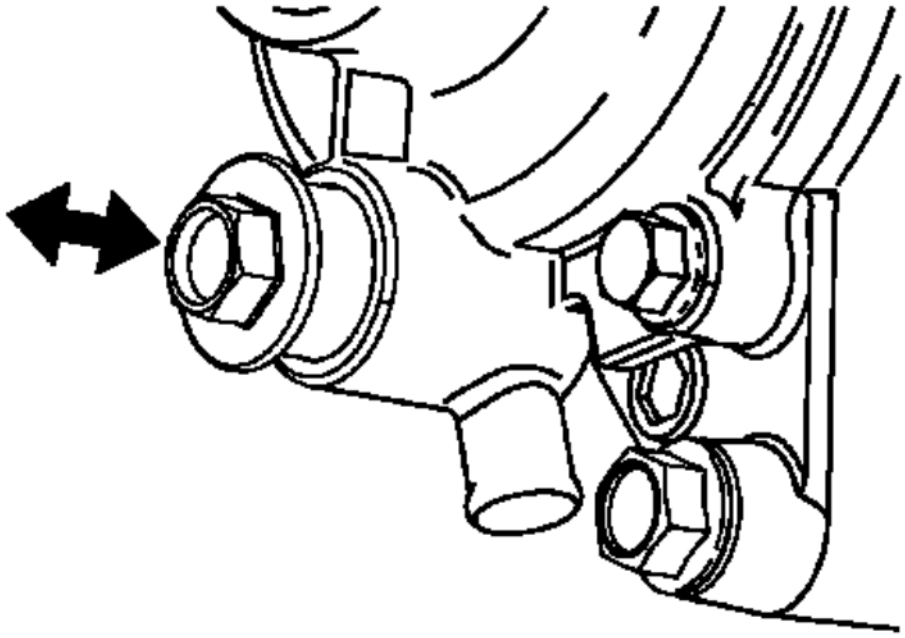


Fig. 62: Opening Water Pump Drain Plug
Courtesy of GENERAL MOTORS COMPANY

16. Verify the drain valves at the radiator and water pump are closed.
17. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

ENGINE COOLANT THERMOSTAT REPLACEMENT (LUK)

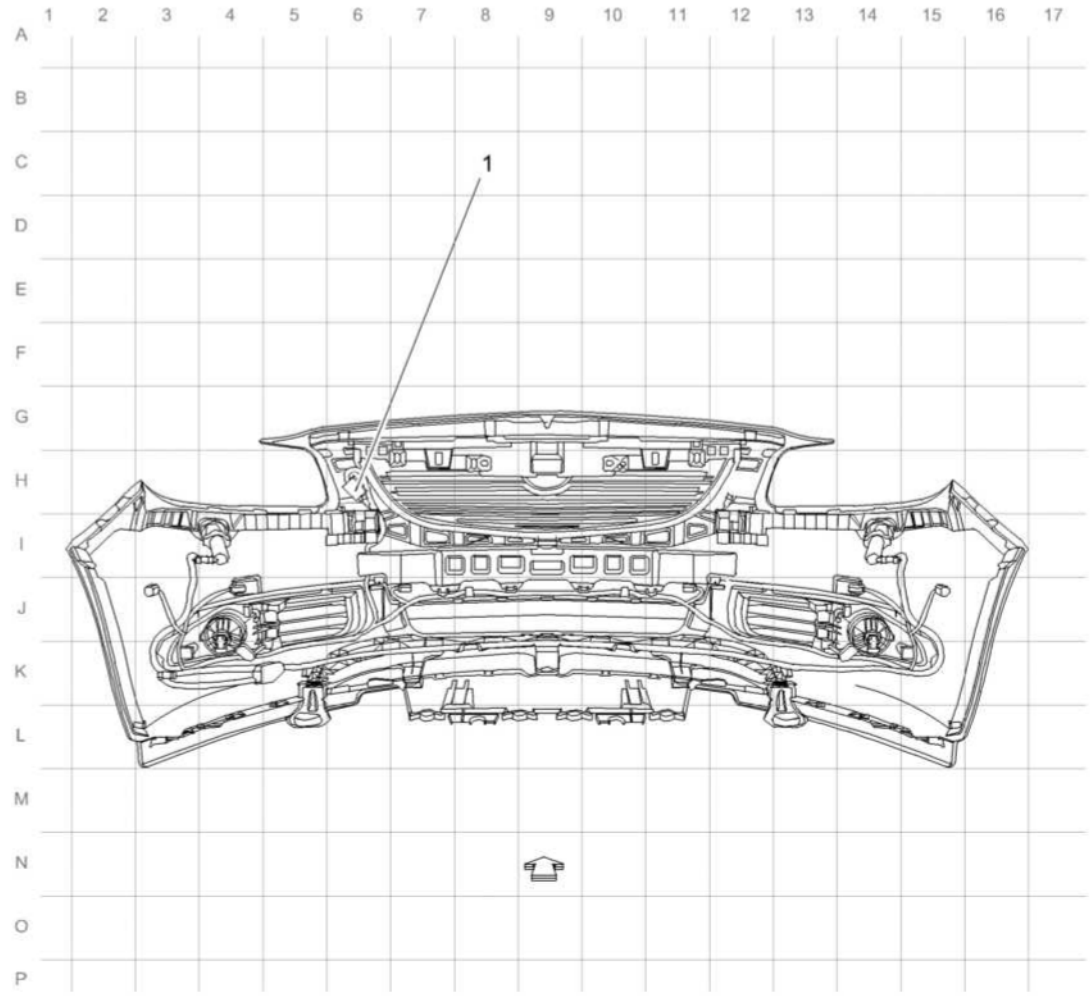


Fig. 63: Engine Coolant Thermostat (LUK)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Thermostat Replacement (LUK)

Callout	Component Name
Preliminary Procedures 1. Draining the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 2. Disconnect the radiator outlet hose from the water inlet housing. 3. Disconnect the radiator surge tank hose from the water inlet housing. Refer to **Radiator Surge Tank Outlet Hose Replacement (LUK)**.	
1	Engine Coolant Thermostat Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (88 lb in)

2	Engine Coolant Thermostat

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LTG)

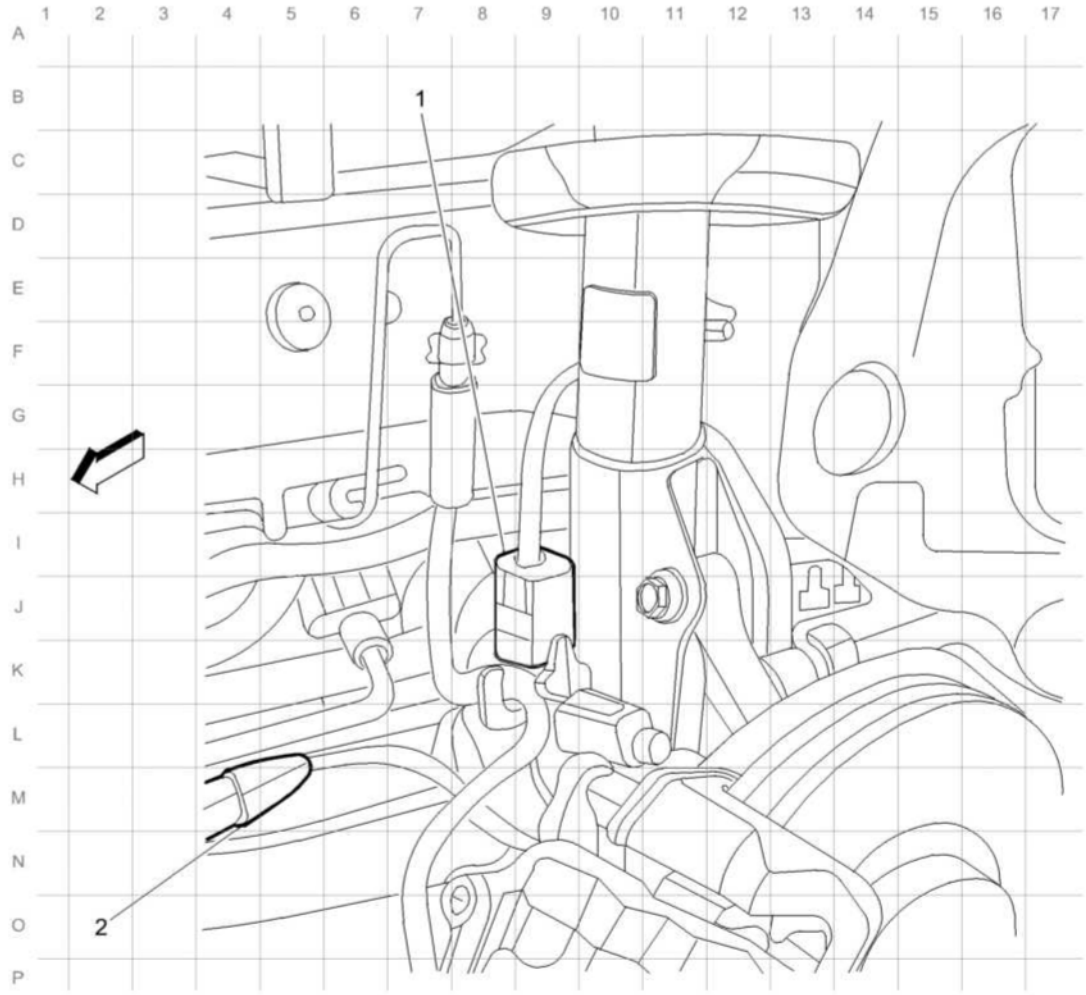


Fig. 64: Engine Coolant Air Bleed Pipe (LTG)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Air Bleed Pipe Replacement (LTG)

Callout	Component Name

Preliminary Procedures

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)** .
4. Disconnect the electrical wiring harness connector from the ignition coil.

NOTE:

Replace hose clamps if necessary.

Special Tools BO-38185 Hose Clamp PliersFor equivalent regional tools, refer to **Special Tools** .

1	Surge Tank Vent Hose Clamp
2	Engine Coolant Air Bleed Hose Clamp
3	Engine Coolant Air Bleed Pipe Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 (89 lb in)
4	Engine Coolant Air Bleed Pipe
5	Seal **NOTE:** **Install NEW seal**

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (LTG)

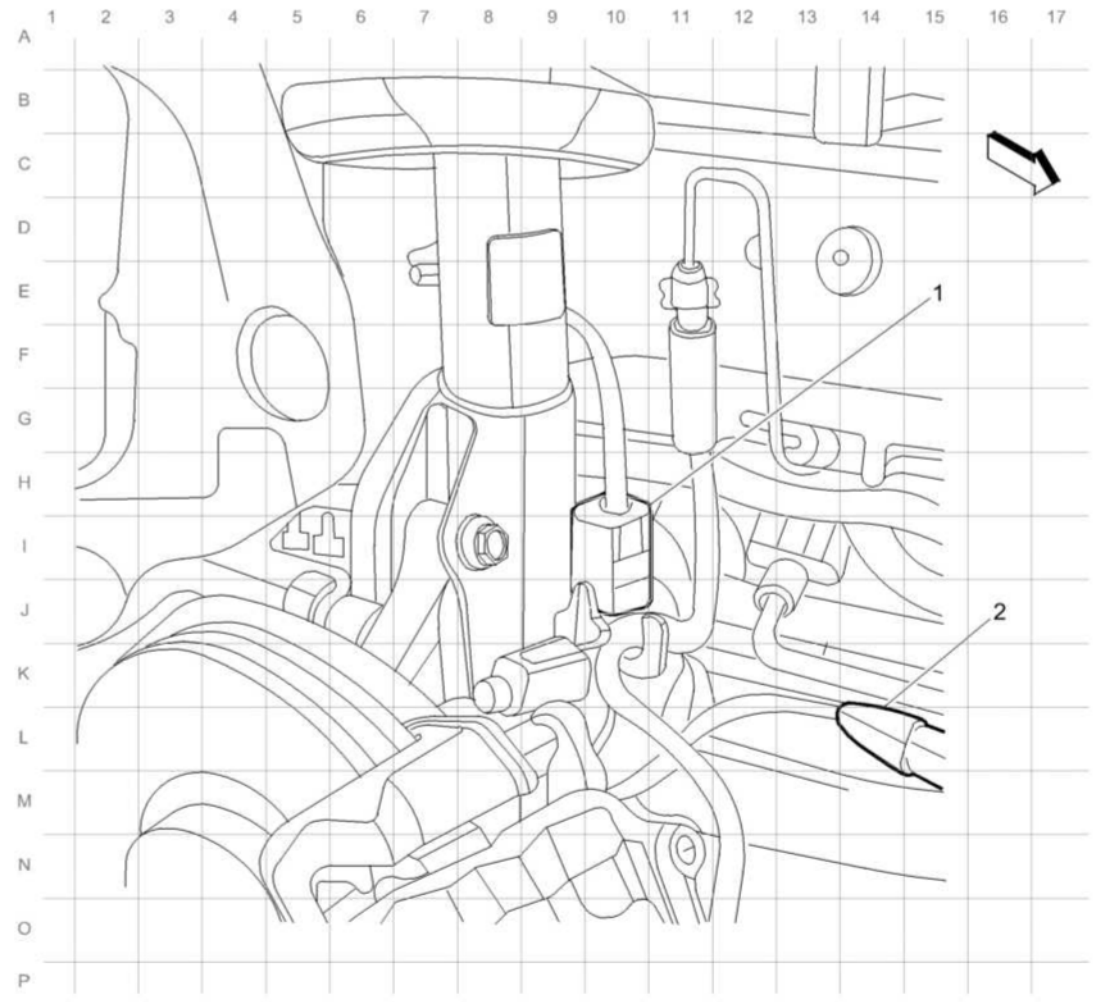


Fig. 65: Engine Coolant Air Bleed Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Air Bleed Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedure Remove the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LTG)**. **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools** .	
1	Engine Coolant Air Bleed Hose **NOTE:** **Replace hose clamps if necessary.**

WATER OUTLET REPLACEMENT (LTG)

Special Tools

BO-38185 Hose Clamp Pliers

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

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the battery tray. Refer to **Battery Tray Replacement** .

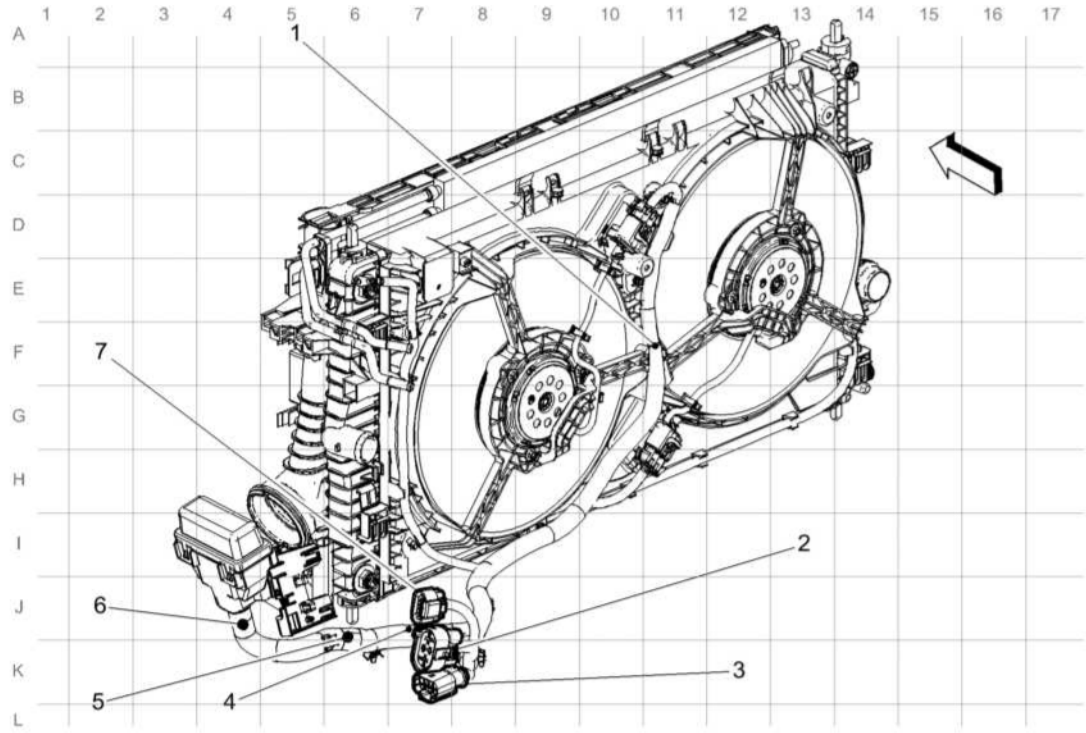


Fig. 66: Engine Coolant Temperature (ECT) Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the engine coolant temperature (ECT) sensor connector (3) from the water outlet (2).
5. Remove the following hoses from the water outlet:
   - Radiator inlet hose (1).
   - Heater inlet hose (4).
   - Heater outlet hose (5).
6. Remove the secondary air injection inlet hose.

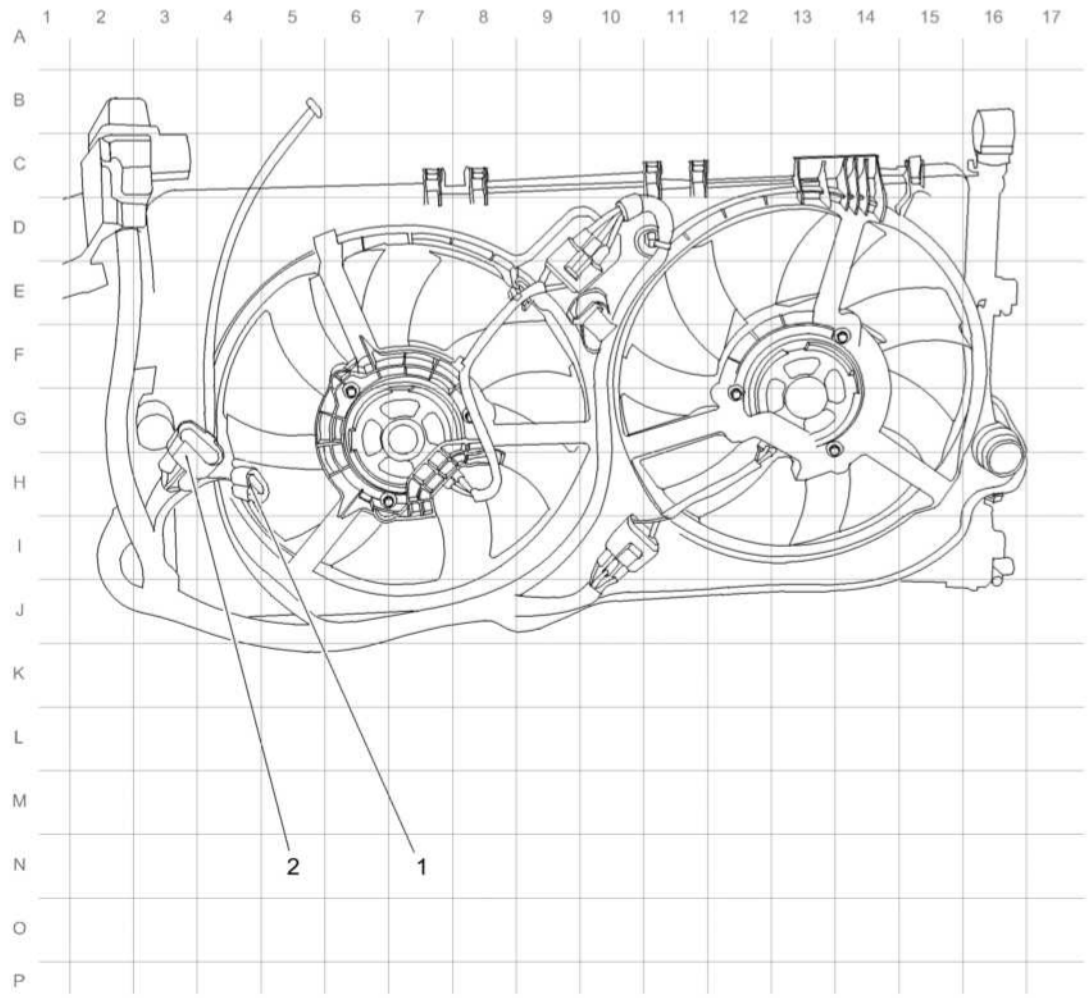


Fig. 67: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

7. Remove the thermostat bypass hose (2) from the water outlet (3).

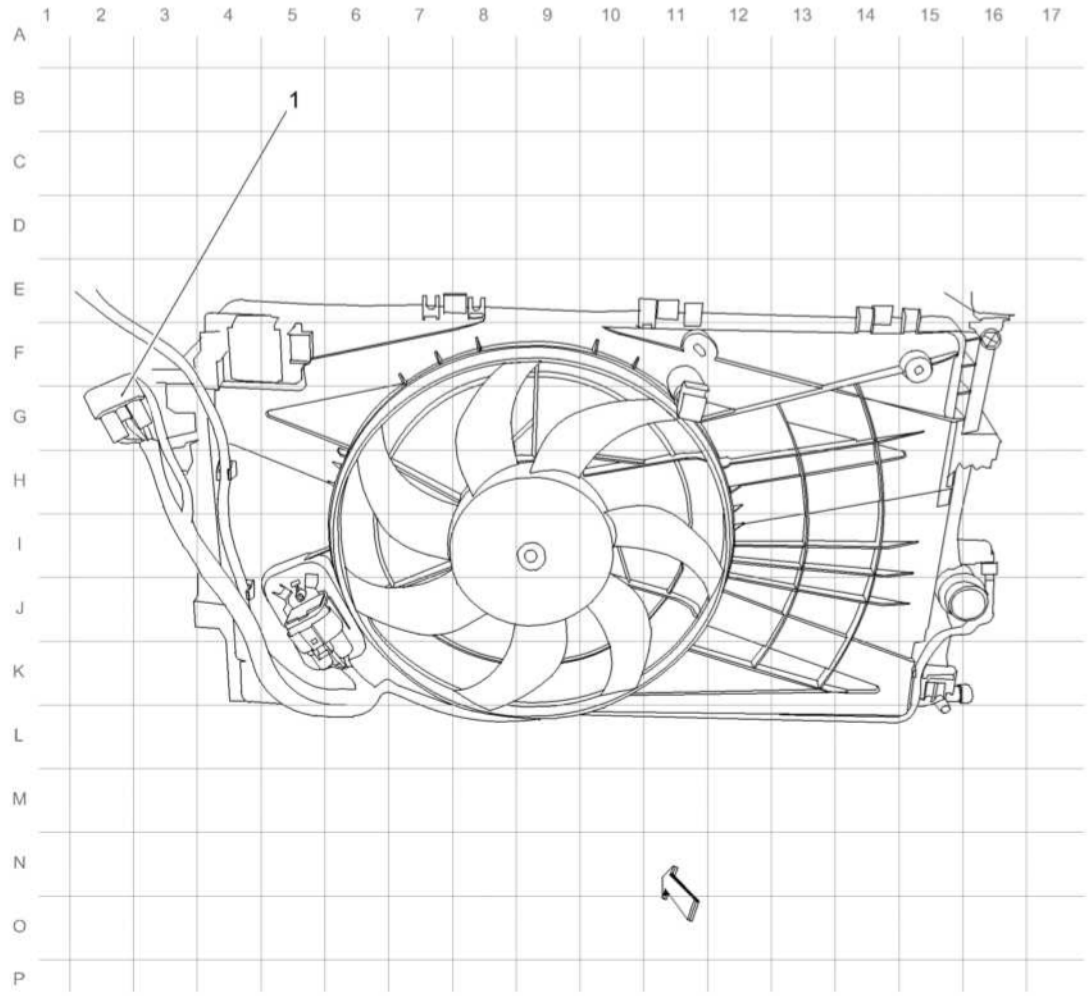


Fig. 68: Water Outlet Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the water outlet fasteners (1) and remove the water outlet (2).
9. Discard the water outlet seal (1).

Installation Procedure

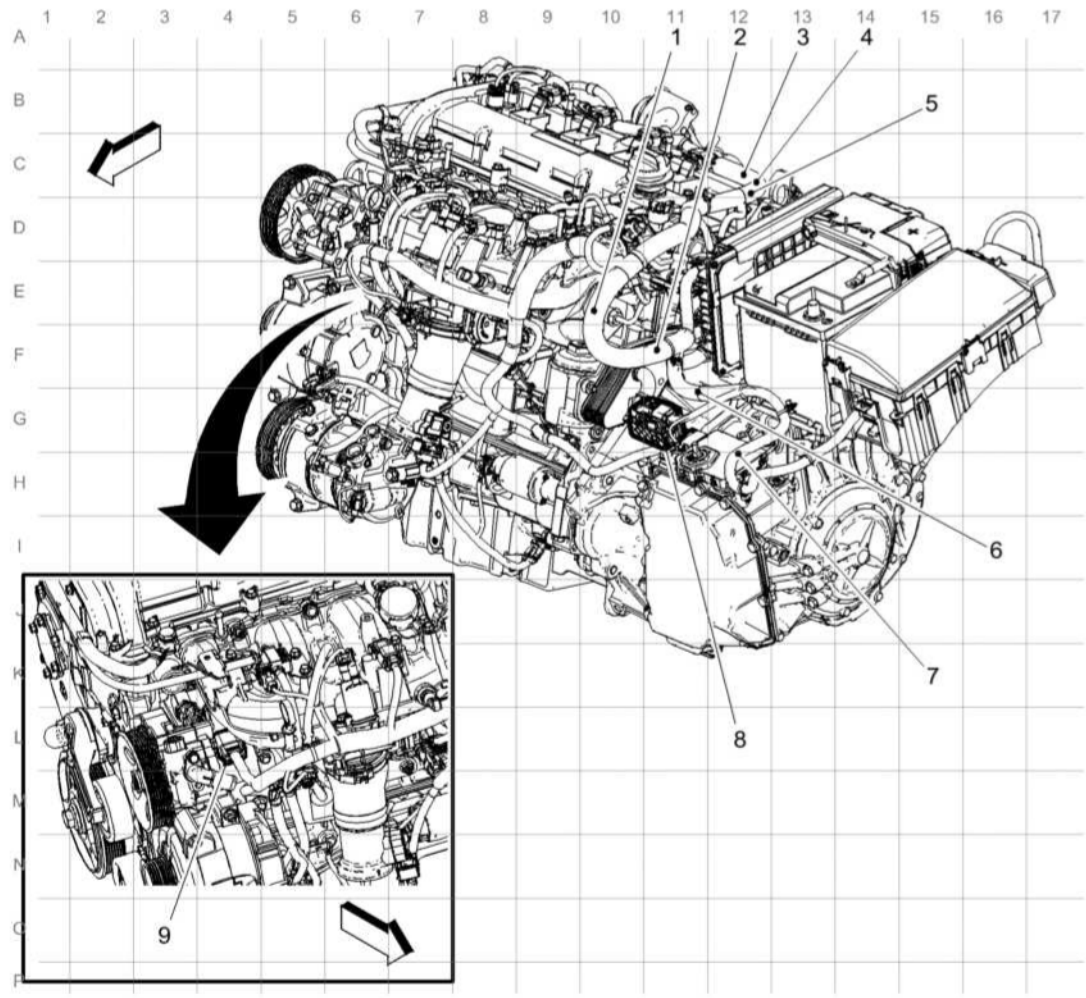


Fig. 69: Water Outlet Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the water outlet (2) into position with a NEW seal (1).

CAUTION: Refer to Fastener Caution .

2. Install the water outlet fasteners (3) and tighten to 12 (106 lb in).

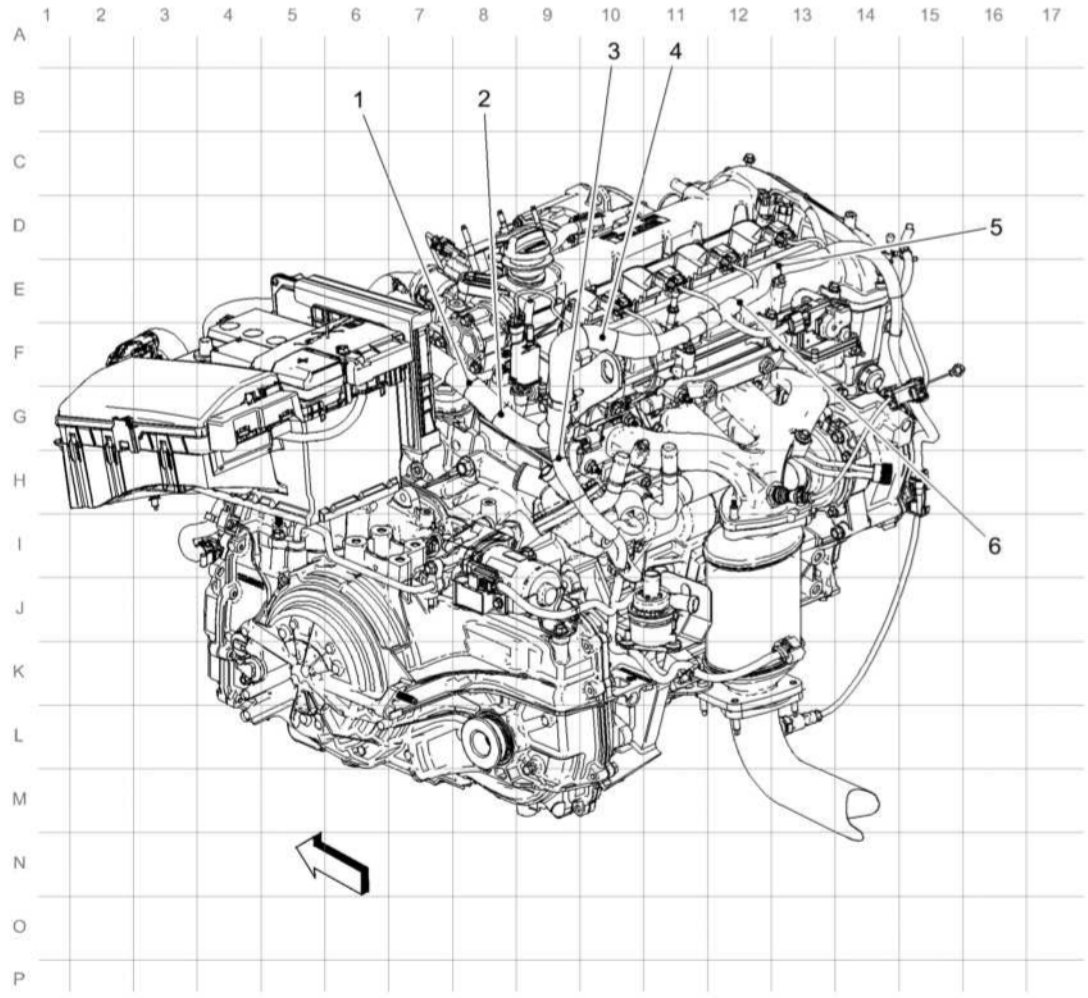


Fig. 70: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

3. Install the thermostat bypass hose (2) to the water outlet (3).
4. Install the secondary air injection inlet hose.

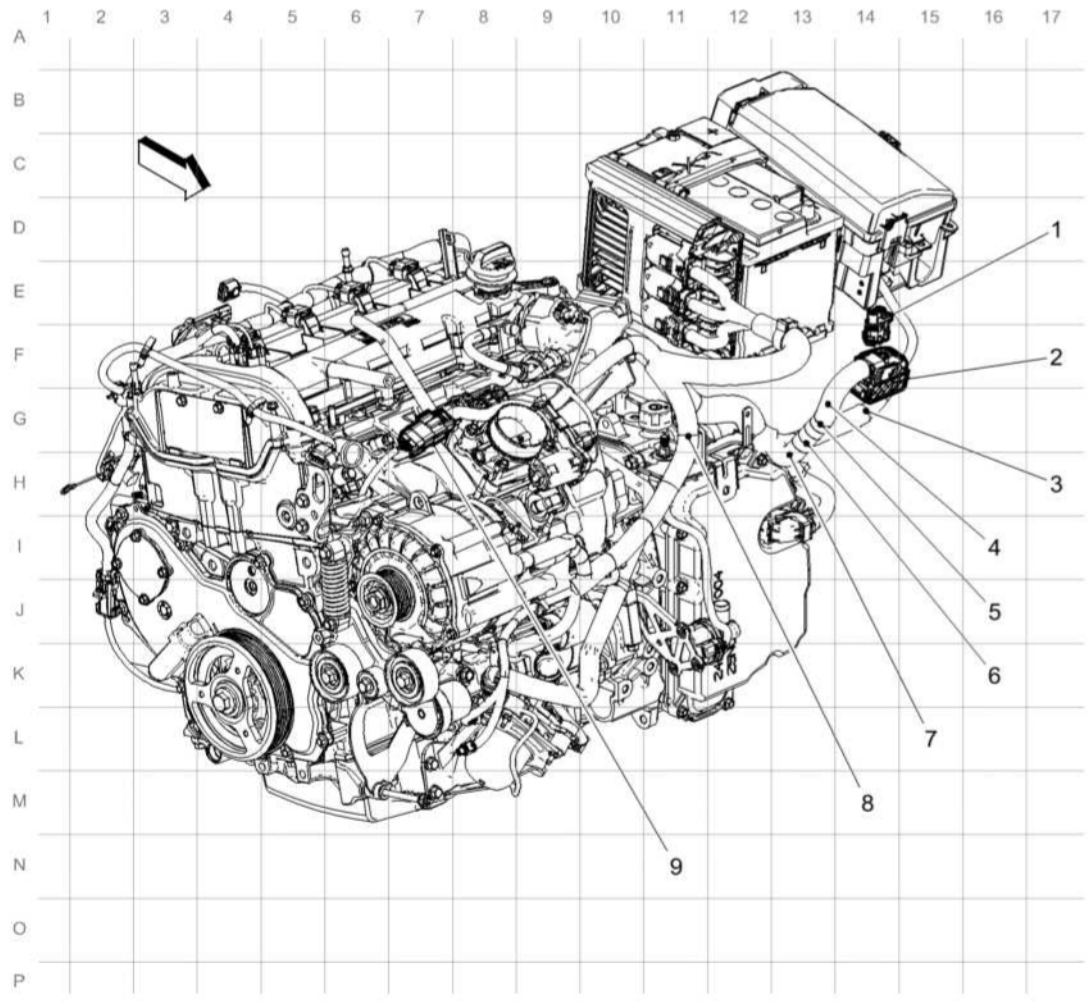


Fig. 71: Engine Coolant Temperature (ECT) Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect the engine coolant temperature (ECT) sensor connector (3) to the water outlet (2).
6. Install the following hoses to the water outlet:
   - Radiator inlet hose (1).
   - Heater inlet hose (4).
   - Heater outlet hose (5).
7. Install the battery tray. Refer to **Battery Tray Replacement** .
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
10. Start the engine and check for coolant leaks.

THERMOSTAT BYPASS PIPE REPLACEMENT (LTG)

Special Tools

BO-38185 Hose Clamp Pliers

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

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .
4. Remove the battery tray. Refer to **Battery Tray Replacement** .

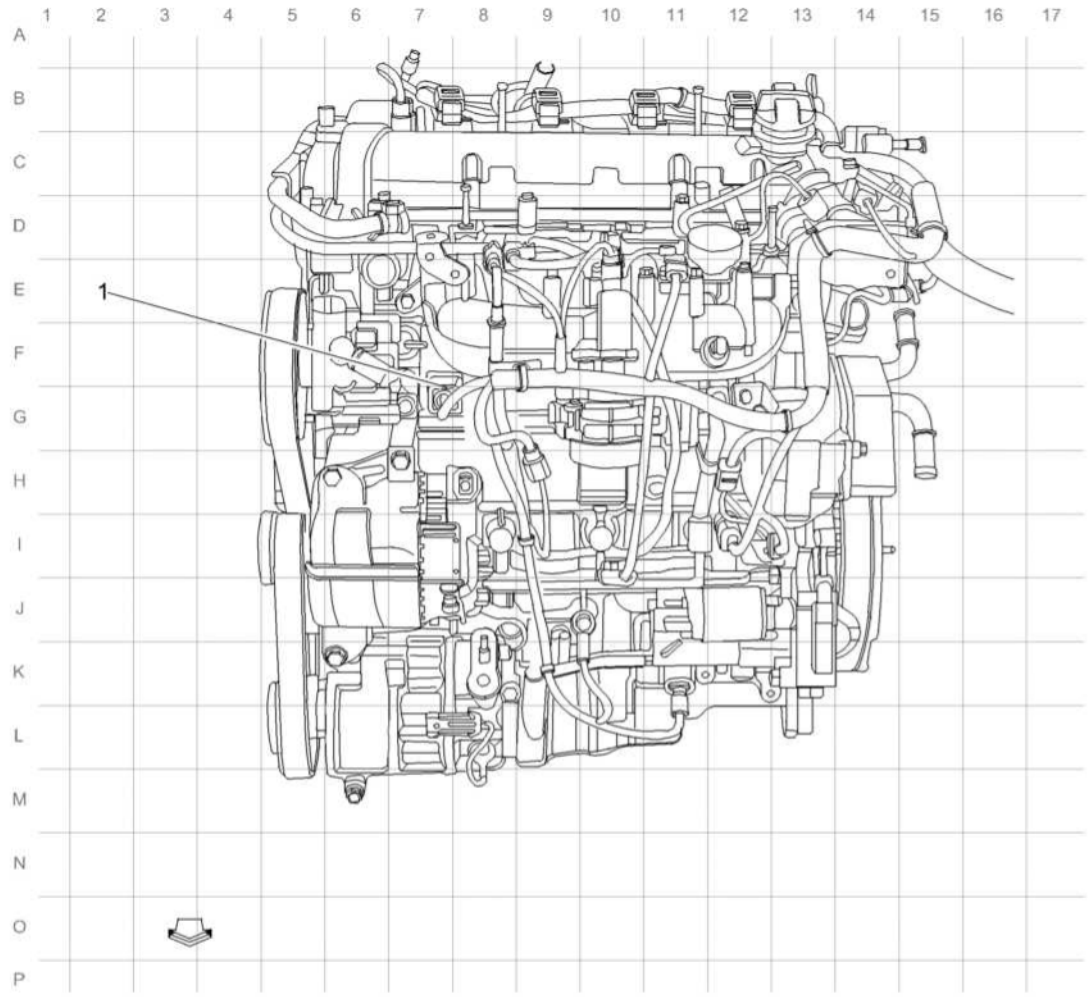


Fig. 72: Radiator Inlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

5. Remove the radiator inlet hose (1) from the water outlet (2).

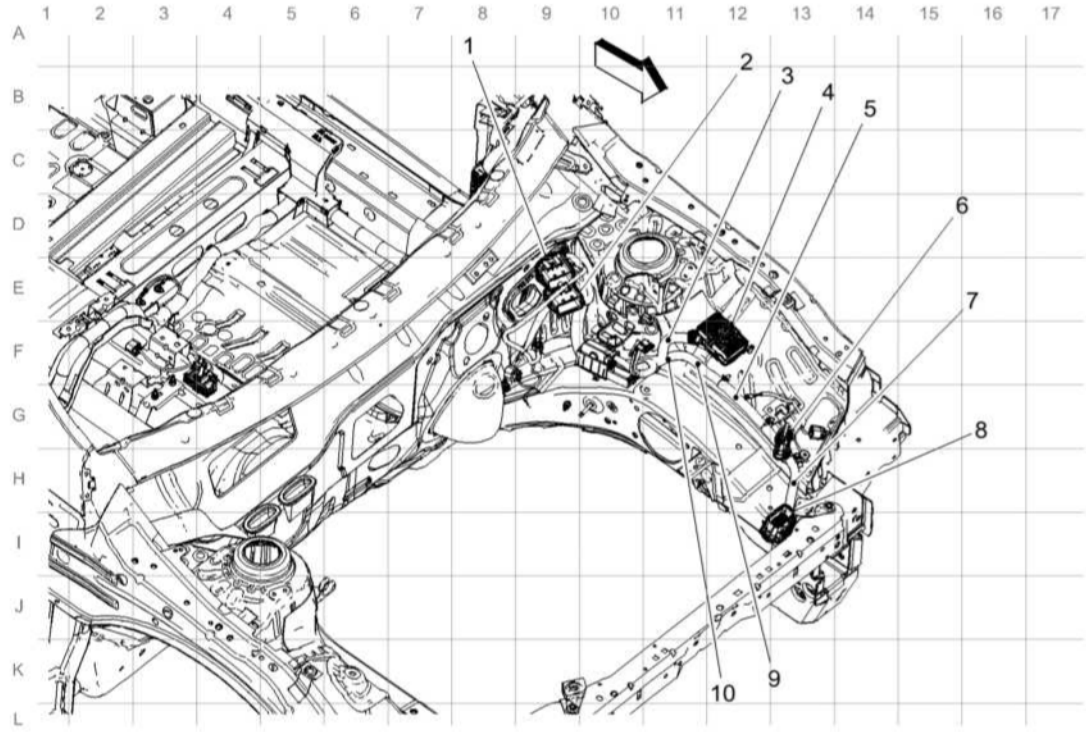


Fig. 73: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove the thermostat bypass hose (2) from the thermostat bypass pipe (1).

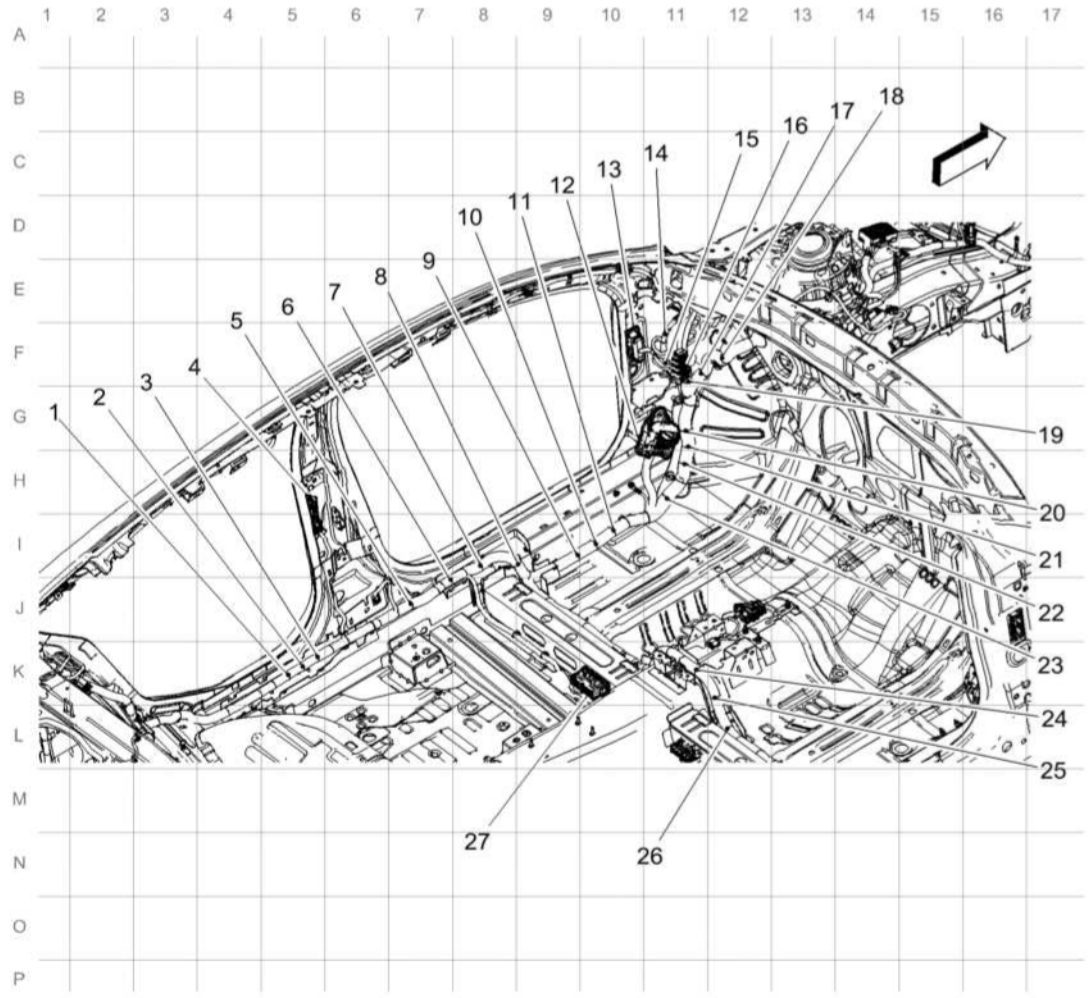


Fig. 74: Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove the hose (1) from the thermostat bypass pipe (2).

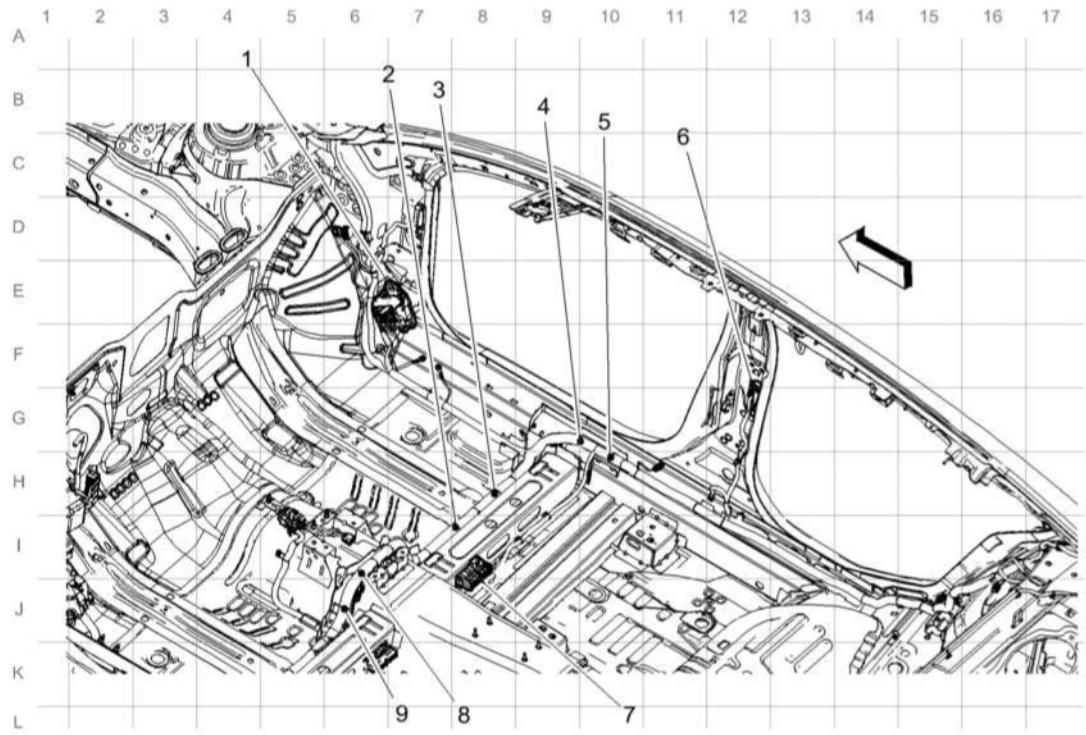


Fig. 75: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the thermostat bypass pipe fasteners (1).
9. Remove the thermostat bypass pipe (2) and discard the gasket (3).

Installation Procedure

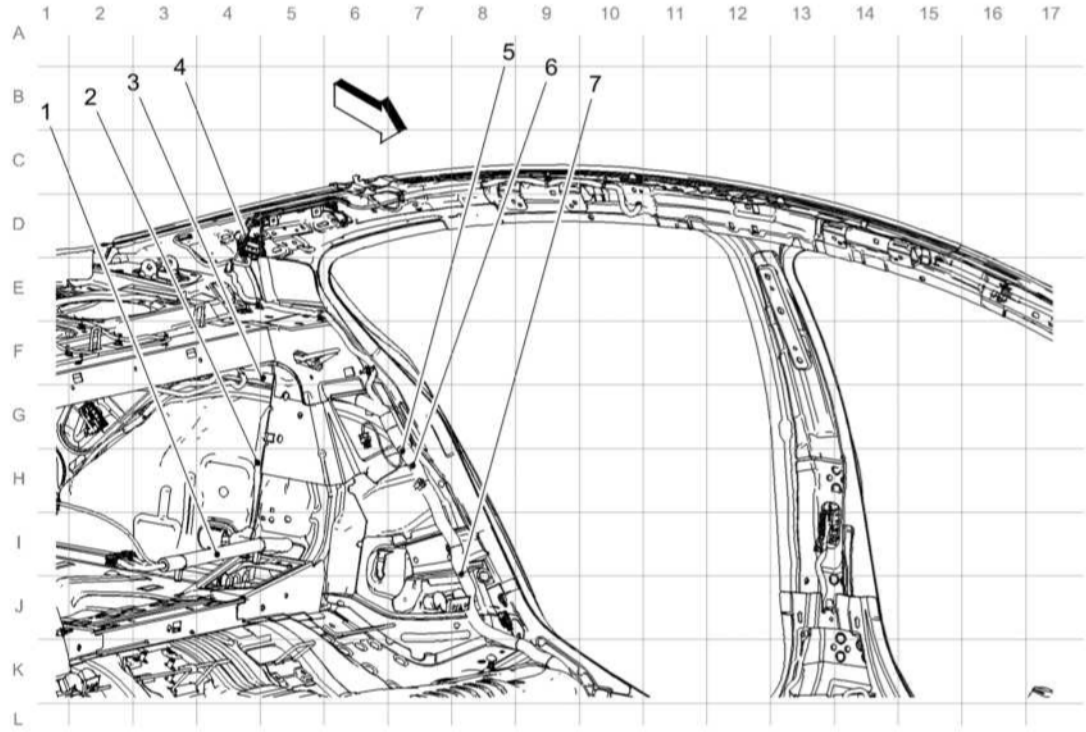


Fig. 76: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the thermostat bypass pipe (2) into position with a NEW gasket (3).

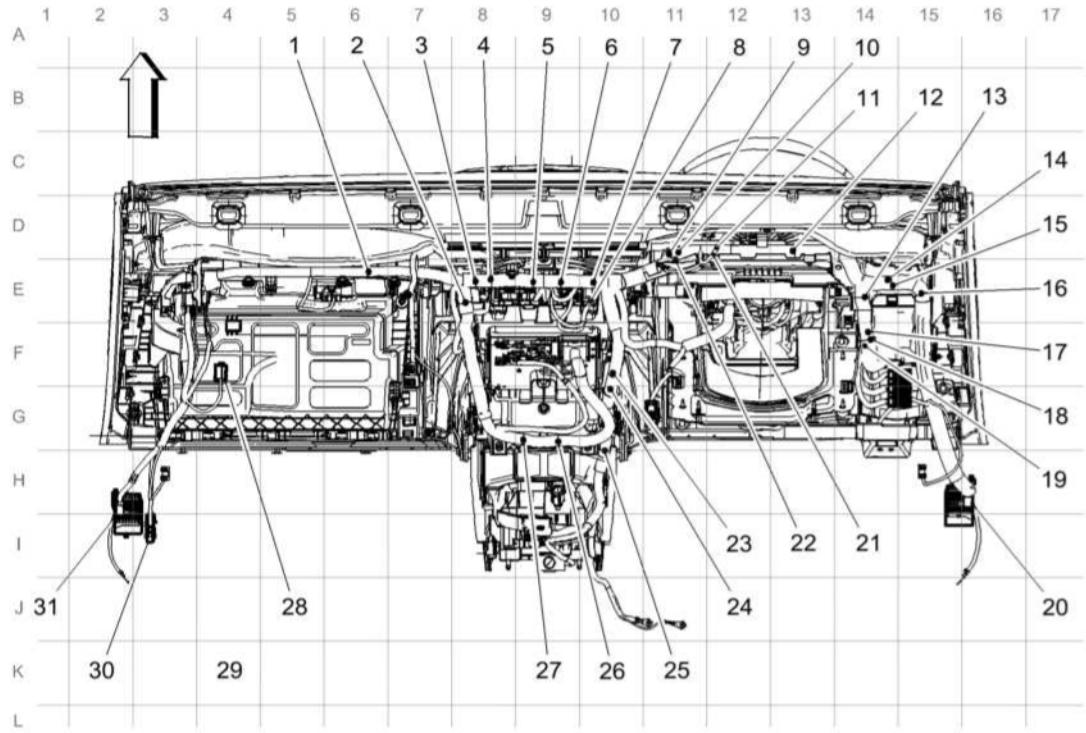


Fig. 77: Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

NOTE: Replace hose clamps if necessary.

2. Install the hose (1) on the thermostat bypass pipe (2).

CAUTION: Refer to Fastener Caution .

3. Install the thermostat bypass pipe fasteners (1) and tighten to 10 (89 lb in).

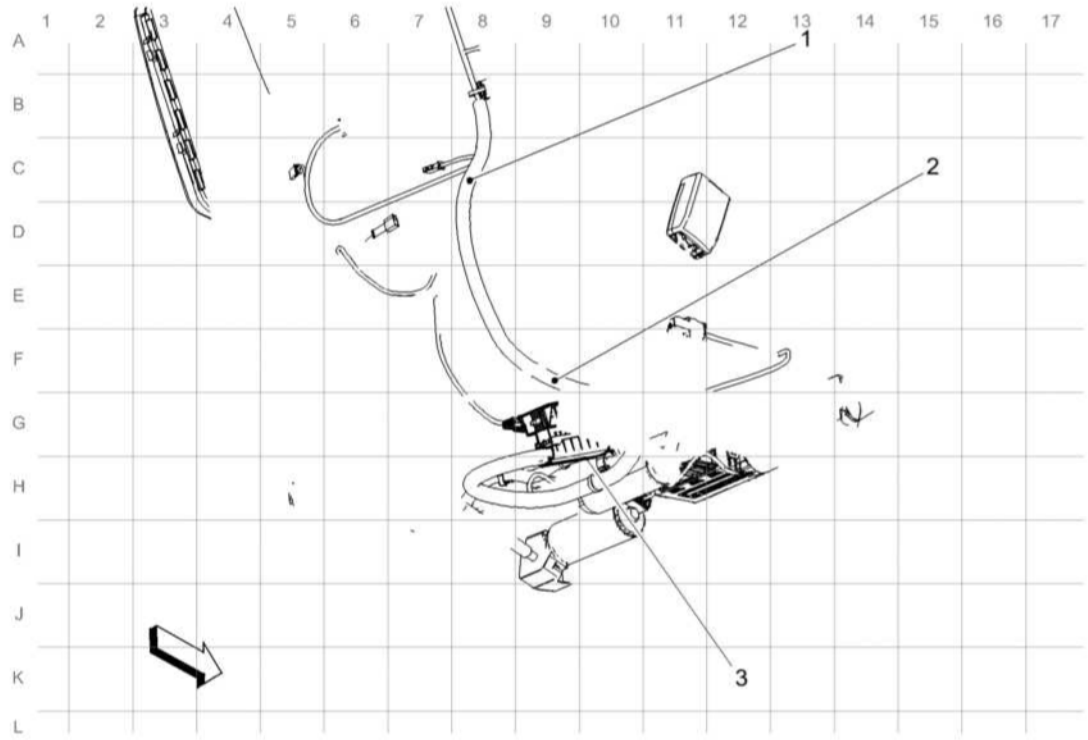


Fig. 78: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

4. Install the thermostat bypass hose (2) on the thermostat bypass pipe (1).

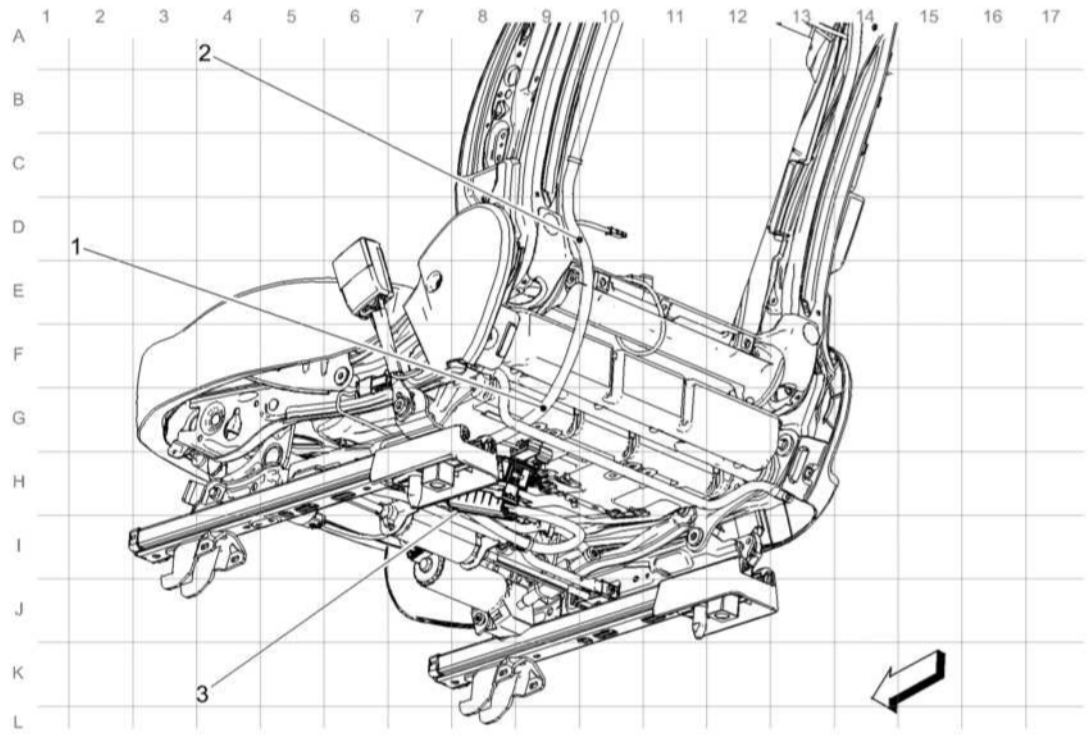


Fig. 79: Radiator Inlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

5. Install the radiator inlet hose (1) to the water outlet (2).
6. Install the battery tray. Refer to **Battery Tray Replacement** .
7. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
10. Start the engine and check for coolant leaks.

WATER PUMP REPLACEMENT (LTG)

Special Tools

BO-38185 Hose Clamp Pliers

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

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the drive belt. Refer to **Drive Belt Replacement** .
3. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .

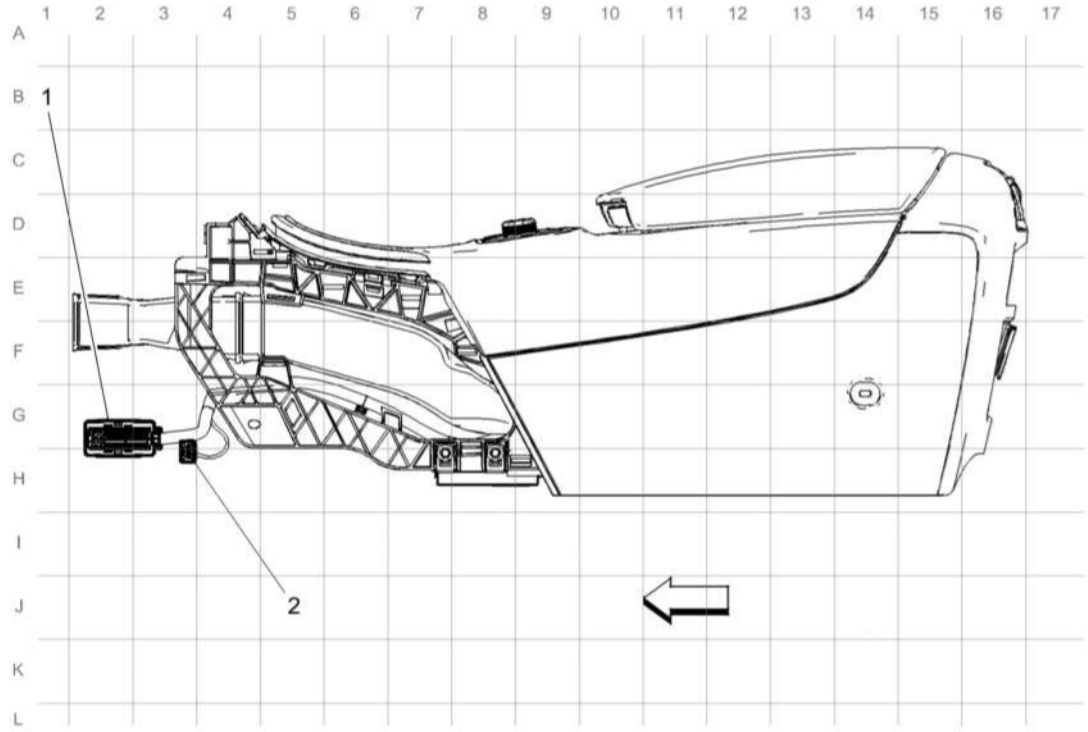


Fig. 80: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Using the BO-38185 hose clamp pliers, remove the radiator outlet hose (1) from the water outlet (2).

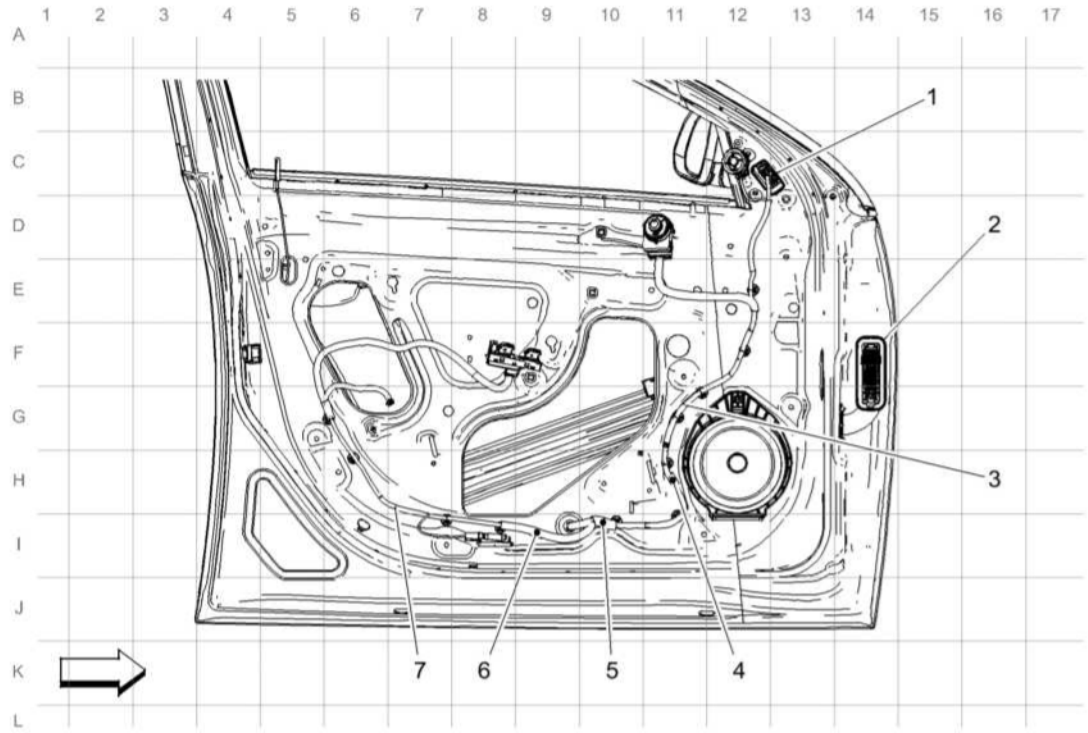


Fig. 81: Engine Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine harness retainer (1) from the water pump (2) .

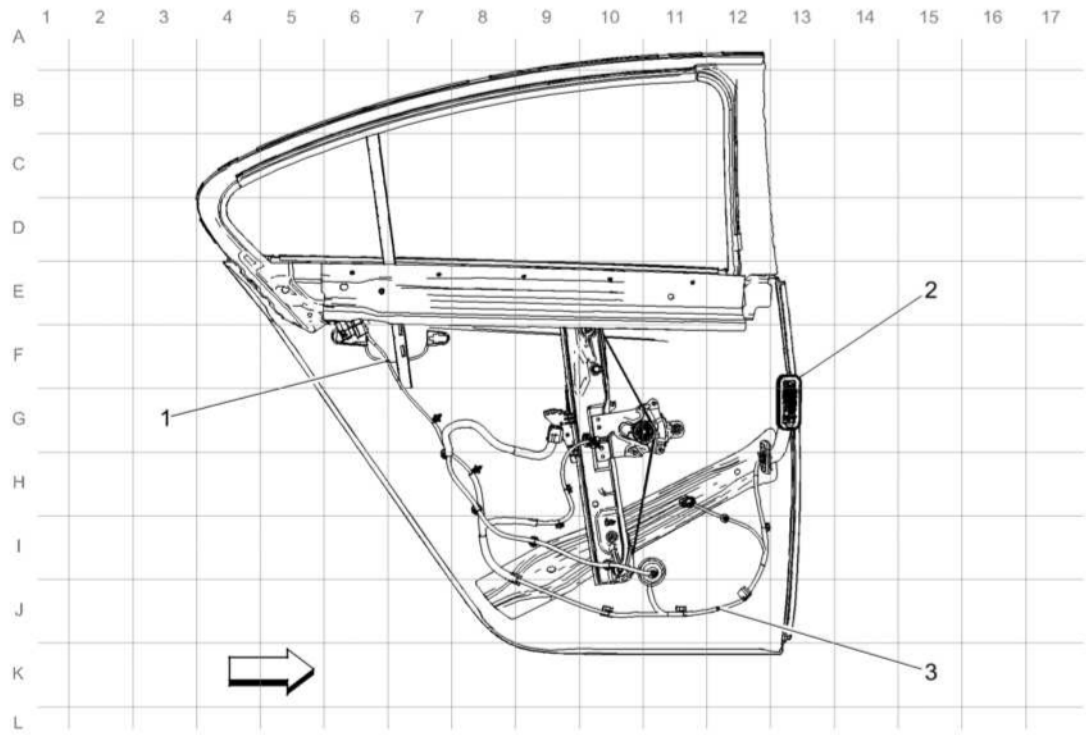


Fig. 82: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the thermostat bypass pipe fasteners (1) and remove the thermostat bypass pipe (2) from the water pump.
7. Discard the thermostat bypass pipe gasket (3).

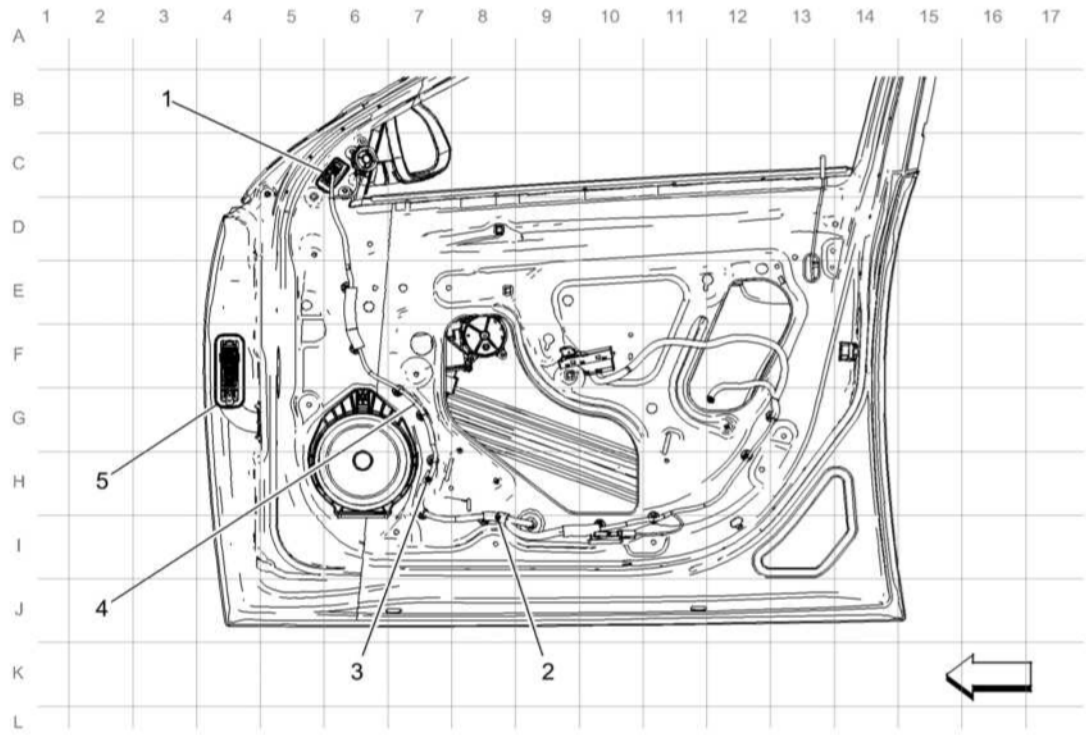


Fig. 83: Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the water pump fasteners (1) and (2) remove the water pump (3).
9. Discard the water pump seal (4).

Installation Procedure

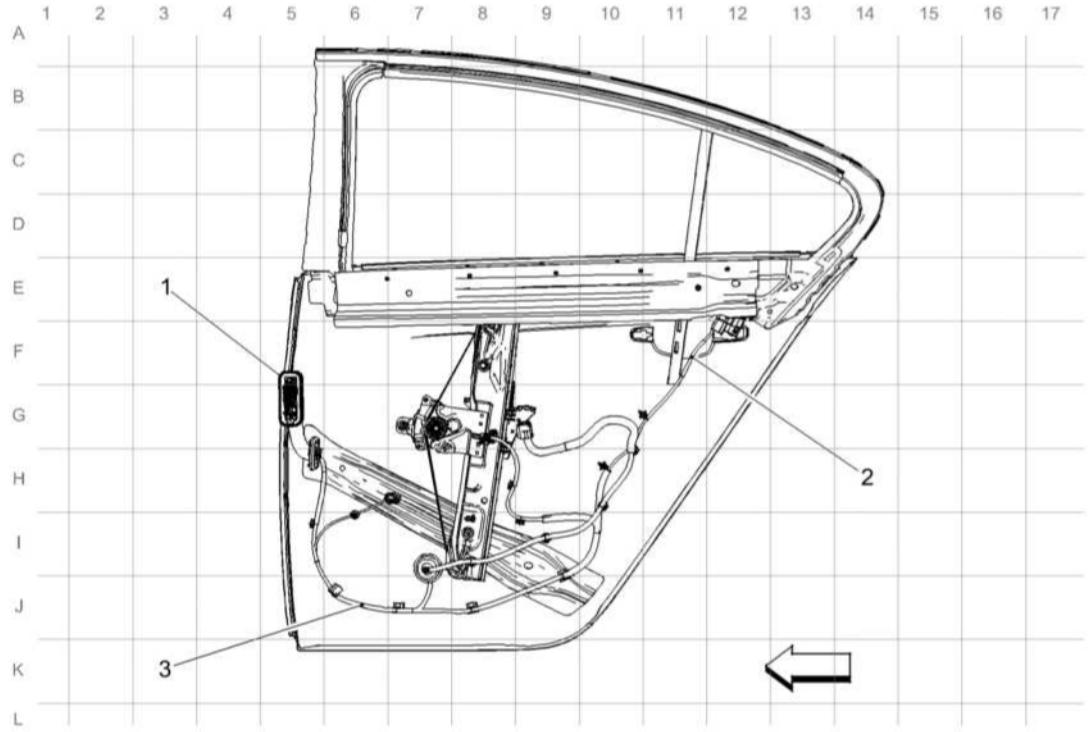


Fig. 84: Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the water pump (3) into position with a NEW water pump seal (4) and hand tighten the bolts.
2. Tighten (1) bolts to 25 (18 lb ft).
3. Tighten (2) bolt to 25 (18 lb ft).

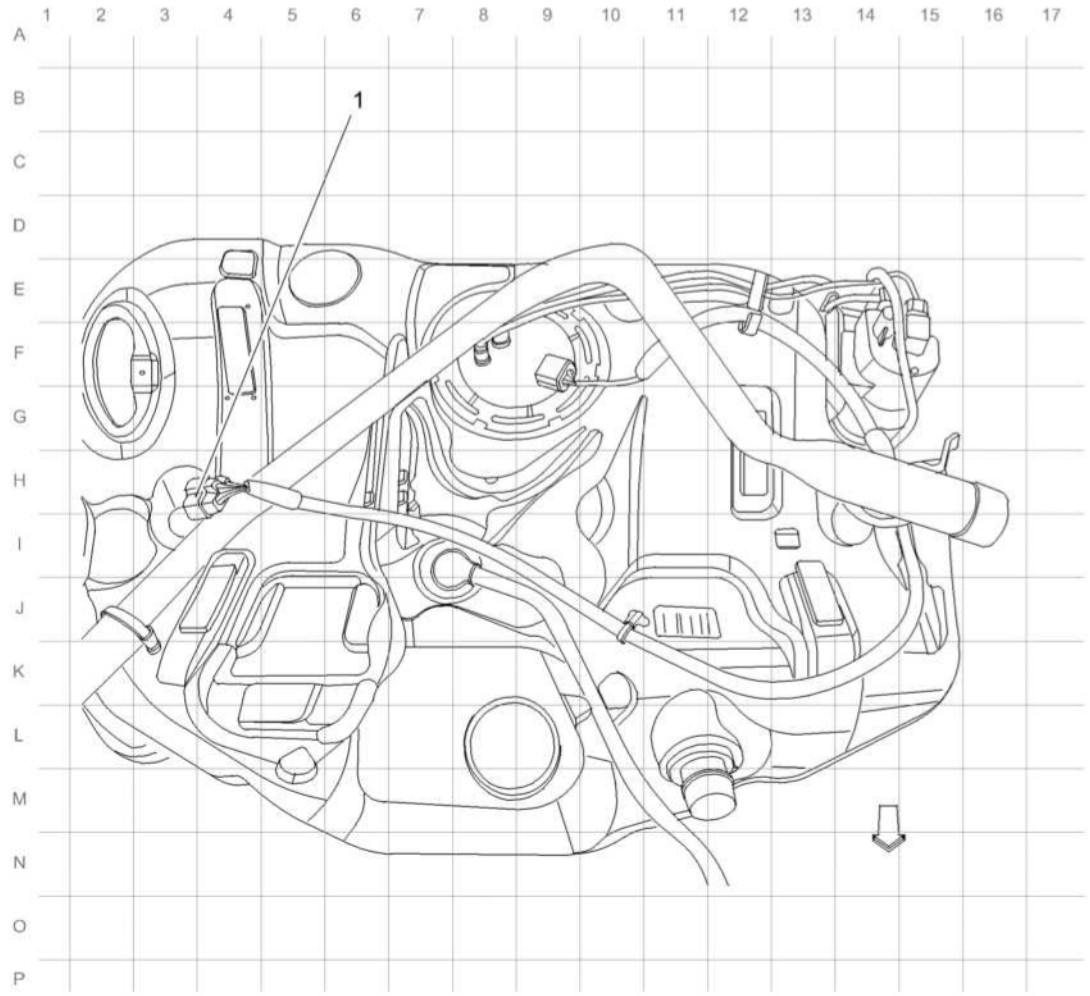


Fig. 85: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the thermostat bypass pipe (2) to the water pump with a NEW gasket (3) and tighten the fasteners (1) to 10 (89 lb in).

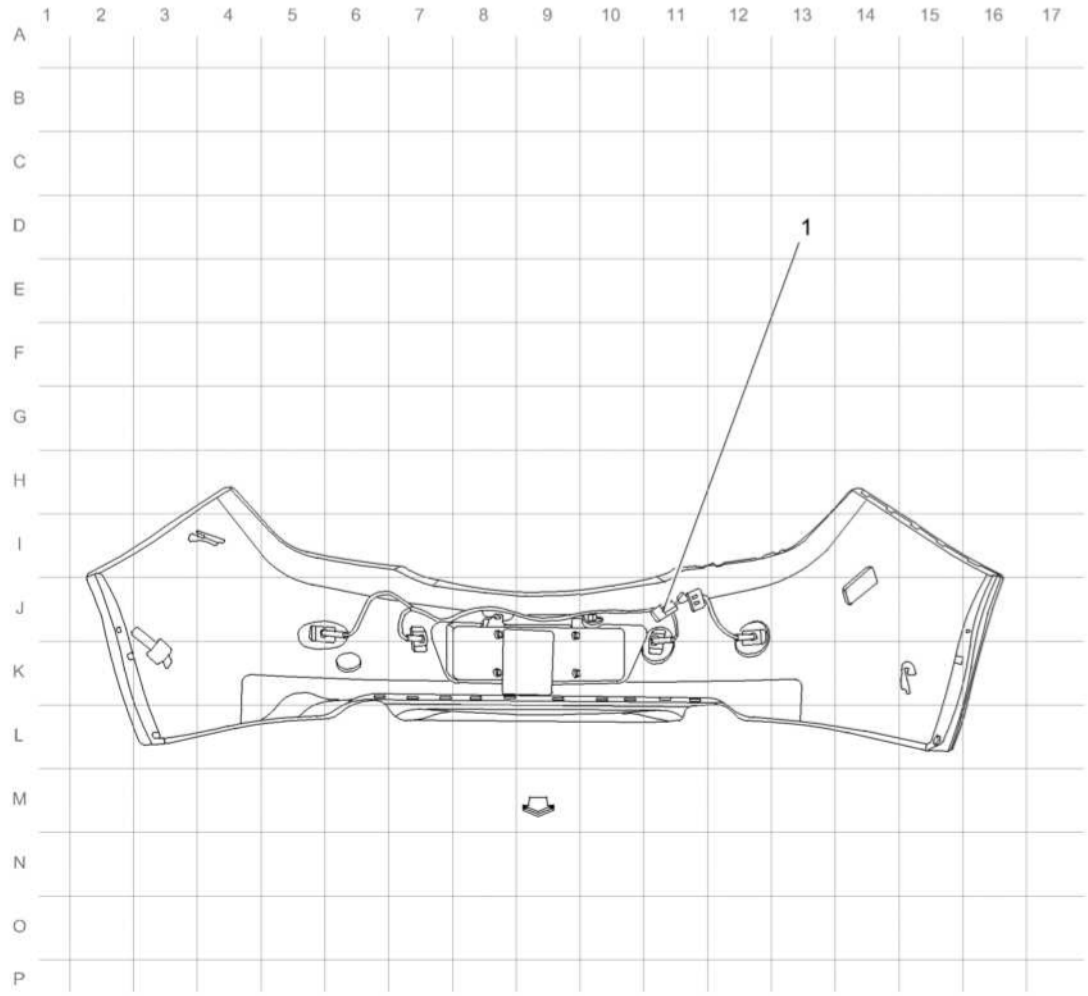


Fig. 86: Engine Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Install the engine wiring harness retainer (1) to the water pump (2).

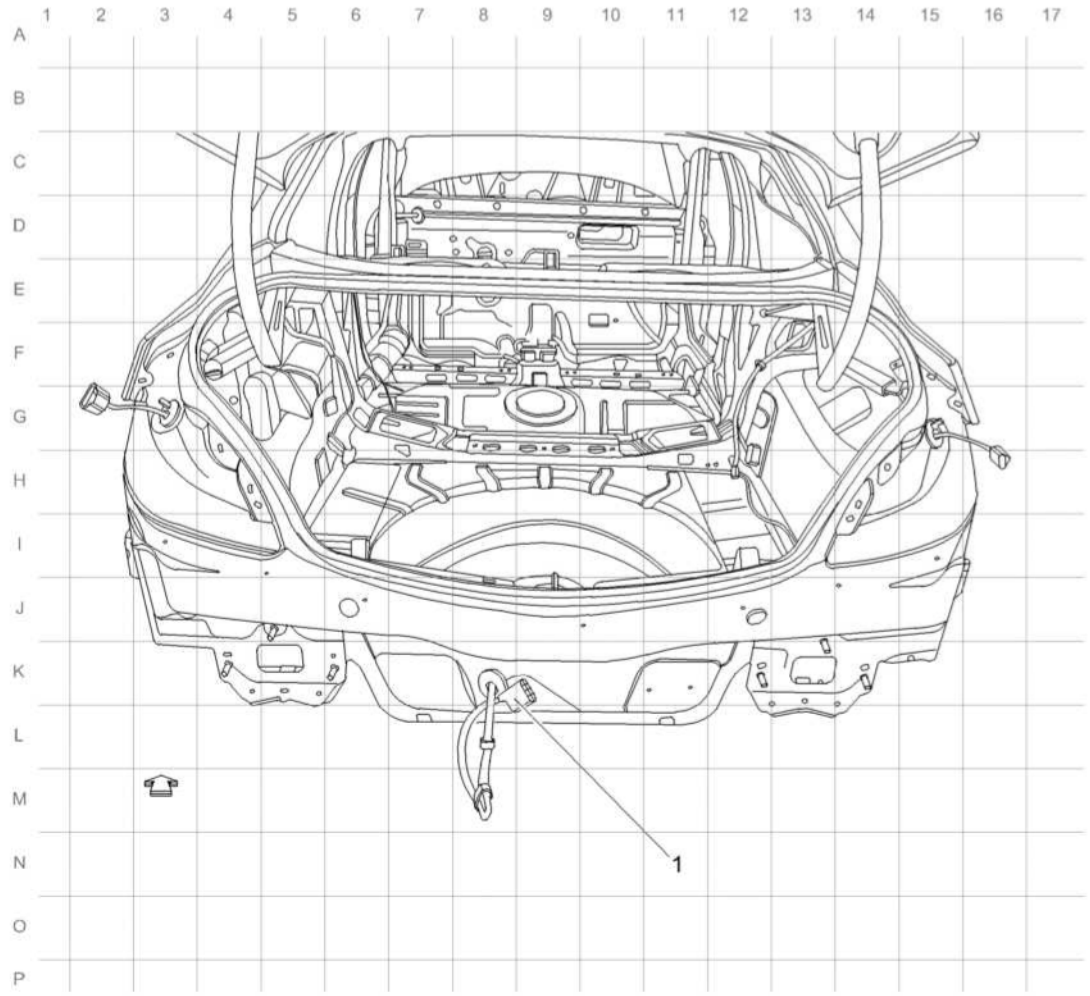


Fig. 87: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Using the BO-38185 hose clamp pliers, install the radiator outlet hose (1) to the water outlet (2).
7. Install the drive belt. Refer to **Drive Belt Replacement** .
8. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
10. Start the engine and check for coolant leaks.

WATER PUMP REPLACEMENT (LUK)

Special Tools

EN-43651 Water Pump Holding Tool

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

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUK)** .
4. If equipped, remove the coolant heater.
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LUK)** .
6. Remove the engine coolant thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement (LUK)**.

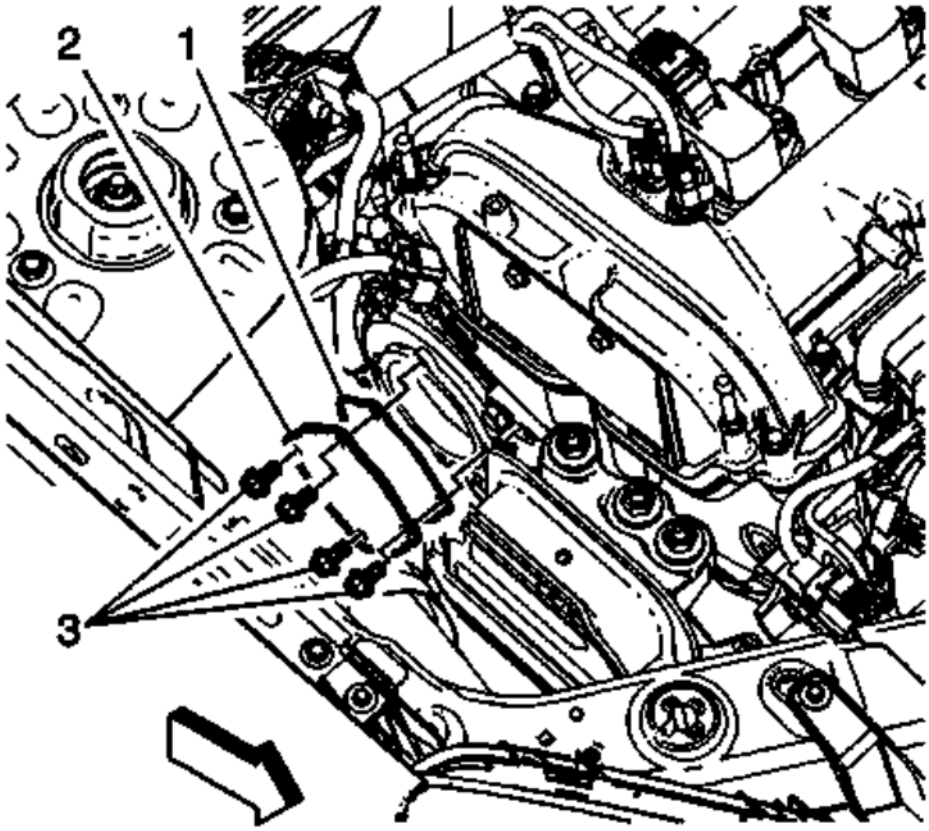


Fig. 88: Water Pump Cover, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

7. Remove the water pump cover (2), fasteners (3) and gasket (1) from the engine front cover.

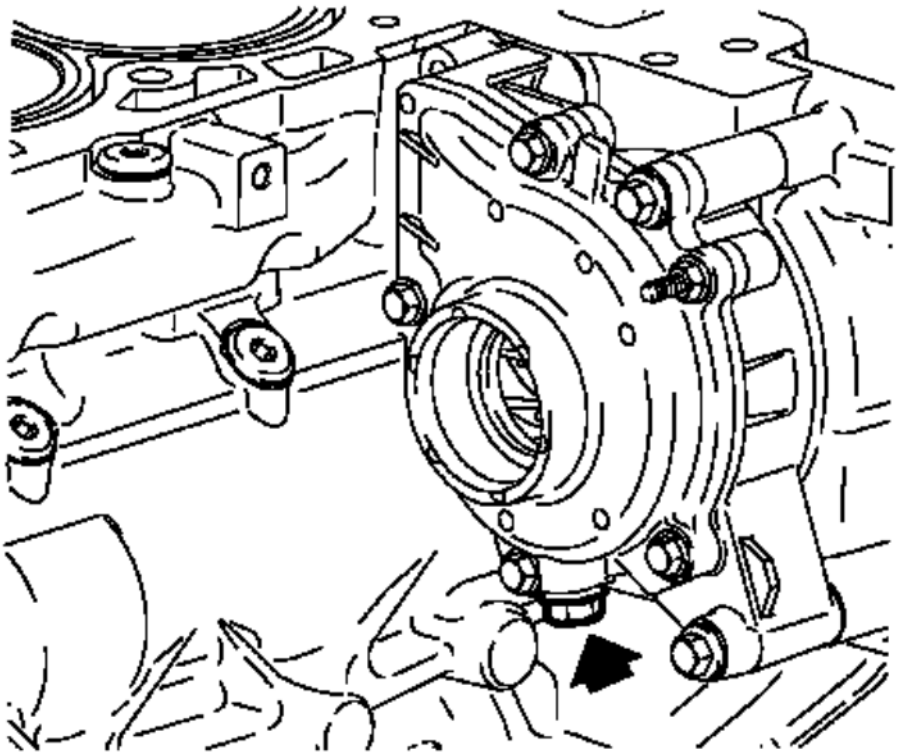


Fig. 89: Locating Water Pump Drain Plug (L61)
Courtesy of GENERAL MOTORS COMPANY

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

8. Drain the coolant from the water pump using the plug at the bottom of the pump. Install the plug when finished.

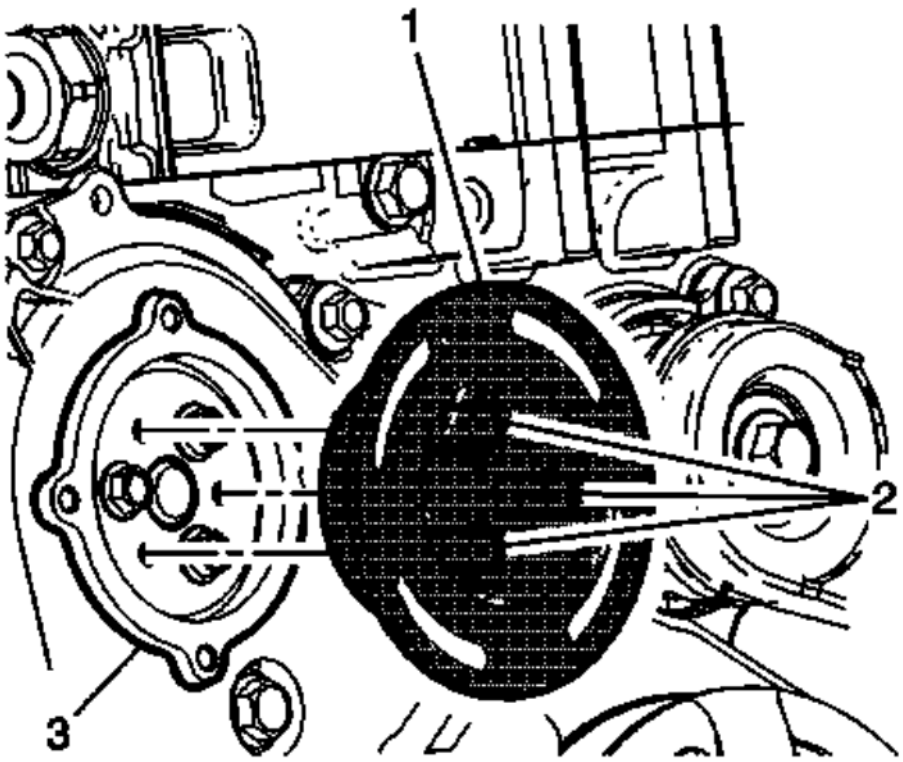


Fig. 90: Water Pump Holding Tool And Fasteners
Courtesy of GENERAL MOTORS COMPANY

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

9. Align the **EN-43651** water pump holding tool (1) with the threads on the water pump sprocket. Tighten the water pump holding tool fasteners (2).

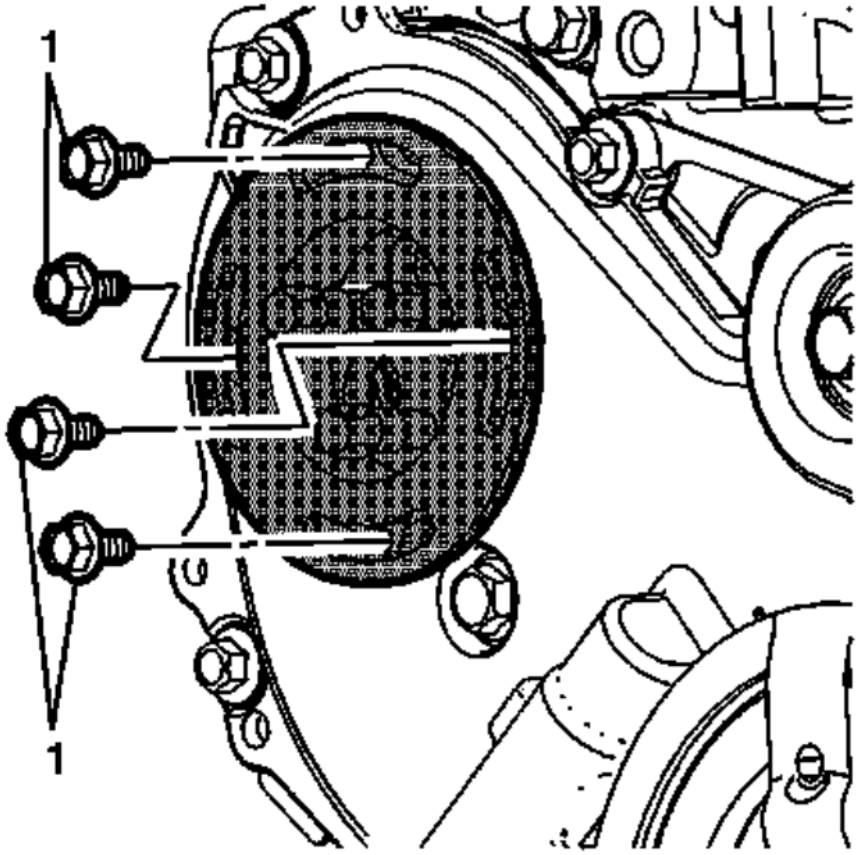


Fig. 91: Water Pump Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Secure the water pump holding tool with the previously removed water pump cover fasteners (1) into the engine front cover.

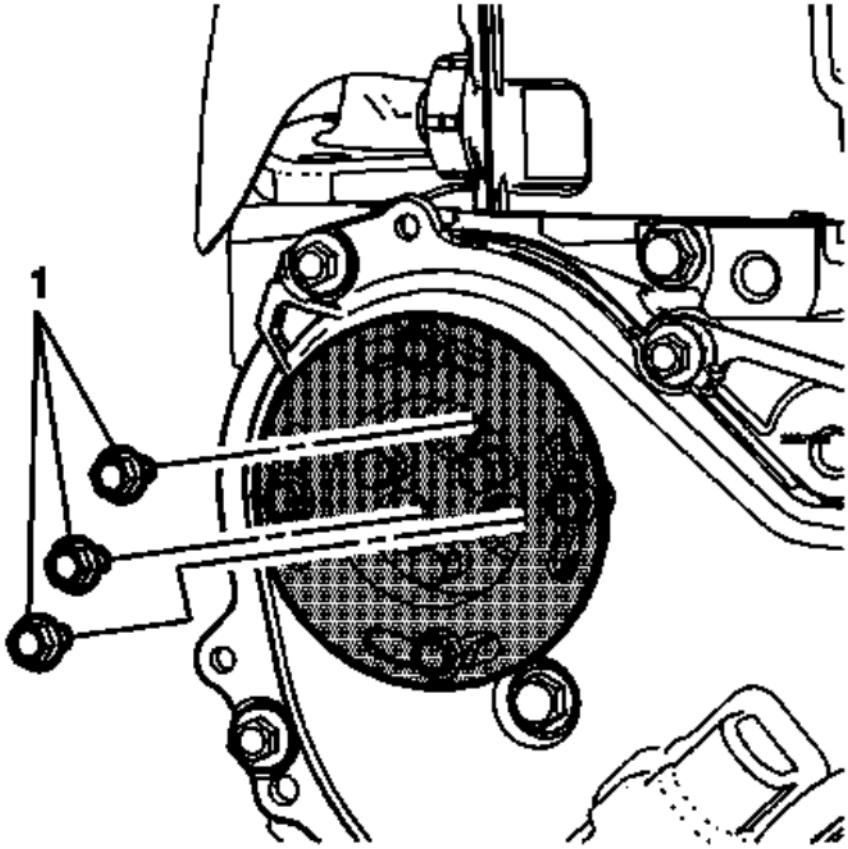


Fig. 92: Water Pump Sprocket To Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

11. Remove the water pump sprocket to water pump fasteners (1).

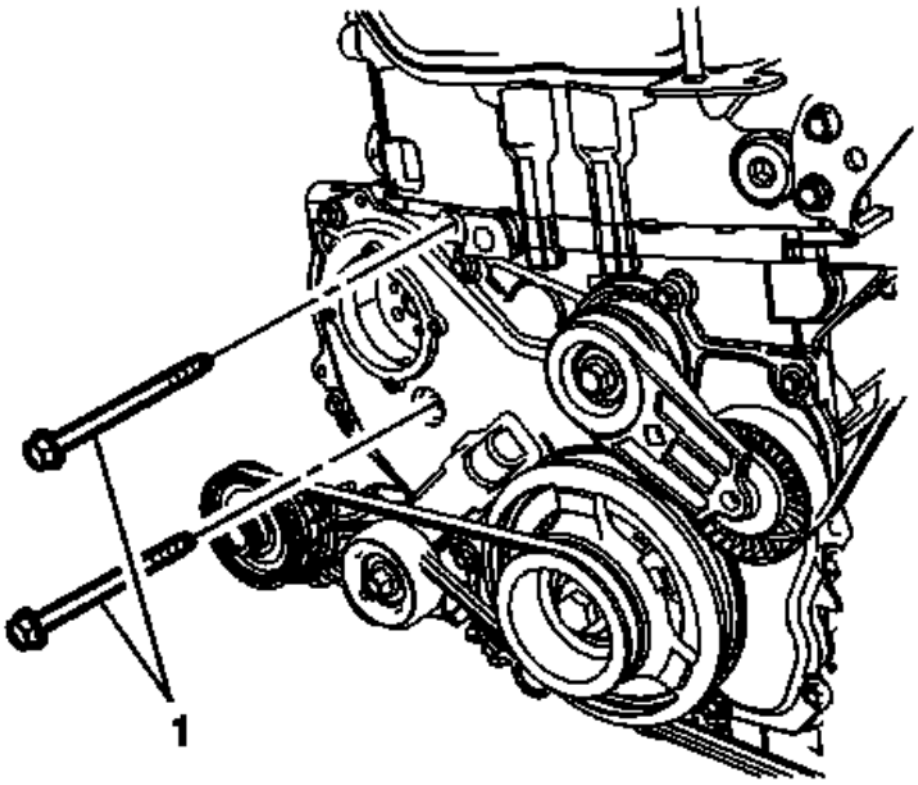


Fig. 93: Water Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

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

12. Remove the front water pump fasteners (1).

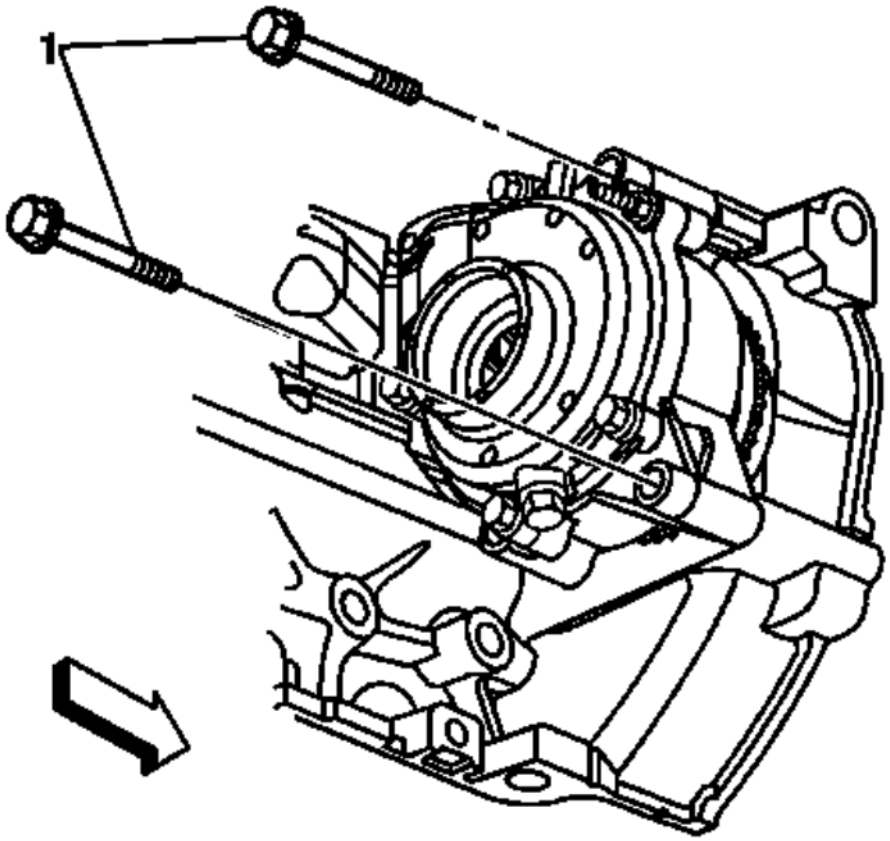


Fig. 94: Identifying Rear Water Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the rear water pump fasteners (1).

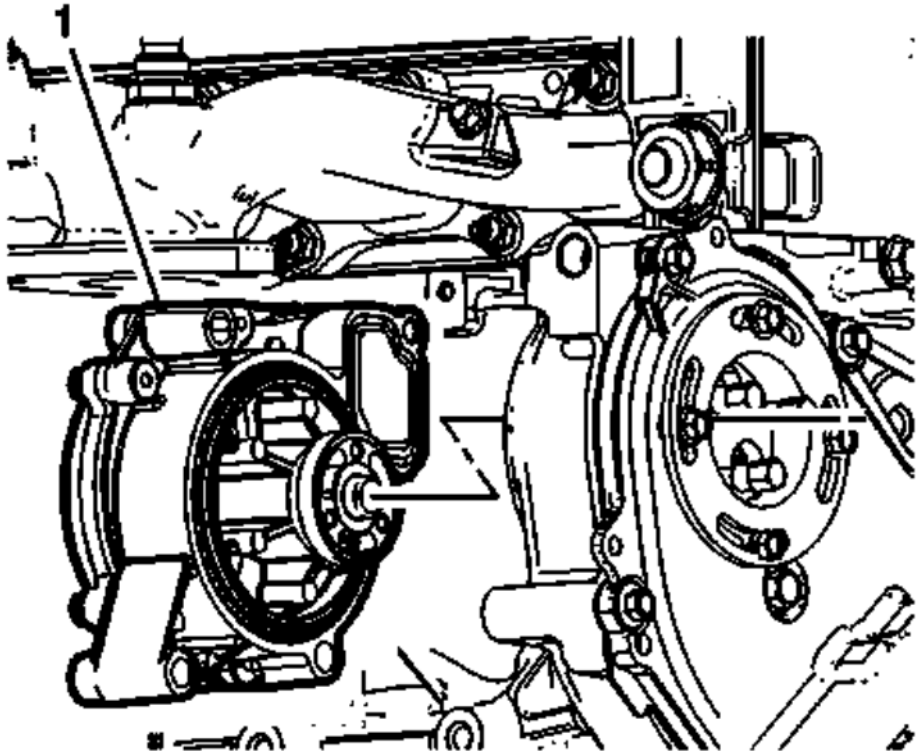


Fig. 95: Water Pump
Courtesy of GENERAL MOTORS COMPANY

14. Remove the water pump (1).

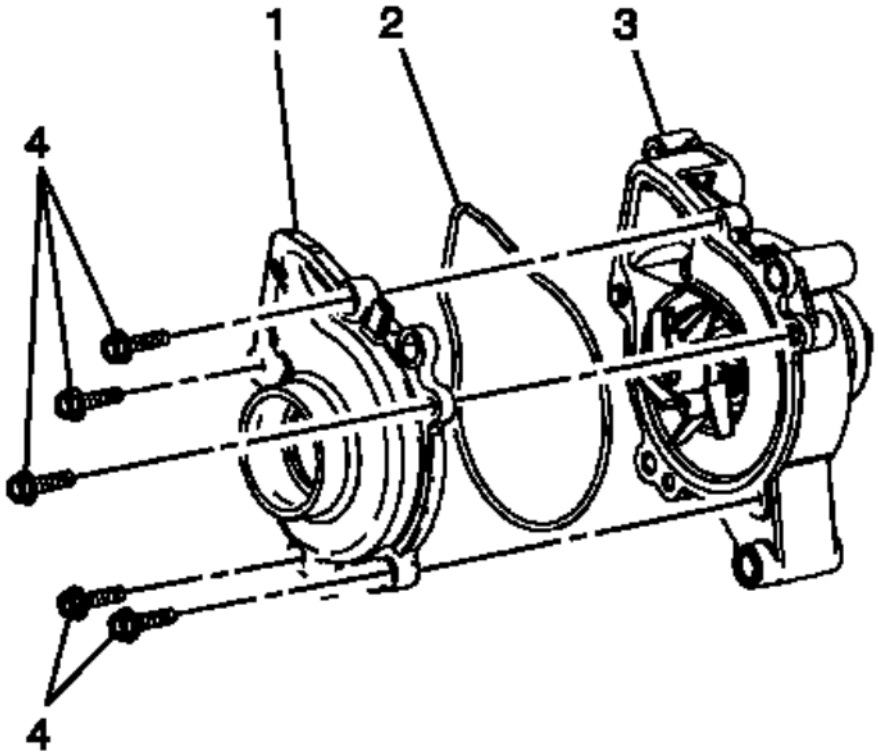


Fig. 96: Water Pump, Water Pump Cover, Rear Cover Fasteners And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

15. If replacing the water pump cover remove the water pump rear cover fasteners (4).
16. Separate the water pump cover (1) from the water pump (3).
17. Remove and discard the water pump O-ring seal (2).

Installation Procedure

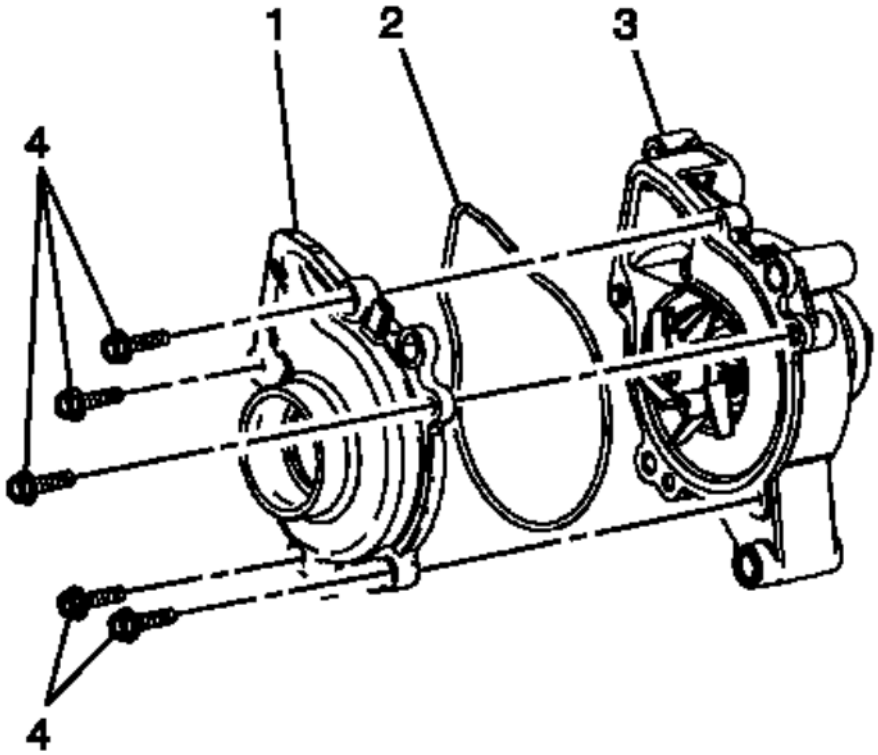


Fig. 97: Water Pump, Water Pump Cover, Rear Cover Fasteners And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. If replacing the water pump cover (1), install a new O-ring (2) to the water pump (3) and tighten the fasteners (4) to 25 N.m (18 lb ft).

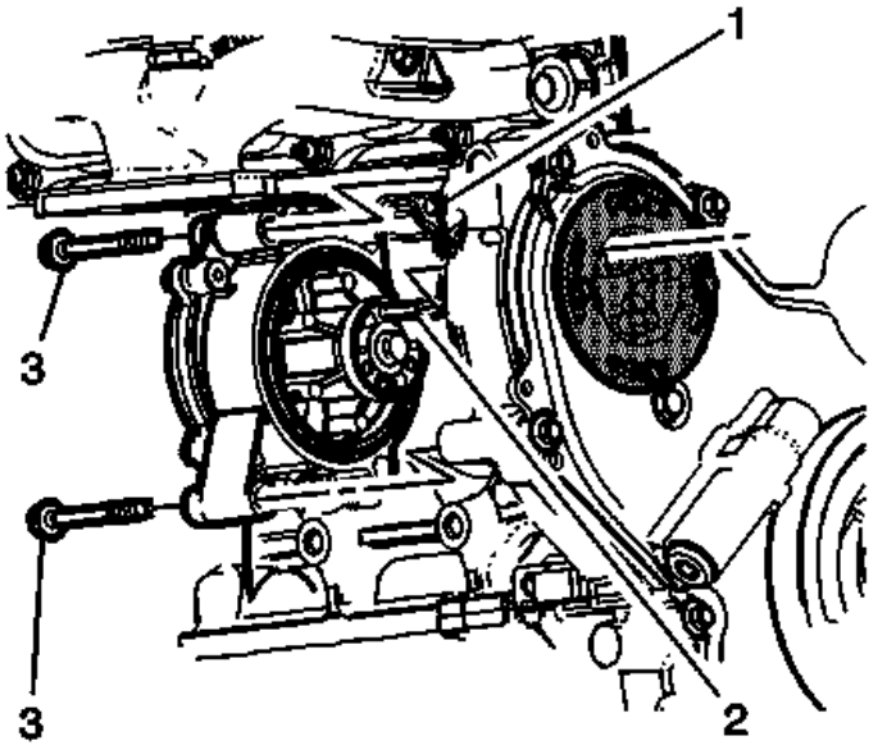


Fig. 98: Water Pump, Guide Pin And Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: A guide pin can be created to aid in water pump alignment. Use a M 6 m x 6 mm x 50.8 mm stud (2 in). Thread the pin into the water pump sprocket.

2. Using a guide pin (2), align the pin with the water pump holding tool.
3. Position the water pump (1) against the engine block and hand tighten the water pump fasteners (3).

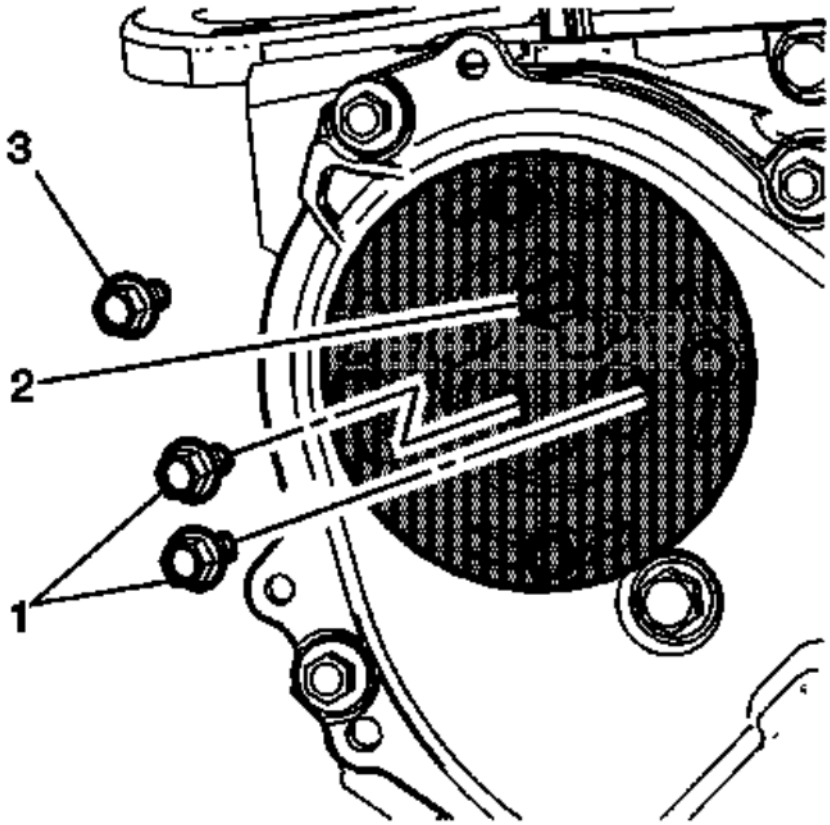


Fig. 99: Water Pump Sprocket To Water Pump Fasteners And Guide Pin
Courtesy of GENERAL MOTORS COMPANY

4. Install 2 water pump sprocket to water pump fasteners (1). After the fasteners are snug, remove the guide pin (2) and install the 3rd fastener (3) and tighten to 10 N.m (89 lb in).

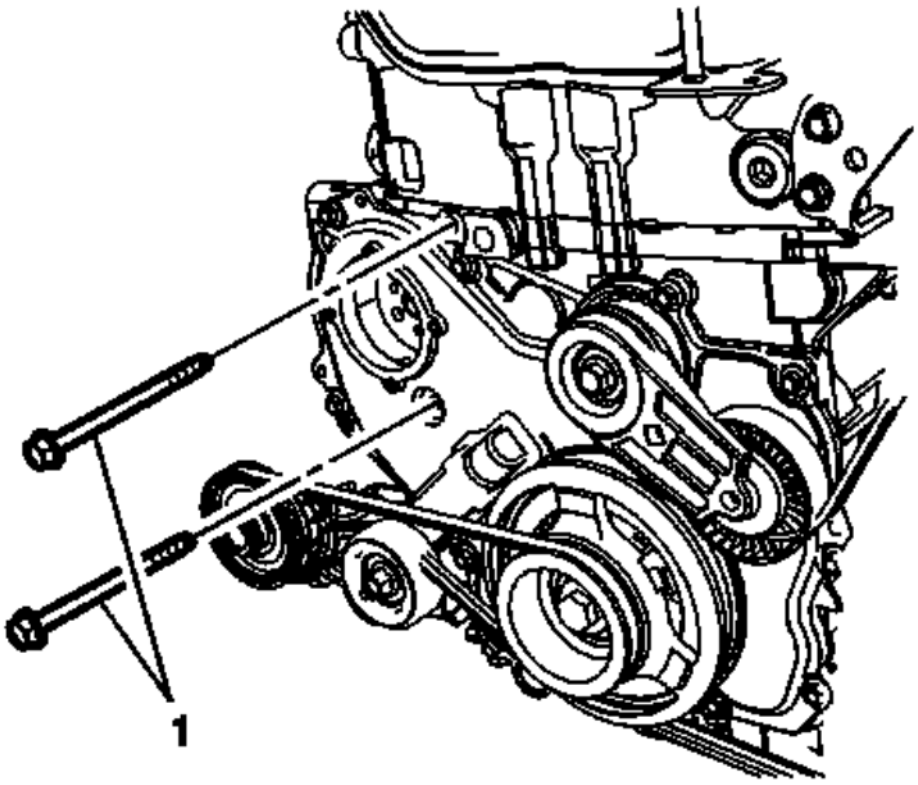


Fig. 100: Water Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the water pump fasteners (1) at the front of the engine. Hand tighten at this time.
6. Tighten the water pump fasteners at the front and rear of the water pump to 25 N.m (18 lb ft).

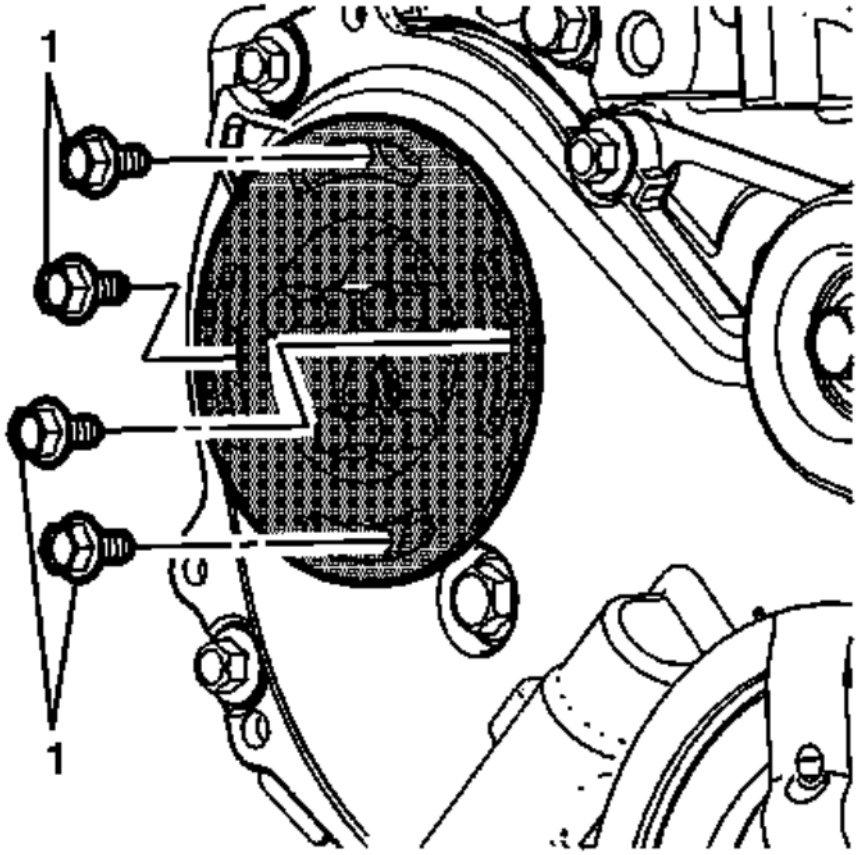


Fig. 101: Water Pump Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the water pump cover fasteners (1) from the engine front cover and water pump holding tool.

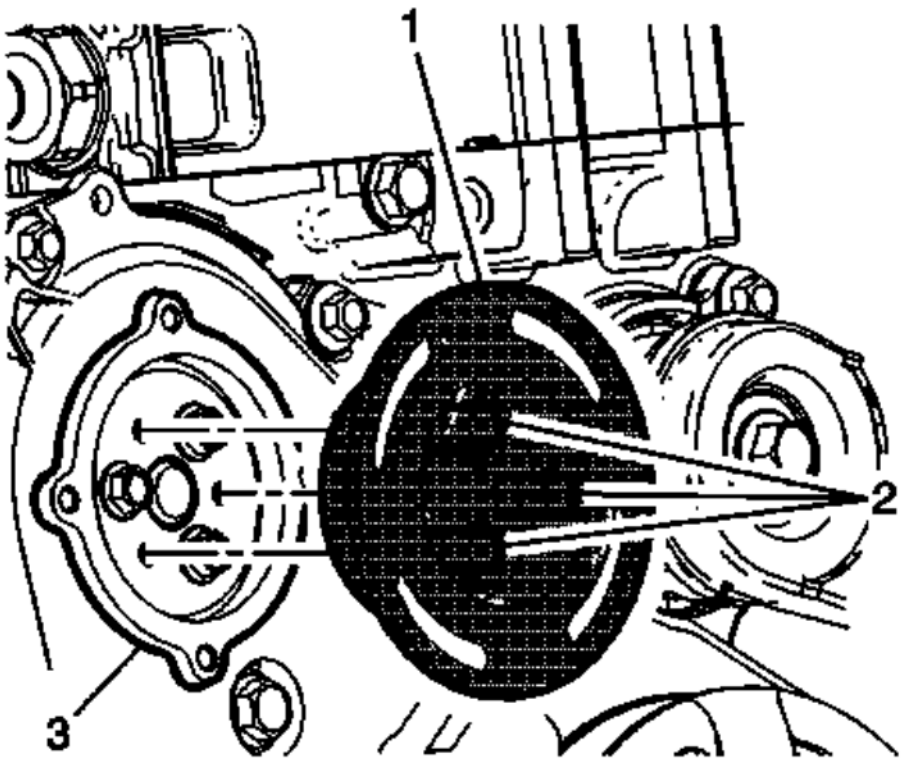


Fig. 102: Water Pump Holding Tool And Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **EN-43651** water pump holding tool (1) from the water pump sprocket.

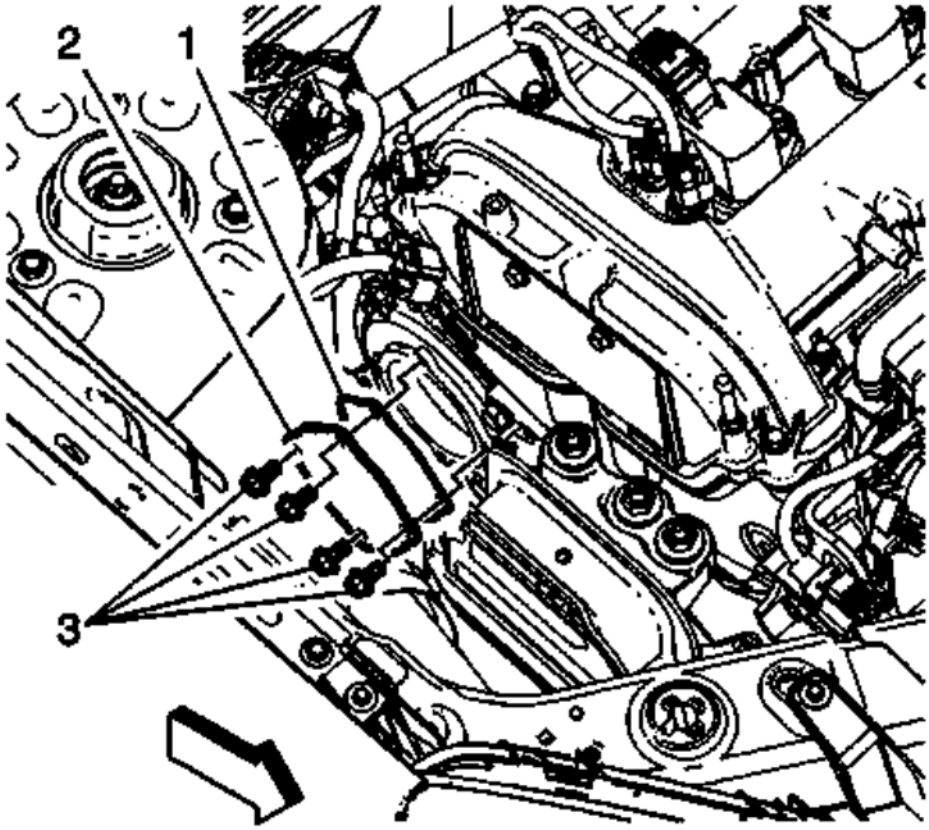


Fig. 103: Water Pump Cover, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

9. Install the water pump access plate (2) gasket (1) and fasteners (3) and tighten to 10 N.m (89 lb in).
10. If equipped, Install the coolant heater.
11. Install the engine coolant thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement (LUK)**.
12. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LUK)** .
13. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUK)** .
14. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
15. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
16. Refill the coolant system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

RADIATOR DRAIN COCK REPLACEMENT (LUK)

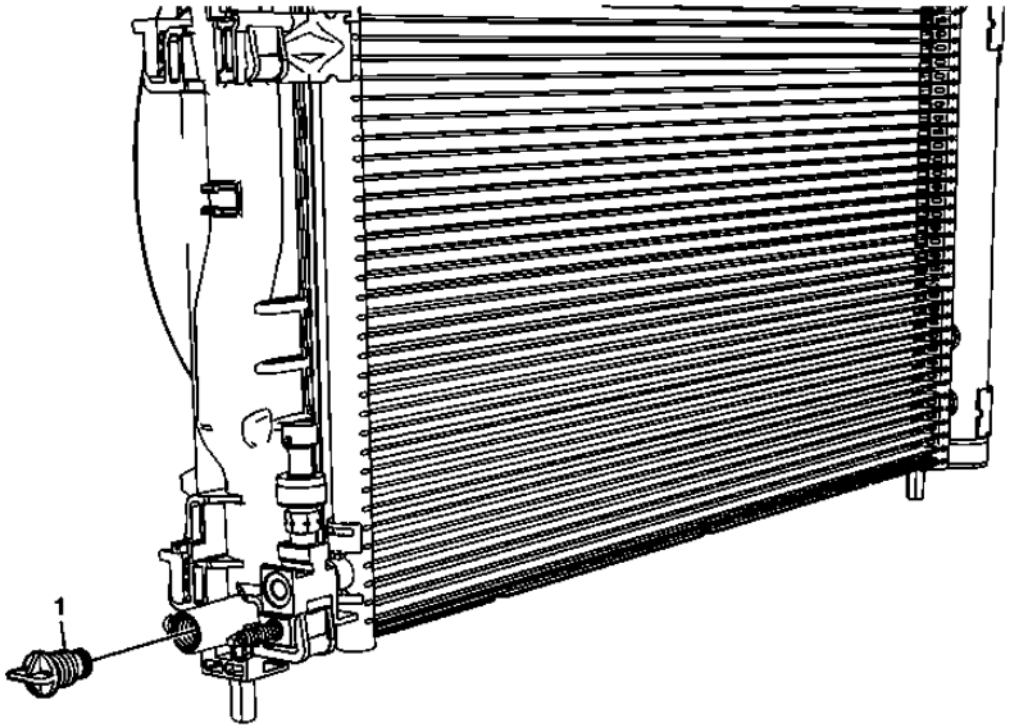


Fig. 104: Radiator Drain Cock (LUK)
Courtesy of GENERAL MOTORS COMPANY

Radiator Drain Cock Replacement (LUK)

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. To gain access to the drain cock reposition the right front wheelhouse liner. 3. Place a drain pan under the right side of the radiator.	
1	Radiator Drain Cock 1. Attach a drain hose to the radiator drain port to guide the coolant into the drain pan. 2. Fill the coolant to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

RADIATOR DRAIN COCK REPLACEMENT (LTG)

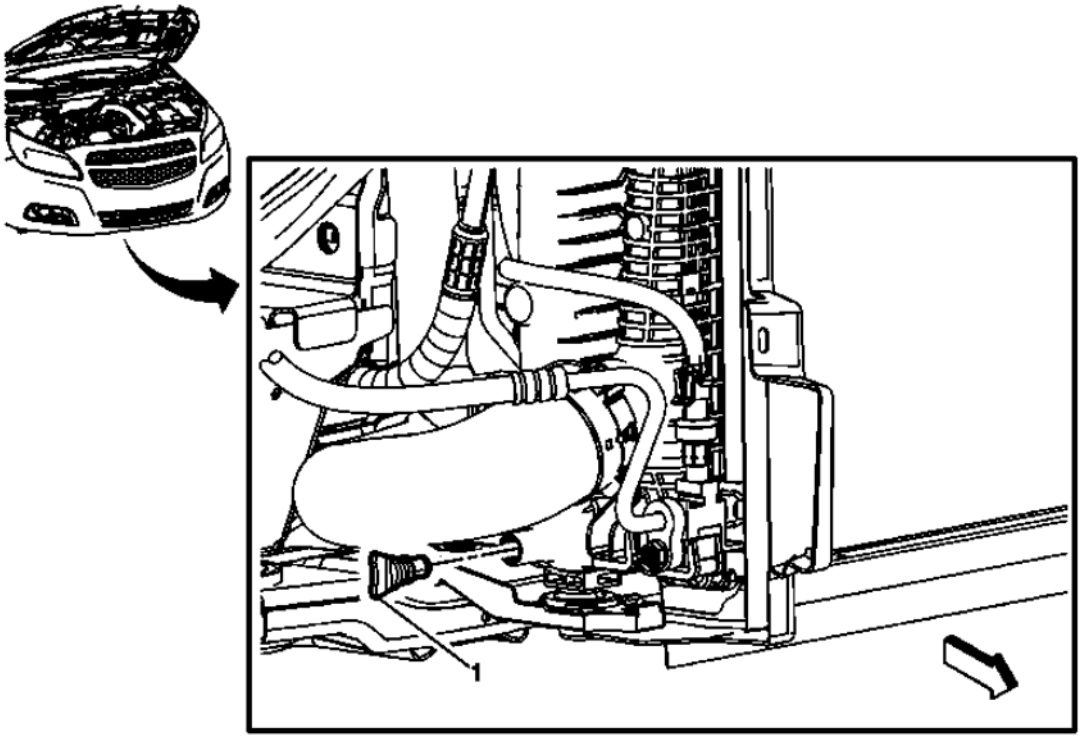


Fig. 105: Radiator Drain Cock (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Drain Cock Replacement (LTG)

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 right side of the radiator.	
1	Radiator Drain Cock **NOTE:** **Attach a drain hose to the radiator drain port to guide the coolant into the drain pan.** **Procedure** Fill the coolant to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

ENGINE COOLANT FAN SHROUD REPLACEMENT (LUK)

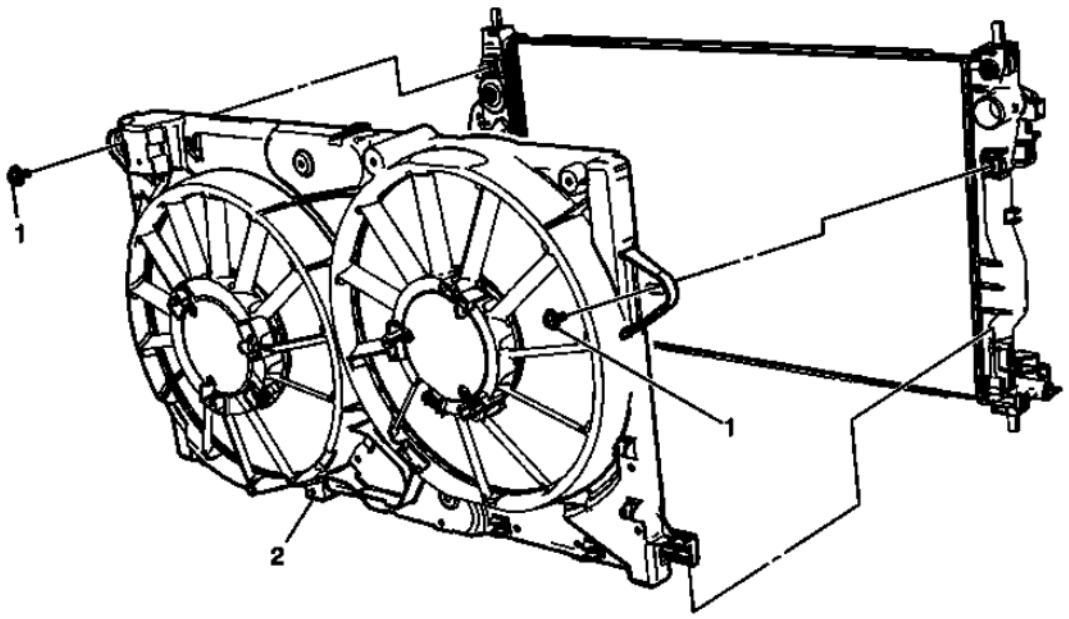


Fig. 106: Engine Coolant Fan Shroud (LUK)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LUK)

Callout	Component Name
Preliminary Procedures 1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** . 2. Remove the radiator outlet hose from the radiator. Refer to **Radiator Outlet Hose Replacement (LUK)**. 3. Disconnect the drive motor battery coolant/air separator from the cooling fan shroud. Refer to **Drive Motor Battery Coolant/Air Separator Replacement** . 4. Disconnect the auxiliary radiator outlet hose from the generator. Refer to **Auxiliary Radiator Outlet Hose Replacement** . 5. Disconnect the engine coolant fan motor electrical connectors. 6. Unclip all wiring harness that are connected to the shroud.	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (88 lb in)
2	Engine Coolant Fan Shroud

ENGINE COOLANT FAN SHROUD REPLACEMENT (LTG)

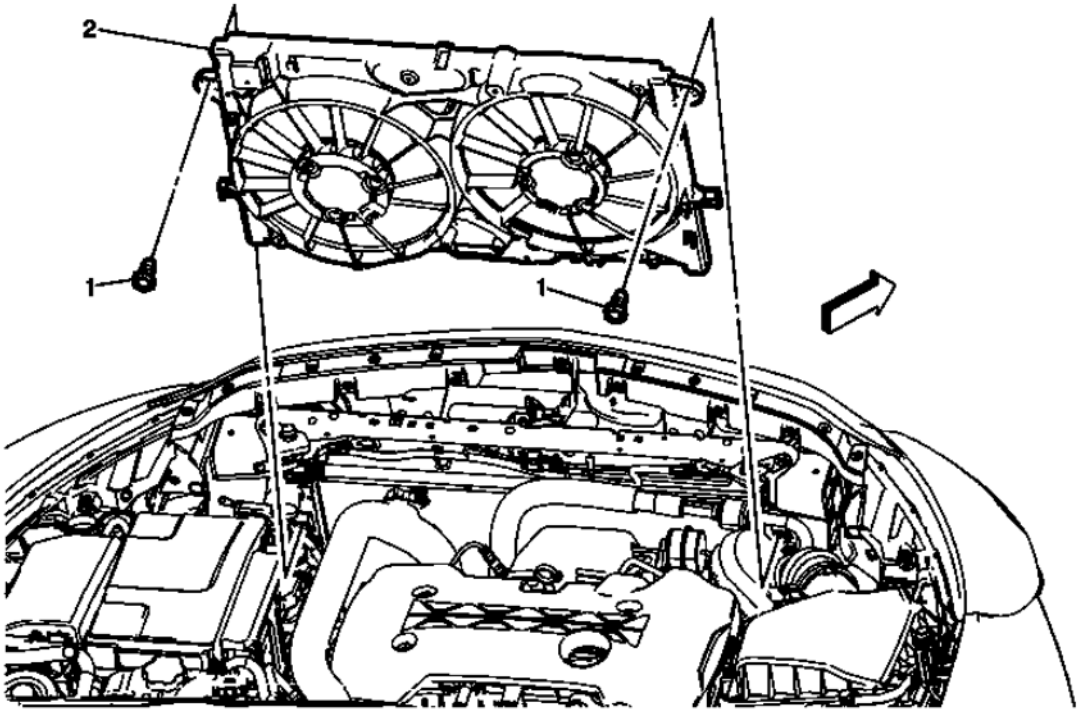


Fig. 107: Engine Coolant Fan Shroud (LTG)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LTG)

Callout	Component Name
Preliminary Procedures 1. Remove the radiator inlet hose from the radiator. Refer to **Radiator Inlet Hose Replacement (LTG)**. 2. Disconnect the engine coolant fan motor electrical connectors. 3. Unclip the wiring harness from the shroud. 4. Release the transmission lines from the fan shroud retainers.	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .**
2	Engine Coolant Fan Shroud **Procedure** Tilt the engine coolant fan shroud towards the engine and lift it off the radiator.

ENGINE COOLANT FAN SHROUD REPLACEMENT (LEA)

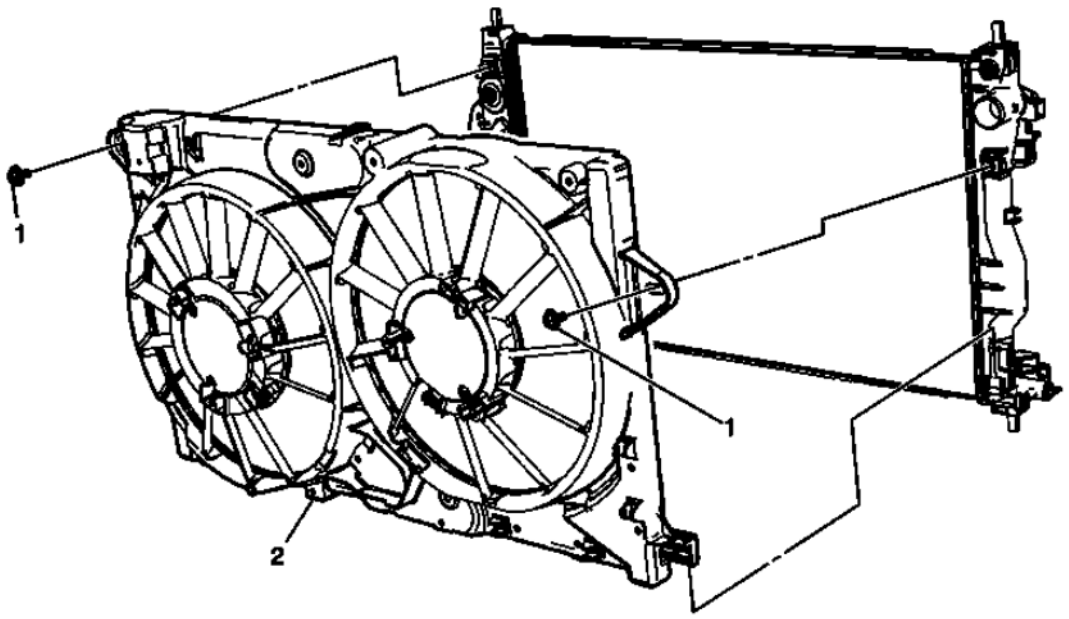


Fig. 108: Engine Coolant Fan Shroud (LUK)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LEA)

Callout	Component Name
Preliminary Procedures 1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** . 2. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LEA)**. 3. Remove the transmission fluid cooler hoses. Refer to **Fluid Cooler Inlet Hose Replacement (MHH)** , and **Fluid Cooler Outlet Hose Replacement (MHH)** . 4. Disconnect the engine coolant fan motor electrical connectors. 5. Unclip all wiring harness that are connected to the shroud.	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (88 lb in)
2	Engine Coolant Fan Shroud **Procedure** 1. Release the 2 tabs at the lower retainers allowing the shroud to slide upward. 2. Reposition the A/C condenser and compressor hose without discharging the

	system.

RADIATOR REPLACEMENT (LUK)

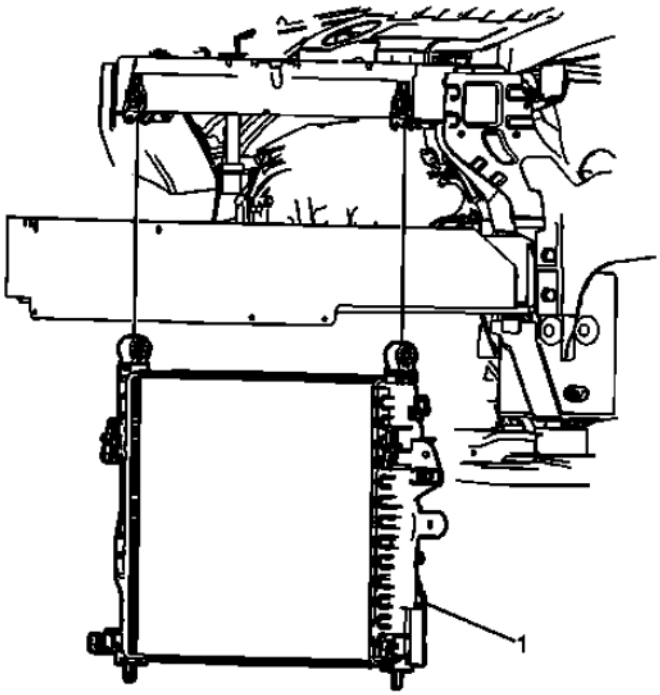


Fig. 109: Radiator (LUK)
Courtesy of GENERAL MOTORS COMPANY

Radiator Replacement (LUK)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**. 2. Remove the radiator inlet hose from the radiator. Refer to **Radiator Inlet Hose Replacement (LUK)**. 3. Remove the radiator outlet hose from the radiator. Refer to **Radiator Outlet Hose Replacement (LUK)**. 4. Remove transmission fluid cooler inlet and outlet hoses from the radiator. Refer to **Fluid Cooler Inlet Hose Replacement (MHH)** , and **Fluid Cooler Outlet Hose Replacement (MHH)** . 5. Reposition and secure the A/C condenser with the auxiliary radiator to the impact bar without disconnecting the lines. Refer to **Air Conditioning Condenser Replacement (LUK)** . 6. Disconnect the engine coolant fan harness electrical connectors. 7. Remove the radiator support brackets. Refer to **Radiator Support Bracket Replacement (LUK)**.	
	Radiator **Procedure**

1	Remove the engine coolant fan shroud from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LUK)**.

RADIATOR REPLACEMENT (LTG)

Removal Procedure

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

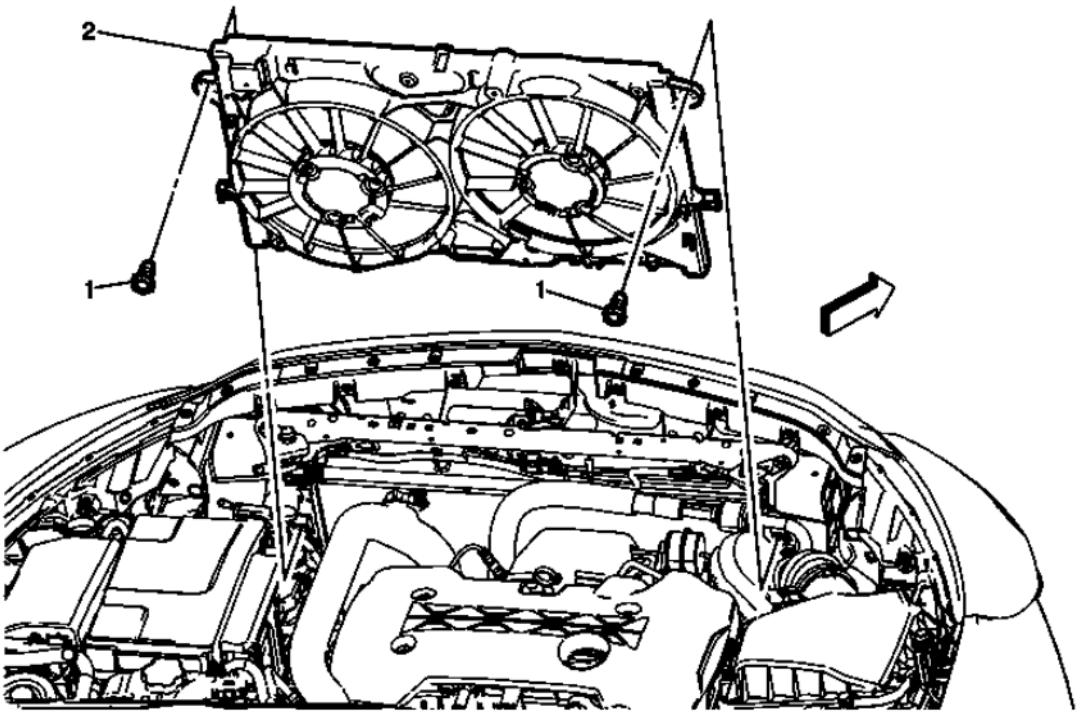


Fig. 110: Engine Coolant Fan Shroud (LTG)
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine coolant fan shroud (2) from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LTG)**.

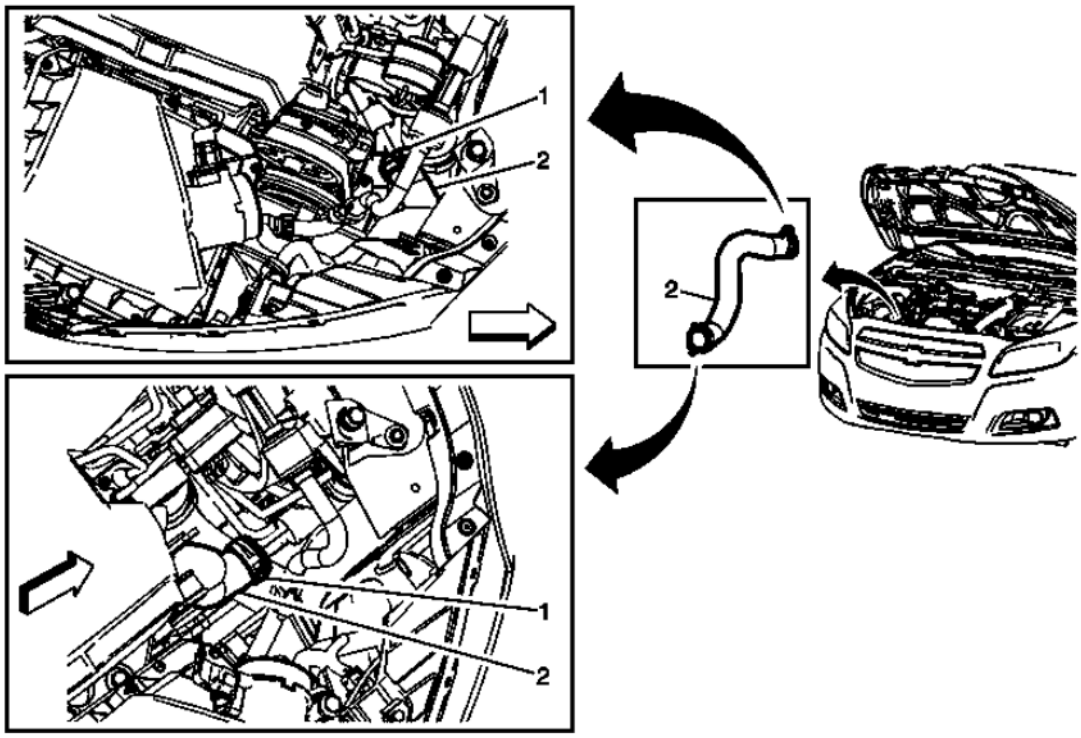


Fig. 111: Radiator Outlet Hose & Clamps (LTG)
Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose (2) from the radiator. Refer to **Radiator Outlet Hose Replacement (LTG)**.

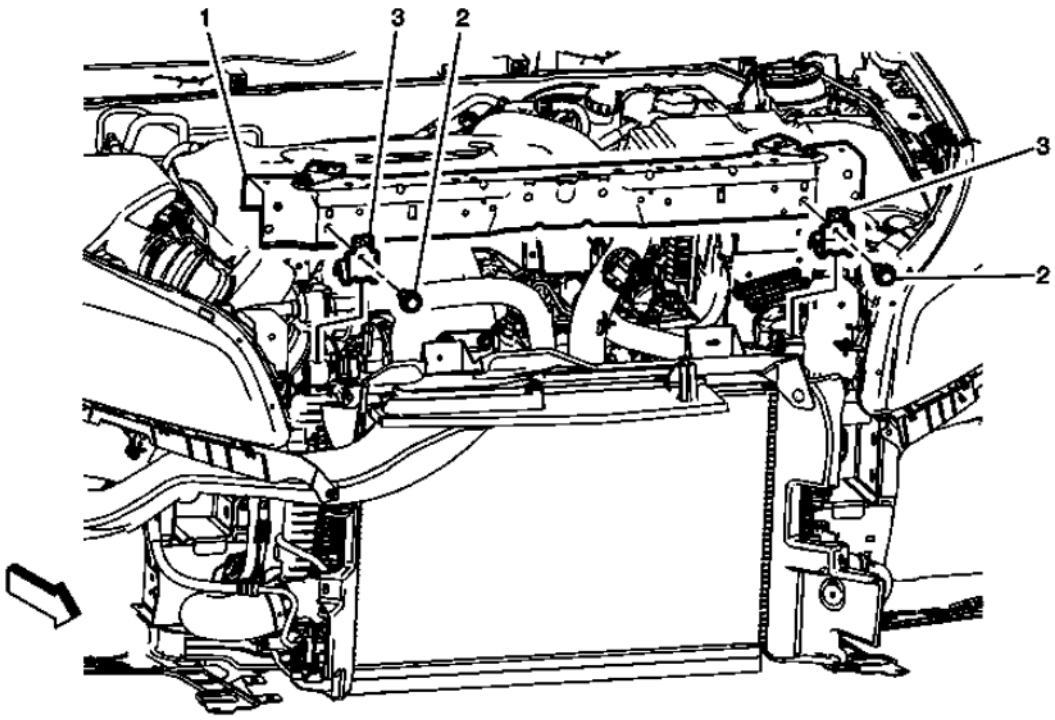


Fig. 112: Radiator Upper Brackets (LTG)
Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator upper brackets (3). Refer to **Radiator Upper Bracket Replacement (LTG)**.

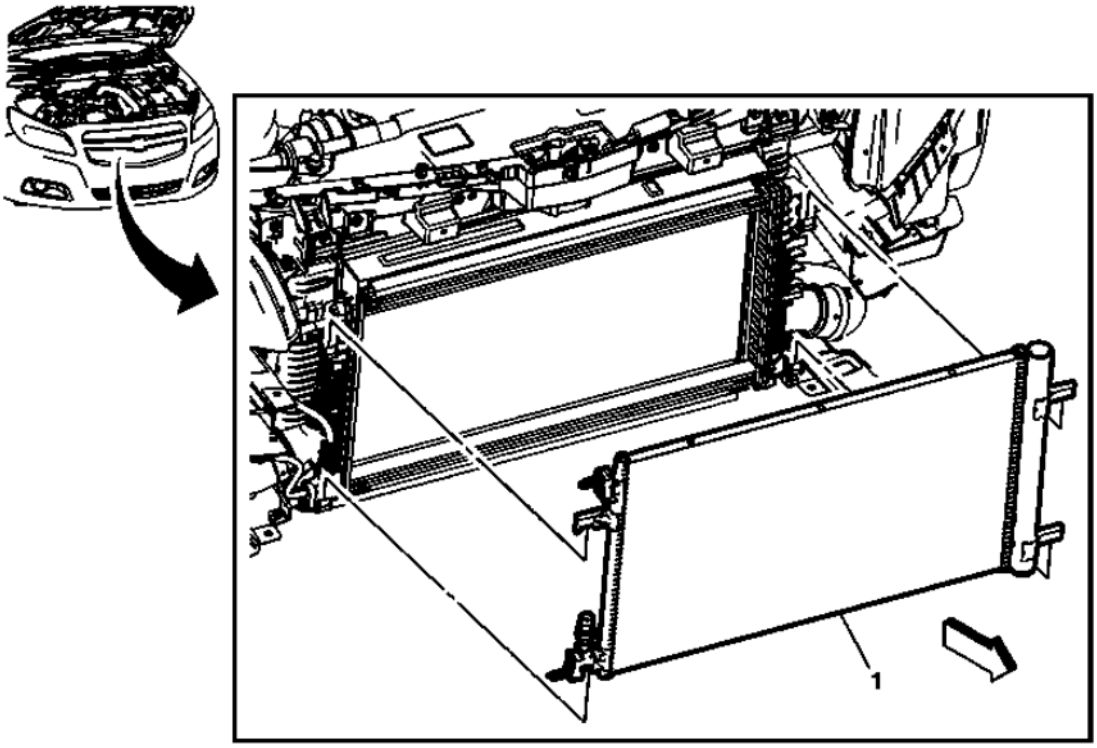


Fig. 113: Air Conditioning Condenser (LTG)
Courtesy of GENERAL MOTORS COMPANY

5. Remove the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LTG)** , **Air Conditioning Condenser Replacement (LUK)** .

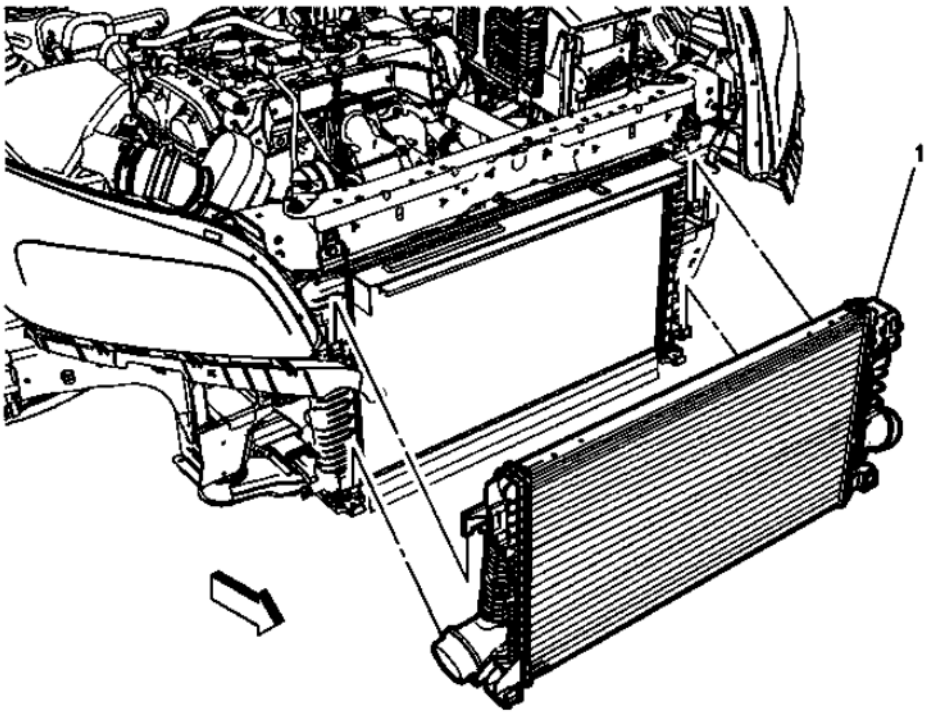


Fig. 114: Charge Air Cooler Radiator
Courtesy of GENERAL MOTORS COMPANY

6. Remove the charge air cooler radiator (1). Refer to **Charge Air Cooler Radiator Replacement** .

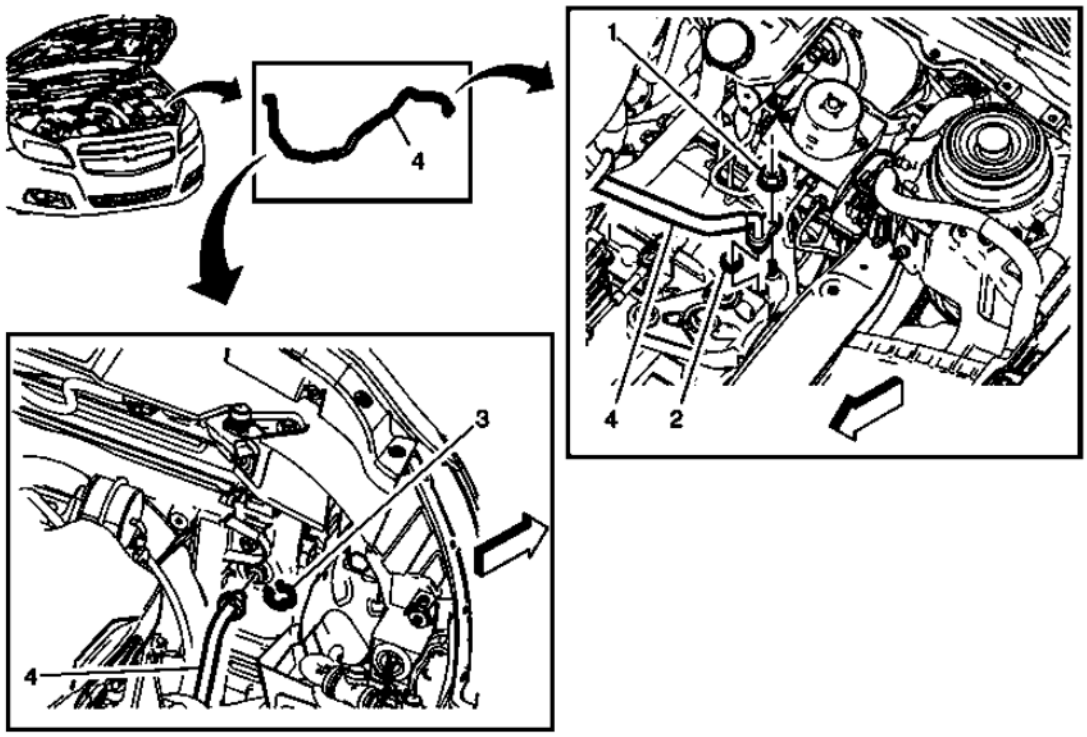


Fig. 115: Transmission Fluid Cooler Outlet Pipe And Radiator (LTG)
Courtesy of GENERAL MOTORS COMPANY

7. Remove the transmission fluid cooler outlet pipe from the radiator. Refer to **Transmission Fluid Cooler Outlet Pipe Replacement (M7U)** .

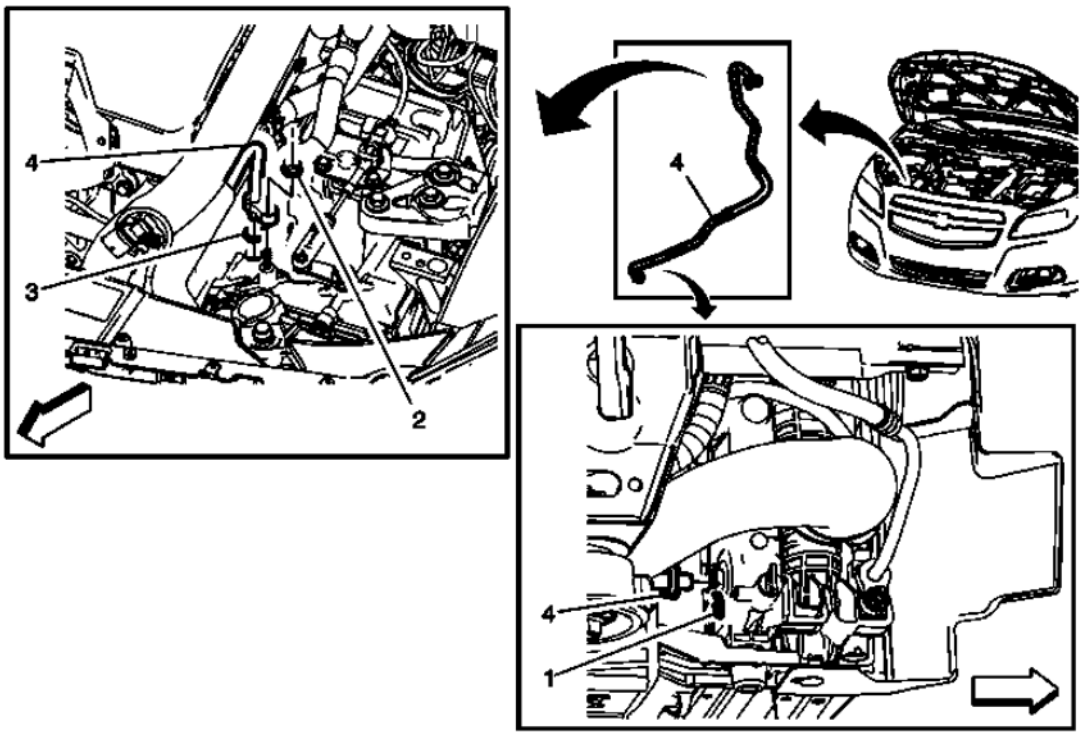


Fig. 116: Transmission Fluid Cooler Inlet Pipe & Components (LTG)
Courtesy of GENERAL MOTORS COMPANY

8. Remove the transmission fluid cooler inlet pipe from the radiator. Refer to **Transmission Fluid Cooler Inlet Pipe Replacement (M7U)** .
9. Remove the radiator air seal.

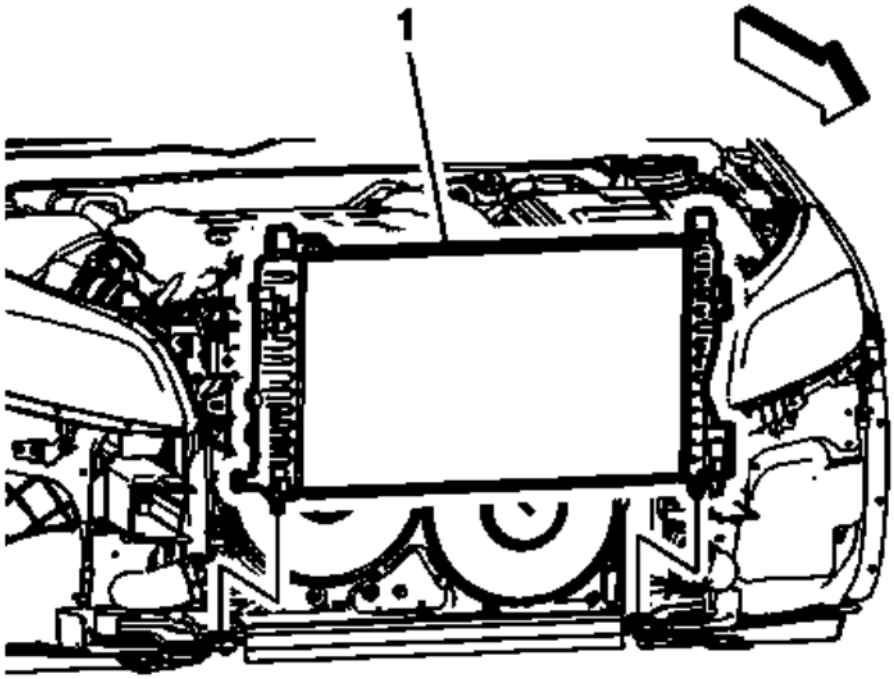


Fig. 117: Radiator
Courtesy of GENERAL MOTORS COMPANY

10. Tilt the radiator (1) forward, lift up to remove the radiator assembly.

Installation Procedure

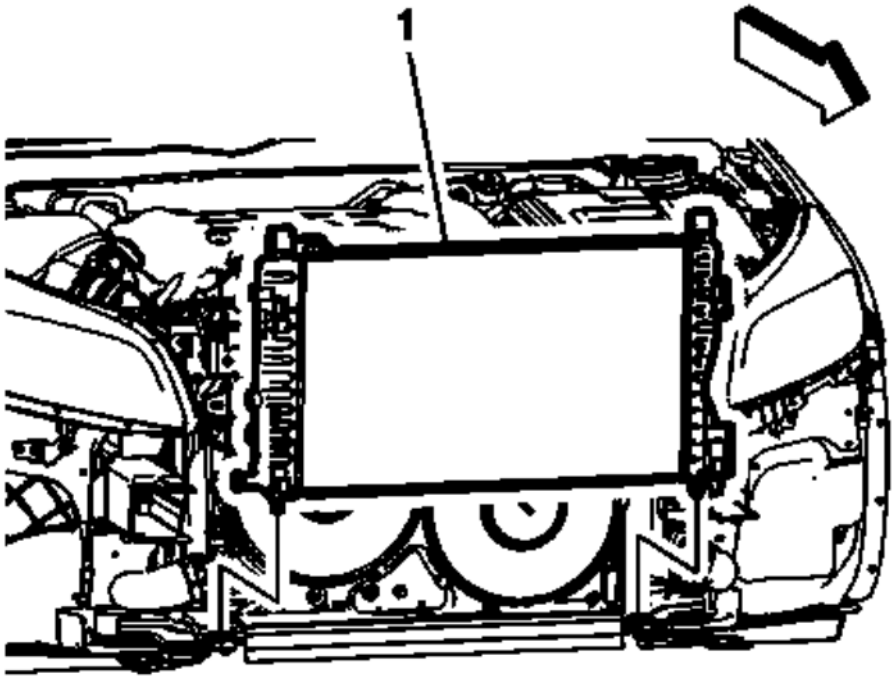


Fig. 118: Radiator
Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator assembly (1).
2. Install the radiator air seal.

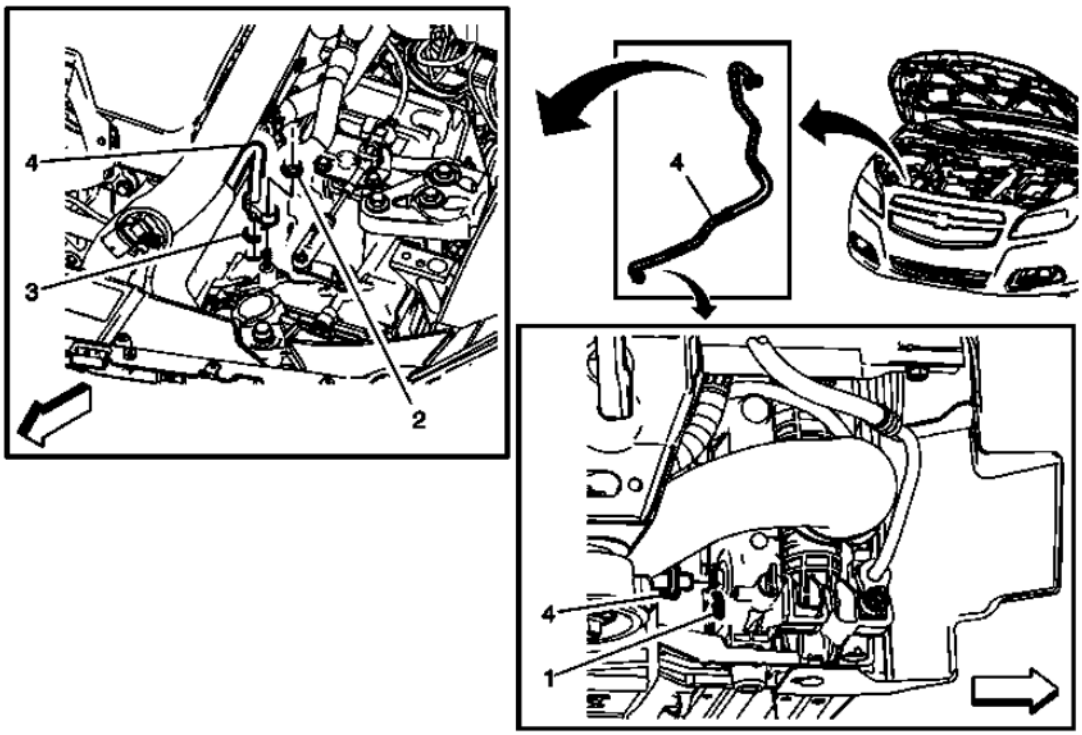


Fig. 119: Transmission Fluid Cooler Inlet Pipe & Components (LTG)
Courtesy of GENERAL MOTORS COMPANY

3. Install the transmission fluid cooler inlet pipe to the radiator. Refer to **Transmission Fluid Cooler Inlet Pipe Replacement (M7U)** .

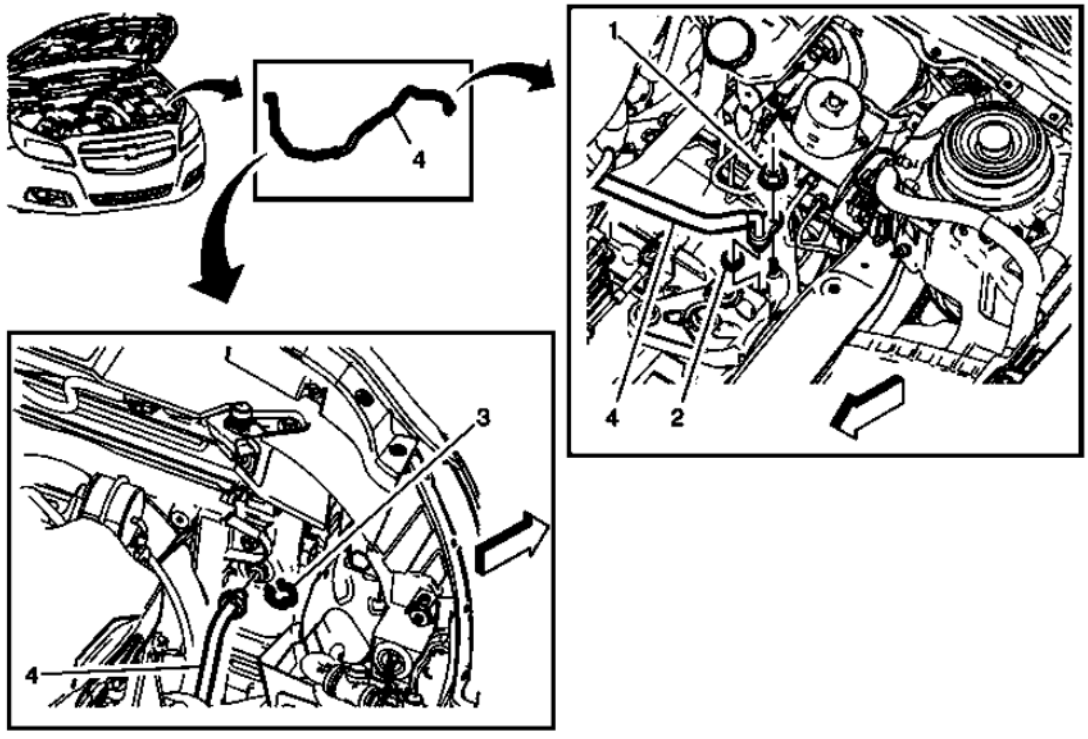


Fig. 120: Transmission Fluid Cooler Outlet Pipe And Radiator (LTG)
Courtesy of GENERAL MOTORS COMPANY

4. Install the transmission fluid cooler outlet pipe to the radiator. Refer to **Transmission Fluid Cooler Outlet Pipe Replacement (M7U)** .

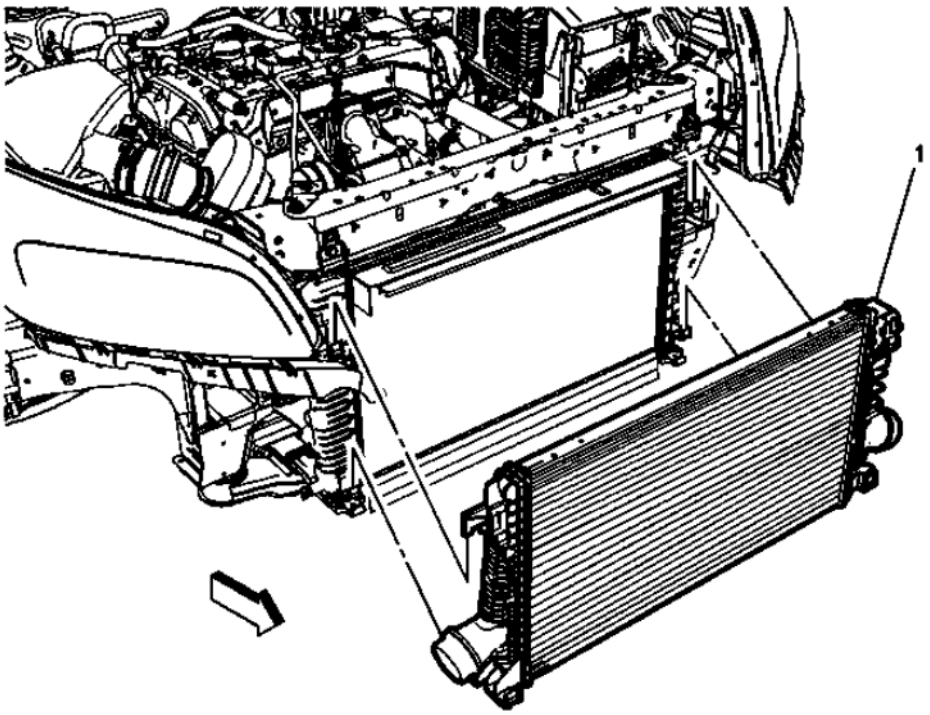


Fig. 121: Charge Air Cooler Radiator
Courtesy of GENERAL MOTORS COMPANY

5. Install the charge air cooler radiator (1). Refer to **Charge Air Cooler Radiator Replacement** .

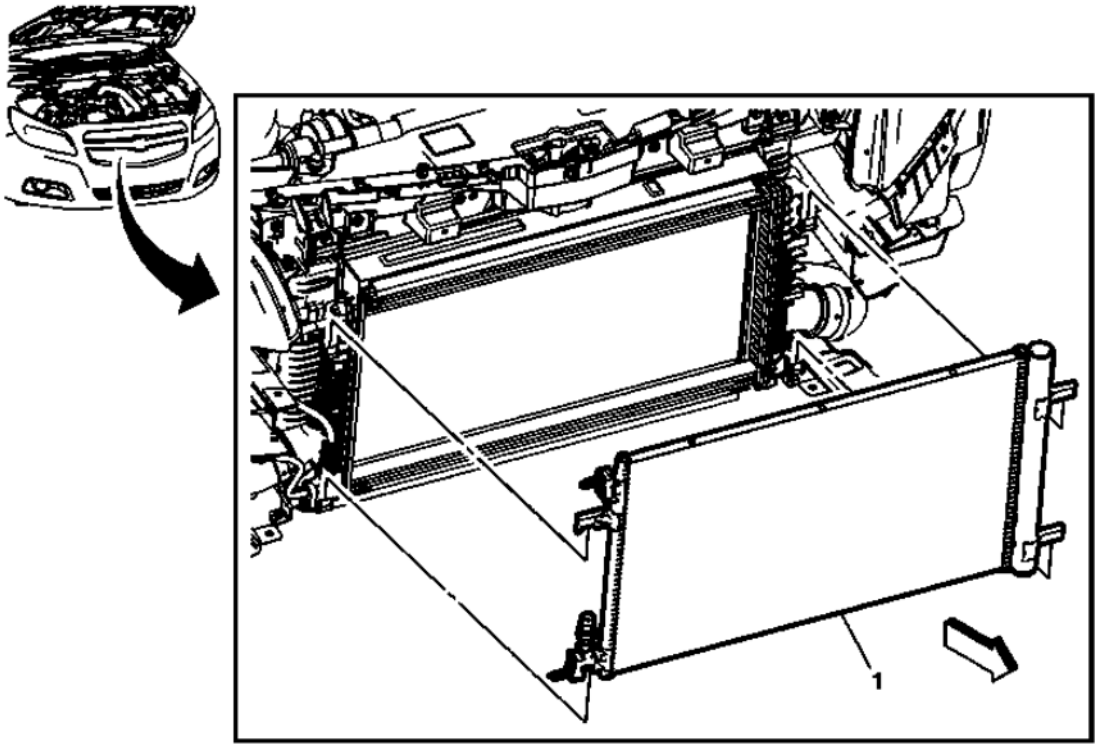


Fig. 122: Air Conditioning Condenser (LTG)
Courtesy of GENERAL MOTORS COMPANY

6. Install the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LTG)** .

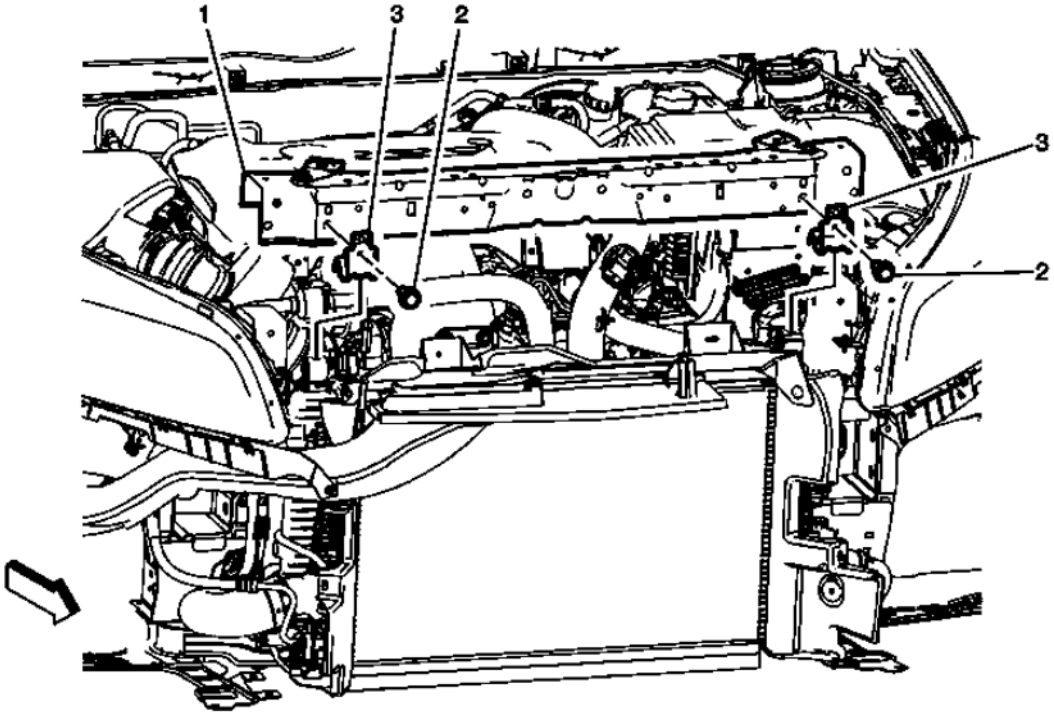


Fig. 123: Radiator Upper Brackets (LTG)
Courtesy of GENERAL MOTORS COMPANY

7. Install the radiator upper brackets (3). Refer to **Radiator Upper Bracket Replacement (LTG)**.

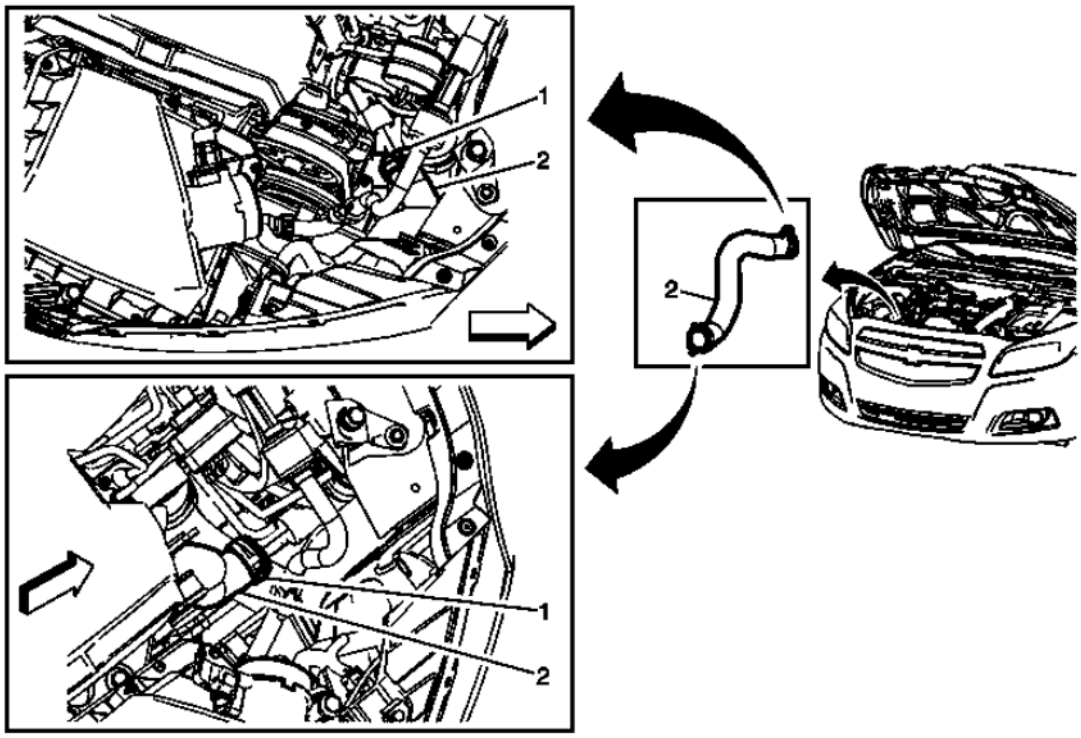


Fig. 124: Radiator Outlet Hose & Clamps (LTG)
Courtesy of GENERAL MOTORS COMPANY

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

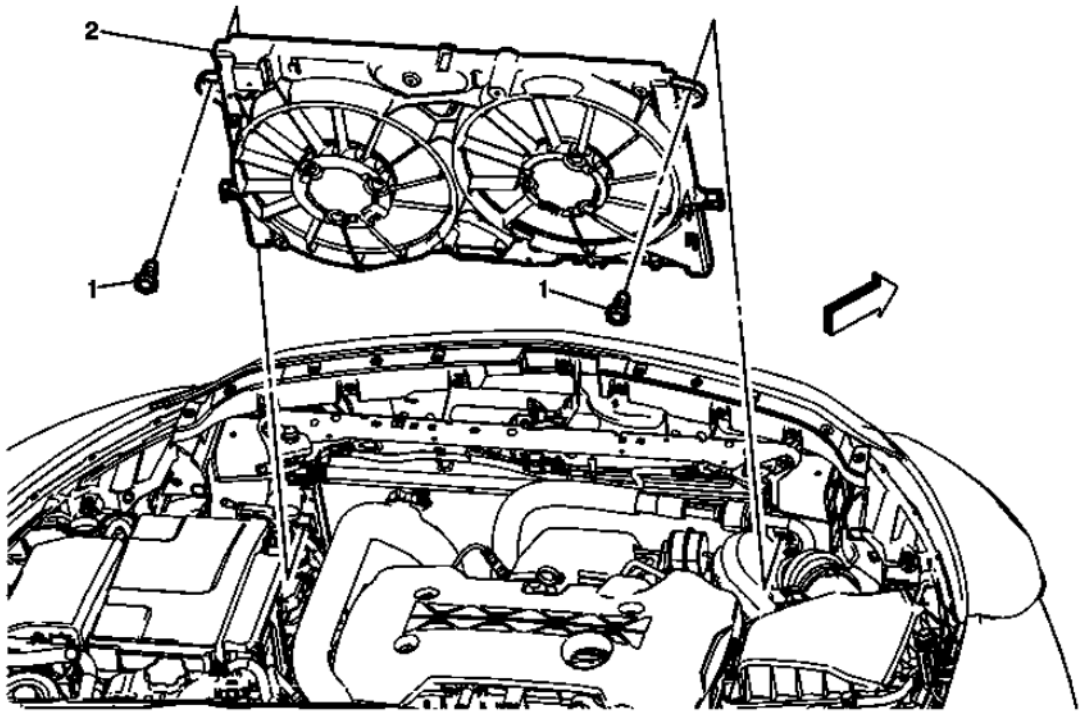


Fig. 125: Engine Coolant Fan Shroud (LTG)
Courtesy of GENERAL MOTORS COMPANY

9. Install the engine coolant fan shroud (2) to the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LTG)**.
10. Fill the engine cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
11. Check the cooling system for leaks. Refer to **Cooling System Leak Testing**.

RADIATOR REPLACEMENT (LEA)

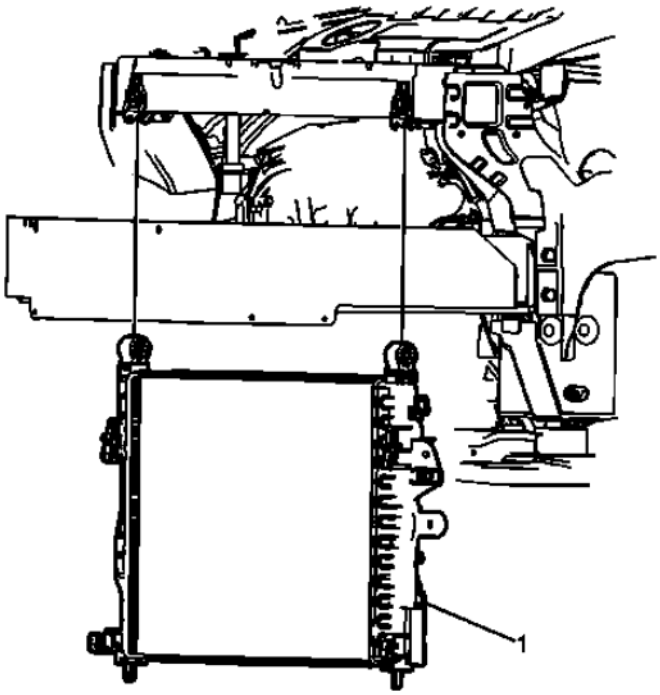


Fig. 126: Radiator (LEA)
Courtesy of GENERAL MOTORS COMPANY

Radiator Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.	
2. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LEA)**.	
3. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LEA)**.	
4. Remove transmission oil cooler lines. Refer to **Fluid Cooler Inlet Hose Replacement (MHH)** , and **Fluid Cooler Outlet Hose Replacement (MHH)** .	
5. Reposition and secure the A/C condenser to the impact bar without disconnecting the lines. Refer to **Air Conditioning Condenser Replacement (LTG)** , **Air Conditioning Condenser Replacement (LUK)** .	
6. Disconnect the engine coolant fan harness electrical connectors.	
7. Remove the radiator support brackets.	

1	Radiator **Procedure** Remove the engine coolant fan shroud from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LEA)**.

RADIATOR SUPPORT BRACKET REPLACEMENT (LUK)

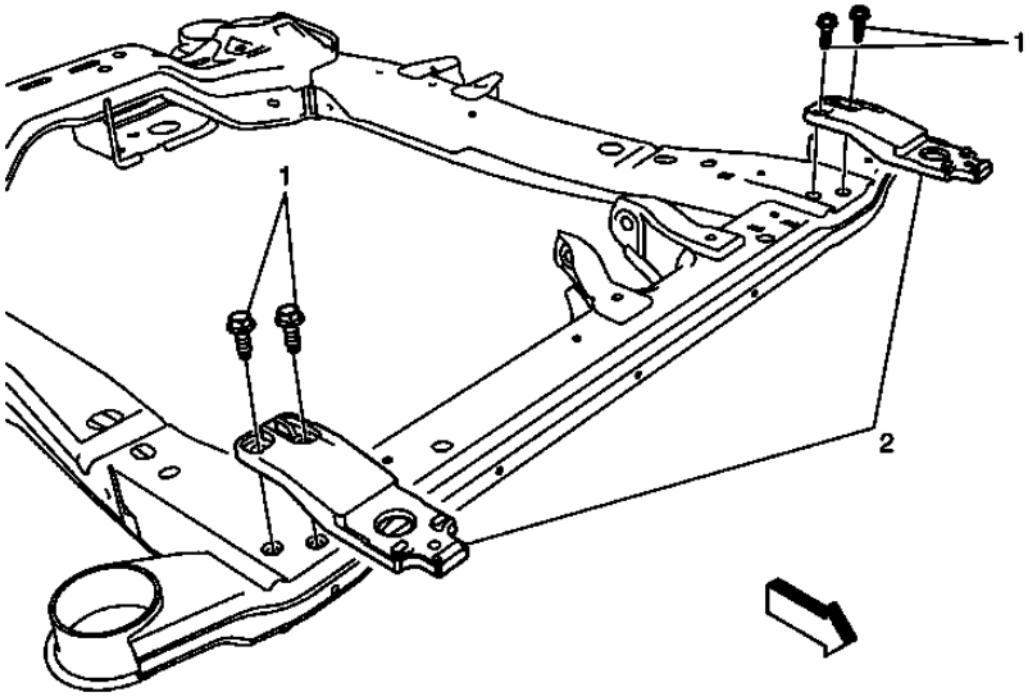


Fig. 127: Radiator Support Bracket (LUK)
Courtesy of GENERAL MOTORS COMPANY

Radiator Support Bracket Replacement (LUK)

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** 2. Support the radiator.	
1	Radiator Support Bracket Fastener (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Radiator Support Bracket (Qty: 2)

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (LEFT LUK)

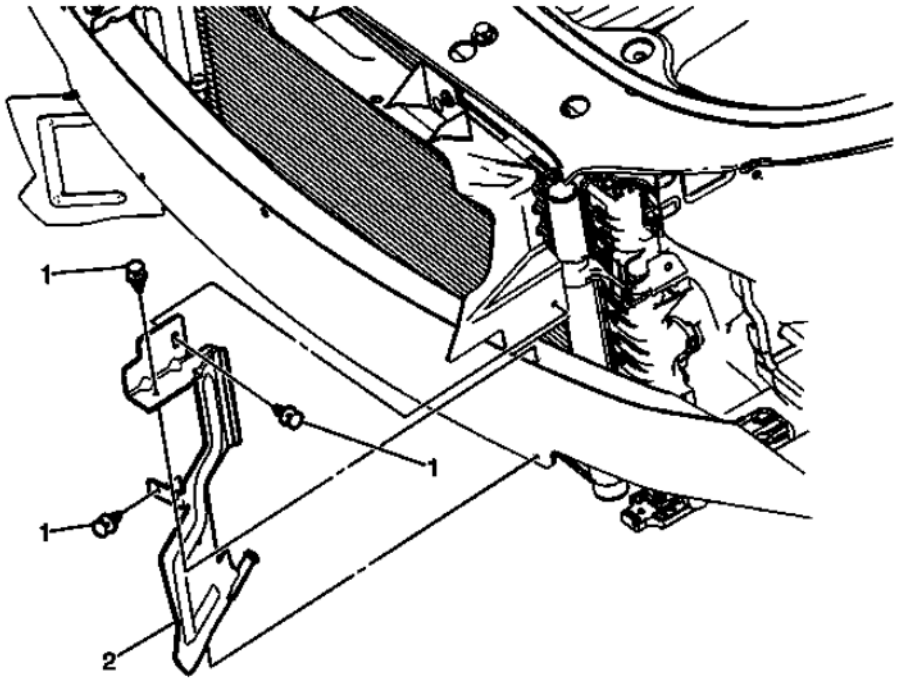


Fig. 128: Radiator Air Side Baffle & Deflector (Left)
Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Baffle and Deflector Replacement (Left LUK)

Callout	Component Name
Preliminary Procedures Remove the front fascia. Refer to **Front Bumper Fascia Replacement**	
1	Radiator Air Side Baffel and Deflector Retainers (Qty 3)
2	Radiator Air Side Baffel and Deflector

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (RIGHT LUK)

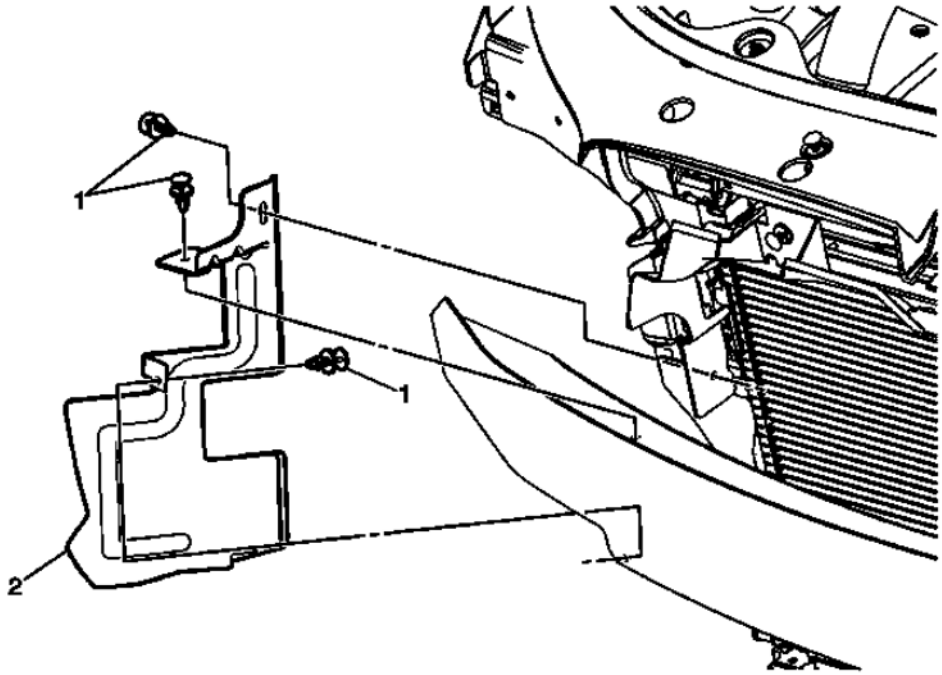


Fig. 129: Radiator Air Side Baffle & Deflector (Right)
Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Baffle and Deflector Replacement (Right LUK)

Callout	Component Name
Preliminary Procedures Remove the front fascia. Refer to **Front Bumper Fascia Replacement** .	
1	Radiator Air Side Baffle and Deflector Retainer (Qty: 3)
2	Radiator Air Side Baffle and Deflector

RADIATOR AIR SIDE UPPER BAFFLE REPLACEMENT (LEFT LTG)

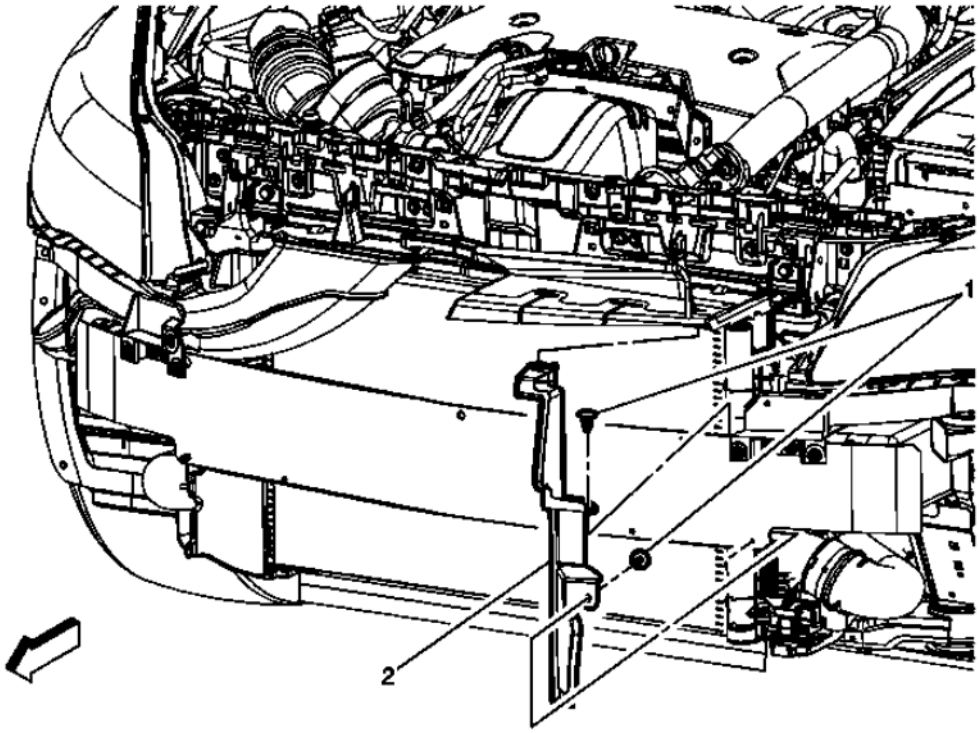


Fig. 130: Radiator Air Side Upper Baffle (Left LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Upper Baffle Replacement (Left LTG)

Callout	Component Name
Preliminary Procedure Remove the front fascia. Refer to **Front Bumper Fascia Replacement** .	
1	Radiator Air Side Upper Baffle Retainer (Qty: 2)
2	Radiator Air Side Upper Baffle **Procedure** Unclip the radiator air side upper baffle from the radiator air upper baffle and deflector.

RADIATOR AIR SIDE UPPER BAFFLE REPLACEMENT (RIGHT LTG)

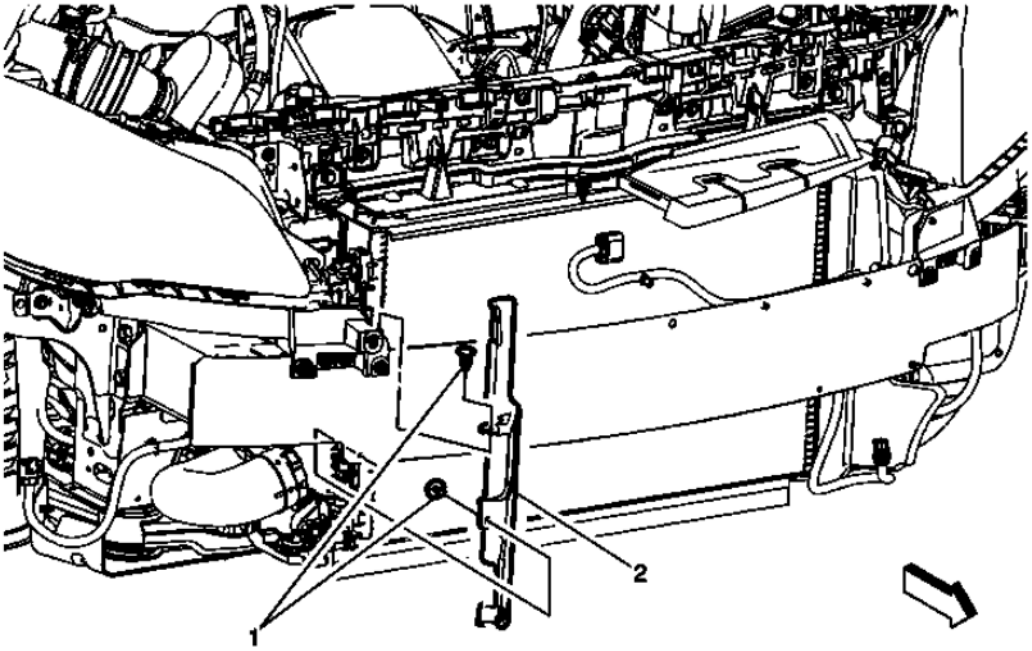


Fig. 131: Radiator Air Side Upper Baffle (Right LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Upper Baffle Replacement (Right LTG)

Callout	Component Name
Preliminary Procedures Remove the front fascia. Refer to **Front Bumper Fascia Replacement** .	
1	Radiator Air Side Upper Baffle Retainer (Qty: 2)
2	Radiator Air Side Upper Baffle

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT (LUK)

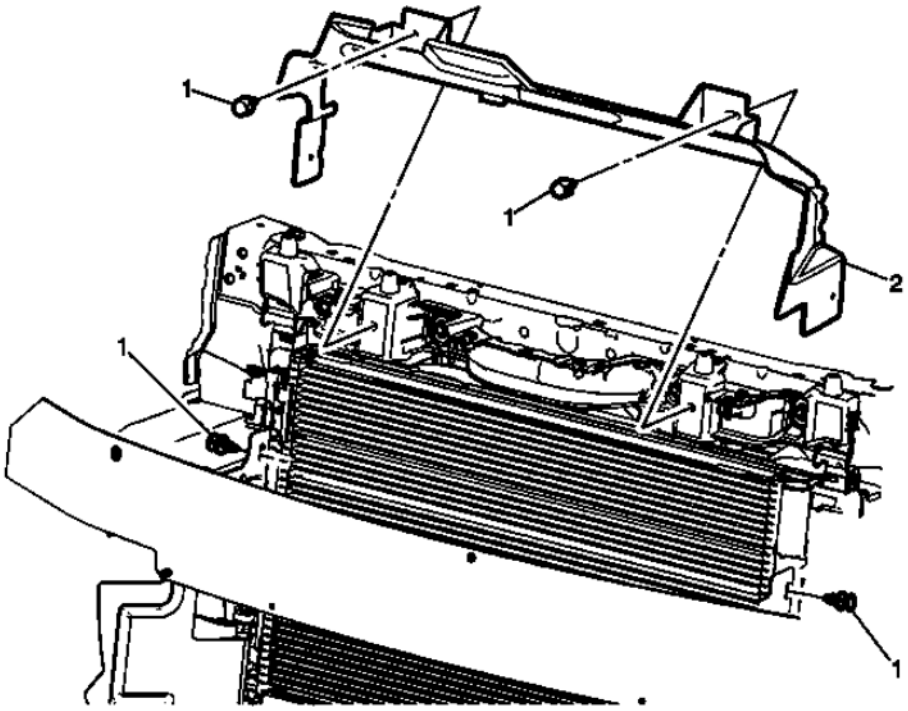


Fig. 132: Radiator Air Upper Baffle & Deflector (LUK)
Courtesy of GENERAL MOTORS COMPANY

Radiator Air Upper Baffle and Deflector Replacement (LUK)

Callout	Component Name
Preliminary Procedures 1. Remove the front fascia. Refer to **Front Bumper Fascia Replacement** . 2. Remove the air cleaner inlet duct. Refer to **Air Cleaner Inlet Duct Replacement** .	
1	Radiator Air Upper Baffle and Deflector Retainer (Qty 4)
2	Radiator Air Upper Baffle and Deflector

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT (LTG)

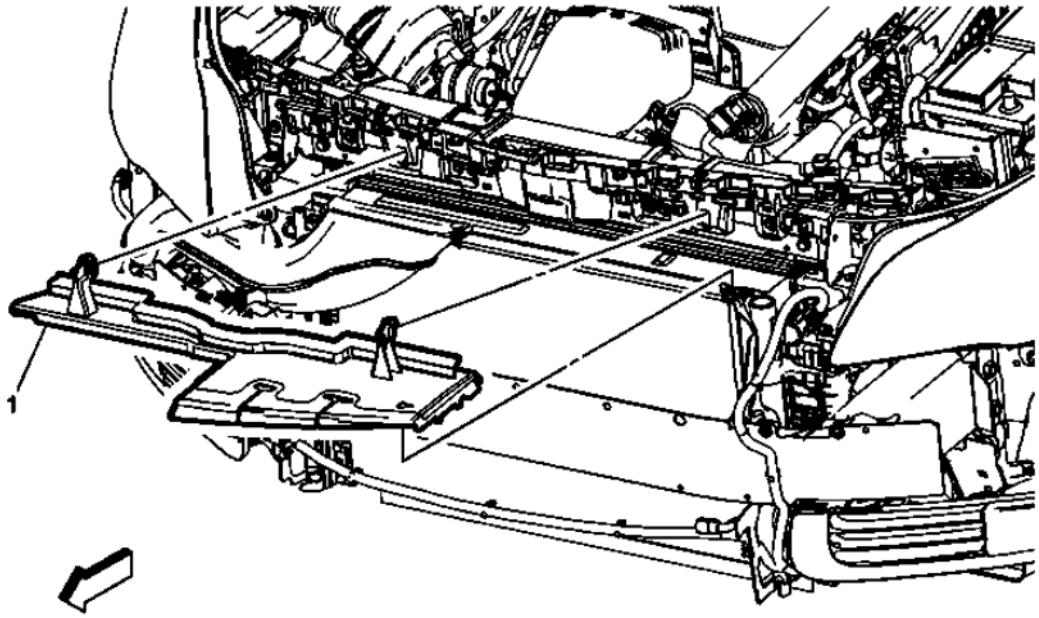


Fig. 133: Radiator Air Upper Baffle and Deflector (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Air Upper Baffle and Deflector Replacement (LTG)

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** . 2. Remove the front intake air duct deflector. Refer to **Front Intake Air Duct Deflector Replacement** . 3. Remove the air cleaner inlet duct. Refer to **Air Cleaner Inlet Duct Replacement** .	
1	Radiator Air Upper Baffle and Deflector **Procedure** Unclip the left radiator air side upper baffle from the radiator air upper baffle and deflector.

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

System Overview

The engine cooling fan system consists of 2 electric cooling fans and 3 fan relays. The cooling fan relays are arranged in a series/parallel (S/P) configuration. This allows the engine control module (ECM) to operate both fans together at low or high speeds using 2 fan control circuits. The underhood fuse block supplies the cooling fan relays with B+ at the switch side, and ignition voltage at the coil side of the relays through separate fuses. When the cooling fans are commanded ON, the ECM grounds the appropriate relay control circuit, which energizes the relay coil. The magnetic field, created within the relay by the energized relay

coil, overcomes the spring tension of the bi-metal switch armature causing the relay switch to close. When the relay switch closes, B+ is supplied to the cooling fan motor through the relay controlled output circuit, causing the cooling fan motors to operate. A dedicated ground is supplied to the cooling motors to complete the circuit.

Low Speed Operation

The ECM supplies a 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 cooling fan speed control relay. The result is a series circuit that operates both fans at low speed.

High Speed Operation

The ECM supplies a ground to the coil side of the cooling fan low speed relay, the cooling fan speed control relay, and the cooling fan-left high speed relay. When energized, the left 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 cooling fan 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 dedicated ground path. The result is a parallel circuit that operates both fans at high speed.

COOLING SYSTEM DESCRIPTION AND OPERATION

Engine Coolant Indicators

- The instrument panel cluster (IPC) shows the engine temperature on the temperature gauge. The value is sent on the data communication line from engine control module (ECM). When the coolant temperature is more than 128°C (262°F) IPC receives a discrete input from ECM requesting illumination.
- The IPC performs the display test at the start of each ignition cycle. The IPC illuminates the TEMP indicator.

Coolant Level Control

The engine cooling system contains an engine coolant level switch to alert the driver in the event of a low coolant level. When the engine coolant level in the surge tank falls below a certain level, the coolant level switch opens. When the body control module (BCM) detects an open or a high voltage level on the coolant level indicator control circuit, for at least 10 seconds, it will send a GM LAN message to the driver information center (DIC) requesting display of the low coolant level message. There is approximately a 10-second delay before the BCM sends the GM LAN message to prevent the message from being displayed, due to coolant sloshing in the surge tank.

Coolant Heater

The optional engine coolant heater operates using AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather. 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.

Cooling System

The cooling system's function is to maintain an efficient engine operating temperature during all engine speeds and operating conditions. The cooling system is designed to remove approximately one-third of the heat produced by the burning of the air-fuel mixture. When the engine is cold, the coolant does not flow to the radiator until the thermostat opens. This allows the engine to warm quickly.

Cooling Cycle

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

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

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

Coolant is also directed to the throttle body. There the coolant circulates through passages in the casting. During initial start up, the coolant assists in warming the throttle body.

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

Efficient operation of the cooling system requires proper functioning of all cooling system components. The cooling system consists of the following components.

Coolant

The engine coolant is a solution made up of a 50/50 mixture of drinking water and anti-freeze. 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 consisting of a core and 2 tanks. The aluminum core is a tube and fin crossflow design that extends from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer to the atmosphere.

The inlet and outlet tanks are a molded, high temperature, nylon reinforced plastic material. A high temperature rubber gasket seals the tank flange edge to the aluminum core. 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 located in the bottom of the left hand tank. The drain cock unit includes the drain cock and drain cock seal.

Heat is removed from the coolant as the coolant passes through the radiator. The fins on the core transfer heat from the coolant passing through the tubes. Air passing between the fins absorbs the heat and cools the

coolant.

Pressure Cap

The pressure cap seals and pressurizes the cooling system. The cap contains a blow off, or pressure valve and a vacuum, or an atmospheric valve:

- The pressure valve is held against the seat by a spring that protects the radiator by relieving pressure that exceeds 15 psi.
- The vacuum valve is held against the seat by a spring that permits opening of the valve to relieve vacuum created when the cooling system cools. The vacuum, if not relieved, might cause the radiator to collapse.

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

The pressure in the cooling system can get too high. When the pressure exceeds the strength of the spring, the pressure valve rises, venting the excess pressure.

As the engine cools, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open. This equalizes the pressure in the cooling system with the atmospheric pressure, preventing the radiator 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. This tank 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 within the cooling system gets too high, the pressure valve in the pressure cap will open. This allows the coolant, which has expanded due to heat, 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 the elimination of 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 cooling system capability. Deflectors are installed under the vehicle to redirect airflow beneath the vehicle and through the radiator to increase engine cooling. Air baffles are also used to direct airflow through the radiator and increase cooling capability. Air seals prevent air from bypassing the radiator and A/C condenser, and prevent recirculation of hot air for better hot weather cooling and A/C condenser performance.

Water Pump

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

The water pump circulates coolant throughout the cooling system. The pump is driven by the crankshaft from the drive belt.

Thermostat

The thermostat is a coolant flow control component, whose purpose is to regulate the operating temperature of the engine. The thermostat utilizes a temperature sensitive wax-pellet element, which connects to a valve through a piston. Heating is causing the element to expand and exert pressure against a rubber diaphragm. This pressure forces the valve to open. Cooling causes the element to contract. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 91°C (195°F), the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches 91°C (195°F), the thermostat valve will open. The switch point will differ a little depending on engine. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after opening. This restriction creates a pressure difference which prevents cavitations at the water pump and forces coolant to circulate through the engine block.

For some engines a solenoid thermostat controlled by the ECM will open and close the circulation.

Transmission Oil Cooler

The transmission oil cooler is a heat exchanger and is located inside the right side end 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.

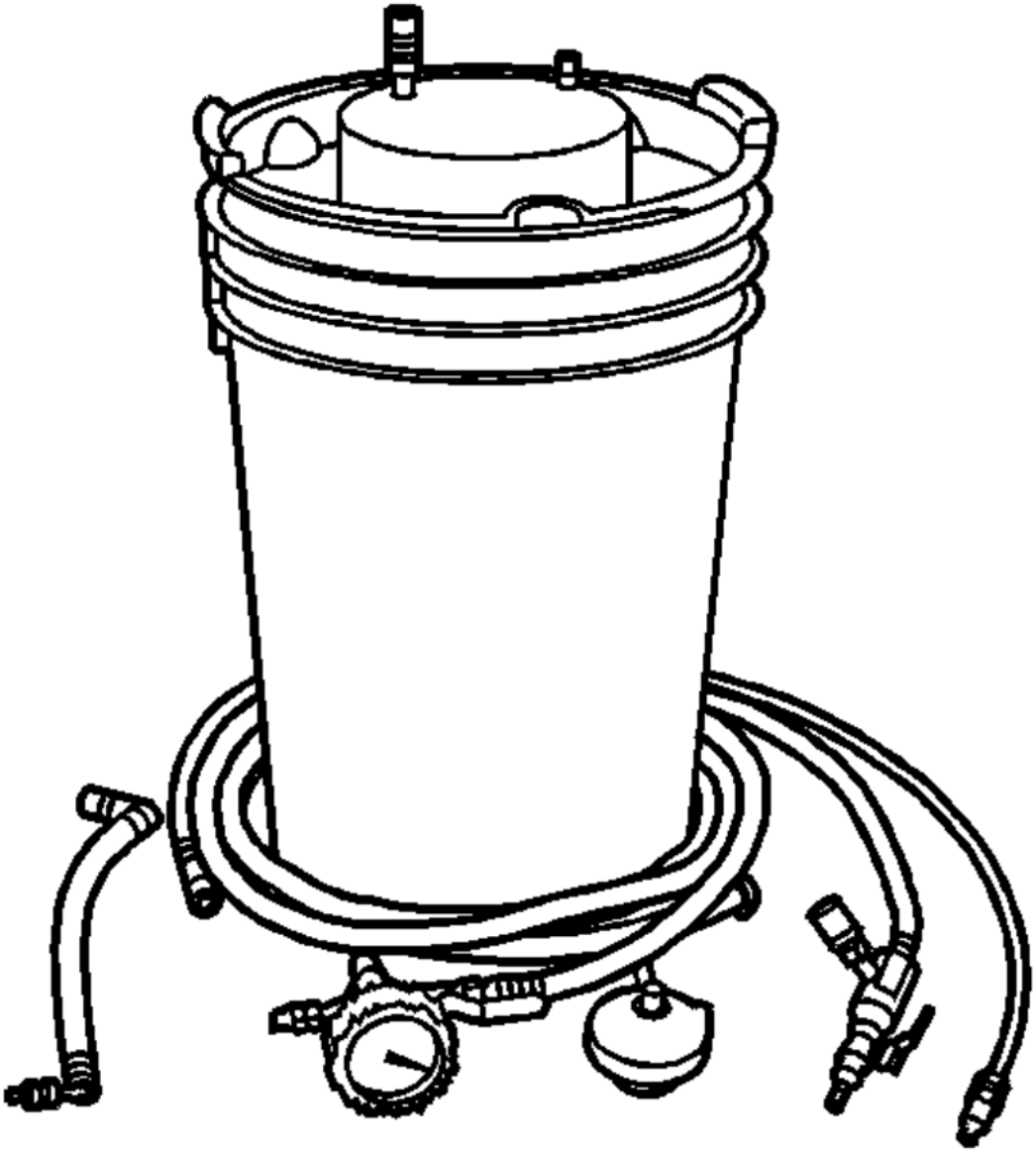
The transmission oil pump circulates the fluid through the feed line to the oil cooler. The fluid then flows through the cooler while the engine coolant absorbs heat from the fluid. The fluid is then pumped through the return line to the transmission.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

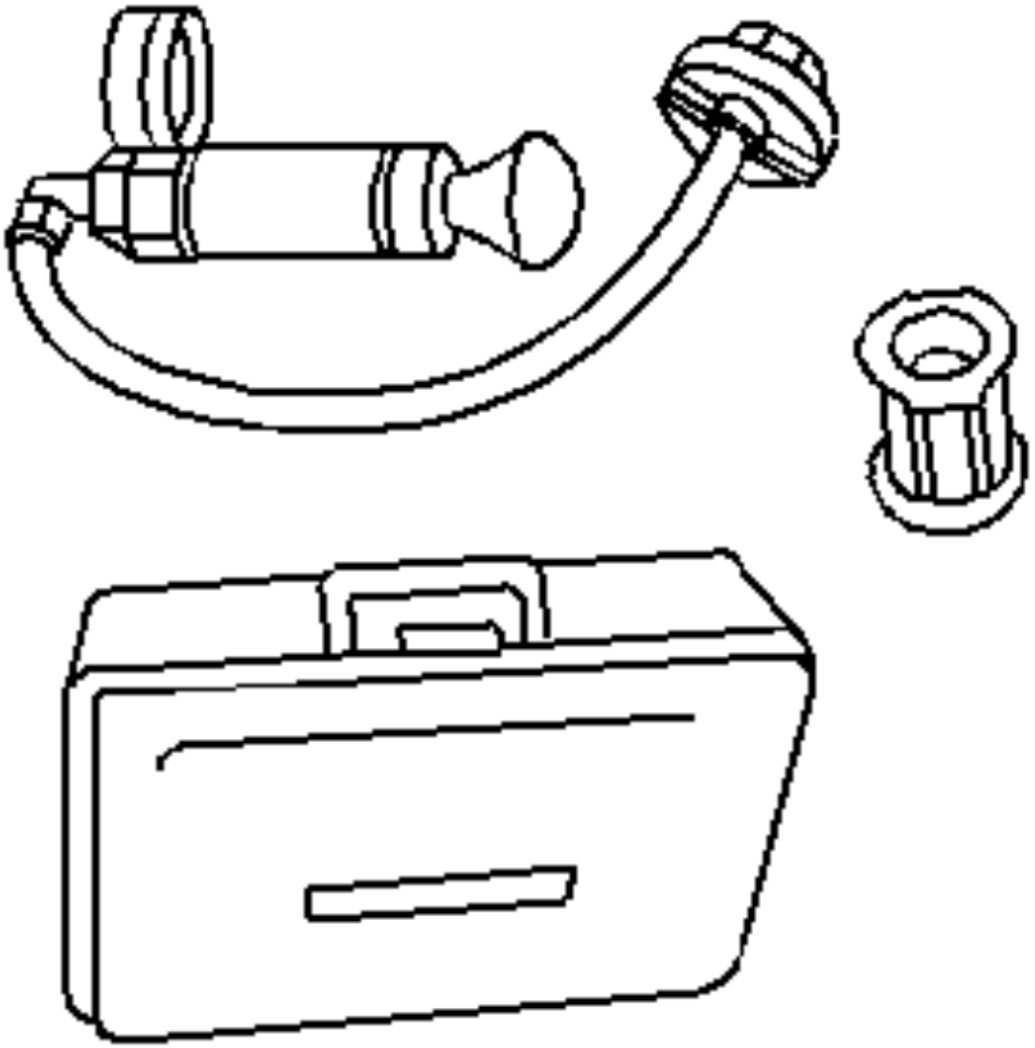
Illustration	Tool Number/ Description

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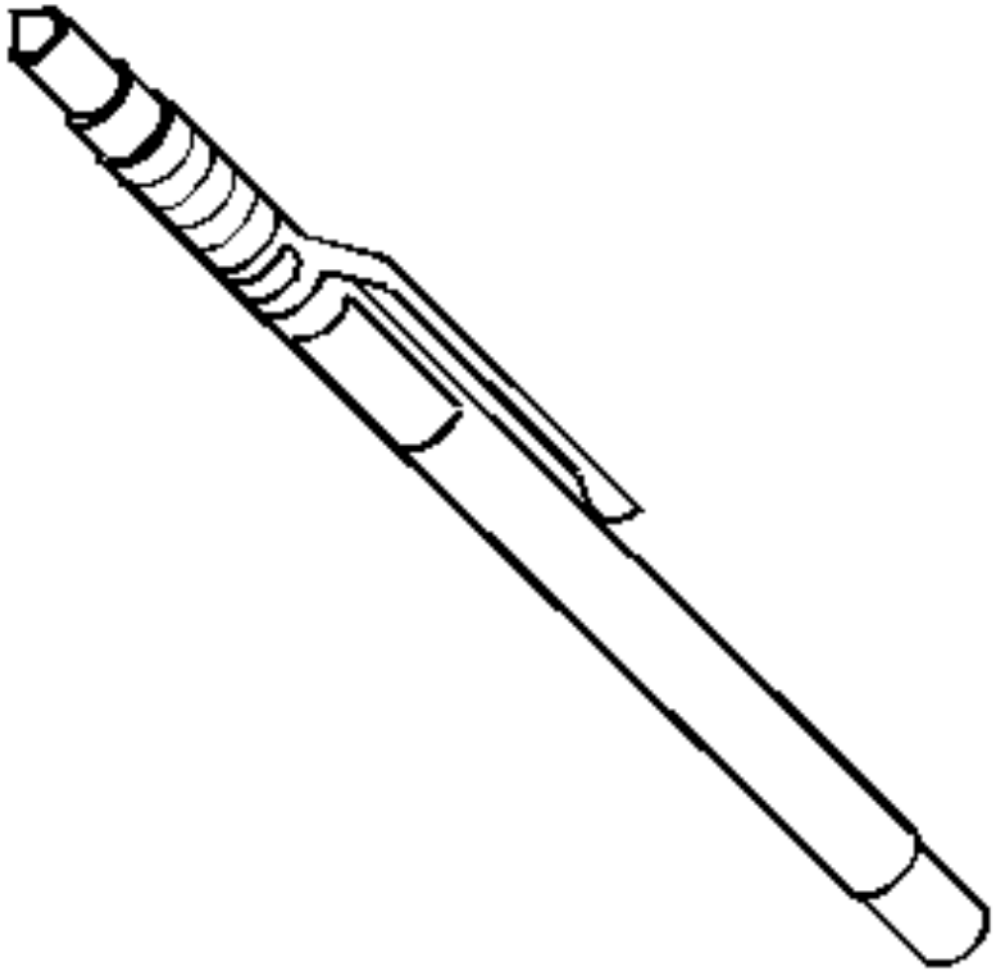


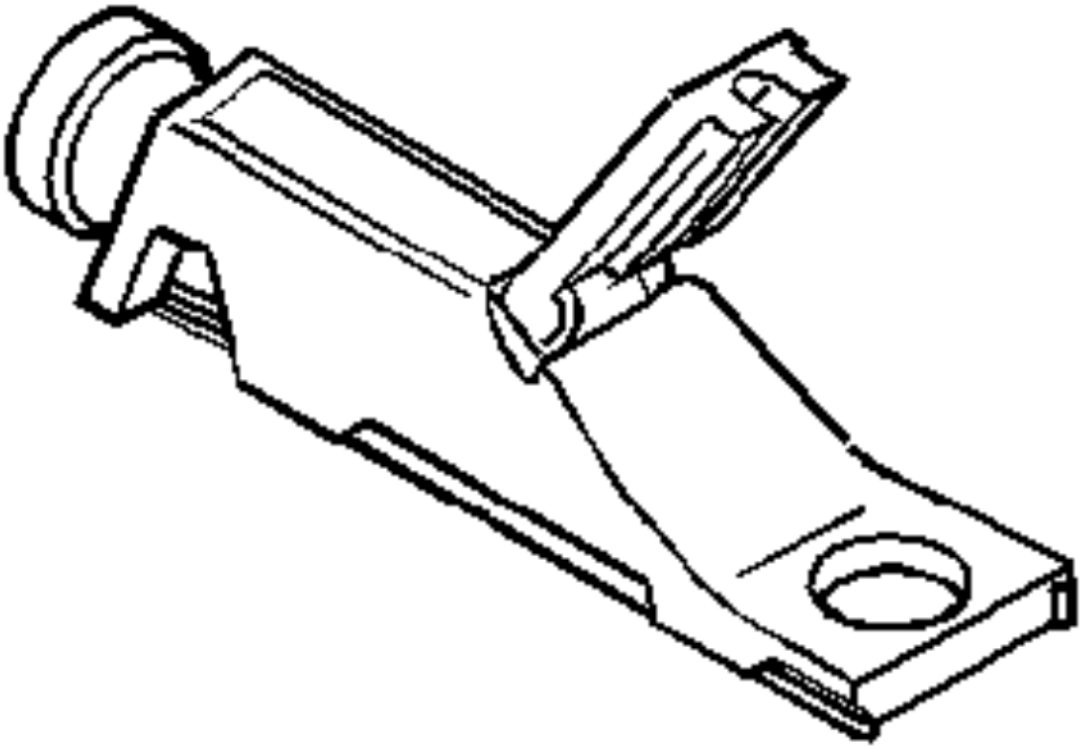
GE 47716
Vac N Fill
Coolant
Refill Tool

EN 24460-
A

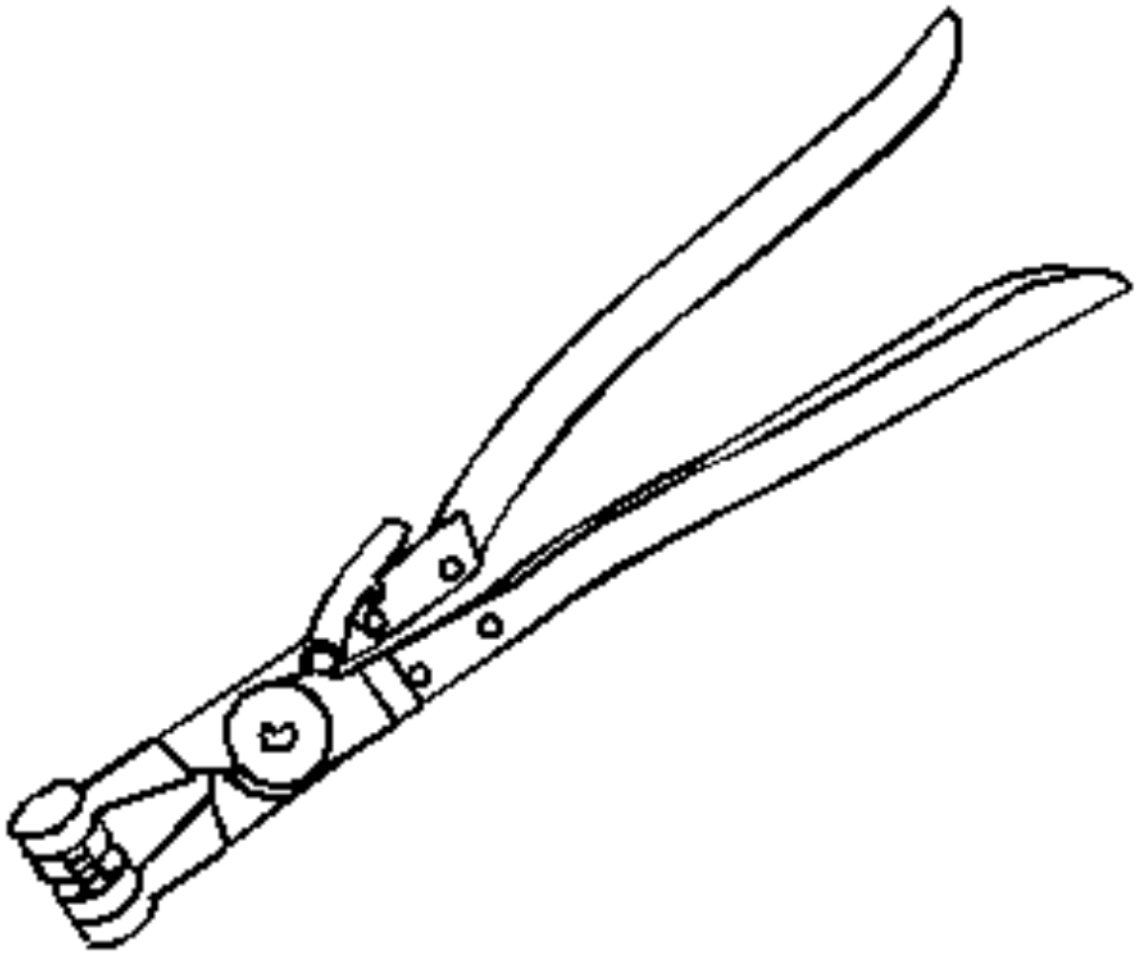


J 24460-01 Cooling System Pressure Tester

	GE 24731 J 24731 Tempil Stick

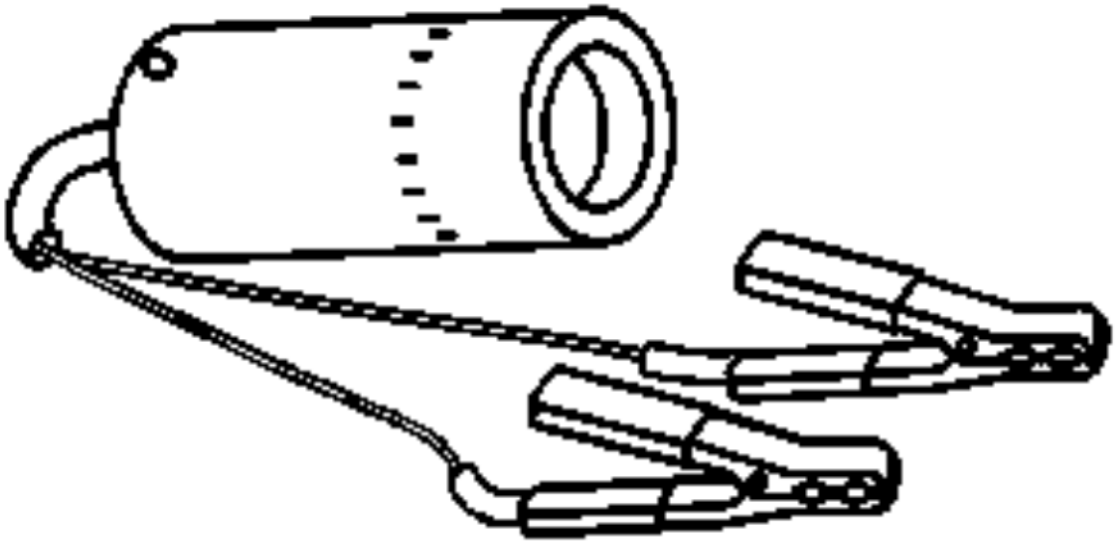


GE 26568
J 26568
Coolant and Battery Fluid Tester



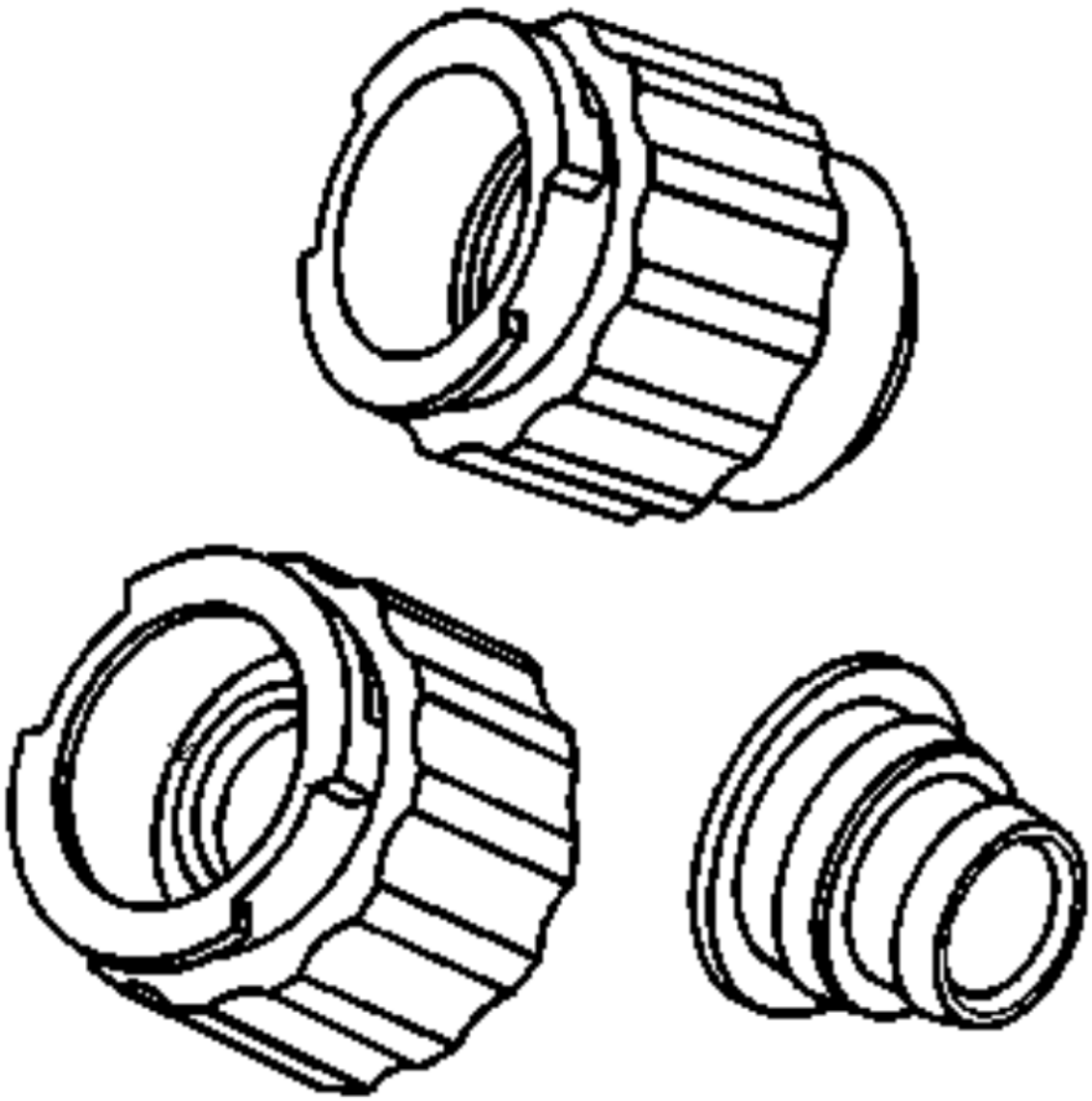
BO 38185
J 38185
Hose
Clamp
Pliers

GE 42220

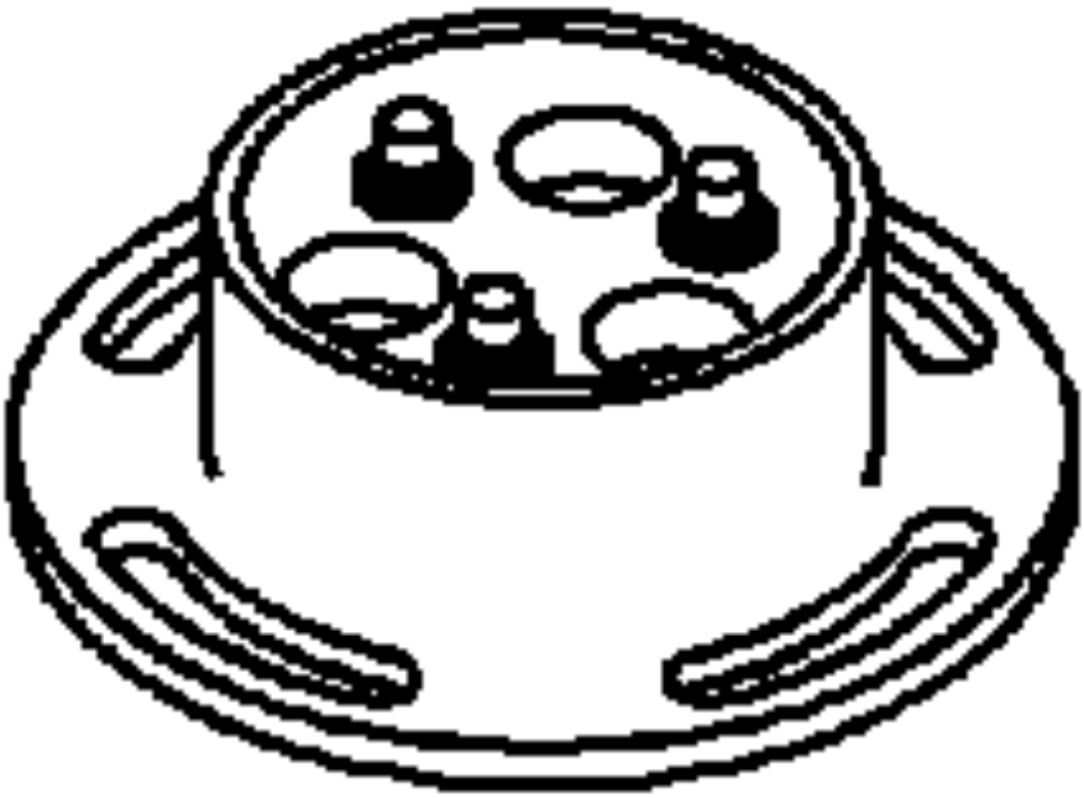


J 42220
Universal
12V Leak
Detection
Lamp

GE 42401
A
J 42401



Radiator Cap and Surge Tank Test Adapter



EN 43651
J 43651
Water
Pump
Holding
Tool