

ENGINE

Engine Heating and Cooling - CTS Sedan

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Charge Air Cooler Fastener	10 N.m	89 lb in
Coolant Heater	50 N.m	37 lb ft
Coolant Heater Cord Fastener	10 N.m	89 lb in
Engine Coolant Air Bleed Pipe Fastener	10 N.m	89 lb in
Engine Coolant Thermostat Housing Fastener	10 N.m	89 lb in
Fan Blade Fastener	8 N.m	71 lb in
Fan Control Module Fastener	8 N.m	71 lb in
Radiator Inlet Pipe Fastener	9 N.m	80 lb in
Radiator Outlet Pipe Fastener	22 N.m	16 lb ft
Radiator Outlet Pipe Retaining Bracket Fastener	58 N.m	43 lb ft
Radiator Surge Tank Fastener	9 N.m	80 lb in
Radiator Upper Bracket Fastener	9 N.m	80 lb in
Thermostat Heat Shield Fastener	5 N.m	44 lb in
Turbocharger Coolant Feed Pipe Banjo Bolt	35 N.m	26 lb ft
Turbocharger Coolant Feed Pipe Fasteners	10 N.m	89 lb in
Turbocharger Coolant Return Pipe Banjo Bolt	35 N.m	26 lb ft
Turbocharger Coolant Return Pipe Fasteners	10 N.m	89 lb in
Water Inlet and Outlet Pipe Fasteners	9 N.m	80 lb in
Water Outlet Fastener	10 N.m	89 lb in
Water Outlet Fastener (LTG)	12 N.m	106 lb in
Water Pump Fastener	10 N.m	89 lb in
Water Pump Fastener (LTG)	25 N.m	18 lb ft

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

Cooling Fan (without V03)

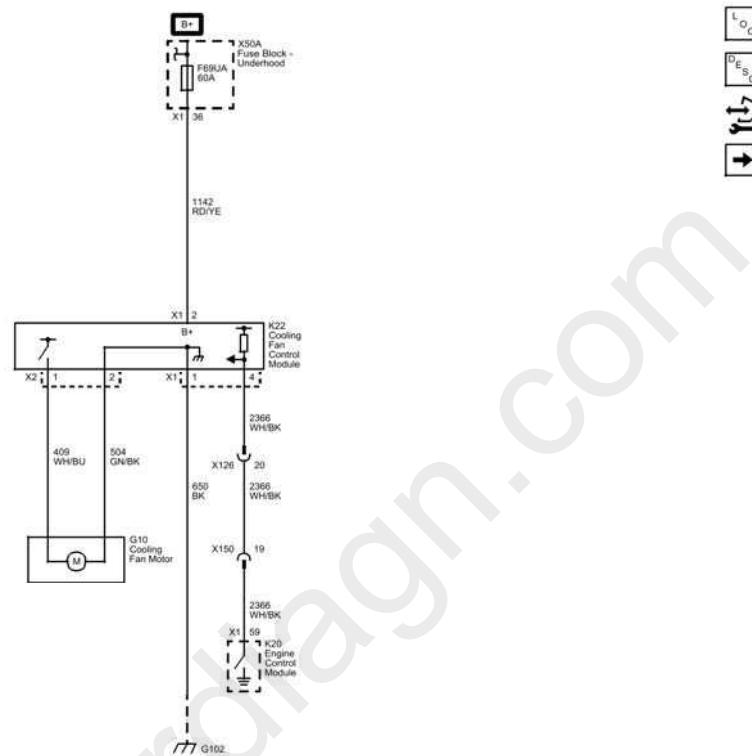
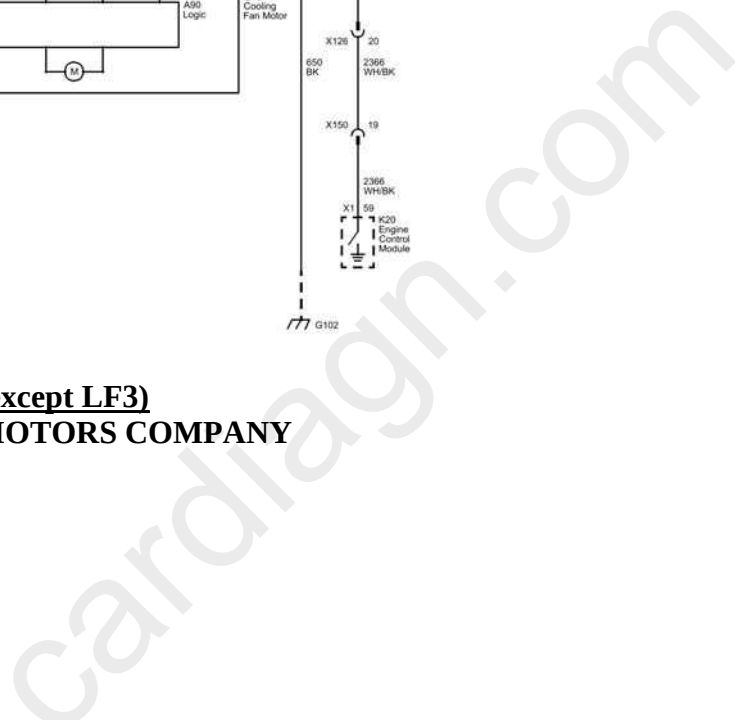


Fig. 1: Cooling Fan (without V03)
Courtesy of GENERAL MOTORS COMPANY

Cooling Fan (V03 except LF3)



Cooling Fan (LF3)

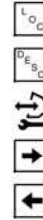
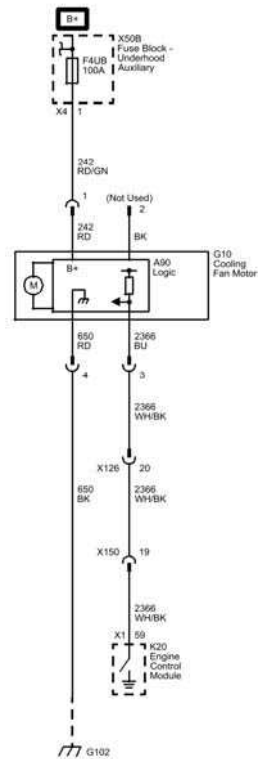


Fig. 3: Cooling Fan (LF3)

Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Pump (LF3)

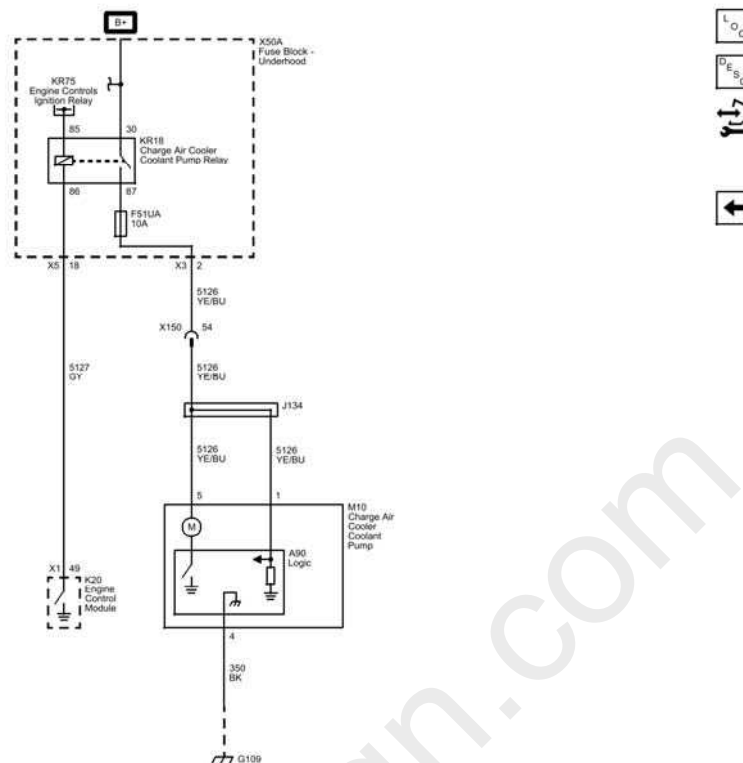


Fig. 4: Charge Air Cooler Pump (LF3)
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P0480, P0691, or P0692</u>	DTC P0480 Cooling Fan Speed Output Circuit DTC P0691 Cooling Fan Speed Output Circuit Low Voltage DTC P0692 Cooling Fan Speed Output Circuit High Voltage
<u>DTC P0480, P0691, or P0692 (LF3, LTG w/V03 or Manual Transmission)</u>	DTC P0480 Cooling Fan Speed Output Circuit DTC P0691 Cooling Fan Speed Output Circuit Low Voltage DTC P0692 Cooling Fan Speed Output Circuit High Voltage
<u>DTC P1258</u>	DTC P1258 Engine Coolant Overtemperature - Protection Mode Active

DTC P0480, P0691, OR P0692: COOLING FAN SPEED OUTPUT CIRCUIT

Diagnostic Instructions

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

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480

Cooling Fan Speed Output Circuit

DTC P0691

Cooling Fan Speed Output Circuit Low Voltage

DTC P0692

Cooling Fan Speed Output Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTCs P0480, P0691, and P0692 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0691, and P0692 are Type B DTCs.

Diagnostic Aids

- The cooling fan will not operate when the scan tool Cooling Fan Motor Command parameter displays less than 4 %. This is a normal condition.
- A delay or ramp up of approximately 12 seconds may occur before the cooling fan activates or changes speed when being commanded with a scan tool.
- The cooling fan Control Function operates as described below when the ignition is ON, and engine is OFF:
 - Command State 1 operates the cooling fan at approximately 18-21 %
 - Command State 2 operates the cooling fan at approximately 54 %
 - Command State 3 operates the cooling fan at approximately 67 %
 - Command State 4 operates the cooling fan at approximately 85 %
 - Command State 5 operates the cooling fan at approximately 90 %
- During normal operating conditions the ECM may initially activate the cooling fan at 4 or 5 % and then increase to the percentages indicated above, as needed, to satisfy powertrain cooling requirements. Generally, the ECM will operate the cooling fan at the specified percentages but, may scale the percentages either higher or lower in response to generator demand.
- When operating the cooling fan with a scan tool, the Commanded States 1-5 should be exercised in order, from OFF to High or High to OFF. The cooling fan control module may disable the cooling fan if a Commanded State is skipped.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - SEDAN

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

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

2. Verify the G10 Cooling Fan Motor activates in each available speed when commanding the cooling fan ON with a scan tool. The cooling fan speed should increase with each command.

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

Refer to Circuit/System Testing

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

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

4. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector X1 at the K22 Cooling Fan Control Module, ignition ON.
2. Verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.

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

1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.

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

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

3. Connect a DMM, set on the diode setting, between the control circuit terminal X1-4 and ground.
4. Verify the DMM reading is greater than 2.5 V or displays O.L. with the cooling fan commanded OFF.
 - **If 2.5 V or less**
 1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Disconnect the harness connector X1 at the K20 Engine Control Module.
 3. Test for infinite resistance between the K22 Cooling Fan Control Module control circuit terminal X1-4 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 2.5 V or displays O.L.**
5. Command the cooling fan ON with a scan tool using Command State 5.
6. Verify the DMM reading is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF.
 2. Disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.
 3. Test for less than 1 V between the K22 Cooling Fan Control Module control circuit terminal X1-4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 4. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 5. Test for less than 2 ohms in the circuit between the K22 Cooling Fan Control Module terminal X1-4 and the K20 Engine Control Module terminal X1-59.
 - If 2 ohms or greater, repair the open in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- If less than 1 V

7. Replace the K22 Cooling Fan Control Module.

Repair Instructions

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

- **Fan Control Module Replacement (LFX, LTG without V03)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0480, P0691, OR P0692 (LF3, LTG W/V03 OR MANUAL TRANSMISSION): COOLING FAN SPEED OUTPUT CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P0480

Cooling Fan Speed Output Circuit

DTC P0691

Cooling Fan Speed Output Circuit Low Voltage

DTC P0692

Cooling Fan Speed Output Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTCs P0480, P0691, and P0692 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0691, and P0692 are Type B DTCs.

Diagnostic Aids

- The cooling fan will not operate when the scan tool Cooling Fan Motor Command parameter displays less than 4 %. This is a normal condition.
- A delay or ramp up of approximately 12 seconds may occur before the cooling fan activates or changes speed when being commanded with a scan tool.
- The cooling fan Control Function operates as described below when the ignition is ON, and engine is OFF:
 - Command State 1 operates the cooling fan at approximately 18-21 %
 - Command State 2 operates the cooling fan at approximately 54 %
 - Command State 3 operates the cooling fan at approximately 67 %
 - Command State 4 operates the cooling fan at approximately 85 %
 - Command State 5 operates the cooling fan at approximately 90 %
- During normal operating conditions the ECM may initially activate the cooling fan at 4 or 5 % and then increase to the percentages indicated above, as needed, to satisfy powertrain cooling requirements. Generally, the ECM will operate the cooling fan at the specified percentages but, may scale the percentages either higher or lower in response to generator demand.
- When operating the cooling fan with a scan tool, the Commanded States 1-5 should be exercised in order, from OFF to High or High to OFF. The cooling fan control module may disable the cooling fan if a Commanded State is skipped.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - SEDAN

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

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

2. Verify the G10 Cooling Fan Motor activates in each available speed when commanding the cooling fan ON with a scan tool. The cooling fan speed should increase with each command.

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

Refer to Circuit/System Testing

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

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

- **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the G10 Cooling Fan Motor, ignition ON.
2. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the K22 Cooling Fan Control Module.
 - **If the test lamp illuminates**

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

3. Connect a DMM, set on the diode setting, between the control circuit terminal 3 and ground.
4. Verify the DMM reading is greater than 2.5 V or displays O.L. with the cooling fan commanded OFF.
 - **If 2.5 V or less**
 1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Disconnect the harness connector X1 at the K20 Engine Control Module.
 3. Test for infinite resistance between the G10 Cooling Fan Motor control circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 2.5 V or displays O.L.**
5. Command the cooling fan ON with a scan tool using Command State 5.
6. Verify the DMM reading is less than 1 V.

- **If 1 V or greater**
 1. Ignition OFF.
 2. Disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.
 3. Test for less than 1 V between the G10 Cooling Fan Motor control circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 4. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 5. Test for less than 2 ohms in the circuit between the G10 Cooling Fan Motor terminal 3 and the K20 Engine Control Module terminal X1-59.
 - If 2 ohms or greater, repair the open in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 1 V**
- 7. Replace the K20 Cooling Fan Control Module.

Repair Instructions

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

- **Engine Coolant Fan Shroud Replacement (LTG with V03)****Engine Coolant Fan Shroud Replacement (LTG without V03)**, **Engine Coolant Fan Shroud Replacement (LF3)** for G10 Cooling Fan Motor replacement.
- **Control Module References** for ECM replacement, setup, and programming

DTC P1258: ENGINE COOLANT OVERTEMPERATURE - PROTECTION MODE ACTIVE

Diagnostic Instructions

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

DTC Descriptors

DTC P1258

Engine Coolant Overtemperature - Protection Mode Active

Circuit/System Description

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

Conditions for Running the DTC

- The engine is operating for greater than 30 seconds.
- DTC P1258 runs continuously once the conditions above have been met.

Conditions for Setting the DTC

The ECM detects that engine coolant temperature is warmer than 132°C (270°F) for 2 seconds or greater.

Action Taken When the DTC Sets

- DTC P1258 is a Type A DTC.
- The engine will operate in the Overheated Engine Protection Operating Mode.
- The IP will illuminate the coolant temperature indicator lamp and the driver information center (DIC), if equipped, may display a message.
- If the protection mode is active and an ECT sensor DTC sets, the protection mode will remain active at the start of the next drive cycle until the ECT sensor DTC runs and passes.

Conditions for Clearing the MIL/DTC

DTC P1258 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX) , Engine Controls Schematics (LF3)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - SEDAN

Description and Operation

- **Cooling Fan Description and Operation**
- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

K20 Engine Control Module: Scan Tool Information for scan tool information

Circuit/System Verification

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

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs is set**

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

3. Verify the cooling fan operates at each available speed as commanded with a scan tool.
 - **Cooling fan does not operate**

Refer to **Cooling Fan Inoperative, Cooling Fan Inoperative (LTG w/V03 or Manual Transmission)**.

- **Cooling fan operates**

4. Verify that the engine does not overheat.
 - **Engine overheats**

Refer to **Engine Overheating**.

- **Engine does not overheat**

5. Operate the vehicle within the conditions that the customer experienced and verify the DTC does not set.
 - **If the DTC sets**

Refer to **Symptoms - Engine Cooling**.

- **If the DTC does not set**

6. All OK

Repair Instructions

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

SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

- Perform **Diagnostic System Check - Vehicle** and verify all of the following items:
 - 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 Always On (LTG w/V03 or Manual Transmission)**
- **Cooling Fan Inoperative, Cooling Fan Inoperative (LTG w/V03 or Manual Transmission)**
- **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 is composed of one electric cooling fan and a cooling fan control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, which enables cooling fan operation at variable speeds.

The ECM will only operate the cooling fan at certain percentages to prevent undesirable noise and vibration. The cooling fan control module is thermally protected to prevent module damage in the case of a short circuit condition in the cooling fan motor.

Diagnostic Aids

- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fan ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the temperature versus resistance tables in the appropriate engine controls subsection.
- The cooling fan will not operate when the scan tool Cooling Fan Motor Command parameter displays less than 4 %. This is a normal condition.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - SEDAN

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to **DTC P0480, P0691, or P0692, DTC P0480, P0691, or P0692 (LF3, LTG w/V03 or Manual Transmission).**

- **If no DTC is set.**
- 3. Verify the scan tool Cooling Fan Motor Command parameter is less than 4 %.
- **If 4 % or greater**

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

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

Refer to Circuit/System Testing.

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

Circuit/System Testing

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

Repair Instructions

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

- **Fan Control Module Replacement (LFX, LTG without V03)**
- **Control Module References**

COOLING FAN ALWAYS ON (LTG W/V03 OR MANUAL TRANSMISSION)

Diagnostic Instructions

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

Circuit/System Description

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

Diagnostic Aids

- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fan ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the temperature versus resistance tables in the appropriate engine controls subsection.
- The cooling fan will not operate when the scan tool Cooling Fan Motor Command parameter displays less than 4 %. This is a normal condition.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - SEDAN

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

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

- **If a DTC is set**

Refer to **DTC P0480, P0691, or P0692, DTC P0480, P0691, or P0692 (LF3, LTG w/V03 or Manual Transmission)**.

- **If no DTC is set.**

3. Verify the scan tool Cooling Fan Motor Command parameter is less than 4 %.

- **If 4 % or greater**

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

- **If less than 4 %**

4. Verify that the G10 Cooling Fan Motor is not operating.

- **If the G10 Cooling Fan Motor is operating**

Test or replace the G10 Cooling Fan Motor.

- **If the G10 Cooling Fan Motor is not operating**

5. All OK.

Repair Instructions

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

- **Engine Coolant Fan Shroud Replacement (LTG with V03)****Engine Coolant Fan Shroud Replacement (LTG without V03)** for G10 Cooling Fan Motor Replacement.
- **Control Module References**

COOLING FAN INOPERATIVE

Diagnostic Instructions

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

Circuit/System Description

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

condition in the cooling fan motor.

Diagnostic Aids

- The cooling fan will not operate when the scan tool Cooling Fan Motor Command parameter displays less than 4 %. This is a normal condition.
- A delay or ramp up of approximately 12 seconds may occur before the cooling fan activates or changes speed when being commanded with a scan tool.
- The cooling fan Control Function operates as described below when the ignition is ON, and engine is OFF:
 - Command State 1 operates the cooling fan at approximately 18-21 %
 - Command State 2 operates the cooling fan at approximately 54 %
 - Command State 3 operates the cooling fan at approximately 67 %
 - Command State 4 operates the cooling fan at approximately 85 %
 - Command State 5 operates the cooling fan at approximately 90 %
- During normal operating conditions the ECM may initially activate the cooling fan at 4 or 5 % and then increase to the percentages indicated above, as needed, to satisfy powertrain cooling requirements. Generally, the ECM will operate the cooling fan at the specified percentages but, may scale the percentages either higher or lower in response to generator demand.
- When operating the cooling fan with a scan tool, the Commanded States 1-5 should be exercised in order, from OFF to High or High to OFF. The cooling fan control module may disable the cooling fan if a Commanded State is skipped.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - SEDAN

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 36169-HD Heavy Duty Fused Jumper

Circuit/System Verification

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

Refer to **DTC P0480, P0691, or P0692, DTC P0480, P0691, or P0692 (LF3, LTG w/V03 or Manual Transmission).**

- **If no DTC is set.**

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

3. Verify the G10 Cooling Fan Motor activates and increases in speed with each command using a scan tool.
 - **The cooling fan does not activate or increase in speed**

Refer to Circuit/System Testing

- **The cooling fan activates and increases in speed**
4. All OK.

Circuit/System Testing

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

NOTE: Perform this test at the motor side of the fan module.

5. Verify a test lamp illuminates between the K22 Cooling Fan Control Module terminal X2-2 and B+.

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

Replace the K22 Cooling Fan Control Module.

- **If the test lamp illuminates**

6. Ignition ON.
7. Connect a test lamp between the K22 Cooling Fan Control Module terminal X2-1 and ground.
8. Verify the test lamp illuminates when commanding the cooling fan ON with a scan tool.

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

Replace the K22 Cooling Fan Control Module.

- **If the test lamp illuminates**

9. Test or replace the G10 Cooling Fan Motor.

Component Testing

1. Ignition OFF.
2. Disconnect the G10 Cooling Fan Motor harness connector X2 from the K22 Cooling Fan Control Module.
3. Connect the **EL 36169-HD** between the G10 Cooling Fan Motor terminal 1 and B+. Connect a jumper wire between the G10 Cooling Fan Motor terminal 2 and ground.
4. Verify the G10 Cooling Fan Motor operates.

- **The cooling fan does not operate**

Replace the G10 Cooling Fan Motor.

- **The cooling fan operates**

5. All OK.

Repair Instructions

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

- **Engine Coolant Fan Motor Replacement (LFX, LTG without V03)**
- **Fan Control Module Replacement (LFX, LTG without V03)**
- **Control Module References**

COOLING FAN INOPERATIVE (LTG W/V03 OR MANUAL TRANSMISSION)

Diagnostic Instructions

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

Circuit/System Description

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

Diagnostic Aids

- The cooling fan will not operate when the scan tool Cooling Fan Motor Command parameter displays less than 4 %. This is a normal condition.
- A delay or ramp up of approximately 12 seconds may occur before the cooling fan activates or changes speed when being commanded with a scan tool.
- The cooling fan Control Function operates as described below when the ignition is ON, and engine is OFF:
 - Command State 1 operates the cooling fan at approximately 18 %
 - Command State 2 operates the cooling fan at approximately 54 %
 - Command State 3 operates the cooling fan at approximately 67 %
 - Command State 4 operates the cooling fan at approximately 85 %
 - Command State 5 operates the cooling fan at approximately 90 %
- During normal operating conditions the ECM may initially activate the cooling fan at 4 or 5 % and then increase to the percentages indicated above, as needed, to satisfy powertrain cooling requirements. Generally, the ECM will operate the cooling fan at the specified percentages but, may scale the percentages either higher or lower in response to generator demand.
- When operating the cooling fan with a scan tool, the Commanded States 1-5 should be exercised in order, from OFF to High or High to OFF. The cooling fan control module may disable the cooling fan if a Commanded State is skipped.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - SEDAN

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to **DTC P0480, P0691, or P0692, DTC P0480, P0691, or P0692 (LF3, LTG w/V03 or Manual Transmission).**

- **If no DTC is set.**

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

3. Verify the G10 Cooling Fan Motor activates and increases in speed with each command using a scan tool.
 - **The cooling fan does not activate or increase in speed**

Refer to Circuit/System Testing

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

4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector G10 Cooling Fan Motor.
2. Verify that a test lamp illuminates between the ground circuit terminal 4 and B+.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, repair the open/high resistance in the ground connection.

○ **If the test lamp illuminates**

3. Test or replace the G10 Cooling Fan Motor.

Repair Instructions

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

- **Engine Coolant Fan Shroud Replacement (LTG with V03), Engine Coolant Fan Shroud Replacement (LTG without V03)** for G10 Cooling Fan Motor replacement.
- **Control Module References**

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 <u>Loss of Coolant</u> . Is there a loss of coolant?	Go to Step 2	Go to Step 3
2	Fill the system to the specified level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 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. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .		

	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 <u>Pressure Cap Testing</u> 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 <u>Engine Coolant Temperature Sensor Replacement (LFX)</u> , <u>Engine Coolant Temperature Sensor Replacement (LF3)</u> , or <u>Engine Coolant Temperature Sensor Replacement</u> . 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. Refer to <u>Flushing</u> 3. Refill the coolant. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> 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 motor. Refer to <u>Engine Coolant Fan Motor Replacement (LFX, LTG without V03)</u> . Does the engine still overheat?	Go to Step 19	System OK
19	Check for a thermostat that is stuck closed. Is the thermostat stuck closed?	Go to Step 20	Go to Step 21
	Replace the thermostat. Refer <u>Engine Coolant Thermostat Housing Replacement (LFX, LF3)</u> .		

20	<u>Engine Coolant Thermostat Housing Replacement (LTG).</u> 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 <u>Water Pump Replacement (LFX, LF3), Water Pump Replacement (LTG).</u> 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 <u>Symptoms - Engine Cooling</u>
2	Repair any present DTCs. Refer to <u>Diagnostic System Check - Vehicle</u> . Is the action complete?	Go to Step 3	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to Step 5	Go to Step 4
4	Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716), and Charge Air Cooling System Draining and Filling (LF3)</u> for LF3. 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 31
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to Step 32	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 34	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
	Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. Condensation in the exhaust system can cause an		

9	odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?	Go to Step 33	Go to Step 10
10	WARNING: Refer to <u>Moving Parts and Hot Surfaces Warning</u> . With the engine idling, inspect the coolant recovery system. Does the coolant recovery system discharge coolant while the engine is idling?	Go to Step 14	Go to Step 11
11	Visually inspect the hoses, pipes and hose clamps at the following locations: • Coolant Reservoir • Water Pump • Throttle Body • Heater core • Radiator Are any of the hoses, clamps or pipes leaking?	Go to Step 21	Go to Step 12
12	Visually inspect the following components: • Coolant pressure cap • Core plugs • Cylinder head gaskets • Engine block • Intake manifold • Radiator • Thermostat housing • Water pump Are any of the listed components leaking?	Go to Step 21	Go to Step 13
13	1. Pressure test the cooling system. Refer to <u>Cooling System Leak Testing</u> . 2. With the cooling system pressurized, visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to Step 21	Go to Step 14
14	Pressure test the coolant pressure cap. Refer to <u>Pressure Cap Testing</u> . Does the coolant pressure cap hold pressure?	Go to Step 15	Go to Step 22
	Inspect for the following conditions:		

15	• 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 23	Go to Step 16
16	1. Add 30 ml (1 oz) of Extended Life Coolant Leak Detection Dye to the cooling system for each 15 L (4 gal) of coolant. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>, and <u>Approximate Fluid Capacities</u>. 2. Start the vehicle and allow the engine to reach normal operating temperature. 3. Shut the engine off. 4. Use the J 42220 Universal 12V Leak Detection Lamp to visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to Step 21	Go to Step 17
17	Use the J 42220 Universal 12V Leak Detection Lamp to inspect for the following conditions: • Coolant dye in the HVAC module drain tube • Coolant dye on the vehicle floor covering near the HVAC module Is coolant dye present?	Go to Step 23	Go to Step 18
18	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is a milky substance under the oil fill cap?	Go to Step 19	Go to Step 20
19	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is a milky substance on the engine oil fluid level indicator?	Go to Step 33	Go to Step 20
20	Inspect the automatic transmission fluid for a gray/white milky substance. Is there a gray/white milky substance in the automatic transmission fluid?	Go to Step 24	Go to Step 26
21	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to Step 36	-
	Replace the coolant pressure cap.		

22	Is the repair complete?	Go to Step 36	-
23	Replace the heater core. Refer to <u>Heater Core Replacement</u> . Is the repair complete?	Go to Step 36	-
24	1. Remove the transmission oil cooler lines from the radiator. 2. Pressure test the cooling system. Refer to <u>Cooling System Leak Testing</u>. 3. Inspect the transmission oil cooler for coolant. Is coolant present?	Go to Step 25	Go to Step 26
25	1. Replace the radiator. Refer to <u>Radiator Replacement (LTG with V03)</u>, <u>Radiator Replacement (LFX with MGG)</u>, <u>Radiator Replacement (LTG without V03)</u>, <u>Radiator Replacement (LFX with V03)</u>, <u>Radiator Replacement (LF3)</u>. 2. Service the automatic transmission. Refer to <u>Engine Coolant/Water in Transmission</u> . Is the repair complete?	Go to Step 36	-
26	Visually inspect the hoses, pipes and hose clamps at the following locations: • Charge Air Cooling Pump • Charge Air Cooler Radiator • Charge Air Cooler Pump Inlet and Outlet Hoses • Charge Air Cooler Reservoir Inlet and Outlet Hoses • Charge Air Cooler Reservoir • Supercharger Are any of the hoses, clamps or pipes leaking?	Go to Step 21	Go to Step 27
27	Visually inspect the following components: • Charge Air Cooling Pump • Charge Air Cooler Radiator • Charge Air Cooler Reservoir • Supercharger Are any of the listed components leaking?	Go to Step 21	Go to Step 28

28	1. Pressure test the cooling system. Refer to <u>Charge Air Cooling System Leak Testing (LF3)</u>. 2. With the CAC cooling system pressurized, visually inspect the components listed in steps 26 and 27. Are any leaks present?	Go to Step 21	Go to Step 29
29	1. Add 30 ml (1 oz) Extended Life Coolant Leak Detection Dye to the cooling system for each 15 L (4 gal) of coolant. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>, and <u>Approximate Fluid Capacities</u> . 2. Activate the pump using the MDI to cycle the dye around the charge air cooling system. 3. Shut the engine off. 4. Use the J 42220 Universal 12V Leak Detection Lamp to visually inspect the components listed in steps 26 and 27. Are any leaks present?	Go to Step 21	Go to Step 36
30	Install the cooler lines to the radiator. Is the action complete?	Go to Step 36	-
31	Repair the engine no crank condition. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> . Is the repair complete?	Go to Step 36	-
32	Repair the engine overheating condition. Refer to <u>Engine Overheating</u>. Is the repair complete?	Go to Step 36	-
33	Repair the engine internal coolant leak. Refer to: • <u>Coolant in Engine Oil</u> • <u>Coolant in Combustion Chamber</u> Is the repair complete?	Go to Step 36	-
34	Repair the engine knock. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u> . Is the repair complete?	Go to Step 36	-
35	Repair the combustion pressure in the cooling system problem. Refer to <u>Cylinder Leakage Test</u> . Is the repair complete?	Go to Step 36	-
36	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

THERMOSTAT DIAGNOSIS

Tools Required

- J 24731 188 Tempilstick
- J 24731 206 Tempilstick

The coolant thermostat can be tested using a temperature (tempil) stick. The temperature stick is a pencil-like device which has a wax material containing certain chemicals that melt at a given temperature. Temperature sticks can be used to determine a thermostat's operating range by rubbing 87°C (188°F) and 97°C (206°F) sticks on the outlet coolant pipe.

1. Use a tempilstick in order to find the opening and the closing temperatures of the thermostat.
 - J 24731 188 tempilstick melts at 87°C (188°F). The thermostat should begin to open at 90°C (194°F).
 - J 24731 206 tempilstick melts at 97°C (206°F). The thermostat should be fully open at 107°C (225°F).
2. Replace the thermostat if it does not operate properly between this temperature range.

COOLANT HEATER INOPERATIVE

Diagnostic Instructions

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

Circuit/System Description

The coolant heater operates using 110 V 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 also helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. There is an internal thermal switch in the coolant heater cord that prevents operation above -18°C (0°F). A weather shield on the cord is provided to protect the plug when not in use.

Reference Information

Electrical Information Reference

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

Circuit/System Testing

NOTE: The coolant heater cord will read Open due to an internal thermal switch if the ambient temperature is above -18°C (0°F).

1. Ignition OFF, disconnect the coolant heater cord from the E19 Coolant Heater.
2. Test for 30-40 ohms between the terminals of the E19 Coolant Heater.
 - **If not within 30-40 ohms**

Replace the E19 Coolant Heater.
 - **If within 30-40 ohms**
3. Test for infinite resistance between each terminal of the E19 Coolant Heater and ground.
 - **If less than infinite resistance**

Replace the E19 Coolant Heater.
 - **If infinite resistance**
4. Test or replace the coolant heater cord.

Repair Instructions

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

- **Coolant Heater Replacement (LTG), Coolant Heater Replacement (LFX)**
- **Coolant Heater Cord Replacement (LFX), Coolant Heater Cord Replacement (LTG)**

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

Engine Fails To Reach Normal Operating Temperature

Step	Action	Yes	No
1	1. Ensure that the cooling system is full. 2. Allow the engine to cool. 3. Start the engine. 4. Turn the air conditioning system off. 5. Inspect the engine cooling fan(s). Is the electric cooling fan on?	Go to Step 2	Go to Step 3
2	1. Diagnose and repair the cooling fan system. Refer to <u>Cooling Fan Always On, Cooling Fan Always On (LTG w/V03 or Manual Transmission)</u>. 2. Verify the customer complaint. Does the engine still fail to reach normal operating		

	temperature?	Go to Step 3	System OK
3	Install the Scan Tool to the DLC. Compare the Scan Tool coolant temperature reading to the I/P cluster coolant temperature. Is the I/P cluster coolant temperature close to the reading on the Scan Tool?	Go to Step 5	Go to Step 4
4	1. Diagnose and repair the coolant temperature gauge system. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 5	System OK
5	Inspect the thermostat for proper operation. Refer to <u>Thermostat Diagnosis</u> . Is the thermostat operating properly?	Go to Step 1	Go to Step 6
6	1. Replace the thermostat and housing. Refer to <u>Engine Coolant Thermostat Housing Replacement (LFX, LF3)</u> , <u>Engine Coolant Thermostat Housing Replacement (LTG)</u> . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 1	System OK

PRESSURE CAP TESTING

Special Tools

- **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.

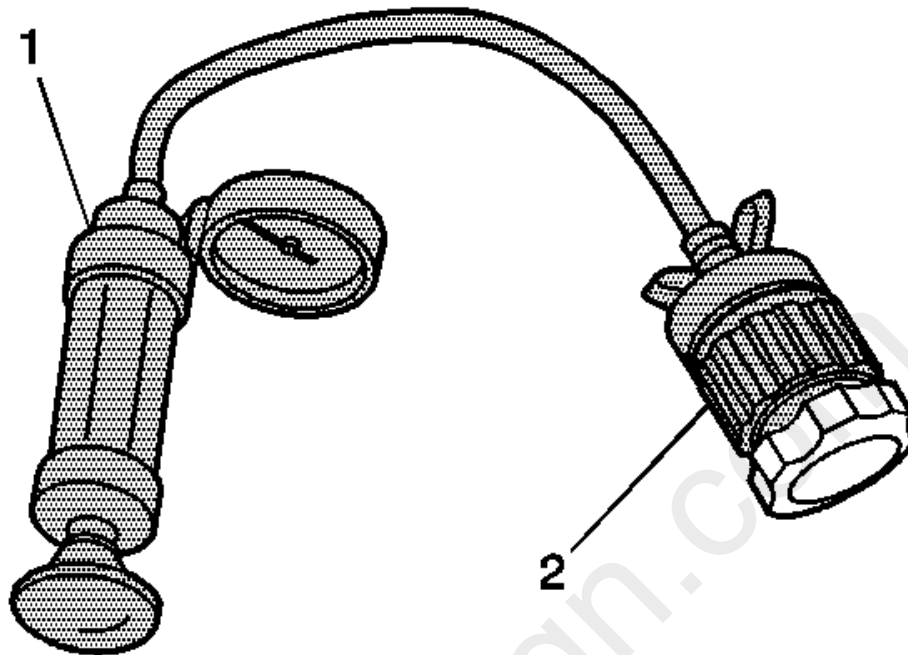


Fig. 5: Identifying Pressure Cap Testing Tool J 42401
Courtesy of GENERAL MOTORS COMPANY

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.

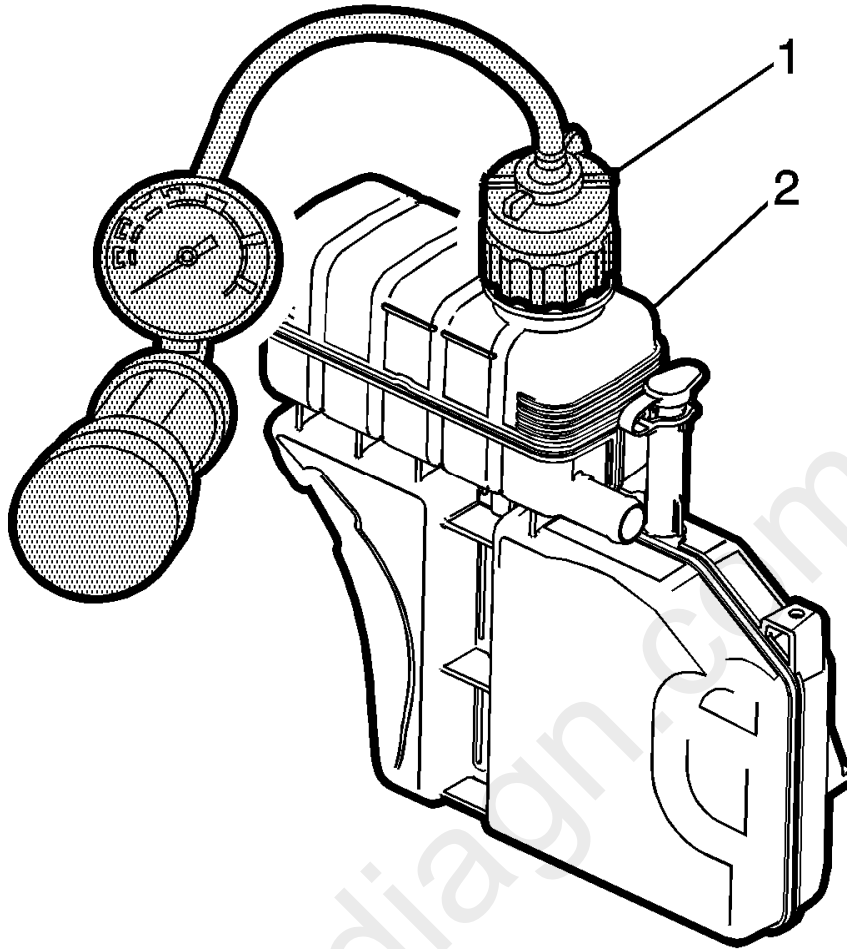


Fig. 6: Cooling System Pressure Tester
Courtesy of GENERAL MOTORS COMPANY

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

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.

CHARGE AIR COOLING SYSTEM LEAK TESTING (LF3)

Special Tools

- **EN-24460-A** Cooling System Pressure Tester

- **GE-50389** Cooling System Pressure Test Quick Connector
- **GE-47716-8** Vac-N-Fill Cap
- **GE-47716-30** Vac-N-Fill 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 intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .
2. Orientate the air charge air coolant (CAC) quick connect fitting to the vertical position. Refer to **Intake Manifold Vacuum Fitting Replacement**.
3. Remove the CAC quick connect vacuum fitting cap.

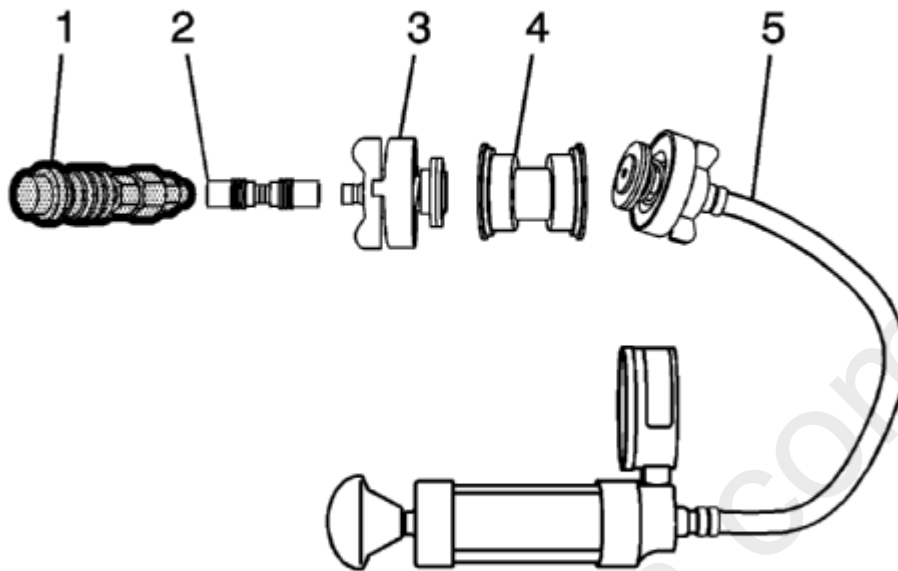


Fig. 7: Cooling System Pressure Tester Cap Adapter
Courtesy of GENERAL MOTORS COMPANY

4. Install Cooling System Pressure Tester Cap Adapter (4) to **EN-24460-A** Cooling System Pressure Tester (5).
5. Install **GE-47716-8** Vac-N-Fill Cap (3) to Cooling System Pressure Tester Cap Adapter (4).
6. Install **GE-50389** Coolant Pressure Test Quick Connector (2) to **GE-47716-8** Vac-N-Fill Cap (3).
7. Install **GE-47716-30** Vac-N-Fill Adapter (1) to **GE-50389** Coolant Pressure Test Quick Connector (2).
8. Apply 5 psi pressure to the charge air cooler system for at least 2 minutes.
9. Observe the gauge for any pressure loss and 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. Place the vehicle on a level surface.

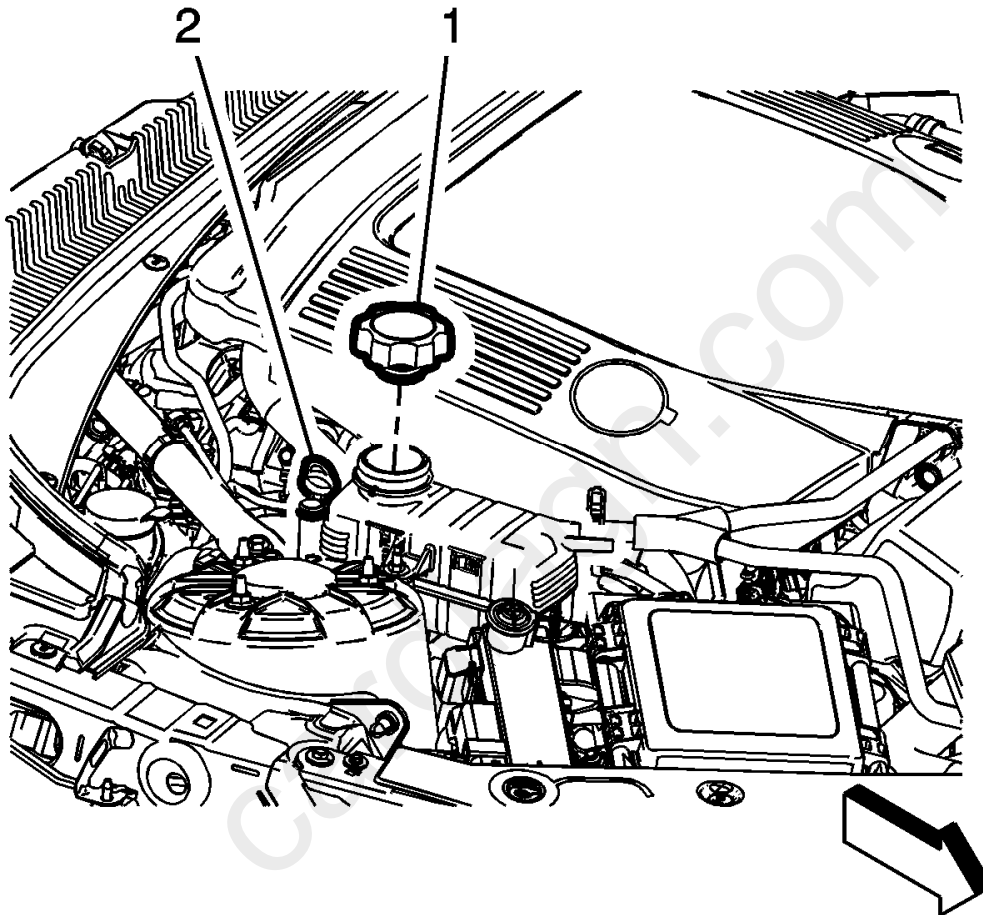


Fig. 8: Coolant Pressure Cap

Courtesy of GENERAL MOTORS COMPANY

2. Remove the coolant pressure cap (1) from the radiator surge tank and open the cap (2) on the lower coolant overflow reservoir.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

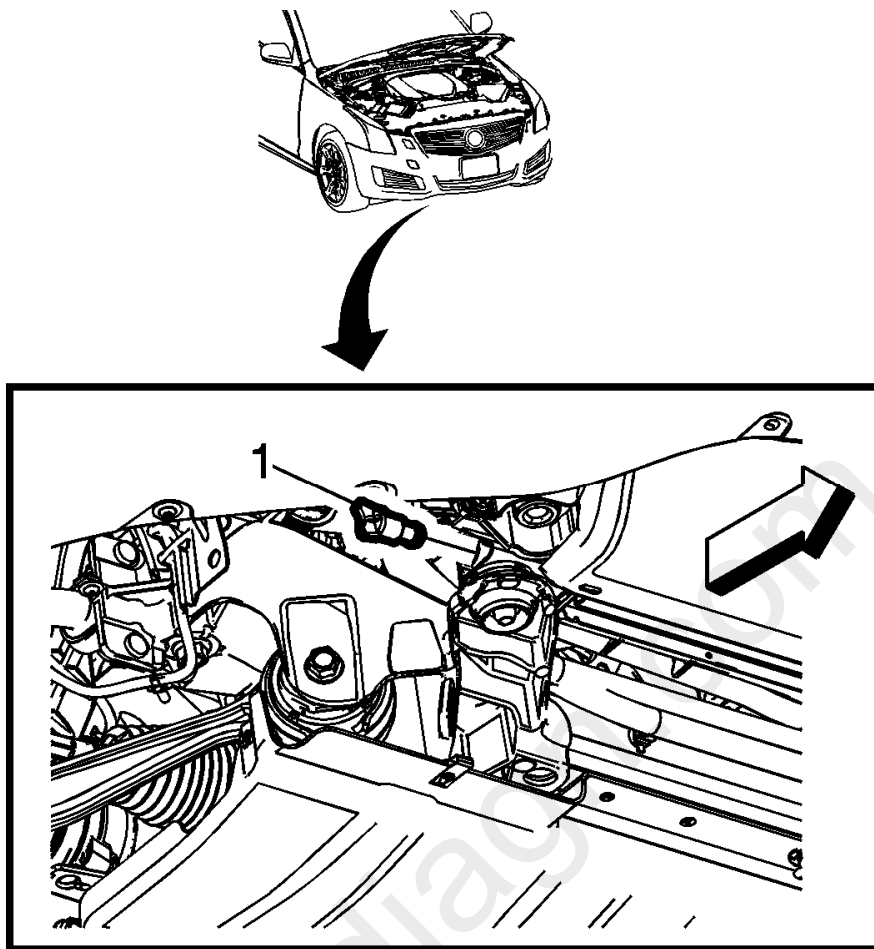


Fig. 9: Drain Cock

Courtesy of GENERAL MOTORS COMPANY

4. Remove the front bumper fascia air deflector. Refer to **Front Bumper Fascia Air Deflector Replacement - Center** .
5. Place a drain pan under the drain cock.
6. Slowly loosen the drain cock (1) and drain the coolant into the drain pan. Do not completely remove the drain cock.
7. Drain the cooling system.
8. Inspect the coolant.
9. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.
 - Discolored-Follow the flush procedure. Refer to **Flushing**.

CAUTION: Refer to **Fastener Caution** .

10. Tighten the drain cock.
11. Install the front bumper fascia air deflector. Refer to **Front Bumper Fascia Air Deflector Replacement - Center**.
12. Lower the vehicle.

Filling Procedure

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

1. Slowly add a mixture of 50/50 DEX-COOL antifreeze and clean drinkable water to the cooling system through the radiator surge tank filler neck and through the top of the lower overflow reservoir as well. Refer to **Approximate Fluid Capacities**.
2. Slowly fill the cooling system until the coolant level stabilizes at the FULL COLD marks on both the surge tank and overflow reservoir.
3. Start the engine and allow the engine to idle in PARK or NEUTRAL with the parking brake engaged.
4. Slowly fill the coolant mixture until the coolant level stabilizes at the FULL COLD mark on the surge tank.
5. Install the surge tank cap and close the cap on the coolant overflow bottle.
6. Run the engine RPM to 2000-2500 rpm until the engine reaches normal operating temperature.
7. Allow the engine to idle for 3 minutes.
8. Shut the engine OFF.
9. Allow the engine to cool, remove the surge tank cap and open the overflow reservoir cap, and repeat steps 1-8 until the coolant level has completely stabilized at the FULL COLD marks on both the surge tank and overflow reservoir.
10. Remove the surge tank cap.
11. Inspect the concentration of the engine coolant using the **J-26568** Coolant and Battery Fluid Tester.
12. Install the surge tank cap.
13. Inspect and if necessary, fill the surge tank and overflow reservoir as necessary.
14. Rinse away any excess coolant from the engine and the engine compartment
15. Inspect the cooling system for leaks.

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

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

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. Park the vehicle on a level surface.

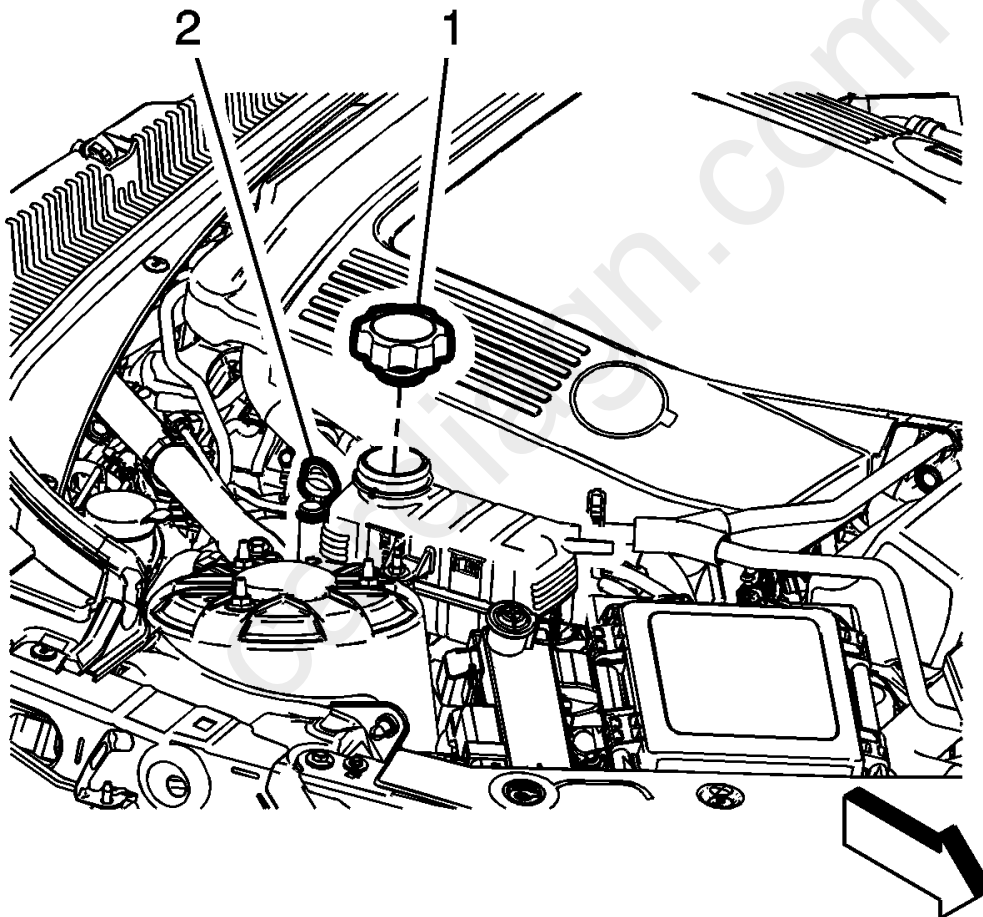


Fig. 10: Coolant Pressure Cap

Courtesy of GENERAL MOTORS COMPANY

2. Remove the coolant pressure cap (1) from the radiator surge tank and open the cap (2) on the lower coolant overflow reservoir. Remove the coolant pressure cap.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

4. Remove the front bumper fascia air deflector. Refer to **Front Bumper Fascia Air Deflector Replacement - Center** .
5. Place a drain pan under the drain cock.

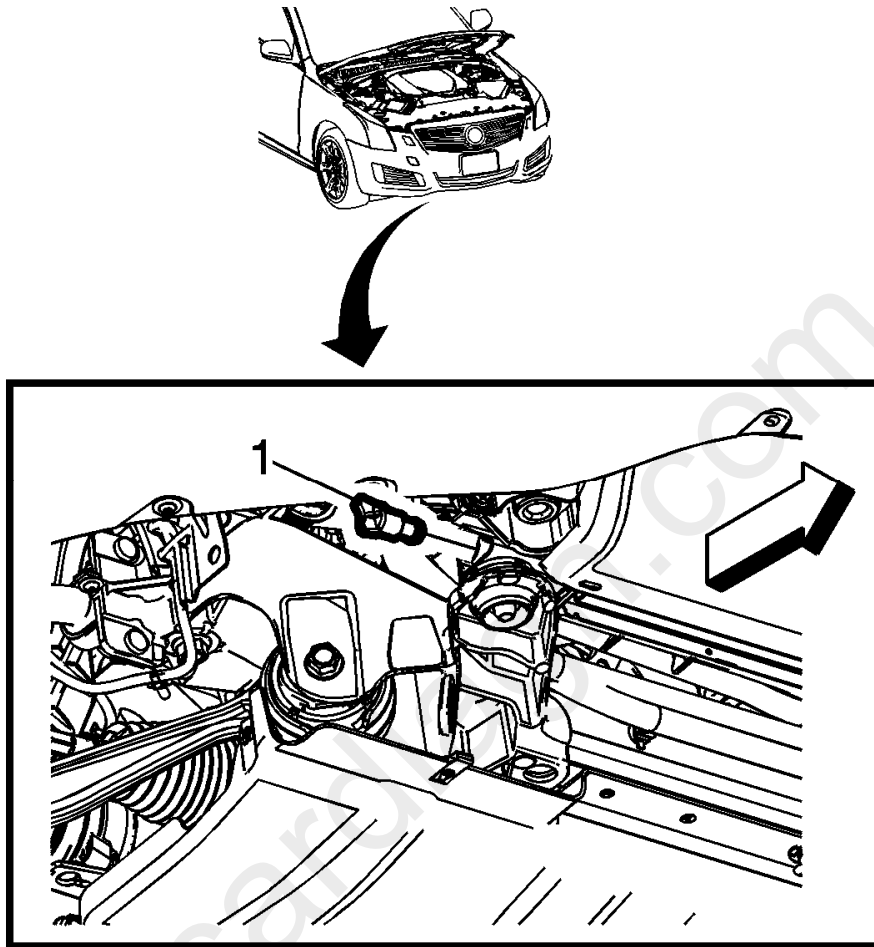


Fig. 11: Drain Cock
Courtesy of GENERAL MOTORS COMPANY

6. Slowly loosen the drain cock (1) and drain the coolant into the drain pan. Do not completely remove the drain cock.
7. Drain the cooling system.
8. Inspect the coolant.
9. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.
 - Discolored-Follow the flush procedure. Refer to **Flushing**.

CAUTION: Refer to **Fastener Caution** .

10. Tighten the drain cock.
11. Install the front bumper fascia air deflector. Refer to **Front Bumper Fascia Air Deflector Replacement - Center**.
12. Lower the vehicle.

Vac-N-Fill Procedure

NOTE: To prevent boiling of the coolant/water mixture in the vehicles cooling system, do not apply vacuum to a cooling system above 49°C (120°F). The tool will not operate properly when the coolant is boiling.

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

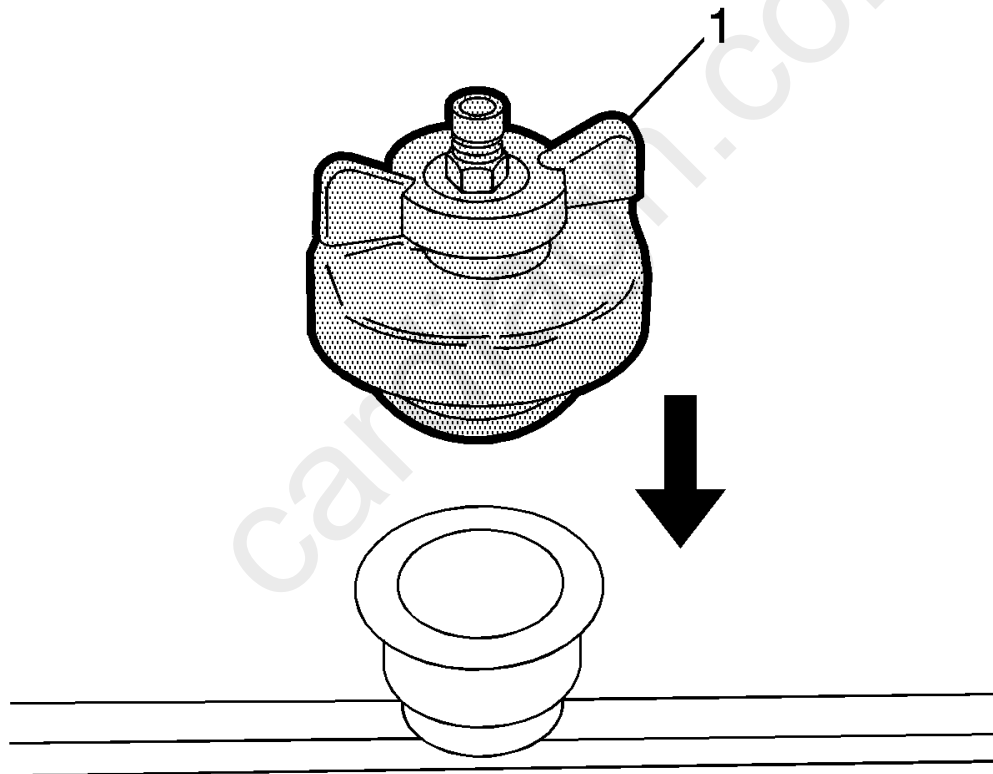


Fig. 12: Radiator Cap & Surge Tank Test Adapter
Courtesy of GENERAL MOTORS COMPANY

WARNING: To avoid being burned, do not remove the radiator cap or surge tank

cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

2. Attach the Vac N Fill cap to the **J-42401** Radiator Cap and Surge Tank Test Adapter (1) to the vehicles surge tank coolant fill port.

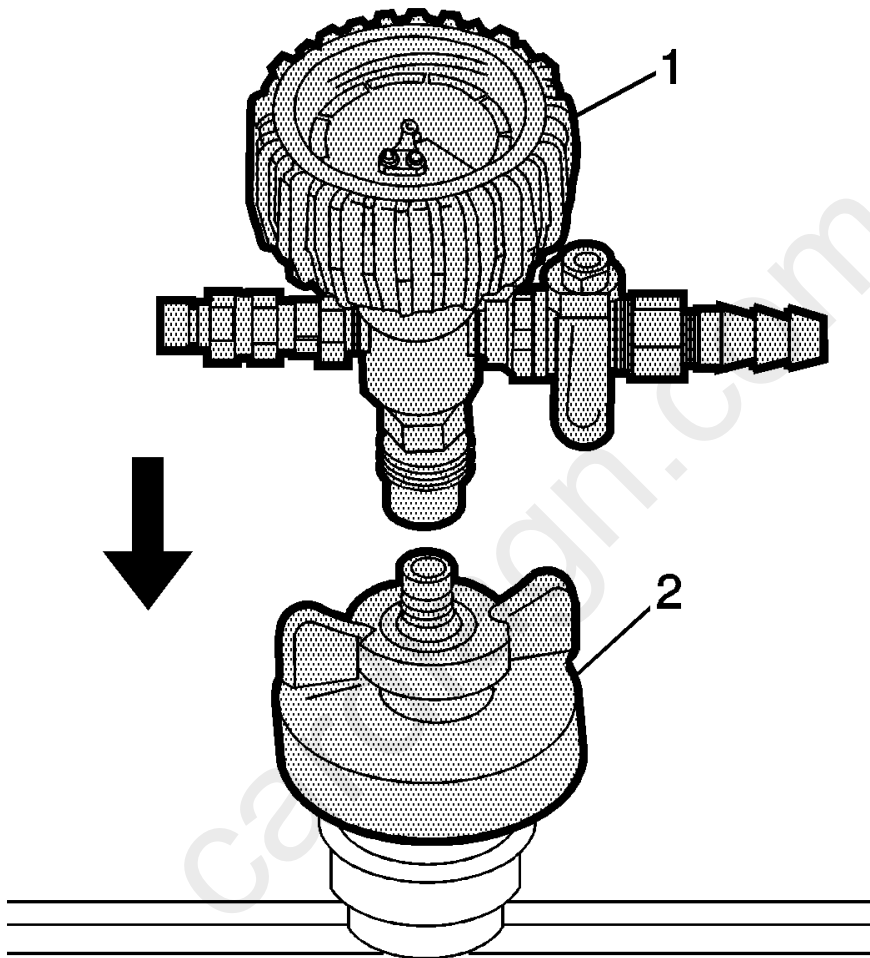


Fig. 13: Vacuum Gauge Assembly & Vac N Fill Cap
Courtesy of GENERAL MOTORS COMPANY

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

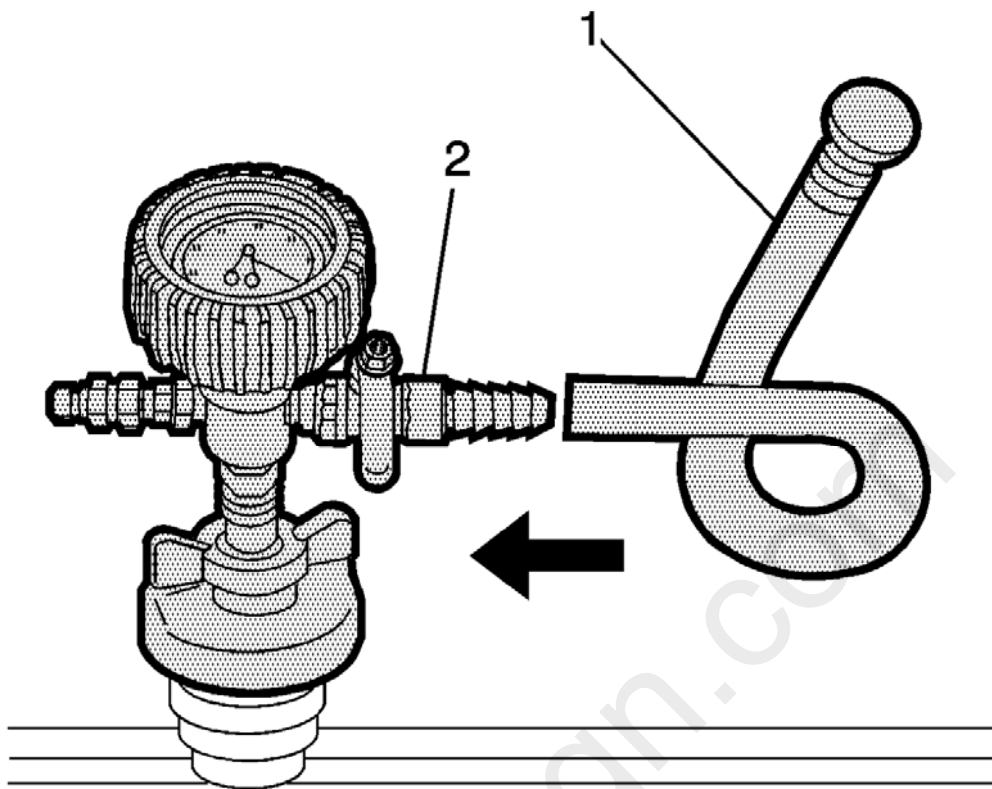


Fig. 14: Vacuum Gauge Assembly & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

4. Attach the fill hose (1) to the barb fitting on the vacuum gauge assembly (2).

Ensure that the valve is closed.

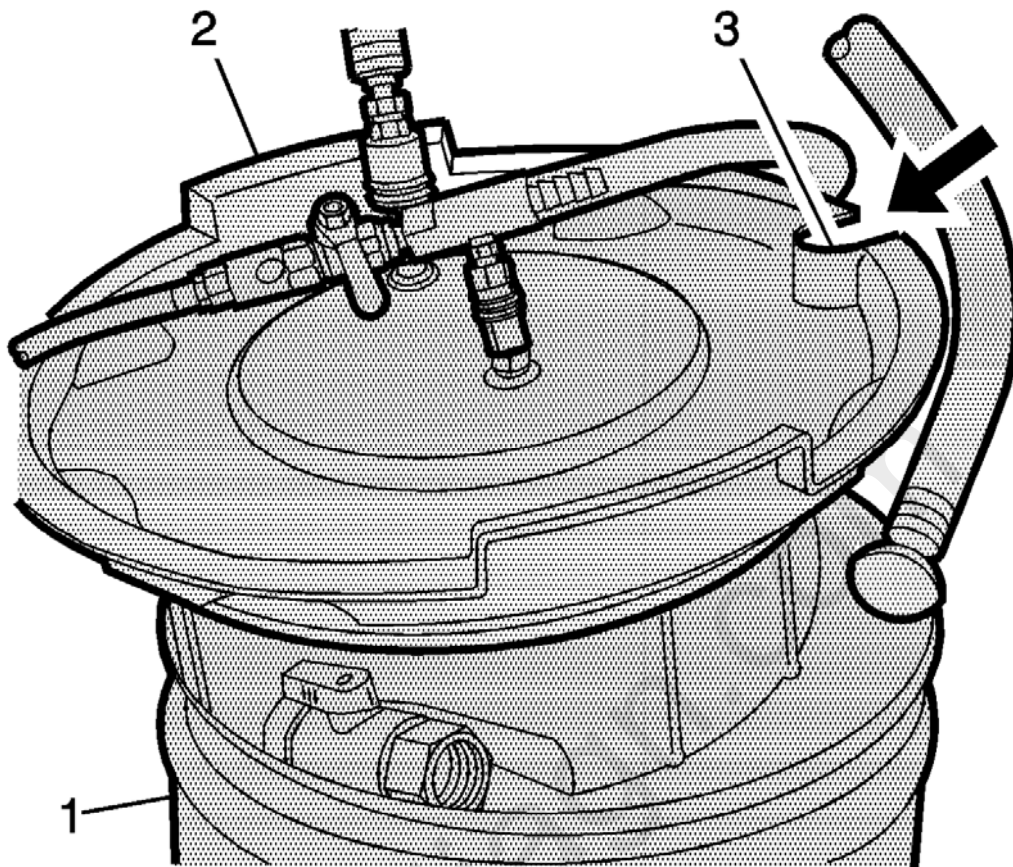


Fig. 15: Graduated Reservoir, Vacuum Tank & Cut-Out Area
Courtesy of GENERAL MOTORS COMPANY

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 (1).
6. Place the fill hose in the graduated reservoir (1).

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

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

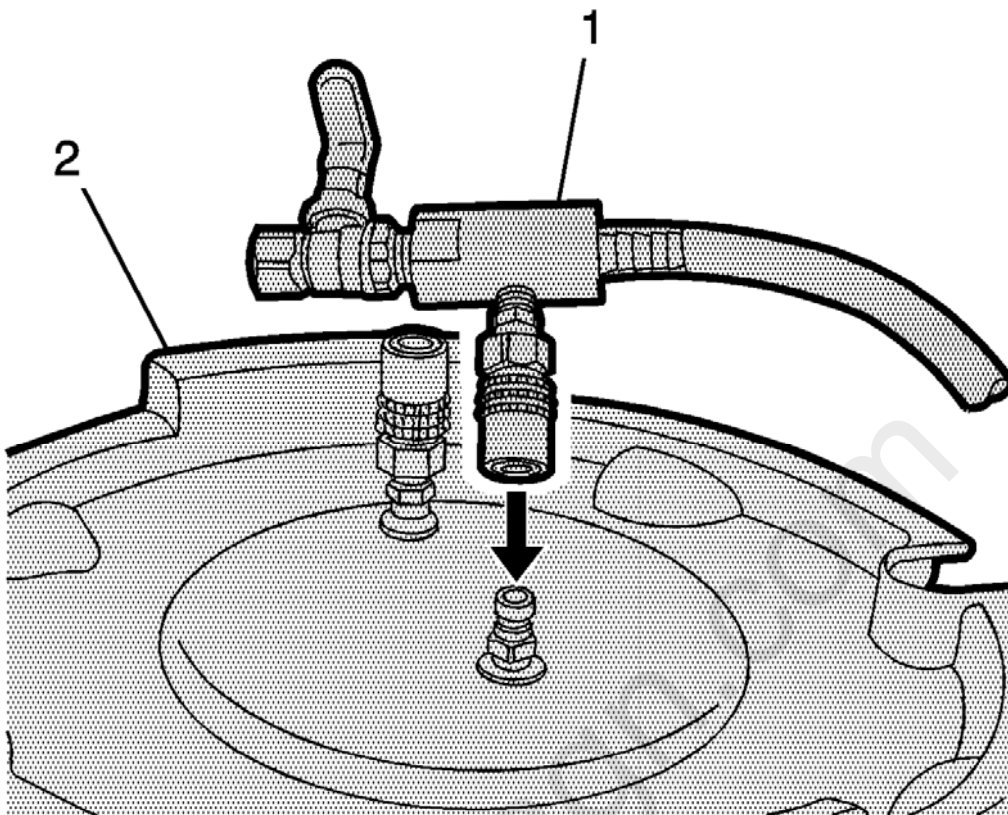


Fig. 16: Vacuum Tank & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

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

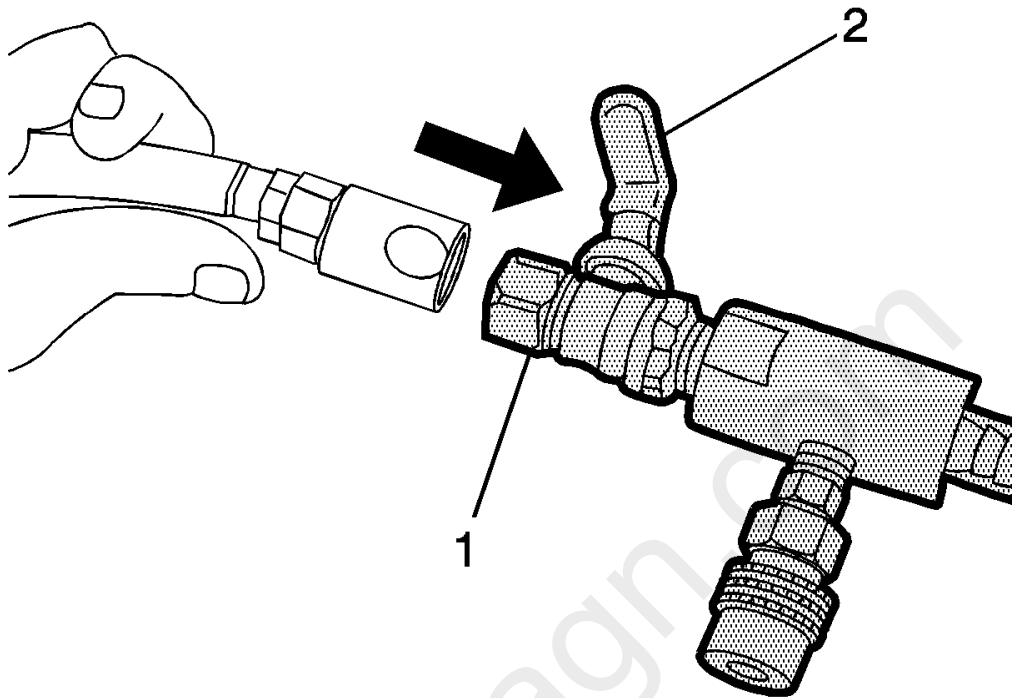


Fig. 17: Venturi Assembly & Valve
Courtesy of GENERAL MOTORS COMPANY

9. Attach a shop air hose to the venturi assembly (1).

Ensure the valve (2) on the venturi assembly is closed.

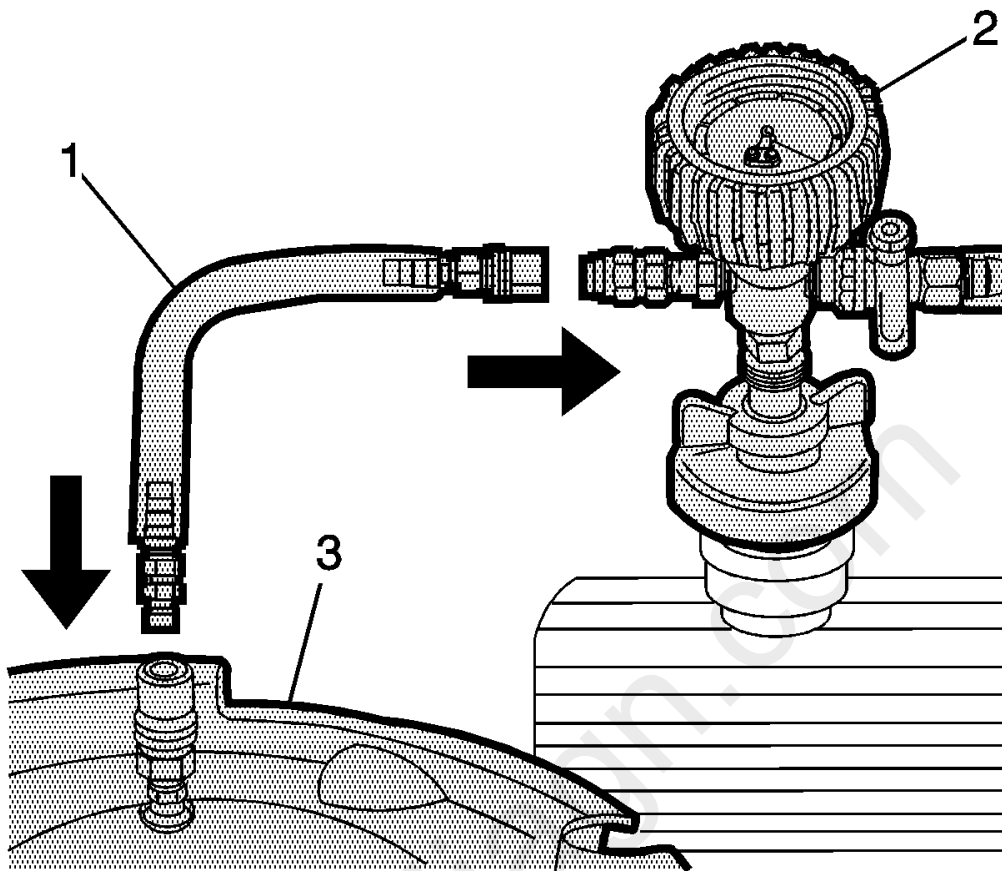


Fig. 18: Vacuum Hose, Gauge Assembly & Tank
Courtesy of GENERAL MOTORS COMPANY

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

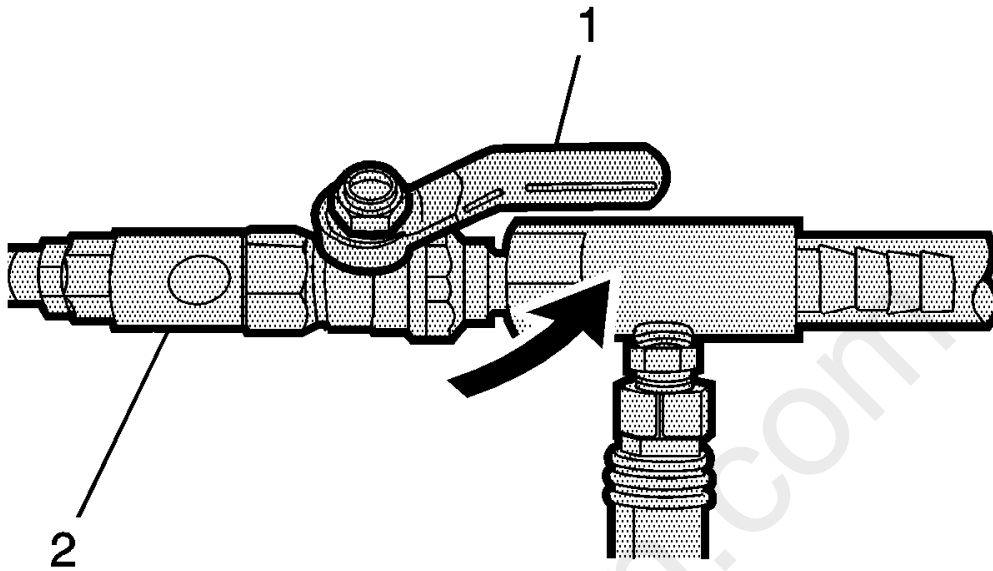


Fig. 19: Valve & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

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

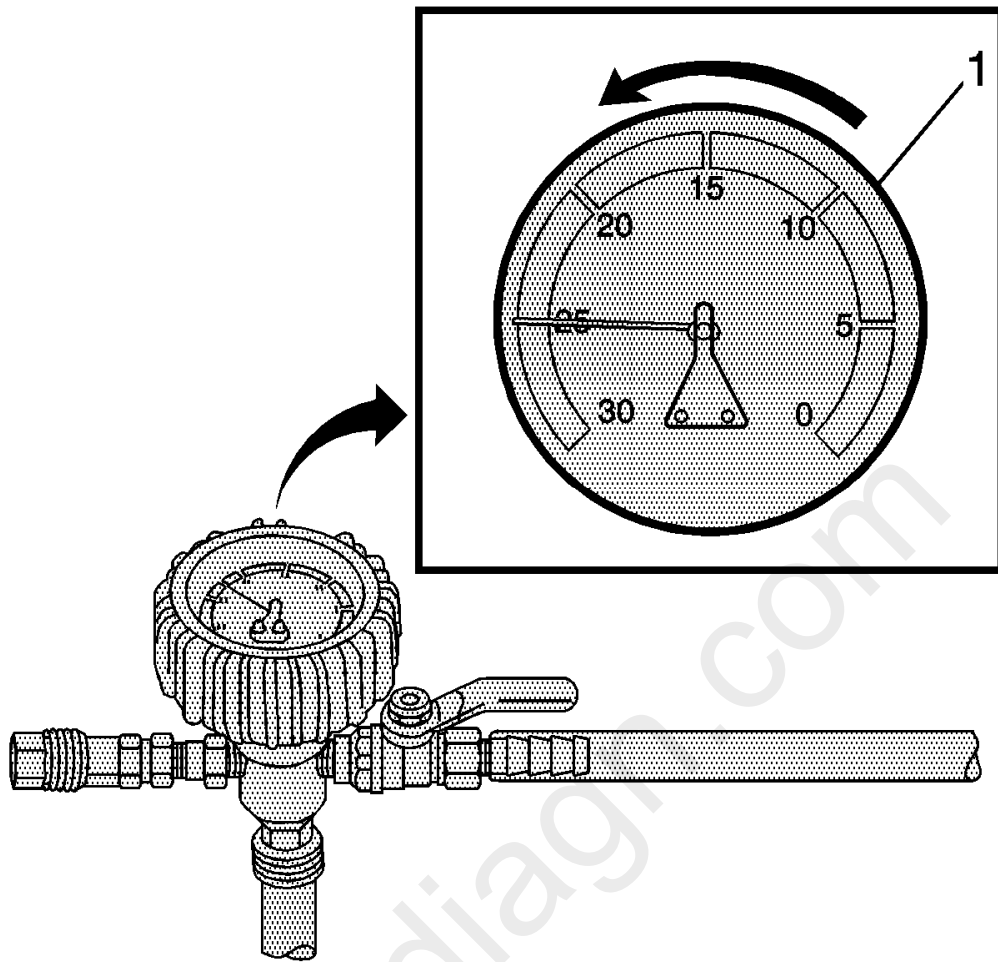


Fig. 20: Vacuum Gauge Needle
Courtesy of GENERAL MOTORS COMPANY

13. Continue to draw vacuum until the needle stops rising (1). This should be 610-660 mm Hg (24-26 in Hg).
Cooling hoses may start to collapse. This is normal due to vacuum draw.
14. To aid in the fill process, position the graduated reservoir above the coolant fill port.

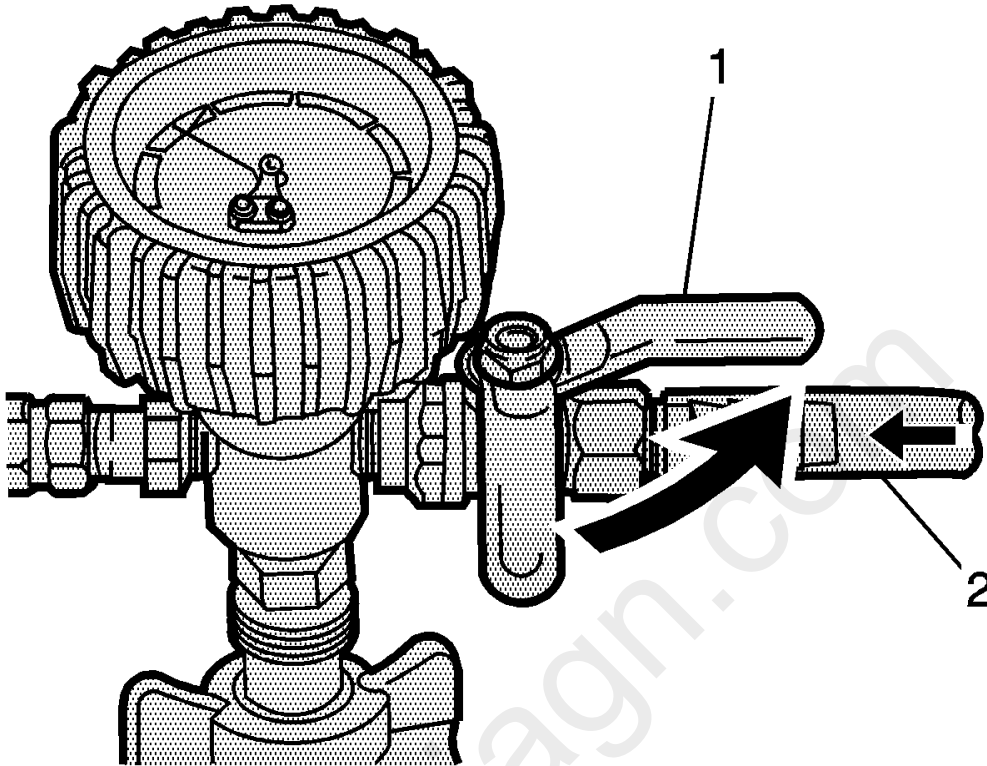


Fig. 21: Vacuum Gauge Assembly & Needle
Courtesy of GENERAL MOTORS COMPANY

15. Slowly open the valve (1) on the vacuum gauge assembly (2). When the coolant reaches the top of the fill hose, close the valve. This will eliminate air from the fill hose.
16. Close the valve on the venturi assembly.
17. 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**.

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

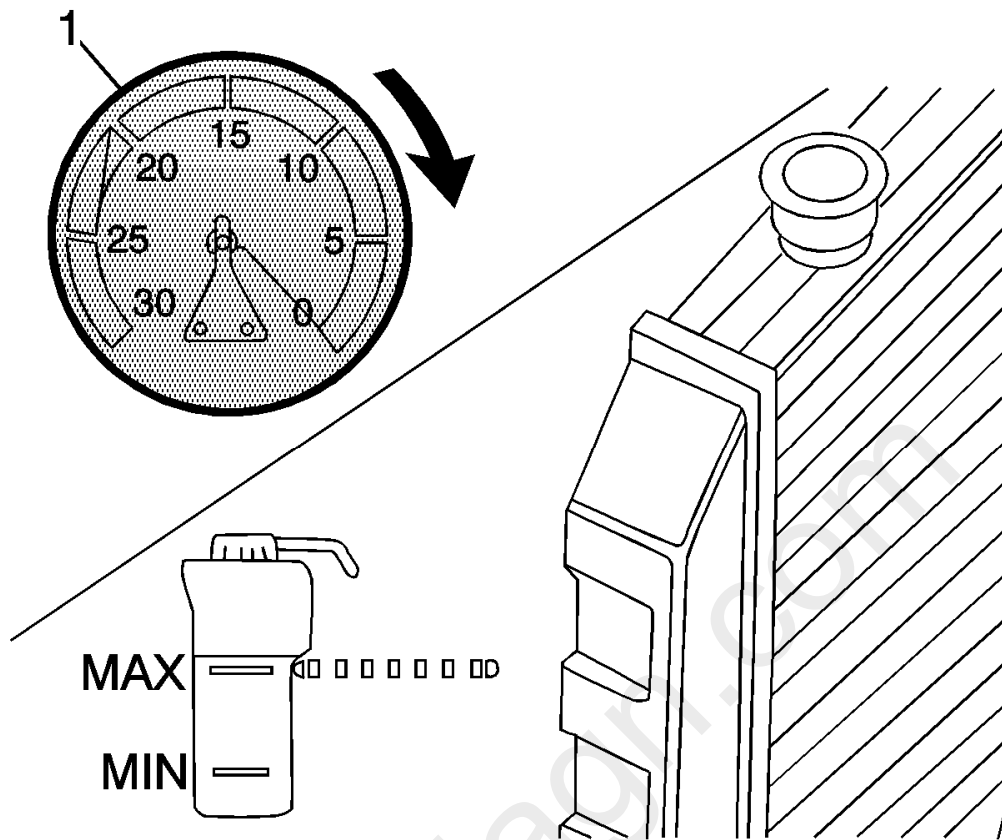


Fig. 22: Vacuum Gauge At Zero
Courtesy of GENERAL MOTORS COMPANY

19. Once the vacuum gauge reaches zero (1), close the valve on the vacuum gauge assembly and repeat steps 11-17.
20. Remove the **J-42401** Radiator Cap and Surge Tank Test Adapter.
21. Detach the **J-42401** Radiator Cap and Surge Tank Test Adapter from the vehicle fill port.
22. Add coolant to the system as necessary until the coolant reaches the FULL COLD fill lines on both the radiator surge tank and coolant overflow bottle.
23. Install the surge tank cap and close the cap on the overflow bottle.
24. Start the engine.
25. Run the engine at 2,000-2,500 RPM until the engine reaches normal operating temperature.
26. Allow the engine to idle for 3 minutes.
27. Shut the engine OFF.
28. Allow the engine to cool.
29. Add or remove coolant as necessary from the surge tank and overflow bottle until the levels are stabilized

at the FULL COLD marks.

30. Inspect the cooling system for leaks.
31. Inspect the concentration of the engine coolant using the **J-26568** Coolant and Battery Fluid Tester.
32. Rinse away any excess coolant from the engine and the engine compartment.
33. 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.

CHARGE AIR COOLING SYSTEM DRAINING AND FILLING (LF3)

Special Tools

- **GE-26568** Coolant and Battery Fluid tester
- **GE-47716** Vac-N-Fill Coolant Refill Tool
- **GE-47716-30** Vac-N-Fill Adapter

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

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.

NOTE: Make sure the intercooler system is cool and that the pump is not in the ON position.

1. Open the hood and remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)**.
2. Orientate the air charge air coolant (CAC) quick connect fitting to the vertical position. Refer to **Intake Manifold Vacuum Fitting Replacement**.
3. Remove the CAC quick connect vacuum fitting cap.
4. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement**.

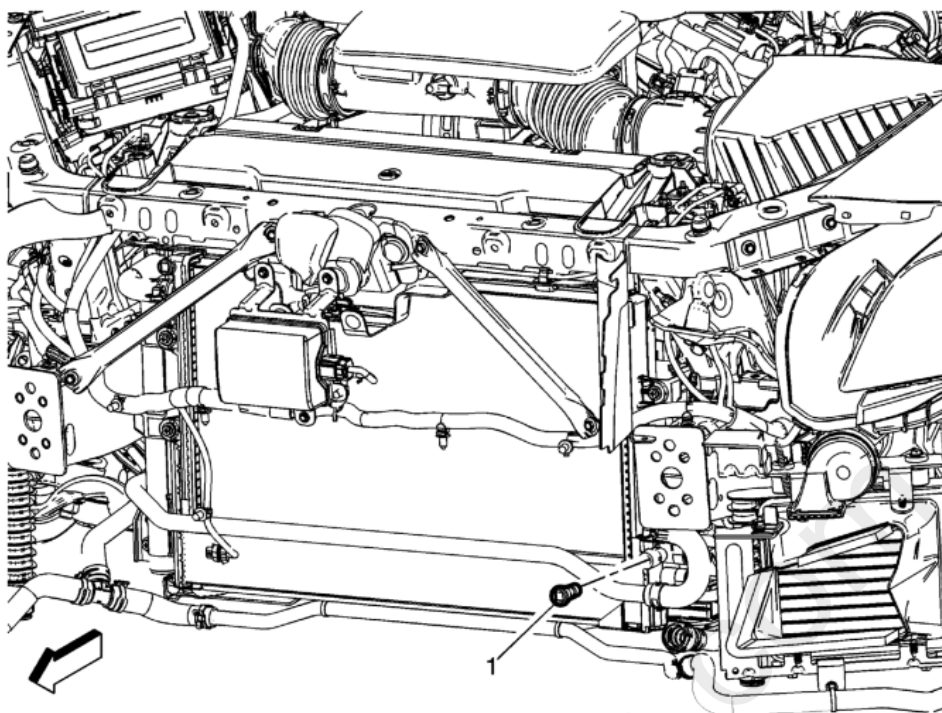


Fig. 23: Drain Cock

Courtesy of GENERAL MOTORS COMPANY

5. Remove the drain cock (1) from the CAC radiator. Refer to **Charge Air Cooler Radiator Drain Plug Replacement (LF3)**.

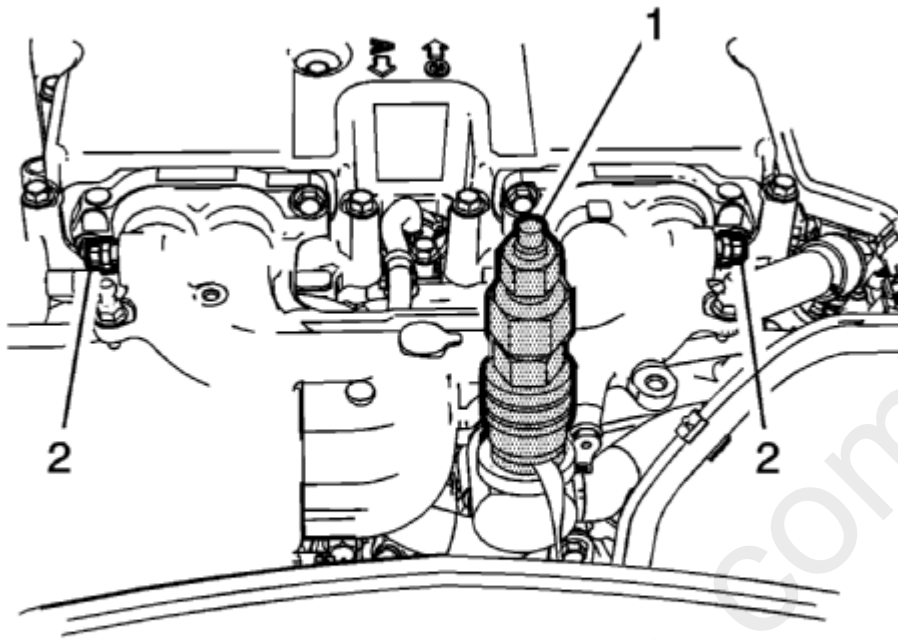


Fig. 24: Turbocharger Water Manifold Bleeder Valves
Courtesy of GENERAL MOTORS COMPANY

6. Install absorbent rags under the turbocharger water manifold bleeder valves (2) to absorb any coolant loss.
7. Open the two air bleeder valves (2) on the turbocharger water manifold.
8. Allow the system to fully drain into a clean container.
9. Measure and record the amount of coolant drained.

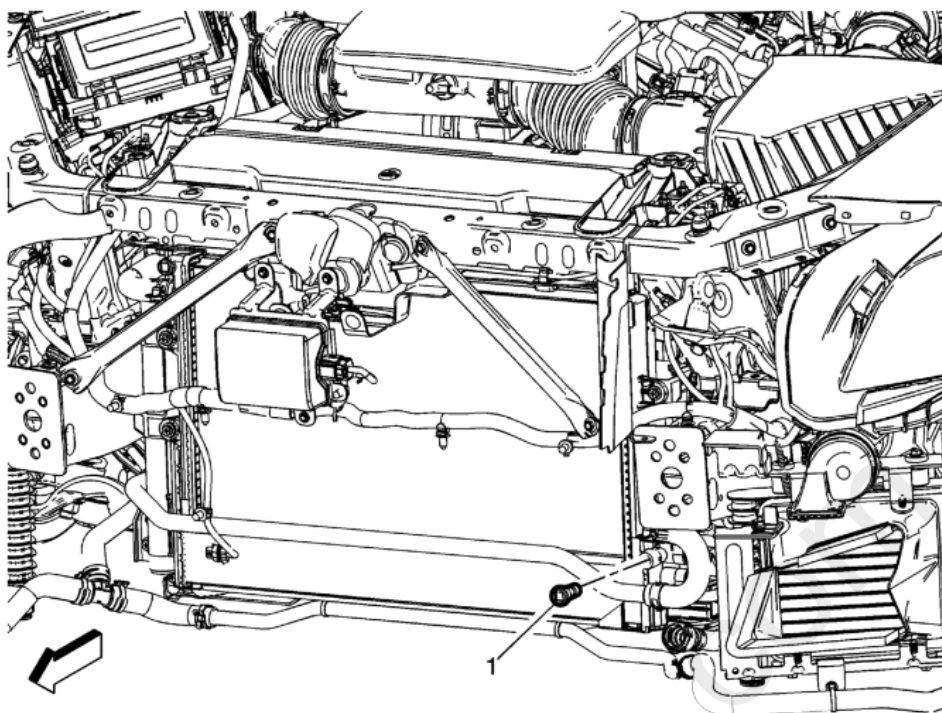


Fig. 25: Drain Cock
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

10. Install and tighten the drain cock (1) to 9.6 (85 lb in).
11. Lower the vehicle.

Vac-N-Fill Procedure

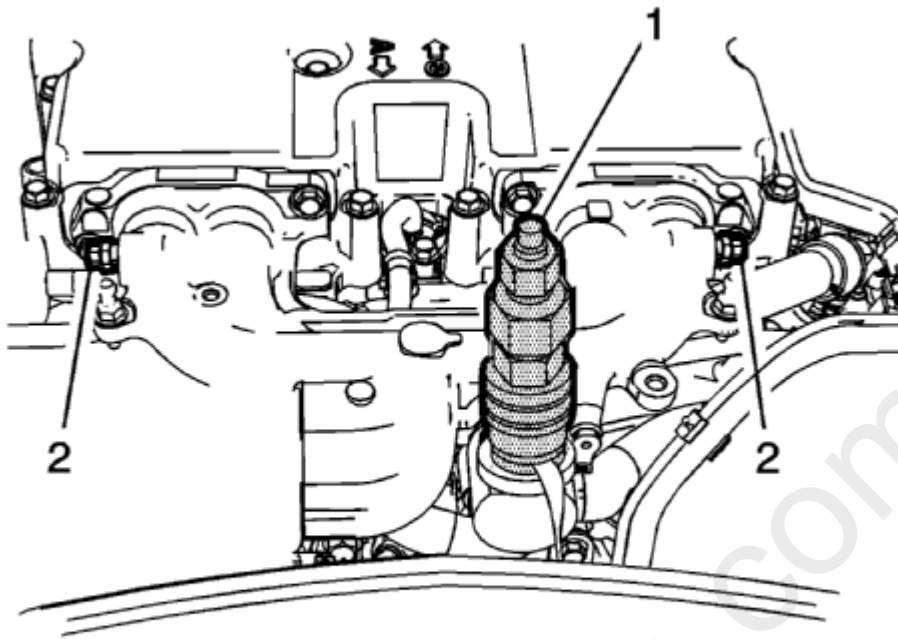


Fig. 26: Turbocharger Water Manifold Bleeder Valves
Courtesy of GENERAL MOTORS COMPANY

NOTE: It is critical that the system must be completely free of air to prevent CAC pump noise and loss of system performance.

1. Close the two air bleeder valves (2) on the turbocharger water manifold and tighten to 12 (106 lb in).
2. Install absorbent rags under the CAC quick connect fitting to absorb any coolant loss.

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

3. Ensure the CAC quick connect fitting is in the vertical position.
4. Install the **GE-47716-30** Vac-N-Fill Adapter (1) to the CAC quick connect fitting.

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.

5. Attach the Vac-N-Fill gauge assembly to **GE-47716-30** Vac-N-Fill Adapter (1).

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

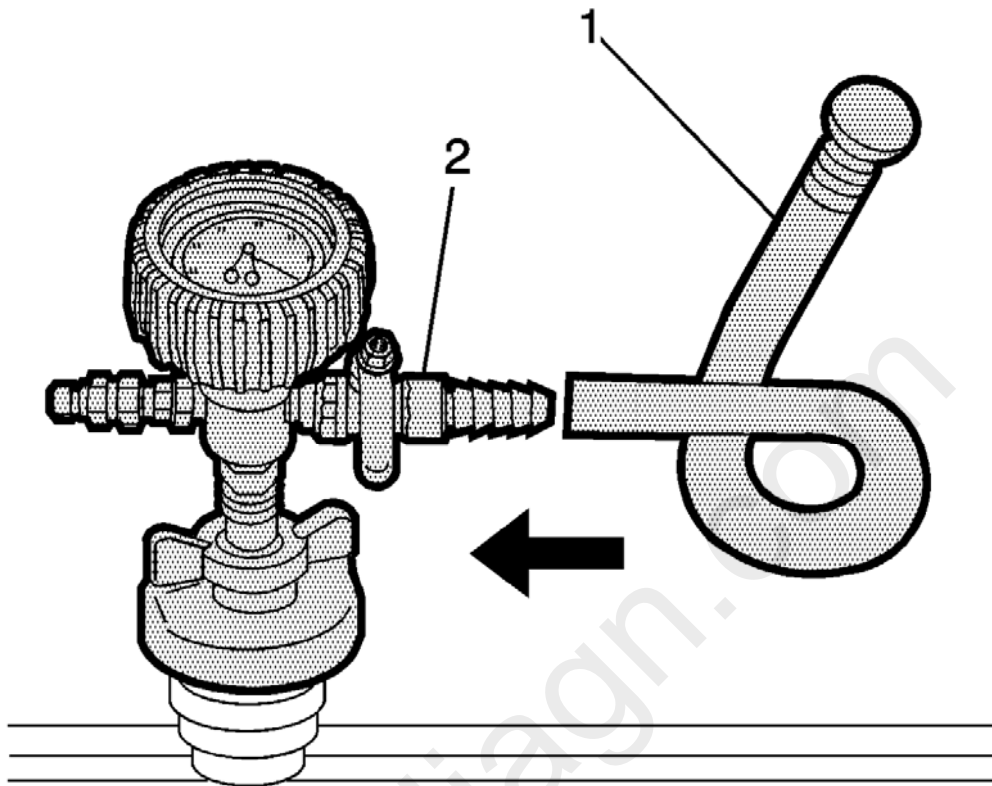


Fig. 27: Vacuum Gauge Assembly & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

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

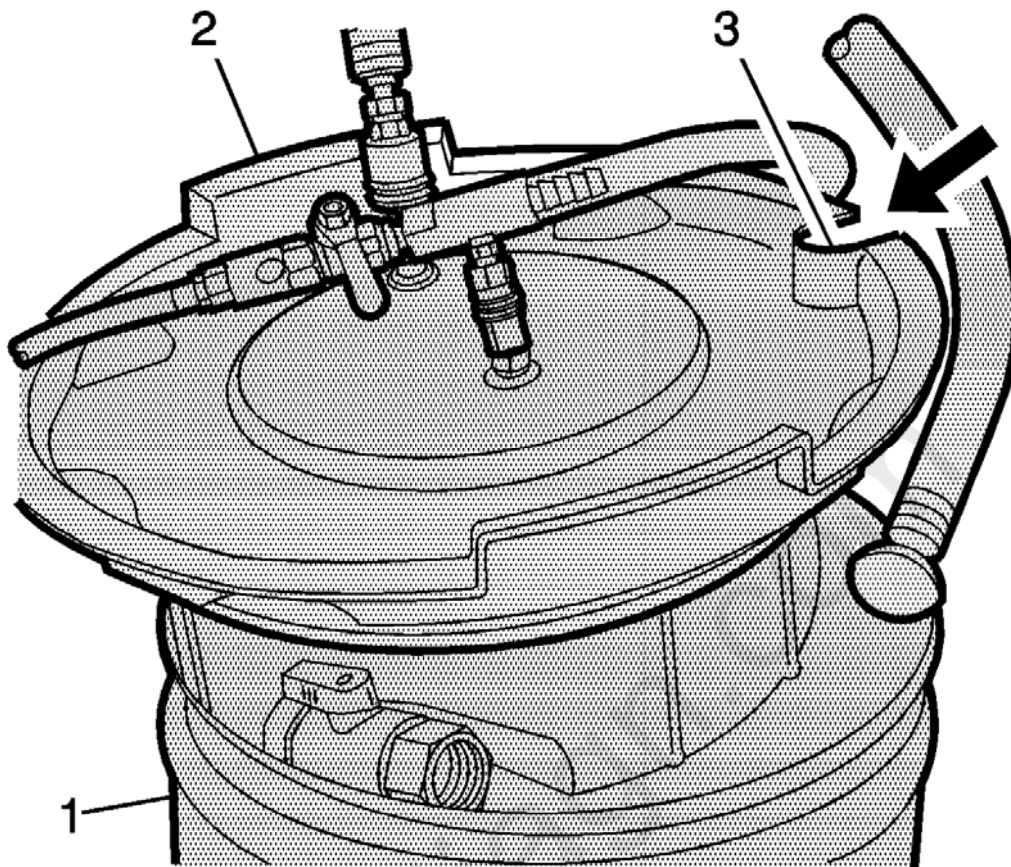


Fig. 28: Graduated Reservoir, Vacuum Tank & Cut-Out Area
Courtesy of GENERAL MOTORS COMPANY

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.

8. Pour the coolant mixture into the graduated reservoir (1).
9. Place the fill hose in the graduated reservoir (1).

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

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

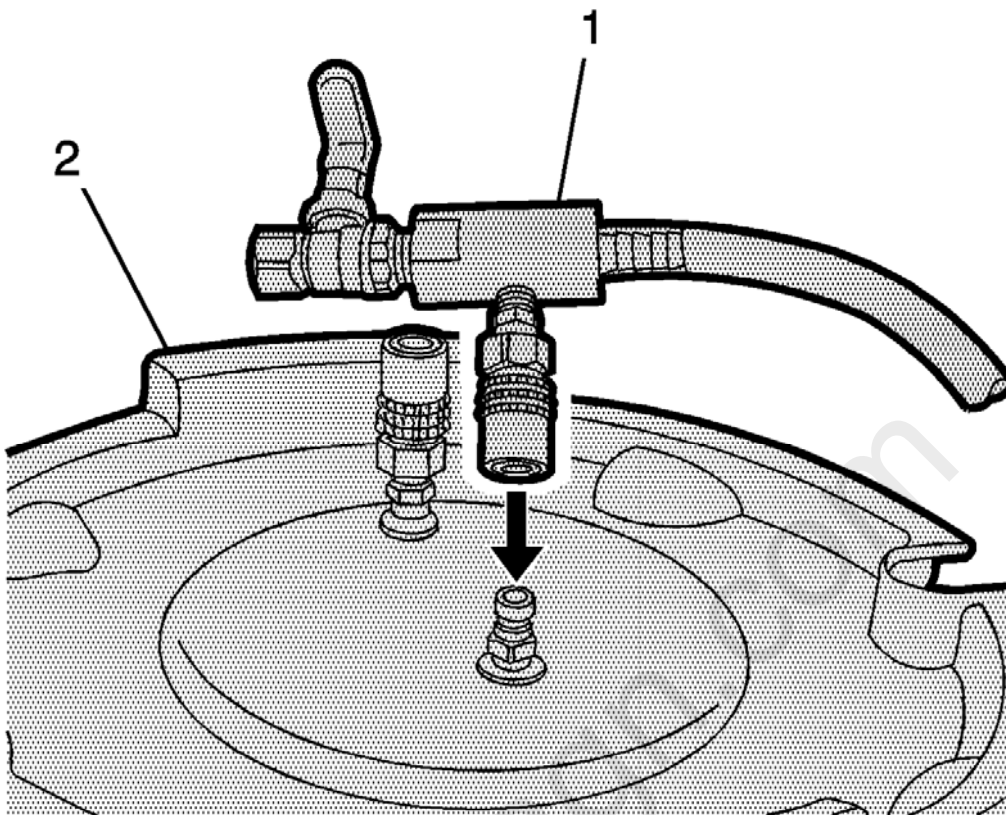


Fig. 29: Vacuum Tank & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

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

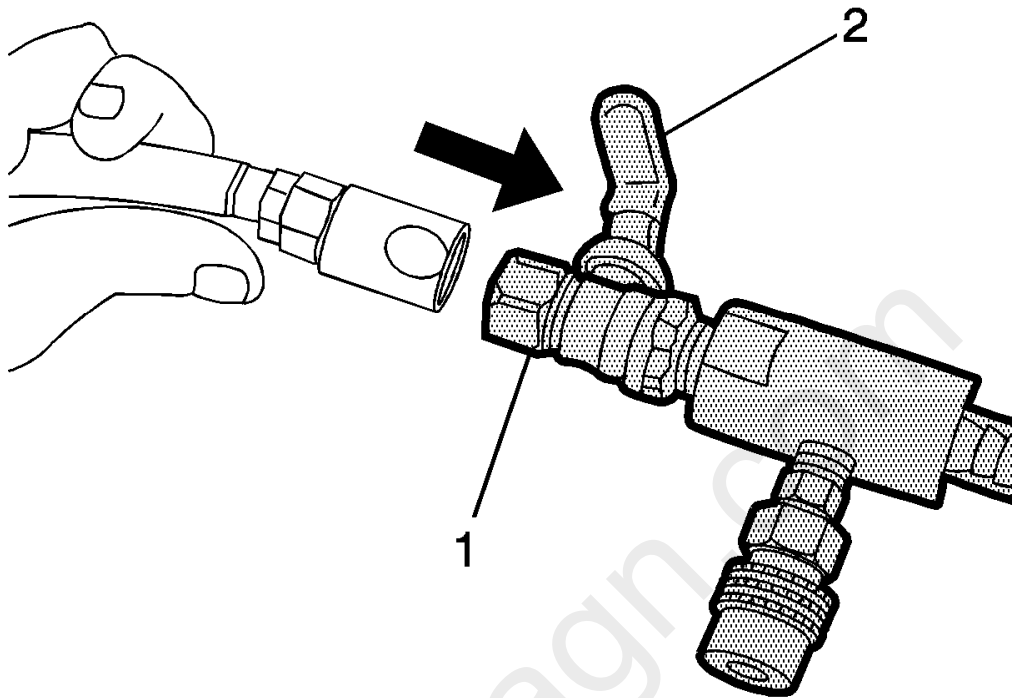


Fig. 30: Venturi Assembly & Valve
Courtesy of GENERAL MOTORS COMPANY

12. Attach a shop air hose to the venturi assembly (1).

Ensure the valve (2) on the venturi assembly is closed.

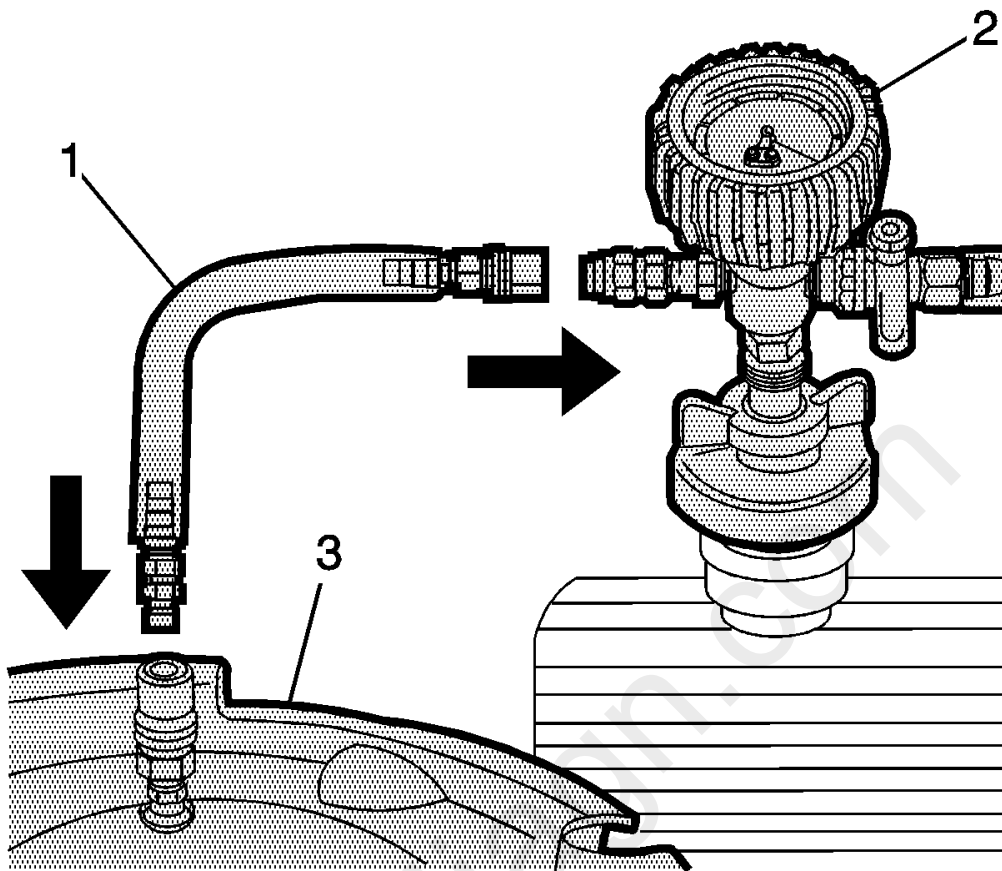


Fig. 31: Vacuum Hose, Gauge Assembly & Tank
Courtesy of GENERAL MOTORS COMPANY

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

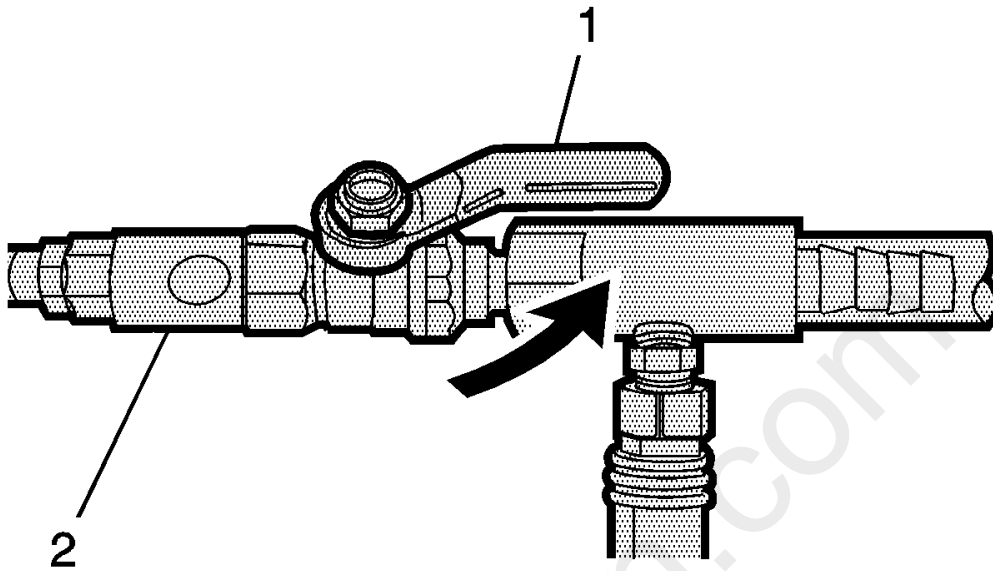


Fig. 32: Valve & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

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

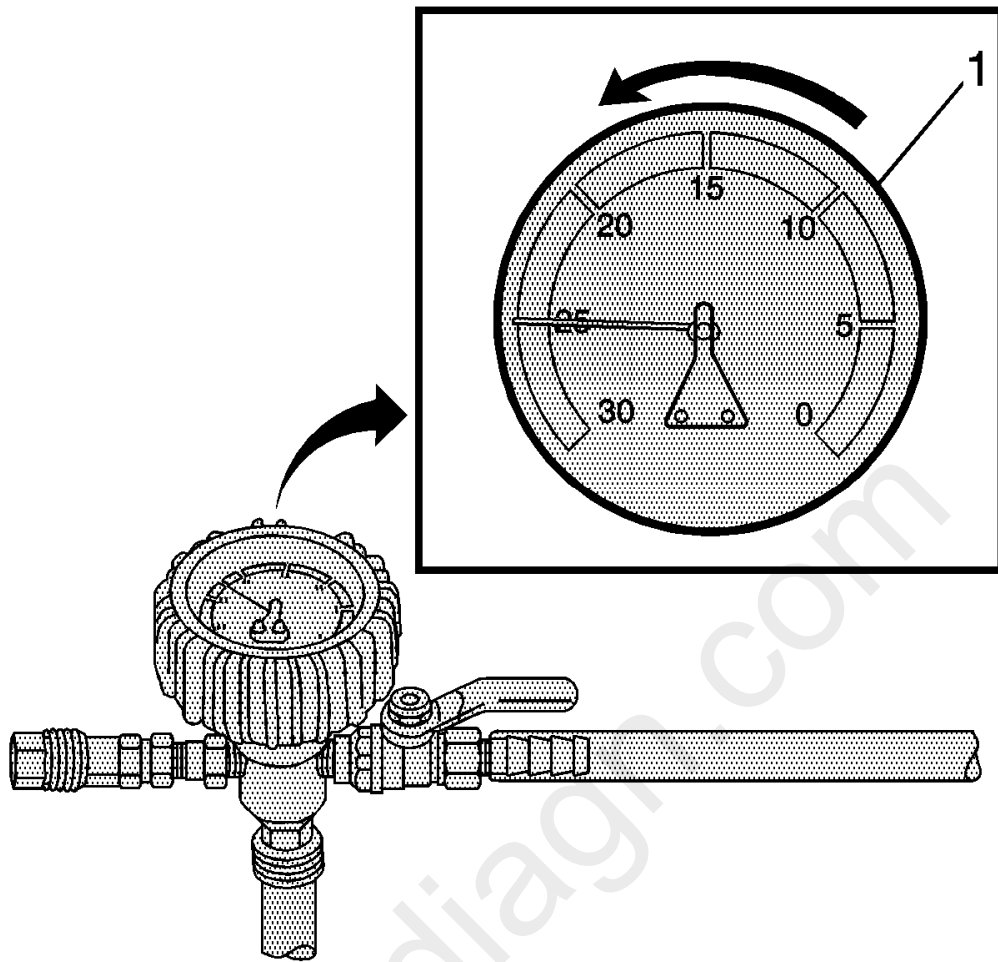


Fig. 33: Vacuum Gauge Needle
Courtesy of GENERAL MOTORS COMPANY

15. Continue to draw vacuum until the needle stops rising (1). This should be 610-660 mm Hg (24-26 in Hg).
Cooling hoses may start to collapse. This is normal due to vacuum draw.
16. To aid in the fill process, position the graduated reservoir above the coolant fill port.

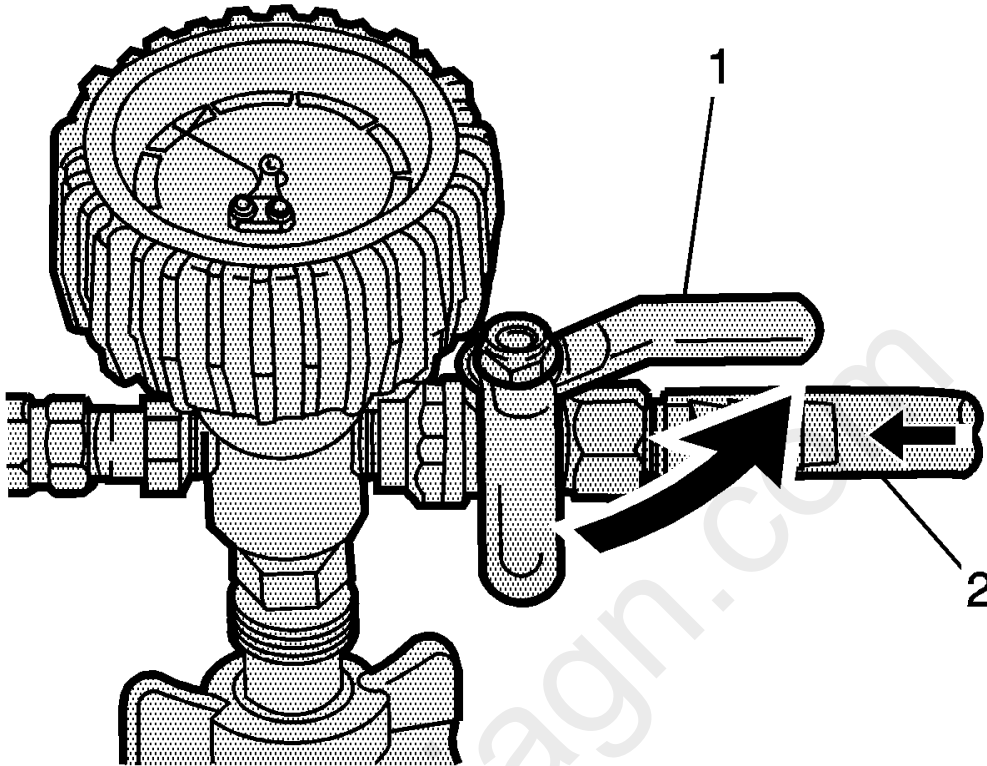


Fig. 34: Vacuum Gauge Assembly & Needle
Courtesy of GENERAL MOTORS COMPANY

17. Slowly open the valve (1) on the vacuum gauge assembly (2). When the coolant reaches the top of the fill hose, close the valve. This will eliminate air from the fill hose.
18. Close the valve on the venturi assembly.
19. 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**.

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

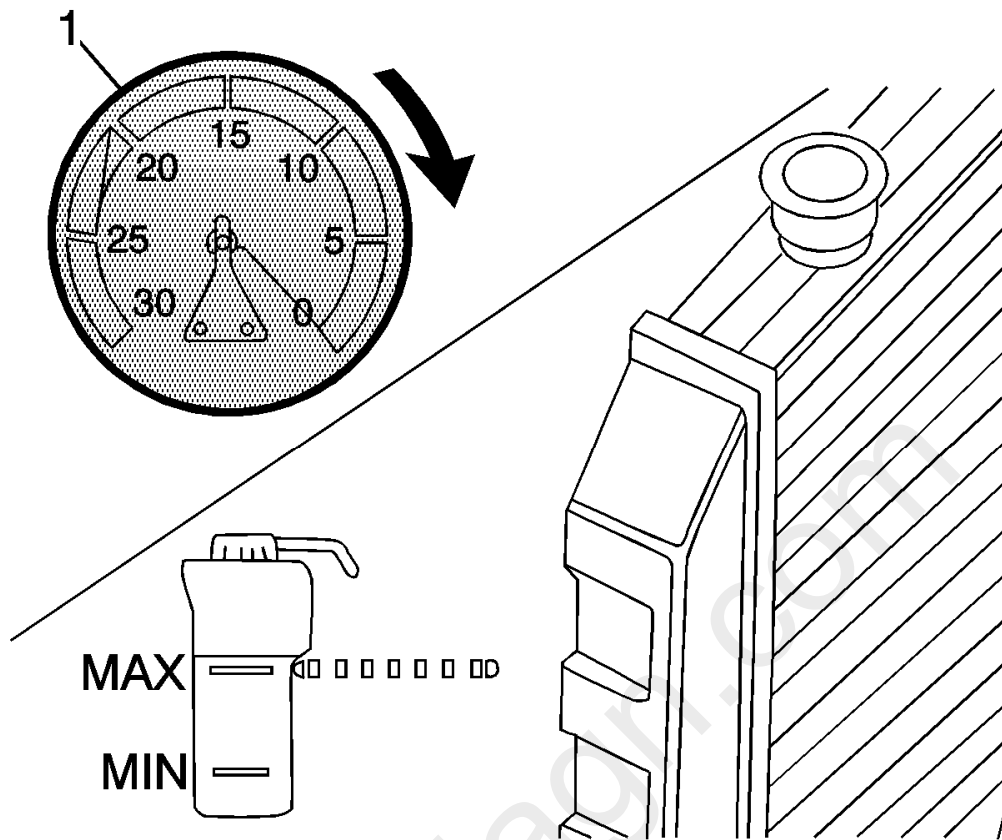


Fig. 35: Vacuum Gauge At Zero
Courtesy of GENERAL MOTORS COMPANY

21. Once the vacuum gauge reaches zero (1), close the valve on the vacuum gauge assembly and repeat steps 12-18.

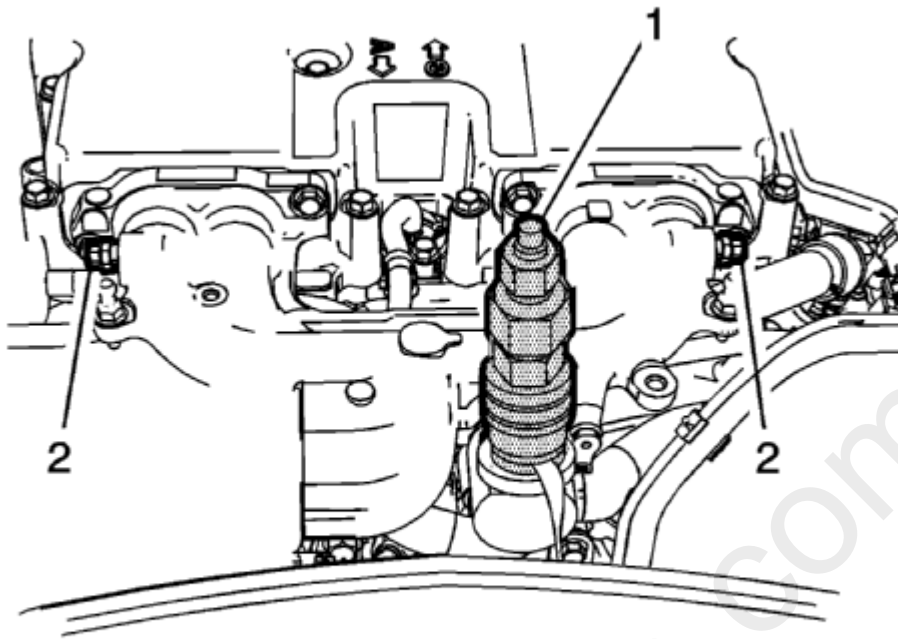


Fig. 36: Turbocharger Water Manifold Bleeder Valves
Courtesy of GENERAL MOTORS COMPANY

22. Detach the Vac-N-Fill gauge assembly from the **GE-47716-30** Vac-N-Fill Adapter (1).
23. Remove the **GE-47716-30** Vac-N-Fill Adapter (1) from the CAC quick connect fitting.
24. Install the quick connect vacuum fitting charge air coolant cap.
25. Inspect the CAC cooling system for leaks.
26. Remove the absorbent rags.
27. Rinse away any excess coolant from the engine and the engine compartment.
28. Orientate the CAC quick connect fitting to the previously installed position to allow for engine cover clearance. Refer to **Intake Manifold Vacuum Fitting Replacement**.
29. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .
30. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

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 (LTG), Radiator Surge Tank Replacement (LFX, LF3).
3. Clean and flush the radiator surge tank with clean, drinkable water.
4. Install the radiator surge tank. Refer to Radiator Surge Tank Replacement (LTG), Radiator Surge Tank Replacement (LFX, LF3).
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).

CHARGE AIR COOLING SYSTEM FLUSHING (LF3)

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.

When the charge air cooling (CAC) cooling system becomes contaminated, the CAC cooling system should be flushed thoroughly to remove the contaminants before the supercharger is seriously damaged.

1. Drain the CAC cooling system. Refer to **Charge Air Cooling System Draining and Filling (LF3)**
2. Follow the drain and fill procedure using only clean, drinkable water. Refer to **Charge Air Cooling System Draining and Filling (LF3)**
3. Command the CAC pump to the ON position using the Tech 2 or by starting the engine. Run the CAC pump for 5 minutes.
4. Drain the CAC cooling system. Refer to **Charge Air Cooling System Draining and Filling (LF3)**
5. Repeat the procedure if necessary, until the fluid is colorless.
6. Fill the CAC cooling system. Refer to **Charge Air Cooling System Draining and Filling (LF3)**

CHARGE AIR COOLING SYSTEM CLEANING (LF3)

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

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

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

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

RADIATOR SURGE TANK REPLACEMENT (LTG)

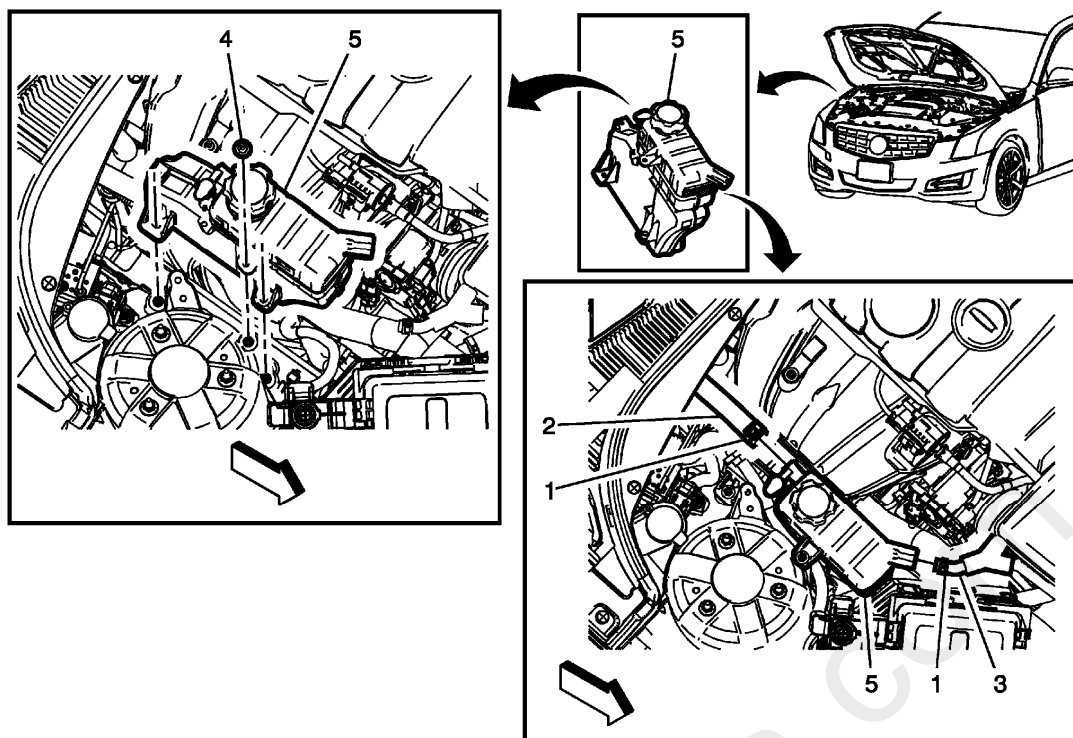


Fig. 37: Radiator Surge Tank (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Replacement (LTG)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
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 <u>Special Tools</u> .
2	Heater Outlet Hose
3	Radiator Surge Tank Inlet Hose
4	Radiator Surge Tank Nut CAUTION: Refer to <u>Fastener Caution</u> .
5	Radiator Surge Tank Procedure 1. Fill the coolant to the proper level. Refer to <u>Cooling System Draining and Filling</u>

(Static Fill), Cooling System Draining and Filling (GE 47716).

2. Inspect cooling system for leaks. Refer to Cooling System Leak Testing.

RADIATOR SURGE TANK REPLACEMENT (LFX, LF3)

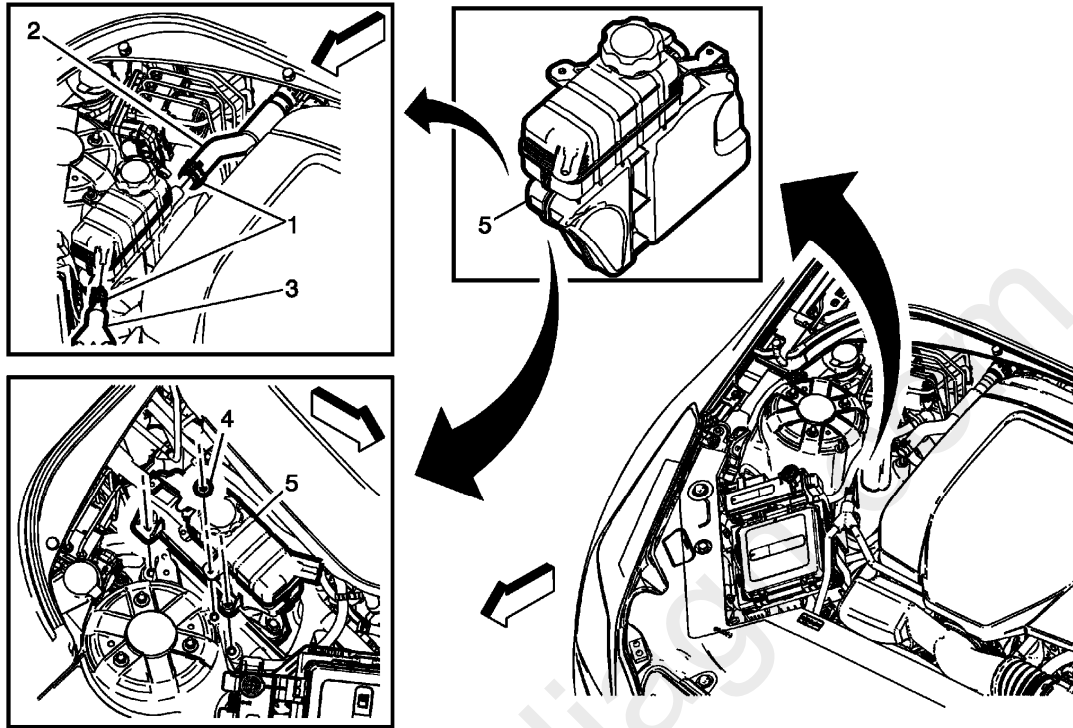


Fig. 38: Radiator Surge Tank (LFX, LF3)

Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Replacement (LFX, LF3)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Radiator Surge Tank 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
2	Heater Outlet Hose
3	Radiator Surge Tank Inlet Hose
4	Radiator Surge Tank Nut CAUTION: Refer to <u>Fastener Caution</u> .

	Radiator Surge Tank
5	Procedure 1. Fill the coolant to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect cooling system for leaks. Refer to <u>Cooling System Leak Testing</u>.

CHARGE AIR COOLER COOLANT PIPE REPLACEMENT (LF3)

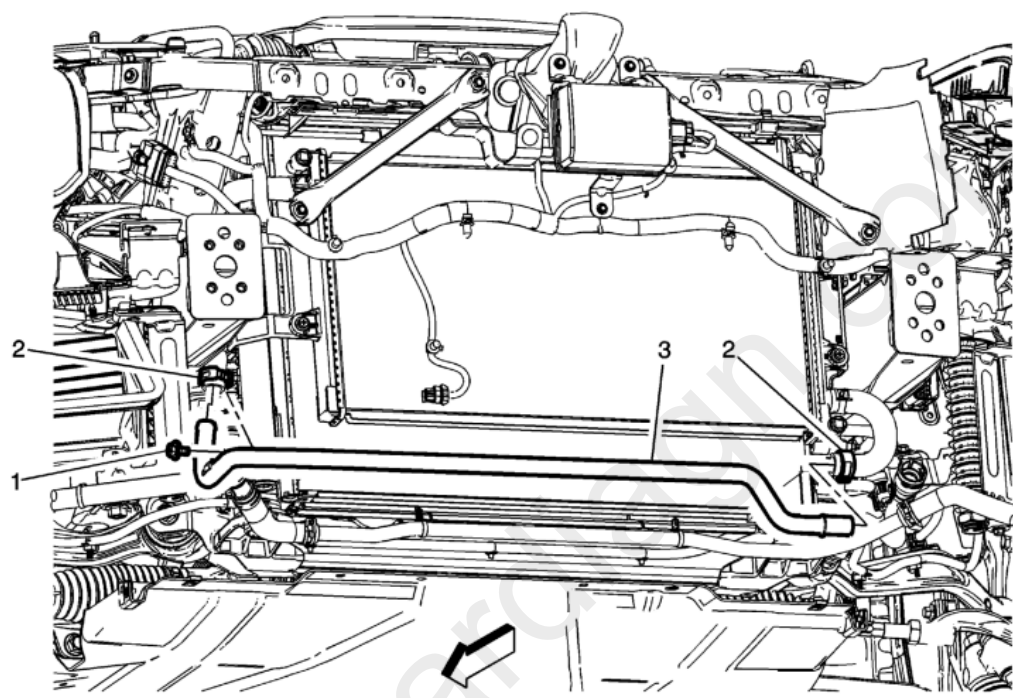


Fig. 39: Charge Air Cooler Coolant Pipe (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Coolant Pipe Replacement (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove the radiator air lower baffle and deflector. Refer to <u>Radiator Air Lower Baffle and Deflector Replacement (LF3)</u>. 2. Drain the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>.	
1	Charge Air Cooler Coolant Pipe Bolt CAUTION:

	Refer to Fastener Caution .
2	Charge Air Cooler Coolant Pipe Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
3	Charge Air Cooler Coolant Pipe Procedure 1. Fill the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling (LF3) . 2. Check the charge air cooling system for leaks.

CHARGE AIR COOLER COOLANT HOSE REPLACEMENT (PUMP TO ENGINE LF3)

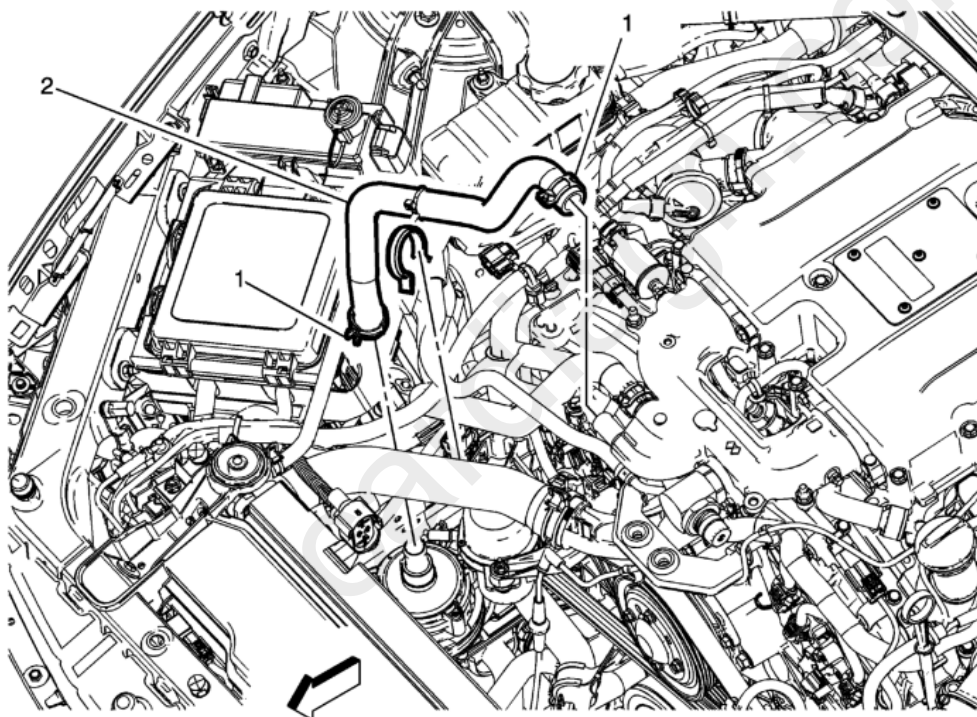


Fig. 40: Charge Air Cooler Coolant Hose (Pump to Engine LF3)

Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Coolant Hose Replacement (Pump to Engine LF3)

Callout	Component Name
Preliminary Procedures	
1.	Drain the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling (LF3) .

2. Remove the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement** .
3. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .
4. Remove the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement** .
5. Remove the air cleaner outlet front duct. Refer to **Air Cleaner Outlet Front Duct Replacement (LF3)** .

1	Charge Air Cooler Coolant Hose Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u>.
2	Charge Air Cooler Coolant Hose Procedure 1. Unclip the charge air cooler coolant hose retaining clip from the radiator inlet hose. 2. Fill the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 3. Check the charge air cooling system for leaks.

CHARGE AIR COOLER COOLANT HOSE REPLACEMENT - PIPE TO PUMP (LF3)

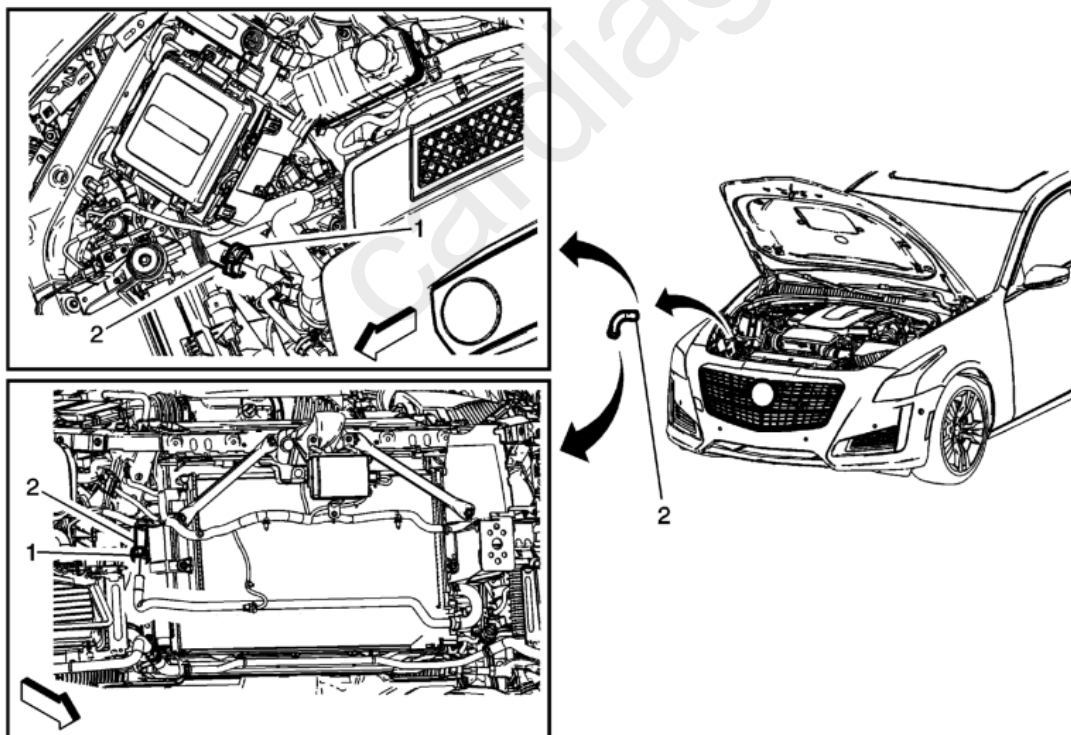


Fig. 41: Charge Air Cooler Coolant Hose - Pipe to Pump (LF3)
Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Coolant Hose Replacement - Pipe to Pump (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove the radiator air lower baffle and deflector. Refer to <u>Radiator Air Lower Baffle and Deflector Replacement (LF3)</u>. 2. Drain the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 3. Remove the radiator inlet hose. Refer to <u>Radiator Inlet Hose Replacement (LF3)</u>.	
1	Charge Air Cooler Coolant Hose-Pipe to Pump Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Charge Air Cooler Coolant Hose-Pipe to Pump Procedure 1. Fill the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 2. Check the charge air cooling system for leaks.

CHARGE AIR COOLER COOLANT HOSE REPLACEMENT - ENGINE TO RADIATOR

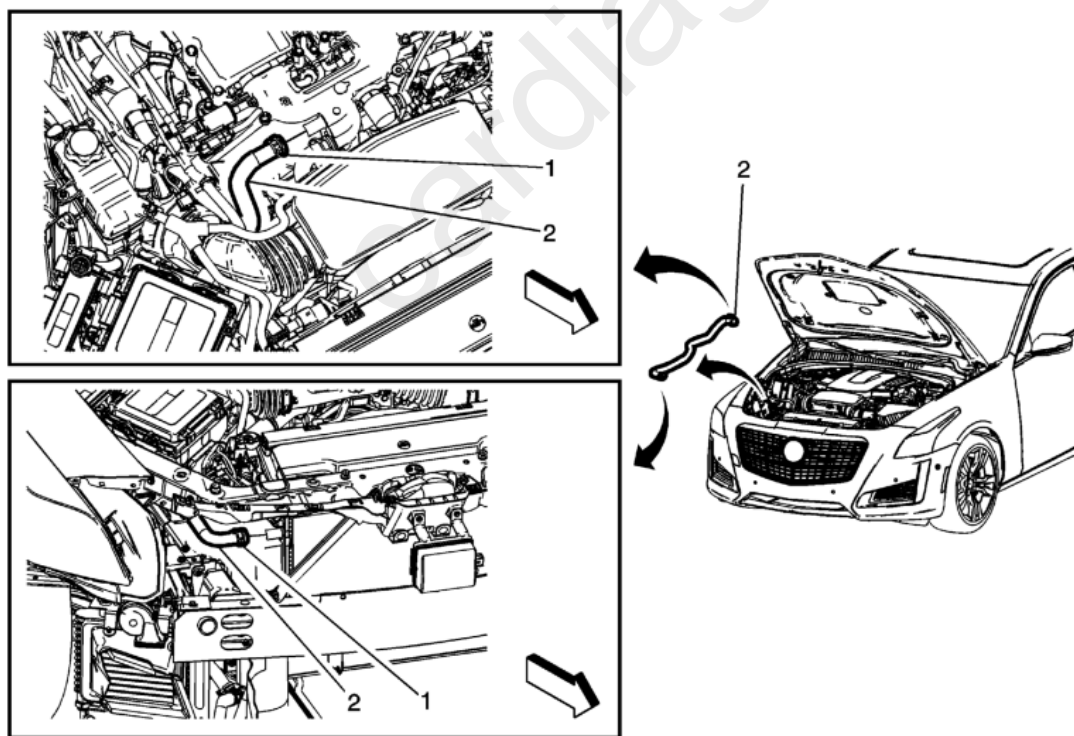


Fig. 42: Charge Air Cooler Coolant Hose - Engine to Radiator
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Coolant Hose Replacement - Engine to Radiator

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> . 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> . 3. Drain the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>.	
1	Charge Air Cooler Coolant Hose-Engine to Charge Air Cooler Radiator Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Charge Air Cooler Coolant Hose-Engine to Charge Air Cooler Radiator Procedure 1. Fill the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 2. Check the charge air cooling system for leaks.

CHARGE AIR COOLER COOLANT HOSE REPLACEMENT - RADIATOR TO PIPE (LF3)

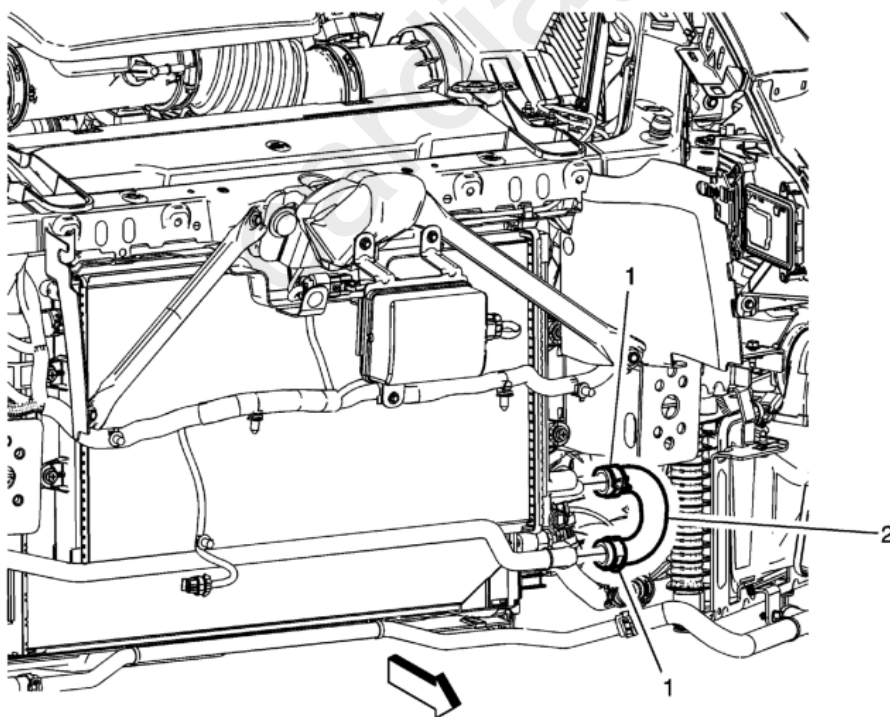


Fig. 43: Charge Air Cooler Coolant Hose - Radiator to Pipe (LF3)

Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Coolant Hose Replacement - Radiator to Pipe (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove the radiator air lower baffle and deflector. Refer to <u>Radiator Air Lower Baffle and Deflector Replacement (LF3)</u>. 2. Drain the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>.	
1	Charge Air Cooler Coolant Hose-Radiator to Pipe Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Charge Air Cooler Coolant Hose-Radiator to Pipe Procedure 1. Fill the charge air cooling system. 2. Check the charge air cooling system for leaks.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LTG)

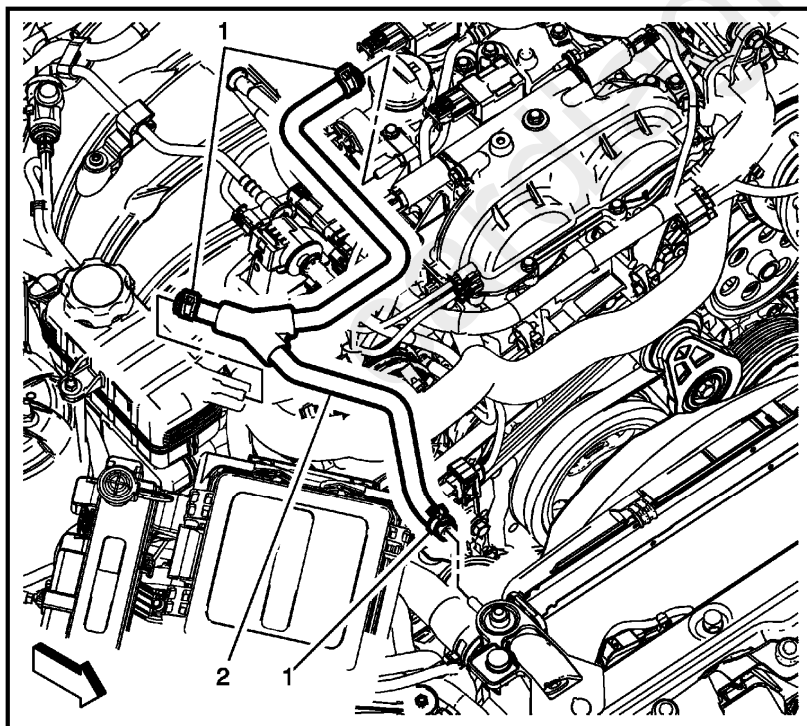


Fig. 44: Radiator Surge Tank Inlet Hose (LTG)

Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 3. Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u>.	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 3) Procedure Reposition the radiator surge tank inlet hose clamps using BO-38185 Hose Clamp Pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Surge Tank Inlet Hose Procedure 1. Fill coolant to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect cooling system for leaks. Refer to <u>Cooling System Leak Testing</u>.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LFX)

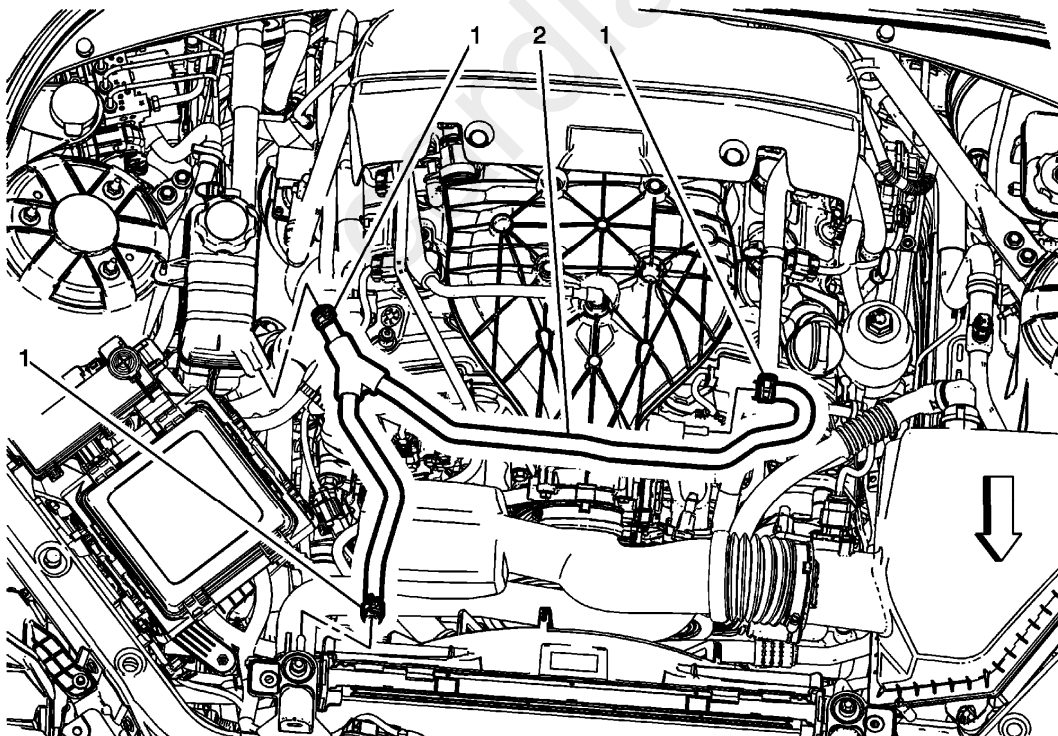


Fig. 45: Radiator Surge Tank Inlet Hose (LFX)

Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (LFX)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> . 3. Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u> .	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 3) Procedure Reposition the radiator surge tank inlet clamps using BO-38185 Hose Clamp Pliers. Special Tools BO-38185 Hose Clamp Pliers
2	Radiator Surge Tank Inlet Hose Procedure 1. Fill coolant to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect cooling system for leaks. Refer to <u>Cooling System Leak Testing</u>.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LF3)

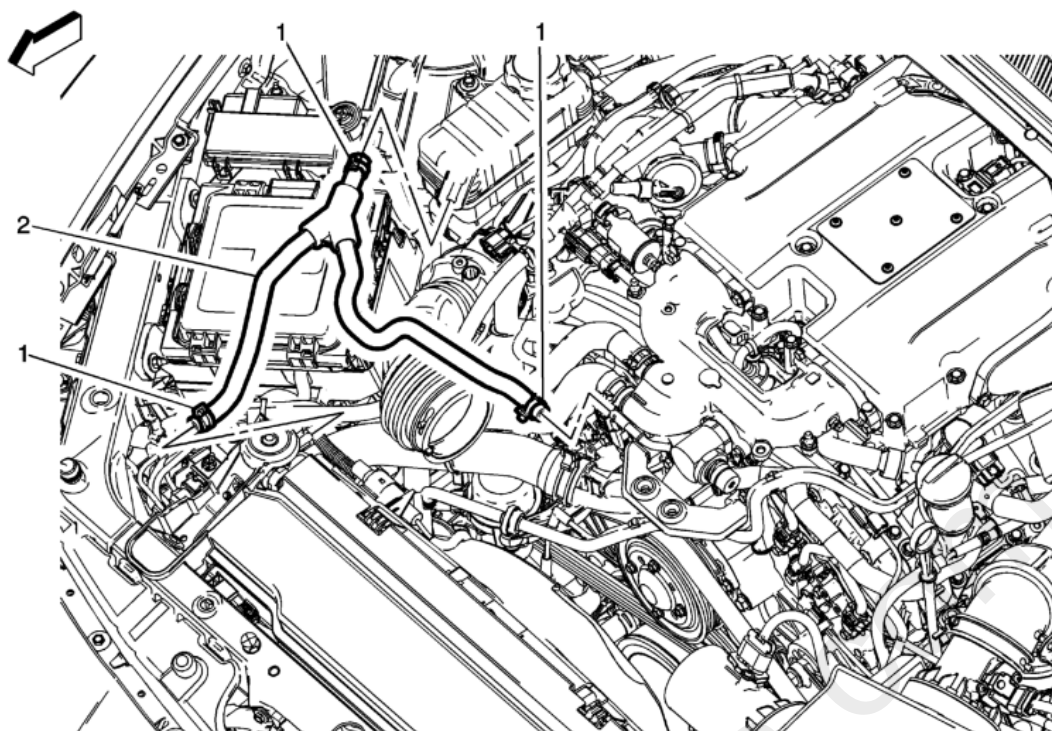


Fig. 46: Radiator Surge Tank Inlet Hose (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (LF3)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u>. 3. Remove the air cleaner outlet front duct. Refer to <u>Air Cleaner Outlet Front Duct Replacement (LF3)</u>.	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 3) Procedure Reposition the radiator surge tank inlet clamps using BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers
2	Radiator Surge Tank Inlet Hose Procedure 1. Fill coolant to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect cooling system for leaks. Refer to <u>Cooling System Leak Testing</u>.

RADIATOR INLET PIPE REPLACEMENT (LTG)

Removal Procedure

Special Tools

BO-38185 Hose Clamp Pliers

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

1. Remove the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LTG)**.
2. Remove the plenum front panel. Refer to **Plenum Front Panel Replacement** .
3. Remove the fuel pump cover. Refer to **Fuel Pump Cover Replacement** .

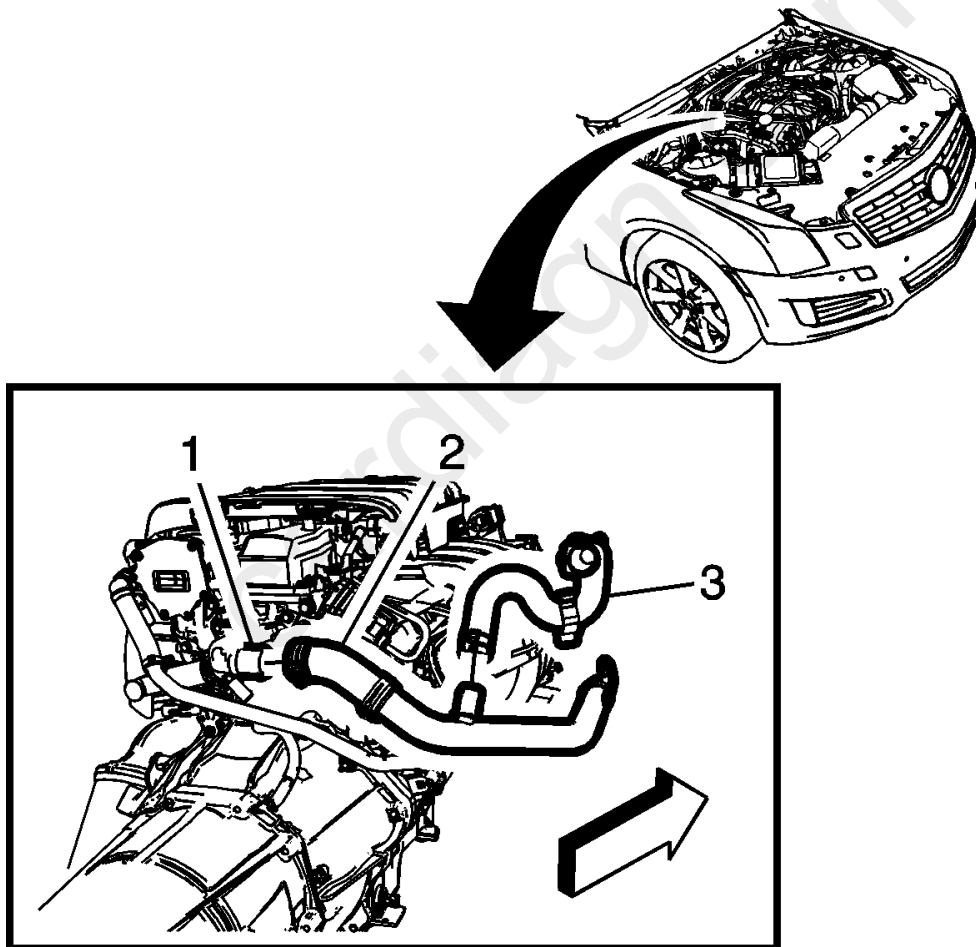


Fig. 47: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

4. Remove the heater inlet hose (3) and the radiator inlet pipe/hose clamp (2), from the water outlet neck (1).

5. Remove the radiator inlet hose from the radiator inlet pipe. Refer to **Radiator Inlet Hose Replacement (LTG)**.
6. If equipped with Secondary Air Injection (SAI), raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.

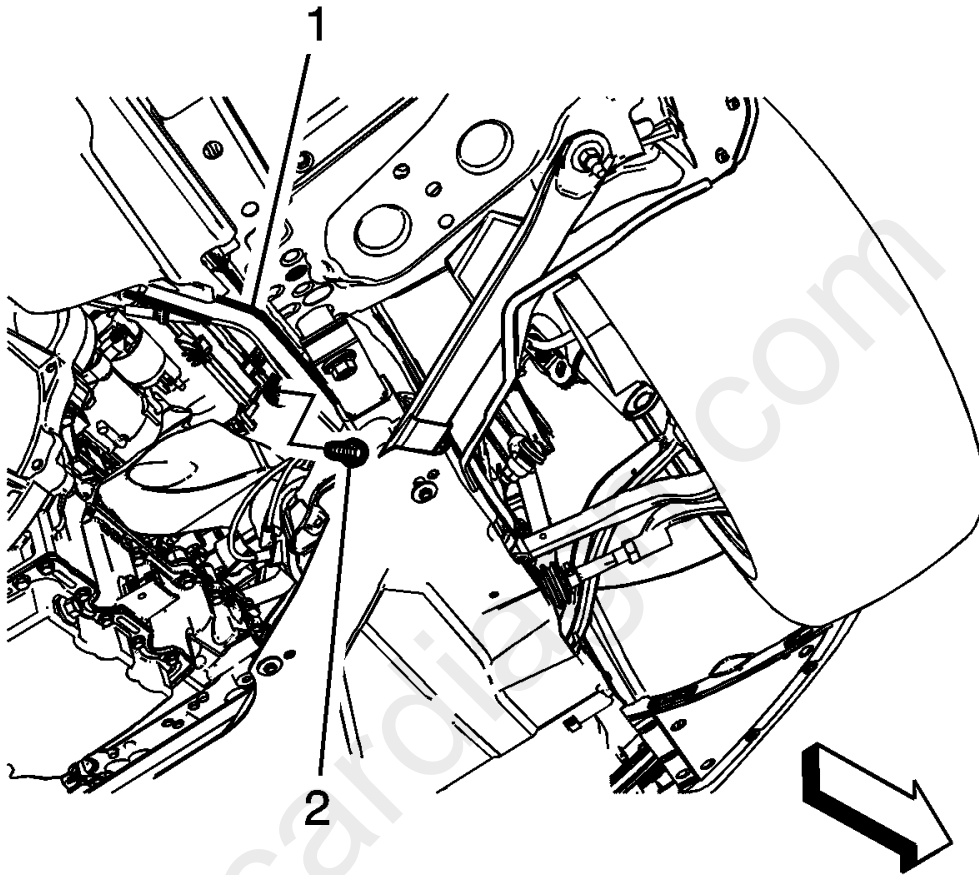


Fig. 48: Secondary Air Injection Feed Tube
Courtesy of GENERAL MOTORS COMPANY

7. If equipped with SAI, remove the fastener (1) securing the secondary air injection feed tube (1) to the radiator inlet pipe.

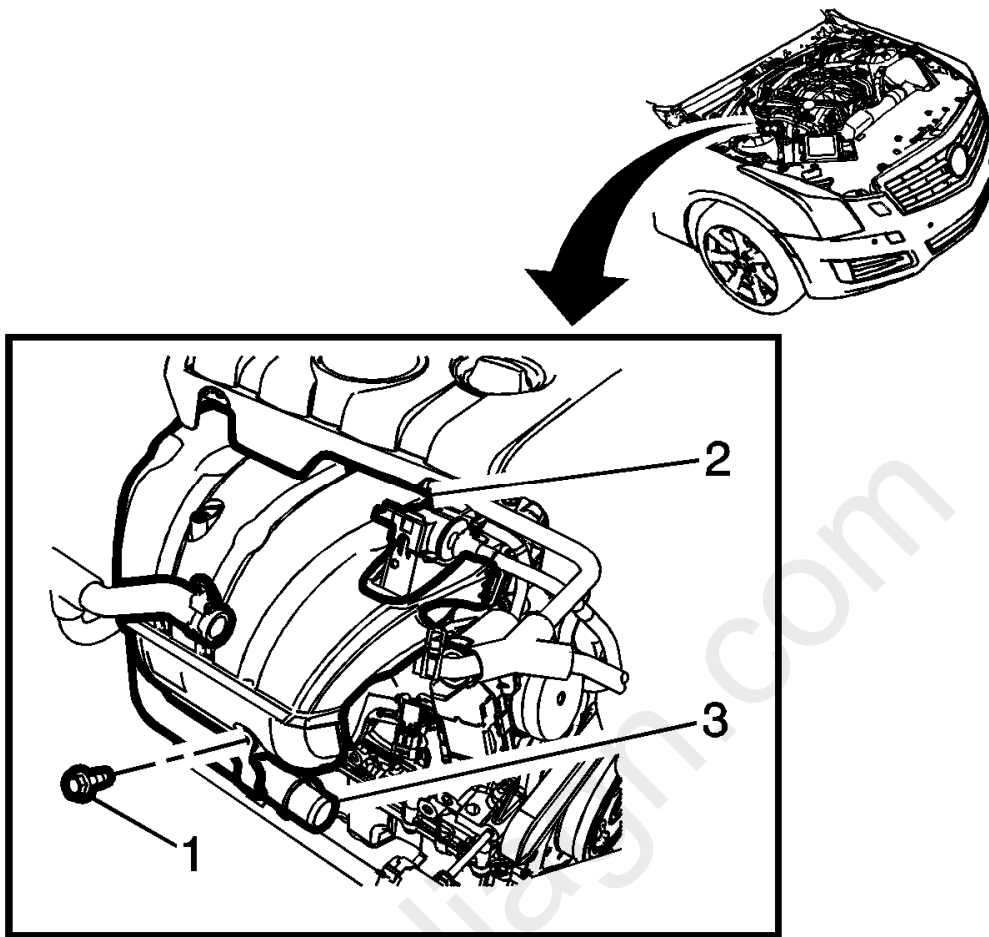


Fig. 49: Radiator Inlet Pipe

Courtesy of GENERAL MOTORS COMPANY

8. Remove the radiator inlet pipe retainer fastener (1), securing the radiator inlet pipe (3), to the intake manifold cover (2).

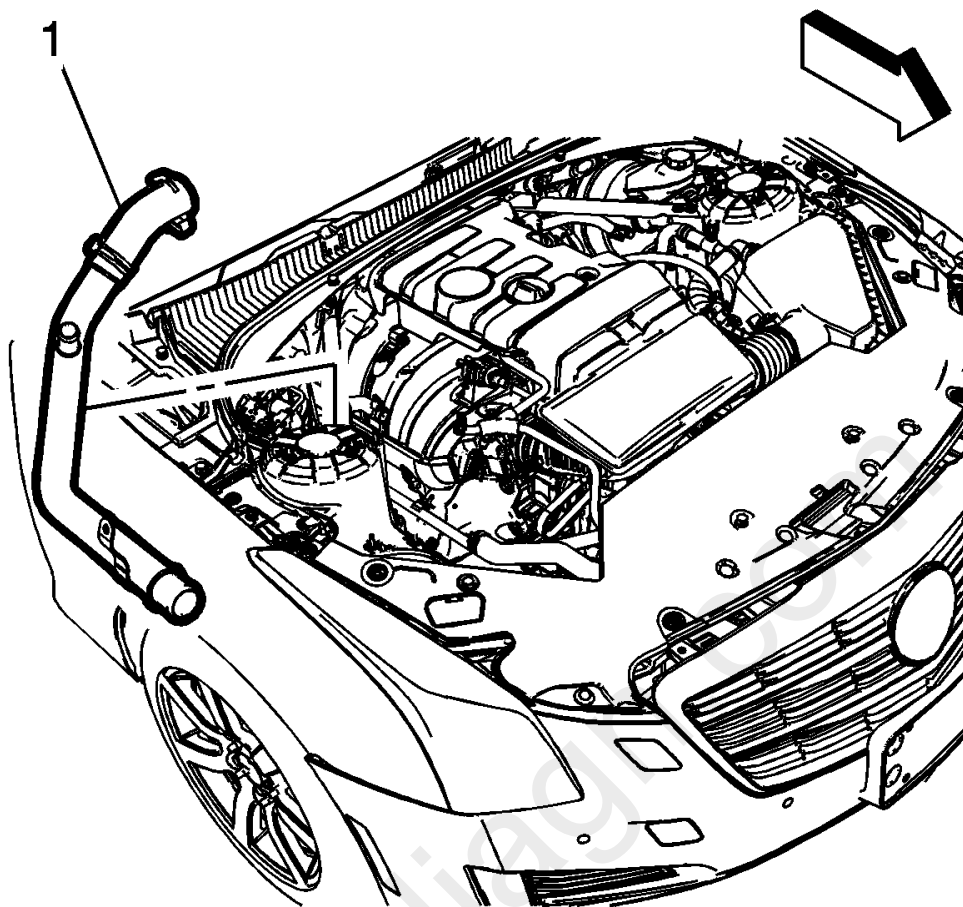


Fig. 50: Radiator Inlet Pipe/Hose
Courtesy of GENERAL MOTORS COMPANY

9. Remove the radiator inlet pipe/hose (1) from the engine compartment.

Installation Procedure

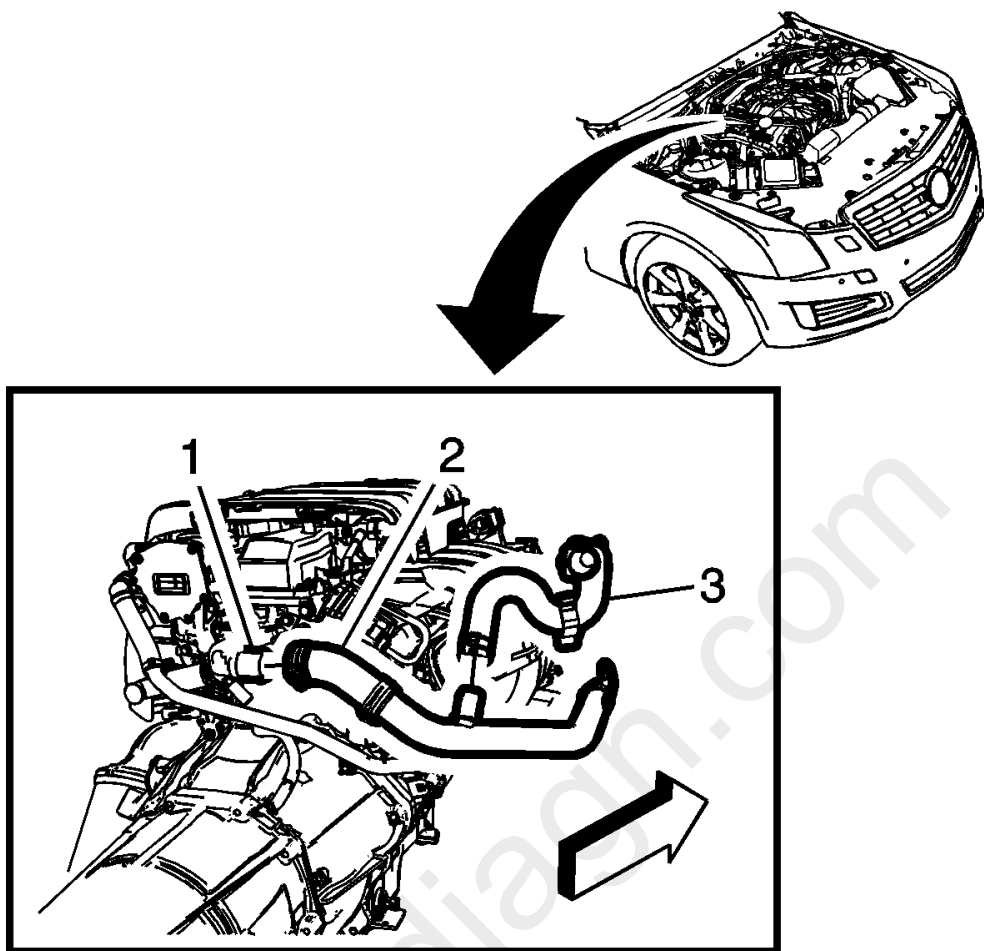


Fig. 51: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator inlet hose/pipe (2) to the water outlet neck (1).
2. Install the heater inlet hose (3) to the radiator inlet pipe.

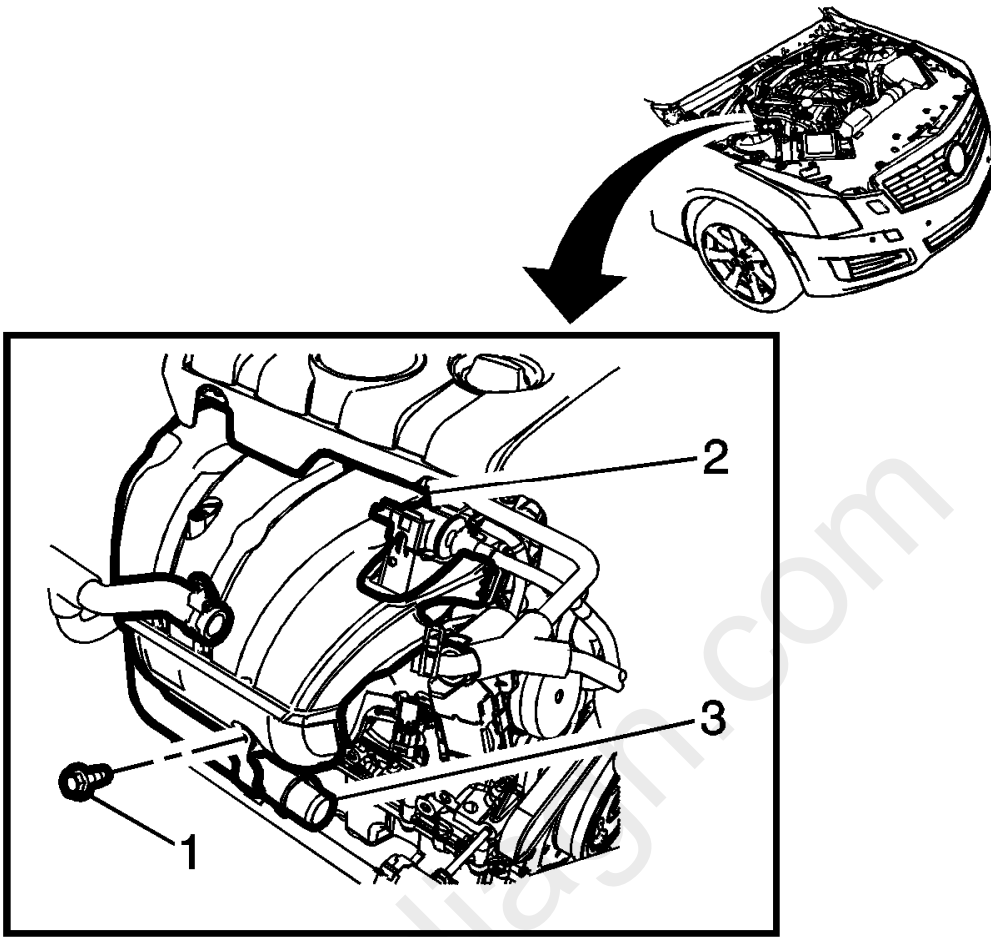


Fig. 52: Radiator Inlet Pipe

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the radiator inlet pipe (3) to the intake manifold cover (2) and tighten the fastener (1) to 9 (80 lb in).

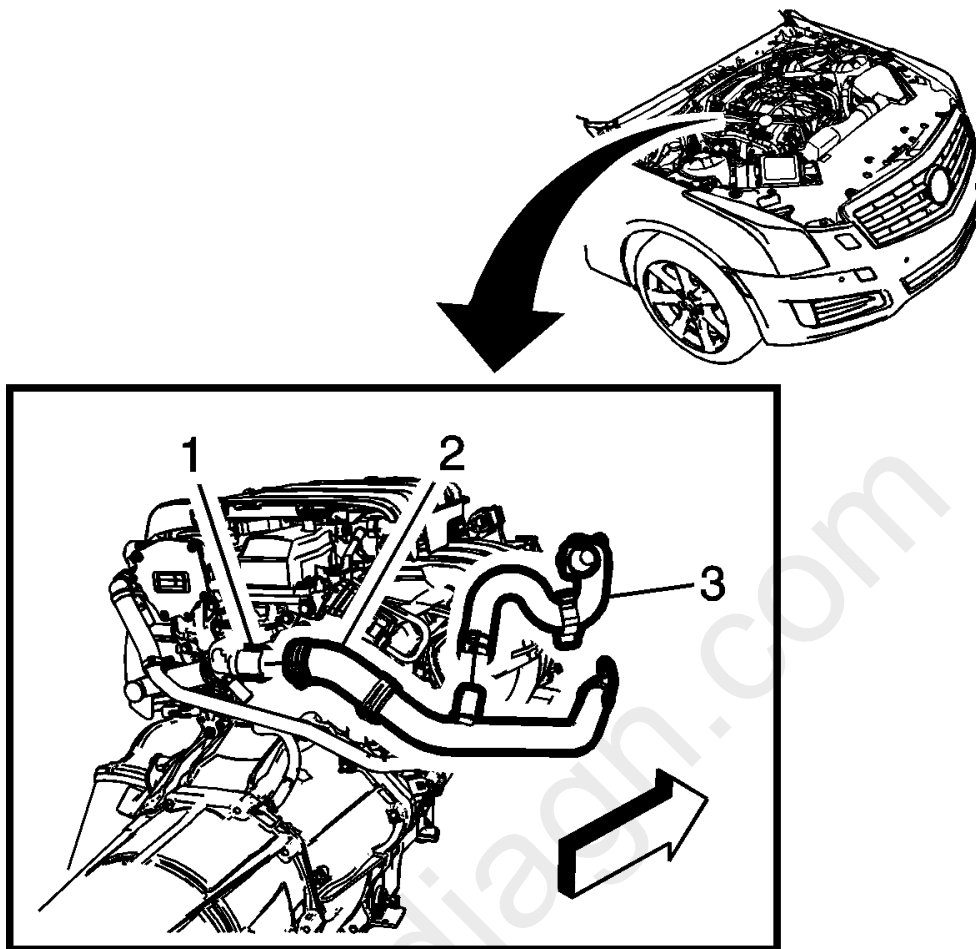


Fig. 53: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

4. If equipped with SAI, install the secondary air injection feed tube (1) to the radiator inlet pipe. Tighten the fastener (2) to 9 (80 lb in).
5. Install the radiator inlet hose from the radiator inlet pipe. Refer to **Radiator Inlet Hose Replacement (LTG)**.
6. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
7. Install the fuel pump cover. Refer to **Fuel Pump Cover Replacement** .
8. Install the plenum front panel. Refer to **Plenum Front Panel Replacement** .
9. Start the engine and check for coolant leaks.

RADIATOR INLET HOSE REPLACEMENT (LTG)

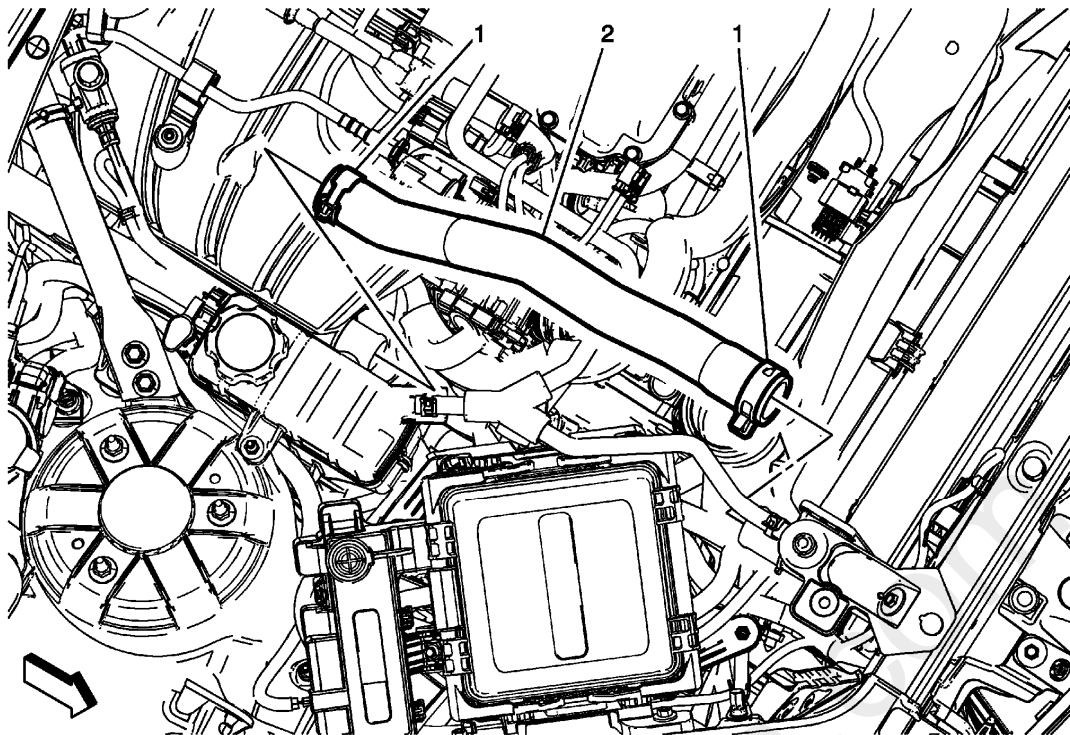


Fig. 54: Radiator Inlet Hose (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Radiator 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 <u>Special Tools</u> .
2	Radiator Inlet Hose Procedure 1. Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect the cooling system for leaks.

RADIATOR INLET HOSE REPLACEMENT (LFX)

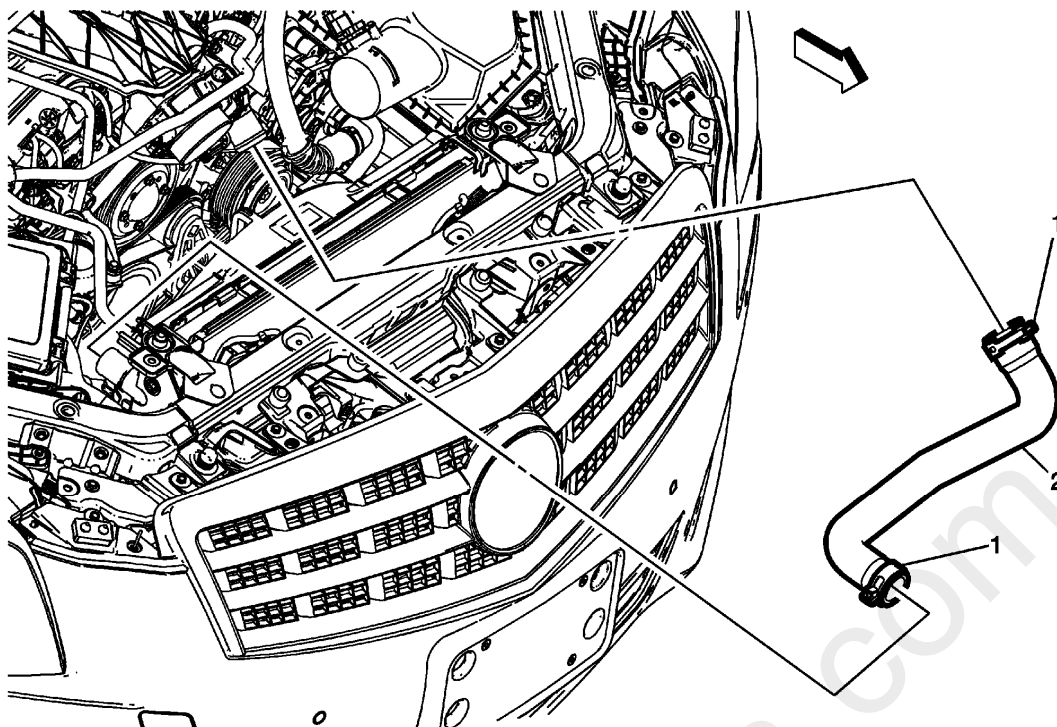


Fig. 55: Radiator Inlet Hose (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LFX)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u> . 3. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> . 4. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LFX)</u> .	
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 <u>Special Tools</u> .
2	Radiator Inlet Hose Procedure 1. Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .

2. Inspect the cooling system for leaks.

RADIATOR INLET HOSE REPLACEMENT (LF3)

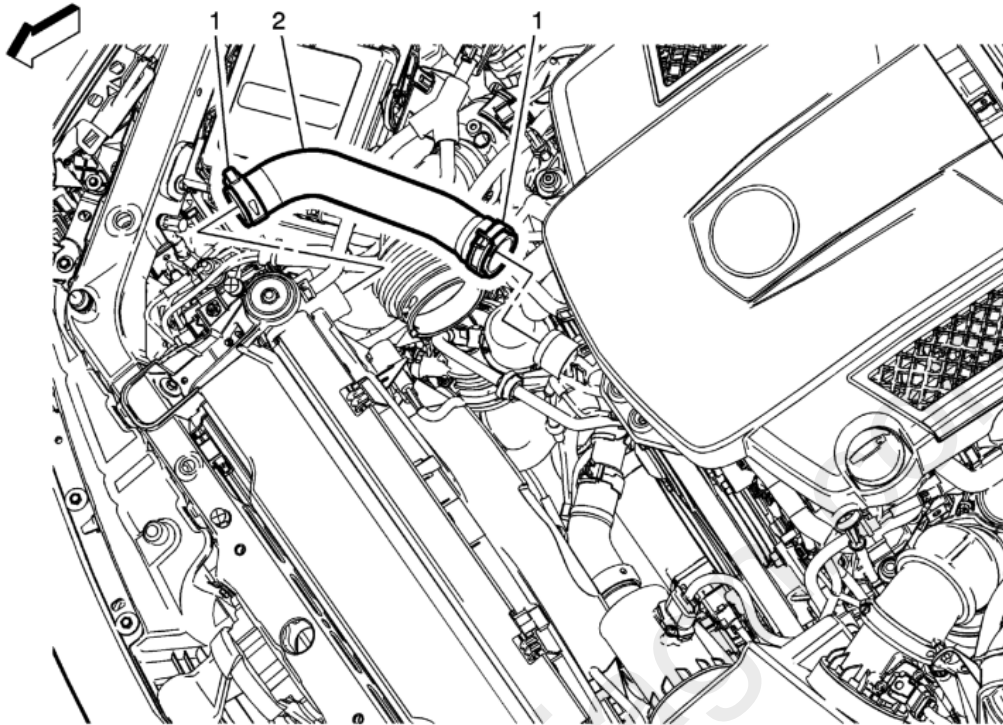


Fig. 56: Radiator Inlet Hose (LF3)

Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LF3)

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 front compartment front sight shield. Refer to Front Compartment Front Sight Shield Replacement. 3. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LF3). 4. Remove the air cleaner outlet front duct. Refer to Air Cleaner Outlet Front Duct Replacement (LF3).	
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.

Radiator Inlet Hose

2

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.

AUXILIARY RADIATOR INLET HOSE REPLACEMENT (LF3)

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)**.

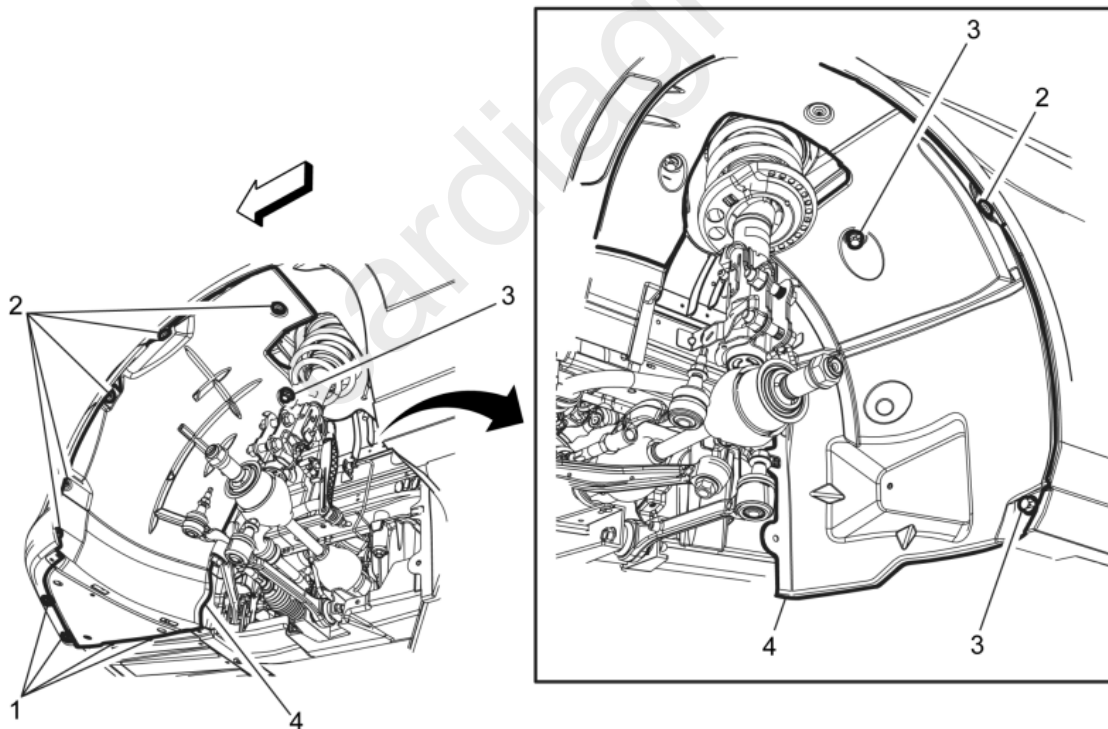


Fig. 57: Front Wheelhouse Liners

Courtesy of GENERAL MOTORS COMPANY

2. Remove the front wheelhouse liners (4). Refer to **Front Wheelhouse Liner Replacement** .

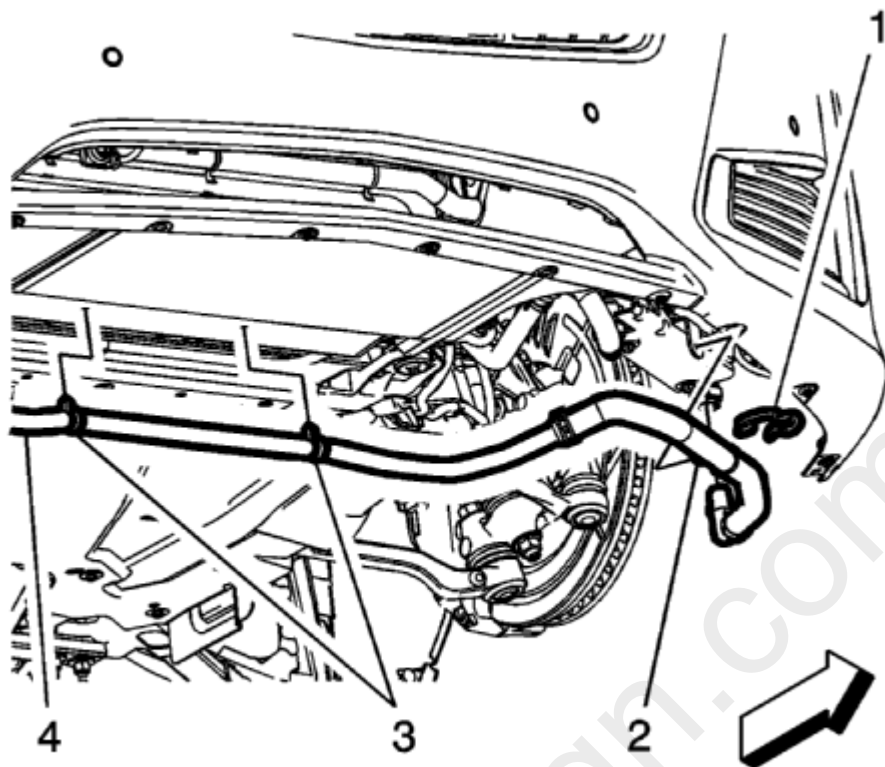


Fig. 58: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove the auxiliary radiator inlet hose retaining clip (1) from the auxiliary radiator.
4. Remove the auxiliary radiator inlet hose retainer (2) from auxiliary radiator lower bracket.
5. Remove the auxiliary radiator inlet hose retainers (3) from the radiator air lower baffle and deflector.
6. Remove the auxiliary radiator inlet hose (4) from the auxiliary radiator.

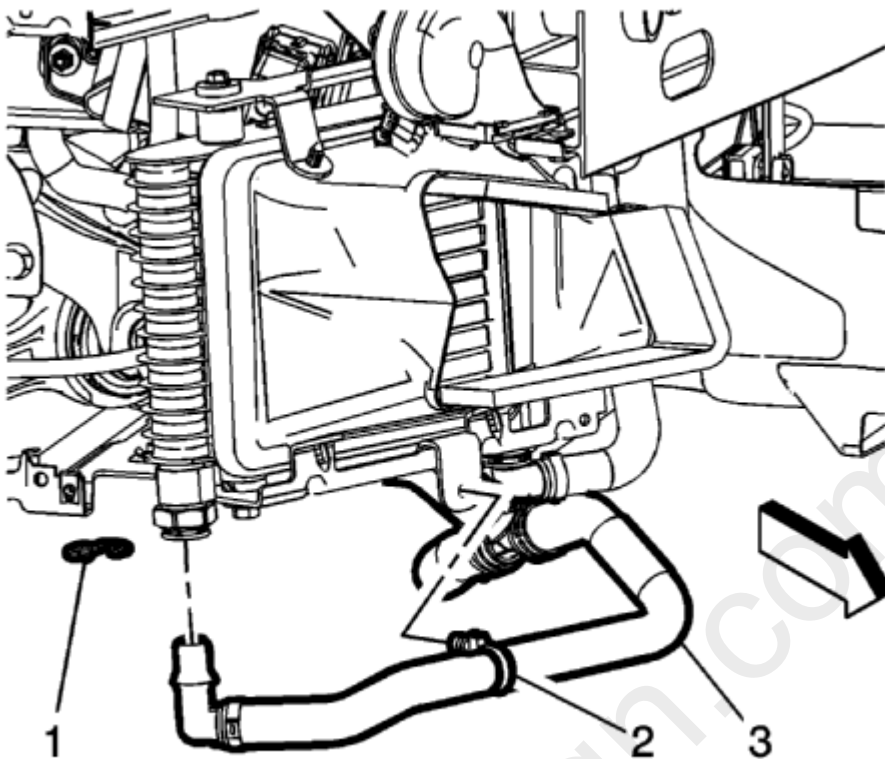


Fig. 59: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Remove the auxiliary radiator inlet hose retaining clip (1) from the auxiliary radiator.
8. Remove the auxiliary radiator inlet hose retainer (2) from auxiliary radiator lower bracket.
9. Remove the auxiliary radiator inlet hose (3) from the auxiliary radiator.

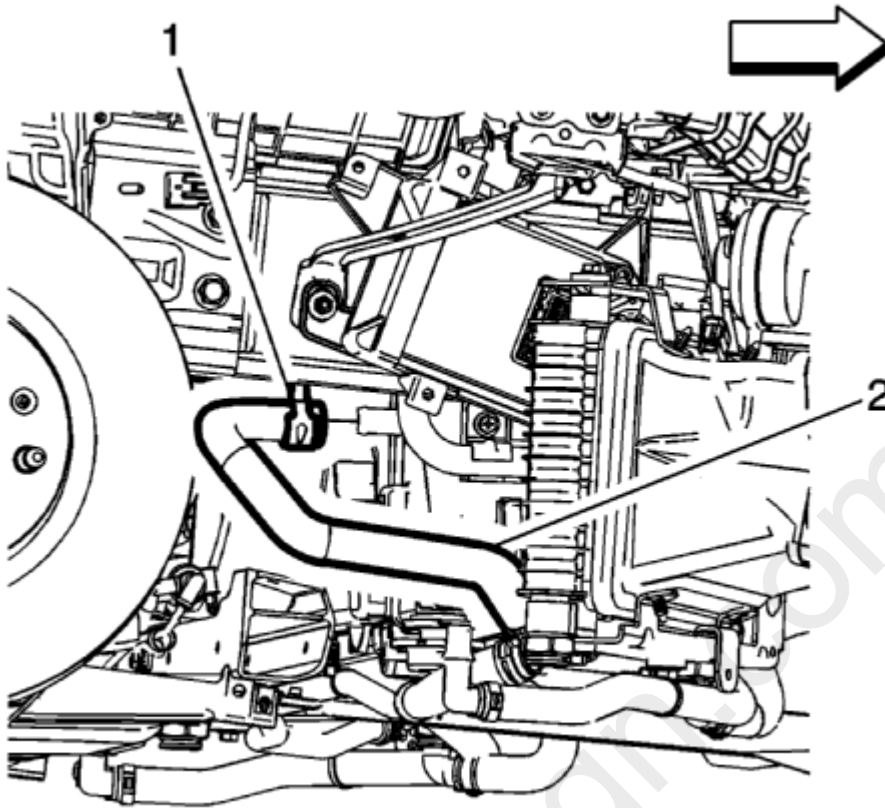


Fig. 60: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

10. Disengage tension on the auxiliary radiator inlet hose clamp (1) using the **BO-38185** hose clamp pliers.
11. Remove the auxiliary radiator inlet hose (2) and clamp (1) from the radiator.

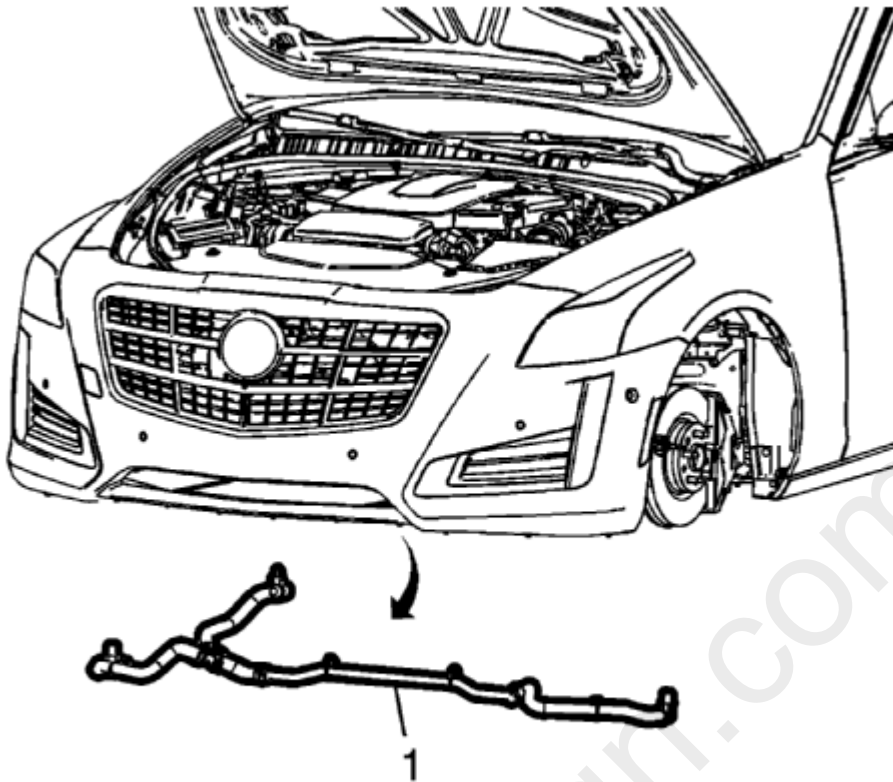


Fig. 61: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

12. Remove the auxiliary radiator inlet hose (1) from the vehicle.

Installation Procedure

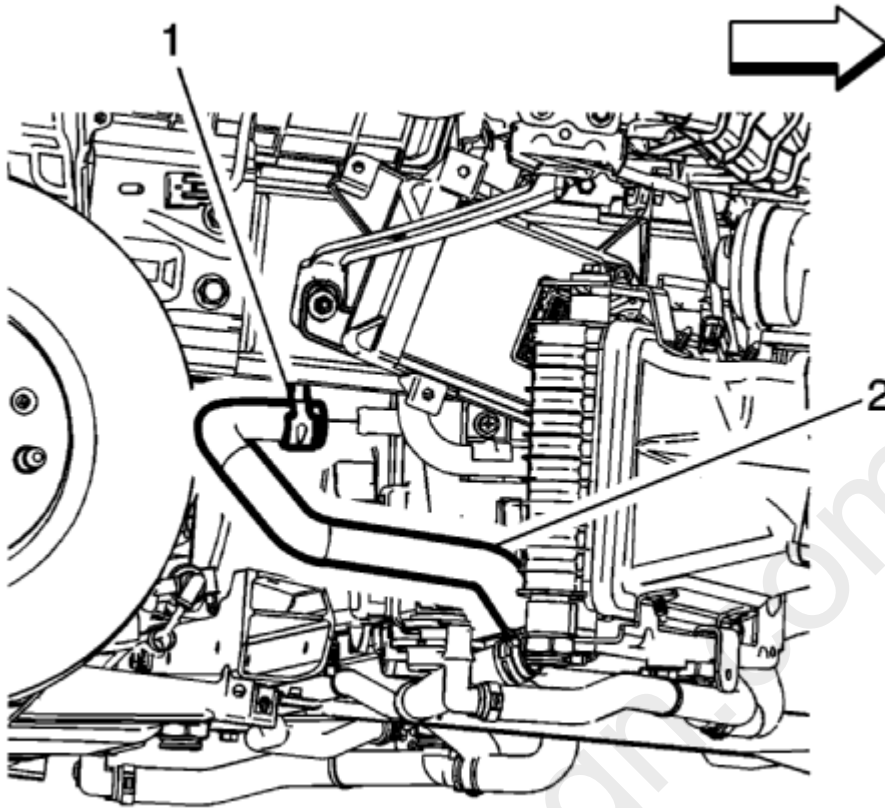


Fig. 62: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install the auxiliary radiator inlet hose (2) and clamp (1) to the radiator.
2. Engage tension on the auxiliary radiator inlet hose clamp (1) using the **BO-38185** hose clamp pliers.

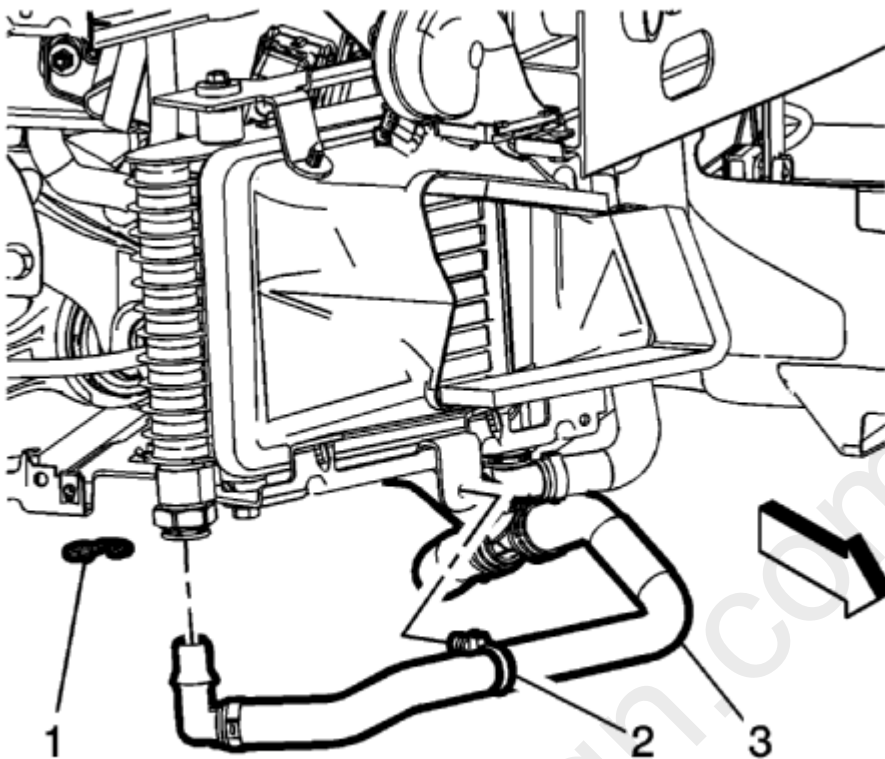


Fig. 63: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

3. Install the auxiliary radiator inlet hose (3) to the auxiliary radiator.
4. Install the auxiliary radiator inlet hose retainer (2) to auxiliary radiator lower bracket.
5. Install the auxiliary radiator inlet hose retaining clip (1) to the auxiliary radiator.

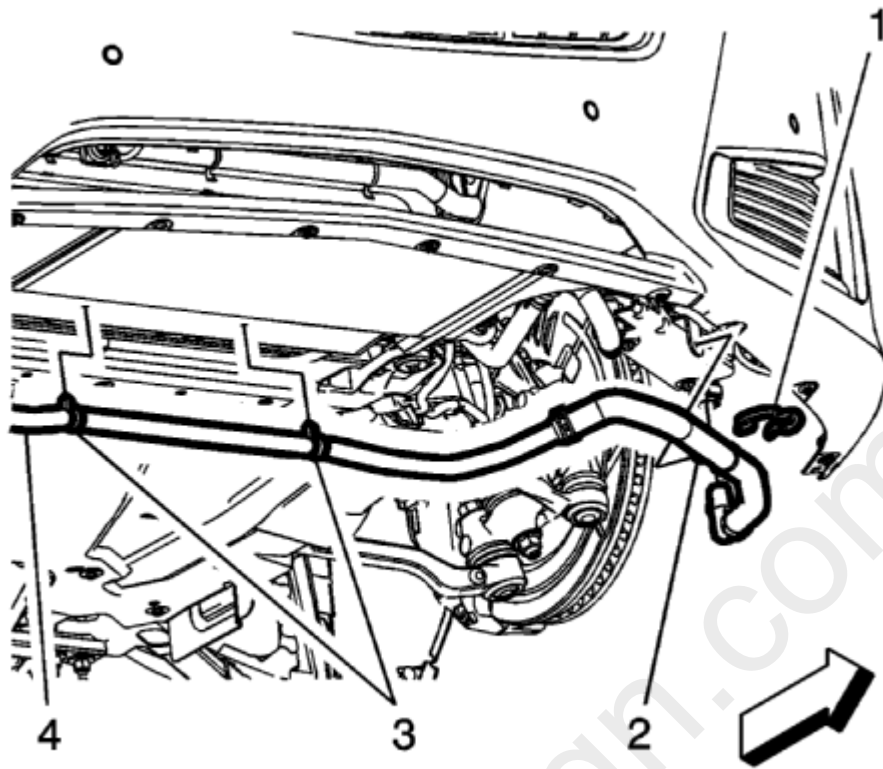


Fig. 64: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install the auxiliary radiator inlet hose (4) to the auxiliary radiator.
7. Install the auxiliary radiator inlet hose retainers (3) to the radiator air lower baffle and deflector.
8. Install the auxiliary radiator inlet hose retainer (2) to auxiliary radiator lower bracket.
9. Install the auxiliary radiator inlet hose retaining clip (1) to the auxiliary radiator.

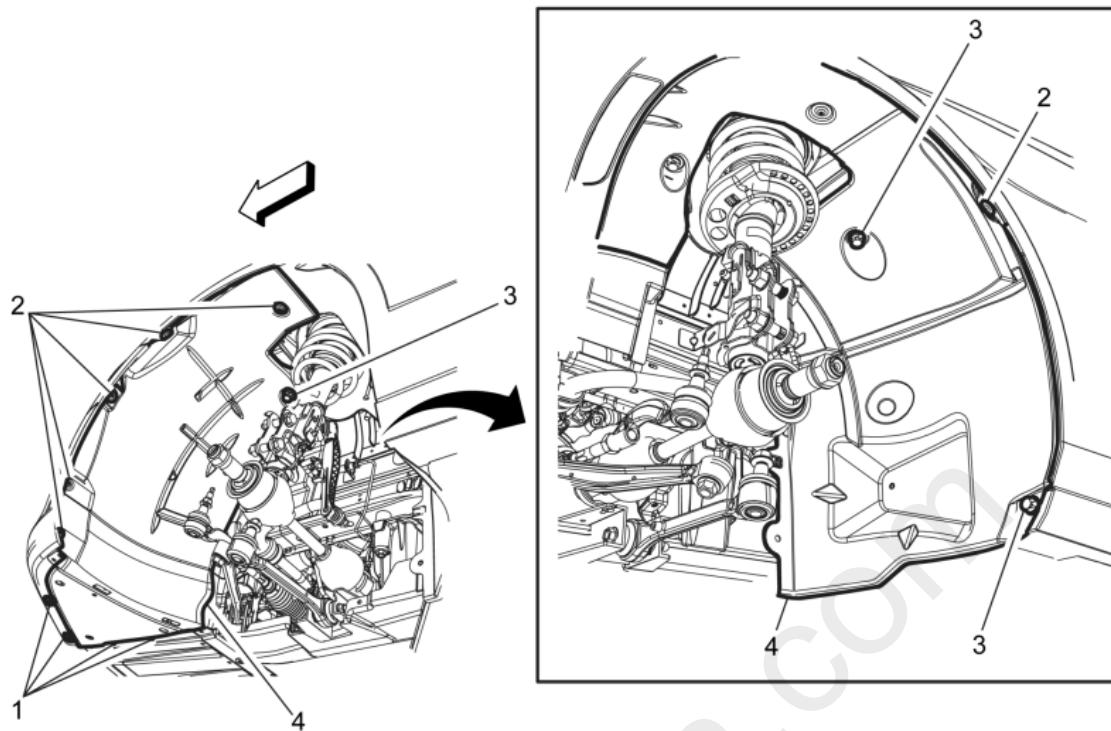


Fig. 65: Front Wheelhouse Liners
 Courtesy of GENERAL MOTORS COMPANY

10. Install the front wheelhouse liners (4). Refer to **Front Wheelhouse Liner Replacement** .
11. Lower the vehicle.
12. Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
13. Inspect the cooling system for leaks. Refer to **Cooling System Leak Testing**.

RADIATOR OUTLET HOSE REPLACEMENT (LTG WITH V03)

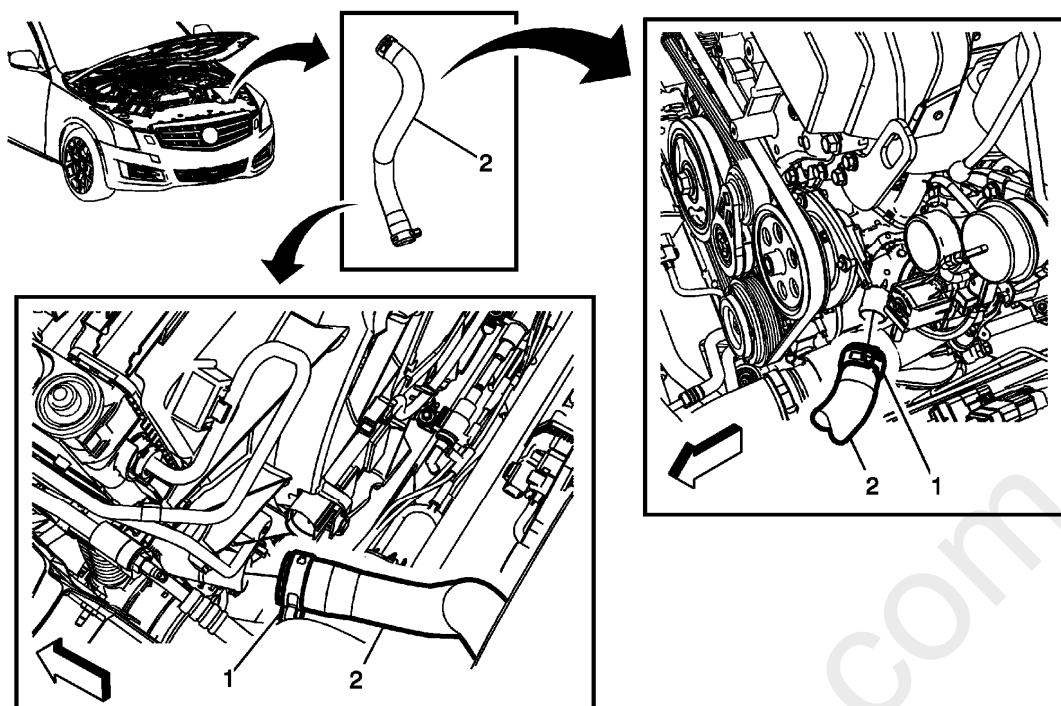


Fig. 66: Radiator Outlet Hose (LTG with V03)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LTG with V03)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u>. 3. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u>.	
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 <u>Special Tools</u> .
2	Radiator Outlet Hose Procedure 1. Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect the cooling system for leaks.

RADIATOR OUTLET HOSE REPLACEMENT (LFX)

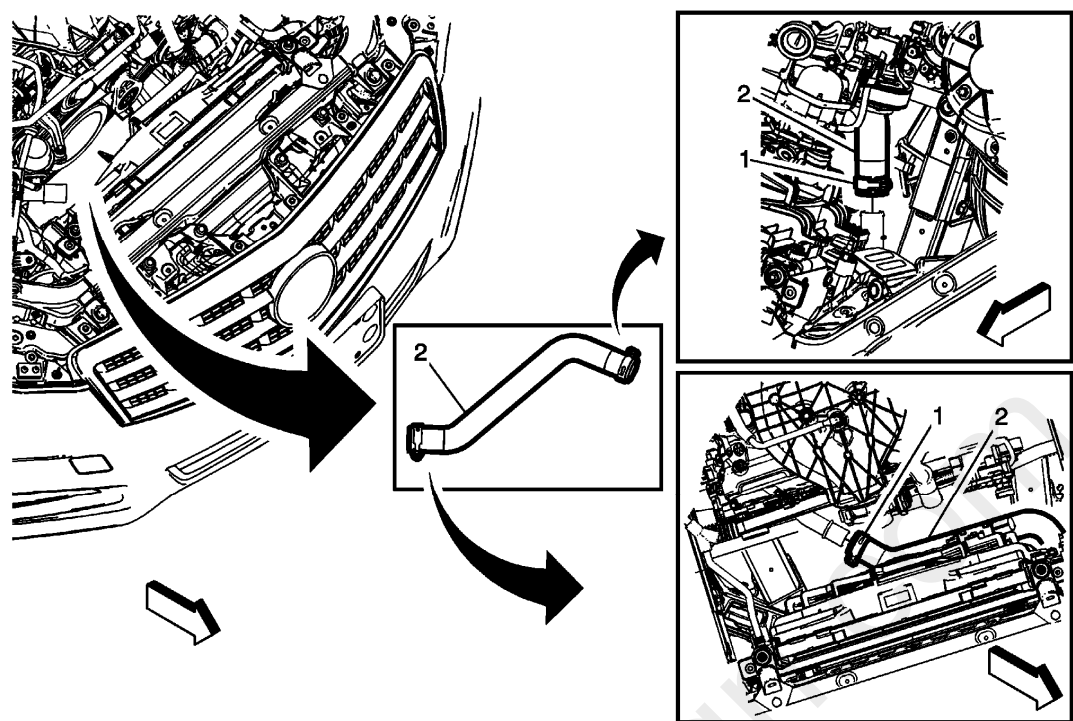


Fig. 67: Radiator Outlet Hose (LFX)
Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LFX)

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 front compartment front sight shield. Refer to Front Compartment Front Sight Shield Replacement .	
3. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) .	
4. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement (LFX) .	
5. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement (LFX) .	
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 .
	Radiator Outlet Hose

Procedure	
2	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 OUTLET HOSE REPLACEMENT (LTG WITHOUT V03)

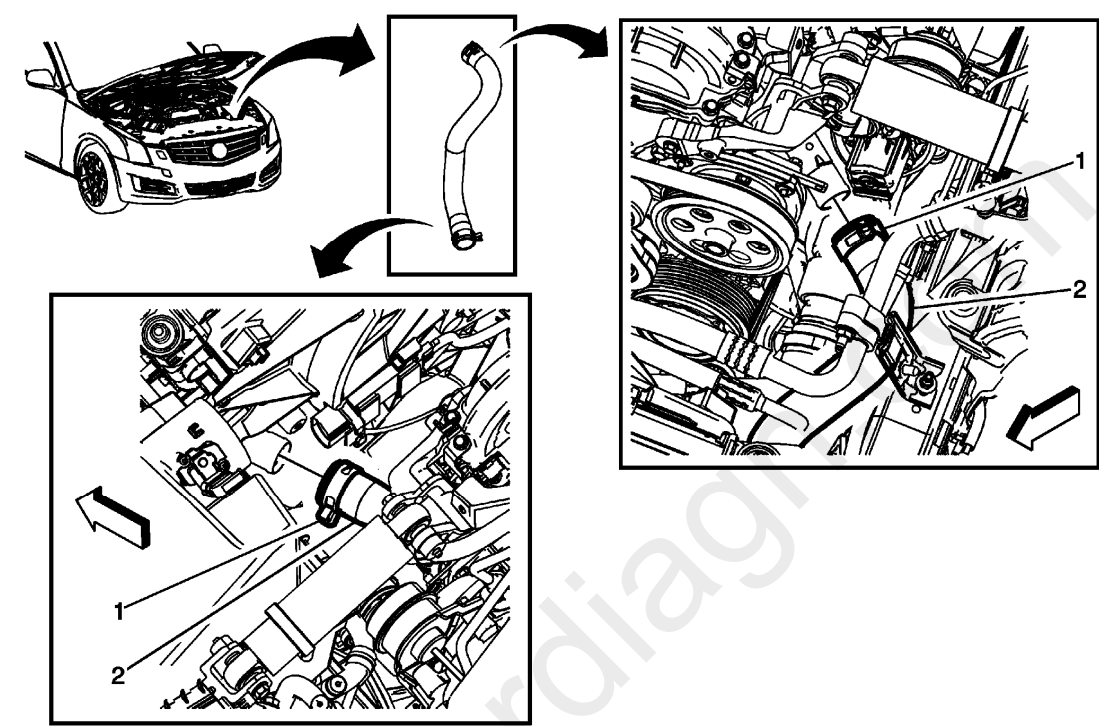


Fig. 68: Radiator Outlet Hose (LTG without V03)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LTG without V03)

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 front compartment front sight shield. Refer to Front Compartment Front Sight Shield Replacement. 3. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement. 4. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.	
1	Radiator Outlet Hose Clamp (Qty: 2) Procedure Reposition the radiator outlet hose clamps using the BO-38185 hose clamp pliers.

	Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Outlet Hose Procedure 1. Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect the cooling system for leaks.

RADIATOR OUTLET HOSE REPLACEMENT (LF3)

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)**.

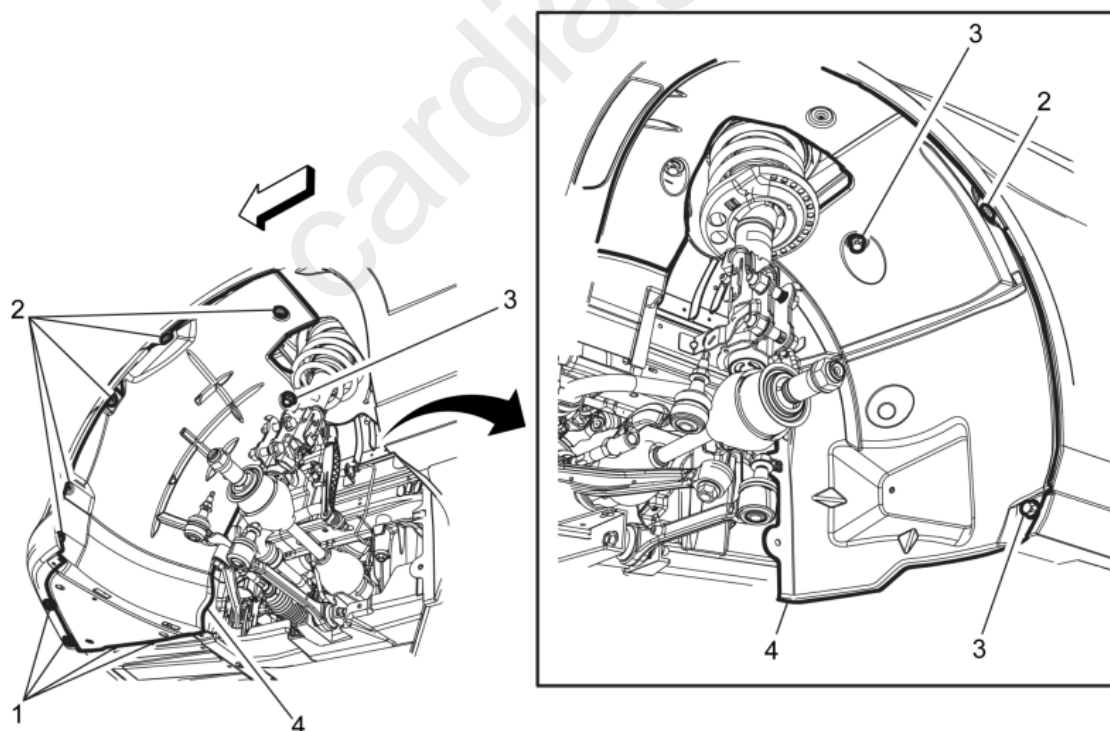


Fig. 69: Front Wheelhouse Liners

Courtesy of GENERAL MOTORS COMPANY

2. .

Remove the left front wheelhouse front liner (4). Refer to Front Wheelhouse Liner Replacement .

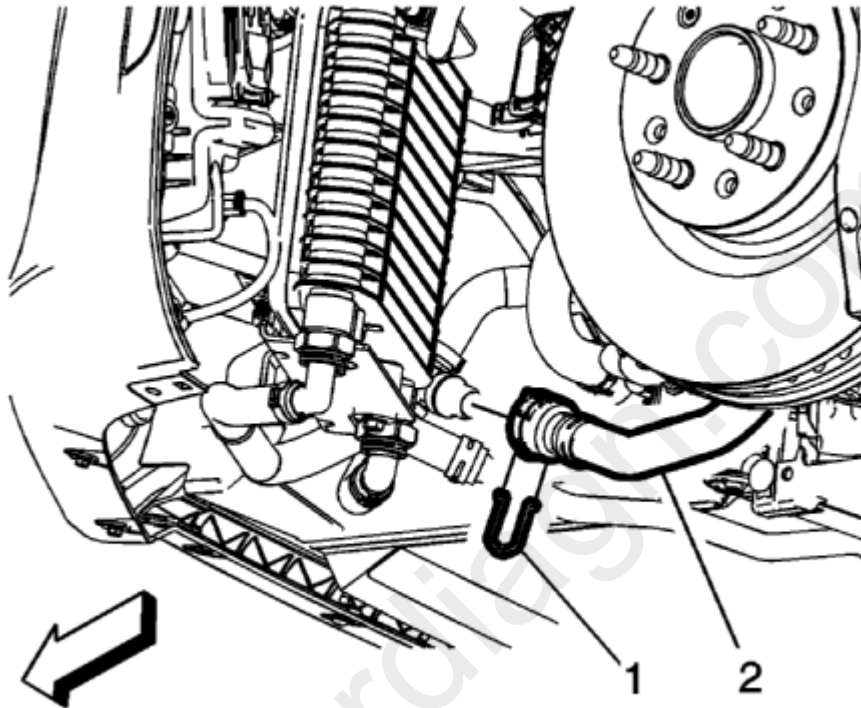


Fig. 70: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose retaining clip (1).
4. Remove the radiator outlet hose (2) from the auxiliary radiator outlet hose.

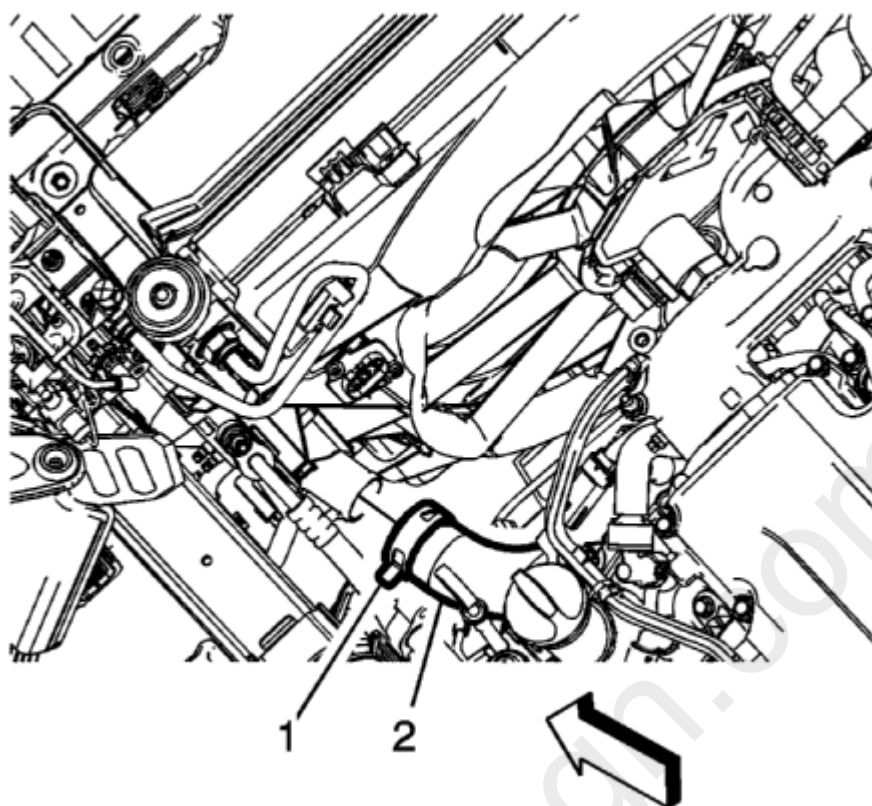


Fig. 71: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

5. Disengage tension on the radiator outlet hose clamp (1) using the **BO-38185** hose clamp pliers.
6. Remove the radiator outlet hose (2) and clamp (1) from the radiator.
7. Lower the vehicle.

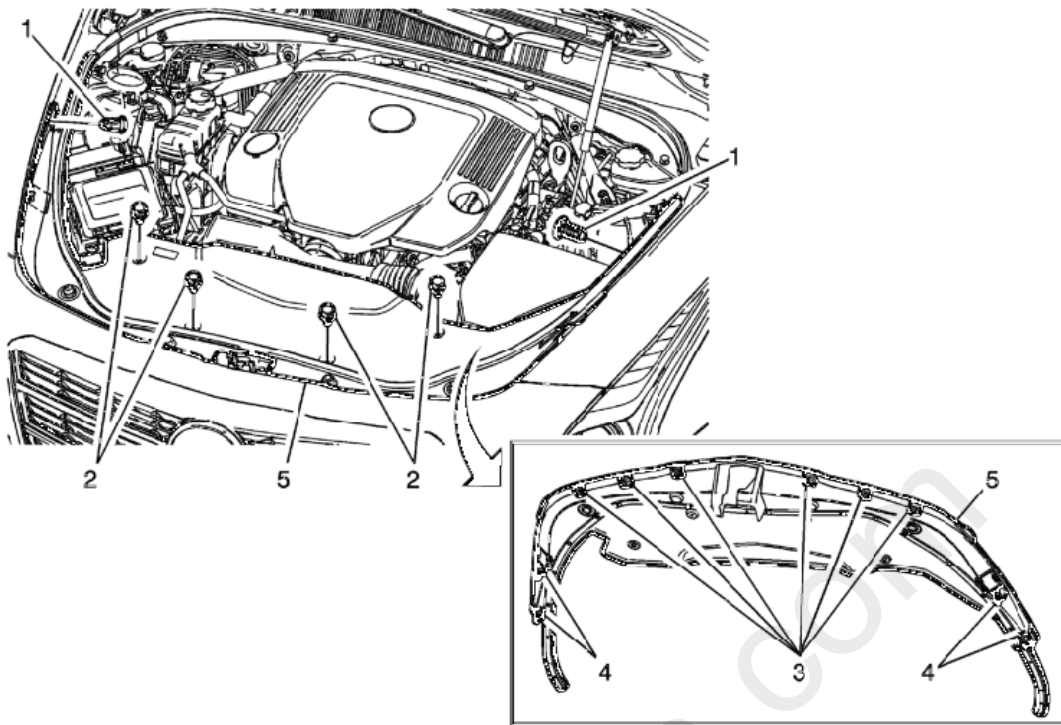


Fig. 72: Front Compartment Front Sight Shield
Courtesy of GENERAL MOTORS COMPANY

8. Remove the front compartment front sight shield (5). Refer to **Front Compartment Front Sight Shield Replacement** .

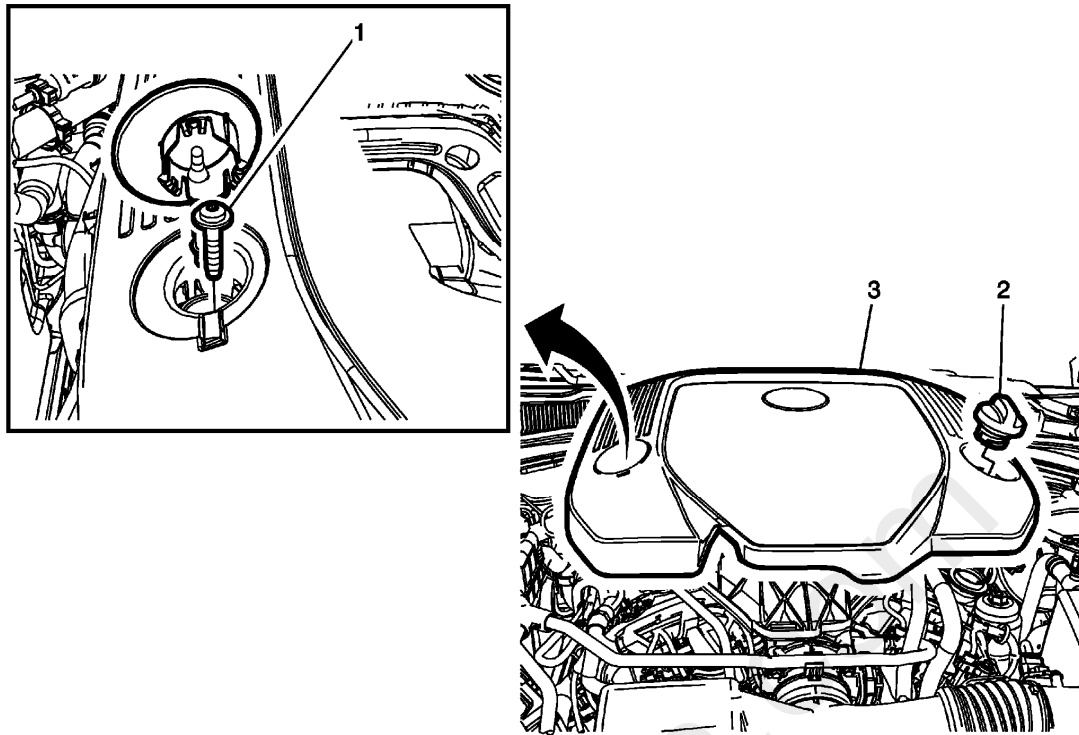


Fig. 73: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake manifold cover (3). Refer to **Intake Manifold Cover Replacement (LF3)** .
10. Remove the air cleaner outlet front duct. Refer to **Air Cleaner Outlet Front Duct Replacement (LF3)** .

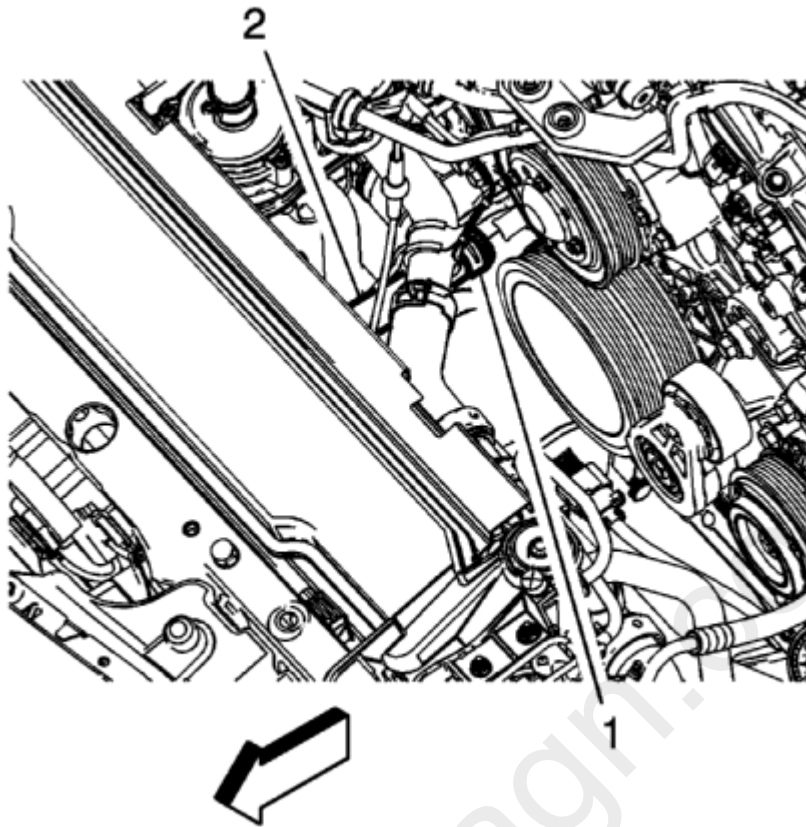


Fig. 74: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

11. Disengage tension on the radiator outlet hose clamp (1) using the **BO-38185** hose clamp pliers.
12. Remove the radiator outlet hose (2) and clamp (1) from the engine oil cooler.

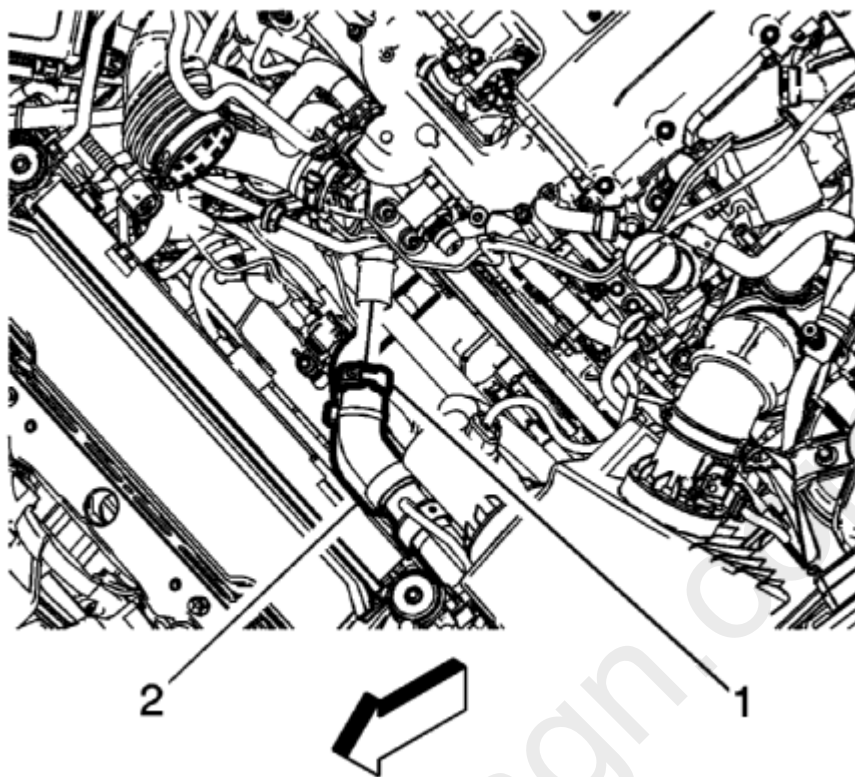


Fig. 75: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

13. Disengage tension on the radiator outlet hose clamp (1) using the **BO-38185** hose clamp pliers.
14. Remove the radiator outlet hose (2) and clamp (1) from the radiator outlet pipe.

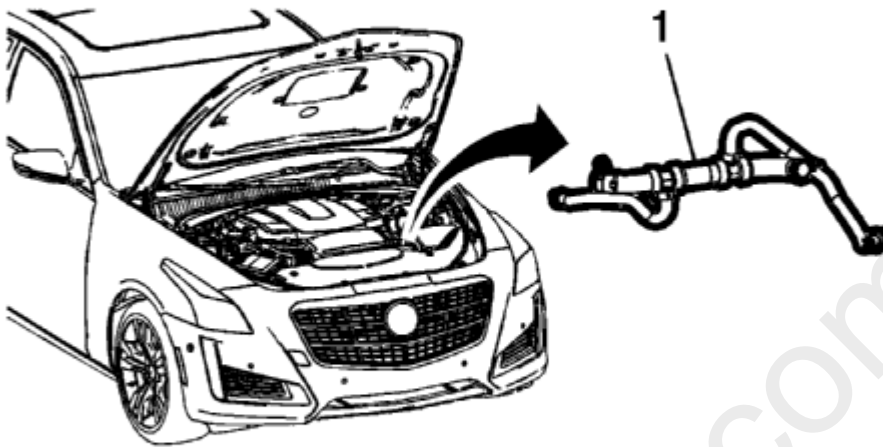


Fig. 76: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

15. Remove the radiator outlet hose (1) from the vehicle.

Installation Procedure

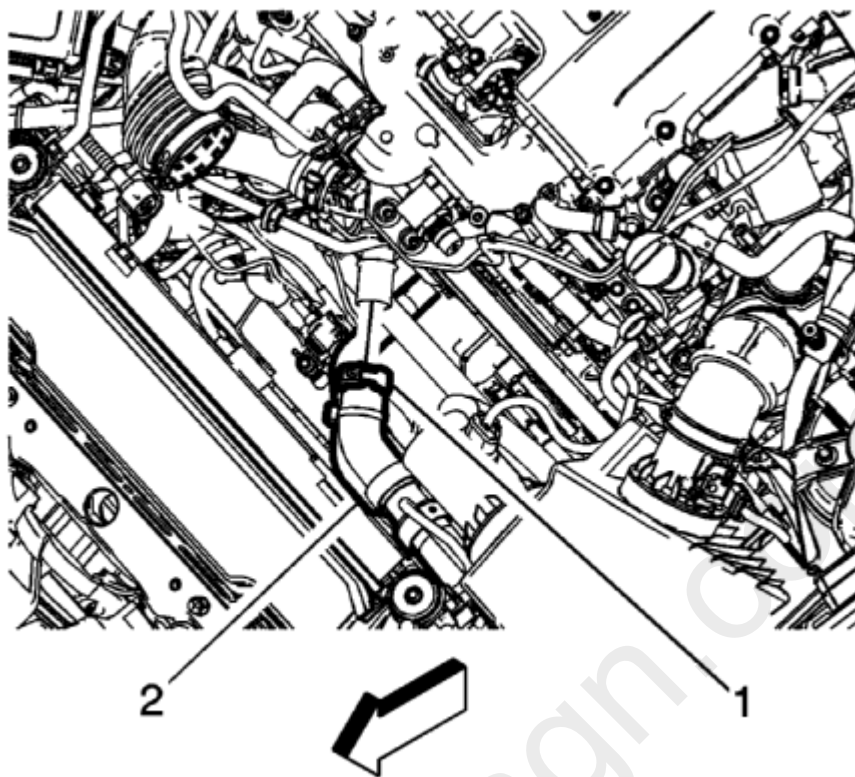


Fig. 77: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator outlet hose (2) and clamp (1) to the radiator outlet pipe.
2. Engage tension on the radiator outlet hose clamp (1) using the **BO-38185** hose clamp pliers.

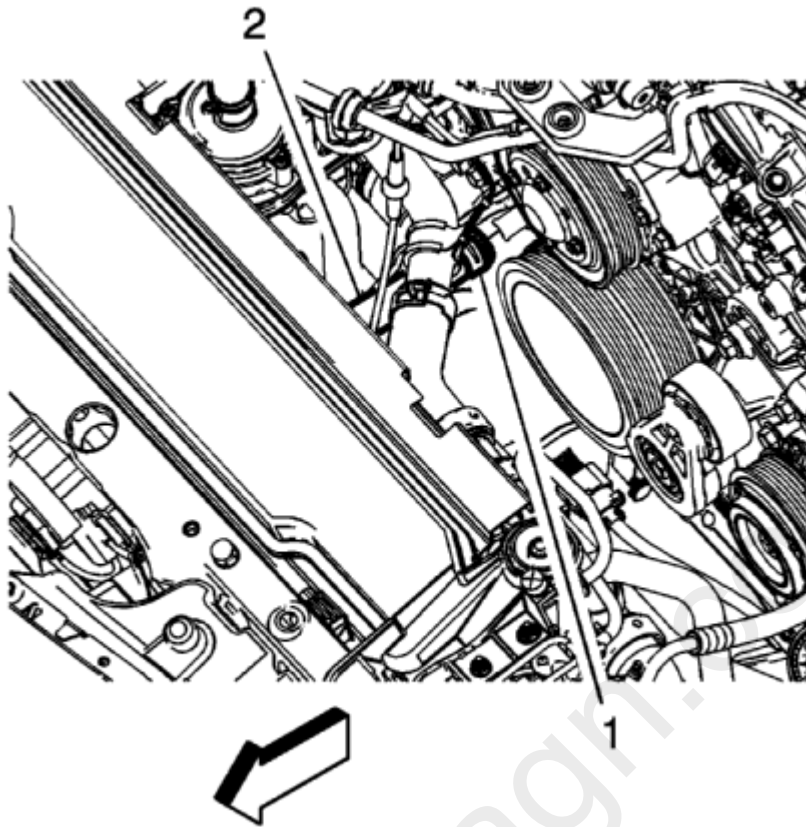


Fig. 78: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

3. Install the radiator outlet hose (2) and clamp (1) to the engine oil cooler.
4. Engage tension on the radiator outlet hose clamp (1) using the **BO-38185** hose clamp pliers.
5. Install the air cleaner outlet front duct. Refer to **Air Cleaner Outlet Front Duct Replacement (LF3)** .

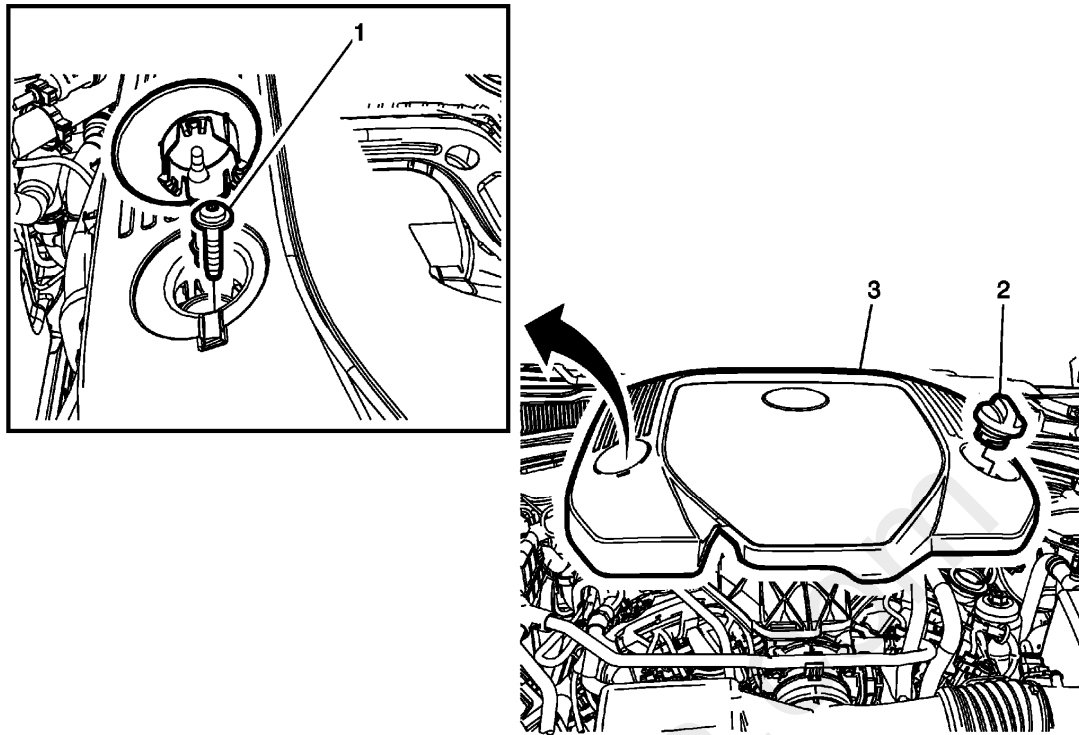


Fig. 79: Intake Manifold Cover
 Courtesy of GENERAL MOTORS COMPANY

6. Install the intake manifold cover (3). Refer to **Intake Manifold Cover Replacement (LF3)** .

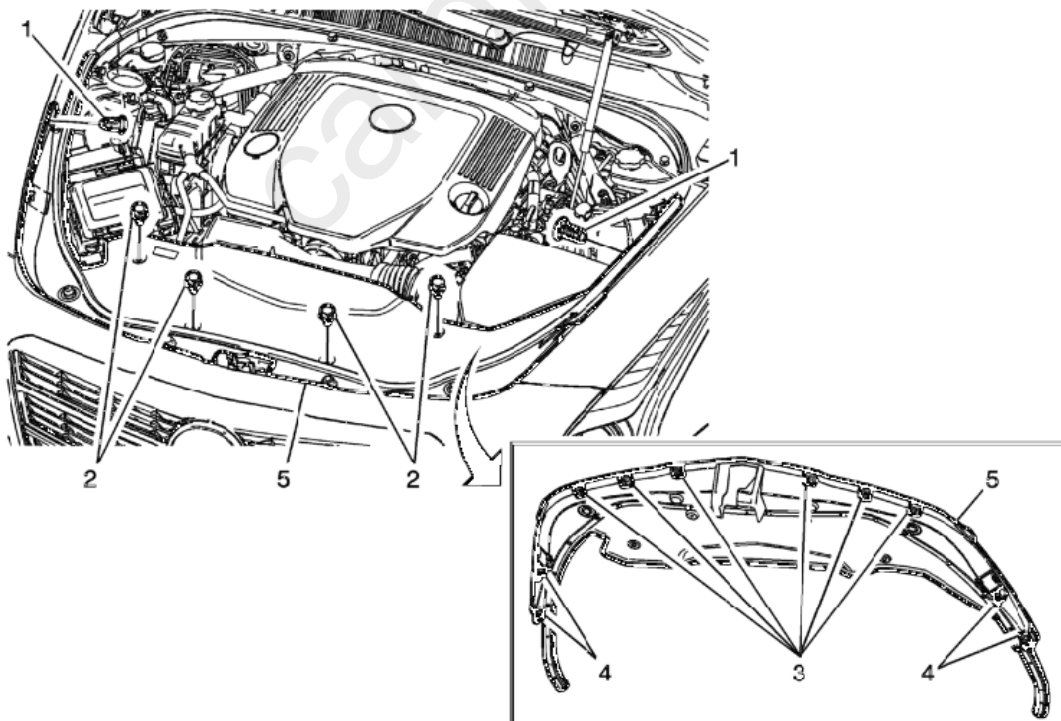


Fig. 80: Front Compartment Front Sight Shield
Courtesy of GENERAL MOTORS COMPANY

7. Install the front compartment front sight shield (5). Refer to **Front Compartment Front Sight Shield Replacement** .
8. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

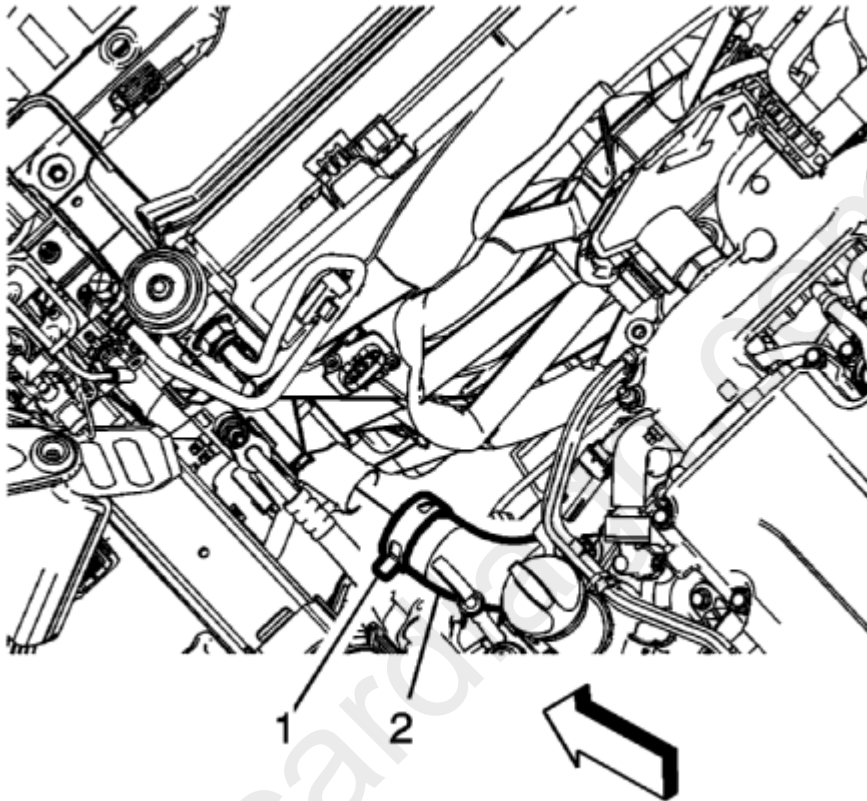


Fig. 81: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

9. Install the radiator outlet hose (2) and clamp (1) to the radiator.
10. Engage tension on the radiator outlet hose clamp (1) using the **BO-38185** hose clamp pliers.

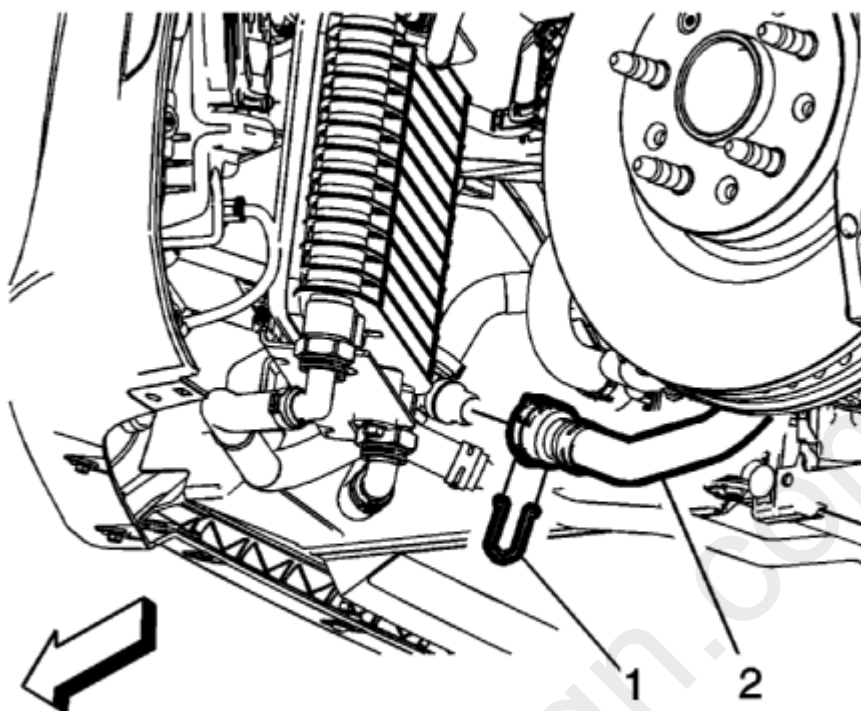


Fig. 82: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

11. Install the radiator outlet hose (2) to the auxiliary radiator outlet hose.
12. Install the radiator outlet hose retaining clip (1).

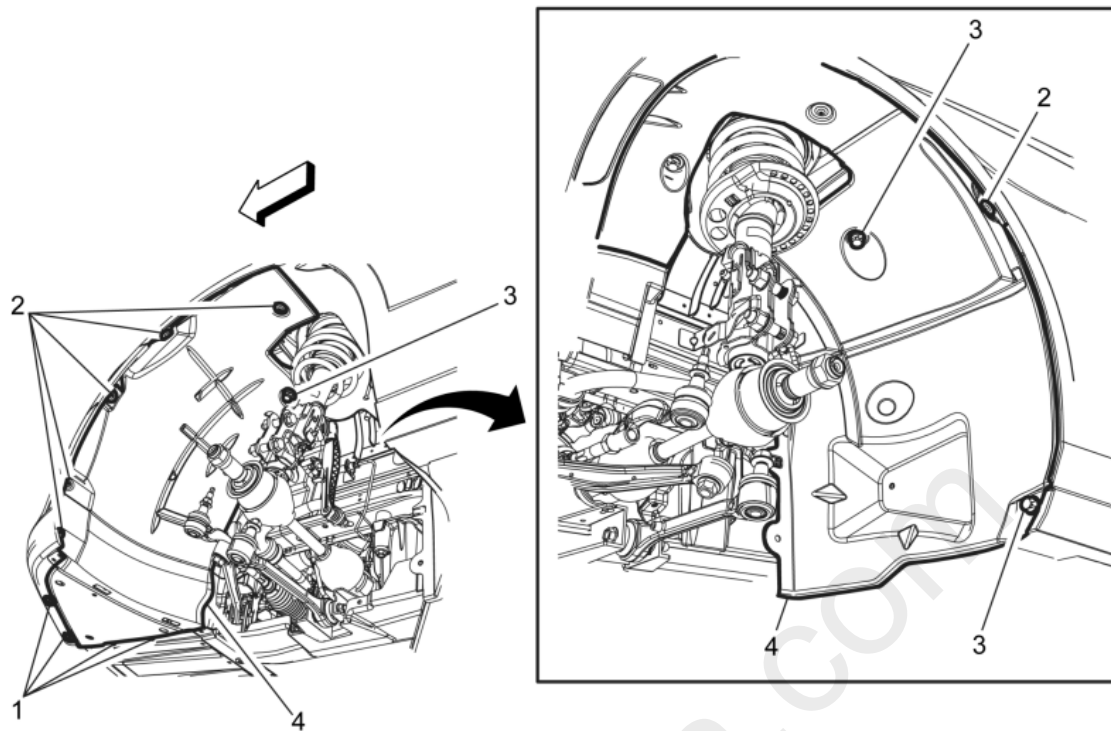


Fig. 83: Front Wheelhouse Liners
 Courtesy of GENERAL MOTORS COMPANY

13. .

Install the left front wheelhouse front liner (4). Refer to **Front Wheelhouse Liner Replacement** .

14. Lower the vehicle.

15. Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

16. Inspect the cooling system for leaks. Refer to **Cooling System Leak Testing**.

AUXILIARY RADIATOR OUTLET HOSE REPLACEMENT (LF3)

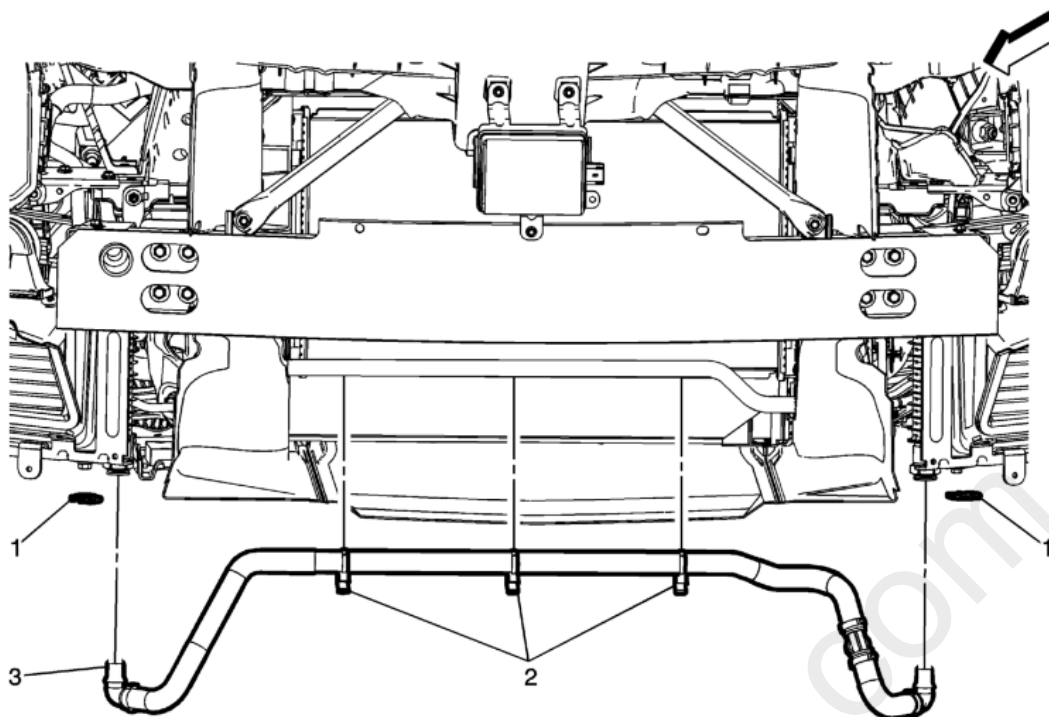


Fig. 84: Auxiliary Radiator Outlet Hose (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Outlet Hose Replacement (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove the radiator air lower baffle and deflector. Refer to <u>Radiator Air Lower Baffle and Deflector Replacement (LF3)</u>. 2. Drain the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 3. Remove the radiator outlet hose from the radiator outlet hose. Refer to <u>Radiator Outlet Hose Replacement (LF3)</u>.	
1	Auxiliary Radiator Outlet Hose Retaining Clips (Qty: 2)
2	Auxiliary Radiator Outlet Pipe Retainer (Qty: 3) Procedure Unclip the auxiliary radiator outlet hose retainers from the charge air cooler coolant pipe.
3	Auxiliary Radiator Outlet Hose Procedure 1. Fill the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 2. Check the charge air cooling system for leaks.

RADIATOR OUTLET PIPE REPLACEMENT (LFX)

Removal Procedure

Special Tools

BO-38185 Hose Clamp Pliers

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

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 system. Refer to **Exhaust System Replacement (LFX)** .

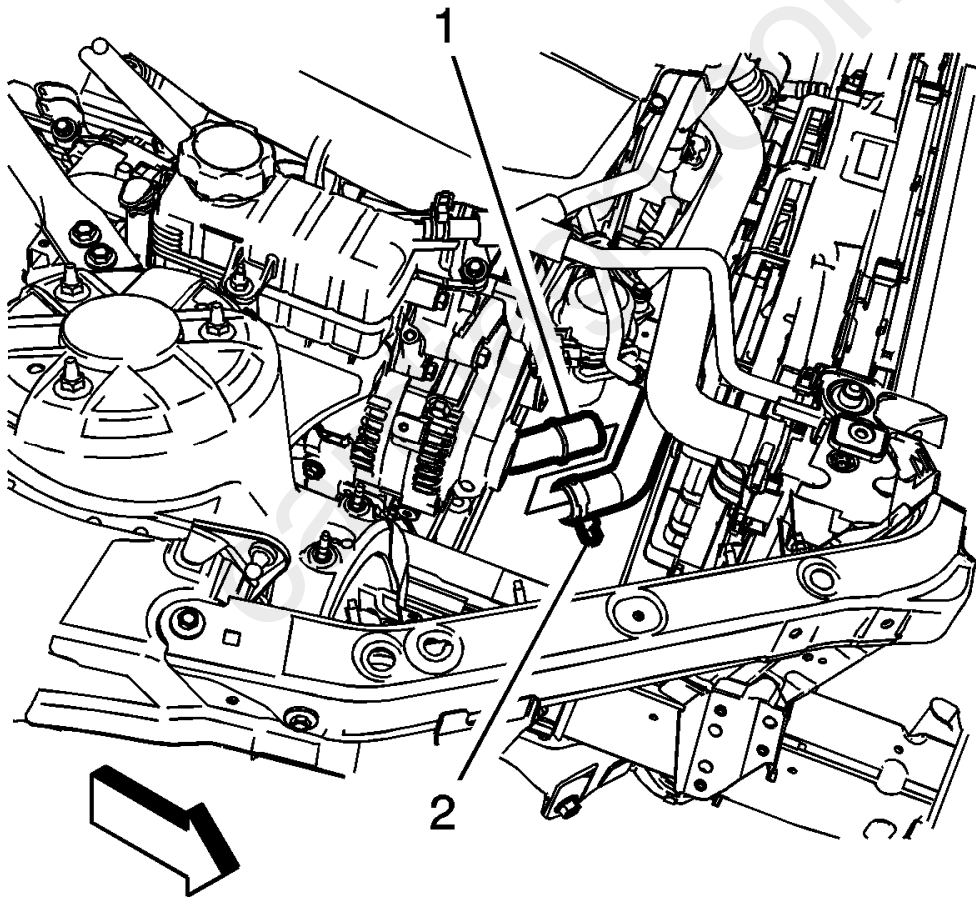


Fig. 85: Radiator Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose (2) from the radiator outlet pipe (1).
4. Remove the plenum front panel. Refer to **Plenum Front Panel Replacement** .

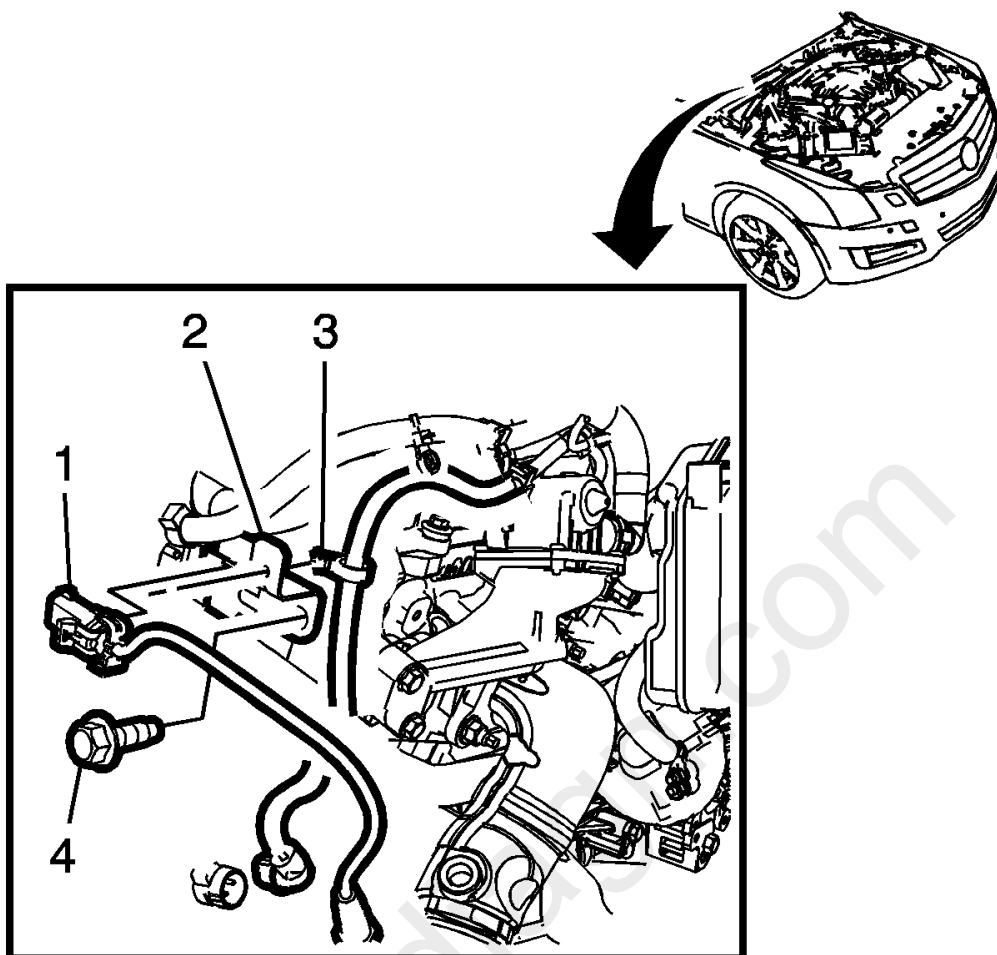


Fig. 86: Radiator Outlet Pipe Retaining Bracket
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the heated oxygen sensor connector (1) and the engine coolant heater cord (3) (if equipped) , from the radiator outlet pipe retaining bracket (2).
6. Remove the radiator outlet pipe retaining bracket fastener (4).

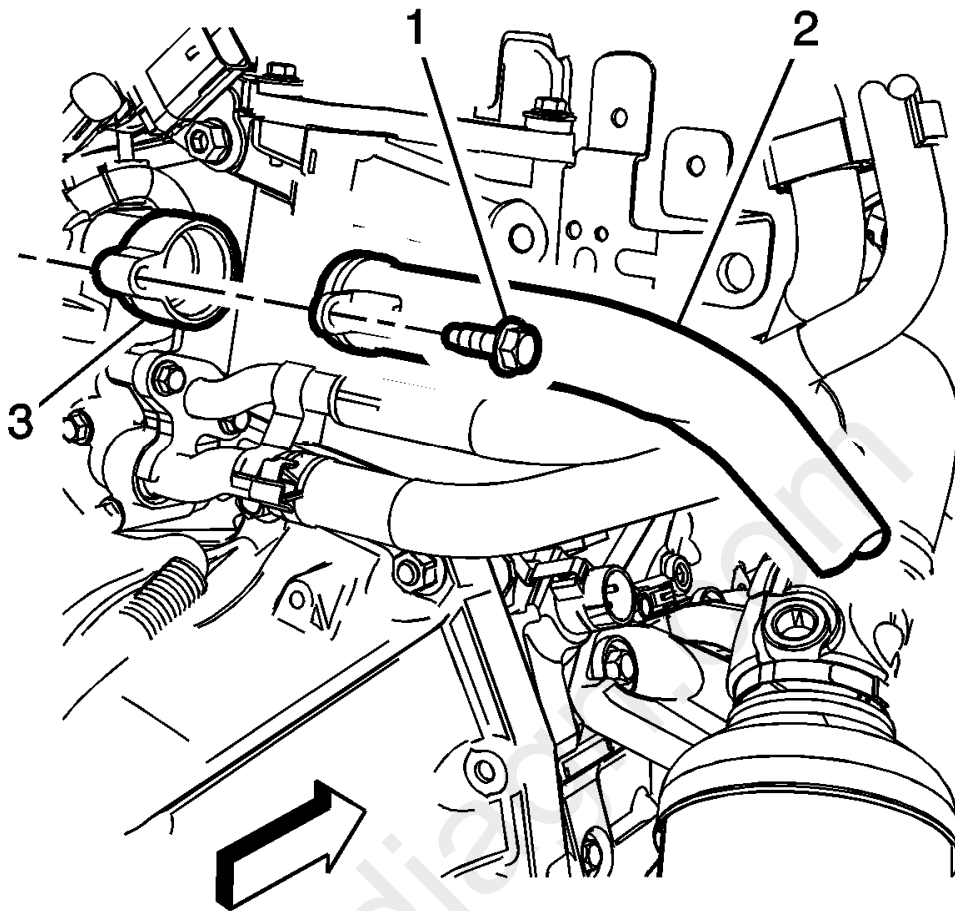


Fig. 87: Radiator Outlet Pipe

Courtesy of GENERAL MOTORS COMPANY

7. Remove the radiator outlet pipe fastener (1) and the radiator outlet pipe (2), from the engine coolant thermostat housing (3).
8. Remove the generator. Refer to **Generator Replacement (LFX)**.

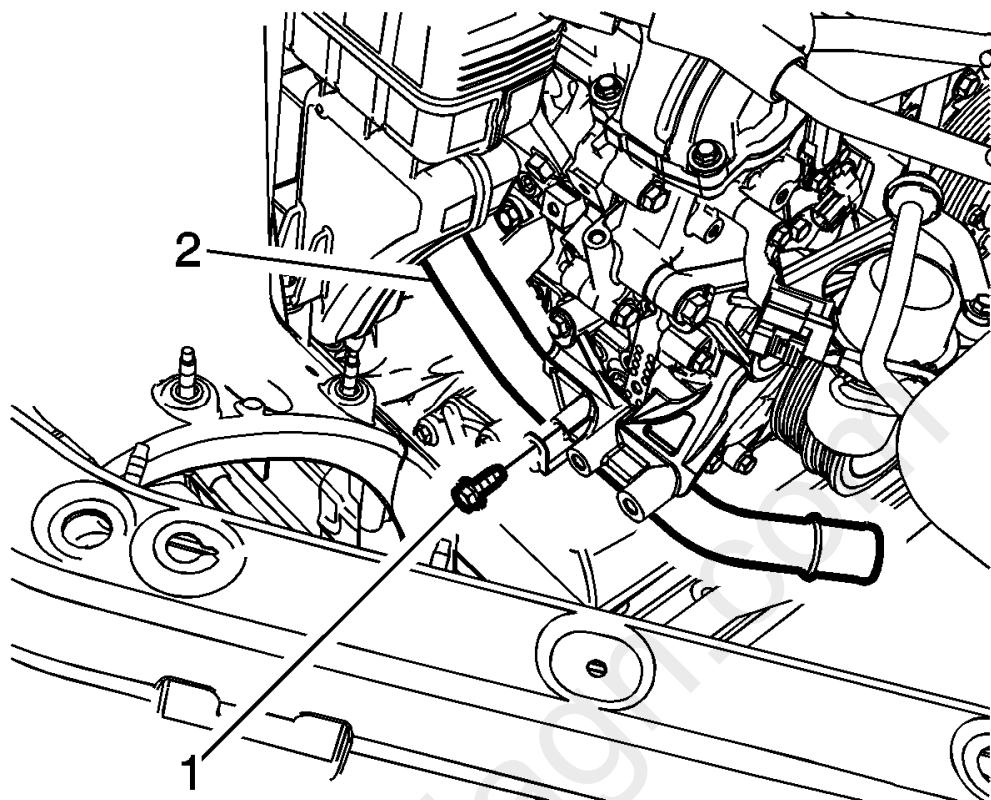


Fig. 88: Radiator Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Remove the radiator outlet pipe clamp fastener (1) and remove the radiator outlet pipe.

Installation Procedure

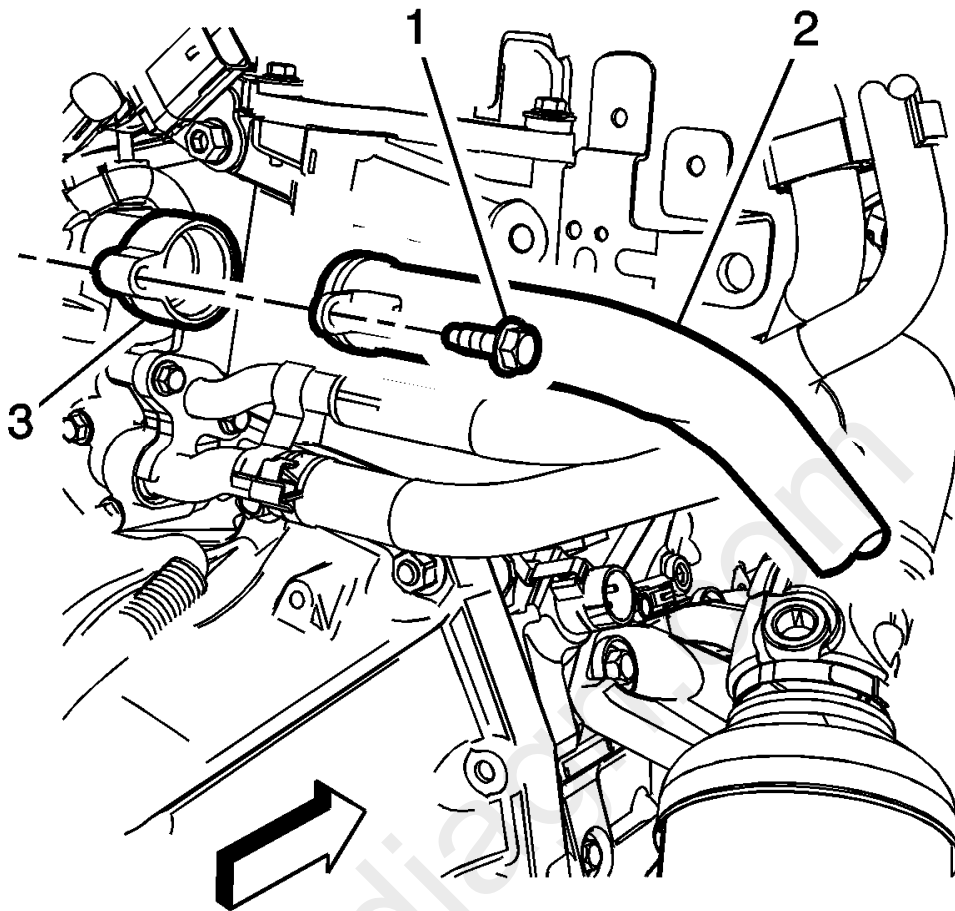


Fig. 89: Radiator Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the radiator outlet pipe (2) into the thermostat housing (3) with a NEW seal and tighten the fastener (1) to 22 (16 lb ft).

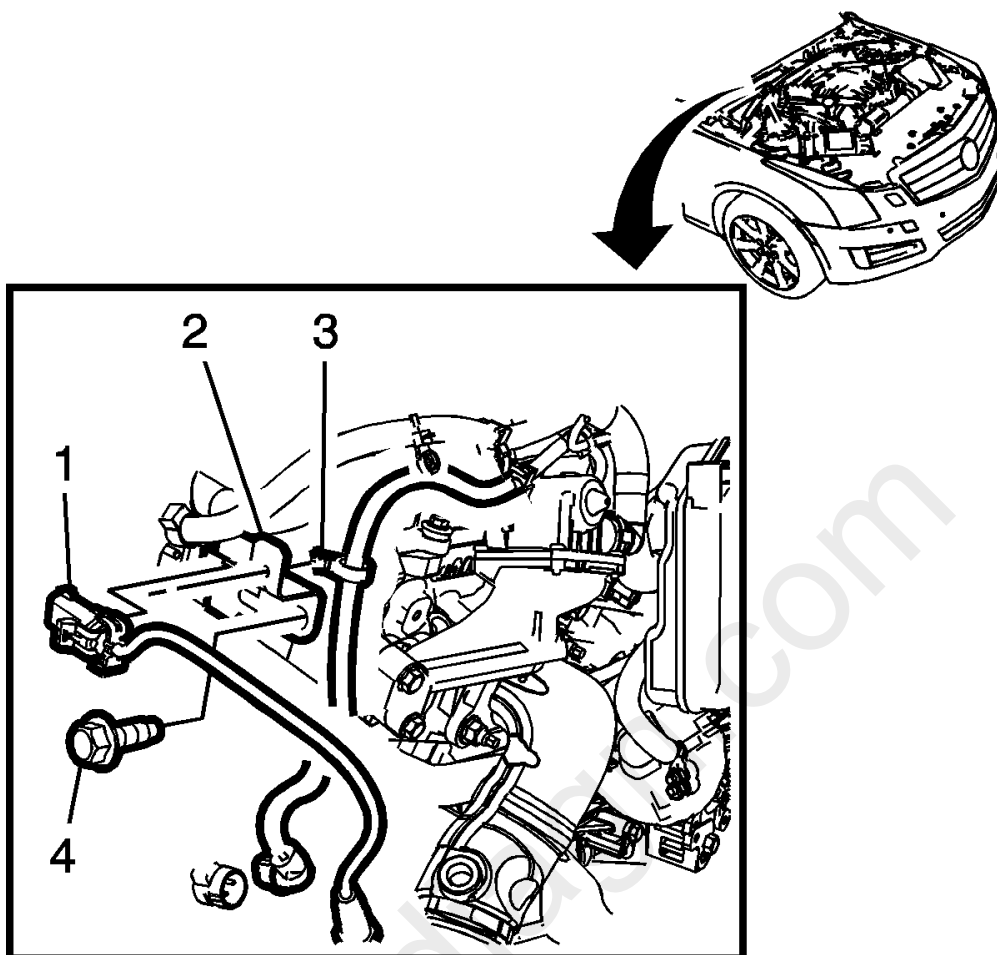


Fig. 90: Radiator Outlet Pipe Retaining Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Install the radiator outlet pipe retaining bracket fastener (4) and tighten to 58 (43 lb ft).
3. Connect the heated oxygen sensor connector (1) to the retaining clip.
4. Insert the engine coolant heater cord harness retainer (3) into the radiator outlet pipe bracket (2), if equipped.

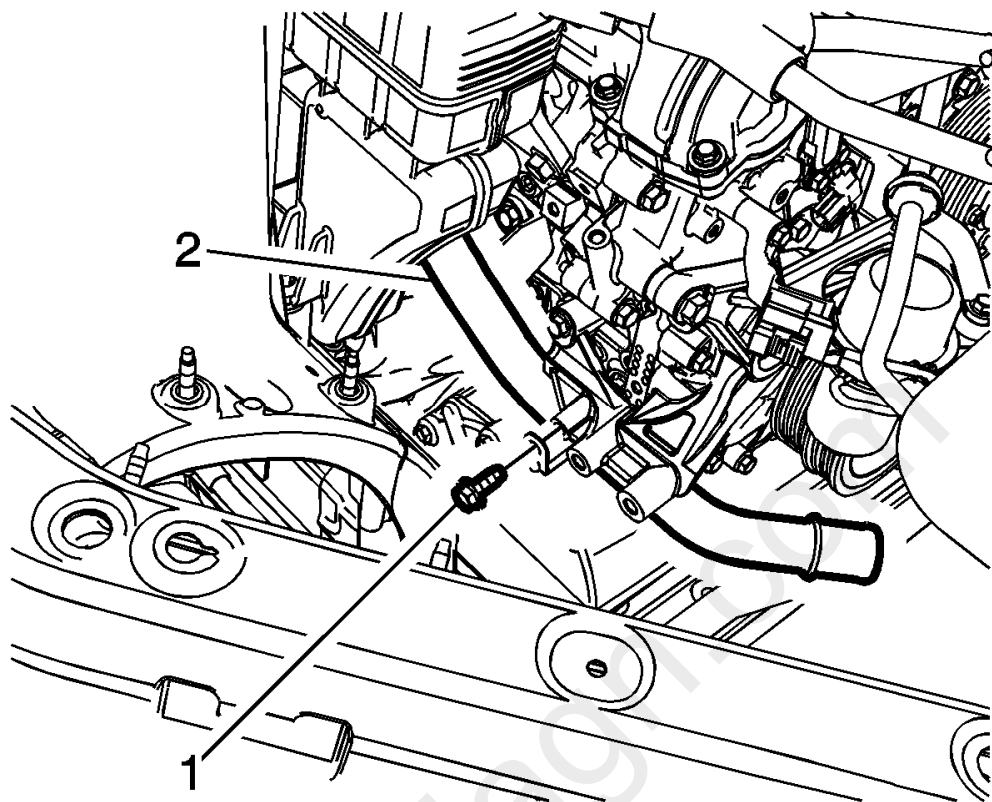


Fig. 91: Radiator Outlet Pipe

Courtesy of GENERAL MOTORS COMPANY

5. Install the radiator outlet pipe clamp fastener (1) to the generator and drive belt tensioner bracket. Tighten to 22 (16 lb ft).

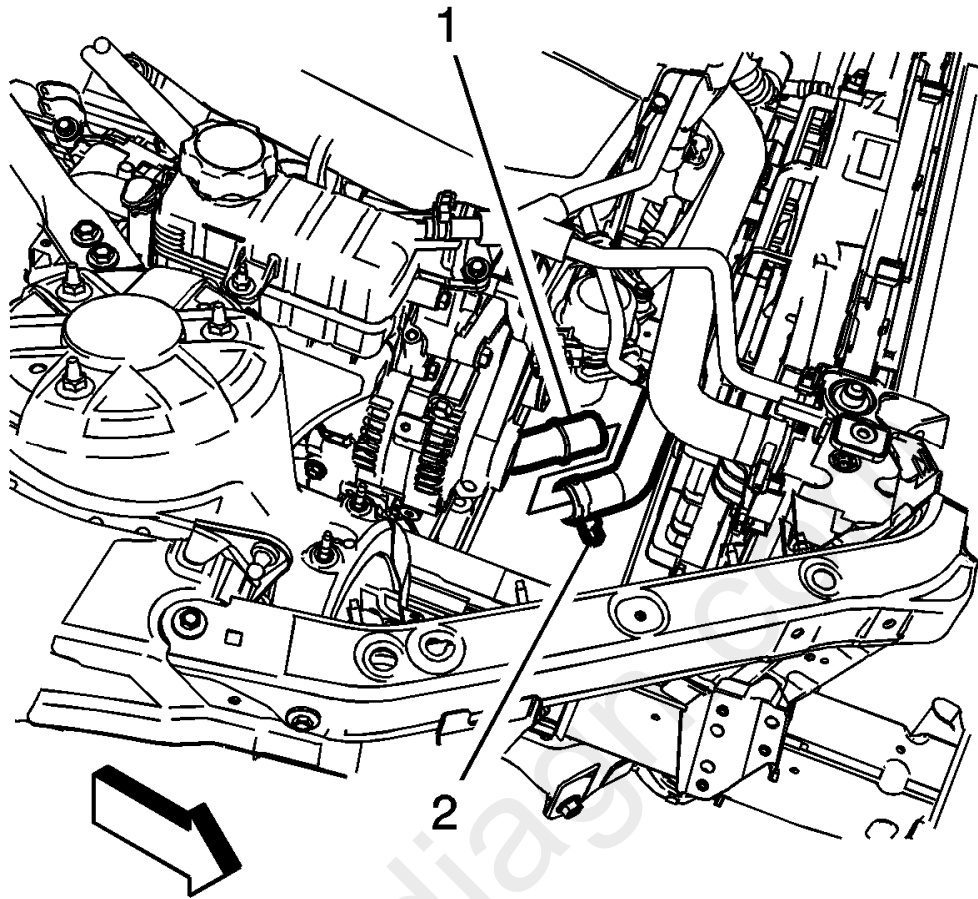


Fig. 92: Radiator Outlet Pipe

Courtesy of GENERAL MOTORS COMPANY

6. Install the radiator outlet hose (2) to the radiator outlet pipe (1).
7. Install the generator. Refer to **Generator Replacement (LFX)** .
8. Install the plenum front panel. Refer to **Plenum Front Panel Replacement** .
9. Install the exhaust system. Refer to **Exhaust System Replacement (LFX)** .
10. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
11. Start the engine and check for coolant leaks.

RADIATOR OUTLET PIPE REPLACEMENT (LF3)

Removal Procedure

Special Tools

BO-38185 Hose Clamp Pliers

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

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 system. Refer to **Exhaust System Replacement (LF3)** .

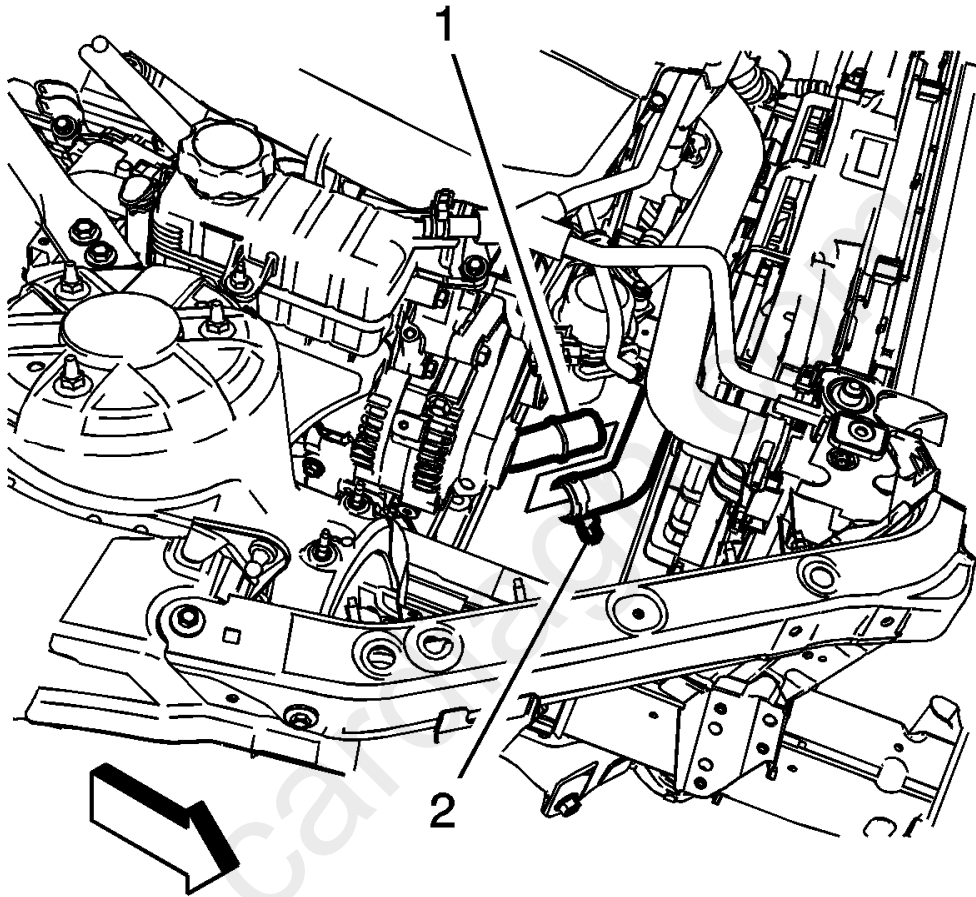


Fig. 93: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose (2) from the radiator outlet pipe (1).
4. Remove the plenum front panel. Refer to **Plenum Front Panel Replacement** .

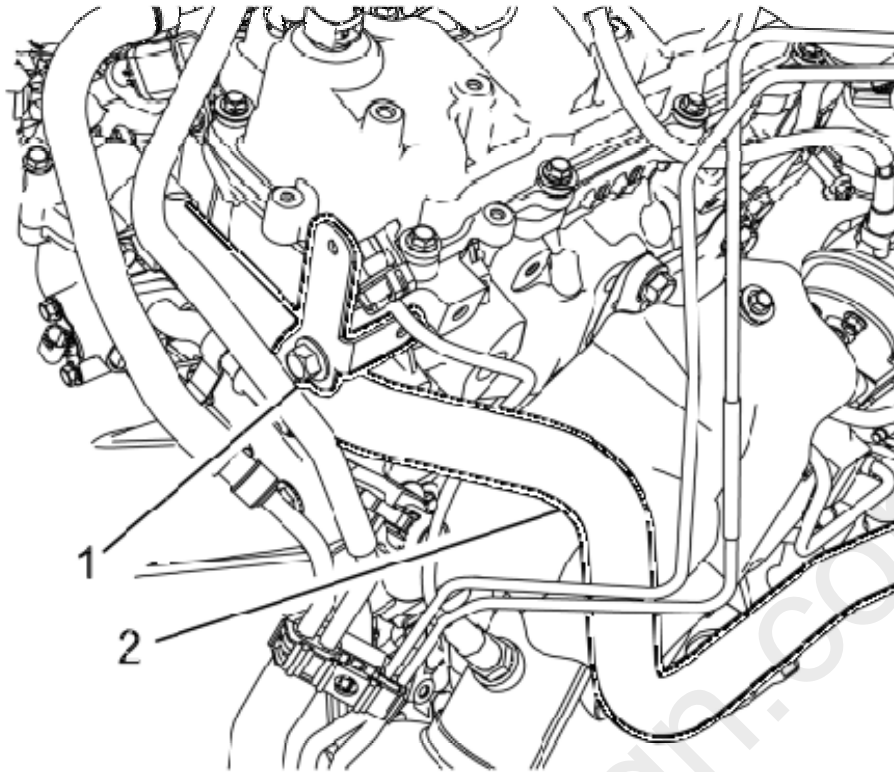


Fig. 94: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fastener (1) from the radiator outlet pipe (2) bracket.

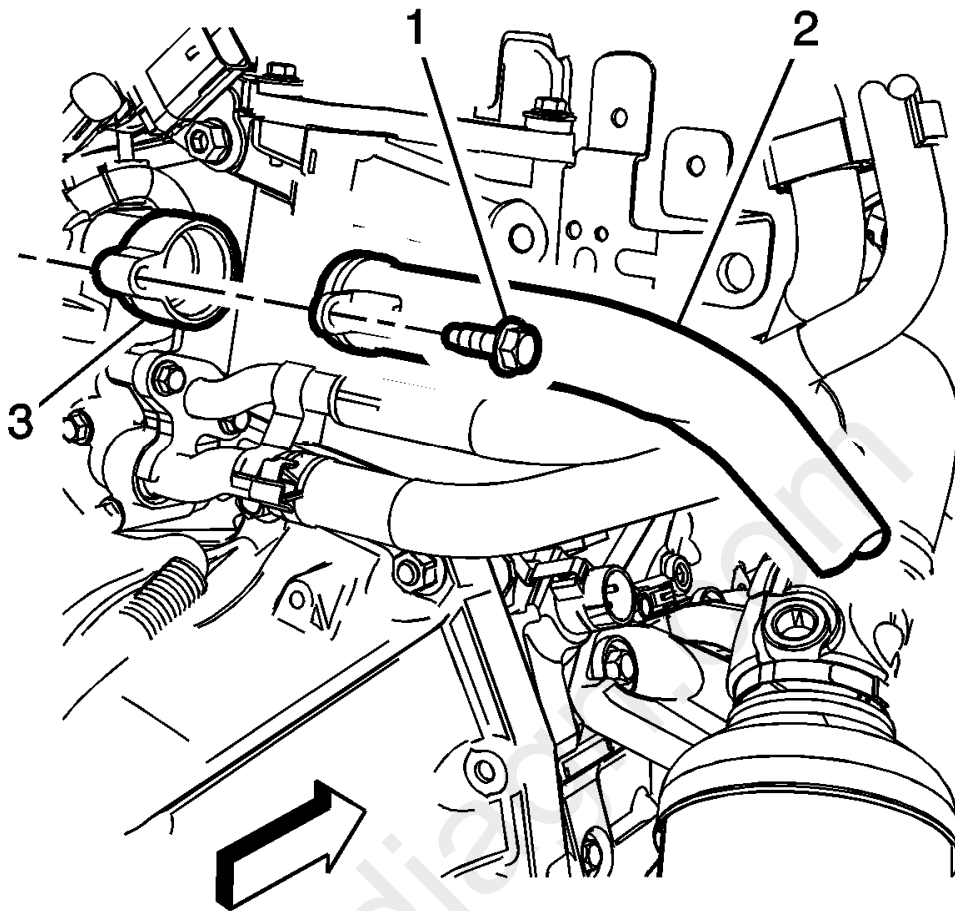


Fig. 95: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

6. Remove the radiator outlet pipe fastener (1) and the radiator outlet pipe (2), from the engine coolant thermostat housing (3).
7. Remove the generator. Refer to **Generator Replacement (LF3)** .

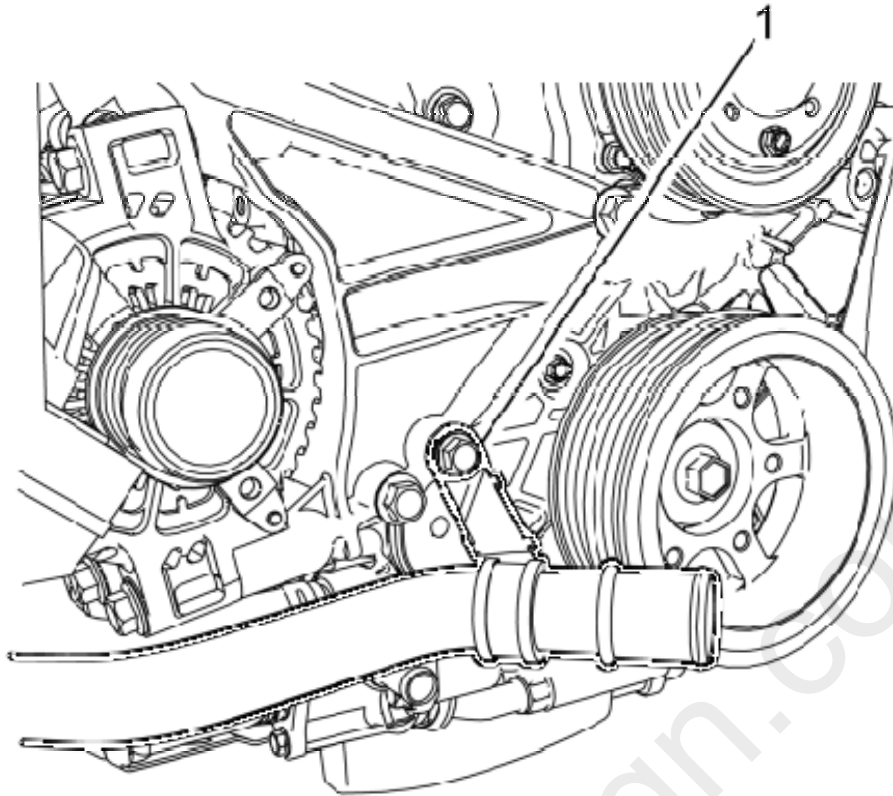


Fig. 96: Radiator Outlet Pipe Clamp Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Remove the radiator outlet pipe clamp fastener (1) and remove the radiator outlet pipe.

Installation Procedure

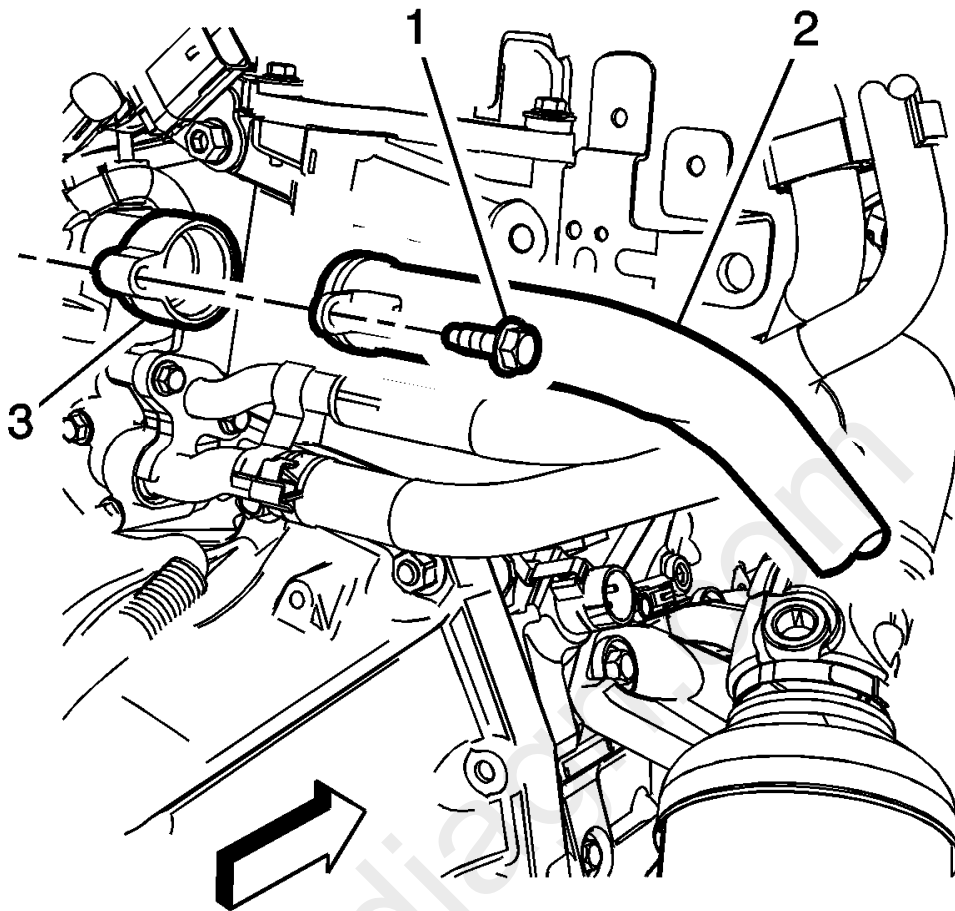


Fig. 97: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the radiator outlet pipe (2) into the thermostat housing (3) with a NEW seal and tighten the fastener (1) to 22 (16 lb ft).

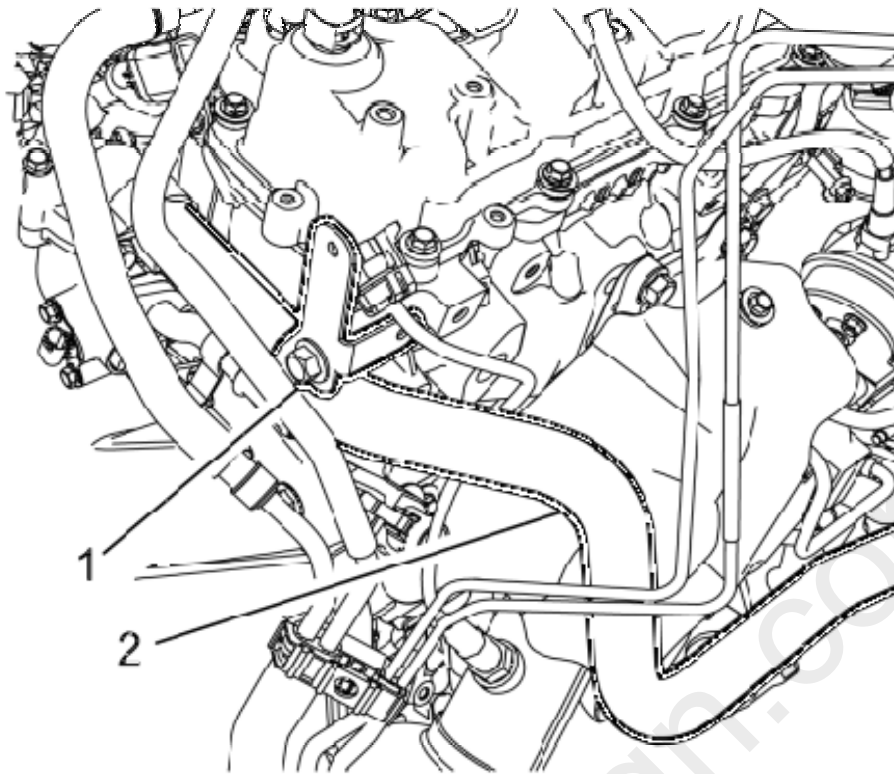


Fig. 98: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

2. Install the radiator outlet pipe (2) bracket fastener (1) and tighten to 58 (43 lb ft).

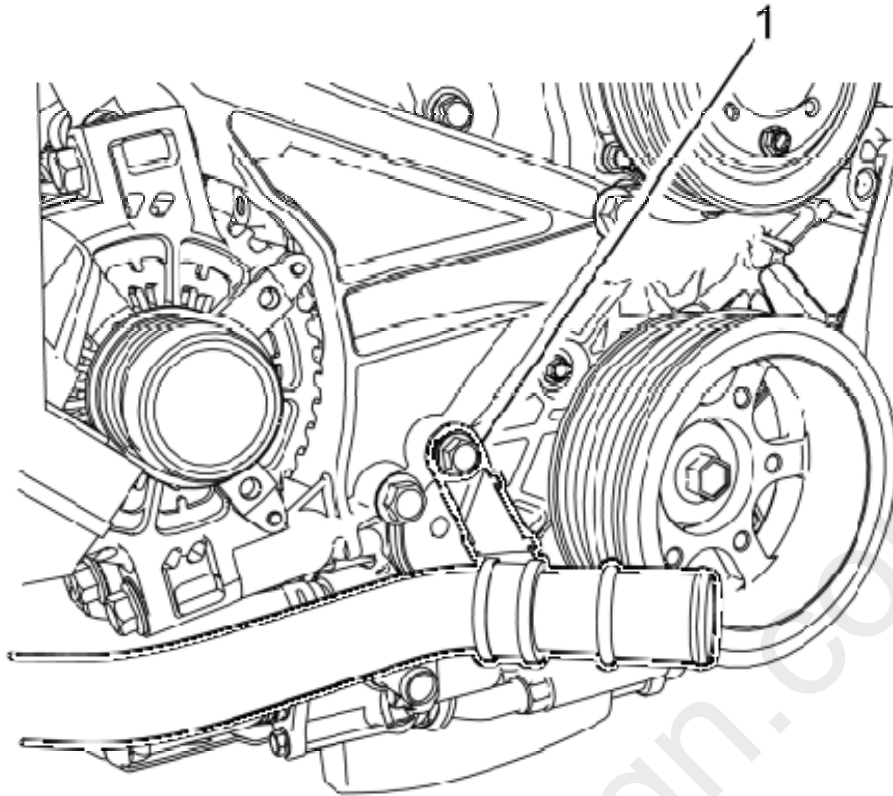


Fig. 99: Radiator Outlet Hose Clamp-
Courtesy of GENERAL MOTORS COMPANY

3. Install the radiator outlet pipe clamp fastener (1) and tighten to 22 (16 lb ft).

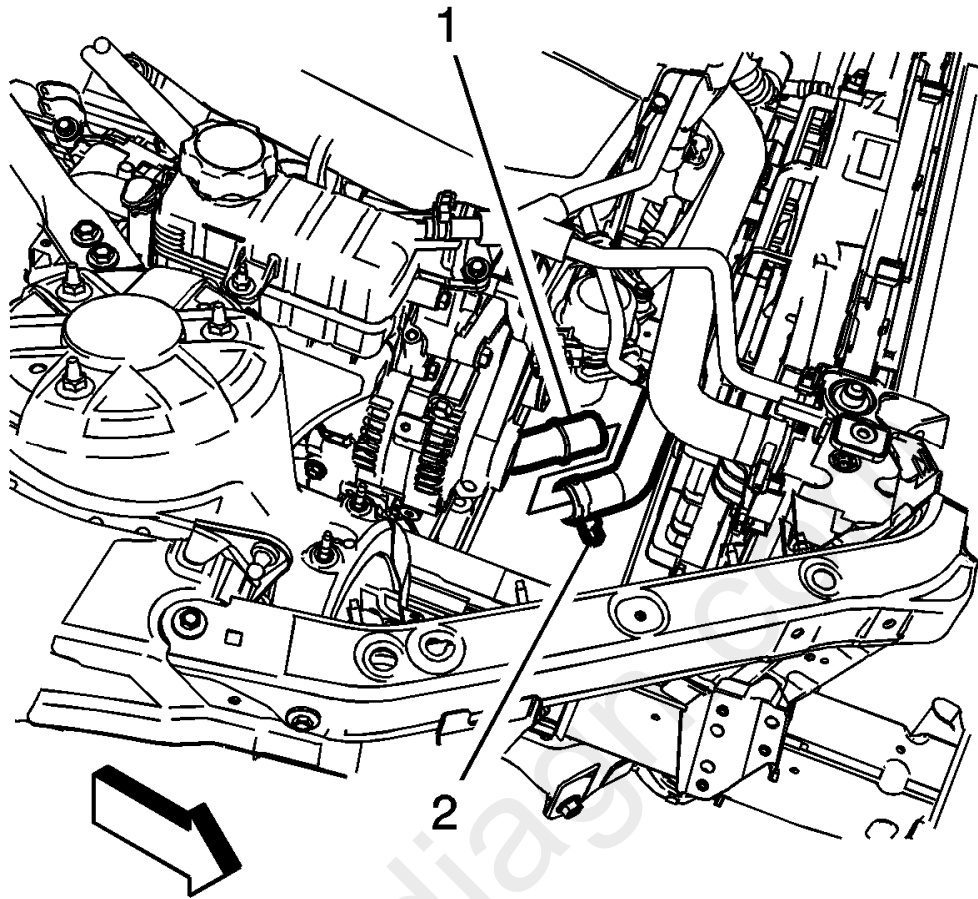


Fig. 100: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Install the radiator outlet hose (2) to the radiator outlet pipe (1).
5. Install the generator. Refer to **Generator Replacement (LF3)** .
6. Install the plenum front panel. Refer to **Plenum Front Panel Replacement** .
7. Install the exhaust system. Refer to **Exhaust System Replacement (LF3)** .
8. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
9. Start the engine and check for coolant leaks.

INTAKE MANIFOLD VACUUM FITTING REPLACEMENT

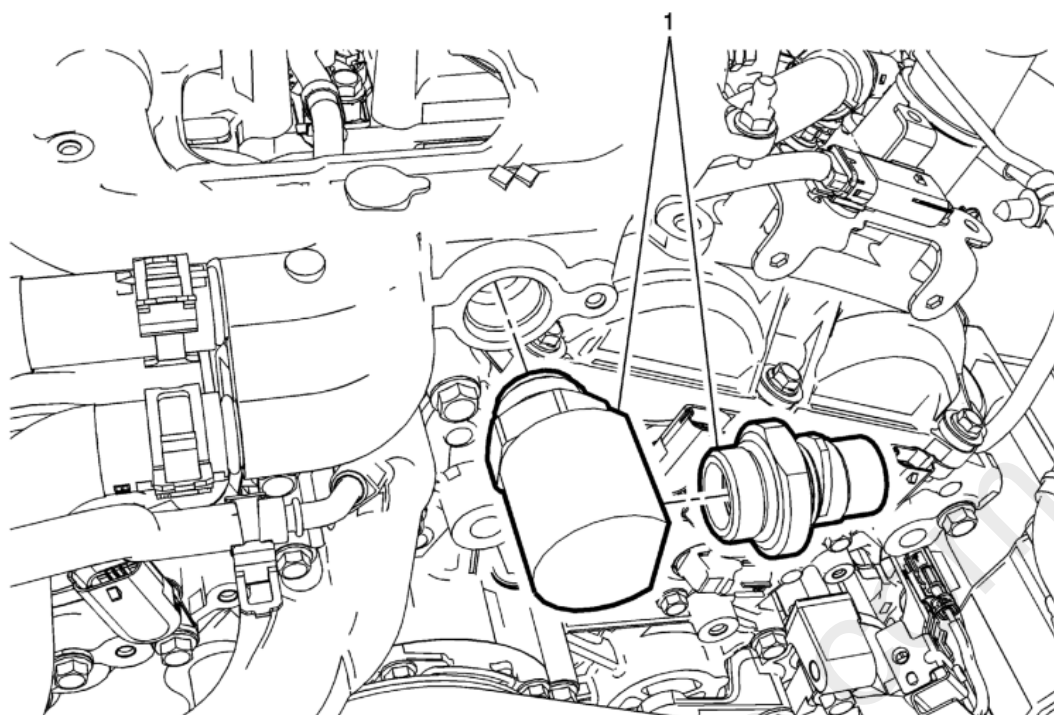


Fig. 101: Intake Manifold Vacuum Fitting
 Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Vacuum Fitting Replacement

Callout	Component Name
Preliminary Procedure - Partially drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. - Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Intake Manifold Vacuum Fitting CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten 12 (106 lb in)

CHARGE AIR COOLER REPLACEMENT

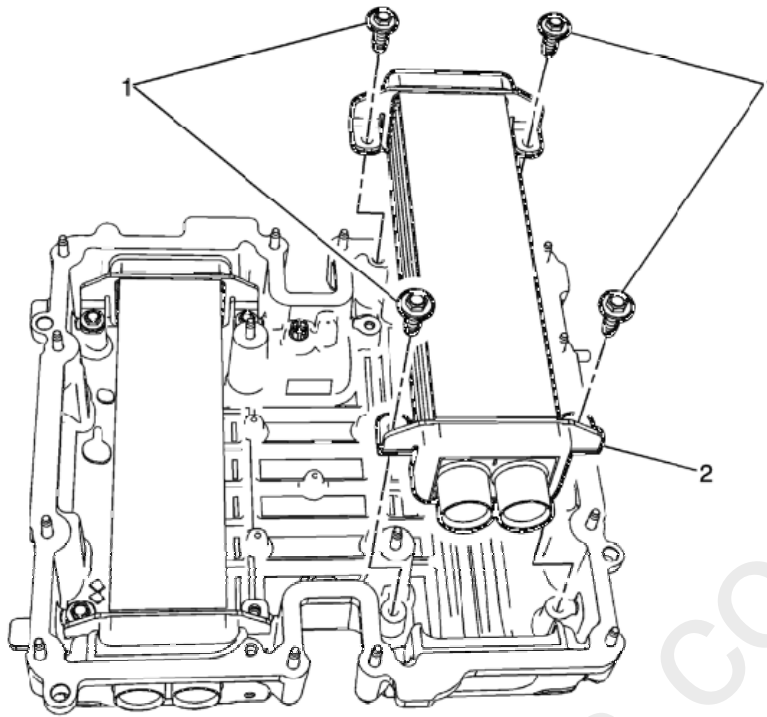


Fig. 102: Charge Air Cooler
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Replacement

Callout	Component Name
Preliminary Procedure Remove the charge air cooler cover. Refer to <u>Charge Air Cooler Cover Replacement</u> .	
1	Charge Air Cooler Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Charge Air Cooler

RADIATOR LOWER BRACKET REPLACEMENT - LEFT SIDE (LF3)

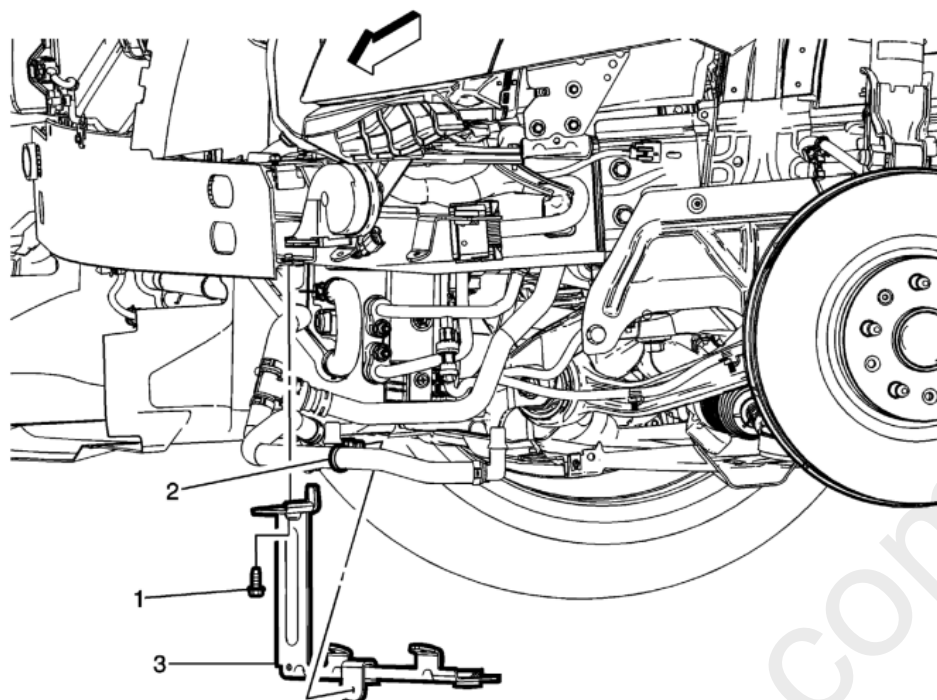


Fig. 103: Radiator Lower Bracket - Left Side (LF3)

Courtesy of GENERAL MOTORS COMPANY

Radiator Lower Bracket Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedure Remove the radiator air baffle. Refer to <u>Radiator Air Baffle Replacement - Left (LF3).</u>	
1	Radiator Lower Bracket Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Tie Strap
3	Radiator Lower Bracket

RADIATOR LOWER BRACKET REPLACEMENT - RIGHT SIDE (LF3)

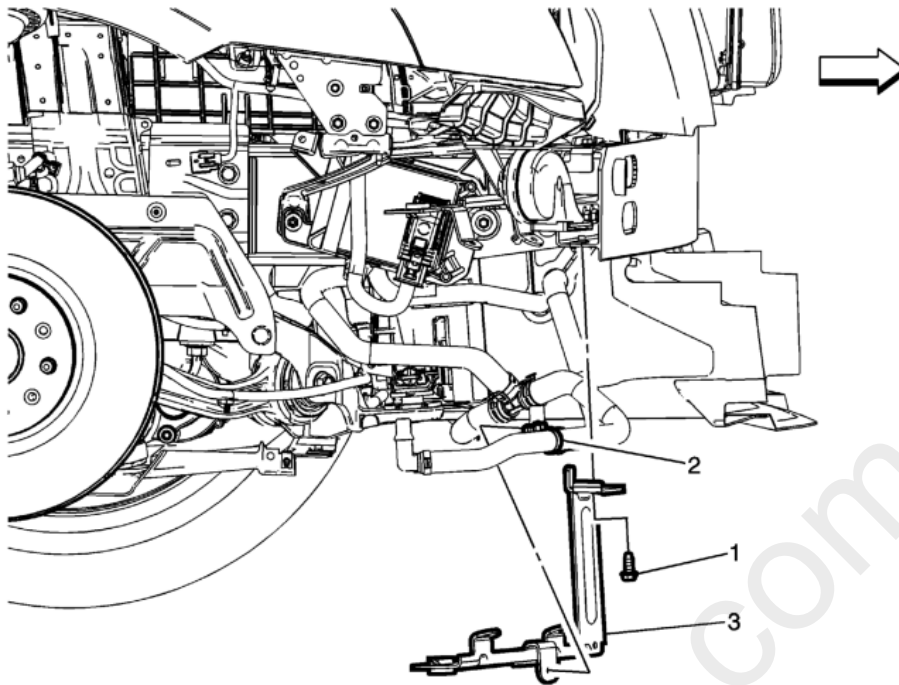


Fig. 104: Radiator Lower Bracket - Right Side (LF3)

Courtesy of GENERAL MOTORS COMPANY

Radiator Lower Bracket Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedure	
Remove the radiator air baffle. Refer to <u>Radiator Air Baffle Replacement - Right (LF3)</u> .	
1	Radiator Lower Bracket Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Tie Strap
3	Radiator Lower Bracket

RADIATOR UPPER BRACKET REPLACEMENT (LFX, LTG)

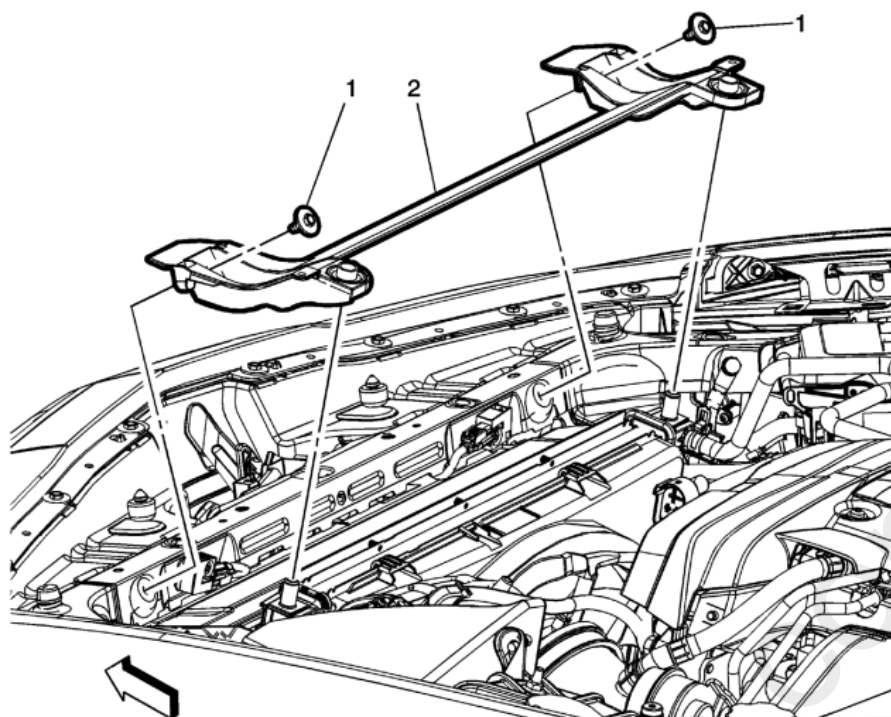


Fig. 105: Radiator Upper Bracket (LFX, LTG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Upper Bracket Replacement (LFX, LTG)

Callout	Component Name
Preliminary Procedure Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u> .	
1	Radiator Upper Bracket Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Radiator Upper Bracket

RADIATOR UPPER BRACKET REPLACEMENT - LEFT SIDE (LF3)

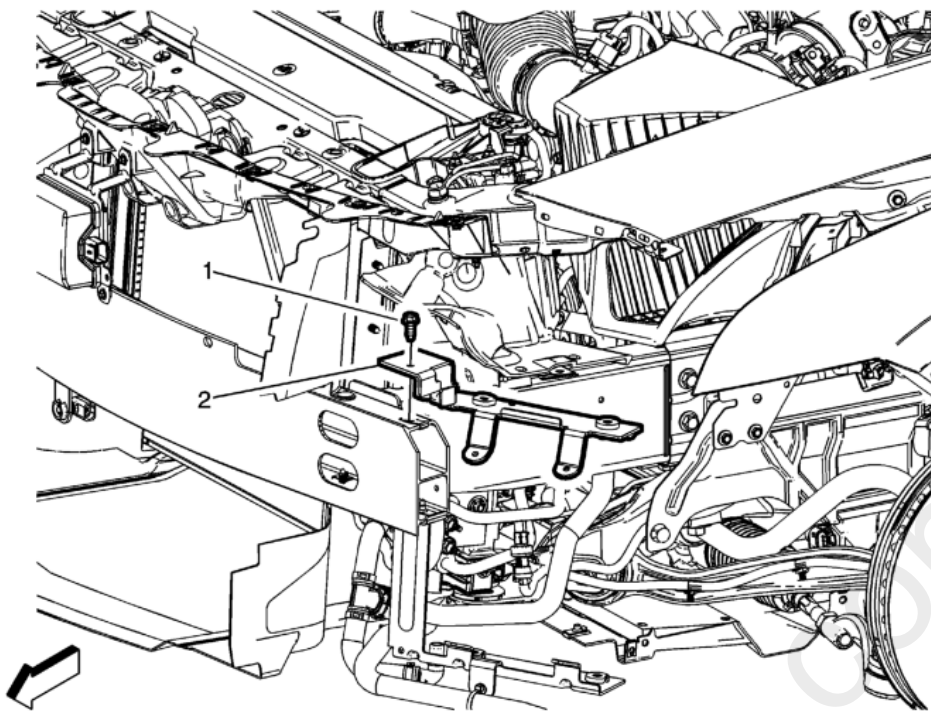


Fig. 106: Radiator Upper Bracket - Left Side (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Upper Bracket Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedures	
1. Remove the radiator air baffle. Refer to <u>Radiator Air Baffle Replacement - Left (LF3).</u> 2. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement .</u>	
1	Radiator Upper Bracket Bolt CAUTION: Refer to <u>Fastener Caution .</u> Tighten 9 (80 lb in)
2	Radiator Upper Bracket

RADIATOR UPPER BRACKET REPLACEMENT - RIGHT SIDE (LF3)

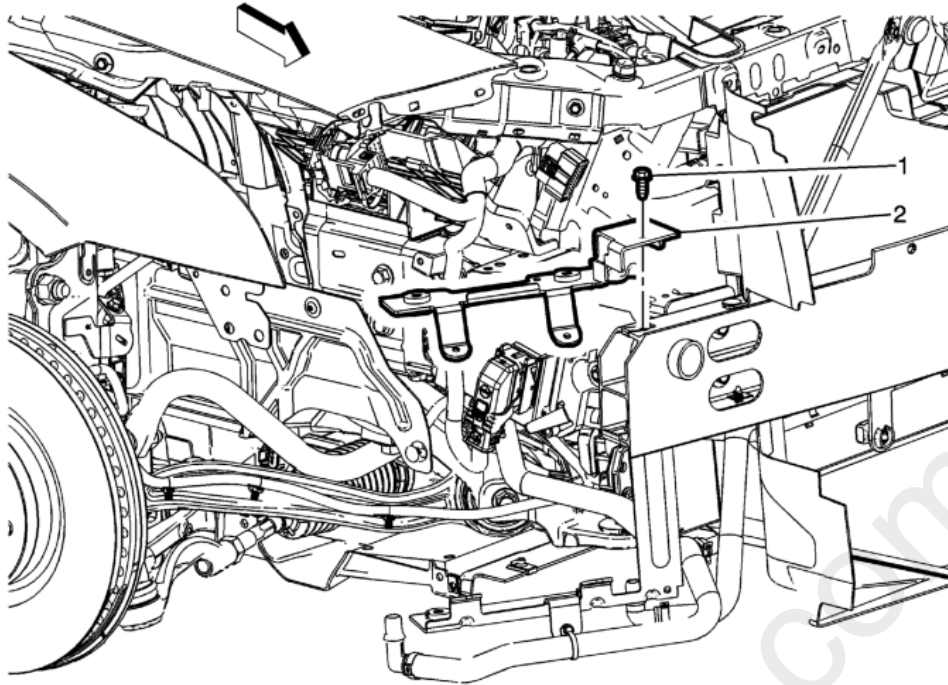


Fig. 107: Radiator Upper Bracket - Right Side (LF3)

Courtesy of GENERAL MOTORS COMPANY

Radiator Upper Bracket Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedures	
1. Remove the radiator air baffle. Refer to <u>Radiator Air Baffle Replacement - Right (LF3)</u> . 2. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Radiator Upper Bracket Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Radiator Upper Bracket

FAN BLADE REPLACEMENT (LFX, LTG WITHOUT V03)

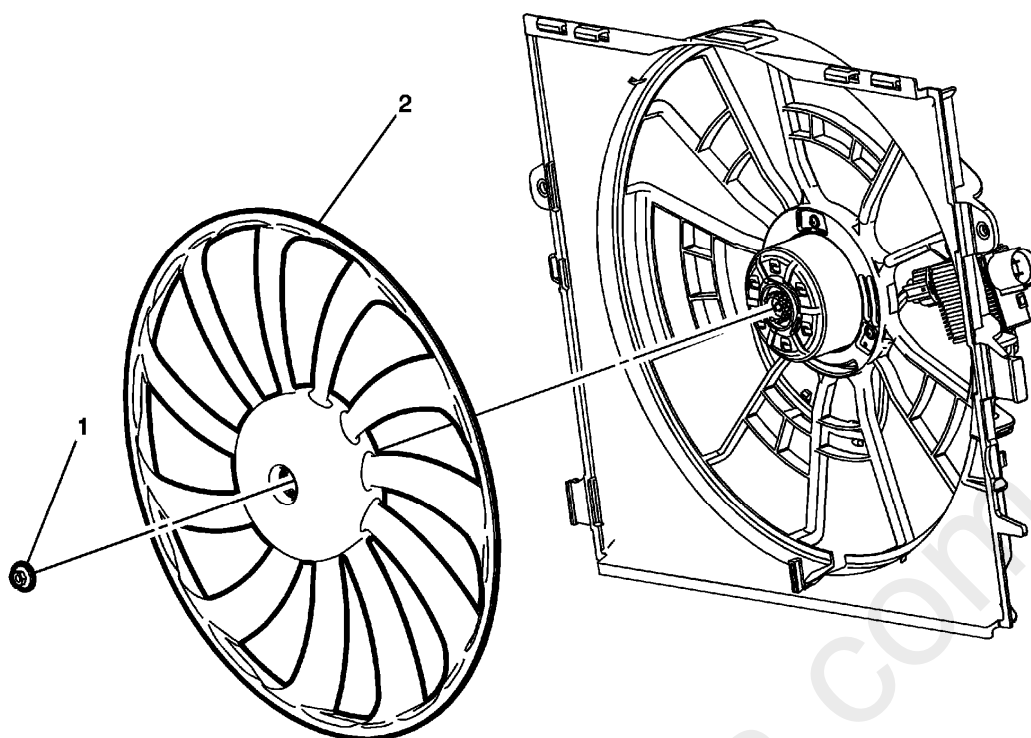


Fig. 108: Fan Blade (LFX, LTG without V03)
 Courtesy of GENERAL MOTORS COMPANY

Fan Blade Replacement (LFX, LTG without V03)

Callout	Component Name
Preliminary Procedures Remove the engine coolant fan shroud. Refer to <u>Engine Coolant Fan Shroud Replacement (LFX)</u> , <u>Engine Coolant Fan Shroud Replacement (LTG without V03)</u> .	
1	Fan Blade Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 8 (71 lb in)
2	Fan Blade

ENGINE COOLANT FAN MOTOR REPLACEMENT (LFX, LTG WITHOUT V03)

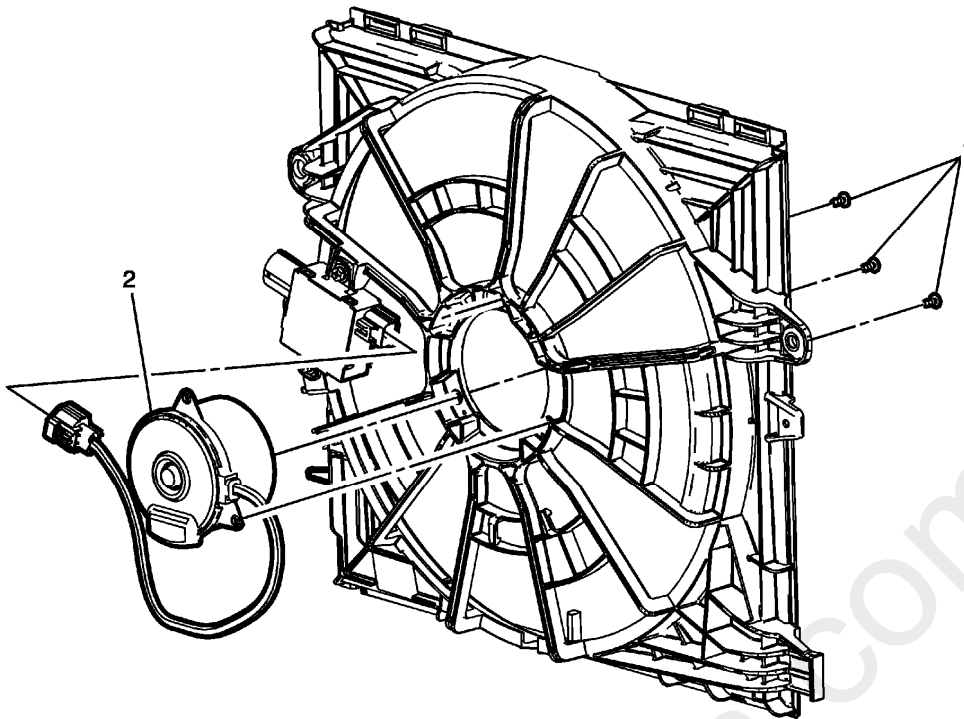


Fig. 109: Engine Coolant Fan Motor (LFX, LTG without V03)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Motor Replacement (LFX, LTG without V03)

Callout	Component Name
Preliminary Procedures	
1. Remove the engine coolant fan shroud. Refer to <u>Engine Coolant Fan Shroud Replacement (LFX), Engine Coolant Fan Shroud Replacement (LTG without V03)</u> 2. Remove the fan blade. Refer to <u>Fan Blade Replacement (LFX, LTG without V03).</u>	
1	Engine Coolant Fan Motor Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
2	Engine Coolant Fan Motor

FAN CONTROL MODULE REPLACEMENT (LFX, LTG WITHOUT V03)

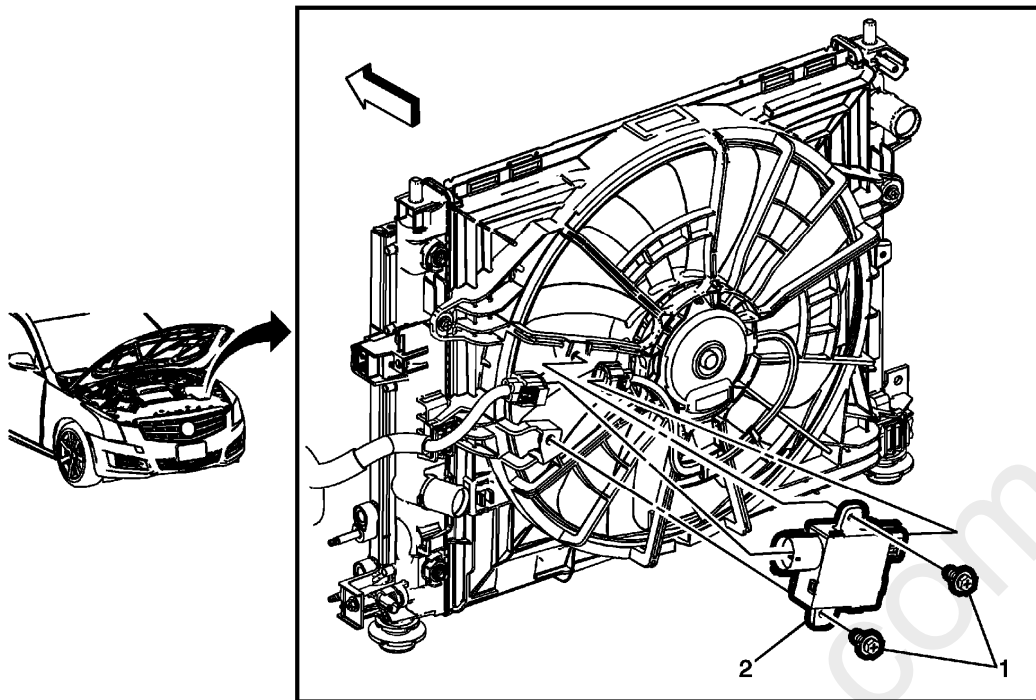


Fig. 110: Fan Control Module (LFX, LTG without V03)

Courtesy of GENERAL MOTORS COMPANY

Fan Control Module Replacement (LFX, LTG without V03)

Callout	Component Name
Preliminary Procedure	
Disconnect the electrical connectors from the fan control module.	
1	Fan Control Module Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 8 (71 lb in)
2	Fan Control Module

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LTG)

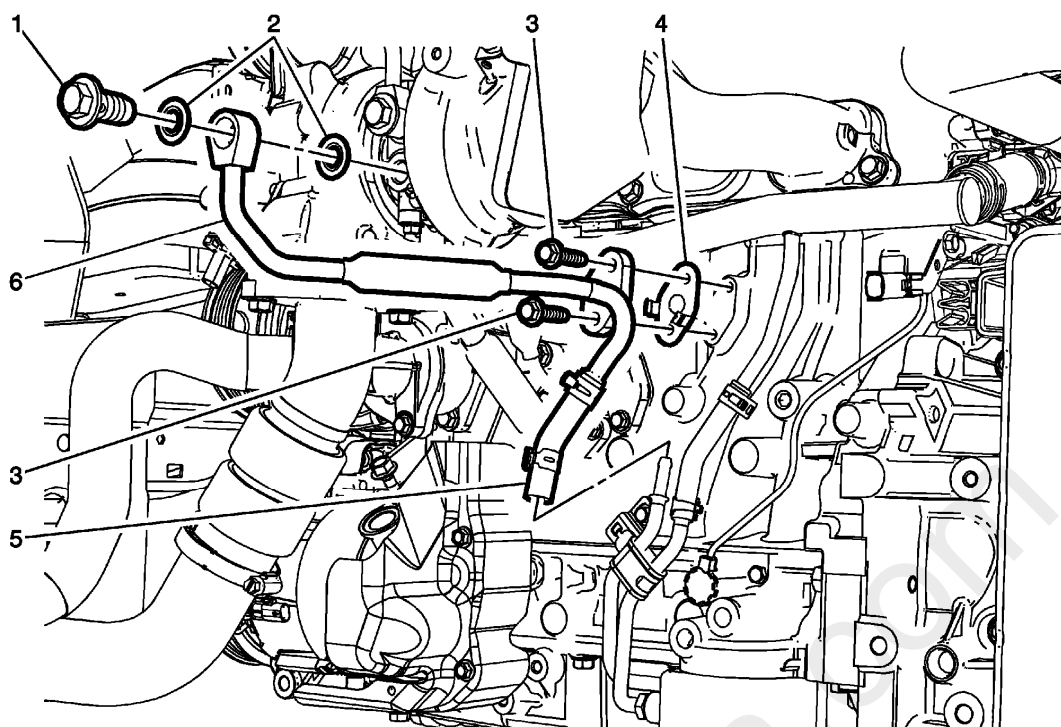


Fig. 111: Turbocharger Coolant Feed Pipe (LTG)
 Courtesy of GENERAL MOTORS COMPANY

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). NOTE: Replace hose clamp if necessary. Special Tools BO-38185 Hose Clamp Pliers For 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.
	Turbocharger Coolant Feed Pipe Fastener (Qty: 2)

3	CAUTION: Refer to <u>Fastener Caution</u> .
	Tighten: 10 (89 lb in)
4	Gasket
5	Hose Clamp
6	Turbocharger Coolant Feed Pipe

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LF3 - BANK 2)

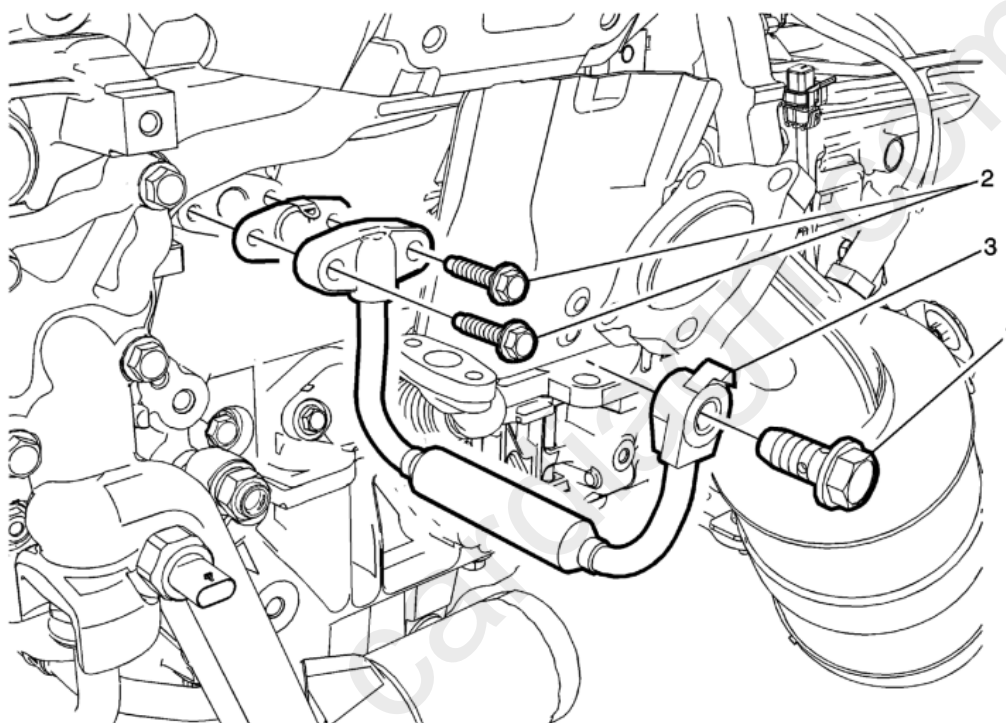


Fig. 112: Turbocharger Coolant Feed Pipe (LF3 - Bank 2)
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 2)

Callout	Component Name
Preliminary Procedures	
Remove the turbocharger. Refer to <u>Turbocharger Replacement (Bank 2)</u> .	
	Turbocharger Coolant Feed Pipe Fastener
	CAUTION: Refer to <u>Fastener Caution</u> .

1	Procedure 1. Clean the gasket surfaces. 2. Install a NEW gaskets. Tighten 35 (26 lb ft)
2	Turbocharger Coolant Feed Pipe Fastener (Qty: 2) Procedure 1. Clean the gasket surfaces. 2. Install a NEW gasket. Tighten 10 (89 lb in)
3	Turbocharger Coolant Feed Pipe

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LF3 - BANK 1)

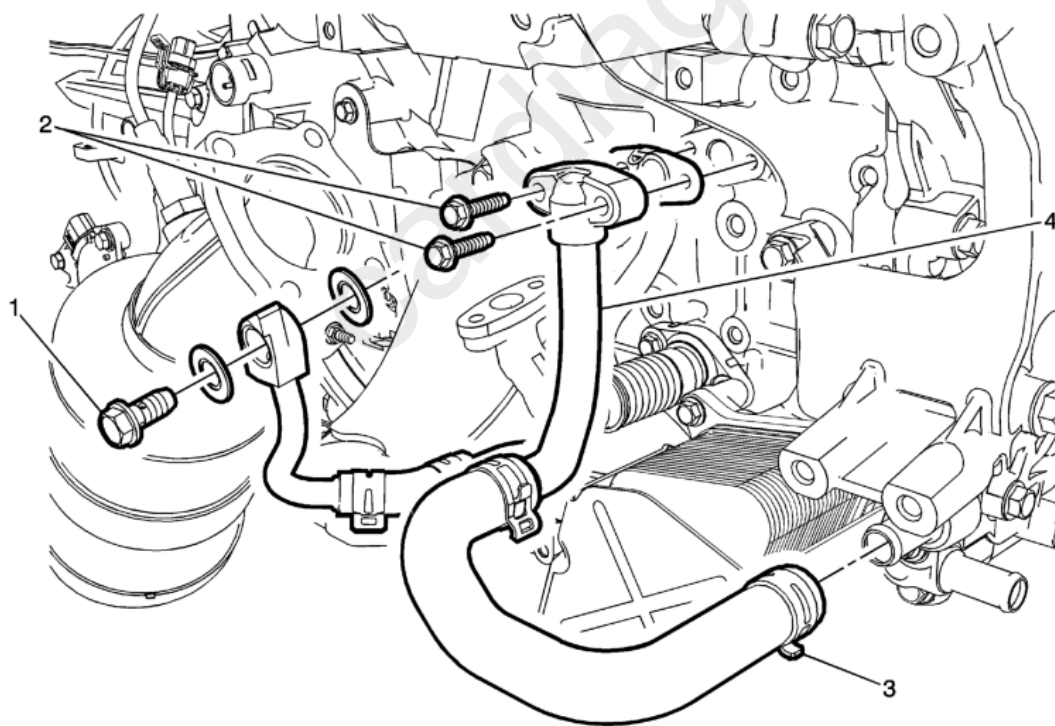


Fig. 113: Turbocharger Coolant Feed Pipe (LF3 - Bank 1)

Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 1)

Callout	Component Name
Special Tools BO-38185 Hose Clamp Pliers	
Preliminary Procedures Remove the turbocharger. Refer to <u>Turbocharger Replacement (Bank 1)</u> .	
1	Turbocharger Coolant Feed Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Clean the gasket surfaces. 2. Install a NEW gaskets. Tighten 35 (26 lb ft)
2	Turbocharger Coolant Feed Pipe Fastener (Qty: 2) Procedure 1. Clean the gasket surfaces. 2. Install a NEW gasket. Tighten 10 (89 lb in)
3	Turbocharger Coolant Feed Pipe Hose Clamp
4	Turbocharger Coolant Feed Pipe

TURBOCHARGER COOLANT RETURN PIPE REPLACEMENT (LTG)

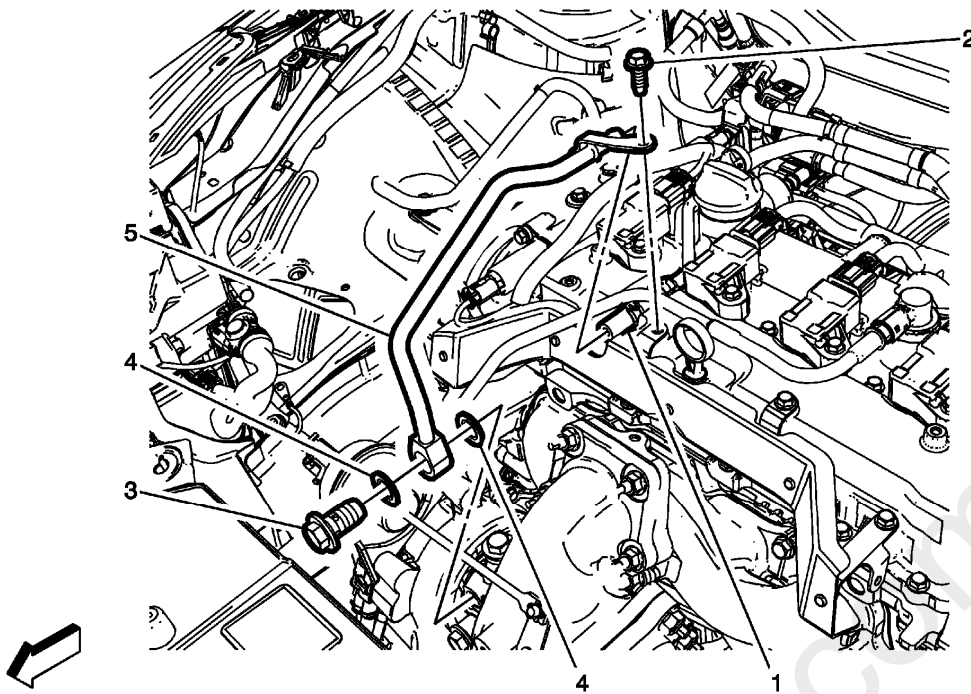


Fig. 114: Turbocharger Coolant Return Pipe (LTG)

Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Return Pipe Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 3. Remove the turbocharger heat shield. Refer to <u>Turbocharger Heat Shield Replacement</u>.	
NOTE: Replace hose clamp if necessary.	
Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .	
1	Engine Coolant Air Bleed Hose
2	Turbocharger Coolant Return Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . 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

TURBOCHARGER COOLANT RETURN PIPE REPLACEMENT (LF3 - BANK 2)

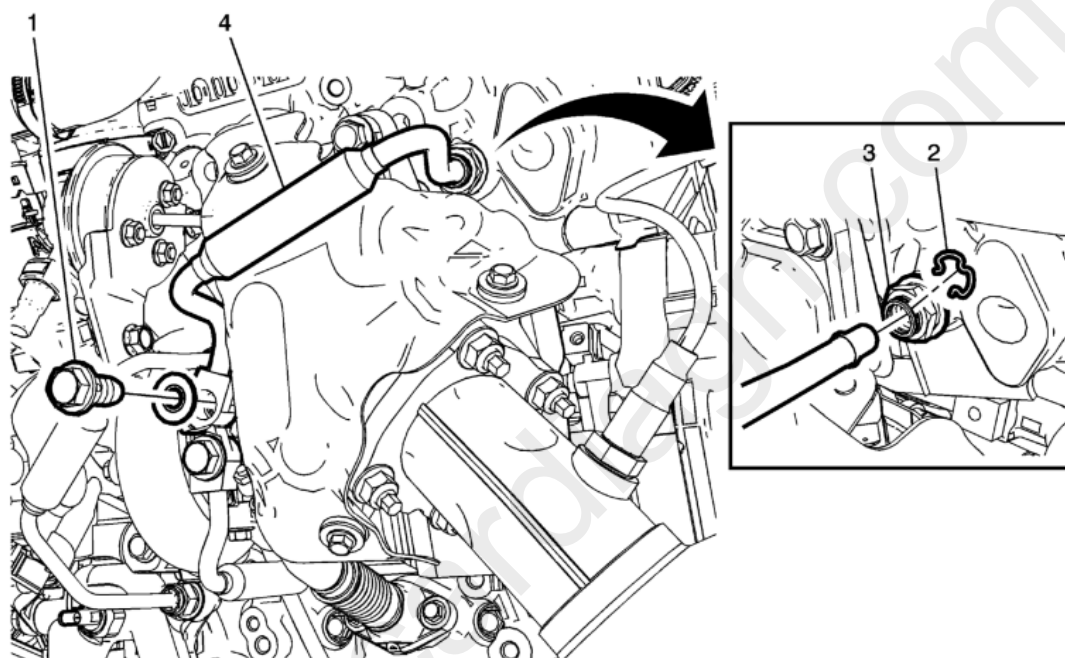


Fig. 115: Turbocharger Coolant Return Pipe (LF3 - Bank 2)
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 2)

Callout	Component Name
Preliminary Procedures Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
	Turbocharger Coolant Return Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> .

1	Procedure 1. Clean the gasket surfaces. 2. Install a NEW gaskets. Tighten 35 (26 lb ft)
2	Turbocharger Coolant Return Pipe Retaining Clip
3	Turbocharger Coolant Return Pipe Jiffy-Tite® Fastener Procedure 1. Remove and DISCARD the Jiffy-Tite® fastener 2. Install a NEW Jiffy-Tite® fastener Tighten 35 (26 lb ft)
4	Turbocharger Coolant Return Pipe

TURBOCHARGER COOLANT RETURN PIPE REPLACEMENT (LF3 - BANK 1)

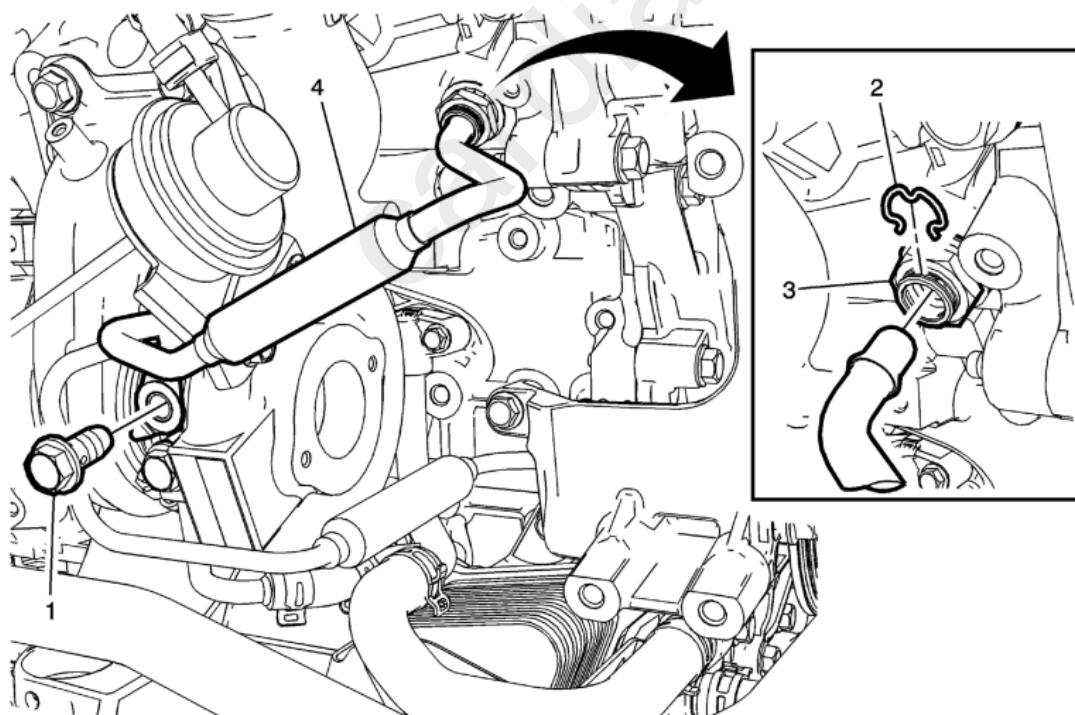


Fig. 116: Turbocharger Coolant Return Pipe (LF3 - Bank 1)

Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 1)

Callout	Component Name
Preliminary Procedures Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Turbocharger Coolant Return Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Clean the gasket surfaces. 2. Install a NEW gaskets. Tighten 35 (26 lb ft)
2	Turbocharger Coolant Return Pipe Retaining Clip
3	Turbocharger Coolant Return Pipe Jiffy-Tite® Fastener Procedure 1. Remove and DISCARD the Jiffy-Tite® fastener 2. Install a NEW Jiffy-Tite® fastener Tighten 35 (26 lb ft)
4	Turbocharger Coolant Return Pipe

TURBOCHARGER COOLANT HOSES/PIPES REPLACEMENT

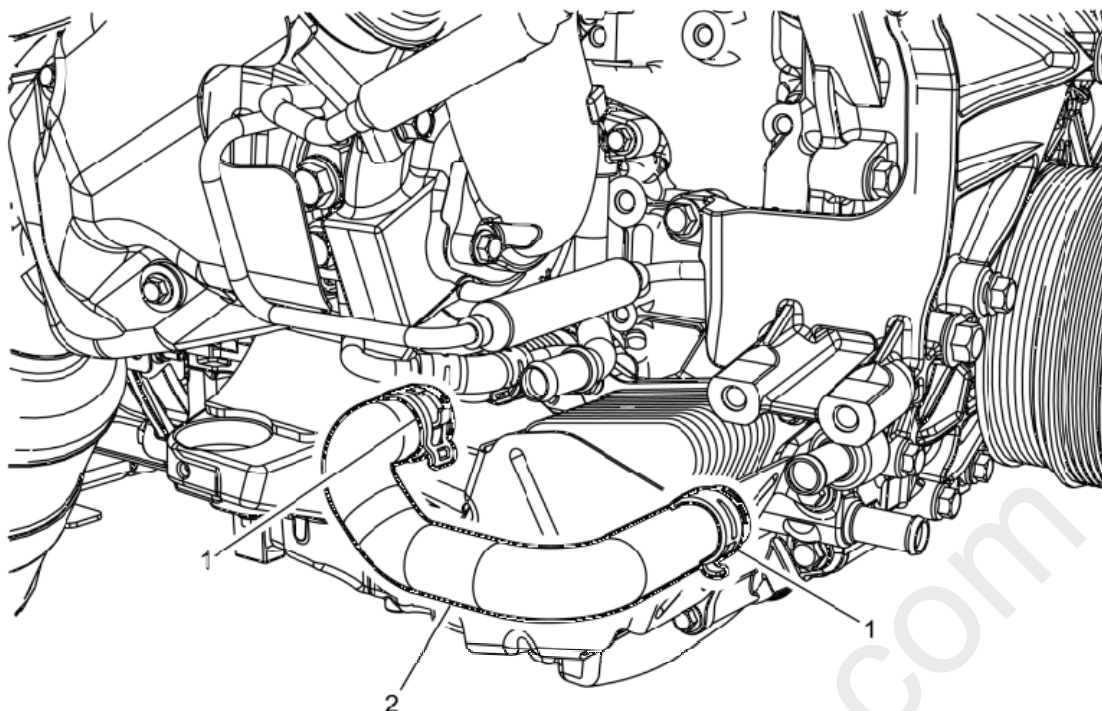


Fig. 117: Turbocharger Coolant Hoses/Pipes
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Hoses/Pipes Replacement

Callout	Component Name
Special Tools BO-38185 Hose Clamp Pliers	
Preliminary Procedures 1. Raise and properly support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 3. Drain the engine coolant. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>.	
1	Turbocharger Coolant Hose Clamps
2	Turbocharger Coolant Hose

SUPERCHARGER WATER MANIFOLD REPLACEMENT

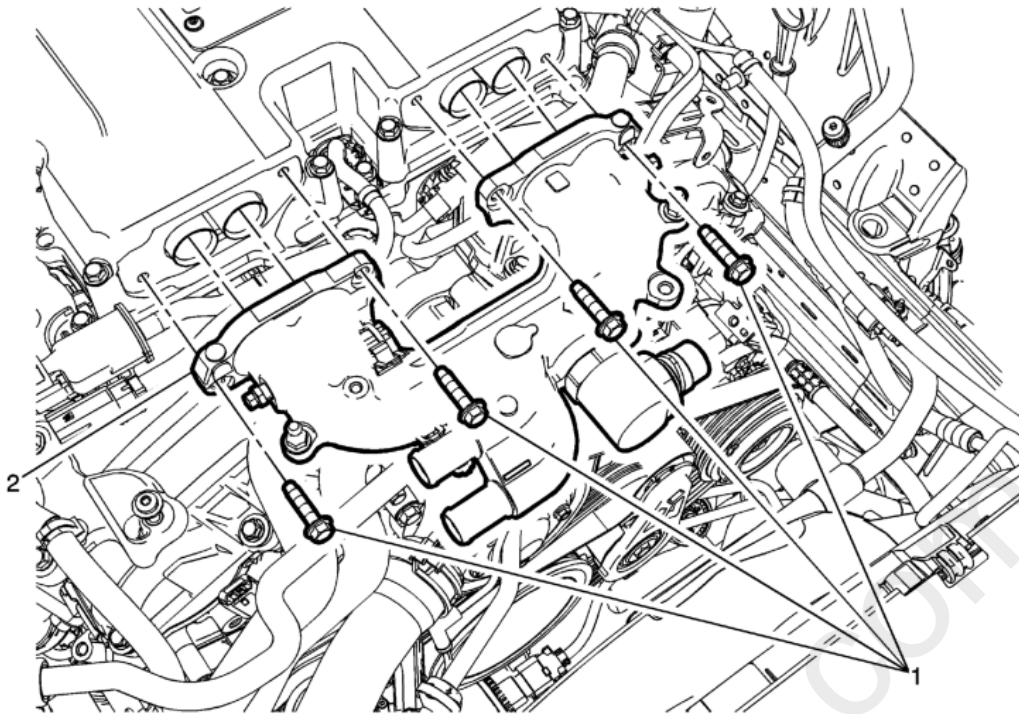


Fig. 118: Supercharger Water Manifold
 Courtesy of GENERAL MOTORS COMPANY

Supercharger Water Manifold Replacement

Callout	Component Name
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> . 3. Remove the air cleaner outlet front duct. Refer to <u>Air Cleaner Outlet Front Duct Replacement (LF3)</u> . 4. Disconnect the charge air cooler coolant hose. Refer to <u>Charge Air Cooler Coolant Hose Replacement (Pump to Engine LF3)</u>. 5. Disconnect the charge air cooler coolant hose - engine to radiator. Refer to <u>Charge Air Cooler Coolant Hose Replacement - Engine to Radiator</u>.	
1	Supercharger Water Manifold Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
	Supercharger Water Manifold

Procedure

Install NEW seals to the supercharger water manifold.

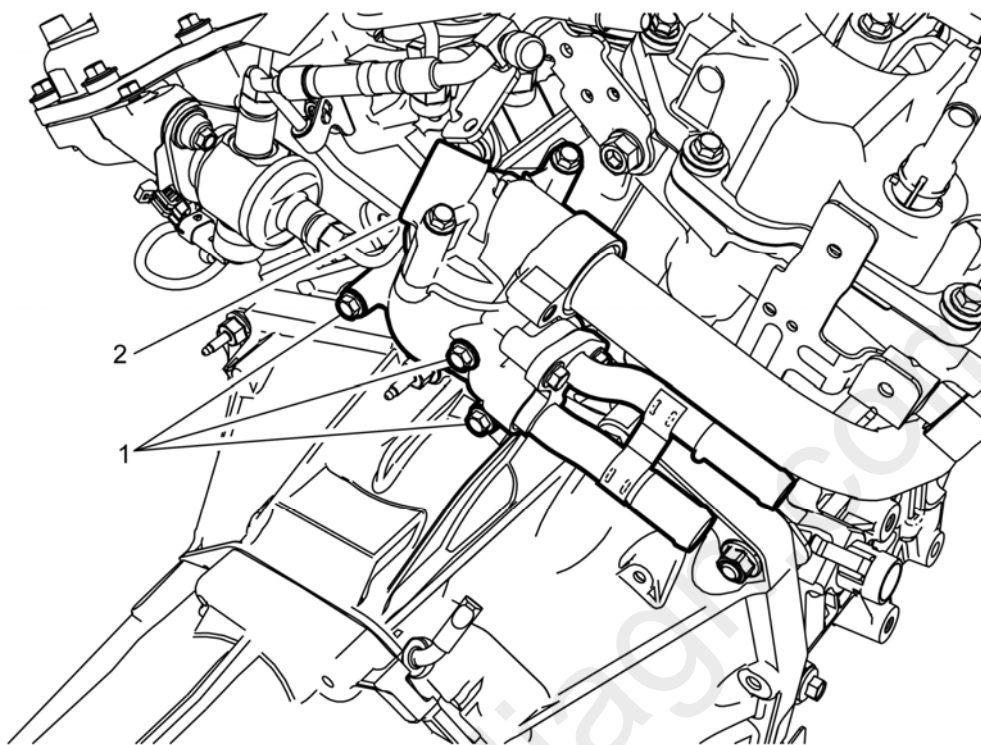
ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LFX, LF3)

Fig. 119: Engine Coolant Thermostat Housing (LFX, LF3)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Thermostat Housing Replacement (LFX, LF3)

Callout	Component Name
Preliminary Procedures	
1.	Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u>
2.	Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement (LFX)</u> , <u>Fuel Pipe Shield Replacement (LF3)</u> .
3.	Remove the right side hood strut. Refer to <u>Hood Strut Replacement</u> .
4.	Disconnect the heater inlet hose from the heater inlet and outlet pipe assembly. Refer to <u>Heater Inlet Hose Replacement (LFX)</u> , <u>Heater Inlet Hose Replacement (LF3)</u> .
5.	Disconnect the heater outlet hose from the heater inlet and outlet pipe assembly. Refer to <u>Heater Outlet Hose Replacement (LFX)</u> , <u>Heater Outlet Hose Replacement (LF3)</u> .
6.	Disconnect the engine wire harness retainers at the rear of the engine and reposition the harness to improve access.
7.	Disconnect the radiator outlet pipe from the thermostat housing. Refer to <u>Radiator Outlet Pipe</u>

Replacement (LFX), Radiator Outlet Pipe Replacement (LF3).

1	Engine Coolant Thermostat Housing Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Engine Coolant Thermostat Housing Procedure 1. Install a NEW thermostat housing gasket. 2. If replacing the thermostat housing, remove the heater inlet and outlet pipe assembly. Refer to <u>Heater Inlet And Outlet Pipe Replacement (LFX, LF3).</u>

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LTG)

Removal Procedure

Special Tools

BO-38185 Hose Clamp Pliers

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

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).**
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
3. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .

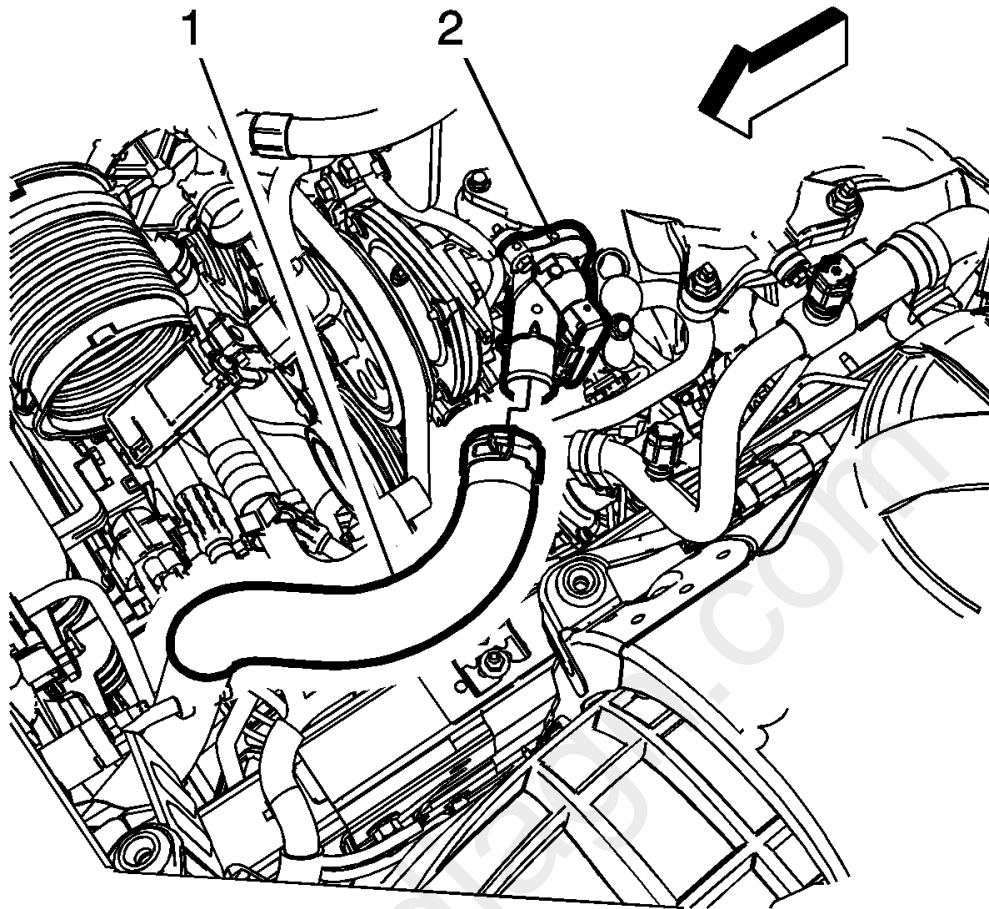


Fig. 120: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

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

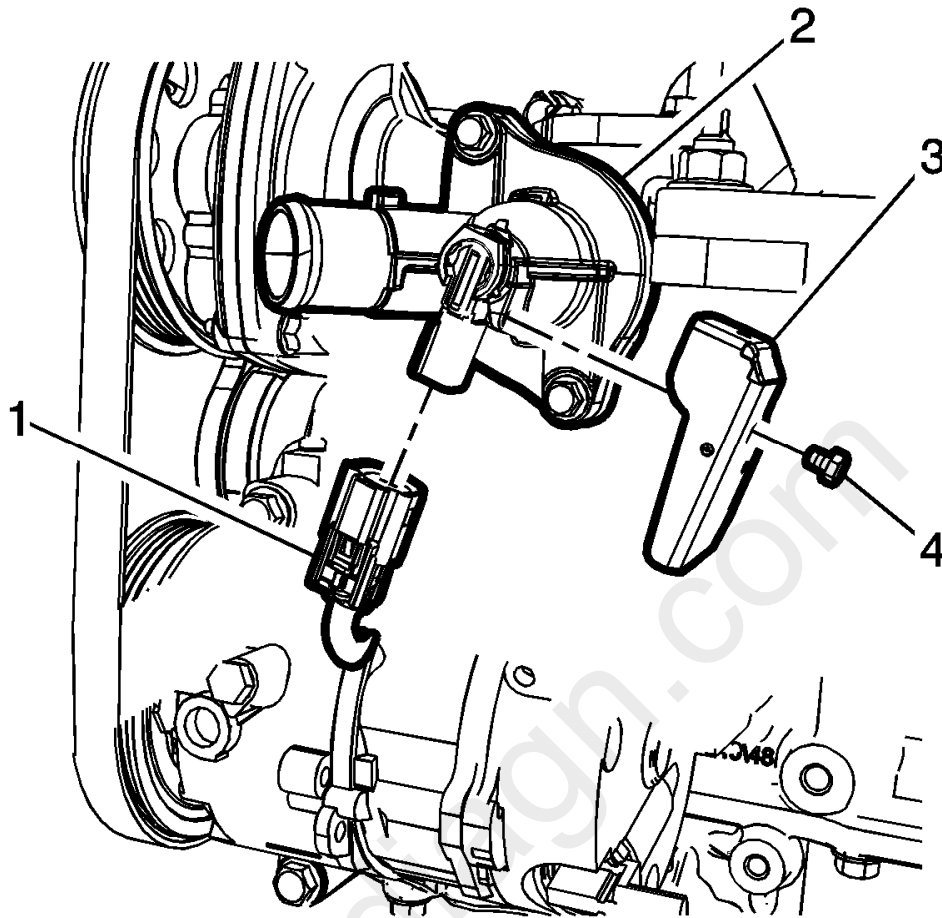


Fig. 121: Thermostat Heater Heat Shield
Courtesy of GENERAL MOTORS COMPANY

5. Remove the thermostat heater heat shield fastener (4) and remove the thermostat heater heat shield (3).
6. Disconnect the thermostat heater connector (1).

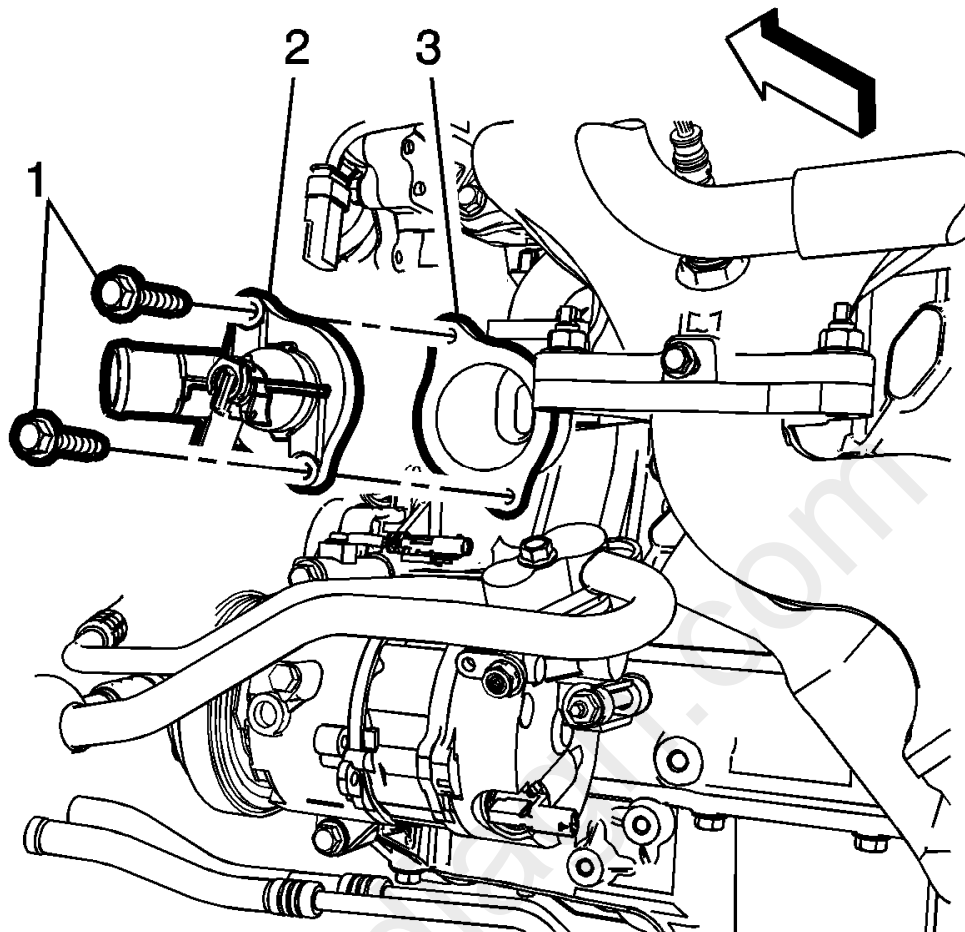


Fig. 122: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine coolant thermostat housing fasteners (1) and remove the engine coolant thermostat housing (2).
8. Discard the engine coolant thermostat housing gasket (3).
9. Transfer the thermostat heater if replacing the thermostat housing with the thermostat.

Installation Procedure

1. Clean the sealing surfaces.

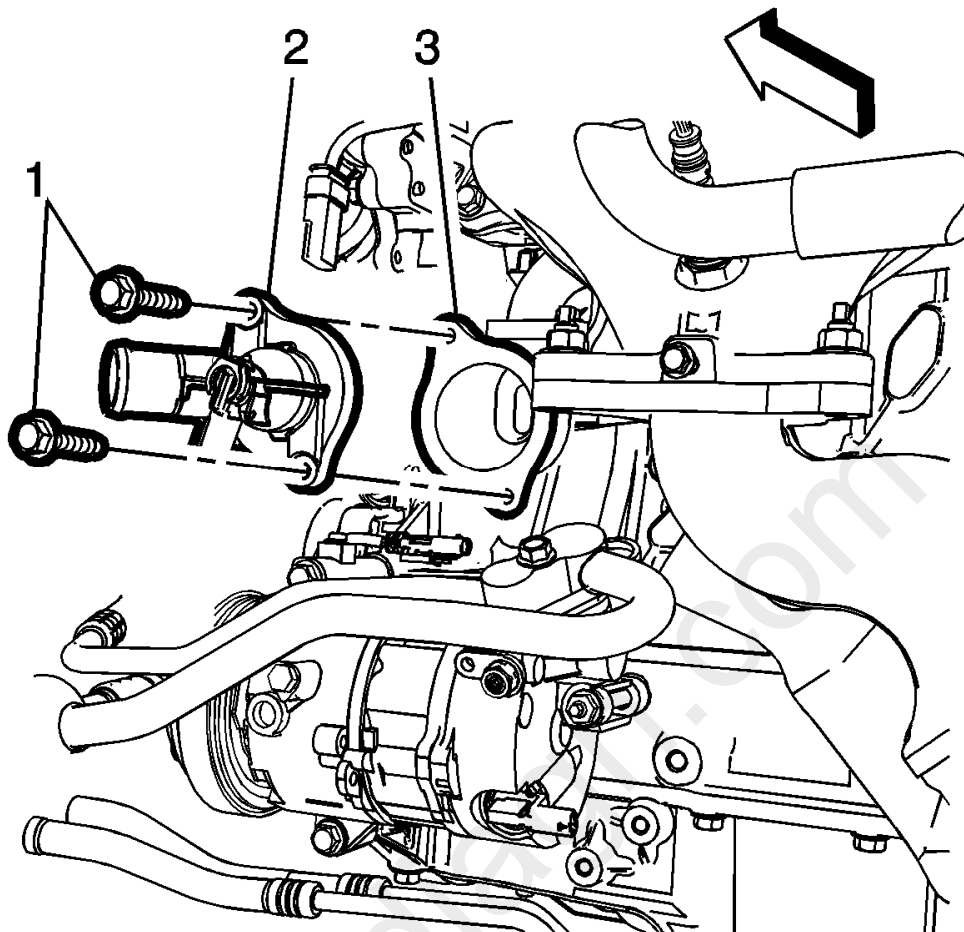


Fig. 123: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

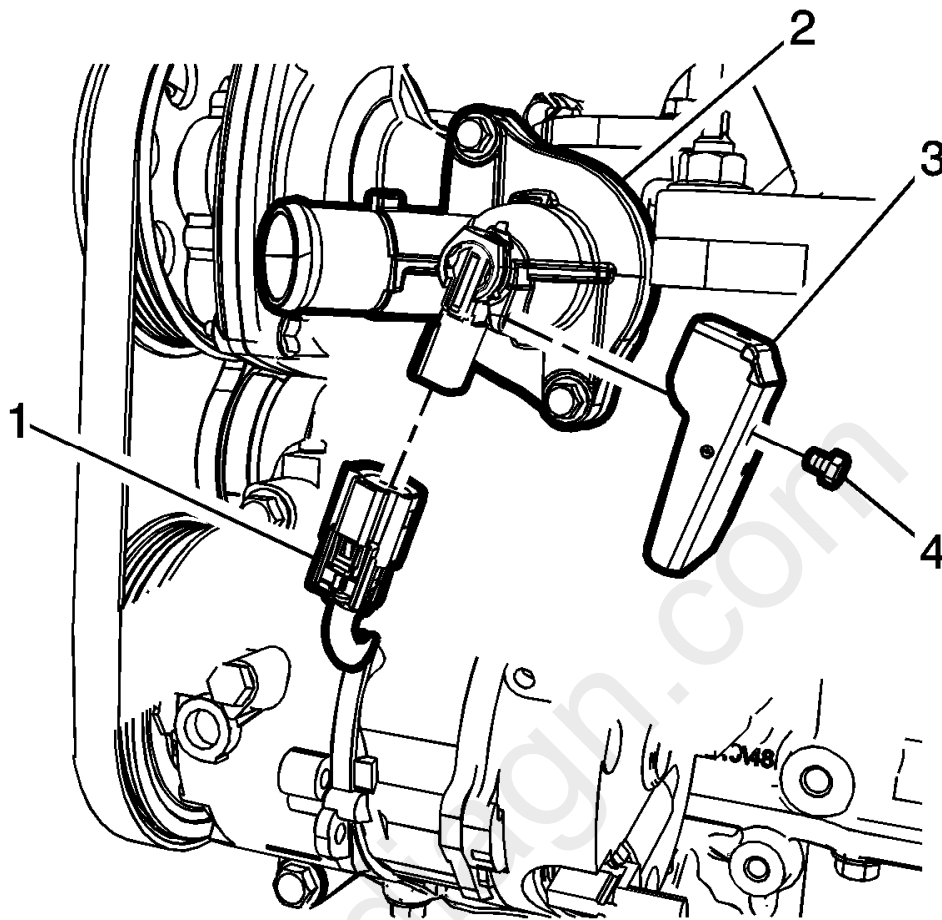


Fig. 124: Thermostat Heater Heat Shield
Courtesy of GENERAL MOTORS COMPANY

3. Connect the thermostat heater connector (1).
4. Install the thermostat heater shield (3) and tighten the fastener (4) to 5 (44 lb in).

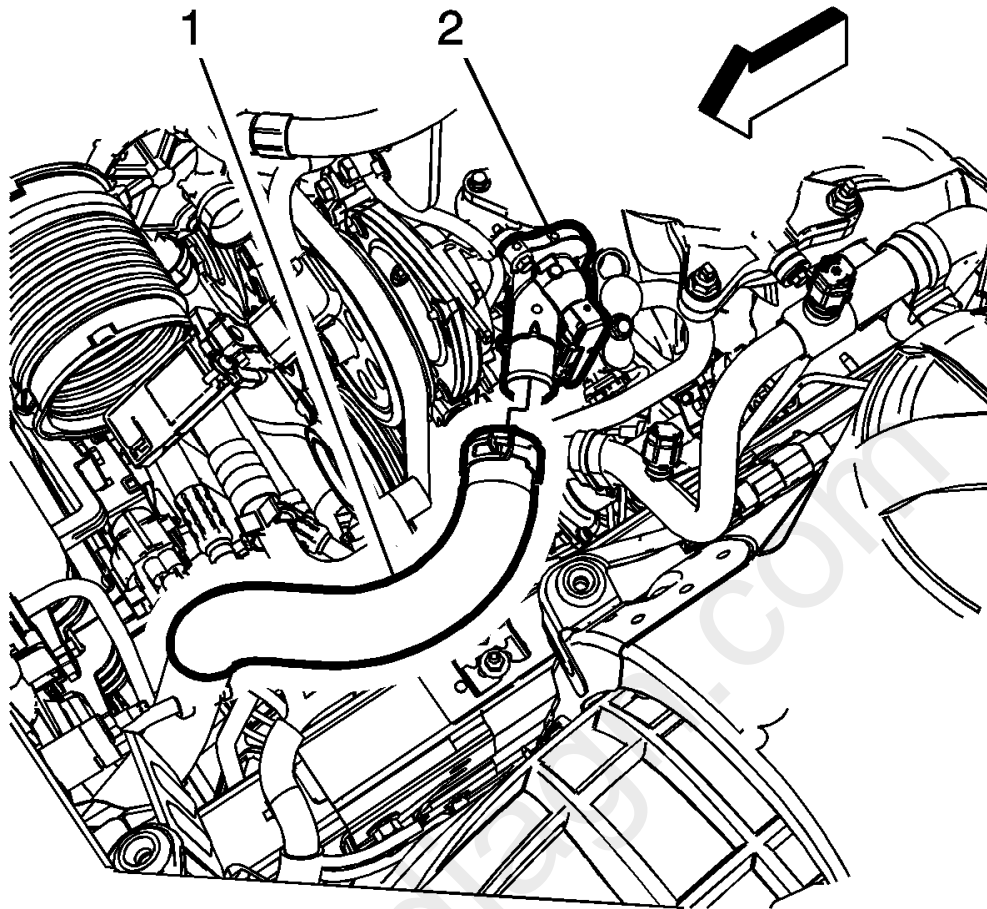


Fig. 125: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

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

ENGINE COOLANT AIR BLEED VALVE REPLACEMENT (LS2)

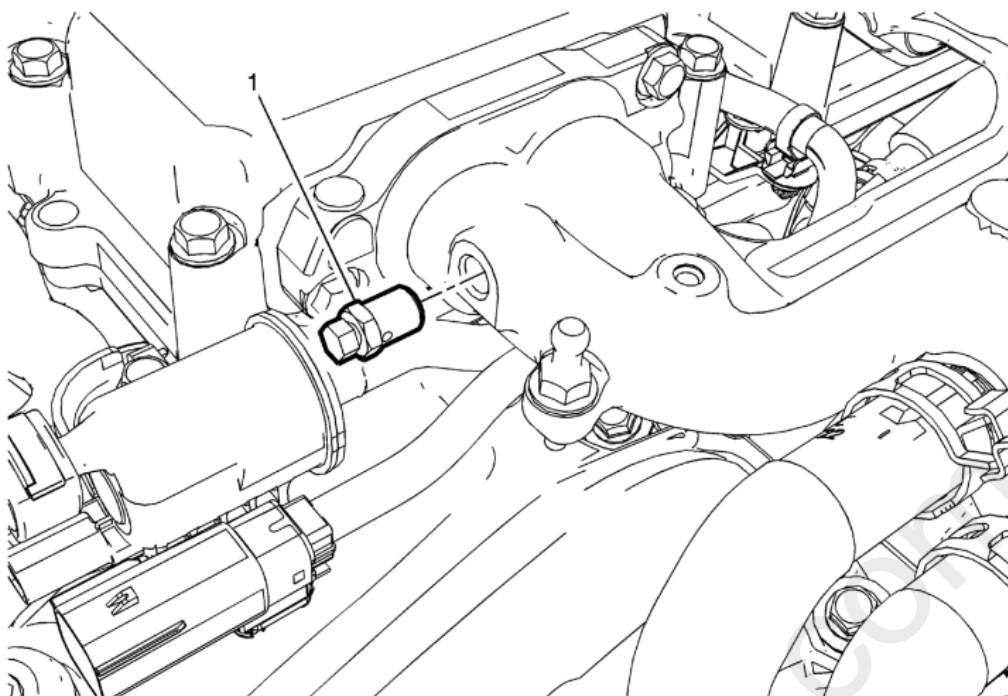


Fig. 126: Engine Coolant Air Bleed Valve (LS2)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Air Bleed Valve Replacement (LS2)

Callout	Component Name
Preliminary Procedure 1. Partially drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Engine Coolant Air Bleed Valve (Qty: 2) CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten 12 (106 lb in)

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LTG)

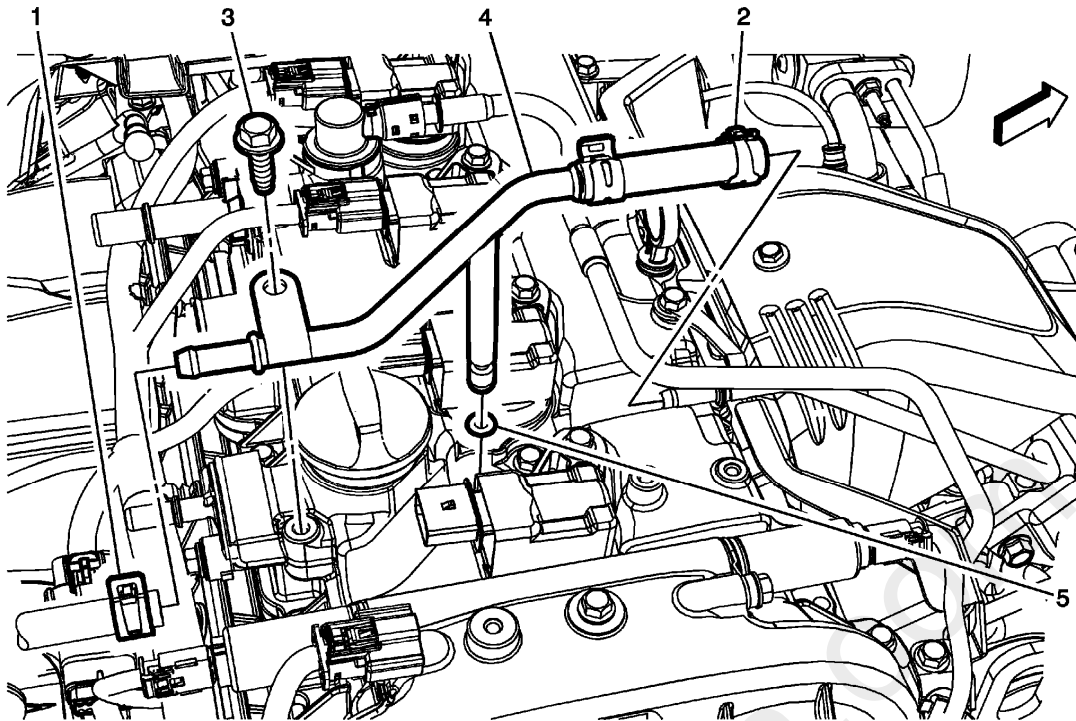


Fig. 127: Engine Coolant Air Bleed Pipe (LTG)

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 (LTG). 4. Disconnect the electrical wiring harness connector from the ignition coil.	
NOTE: Replace hose clamps if necessary.	
Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .	
1	Surge Tank Vent Hose Clamp
2	Engine Coolant Air Bleed Hose Clamp
	Engine Coolant Air Bleed Pipe Fastener
CAUTION: Refer to Fastener Caution .	

3	Tighten: 10 (89 lb in)
4	Engine Coolant Air Bleed Pipe
5	Seal
	NOTE: Install NEW seal

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (LTG)

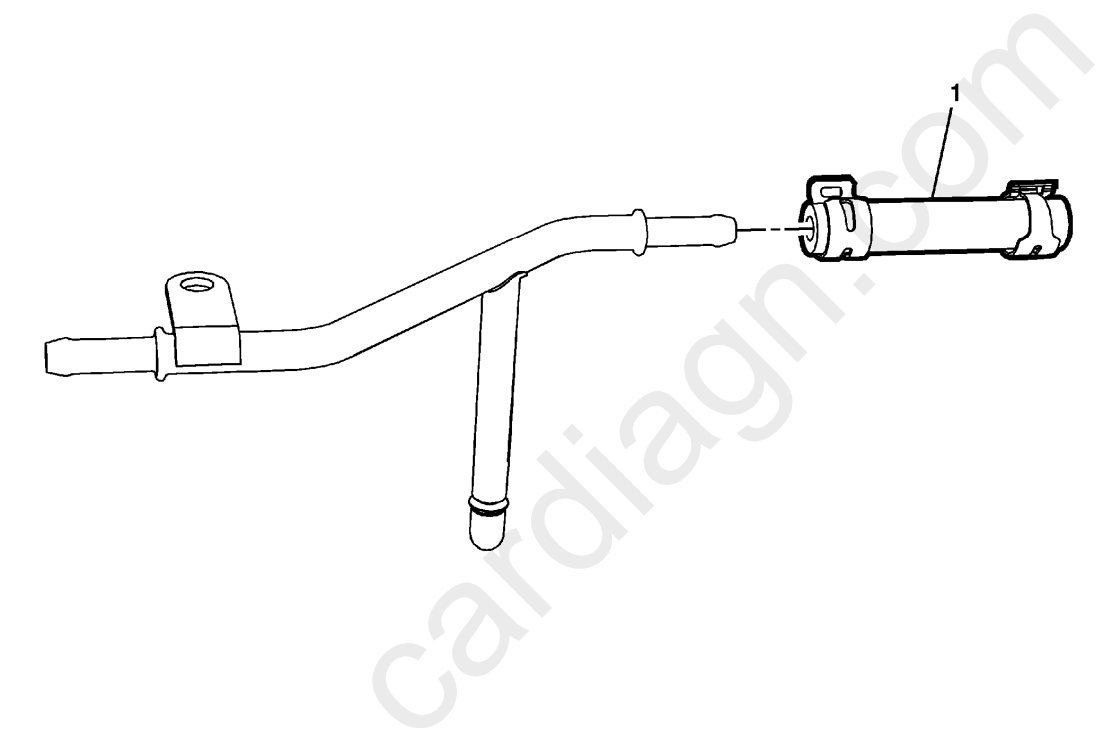


Fig. 128: Engine Coolant Air Bleed Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

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 .	
	Engine Coolant Air Bleed Hose

NOTE:
Replace hose clamps if necessary.

WATER OUTLET REPLACEMENT (LFX)

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. Refer to Intake Manifold Replacement (LFX).

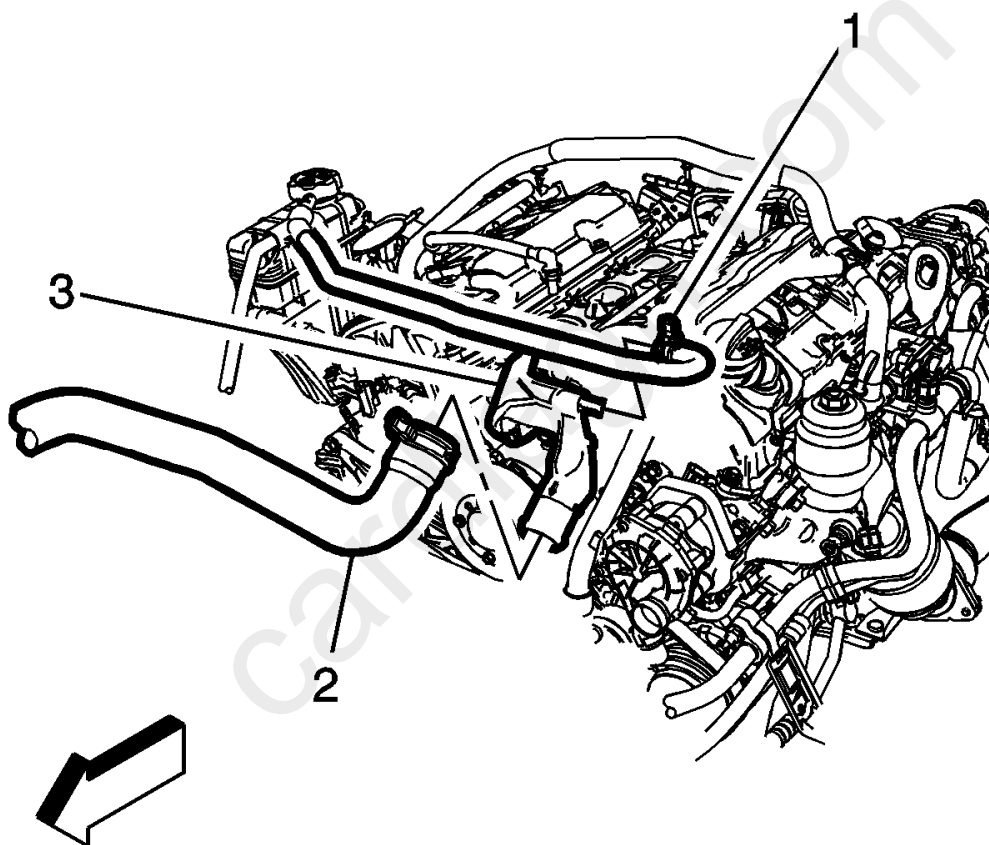


Fig. 129: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine coolant air bleed hose (1) and the radiator inlet hose (2) from the water outlet (3).

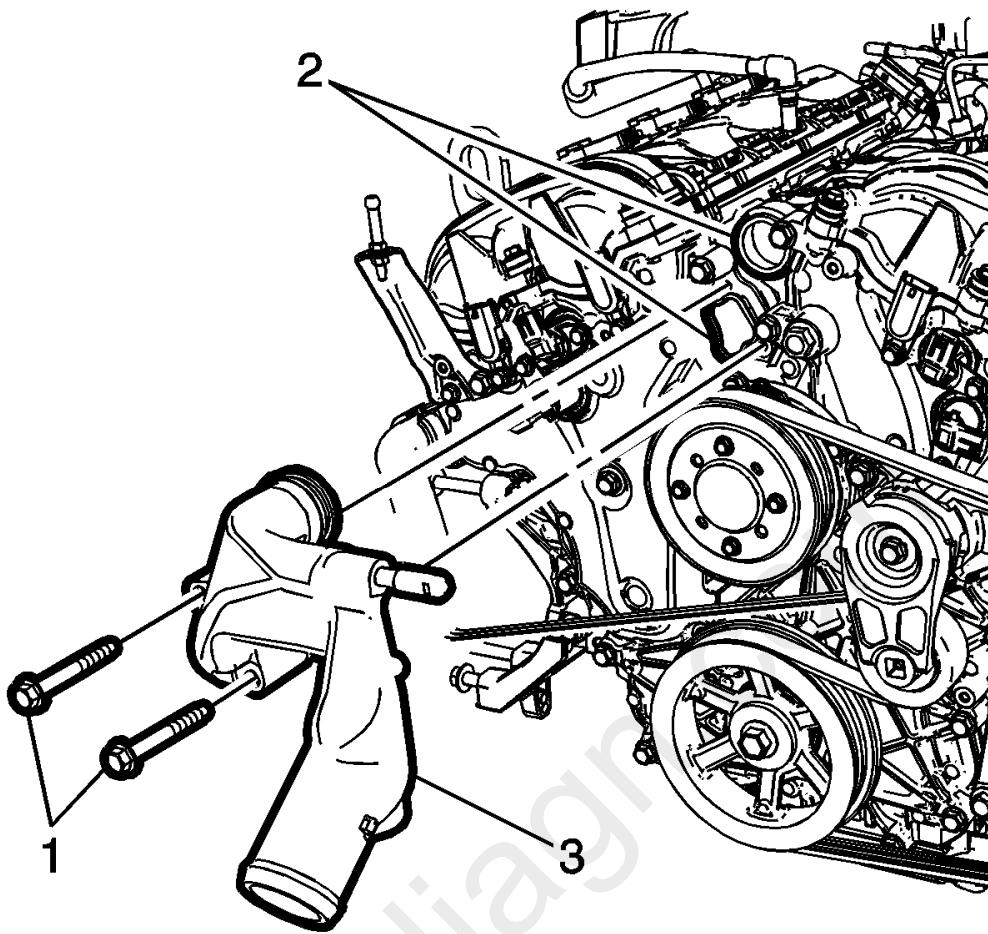


Fig. 130: Water Outlet, Seals & Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the water outlet fasteners (1) and the 2 water outlet seals (2).
5. Remove the water outlet (3) and discard the seals (2).

Installation Procedure

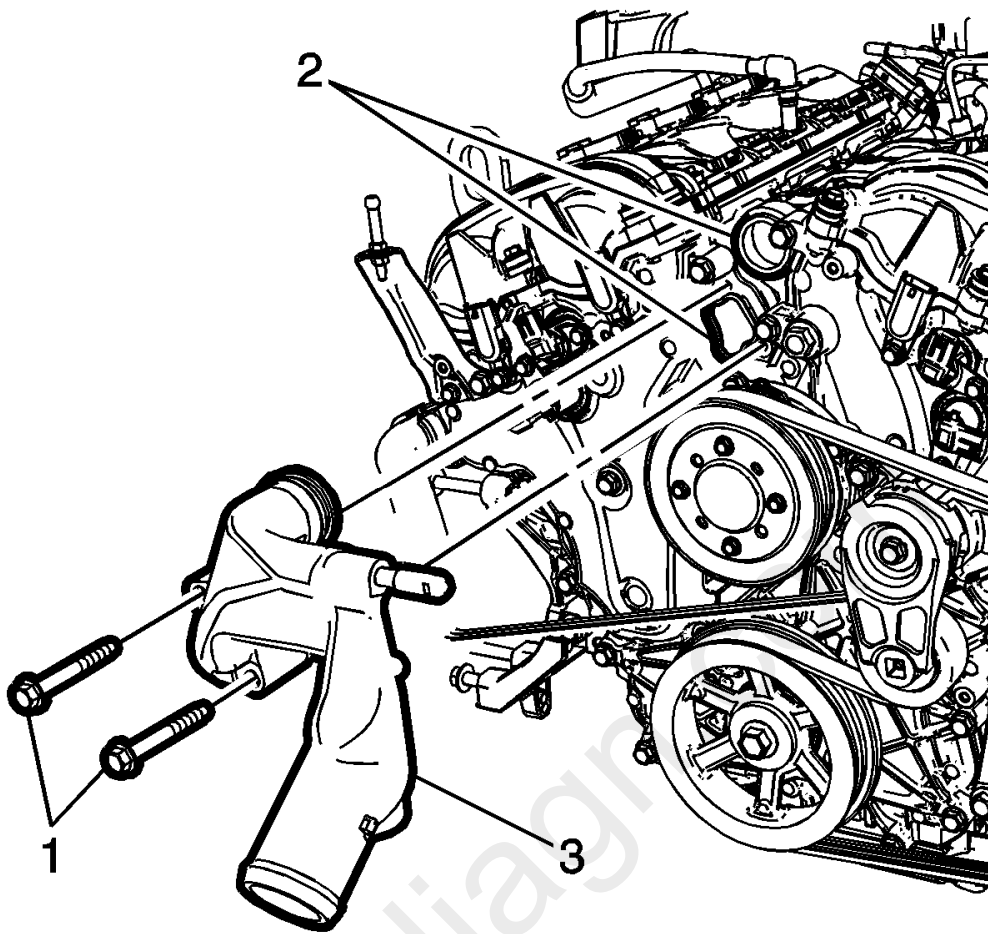


Fig. 131: Water Outlet, Seals & Fasteners
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

2. Install the water outlet fasteners (1) and tighten to 10 N.m (89 lb in).

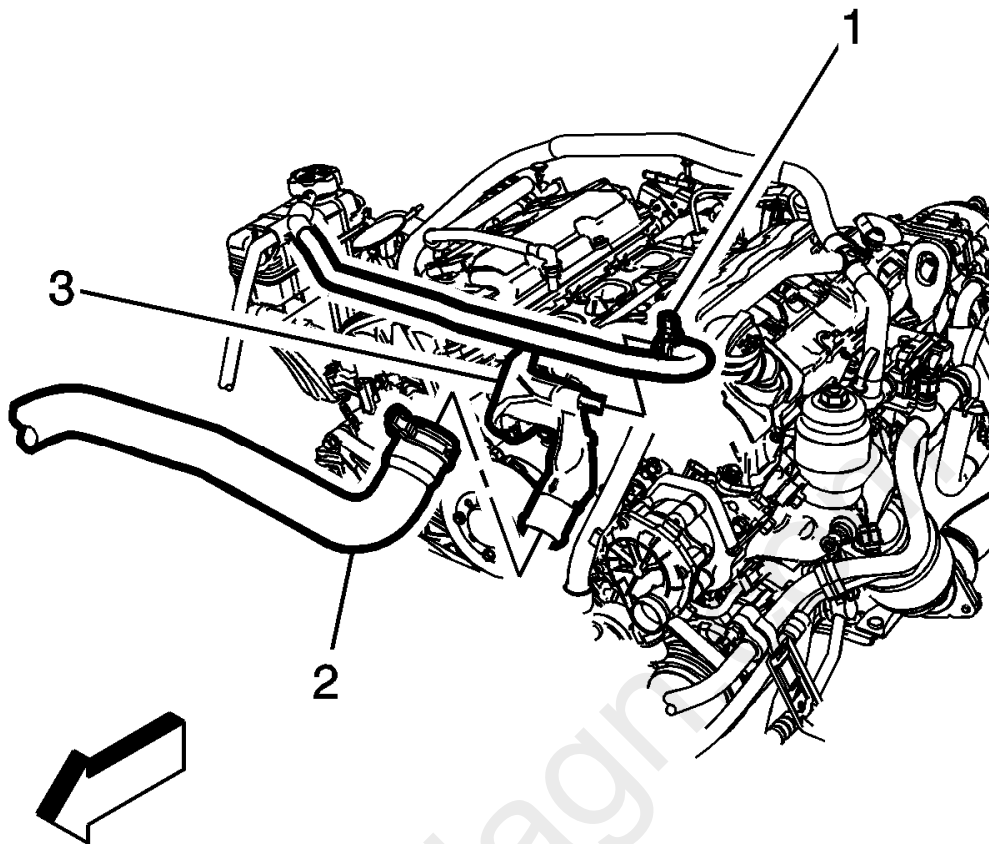


Fig. 132: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

3. Install the engine coolant air bleed hose (1) and the radiator inlet hose (2) to the water outlet (3).
4. Install the intake manifold. Refer to **Intake Manifold Replacement (LFX)** .
5. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

WATER OUTLET REPLACEMENT (LF3)

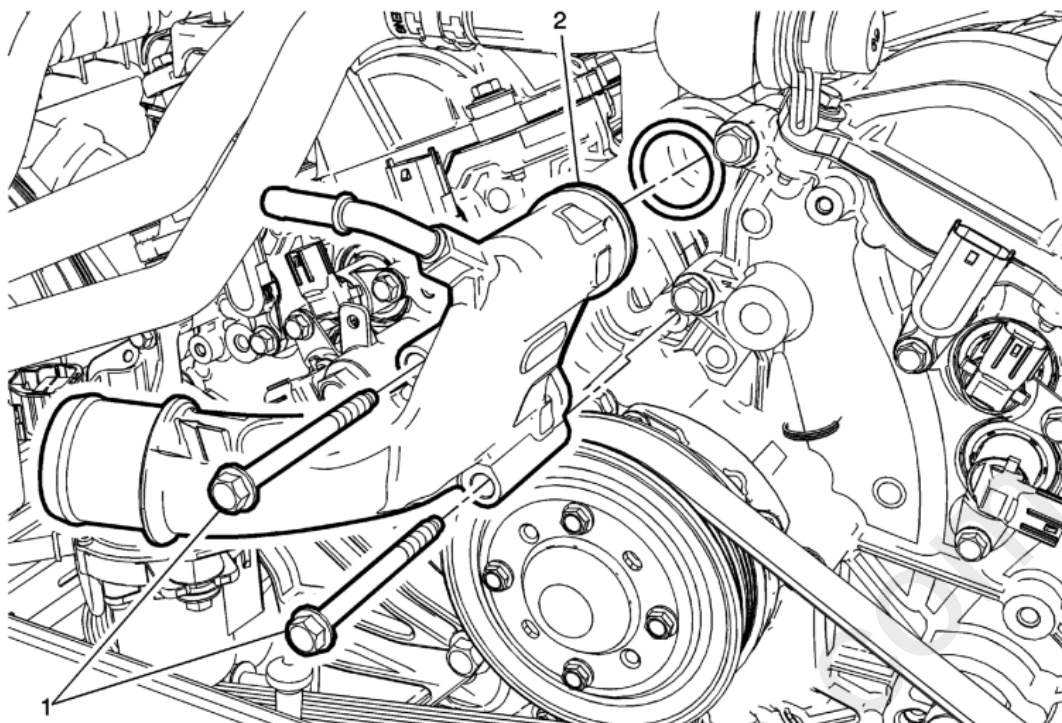


Fig. 133: Water Outlet (LF3)

Courtesy of GENERAL MOTORS COMPANY

Water Outlet Replacement (LF3)

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Disconnect the radiator surge tank inlet hose. Refer to <u>Radiator Surge Tank Inlet Hose Replacement (LF3)</u> . 3. Disconnect the radiator inlet hose. Refer to <u>Radiator Inlet Hose Replacement (LF3)</u> .	
1	Water Outlet Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Water Outlet Procedure Clean the mating surfaces and install a NEW seal.

WATER OUTLET REPLACEMENT (LTG)

Removal Procedure

Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to Special Tools .

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).
2. Remove the plenum front panel. Refer to Plenum Front Panel Replacement .
3. Remove the fuel pump cover. Refer to Fuel Pump Cover Replacement .
4. Remove the power brake booster. Refer to Power Brake Booster Pump Replacement (LTG) .

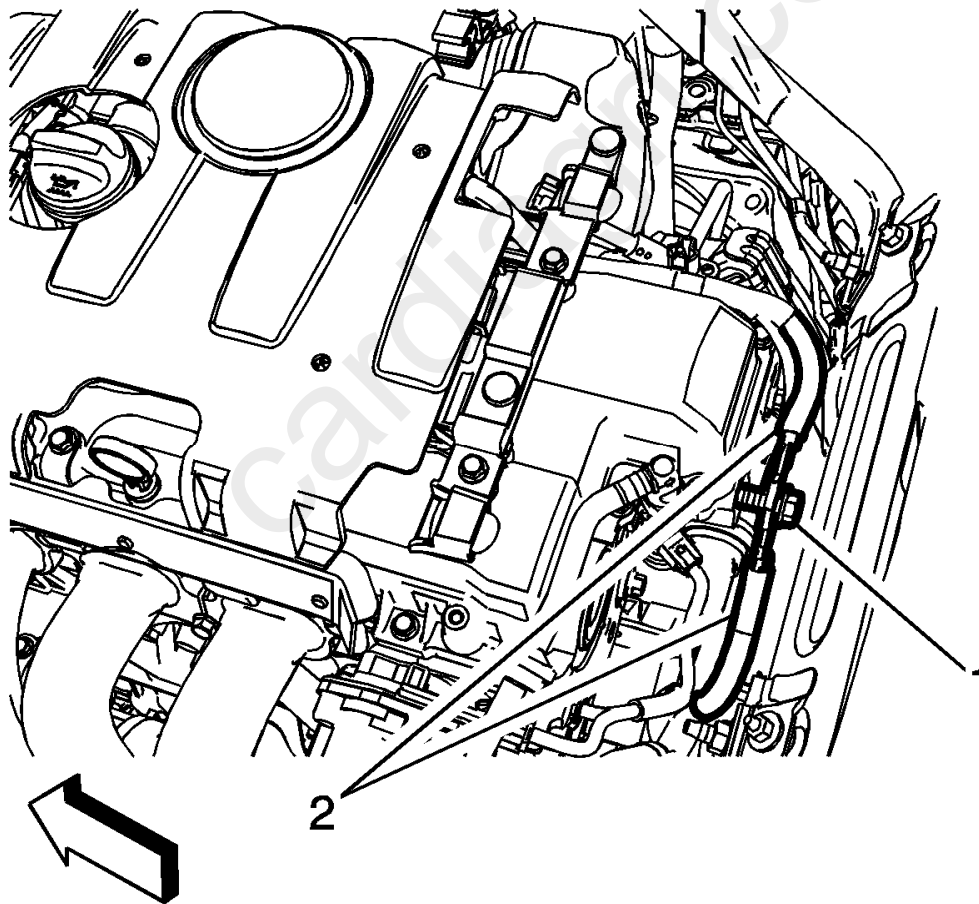


Fig. 134: Engine Harness Ground Cables
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine harness ground fastener (1) and set aside the engine harness ground cables (2).
6. If equipped with RPO code LCV, remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)**.
7. If equipped with RPO code LTG, remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
8. Remove the thermostat bypass pipe fasteners in order to remove the thermostat bypass pipe from the water pump. Discard the gasket

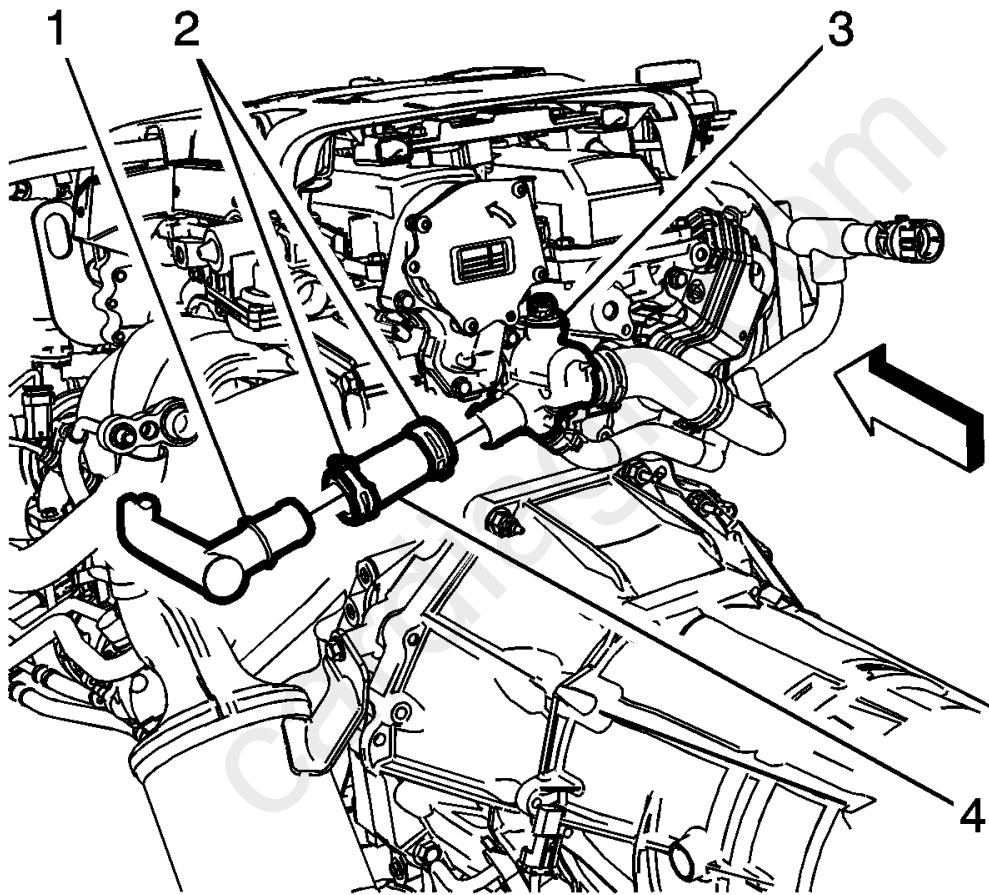


Fig. 135: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

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

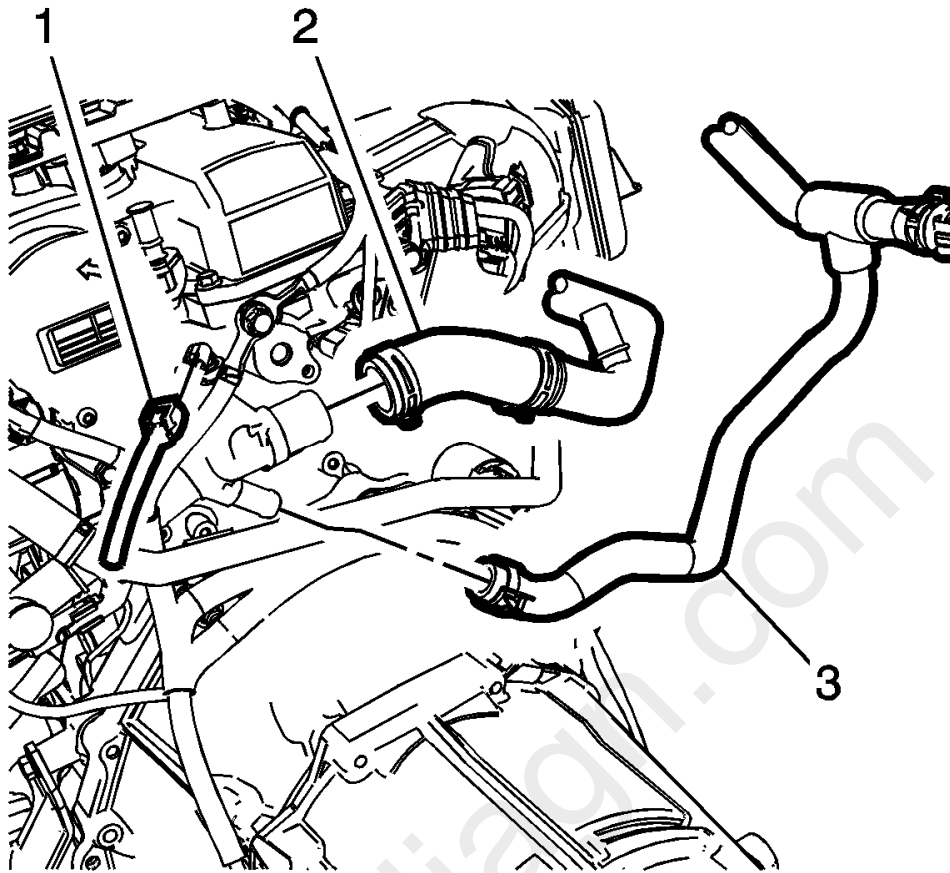


Fig. 136: Engine Coolant Temperature (ECT) Sensor
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the engine coolant temperature (ECT) sensor connector (1).
11. Remove the radiator inlet hose (2) and the heater outlet hose (3), from the water outlet.

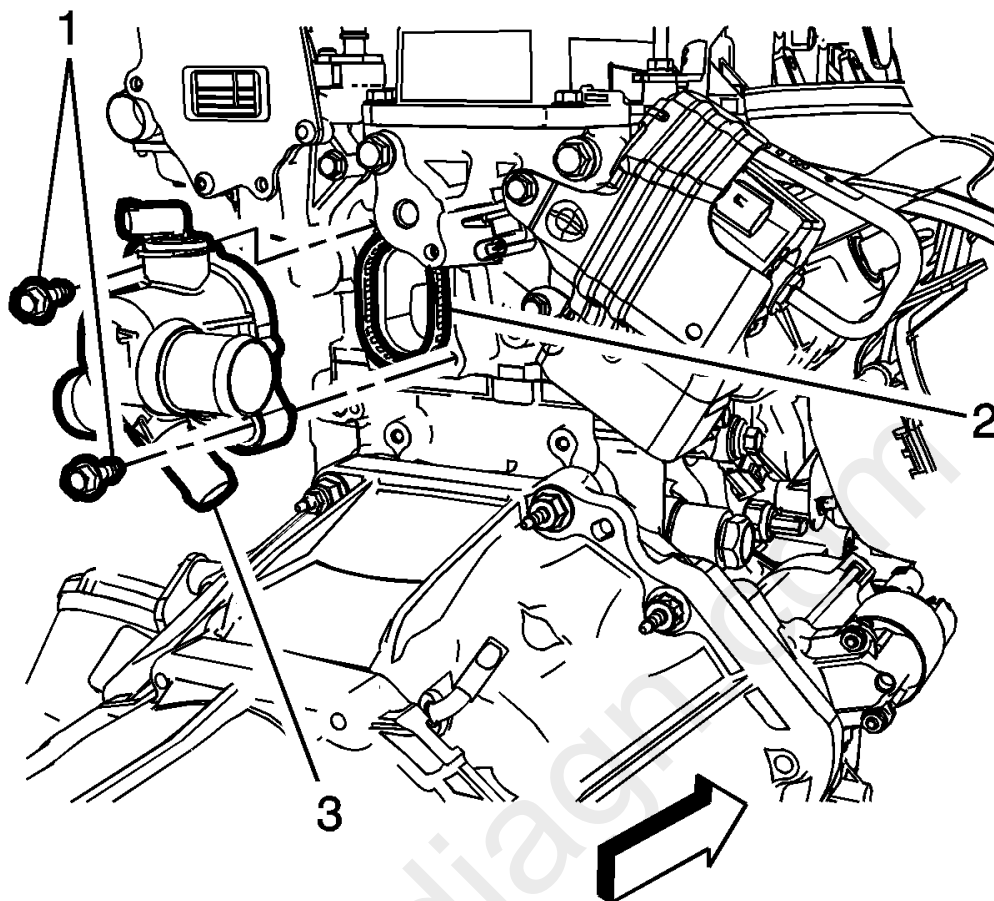


Fig. 137: Water Outlet
Courtesy of GENERAL MOTORS COMPANY

12. Remove the water outlet fasteners (1) and remove the water outlet (3).
13. Discard the water outlet seal (2).

Installation Procedure

1. Clean the sealing surfaces.

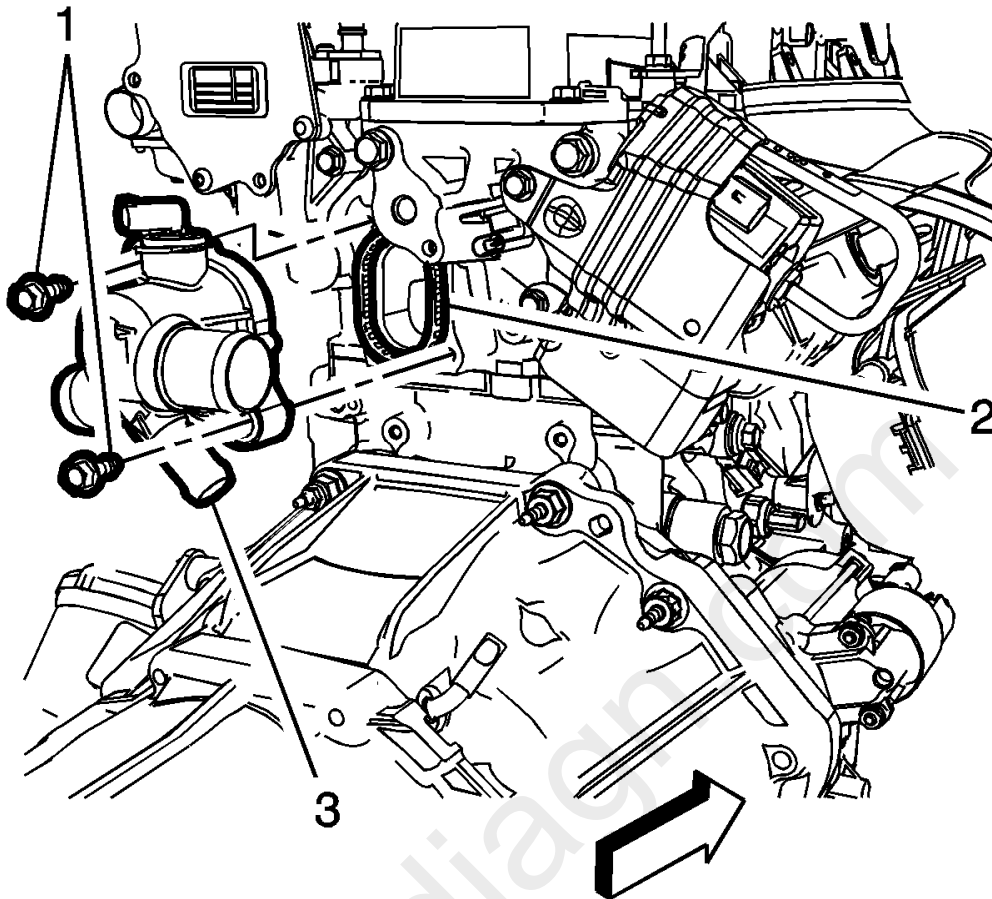


Fig. 138: Water Outlet
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the water outlet (3) to the engine block with a NEW seal (2) and tighten the fasteners (1) to 12 (106 lb in).

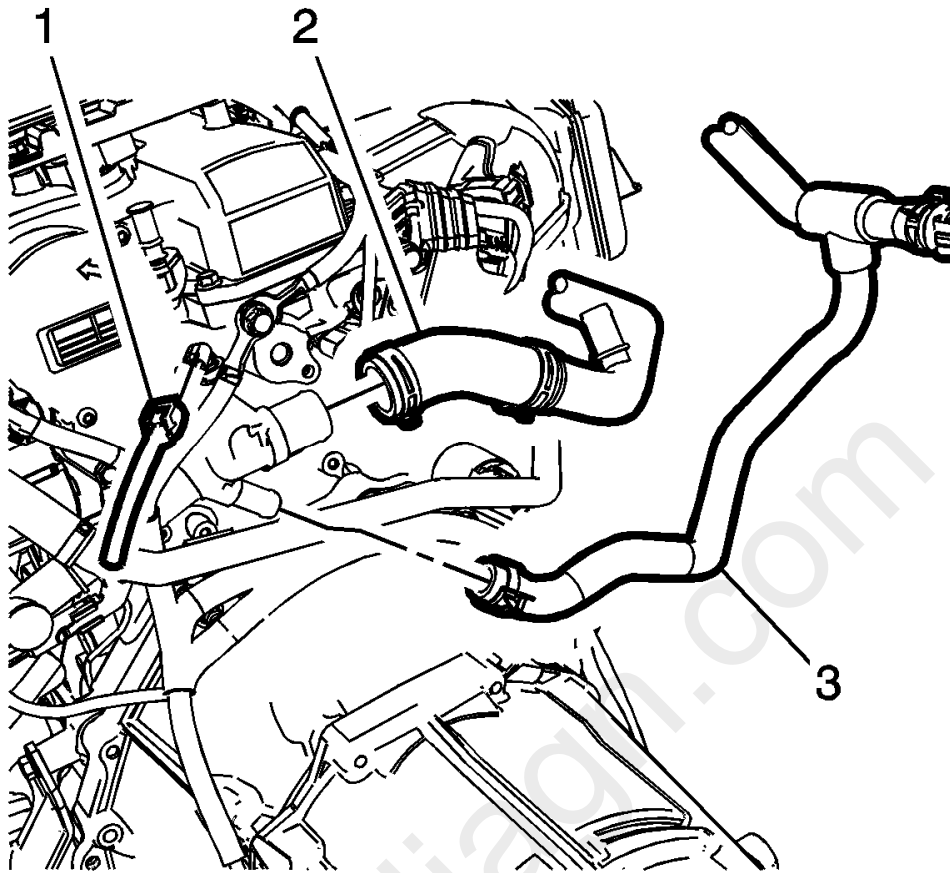


Fig. 139: Engine Coolant Temperature (ECT) Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Install the heater outlet hose (3) and the radiator inlet hose (2) to the water outlet.
4. Connect the ECT sensor connector (1).

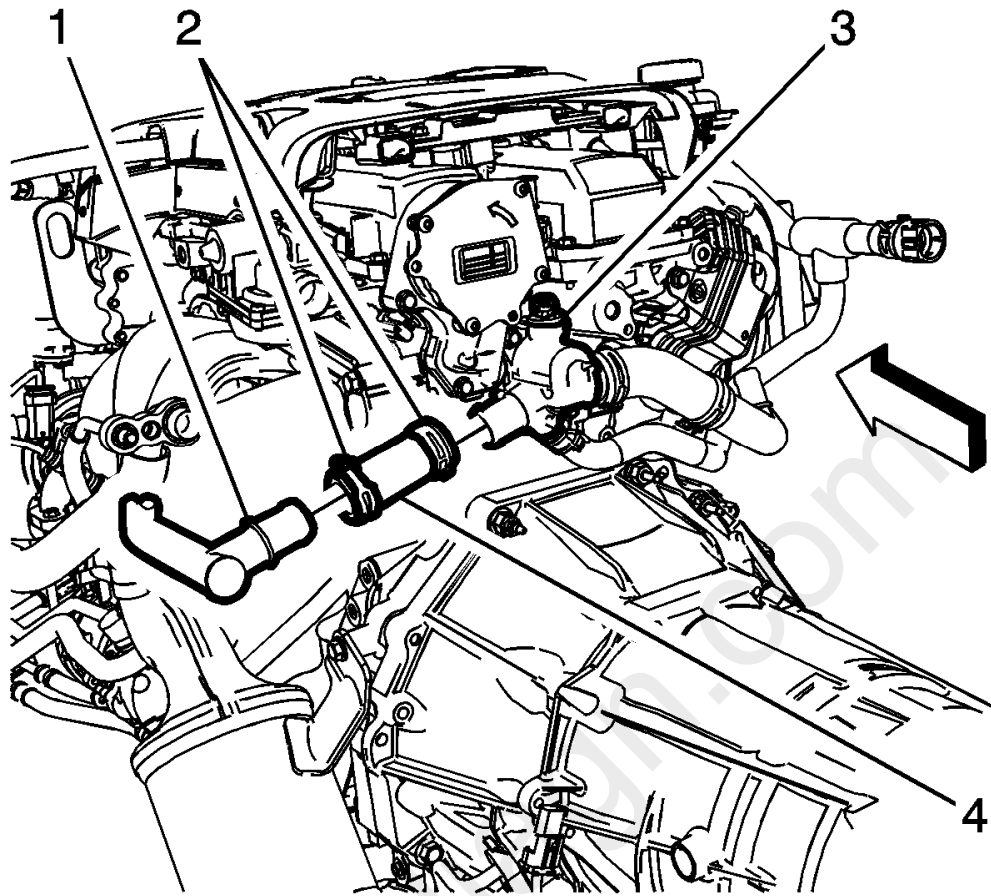


Fig. 140: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install the thermostat bypass hose (2) to the water outlet (3)..
6. Install the thermostat bypass pipe using a NEW gasket.
7. Install the thermostat bypass pipe fasteners and tighten them to 10 (89 lb in).
8. If equipped with RPO code LTG, install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
9. If equipped with RPO code LCV, install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .

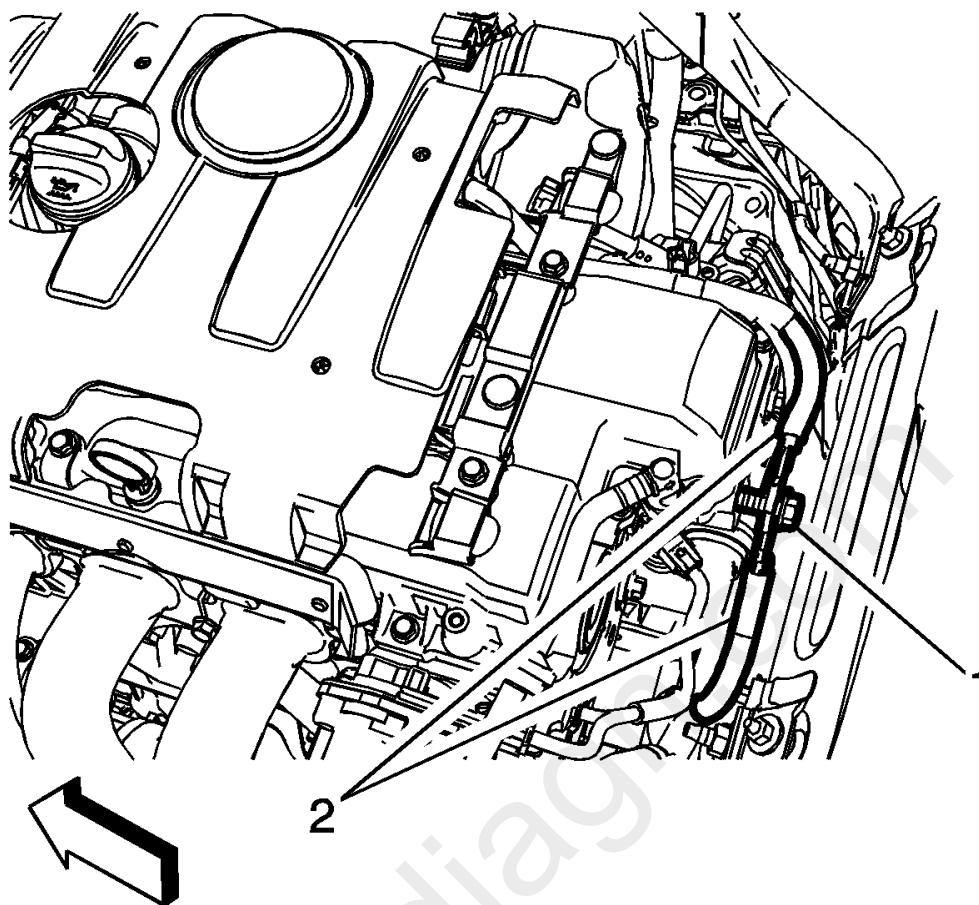


Fig. 141: Engine Harness Ground Cables
Courtesy of GENERAL MOTORS COMPANY

10. Install the engine harness ground cables (2) to the engine block and tighten the fastener (1) to 25 (18 lb ft).
11. Install the power brake booster. Refer to **Power Brake Booster Pump Replacement (LTG)** .
12. Install the fuel pump cover. Refer to **Fuel Pump Cover Replacement** .
13. Install the plenum front panel. Refer to **Plenum Front Panel Replacement** .
14. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
15. Start the engine and check for coolant leaks.

HEATER INLET AND OUTLET PIPE REPLACEMENT (LFX, LF3)

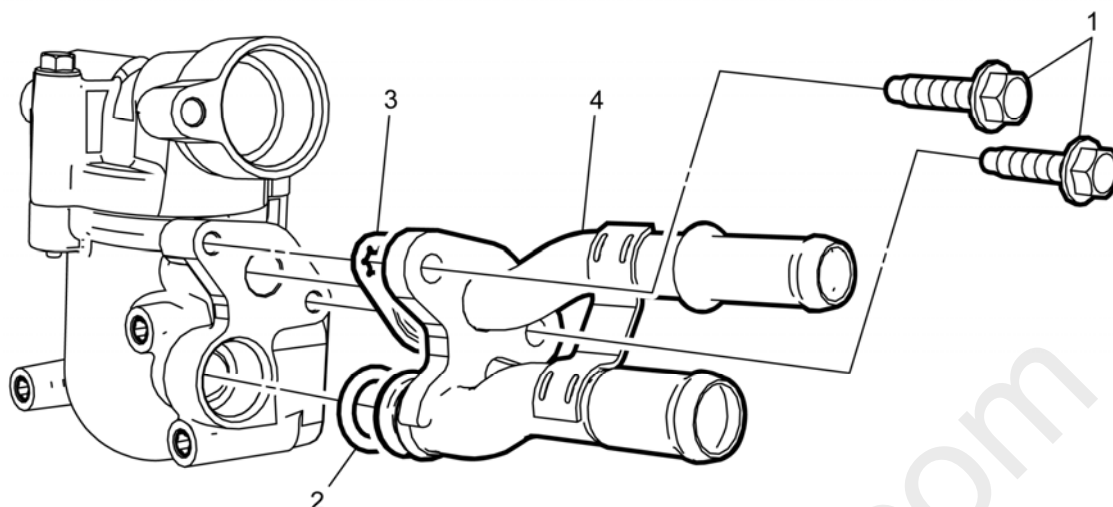


Fig. 142: Heater Inlet And Outlet Pipe (LFX, LF3)
 Courtesy of GENERAL MOTORS COMPANY

Heater Inlet And Outlet Pipe Replacement (LFX, LF3)

Callout	Component Name
Preliminary Procedures	
1. Remove the heater inlet hose. Refer to <u>Heater Inlet Hose Replacement (LFX)</u> , <u>Heater Inlet Hose Replacement (LF3)</u> . 2. Remove the heater outlet hose. Refer to <u>Heater Outlet Hose Replacement (LFX)</u> , <u>Heater Outlet Hose Replacement (LF3)</u> . 3. Remove the radiator outlet pipe. Refer to <u>Radiator Outlet Pipe Replacement (LFX)</u> , <u>Radiator Outlet Pipe Replacement (LF3)</u> . 4. Remove the engine coolant thermostat housing. Refer to <u>Engine Coolant Thermostat Housing Replacement (LFX, LF3)</u> .	
1	Heater Inlet and Outlet Pipe Fasteners (Qty: 2) Tighten 9 (80 lb in)
2	Heater Inlet and Outlet Pipe Seal NOTE: Replace with a NEW seal.
	Heater Inlet and Outlet Pipe Gasket

3	NOTE: Replace with a NEW gasket.
4	Heater Inlet and Outlet Pipe

WATER PUMP REPLACEMENT (LFX, LF3)

Special Tools

EN 46104 Water Pump Pulley Holder

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

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the drive belt. Refer to **Drive Belt Replacement (LFX)** , **Drive Belt Replacement (LF3)** .

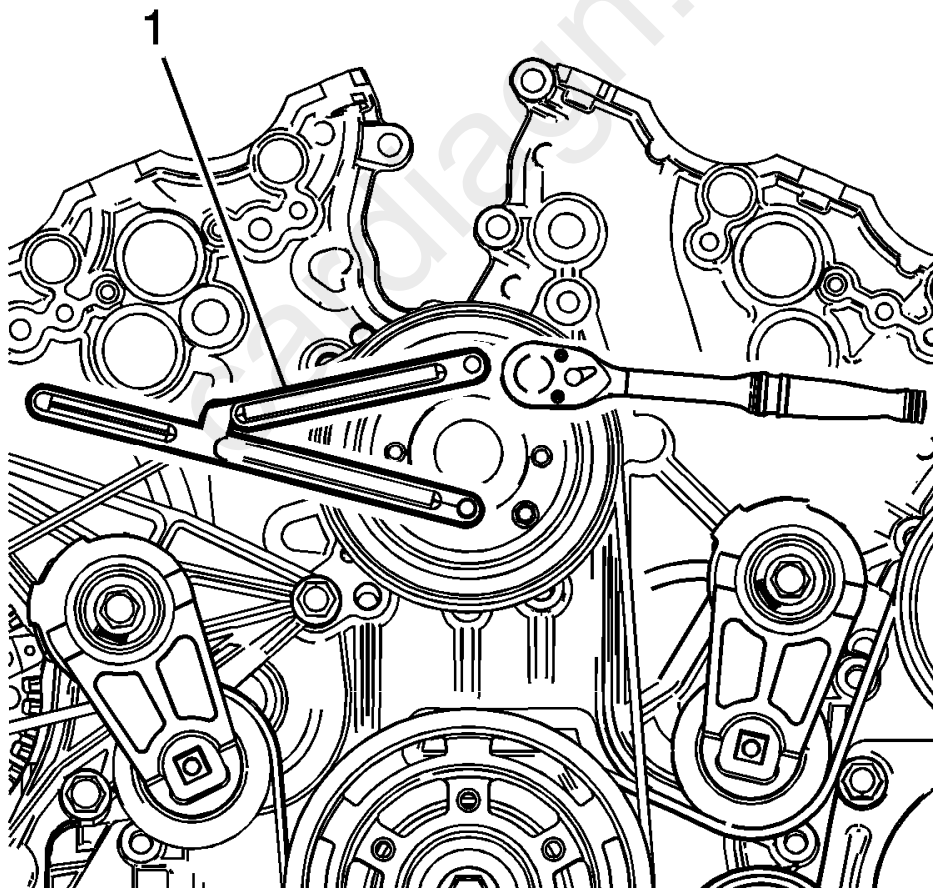


Fig. 143: Securing Water Pump Pulley With Water Pump Pulley Holder
Courtesy of GENERAL MOTORS COMPANY

3. Use the **EN 46104** water pump pulley holder (1) to retain the pulley.

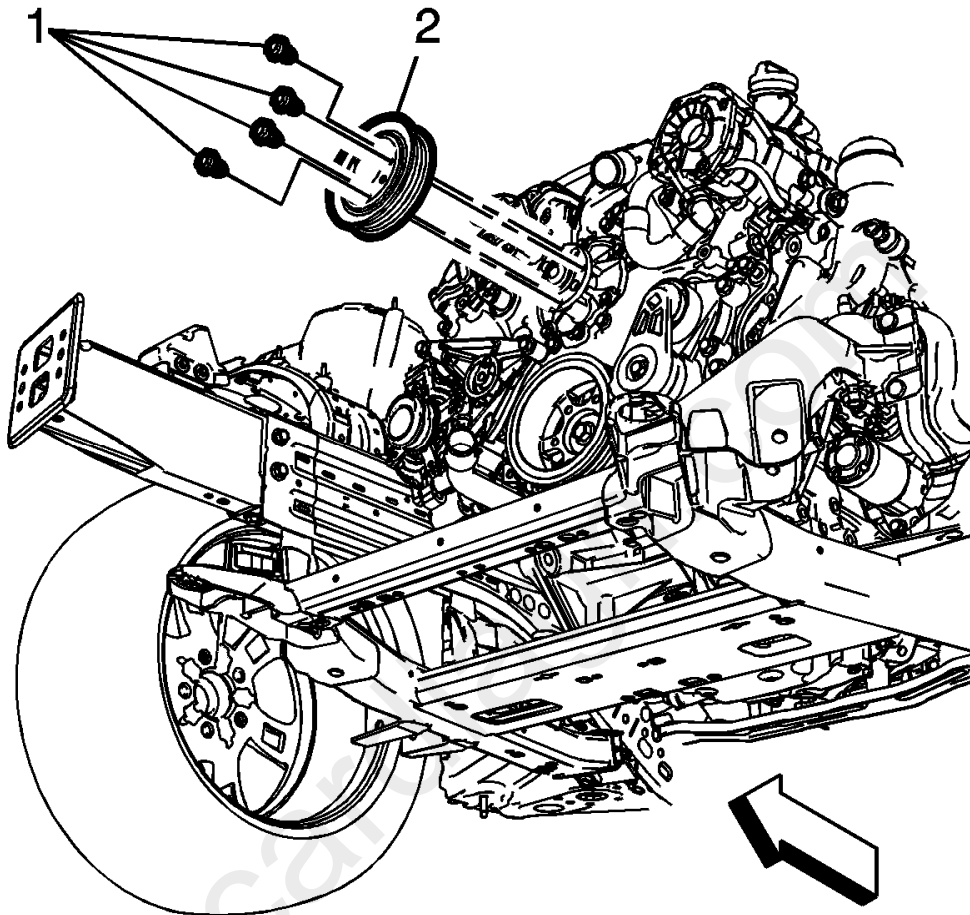


Fig. 144: Water Pump Pulley
Courtesy of GENERAL MOTORS COMPANY

4. Remove the water pump pulley fasteners (1) and **DISCARD** the fasteners.
5. Remove the water pump pulley (2).

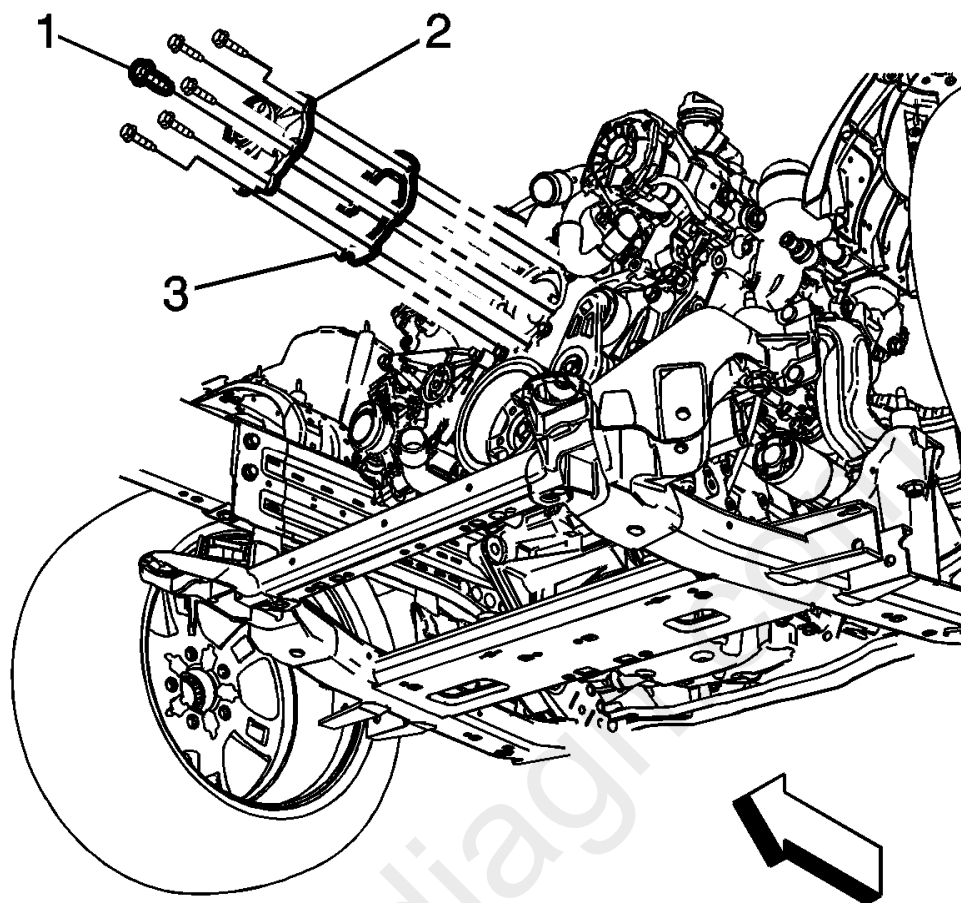


Fig. 145: Water Pump
Courtesy of GENERAL MOTORS COMPANY

6. Remove the water pump fasteners (1) and DISCARD the fasteners.
7. Remove the water pump (2) and discard the water pump gasket (3).
8. Carefully clean the water pump sealing surfaces.

Installation Procedure

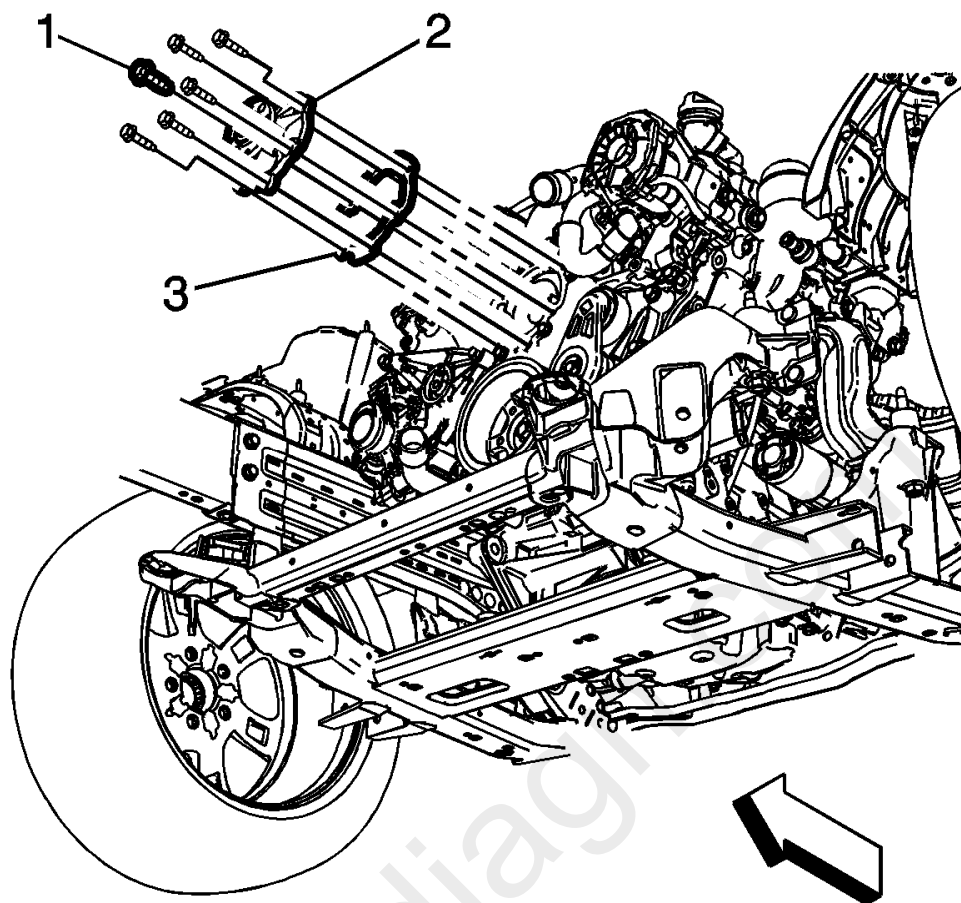


Fig. 146: Water Pump
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW water pump gasket (3).
2. Install the water pump and hand tighten the water pump fasteners (1).

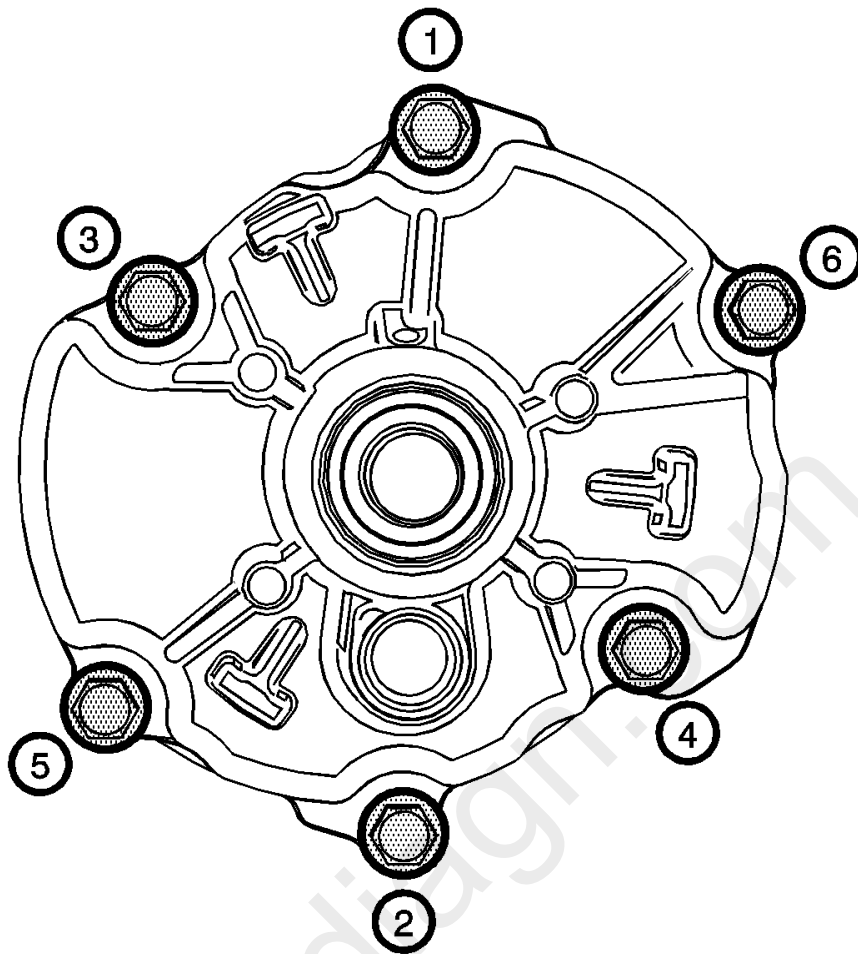


Fig. 147: Water Pump Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

CAUTION: Refer to Fastener Caution .

3. Tighten the water pump fasteners in the sequence.
 1. On the initial pass, tighten the fasteners in sequence to 10 (89 lb in).
 2. On the second pass, tighten the fasteners in sequence to 10 (89 lb in).
 3. On the final pass, tighten the fasteners in sequence shown an additional 45 degrees.

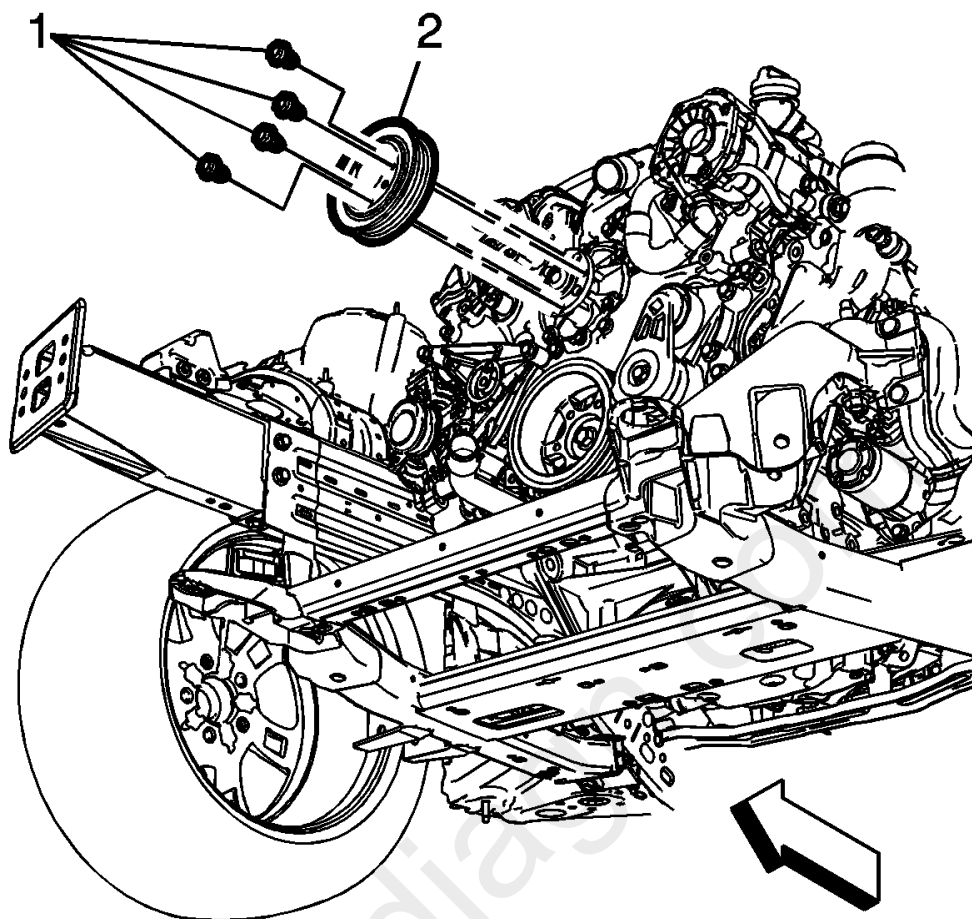


Fig. 148: Water Pump Pulley
Courtesy of GENERAL MOTORS COMPANY

4. Install the water pump pulley (2) and hand tighten the NEW water pump pulley fasteners (1).

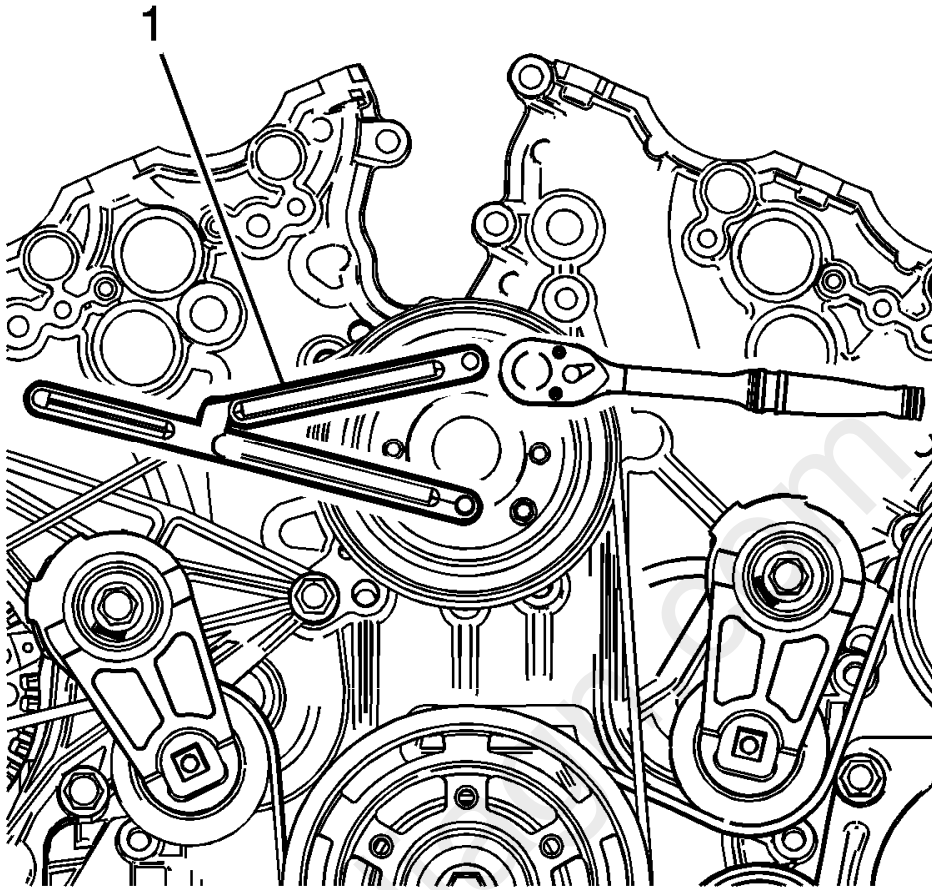


Fig. 149: Securing Water Pump Pulley With Water Pump Pulley Holder
Courtesy of GENERAL MOTORS COMPANY

5. Use the **EN 46104** water pump pulley holder (1) to hold the pulley.
6. Tighten the water pump pulley fasteners to 12 (108 lb in).
7. Install the drive belt. Refer to **Drive Belt Replacement (LFX)** , **Drive Belt Replacement (LF3)** .
8. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

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).

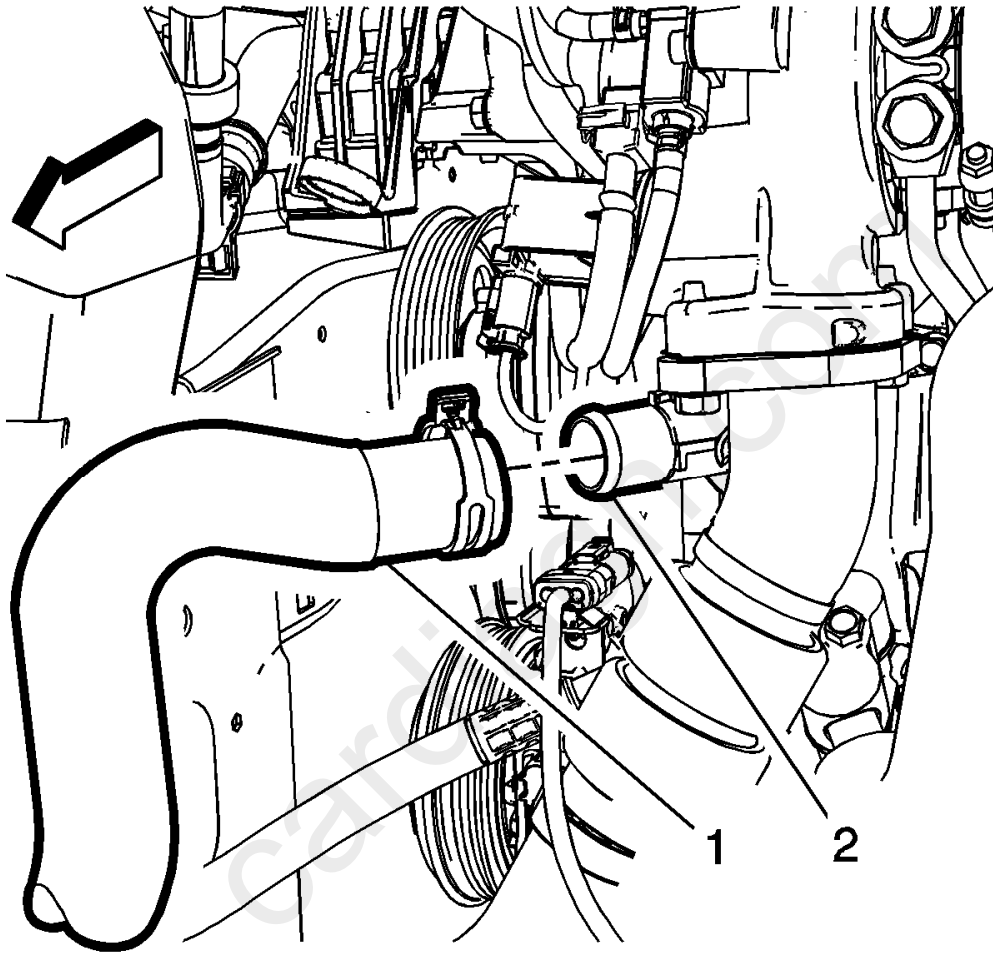


Fig. 150: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

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

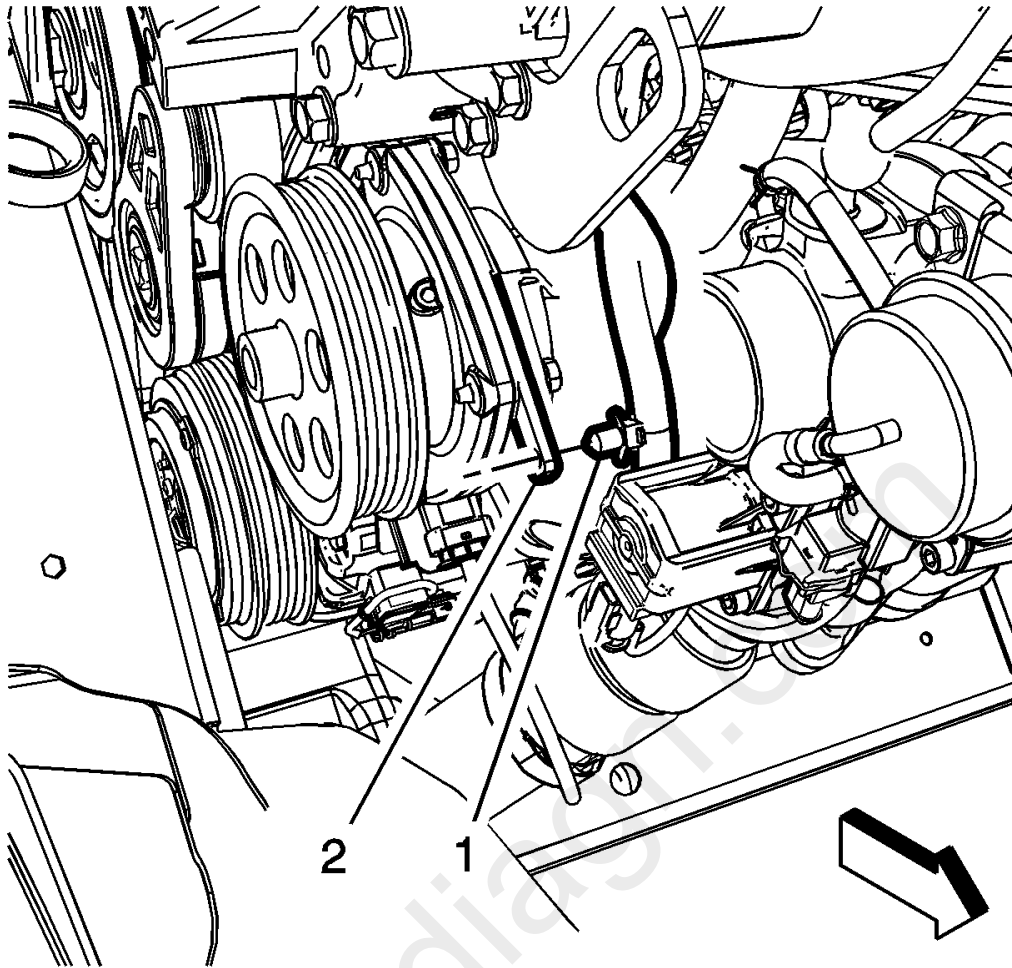


Fig. 151: Engine Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

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

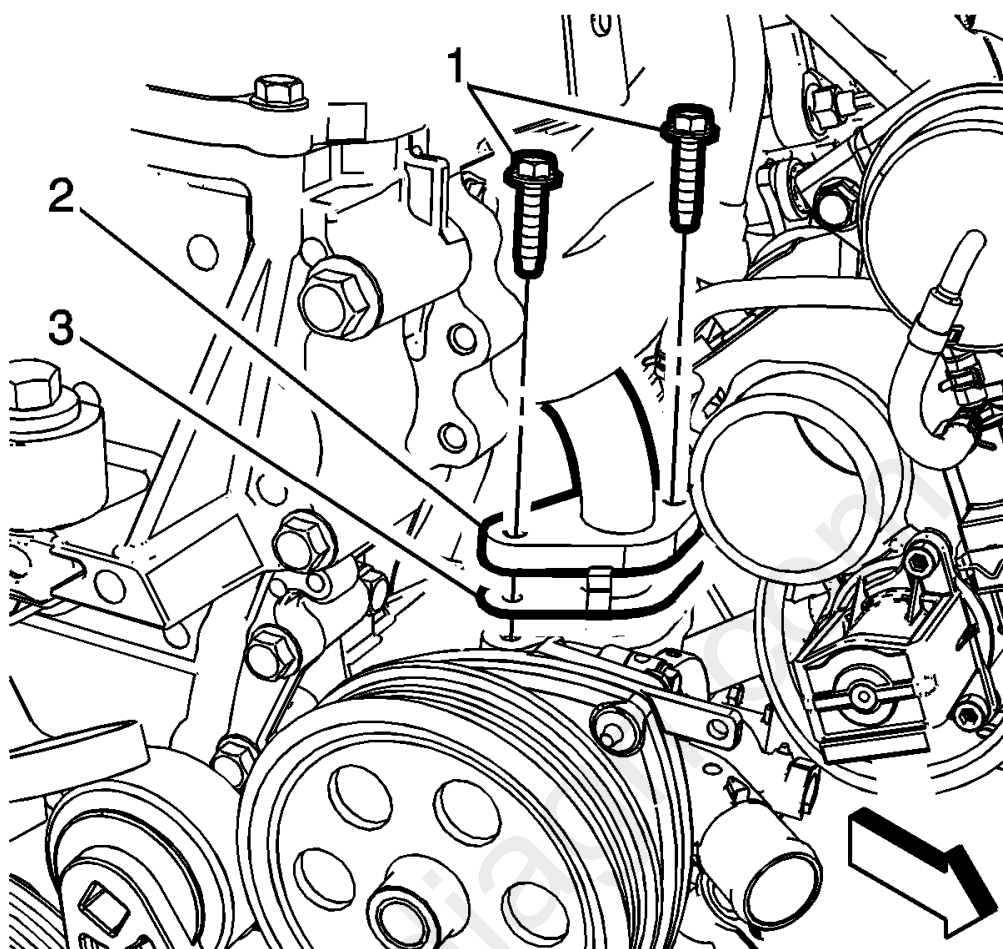


Fig. 152: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

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).

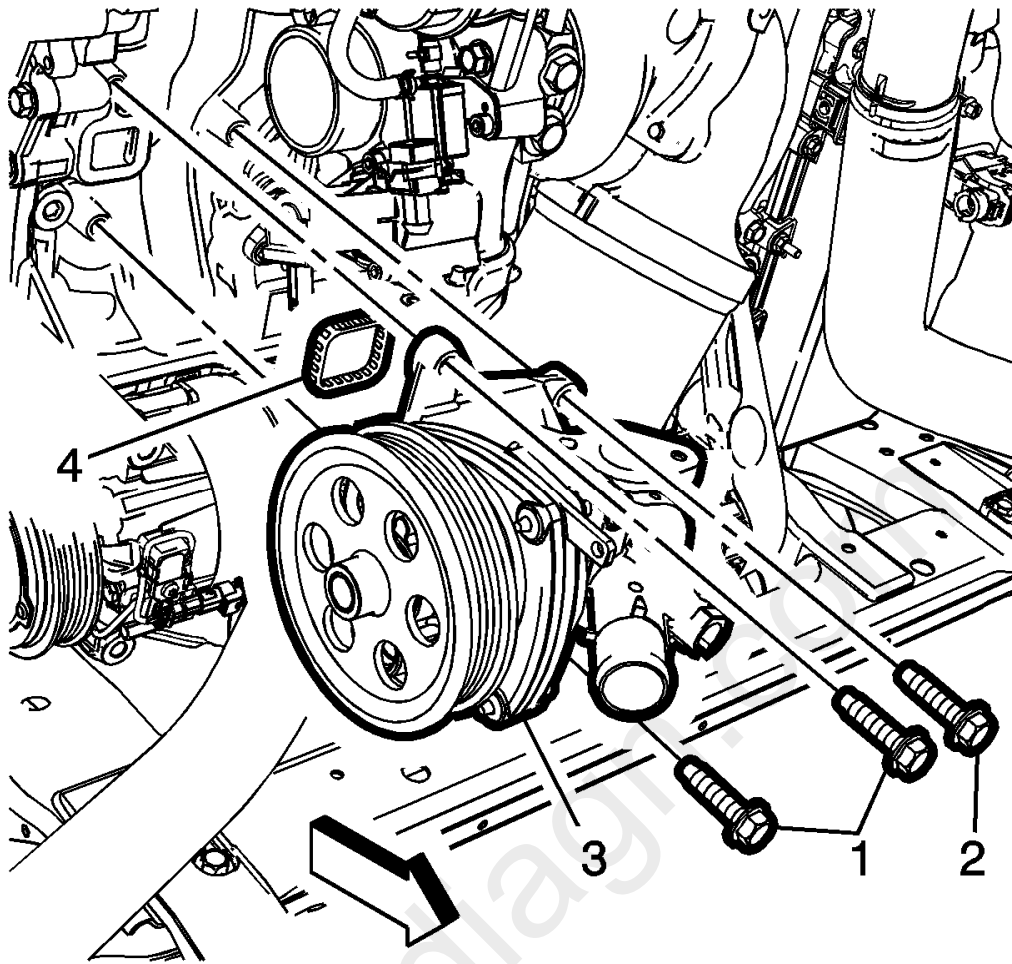


Fig. 153: Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

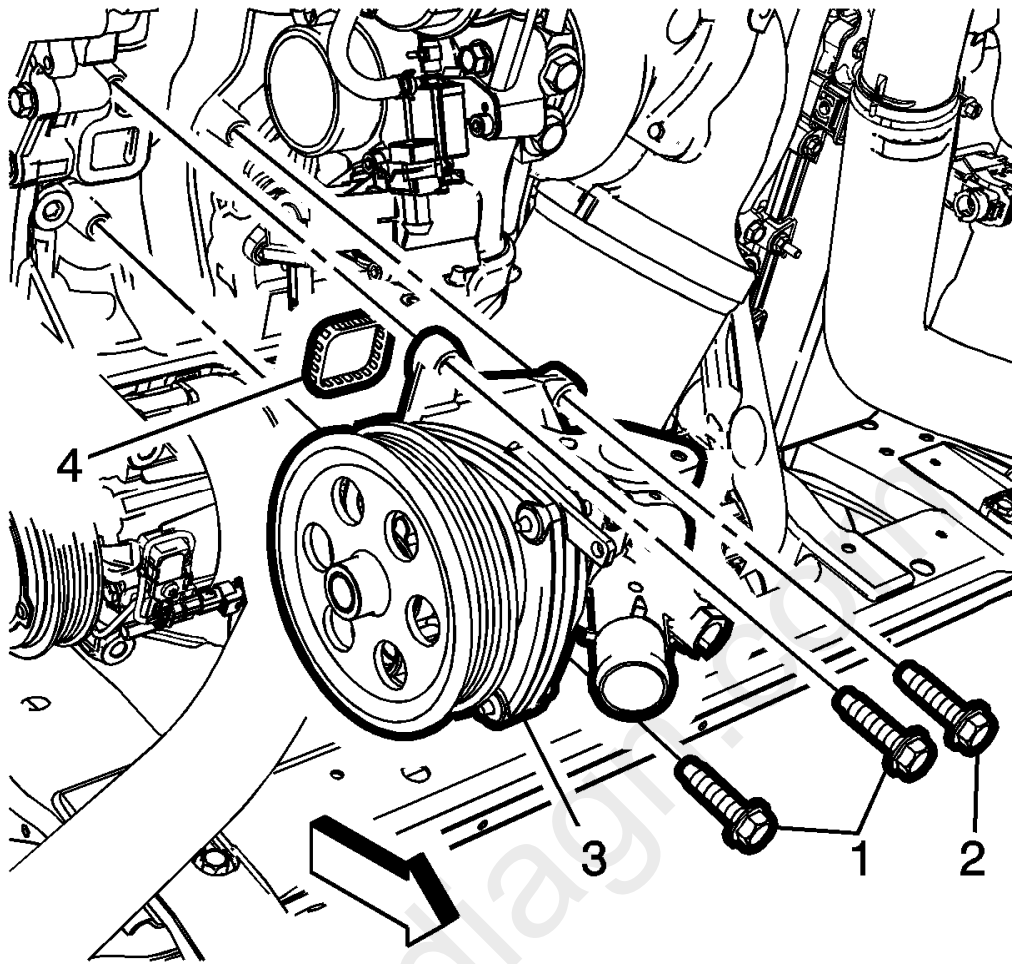


Fig. 154: Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

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).

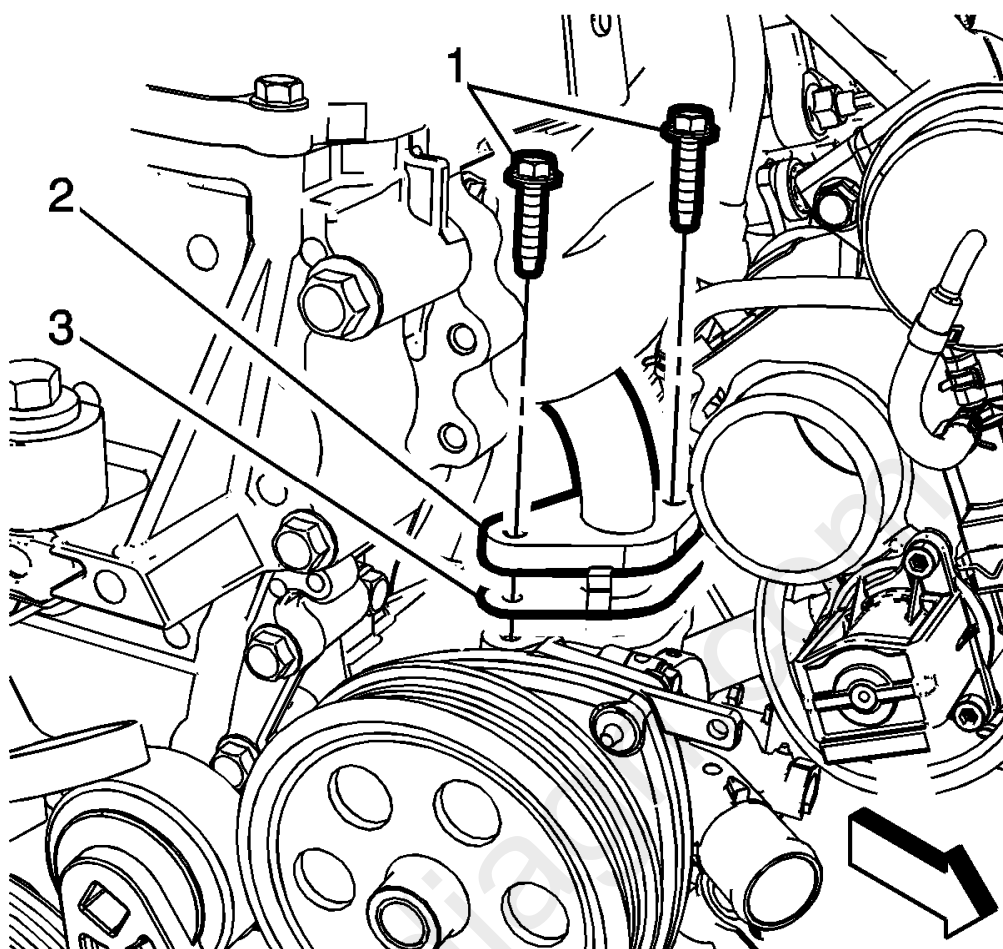


Fig. 155: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

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).

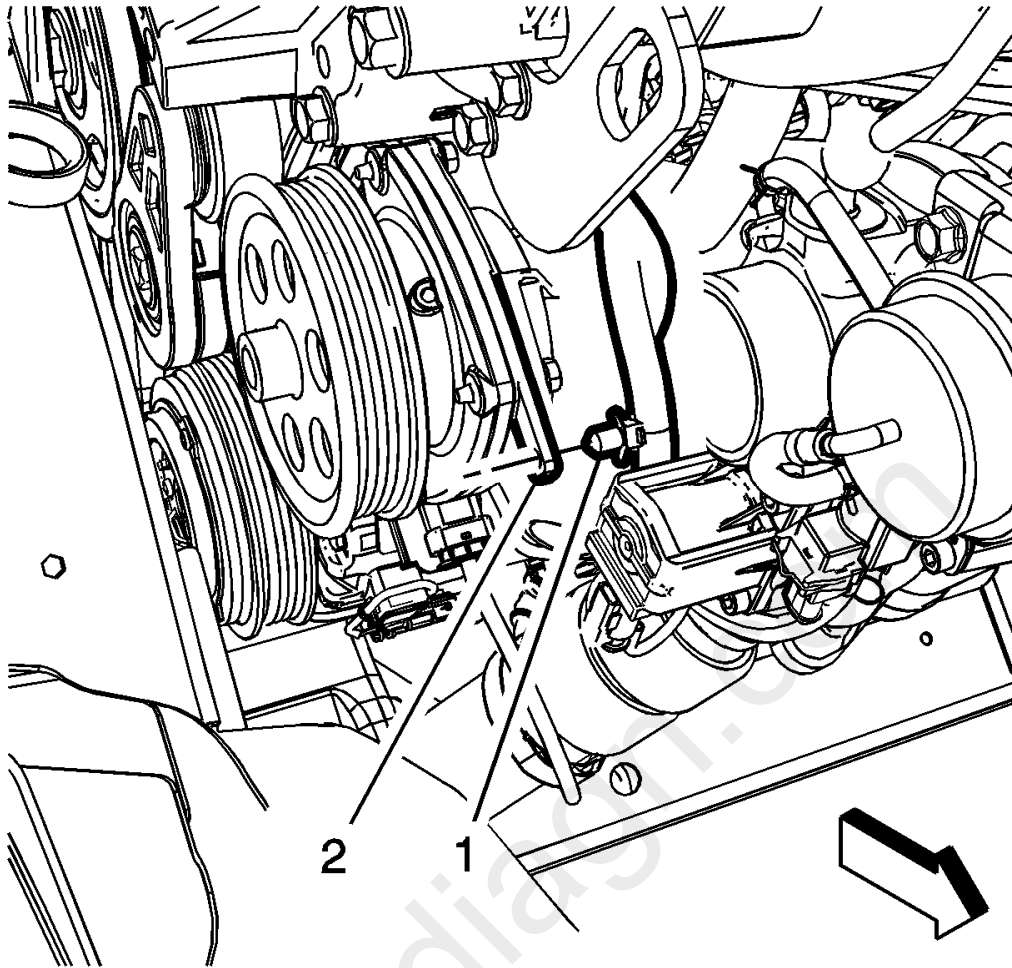


Fig. 156: Engine Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

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

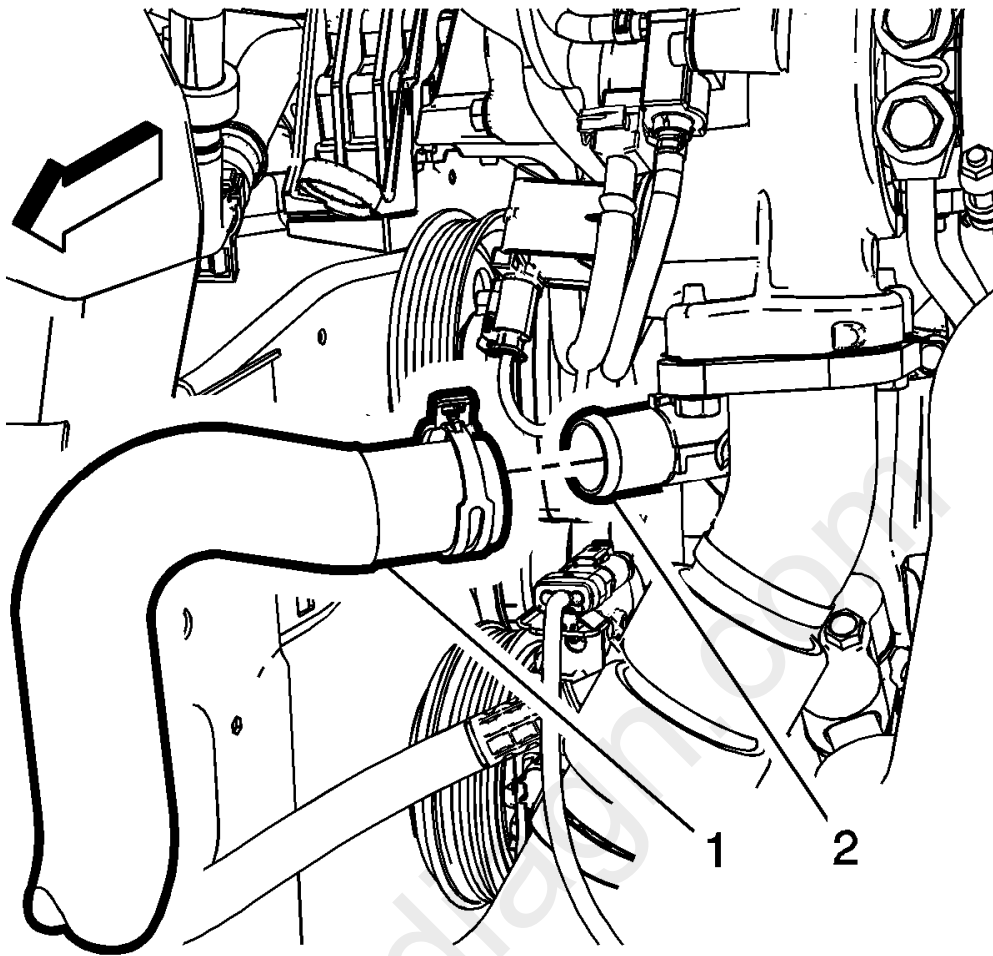


Fig. 157: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

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.

CHARGE AIR COOLER COOLANT PUMP REPLACEMENT (LF3)

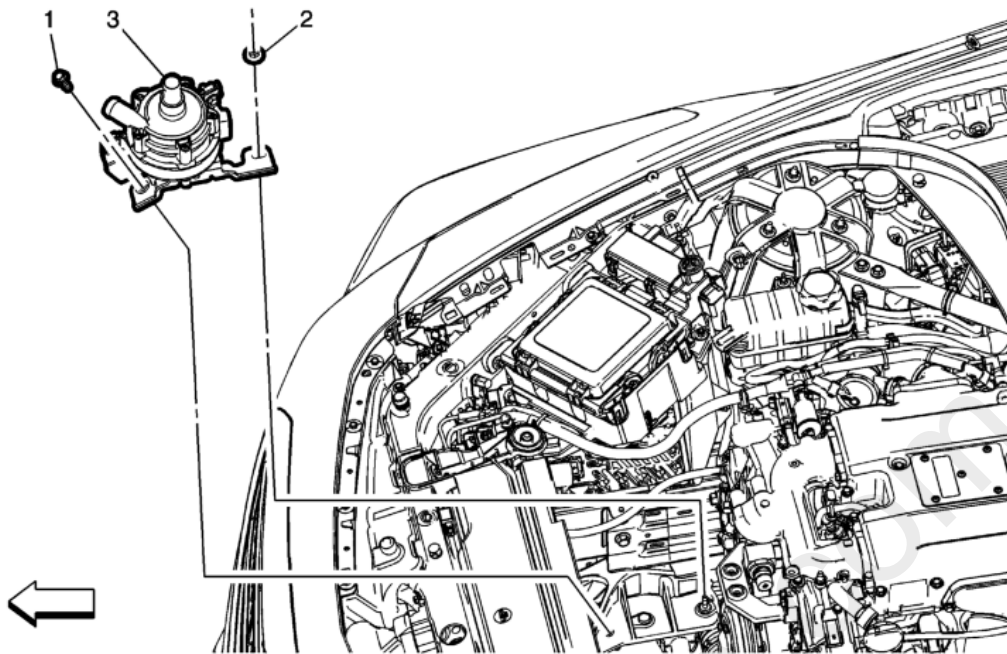


Fig. 158: Charge Air Cooler Coolant Pump (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Coolant Pump Replacement (LF3)

Callout	Component Name
Preliminary Procedures	
1. Drain the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 2. Remove the air cleaner outlet rear duct. Refer to <u>Air Cleaner Outlet Rear Duct Replacement (LF3)</u>. 3. Remove the charge air cooler coolant hose-pump engine from the charge air cooler coolant pump. Refer to <u>Charge Air Cooler Coolant Hose Replacement (Pump to Engine LF3)</u>. 4. Remove the charge air cooler coolant hose-pipe to pump from the charge air cooler coolant pump. Refer to <u>Charge Air Cooler Coolant Hose Replacement - Pipe to Pump (LF3)</u>. 5. Disconnect the electrical connector from the charge air cooler coolant pump.	
1	Charge Air Cooler Coolant Pump Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)

2	Charge Air Cooler Coolant Pump Nut Tighten 10 (89 lb in)
3	Charge Air Cooler Coolant Pump Procedure 1. Fill the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u> . 2. Check the charge air cooling system for leaks.

RADIATOR DRAIN PLUG REPLACEMENT

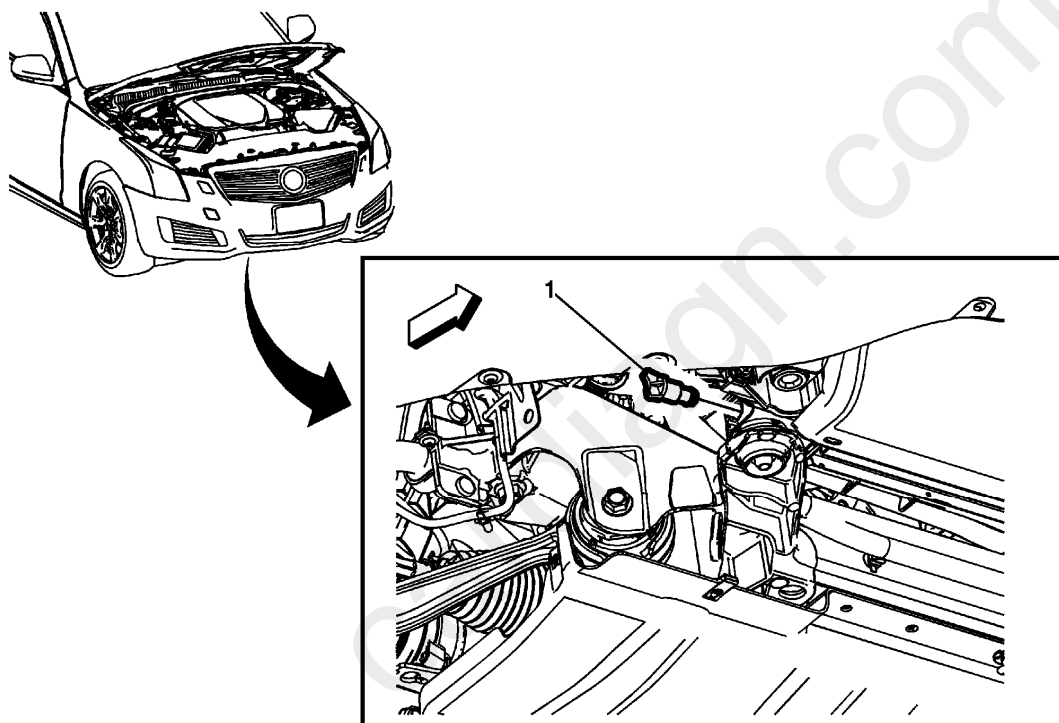


Fig. 159: Radiator Drain Plug

Courtesy of GENERAL MOTORS COMPANY

Radiator Drain Plug Replacement

Callout	Component Name
Preliminary Procedures	
1.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .
2.	Remove the front bumper fascia air deflector. Refer to <u>Front Bumper Fascia Air Deflector Replacement - Center</u> .
3.	Place a drain pan under the right side of the radiator.

Radiator Drain Plug

CAUTION:

Refer to Fastener Caution .

1

Procedure

Fill coolant to the proper level. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).

CHARGE AIR COOLER RADIATOR DRAIN PLUG REPLACEMENT (LF3)

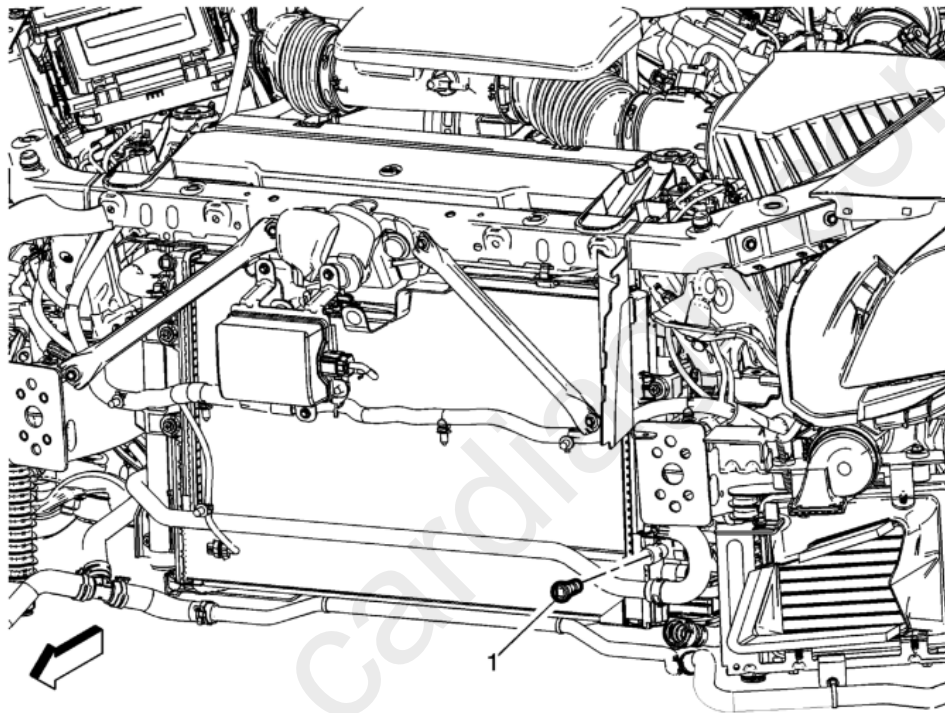


Fig. 160: Charge Air Cooler Radiator Drain Plug (LF3)

Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Radiator Drain Plug Replacement (LF3)

Callout	Component Name
Preliminary Procedures	
1.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .
2.	Remove the radiator air lower baffle and deflector. Refer to <u>Radiator Air Lower Baffle and Deflector Replacement (LF3)</u> .
3.	Reposition the Charge Air Cooler Coolant Hose to access to the charge air cooler radiator drain plug. Refer to <u>Charge Air Cooler Coolant Hose Replacement (Pump to Engine LF3)</u> .

4. Place a drain pan under the charge air cooler radiator drain plug.	
1	Charge Air Cooler Radiator Drain Plug
	CAUTION: Refer to <u>Fastener Caution</u> .
	Procedure 1. Fill the charge air cooling system. 2. Check the charge air cooling system for leaks.

ENGINE COOLANT FAN SHROUD REPLACEMENT (LTG WITH V03)

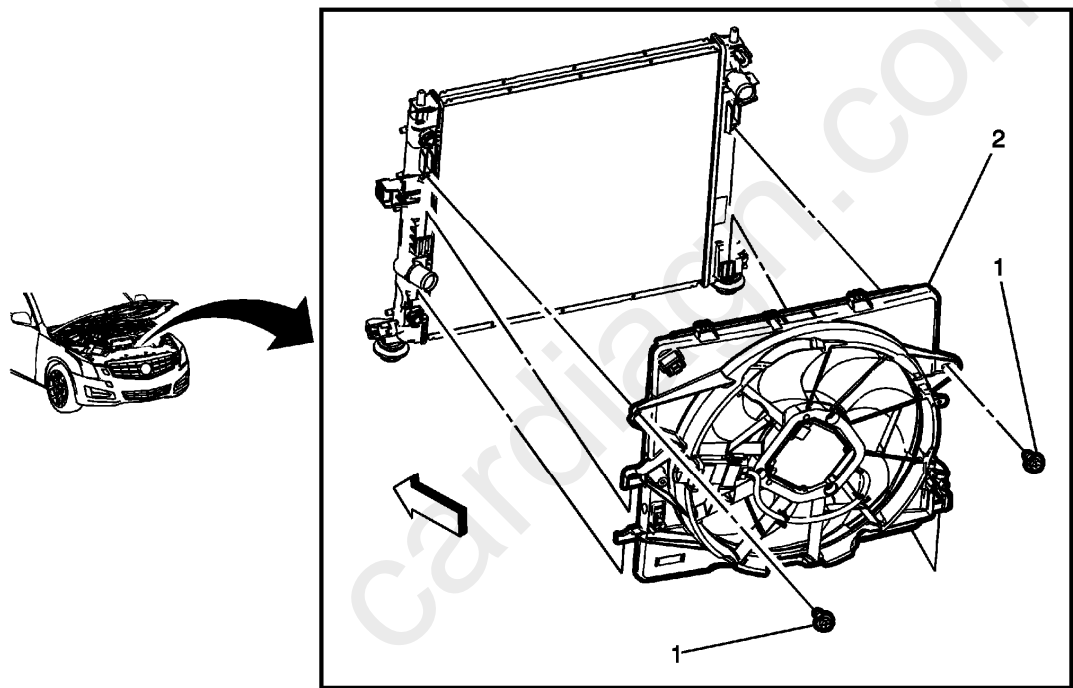


Fig. 161: Engine Coolant Fan Shroud (LTG with V03)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LTG with V03)

Callout	Component Name
Preliminary Procedures	
1. Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u> . 2. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> . 3. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	

4. Remove the charge air cooler outlet air tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement** .
5. Remove the engine mount vacuum filter from the engine coolant fan shroud. Refer to **Engine Mount Vacuum Filter Replacement** .
6. Disconnect the engine coolant fan motor electrical connector from the fan control module and reposition the wiring harness out of the way.
7. Remove the radiator upper brackets. Refer to **Radiator Upper Bracket Replacement (LFX, LTG)**.

1	Engine Coolant Fan Shroud Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Engine Coolant Fan Shroud 1. Unclip the transmission fluid cooler pipes from the engine coolant fan shroud is equipped. 2. Transfer all necessary parts.

ENGINE COOLANT FAN SHROUD REPLACEMENT (LFX)

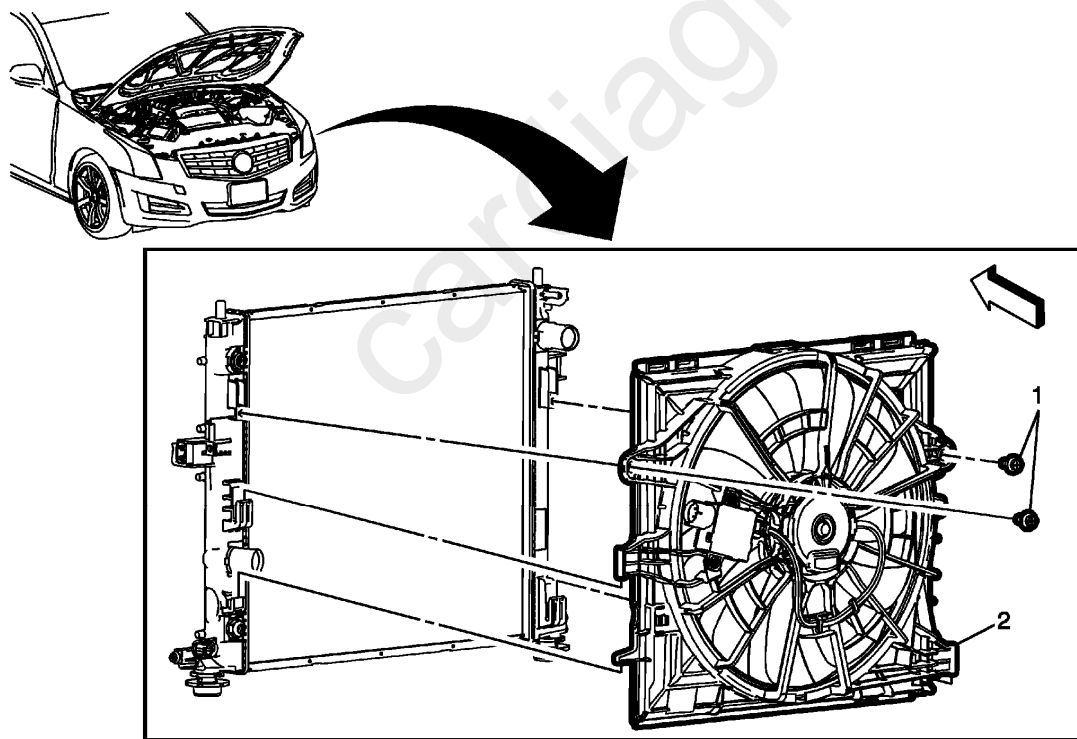


Fig. 162: Engine Coolant Fan Shroud (LFX)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LFX)

Callout	Component Name
Preliminary Procedures	
1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 2. Remove the air cleaner cover. Refer to <u>Air Cleaner Element Replacement (LTG)</u> . 3. Remove the engine mount vacuum filter from the engine coolant fan shroud. Refer to <u>Engine Mount Vacuum Filter Replacement</u> . 4. Disconnect the engine coolant fan motor connector. 5. Unclip the transmission fluid cooler pipes from the engine coolant fan shroud, if equipped.	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Engine Coolant Fan Shroud

ENGINE COOLANT FAN SHROUD REPLACEMENT (LTG WITHOUT V03)

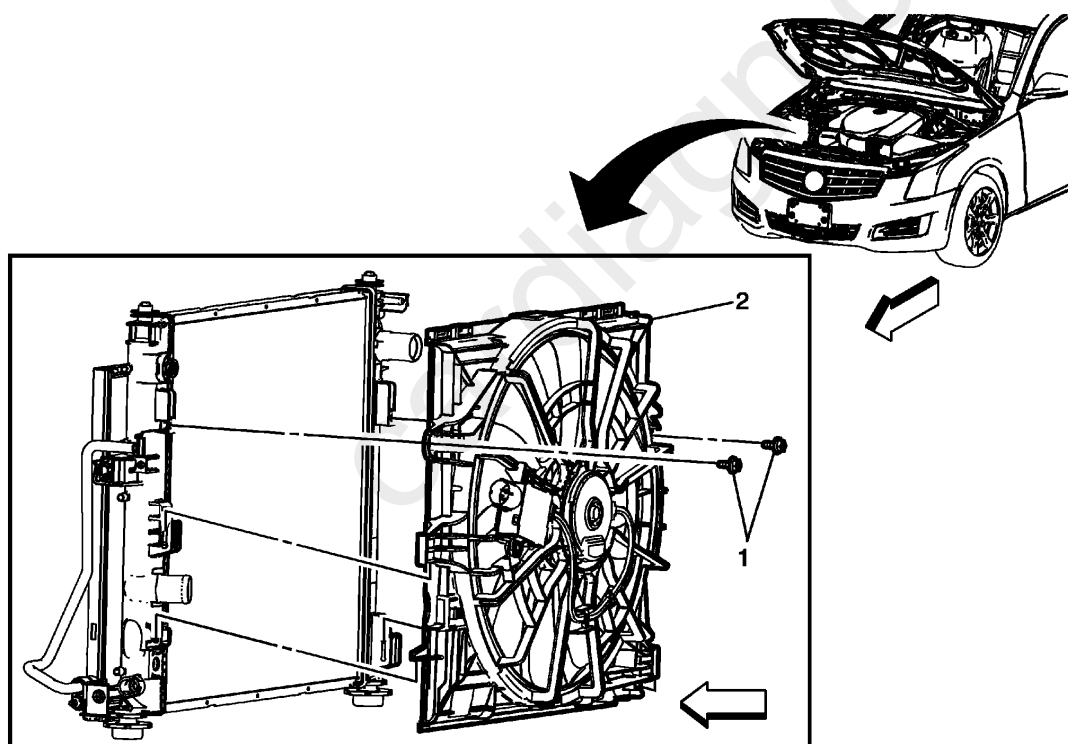


Fig. 163: Engine Coolant Fan Shroud (LTG without V03)

Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LTG without V03)

Callout	Component Name
Preliminary Procedures	

1. Remove the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement** .
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
3. Remove the engine mount vacuum filter from the engine coolant fan shroud. Refer to **Engine Mount Vacuum Filter Replacement** .
4. Disconnect the engine coolant fan motor electrical connector from the fan control module .
5. Unclip the transmission fluid cooler pipes from the engine coolant fan shroud, if equipped.

1	Engine Coolant Fan Shroud Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Engine Coolant Fan Shroud Procedure Transfer all necessary parts.

ENGINE COOLANT FAN SHROUD REPLACEMENT (LF3)

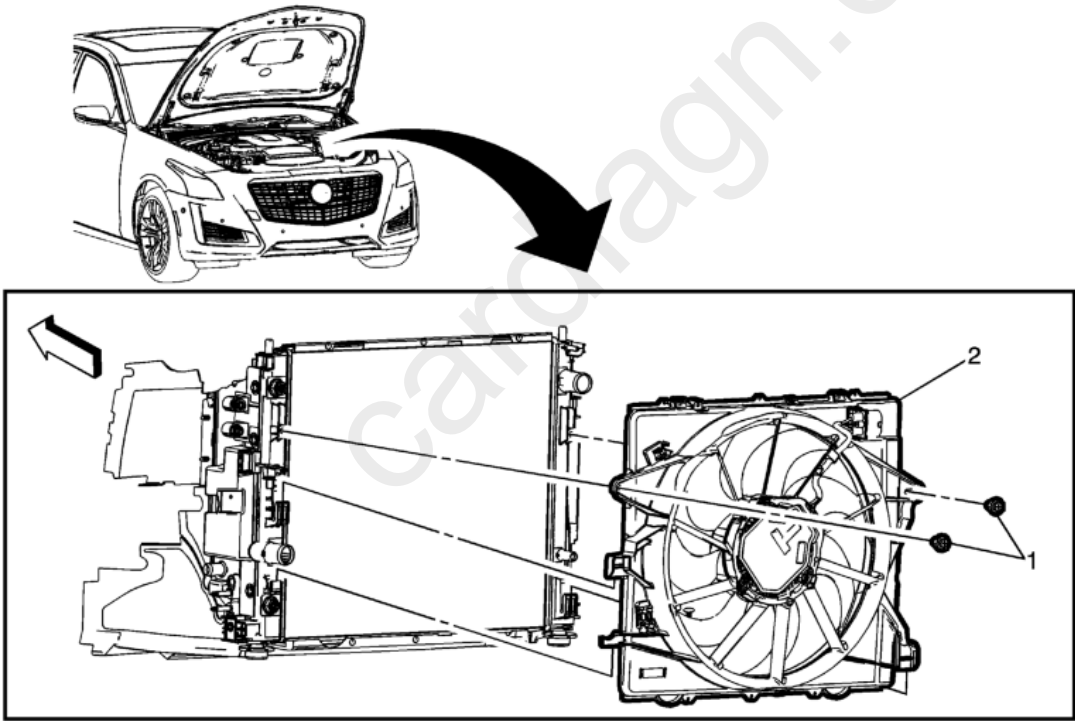


Fig. 164: Engine Coolant Fan Shroud (LF3)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LF3)

Callout	Component Name
Preliminary Procedures	

1. Remove the air cleaner outlet front duct. Refer to **Air Cleaner Outlet Front Duct Replacement (LF3)** .
2. Remove the transmission fluid cooler pipe. Refer to **Transmission Fluid Cooler Pipe Replacement (LF3, LFX with V03)** .
3. Remove the engine mount vacuum hose from the engine coolant fan shroud. Refer to **Engine Mount Vacuum Hose Replacement (LF3)** .
4. Disconnect the engine coolant fan motor electrical connector.
5. Remove the radiator air lower baffle and deflector lower retainers (1) from the engine coolant fan shroud. Refer to **Radiator Air Lower Baffle and Deflector Replacement (LF3)**.
6. Unclip the transmission fluid cooler pipes from the engine coolant fan shroud.

1	Engine Coolant Fan Shroud Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Engine Coolant Fan Shroud Procedure Unclip the engine coolant fan shroud from the radiator.

RADIATOR REPLACEMENT (LTG WITH V03)

Removal Procedure

1. Remove the charge air cooler radiator. Refer **Charge Air Cooler Radiator Replacement** .
2. Drain the engine cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

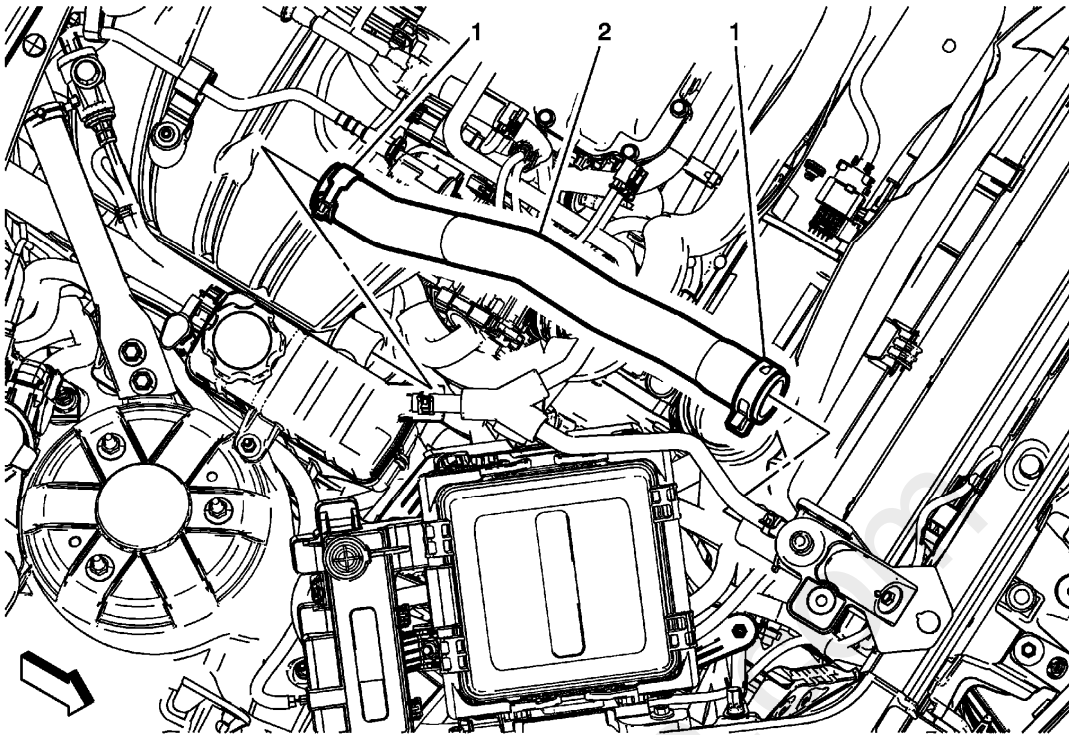


Fig. 165: Radiator Inlet Hose (LTG)
 Courtesy of GENERAL MOTORS COMPANY

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

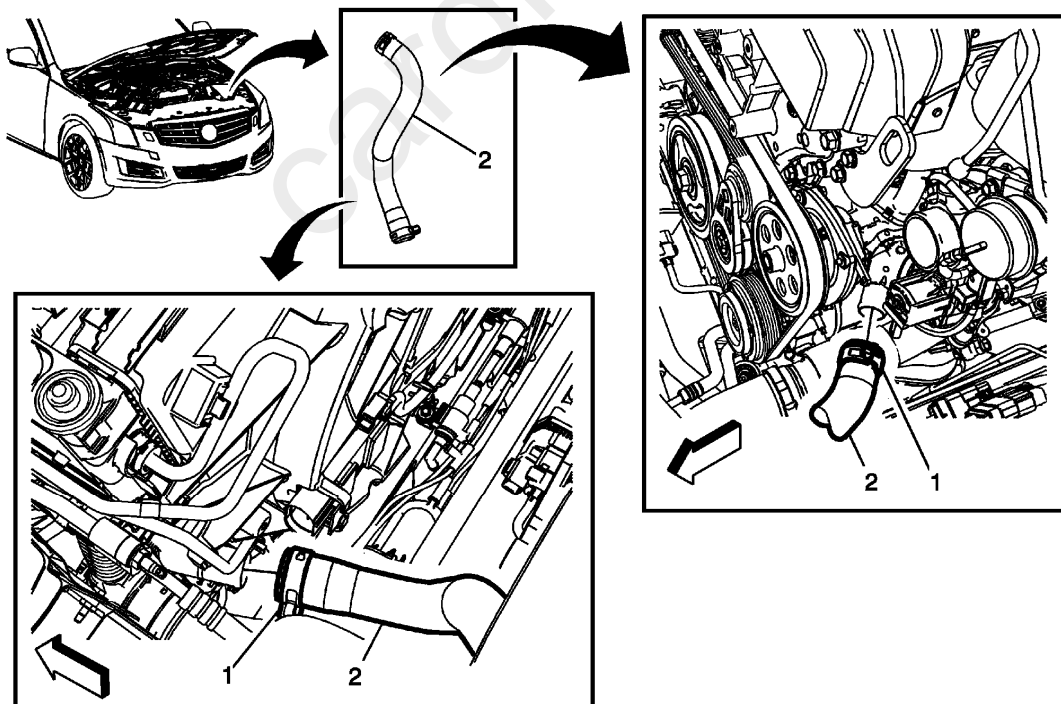


Fig. 166: Radiator Outlet Hose (LTG with V03)
Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator outlet hose (2) from the radiator. Refer to **Radiator Outlet Hose Replacement (LTG with V03)**.
5. Disconnect the radiator surge tank inlet hose from the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (LTG)**.

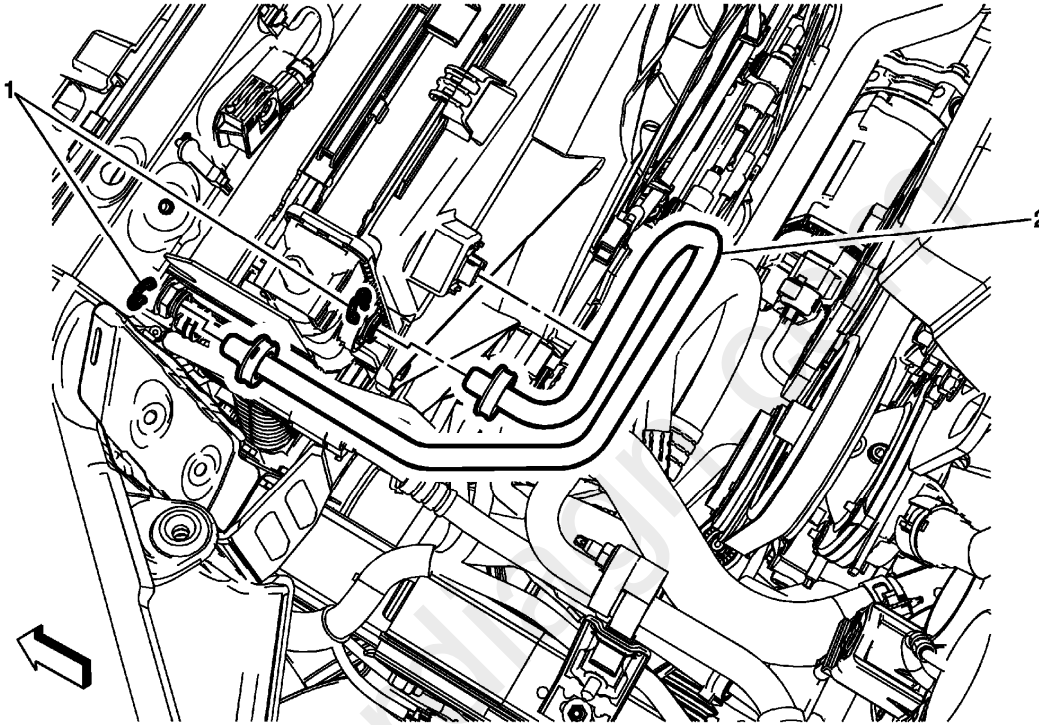


Fig. 167: Transmission Fluid Cooler Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transmission fluid cooler pipe (2) from the radiator. Refer to **Transmission Fluid Cooler Pipe Replacement (LTG MYA with V03)**.

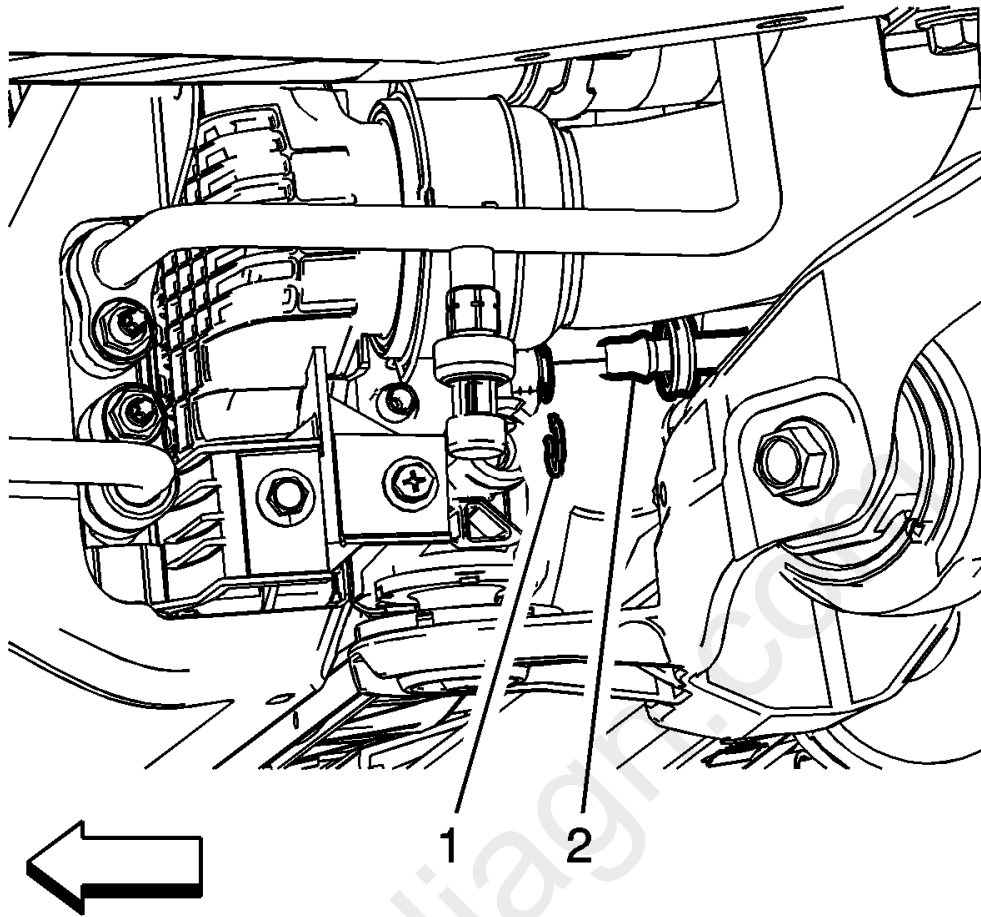


Fig. 168: Transmission Fluid Cooler Inlet And Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove the transmission fluid cooler inlet and outlet pipe (2) from the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** .

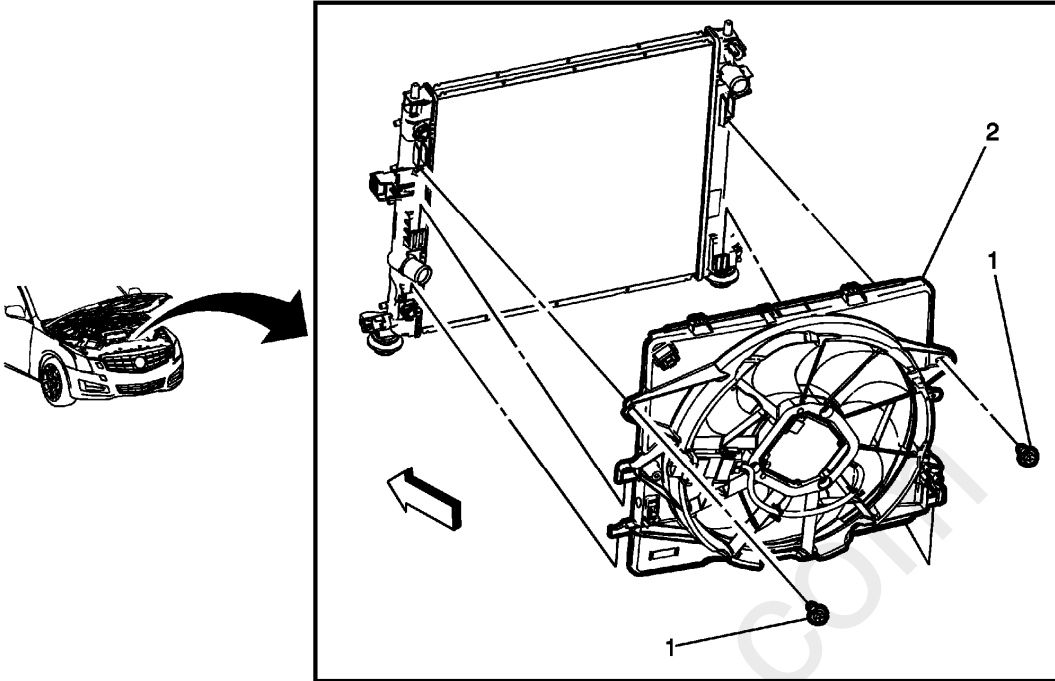


Fig. 169: Fan Shroud And Radiator
Courtesy of GENERAL MOTORS COMPANY

8. Remove the engine coolant fan shroud (2) from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LTG with V03)**.
9. Remove three push pin retainers at the bottom of the radiator and remove the radiator lower air baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement (LTG)**.

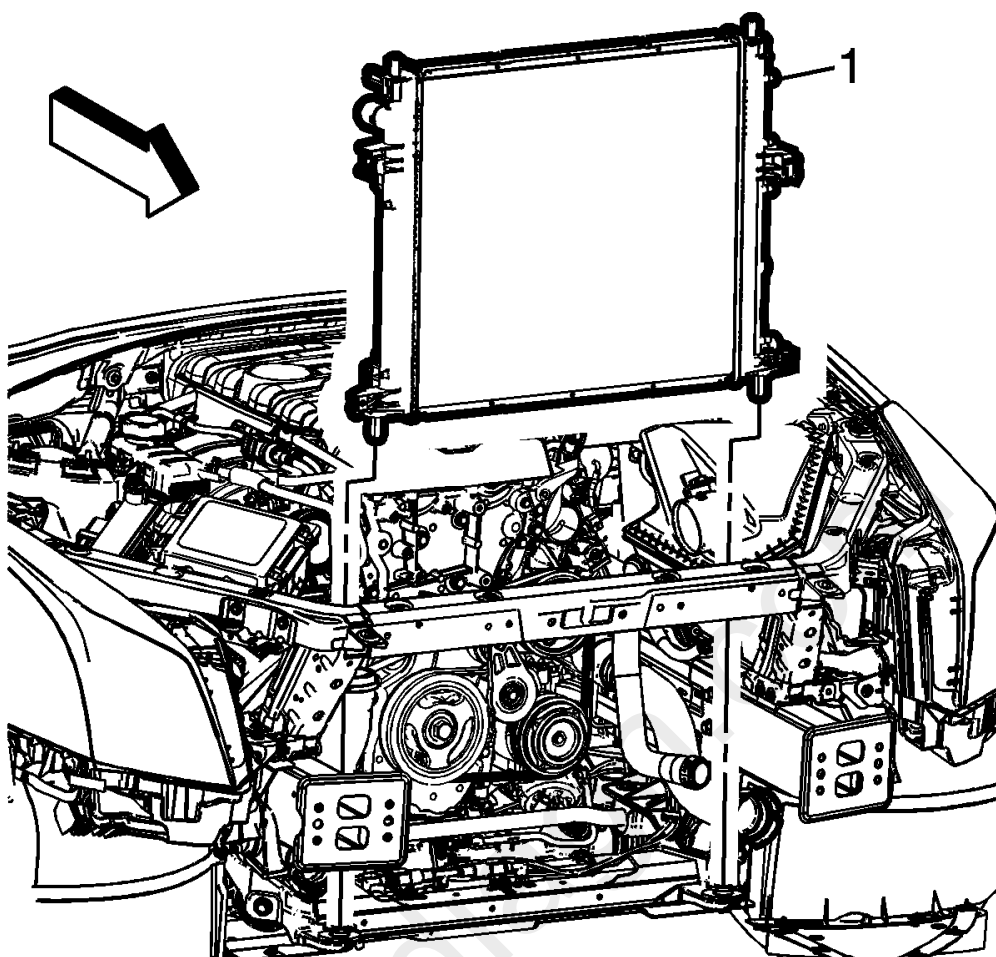


Fig. 170: Radiator

Courtesy of GENERAL MOTORS COMPANY

10. Lift up to remove the radiator (1) from the vehicle.

Installation Procedure

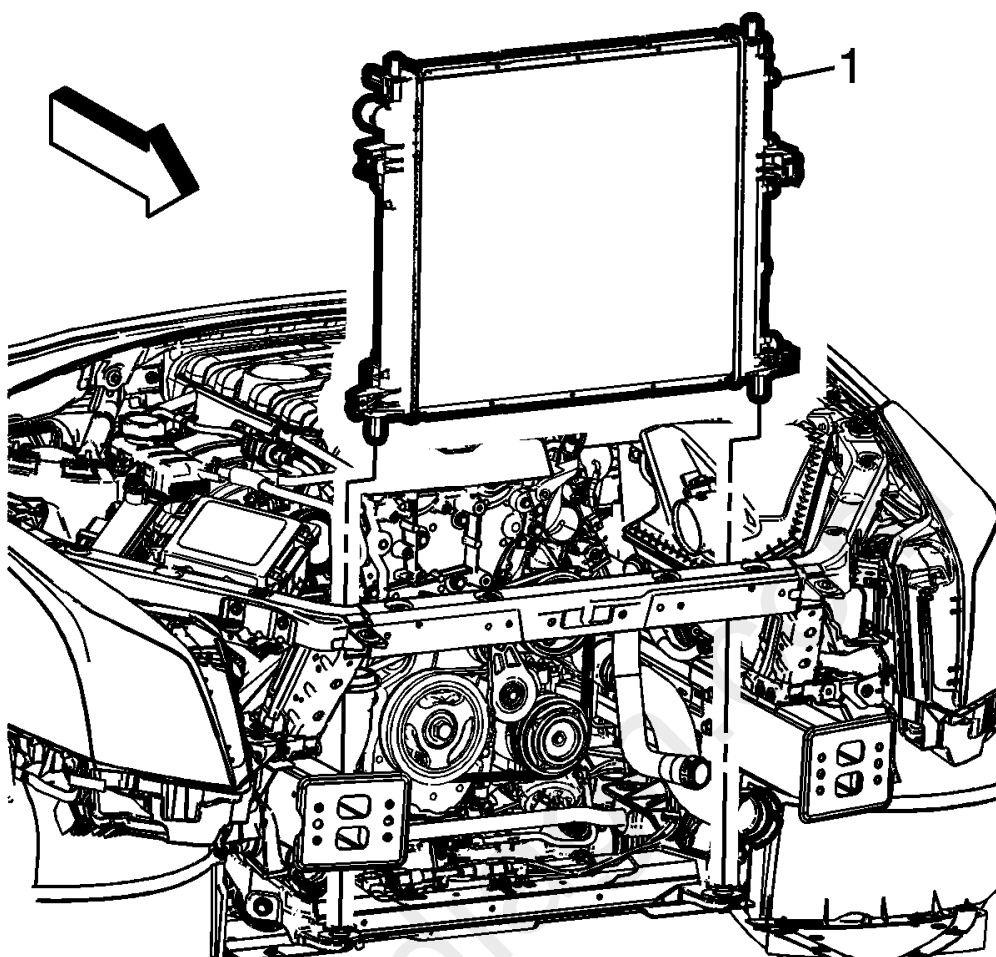


Fig. 171: Radiator

Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator assembly (1) to the vehicle.
2. Install three push pin retainers at the bottom of the radiator and install the radiator lower air baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement (LTG)**.

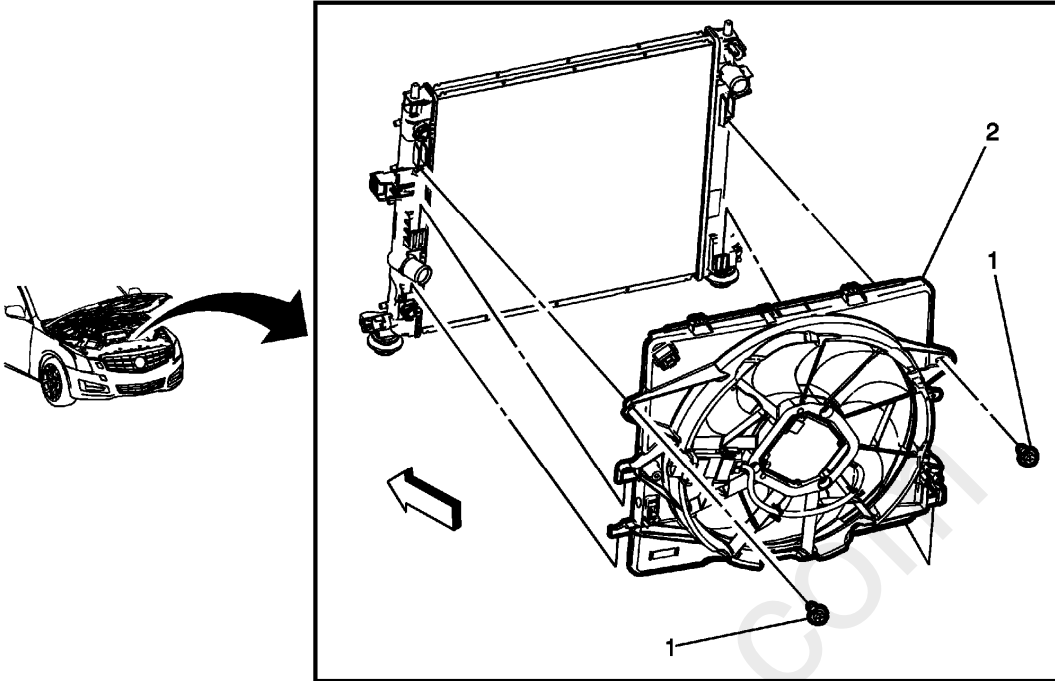


Fig. 172: Fan Shroud And Radiator
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine coolant fan shroud (2) to the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LTG with V03)**.

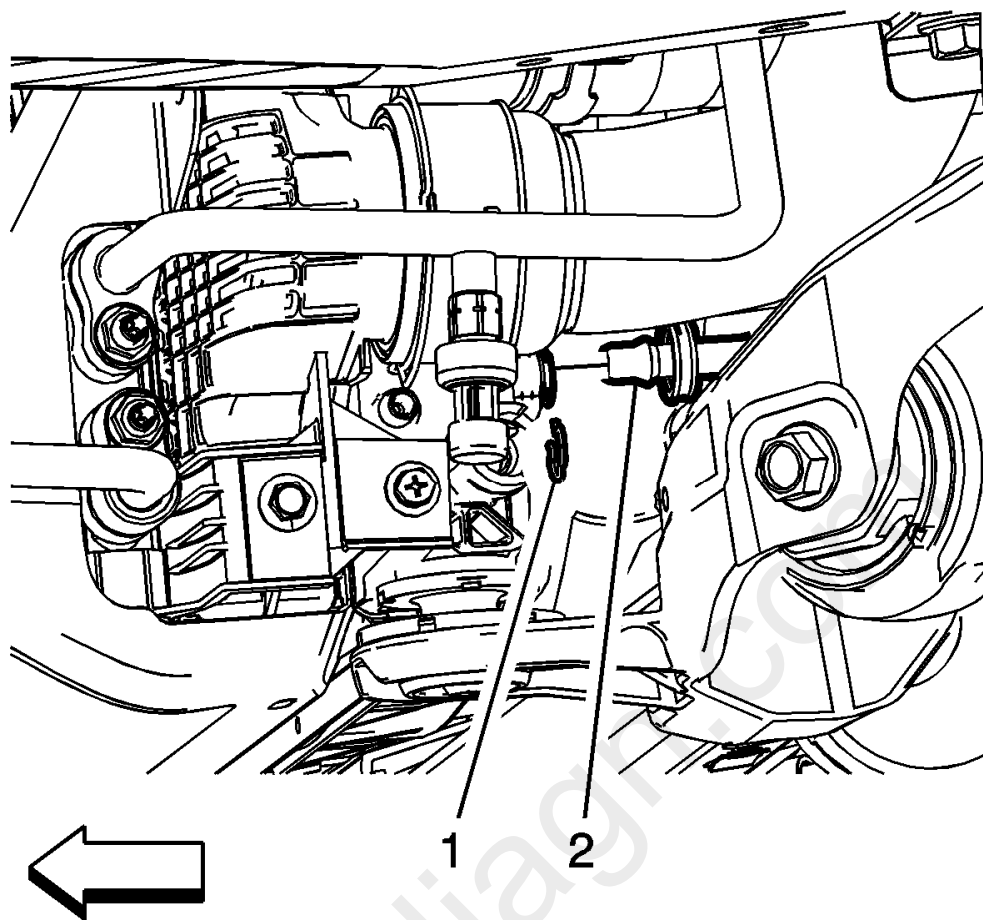


Fig. 173: Transmission Fluid Cooler Inlet And Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Install the transmission fluid cooler inlet and outlet pipe (2) to the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** .

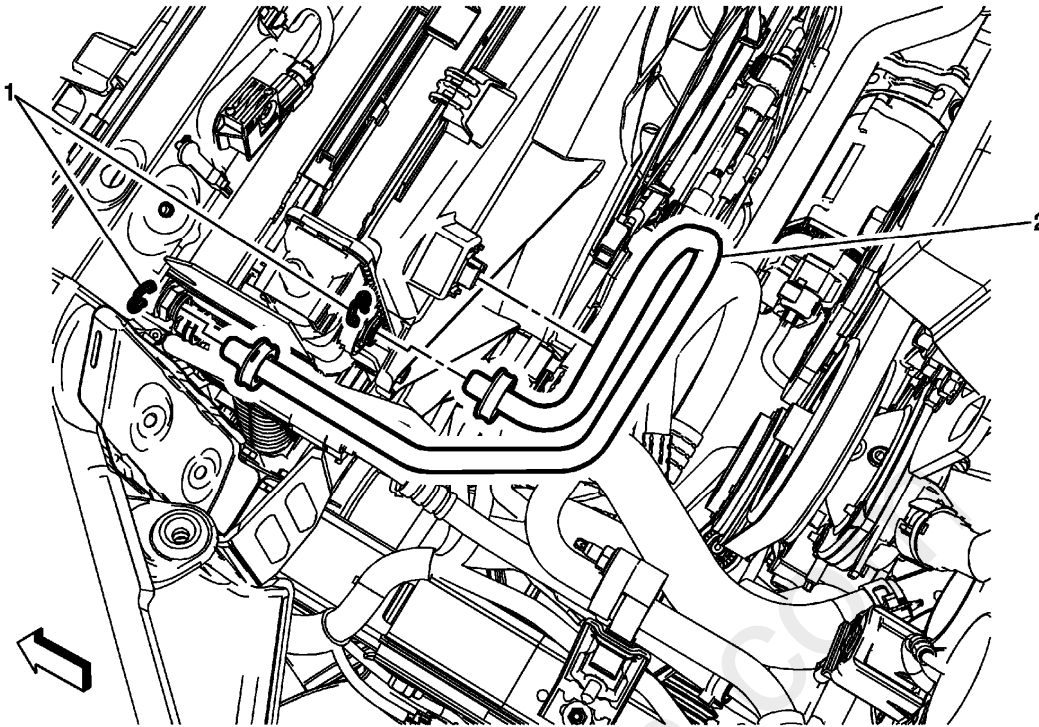


Fig. 174: Transmission Fluid Cooler Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission fluid cooler pipe (2) to the radiator. Refer to **Transmission Fluid Cooler Pipe Replacement (LTG MYA with V03)** .
6. Connect the radiator surge tank inlet hose to the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (LTG)**.

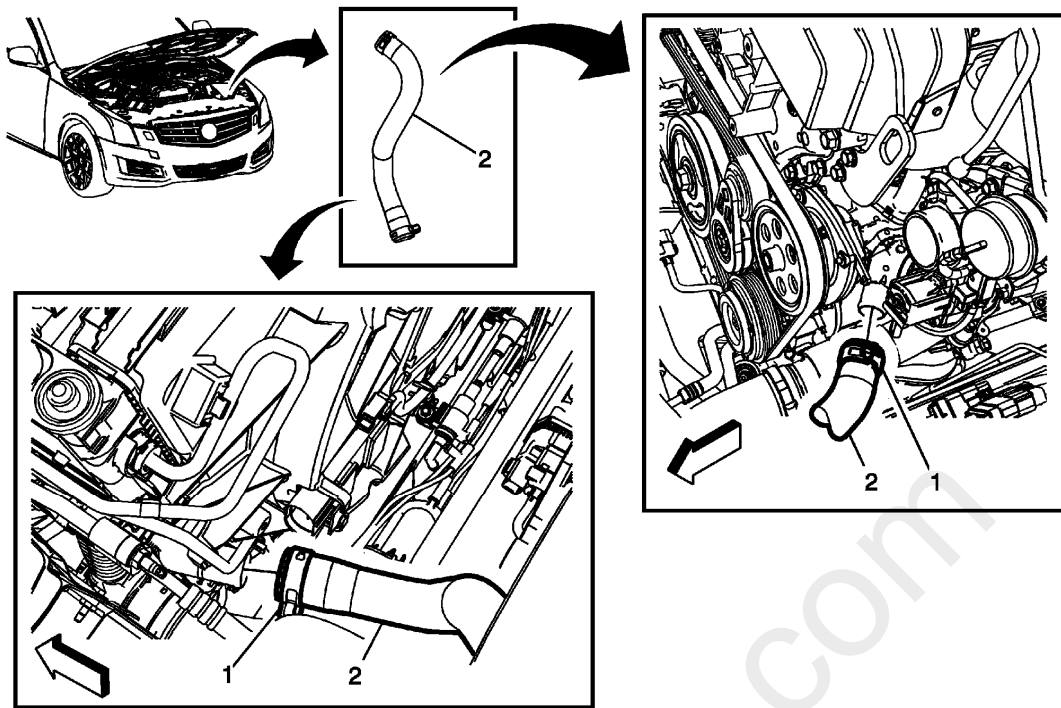


Fig. 175: Radiator Outlet Hose (LTG with V03)
Courtesy of GENERAL MOTORS COMPANY

7. Install the radiator outlet hose (2) to the radiator. Refer to **Radiator Outlet Hose Replacement (LTG with V03)**.

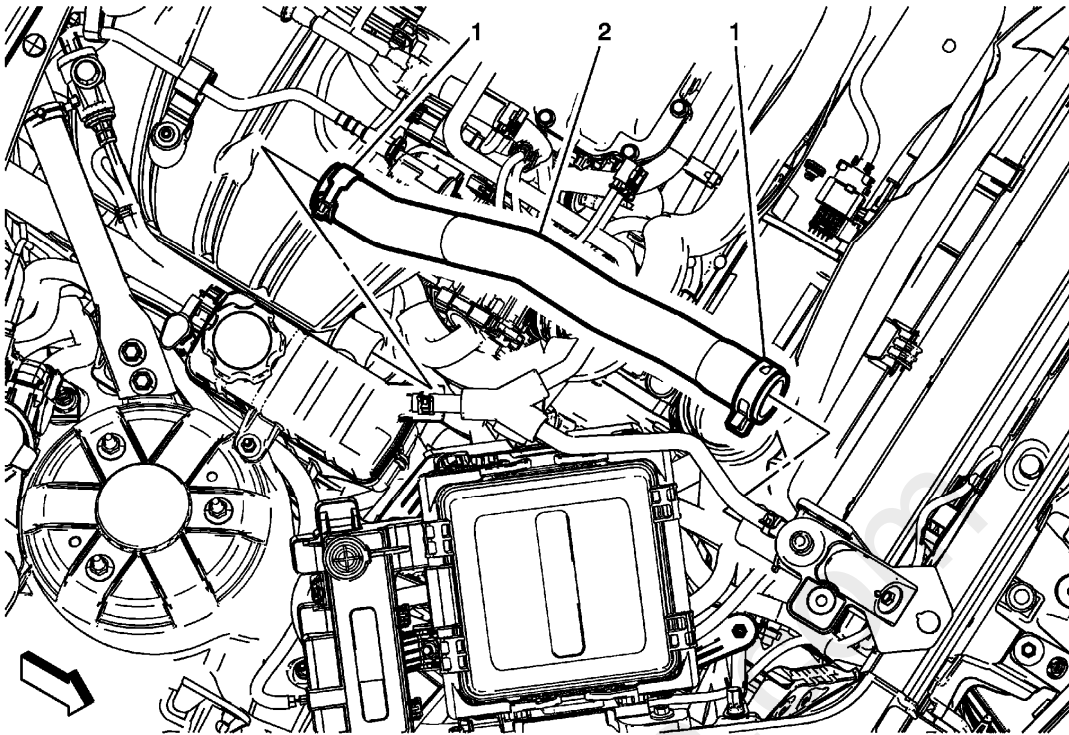


Fig. 176: Radiator Inlet Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

8. Install the radiator inlet hose (2) to the radiator. Refer to **Radiator Inlet Hose Replacement (LTG)**.
9. Install the charge air cooler radiator. Refer **Charge Air Cooler Radiator Replacement** .
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 (LFX WITH MGG)

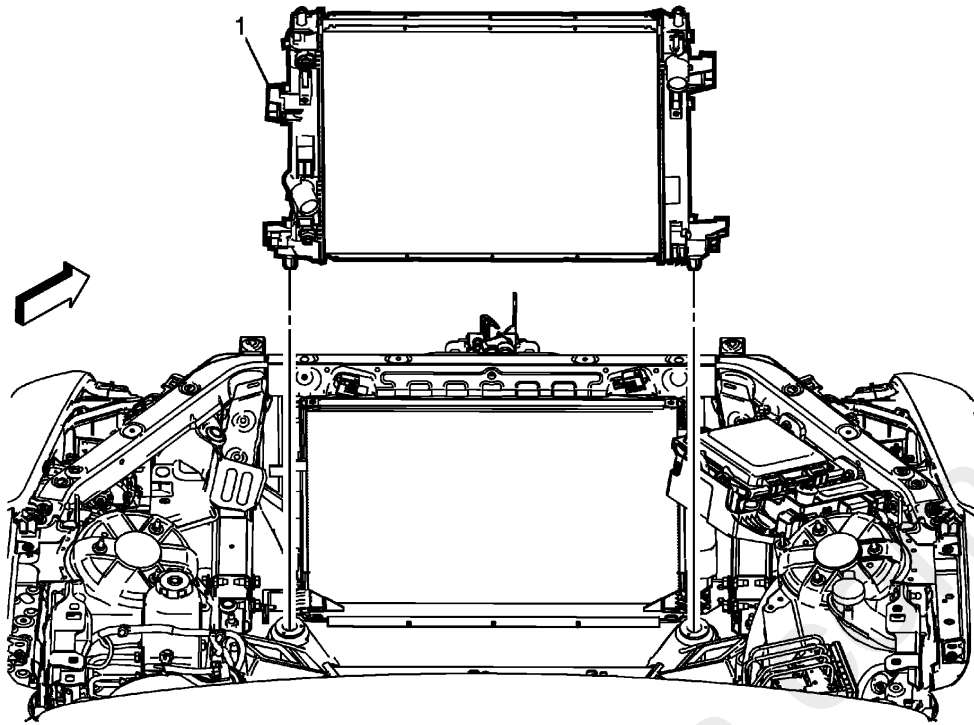


Fig. 177: Radiator (LFX with MGG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Replacement (LFX with MGG)

Callout	Component Name
Preliminary Procedures	
1.	Remove the radiator air upper baffle and deflector. Refer to <u>Radiator Air Upper Baffle and Deflector Replacement (LFX, LTG)</u> .
2.	Detach the radiator air lower baffle and deflector from the radiator. Refer to <u>Radiator Air Lower Baffle and Deflector Replacement (LFX)</u>
3.	Remove the engine coolant fan shroud. Refer to <u>Engine Coolant Fan Shroud Replacement (LFX)</u> .
4.	Remove the radiator inlet and outlet hoses from the radiator. Refer to <u>Radiator Inlet Hose Replacement (LFX)</u> and <u>Radiator Outlet Hose Replacement (LFX)</u> .
5.	Remove the transmission fluid cooler inlet and outlet pipe from the radiator. Refer to <u>Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)</u> , <u>Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)</u> , <u>Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX MGG)</u> .
6.	Without disconnecting the air conditioning condenser compressor hose assembly from the condenser separate the air conditioning condenser from the radiator. Refer to <u>Air Conditioning Condenser Replacement (LFX with V03)</u> , <u>Air Conditioning Condenser Replacement (LFX without V03)</u> .
	Radiator

Procedure

1

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. Check the cooling system for leaks. Refer to Cooling System Leak Testing.

RADIATOR REPLACEMENT (LTG WITHOUT V03)

Removal Procedure

1. Remove the charge air cooler radiator. Refer Charge Air Cooler Radiator Replacement .
2. Remove the radiator air lower baffle and deflector. Refer Radiator Air Lower Baffle and Deflector Replacement (LTG).
3. Drain the engine cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).

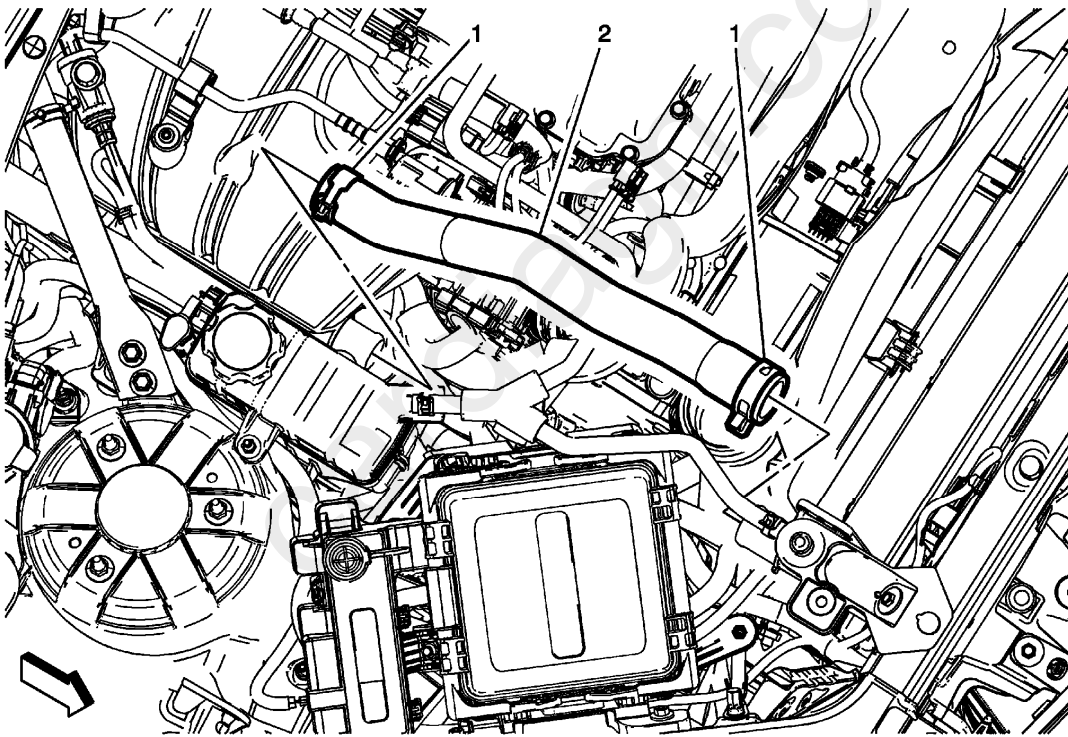


Fig. 178: Radiator Inlet Hose (LTG)

Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator inlet hose (2) from the radiator. Refer to Radiator Inlet Hose Replacement (LTG).

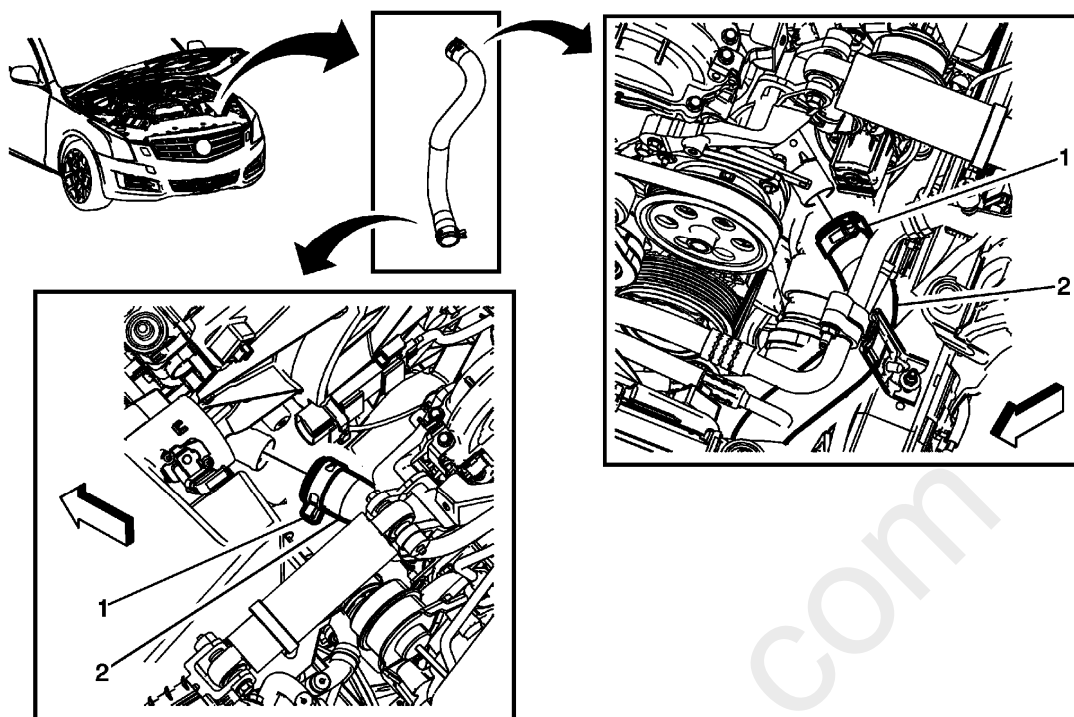


Fig. 179: Radiator Outlet Hose (LTG without V03)

Courtesy of GENERAL MOTORS COMPANY

5. Remove the radiator outlet hose (2) from the radiator. Refer to **Radiator Outlet Hose Replacement (LTG without V03)**.

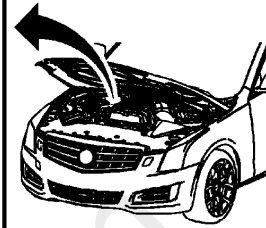
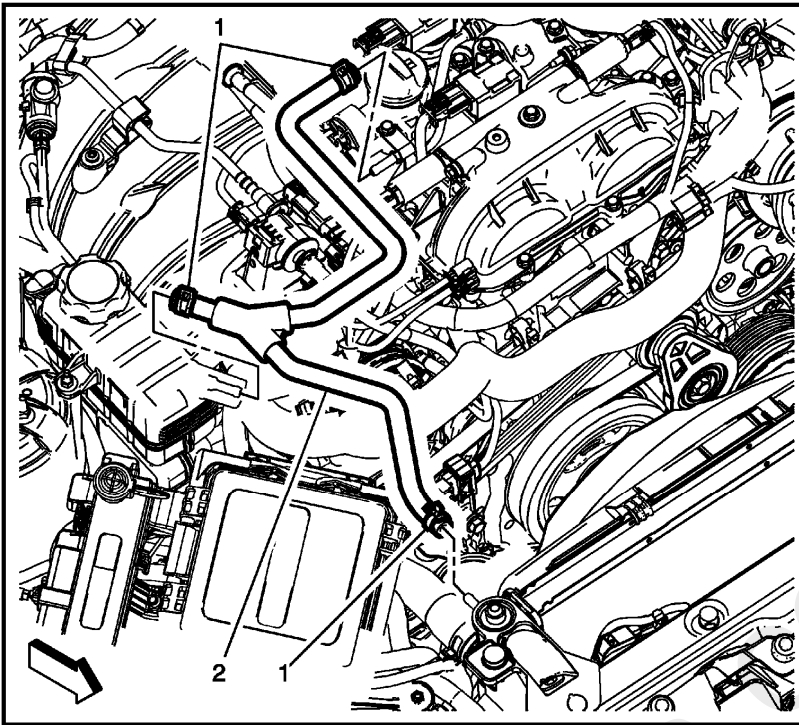


Fig. 180: Radiator Surge Tank Inlet Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

6. Remove the radiator surge tank inlet hose (2) from the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (LTG)**.

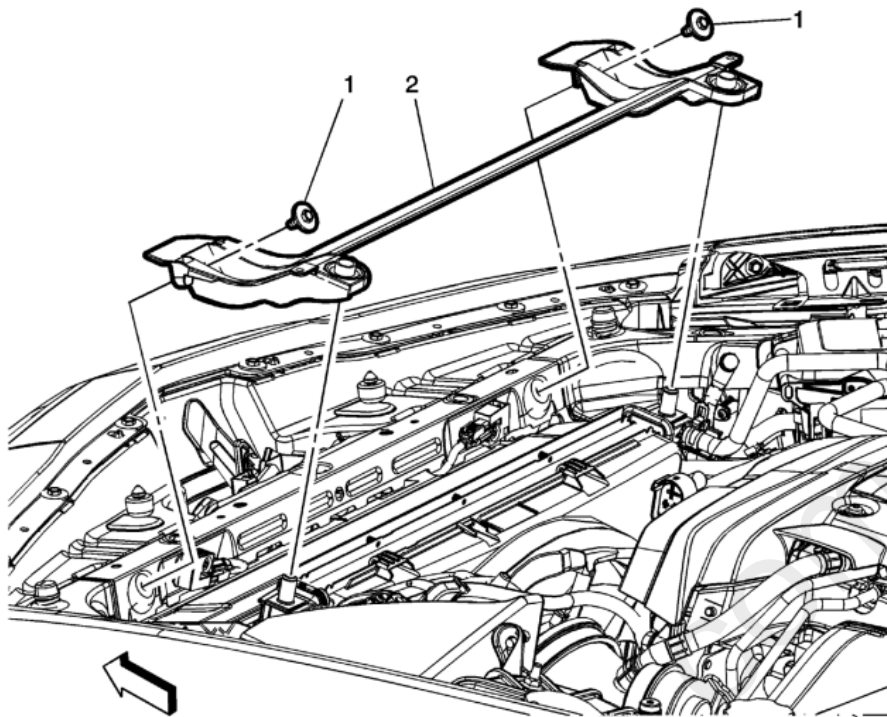


Fig. 181: Radiator Upper Bracket (LFX, LTG)
 Courtesy of GENERAL MOTORS COMPANY

7. Remove the radiator upper bracket. Refer to **Radiator Upper Bracket Replacement (LFX, LTG)**.

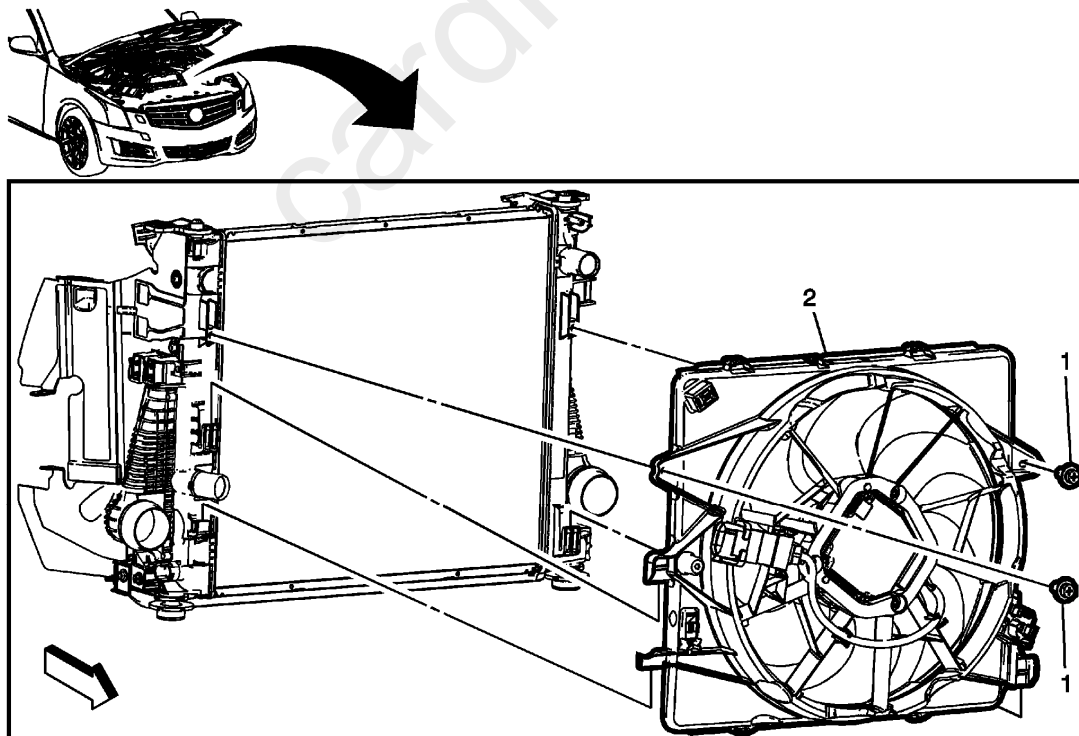


Fig. 182: Engine Coolant Fan Shroud

Courtesy of GENERAL MOTORS COMPANY

8. Remove the engine coolant fan shroud (2) from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LTG without V03)**.

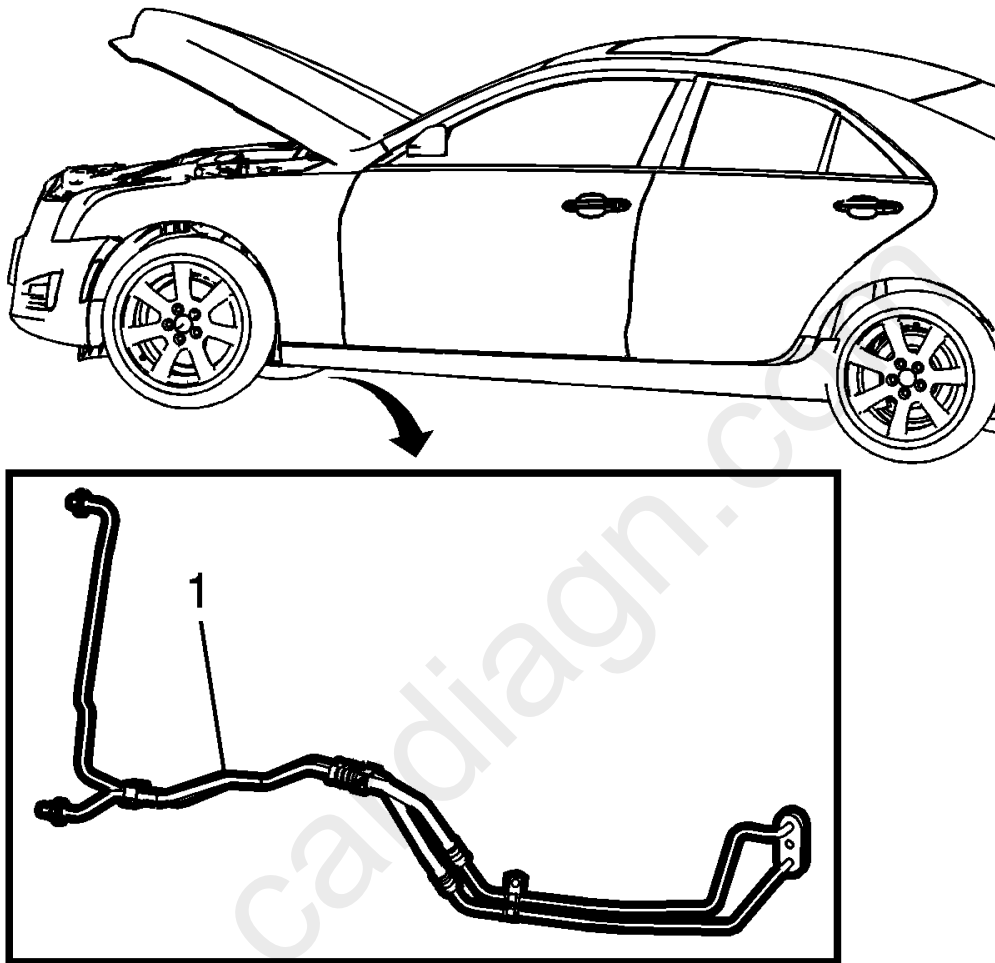


Fig. 183: Transmission Fluid Cooler Inlet And Outlet Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Remove the transmission fluid cooler inlet and outlet pipe (1) from the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** .

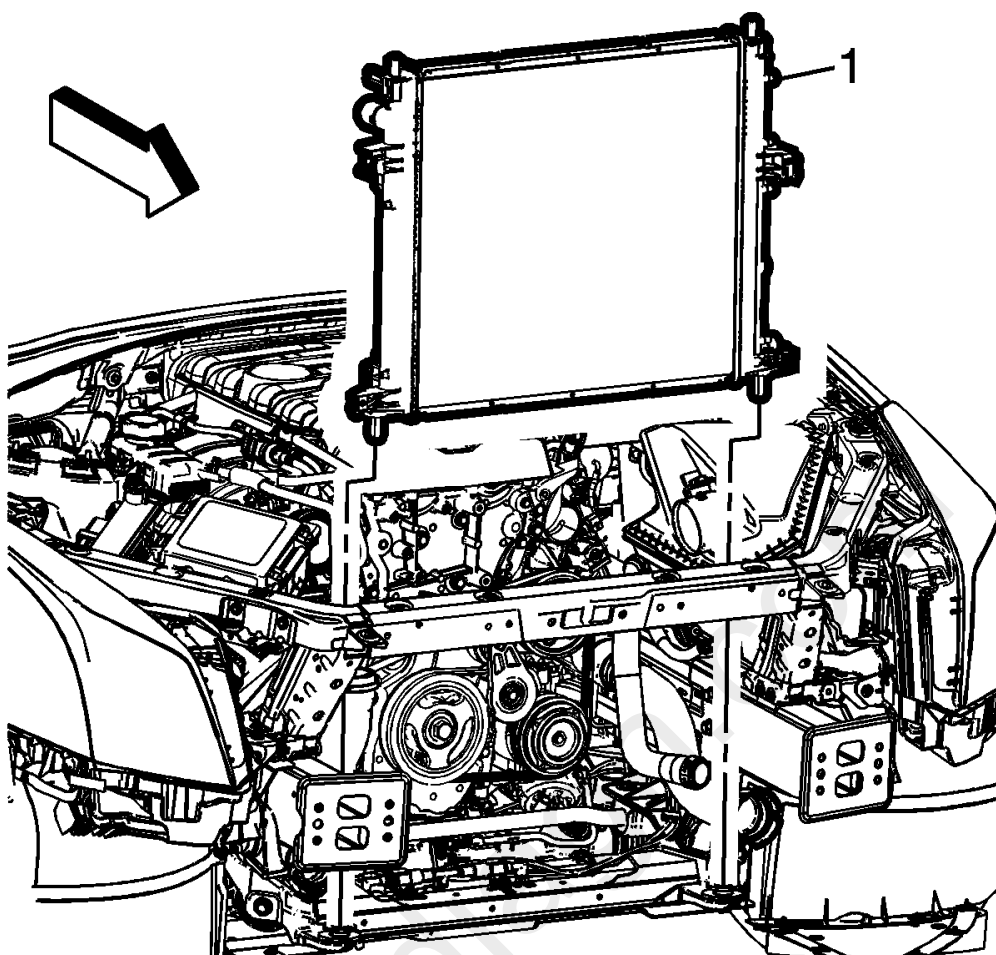


Fig. 184: Radiator

Courtesy of GENERAL MOTORS COMPANY

10. Lift up to remove the radiator (1) from the vehicle.

Installation Procedure

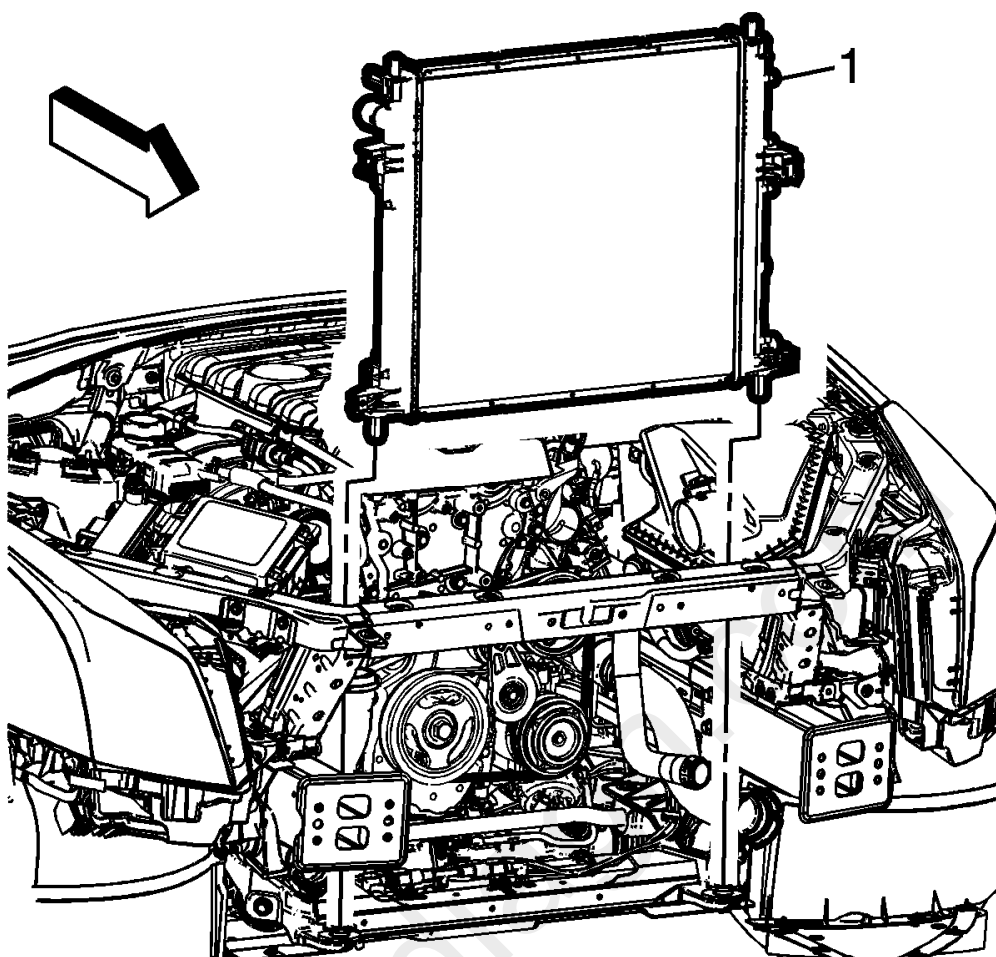


Fig. 185: Radiator

Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator assembly (1) to the vehicle.

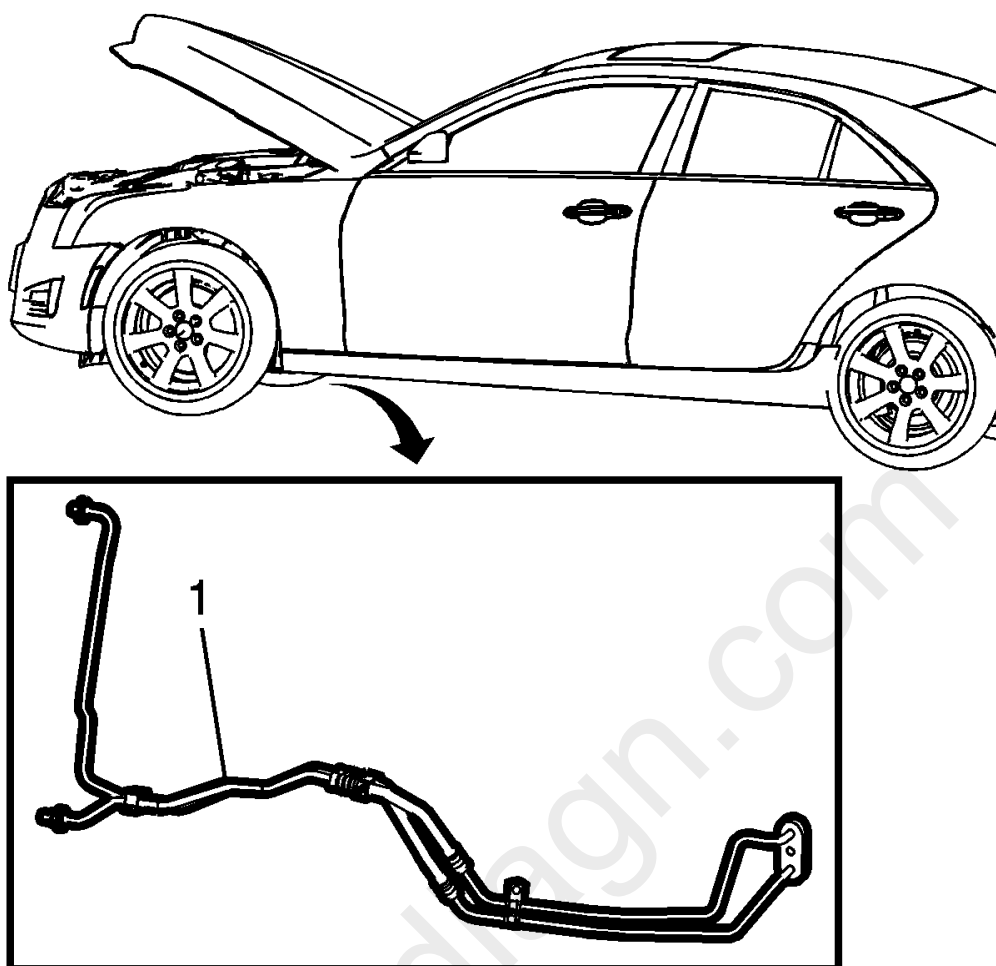


Fig. 186: Transmission Fluid Cooler Inlet And Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install the transmission fluid cooler inlet and outlet pipe (1) to the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)** .

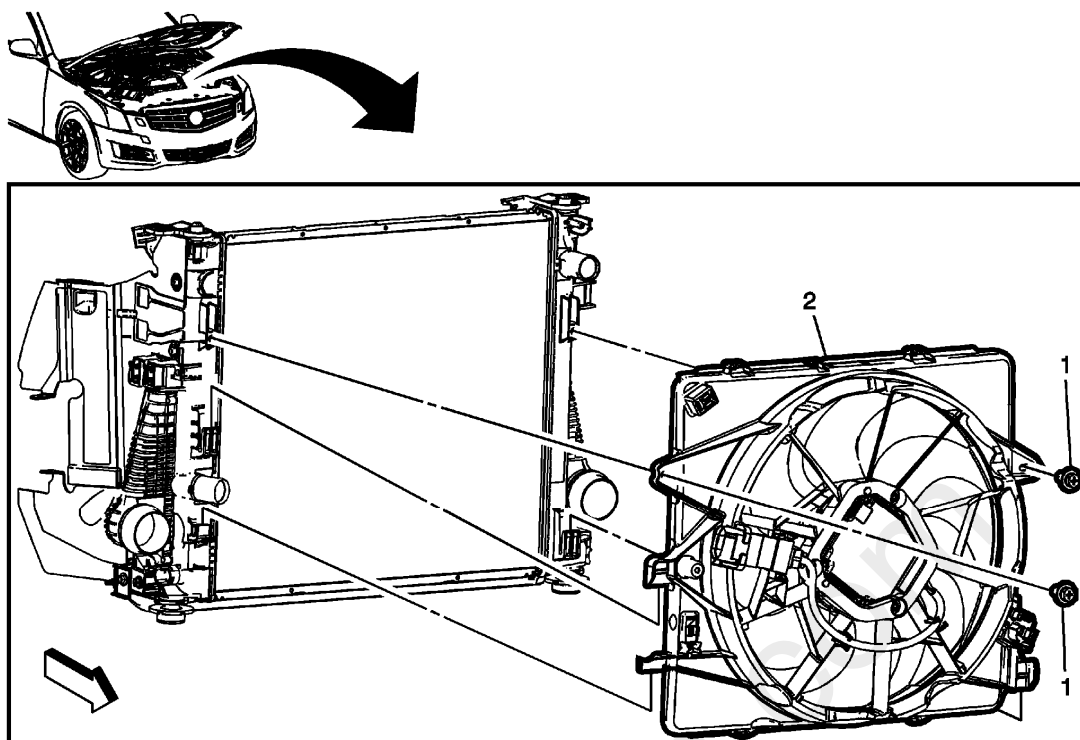


Fig. 187: Engine Coolant Fan Shroud
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine coolant fan shroud (2) to the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LTG without V03)**.

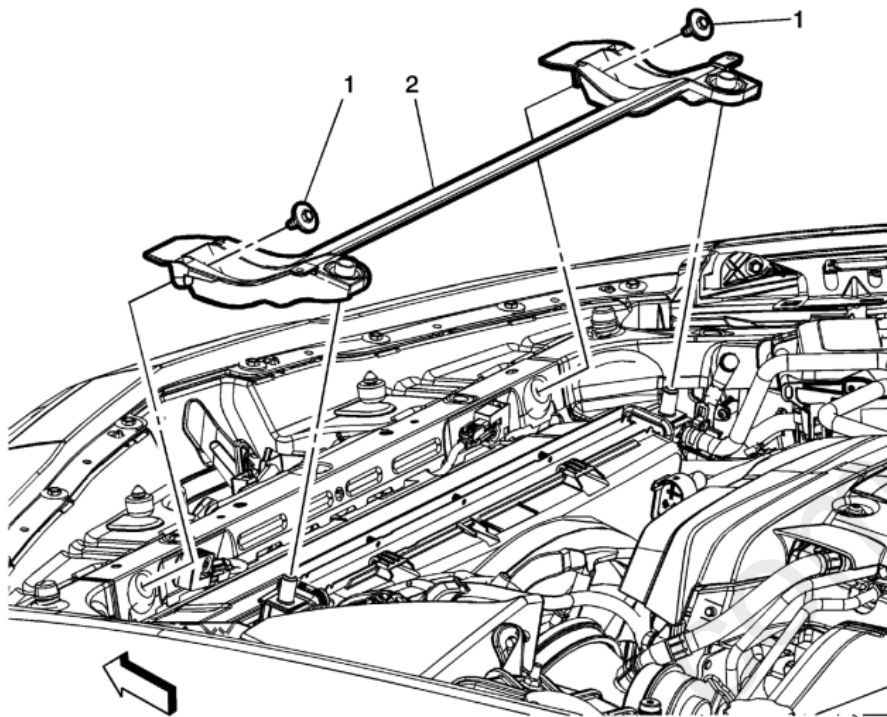


Fig. 188: Radiator Upper Bracket (LFX, LTG)
 Courtesy of GENERAL MOTORS COMPANY

4. Install the radiator upper bracket. Refer to **Radiator Upper Bracket Replacement (LFX, LTG)**.

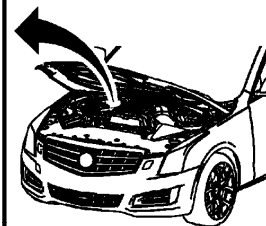
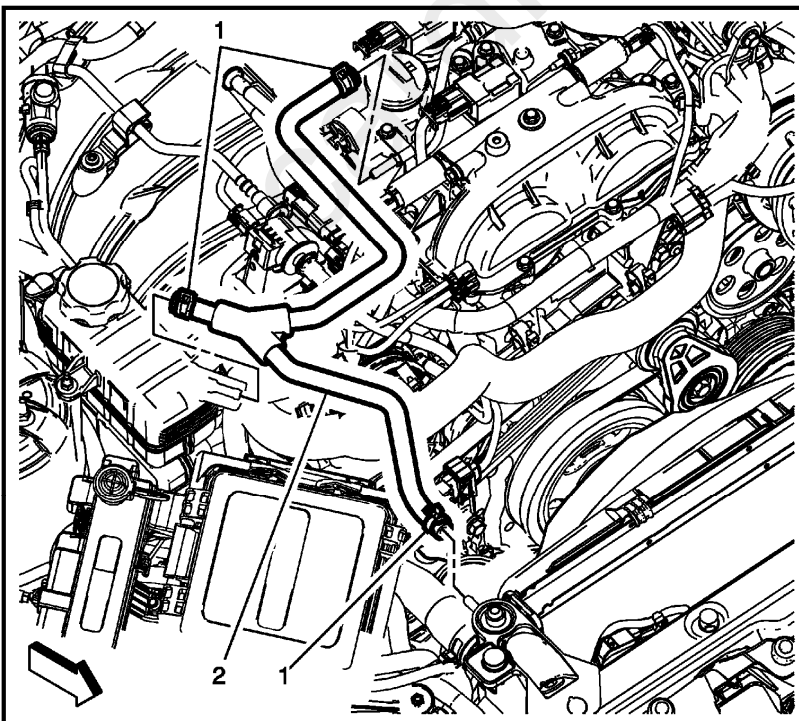


Fig. 189: Radiator Surge Tank Inlet Hose (LTG)

Courtesy of GENERAL MOTORS COMPANY

5. Install the radiator surge tank inlet hose (2) to the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (LTG)**.

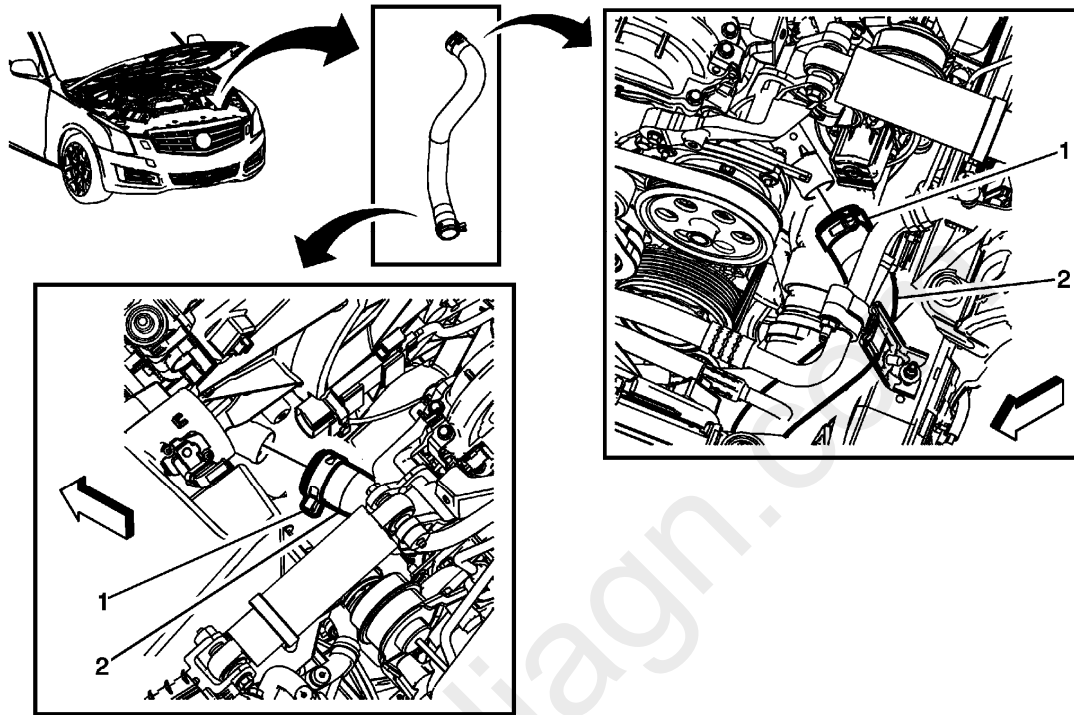


Fig. 190: Radiator Outlet Hose (LTG without V03)

Courtesy of GENERAL MOTORS COMPANY

6. Install the radiator outlet hose (2) to the radiator. Refer to **Radiator Outlet Hose Replacement (LTG without V03)**.

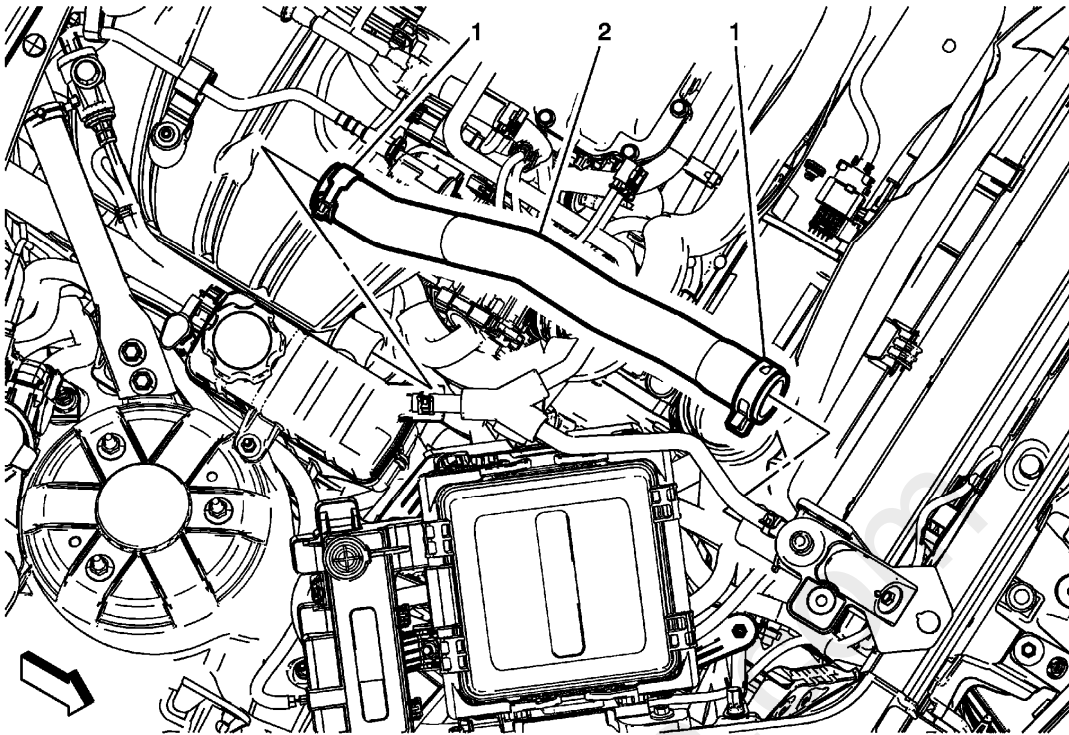


Fig. 191: Radiator Inlet Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

7. Install the radiator inlet hose (2) to the radiator. Refer to **Radiator Inlet Hose Replacement (LTG)**.
8. Install the radiator air lower baffle and deflector to the vehicle. Refer **Radiator Air Lower Baffle and Deflector Replacement (LTG)**.
9. Install the charge air cooler radiator. Refer **Charge Air Cooler Radiator Replacement** .
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 (LFX WITH V03)

Removal Procedure

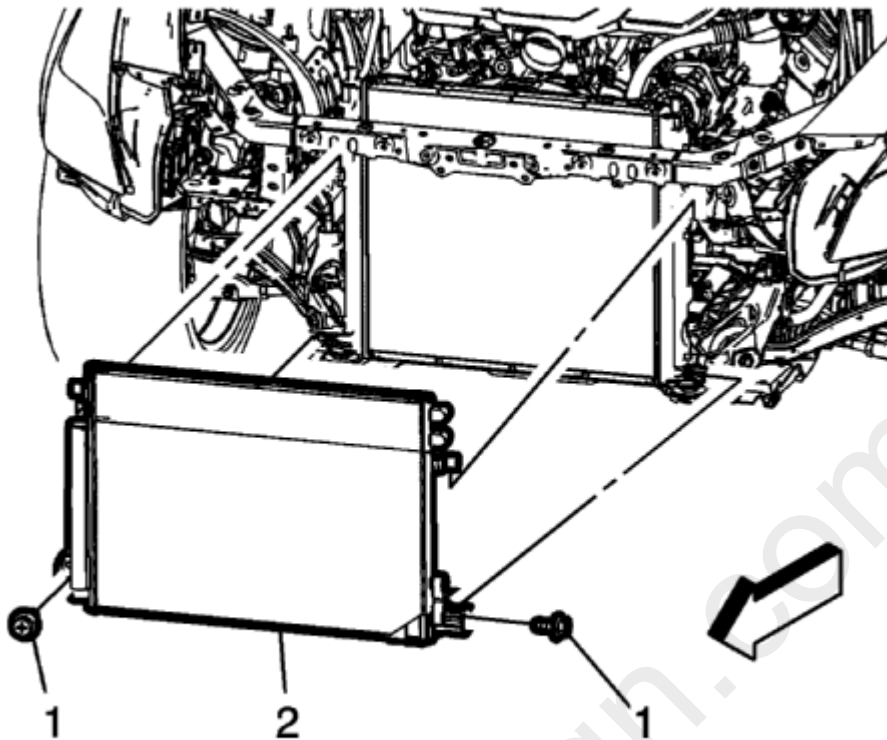


Fig. 192: Air Conditioning Condenser
Courtesy of GENERAL MOTORS COMPANY

1. Remove the air conditioning condenser (2). Refer **Air Conditioning Condenser Replacement (LFX with V03)** .
2. Drain the engine cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

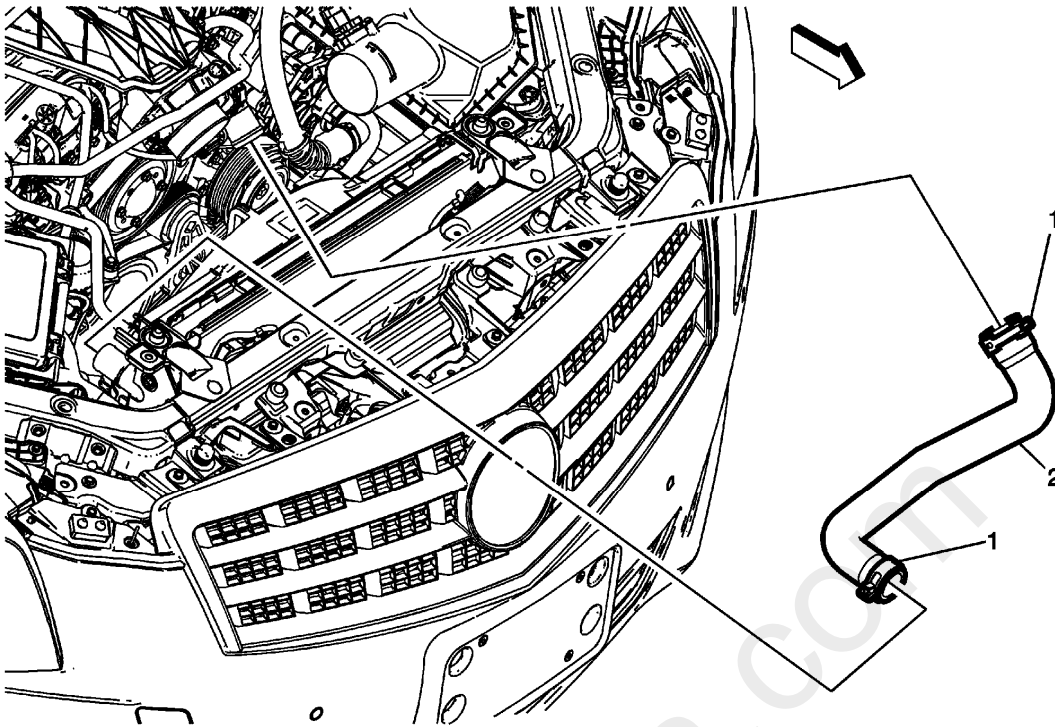


Fig. 193: Radiator Inlet Hose (LFX)
 Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator inlet hose (2) from the radiator. Refer to **Radiator Inlet Hose Replacement (LFX)**.

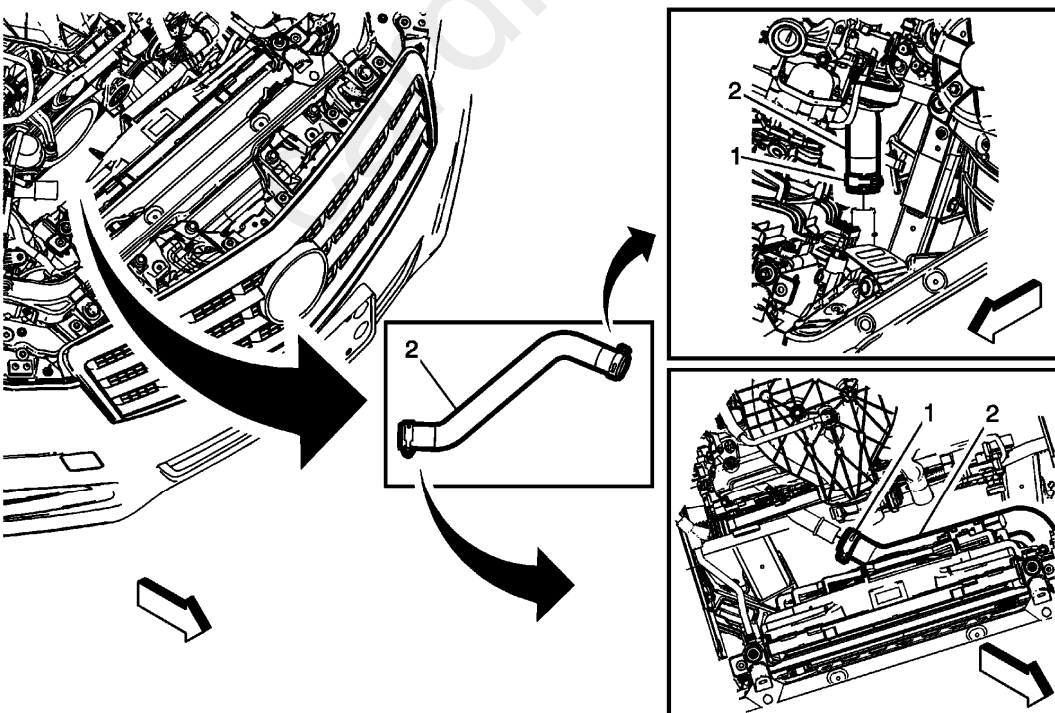


Fig. 194: Radiator Outlet Hose (LFX)

Courtesy of GENERAL MOTORS COMPANY

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

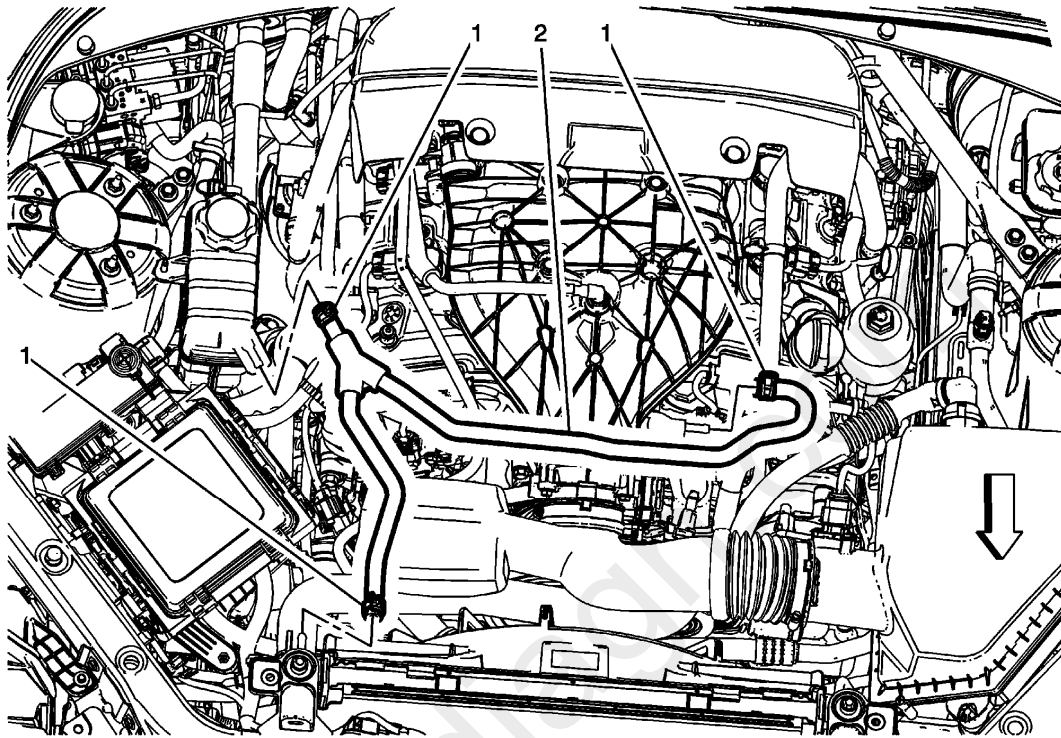


Fig. 195: Radiator Surge Tank Inlet Hose (LFX)

Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the radiator surge tank inlet hose (2) from the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (LTG)**, **Radiator Surge Tank Inlet Hose Replacement (LFX)**, **Radiator Surge Tank Inlet Hose Replacement (LF3)**.

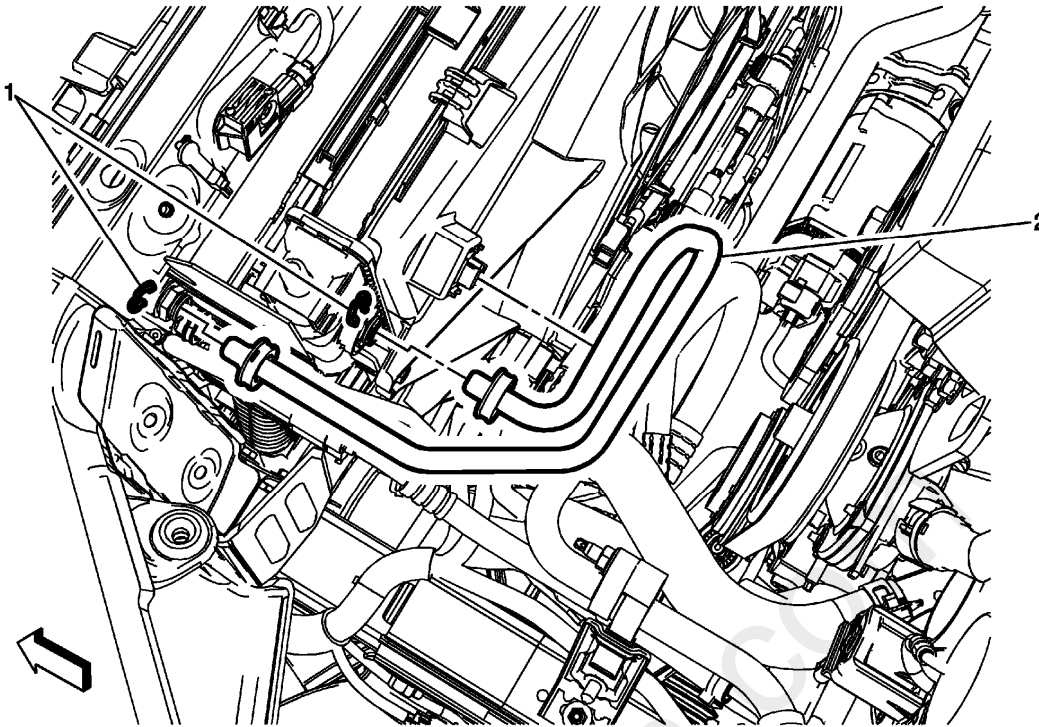


Fig. 196: Transmission Fluid Cooler Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transmission fluid cooler pipe (2) from the radiator. Refer to **Transmission Fluid Cooler Pipe Replacement (LF3, LFX with V03)** .

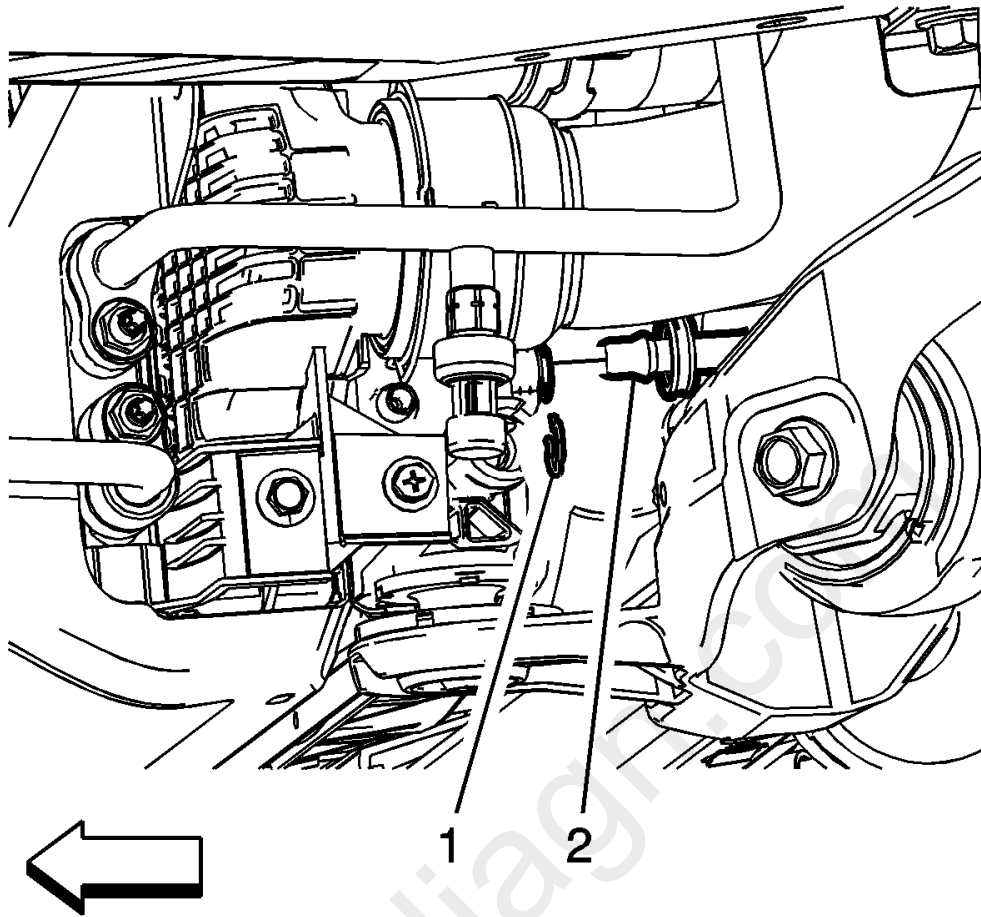


Fig. 197: Transmission Fluid Cooler Inlet And Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove the transmission fluid cooler inlet and outlet pipe (2) from the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** .

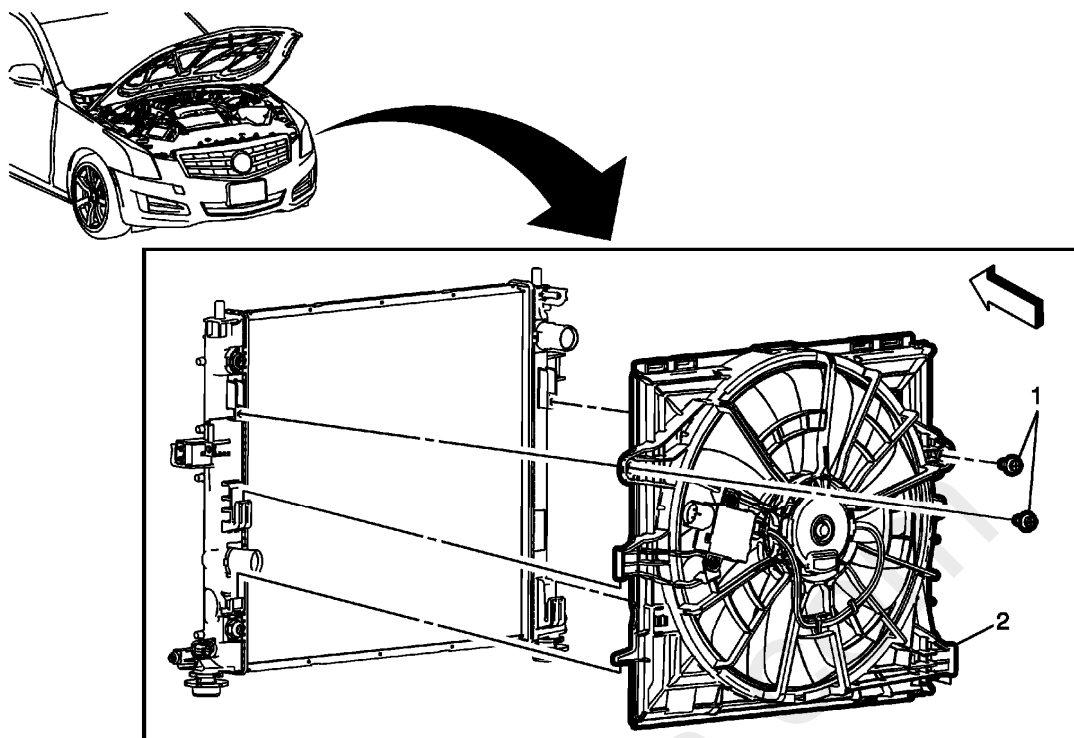


Fig. 198: Engine Coolant Fan Shroud (LFX)
Courtesy of GENERAL MOTORS COMPANY

8. Remove the engine coolant fan shroud (2) from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LFX)**.
9. Remove three push pin retainers at the bottom of the radiator and remove the radiator lower air baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement (LFX)**.

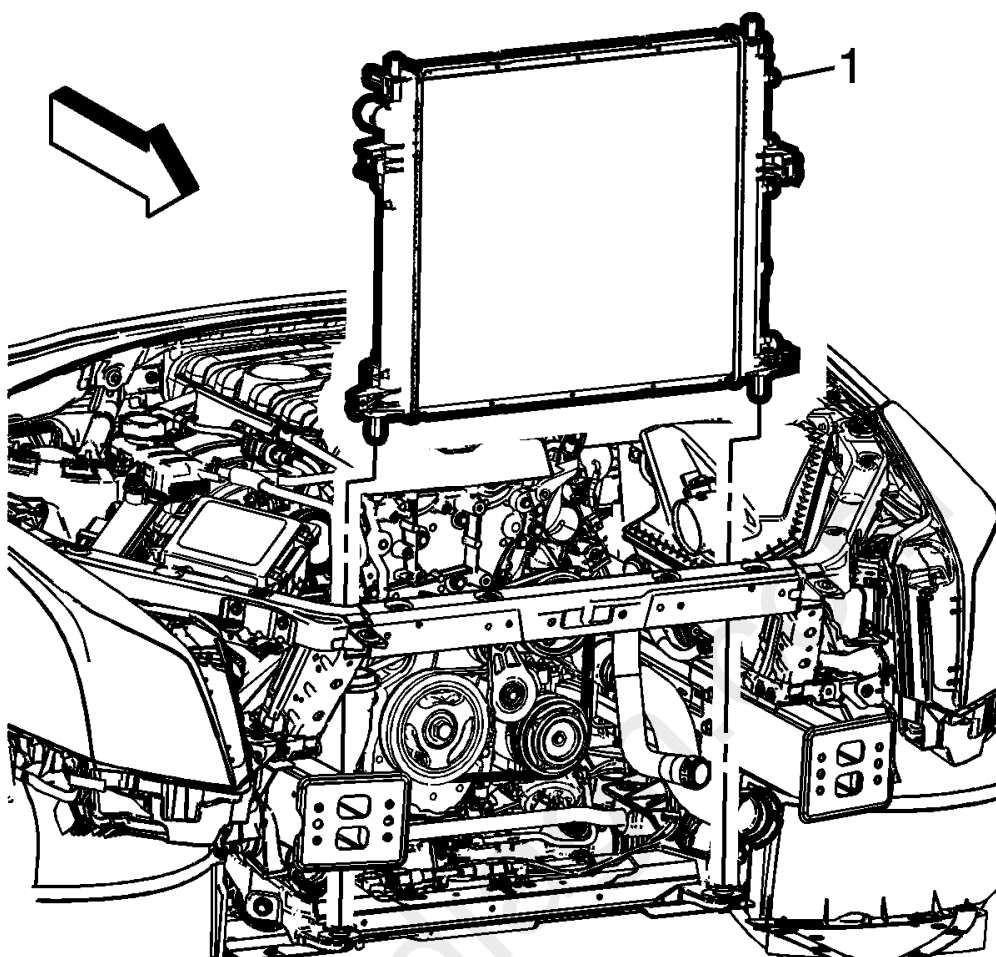


Fig. 199: Radiator
Courtesy of GENERAL MOTORS COMPANY

10. Lift up to remove the radiator (1) from the vehicle.

Installation Procedure

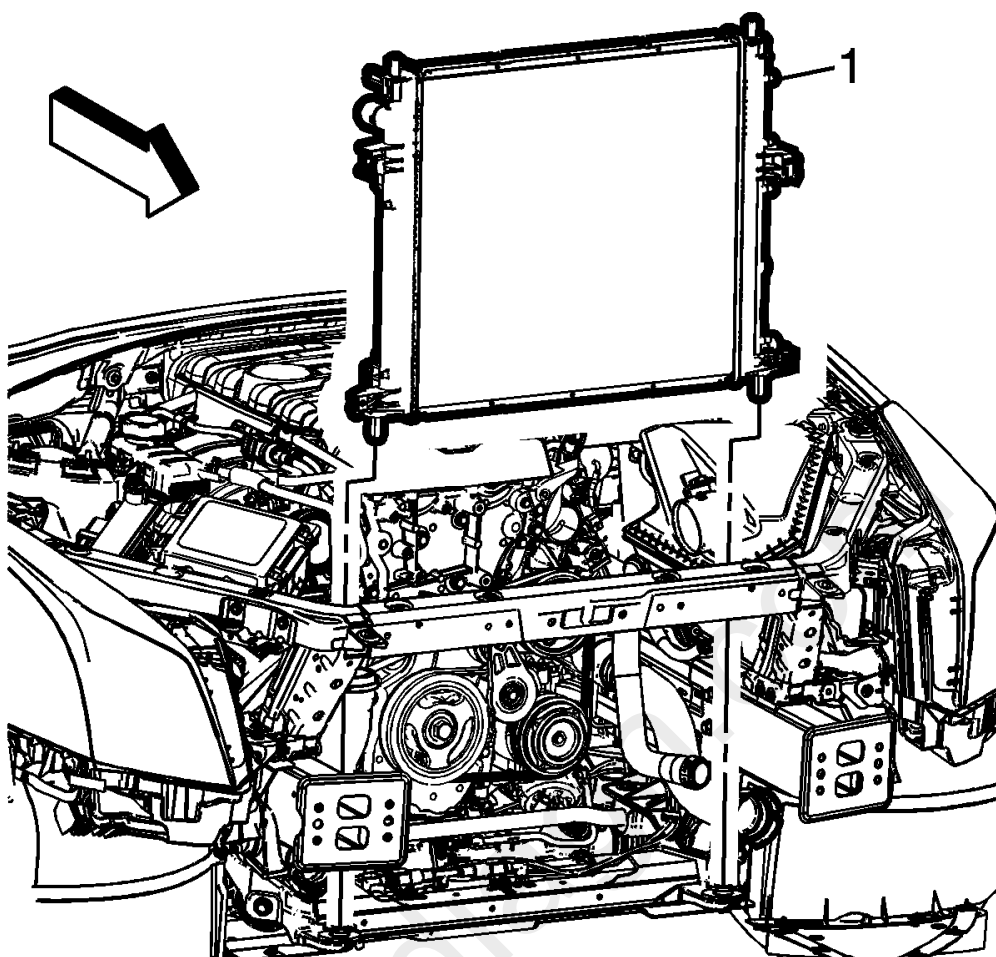


Fig. 200: Radiator

Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator assembly (1) to the vehicle.
2. Install the radiator lower air baffle and deflector to the radiator and install the three push pin retainers at the bottom of the radiator. Refer to **Radiator Air Lower Baffle and Deflector Replacement (LFX)**.

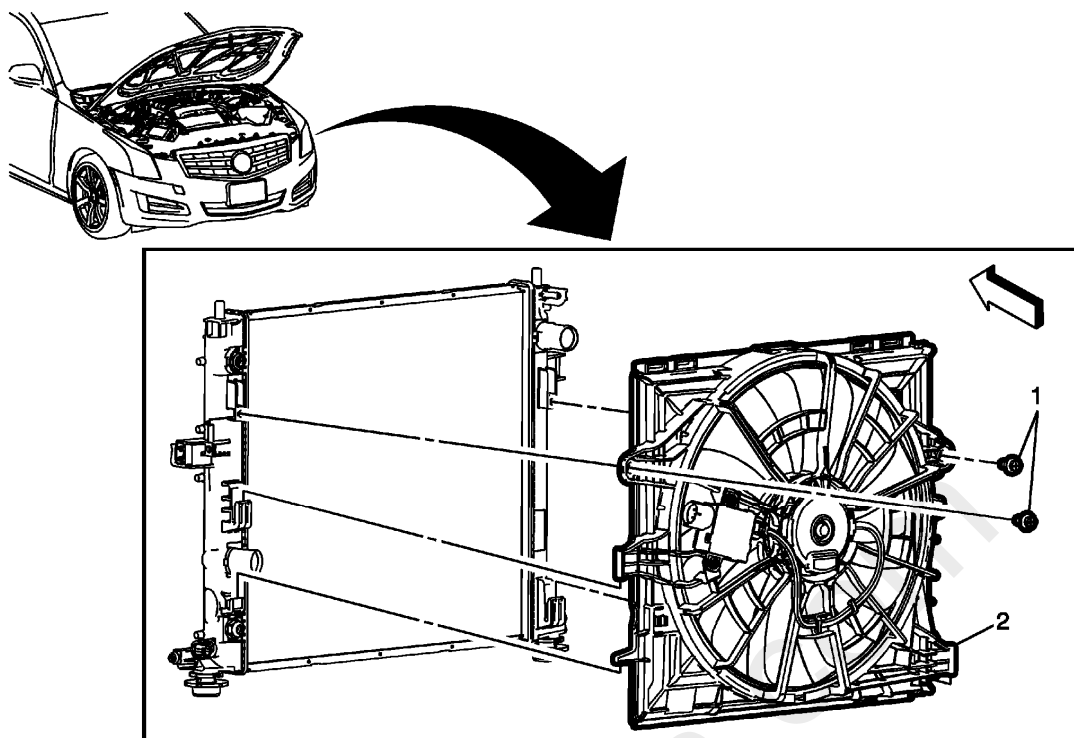


Fig. 201: Engine Coolant Fan Shroud (LFX)
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine coolant fan shroud (2) to the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LFX)**.

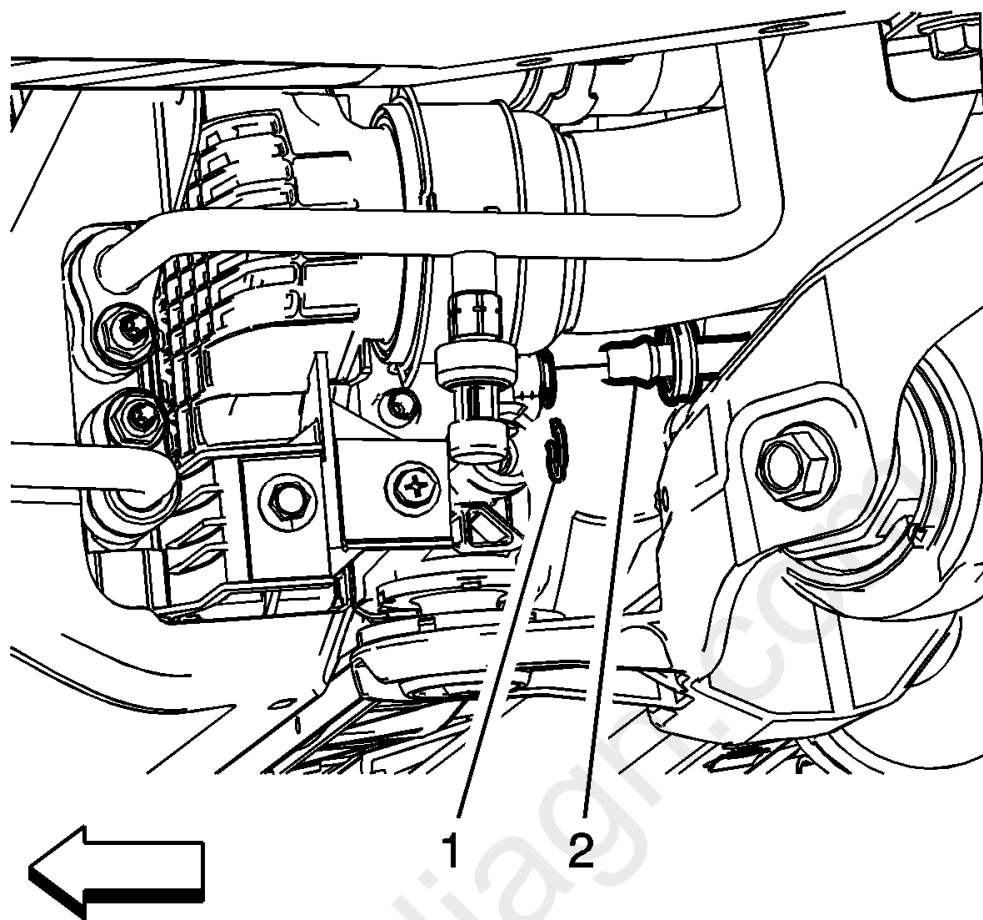


Fig. 202: Transmission Fluid Cooler Inlet And Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Install the transmission fluid cooler inlet and outlet pipe (2) to the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** .

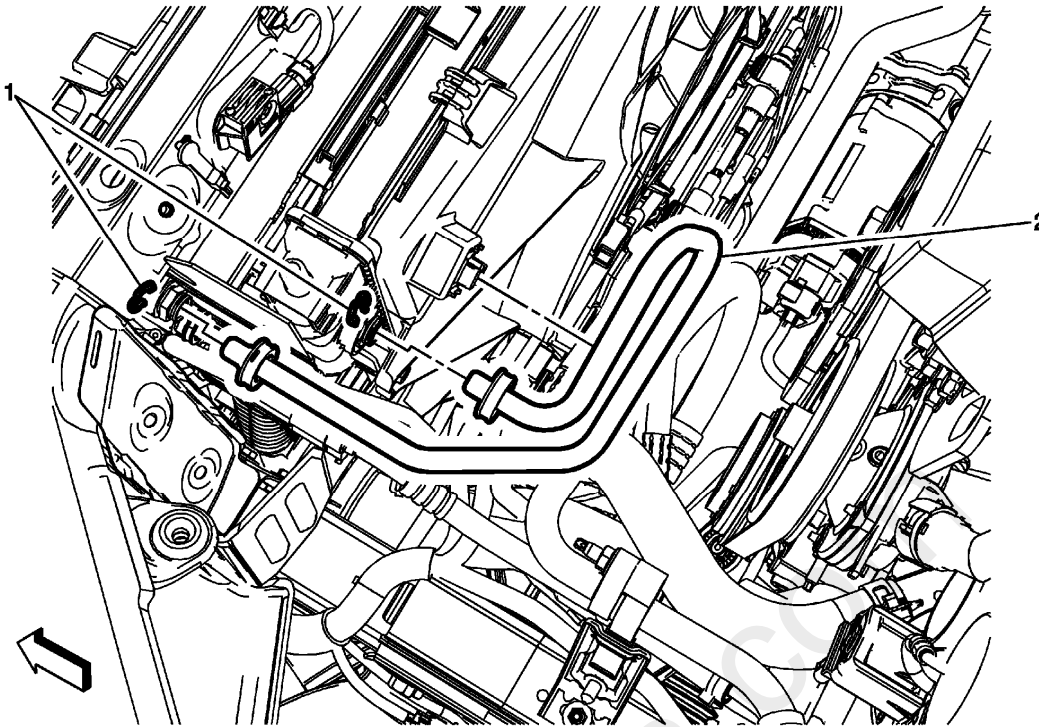


Fig. 203: Transmission Fluid Cooler Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission fluid cooler pipe (2) to the radiator. Refer to **Transmission Fluid Cooler Pipe Replacement (LF3, LFX with V03)** .

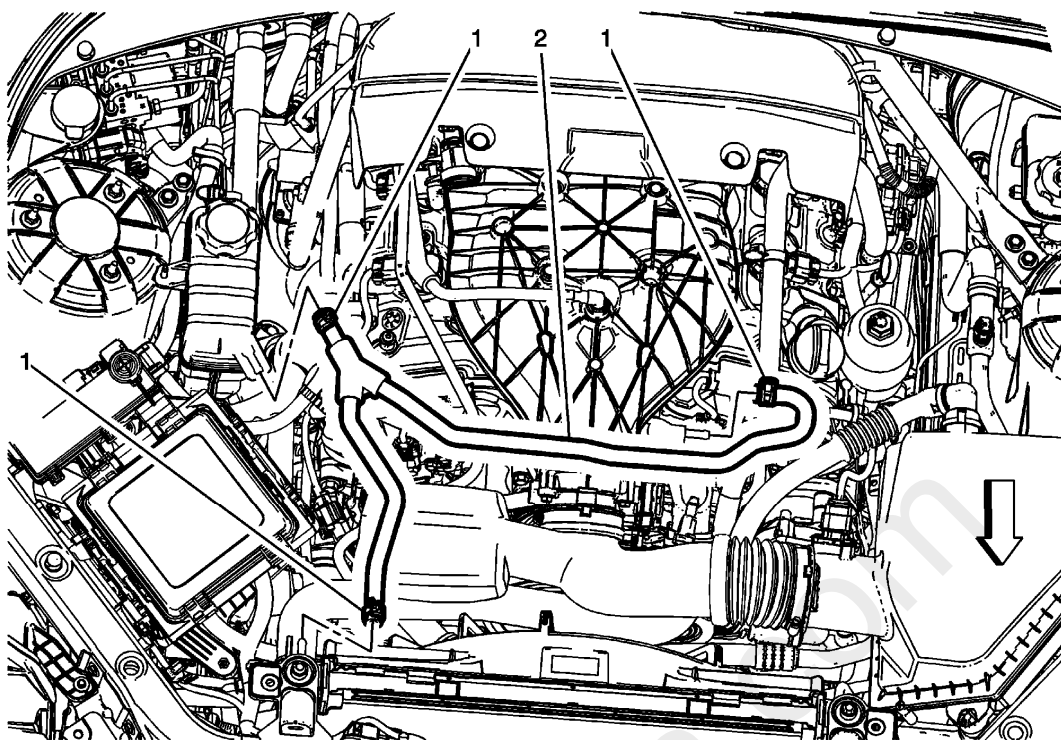


Fig. 204: Radiator Surge Tank Inlet Hose (LFX)
Courtesy of GENERAL MOTORS COMPANY

6. Connect the radiator surge tank inlet hose (2) to the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (LFX)**.

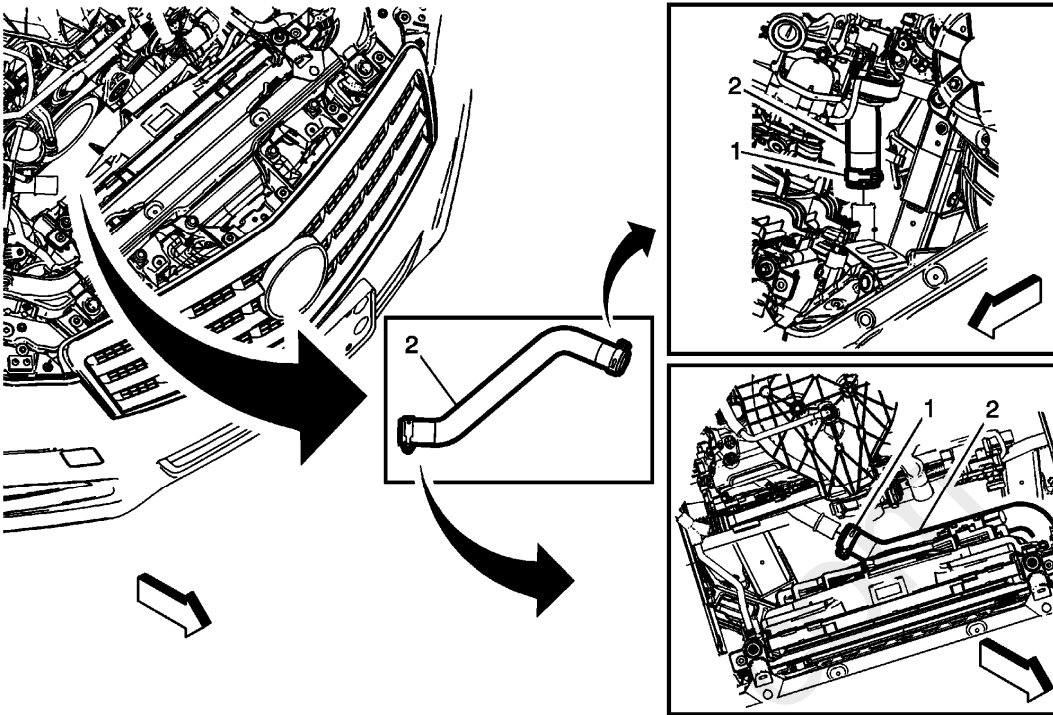


Fig. 205: Radiator Outlet Hose (LFX)
 Courtesy of GENERAL MOTORS COMPANY

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

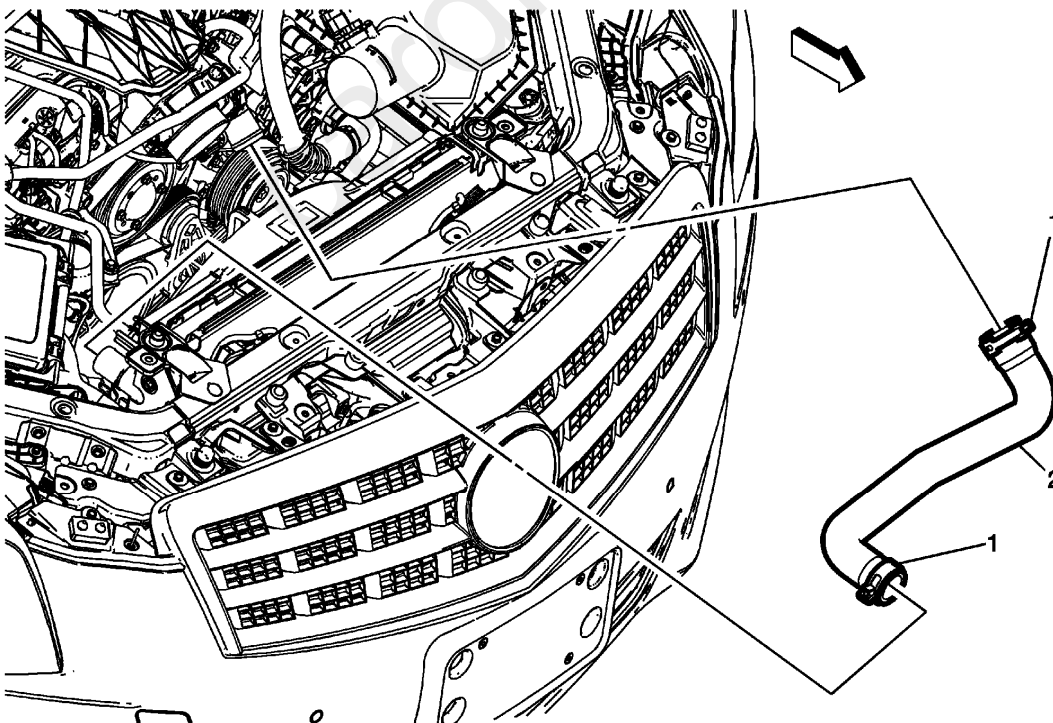


Fig. 206: Radiator Inlet Hose (LFX)

Courtesy of GENERAL MOTORS COMPANY

8. Install the radiator inlet hose (2) to the radiator. Refer to **Radiator Inlet Hose Replacement (LFX)**.

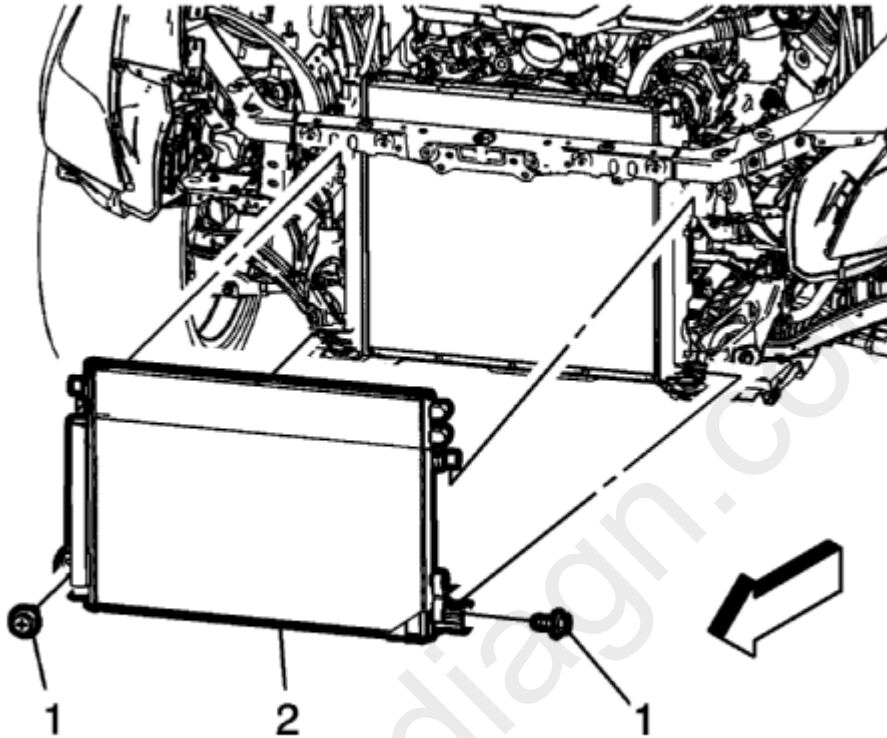


Fig. 207: Air Conditioning Condenser

Courtesy of GENERAL MOTORS COMPANY

9. Install the air conditioning condenser (2). Refer **Air Conditioning Condenser Replacement (LFX with V03)** .
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 (LF3)

Removal Procedure

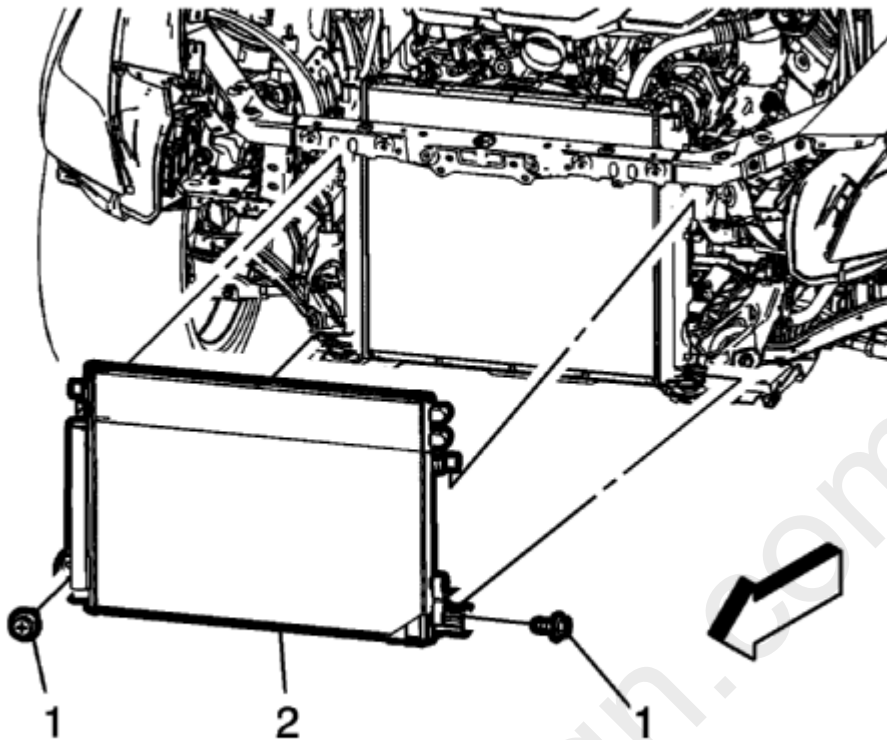


Fig. 208: Air Conditioning Condenser
Courtesy of GENERAL MOTORS COMPANY

1. Remove the air conditioning condenser (2). Refer **Air Conditioning Condenser Replacement (LF3 with V03)** .
2. Drain the engine cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

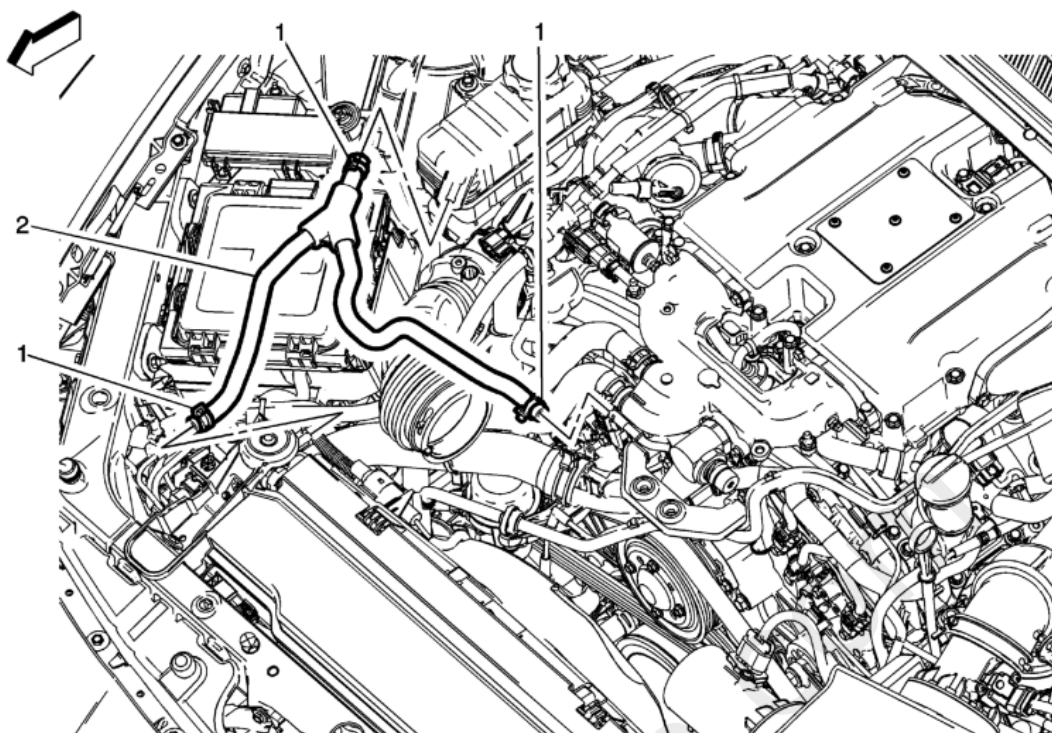


Fig. 209: Radiator Surge Tank Inlet Hose (LF3)
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the radiator surge tank inlet hose (2) from the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (LF3)**.

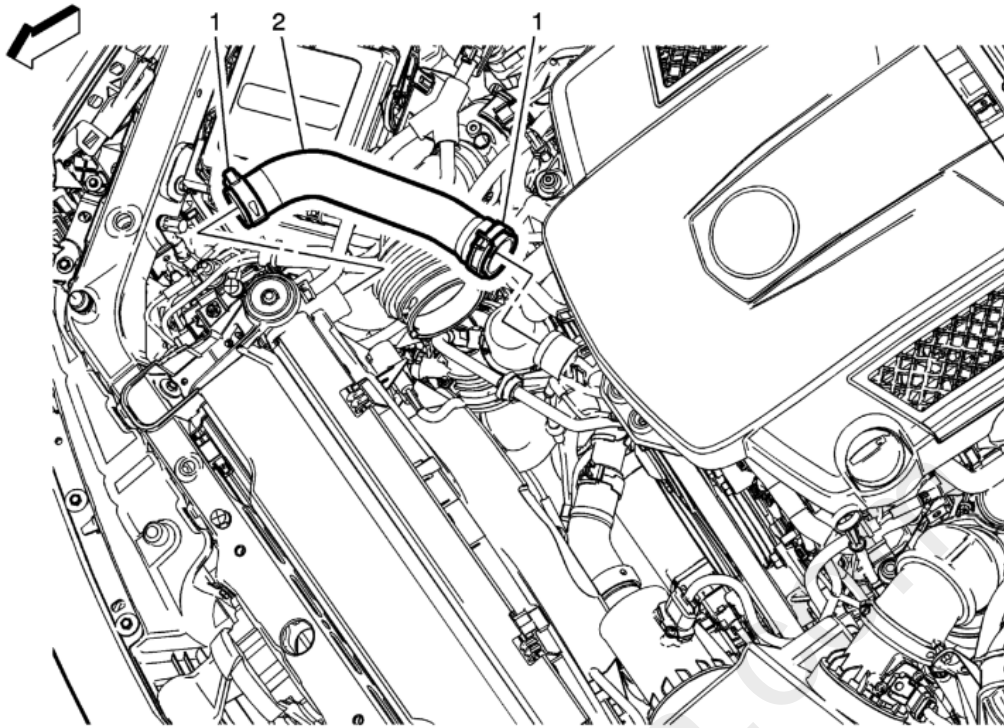


Fig. 210: Radiator Inlet Hose (LF3)
Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator inlet hose (2) from the radiator. Refer to **Radiator Inlet Hose Replacement (LF3)**.

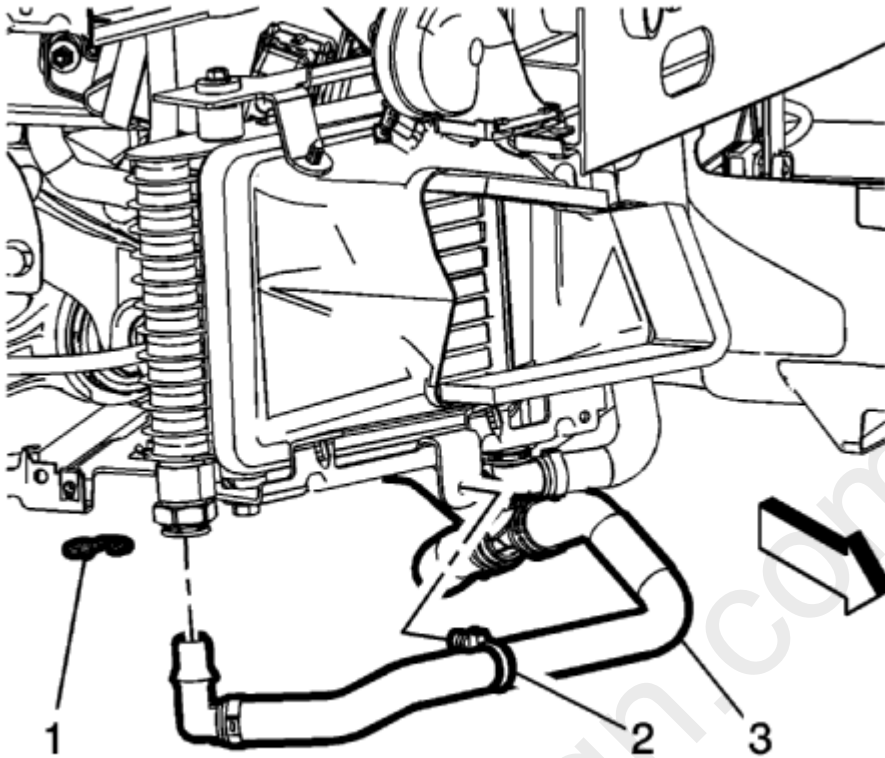


Fig. 211: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove the auxiliary radiator inlet hose (3) from the auxiliary radiator. Refer to **Auxiliary Radiator Inlet Hose Replacement (LF3)**.

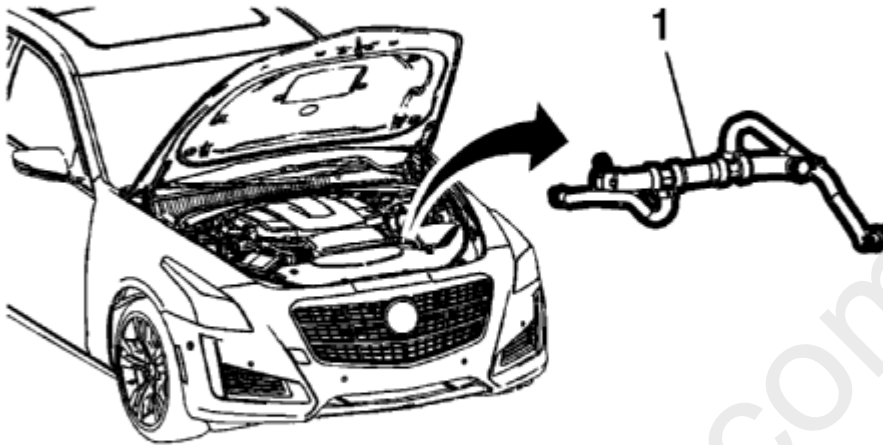


Fig. 212: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

6. Remove the radiator outlet hose (1) from the radiator. Refer to **Radiator Outlet Hose Replacement (LF3)**.

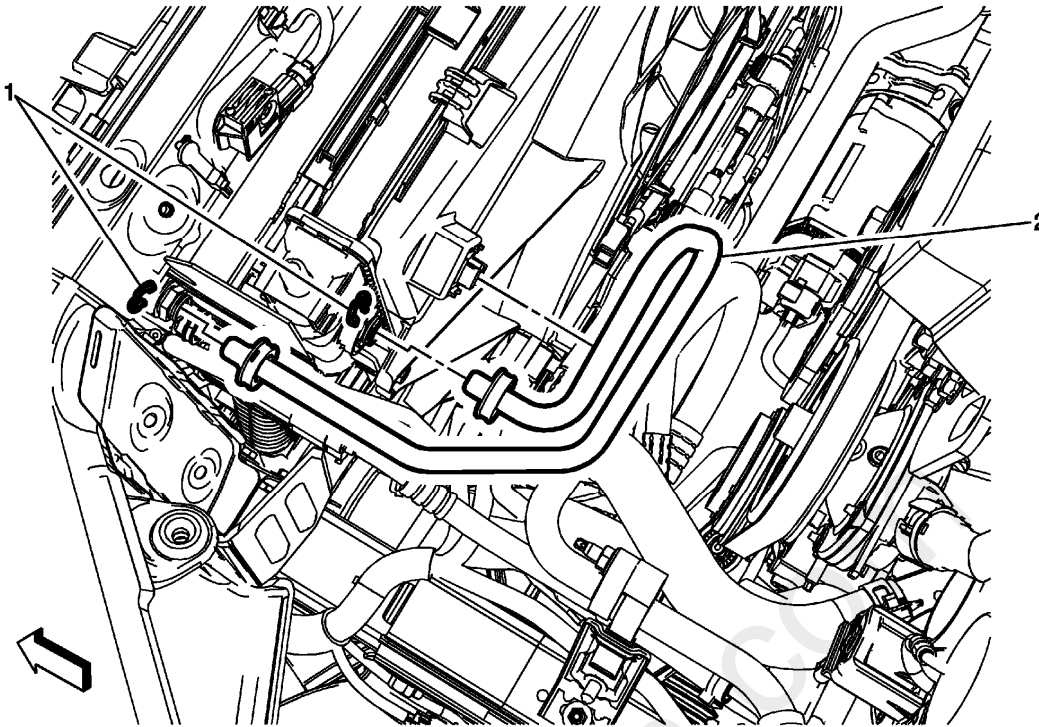


Fig. 213: Transmission Fluid Cooler Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove the transmission fluid cooler pipe (2) from the radiator. Refer to **Transmission Fluid Cooler Pipe Replacement (LF3, LFX with V03)** .

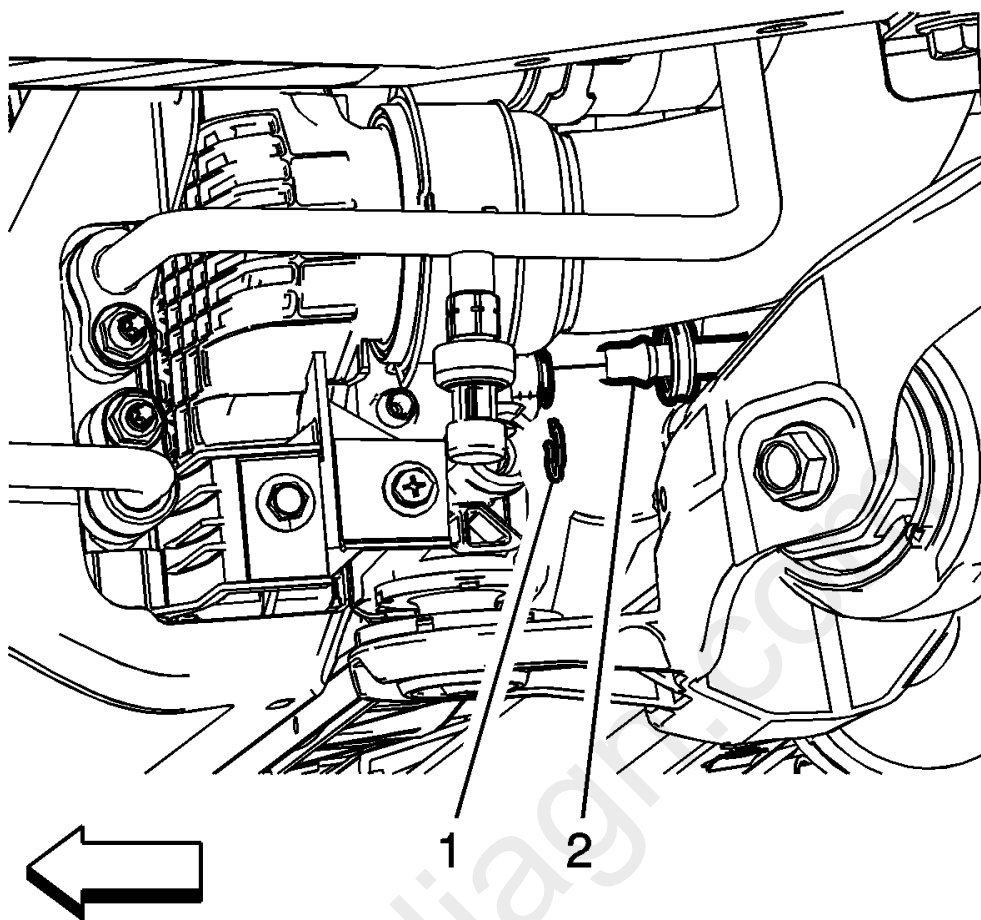


Fig. 214: Transmission Fluid Cooler Inlet And Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Remove the transmission fluid cooler inlet and outlet pipe (2) from the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LF3 with MGG and V03)** .

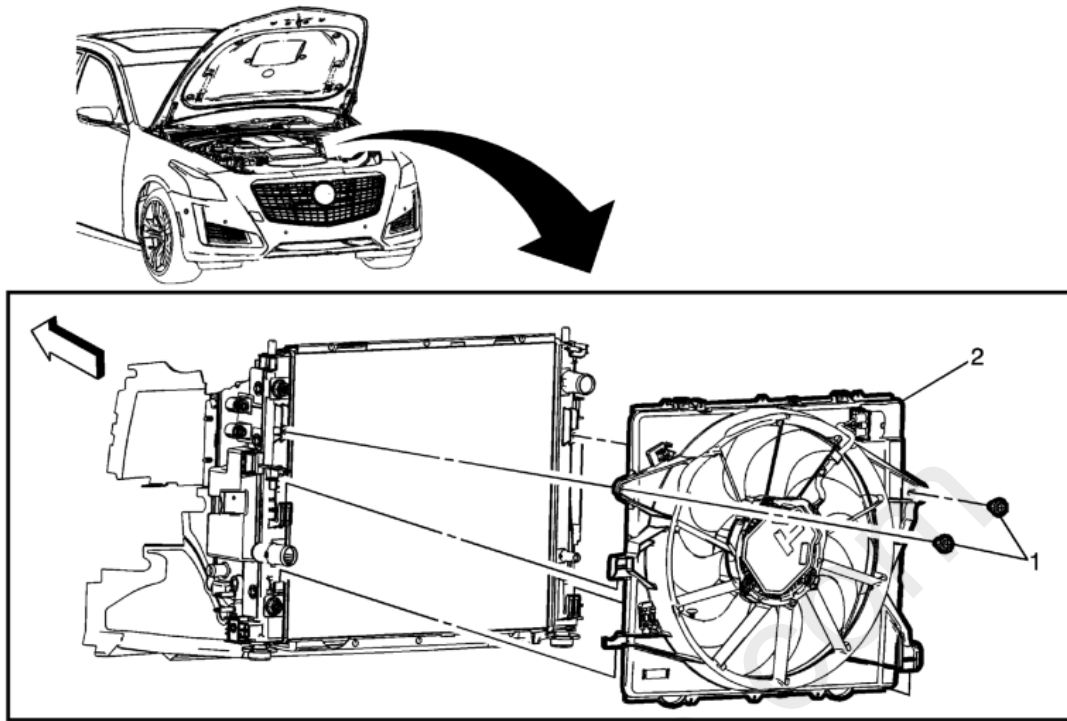


Fig. 215: Engine Coolant Fan Shroud (LF3)
Courtesy of GENERAL MOTORS COMPANY

9. Remove the engine coolant fan shroud (2) from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LF3)**.
10. Remove the left and right charge air cooler radiator lower brackets from the radiator. Refer to **Charge Air Cooler Radiator Lower Bracket Replacement - Left Side (LF3)**, and **Charge Air Cooler Radiator Lower Bracket Replacement - Right Side (LF3)**.

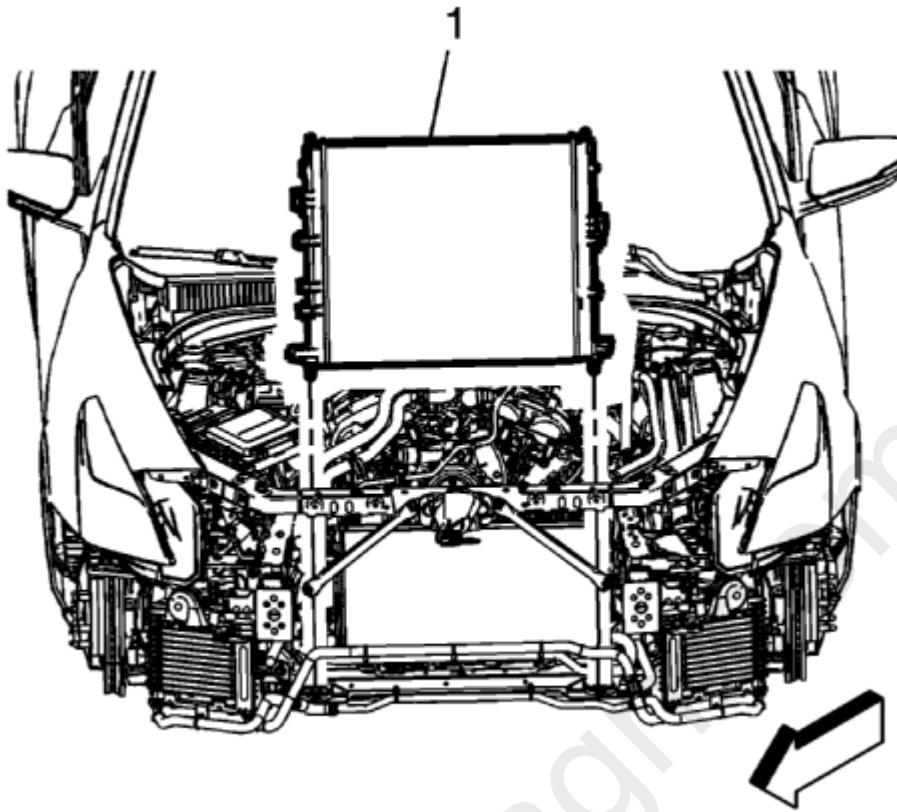


Fig. 216: Radiator

Courtesy of GENERAL MOTORS COMPANY

11. Lift up to remove the radiator (1) from the vehicle.

Installation Procedure

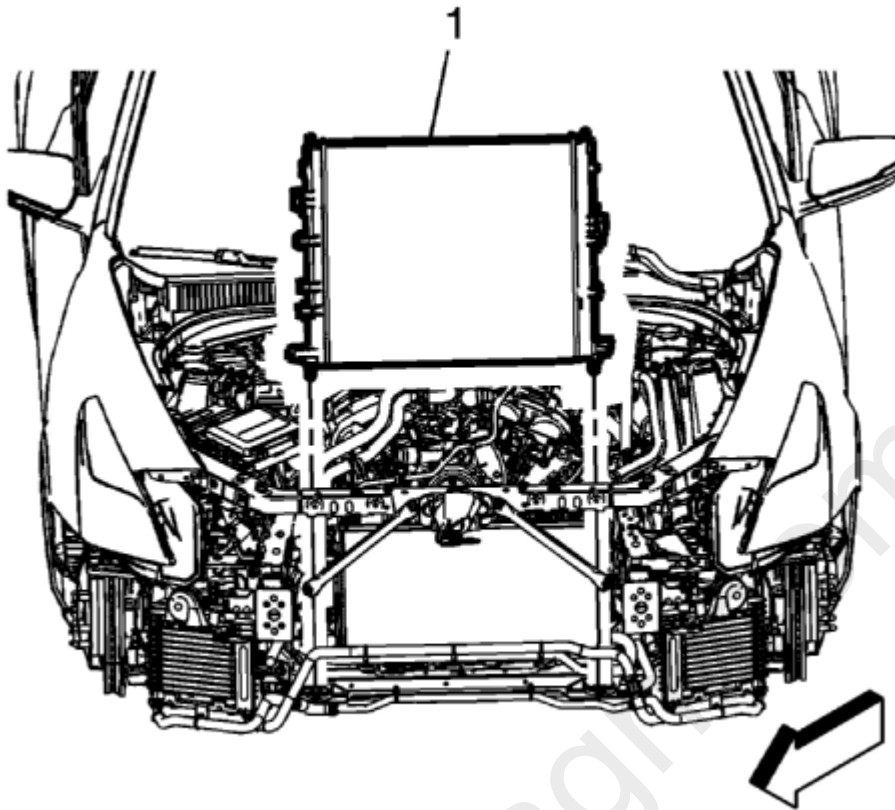


Fig. 217: Radiator

Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator assembly (1) to the vehicle.
2. Install the left and right charge air cooler radiator lower brackets from the radiator. Refer to **Charge Air Cooler Radiator Lower Bracket Replacement - Left Side (LF3)**, and **Charge Air Cooler Radiator Lower Bracket Replacement - Right Side (LF3)**.

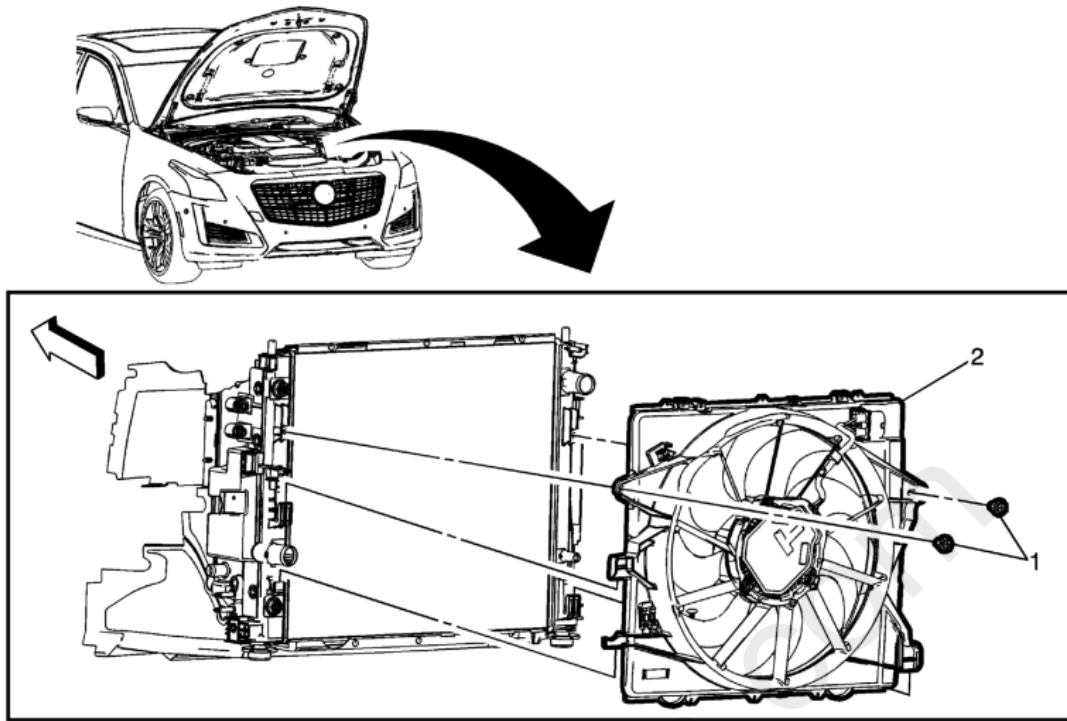


Fig. 218: Engine Coolant Fan Shroud (LF3)
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine coolant fan shroud (2) to the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LF3)**.

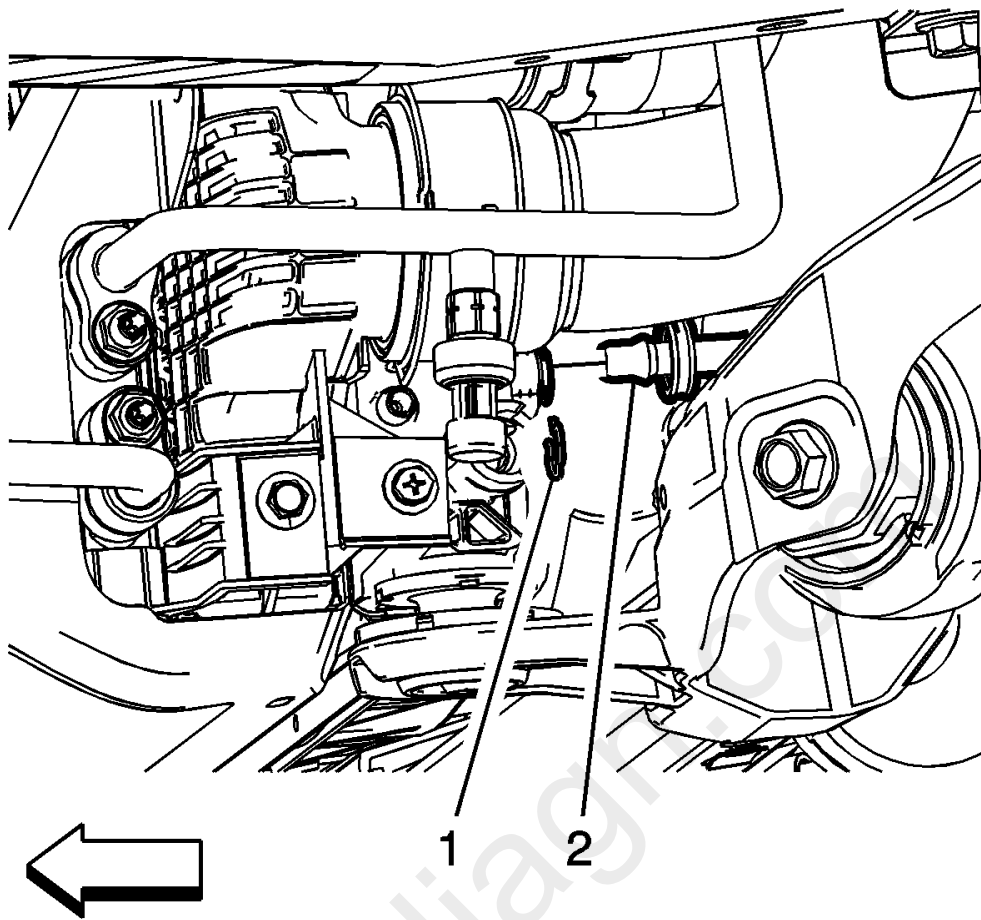


Fig. 219: Transmission Fluid Cooler Inlet And Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Install the transmission fluid cooler inlet and outlet pipe (2) to the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LF3 with MGG and V03)** .

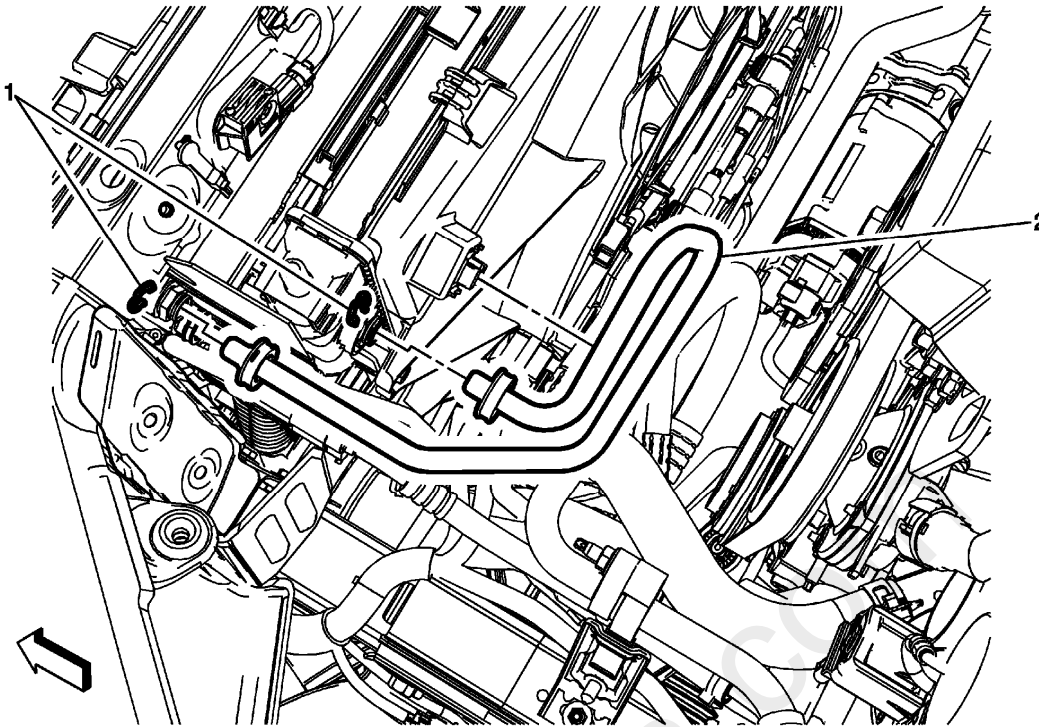


Fig. 220: Transmission Fluid Cooler Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission fluid cooler pipe (2) to the radiator. Refer to **Transmission Fluid Cooler Pipe Replacement (LF3, LFX with V03)** .

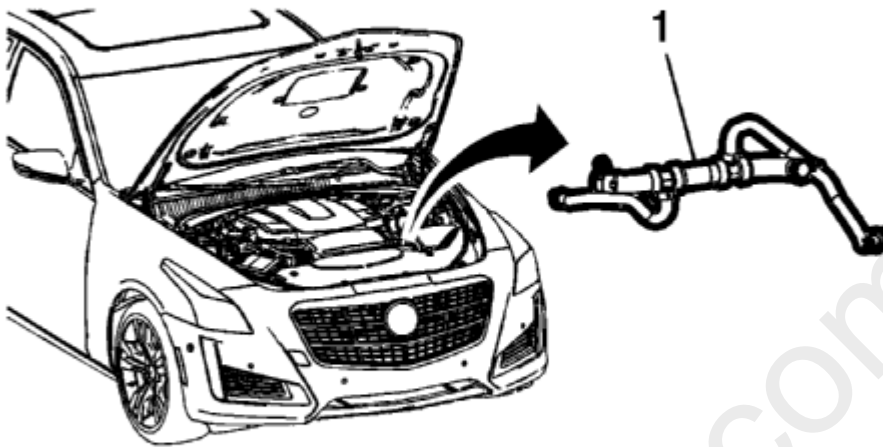


Fig. 221: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

6. Install the radiator outlet hose (1) to the radiator. Refer to **Radiator Outlet Hose Replacement (LF3)**.

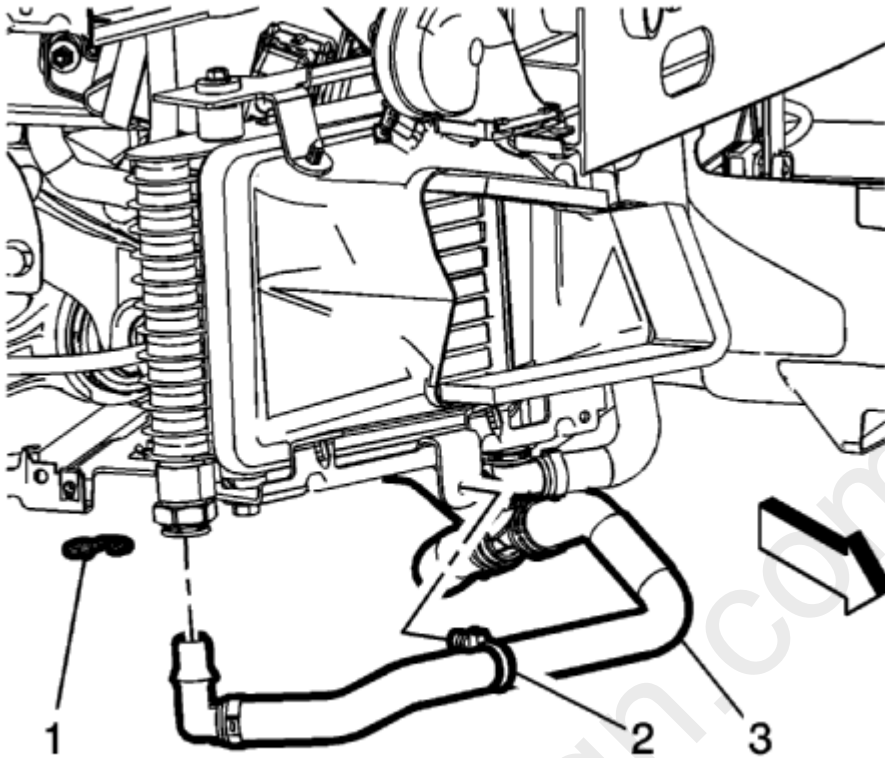


Fig. 222: Auxiliary Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Install the auxiliary radiator inlet hose (3) to the auxiliary radiator. Refer to **Auxiliary Radiator Inlet Hose Replacement (LF3)**.

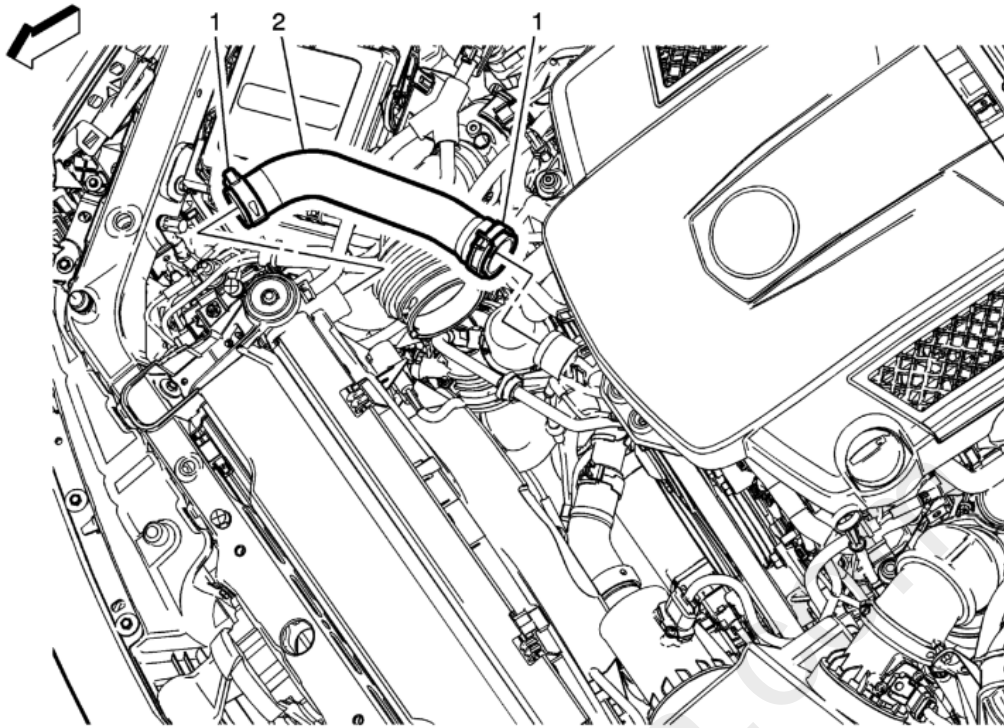


Fig. 223: Radiator Inlet Hose (LF3)
Courtesy of GENERAL MOTORS COMPANY

8. Install the radiator inlet hose (2) to the radiator. Refer to **Radiator Inlet Hose Replacement (LF3)**.

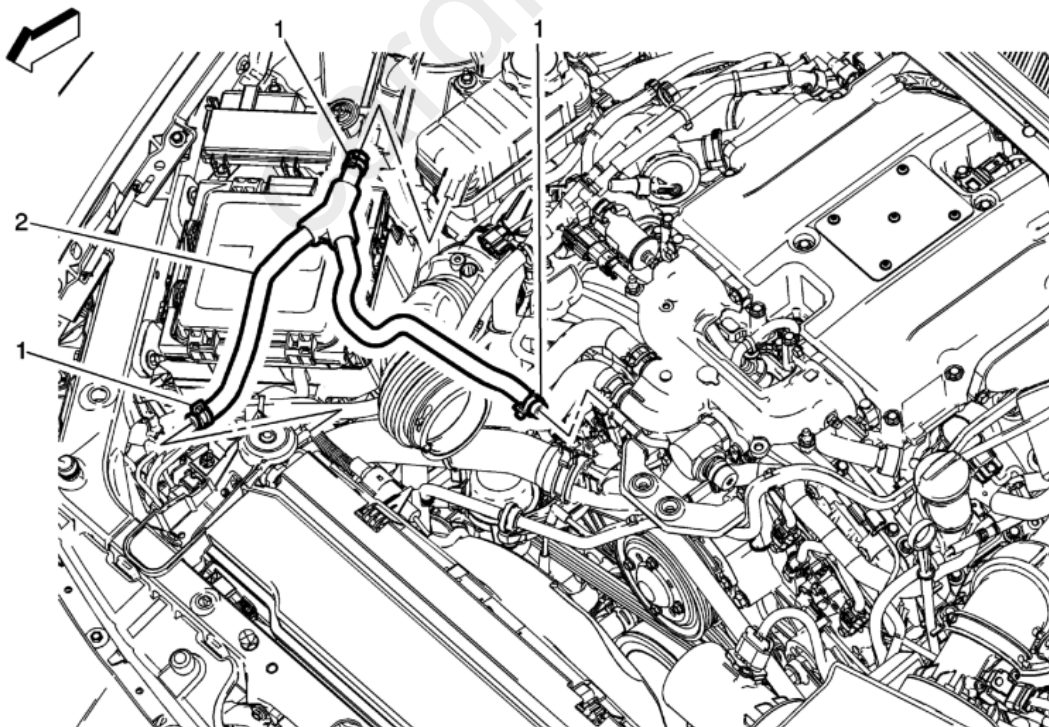


Fig. 224: Radiator Surge Tank Inlet Hose (LF3)
Courtesy of GENERAL MOTORS COMPANY

9. Connect the radiator surge tank inlet hose (2) to the radiator. Refer to **Radiator Surge Tank Inlet Hose Replacement (LF3)**.

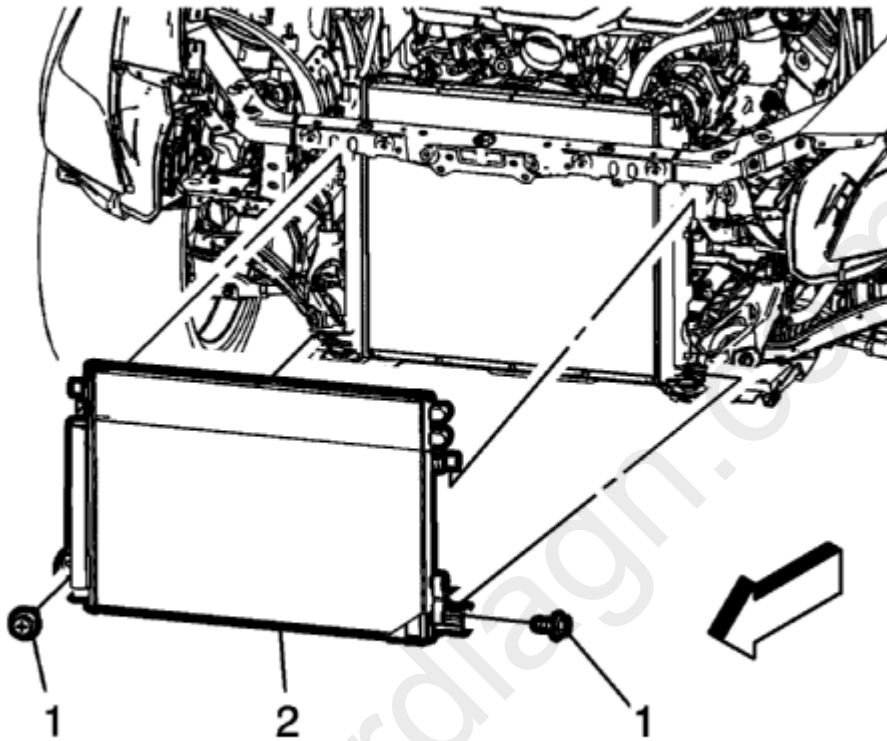


Fig. 225: Air Conditioning Condenser
Courtesy of GENERAL MOTORS COMPANY

10. Install the air conditioning condenser (2). Refer **Air Conditioning Condenser Replacement (LF3 with V03)** .
11. Fill the engine cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
12. Check the cooling system for leaks. Refer to **Cooling System Leak Testing**.

AUXILIARY RADIATOR REPLACEMENT - LEFT SIDE (LF3)

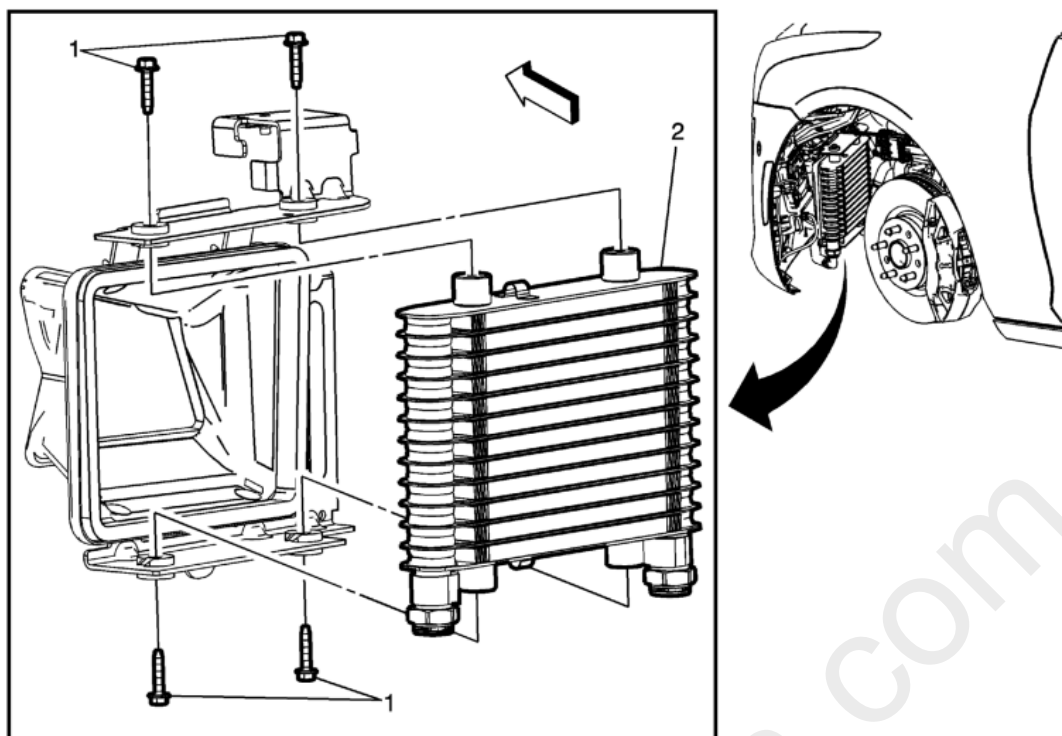


Fig. 226: Auxiliary Radiator - Left Side (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove the left front wheelhouse liner (4). Refer to Front Wheelhouse Liner Replacement. 2. Remove auxiliary radiator inlet hose from the auxiliary radiator. Refer to Auxiliary Radiator Inlet Hose Replacement (LF3). 3. Remove auxiliary radiator outlet hose from the auxiliary radiator. Refer to Auxiliary Radiator Outlet Hose Replacement (LF3).	
1	Auxiliary Radiator Bolt (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 9 (80 lb in)
2	Auxiliary Radiator Procedure

1. Fill the charge air cooling system. Refer to **Charge Air Cooling System Draining and Filling (LF3)**.
2. Check the charge air cooling system for leaks.

AUXILIARY RADIATOR REPLACEMENT - RIGHT SIDE (LF3)

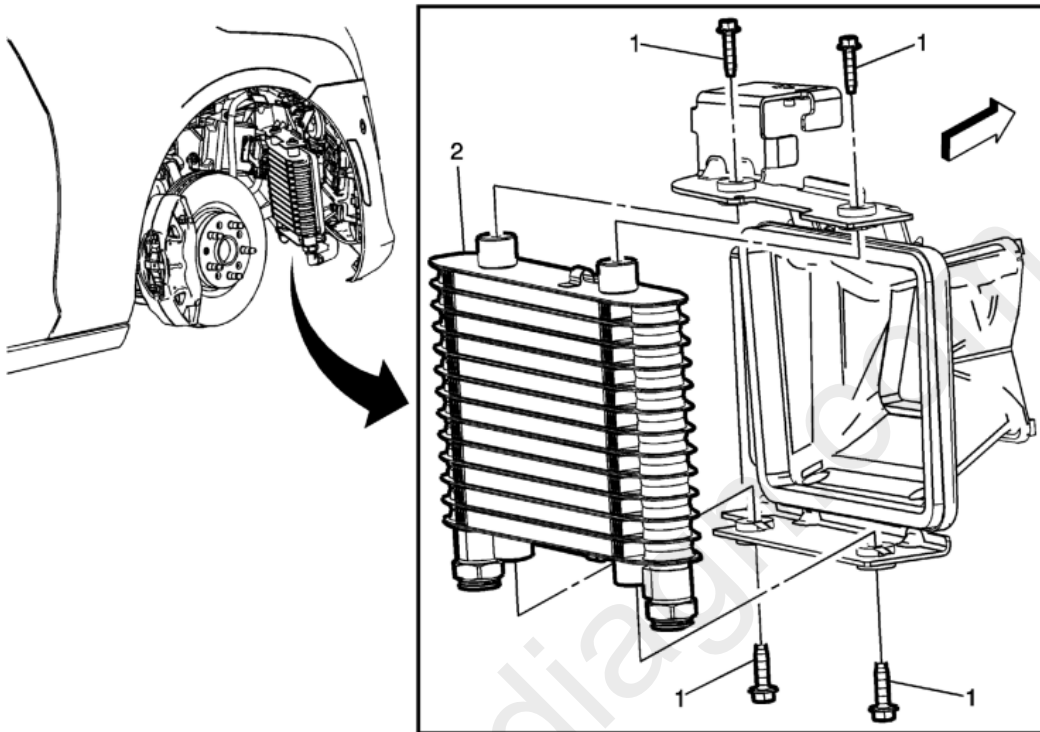


Fig. 227: Auxiliary Radiator - Right Side (LF3)

Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedures	
1. Remove the right front wheelhouse liner (4). Refer to <u>Front Wheelhouse Liner Replacement</u> . 2. Remove auxiliary radiator inlet hose from the auxiliary radiator. Refer to <u>Auxiliary Radiator Inlet Hose Replacement (LF3)</u>. 3. Remove auxiliary radiator outlet hose from the auxiliary radiator. Refer to <u>Auxiliary Radiator Outlet Hose Replacement (LF3)</u>.	
1	Auxiliary Radiator Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 9 (80 lb in)
2	Auxiliary Radiator Procedure 1. Fill the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 2. Check the charge air cooling system for leaks.

RADIATOR UPPER INSULATOR REPLACEMENT (LF3)

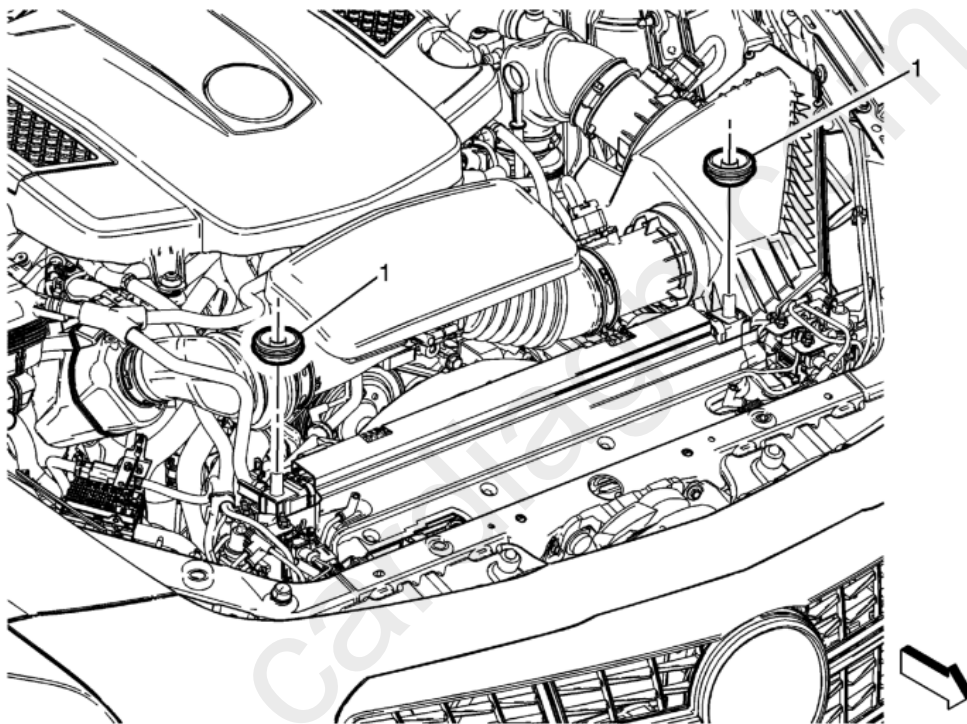


Fig. 228: Radiator Upper Insulator (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Upper Insulator Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the Turbocharger wastegate actuator vacuum tank. Refer to <u>Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)</u> .	
1	Radiator Upper Insulator (Qty: 2)

RADIATOR LOWER INSULATOR REPLACEMENT

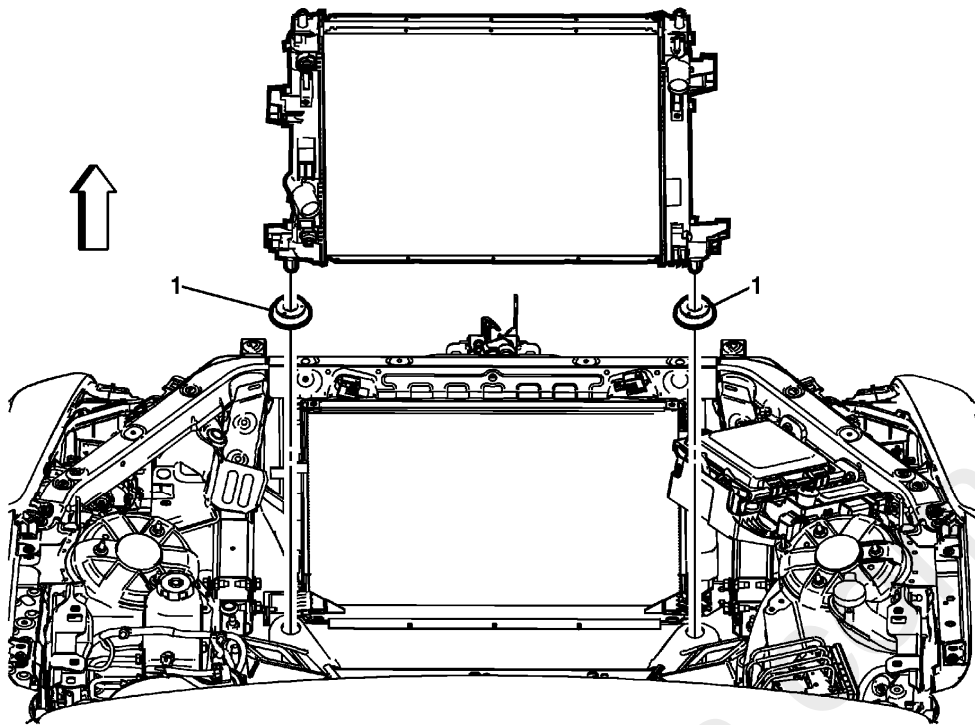


Fig. 229: Radiator Lower Insulator
 Courtesy of GENERAL MOTORS COMPANY

Radiator Lower Insulator Replacement

Callout	Component Name
Preliminary Procedures Remove the radiator. Refer to Radiator Replacement (LTG with V03) , Radiator Replacement (LFX with MGG) , Radiator Replacement (LTG without V03) , Radiator Replacement (LFX with V03) , Radiator Replacement (LF3) .	
1	Radiator Lower Insulator (Qty: 2)

CHARGE AIR COOLER RADIATOR REPLACEMENT (LF3)

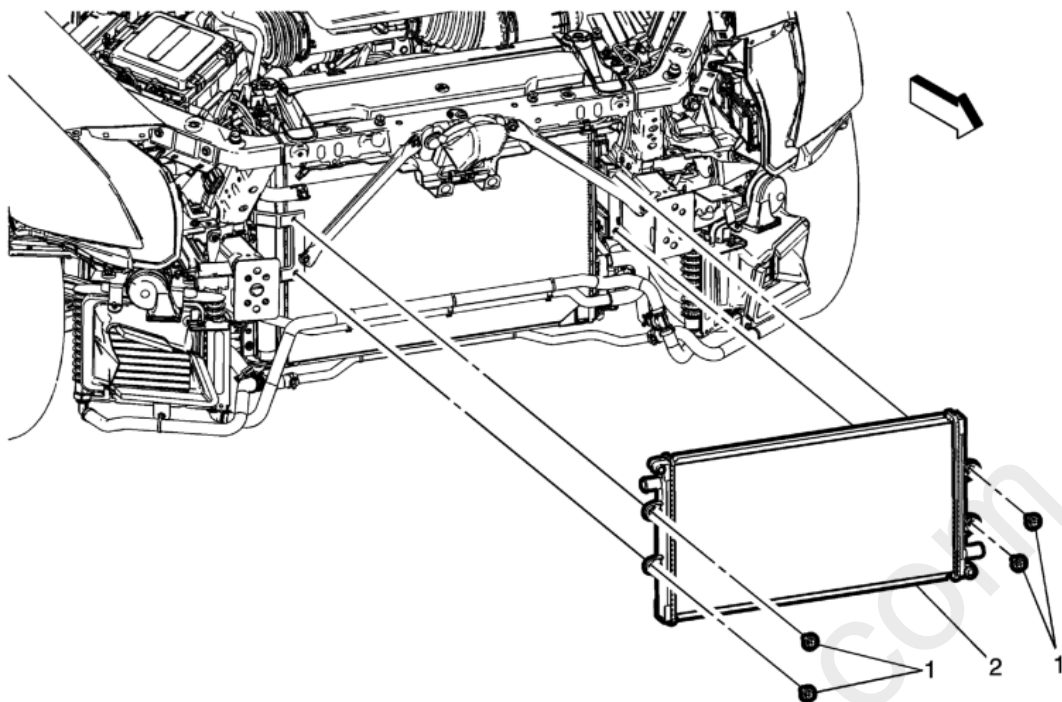


Fig. 230: Charge Air Cooler Radiator (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Radiator Replacement (LF3)

Callout	Component Name
Preliminary Procedures 1. Drain the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 2. Remove charge air cooler coolant hose from the charge air cooler radiator. Refer to <u>Charge Air Cooler Coolant Hose Replacement (Pump to Engine LF3)</u>. 3. Remove the charge air cooler coolant hose from the charge air cooler radiator. Refer to <u>Charge Air Cooler Coolant Hose Replacement - Radiator to Pipe (LF3)</u>.	
1	Charge Air Cooler Radiator Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .
2	Charge Air Cooler Radiator Procedure 1. Fill the charge air cooling system. Refer to <u>Charge Air Cooling System Draining and Filling (LF3)</u>. 2. Check the charge air cooling system for leaks.

CHARGE AIR COOLER RADIATOR LOWER BRACKET REPLACEMENT - LEFT SIDE (LF3)

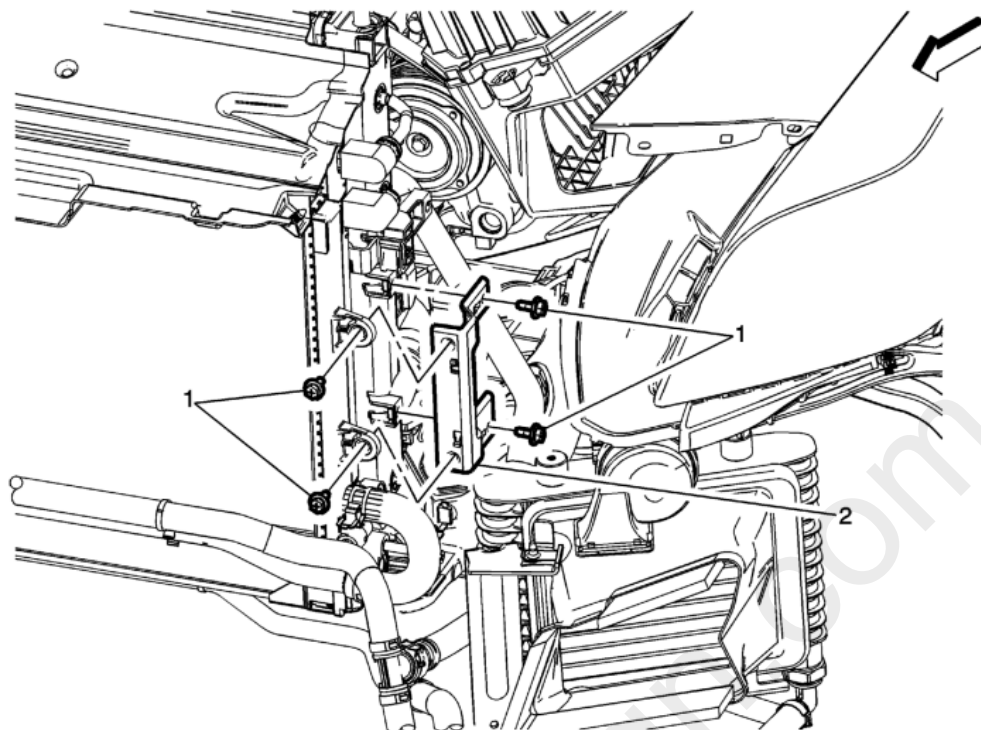


Fig. 231: Charge Air Cooler Radiator Lower Bracket - Left Side (LF3)
Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Radiator Lower Bracket Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedures	
1. Remove the turbocharger wastegate actuator vacuum tank. Refer to <u>Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)</u> .	
2. Remove the radiator air lower baffle and deflector. Refer to <u>Radiator Air Lower Baffle and Deflector Replacement (LF3)</u> .	
1	Charge Air Cooler Radiator Lower Bracket Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .
2	Charge Air Cooler Radiator Lower Bracket

CHARGE AIR COOLER RADIATOR LOWER BRACKET REPLACEMENT - RIGHT SIDE (LF3)

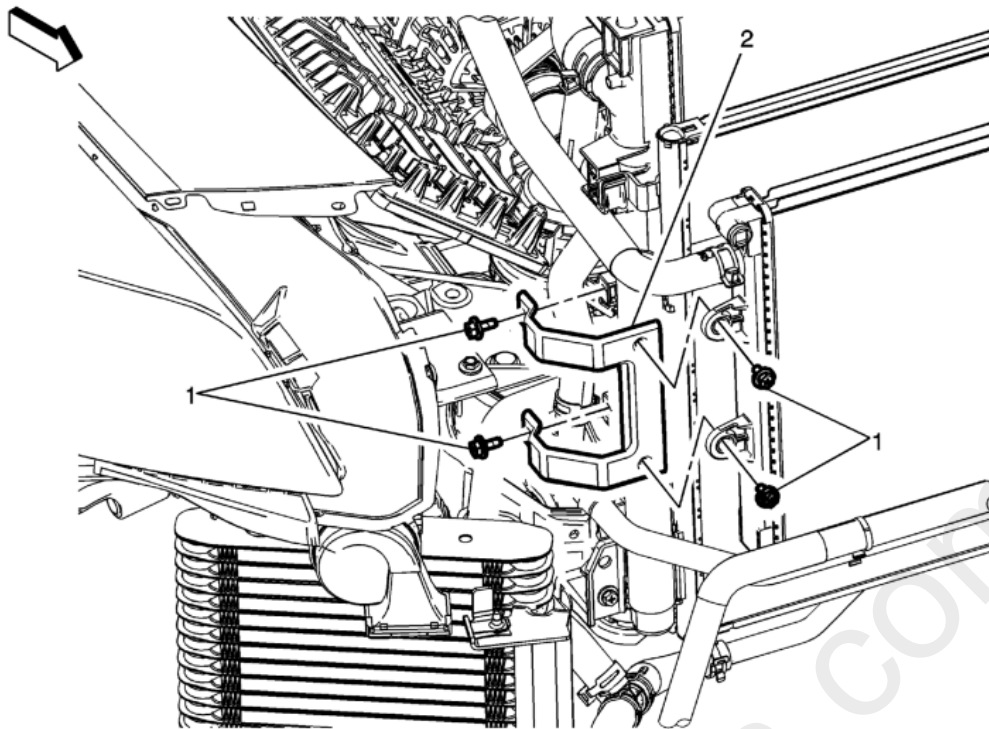


Fig. 232: Charge Air Cooler Radiator Lower Bracket - Right Side (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Radiator Lower Bracket Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove the turbocharger wastegate actuator vacuum tank. Refer to <u>Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)</u> . 2. Remove the radiator air lower baffle and deflector. Refer to <u>Radiator Air Lower Baffle and Deflector Replacement (LF3)</u>.	
1	Charge Air Cooler Radiator Lower Bracket Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .
2	Charge Air Cooler Radiator Lower Bracket

RADIATOR AIR BAFFLE REPLACEMENT - LEFT (LF3)

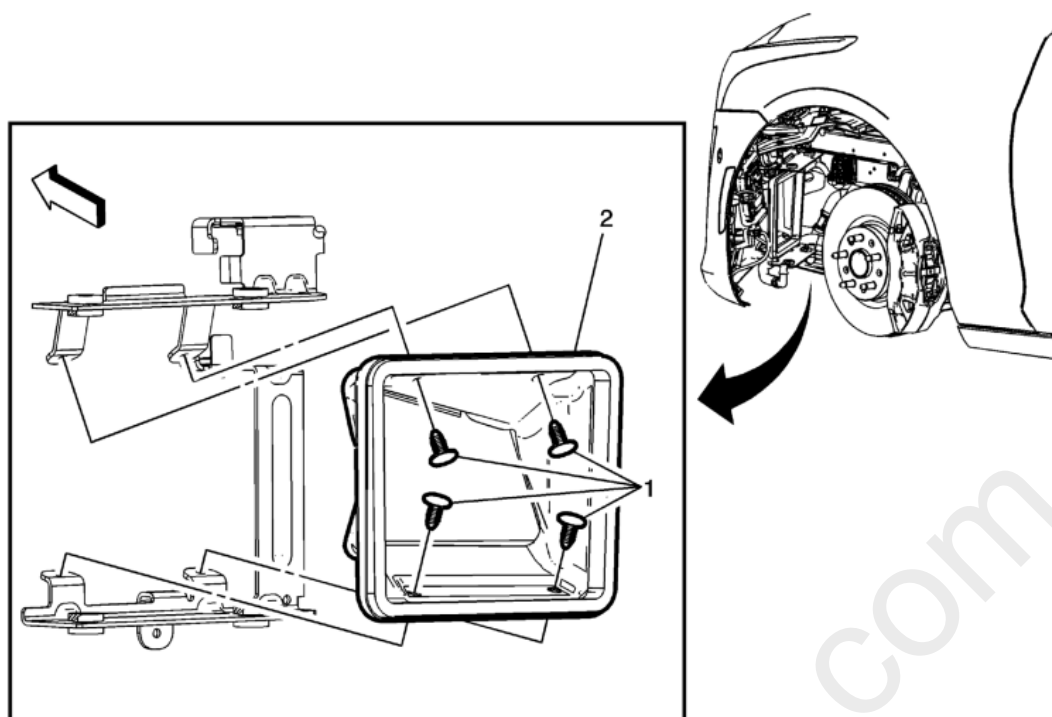


Fig. 233: Radiator Air Baffle - Left (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Air Baffle Replacement - Left (LF3)

Callout	Component Name
Preliminary Procedure	
Remove the auxiliary radiator left side. Refer to Auxiliary Radiator Replacement - Left Side (LF3) .	
1	Radiator Air Baffle Retainer (Qty: 4)
2	Radiator Air Baffle

RADIATOR AIR BAFFLE REPLACEMENT - RIGHT (LF3)

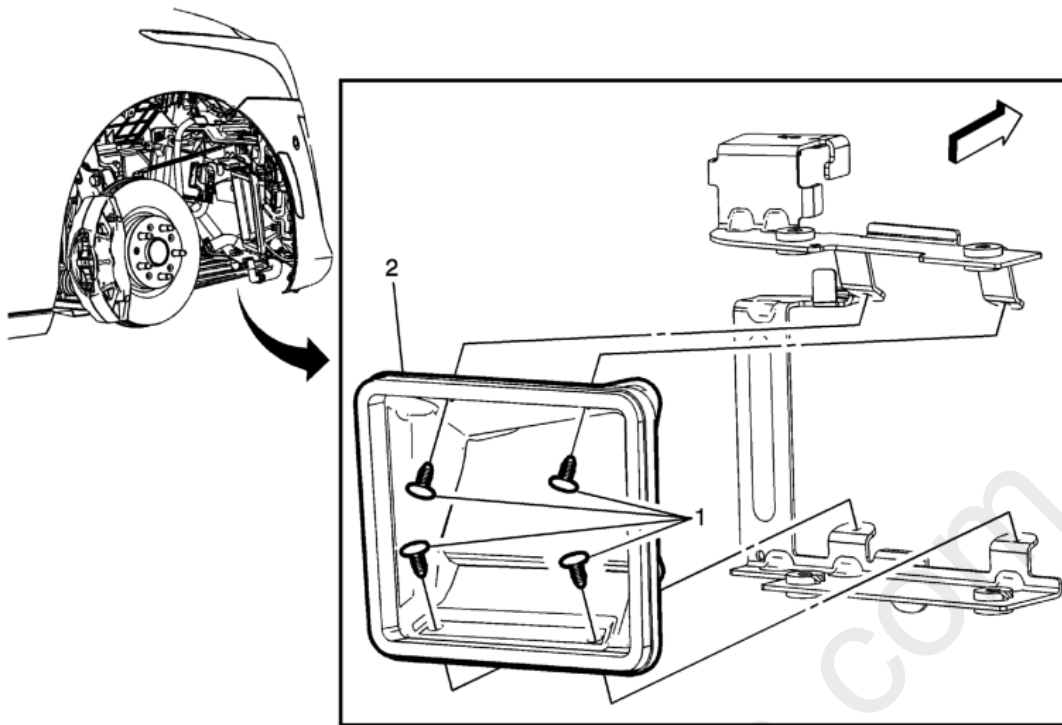


Fig. 234: Radiator Air Baffle - Right (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Air Baffle Replacement - Right (LF3)

Callout	Component Name
Preliminary Procedure	
Remove the auxiliary radiator right side. Refer to <u>Auxiliary Radiator Replacement - Right Side (LF3).</u>	
1	Radiator Air Baffle Retainer (Qty: 4)
2	Radiator Air Baffle

RADIATOR AIR LOWER BAFFLE AND DEFLECTOR REPLACEMENT (LTG)

Removal Procedure

1. Remove the front bumper fascia center support. Refer to **Front Bumper Fascia Center Support Replacement (Upper)** , **Front Bumper Fascia Center Support Replacement (Lower)** .
2. Remove the forward range radar module if equipped. Refer to **Forward Range Radar Module Replacement** .
3. Remove the left radiator air side baffle. Refer to **Radiator Air Side Baffle Replacement - Left Side (LF3, LFX, LTG).**
4. Remove the right radiator air side baffle. Refer to **Radiator Air Side Baffle Replacement - Right Side (LF3, LFX, LTG).**

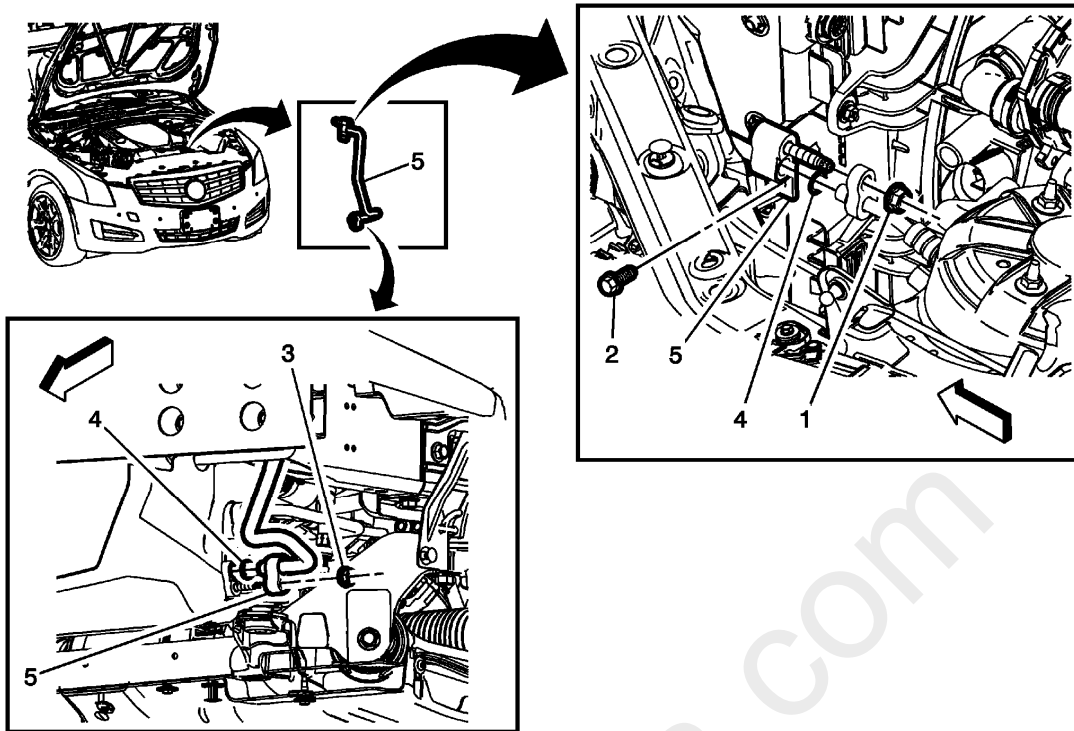


Fig. 235: Air Conditioning Condenser Outlet Tube
 Courtesy of GENERAL MOTORS COMPANY

5. Remove the air conditioning condenser outlet tube (5). Refer to **Condenser Outlet Tube Replacement (LTG)**.
6. Remove the radiator air lower baffle and deflector retainers from the front bumper impact bar.

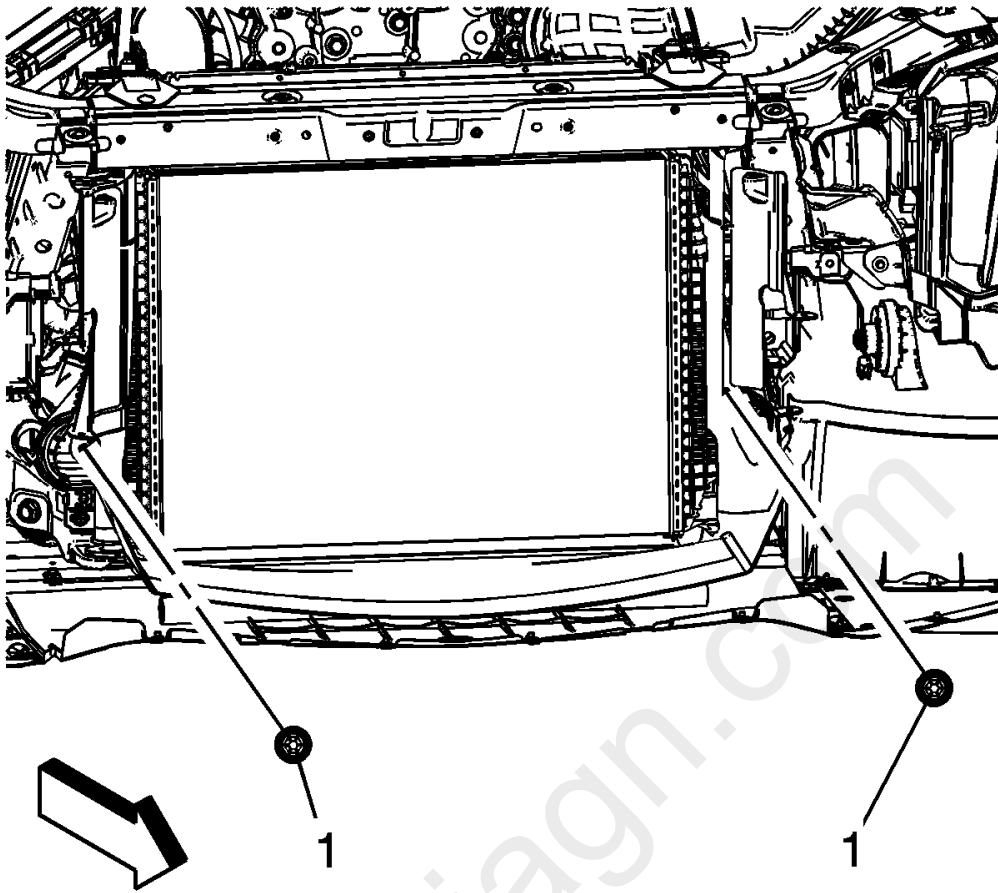


Fig. 236: Radiator Air Lower Baffle And Deflector Front Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Remove the radiator air lower baffle and deflector front retainers (1) from the front of the charge air cooler radiator.

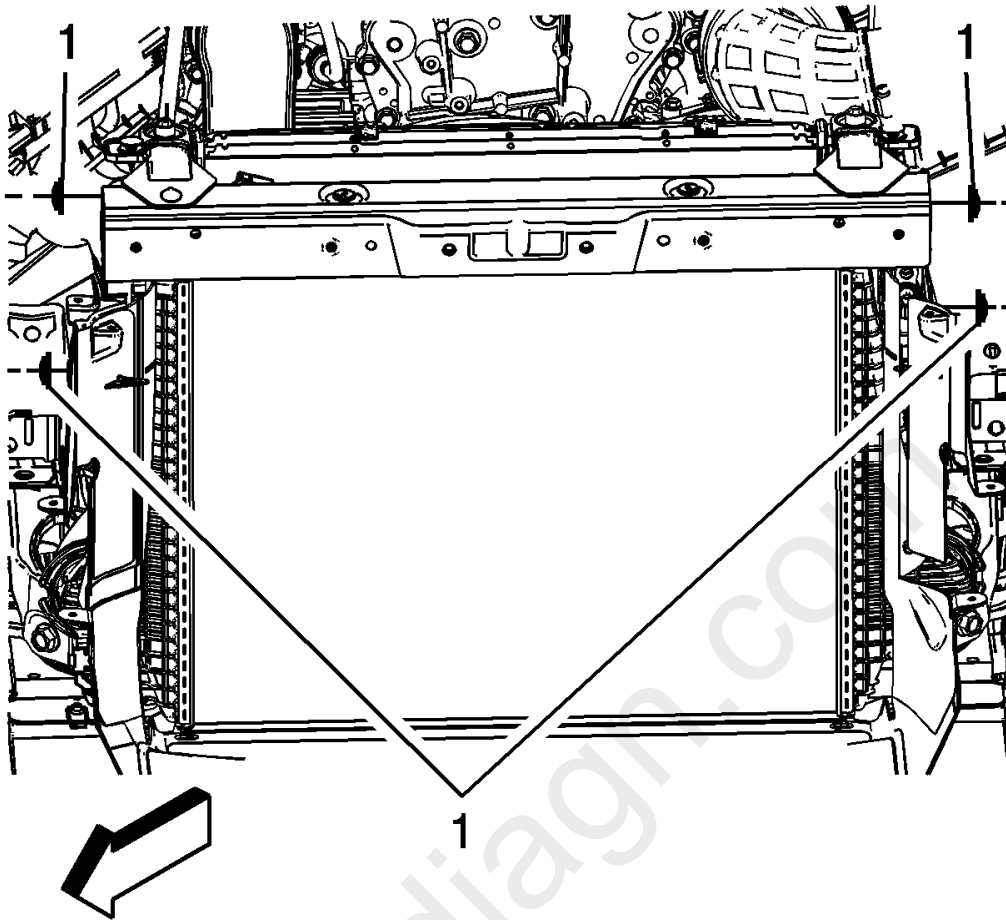


Fig. 237: Radiator Air Lower Baffle And Deflector Side Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Remove the radiator air lower baffle and deflector side retainers (1) from the charge air cooler radiator and the radiator.

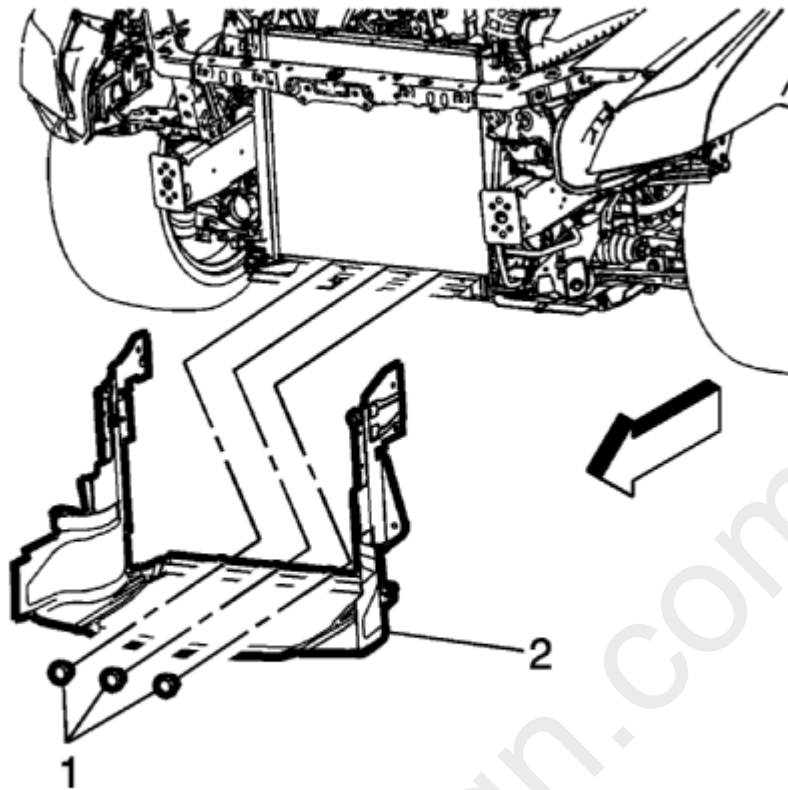


Fig. 238: Radiator Air Lower Baffle And Deflector Front Lower Retainers
Courtesy of GENERAL MOTORS COMPANY

9. Remove the radiator air lower baffle and deflector front lower retainers (1) from the radiator.
10. Detach radiator air lower baffle and deflector from the radiator (2) and remove from the vehicle.

Installation Procedure

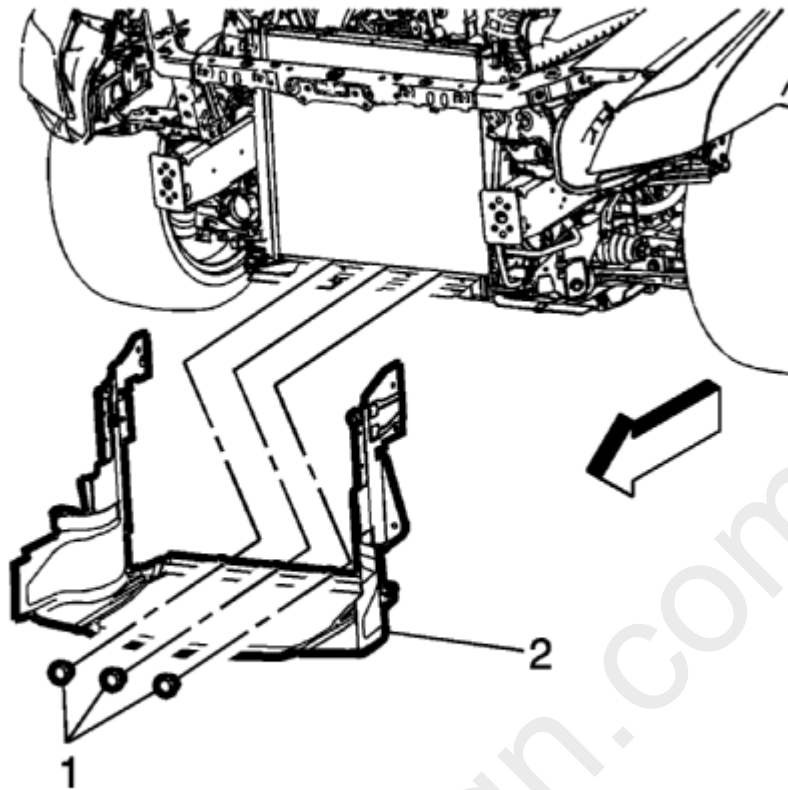


Fig. 239: Radiator Air Lower Baffle And Deflector Front Lower Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator air lower baffle and deflector to the radiator (2).
2. Install the radiator air lower baffle and deflector front lower retainers (1) to the radiator.

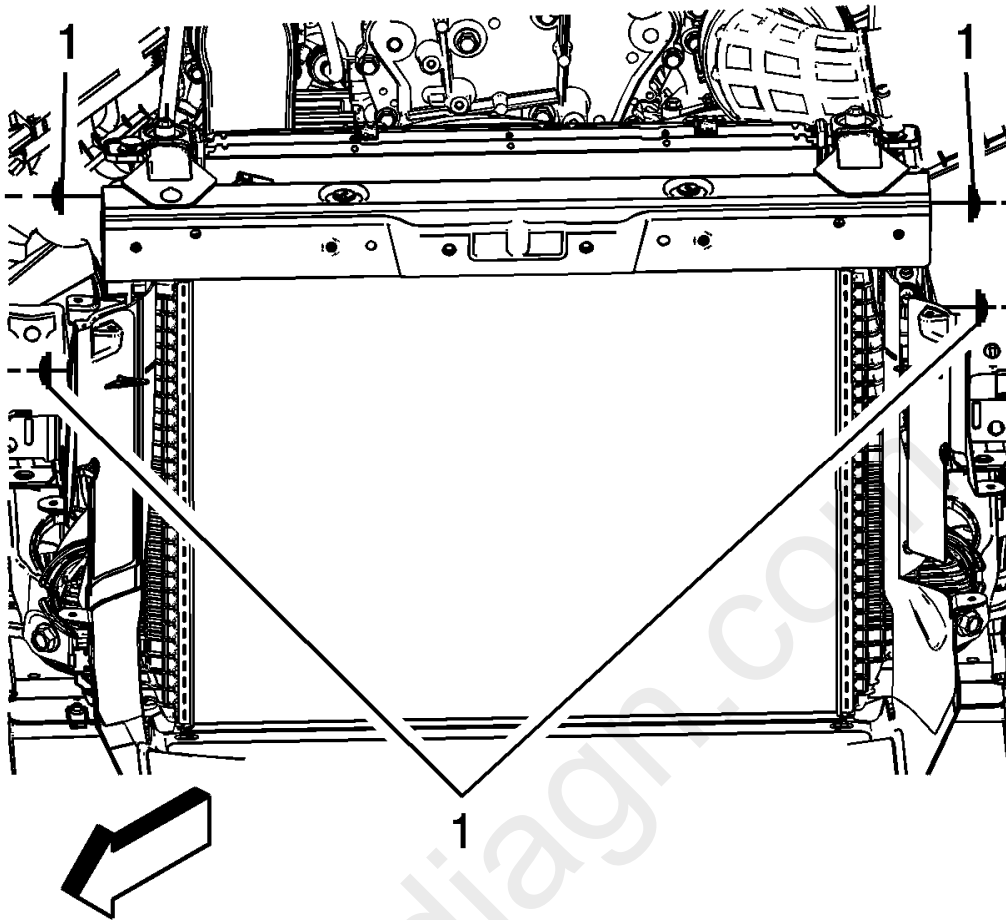


Fig. 240: Radiator Air Lower Baffle And Deflector Side Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install the radiator air lower baffle and deflector side retainers (1) to the charge air cooler radiator and the radiator.

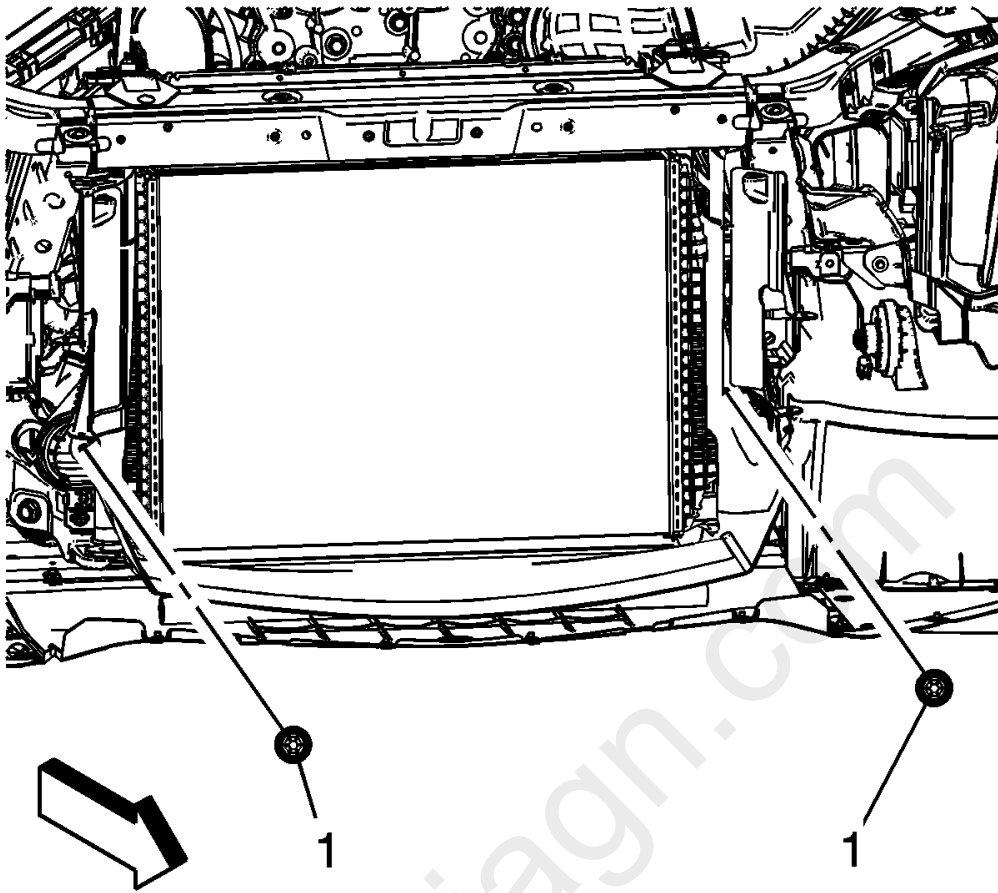


Fig. 241: Radiator Air Lower Baffle And Deflector Front Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Install the radiator air lower baffle and deflector front retainers (1) to the front of the charge air cooler radiator.
5. Install the radiator air lower baffle and deflector retainers to the front bumper impact bar.

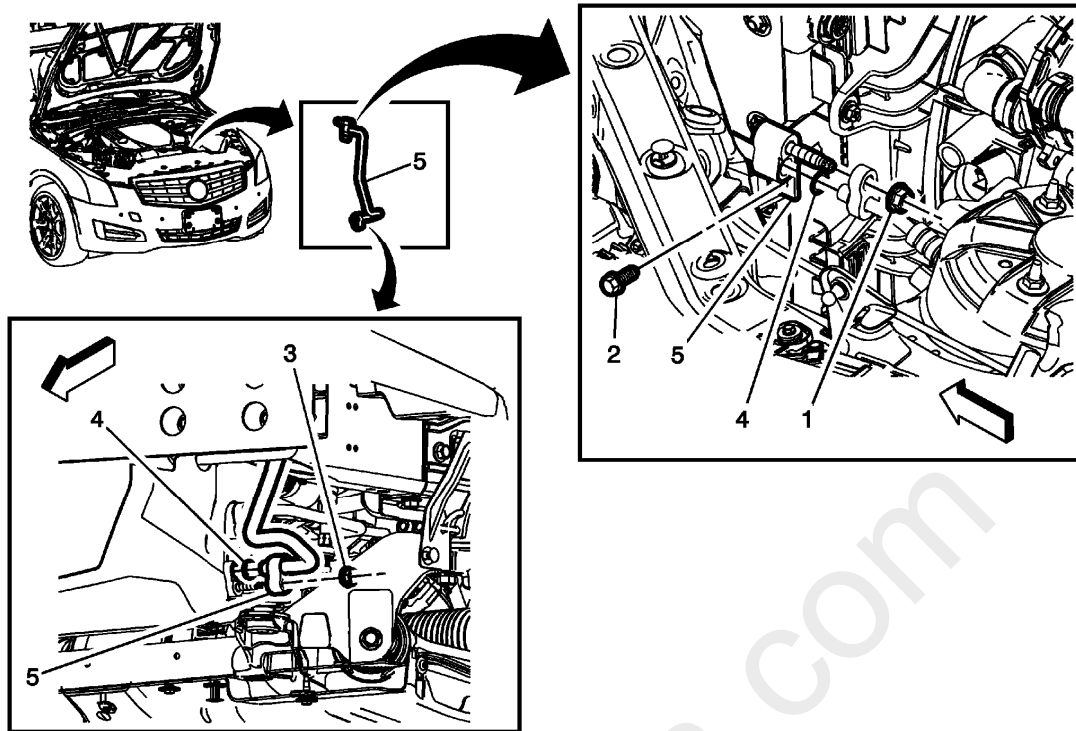


Fig. 242: Air Conditioning Condenser Outlet Tube
 Courtesy of GENERAL MOTORS COMPANY

6. Install the air conditioning condenser outlet tube (5). Refer to **Condenser Outlet Tube Replacement (LTG)** .
7. Install the right radiator air side baffle. Refer to **Radiator Air Side Baffle Replacement - Right Side (LF3, LFX, LTG)**.
8. Install the left radiator air side baffle. Refer to **Radiator Air Side Baffle Replacement - Left Side (LF3, LFX, LTG)**.
9. Install the forward range radar module if equipped. Refer to **Forward Range Radar Module Replacement** .
10. Install the front bumper fascia center support. Refer to **Front Bumper Fascia Center Support Replacement (Upper)** , **Front Bumper Fascia Center Support Replacement (Lower)** .

RADIATOR AIR LOWER BAFFLE AND DEFLECTOR REPLACEMENT (LFX)

Removal Procedure

1. Remove the front bumper impact bar. Refer to **Front Bumper Impact Bar Replacement** .
2. Remove the front bumper fascia center support. Refer to **Front Bumper Fascia Center Support Replacement (Upper)** , **Front Bumper Fascia Center Support Replacement (Lower)** .
3. Remove the forward range radar module if equipped. Refer to **Forward Range Radar Module Replacement** .

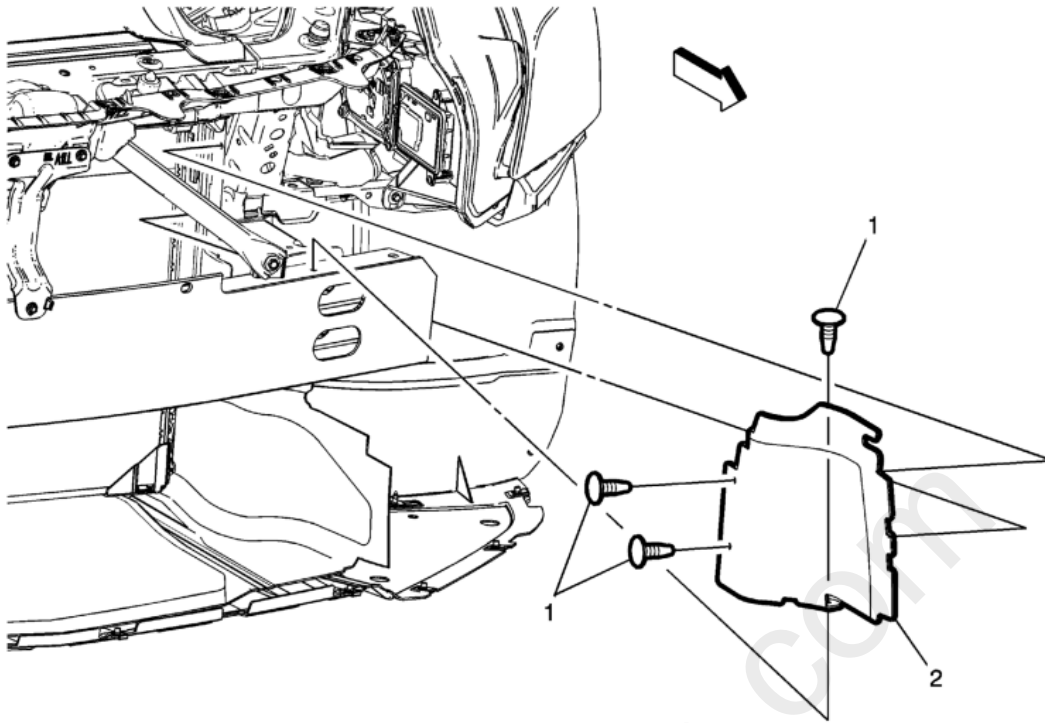


Fig. 243: Left Radiator Air Side Baffle
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left radiator air side baffle (2). Refer to **Radiator Air Side Baffle Replacement - Left Side (LF3, LFX, LTG)**.

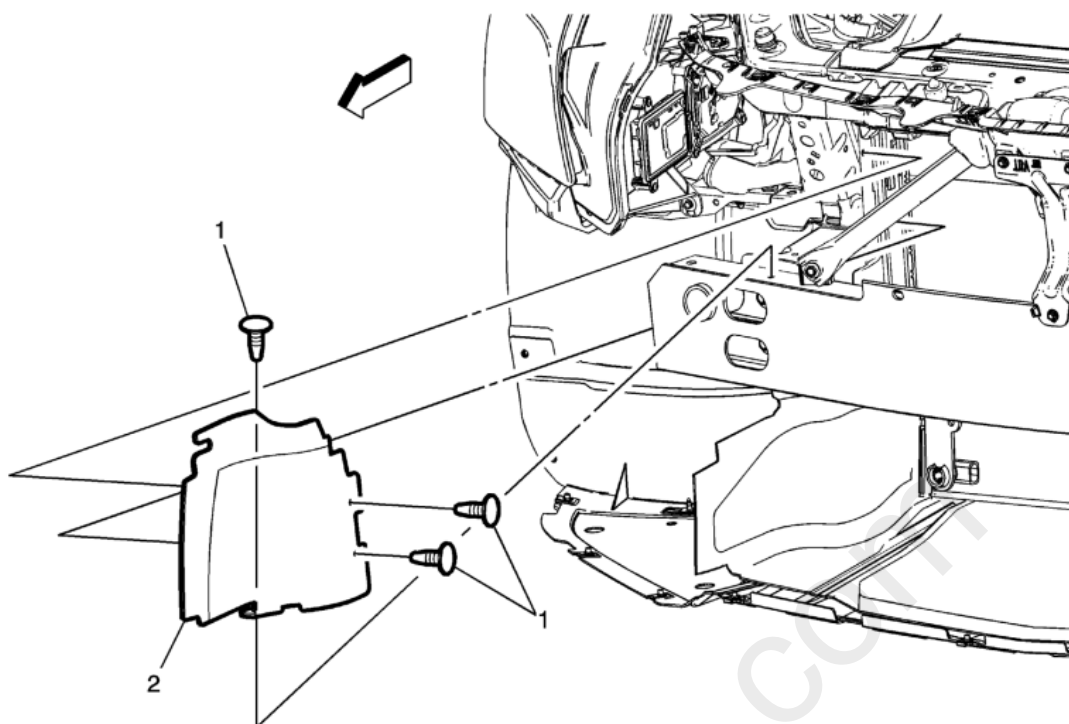


Fig. 244: Right Radiator Air Side Baffle
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right radiator air side baffle (2). Refer to **Radiator Air Side Baffle Replacement - Right Side (LF3, LFX, LTG)**.

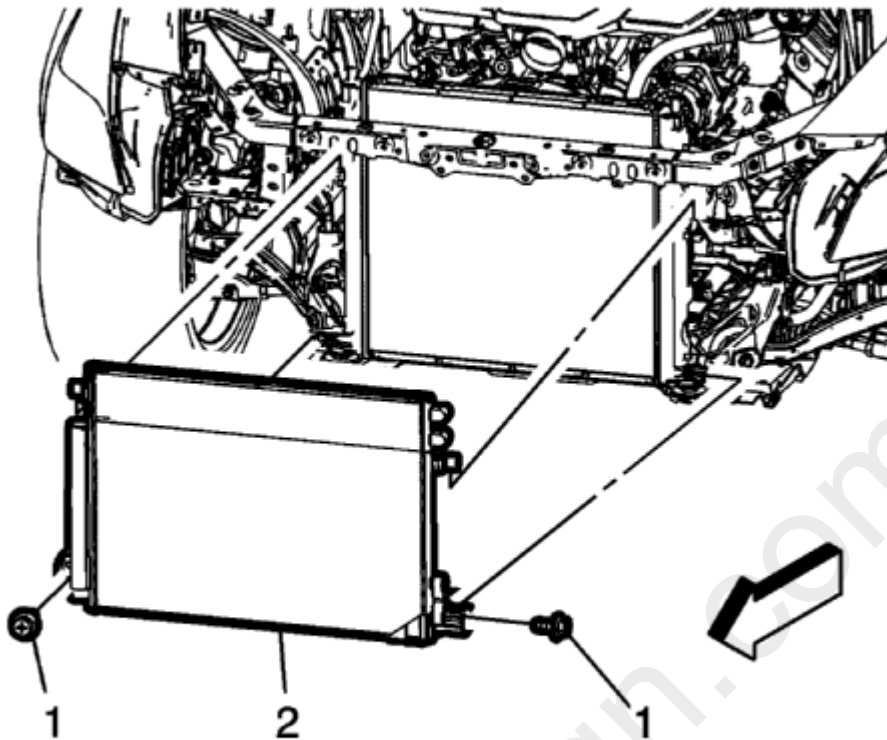


Fig. 245: Air Conditioning Condenser
Courtesy of GENERAL MOTORS COMPANY

6. Remove the air conditioning condenser (2) from the radiator. Refer to **Air Conditioning Condenser Replacement (LFX with V03)** , **Air Conditioning Condenser Replacement (LFX without V03)** .

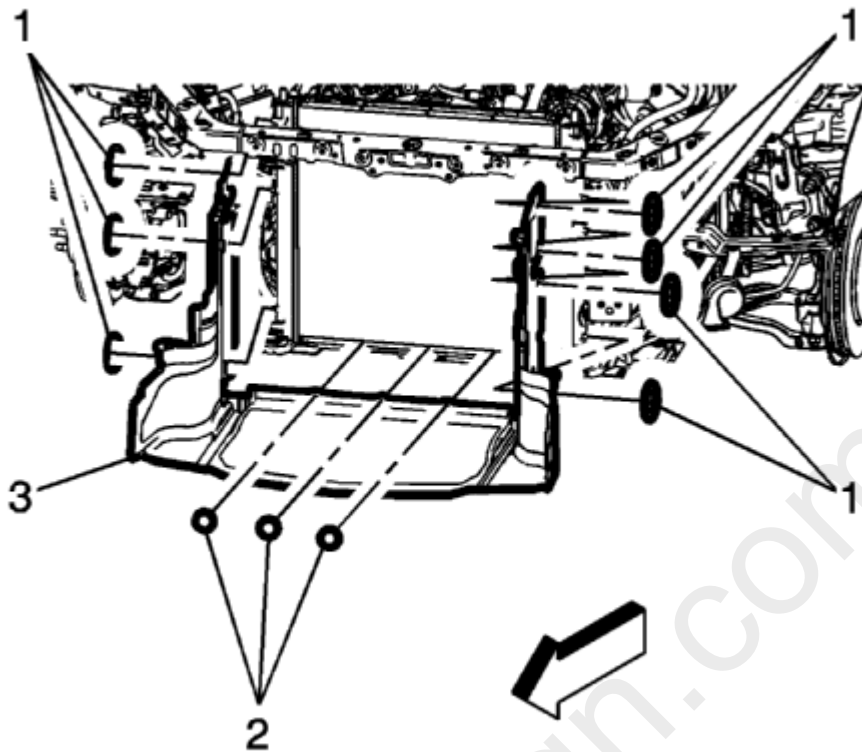


Fig. 246: Radiator Air Lower Baffle And Deflector Side Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Remove the radiator air lower baffle and deflector side retainers (1) from the radiator.
8. Remove the radiator air lower baffle and deflector front lower retainers (2) from the radiator.
9. Detach radiator air lower baffle and deflector from the radiator (3) and remove from the vehicle.

Installation Procedure

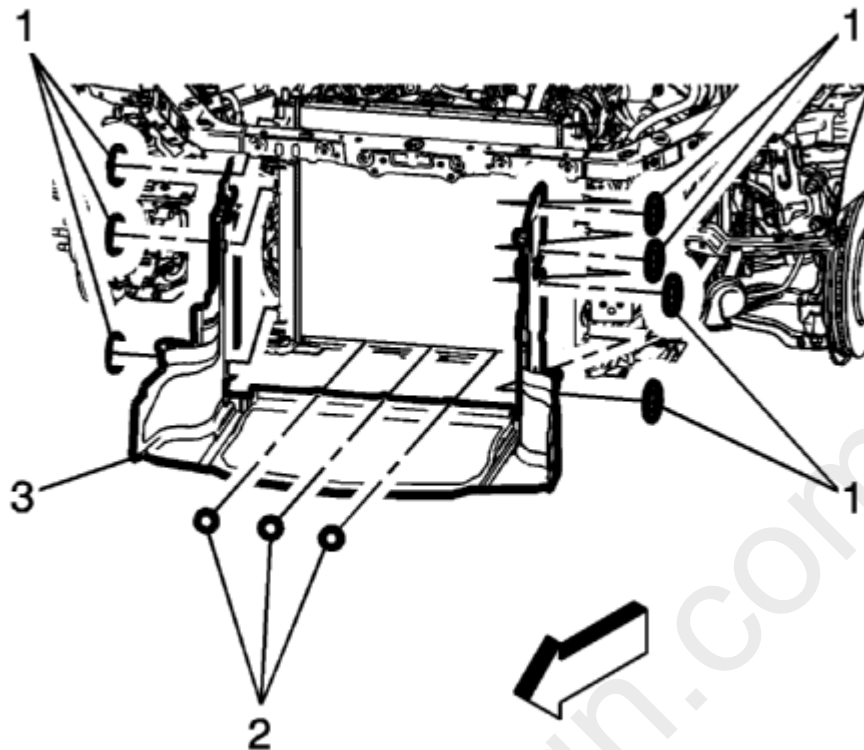


Fig. 247: Radiator Air Lower Baffle And Deflector Side Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator air lower baffle and deflector to the radiator (3).
2. Install the radiator air lower baffle and deflector front lower retainers (2) to the radiator.
3. Install the radiator air lower baffle and deflector side retainers (1) to the radiator.

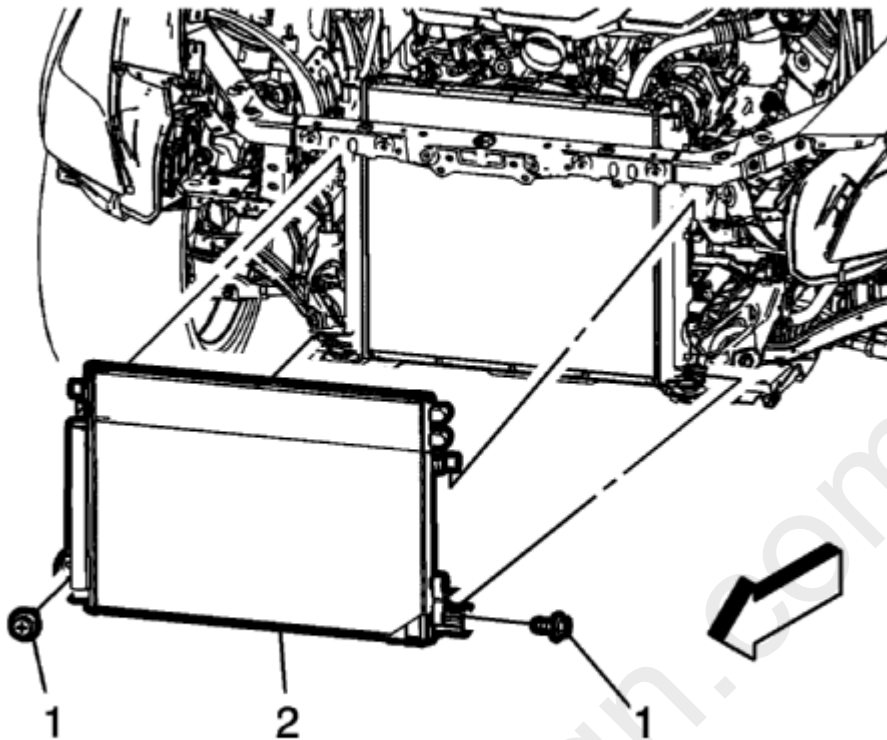


Fig. 248: Air Conditioning Condenser
Courtesy of GENERAL MOTORS COMPANY

4. Install the air conditioning condenser (2) to the charge air cooler radiator. Refer to **Air Conditioning Condenser Replacement (LFX with V03)** , **Air Conditioning Condenser Replacement (LFX without V03)** .

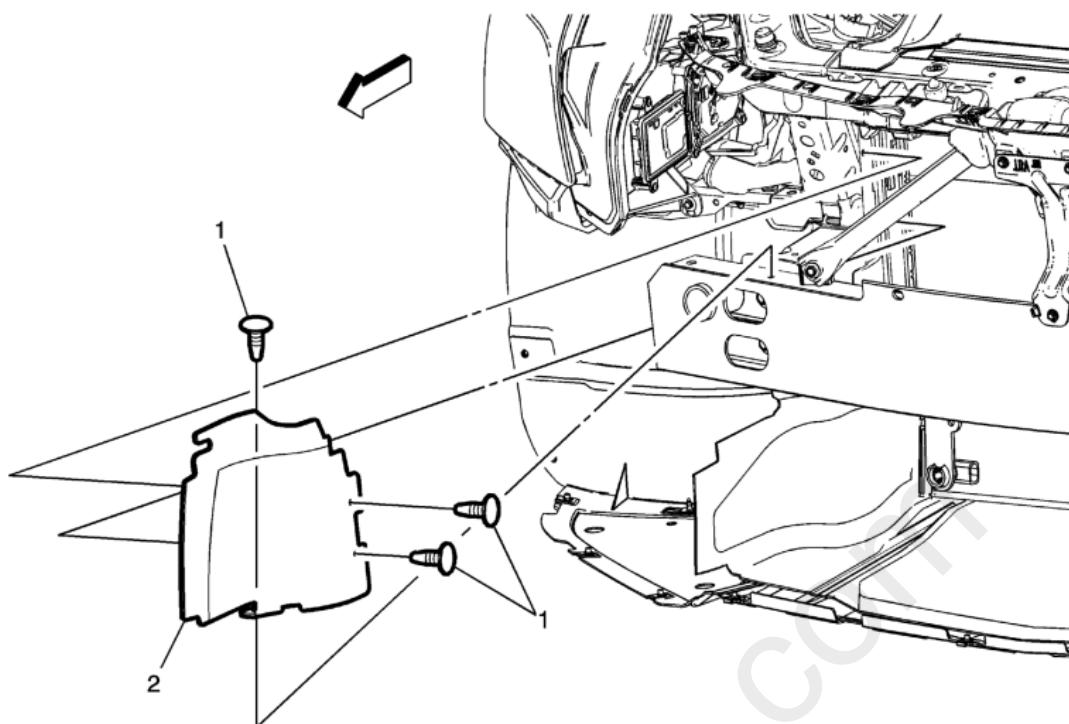


Fig. 249: Right Radiator Air Side Baffle
Courtesy of GENERAL MOTORS COMPANY

5. Install the right radiator air side baffle (2). Refer to **Radiator Air Side Baffle Replacement - Right Side (LF3, LFX, LTG)**.

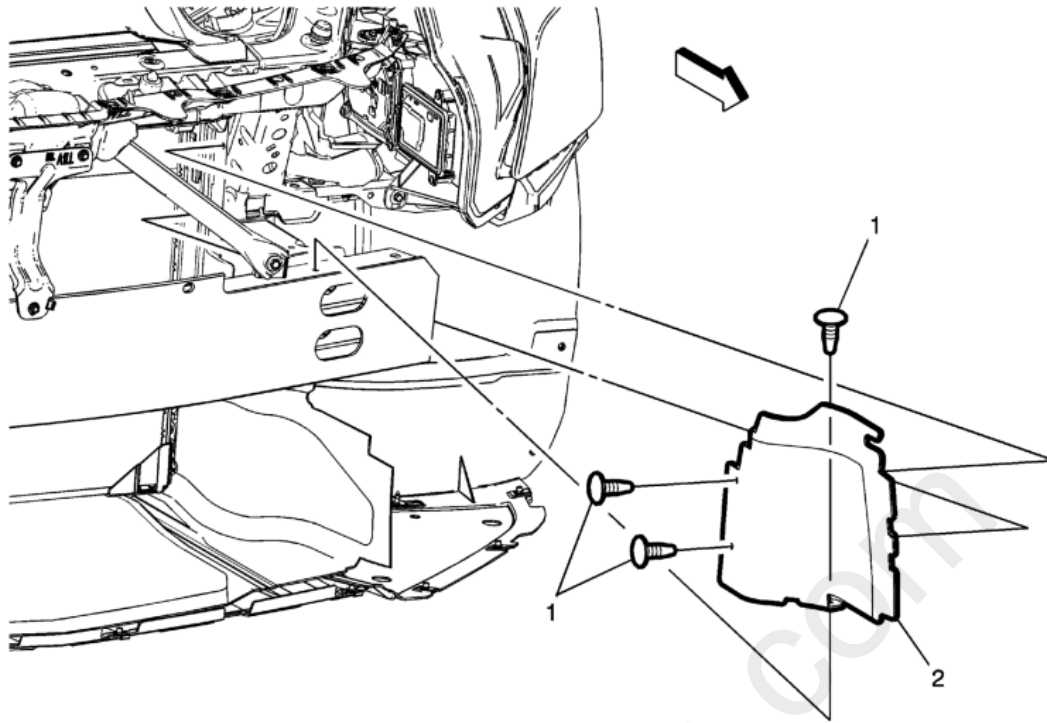


Fig. 250: Left Radiator Air Side Baffle
Courtesy of GENERAL MOTORS COMPANY

6. Install the left radiator air side baffle (2). Refer to **Radiator Air Side Baffle Replacement - Left Side (LF3, LFX, LTG)**.
7. Install the forward range radar module if equipped. Refer to **Forward Range Radar Module Replacement**.
8. Install the front bumper fascia center support. Refer to **Front Bumper Fascia Center Support Replacement (Upper)**, **Front Bumper Fascia Center Support Replacement (Lower)**.
9. Install the front bumper impact bar. Refer to **Front Bumper Impact Bar Replacement**.

RADIATOR AIR LOWER BAFFLE AND DEFLECTOR REPLACEMENT (LF3)

Removal Procedure

1. Remove the turbocharger wastegate actuator vacuum tank. Refer to **Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)**.
2. Remove the front bumper impact bar. Refer to **Front Bumper Impact Bar Replacement**.
3. Remove the front bumper fascia center support. Refer to **Front Bumper Fascia Center Support Replacement (Upper)**, **Front Bumper Fascia Center Support Replacement (Lower)**.
4. Remove the forward range radar module if equipped. Refer to **Forward Range Radar Module Replacement**.

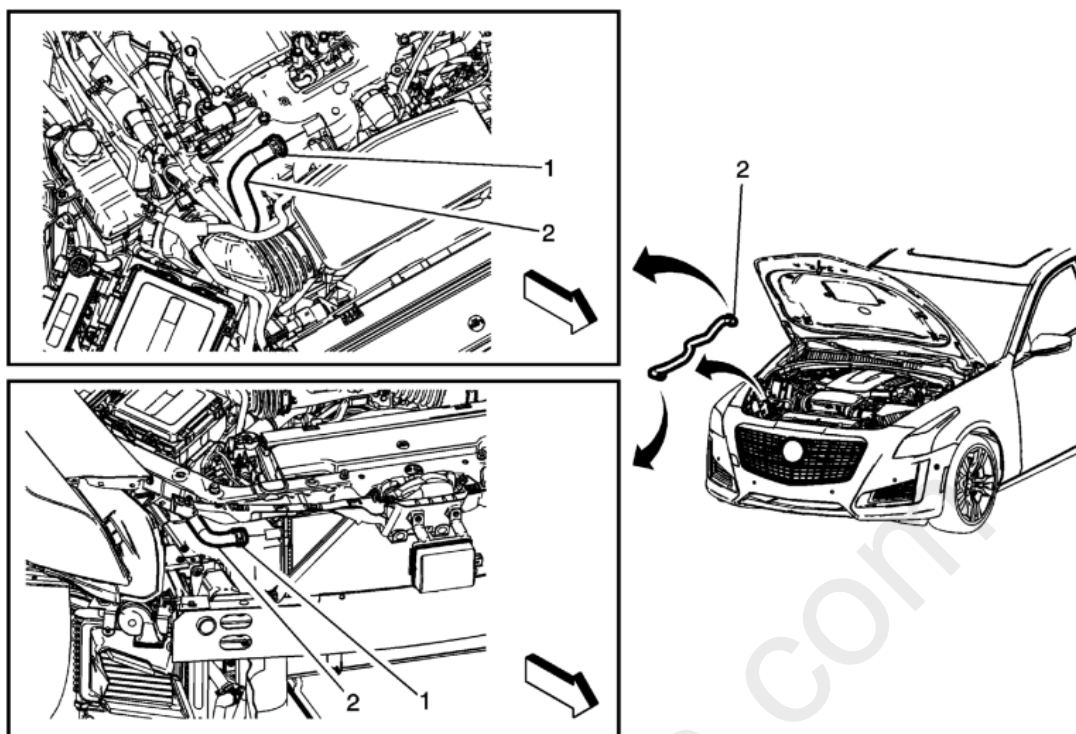


Fig. 251: Charge Air Cooler Coolant Hose - Engine to Radiator
Courtesy of GENERAL MOTORS COMPANY

5. Remove the charge air cooler coolant hose (2) from the charge air cooler radiator. Refer to **Charge Air Cooler Coolant Hose Replacement - Engine to Radiator**.

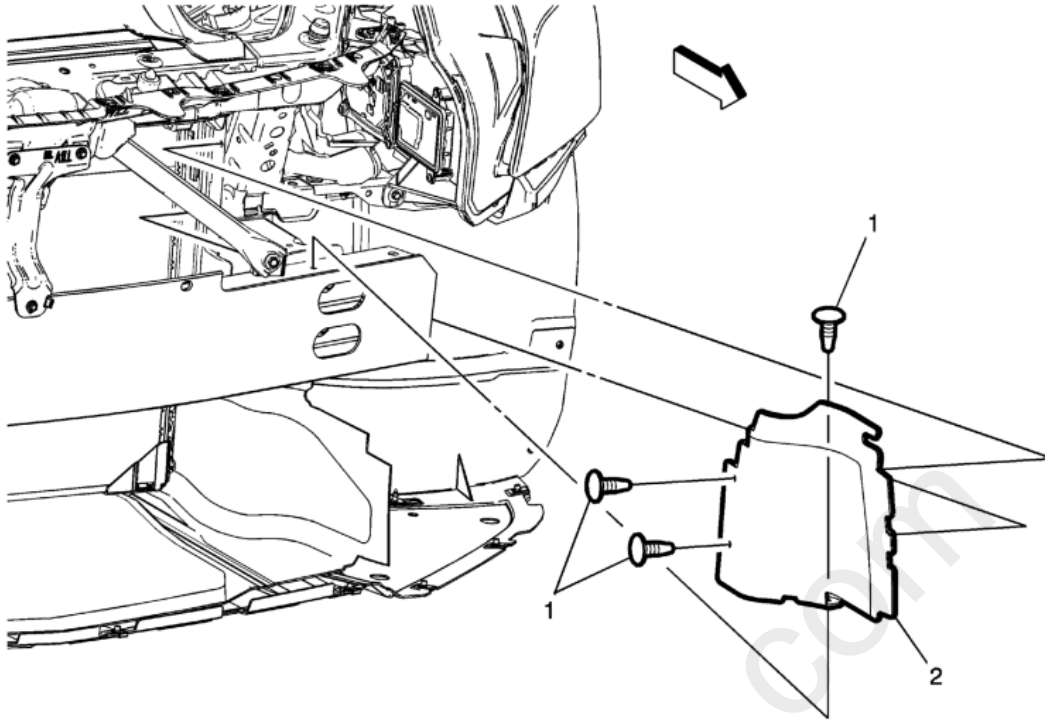


Fig. 252: Left Radiator Air Side Baffle
Courtesy of GENERAL MOTORS COMPANY

6. Remove the left radiator air side baffle (2). Refer to **Radiator Air Side Baffle Replacement - Left Side (LF3, LFX, LTG)**.

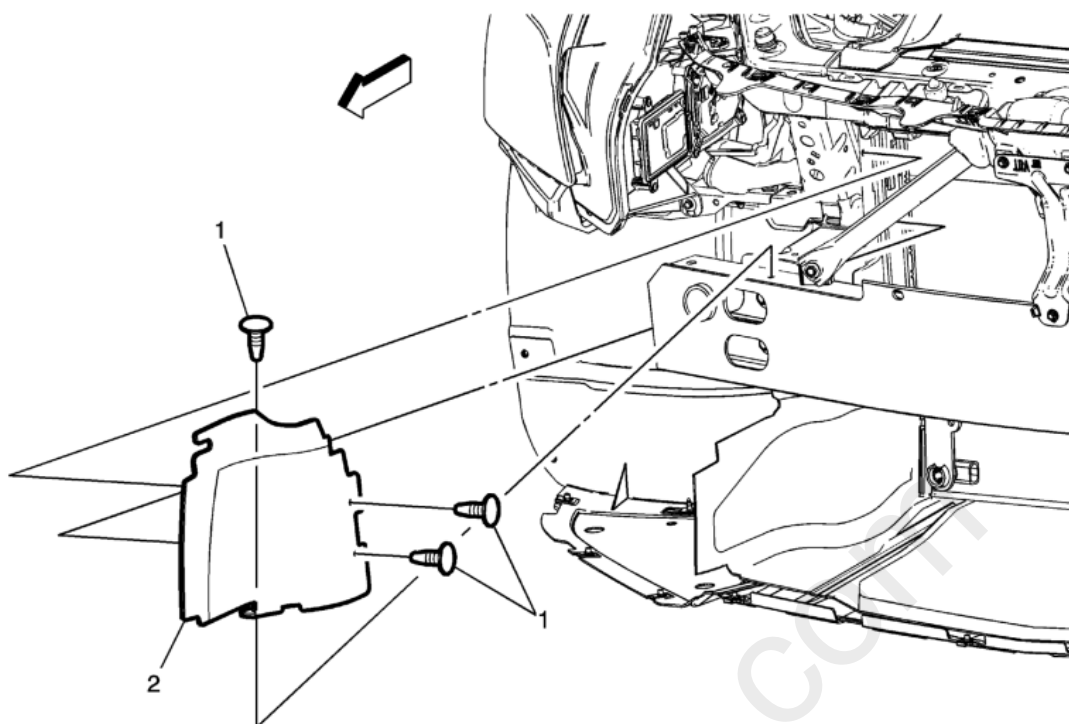


Fig. 253: Right Radiator Air Side Baffle
Courtesy of GENERAL MOTORS COMPANY

7. Remove the right radiator air side baffle (2). Refer to **Radiator Air Side Baffle Replacement - Right Side (LF3, LFX, LTG)**.

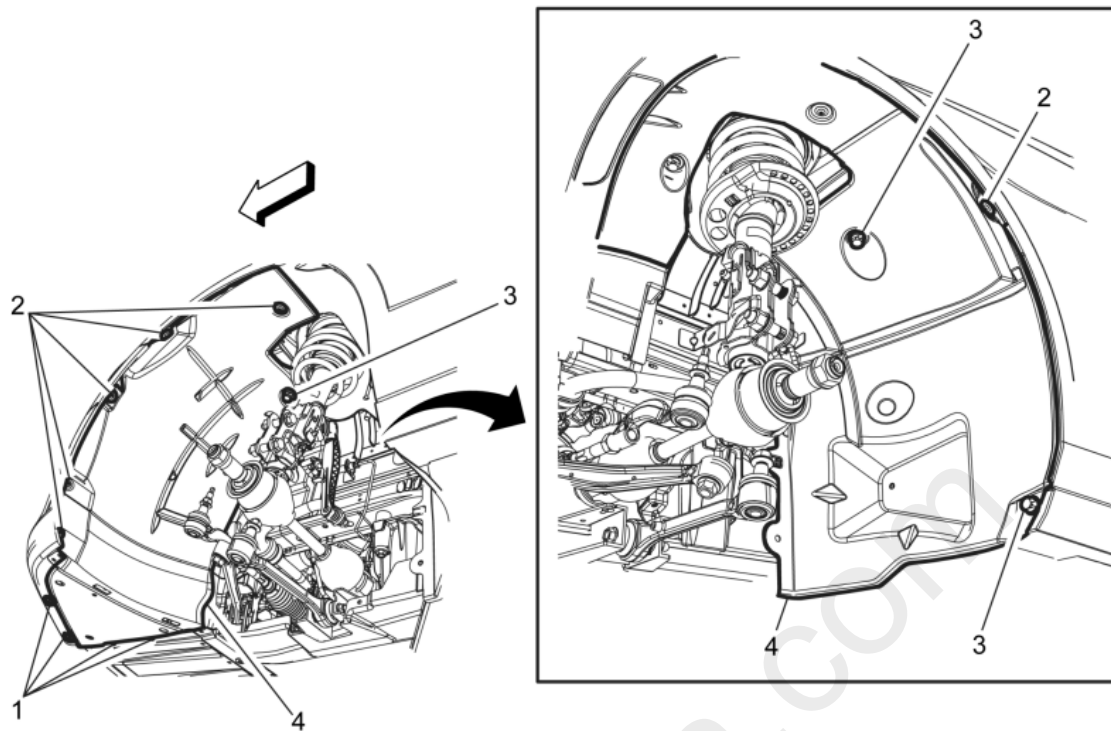


Fig. 254: Front Wheelhouse Liners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the front wheelhouse liners (4). Refer to **Front Wheelhouse Liner Replacement** .

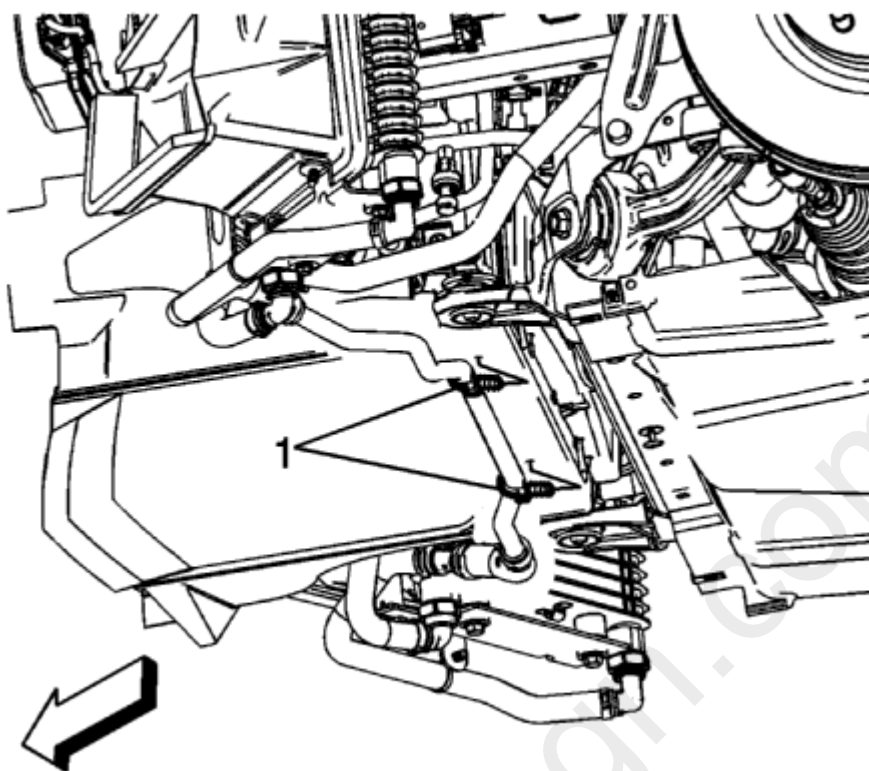


Fig. 255: Auxiliary Radiator Inlet Hose Retainers
Courtesy of GENERAL MOTORS COMPANY

9. Remove the auxiliary radiator inlet hose retainers (1) from the radiator air lower baffle and deflector.

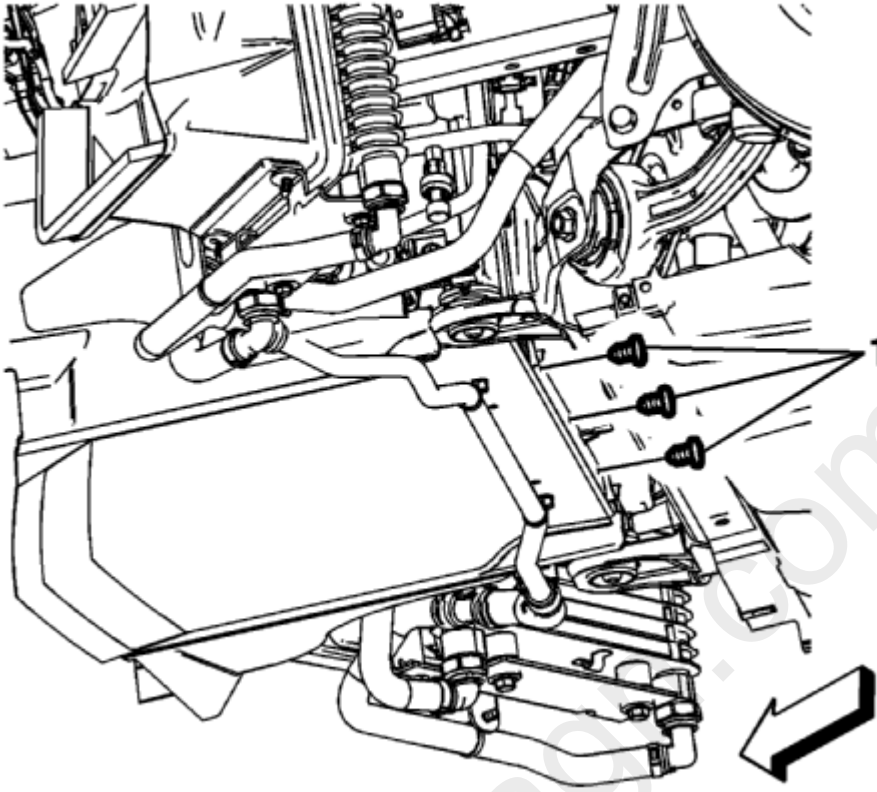


Fig. 256: Radiator Air Lower Baffle And Deflector Lower Retainers
Courtesy of GENERAL MOTORS COMPANY

10. Remove the radiator air lower baffle and deflector lower retainers (1) from the engine coolant fan shroud.

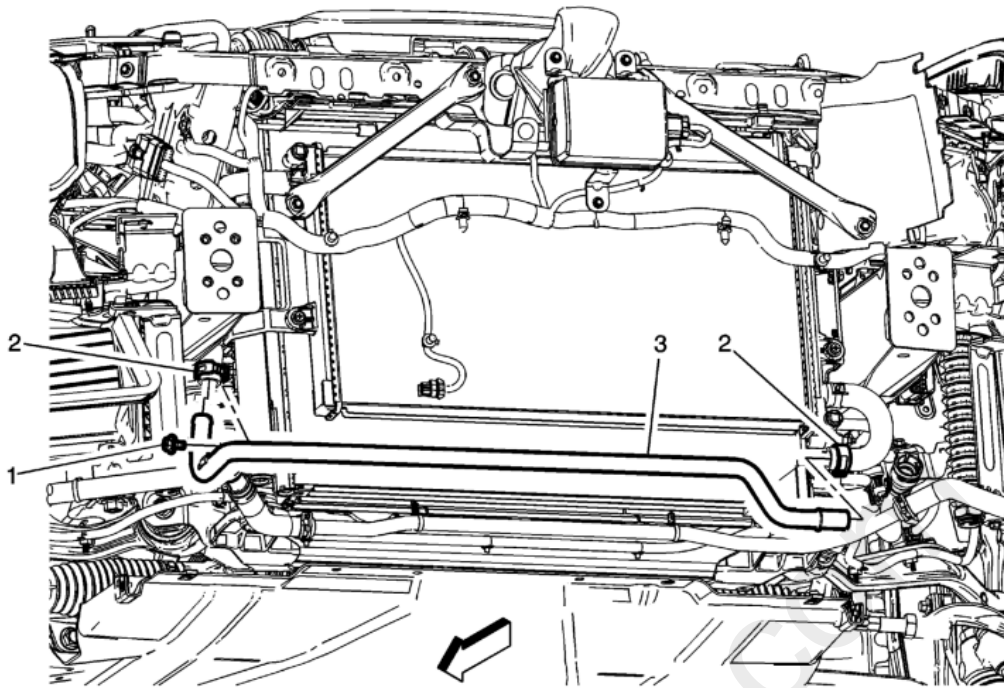


Fig. 257: Charge Air Cooler Coolant Pipe (LF3)
Courtesy of GENERAL MOTORS COMPANY

11. Remove the charge air cooler coolant pipe (3). Refer to **Charge Air Cooler Coolant Pipe Replacement (LF3)**.

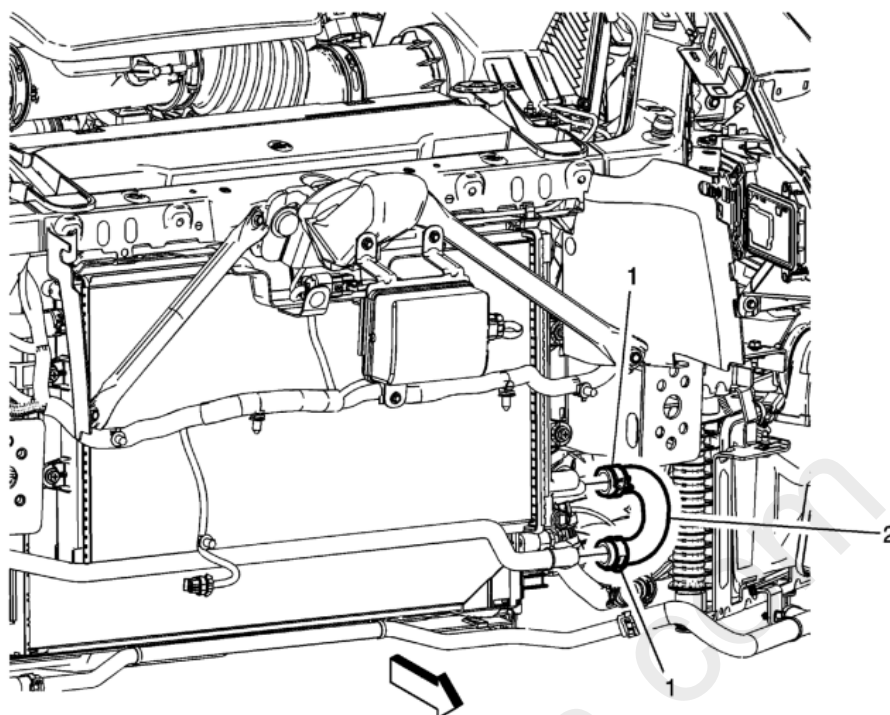


Fig. 258: Charge Air Cooler Coolant Hose - Radiator to Pipe (LF3)

Courtesy of GENERAL MOTORS COMPANY

12. Remove the charge air cooler coolant hose (2) from the charge air cooler radiator. Refer to **Charge Air Cooler Coolant Hose Replacement - Radiator to Pipe (LF3)**.

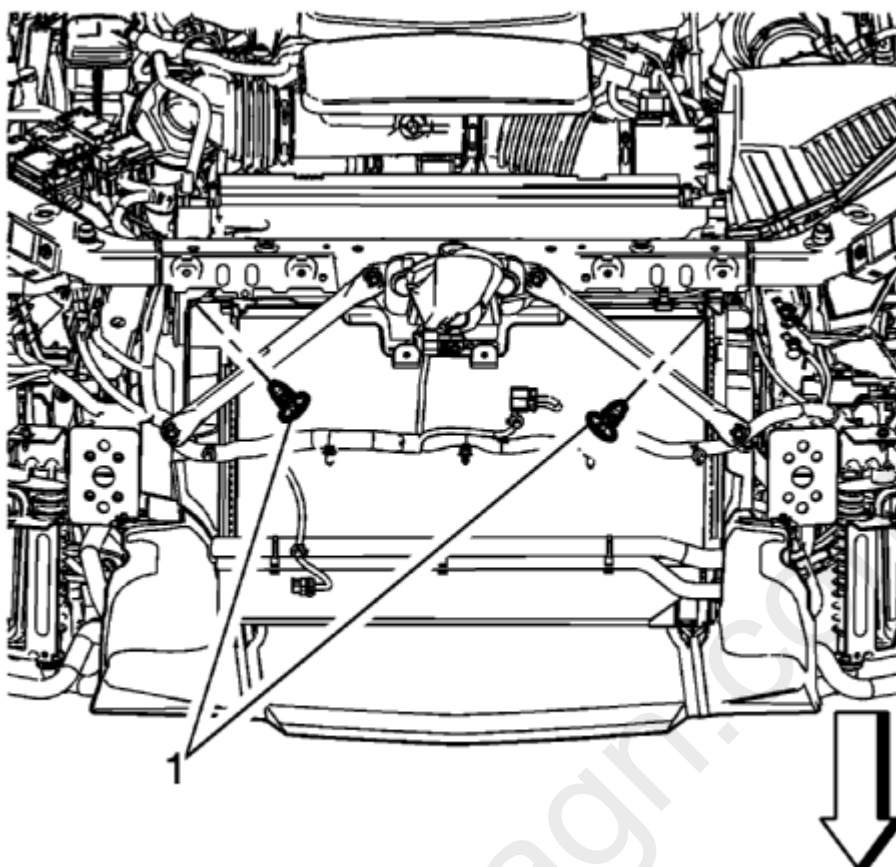


Fig. 259: Radiator Air Lower Baffle And Deflector Upper Retainers
Courtesy of GENERAL MOTORS COMPANY

13. Remove the radiator air lower baffle and deflector upper retainers (1) from the radiator air upper baffle and deflector.

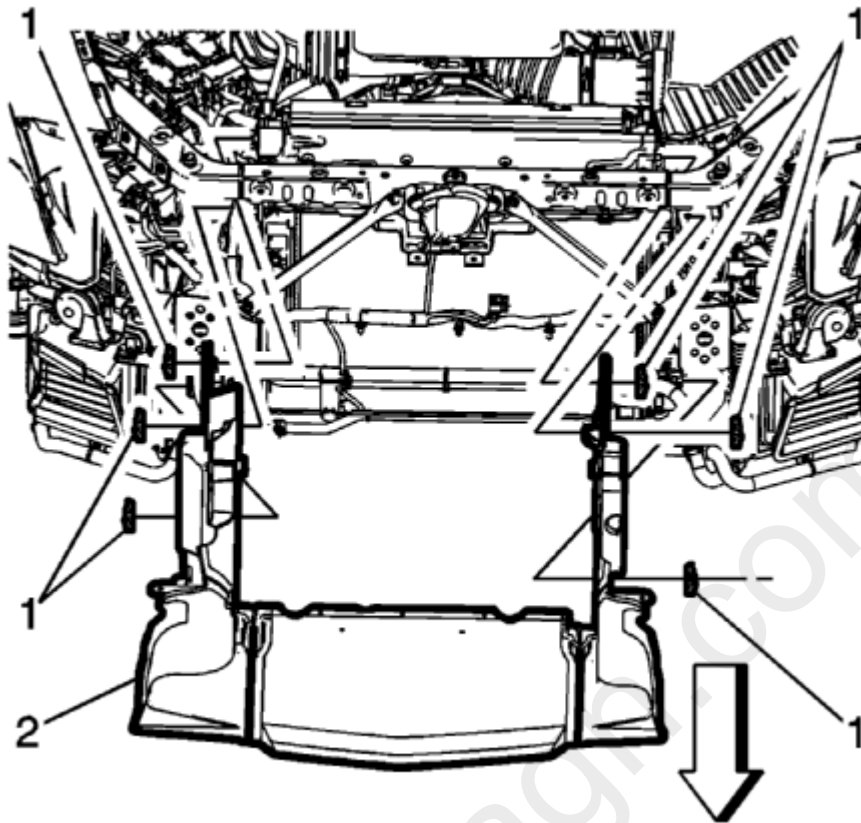


Fig. 260: Radiator Air Lower Baffle And Deflector Side Retainers
Courtesy of GENERAL MOTORS COMPANY

14. Remove the radiator air lower baffle and deflector side retainers (1) from the radiator.
15. Detach radiator air lower baffle and deflector from the radiator (2) and remove from the vehicle.

Installation Procedure

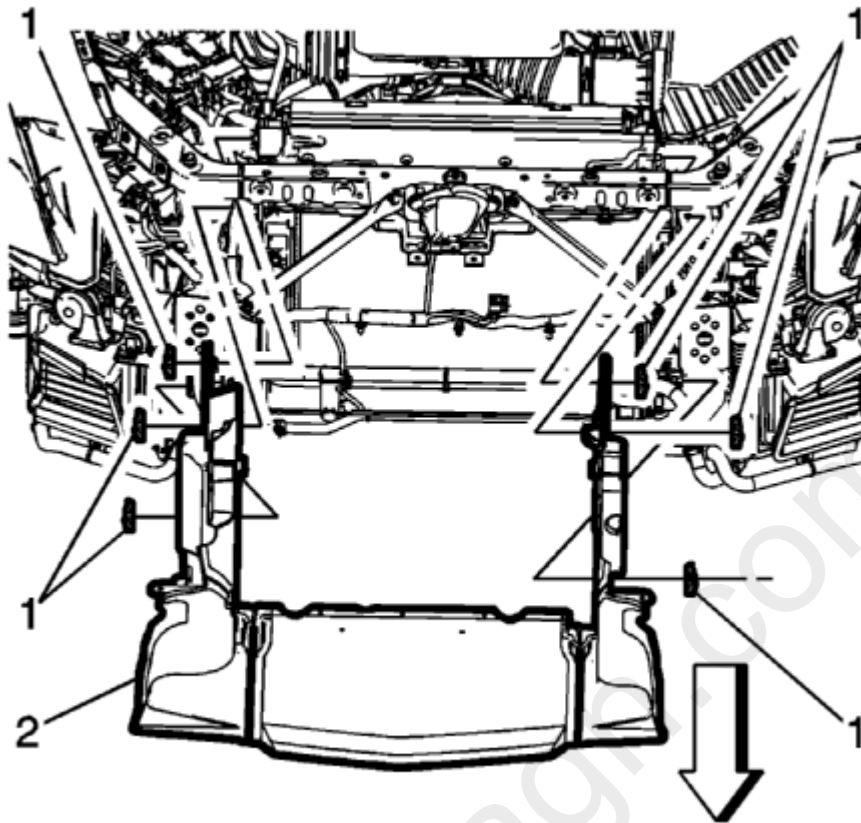


Fig. 261: Radiator Air Lower Baffle And Deflector Side Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator air lower baffle and deflector to the radiator (2).
2. Install the radiator air lower baffle and deflector side retainers (1) to the radiator.

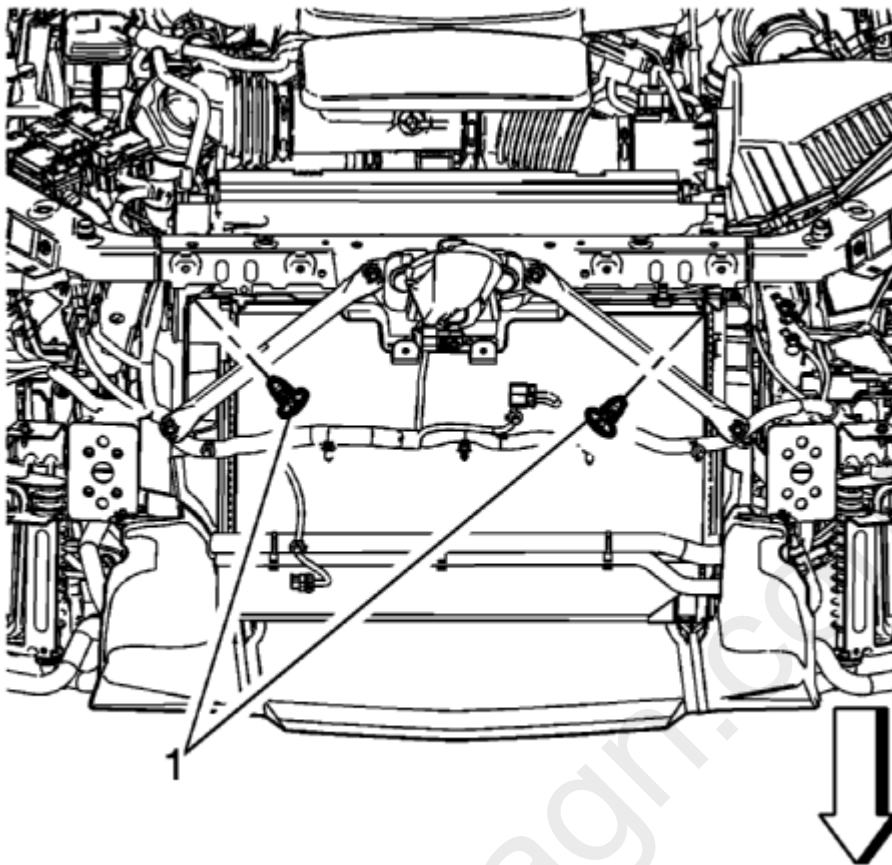


Fig. 262: Radiator Air Lower Baffle And Deflector Upper Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install the radiator air lower baffle and deflector upper retainers (1) to the radiator air upper baffle and deflector.

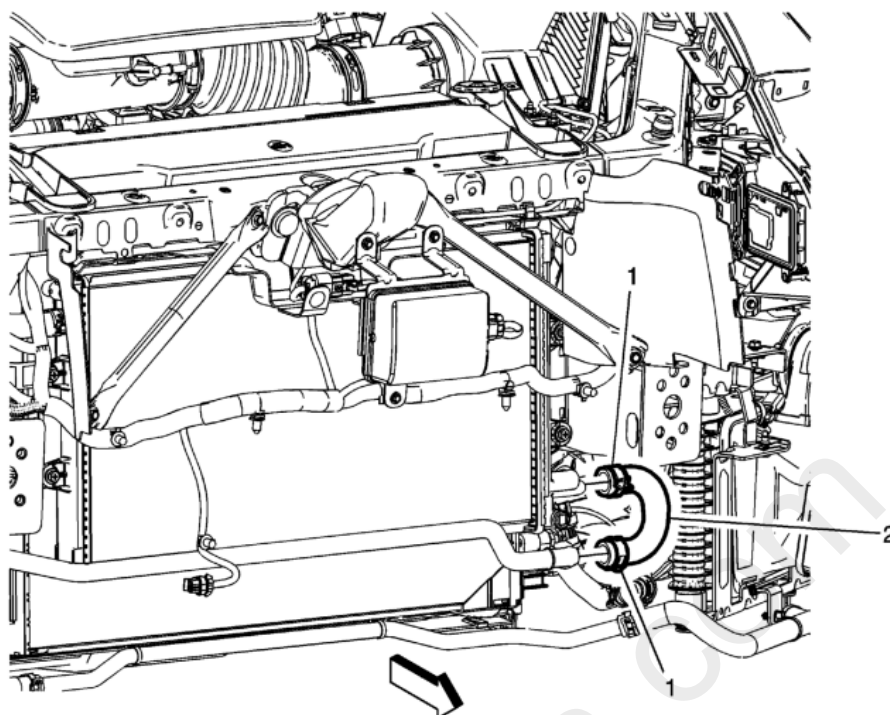


Fig. 263: Charge Air Cooler Coolant Hose - Radiator to Pipe (LF3)

Courtesy of GENERAL MOTORS COMPANY

4. Install the charge air cooler coolant hose (2) to the charge air cooler radiator. Refer to **Charge Air Cooler Coolant Hose Replacement - Radiator to Pipe (LF3)**.

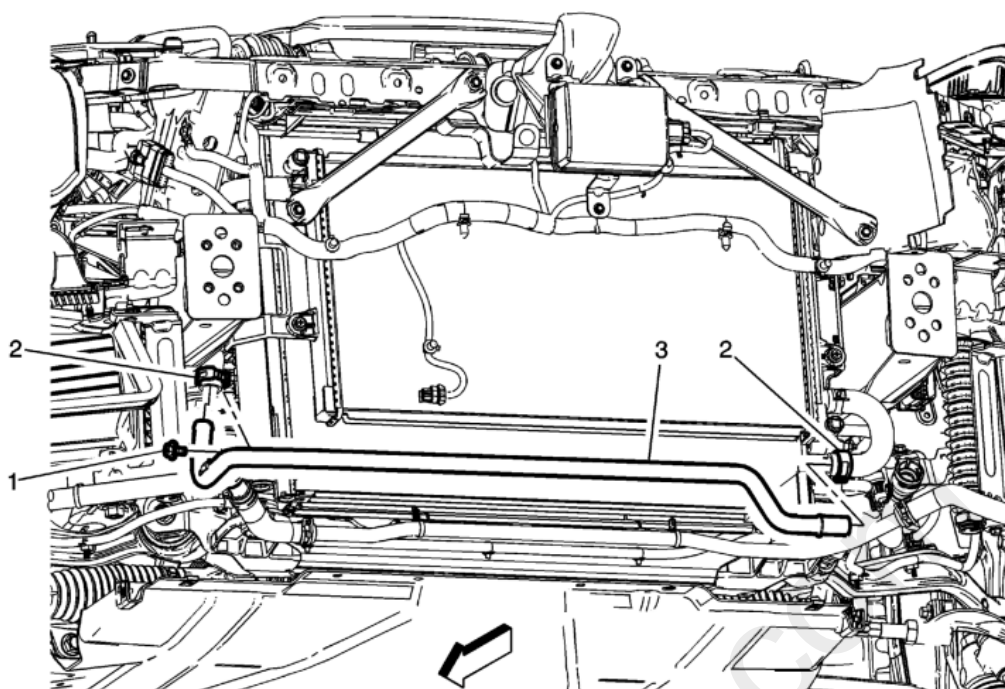


Fig. 264: Charge Air Cooler Coolant Pipe (LF3)
Courtesy of GENERAL MOTORS COMPANY

5. Install the charge air cooler coolant pipe (3). Refer to **Charge Air Cooler Coolant Pipe Replacement (LF3)**.

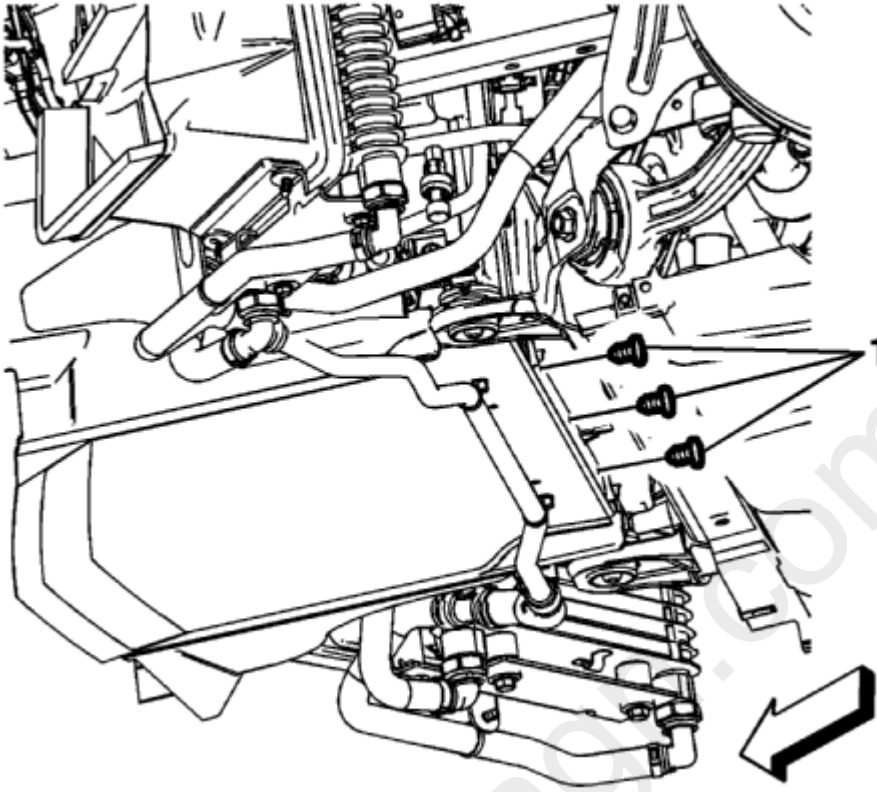


Fig. 265: Radiator Air Lower Baffle And Deflector Lower Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Install the radiator air lower baffle and deflector lower retainers (1) to the engine coolant fan shroud.

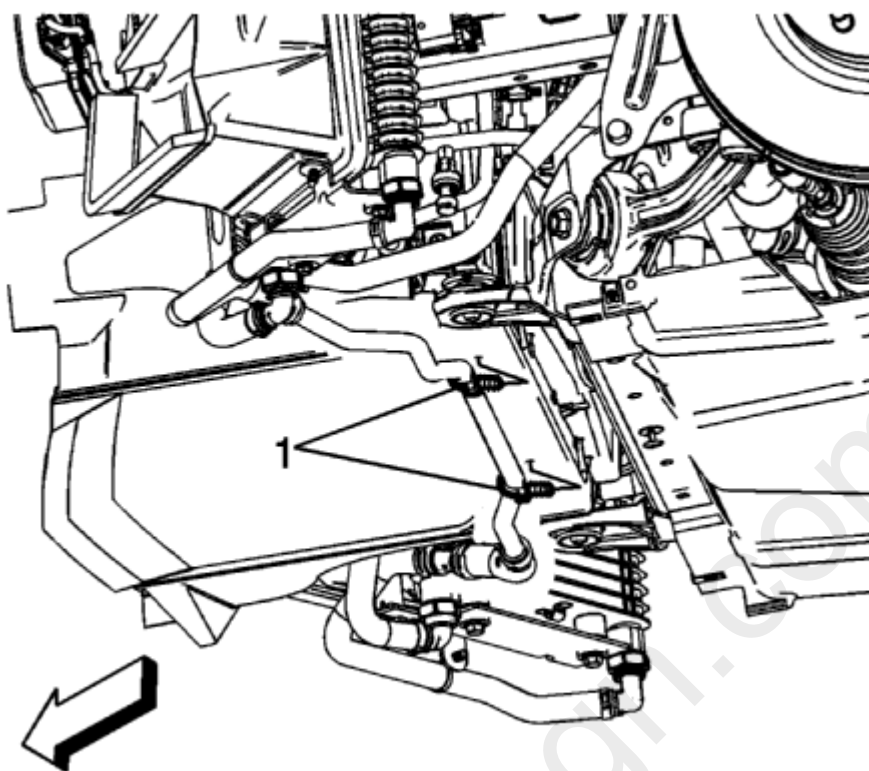


Fig. 266: Auxiliary Radiator Inlet Hose Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Install the auxiliary radiator inlet hose retainers (1) to the radiator air lower baffle and deflector.

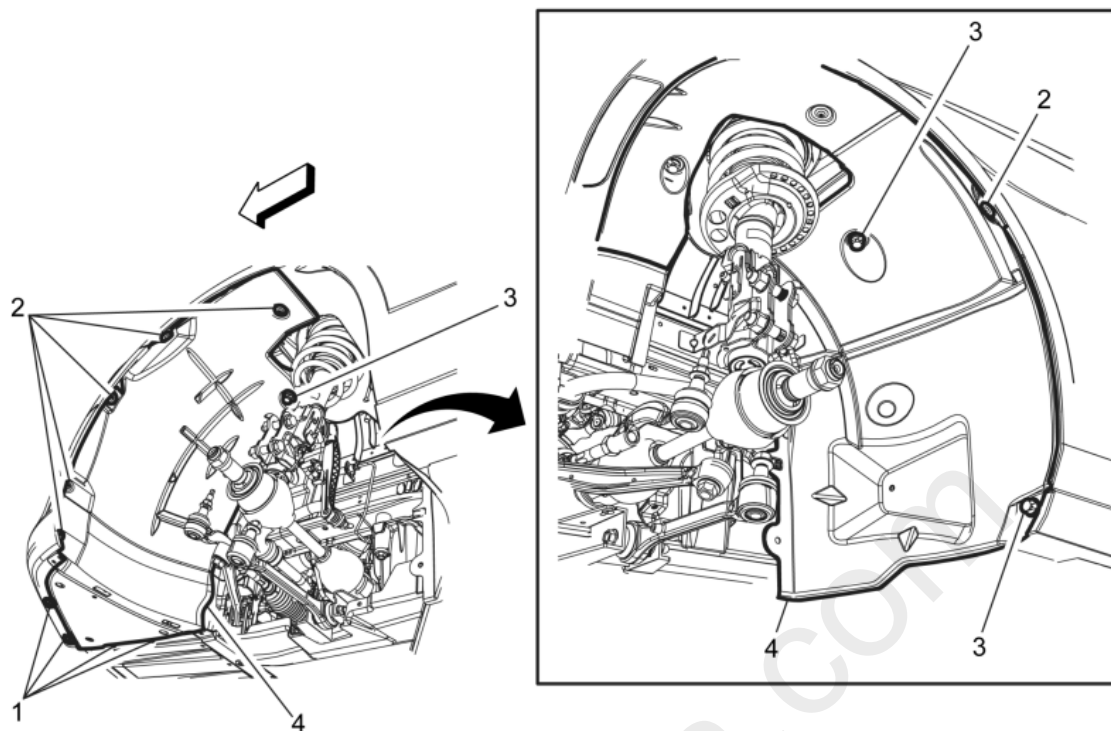


Fig. 267: Front Wheelhouse Liners
 Courtesy of GENERAL MOTORS COMPANY

8. Install the front wheelhouse liners (4). Refer to **Front Wheelhouse Liner Replacement** .

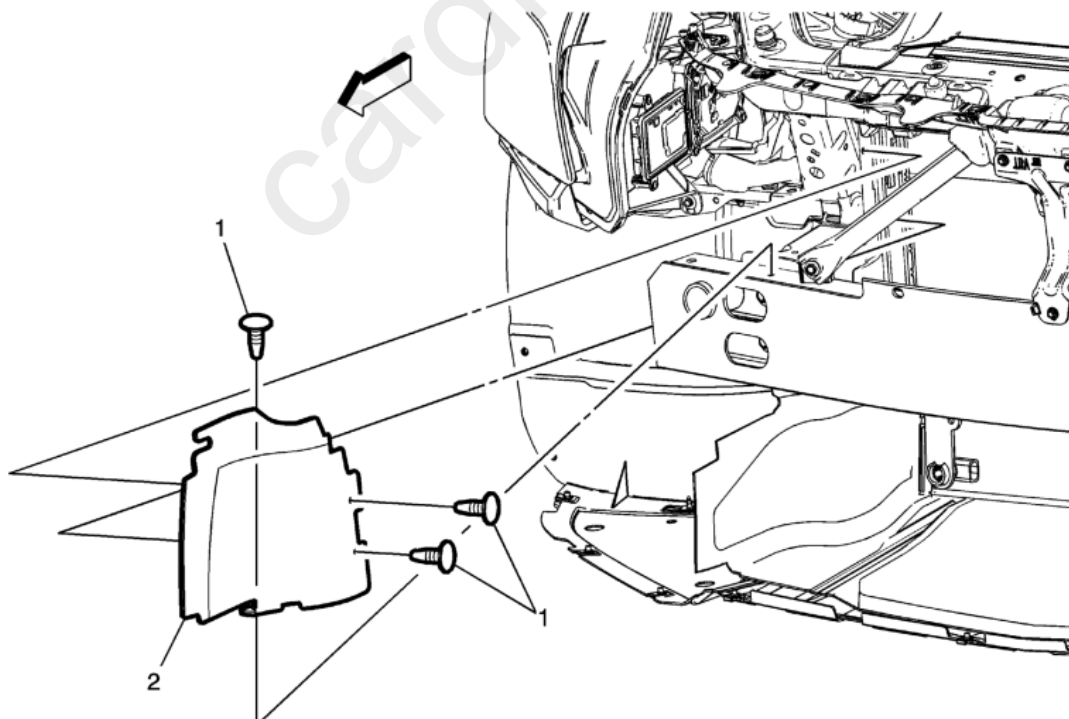


Fig. 268: Right Radiator Air Side Baffle
Courtesy of GENERAL MOTORS COMPANY

9. Install the right radiator air side baffle (2). Refer to **Radiator Air Side Baffle Replacement - Right Side (LF3, LFX, LTG)**.

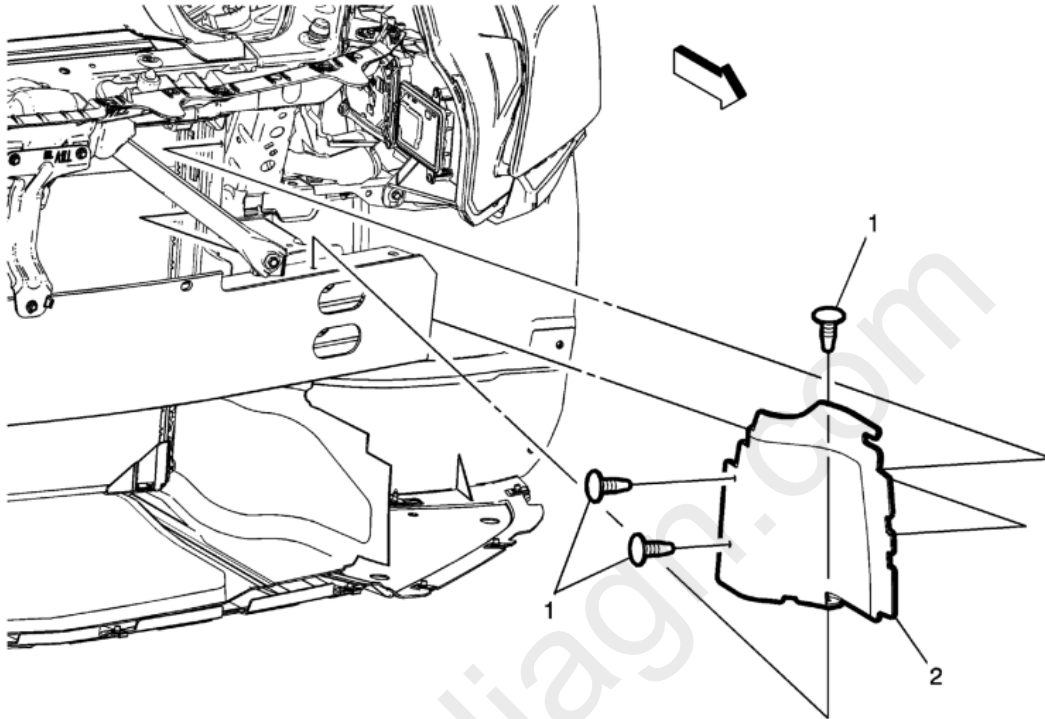


Fig. 269: Left Radiator Air Side Baffle
Courtesy of GENERAL MOTORS COMPANY

10. Install the left radiator air side baffle (2). Refer to **Radiator Air Side Baffle Replacement - Left Side (LF3, LFX, LTG)**.

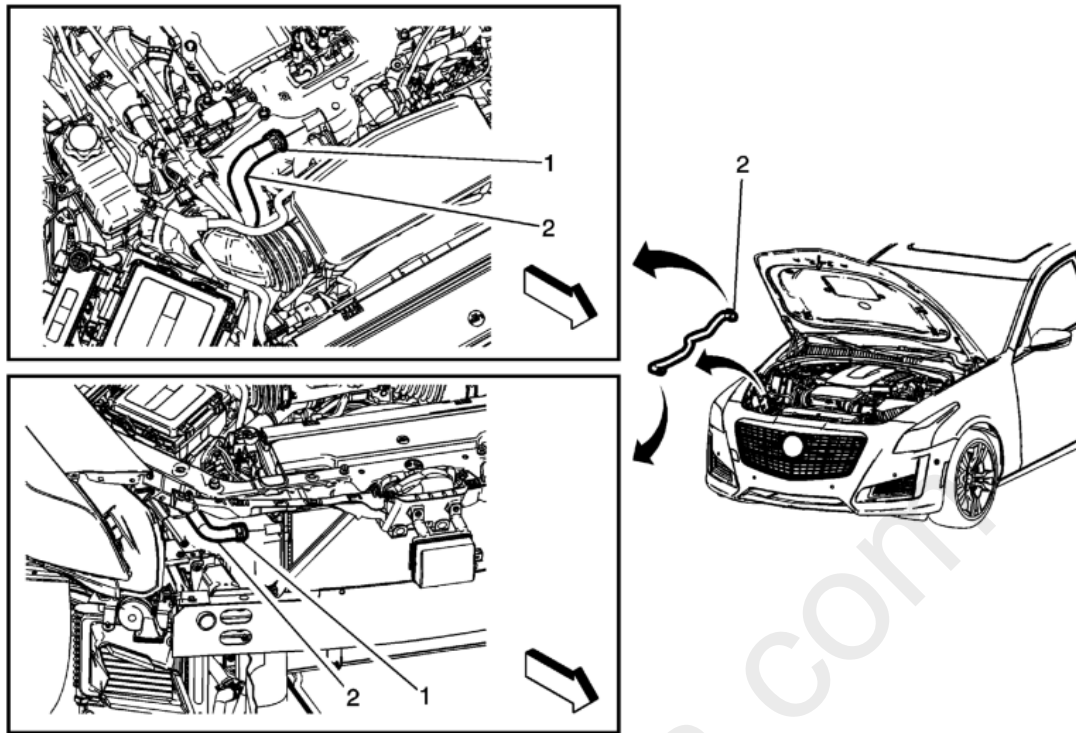


Fig. 270: Charge Air Cooler Coolant Hose - Engine to Radiator
 Courtesy of GENERAL MOTORS COMPANY

11. Install the charge air cooler coolant hose (2) to the charge air cooler radiator. Refer to **Charge Air Cooler Coolant Hose Replacement - Engine to Radiator**.
12. Install the forward range radar module if equipped. Refer to **Forward Range Radar Module Replacement**.
13. Install the front bumper fascia center support. Refer to **Front Bumper Fascia Center Support Replacement (Upper)**, **Front Bumper Fascia Center Support Replacement (Lower)**.
14. Install the front bumper impact bar. Refer to **Front Bumper Impact Bar Replacement**.
15. Install the turbocharger wastegate actuator vacuum tank. Refer to **Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)**.

RADIATOR AIR SIDE BAFFLE REPLACEMENT - LEFT SIDE (LF3, LFX, LTG)

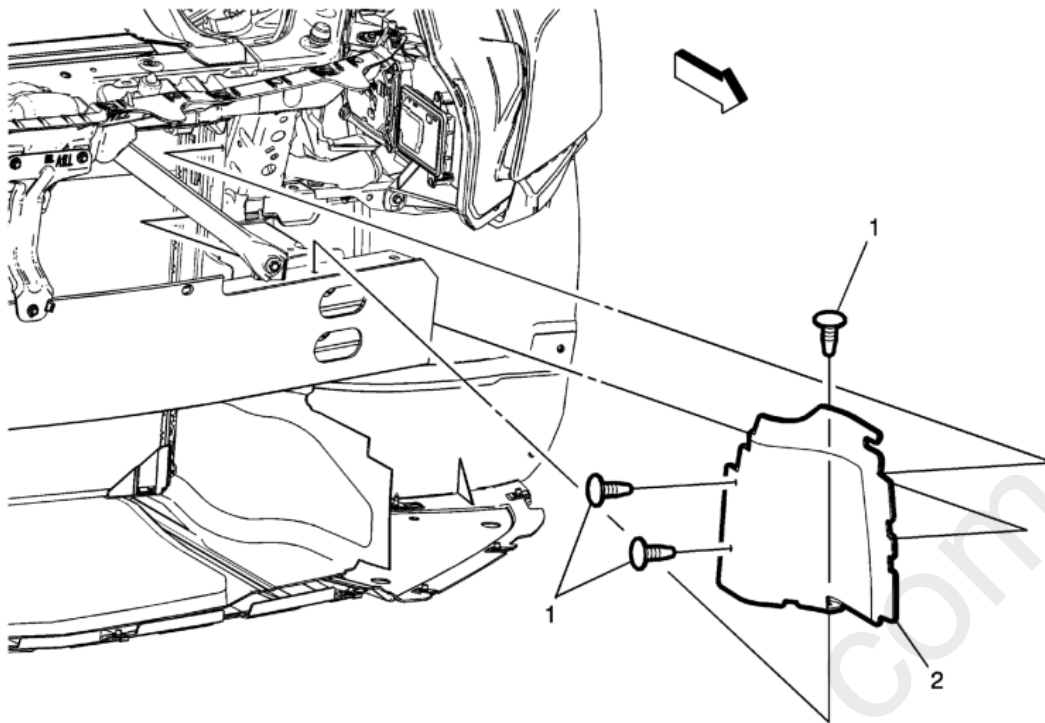


Fig. 271: Left Radiator Air Side Baffle
 Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Baffle Replacement - Left Side (LF3, LFX, LTG)

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Radiator Air Side Baffle-Left Retainer (Qty: 3)
2	Radiator Air Side Baffle-Left

RADIATOR AIR SIDE BAFFLE REPLACEMENT - RIGHT SIDE (LF3, LFX, LTG)

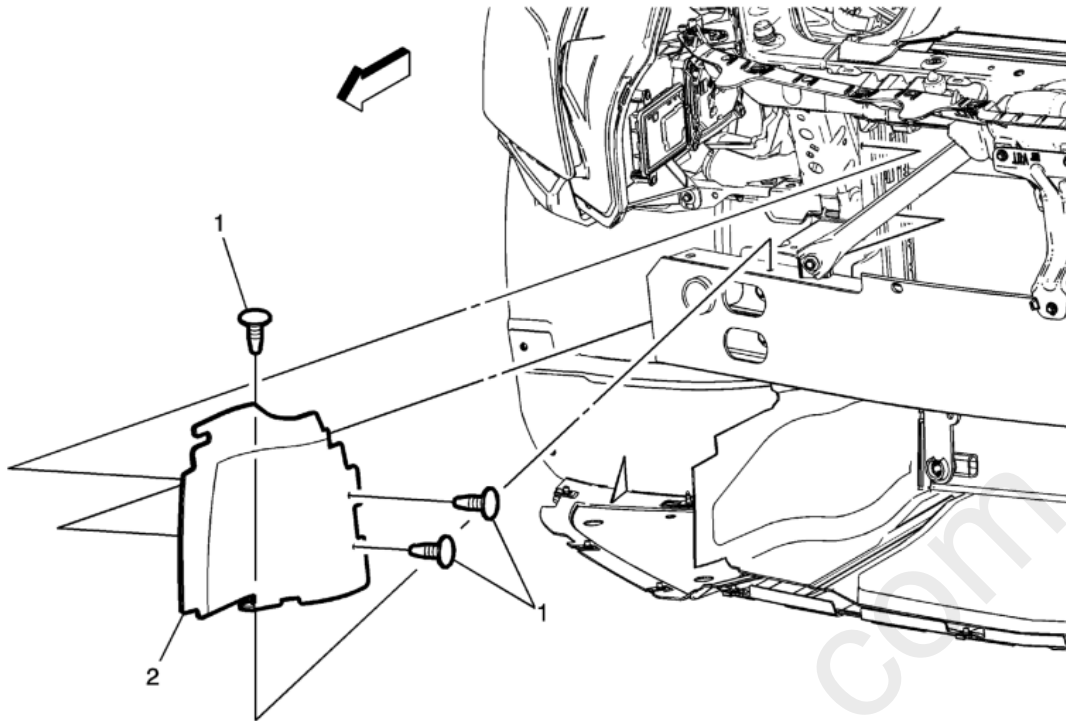


Fig. 272: Right Radiator Air Side Baffle
 Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Baffle Replacement - Right Side (LF3, LFX, LTG)

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Radiator Air Side Baffle-Right Retainer (Qty: 3)
2	Radiator Air Side Baffle-Right

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT (LFX, LTG)

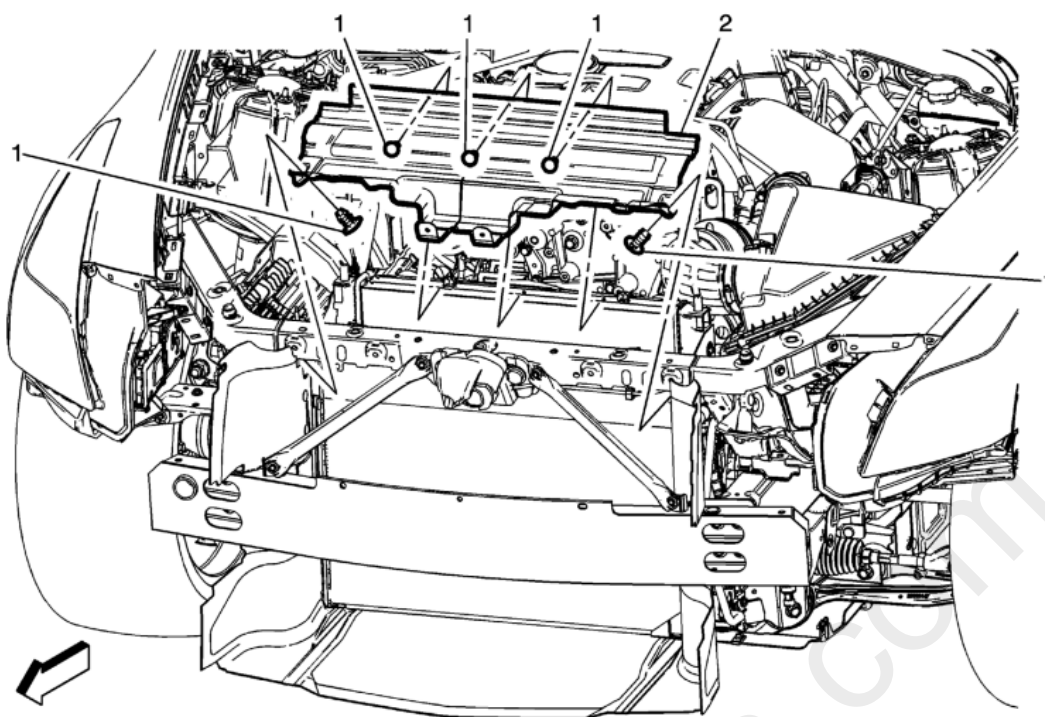


Fig. 273: Radiator Air Upper Baffle and Deflector (LFX, LTG)

Courtesy of GENERAL MOTORS COMPANY

Radiator Air Upper Baffle and Deflector Replacement (LFX, LTG)

Callout	Component Name
Preliminary Procedures	
1. Remove the front bumper fascia center support if equipped. Refer to <u>Front Bumper Fascia Center Support Replacement (Upper)</u> , <u>Front Bumper Fascia Center Support Replacement (Lower)</u> . 2. Remove the forward range radar module if equipped. Refer to <u>Forward Range Radar Module Replacement</u> . 3. Remove the radiator upper bracket. Refer to <u>Radiator Upper Bracket Replacement (LFX, LTG)</u>.	
1	Radiator Air Upper Baffle and Deflector Retainer (Qty: 5)
2	Radiator Air Upper Baffle and Deflector
	Procedure Lift up and remove rearward.

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT (LF3)

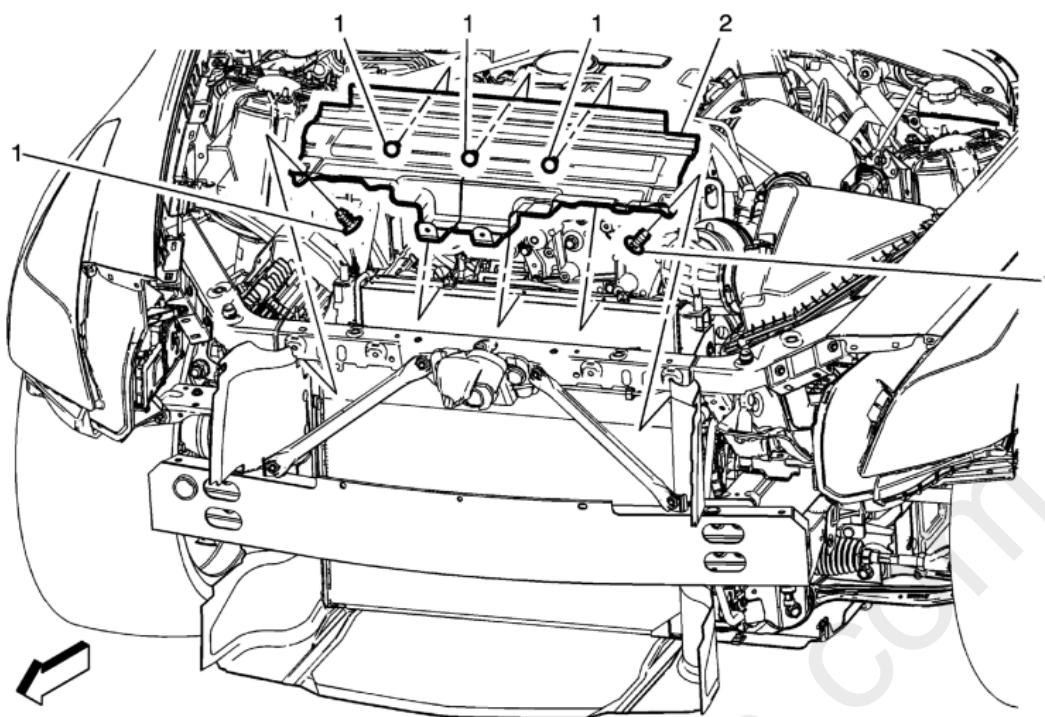


Fig. 274: Radiator Air Upper Baffle and Deflector (LF3)

Courtesy of GENERAL MOTORS COMPANY

Radiator Air Upper Baffle and Deflector Replacement (LF3)

Callout	Component Name
Preliminary Procedures	
1. Remove the front bumper fascia center support if equipped. Refer to <u>Front Bumper Fascia Center Support Replacement (Upper)</u> , <u>Front Bumper Fascia Center Support Replacement (Lower)</u> . 2. Remove the forward range radar module if equipped. Refer to <u>Forward Range Radar Module Replacement</u> . 3. Remove the turbocharger wastegate actuator vacuum tank. Refer to <u>Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)</u> .	
1	Radiator Air Upper Baffle and Deflector Retainer (Qty: 5)
2	Radiator Air Upper Baffle and Deflector
	Procedure Lift up and remove rearward.

COOLANT HEATER REPLACEMENT (LTG)

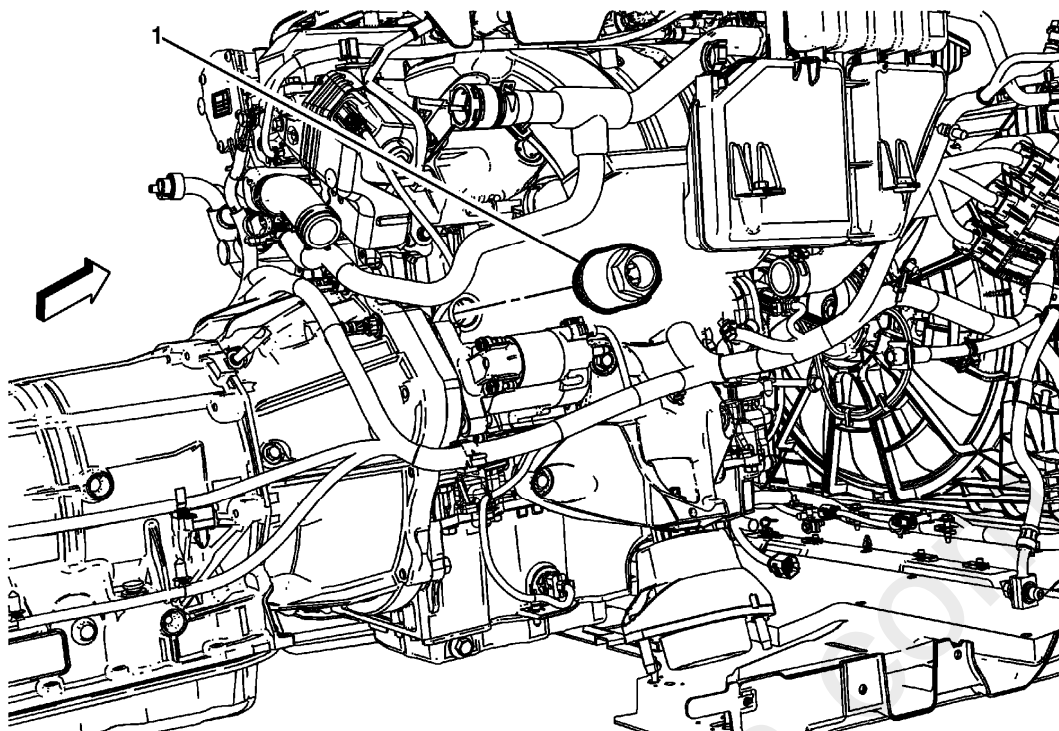


Fig. 275: Coolant Heater (LTG)
Courtesy of GENERAL MOTORS COMPANY

Coolant Heater Replacement (LTG)

Callout	Component Name
Preliminary 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 starter. Refer to Starter Replacement (LTG).	
1	Engine Coolant Heater CAUTION: Refer to Fastener Caution. Procedure Disconnect the engine coolant heater cord. Tighten 50 (37 lb ft)

COOLANT HEATER REPLACEMENT (LFX)

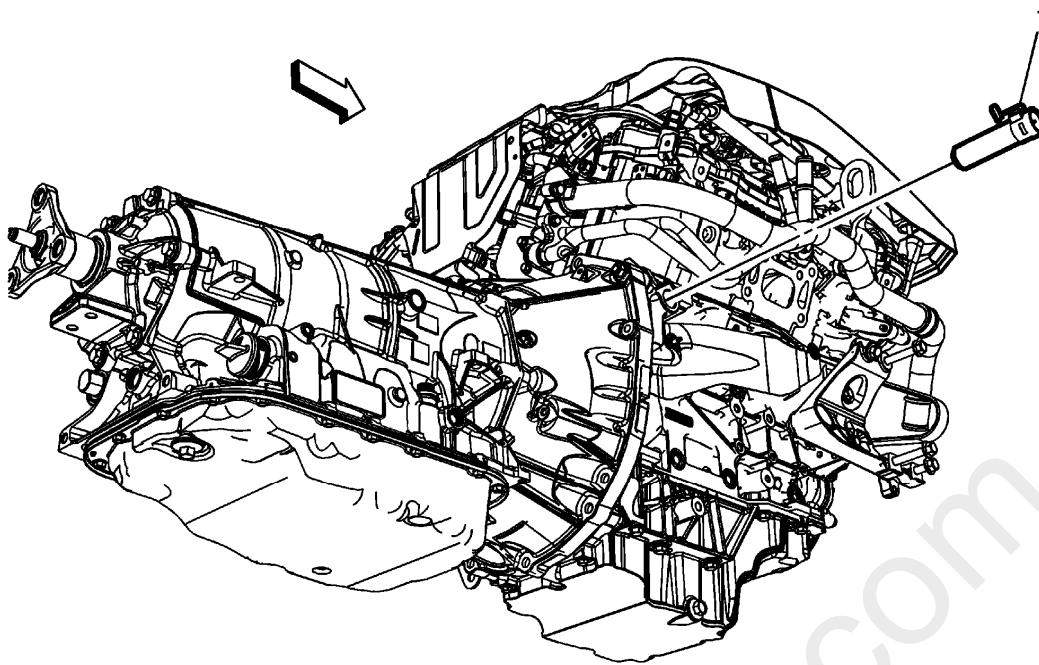


Fig. 276: Engine Coolant Heater (LFX)
Courtesy of GENERAL MOTORS COMPANY

Coolant Heater Replacement (LFX)

Callout	Component Name
Preliminary Procedure Remove the radiator surge tank. Refer to Radiator Surge Tank Replacement (LFX, LF3) .	
1	Engine Coolant Heater Procedure Disconnect the coolant heater cord connector at the engine block.

COOLANT HEATER CORD REPLACEMENT (LFX)

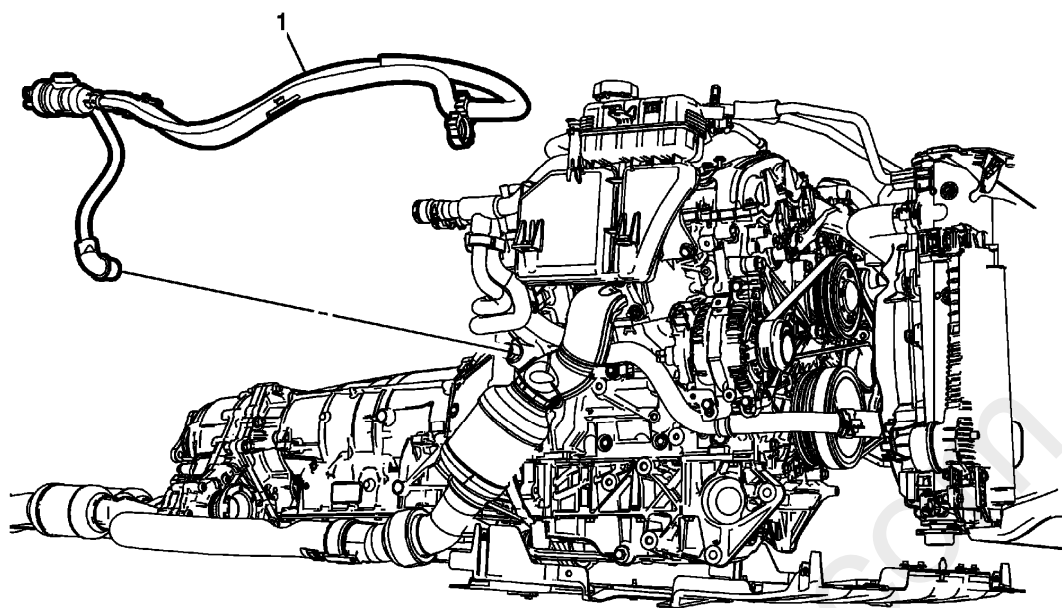


Fig. 277: Coolant Heater Cord (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Coolant Heater Cord Replacement (LFX)

Callout	Component Name
Preliminary Procedure	
Disconnect the engine coolant heater cord from the engine coolant heater.	
1	Engine Coolant Heater Cord

COOLANT HEATER CORD REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
3. If equipped with AWD, remove the front propeller shaft. Refer to **Front Axle Propeller Shaft Replacement** .

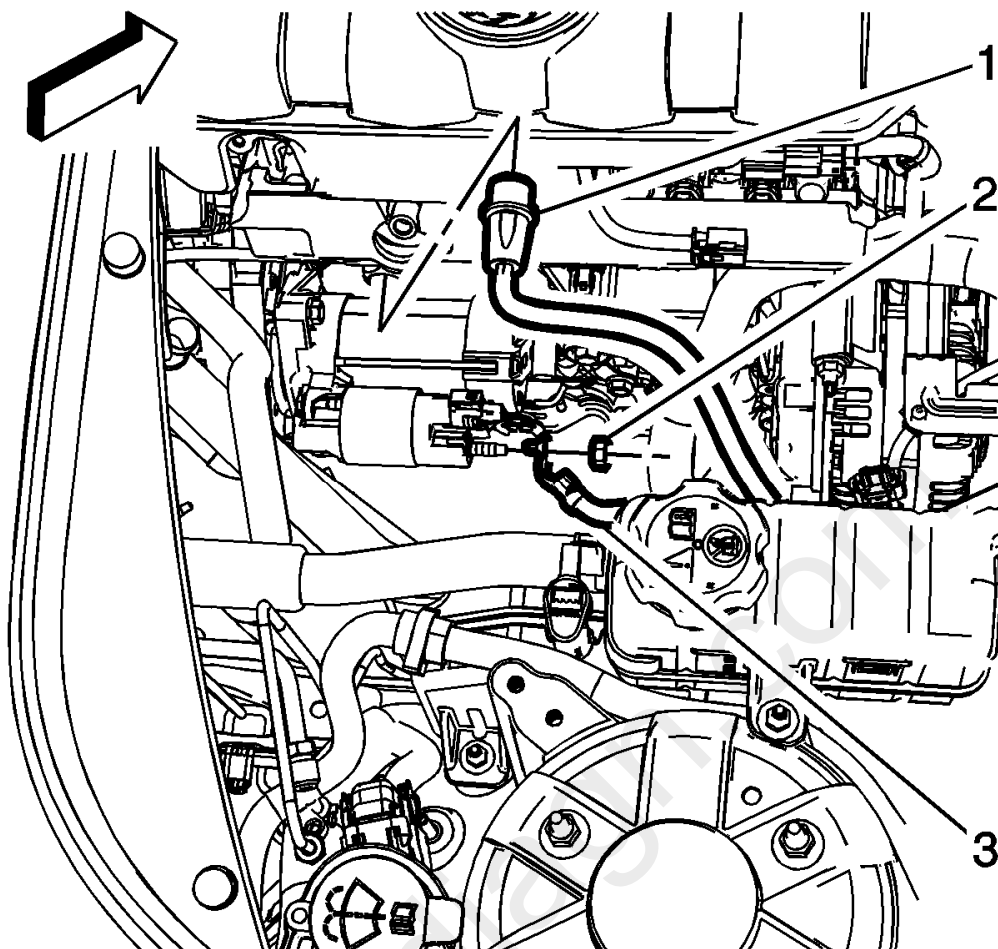


Fig. 278: Engine Coolant Heater Cord Connector And Starter Solenoid Cable
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine coolant heater cord connector (1) from the engine coolant heater.
5. Remove the starter solenoid fastener (2) and remove the starter solenoid cable (3).

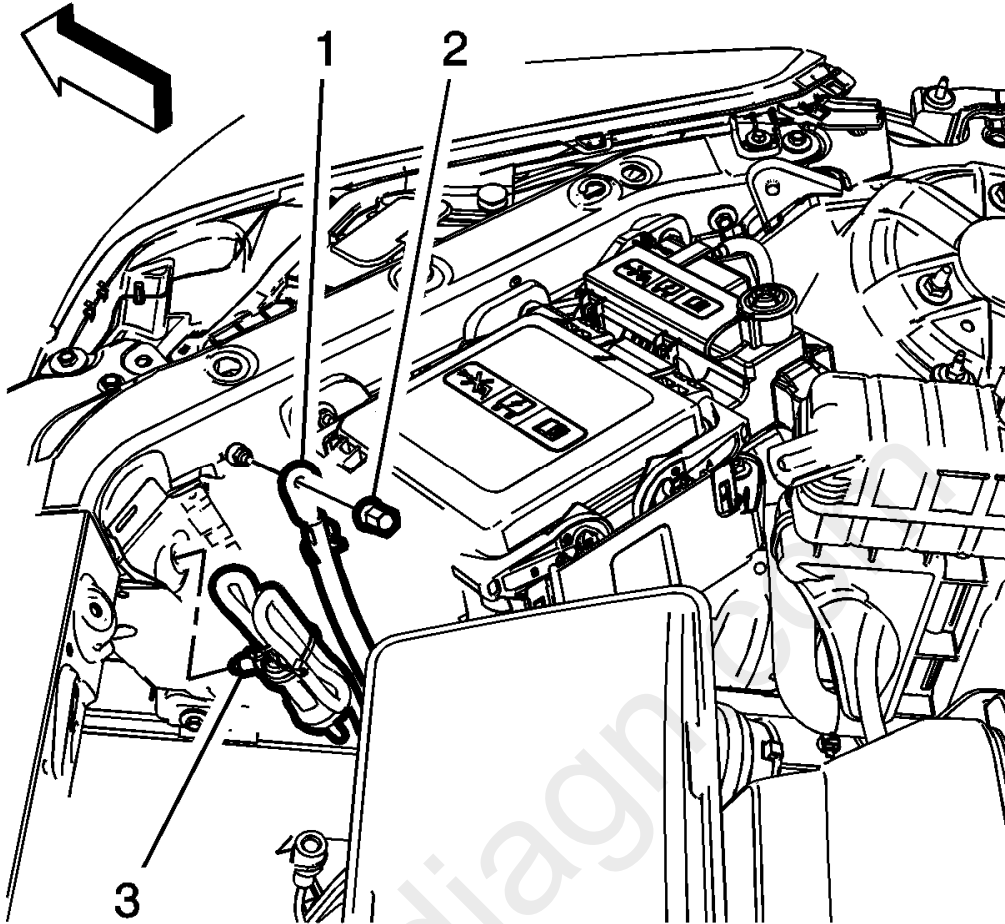


Fig. 279: Starter Solenoid Ground Cable
Courtesy of GENERAL MOTORS COMPANY

6. Remove the right upper tie bar extension frame rail fastener (2) and remove the starter solenoid ground cable (1).
7. Detach the heater cord retainer (3).

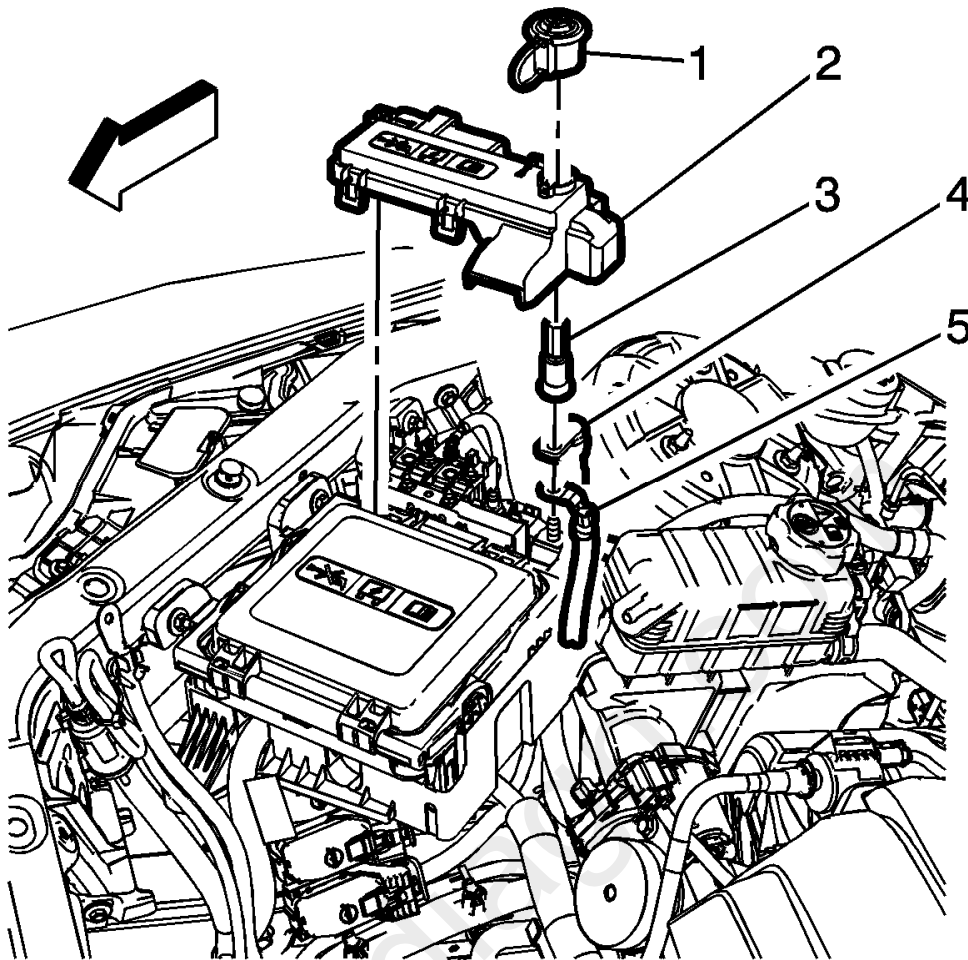


Fig. 280: Pre-Fuse Block

Courtesy of GENERAL MOTORS COMPANY

8. Remove the following from the pre-fuse block:
 - Battery Jumper Post Cover (1).
 - Pre-Fuse Block Cover (2).
 - Battery Positive Barrel Retainer (3).
 - Battery Positive Cable (4).
 - Starter Solenoid Cable (5).
9. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

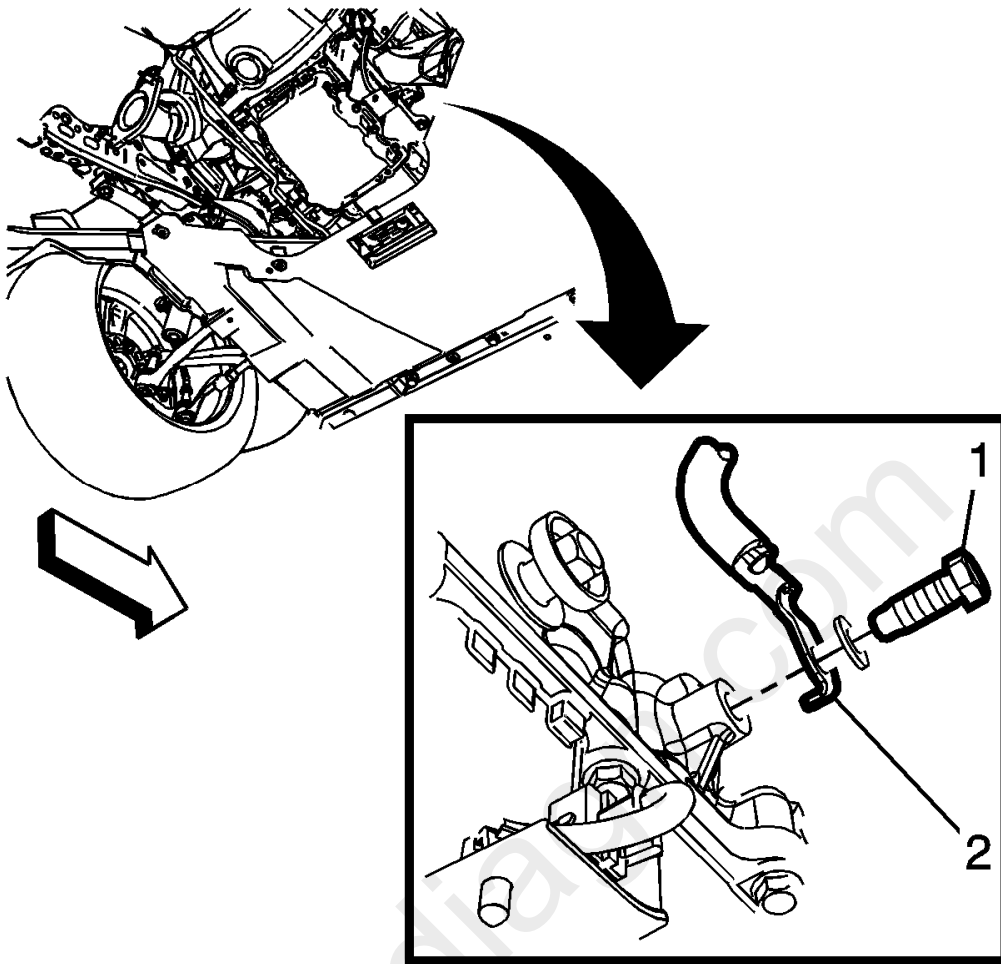


Fig. 281: Cable Ground Fastener
Courtesy of GENERAL MOTORS COMPANY

10. Remove the starter solenoid cable ground fastener (1) and the starter solenoid cable (2), from the engine block.

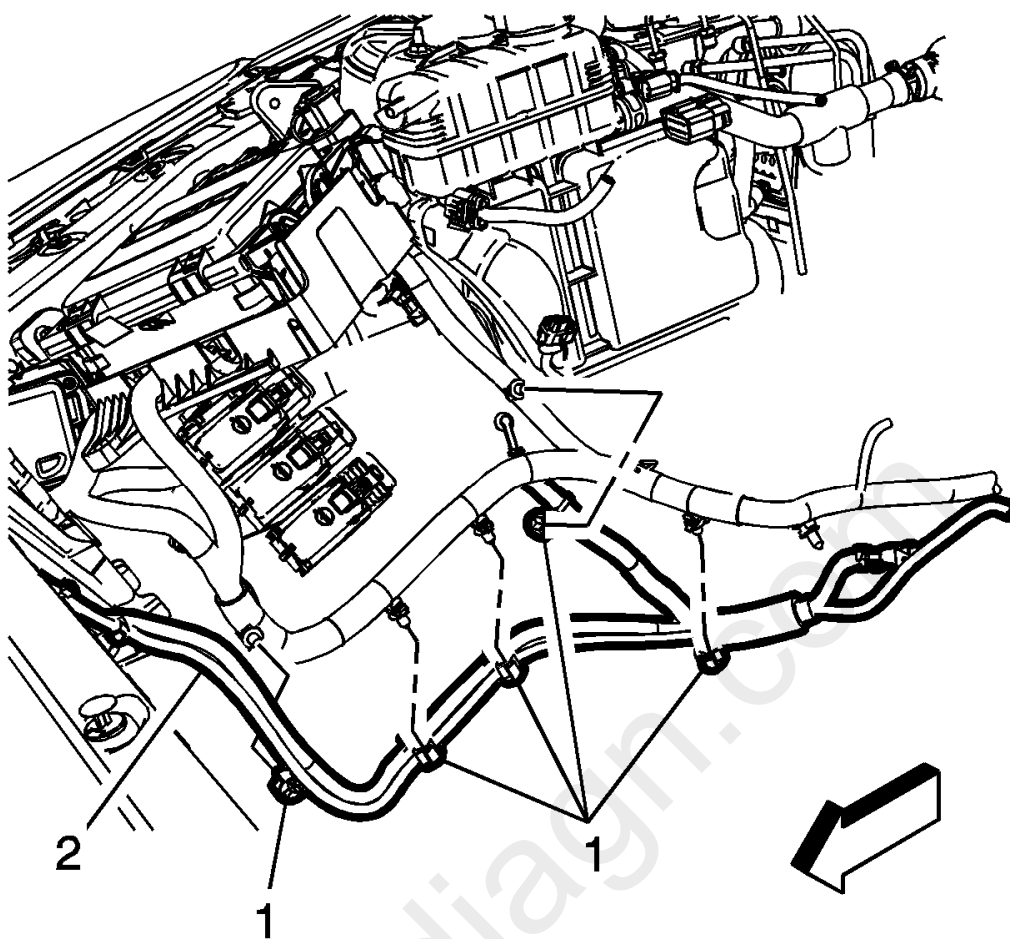


Fig. 282: Starter Solenoid Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: The coolant heater cord is attached to the starter solenoid cable.

11. Detach the starter solenoid cable retainers (1) from the engine harness and remove the starter solenoid cable (2) from the engine compartment.

Installation Procedure

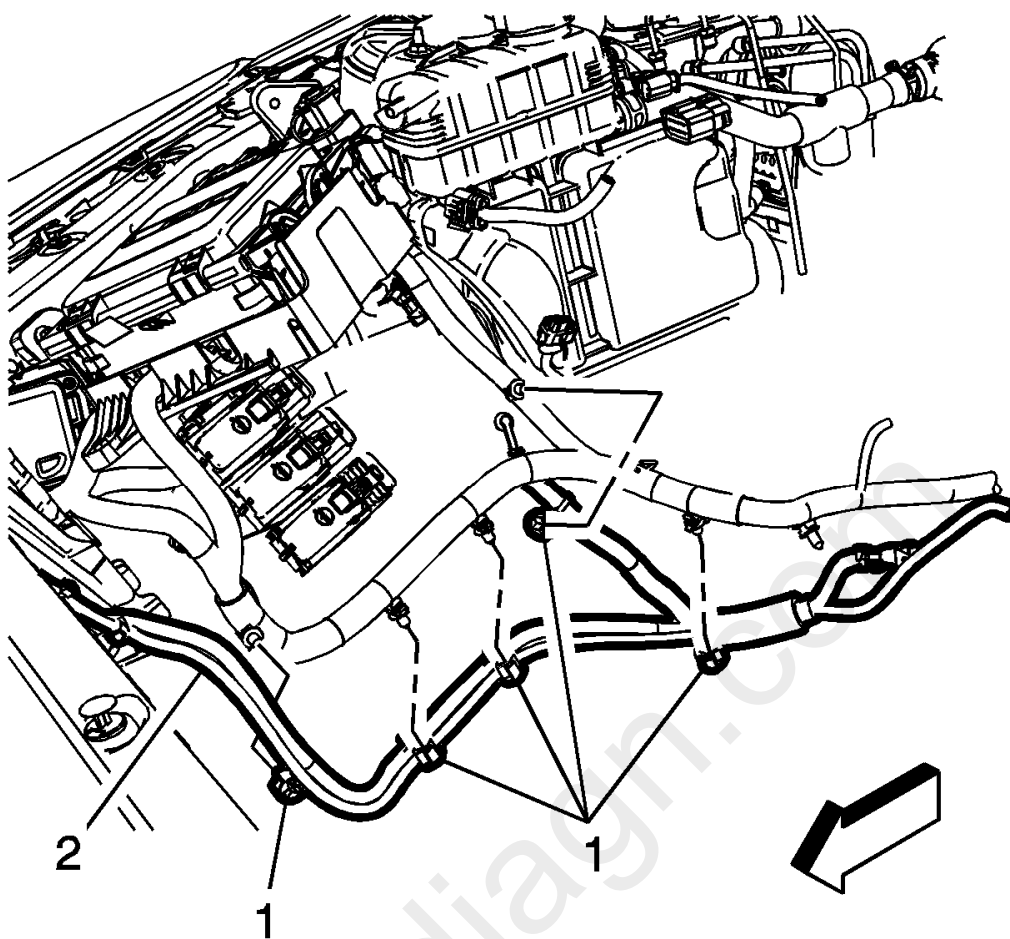


Fig. 283: Starter Solenoid Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Attach the starter solenoid cable retainers (1) to the engine harness.

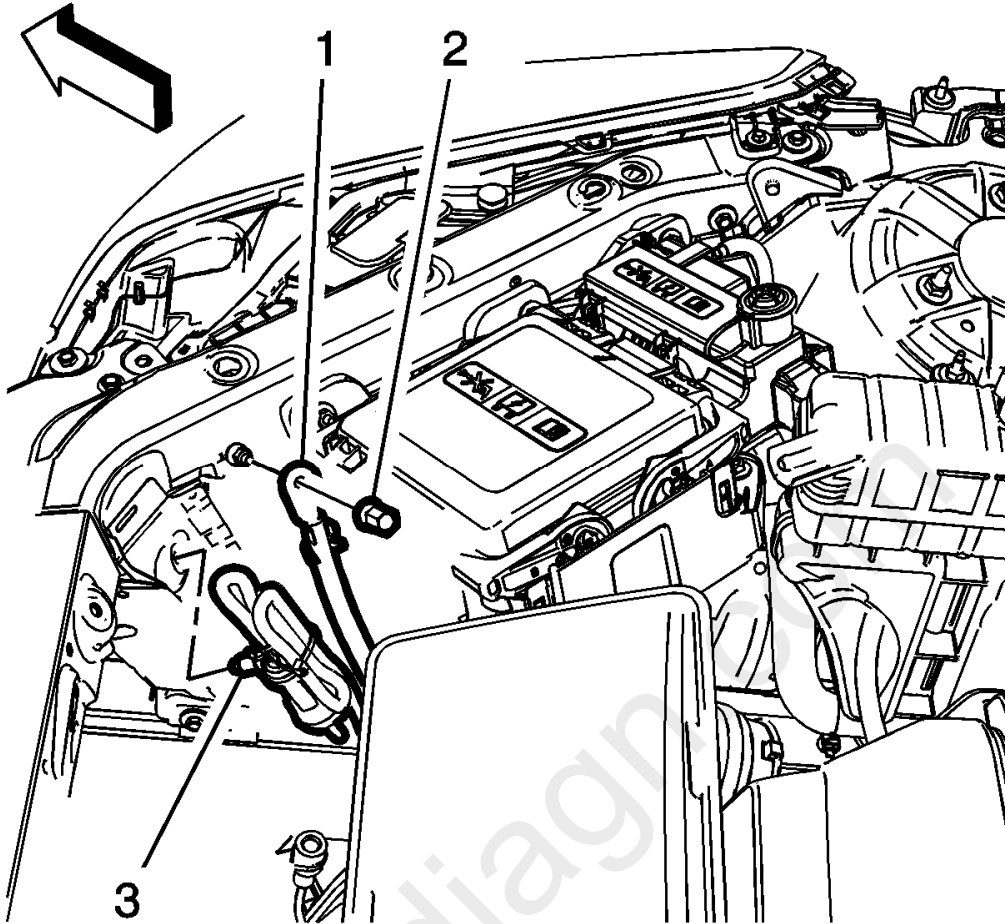


Fig. 284: Starter Solenoid Ground Cable
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the starter solenoid cable ground (1), to the right upper tie bar frame extension rail, and tighten the fastener (2) to 9 (80 lb in).
3. Attach the heater cord retainer (3).

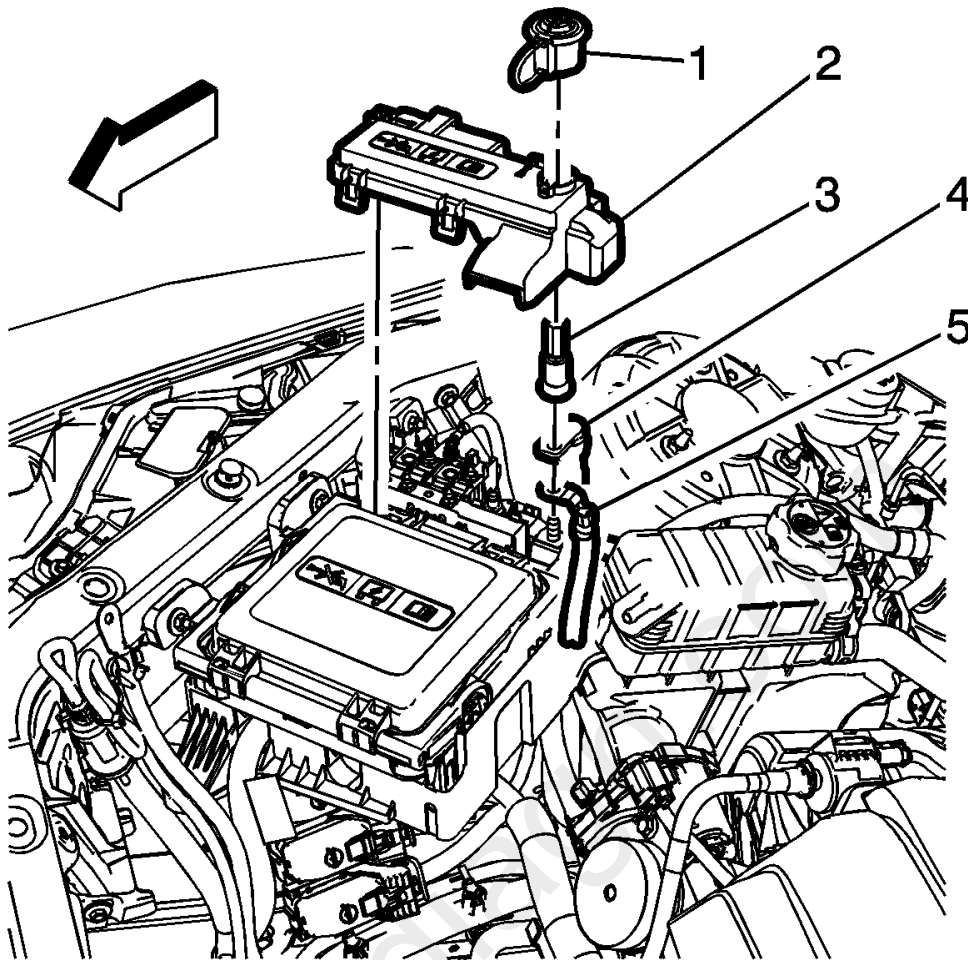


Fig. 285: Pre-Fuse Block

Courtesy of GENERAL MOTORS COMPANY

4. Attach the following to the pre-fuse block:
 - Starter Solenoid Cable (5).
 - Battery Positive Cable (4).
 - Battery Positive Barrel Retainer (3).
 - Pre-Fuse Block Cover (2).
 - Battery Jumper Post Cover (1).

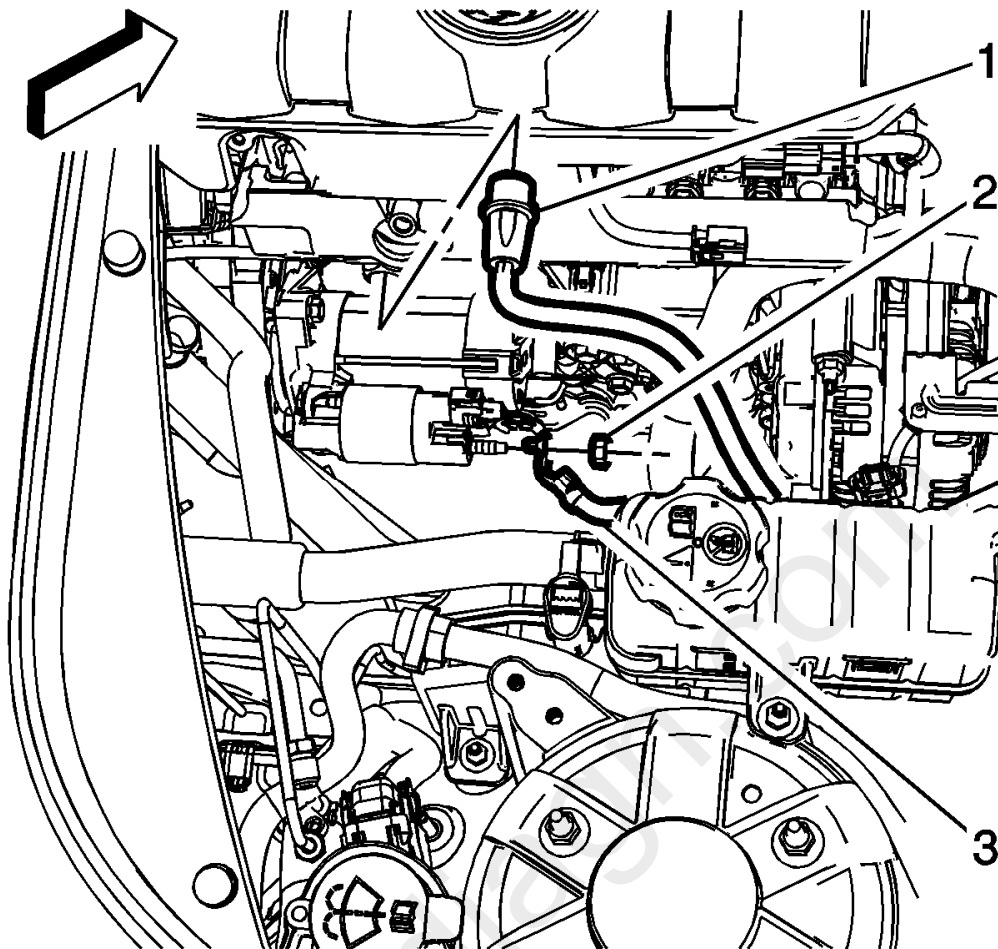


Fig. 286: Engine Coolant Heater Cord Connector And Starter Solenoid Cable
Courtesy of GENERAL MOTORS COMPANY

5. Install the starter solenoid cable (3) to the starter solenoid and tighten the fastener (4) to 10 (89 lb in).
6. Install the engine coolant heater connector (1).
7. Install the intake manifold. Refer to **Intake Manifold Replacement** .
8. If equipped with AWD, install the front propeller shaft. Refer to **Front Axle Propeller Shaft Replacement** .

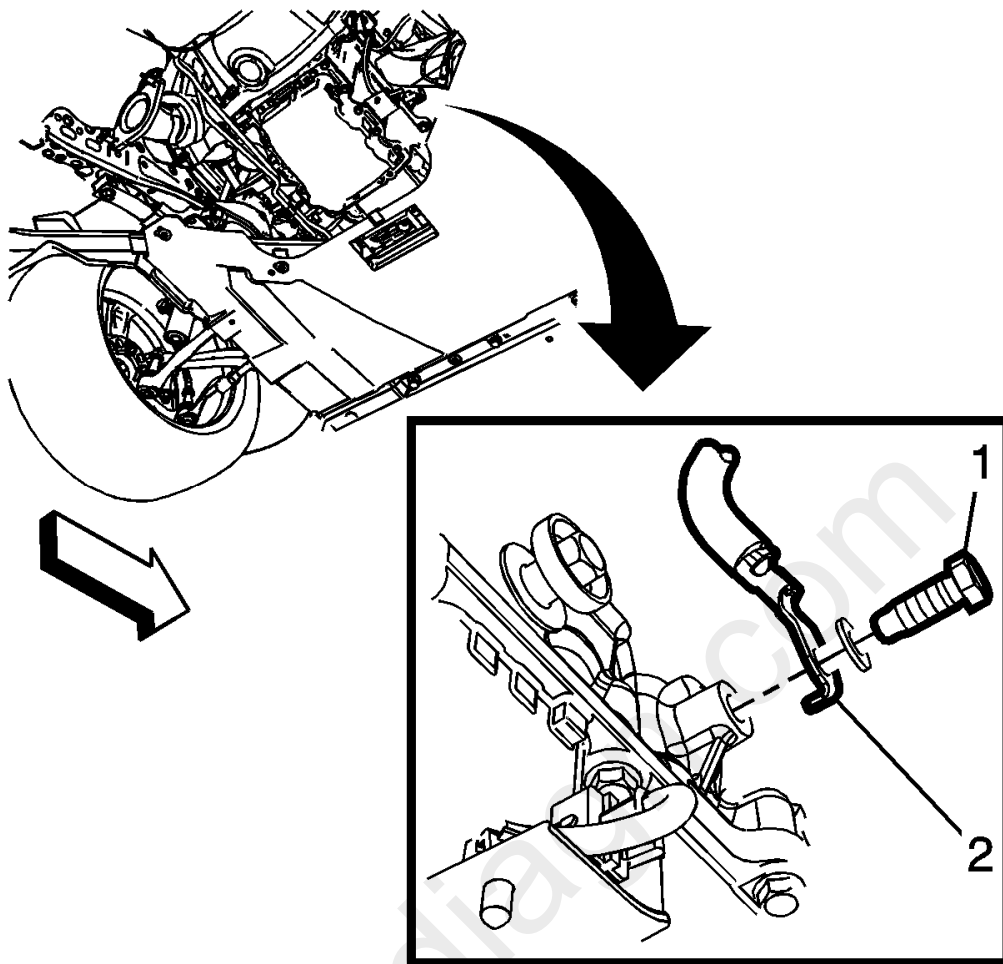


Fig. 287: Cable Ground Fastener
 Courtesy of GENERAL MOTORS COMPANY

9. Install the starter solenoid cable ground (2), to the engine block, and tighten the fastener (1) to 45 (33 lb ft).
10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

Cooling Fan Control

The engine cooling fan system is composed of one electric cooling fan and a cooling fan control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, allowing the cooling fan to operate at variable speeds. The cooling fan speed is effected by many different operating conditions and the ECM will adjust the duty cycle based on cooling system requirements.

This system is unique in that the ECM will not operate the cooling fan at every speed within a 0-90 percent range. The cooling fan calibration is designed to operate the cooling fan at 5 specific percentages in order to avoid the speed regions that create undesirable noise and vibration. During normal operating conditions the ECM may initially activate the cooling fan at 4 or 5 % and then increase to the desired percentages to satisfy powertrain cooling requirements. Generally, the ECM will operate the cooling fan at specific percentages but, may scale the percentages either higher or lower in response to generator demand. The percentages at which the cooling fan operates may vary between vehicle lines and engines.

The cooling fan control module is thermally protected to prevent module damage in the case of a short circuit condition in the cooling fan motor. The scan tool output control is only capable of operating the cooling fan in the speed percentages allowed by the ECM. When multiple cooling fan speed requests are received, the ECM operates the fan at the highest of the speed requests. The ECM commands the fans ON under the following conditions:

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

COOLING SYSTEM DESCRIPTION AND OPERATION

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 132°C (270°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 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

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

Charge Air Cooling System - LTG

The charge air cooling system's function is to reduce the temperature of the air charge that is heated during the turbocharging process, which improves the efficiency and performance of the Powertrain. The charge air cooling system is an air-to-air system that uses a separate charge air cooling radiator located between the condenser and the radiator to cool the air charge. Filtered air from the air induction system is compressed in the turbocharger, by an exhaust air driven turbine in the turbocharger. That compressed filtered air is then forced down the charge air cooler duct, through the charge air cooler radiator where it is cooled, and then proceeds up to the engine intake manifold, for use by the engine.

Charge Air Cooling System - LF3

The charge air cooling system function is to reduce the temperature of the air charge that is heated during the twin turbocharger process which improves the efficiency and performance of the Powertrain. The charge air cooling system is an air-to-water system that uses a separate charge air cooling radiator located in front of the condenser and the radiator to cool the air charge. An electric pump is used to flow coolant from the charge air cooler, through the twin turbocharger and charge air cooler reservoir, then back to the charge air cooler where the cycle repeats.

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 right 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 the cooling system. It contains a blow off or pressure relief valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring, which protects the radiator from excessive cooling system pressure. The vacuum valve is held against its seat by a spring, which permits opening of the valve to relieve vacuum created in the cooling system as it cools off. The vacuum, if not relieved, might cause the radiator and/or coolant hoses to collapse.

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

The pressure in the cooling system can get too high. When the cooling system pressure exceeds the rating of the pressure cap, it raises the pressure valve, venting the excess pressure and releasing coolant to the overflow portion of the surge tank, which is at atmospheric pressure.

As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing coolant from the overflow bottle to draw back into the upper surge tank. This equalizes the pressure in the cooling system with atmospheric pressure, preventing the radiator and coolant hoses from collapsing.

Surge Tank

This surge tank is actually two chambers connected together, a surge tank and an overflow bottle. The top chamber is the surge tank and is the highest point of the coolant system. It uses a threaded pressure cap, similar to the one used on a radiator or engine fill system. The bottom chamber is the overflow bottle. This is the air space in the cooling system where the coolant can expand into and contract from.

During vehicle use, the coolant heats and expands. The increased coolant volume can in some conditions push past the pressure cap and through a channel into the overflow bottle. As the coolant circulates, air is allowed to bubble out. This air is then transferred to the overflow bottle, through the surge tank cap, where it returns to the

atmosphere. Under normal operating conditions, no coolant is lost. Coolant without air bubbles absorbs heat much better than coolant with bubbles. When the engine cools, the coolant, without air bubbles, contracts back into the surge tank from the bottom of the overflow bottle.

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 cavitation 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

CAUTION: The transmission oil cooler system uses quick connect fittings throughout the system. Use a special tool to disconnect these quick connect fittings. Removing the transmission oil cooler lines without this tool will result in damage to the radiator, the transmission, and the transmission oil cooler

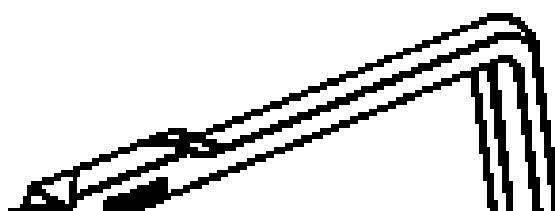
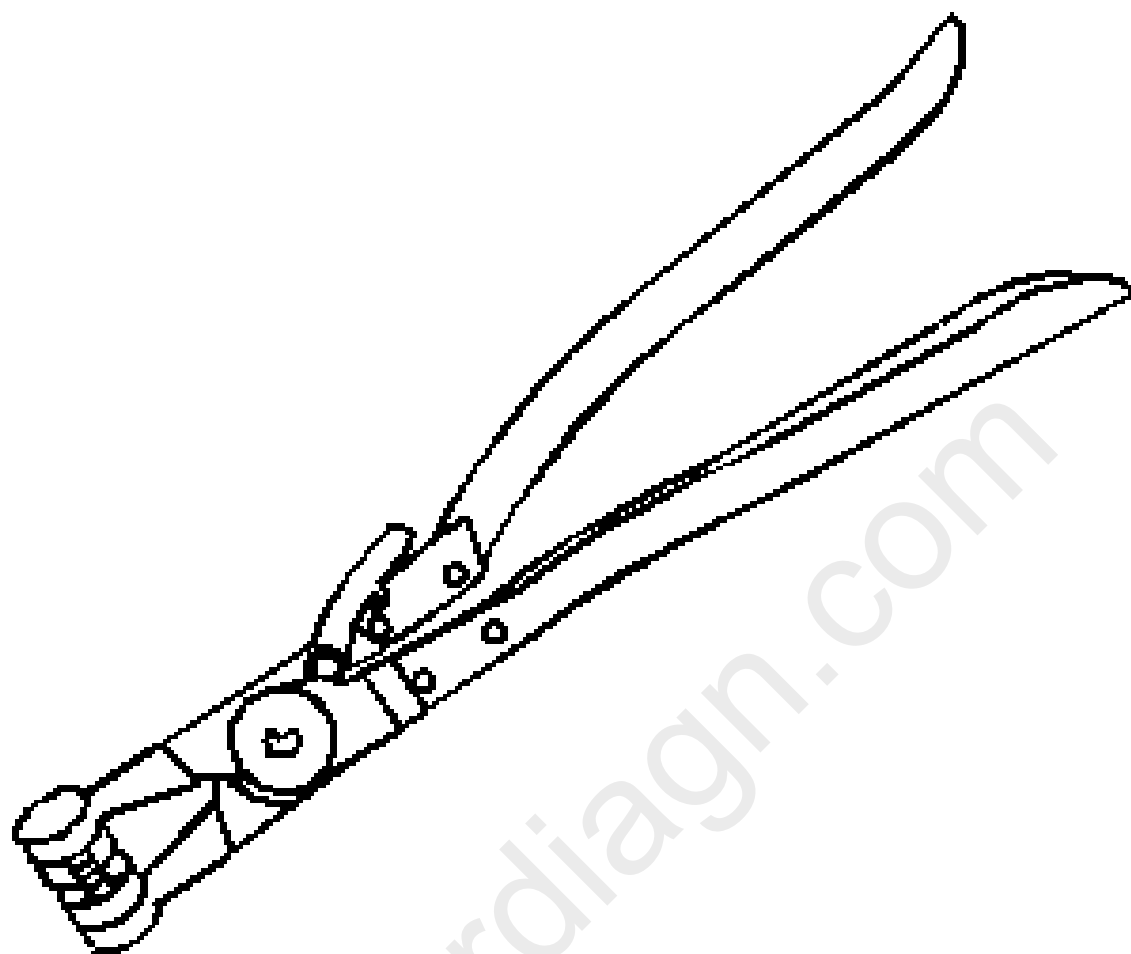
caused by mixing the transmission oil and coolant or due to transmission oil loss.

There are two transmission oil coolers in a series in the heavy duty transmission oil cooler system. The initial transmission oil cooler is a heat exchanger located in the end tank of the radiator. The transmission oil temperature is partially regulated by the temperature of the coolant leaving the radiator and passing over the heat exchanger. Lines from the transmission bring oil pumped at a high pressure to the end tank cooler. The oil out of the end tank cooler is plumbed to an air-to-oil cooler on the condenser multicooler assembly. This cooler provides additional cooling for heavy duty trailering. The transmission oil is then directed out of the external oil cooler and back to the transmission.

SPECIAL TOOLS AND EQUIPMENT

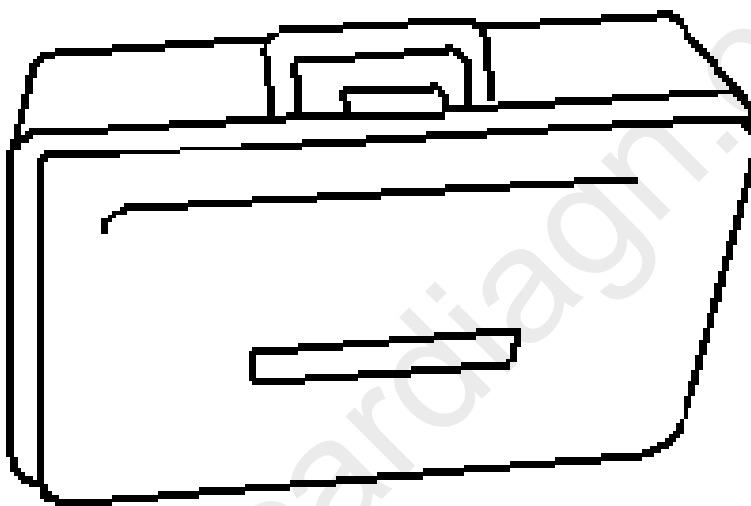
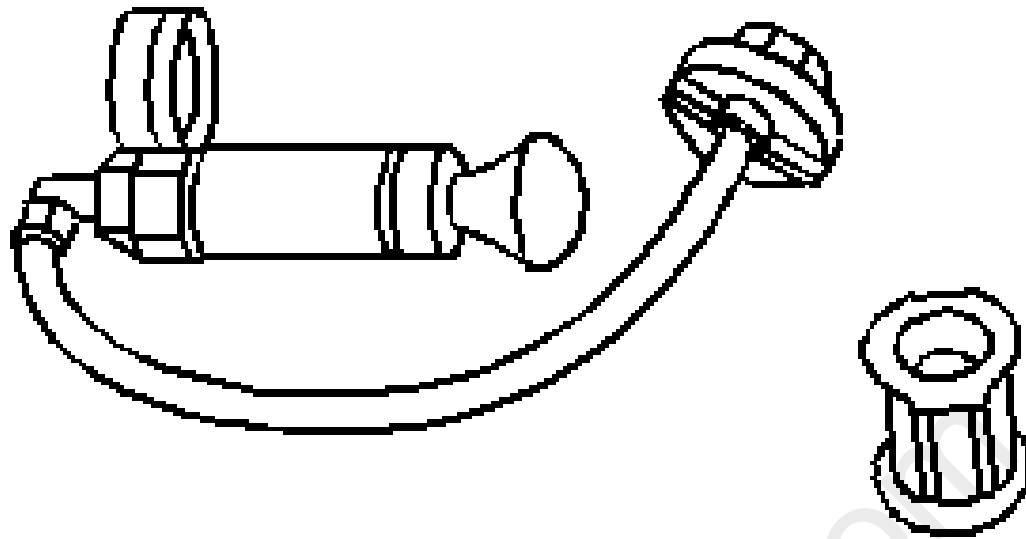
SPECIAL TOOLS

Illustration	Tool Number/ Description
	BO 38185 J 38185 Hose Clamp Pliers



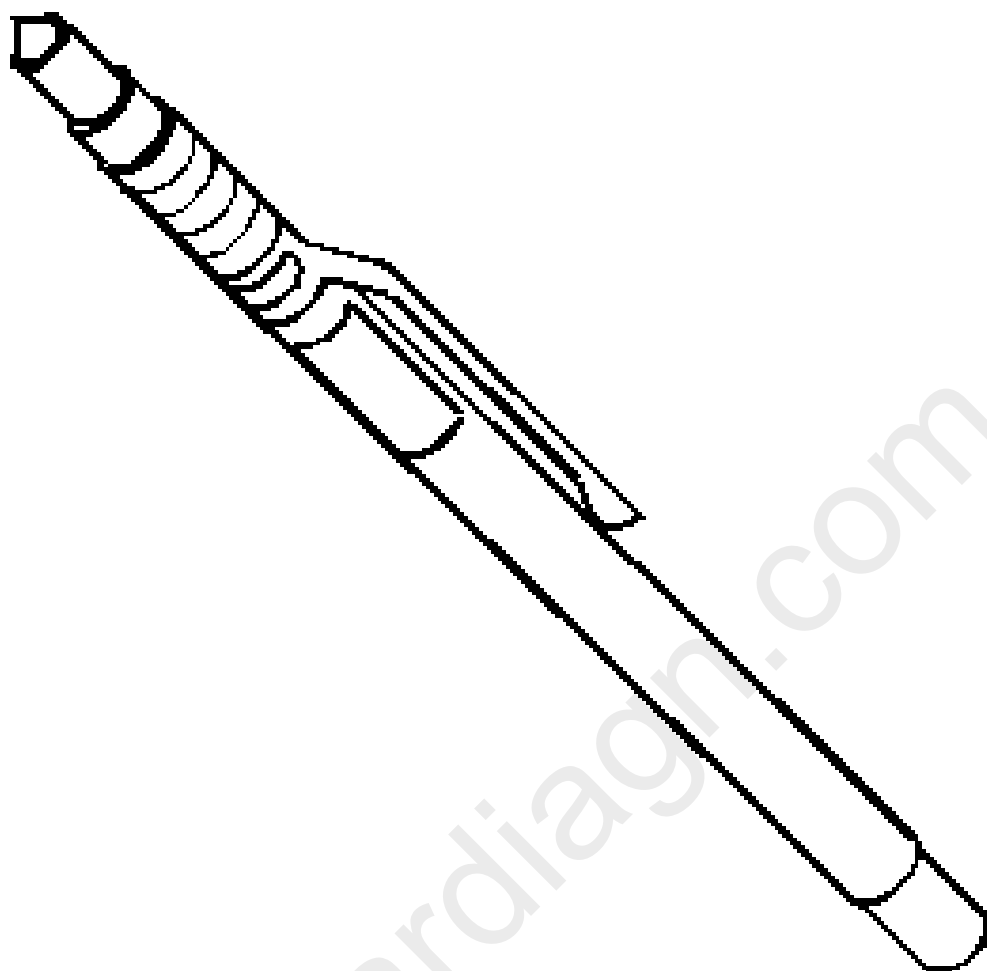
EL 35616-F
J 35616-F
Connector
Test
Adapter Kit

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



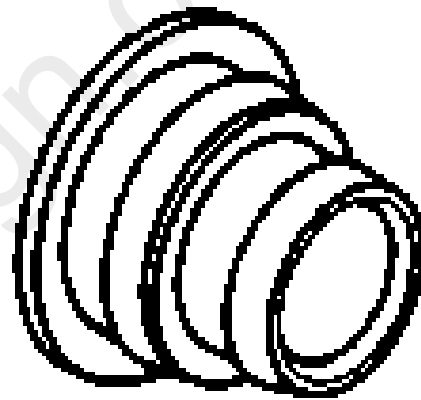
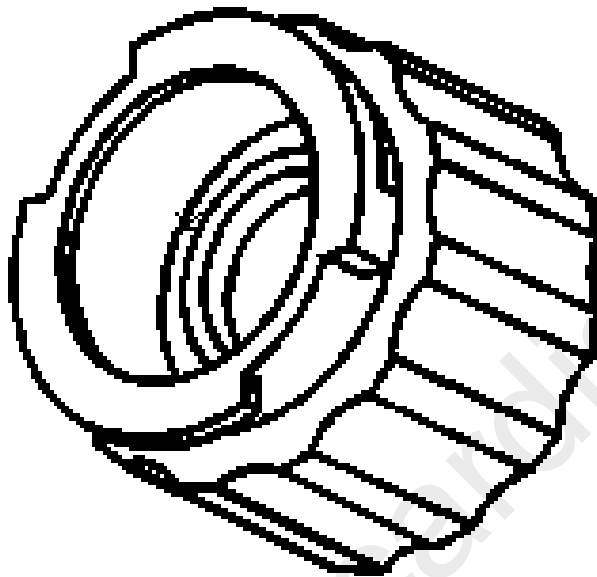
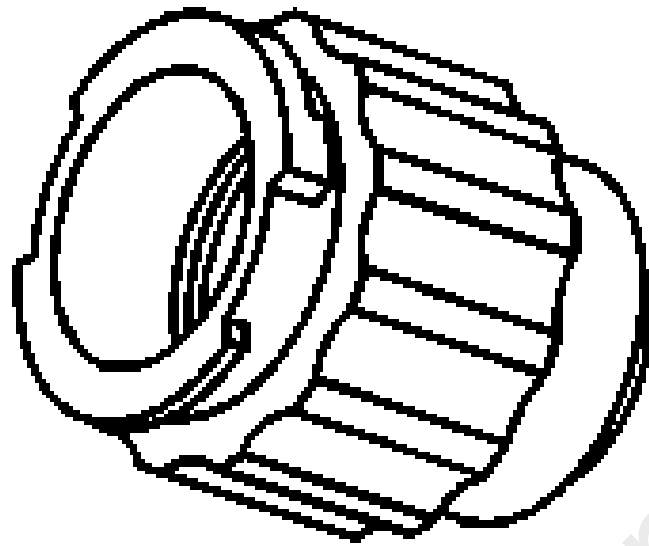
EN 46104
J 46104
Water
Pump
Pulley
Holding
Tool

GE 24731
J 24731
Tempilstick



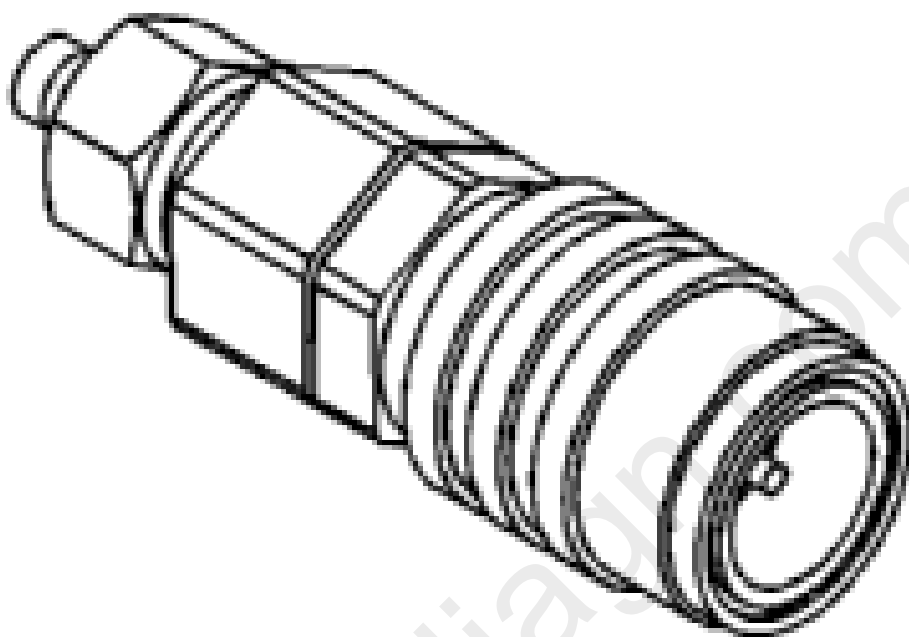
GE 26568
J 26568
Coolant and
Battery
Fluid Tester

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



GE 47716
Vac N Fill
Coolant
Refill Tool

GE 47716-
30
Vac N Fill
Coolant
Adapter



GE 50389 Coolant Pressure Test Quick Connector
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