

2017 ENGINE
Engine Cooling - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

NOTE: <i>All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.</i>	
Application	
Engine Coolant Thermostat Housing Gasket	
Engine Coolant Thermostat Housing Seal	
Heater Inlet And Outlet Pipe Gasket	
Thermostat Bypass Pipe Gasket	
Water Outlet Seal	
Water Pump Gasket	
Water Pump Seal	

Single Use Threaded Fastener/Component Tightening Specifications

NOTE: <i>All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.</i>	
Application	Specification
	Metric (English)
Water Pump Fastener (LFX)	
• First Pass:	10 N.m (89 lb in)
• Second Pass:	10 N.m (89 lb in)
• Final Pass:	Plus 45 Degrees

Reusable Threaded Fastener Tightening Specifications

NOTE: <i>All fasteners listed in this table can be reused after removal.</i>	
Application	Specification
	Metric (English)
Auxiliary Water Pump Bracket Bolt (LCV)	10 N.m (89 lb in)
Engine Coolant Air Bleed Pipe Fastener (LCV LFX)	9 N.m (80 lb in)
Engine Coolant Heater Cord Fastener	9 N.m (80 lb in)
Engine Coolant Temperature (ECT) Sensor	20 N.m (15 lb in)
Engine Coolant Thermostat Housing Bolt (LFX)	10 N.m (89 lb in)
Engine Coolant Thermostat Housing Fastener (LCV)	10 N.m (89 lb in)
Radiator Lower Bracket Fastener (LCV)	22 N.m (16 lb ft)

NOTE:

All fasteners listed in this table can be reused after removal.

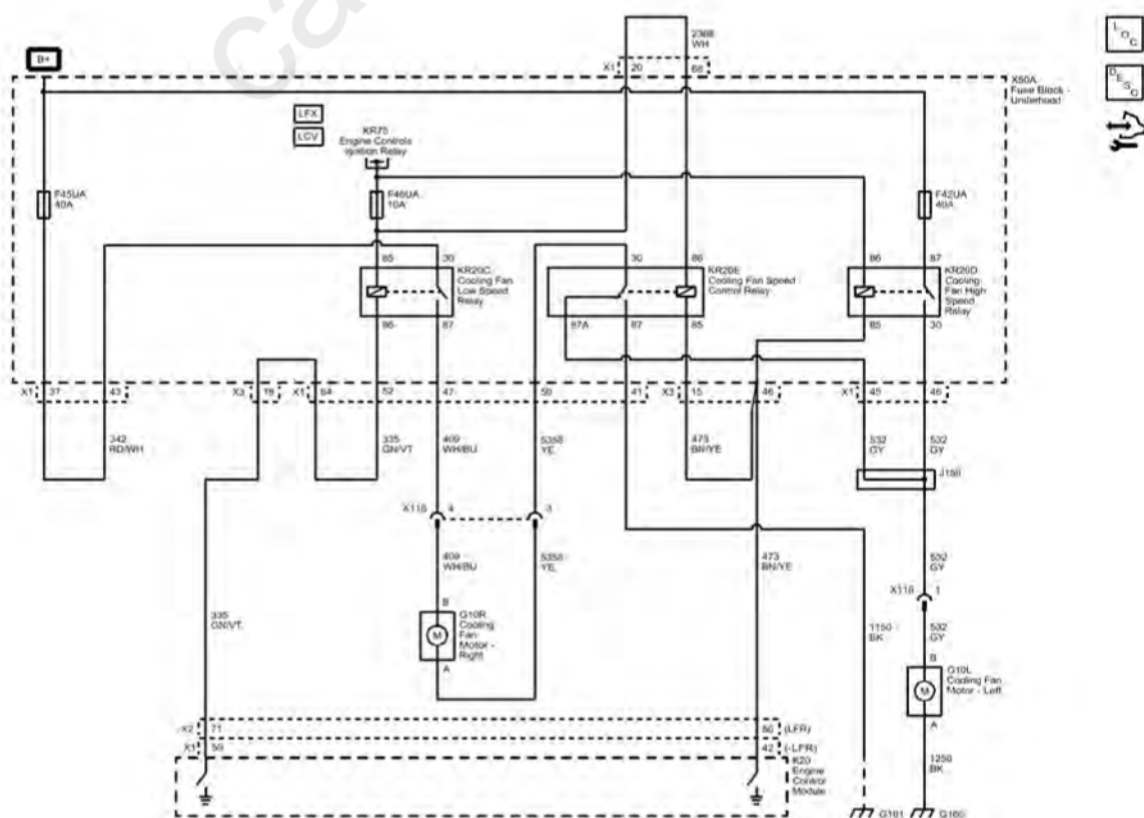
Application	Specification
	Metric (English)
Radiator Upper Bracket Bolt	22 N.m (16 lb ft)
Thermostat Bypass Pipe Fastener (LCV)	10 N.m (89 lb in)
Water Outlet Bolt (LFX)	10 N.m (89 lb in)
Water Outlet Fastener (LCV)	12 N.m (106 lb in)
Water Pump Bolt (LCV)	25 N.m (18 lb ft)
Water Pump Pulley Fastener (LFX)	10 N.m (89 lb in)

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	US English
Cooling System		
2.5L (LCV) Engine	7.4 L	7.8 qt
3.6L (LFX) Engine	9.4 L	9.9 qt

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 Fans**

DIAGNOSTIC INFORMATION AND PROCEDURES

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0480

Cooling Fan Relay 1 Control Circuit

DTC P0481

Cooling Fan Relays 2 and 3 Control Circuit

DTC P0691

Cooling Fan Relay 1 Control Circuit Low Voltage

DTC P0692

Cooling Fan Relay 1 Control Circuit High Voltage

DTC P0693

Cooling Fan Relays 2 and 3 Control Circuit Low Voltage

DTC P0694

Cooling Fan Relays 2 and 3 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0480	P0480, P0481	-	-
Relay Switch B+	1	1	-	-
Low Speed Cooling Fan Relay Control	P0691	P0480, P0691	P0692	-
High Speed Cooling Fan Relay Control	P0693	P0481 or 1	P0694	-
Cooling Fan Speed Control Relay Control	P0693	P0481 or 1	P0694	-
Relay Controlled Output	1	1	2	-
1. Fan(s) inoperative without a DTC 2. Fan(s) always ON without a DTC				

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. The ECM activates the

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

Conditions for Running the DTC

- The ignition voltage is greater than 11 volts.
- The ECM driver transitions from ON to OFF or from OFF to ON.
- DTCs P0480, P0481, P0691, P0692, P0693, and P0694 run continuously when the conditions above are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

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

Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates both fans at a low speed
 - Cooling Fan Relays 2 and 3 operates one fan at a high speed
 - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **[COMPONENT CONNECTOR END VIEWS - INDEX](#)**
- **[Electrical Center Identification Views](#)**

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **[Circuit Testing](#)**
- **[Connector Repairs](#)**
- **[Testing for Intermittent Conditions and Poor Connections](#)**
- **[Wiring Repairs](#)**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Circuit/System Verification

1. Ignition ON.
2. Verify an audible click is heard or felt from cooling fan relays 1, 2, and 3 when commanding the cooling fans ON and OFF with a scan tool.
 - **If a click is not heard or felt at one or more of the relays**

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

Refer to Circuit/System Testing
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

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

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

2. Verify that a test lamp illuminates between ground and a relay coil ignition circuit terminal listed below:
 - KR20C Cooling Fan Low Speed Relay terminal 85/2
 - KR20D Cooling Fan High Speed Relay terminal 86/1
 - KR20E Cooling Fan Speed Control Relay terminal 86/1
 - **If the test lamp does not illuminate**
 1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Remove the test lamp.
 2. Test for less than 2 Ω in the ignition circuit of the appropriate cooling fan relay, end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Remove the test lamp.
 2. Test for infinite resistance between the appropriate cooling fan relay ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance test or replace the appropriate cooling fan relay.
 - **If the test lamp illuminates**

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

3. Connect a DMM, set on the diode setting, between ground and a relay control circuit terminal listed below:
 - KR20C cooling fan low speed relay terminal 86/1
 - KR20D cooling fan high speed relay terminal 85/2
 - KR20E cooling fan speed control relay terminal 85/2

4. Verify the DMM reading is greater than 2.5 V or displays O.L with the cooling fan relays commanded OFF with a scan tool.
 - **If 2.5 V or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the appropriate relay coil control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 2.5 V or displays O.L.**
5. Verify the DMM reading is less than 1 V when commanding the cooling fan relays ON with a scan tool.
 - **If greater than 1 V or displays OL.**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the appropriate cooling fan relay control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 3. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
 4. Test for less than 2 Ω in the appropriate cooling fan relay control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 1 V**
6. Test or replace the appropriate cooling fan relay.

Component Testing

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

Replace the cooling fan relay.
 - **If between 70 - 110 Ω**
4. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87

OR

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

Replace the cooling fan relay.
 - **If infinite resistance**

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

5. Test for less than 2 Ω between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.

- **If 2 Ω or greater**

Replace the KR20E Cooling Fan Speed Control Relay.

- **If less than 2 Ω**

6. Install a 10 A fused jumper wire between relay terminal 85 or 2 and 12 V.

7. Install a jumper wire between relay terminal 86 or 1 and ground.

8. Test for less than 2 Ω between terminals 3/30 and 5/87.

- **If 2 Ω or greater**

Replace the cooling fan relay.

- **If less than 2 Ω**

9. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- [Relay Replacement \(Attached to Wire Harness\)](#) [Relay Replacement \(Within an Electrical Center\)](#)
- [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 $^{\circ}$ C (270 $^{\circ}$ 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 (LFR)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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, P0481, P0691, P0692, P0693, or P0694 is not set.

- **If a DTC is set**

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

- **If no DTCs is set**

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 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 for Running the DTC.

- **If the DTC sets**

Refer to **Symptoms - Engine Cooling**.

- **If the DTC does not set**

6. All OK

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

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

Review the system operation in order to familiarize yourself with the system functions.

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 areas:

- Ensure that the ECM grounds are clean, tight, and correctly located. Refer to [Master Electrical Component List](#) , and [COMPONENT CONNECTOR END VIEWS - INDEX](#) .
- Inspect cooling system hoses and pipes for splits, kinks, and proper connections. Inspect thoroughly for any type of a leak or a restriction.
- Inspect for a dirty or restricted radiator and HVAC condenser.
- Inspect for aftermarket devices which could affect the operation of the Cooling System. Refer to [Checking Aftermarket Accessories](#) .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the surge tank reservoir for the proper coolant level.

Identifying Intermittent Conditions

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

- Moisture and water intrusion in connectors, terminals, and components
- Connector mating
- Terminal contact

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

If an intermittent is determined, refer to [Testing for Intermittent Conditions and Poor Connections](#) for specific strategies in diagnosing intermittent conditions.

Symptom List

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

- [Cooling Fan Always On](#)
- [Cooling Fan Inoperative](#)
- [Coolant Heater Inoperative](#)
- [Engine Overheating](#)
- [Loss of Coolant](#)
- [Thermostat Diagnosis](#)
- [Engine Fails To Reach Normal Operating Temperature](#)

COOLING FAN ALWAYS ON

Diagnostic Instructions

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

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

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

suspected, refer to the temperature versus resistance tables in the appropriate Engine Controls subsection.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- [COMPONENT CONNECTOR END VIEWS - INDEX](#)
- [Electrical Center Identification Views](#)

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.
 - **If a DTC is set**

Refer to [DTC P0480, P0481, P0691, P0692, P0693, or P0694](#).

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

Refer to Diagnostic Aids and [Symptoms - Engine Cooling](#) for further diagnosis.

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

Refer to Circuit/System Testing.

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

Circuit/System Testing

Both Cooling Fans Always ON

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

- **If the cooling fans are ON**

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

- **If the cooling fans are OFF**

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

One Cooling Fan Always ON

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

Component Testing

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

Replace the KR20 cooling fan relay.
 - **If between 70 - 110 Ω**
4. Test for infinite resistance between the following terminals:
 - 30/3 and 86/1
 - 30/3 and 87/5
 - 30/3 and 85/2
 - 85/2 and 87/5
 - **If less than infinite resistance**

Replace the KR20 Cooling Fan Relay.
 - **If infinite resistance**

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

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

Replace the KR20E Cooling Fan Speed Control Relay.
 - **If less than 2 Ω**
6. Install a 10 A fused jumper wire between relay terminal 85 or 2 and 12 V.
7. Install a jumper wire between relay terminal 86 or 1 and ground.
8. Test for less than 2 Ω between terminals 30/3 and 87/5.
 - **If 2 Ω or greater**

Replace the KR20 Cooling Fan Relay.

- **If less than 2 Ω**

9. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

[Relay Replacement \(Attached to Wire Harness\)](#) [Relay Replacement \(Within an Electrical Center\)](#)

COOLING FAN INOPERATIVE

Diagnostic Instructions

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

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates both fans at a low speed
 - Cooling Fan Relays 2 and 3 operates one fan at a high speed
 - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed

Reference Information

Schematic Reference

[Engine Heating/Cooling Schematics](#)

Connector End View Reference

- [COMPONENT CONNECTOR END VIEWS - INDEX](#)
- [Electrical Center Identification Views](#)

Description and Operation

[Cooling Fan Description and Operation](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.
 - **If a DTC is set**

Refer to **DTC P0480, P0481, P0691, P0692, P0693, or P0694.**
 - **If no DTCs is set**
3. Verify that both cooling fans turn ON and OFF and operate at low and high speed, when commanding the appropriate cooling fan relays ON and OFF with a scan tool.
 - **If a cooling fan does not operate**

Refer to Circuit/System Testing
 - **If both cooling fans operate**
4. All OK.

Circuit/System Testing

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

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

3. Connect a DMM, set on the diode setting, between ground and a relay control circuit terminal listed below:
 - KR20D Cooling Fan High Speed Relay terminal 85/2
 - KR20E Cooling Fan Speed Control Relay terminal 85/2

4. Verify the DMM reading is less than 1 V when commanding the cooling fan relays ON with a scan tool.
 - **If greater than 1 V or displays OL.**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the appropriate cooling fan relay control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 3. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
 4. Test for less than 2 Ω between the KR20E Cooling Fan Speed Control Relay terminal 85/2 and KR20D Cooling Fan High Speed Relay terminal 85/2.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 1 V**
5. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G10L Cooling Fan Motor - Left. It may take up to 2 minutes for all vehicle systems to power down.
6. Test for less than 5 Ω between the circuits listed below and ground:
 - G10L Cooling Fan Motor - Left terminal A
 - KR20E Cooling Fan Speed Control Relay terminal 87/5
- **If 5 Ω or greater**
 1. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Test for less than 2 Ω in the appropriate ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
- **If less than 5 Ω**
7. Connect the harness connector at the G10L Cooling Fan Motor - Left.
8. Connect a 50 A fused jumper between the KR20D Cooling Fan High Speed Relay terminals 30/3 and 87/5.
9. Ignition ON, verify the G10L Cooling Fan Motor - Left is activated at high speed.
 - **If the cooling fan does not activate or jumper fuse opens**
 1. Disconnect the harness connector at the G10L Cooling Fan Motor - Left.
 2. Test for less than 2 Ω in the circuit between KR20D Cooling Fan High Speed Relay terminal 30/3 and the G10L Cooling Fan Motor - Left terminal B.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the G10L Cooling Fan Motor - Left.
 - **If the cooling fan activates**
10. Ignition OFF, connect a fused jumper between the KR20E Cooling Fan Speed Control Relay switch circuit terminal 30/3 and the ground circuit terminal 87/5.
11. Connect a 40 A fused jumper between the KR20C Cooling Fan Low Speed Relay terminals 30/3 and 87/5.
12. Ignition ON, verify the G10R Cooling Fan Motor - Right is activated at high speed.
 - **If the cooling fan does not activate**
 1. Disconnect the harness connector at the G10R Cooling Fan Motor - Right.
 2. Test for less than 2 Ω in the circuit between KR20C Cooling Fan Low Speed Relay terminal 87/5 and the G10R Cooling Fan Motor - Right terminal B.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for less than 2 Ω in the circuit between KR20E Cooling Fan Speed Control Relay terminal 30/3 and the G10R Cooling Fan Motor - Right terminal A.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the G10R Cooling Fan Motor - Right.
 - **If the cooling fan activates**
13. Ignition OFF, Install the KR20E Cooling Fan Speed Control Relay.
 14. Ignition ON, verify both fan motors activate at low speed.
 - **If both cooling fans do not activate at low speed**
 1. Disconnect both cooling fan motor harness connectors and the KR20E Cooling Fan Speed Control Relay.
 2. Test for less than 2 Ω in circuit between KR20E Cooling Fan Speed Control Relay terminal 87A/4 and the G10L Cooling Fan Motor - Left terminal B.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for infinite resistance between KR20E Cooling Fan Speed Control Relay terminal listed below and ground.
 - KR20E Cooling Fan Speed Control Relay terminal 30/3
 - KR20E Cooling Fan Speed Control Relay terminal 87A/4
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite, replace the KR20E cooling fan speed control relay.
 - **If both cooling fans activate**
 15. Ignition OFF, test or replace the cooling fan relay listed below as appropriate:
 - KR20C Cooling Fan Low Speed Relay
 - KR20D Cooling Fan High Speed Relay

Component Testing

1. Ignition OFF.
2. Disconnect a KR20 Cooling Fan Relay.
3. Test for 70 - 110 Ω between terminals 85/2 and 86/1.
 - **If less than 70 Ω or greater than 110 Ω**
 Replace the KR20 cooling fan relay.
 - **If between 70 - 110 Ω**
4. Test for infinite resistance between the following terminals:
 - 30/3 and 86/1
 - 30/3 and 87/5
 - 30/3 and 85/2
 - 85/2 and 87/5
 - **If less than infinite resistance**
 Replace the KR20 Cooling Fan Relay.
 - **If infinite resistance**

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

5. Test for less than 2 Ω between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
 - **If 2 Ω or greater**
 Replace the KR20E Cooling Fan Speed Control Relay.
 - **If less than 2 Ω**
6. Install a 20 A fused jumper wire between relay terminal 85/2 and 12 V.
7. Install a jumper wire between relay terminal 86/1 and ground.

8. Test for less than 2 Ω between terminals 3/30 and 87/5.

- **If 2 Ω or greater**

Replace the KR20 Cooling Fan Relay.

- **If less than 2 Ω**

9. All OK.

Repair Instructions

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

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Engine Coolant Fan Shroud Replacement (LFX)** **Engine Coolant Fan Shroud Replacement (LCV)**

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. Does the engine still overheat?	Go to Step 3	System OK
3	Check for kinked or pinched surge tank hoses, especially at the radiator. Are any surge tank hoses kinked or pinched?	Go to Step 4	Go to Step 5
4	1. Relieve any kinks by rerouting the hoses. 2. Replace the hoses, if necessary. Does the engine still overheat?	Go to Step 5	System OK
5	Check for loose, missing, or damaged radiator air seals or deflectors. Are there any loose, missing, or damaged radiator air seals or deflectors?	Go to Step 6	Go to Step 7
6	Repair or replace any loose, missing, or damaged radiator air seals or deflectors. Does the engine still overheat?	Go to Step 7	System OK
7	Check the coolant concentration. Does the coolant concentration test correctly?	Go to Step 9	Go to Step 8
8	Replace the coolant, if necessary. Does the engine still overheat?	Go to Step 9	System OK
9	NOTE: Use the correct pressure cap. Check the system for loss of pressure. Refer to <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

Step	Action	Yes	No
12	Replace the engine coolant temperature sensor. Refer to <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. 3. Refill the coolant. Does the engine still overheat?	Go to Step 17	System OK
17	Check for an inoperative cooling fan. Is the cooling fan inoperative?	Go to Step 18	Go to Step 19
18	Replace the cooling fan. Refer to <u>Engine Coolant Fan Replacement (LFX)Engine Coolant Fan Replacement (LCV)</u> . Does the engine still overheat?	Go to Step 19	System OK
19	Perform the Thermostat Diagnosis. Refer to <u>Thermostat Diagnosis</u> . Did you find and correct the condition?	Go to Step 21	Go to Step 20
20	Check for a damaged water pump. The impeller blades may be eroded or broken. Is the water pump damaged?	Go to Step 21	System OK
21	Replace the water pump. Refer to <u>Water Pump Replacement (LFX)Water Pump Replacement (LCV)</u> . Does the engine still overheat?	-	System OK

LOSS OF COOLANT

Step	Action	Yes	No
DEFINITION: The cooling system is losing coolant either internally or externally.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to <u>Symptoms - Engine Cooling</u>
2	Repair any present DTCs. Refer to <u>Diagnostic System Check - Vehicle</u> . Is the action complete?	Go to Step 3	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to Step 5	Go to Step 4
4	Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static)</u> . Is the action complete?	Go to Step 5	-
5	If the engine is suspected to have a coolant leak into a cylinder, the coolant can hydraulically lock the engine. Does the engine crankshaft rotate?	Go to Step 6	Go to Step 28

Step	Action	Yes	No
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to Step 29	Go to Step 7
7	Extended operation with a low coolant level can cause engine internal component failure. Is the engine knocking?	Go to Step 31	Go to Step 8
8	1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust pipe. Is a heavy white smoke present from the exhaust pipe?	Go to Step 9	Go to Step 10
9	• Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. • Condensation in the exhaust system can cause an odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?	Go to Step 30	Go to Step 10
10	WARNING: Refer to <u>Moving Parts and Hot Surfaces Warning</u> . With the engine idling, inspect the surge tank. Does the surge tank discharge coolant while the engine is idling?	Go to Step 15	Go to Step 11
11	Visually inspect the hoses, pipes and hose clamps at the following locations: • Coolant surge tank • Heater core • Radiator Are any of the hoses, clamps or pipes leaking?	Go to Step 22	Go to Step 12
12	Visually inspect the following components: • The coolant pressure cap • The core plugs • The cylinder head gaskets • The engine block • The intake manifold • The radiator • The thermostat housing • The water pump Are any of the listed components leaking?	Go to Step 22	Go to Step 13

Step	Action	Yes	No
13	1. Pressure test the cooling system. Refer to Cooling System Leak Testing. 2. With the cooling system pressurized, visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to Step 22	Go to Step 14
14	Pressure test the coolant pressure cap. Refer to Pressure Cap Testing. Does the coolant pressure cap hold pressure?	Go to Step 16	Go to Step 23
15	Pressure test the coolant pressure cap. Refer to Pressure Cap Testing. Does the coolant pressure cap hold pressure?	Go to Step 32	Go to Step 23
16	Inspect for the following conditions: • A coolant smell inside of the vehicle • Coolant in the HVAC module drain tube • Coolant on the vehicle floor covering near the HVAC module Is coolant present?	Go to Step 24	Go to Step 17
17	1. Add 30 ml (1 oz) of Extended Life Coolant Leak Detection Dye to the cooling system for each 15 liters (4 gallons) of coolant. Refer to Adhesives, Fluids, Lubricants, and Sealers, and Approximate Fluid Capacities. 2. Start the vehicle and allow the engine to reach normal operating temperature. 3. Shut the engine off. 4. Use J 42220 Universal 12V Leak Detection Lamp to visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to Step 22	Go to Step 18
18	Use J 42220 Universal 12V Leak Detection Lamp to inspect for the following conditions: • Coolant dye in the HVAC module drain tube • Coolant dye on the vehicle floor covering near the HVAC module Is coolant dye present?	Go to Step 24	Go to Step 19
19	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is there a milky substance on under the oil fill cap?	Go to Step 20	Go to Step 21
20	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is there a milky substance on the engine oil fluid level indicator?	Go to Step 30	Go to Step 21
21	Inspect the automatic transmission oil fluid level indicator, if equipped, for a gray/white milky substance. Is there a milky substance on the automatic transmission fluid level indicator?	Go to Step 25	Go to Step 33

Step	Action	Yes	No
22	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to Step 33	-
23	Replace the coolant pressure cap. Is the repair complete?	Go to Step 33	-
24	Replace the heater core. Refer to <u>Heater Core Replacement</u> . Is the repair complete?	Go to Step 33	-
25	1. Remove the transmission oil cooler lines from the radiator. 2. Pressure test the cooling system. Refer to <u>Cooling System Leak Testing</u>. 3. Inspect the transmission oil cooler for coolant. Is coolant present?	Go to Step 26	Go to Step 27
26	1. Replace the radiator. Refer to <u>Radiator Replacement (LFX) Radiator Replacement (LCV)</u>. 2. Service the automatic transmission. Refer to <u>Engine Coolant/Water in Transmission</u> Is the repair complete?	Go to Step 33	-
27	Install the cooler lines to the radiator. Is the action complete?	Go to Step 33	-
28	Repair the engine no crank condition. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> Is the repair complete?	Go to Step 33	-
29	Repair the engine overheating condition. Refer to <u>Engine Overheating</u> . Is the repair complete?	Go to Step 33	-
30	Repair the engine internal coolant leak. Refer to <u>Coolant in Combustion Chamber</u> , or <u>Coolant in Engine Oil</u> Is the repair complete?	Go to Step 33	-
31	Repair the engine knock. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u> Is the repair complete?	Go to Step 33	-
32	Repair the combustion pressure in the cooling system problem. Refer to <u>Coolant in Combustion Chamber</u> Is the repair complete?	Go to Step 33	-
33	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

THERMOSTAT DIAGNOSIS

Thermostat Test Procedure Using Glycol

Inspect the operation of the thermostat by hanging the thermostat on a hook in a 33 percent glycol solution.

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

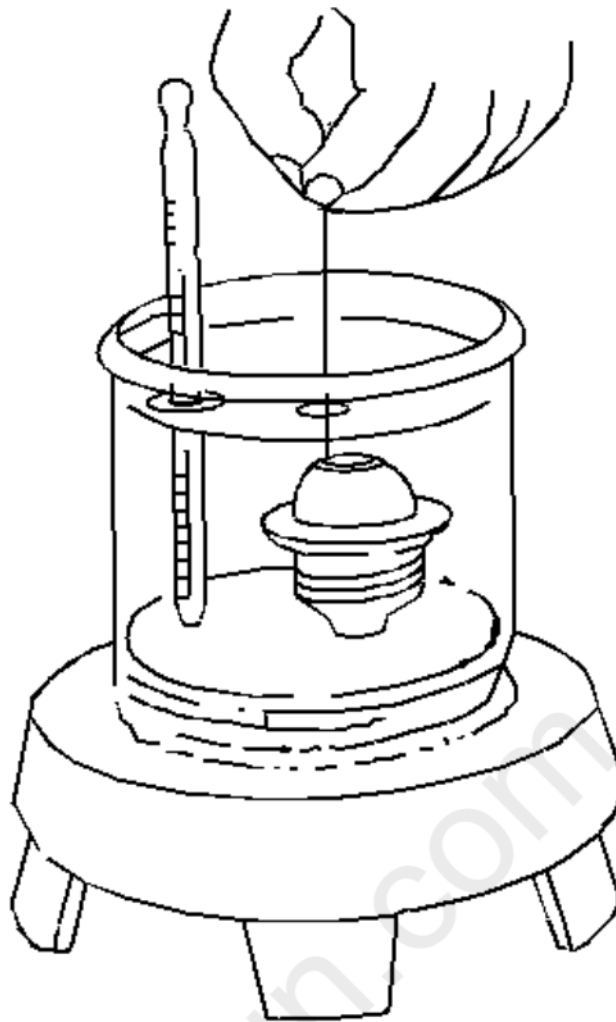


Fig. 2: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS COMPANY

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

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

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

COOLANT HEATER INOPERATIVE

Diagnostic Instructions

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

Circuit/System Description

The 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 40 - 55 Ω between the terminals of the E19 Coolant Heater.
 - **If not within 40 - 55 Ω**
Replace the E19 Coolant Heater.
 - **If within 40 - 55 Ω**
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 for less than 2 Ω between the engine coolant heater cord plug and the engine coolant heater cord connector for each circuit.
 - **If greater than 2 Ω**
Replace the engine coolant heater cord.
 - **If less than 2 Ω**
All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic repair.

- [Coolant Heater Replacement \(LFX\)](#)[Coolant Heater Replacement \(LCV\)](#)
- [Coolant Heater Cord Replacement \(LFX\)](#)[Coolant Heater Cord Replacement \(LCV\)](#)

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

Step	Action	Yes	No
2	1. Diagnose and repair the cooling fan system. Refer to Cooling Fan Always On . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 3	System OK
3	Install the Scan Tool to the DLC. Compare the Scan Tool coolant temperature reading to the I/P cluster coolant temperature. Is the I/P cluster coolant temperature close to the reading on the Scan Tool?	Go to Step 5	Go to Step 4
4	1. Diagnose and repair the coolant temperature gauge system. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 5	System OK
5	Inspect the thermostat for proper operation. Refer to Thermostat Diagnosis . Is the thermostat operating properly?	Go to Step 1	Go to Step 6
6	1. Replace the thermostat. Refer to Engine Coolant Thermostat Housing Replacement (LFX)Engine Coolant Thermostat Housing Replacement (LCV) . 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.

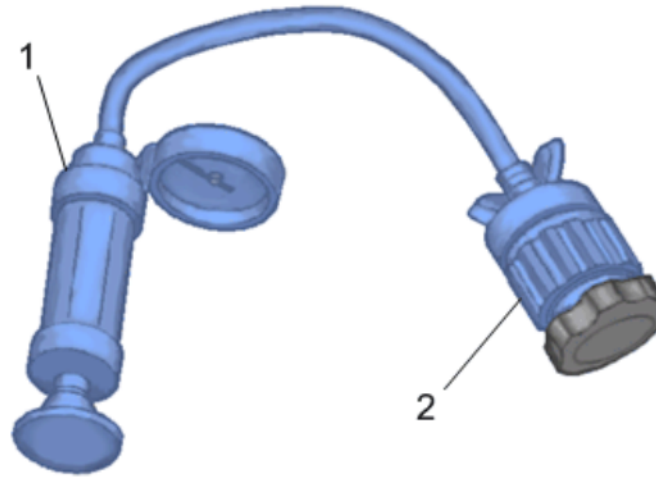


Fig. 3: Identifying Pressure Cap Tester

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.

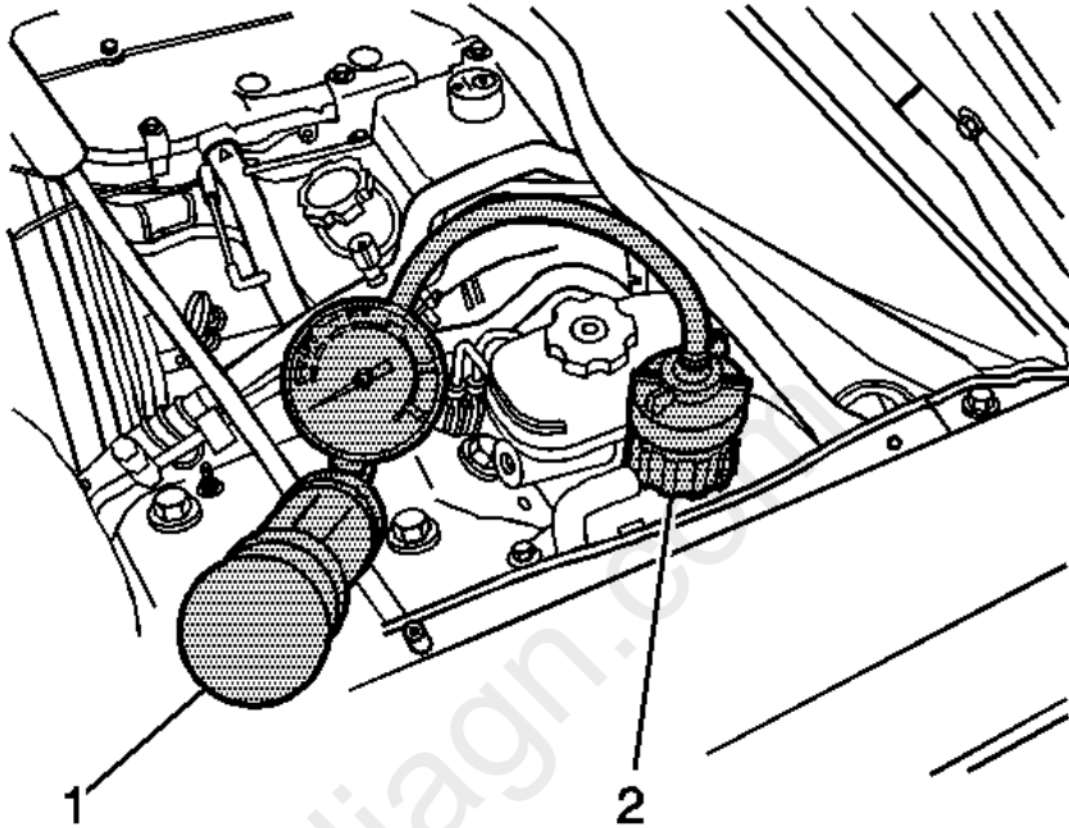


Fig. 4: Applying Pressure To Cooling System
Courtesy of GENERAL MOTORS COMPANY

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

Do not exceed the pressure cap rating.

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

Observe the gauge for any pressure loss.

6. Repair any leaks as required.

REPAIR INSTRUCTIONS

HOSE CLAMP REPLACEMENT GUIDELINES - SPRING TYPE

Special Tools

- **BO-38185** Hose Clamp Pliers
- **GE-47622** Hose Clamp Pliers.

Equivalent regional tools: [Special Tools](#)

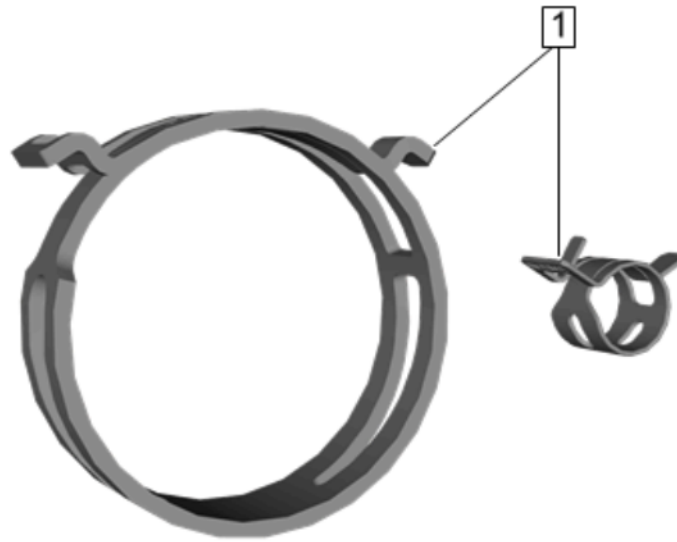


Fig. 5: Spring Type Hose Clamps

Courtesy of GENERAL MOTORS COMPANY

Vehicles utilize spring type hose clamps (1) to secure joints in which fluids, gases, or engine vacuum can travel to various vehicle systems. Spring type hose clamps are engineered to provide the proper amount of tension to maintain a leak & maintenance free joint for the life of the vehicle.

Spring type hose clamps have a special coating applied to the exterior of the clamp that is engineered to resist rust/corrosion, improve durability and increase the life of the hose clamp. If the coating is damaged, rust/corrosion could form resulting in the need to replace the hose clamp.

Many spring type hose clamps within GM utilize a small amount of adhesive placed directly on the hose clamp to secure the clamp to the mating hose for manufacturing purposes. Over time the strength of the adhesive will deteriorate. It is extremely important when a technician is attempting to service a joint or remove the hose clamp, that the clamp is not rotated or repositioned so that it tears and/or damages the hose. In this case, the hose and clamp must both be replaced.

When repairing a vehicle it is very important to observe the condition of both the hose and the spring type hose clamp as well as the orientation of the clamp to the hose.

If the spring type hose clamp(s) have any of the following conditions on any area of the clamp, replace the clamp(s) immediately.

- Rust/Corrosion
- Cracks
- Physical damage
- Leakage attributed to the retention of the clamp

Removing The Spring Type Hose Clamp

While keeping the hose stationary, use BO-38185 Hose Clamp Pliers or GE-47622 Hose Clamp Pliers and release the spring type hose clamp tension while attempting to separate the hose clamp from the hose.

- If the spring type hose clamp will not easily separate from the hose and/or the clamp tears or damages the hose, both the hose and hose clamp must be replaced
- If the spring type hose clamp is easily removed from the hose, the clamp can be reused provided that the clamp does not have any of the conditions as noted above.

If The Spring Type Hose Clamp Is Being Reused

It is extremely important that the spring type hose clamp is orientated to the hose in the exact same position as it was installed during vehicle assembly so that the hose clamp is not damaged or the hose clamp does not contact or damage any adjacent components. Do not use any type of adhesive on the hose clamp prior to installation.

When Reusing The Spring Type Hose Clamp and Replacing The Hose

- The inside and outside hose diameter must be identical between the new hose and the existing hose to guarantee proper hose clamp tension and joint integrity.
- Always place the existing spring type hose clamp in the same orientation as it was positioned prior to separating the joint. The new hose might have a marking on the hose indicating the correct position of a hose clamp, which should re-confirm the correct hose clamp position. The hose clamp should not contact any adjacent components after installation.

When Reusing The Spring Type Hose Clamp with an Existing Hose

Always place the existing spring type hose clamp in the same orientation as it was positioned prior to separating the joint. The existing hose might have an indentation or compression mark on the hose from where the hose clamp was installed previously. The hose clamp should identically overlay this position. The existing hose might also have a marking on the hose indicating the correct position of the hose clamp, which should re-confirm the correct hose clamp position. The hose clamp should not contact any adjacent components after installation.

If The Spring Type Hose Clamp Is Being Replaced

If the hose clamp needs to be replaced, always replace the hose as part of the service repair. It is extremely important that a new spring type hose clamp is orientated to the hose in the exact same position as it was installed during vehicle assembly so that the hose clamp is not damaged or the hose clamp does not contact or damage any adjacent components. Do not use any type of adhesive on the hose clamp prior to installation.

When Replacing The Spring Type Hose Clamp and Replacing The Hose

- The inside and outside hose diameter must be identical between the new hose and the existing hose to guarantee proper hose clamp tension and joint integrity.
- Always place the new spring type hose clamp in the same orientation as it was positioned prior to separating the joint. The new hose might have a marking on the hose indicating the correct position of a hose clamp, which should re-confirm the correct hose clamp position. The hose clamp should not contact any adjacent components after installation.

When Replacing The Spring Type Hose Clamp with an Existing Hose

Always place the new spring type hose clamp in the same orientation as it was positioned prior to separating the joint. The existing hose might have an indentation or compression mark on the hose from where a hose clamp was installed previously. The hose clamp should identically overlay this position. The existing hose might also have a marking on the hose indicating the correct position of the hose clamp, which should re-confirm the correct hose clamp position. The hose clamp should not contact any adjacent components after installation.

COOLING SYSTEM DRAINING AND FILLING (VACUUM AND FILL)

Special Tools

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

Draining Procedure

WARNING: With a pressurized cooling system, the coolant temperature in the radiator can be considerably higher than the boiling point of the solution at atmospheric pressure. Removal of the surge tank cap, while the cooling system is hot and under high pressure, causes the solution to boil

instantaneously with explosive force. This will cause the solution to spew out over the engine, the fenders, and the person removing the cap. Serious bodily injury may result.

1. Remove the coolant pressure cap.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
3. Remove the right front wheelhouse front liner to gain access to the drain plug. Refer to [Front Wheelhouse Liner Replacement](#) .
4. Place a drain pan under the drain cock.

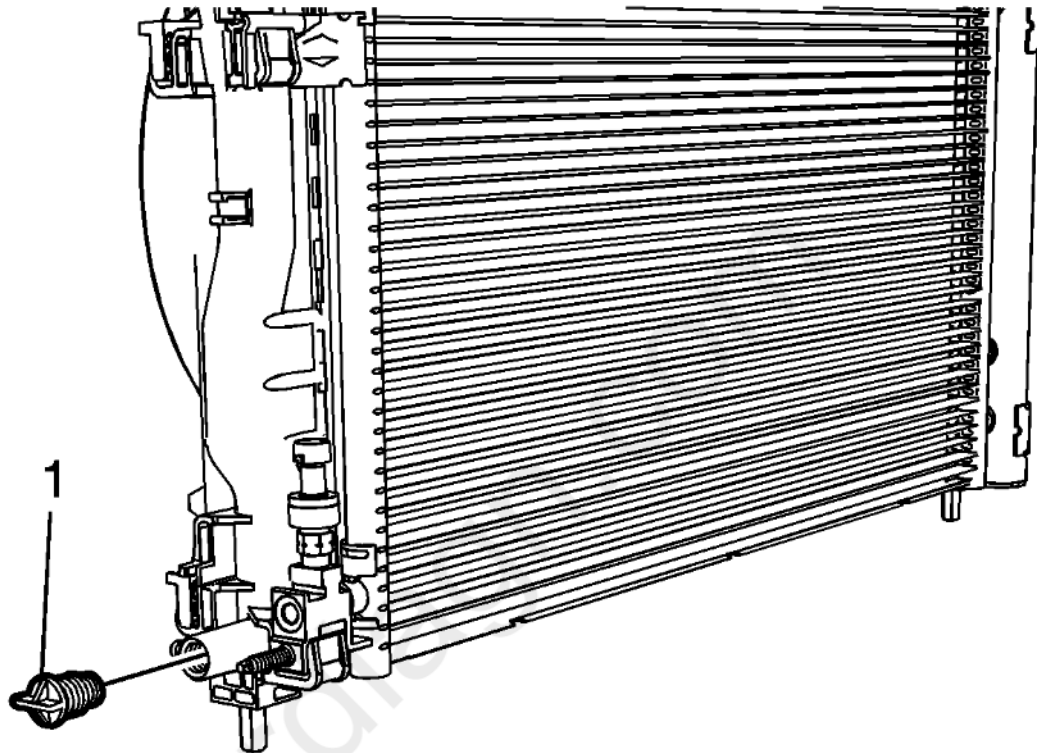


Fig. 6: Radiator Drain Cock

Courtesy of GENERAL MOTORS COMPANY

5. Remove the radiator drain cock (1).
6. Drain the cooling system.
7. Install the drain plug (1).
8. Install the right front wheelhouse front liner. Refer to [Front Wheelhouse Liner Replacement](#) .
9. Lower the vehicle.
10. Inspect the coolant.
11. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance - Follow the filling procedure.
 - Discolored - Follow the flush procedure. Refer to [Flushing](#).

Vac-N-Fill Procedure

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

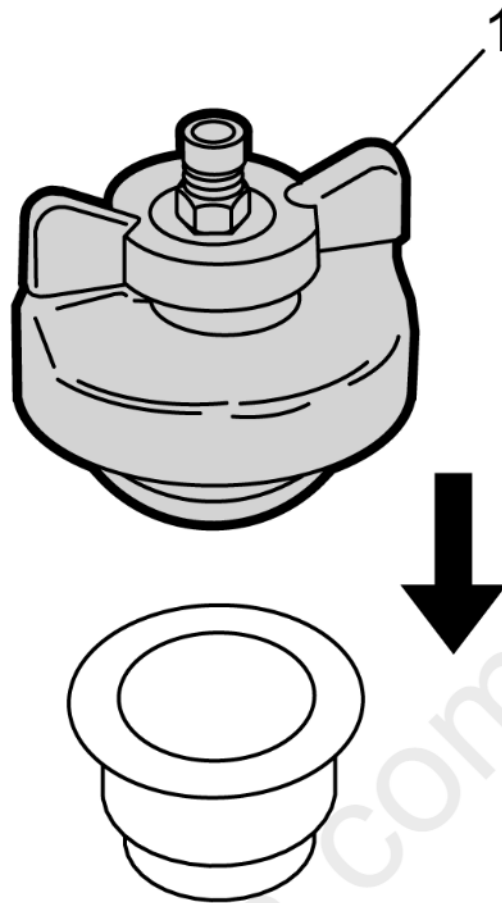


Fig. 7: Radiator Cap & Surge Tank Test Adapter
Courtesy of GENERAL MOTORS COMPANY

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).

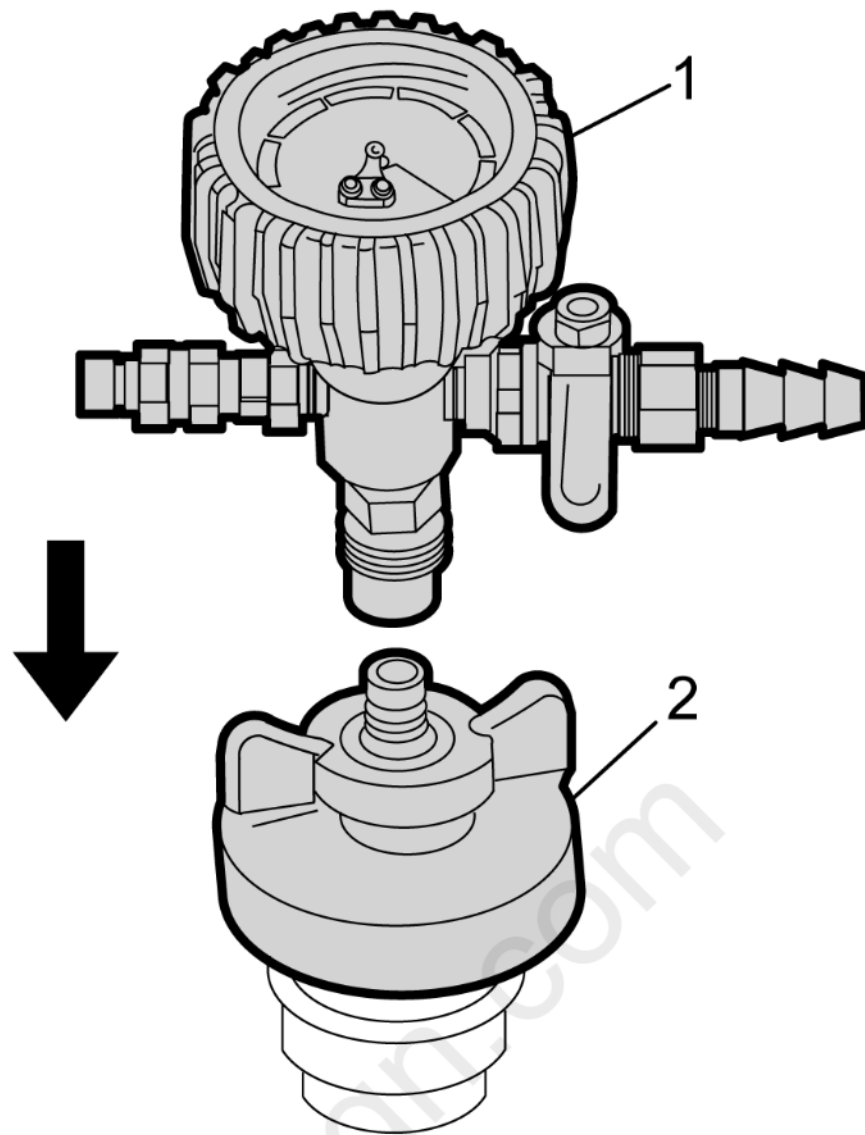


Fig. 8: Vacuum Gauge Assembly & Vac N Fill Cap
Courtesy of GENERAL MOTORS COMPANY

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

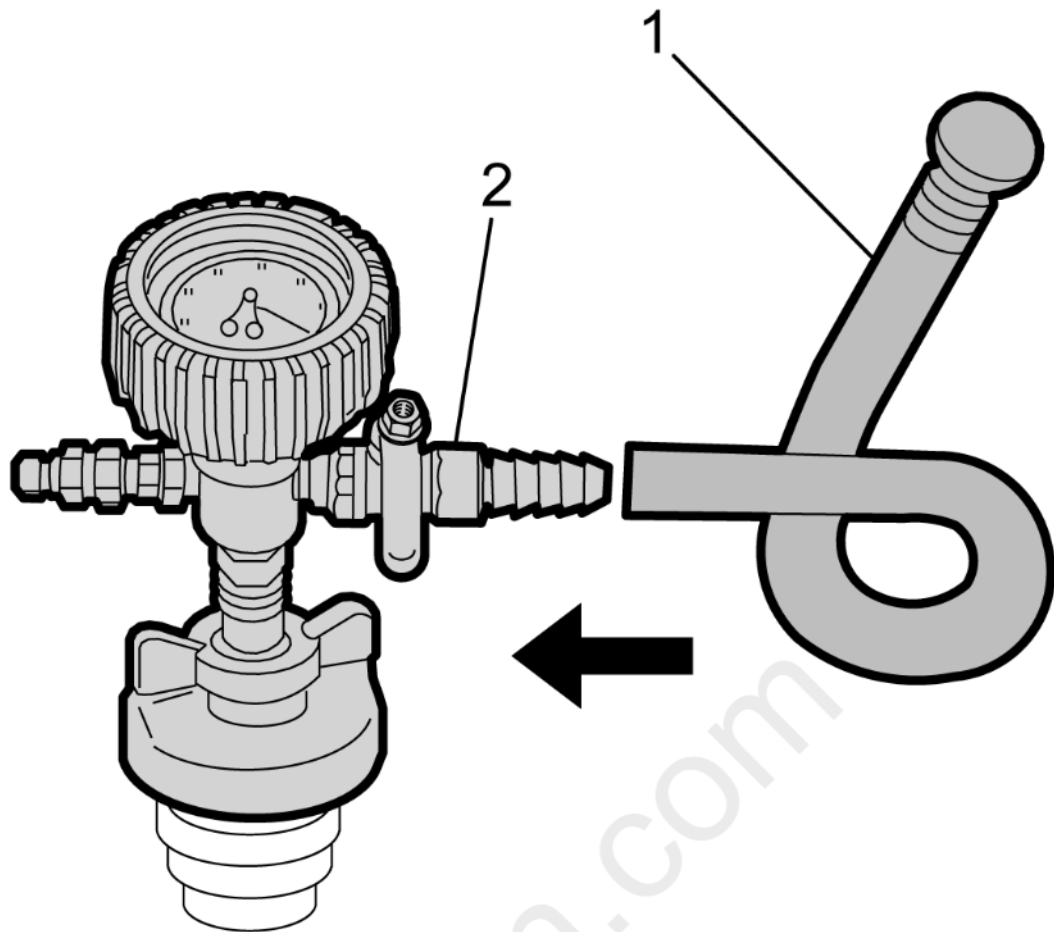


Fig. 9: Vacuum Gauge Assembly & Fill Hose

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.

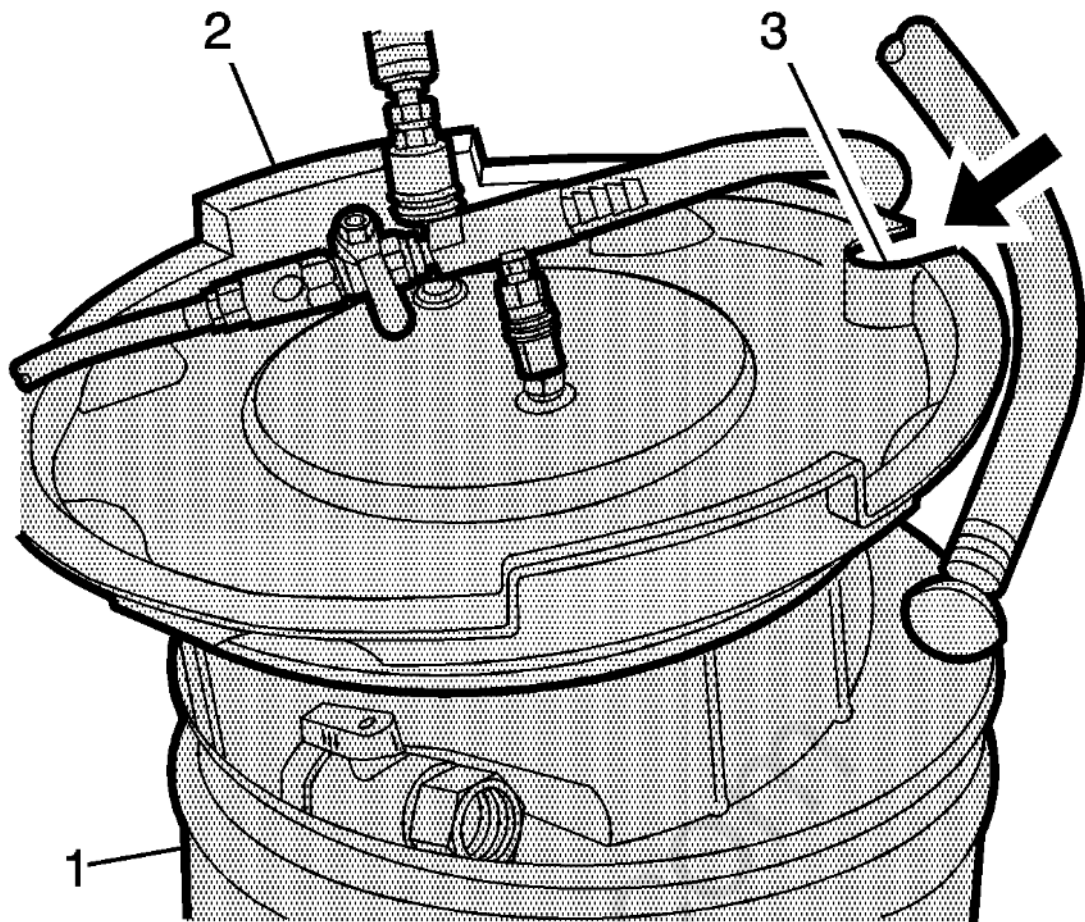


Fig. 10: Graduated Reservoir, Vacuum Tank & Cut-Out Area

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.

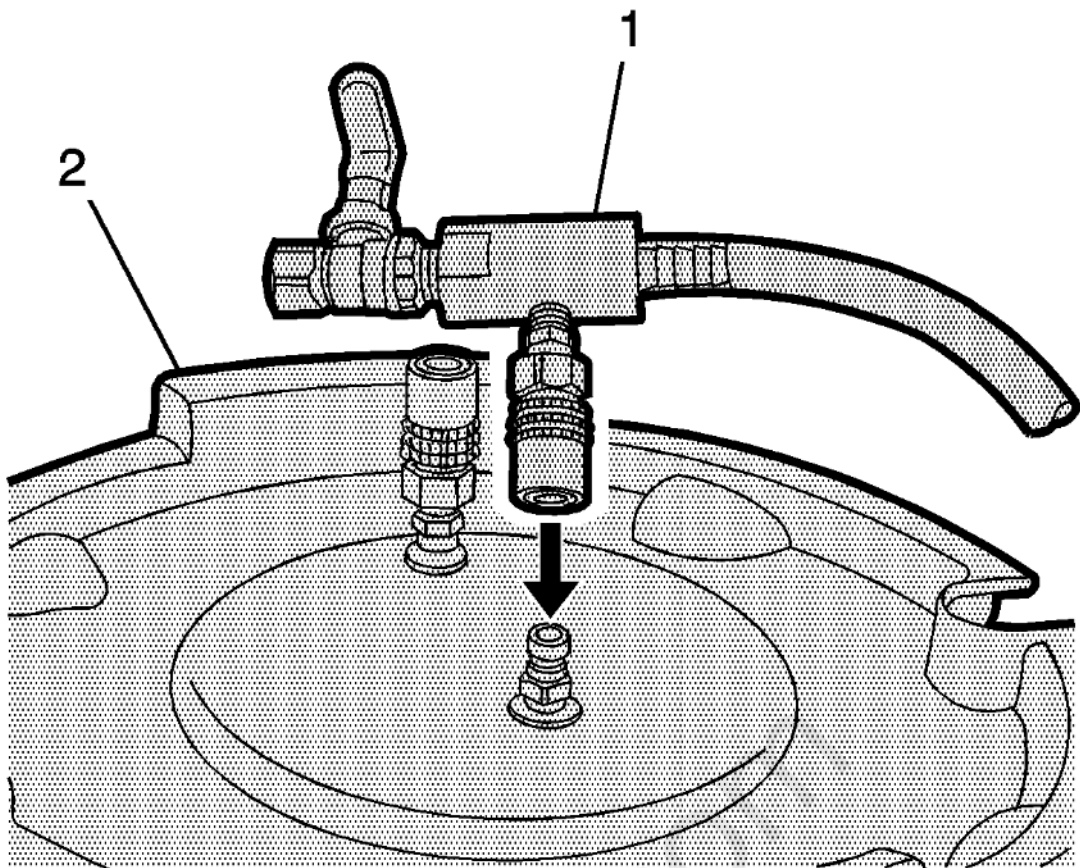


Fig. 11: Vacuum Tank & Venturi Assembly

Courtesy of GENERAL MOTORS COMPANY

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

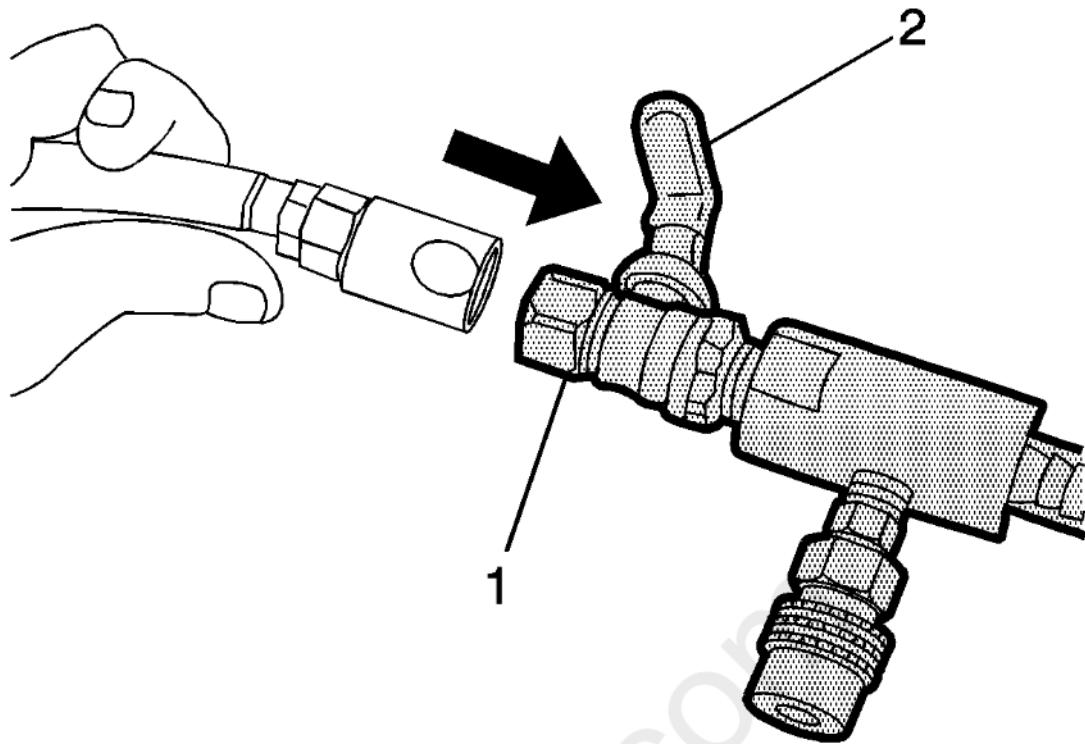


Fig. 12: Venturi Assembly & Valve
Courtesy of GENERAL MOTORS COMPANY

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

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

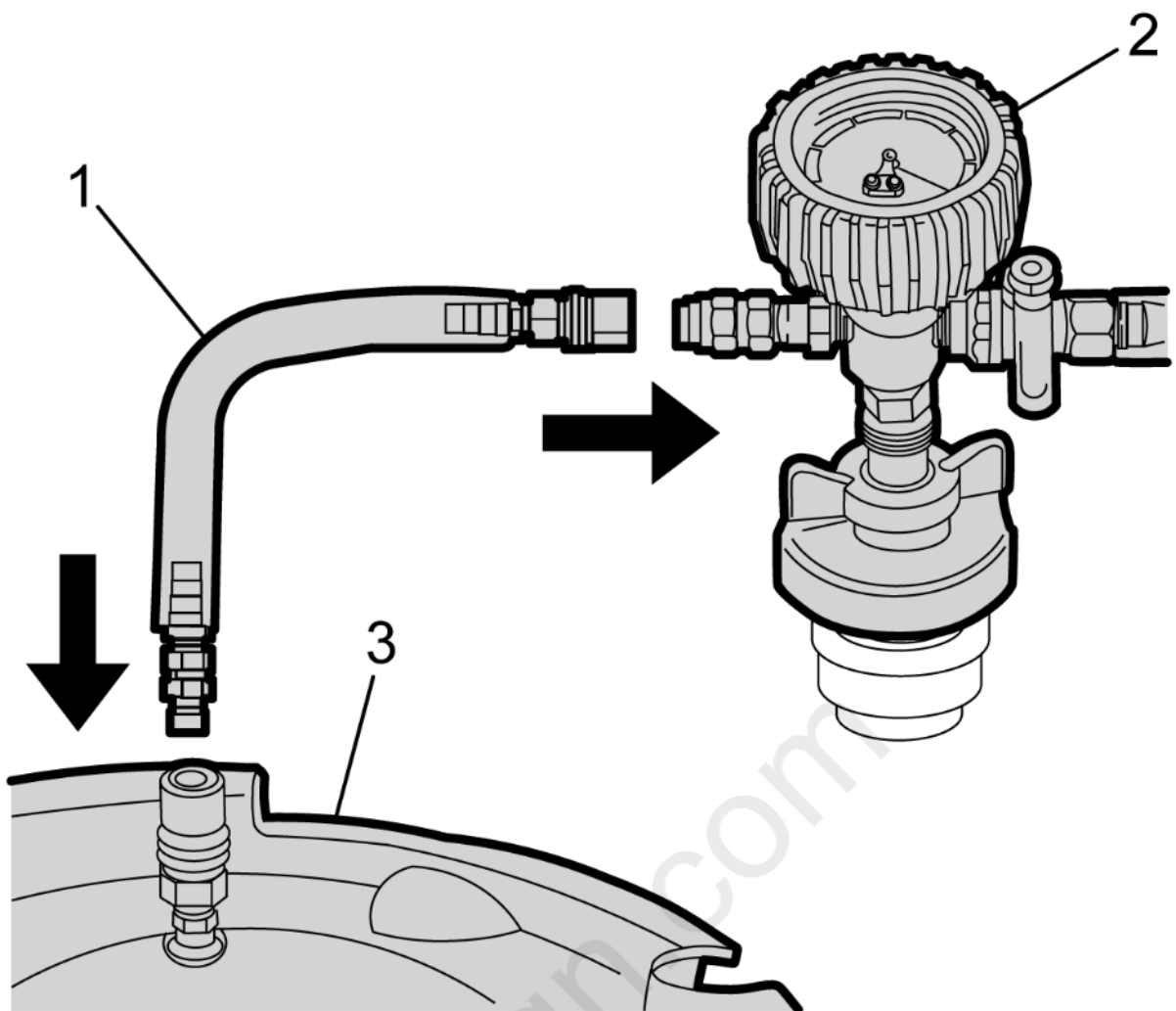


Fig. 13: Vacuum Hose, Gauge Assembly & Tank
Courtesy of GENERAL MOTORS COMPANY

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

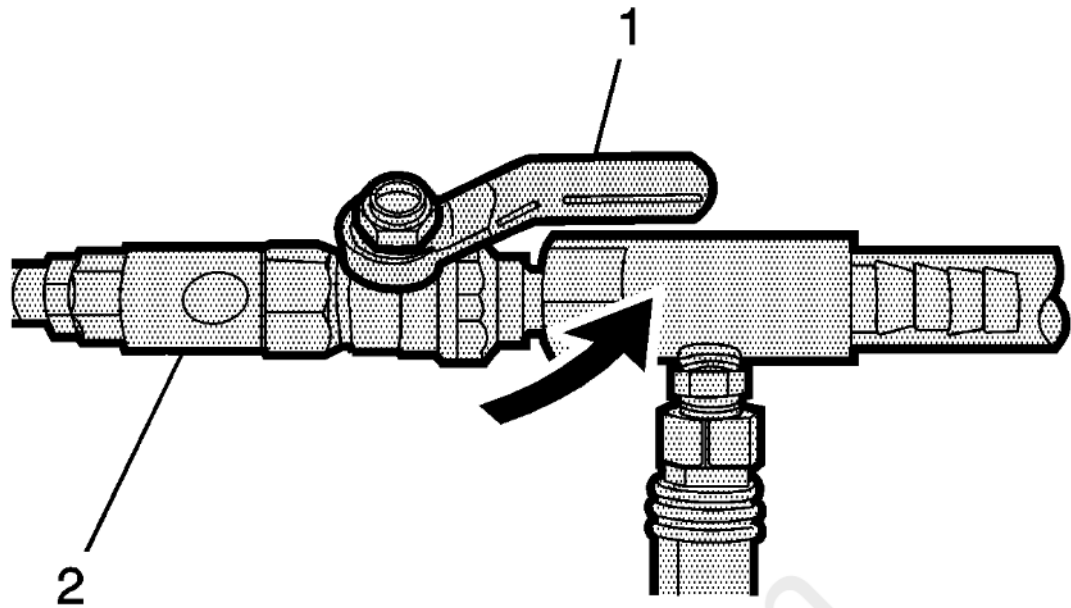


Fig. 14: Valve & Venturi Assembly

Courtesy of GENERAL MOTORS COMPANY

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

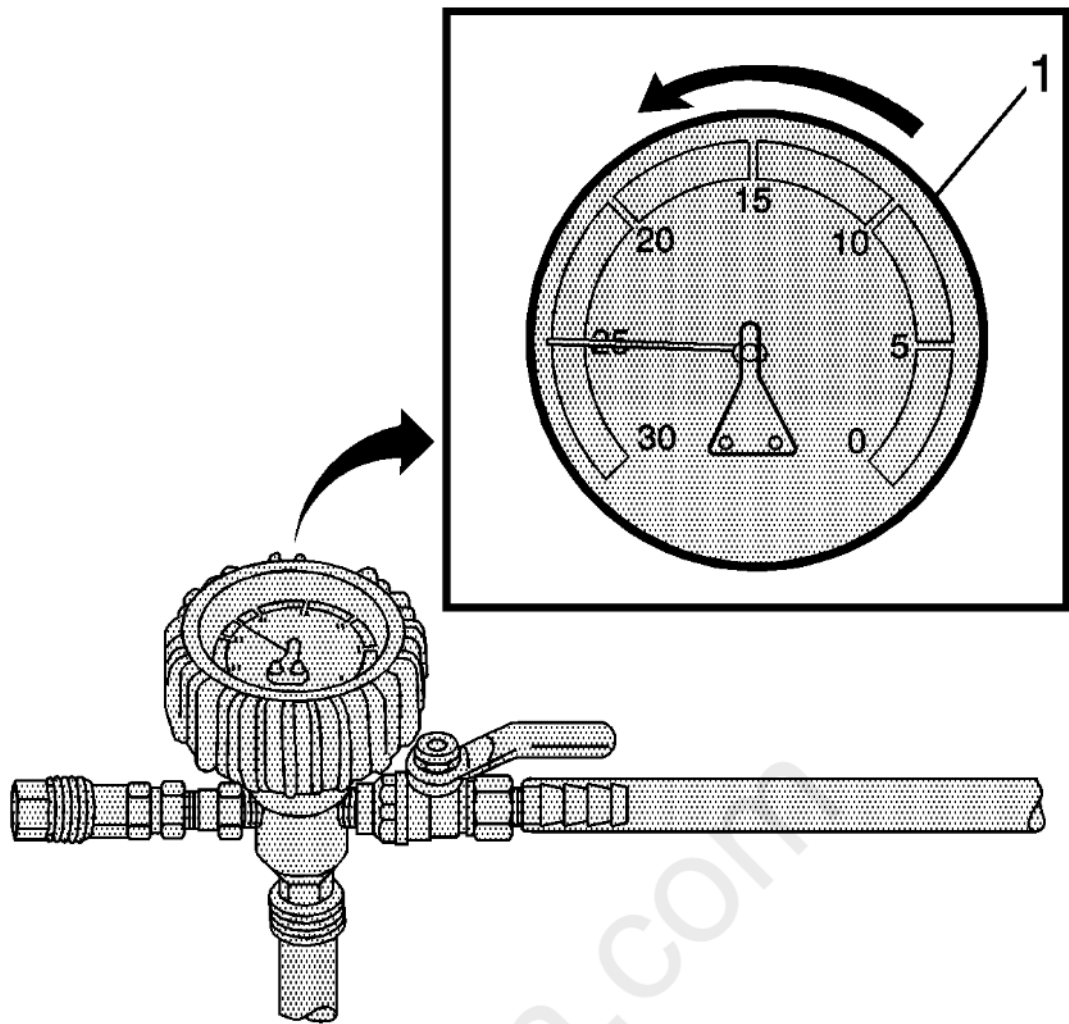


Fig. 15: Vacuum Gauge Needle

Courtesy of GENERAL MOTORS COMPANY

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

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

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

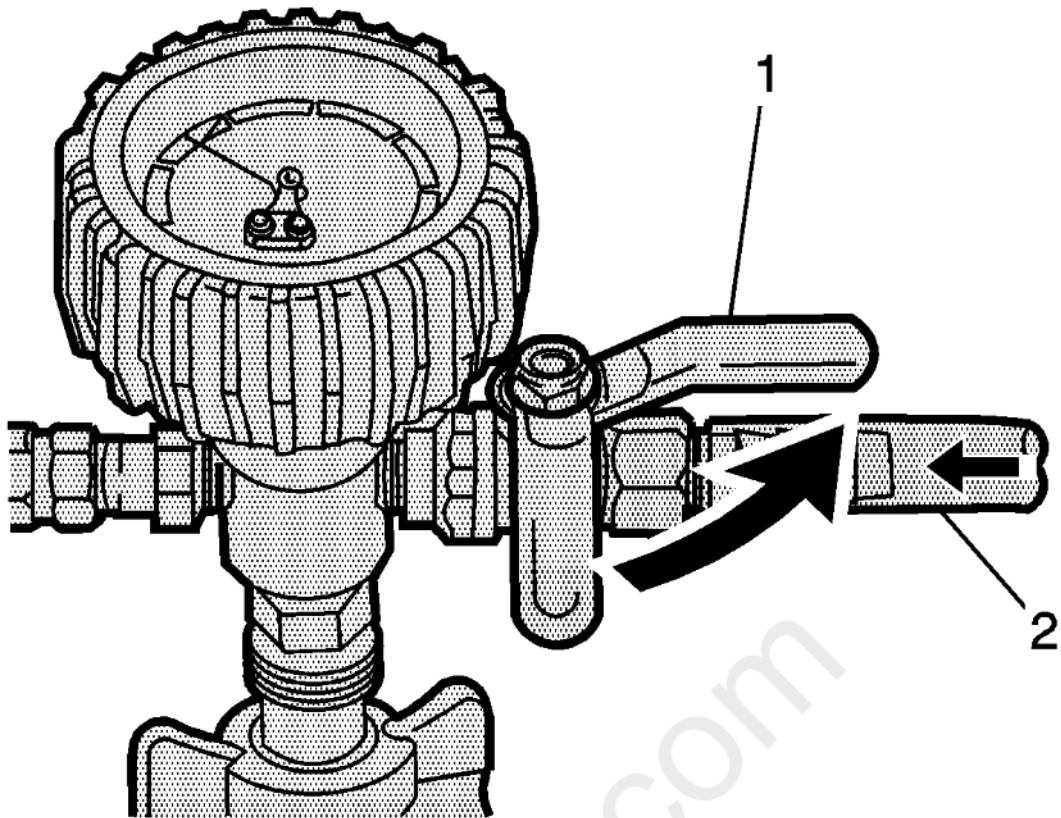


Fig. 16: Vacuum Gauge Assembly & Needle
Courtesy of GENERAL MOTORS COMPANY

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

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

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

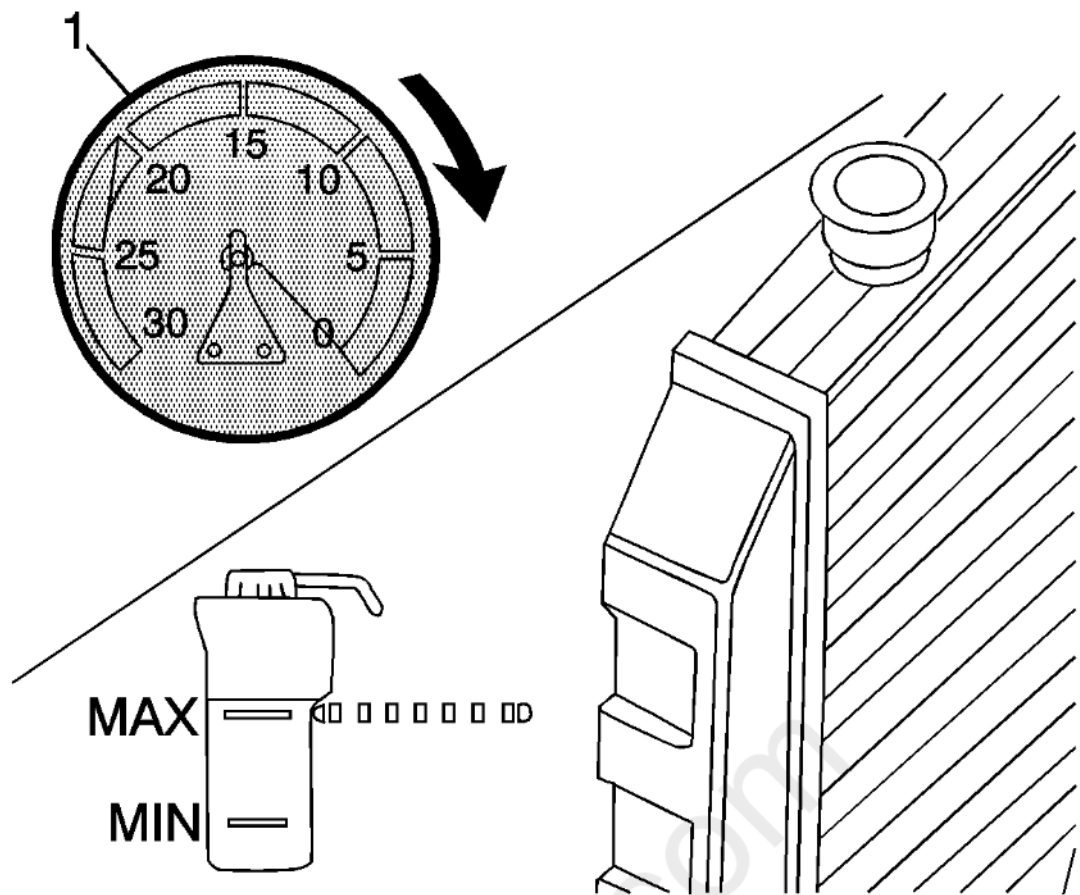


Fig. 17: Vacuum Gauge At Zero

Courtesy of GENERAL MOTORS COMPANY

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

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

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

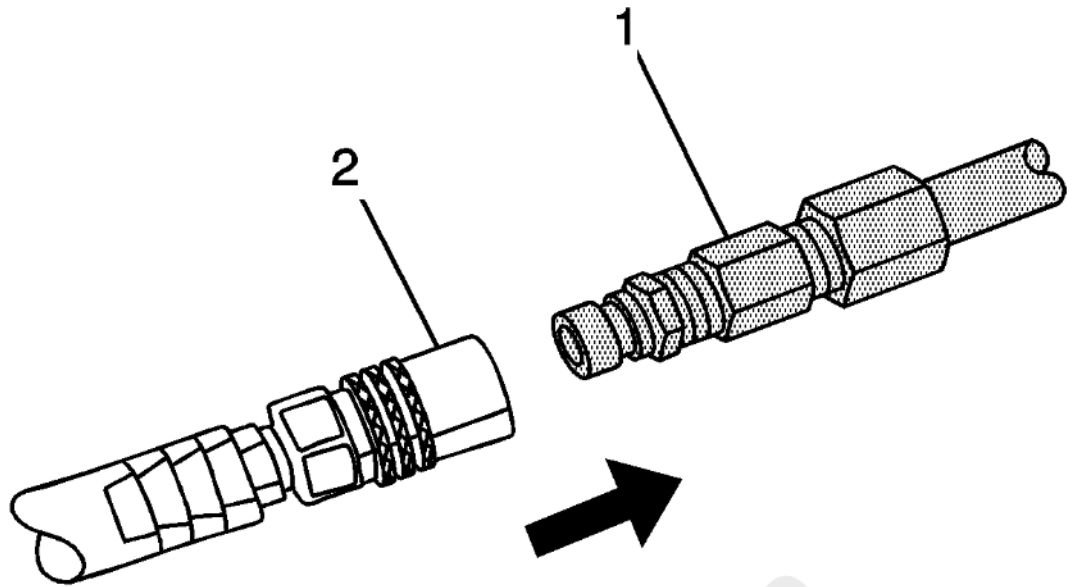


Fig. 18: Vacuum Hose & Extraction Hose
Courtesy of GENERAL MOTORS COMPANY

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

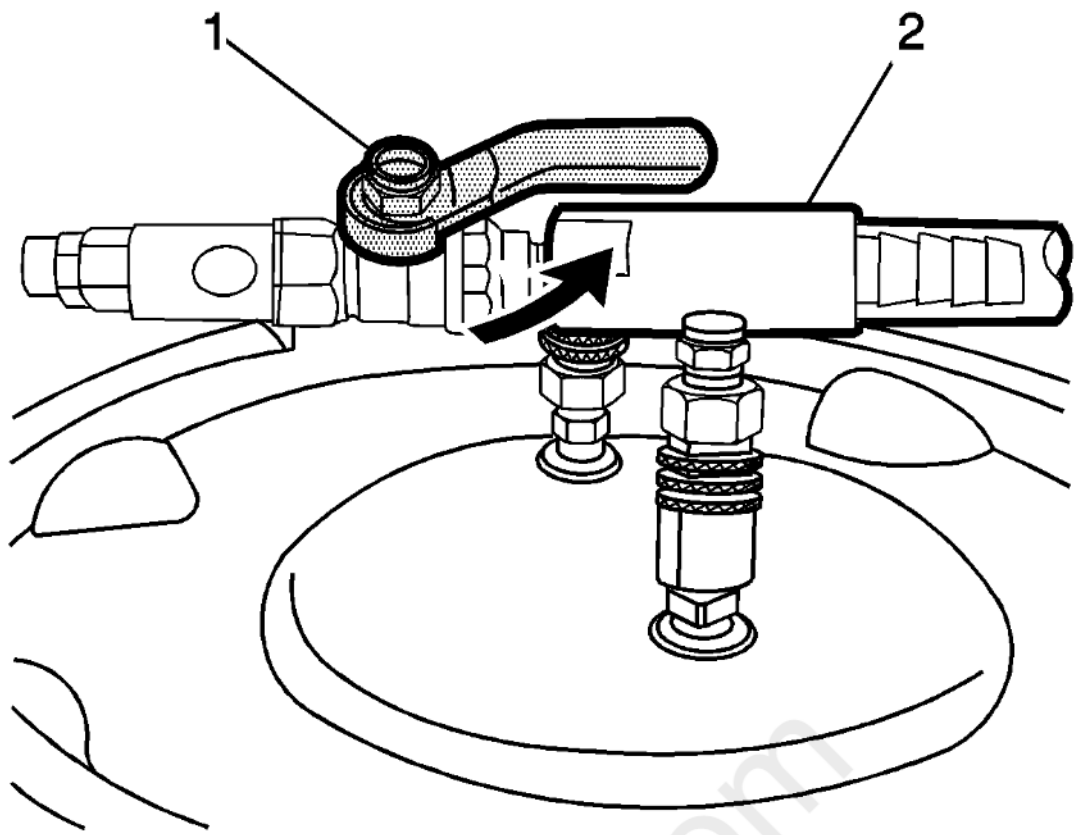


Fig. 19: Venturi Assembly & Valve
Courtesy of GENERAL MOTORS COMPANY

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

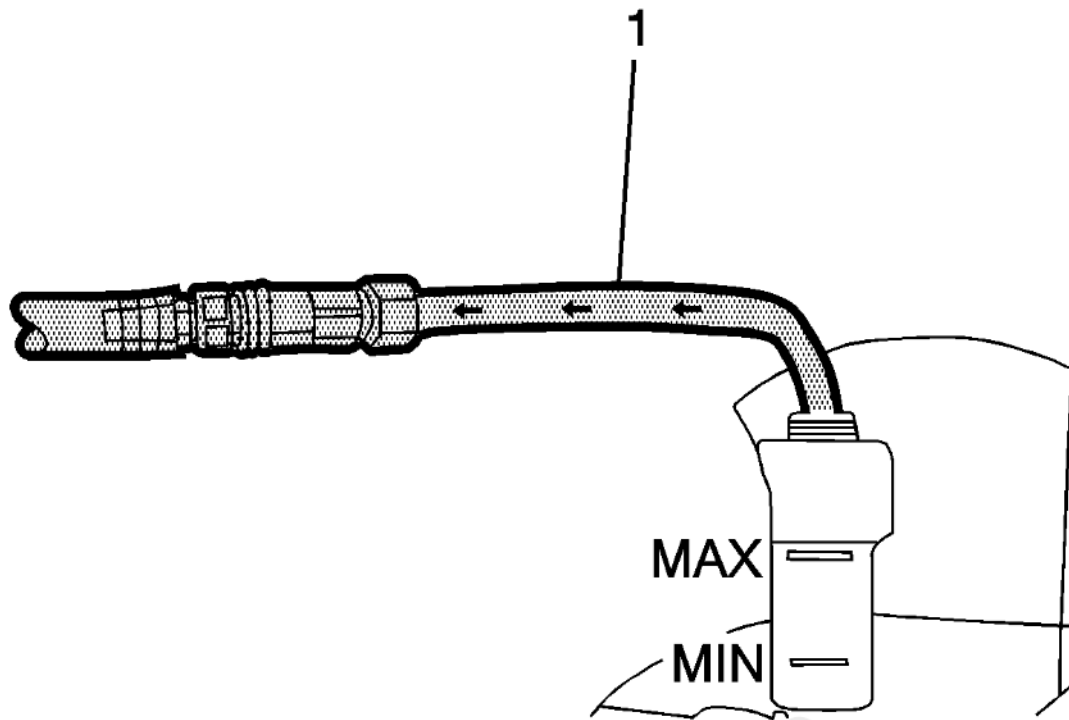


Fig. 20: Coolant Extraction Hose

Courtesy of GENERAL MOTORS COMPANY

26. Use the extraction hose (1) to draw out coolant to the proper level.
27. The vacuum tank has a drain valve on the bottom of the tank. Open the valve to drain coolant from the vacuum tank into a suitable container for disposal.
28. Install the surge tank cap.
29. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
30. Install the right front wheelhouse front liner. Refer to [Front Wheelhouse Liner Replacement](#) .
31. Lower the vehicle.

COOLING SYSTEM DRAINING AND FILLING (STATIC)

Special Tools

J 26568 Coolant and Battery 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.

NOTE: Draining the cooling system with the pressure cap installed will syphon the coolant from the overflow tank.

1. Remove the coolant pressure cap.
2. Remove the right front wheelhouse liner to gain access to the drain plug. Refer to [Front Wheelhouse Liner Replacement](#) .

3. Place a drain pan under the drain cock.
4. Open the radiator drain cock.
5. Drain the cooling system.
6. If a complete engine block drain is required, remove the coolant drain plugs from the engine block.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance - Follow the filling procedure.
 - Discolored - Follow the flush procedure. Refer to [Flushing](#).

Filling Procedure

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

CAUTION: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Fasteners requiring replacement or fasteners requiring the use of thread locking compound or sealant are identified in the service procedure. Do not use paints, lubricants, or corrosion inhibitors on fasteners or fastener joint surfaces unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems.

1. Close the radiator drain cock.
2. Install the right front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).
3. If a complete engine block drain was required, install the coolant drain plugs to the engine block..

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

4. Slowly fill the cooling system with a 50/50 coolant mixture until the coolant level is visible and stable. Refer to [Approximate Fluid Capacities](#).
5. Install the pressure cap loosely (threaded on about one turn).
6. Start the engine and raise the engine speed to 2500 RPM and hold it there for 40 seconds, then shut engine off.
7. Remove the pressure cap and fill the coolant system until the level is visible and stable.
8. Install the pressure cap loosely (threaded on about one turn).
9. Start the engine and raise the engine speed to 2500 RPM and hold it there for 30 seconds, then shut engine off.
10. Remove the pressure cap and fill the coolant system until the level is visible and stable.
11. Install the pressure cap loosely (threaded on about one turn).
12. Start the engine and raise the engine speed to 2500 RPM and hold it there for 20 seconds, then shut engine off.
13. Remove the pressure cap and fill the coolant system until the level is visible and stable.
14. Install the pressure cap, fully threaded on.
15. Fill the coolant recovery bottle to the indicator line, then add 400 milliliters (13.5 ounces) more.
16. Start the engine and run it above 2500 RPM until it is hot enough to open the thermostat, this will allow the trapped air to be purged from the engine.
17. Complete a series of three, 4-second-duration idles with 4-second-duration 3000 RPM cycles.
18. Turn the engine off and allow it to cool down to room temperature.
19. Fill the coolant recovery bottle to the indicator line.
20. Inspect the concentration of the engine coolant using the **J 26568** tester.
21. Rinse away any excess coolant from the engine and the engine compartment.

FLUSHING

NOTE:

- When the cooling system becomes contaminated, the cooling system should be flushed thoroughly to remove the contaminants before the engine is seriously damaged.
- This procedure is effective in removing contaminants caused by the use of improper coolants, coolant at the end of its life, or some liquid chemical flushing agents. This procedure is NOT effective for removing debris contamination caused by component failure, or the use of 'stop leak' additives. When the system is contaminated by this type of debris, use the system flow diagrams to identify components that may need replacement to restore proper system flow.
- Do not use chemical flush agents.
- 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.

1. Drain the cooling system. [Cooling System Draining and Filling \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).
2. Remove the radiator surge tank. [Radiator Surge Tank Replacement \(LFX\)](#)[Radiator Surge Tank Replacement \(LCV\)](#).
3. Clean and flush the coolant recovery reservoir with clean, drinkable water.
4. Install the radiator surge tank. [Radiator Surge Tank Replacement \(LFX\)](#)[Radiator Surge Tank Replacement \(LCV\)](#).
5. Follow the drain and fill procedure using only clean, drinkable water. [Cooling System Draining and Filling \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).
6. Run the engine for 20 minutes.
7. Stop the engine.
8. Drain the cooling system. [Cooling System Draining and Filling \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).
9. Repeat the procedure if necessary, until the fluid is nearly colorless.
10. Fill the cooling system. [Cooling System Draining and Filling \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).

RADIATOR CLEANING

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

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

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

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

- Straighten any damaged cooling fins.

RADIATOR SURGE TANK REPLACEMENT (LFX)

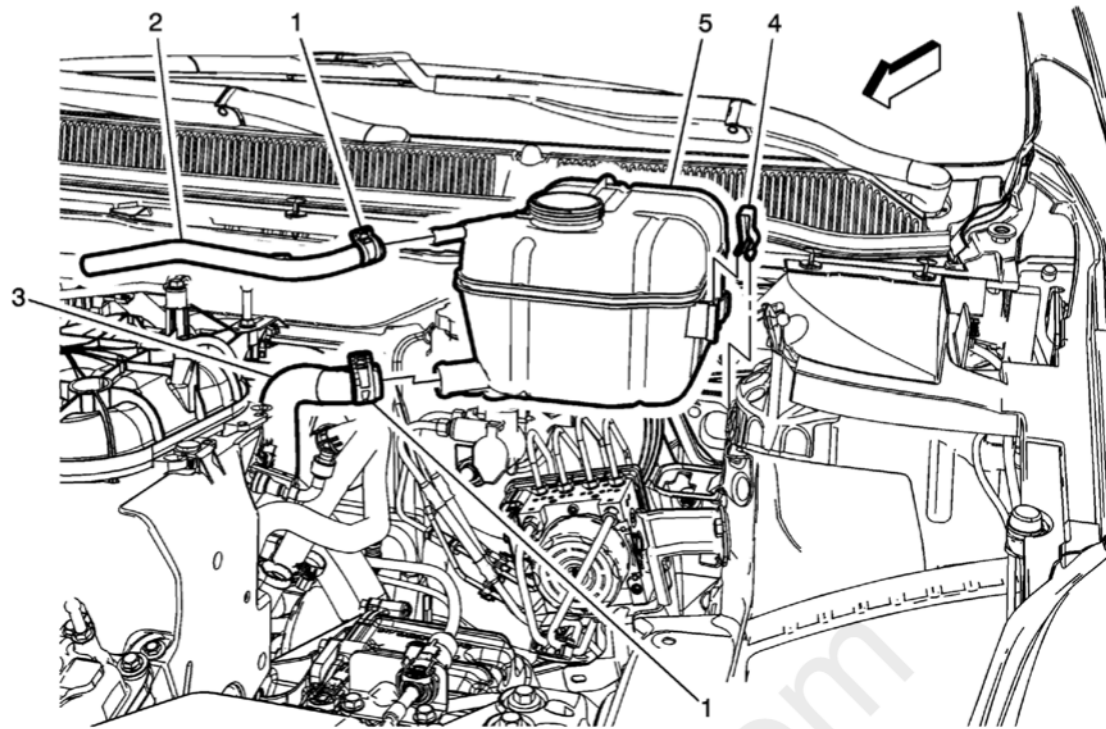


Fig. 21: Radiator Surge Tank Components

Courtesy of GENERAL MOTORS COMPANY

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

RADIATOR SURGE TANK REPLACEMENT (LCV)

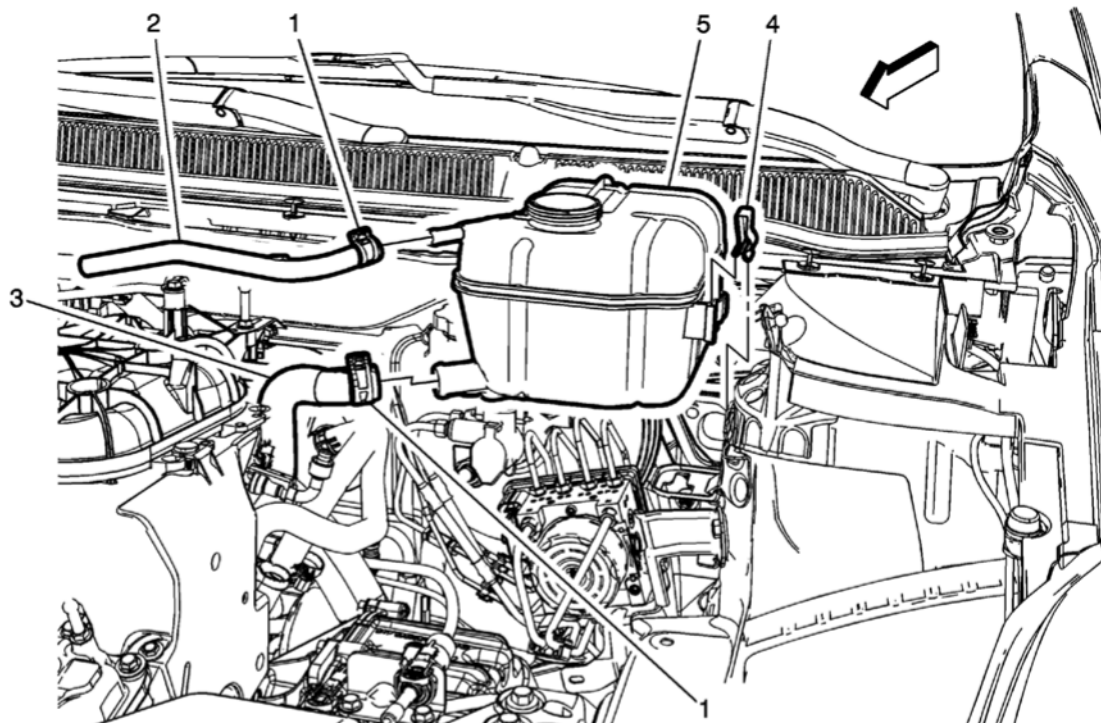


Fig. 22: Radiator Surge Tank Components
Courtesy of GENERAL MOTORS COMPANY

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

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LFX)

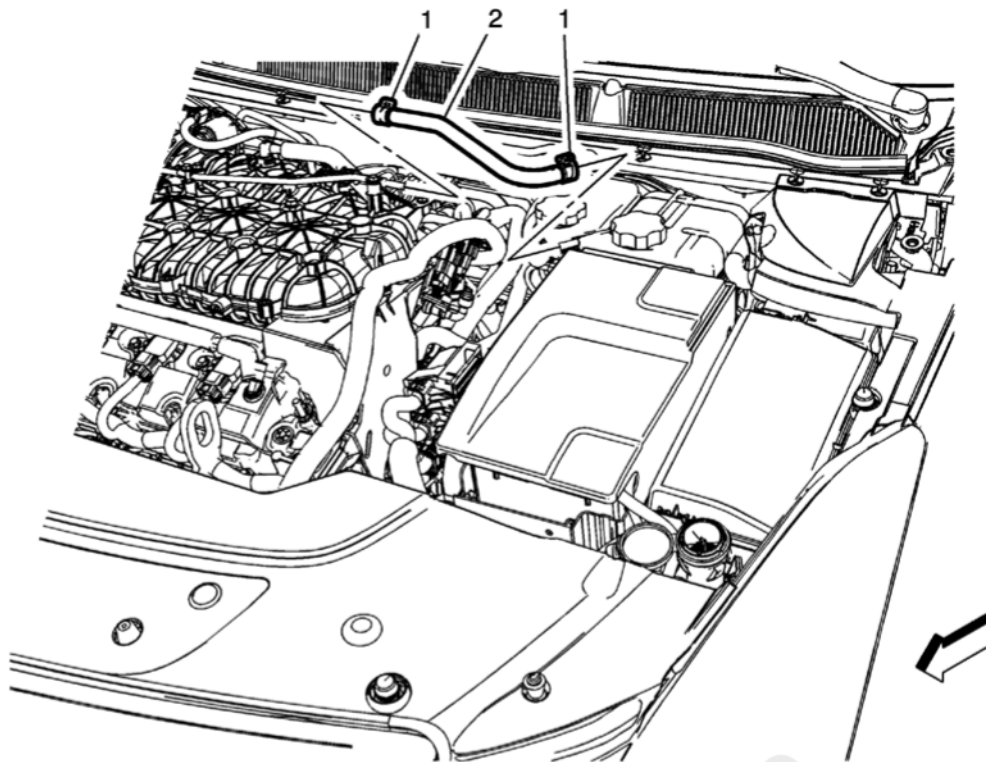


Fig. 23: Radiator Surge Tank Inlet Hose & Clamps (LFX)

Courtesy of GENERAL MOTORS COMPANY

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

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LCV)

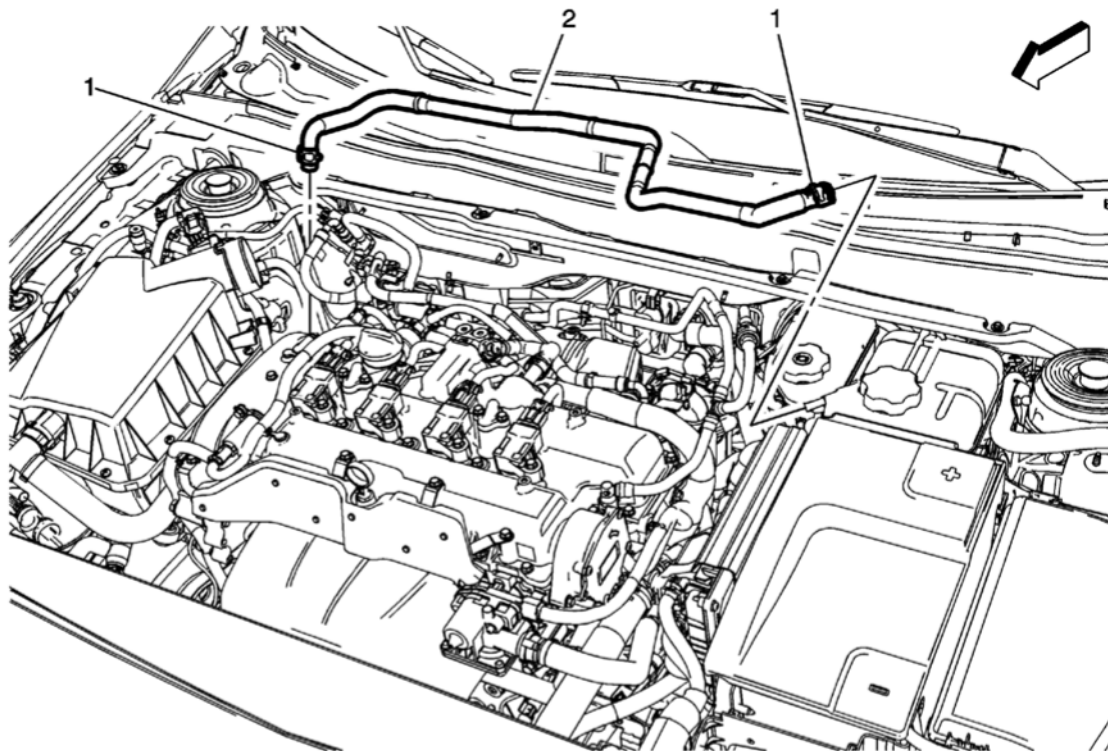


Fig. 24: Radiator Surge Tank Inlet Hose & Clamps

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement. 3. Remove the air cleaner resonator and outlet duct. Refer to Air Cleaner Resonator and Outlet Duct Replacement.	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Surge Tank Inlet Hose

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT (LFX)

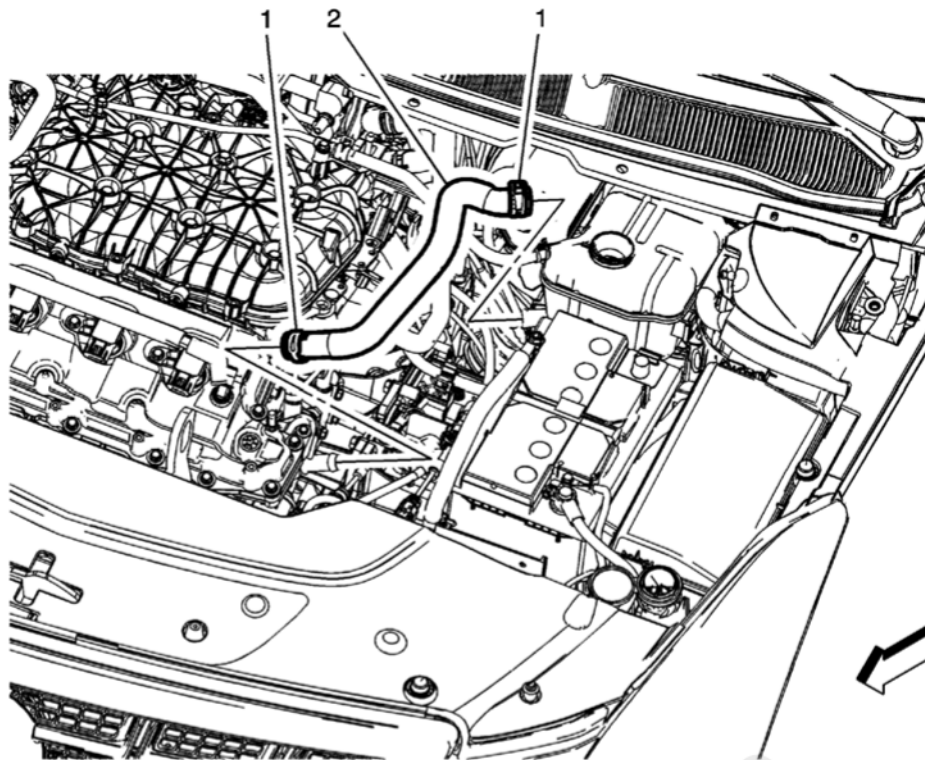


Fig. 25: Radiator Surge Tank Outlet Hose & Clamps (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX). 3. Unclip and reposition the Engine Control Module (ECM) and ECM bracket. Refer to Engine Control Module Replacement (LFX).	
1	Radiator Surge Tank Outlet Hose Clamp (Qty: 2) Procedure Reposition the radiator surge tank outlet hose clamps using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Surge Tank Outlet Hose Procedure 1. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Check the cooling system for leaks.

RADIATOR INLET HOSE REPLACEMENT (LFX)

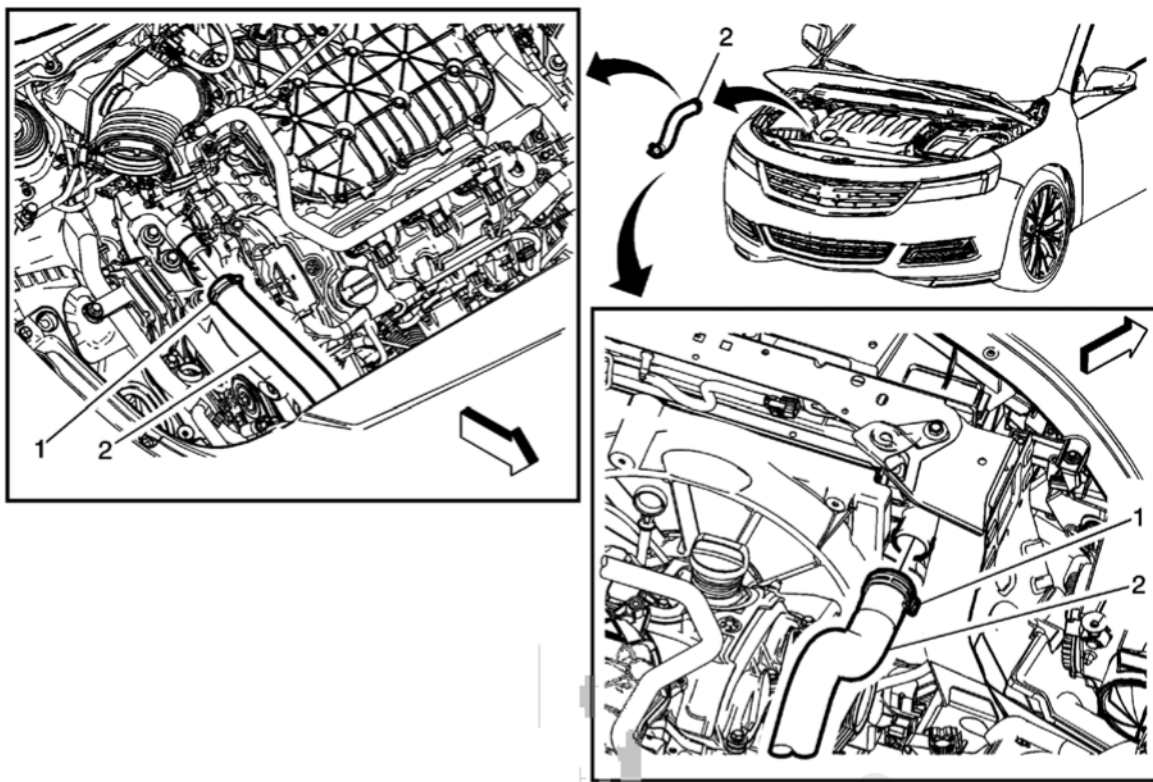


Fig. 26: Radiator Inlet Hose & Clamps (LFX)
Courtesy of GENERAL MOTORS COMPANY

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

RADIATOR INLET HOSE REPLACEMENT (LCV)

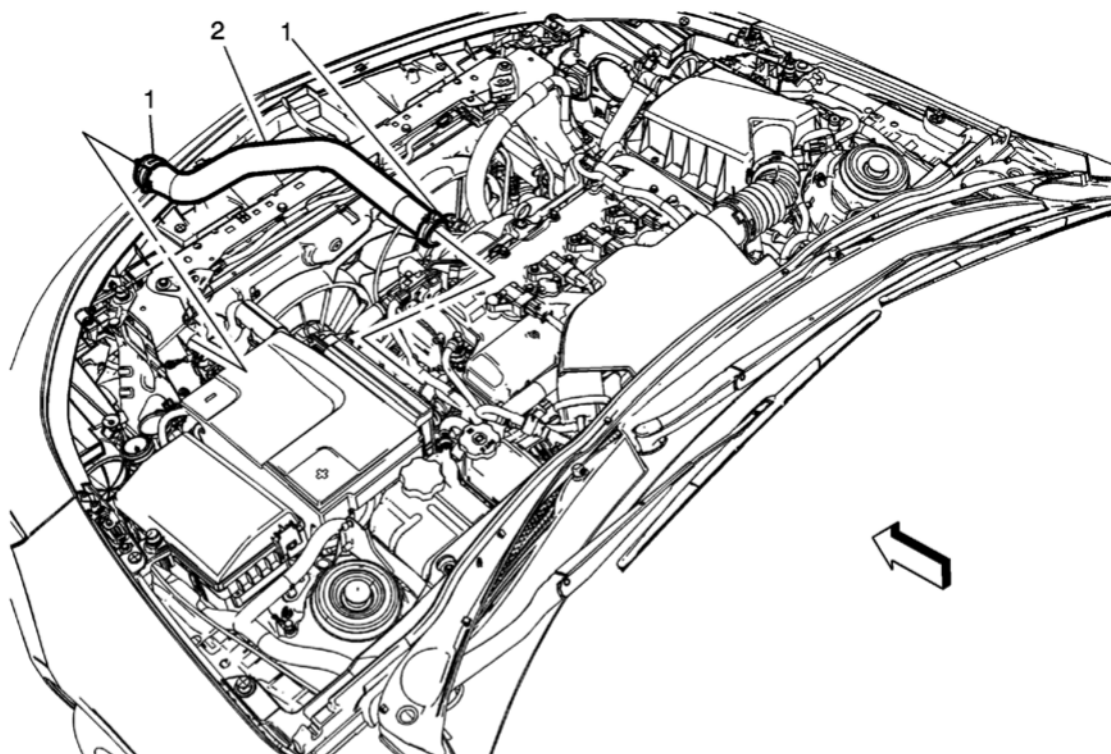


Fig. 27: Radiator Inlet Hose & Clamps (LCV)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the front compartment front sight shield. Refer to Front Compartment Front Sight Shield Replacement. 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement. 3. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill) Cooling System Draining and Filling (Static).	
1	Radiator Inlet Hose Clamp (Qty: 2) Procedure 1. Using the BO-38185 hose clamp pliers release the radiator inlet hose clamp and remove the radiator inlet hose from the engine. 2. Using the BO-38185 hose clamp pliers release the radiator inlet hose clamp and remove the radiator inlet hose from the radiator. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Inlet Hose

RADIATOR INLET HOSE CONNECTOR REPLACEMENT (LFX)

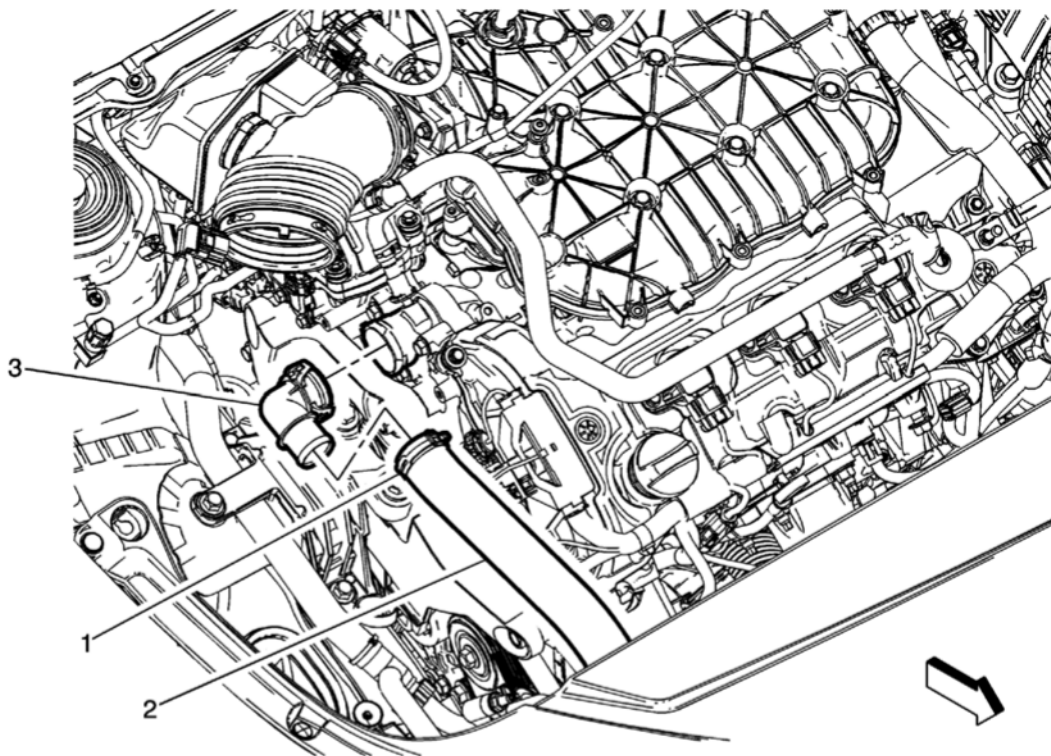


Fig. 28: Radiator Inlet Hose, Connector & Clamp (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX). 2. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static).	
1	Radiator Inlet Hose Clamp Procedure Reposition the radiator inlet hose clamps using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Inlet Hose Procedure Remove the radiator inlet hose from the radiator inlet hose connector.
3	Radiator Inlet Hose Connector Procedure 1. Rotate the radiator inlet hose connector counterclockwise to remove it from the water outlet assembly. 2. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 3. Inspect the cooling system for leaks.

RADIATOR OUTLET HOSE REPLACEMENT (LFX)

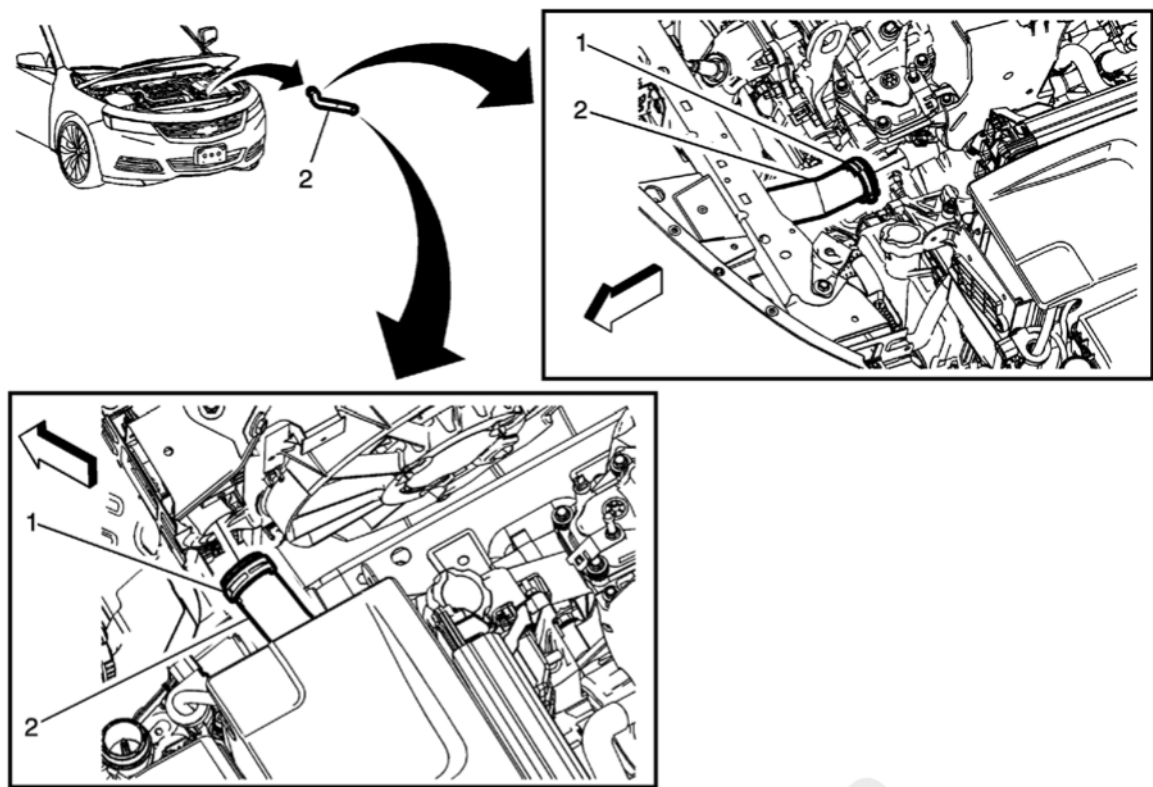


Fig. 29: Radiator Outlet Hose & Clamps (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 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).	
1	Radiator Outlet Hose Clamp (Qty: 2) Procedure Reposition the radiator outlet hose clamps using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Outlet Hose Procedure 1. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Inspect the cooling system for leaks.

RADIATOR OUTLET HOSE REPLACEMENT (LCV)

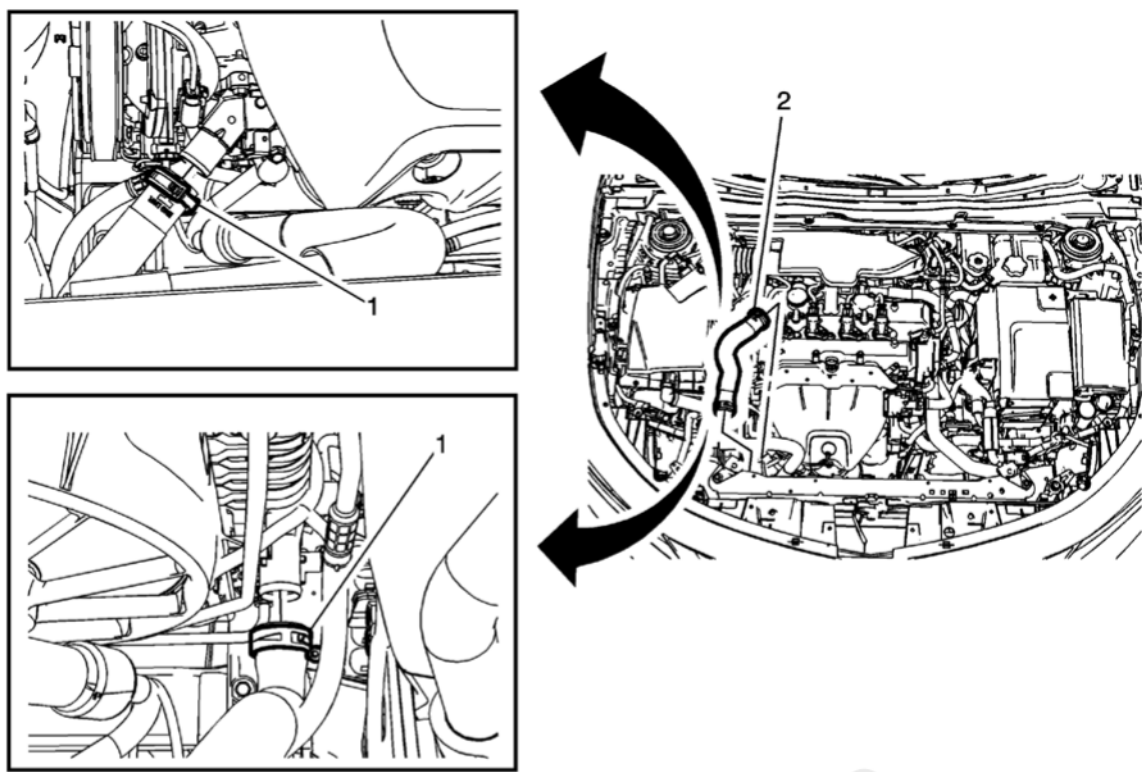


Fig. 30: Radiator Outlet Hose & Clamps (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the front compartment front sight shield. Refer to Front Compartment Front Sight Shield Replacement.	
1	Radiator Outlet Hose Clamp (Qty: 2) Procedure 1. Using the BO-38185 hose clamp pliers release the radiator outlet hose clamp and remove the radiator outlet hose from the engine. 2. Using the BO-38185 hose clamp pliers release the radiator outlet hose clamp and remove the radiator outlet hose from the radiator. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Outlet Hose Procedure 1. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Inspect the cooling system for leaks.

RADIATOR LOWER MOUNT REPLACEMENT (LFX)

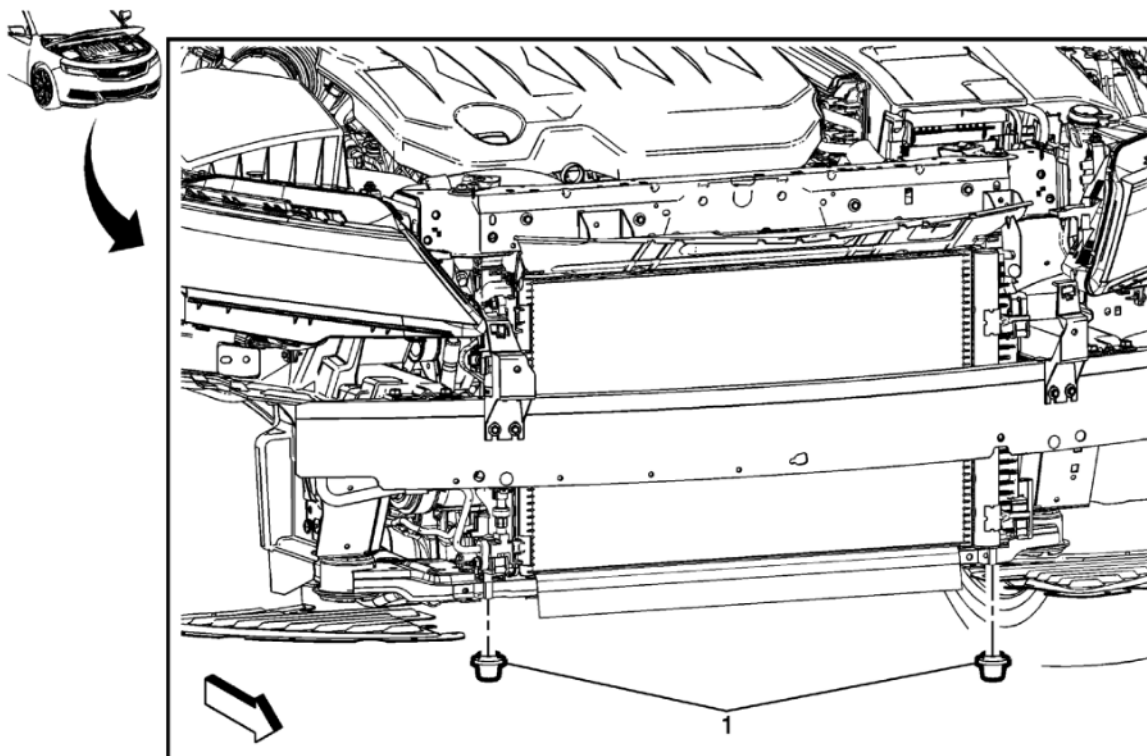


Fig. 31: Radiator Lower Mounts (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement . 2. Support the radiator. 3. Remove the side member reinforcements. Refer to Side Member Reinforcement Replacement (NJ2) .	
1	Radiator Lower Mount (Qty: 2)

RADIATOR UPPER MOUNT REPLACEMENT (LFX)

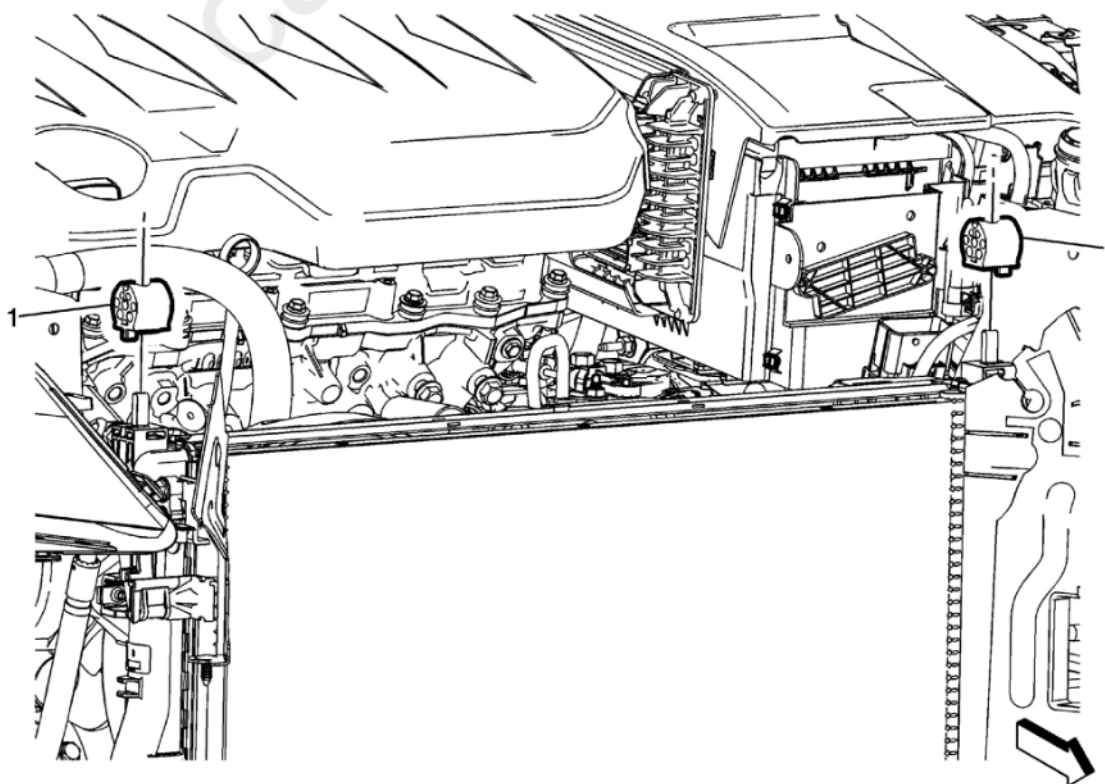


Fig. 32: Radiator Upper Mounts (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the radiator upper bracket. Refer to Radiator Upper Bracket Replacement .	
1	Radiator Upper Mount (Qty: 2)

RADIATOR LOWER BRACKET REPLACEMENT (LCV)

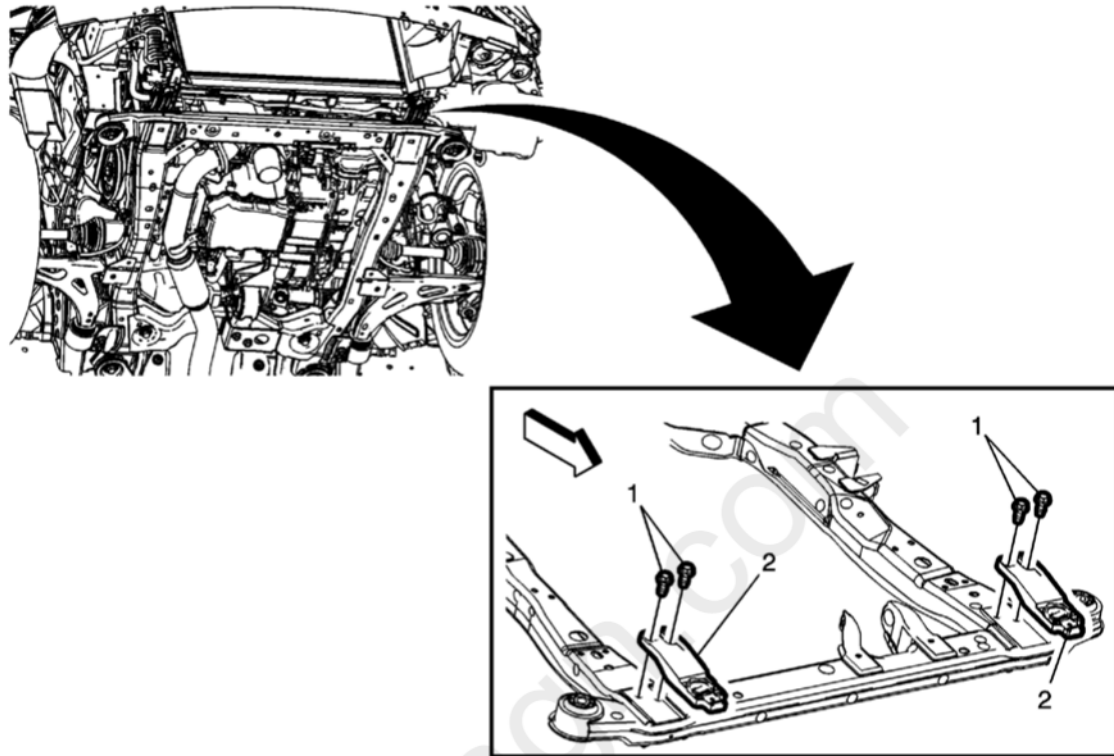


Fig. 33: Radiator Lower Brackets & Fasteners (LCV)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement . 2. Remove the radiator air side baffle and deflector retainers from the radiator lower bracket. 3. Support the radiator assembly.	
1	Radiator Lower Bracket Fastener (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft)
2	Radiator Lower Bracket (Qty: 2)

RADIATOR UPPER BRACKET REPLACEMENT

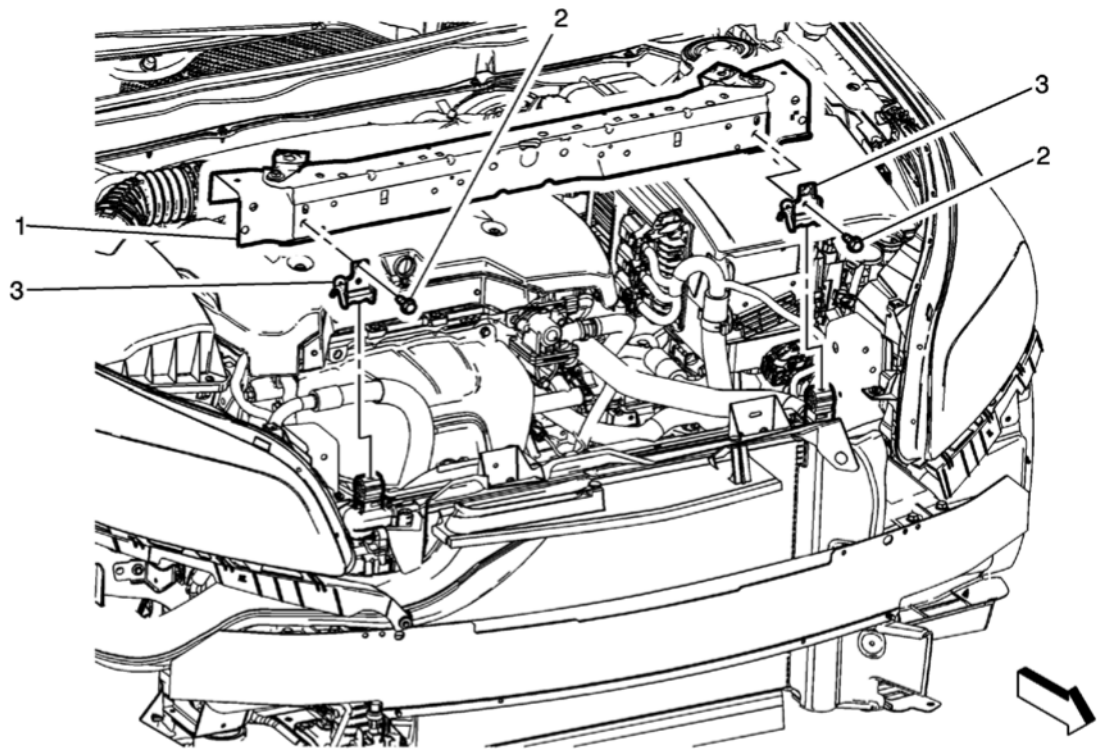


Fig. 34: Radiator Upper Bracket

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front End Upper Tie Bar Procedure Refer to Front End Upper Tie Bar Replacement .
2	Radiator Upper Bracket Bolt (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft)
3	Radiator Upper Bracket (Qty: 2)

ENGINE COOLANT FAN REPLACEMENT (LFX)

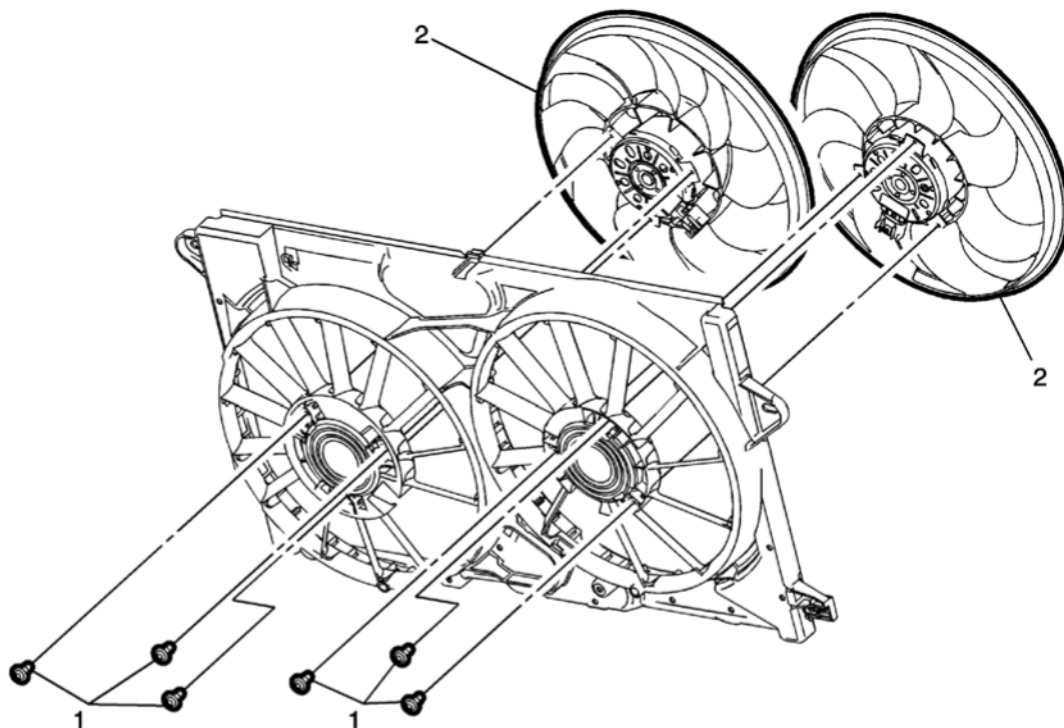


Fig. 35: Engine Coolant Fans & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the engine coolant fan shroud from the vehicle. Engine Coolant Fan Shroud Replacement (LFX) .	
1	Engine Coolant Fan Bolt (Qty: 6) (Qty: 3 Per Fan Assembly) CAUTION: Refer to Fastener Caution . Tighten 4 N.m (35 lb in)
2	Engine Coolant Fan (Qty: 2)

ENGINE COOLANT FAN REPLACEMENT (LCV)

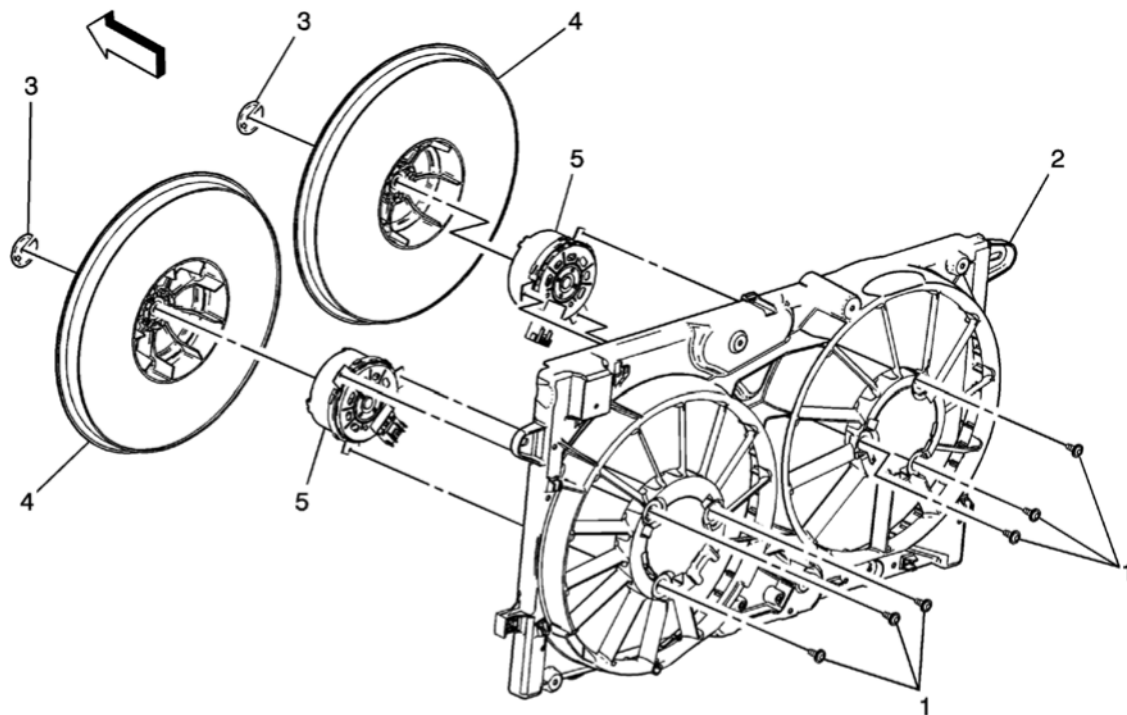


Fig. 36: Engine Coolant Fan Components (LCV)

Courtesy of GENERAL MOTORS COMPANY

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

THERMOSTAT BYPASS HOSE REPLACEMENT (LCV)

Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

1. Remove the thermostat bypass pipe. Refer to [Thermostat Bypass Pipe Replacement \(LCV\)](#).

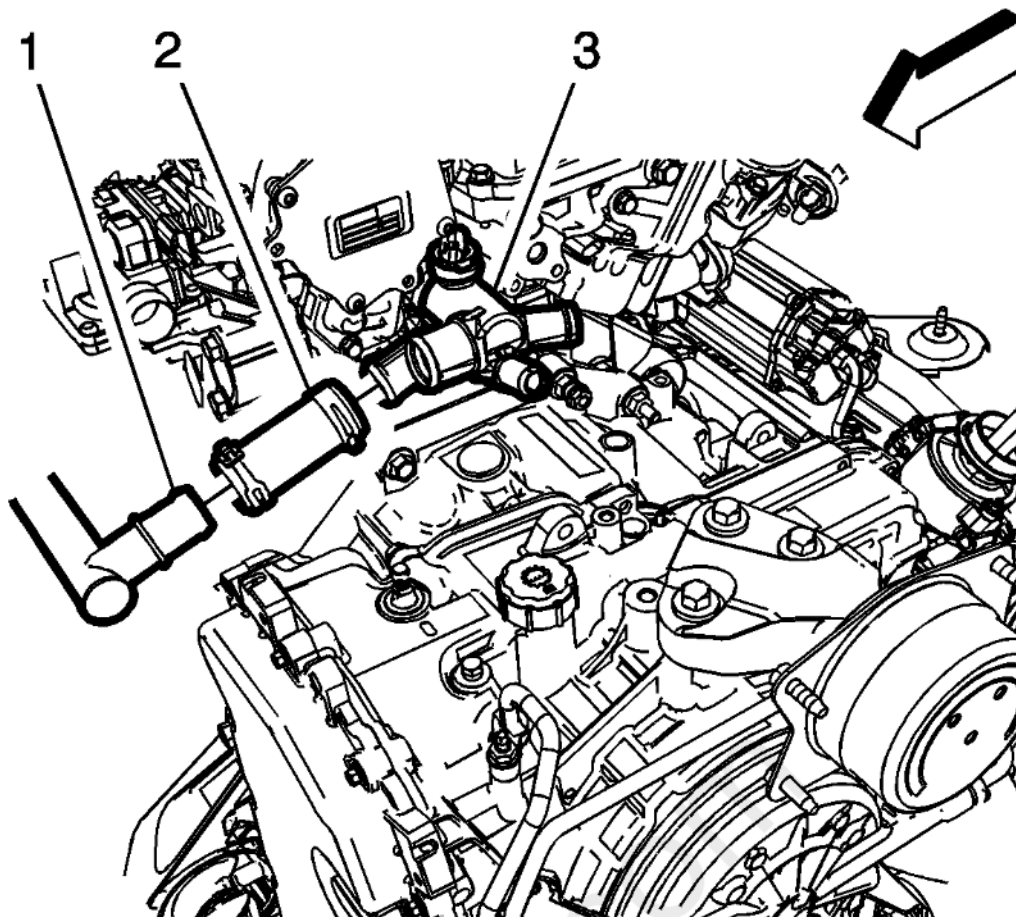


Fig. 37: Thermostat Bypass Hose

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

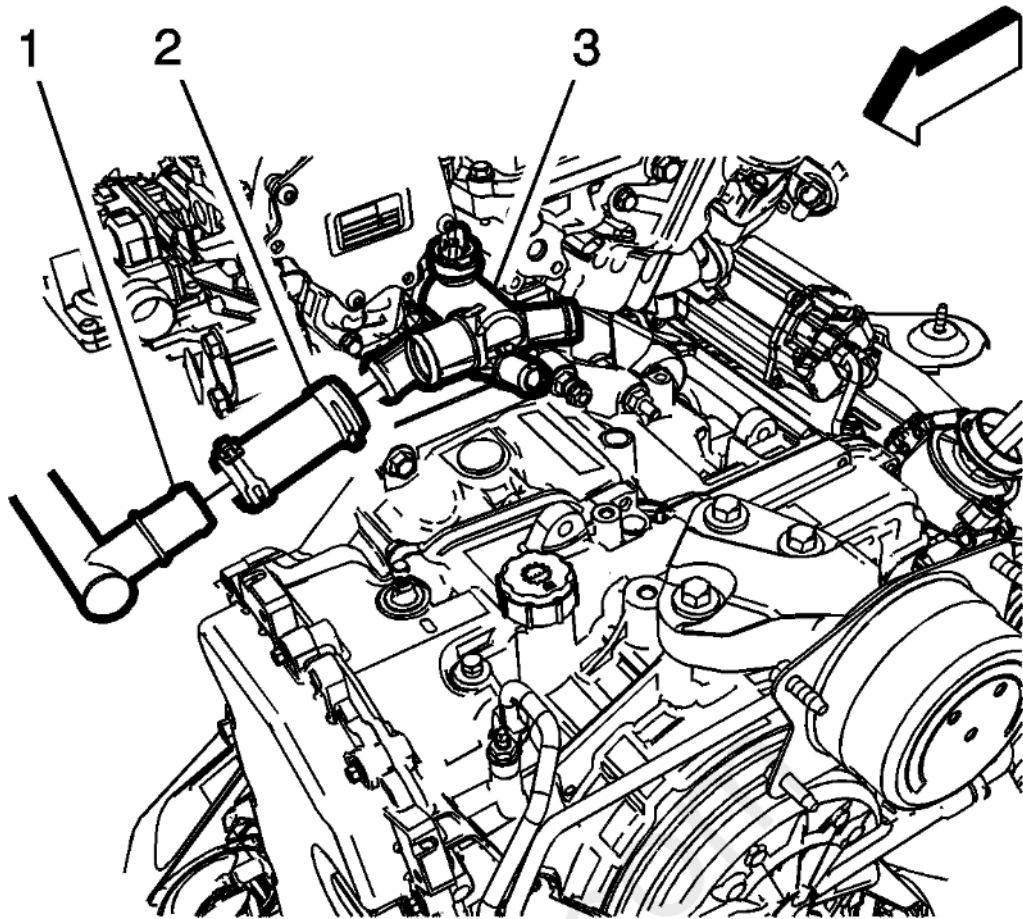


Fig. 38: Thermostat Bypass Hose

Courtesy of GENERAL MOTORS COMPANY

1. Install the thermostat bypass hose (2) to the thermostat bypass pipe (1) and the water outlet (3).
2. Install the thermostat bypass pipe. Refer to [Thermostat Bypass Pipe Replacement \(LCV\)](#).

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LFX)

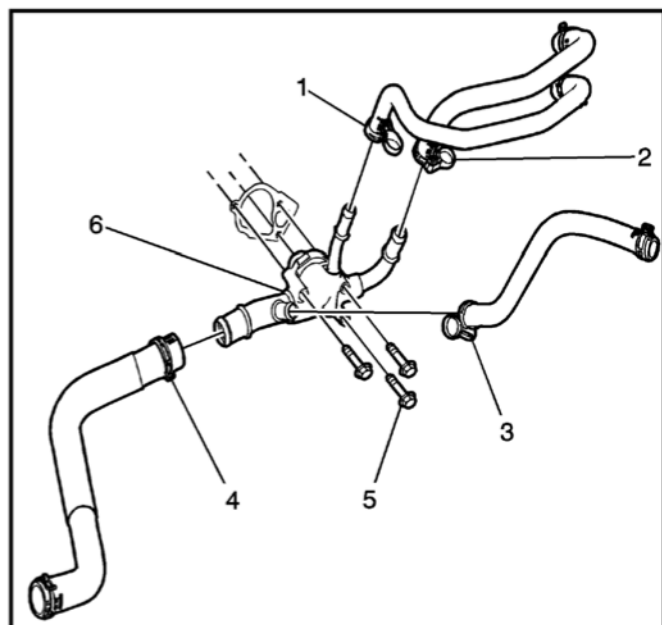
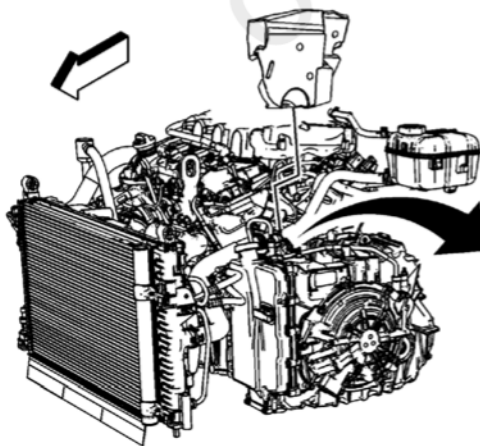


Fig. 39: View Of Engine Coolant Thermostat Housing, Hoses & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the fuel injector pipe shield. Refer to Fuel Pipe Shield Replacement . 2. Reposition engine control module. Refer to Engine Control Module Replacement (LFX) . 3. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). NOTE: Replace hose clamps if necessary. Special Tools BO-38185 Hose Clamp PliersFor equivalent regional tools, refer to Special Tools.	
1	Heater Outlet Hose
2	Heater Inlet Hose
3	Surge Tank Hose
4	Radiator Outlet Hose
5	Bolt (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (88 lb in)
6	Engine Cooling Thermostat Housing Procedure 1. Clean the engine block and thermostat gasket surfaces. 2. Replace gasket and any worn hoses.

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LCV)

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 \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).
2. Remove the exhaust manifold heat shield. Refer to [Exhaust Manifold Heat Shield Replacement](#) .

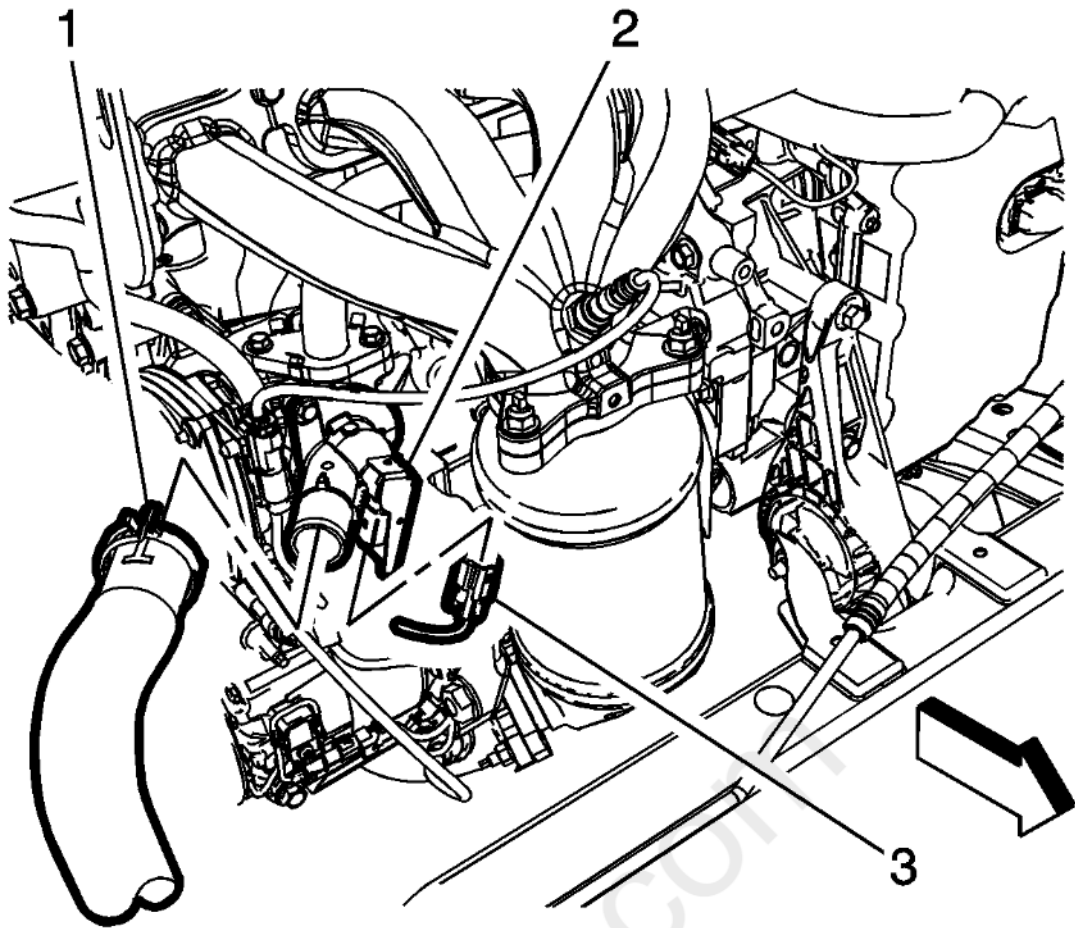


Fig. 40: Engine Coolant Thermostat Housing

Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose (1) from the engine coolant thermostat housing (2).
4. If equipped, disconnect the connector (3) from the engine coolant thermostat housing (2).

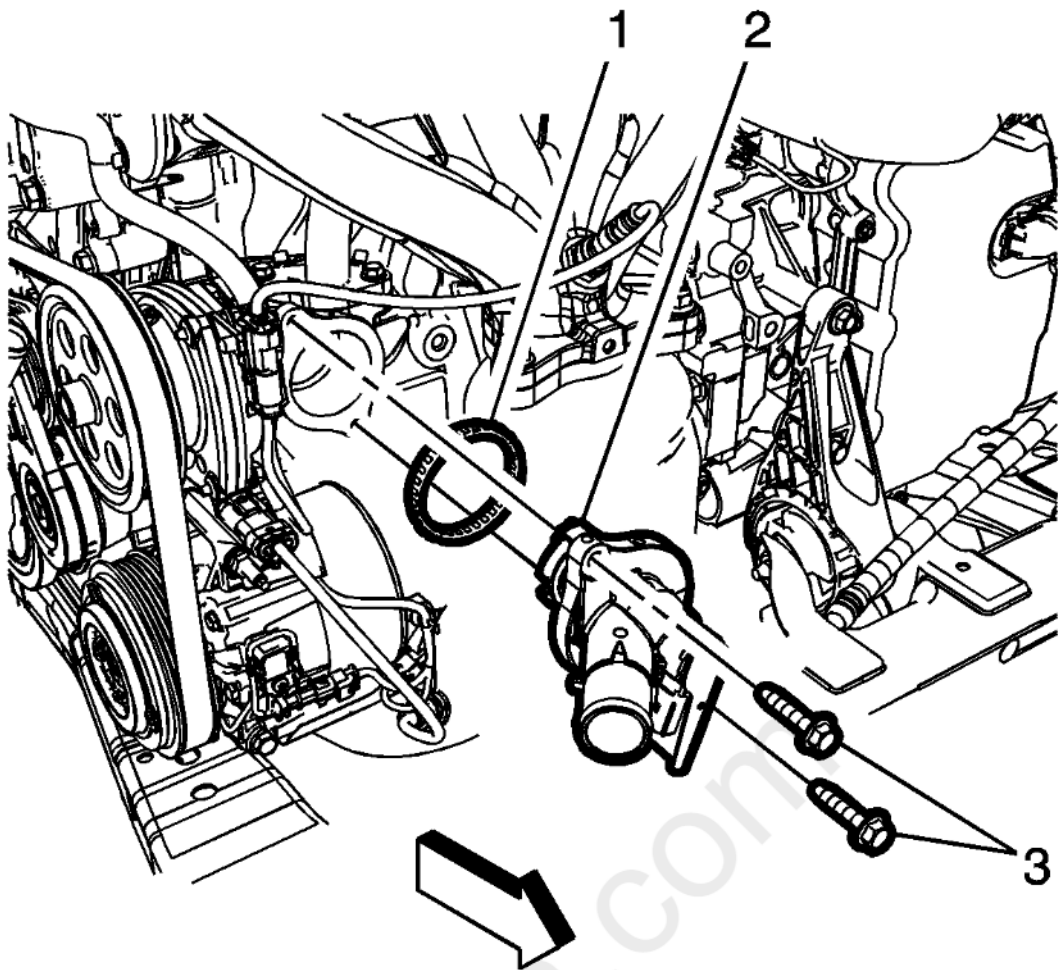


Fig. 41: Engine Coolant Thermostat Housing Fasteners And Engine Coolant Thermostat Housing

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

1. Clean the sealing surfaces.

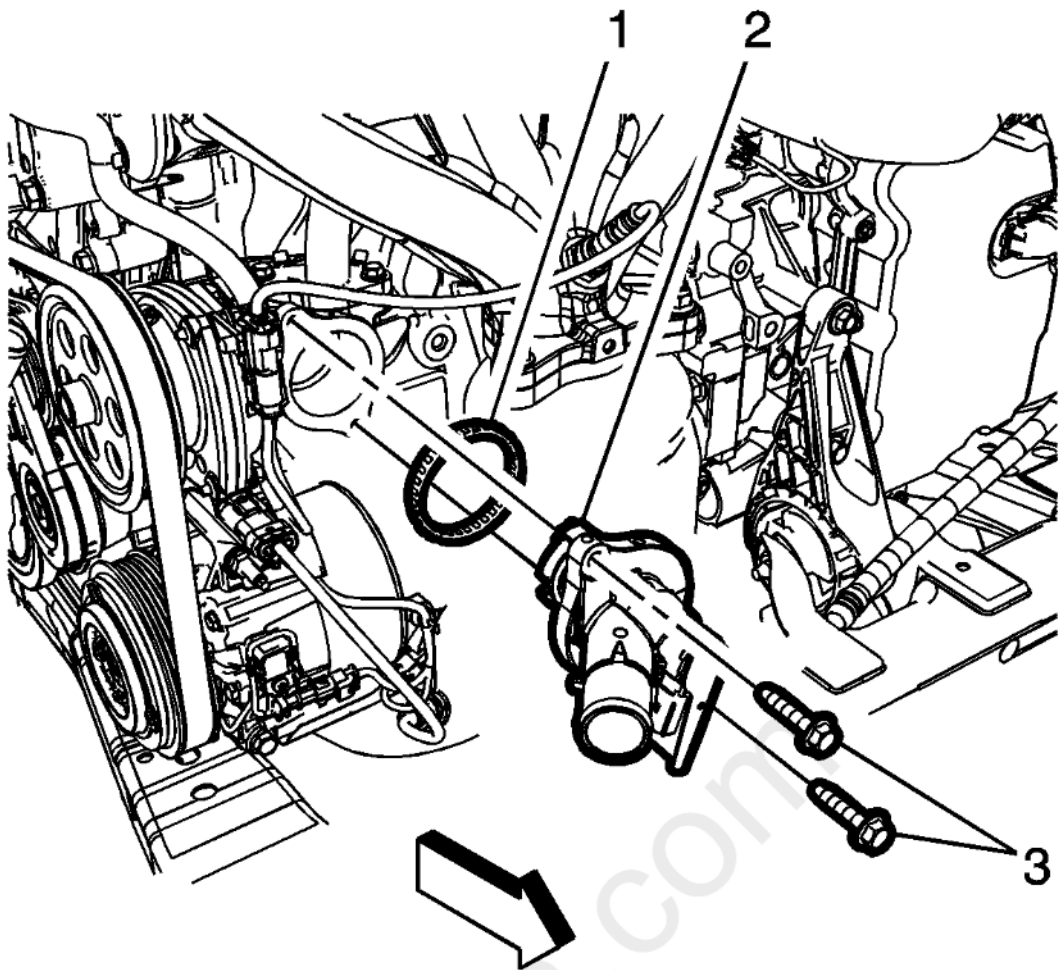


Fig. 42: Engine Coolant Thermostat Housing Fasteners And Engine Coolant Thermostat Housing

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

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

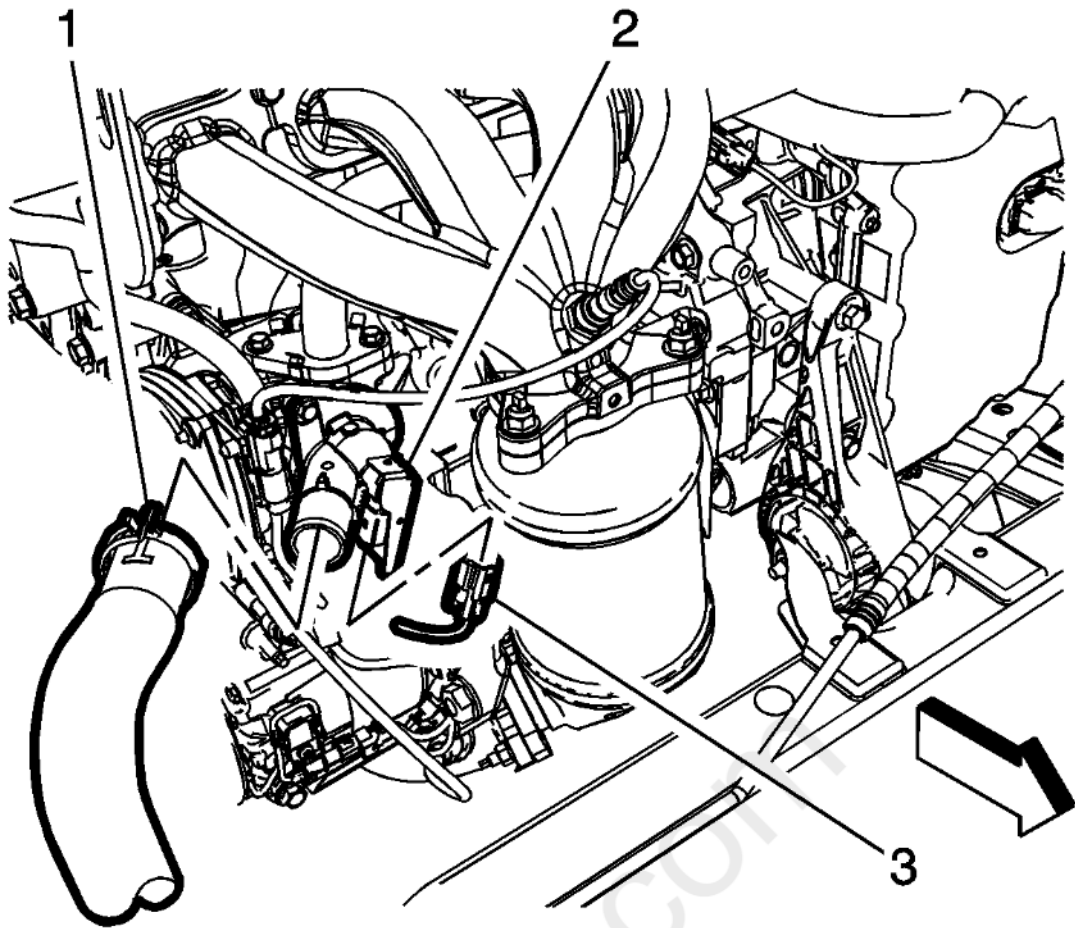


Fig. 43: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

4. If equipped, connect the connector (3) to the engine coolant thermostat housing (2).
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**](#) .
7. Fill the cooling system. Refer to [**Cooling System Draining and Filling \(Vacuum and Fill\)**](#)[**Cooling System Draining and Filling \(Static\)**](#).
8. Start the engine and check for coolant leaks.

ENGINE COOLANT THERMOSTAT REPLACEMENT (LFX)

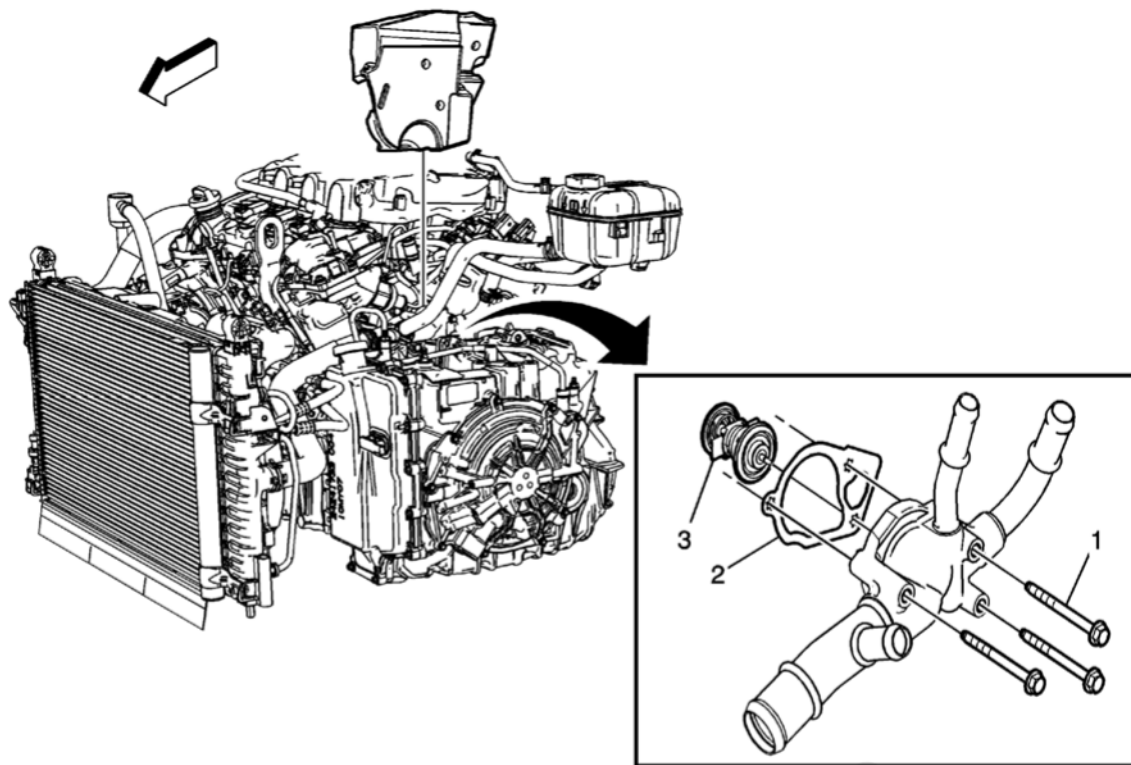


Fig. 44: Engine Coolant Thermostat, Gasket And Bolts
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the engine cooling thermostat housing. Refer to Engine Coolant Thermostat Housing Replacement (LFX) .	
1	Bolt (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Engine Cooling Thermostat Gasket
3	Engine Cooling Thermostat Procedure 1. Clean the engine block and thermostat gasket surfaces. 2. Replace gasket and any worn hoses.

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LFX)

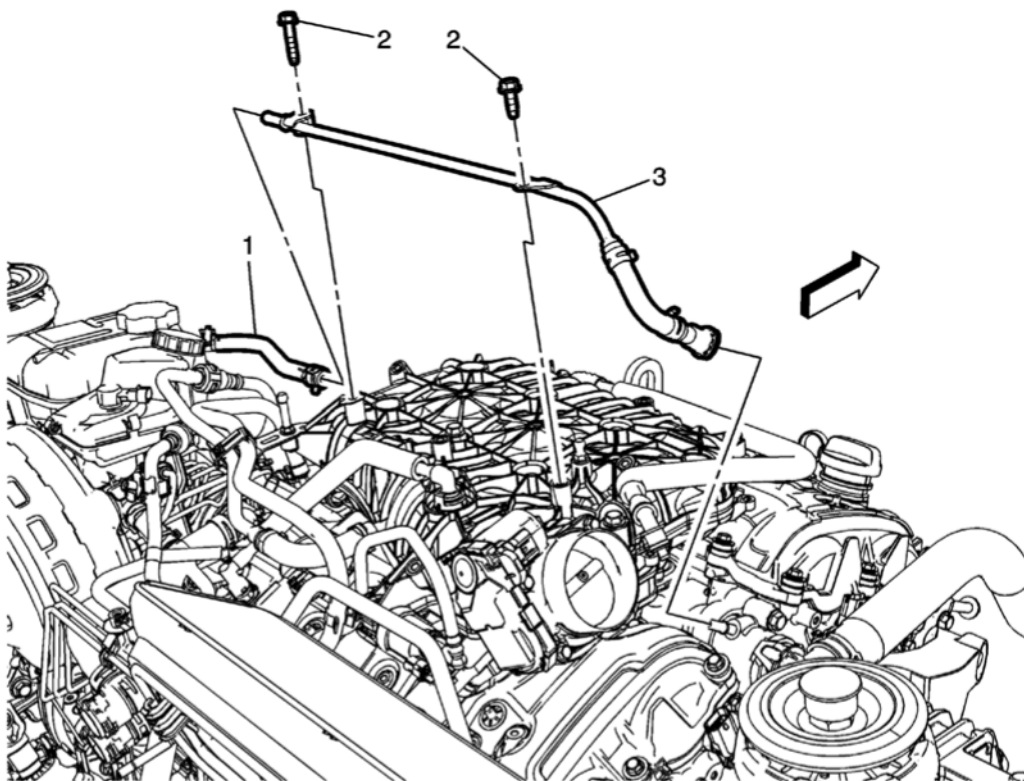


Fig. 45: Engine Coolant Air Bleed Pipe (LFX)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Partially drain coolant system. 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) . 3. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Radiator Surge Tank Inlet Hose Clamp Procedure Reposition radiator surge tank inlet hose clamp using the BO-38185 Hose Clamp Pliers. NOTE: Replace hose clamps if necessary. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Engine Coolant Air Bleed Pipe Fastener (Qty 2) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
3	Engine Coolant Air Bleed Pipe

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LCV)

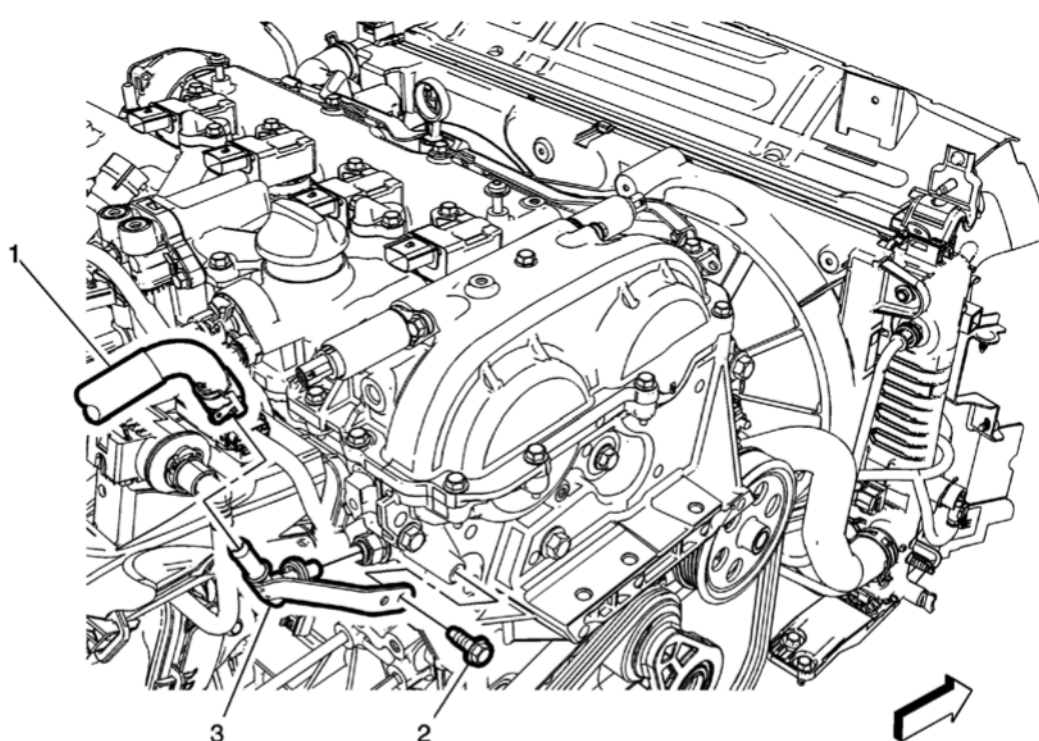


Fig. 46: Engine Coolant Air Bleed Pipe (LCV)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement.	
1	Radiator Surge Tank Inlet Hose Procedure Reposition the radiator surge tank hose using the BO-38185 Hose Clamp Pliers NOTE: Repalce hose clamp if necessary Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Engine Coolant Air Bleed Pipe Fastener CAUTION: Refer to Fastener Caution. Tighten: 9 N.m (80 lb in)
3	Engine Coolant Air Bleed Pipe

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (LFX)

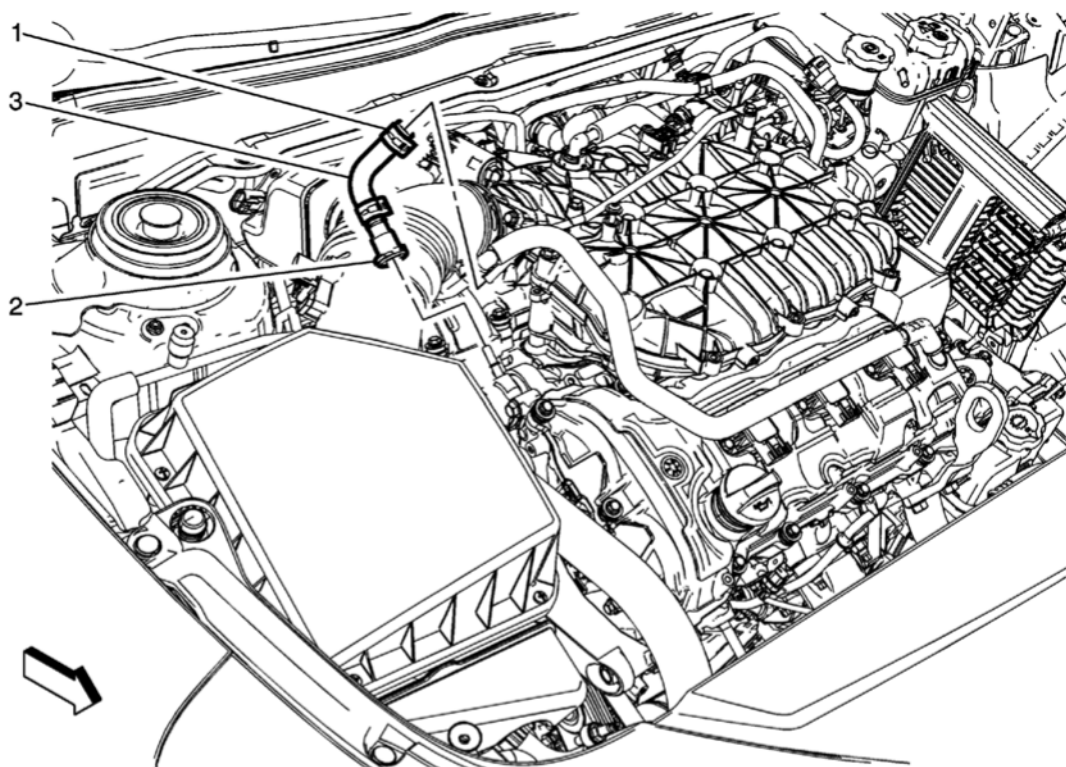


Fig. 47: Engine Coolant Air Bleed Hose, Clamp & Connector Retainer (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX). 3. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.	
1	Engine Coolant Air Bleed Hose Clamp Procedure Reposition the engine coolant air bleed hose clamp using BO-38185 hose clamp pliers. NOTE: Replace hose clamp if necessary. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Engine Coolant Air Bleed Hose Connector Retainer Procedure Release the quick connect by pushing in the retainer and pulling back on the quick connect. Refer to Plastic Collar Quick Connect Fitting Service .
3	Engine Coolant Air Bleed Hose Procedure 1. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Check the cooling system for leaks.

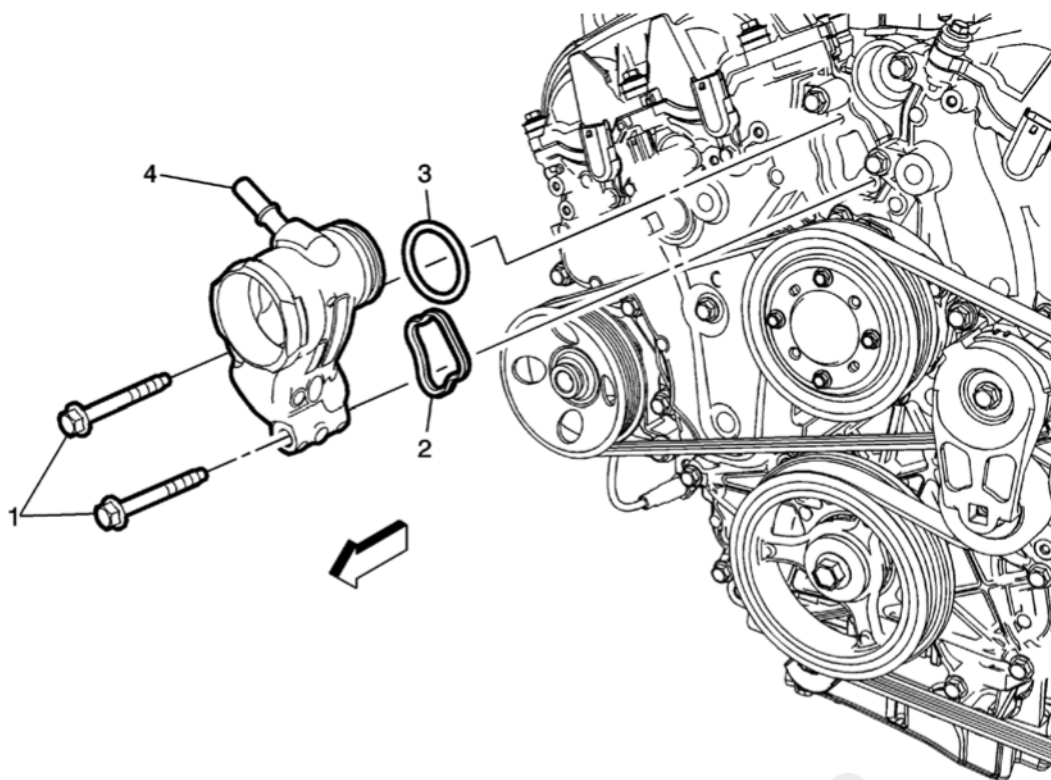


Fig. 48: Water Outlet, Seals & Fasteners (LFX)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the right engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side. 3. Remove the engine coolant air bleed pipe. Refer to Engine Coolant Air Bleed Pipe Replacement (LFX). 4. Remove radiator inlet hose. Refer to Radiator Inlet Hose Replacement (LFX).	
1	Bolt (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Seal
3	Seal
4	Water Outlet TIP: Clean the surfaces and replace the seal.

WATER OUTLET REPLACEMENT (LCV)

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 \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).
2. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
3. Reposition the engine control module and bracket without disconnecting the module electrical connectors. Refer to [Engine Control Module Replacement](#).

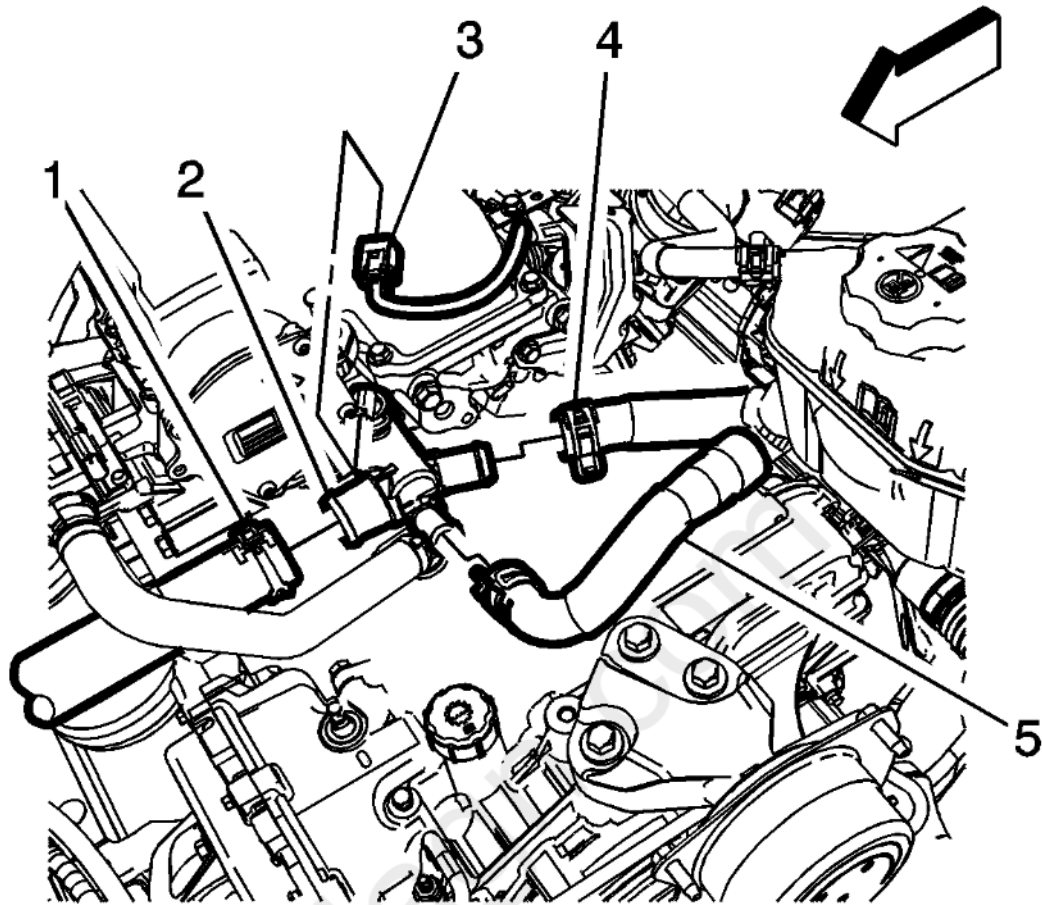


Fig. 49: Engine Coolant Temperature (ECT) Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

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

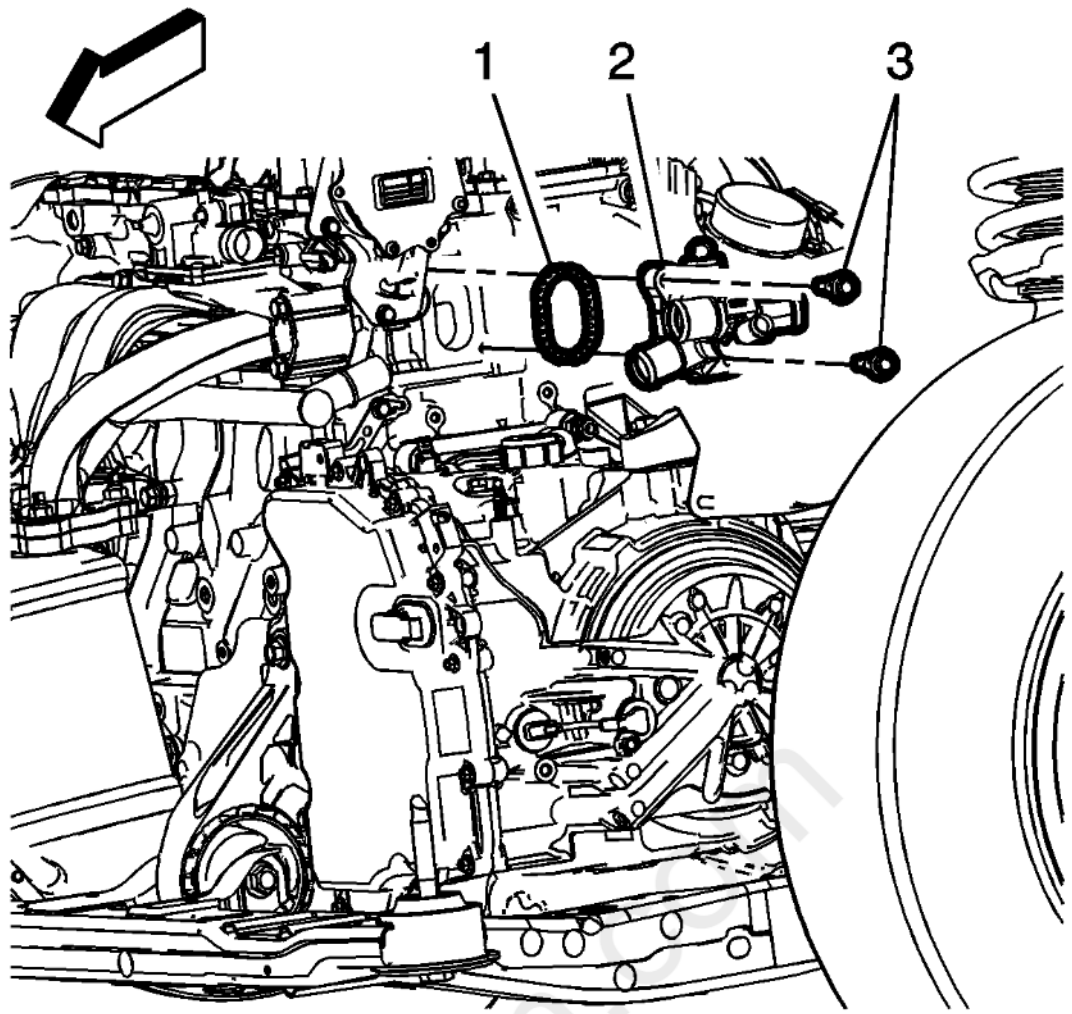


Fig. 50: Water Outlet Fasteners

Courtesy of GENERAL MOTORS COMPANY

6. Remove the water outlet fasteners (3) and remove the water outlet (2).

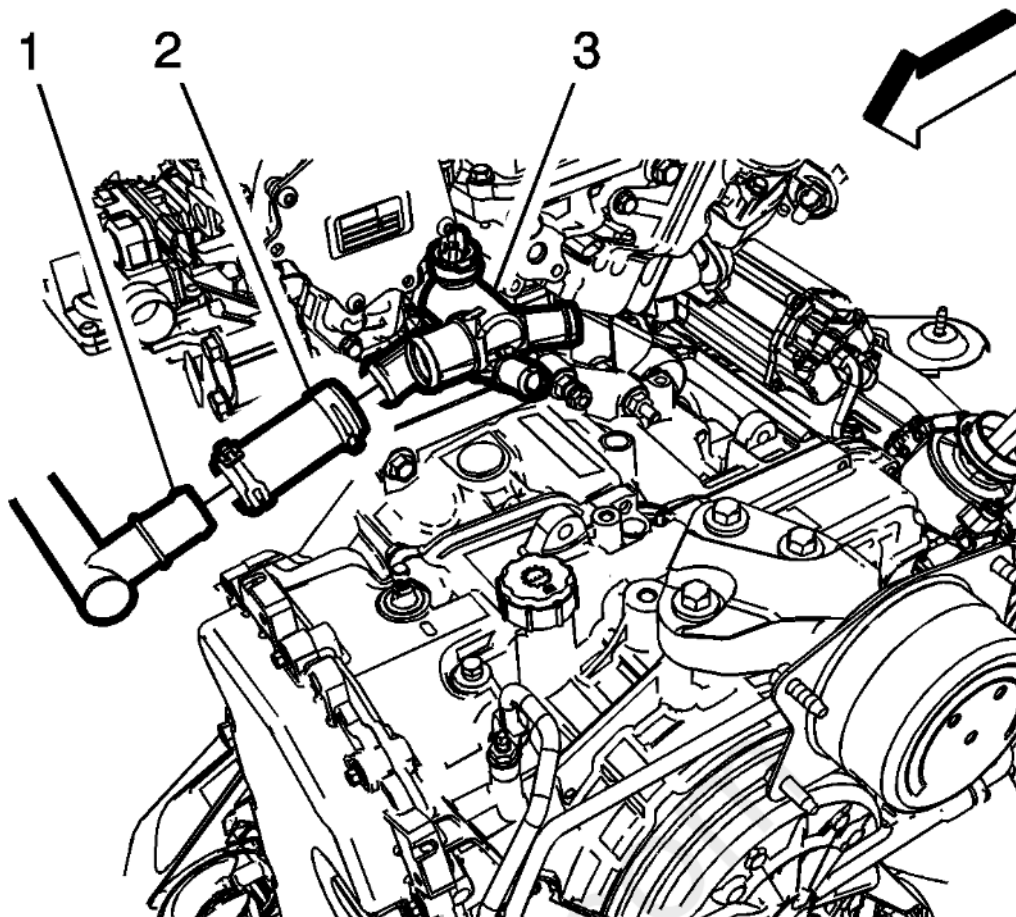


Fig. 51: Thermostat Bypass Hose

Courtesy of GENERAL MOTORS COMPANY

7. Remove the thermostat bypass hose (2) from the water outlet (3).
8. Discard the water outlet seal (1).

Installation Procedure

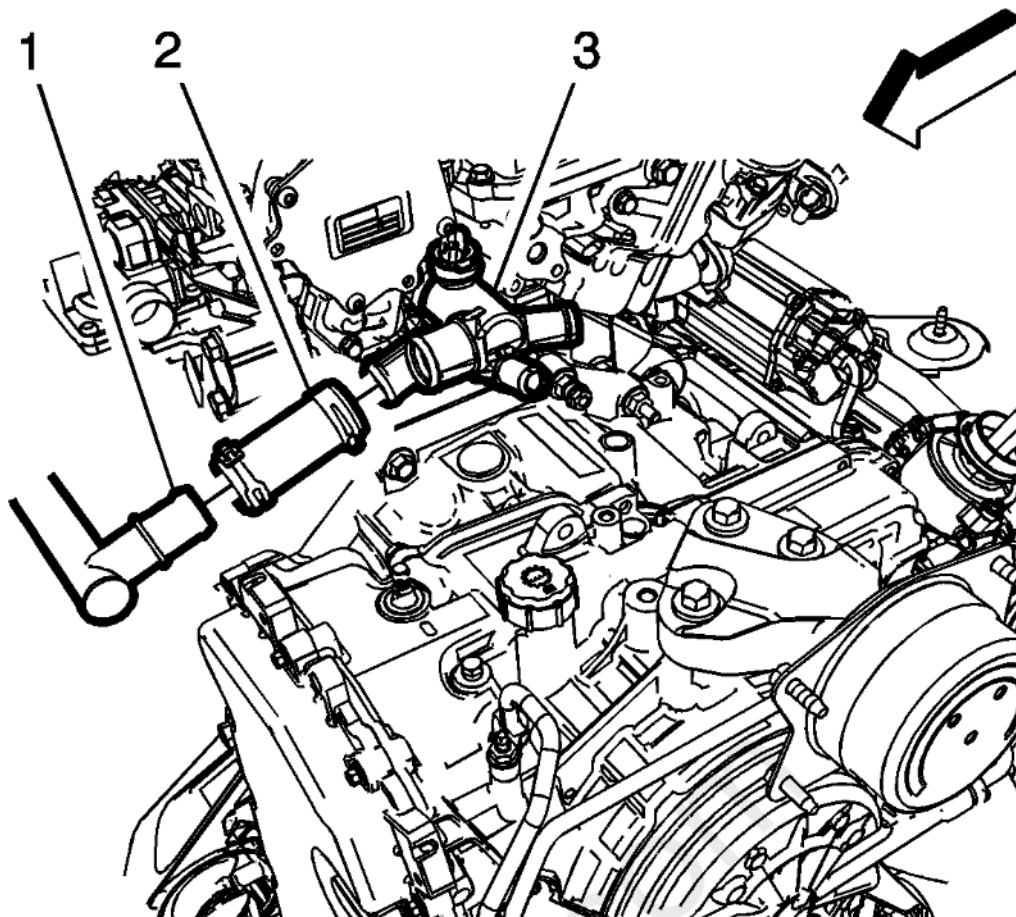


Fig. 52: Thermostat Bypass Hose

Courtesy of GENERAL MOTORS COMPANY

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

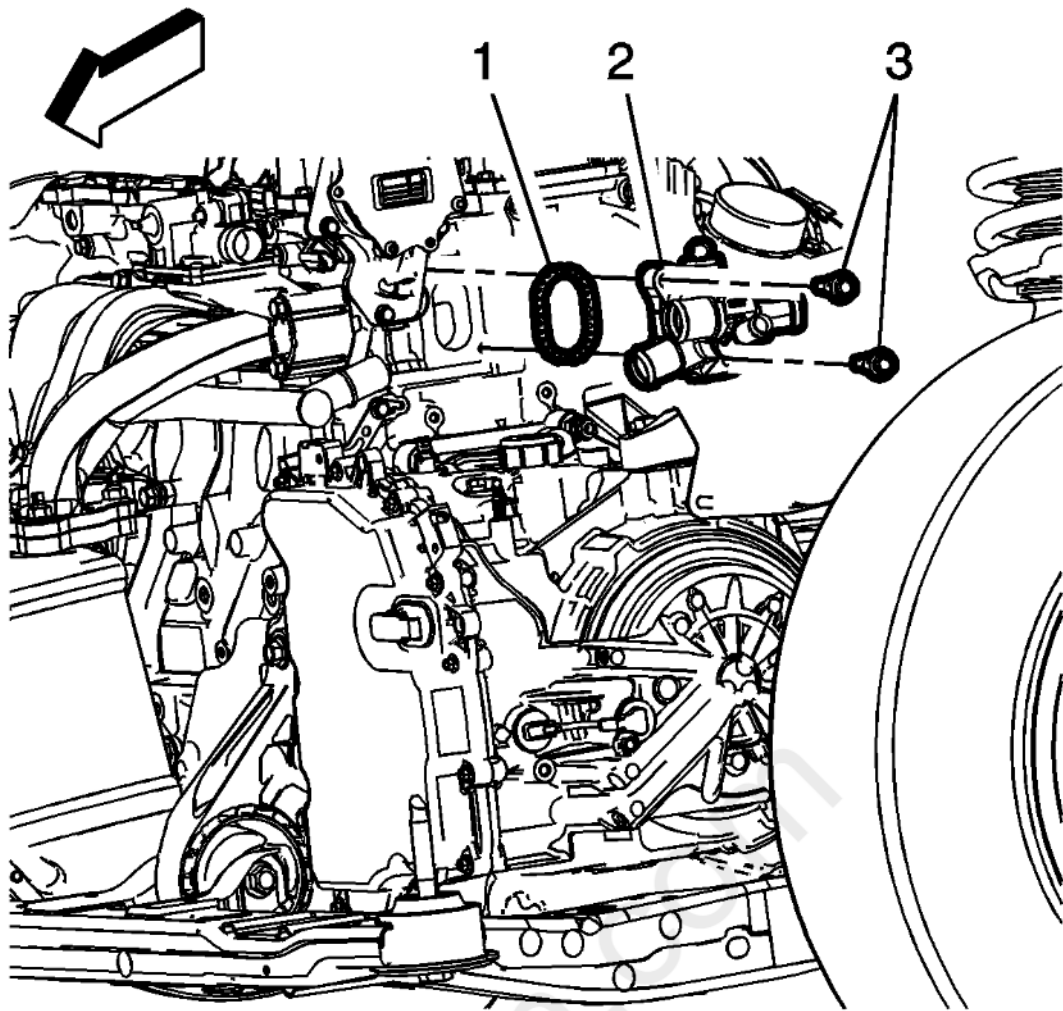


Fig. 53: Water Outlet Fasteners

Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to **Fastener Caution** .

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

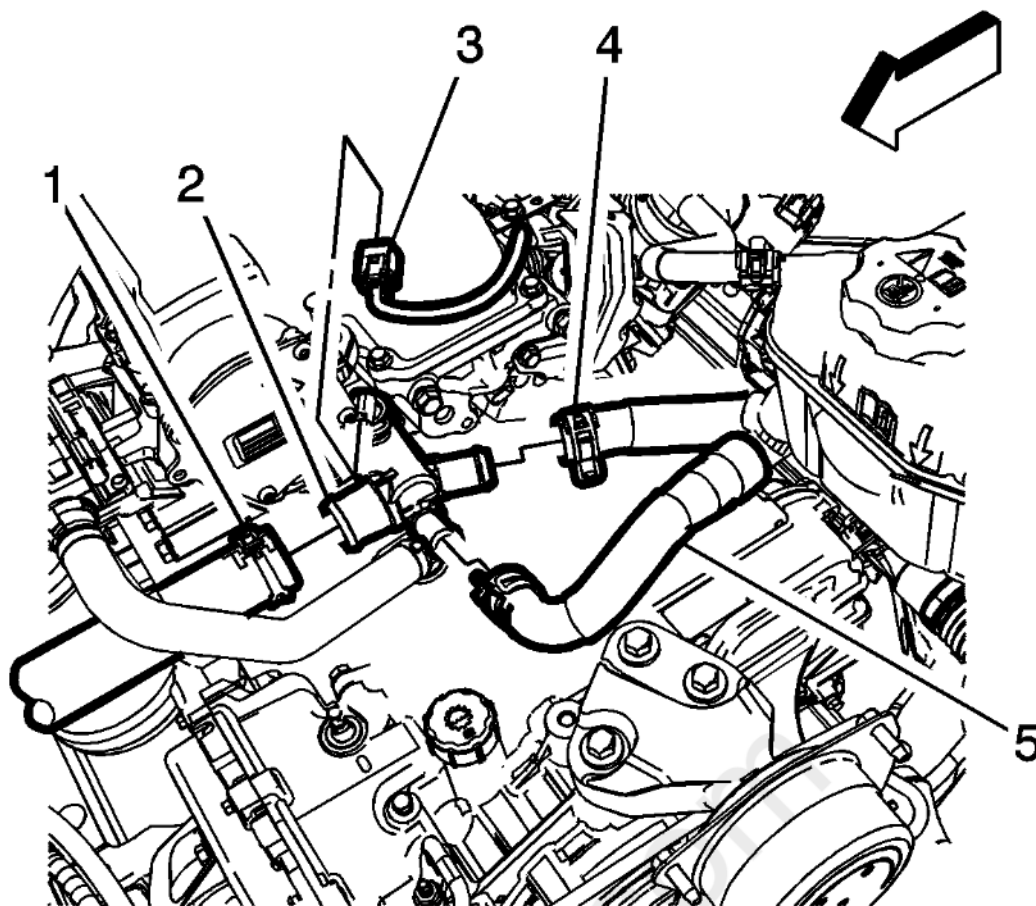


Fig. 54: Engine Coolant Temperature (ECT) Sensor Connector

Courtesy of GENERAL MOTORS COMPANY

4. Connect the engine coolant temperature (ECT) sensor connector (3) to the water outlet (2).
5. Install the following hoses to the water outlet:
 - Radiator inlet hose (1).
 - Heater inlet hose (4).
 - Heater outlet hose (5).
6. Install the engine control module and bracket. Refer to [Engine Control Module Replacement](#) .
7. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#) .
8. Fill the cooling system. Refer to [Cooling System Draining and Filling.\(Vacuum and Fill\)Cooling System Draining and Filling.\(Static\)](#).
9. Start the engine and check for coolant leaks.

THERMOSTAT BYPASS PIPE REPLACEMENT (LCV)

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.\(Vacuum and Fill\)Cooling System Draining and Filling.\(Static\)](#).
2. Remove the exhaust manifold heat shield. Refer to [Exhaust Manifold Heat Shield Replacement](#) .
3. Reposition the engine control module and bracket without disconnecting the module electrical connectors. Refer to [Engine Control Module Replacement](#) .

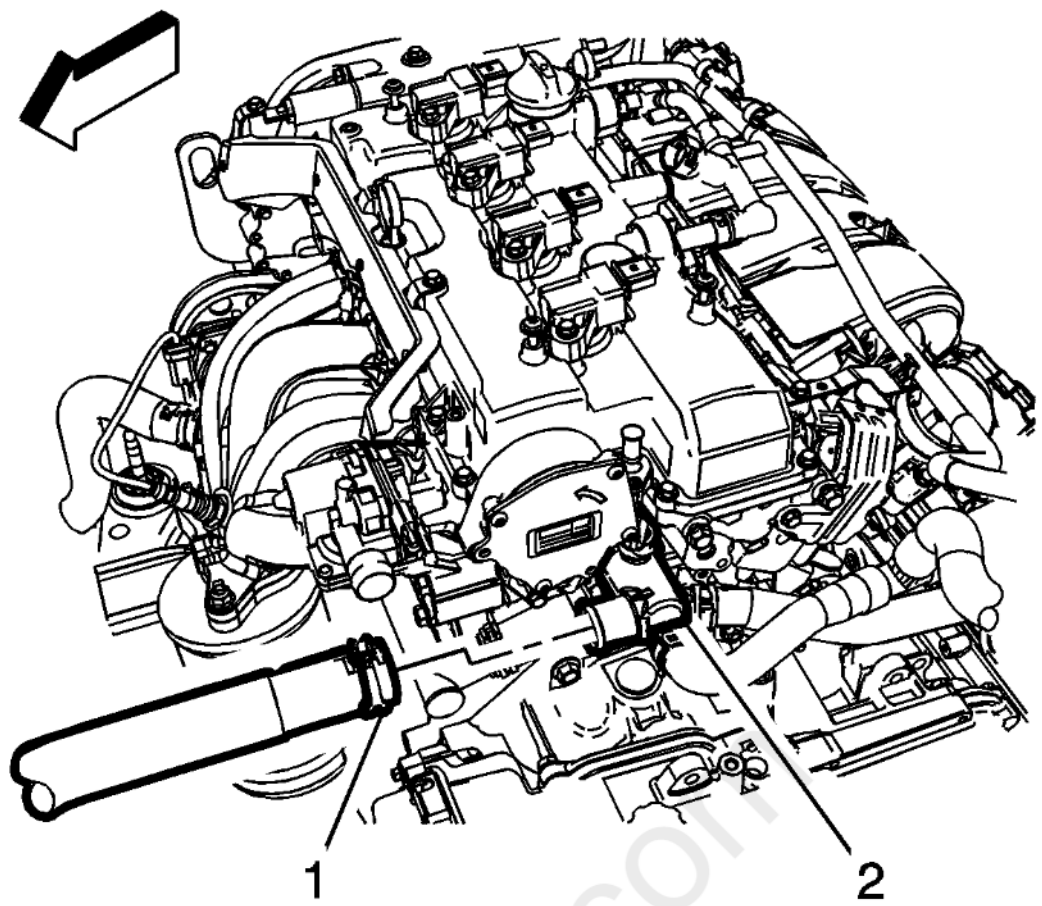


Fig. 55: Radiator Inlet Hose And Water Outlet

Courtesy of GENERAL MOTORS COMPANY

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

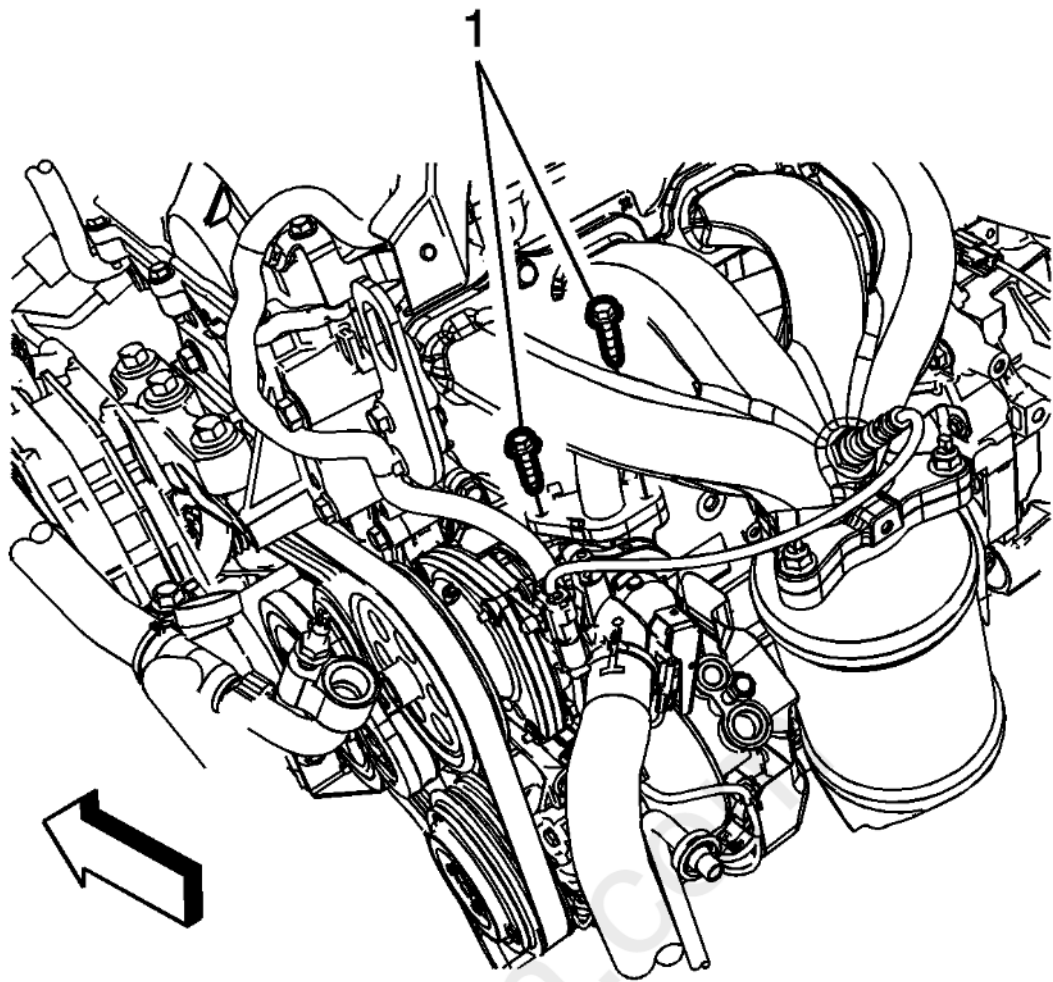


Fig. 56: Thermostat Bypass Pipe Fasteners

Courtesy of GENERAL MOTORS COMPANY

5. Remove the thermostat bypass pipe fasteners (1).

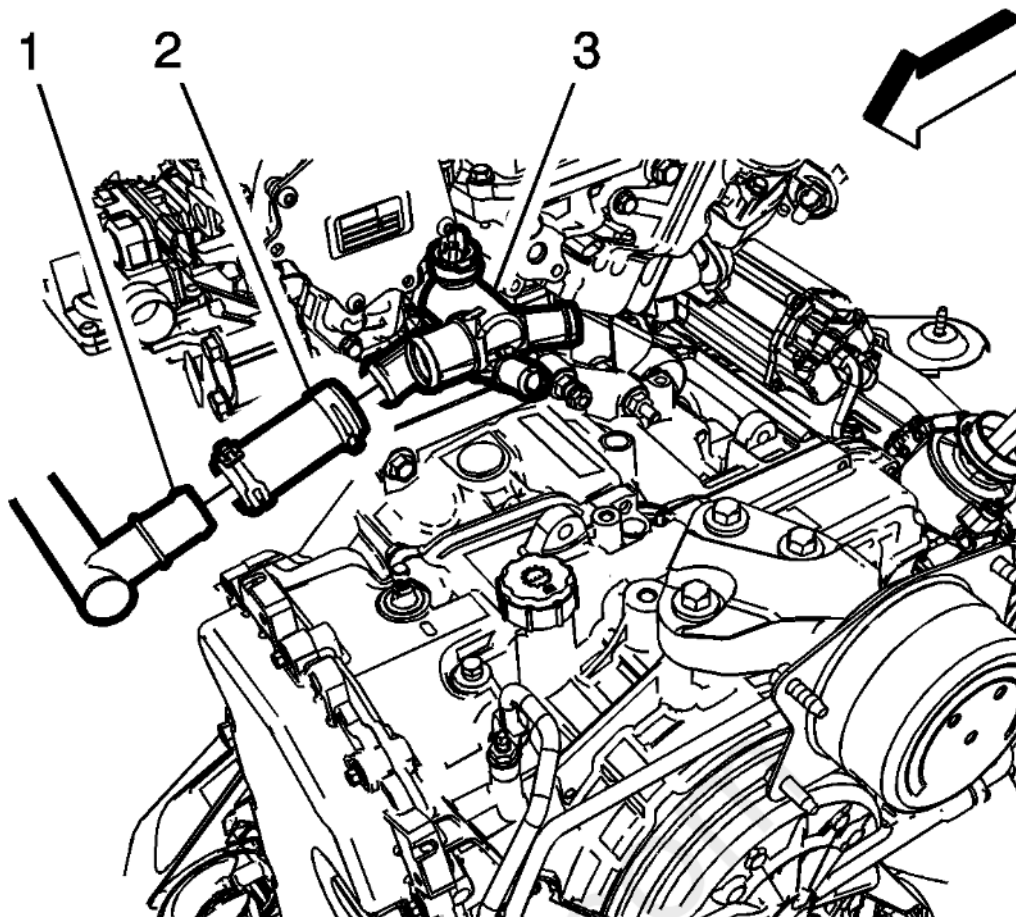


Fig. 57: Thermostat Bypass Hose

Courtesy of GENERAL MOTORS COMPANY

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

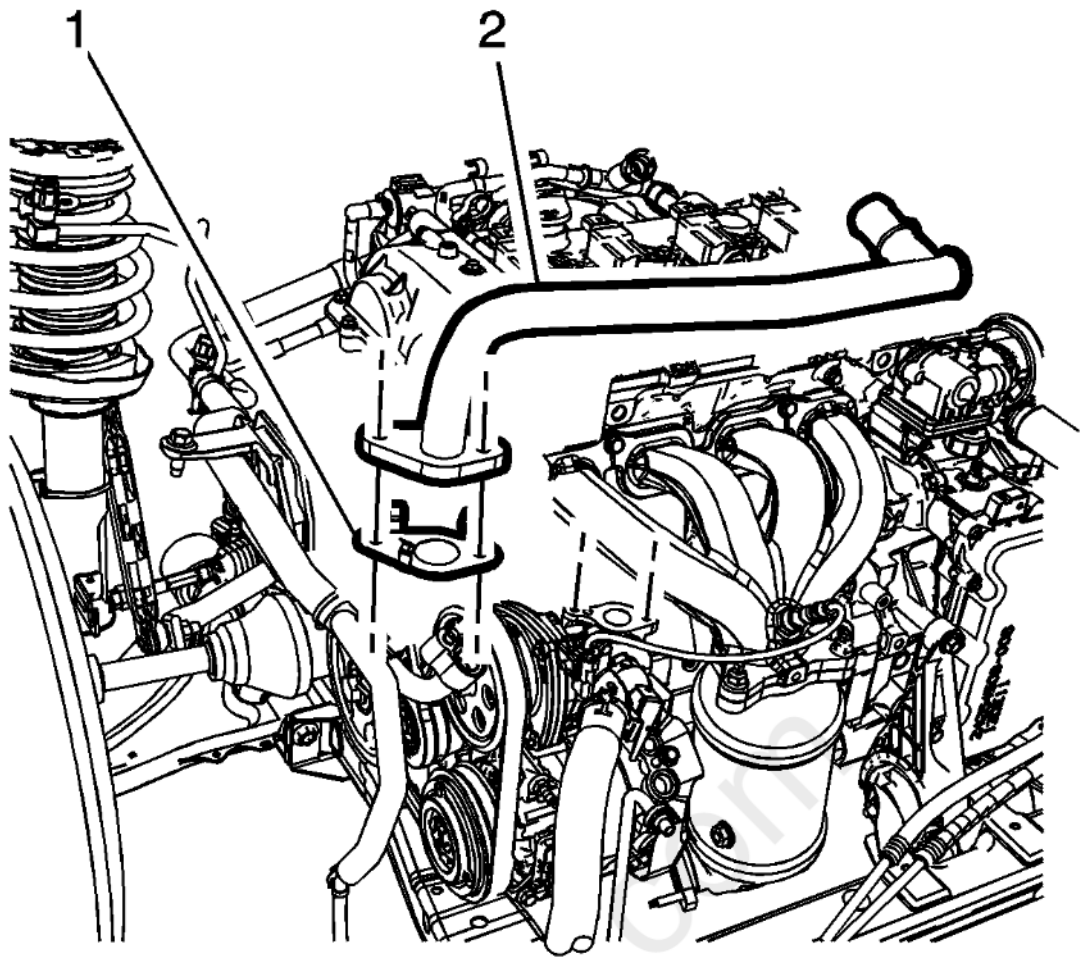


Fig. 58: Thermostat Bypass Pipe And Gasket
Courtesy of GENERAL MOTORS COMPANY

7. Remove the thermostat bypass pipe (2) and discard the gasket (1).

Installation Procedure

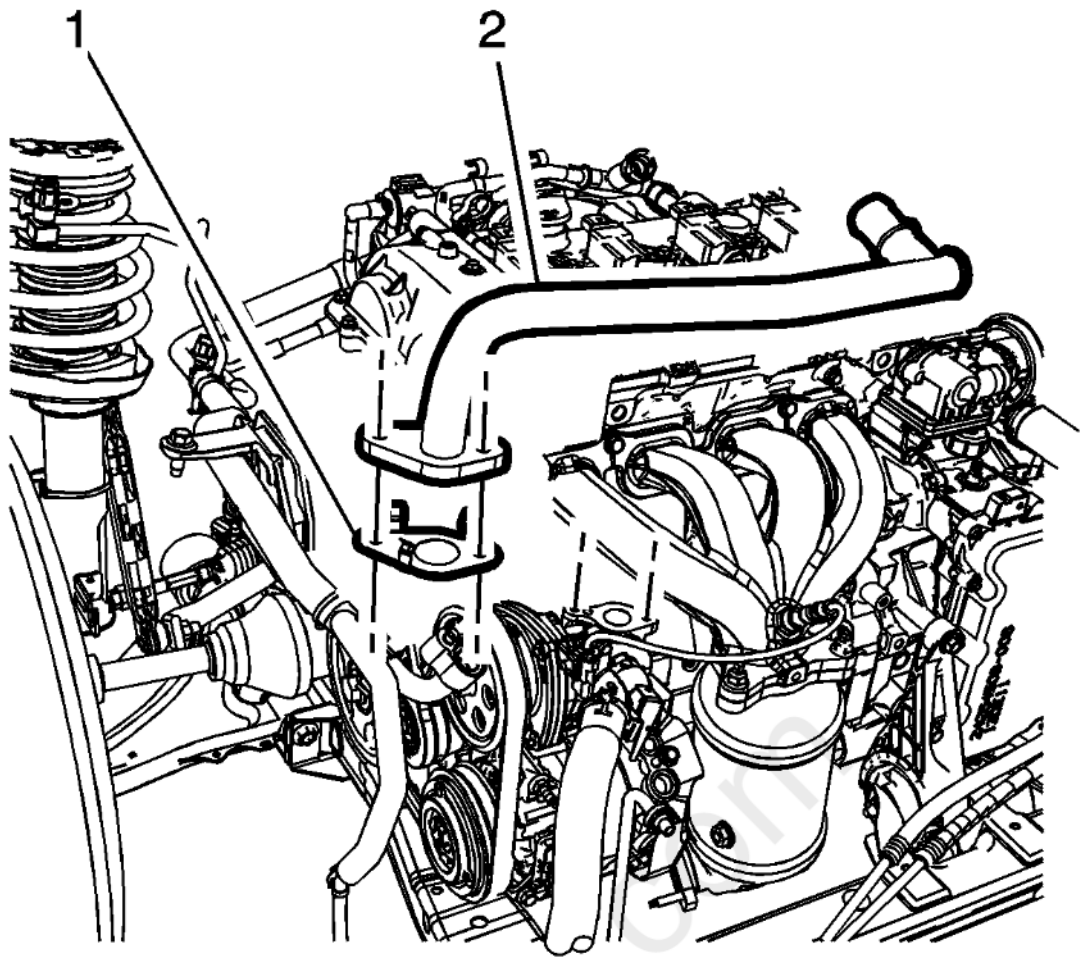


Fig. 59: Thermostat Bypass Pipe And Gasket
Courtesy of GENERAL MOTORS COMPANY

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

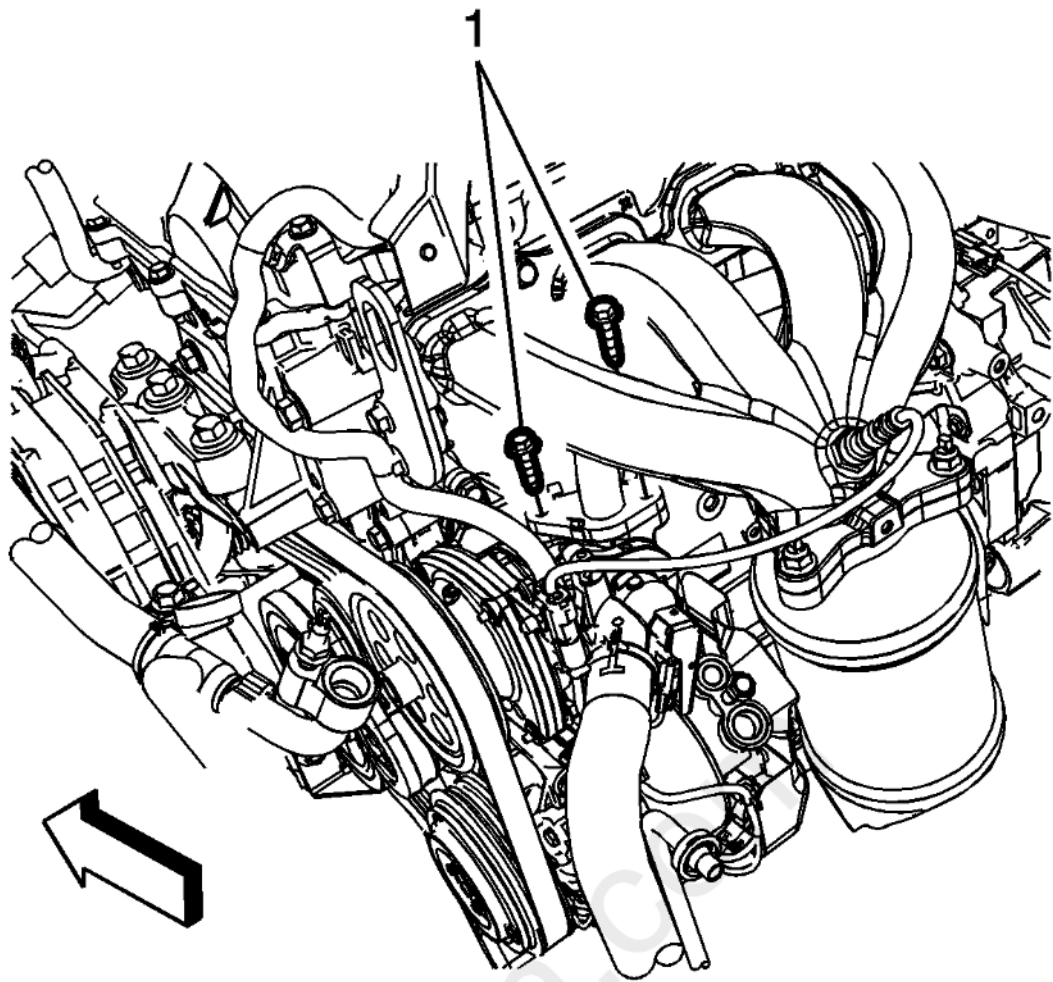


Fig. 60: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

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

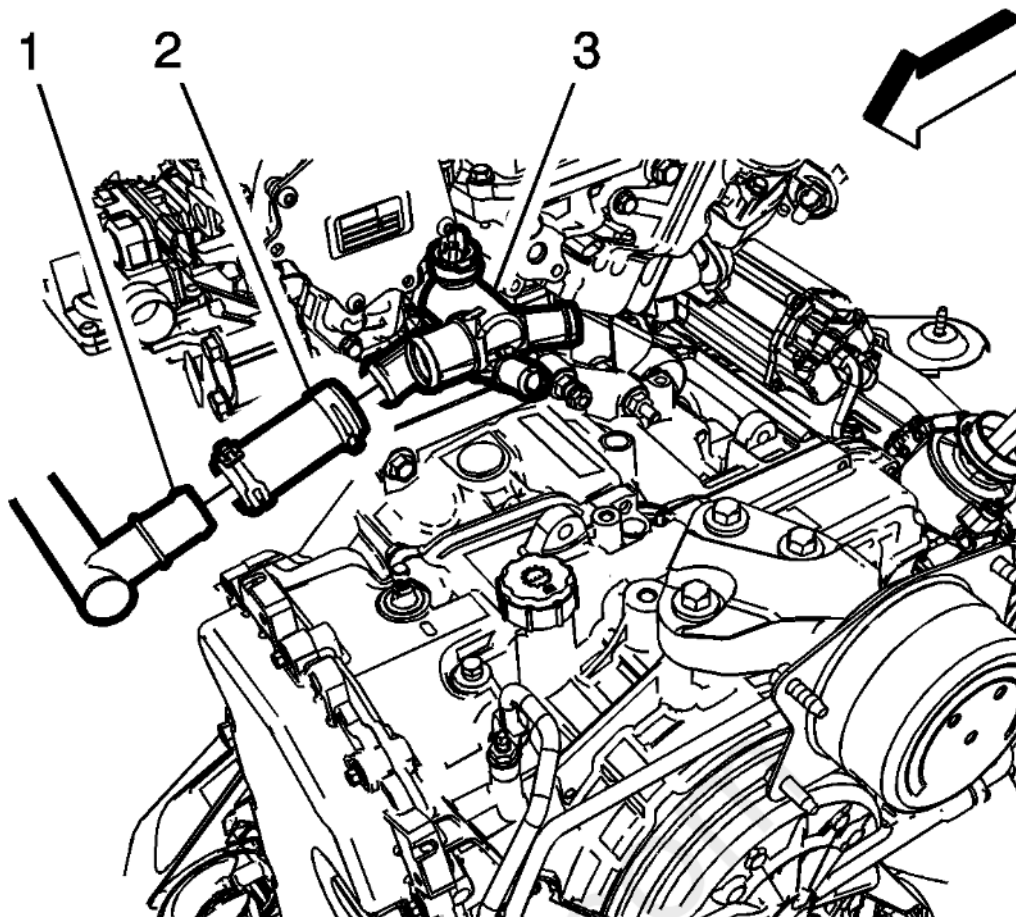


Fig. 61: Thermostat Bypass Hose

Courtesy of GENERAL MOTORS COMPANY

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

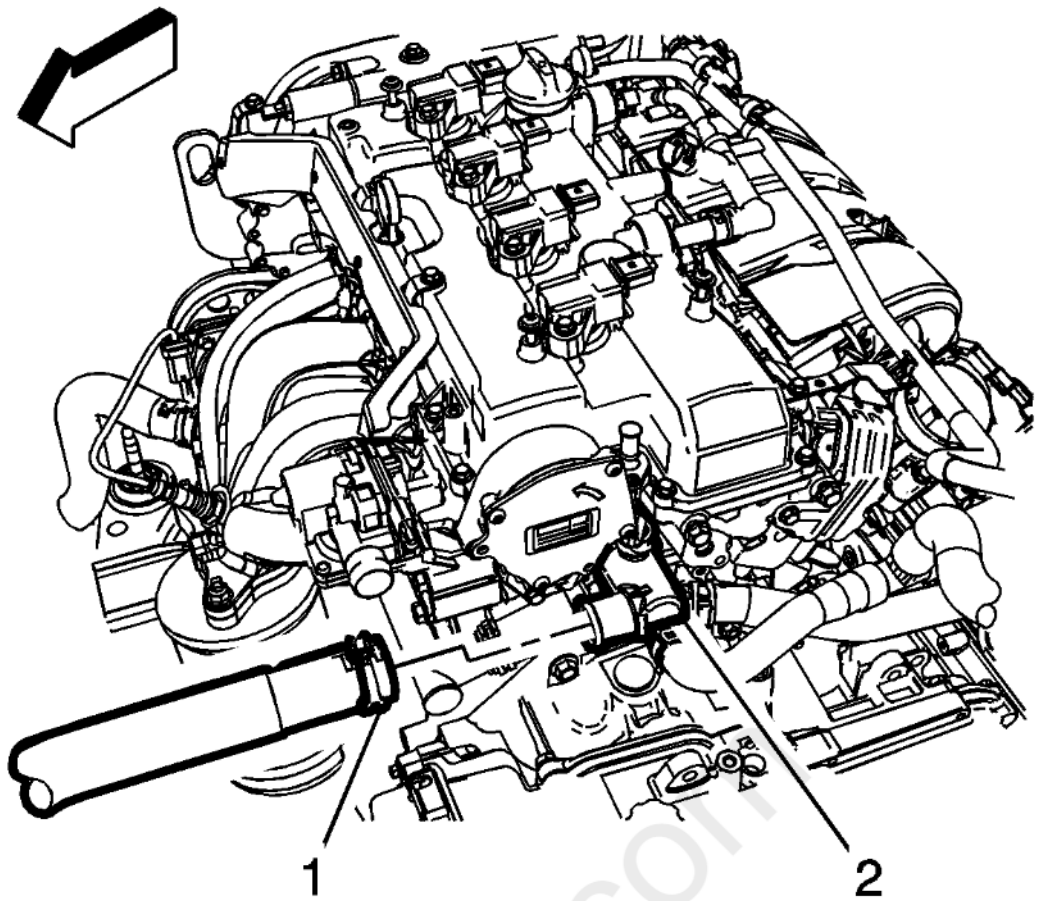


Fig. 62: Radiator Inlet Hose And Water Outlet
 Courtesy of GENERAL MOTORS COMPANY

4. Install the radiator inlet hose (1) to the water outlet (2).
5. Install the engine control module and bracket. Refer to [Engine Control Module Replacement](#) .
6. Install the exhaust manifold heat shield. Refer to [Exhaust Manifold Heat Shield Replacement](#) .
7. Fill the cooling system. Refer to [Cooling System Draining and Filling \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).
8. Start the engine and check for coolant leaks.

WATER PUMP REPLACEMENT (LFX)

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 \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).
2. Remove the drive belt. Refer to [Drive Belt Replacement](#) .

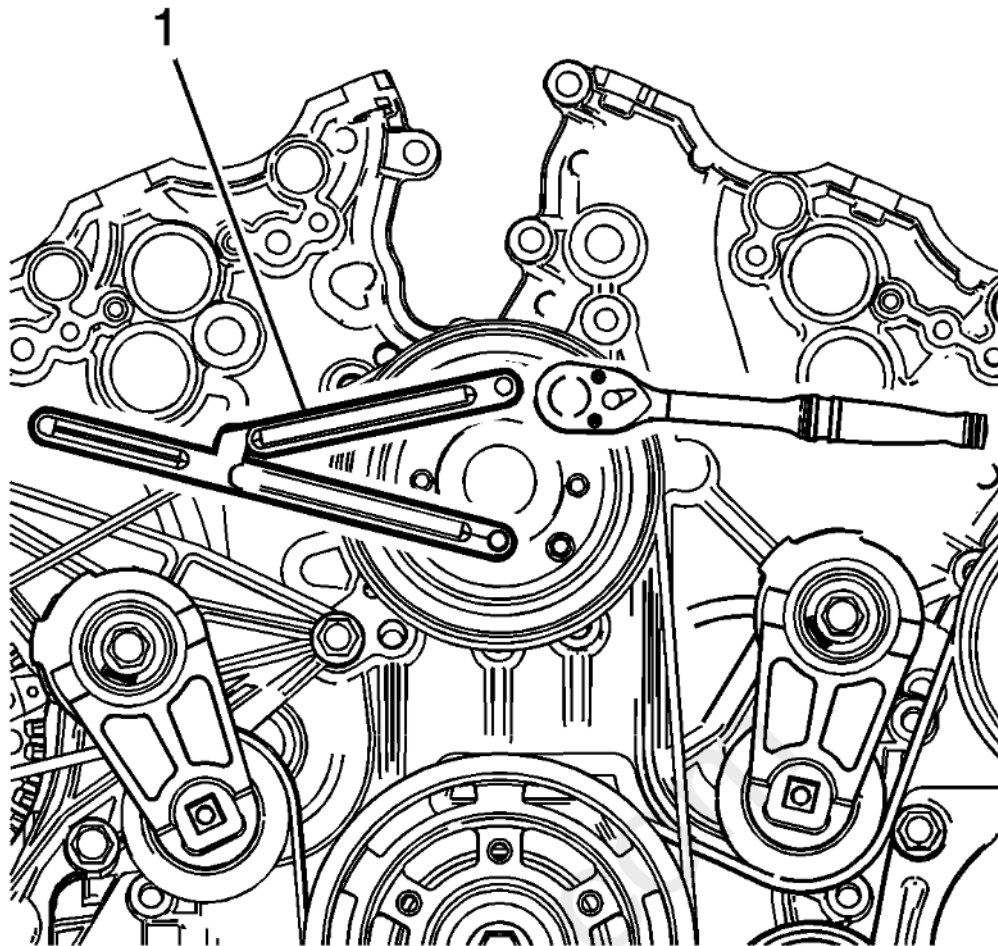


Fig. 63: Securing Water Pump Pulley With EN 46104

Courtesy of GENERAL MOTORS COMPANY

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

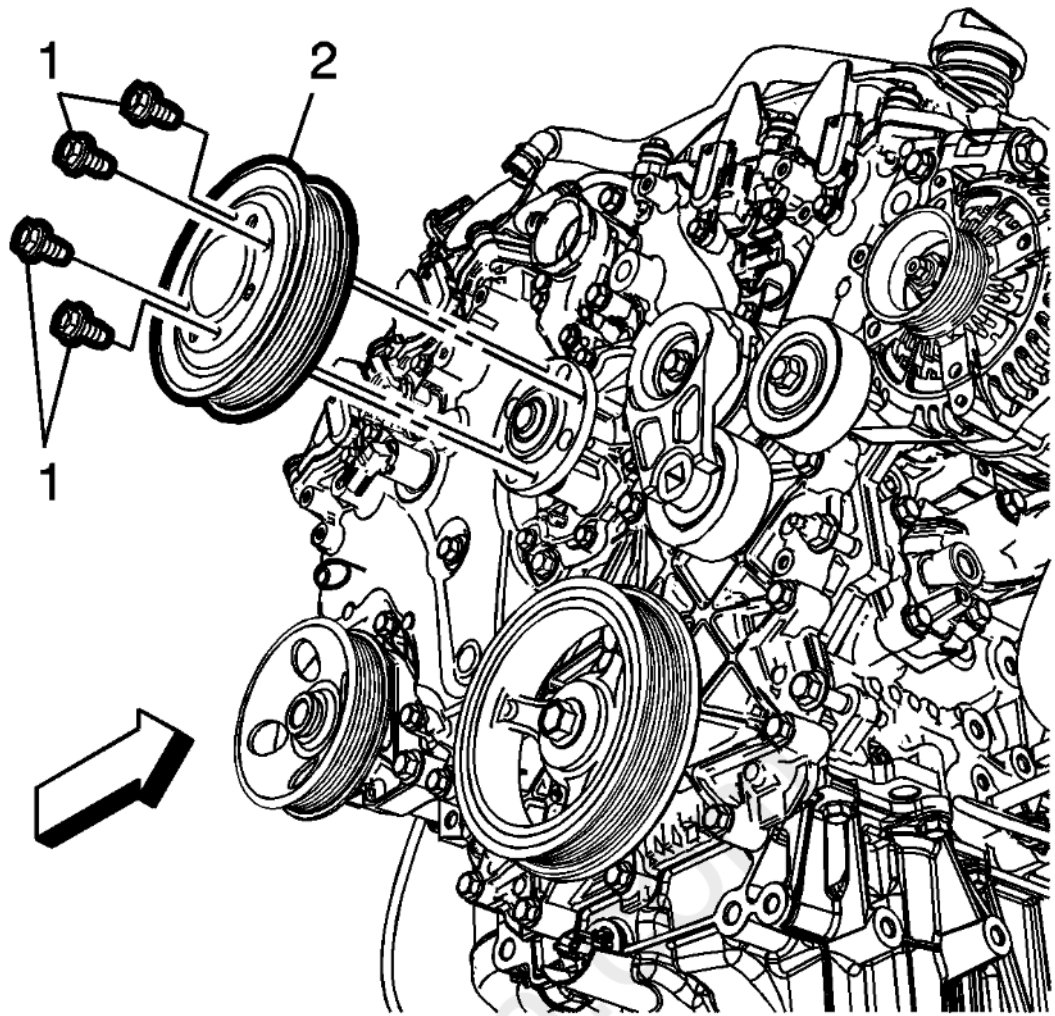


Fig. 64: Water Pump Pulley & Fasteners

Courtesy of GENERAL MOTORS COMPANY

4. Remove the water pump pulley fasteners (1).

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.

5. Remove the water pump pulley (2).

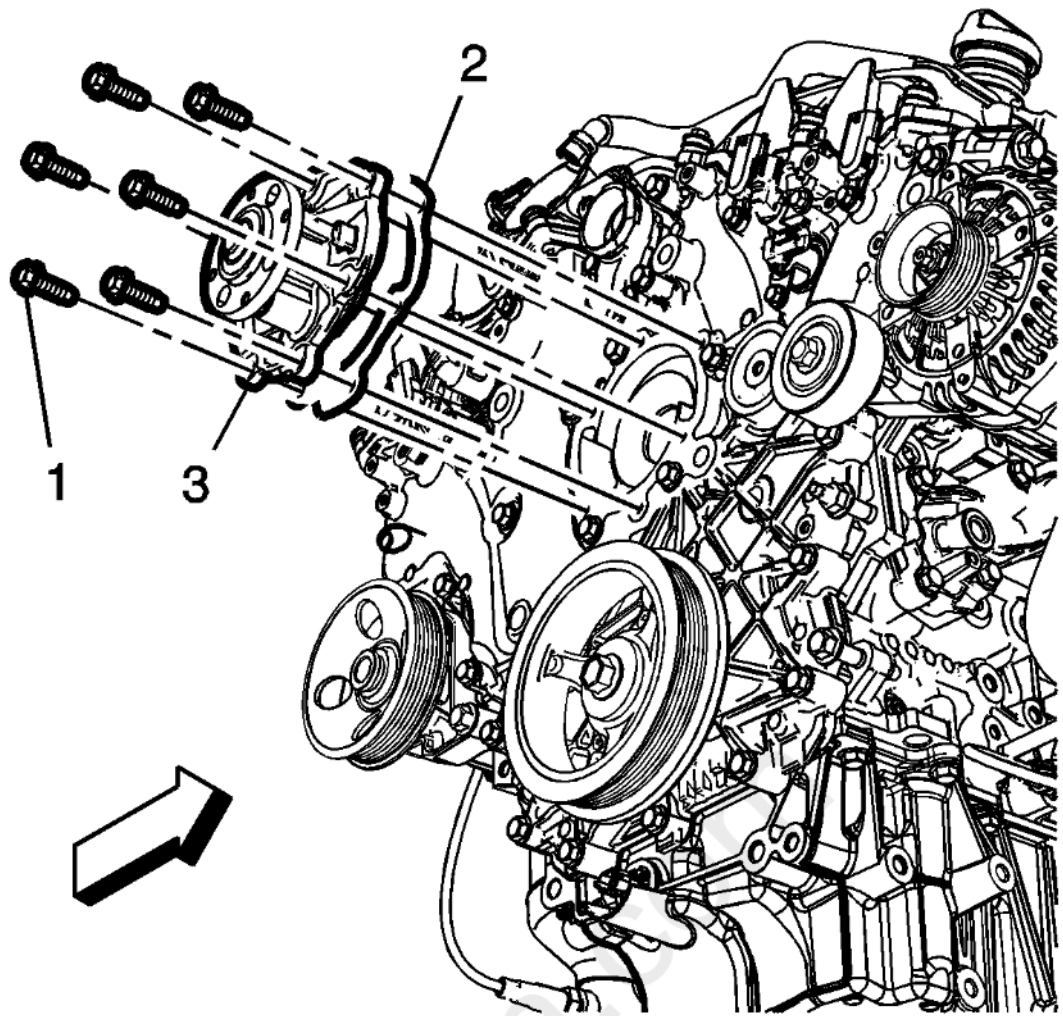


Fig. 65: Water Pump, Seal & Fasteners

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

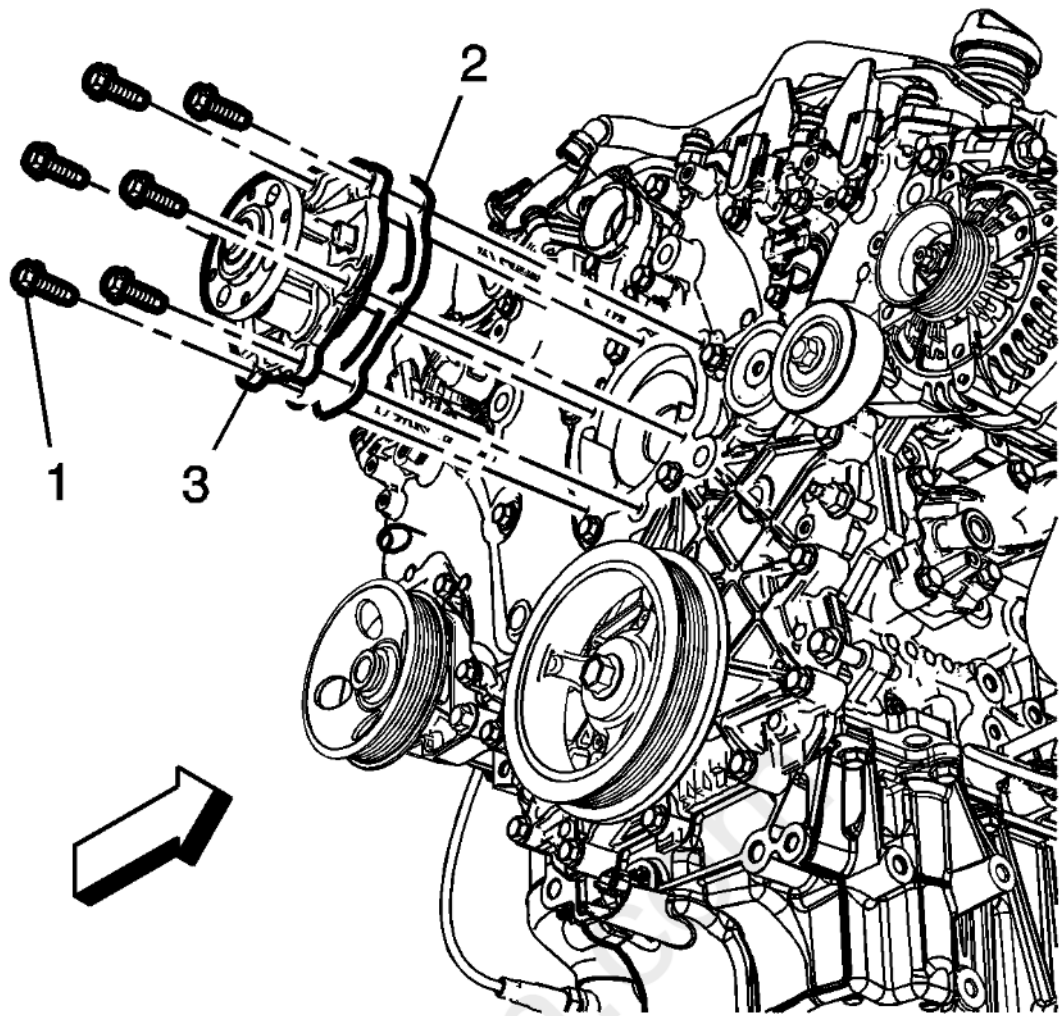


Fig. 66: Water Pump, Seal & Fasteners

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW water pump seal (2).
2. Install the water pump (3).

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.

3. Install the NEW water pump fasteners and hand tighten the water pump fasteners.

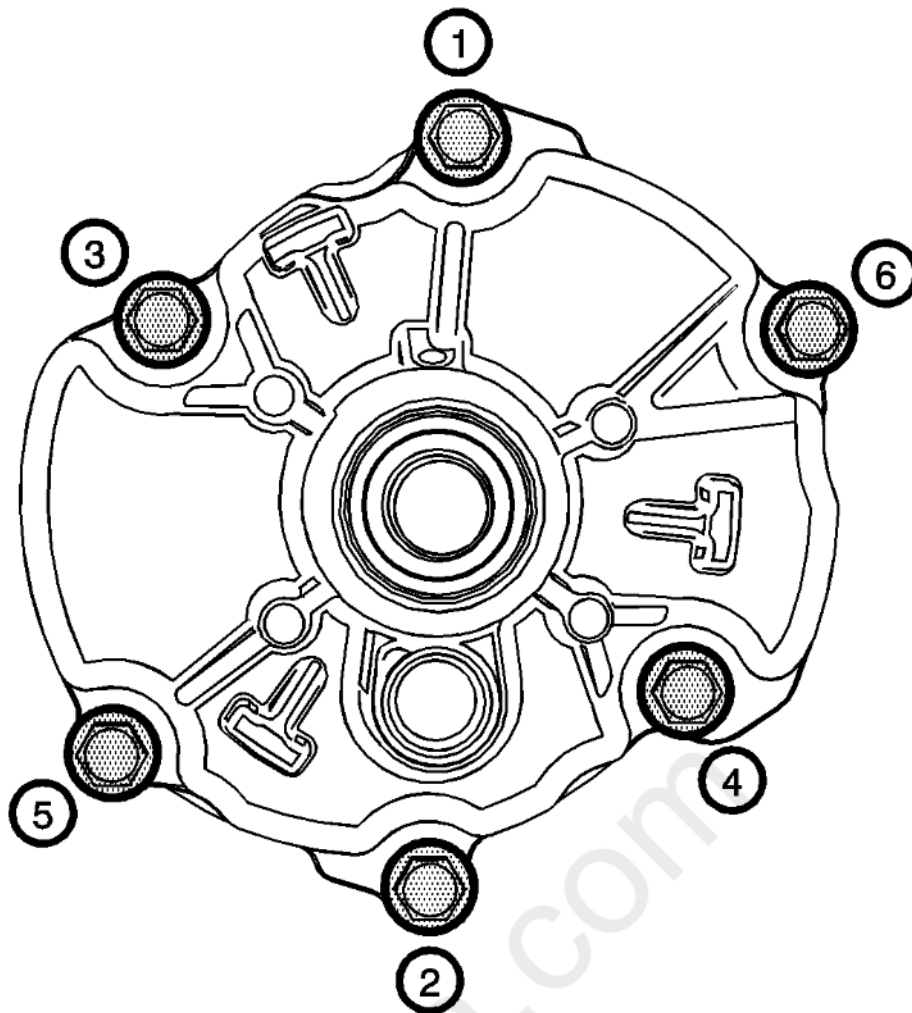


Fig. 67: Water Pump Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

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

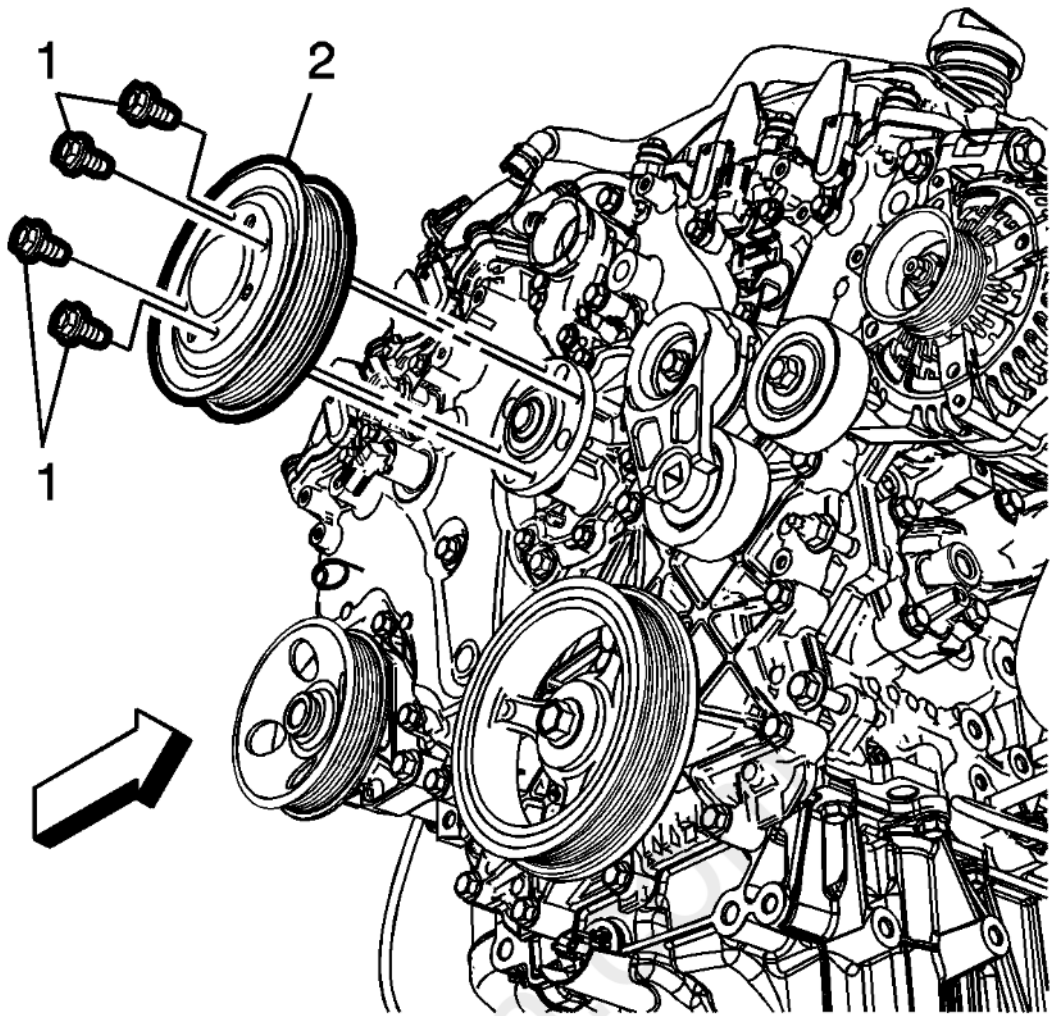


Fig. 68: Water Pump Pulley & Fasteners

Courtesy of GENERAL MOTORS COMPANY

5. Loosely install the water pump pulley (2) using the water pump pulley fasteners (1).

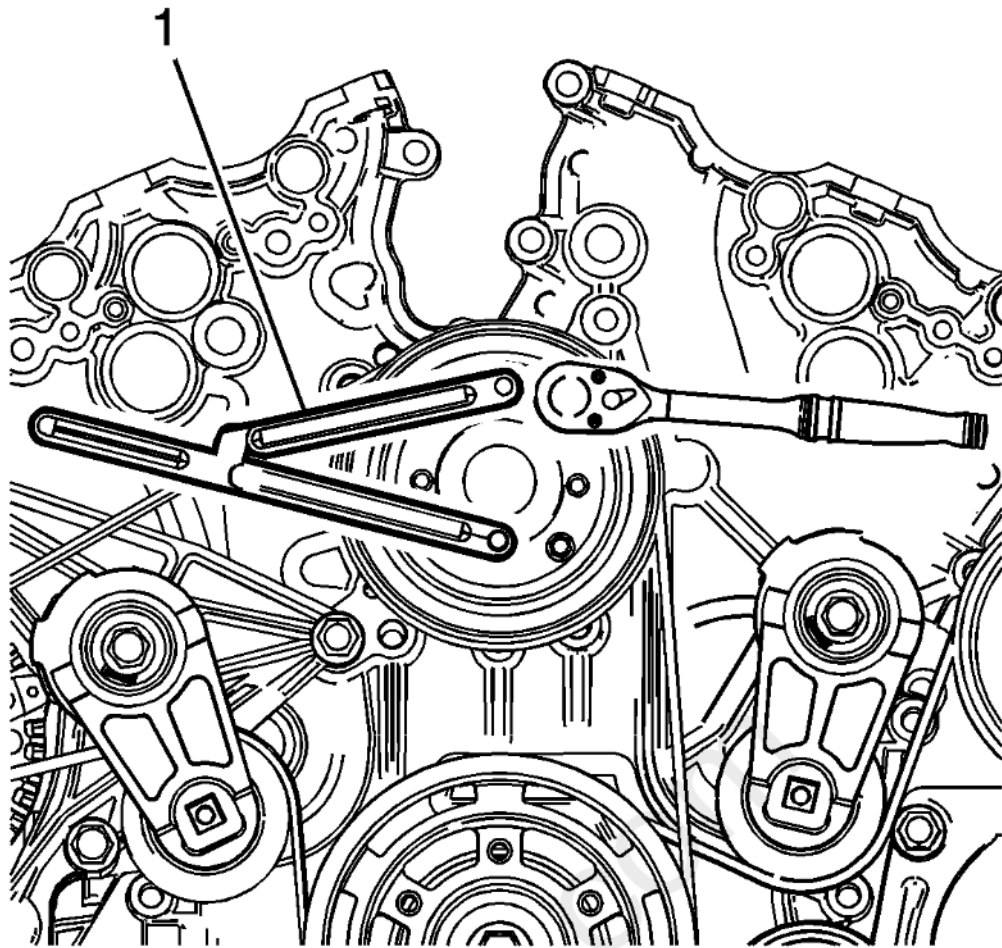


Fig. 69: Securing Water Pump Pulley With EN 46104

Courtesy of GENERAL MOTORS COMPANY

6. Use the **EN 46104** water pump pulley holder (1) to hold the pulley.
7. Tighten the water pump pulley fasteners to 10 N.m (89 lb in).
8. Install the drive belt. Refer to [**Drive Belt Replacement**](#).
9. Fill the cooling system. Refer to [**Cooling System Draining and Filling.\(Vacuum and Fill\)**](#)[**Cooling System Draining and Filling.\(Static\).**](#)

WATER PUMP REPLACEMENT (LCV)

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.\(Vacuum and Fill\)**](#)[**Cooling System Draining and Filling.\(Static\).**](#)
2. Remove the drive belt. Refer to [**Drive Belt Replacement**](#).
3. Remove the exhaust manifold heat shield. Refer to [**Exhaust Manifold Heat Shield Replacement**](#).

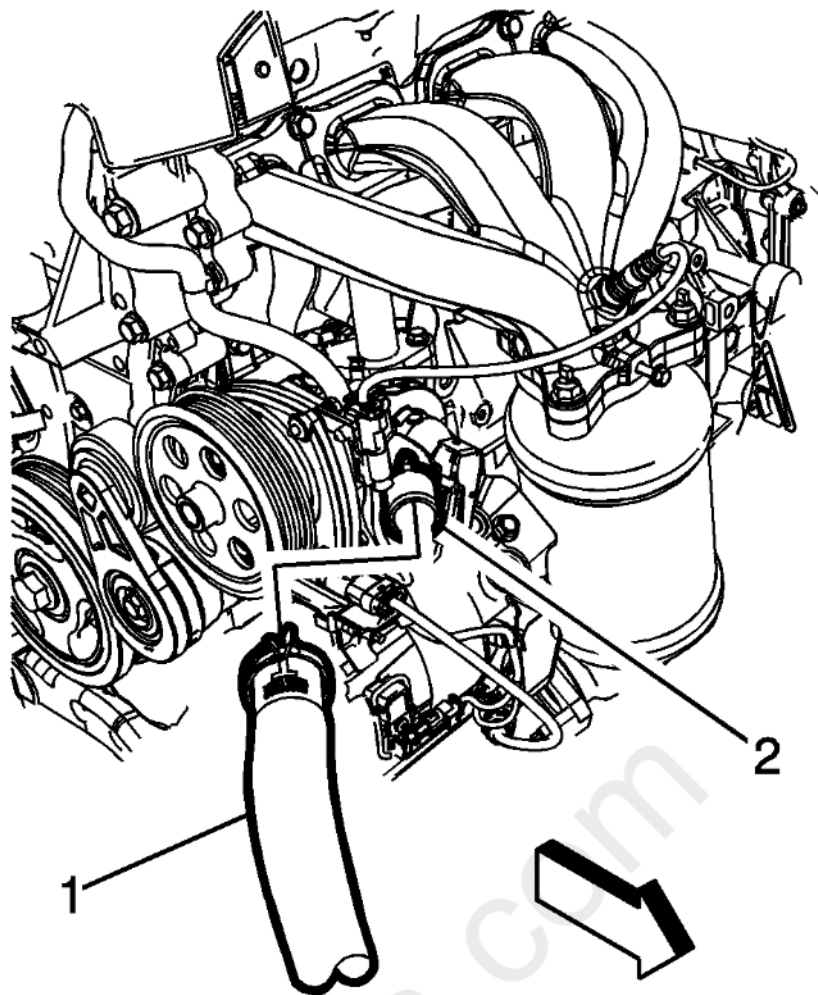


Fig. 70: Radiator Outlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

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

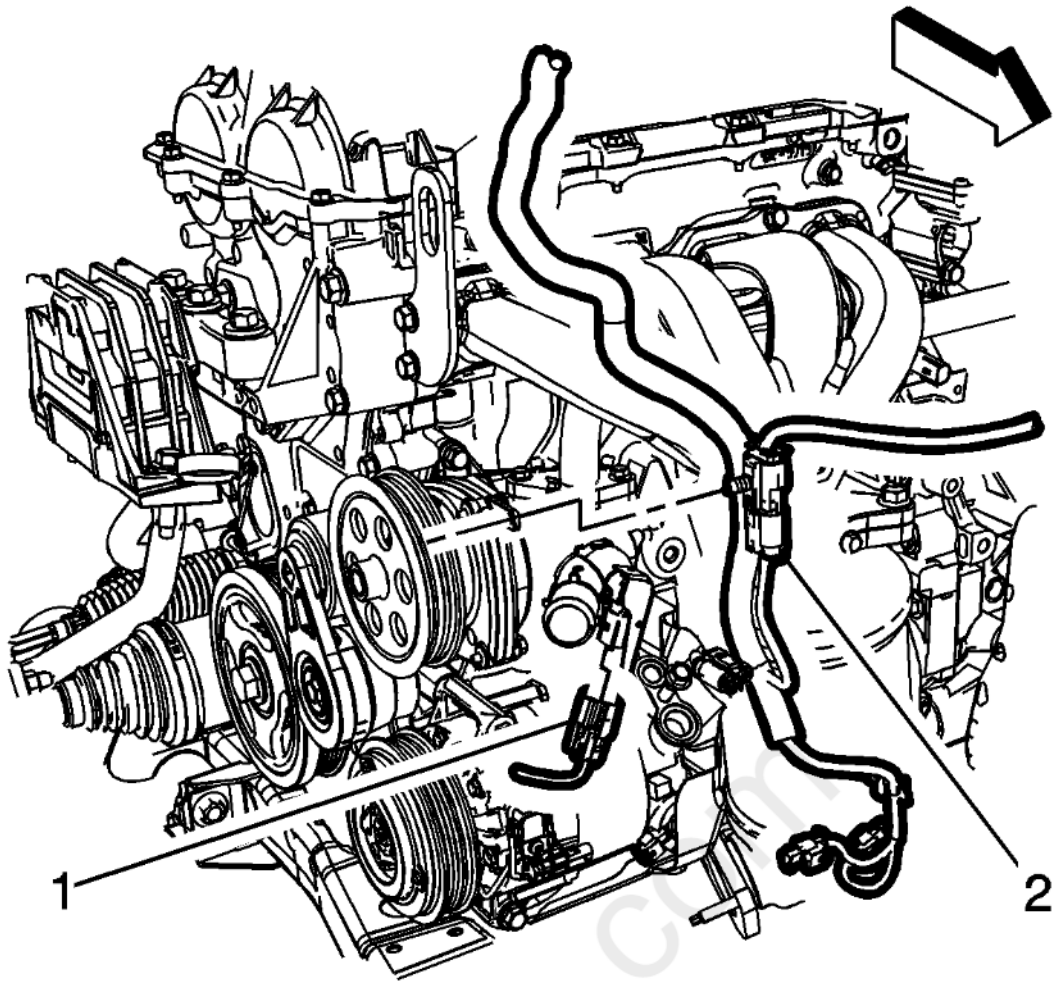


Fig. 71: Thermostat Housing Connector

Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the thermostat housing connector (1) and remove the engine harness retainer (2) from the water pump.

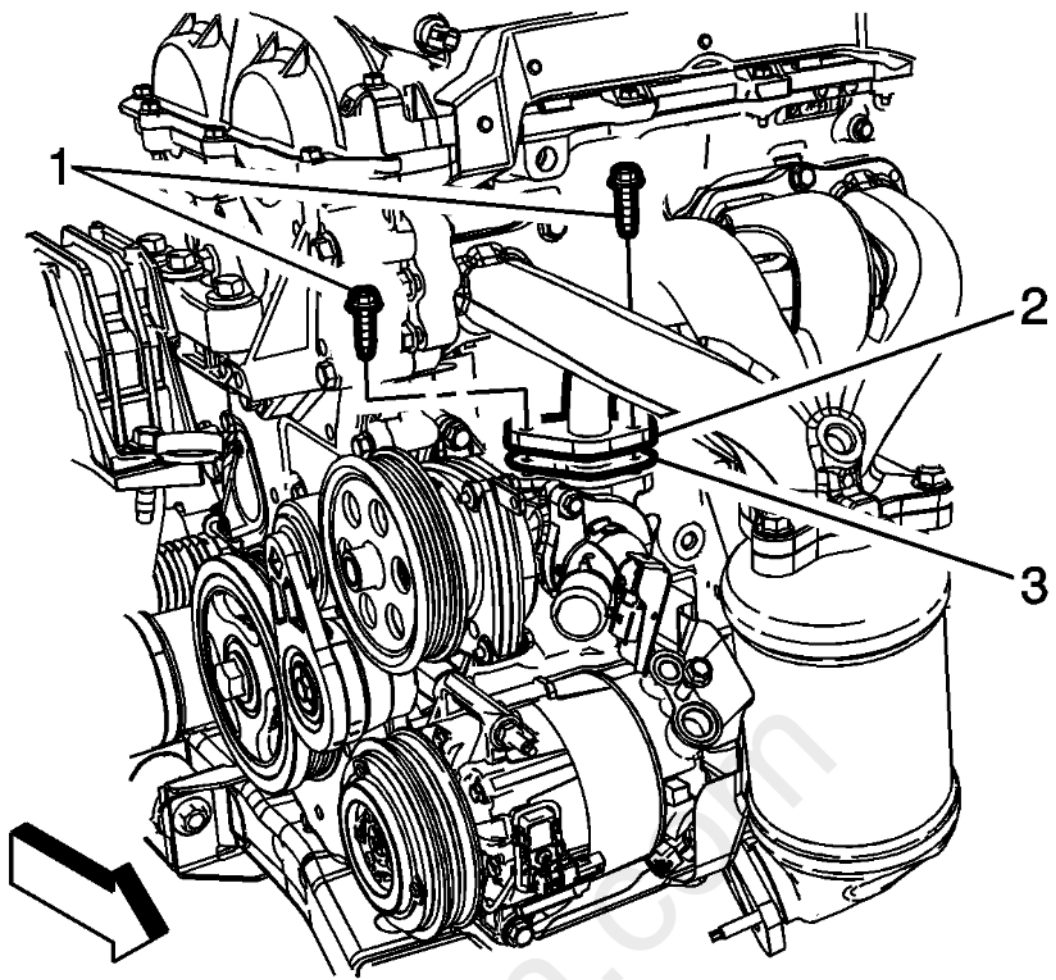


Fig. 72: Thermostat Bypass Pipe Fasteners

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).

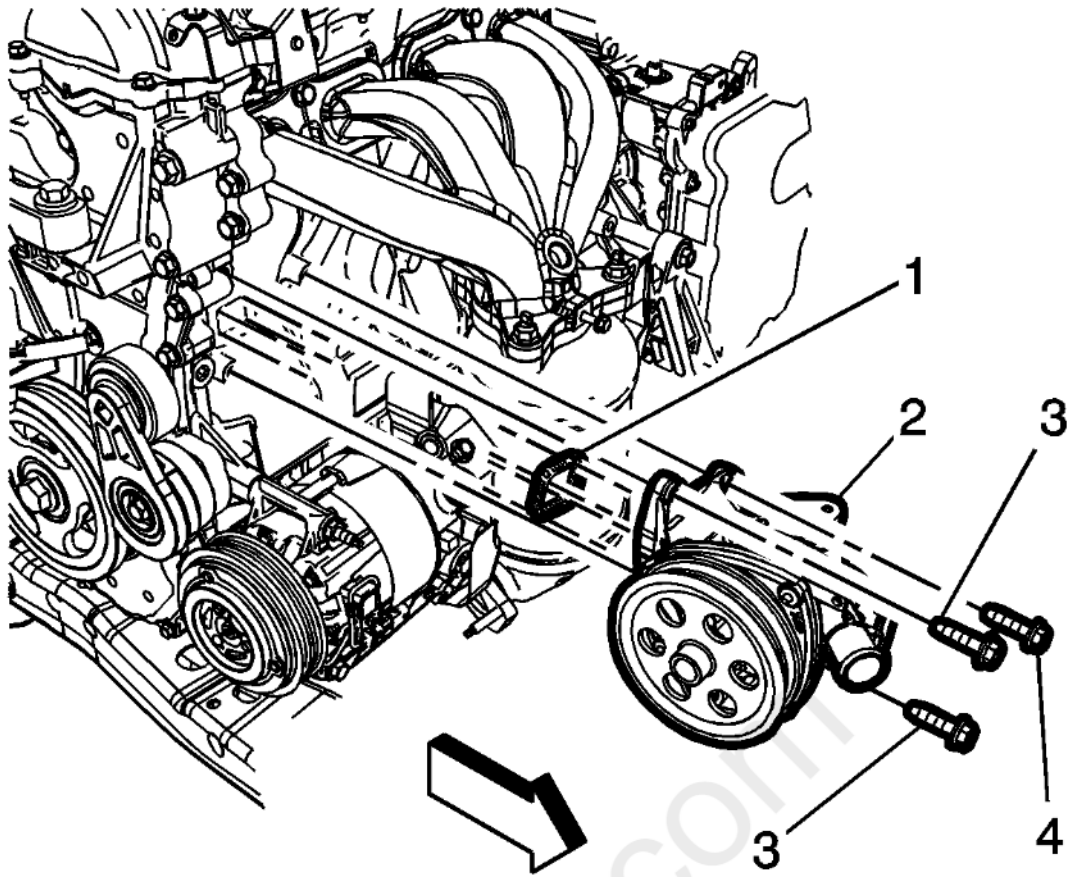


Fig. 73: Water Pump Fasteners

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

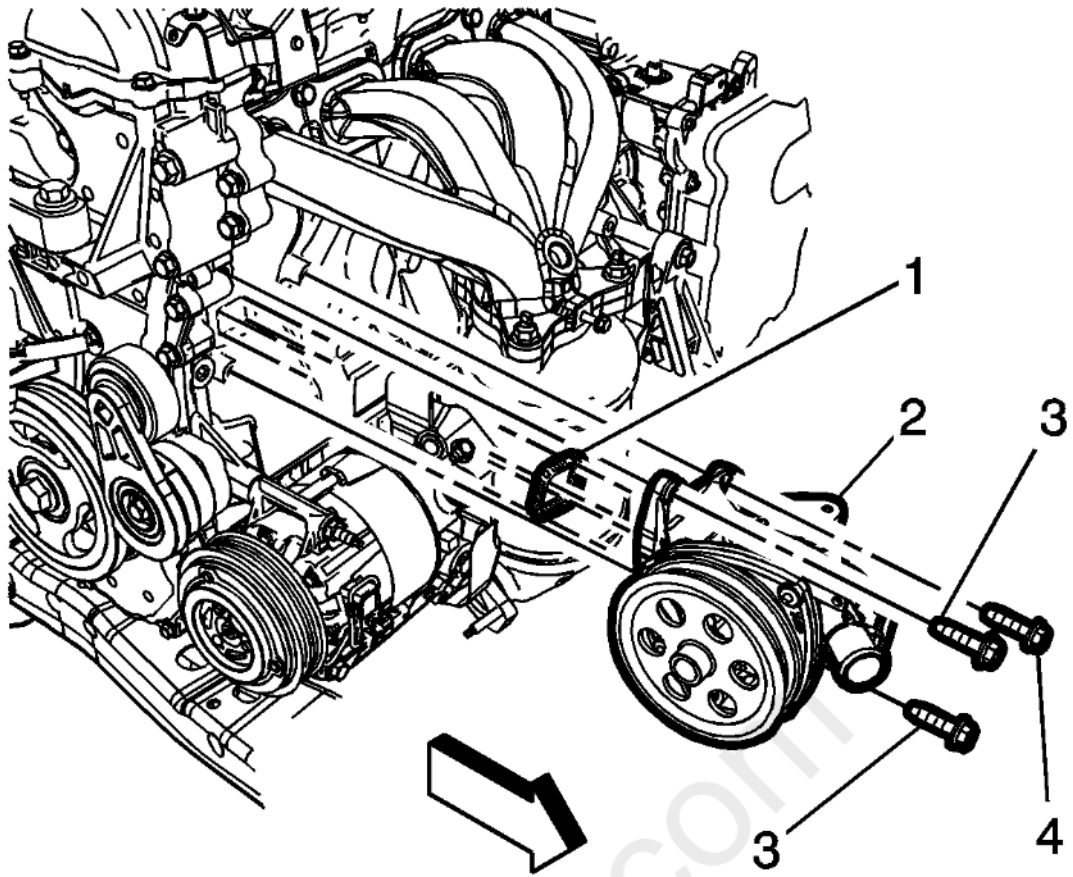


Fig. 74: Water Pump Fasteners

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

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

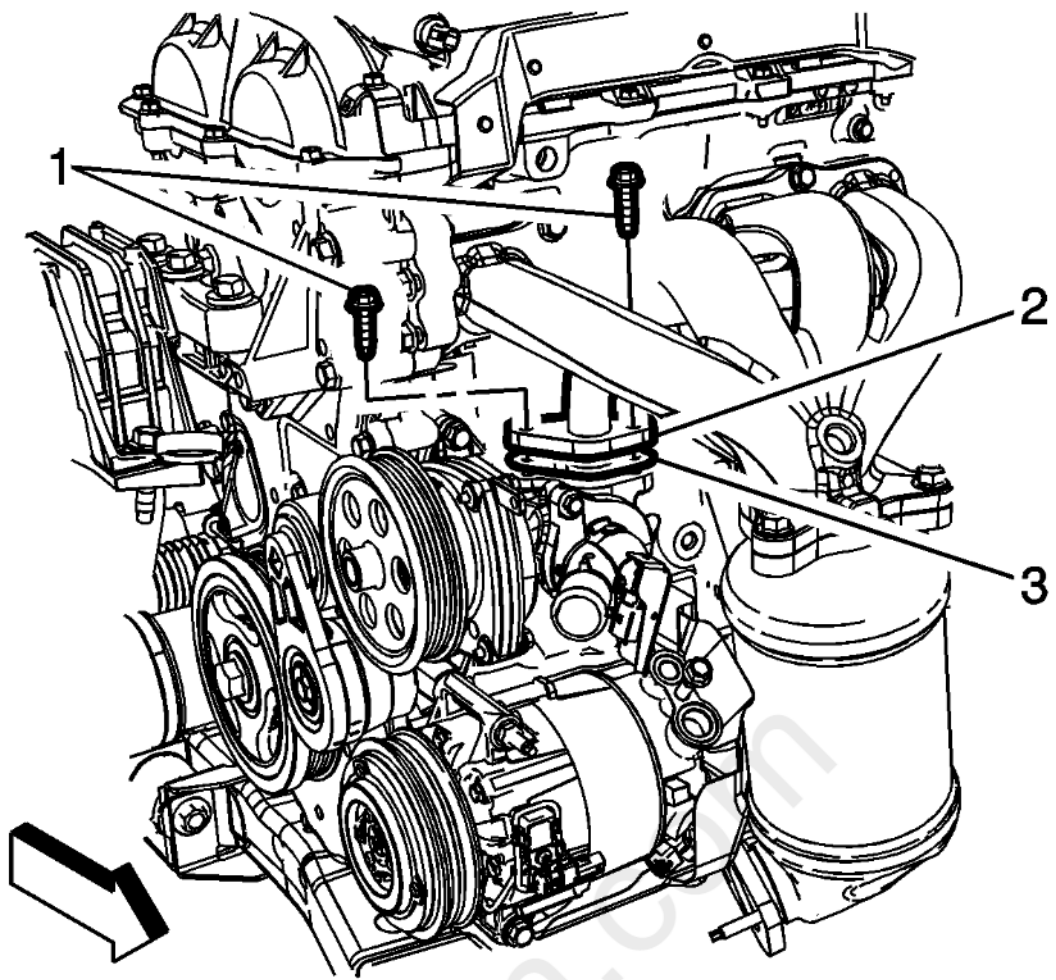


Fig. 75: Thermostat Bypass Pipe Fasteners

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 N.m (89 lb in).

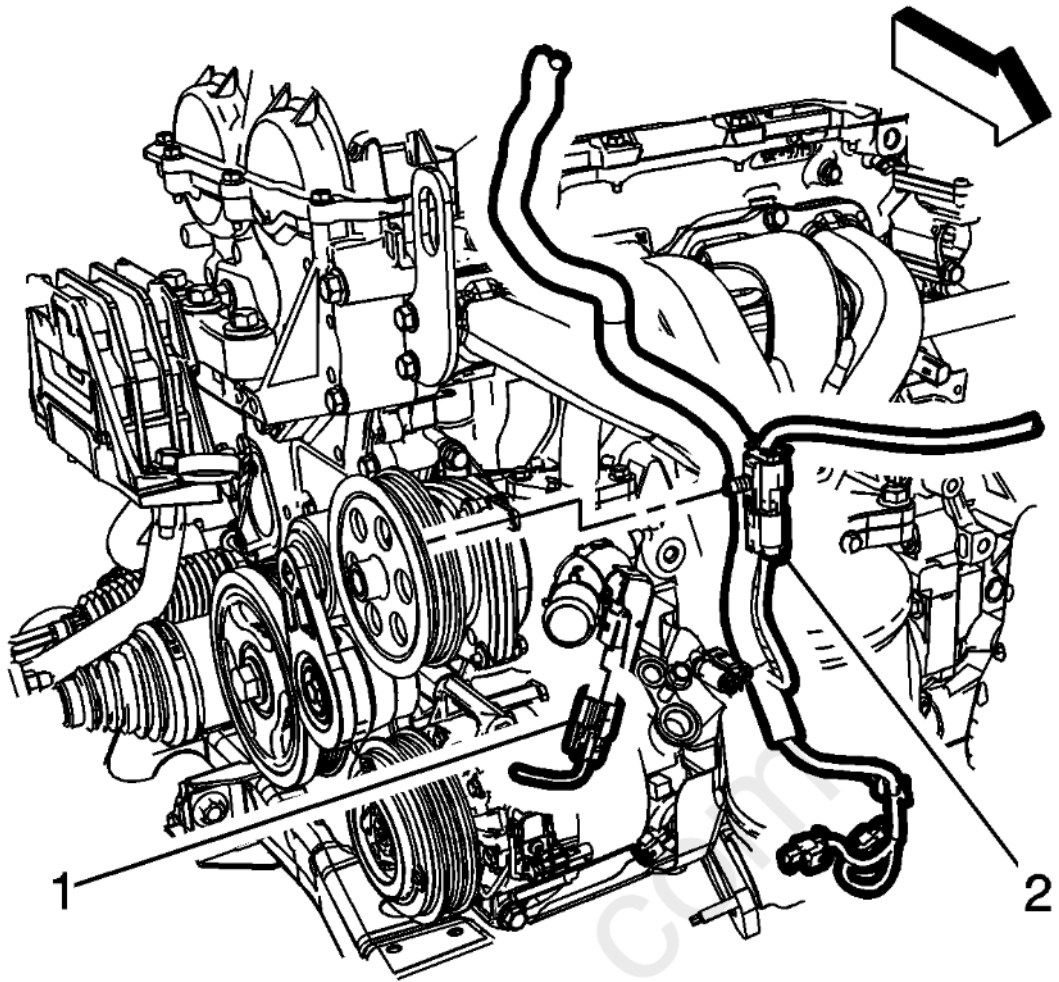


Fig. 76: Thermostat Housing Connector

Courtesy of GENERAL MOTORS COMPANY

5. Connect the connector (1) to the water outlet.
6. Install the engine wiring harness retainer (2) to the water pump.

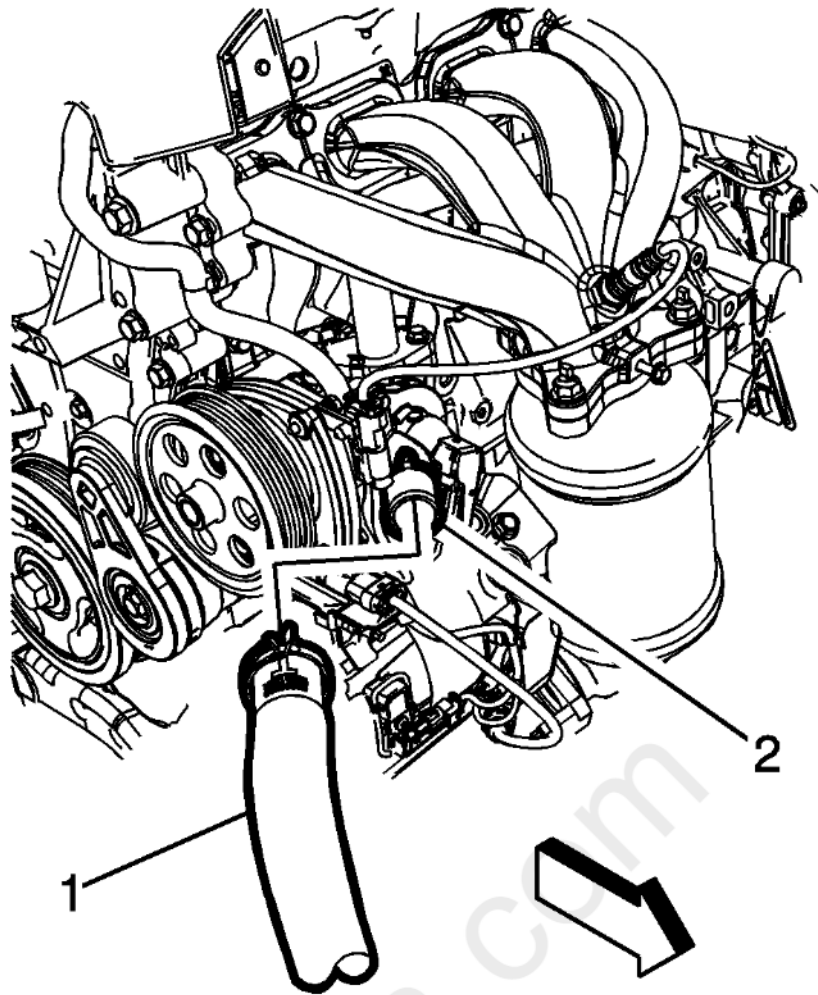


Fig. 77: Radiator Outlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

7. Install the radiator outlet hose (1) to the water outlet (2).
8. Install the drive belt. Refer to [Drive Belt Replacement](#) .
9. Install the exhaust manifold heat shield. Refer to [Exhaust Manifold Heat Shield Replacement](#) .
10. Fill the cooling system. Refer to [Cooling System Draining and Filling \(Vacuum and Fill\)](#)[Cooling System Draining and Filling \(Static\)](#).
11. Start the engine and check for coolant leaks.

AUXILIARY WATER PUMP REPLACEMENT (LCV)

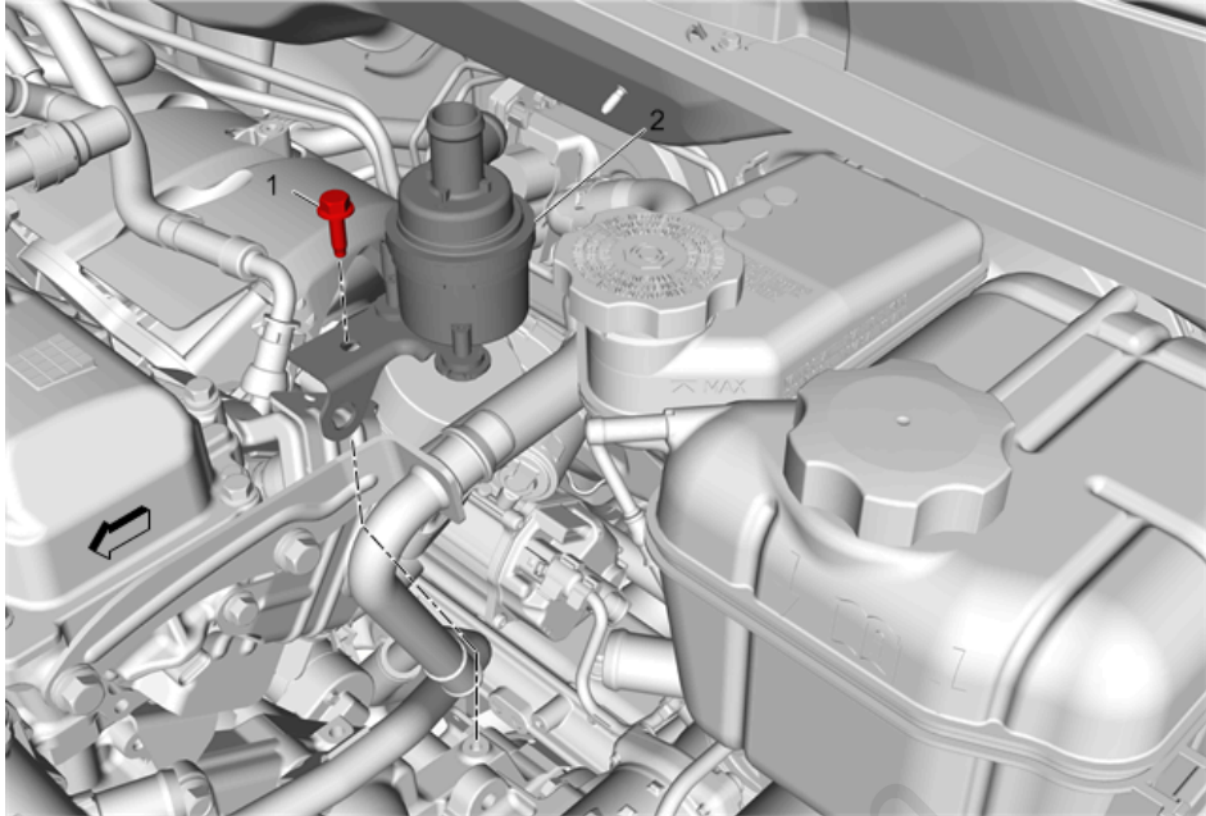


Fig. 78: Auxiliary Water Pump (LCV)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the air cleaner resonator and outlet duct. Refer to Air Cleaner Resonator and Outlet Duct Replacement. 3. Remove the battery tray. Refer to Battery Tray Replacement. 4. Remove the heater coolant pump hose. Refer to Heater Coolant Pump Hose Replacement (LCV). 5. Remove the heater outlet hose from the auxiliary water pump. Refer to Heater Outlet Hose Replacement (LCV) Heater Outlet Hose Replacement (LCV Heater Outlet Pipe to Auxiliary Water Pump). 6. Remove the heater coolant pump hose from the heater outlet pipe. Refer to Heater Outlet Hose Replacement (LCV) Heater Outlet Hose Replacement (LCV Heater Outlet Pipe to Auxiliary Water Pump).	
1	Auxiliary Water Pump Bracket Bolt CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)

Callout	Component Name
2	Auxiliary Water Pump Procedures 1. Disconnect the auxiliary water pump electrical connector. 2. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 3. Inspect the cooling system for leaks.

RADIATOR DRAIN COCK REPLACEMENT (LFX)

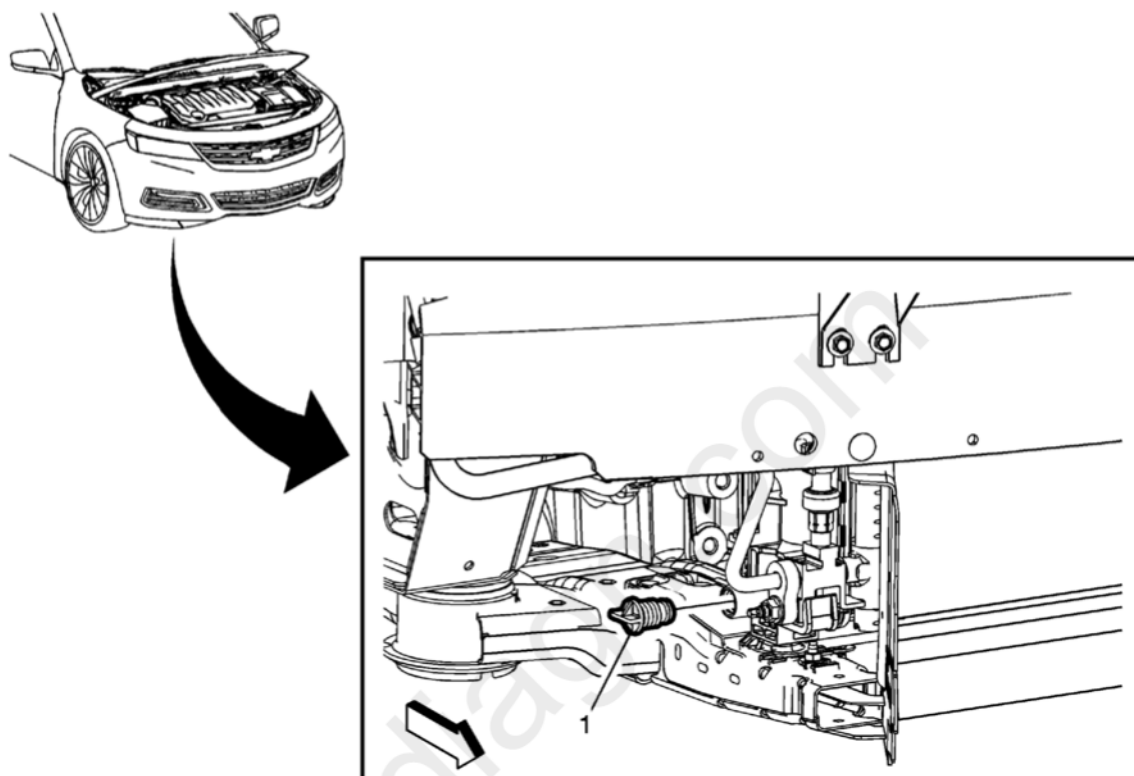


Fig. 79: Radiator Drain Cock (LFX)

Courtesy of GENERAL MOTORS COMPANY

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

RADIATOR DRAIN COCK REPLACEMENT (LCV)

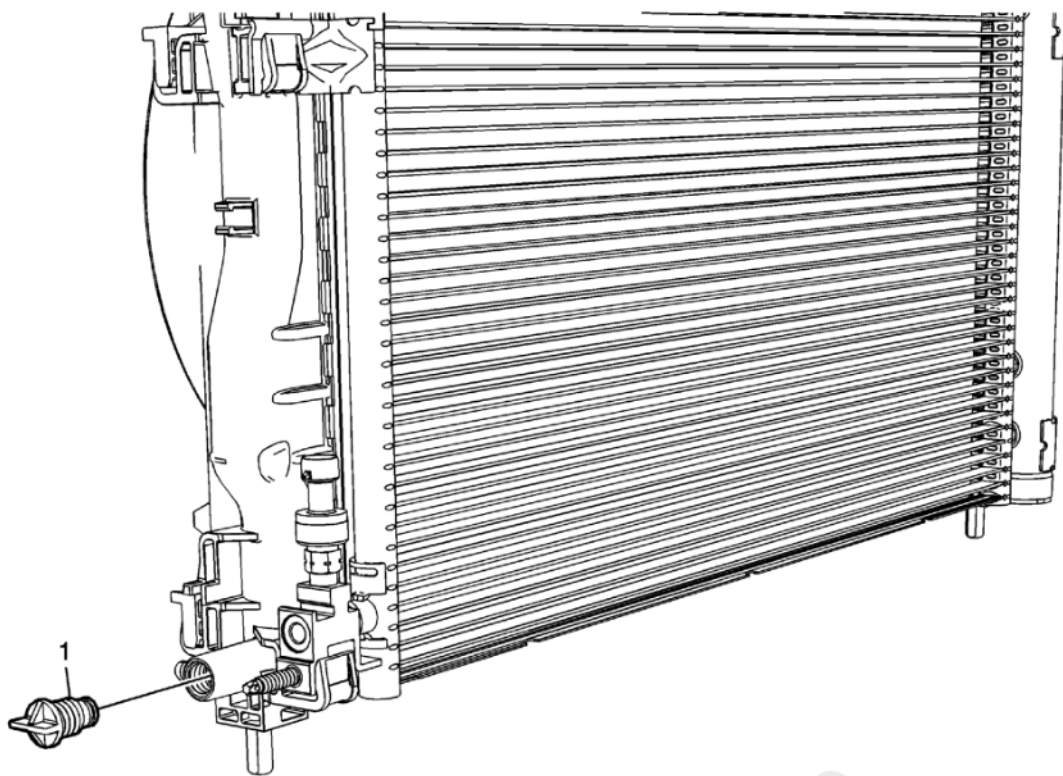


Fig. 80: Radiator Drain Cock

Courtesy of GENERAL MOTORS COMPANY

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

ENGINE COOLANT FAN SHROUD REPLACEMENT (LFX)

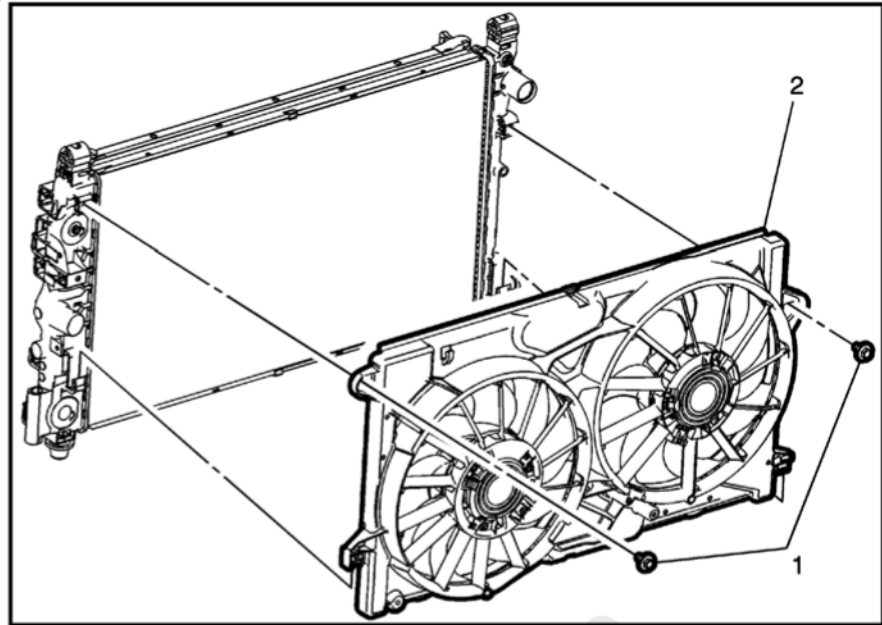


Fig. 81: Engine Coolant Fan Shroud (LEX)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Reposition the front end upper tie bar to gain access to the engine coolant fan shroud. Refer to Front End Upper Tie Bar Replacement. 2. Disconnect the engine coolant fan motor connectors. 3. Remove the electrical wiring harness from the engine coolant fan shroud and reposition out of the way. 4. Reposition the transmission fluid cooler pipes.	
1	Engine Coolant Fan Shroud Fastener (Qty: 2) CAUTION: Refer to Fastener Caution .
2	Engine Coolant Fan Shroud Procedure 1. Remove the engine coolant fan shroud metal retaining clips from the radiator. 2. Transfer all necessary parts.

ENGINE COOLANT FAN SHROUD REPLACEMENT (LCV)

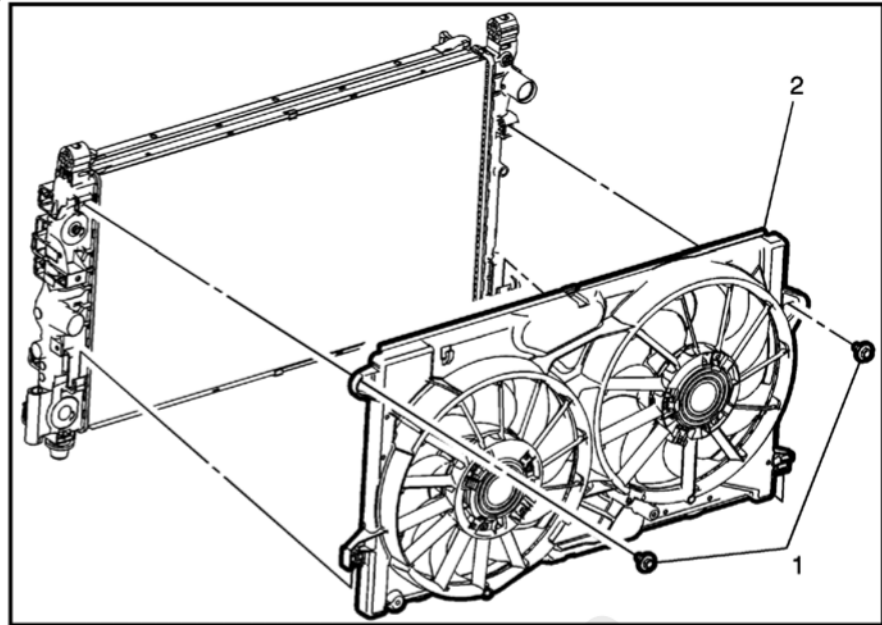


Fig. 82: Engine Coolant Fan Shroud (LCV)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Reposition the front end upper tie bar to gain access to the engine coolant fan shroud. Refer to Front End Upper Tie Bar Replacement. 2. Disconnect the engine coolant fan motor connectors. 3. Remove the electrical wiring harness from the engine coolant fan shroud and reposition out of the way. 4. Reposition the transmission fluid cooler pipes.	
1	Engine Coolant Fan Shroud Fastener (Qty: 2) CAUTION: Refer to Fastener Caution .
2	Engine Coolant Fan Shroud Procedures 1. Remove the engine coolant fan shroud metal retaining clips from the radiator. 2. Transfer all necessary parts.

RADIATOR REPLACEMENT (LFX)

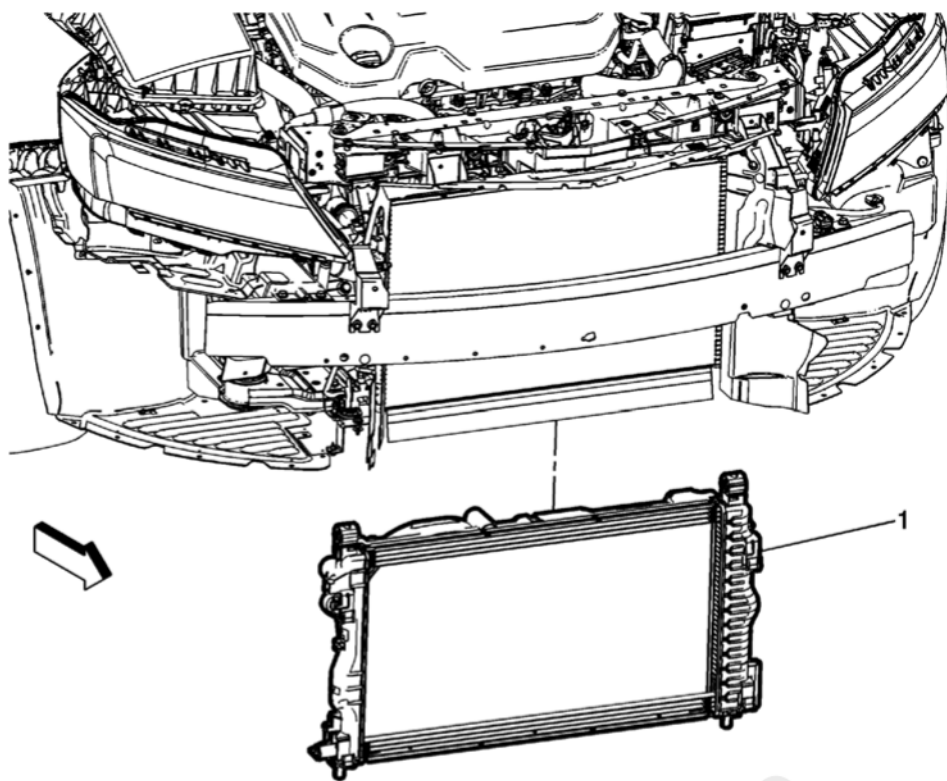


Fig. 83: Radiator (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the radiator inlet and outlet hoses from the radiator. Refer to, and Radiator Outlet Hose Replacement (LFX). 3. Remove the transmission fluid cooler inlet and outlet pipes from the radiator and the engine coolant fan shroud. Refer to Transmission Fluid Cooler Inlet Pipe Replacement (LFX) , and Transmission Fluid Cooler Outlet Pipe Replacement (LFX) . 4. Disconnect the electrical connectors from the engine coolant fan and unclip the wiring harness from the fan shroud. 5. Lift the condenser off of the retainers on the radiator and support the air conditioning condenser. 6. Remove the left and right side member reinforcements. Refer to Side Member Reinforcement Replacement (NJ2) . 7. Remove the radiator and shroud as an assembly.	
1	Radiator Procedure 1. Remove the engine coolant fan shroud from the radiator. Refer to Engine Coolant Fan Shroud Replacement (LFX). 2. Transfer components as necessary. 3. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 4. Check the cooling system for leaks. Refer to Cooling System Leak Testing.

RADIATOR REPLACEMENT (LCV)

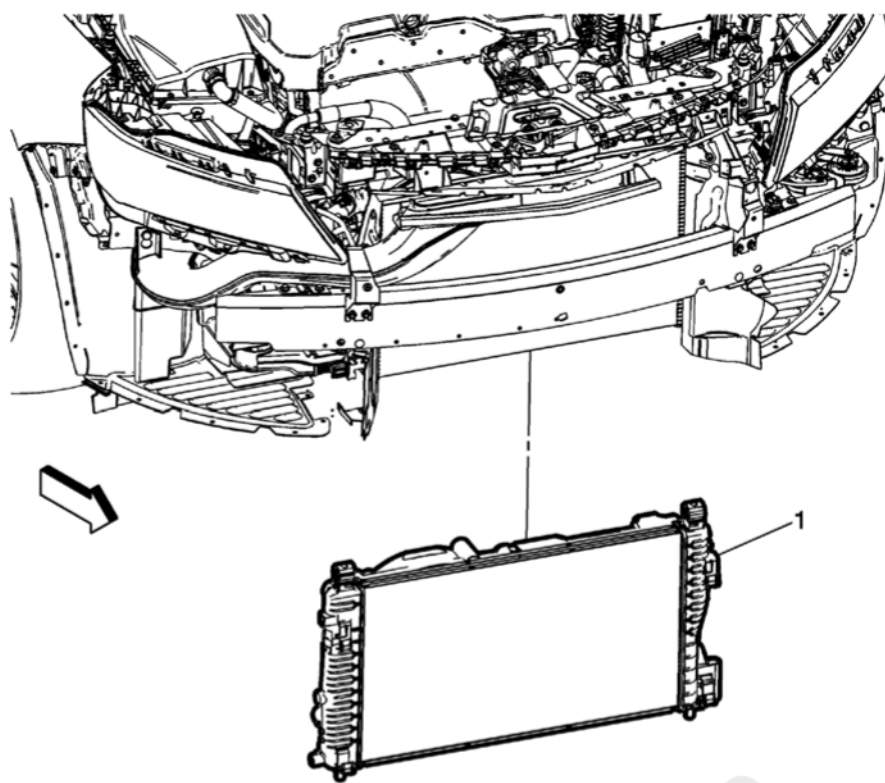


Fig. 84: Radiator (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 2. Remove the radiator inlet and outlet hoses from the radiator. Refer to Radiator Inlet Hose Replacement (LCV), and Radiator Outlet Hose Replacement (LCV). 3. Remove the transmission fluid cooler inlet and outlet pipes from the radiator and the engine coolant fan shroud. Refer to Transmission Fluid Cooler Inlet Pipe Replacement (LCV), and Transmission Fluid Cooler Outlet Pipe Replacement (LCV). 4. Disconnect the electrical connectors from the engine coolant fan and unclip the wiring harness from the fan shroud. 5. Lift the condenser off of the retainers on the radiator and support the air conditioning condenser. 6. Remove the left and right radiator support brackets. Refer to Radiator Lower Bracket Replacement (LCV). 7. Remove the radiator and shroud as an assembly.	
1	Radiator Procedure 1. Remove the engine coolant fan shroud from the radiator. Refer to Engine Coolant Fan Shroud Replacement (LCV). 2. Transfer components as necessary. 3. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Vacuum and Fill)Cooling System Draining and Filling (Static). 4. Check the cooling system for leaks. Refer to Cooling System Leak Testing.

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (LEFT)

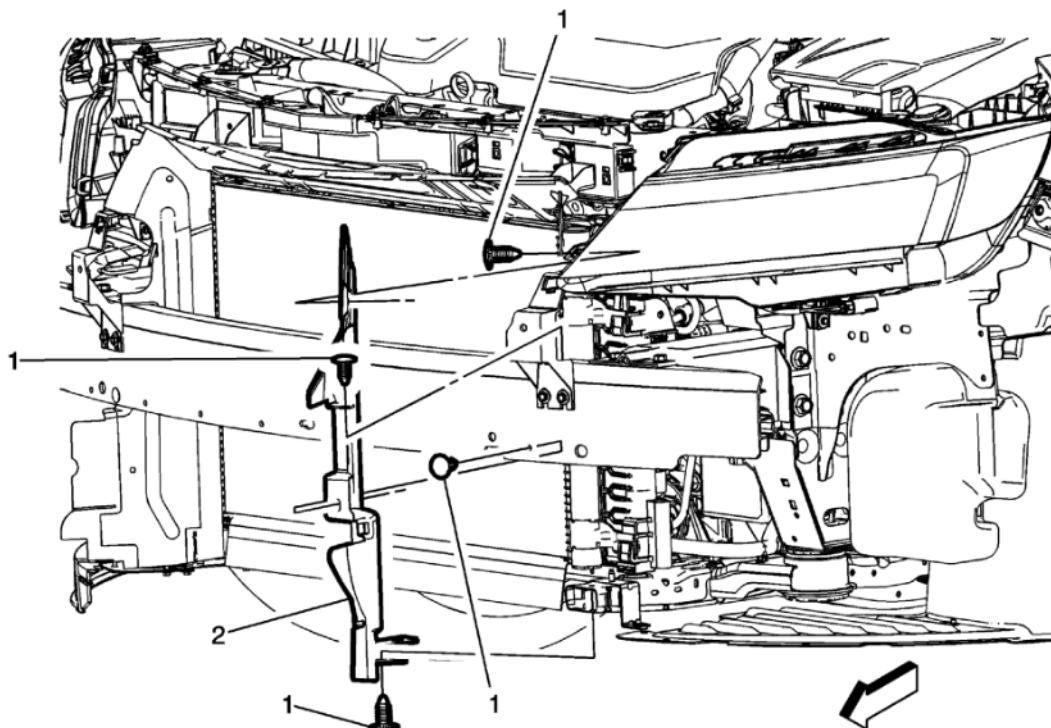


Fig. 85: Radiator Air Side Baffle and Deflector (Left)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Remove the left side front bumper fascia reinforcement. Refer to <u>Front Bumper Fascia Reinforcement Replacement - Left Side</u> .	
1	Radiator Air Side Baffle and Deflector Retainer (Qty: 4)
2	Radiator Air Side Baffle and Deflector

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (RIGHT)

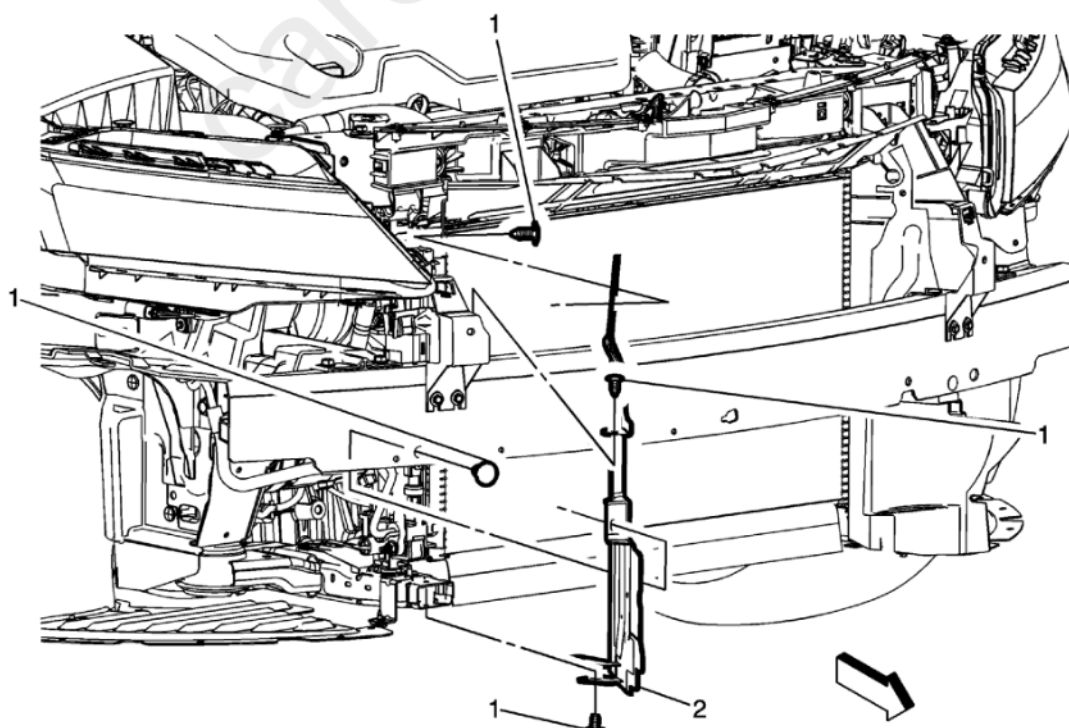


Fig. 86: Radiator Air Side Baffle and Deflector (Right)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Remove the right side front bumper fascia reinforcement. Refer to Front Bumper Fascia Reinforcement Replacement - Right Side .	
1	Radiator Air Side Baffle and Deflector Retainer (Qty: 4)
2	Radiator Air Side Baffle and Deflector

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT (LFX)

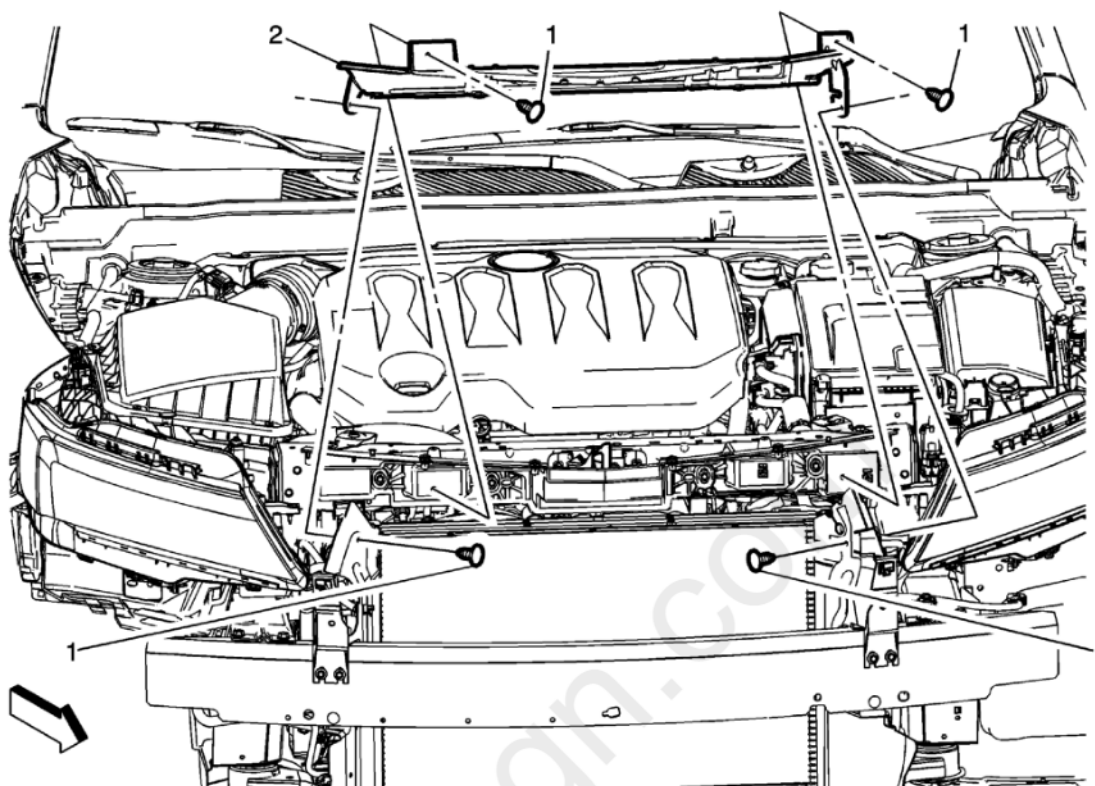


Fig. 87: Radiator Air Upper Baffle & Deflector (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Radiator Air Upper Baffle and Deflector Retainer (Qty: 4)
2	Radiator Air Upper Baffle and Deflector

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT (LCV)

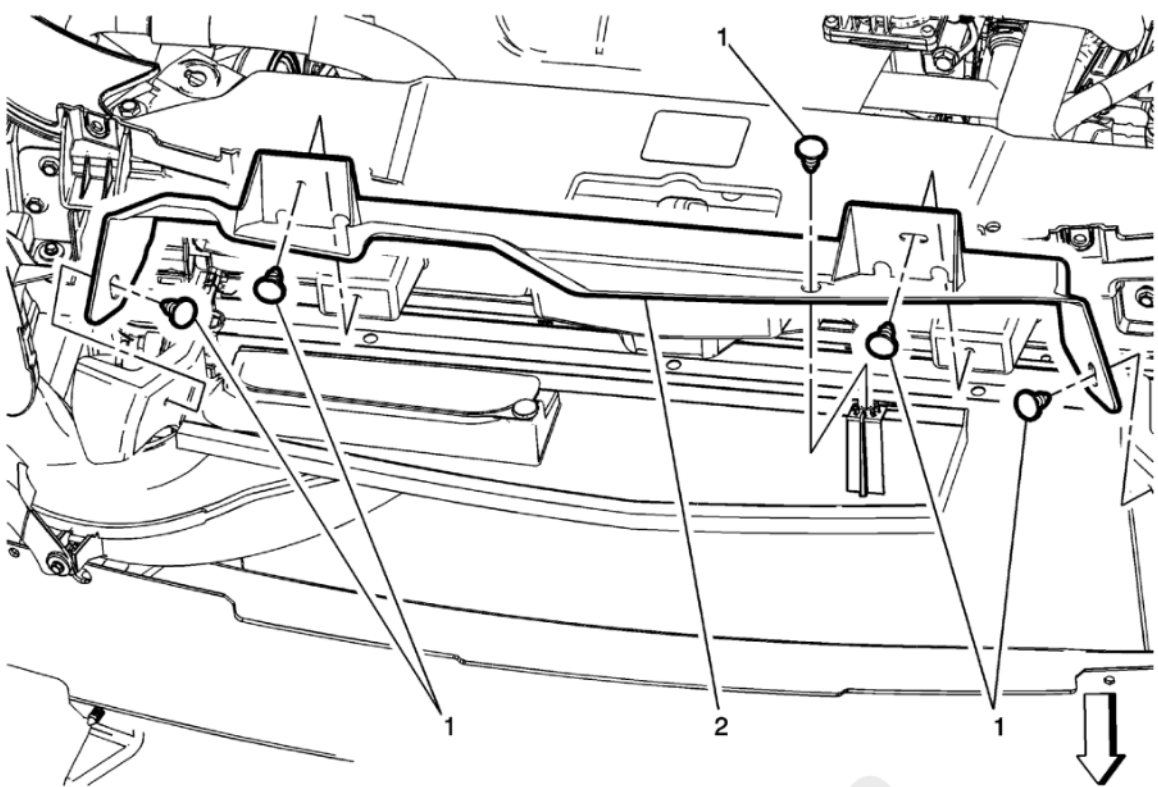


Fig. 88: Radiator Air Upper Baffle and Deflector (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the front fascia. Refer to Front Bumper Fascia Replacement .	
1	Radiator Air Upper Baffle and Deflector Retainers (Qty 5)
2	Radiator Air Upper Baffle and Deflector

COOLANT HEATER REPLACEMENT (LFX)

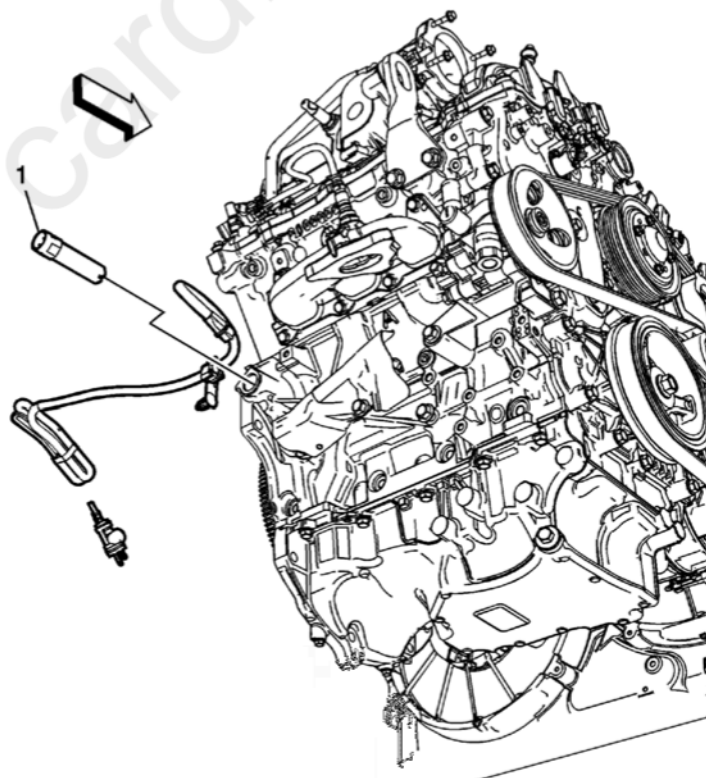


Fig. 89: Identifying Engine Coolant Heater (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the drivetrain and front suspension frame. Refer to Drivetrain and Front Suspension Frame Replacement .	
1	Coolant Heater NOTE: Be careful not to score inner surface of the engine block when removing coolant heater.

COOLANT HEATER REPLACEMENT (LCV)

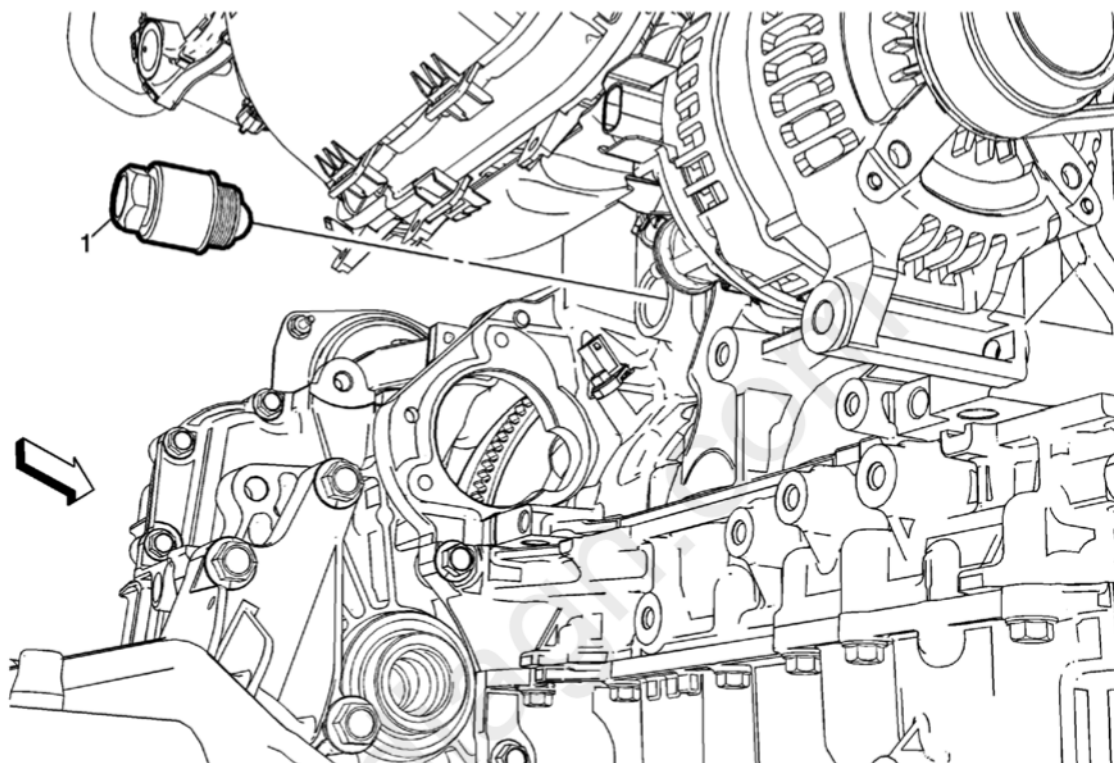


Fig. 90: Coolant Heater (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill) Cooling System Draining and Filling (Static) . 2. Remove the starter. Refer to Starter Replacement (LCV) .	
1	Engine Coolant Heater CAUTION: Refer to Component Fastener Tightening Caution . Procedure Disconnect the engine coolant heater cord. Tighten 50 N.m (37 lb ft)

COOLANT HEATER CORD REPLACEMENT (LFX)

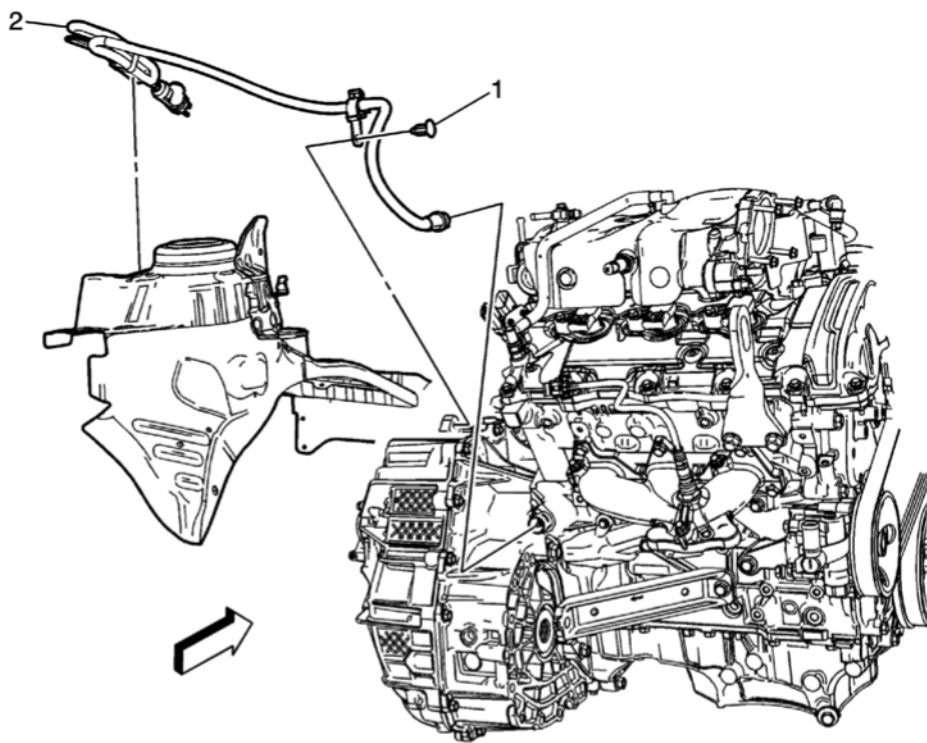


Fig. 91: Coolant Heater Cord

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .	
1	Retainer
2	Coolant Heater Cord

COOLANT HEATER CORD REPLACEMENT (LCV)

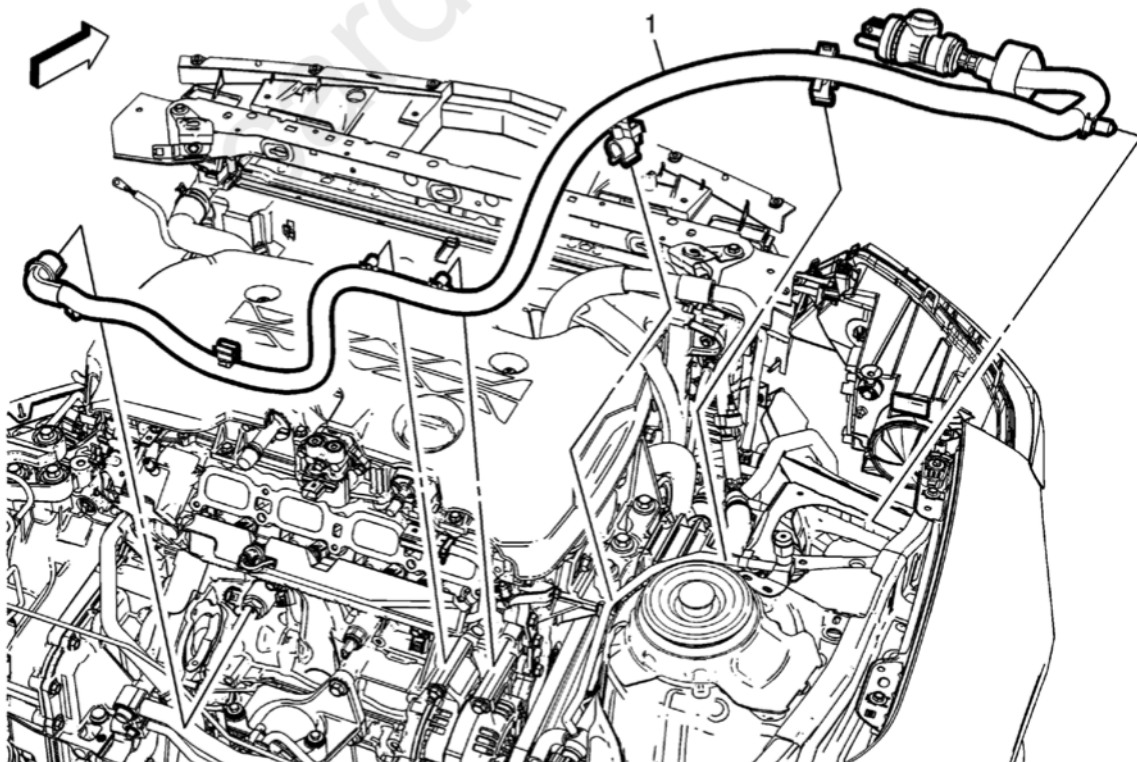


Fig. 92: Coolant Heater Cord (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the starter. Refer to Starter Replacement (LCV) .	
1	Coolant Heater Cord NOTE: Observe how the coolant heater cord was routed within the engine compartment.

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

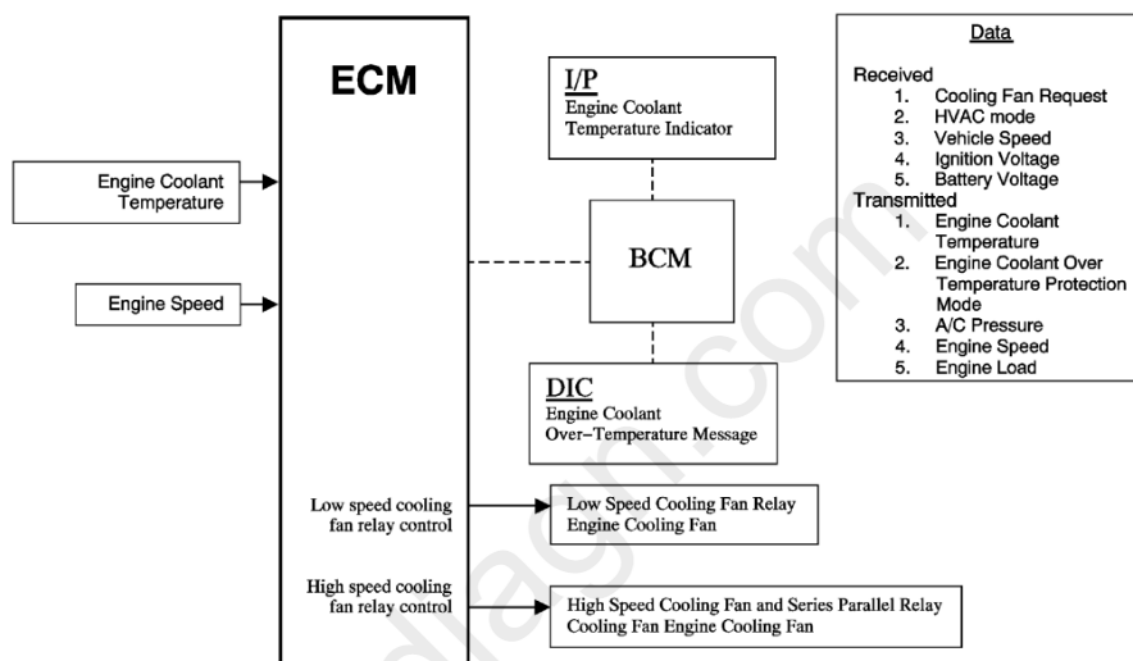


Fig. 93: Cooling Fan Description and Operation
Courtesy of GENERAL MOTORS COMPANY

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

During low speed operation, the ECM supplies the ground path for the low speed fan 1 relay through the fan 1 relay control circuit. This energizes the fan 1 relay coil, closes the relay contacts, and supplies battery positive voltage from the Fan 1 fuse through the cooling fan motor supply voltage circuit to the left engine cooling fan. The ground path for the left cooling fan is through the S/P fan 2 relay and the right engine cooling fan. The result is a series circuit with both fans running at low speed.

During high speed operation the ECM continues to supply battery positive voltage for the right cooling fan by grounding the coil of the fan 1 relay. The ECM also grounds the high speed fan 3 relay and the S/P fan 2 relay through the fan 3 relay control circuit. This energizes the S/P fan 2 relay coil, closes the relay contacts, and provides a direct ground path for the left engine cooling fan. At the same time the fan 3 relay coil is energized closing the relay contacts and providing battery positive voltage from the Fan 2 fuse on the cooling fan motor supply voltage circuit to the right cooling fan. During high speed fan operation, both engine cooling fans have their own ground path. The result is a parallel circuit with both fans running at high speed.

COOLING SYSTEM DESCRIPTION AND OPERATION

Engine Coolant Indicators

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

Coolant Heater

The optional engine coolant heater operates using AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather. The coolant heater helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. A weather shield on the cord is provided to protect the plug when not in use.

Cooling System

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

Cooling Cycle

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

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

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

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

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

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

Coolant

The engine coolant is a solution made up of a 50/50 mixture of drinking water and anti-freeze. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger consisting of a core and 2 tanks. The aluminum core is a tube and fin crossflow design that extends from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer to the atmosphere.

The inlet and outlet tanks are a molded, high temperature, nylon reinforced plastic material. A high temperature rubber gasket seals the tank flange edge to the aluminum core. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminum header at each end of the core.

The radiator also has a drain cock located in the bottom of the left or 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 is a cap that seals and pressurizes the cooling system. It contains a blow off or pressure valve and a vacuum or atmospheric valve.

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

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

However, if the pressure exceeds the strength of the spring, the pressure valve rises so that the excess pressure can escape.

When the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing outside air into the cooling system. This equalizes the pressure in the cooling system with atmospheric pressure, thus preventing the radiator hoses from collapsing.

Surge Tank

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

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

Air Baffles and Seals

The cooling system uses deflectors, air baffles and air seals to increase 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 91Â°C (195Â°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 91Â°C (195Â°F), the thermostat valve will open. The switch point will differ a little depending on engine. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after opening. This restriction creates a pressure difference which prevents cavitations at the water pump and forces coolant to circulate through the engine block.

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

Transmission Oil Cooler

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

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

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

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

Illustration	Tool Number/ Description
	

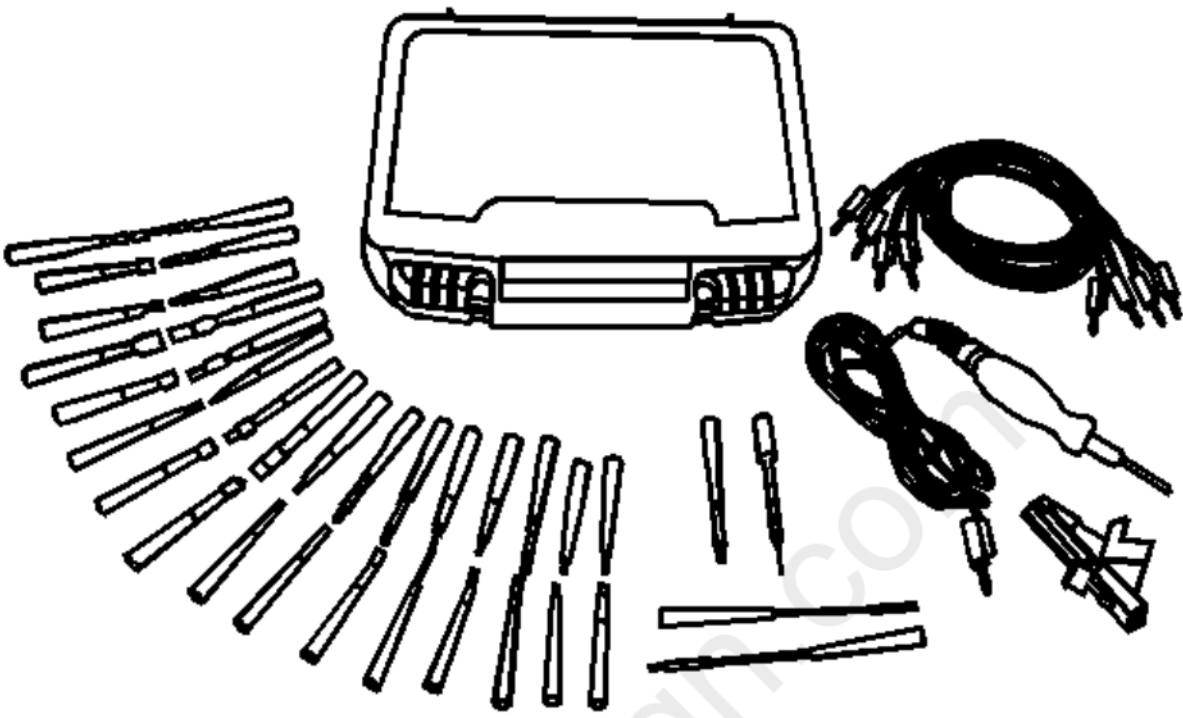
Illustration	Tool Number/ Description
	EL 35616-F J 35616-F Terminal Test Kit
	EN 24460-A J 24460-01 Cooling System Pressure Tester

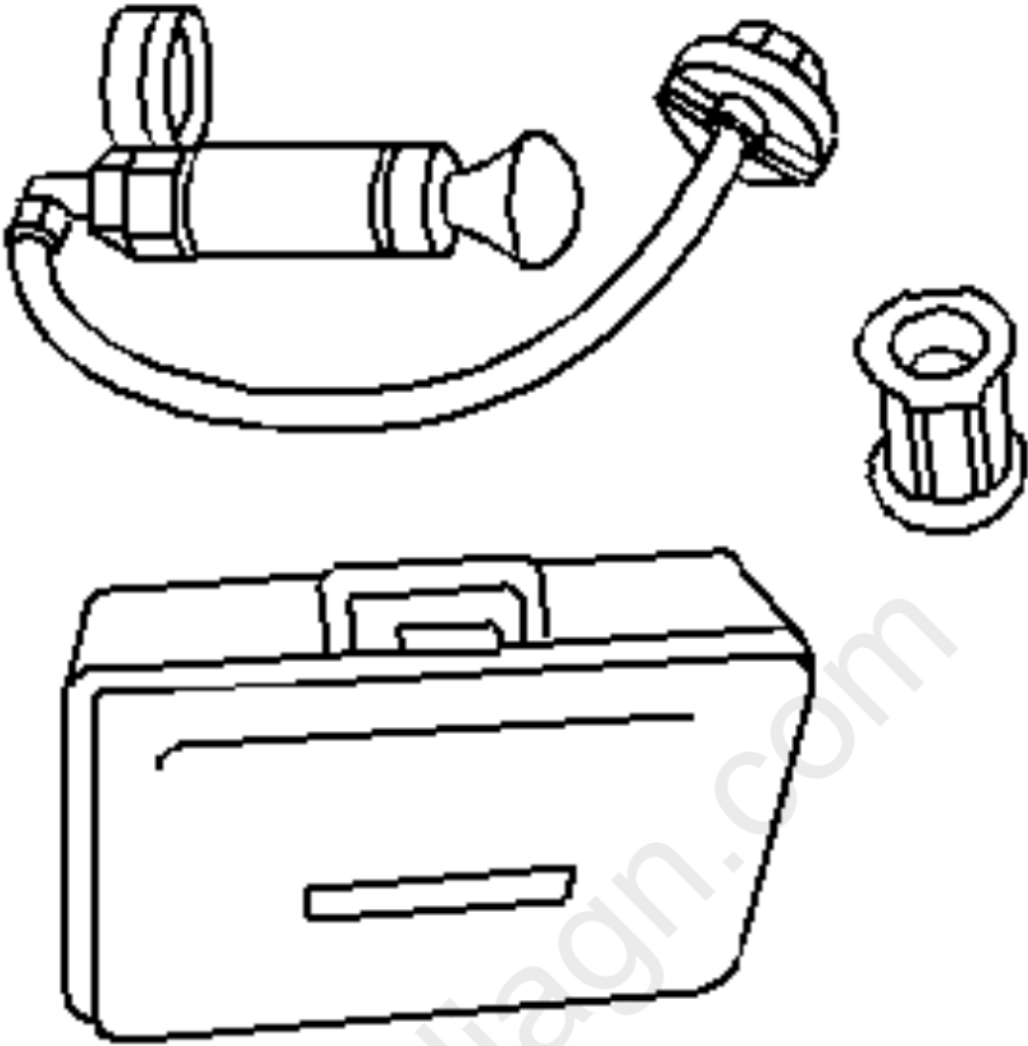
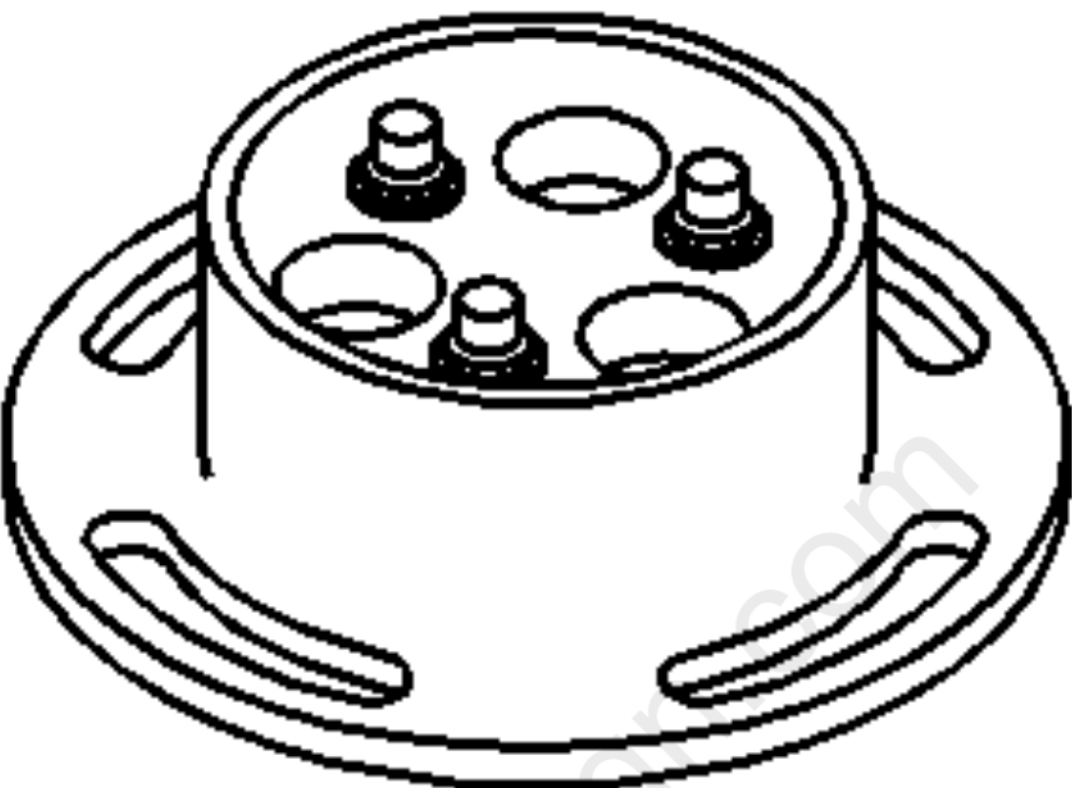
Illustration	Tool Number/ Description
 The illustration shows a medical device, likely a manual resuscitator or a small pump. It consists of a main body with a handle on the left, a tube extending from the top, and a connector on the right. A small cylindrical component is shown separately to the right. Below these components is a rectangular carrying case with a handle on top and a slot on the front. A faint watermark 'cardiagn.com' is visible across the illustration.	

Illustration	Tool Number/ Description
	EN 43651 J 43651 Water Pump Holding Tool

--

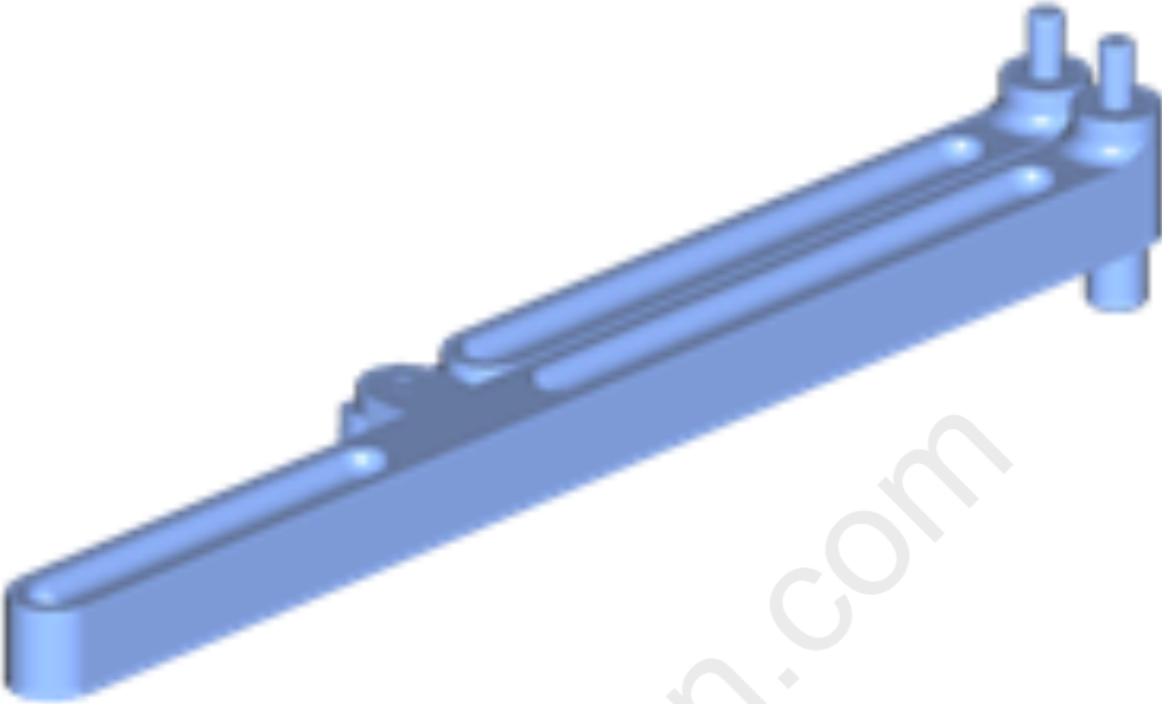
Illustration	Tool Number/ Description
	EN 46104 J 46104 Water Pump Pulley Holding Tool
	GE 24731 J 24731 Tempilstick

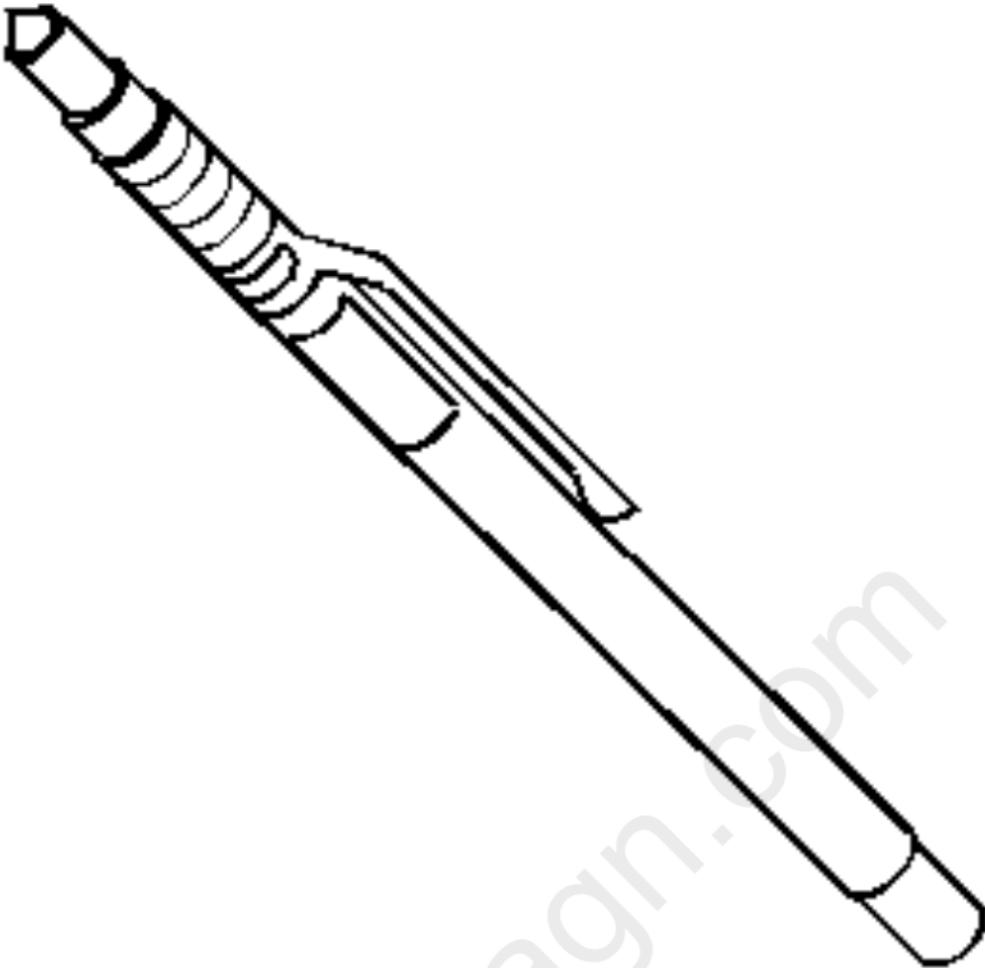
Illustration	Tool Number/ Description
	

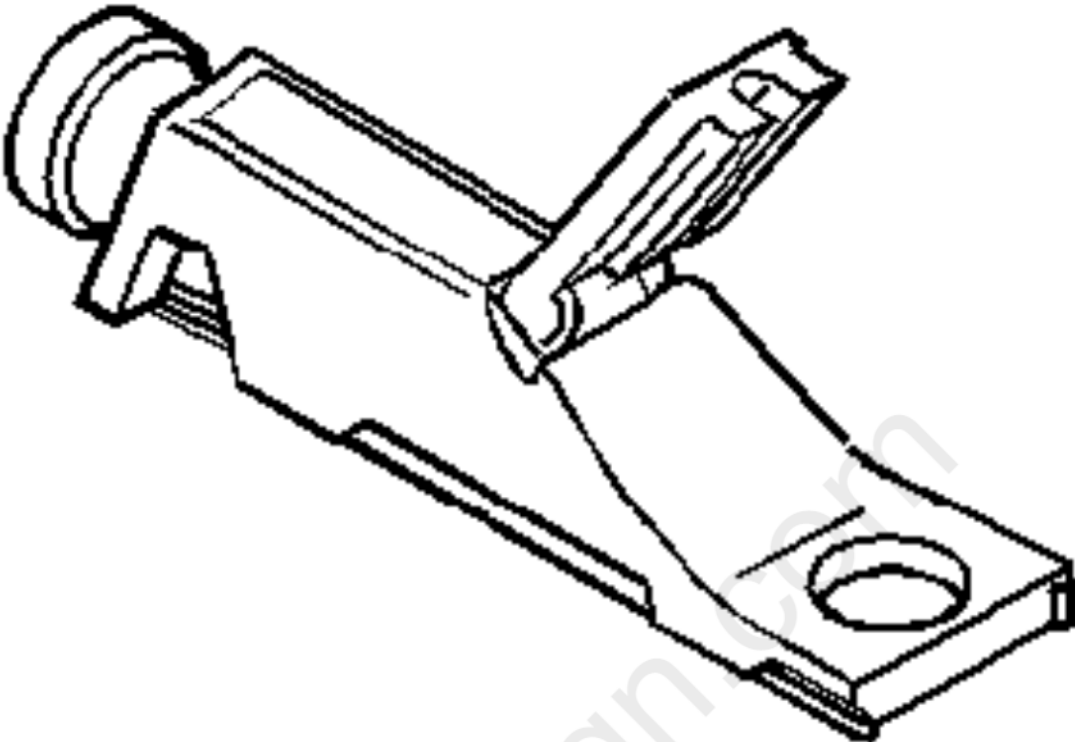
Illustration	Tool Number/ Description
	GE 26568 J 26568 Coolant and Battery Fluid Tester

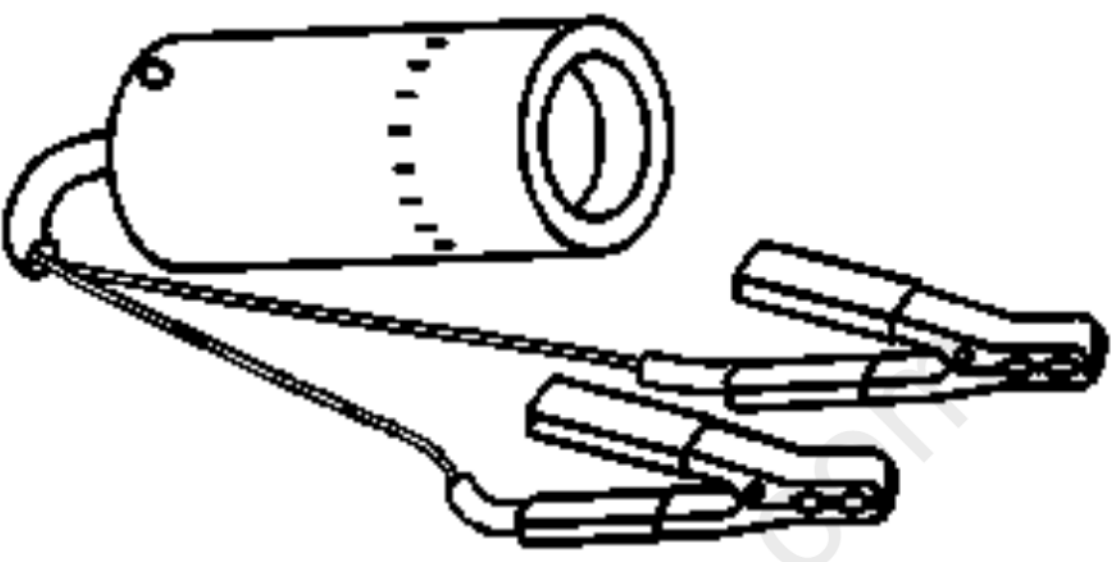
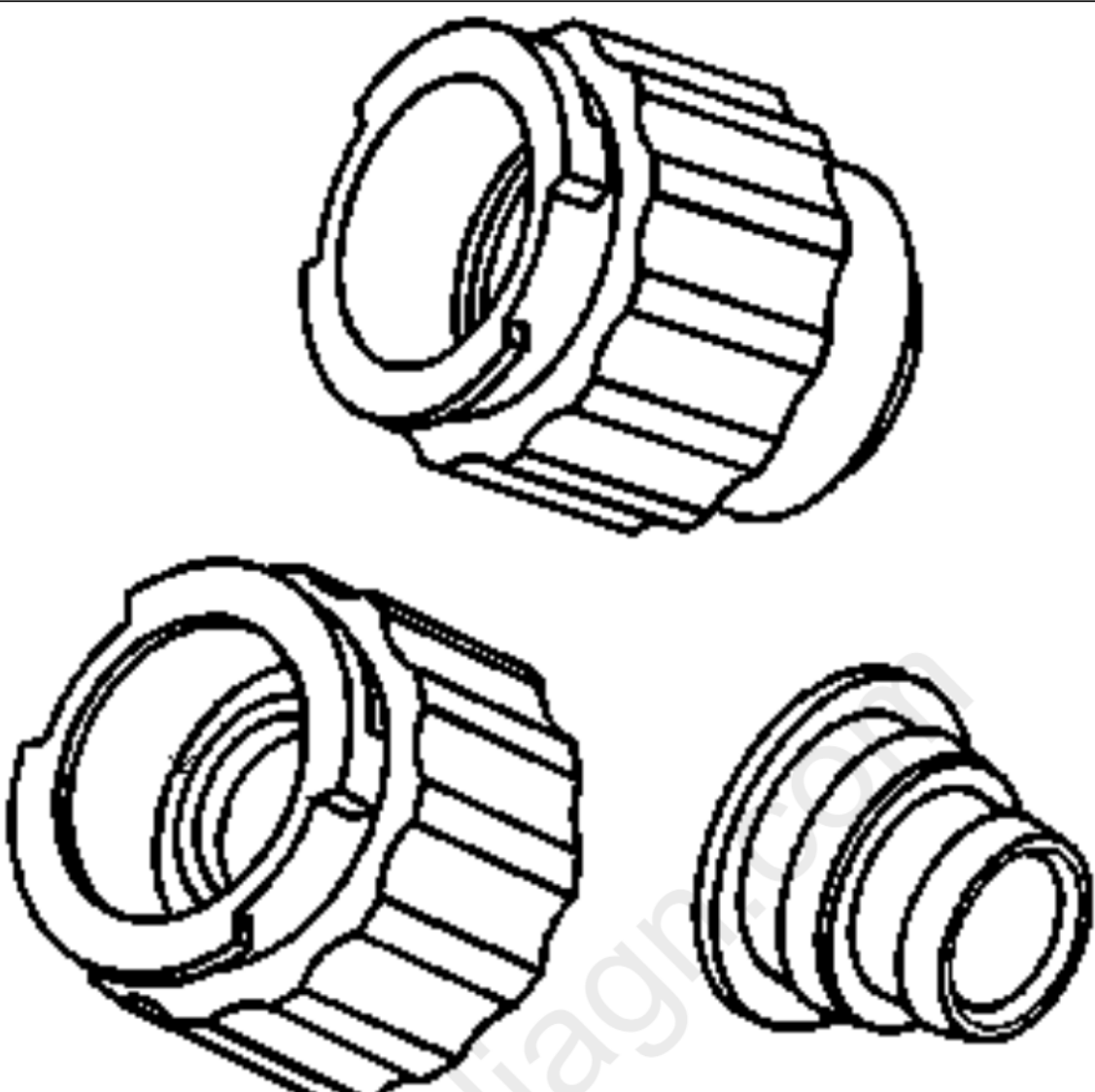
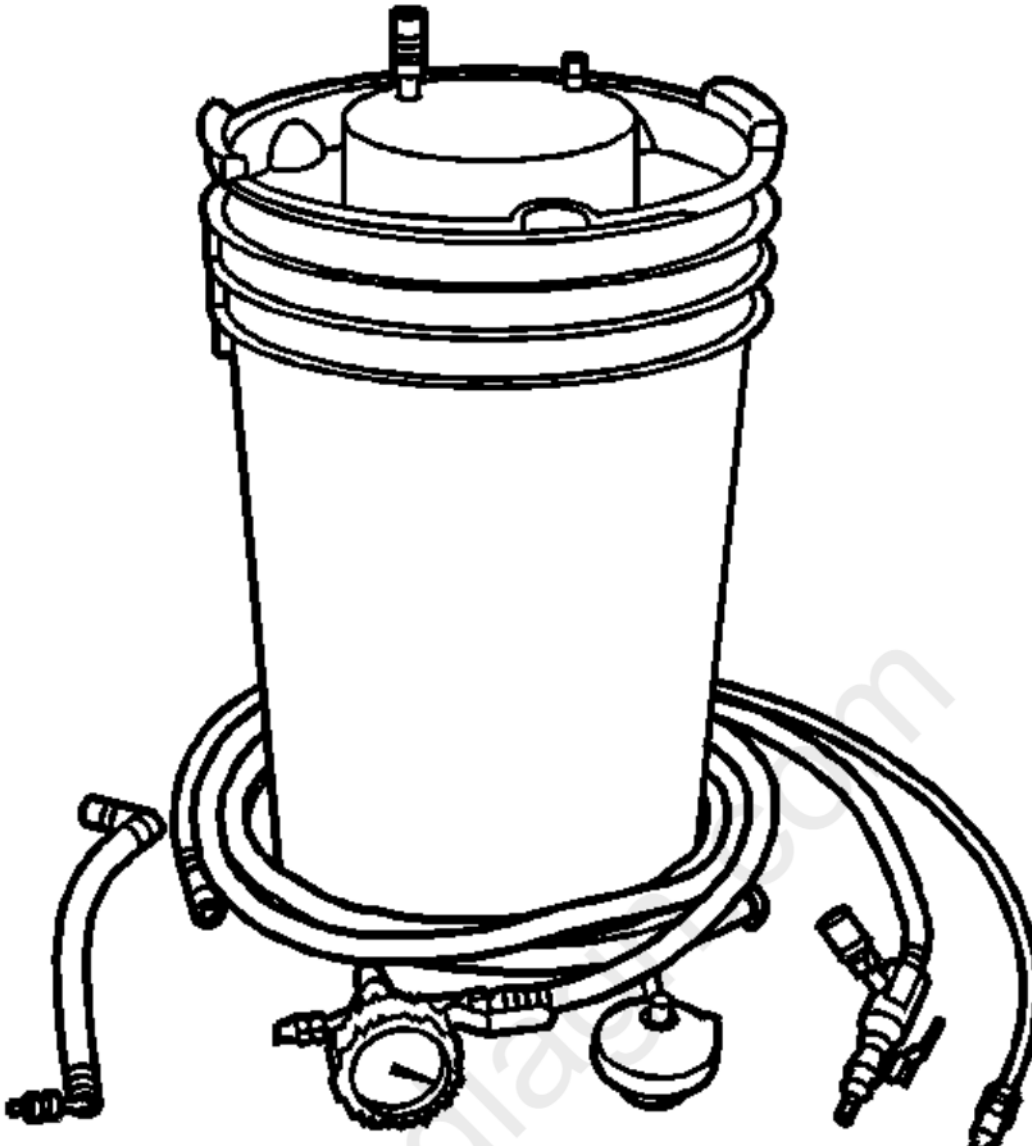
Illustration	Tool Number/ Description
	GE 42220 J 42220 Universal 12V Leak Detection Lamp
	GE 42401 - A J 42401 Radiator Cap and Surge Tank Test Adapter

Illustration	Tool Number/ Description
 The illustration shows three mechanical parts. The top part is a large, hexagonal flanged nut with a wide, flat flange and a threaded central hole. Below it to the left is a smaller, similar flanged nut. To the right of the smaller nut is a small, cylindrical pin or bolt with a hexagonal head and a threaded shaft.	

--

Illustration	Tool Number/ Description
	GE 47716 Vac N Fill Coolant Refill Tool