

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

2010 ENGINE

Engine Cooling - SRX

SECTIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Cooling Fan Shroud to Radiator Bolt	8 N.m	70 lb in
Engine Coolant Air Bleed Pipe Bolt	10 N.m	89 lb in
Engine Coolant Fan Motor Bolt	7 N.m	52 lb in
Engine Coolant Fan Resistor Bolt	5.4 N.m	48 lb in
Radiator Support Bracket Bolt	9 N.m	80 lb in
Thermostat Bolt	10 N.m	88 lb in
Thermostat Housing Bolt	10 N.m	88 lb in
Water Outlet Housing Bolt	10 N.m	88 lb in
Water Pump Bolt	10 N.m	88 lb in
Water Pump Pulley Bolt	12 N.m	106 lb in

SCHEMATICS

ENGINE COOLING SCHEMATICS

2010 ENGINE Engine Cooling - SRX



Courtesy of GENERAL MOTORS CORP

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

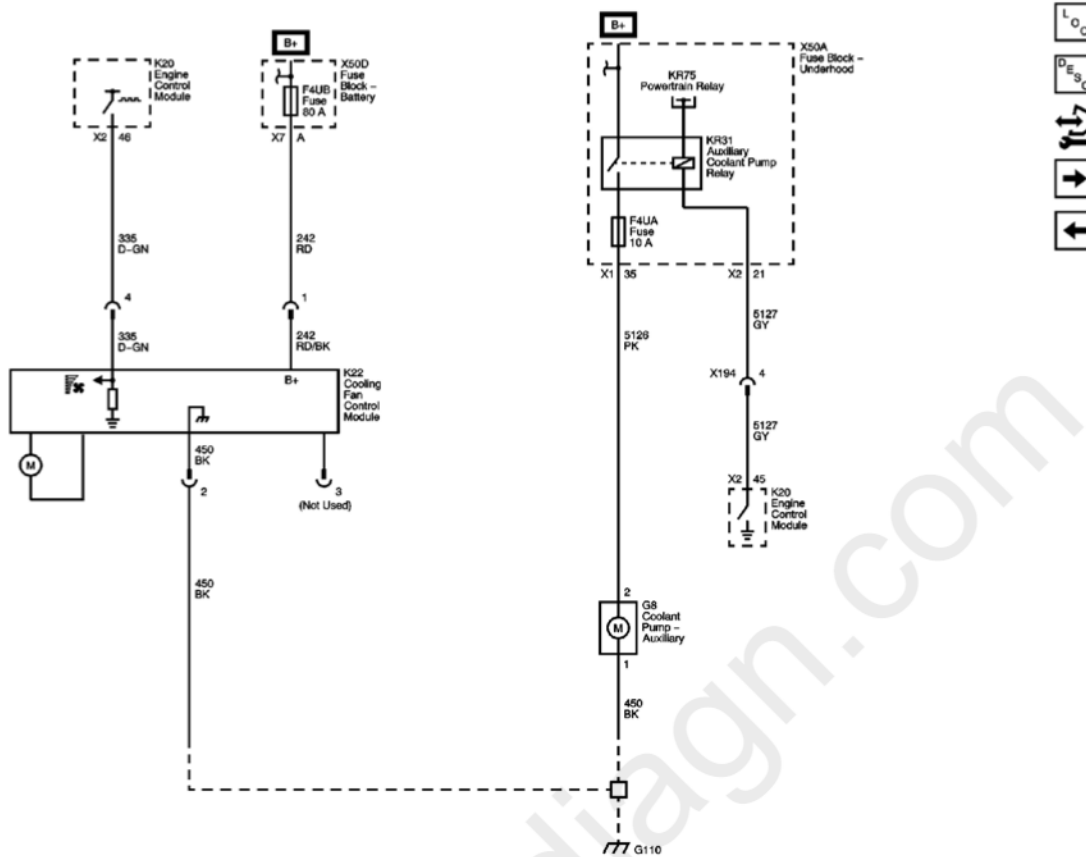


Fig 2: Cooling Fan Circuit Schematic (LAU)
Courtesy of GENERAL MOTORS CORP

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

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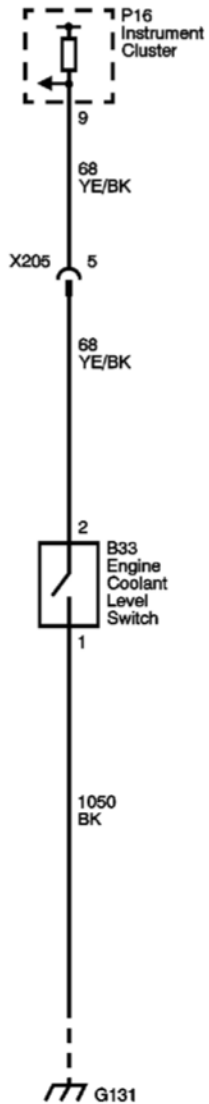


Fig 3: Engine Coolant Level Switch Circuit Schematic
Courtesy of GENERAL MOTORS CORP

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DIAGNOSTIC CODE INDE

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

DIAGNOSTIC CODE INDE

DTC	Description
<u>DTC P0480 (w/LF1)</u>	P0480: Cooling Fan Relay 1 Control Circuit
<u>DTC P0480, P0691, or P0692 (without/LF1)</u>	P0480: Cooling Fan Speed Output Circuit P0691: Cooling Fan Speed Output Circuit Low Voltage P0692: Cooling Fan Speed Output Circuit High Voltage
<u>DTC P0481 (w/LF1)</u>	P0481: Cooling Fan Relays 2 and 3 Control Circuit
<u>DTC P1258</u>	P1258: Engine Coolant Overtemperature - Protection Mode Active
<u>DTC P2600-P2603</u>	P2600: Auxiliary Coolant Pump Relay Control Circuit P2601: Auxiliary Coolant Pump Performance P2602: Auxiliary Coolant Pump Relay Control Circuit Low Voltage P2603: Auxiliary Coolant Pump Relay Control Circuit High Voltage

DTC P0480 (W/LF1)**Diagnostic Instructions**

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

DTC Descriptors**DTC P0480**

Cooling Fan Relay 1 Control Circuit

Diagnostic Fault Information**KR20A COOL FAN 2 Relay**

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480, P0481	P0481	-	-
Relay Switch B+ Circuit	1	2	-	-
Relay Control Circuit	P0481	P0481	P0481	-
Relay Controlled Output Circuit	1	2	3	-
1. Low and medium speed fan inoperative without a DTC. 2. Medium speed fan inoperative without a DTC. 3. Medium speed fan always ON without a DTC.				

KR20B COOL FAN 3 Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480	2	-	-

2010 Cadillac SRX**2010 ENGINE Engine Cooling - SRX**

Relay Switch B+ Circuit	1	2	-	-
Relay Control Circuit	3	2	4	-
Relay Controlled Output Circuit	1	2	3	-
1. Low and medium speed fan inoperative without a DTC. 2. Low speed fan inoperative without a DTC. 3. Low speed fan always ON without a DTC. 4. Low and high speed fan inoperative without a DTC.				

KR20D COOL FAN 1 Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480, P0481	P0481	1	-
Relay Switch B+ Circuit	2	2	-	-
Relay Control Circuit	P0481	P0481	P0481	-
Relay Controlled Output Circuit	2	2	3	-
1. Medium speed fan replaced by high speed fan without a DTC. 2. High speed fan inoperative without a DTC. 3. High speed fan always ON without a DTC.				

KR20E COOL FAN 5 Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480	1	-	-
Relay Switch Ignition Circuit	P0480	1	-	-
Relay Control Circuit	2	1	3	-
Relay Controlled Output Circuit	P0480, P0481	1	4	-
1. High speed fan inoperative without a DTC. 2. Low speed fan always ON without a DTC. 3. Low and high speed fan inoperative without a DTC. 4. Medium speed fan inoperative without a DTC.				

KR20F COOL FAN 4 Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480	P0480	-	-
Relay Switch Ignition Circuit	1	2	-	-
Relay Control Circuit	P0480	P0480	P0480	-
Relay Controlled Output Circuit	-	2	-	-
1. Low speed fan always ON without a DTC. 2. Low speed fan and high speed fan inoperative.				

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

Typical Scan Tool Data**Cooling Fan Relay 1 and Cooling Fan Relays 2 and 3 Control Circuit Open, Low, and High Voltage Test Status**

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded OFF Parameter Normal Range: The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage Circuit	Malfunction	Malfunction	-
Cooling Fan Relays 1 and 2 Control Circuit	Malfunction	Malfunction	Not Run
Cooling Fan Relay 4 Control Circuit	Malfunction	Malfunction	Not Run

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

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded ON Parameter Normal Range: The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage Circuit	Not Run	Not Run	-
Cooling Fan Relays 1 and 2 Control Circuit	Not Run	Not Run	Malfunction
Cooling Fan Relay 4 Control Circuit	Not Run	Not Run	Malfunction

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two individual resistors mounted to each side of the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

To operate the fan, the ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- The ignition voltage is between 11-18 volts.
- The engine speed is greater than 400 RPM.
- The ECM driver transitions from ON to OFF or from OFF to ON.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- DTC P0480 runs continuously when the conditions above are met.

Conditions for Setting the DTC

P0480

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

Action Taken When the DTC Sets

DTC P0480 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0480 is a Type B DTC.

Diagnostic Aids

- A condition with the powertrain relay or the bussed ignition voltage circuit to the cooling fan relay may set this DTC.
- 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 scan tool Cooling Fan Relay Command parameters to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates the fan at a low speed
 - Cooling Fan Relay 2 and 3 operates the fan at a medium speed
 - Cooling Fan Relay 1, 2 and 3 operates the fan at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (LAU) or Cooling Fan Description and Operation (LF1)

Electrical Information Reference

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

DTC Type Reference**Powertrain Diagnostic Trouble Code (DTC) Type Definitions****Scan Tool Reference****Control Module References** for scan tool information**Circuit/System Verification**

1. Ignition ON, observe the scan tool parameters listed below. Command the cooling fan ON and OFF with a scan tool. The parameters should display OK or Not Run in each of the commanded states.
 - Cooling Fan Relay 1 Open Circuit Test Status
 - Cooling Fan Relay 1 Low Voltage Test Status
 - Cooling Fan Relay 1 High Voltage Test Status
2. Engine operating, observe the DTC information with a scan tool. DTC P0480 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect and remove the underhood fuse block (BEC) and housing.
2. Connect the engine harness connectors 2 and 3 to the BEC.
3. Connect the red lead of a DMM to the control circuit terminal 1-33. Connect the black lead to ground. Set the DMM on the diode setting. Ignition ON, the DMM should display OL.
 - If less than the specified range, test the relay coil control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Command the cooling fan relay ON and OFF at low speed, with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
 - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the 50A BEC.

Repair Procedures

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

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

DTC P0480, P0691, OR P0692 (WITHOUT/LF1)

Diagnostic Instructions

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

DTC Descriptors

DTC P0480

Cooling Fan Speed Output Circuit

DTC P0691

Cooling Fan Speed Output Circuit Low Voltage

DTC P0692

Cooling Fan Speed Output Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

The engine control module (ECM) commands the cooling fan depending on cooling requirements. The ECM controls the cooling fan speed by commanding the cooling fan control module. The cooling fan control module supplies the power and ground circuits for the cooling fan. The ECM sends a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module interprets the signal and operates the cooling fan at the commanded speed.

Conditions for Running the DTC

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- The engine speed is greater than 0 RPM.
- The ignition voltage is between 10-18 volts.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 1 second.

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

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

Diagnostic Aids

The ECM has the capability of providing command to the fan module even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know when the fan is being commanded ON by the ECM.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (LAU) or Cooling Fan Description and Operation (LF1)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions**Scan Tool Reference****Control Module References** for scan tool information**Circuit/System Verification**

NOTE: **There is a slight delay before the cooling fans activate.**

1. Ignition ON, command the cooling fan ON and OFF with a scan tool. The cooling fan should respond to the commanded states.
2. Observe the DTC information with a scan tool. DTC P0480, P0691, or P0692 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the K22 cooling fan control module.
2. Verify that a test lamp illuminates between the ground circuit terminal 2 and B+.
 - o If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the B+ supply circuit terminal 1 and ground.
 - o If the test lamp does not illuminate, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test or replace the K22 cooling fan control module.

NOTE: **The cooling fan speed control circuit is pulled-up to a voltage within the ECM, 3-4 volts on the control circuit is normal.**

4. Test for 3-4 V between the control circuit terminal 4 and ground.
 - o If less than the specified range, test the control circuit for an open or a short to ground. If the circuit tests normal, replace the K20 ECM.
 - o If greater than the specified range, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Command the cooling fan ON and OFF with a scan tool. The DMM should transition from 3-4 V when commanded OFF to less than 1 V, when commanded ON to greater than 70 %.
 - o If the circuit voltage does not correspond to the specified values, test the control circuit for a high resistance. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, replace the K22 cooling fan control module.

Repair Procedures

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- **Engine Coolant Fan Replacement (LF1)** or **Engine Coolant Fan Replacement (LAU)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0481 (W/LF1)

Diagnostic Instructions

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

DTC Descriptors

DTC P0481

Cooling Fan Relays 2 and 3 Control Circuit

Diagnostic Fault Information

KR20A COOL FAN 2 Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480, P0481	P0481	-	-
Relay Switch B+ Circuit	1	2	-	-
Relay Control Circuit	P0481	P0481	P0481	-
Relay Controlled Output Circuit	1	2	3	-
1. Low and medium speed fan inoperative without a DTC. 2. Medium speed fan inoperative without a DTC. 3. Medium speed fan always ON without a DTC.				

KR20B COOL FAN 3 Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480	2	-	-
Relay Switch B+ Circuit	1	2	-	-
Relay Control Circuit	3	2	4	-
Relay Controlled Output Circuit	1	2	3	-
1. Low and medium speed fan inoperative without a DTC. 2. Low speed fan inoperative without a DTC. 3. Low speed fan always ON without a DTC. 4. Low and high speed fan inoperative without a DTC.				

KR20D COOL FAN 1 Relay

2010 Cadillac SRX**2010 ENGINE Engine Cooling - SRX**

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480, P0481	P0481	1	-
Relay Switch B+ Circuit	2	2	-	-
Relay Control Circuit	P0481	P0481	P0481	-
Relay Controlled Output Circuit	2	2	3	-
1. Medium speed fan replaced by high speed fan without a DTC. 2. High speed fan inoperative without a DTC. 3. High speed fan always ON without a DTC.				

KR20E COOL FAN 5 Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480	1	-	-
Relay Switch Ignition Circuit	P0480	1	-	-
Relay Control Circuit	2	1	3	-
Relay Controlled Output Circuit	P0480, P0481	1	4	-
1. High speed fan inoperative without a DTC. 2. Low speed fan always ON without a DTC. 3. Low and high speed fan inoperative without a DTC. 4. Medium speed fan inoperative without a DTC.				

KR20F COOL FAN 4 Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480	P0480	-	-
Relay Switch Ignition Circuit	1	2	-	-
Relay Control Circuit	P0480	P0480	P0480	-
Relay Controlled Output Circuit	-	2	-	-
1. Low speed fan always ON without a DTC. 2. Low speed fan and high speed fan inoperative.				

Typical Scan Tool Data**Cooling Fan Relay 1 and Cooling Fan Relays 2 and 3 Control Circuit Open, Low, and High Voltage Test Status**

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test

Ignition Voltage Circuit	Malfunction	Malfunction	-
Cooling Fan Relays 1 and 2 Control Circuit	Malfunction	Malfunction	Not Run
Cooling Fan Relay 4 Control Circuit	Malfunction	Malfunction	Not Run

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

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded ON Parameter Normal Range: The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage Circuit	Not Run	Not Run	-
Cooling Fan Relays 1 and 2 Control Circuit	Not Run	Not Run	Malfunction
Cooling Fan Relay 4 Control Circuit	Not Run	Not Run	Malfunction

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two individual resistors mounted to each side of the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

To operate the fan, the ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

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

Conditions for Setting the DTC

P0481

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

Action Taken When the DTC Sets

DTC P0481 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0481 is a Type B DTC.

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 scan tool Cooling Fan Relay Command parameters to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates the fan at a low speed
 - Cooling Fan Relay 2 and 3 operates the fan at a medium speed
 - Cooling Fan Relay 1, 2 and 3 operates the fan at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information**Schematic Reference****Engine Cooling Schematics****Connector End View Reference****Component Connector End Views****Description and Operation**

Cooling Fan Description and Operation (LAU) or **Cooling Fan Description and Operation (LF1)**

Electrical Information Reference

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

DTC Type Reference**Powertrain Diagnostic Trouble Code (DTC) Type Definitions****Scan Tool Reference**

Control Module References for scan tool information**Circuit/System Verification**

1. Ignition ON, observe the scan tool parameters listed below. Command the cooling fan ON and OFF with a scan tool. The parameters should display OK or Not Run in each of the commanded states.
 - Cooling Fan Relay 2 and 3 Open Circuit Test Status
 - Cooling Fan Relay 2 and 3 Low Voltage Test Status
 - Cooling Fan Relay 2 and 3 High Voltage Test Status
2. Engine operating, observe the DTC information with a scan tool. DTC P0481 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the KR20 cooling fan relays listed below:
 - KR20A COOL FAN 2 Relay 9
 - KR20D COOL FAN 1 Relay 13
2. Ignition ON, verify that a test lamp illuminates between ground and the COOL FAN 2 relay coil ignition circuit terminal 86.
 - If the test lamp does not illuminate, test the relay coil ignition circuit for an open/high resistance.

NOTE: **The following tests must be performed on each relay control circuit.**

3. Connect the red lead of the DMM to a control circuit terminal listed below. Connect the black lead to ground. Set the DMM on the diode setting. The DMM should display OL.
 - KR20A COOL FAN 2 relay terminal 85
 - KR20D COOL FAN 1 relay terminal 86
 - If less than the specified range, test the relay coil control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: **The following test must be performed on each relay control circuit.**

4. Command the cooling fan relay ON and OFF at high speed, with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
 - KR20A COOL FAN 2 relay terminal 85
 - KR20D COOL FAN 1 relay terminal 86
 - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the appropriate KR20 relay.

Component Testing

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 60-100 ohms between terminals 85 and 86.
 - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display OL.
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - If less than the specified range, replace the KR20 cooling fan relay.
4. Connect a 20 A fused jumper wire between relay terminal 85 and B+. Connect a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
 - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

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

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

DTC P12 8

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 P12 8

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

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

Conditions for Setting the DTC

3.0L - LF1

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

3.6L - LLT

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

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

DTC P1258 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LAU) or Engine Controls Schematics (LF1)

Connector End View Reference

Component Connector End Views

Description and Operation

- Cooling Fan Description and Operation (LAU) or Cooling Fan Description and Operation (LF1)
- Instrument Cluster Description and Operation
- Indicator/Warning Message Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Wiring Repairs

DTC Type Reference**Powertrain Diagnostic Trouble Code (DTC) Type Definitions****Scan Tool Reference**

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

Circuit/System Verification

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

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

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

Circuit/System Testing

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

Repair Procedures

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

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 P2600

Auxiliary Coolant Pump Relay Control Circuit

DTC P2601

Auxiliary Coolant Pump Performance

DTC P2602

Auxiliary Coolant Pump Relay Control Circuit Low Voltage

DTC P2603

Auxiliary Coolant Pump Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Auxiliary Coolant Pump Relay Control	P2602	P2600	P2603	-
Ground	-	P2600	-	-

Circuit/System Description

The auxiliary coolant pump and cooling fan system provides a measure of prevention against fuel vaporization due to excessive engine temperatures. The engine control module (ECM) commands the auxiliary or after boil coolant pump ON when the engine coolant temperature exceeds a calibrated value after engine shut down. The ECM applies ground to the coil side of the auxiliary pump printed circuit board (PCB) relay. This energizes the coil and applies voltage directly to the pump motor through the switch side of the relay.

Conditions for Running the DTC

P2600, P2602, or P2603

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 V.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- The ECM has commanded the pump ON and OFF at least once during the ignition cycle.
- The DTCs run continuously once the above conditions are met.

P2601

- DTC P0111, P0112, P0113, P0116, P0117, P0118, P0119, P2600, P2602, or P2603 is not set.
- The ignition is OFF.
- The engine coolant temperature (ECT) at engine shut down is warmer than 110 °C (230 °F).
- The auxiliary coolant pump is enabled.
- The DTC runs continuously once the conditions above are met for greater than 30 S.

Conditions for Setting the DTC

P2600

The ECM detects the pump control circuit is open. The condition exists for 4 S or a cumulative of 30 S.

P2601

The ECM detects that the ECT decreases less than 2 °C (4 °F) within 60 seconds. The condition exists for 4 S or a cumulative of 30 S.

P2602

The ECM detects the pump control circuit is shorted to ground. The condition exists for 4 seconds or a cumulative of 30 seconds.

P2603

The ECM detects the pump control circuit is shorted to voltage. The condition exists for 4 seconds or a cumulative of 30 seconds.

Action Taken When the DTC Sets

The DTCs are Type C DTCs.

Conditions for Clearing the DTC

The DTCs are Type C DTCs.

Diagnostic Aids

- This diagnostic uses a comprehensive approach to the diagnosis of the KR31 auxiliary coolant pump relay and its related circuits. The auxiliary coolant pump relay is a printed circuit board (PCB) relay. The relay is an integral component to the underhood bussed electrical center (UBEC). It cannot be removed and it is not visible.
- Much of the diagnosis is performed at the ECM connectors. Great care should be taken to ensure that the

correct terminals are tested and the proper test probes are utilized when performing this diagnostic.

- The test lamp is used to provide a visual aid to observe the integrity of the KR31 relay, the UBEC and the relay control circuit.
- Grounding terminal X2-58 activates the powertrain relay, which will supply power through KR31 relay coil and the relay control circuit. Under normal circumstances the test lamp will illuminate with dim intensity due to the load created by the KR31 relay coil. If the test lamp does not illuminate, or illuminates brightly a condition exists in the KR31 relay control circuit or the UBEC.

Reference Information

Schematic Reference

- Engine Cooling Schematics
- Engine Controls Schematics (LAU) or Engine Controls Schematics (LF1)

Connector End View Reference

Component Connector End Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that DTC P0480, P0691, or P0692, is not set.
 - If a DTC is set, refer to **DTC P0480, P0691, or P0692 (without/LF1)** for further diagnosis.

NOTE: **There is a slight delay before the cooling fan activates and reaches full speed.**

2. Command the cooling fan ON from 20-90 % with a scan tool. Verify that the cooling fan turns ON and operates as commanded.
 - If the cooling fan does not respond to the commanded states, refer to **Cooling Fan Inoperative**

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

(LAU) or **Cooling Fan Inoperative (LF1)** for further diagnosis.

3. Ignition ON, command the KR31 auxiliary coolant pump relay ON and OFF with the scan tool. An audible click should be heard when changing between the commanded states.
4. Start the engine, observe the DTC information with a scan tool. DTCs P2600, P2602, or P2603 should not set.
5. Ignition ON, engine off observe the DTC information with a scan tool. DTC P2601 should not set.
 - o If DTC P2601 is set, refer to the following procedures for further diagnosis:
 - **After Boil Coolant Pump Always On**
 - **After Boil Coolant Pump Inoperative**
 - **After Boil Coolant Pump Malfunction**
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

CAUTION: Use the connector test adapter kit 1 A for any test that requires probing the following items:

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

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

NOTE: Refer to **Diagnostic Aids** before performing the Circuit System Testing.

1. Ignition OFF, disconnect harness connector X2 at the K20 ECM.
2. Connect a test lamp between terminal X2-45 and ground.

NOTE:

- A **connected between the test lamp probe and ground will measure if the test lamp illuminates with low intensity. The voltage will measure near B if the test lamp illuminates with bright intensity.**
- The values listed above are based on the use of the **1 210 test lamp or a comparable test lamp that has approximately 0 ohms of internal resistance.**

3. Ignition ON, connect a fused jumper wire between the powertrain relay control circuit terminal X2-58 and ground. The test lamp should illuminate with low intensity.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- If the test lamp does not illuminate, test the auxiliary coolant pump relay control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the X50A underhood fuse block (UBEC).
 - If the test lamp illuminates with bright intensity, test the auxiliary coolant pump relay control circuit for a short to voltage. If the circuit tests normal, test or replace the X50A UBEC.
4. If all circuits/connections test normal, replace the K20 ECM.

Component Testing

1. Ignition OFF, disconnect and remove the X50A UBEC.
2. Remove the KR75 powertrain relay.
3. Test for 170-210 ohms between the powertrain relay switched output circuit terminal 87 and the auxiliary coolant pump relay control circuit at UBEC terminal X2-21.
 - If not within the specified range, replace the X50A UBEC.
4. Test for greater than 2 ohms between UBEC B+ supply cable and the AFTERBOIL PUMP Fuse 4.
 - If less than the specified range, replace the X50A UBEC.
5. Connect a 10 A fused jumper wire from the positive terminal of the battery to the powertrain relay switched output circuit terminal 87. Connect a jumper wire from the negative terminal of the battery to the auxiliary coolant pump relay control circuit at UBEC terminal X2-21. Test for less than 2 ohms between UBEC B+ supply cable and the AFTERBOIL PUMP Fuse 4.
 - If greater than the specified range, replace the X50A UBEC.

Repair Procedures

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

- **Fuse Block Replacement**
- **Control Module References** for ECM replacement, setup, and programming

SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

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

- Locate the correct symptom. Perform the tests and inspections associated with the symptom.

Review the entire cooling system operation in order to familiarize yourself with the system functions. Refer to **Cooling Fan Description and Operation (LAU)** or **Cooling Fan Description and Operation (LF1)** and **Cooling System Description and Operation**.

Visual/Physical Inspection

CAUTION: Use the connector test adapter kit 1 A for any test that requires probing the following items:

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

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

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

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

Identifying Intermittent Conditions

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

- Moisture and water intrusion in connectors, terminals, and components
- Connector mating
- Terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that are routed too tight, or chaffed circuits

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surface
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of non-factory, aftermarket, and after factory add on accessories

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

Symptom List

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

- **Cooling Fan Always On (LAU)** or **Cooling Fan Always On (LF1)**
- **Cooling Fan Inoperative (LAU)** or **Cooling Fan Inoperative (LF1)**
- **Engine Overheating**
- **Loss of Coolant**
- **Thermostat Diagnosis**
- **Engine Fails To Reach Normal Operating Temperature**

LOW ENGINE COOLANT INDICATOR 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.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Coolant Level Switch Signal	Lamp ON	Lamp OFF	Lamp OFF	-
Low Reference	-	Lamp OFF	-	-

Circuit/System Description

The low engine coolant level indicator lamp is located in, and controlled by the instrument panel cluster (IPC).

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

The engine coolant level switch is located in the engine coolant surge tank. The switch remains open when surrounded by coolant. When the engine coolant level switch is closed for greater than 10 seconds, indicating low coolant, the IPC will turn ON the Low Coolant Indicator lamp. The lamp will also illuminate for approximately 3 seconds during the display test at the start of each ignition cycle.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling System 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 OFF, verify the radiator surge tank is filled to the correct level, with engine coolant.
2. Ignition ON, observe the scan tool Coolant Level Switch parameter. The parameter should display OK.
3. Command the instrument cluster indicators ON and OFF with a scan tool. The low coolant indicator lamp should turn ON and OFF as commanded. Refer to Cooling System Description and Operation.
4. The low coolant indicator should be OFF with the engine coolant at the correct level.

Circuit/System Testing

NOTE: **Circuit System Verification must be performed before performing the Circuit System Testing.**

1. Ignition OFF, disconnect the harness connector at the B33 coolant level switch.
2. Test for less than 5 ohms between the ground circuit terminal 1 and ground.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- If greater than the specified range, test the ground circuit for an open/high resistance.
- 3. Ignition ON, observe the scan tool Coolant Level Switch parameter. The parameter should display OK.
 - If not the specified value, test the signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the P16 IPC.
- 4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 1. Verify the scan tool Coolant Level Switch parameter displays Low, and the low coolant lamp in the IPC is ON.
 - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the P16 IPC.
- 5. If all circuits test normal, test or replace the B33 coolant level switch.

Repair Procedures

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

- **Engine Coolant Level Indicator Module Replacement**
- **Control Module References** for ECM replacement, setup, and programming

COOLING FAN ALWAYS ON (LAU)

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 control module (ECM) commands the cooling fan ON depending on the engine cooling requirements. The ECM controls the cooling fan speed by commanding the cooling fan control module. The cooling fan control module supplies the power and ground circuits for the cooling fan. The ECM sends a pulse width modulated (PWM) signal voltage to the cooling fan control module. The cooling fan control module interprets the signal and operates the cooling fan at the commanded speed.

Diagnostic Aids

The ECM has the capability of providing command to the fan module even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know when the fan is being commanded ON by the ECM.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference**Component Connector End Views****Description and Operation****Cooling Fan Description and Operation (LAU) or Cooling Fan Description and Operation (LF1)****Electrical Information Reference**

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

Scan Tool Reference**Control Module References** for scan tool information**Circuit/System Verification**

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0480, P0691, or P0692, is not set.
 - If a DTC is set, refer to **DTC P0480, P0691, or P0692 (without/LF1)**.
2. Ignition ON, observe the scan tool Cooling Fan Motor Command parameter. The parameter should display 0 .
3. Ignition ON, observe that the engine cooling fan is not operating.
 - If the fan is operating, replace the K22 cooling fan control module.

Repair Procedures

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

- **Engine Coolant Fan Replacement (LF1)** or **Engine Coolant Fan Replacement (LAU)**
- **Control Module References**

COOLING FAN ALWAYS ON (LF1)**Diagnostic Instructions**

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

Circuit/System Description

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

The engine cooling fan system is composed of one cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two resistors. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates the fan at a low speed
 - Cooling Fan Relay 2 and 3 operates the fan at a medium speed
 - Cooling Fan Relay 1, 2 and 3 operates the fan at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.
- If the cooling fan operates at high speed when the ECM is requesting medium speed operation, test or replace the KR20E cooling fan speed control relay.

Reference Information

Schematic Reference

- Engine Cooling Schematics
- Electrical Center Identification Views

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (LAU) or Cooling Fan Description and Operation (LF1)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0480 or P0481 is not set.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- If any cooling system DTCs are set, repair the DTC first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
- 2. Ignition ON, observe the scan tool Cooling Fan Relay 1 and Cooling Fan Relays 2 and 3 Command parameters. The parameters should display OFF.
- 3. Ignition ON, observe that the fan is not activated.

Circuit/System Testing

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

1. Ignition OFF, disconnect each KR20 cooling fan relay one at a time in the order listed below.
 - KR20F cooling fan relay
 - KR20B cooling fan low speed relay
 - KR20A cooling fan medium speed relay
 - KR20D cooling fan high speed relay
2. Ignition ON, observe that the fan is not activated after each relay is removed.
 - If the fan is not activated, replace the appropriate KR20 relay.
 - If the fan is activated, test the appropriate relay controlled output circuit for a short to voltage.

Component Testing

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

Repair Verification

1. Ignition ON, verify with a scan tool that the ECM is not commanding fan activation.
2. Ignition ON, observe that the fan is not activated.

COOLING FAN INOPERATIVE (LAU)

Diagnostic Instructions

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- 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 control module (ECM) commands the cooling fan ON depending on the engine cooling requirements. The ECM controls the cooling fan speed by commanding the cooling fan control module. The cooling fan control module supplies the power and ground circuits for the cooling fan. The ECM sends a pulse width modulated (P M) signal voltage to the cooling fan control module. The cooling fan control module interprets the signal and operates the cooling fan at the commanded speed.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (LAU) or Cooling Fan Description and Operation (LF1)

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, verify that DTC P0480, P0691, or P0692, is not set.
 - If a DTCs is set, refer to **DTC P0480, P0691, or P0692 (without/LF1)**.

NOTE: There is a slight delay before the cooling fan activates and reaches full speed.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

2. Command the cooling fan ON with a scan tool. Verify that the cooling fan turns ON and operates at a high speed.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the K22 cooling fan control module.
2. Verify that a test lamp illuminates between the ground circuit terminal 2 and B+.
 - o If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. If the cooling fan ground circuit/connections test normal, replace the K22 cooling fan control module.

Repair Procedures

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

- **Engine Coolant Fan Replacement (LF1)** or **Engine Coolant Fan Replacement (LAU)**
- **Control Module References**

COOLING FAN INOPERATIVE (LF1)

Diagnostic Instructions

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

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two individual resistors mounted to each side of the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Cooling Schematics**Connector End View Reference****Component Connector End Views****Description and Operation****Cooling Fan Description and Operation (LAU) or Cooling Fan Description and Operation (LF1)****Electrical Information Reference**

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

Scan Tool Reference**Control Module References** for scan tool information**Circuit/System Verification**

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

Circuit/System Testing

1. Ignition OFF, disconnect the following relays:
 - KR20A COOL FAN 2 relay
 - KR20B COOL FAN 3 relay
 - KR20D COOL FAN 1 relay
2. Ignition ON, verify a test lamp illuminates between the KR20B relay coil ignition voltage circuit terminal 86 and ground.
 - If the test lamp does not illuminate, test the relay voltage supply circuit for an open/high resistance.
3. Ignition ON, command the cooling fan ON at low speed.
4. Connect a test lamp between B+ and the KR20B relay control circuit terminal 85. The test lamp should illuminate.

NOTE: The KR20B relay is controlled through the switch side of the KR20F COOL FAN 4 relay.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- If the test lamp does not illuminate, test the relay control circuit for an open/high resistance. If the circuit tests normal, test or replace the X50A underhood fuse block (UBEC).
- 5. Ignition ON, command the cooling fan ON at high speed.
- 6. Connect a test lamp between ground and the KR20D relay coil ignition voltage terminal 85. The test lamp should illuminate.

NOTE: The ignition voltage for the R20 relay coil is supplied through the switch side of the R20E COO FAN relay.

- If the test lamp does not illuminate, test or replace the X50A underhood fuse block (UBEC).
- 7. Ignition OFF, install the previously removed KR20 cooling fan relays.
- 8. Disconnect the harness connectors at the G10 cooling fan and both R10 cooling fan resistors.
- 9. Test for less than 1.0ohms between the G10 engine cooling fan ground circuit terminal 1 and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
- 10. Ignition ON, connect a test lamp between ground and the cooling fan circuit terminals listed below. Command the cooling fan ON at High speed. The test lamp should illuminate at each terminal.
 - R10R low speed cooling fan resistor terminal 1
 - R10L medium speed cooling fan resistor terminal 1
 - G10 cooling fan B+ supply circuit terminal 2
 - If the test lamp does not illuminate, test the appropriate KR20 relay controlled output and B+ supply circuits for a short to ground or for an open/high resistance. If the circuits test normal, test or replace the appropriate KR20A, KR20B, or KR20D cooling fan relay.
- 11. Ignition OFF, connect the harness connectors to the R10 cooling fan resistors.
- 12. Ignition ON, connect a test lamp between ground and the G10 cooling fan B+ supply circuit terminal 2. Command the cooling fan ON at Low and Medium speed. The test lamp should illuminate as commanded in each speed.
 - If the test lamp does not illuminate, test or replace the appropriate R10 cooling fan resistor.
- 13. If all of the circuits and components test normal, test or replace the G10 cooling fan.

Component Testing

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

terminal 85 and ground. Test for less than 2ohms between terminals 30 and 87.

- If greater than the specified range, replace the relay.

Cool Fan 5 Printed Circuit Board Relay

1. Ignition OFF, disconnect the following cooling fan relays:
 - Cool Fan 1 relay
 - Cool Fan 3 relay
2. Test for 190-230 ohms between Cool Fan 3 relay terminals 85 and 86 in the UBEC.
 - If not within the specified range, replace the X50A UBEC.
3. Measure the resistance between the Cool Fan 3 relay terminal 86 and Cool Fan 1 relay terminal 85 at the UBEC. The DMM should display OL.
 - If less than the specified range, replace the X50A UBEC.
4. Connect a 3 A fused jumper wire between ground and Cool Fan 3 relay terminal 85, at the UBEC.
5. Ignition ON, verify a test lamp illuminates between ground and Cool Fan 1 relay terminal 85, at the UBEC.
 - If the test lamp does not illuminate, replace the X50A UBEC.

Repair Procedures

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

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

AFTER BOIL COOLANT PUMP 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 procedure.
- **Diagnostic Procedure Instructions** provides an overview of the diagnostic category.

Circuit/System Description

The auxiliary coolant pump and cooling fan system provides a measure of prevention against fuel vaporization due to excessive engine temperatures. The engine control module (ECM) commands the auxiliary or after boil coolant pump ON when the engine coolant temperature exceeds a calibrated value after engine shut down. The ECM applies ground to the coil side of the auxiliary pump printed circuit board (PCB) relay. This energizes the coil and applies voltage directly to the pump motor through the switch side of the relay.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

Diagnostic Aids

The auxiliary coolant pump relay is a printed circuit board (PCB) relay. The relay is an integral component to the underhood bussed electrical center (UBEC). It cannot be removed and it is not visible.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation (LAU) or Cooling Fan Description and Operation (LF1)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P2600, P2602, or P2603 is not set.
 - If any auxiliary coolant pump DTC is set, repair the DTC first. Refer to **DTC P2600-P2603**.
2. Ignition ON, observe the scan tool engine coolant temperature (ECT) sensor parameter. Verify the ECT is colder than 110 °C (230 °F).
3. Observe that the pump is not activated.

Circuit/System Testing

1. Ignition OFF, remove the AFTERBOIL PUMP Fuse 4.
2. Ignition ON, observe that the auxiliary coolant pump is not activated.
 - If the pump is activated, test for a short to voltage in the KR31 auxiliary coolant pump relay controlled output circuit.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- If the pump is not activated, test or replace the X50A underhood fuse block (UBEC).

Component Testing

1. Ignition OFF, disconnect and remove the X50A UBEC.
2. Remove the KR75 powertrain relay.
3. Test for 170-210 ohms between the powertrain relay switched output circuit terminal 87 and the auxiliary coolant pump relay control circuit at UBEC terminal X2-21.
 - If not within the specified range, replace the X50A UBEC.
4. Test for greater than 2 ohms between UBEC B+ supply cable and the AFTERBOIL PUMP Fuse 4.
 - If less than the specified range, replace the X50A UBEC.
5. Connect a 10 A fused jumper wire from the positive terminal of the battery to the powertrain relay switched output circuit terminal 87. Connect a jumper wire from the negative terminal of the battery to the auxiliary coolant pump relay control circuit at UBEC terminal X2-21. Test for less than 2 ohms between UBEC B+ supply cable and the AFTERBOIL PUMP Fuse 4.
 - If greater than the specified range, replace the X50A UBEC.

Repair Procedures

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

Fuse Block Replacement

AFTER BOIL COOLANT PUMP 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 auxiliary coolant pump and cooling fan system provides a measure of prevention against fuel vaporization due to excessive engine temperatures. The engine control module (ECM) commands the auxiliary or after boil coolant pump ON when the engine coolant temperature exceeds a calibrated value after engine shut down. The ECM applies ground to the coil side of the auxiliary pump printed circuit board (PCB) relay. This energizes the coil and applies voltage directly to the pump motor through the switch side of the relay.

Diagnostic Aids

The auxiliary coolant pump relay is a printed circuit board (PCB) relay. The relay is an integral component to the underhood bussed electrical center (UBEC). It cannot be removed and it is not visible.

Reference Information

Schematic Reference**Engine Cooling Schematics****Connector End View Reference****Component Connector End Views****Description and Operation****Cooling System 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, observe the DTC information with a scan tool. Verify that DTC P2600, P2602, or P2603 is not set.
 - If any auxiliary coolant pump DTC is set, repair the DTC first. Refer to **DTC P2600-P2603**.
2. Ignition ON, command the auxiliary coolant pump relay ON and OFF with a scan tool. Verify that the pump turns ON and OFF when changing between the commanded states.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the G8 auxiliary coolant pump.
2. Ignition ON, verify that a test lamp illuminates between the G8 pump ground circuit terminal 1 and B+.
 - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the G8 pump voltage supply circuit terminal 2 and ground. Command the G8 pump on with a scan tool. The test lamp should illuminate.
 - If the test lamp does not illuminate, test the voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and the AFTERBOIL fuse is OK, test or replace the X50A UBEC.
 - If the circuit tests normal and the AFTERBOIL fuse is open, test or replace the G8 auxiliary coolant pump.
4. If all of the circuits/connections test normal, replace the G8 auxiliary coolant pump.

Component Testing

1. Ignition OFF, disconnect and remove the X50A UBEC.
2. Remove the KR75 powertrain relay.
3. Test for 170-210 ohms between the powertrain relay switched output circuit terminal 87 and the auxiliary coolant pump relay control circuit at UBEC terminal X2-21.
 - If not within the specified range, replace the X50A UBEC.
4. Test for greater than 2 ohms between UBEC B+ supply cable and the AFTERBOIL PUMP Fuse 4.
 - If less than the specified range, replace the X50A UBEC.
5. Connect a 10 A fused jumper wire from the positive terminal of the battery to the powertrain relay switched output circuit terminal 87. Connect a jumper wire from the negative terminal of the battery to the auxiliary coolant pump relay control circuit at UBEC terminal X2-21. Test for less than 2 ohms between UBEC B+ supply cable and the AFTERBOIL PUMP Fuse 4.
 - If greater than the specified range, replace the X50A UBEC.

Repair Procedures

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

- **Fuse Block Replacement**
- **Auxiliary Water Pump Replacement (LAU)**

AFTER BOIL COOLANT PUMP MALFUNCTION**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** provide an overview of each diagnostic category.

Circuit/System Description

The auxiliary coolant pump and cooling fan system provides a measure of prevention against fuel vaporization due to excessive engine temperatures. The engine control module (ECM) commands the auxiliary or after boil coolant pump ON when the engine coolant temperature exceeds a calibrated value after engine shut down. The ECM applies ground to the coil side of the auxiliary pump printed circuit board (PCB) relay. This energizes the coil and applies voltage directly to the pump motor through the switch side of the relay.

Reference Information**Description and Operation****Cooling System Description and Operation****Scan Tool Reference**

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P2600, P2602, or P2603 is not set.
 - If any auxiliary coolant pump DTC is set, repair the DTC first. Refer to **DTC P2600-P2603**.
2. Ignition ON, command the Aux. Coolant Pump Relay ON and OFF with a scan tool. Verify that the G8 auxiliary coolant pump turns ON and OFF when changing between the commanded states.
 - If the G8 pump does not activate, refer to **After Boil Coolant Pump Inoperative**.

Circuit/System Testing

1. Test for a blockage or restriction in the G8 auxiliary coolant pump lines and hoses.
2. Test the G8 pump coolant passage for a blockage or a restriction.
3. Test the G8 pump impeller for a seized or binding condition.

Repair Procedures

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

- **Auxiliary Water Pump Replacement (LAU)**
- **Auxiliary Water Pump Inlet Hose Replacement (LAU)**
- **Auxiliary Water Pump Outlet Hose Replacement (LAU)**

ENGINE OVERHEATING

Step	Action	Yes	No
DEFINITION: The engine temperature lamp comes on and stays on, or temperature gauge shows hot, or coolant overflows from the surge tank onto the ground while the engine is running.			
1	Check the condenser, radiator, and auxiliary coolers for any obstructions or bent fins that would prevent air flow through the radiator. Is there any airflow obstruction or bent fins?	Go to Step 2	Go to Step 3
2	1. Remove any debris that may cause an air flow obstruction. 2. Remove or relocate aftermarket add-on components that block air flow to the radiator. Does the engine still overheat?	Go to Step 3	System OK
3	Check for loose, missing, or damaged radiator air seals or deflectors. Are there any loose, missing, or damaged radiator air seals or deflectors?	Go to Step 4	Go to Step 5

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

4	Repair or replace any loose, missing, or damaged radiator air seals or deflectors. Does the engine still overheat?	Go to Step 5	System OK
5	Check for an inoperative cooling fan. Refer to Cooling Fan Inoperative (LAU) or Cooling Fan Inoperative (LF1) . Is the thermostat operating properly?	Go to Step 6	Go to Step 7
6	Repair or replace the cooling fan(s) as necessary. Refer to Engine Coolant Fan Motor Replacement (LF1) . Does the engine still overheat?	Go to Step 7	System OK
7	Check for a loss of coolant. Refer to Loss of Coolant . Does the engine still overheat?	Go to Step	System OK
8	Check for kinked or pinched cooling hoses. Are any cooling hoses kinked or pinched?	Go to Step	Go to Step 10
9	1. Relieve any kinks by rerouting the hoses. 2. Replace the hoses, if necessary. Does the engine still overheat?	Go to Step 10	System OK
10	Using J-2656 : Coolant and Battery Fluid Tester , check the coolant concentration. Does the coolant concentration test correctly?	Go to Step 12	Go to Step 11
11	Replace the coolant, if necessary. Refer to Loss of Coolant . Does the engine still overheat?	Go to Step 12	System OK
12	Check for any blocked cooling system passages. Are there blocked cooling system passages?	Go to Step 13	Go to Step 14
13	Remove any obstructions by flushing the cooling system. Refer to Flushing . Does the engine still overheat?	Go to Step 14	Go to Step 1
14	Inspect the accessory drive belt tensioner. Refer to Drive Belt Tensioner Diagnosis . Does the engine still overheat?	Go to Step 15	System OK
15	Check for a faulty thermostat. Refer to Thermostat Diagnosis . Does the engine still overheat?	Go to Step 16	System OK
16	Replace the radiator. Refer to Radiator Replacement (LF1) or Radiator Replacement (LAU) . Does the engine still overheat?	Go to Step 17	System OK
17	Check for a faulty water pump. The impeller blades may be eroded or broken. Is the water pump faulty?	Go to Step 1	-
18	Replace the water pump. Refer to Water Pump Replacement . Did you complete the repair?	Go to Step 1	-
	Operate the system to verify the repair.		

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

19	Did you correct the condition?	System OK	-
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LOSS OF COOLANT

Step	Action	Yes	No
DEFINITION: The cooling system is loosing coolant either internally or externally.			
1	Were you sent here from Symptoms, or another diagnostic table?	Go to Step 2	Go to Symptoms - Engine Cooling
2	Repair any present DTCs. Refer to Diagnostic System Check - Vehicle . Is the action complete?	Go to Step 3	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to Step 5	Go to Step 4
4	Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU) . Is the action complete?	Go to Step 5	-
5	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to Step 1	Go to Step 6
6	1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust pipe. Is a heavy white smoke present from the exhaust pipe?	Go to Step 7	Go to Step
7	1. Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. 2. Condensation in the exhaust system can cause an odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?	Go to Step 20	Go to Step
8	Visually inspect the hoses, pipes and hose clamps. Are any of the hoses, clamps or pipes leaking?	Go to Step 21	Go to Step
9	Visually inspect the following components: • Block heater • Coolant pressure cap • Core plugs • Throttle body • Engine block • Intake manifold		

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

	• Radiator • Thermostat housing • Water pump		
	Are any of the listed components leaking?	Go to Step 21	Go to Step 10
10	1. Pressure test the cooling system. Refer to Cooling System Leak Testing. 2. With the cooling system pressurized, visually inspect the components listed in steps 7, 8 and 9.		
	Are any leaks present?	Go to Step 21	Go to Step 11
11	Pressure test the coolant pressure cap. Refer to Pressure Cap Testing .		
	Does the coolant pressure cap hold pressure?	Go to Step 12	Go to Step 16
12	Inspect for the following conditions: • A coolant smell inside of the vehicle • Coolant in the HVAC module drain tube • Coolant on the vehicle floor covering near the HVAC module		
	Is coolant present?	Go to Step 21	Go to Step 13
13	Inspect the underside of the engine oil fill cap for a gray/white milky substance.		
	Is there a milky substance under the oil fill cap?	Go to Step 14	Go to Step 15
14	Inspect the engine oil fluid level indicator for a gray/white milky substance.		
	Is there a milky substance on the engine oil fluid level indicator?	Go to Step 17	Go to Step 15
15	Inspect the automatic transmission oil fluid level indicator, if equipped, for a gray/white milky substance.		
	Is there a milky substance on the automatic transmission fluid level indicator?	Go to Step 1	Go to Step 22
16	Replace the coolant pressure cap.		
	Is the repair complete?	Go to Step 22	-
17	1. Replace the radiator. Refer to Radiator Replacement (LF1) or Radiator Replacement (LAU). 2. Replace the oil and filter. Refer to Engine Oil and Oil Filter Replacement (LF1) or Engine Oil and Oil Filter Replacement (LAU).		

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

	Is the repair complete	o to Step 22	-
18	1. Replace the radiator. Refer to <u>Radiator Replacement (LF1)</u> or <u>Radiator Replacement (LAU)</u>. 2. Service the automatic transmission. Refer to the following: <u>Engine Coolant/Water in Transmission</u>.		
	Is the repair complete	o to Step 22	-
19	Repair the engine overheating condition. Refer to <u>Engine Overheating</u> .		
	Is the repair complete	o to Step 22	-
20	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	o to Step 22	-
21	Repair or replace the leaking component. Refer to the appropriate repair.		
	Is the repair complete	o to Step 22	-
22	Operate the system in order to verify the repair.		
	Did you find and correct the condition	System OK	o to Step 2

THERMOSTAT DIAGNOSIS

Step	Action	Yes	No
1	1. Ensure that the cooling system is full. 2. Allow the engine to cool. 3. Start the engine. 4. Turn the air conditioning system off. 5. Inspect the engine cooling fan(s).		
	Is the electric cooling fan on	o to Step 2	o to Step 3
2	1. Diagnose and repair the cooling fan system. Refer to <u>Cooling Fan Always On (LAU)</u> or <u>Cooling Fan Always On (LF1)</u>. 2. Verify the customer complaint.		
	Does the engine still fail to reach normal operating temperature	o 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		

2010 Cadillac SRX**2010 ENGINE Engine Cooling - SRX**

	reading on the Scan Tool	o to Step 5	o 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	o to Step 5	System OK
5	Inspect the thermostat for correct operation. Refer to Thermostat Diagnosis . Is the thermostat operating correctly	System OK	o to Step 6
6	1. Replace the thermostat. Refer to Engine Coolant Thermostat Replacement (LF1) . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature	o to Step 1	System OK

COOLANT HEATER INOPERATIVE**Diagnostic Instructions**

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

Circuit/System Description

The optional coolant heater operates using 110 AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather. There is an internal thermal switch in the power cord that prevents operation above -18 C (0 F). The coolant heater helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. A weather shield on the cord is provided to protect the plug when not in use.

Reference Information**Schematic Reference**

Engine Controls Schematics (LAU) or **Engine Controls Schematics (LF1)**

Connector End View Reference**Component Connector End Views****Electrical Information Reference**

- Circuit Testing
- Connector Repairs
- Wiring Repairs

Circuit/System Testing

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

1. Test the engine coolant heater for an open or short to ground.
 - If open or shorted, replace the E19 coolant heater.
2. If the E19 heater tests normal, replace the coolant heater power cord.

Repair Procedures

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

- **Engine Coolant Heater Replacement (LF1)**
- **Coolant Heater Cord Replacement (LF1)**

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE**Special Tools**

J 24731: Tempil Stick

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

Use one of the following procedures in testing for a malfunctioning thermostat.

Thermostat Test Procedure Using Tempil Sticks

The coolant thermostat can be tested using a temperature (tempil) stick. The temperature stick is a pencil like device. It has a wax material containing certain chemicals which melt at a given temperature. Take a 87 C (188 F) tempil stick or a 97 C (206 F) tempil stick and rub it on the thermostat housing. Temperature sticks can be used to determine a thermostat's operating range.

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

Thermostat Test Procedure Using Glycol

Inspect the operation of the thermostat by hanging the thermostat on a hook in a 50/50 percent solution of DE - COOL and clean drinkable water.

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

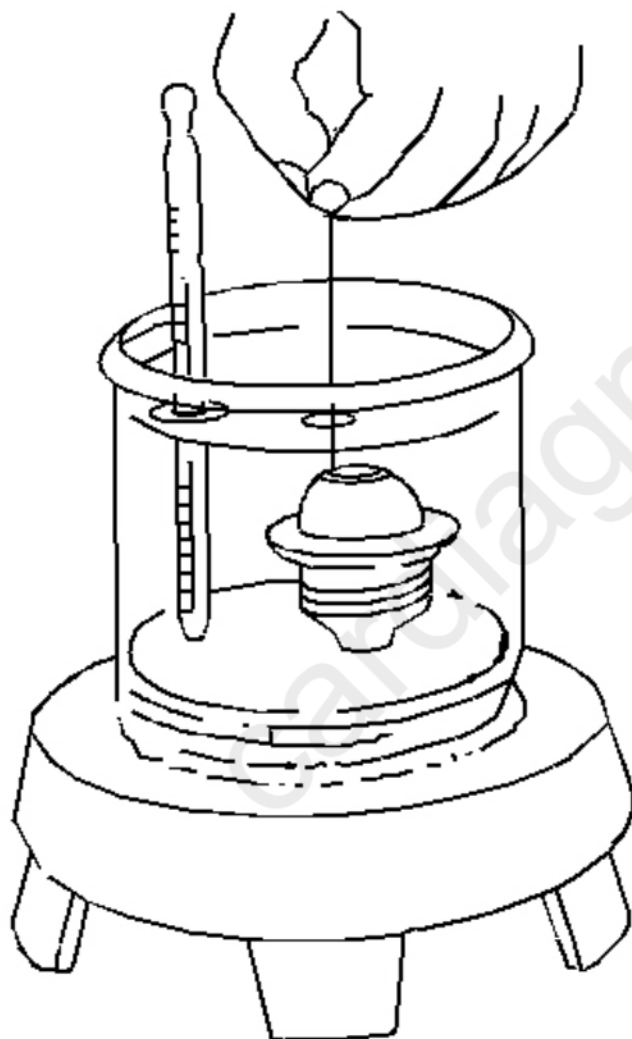


Fig. 4: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS CORP.

1. Completely submerge the thermostat in the glycol solution. The solution should be 11 °C (22 °F) above the temperature indicated on the thermostat valve.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should open.

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

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

PRESSURE CAP TESTING

Special Tools

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

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

Pressure Cap Testing

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

1. Remove the pressure cap.
2. Wash the pressure cap sealing surface with water.

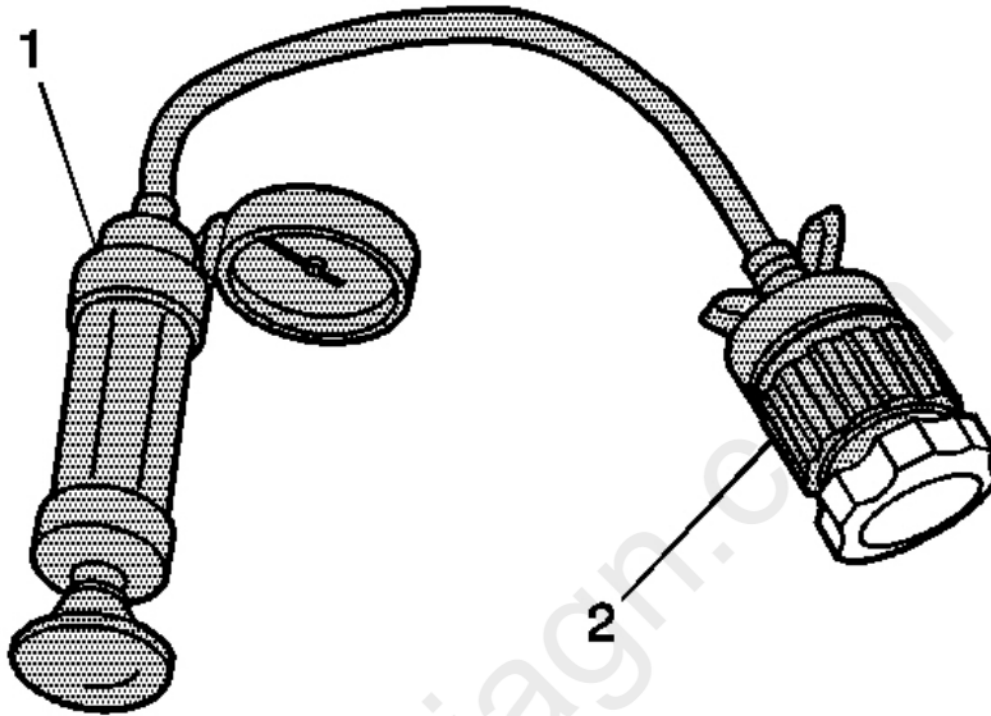


Fig. 5: Identifying Pressure Cap Testing Tool J 42401
Courtesy of GENERAL MOTORS CORP.

3. Use the **GE-24460-01: Cooling System Pressure Tester** (1) with **GE-42401-A: Radiator Cap/Surge Tank Test Adapter Kit** (2) in order to test the pressure cap.
4. Test the pressure cap for the following conditions:
 - Pressure release when the **GE-24460-01: Cooling System Pressure Tester** exceeds the pressure rating of the pressure cap.
 - Maintain the rated pressure for at least 10 seconds.

Note the rate of pressure loss.
5. Replace the pressure cap under the following conditions:
 - The pressure cap does not release pressure which exceeds the rated pressure of the cap.
 - The pressure cap does not hold the rated pressure.

SPECIAL TOOLS

- **GE-24460-01: Cooling System Pressure Tester**

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

- **GE-42401-A:** Radiator Cap/Surge Tank Test Adapter

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

COOLING SYSTEM LEAK TESTING

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

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

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

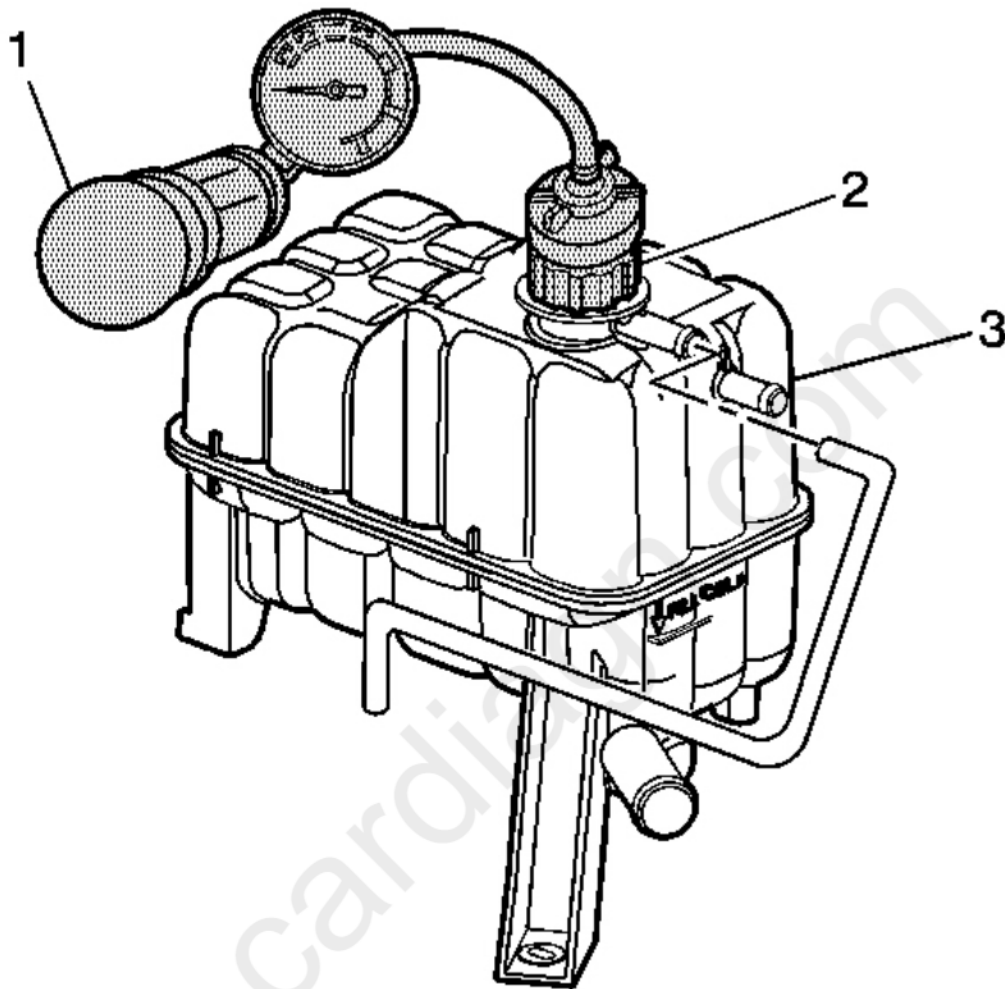


Fig. 6: Applying Pressure To Cooling System using J 42401
 Courtesy of GENERAL MOTORS CORP.

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

Do not exceed the pressure cap rating.

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

Observe the gauge for any pressure loss.

6. Repair any leaks as required.

RE AIR INSTRUCTIONS

COOLING SYSTEM DRAINING AND FILLING (STATIC FILL LF1)

Special Tools

GE-26568: Coolant and Battery Fluid Tester

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

Draining Procedure

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

1. Remove the coolant pressure cap from the radiator surge tank.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the radiator air lower deflector. Refer to **Radiator Air Lower Deflector Replacement**
4. Place a drain pan under the drain cock.

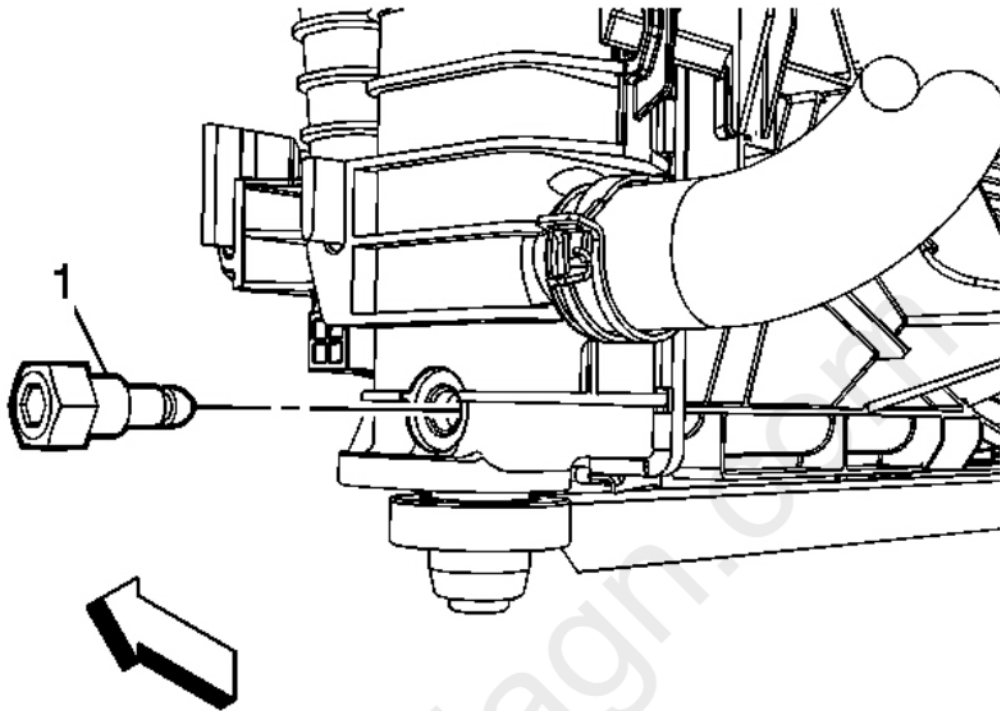


Fig. 7: Identifying Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

5. Loosen the radiator drain cock (1).
6. Drain the cooling system.
7. Lower the vehicle.
8. Inspect the coolant.
9. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.
 - Discolored-Follow the flush procedure. Refer to **Flushing**.

Filling Procedure

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

1. Raise and support the vehicle.

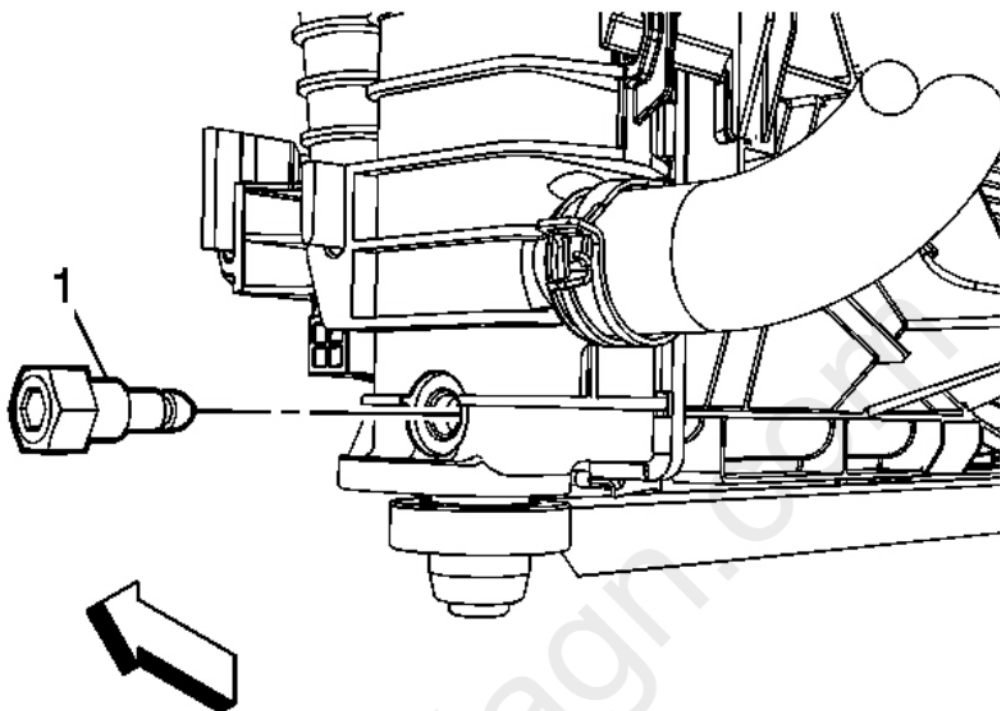


Fig. 8: Identifying Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Tighten the radiator drain cock (1) to 2 N.m (18 lb in).
3. Install the radiator air lower deflector. Refer to Radiator Air Lower Deflector Replacement
4. Lower the vehicle.

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

5. Slowly fill the radiator with a 50/50 coolant mixture until the coolant level reaches the base of the radiator surge tank. Refer to Approximate Fluid Capacities .

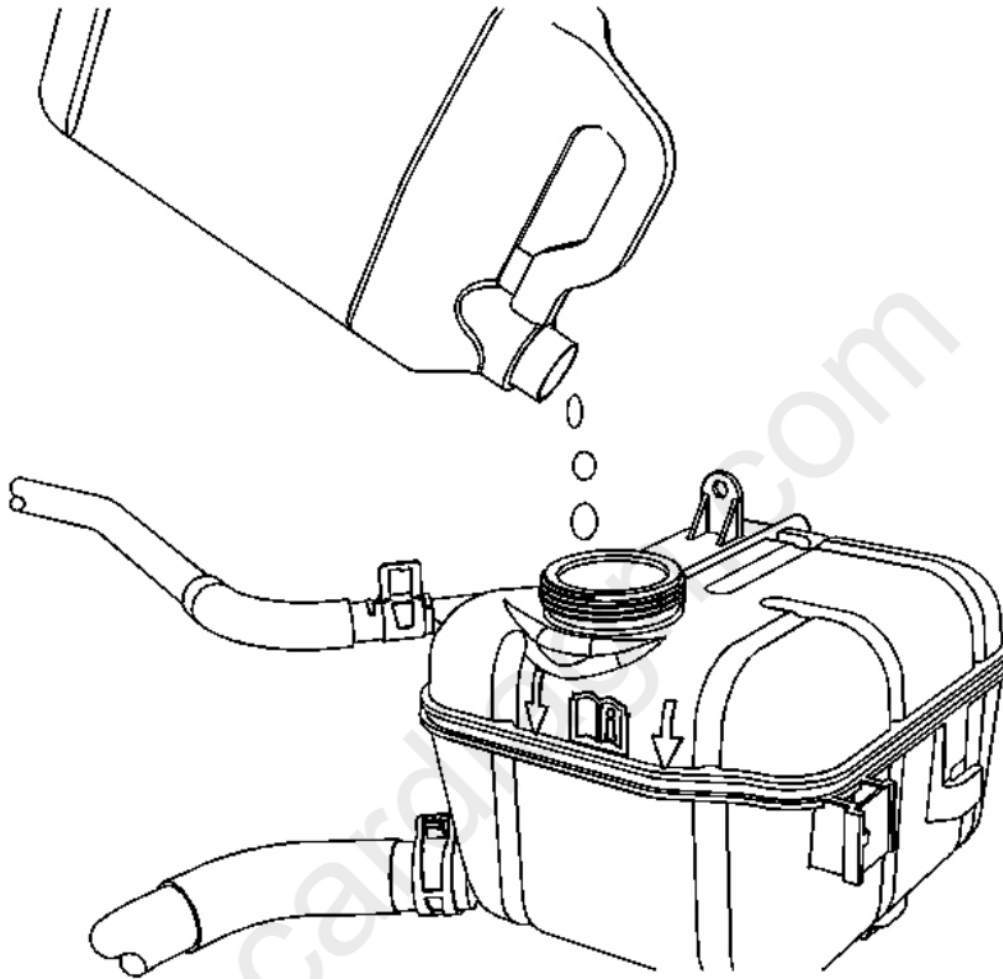


Fig. 9: View Of Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

6. Allow 30 seconds for the coolant level to stabilize and continue to fill the coolant filler neck until the level stabilizes for at least 2 minutes.
7. Start the engine and allow to the engine to idle in PARK or NEUTRAL with the parking brake engaged.
8. Slowly fill the coolant mixture until the level stabilizes at the base of the radiator surge tank.
9. Install the coolant pressure cap.
10. Raise the engine RPM to 2500 RPM for 30-40 seconds.
11. Shut the engine OFF.
12. Allow the engine to cool, remove coolant fill cap and repeat steps 4-10 until the coolant level has completely stabilized within the radiator surge tank.

13. Inspect the concentration of the engine coolant using the **GE-26568: Coolant and Battery Fluid Tester**.
14. Inspect and if necessary, fill the coolant reservoir bottle as necessary.
15. Rinse away any excess coolant from the engine and the engine compartment.
16. Inspect the cooling system for leaks.
17. Top off the radiator surge tank if necessary.

COOLING SYSTEM DRAINING AND FILLING - VAC-N-FILL (GE 47716)

Special Tools

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

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

Draining Procedure

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

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

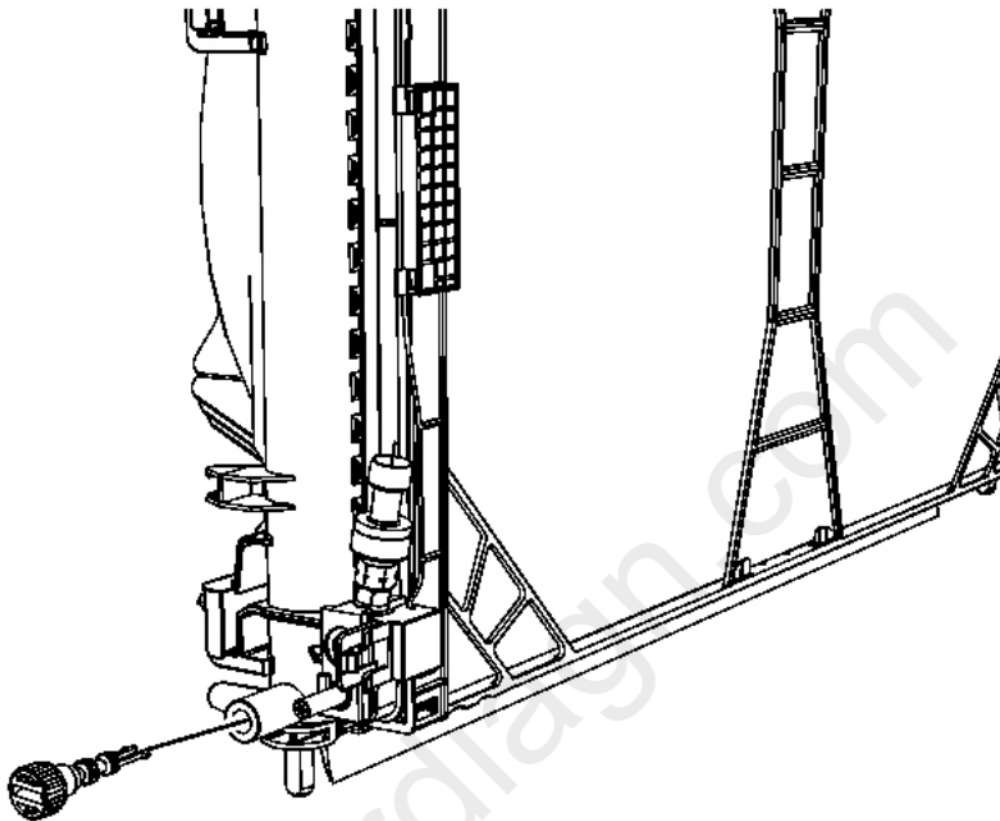


Fig. 10: View Of Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

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

Vac-N-Fill Procedure

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

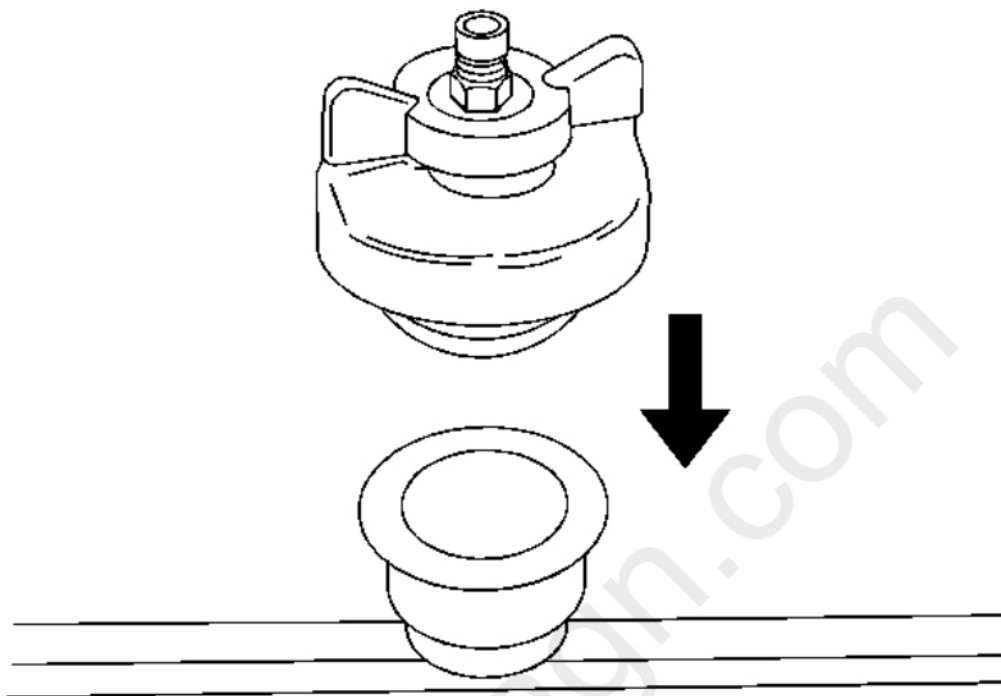


Fig. 11: Identifying Vac-N-Fill Cap
Courtesy of GENERAL MOTORS CORP.

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

2. Attach the Vac N Fill cap to the **GE-42401-A: Radiator Cap and Surge Tank Test Adapter**.

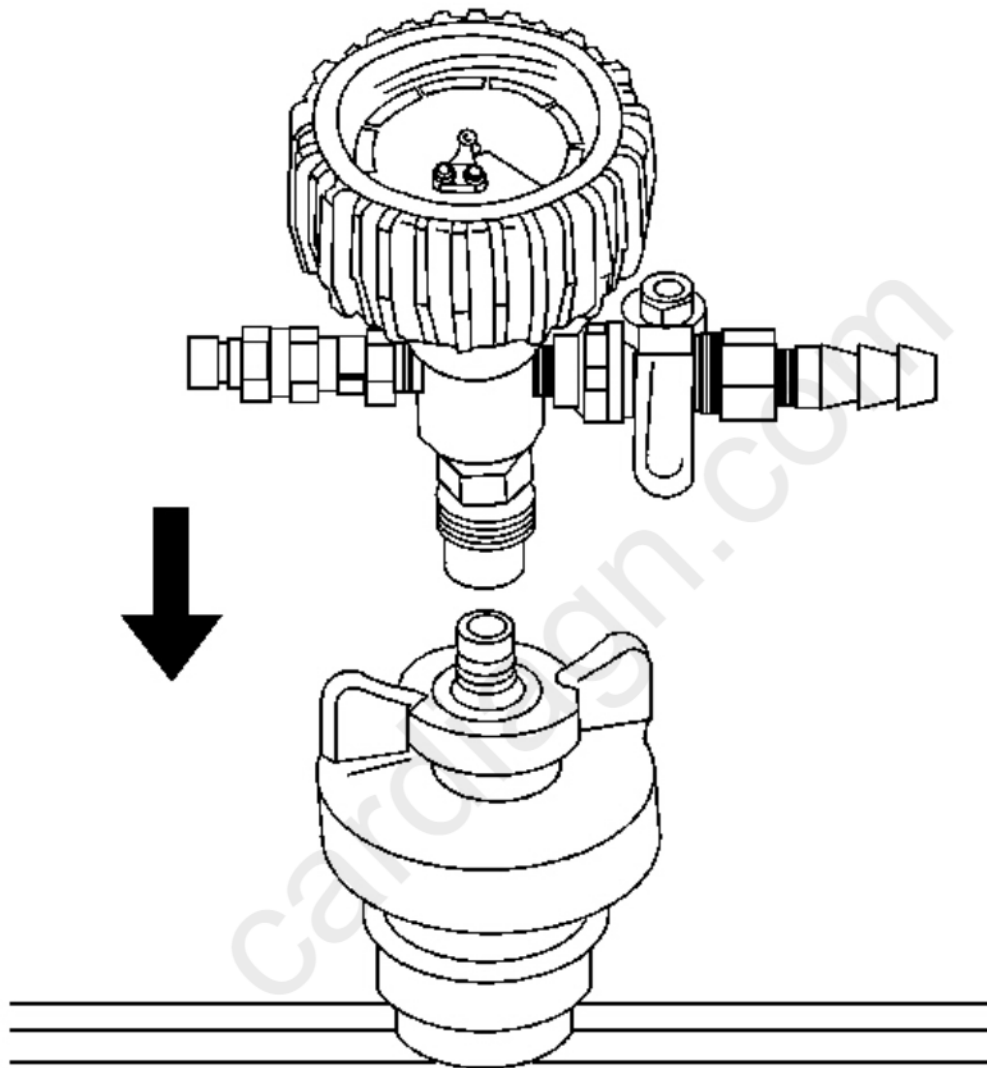


Fig. 12: Attaching The Vacuum Gage Assembly To The Vac-N-Fill Ca
Courtesy of GENERAL MOTORS CORP.

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

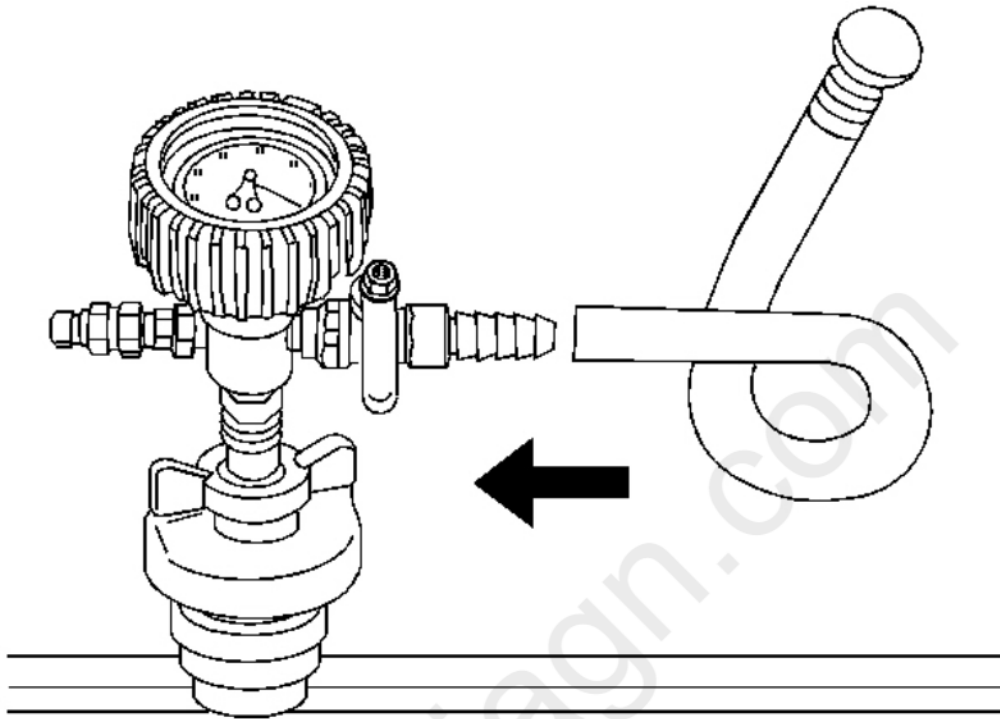


Fig. 1 : Attaching Fill Hose To Barb Fitting On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

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

Ensure that the valve is closed.

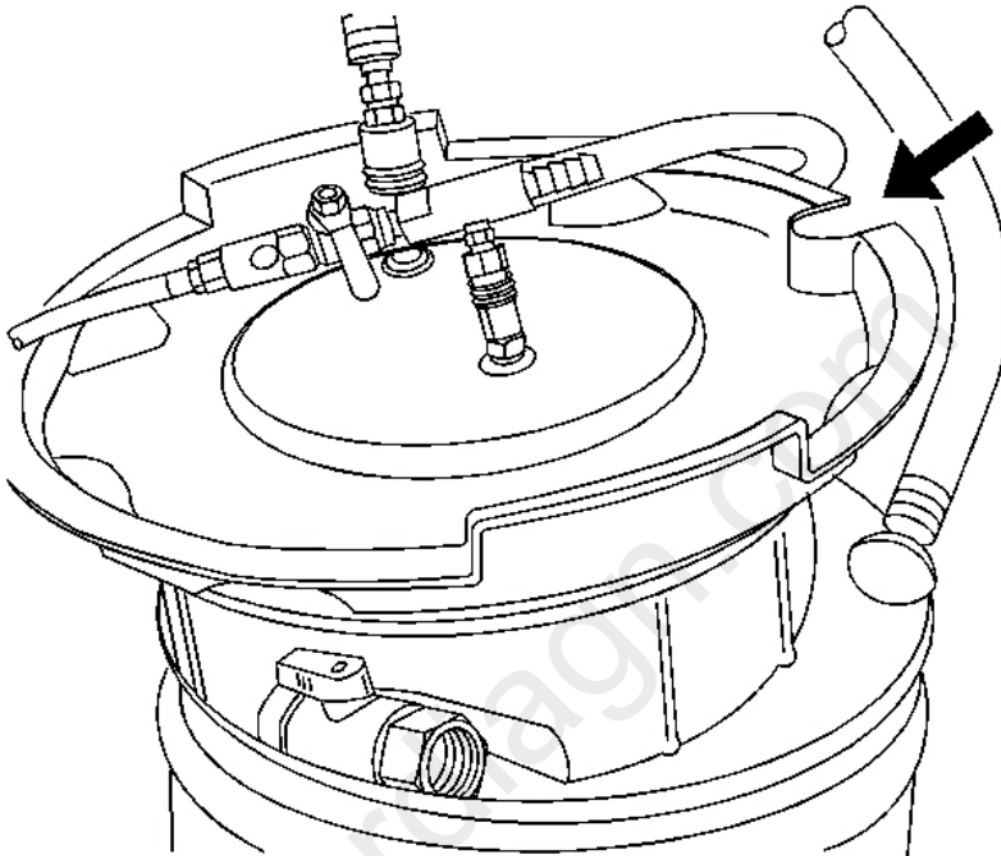


Fig. 14: View Of Graduated Reservoir & Hose
Courtesy of GENERAL MOTORS CORP.

NOTE: se a 0 0 mixture of DEX COO antifreeze and clean, drinkable water. Always use more coolant than necessary. This will eliminate air from being drawn into the cooling system.

5. Pour the coolant mixture into the graduated reservoir.
6. Place the fill hose in the graduated reservoir.

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

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

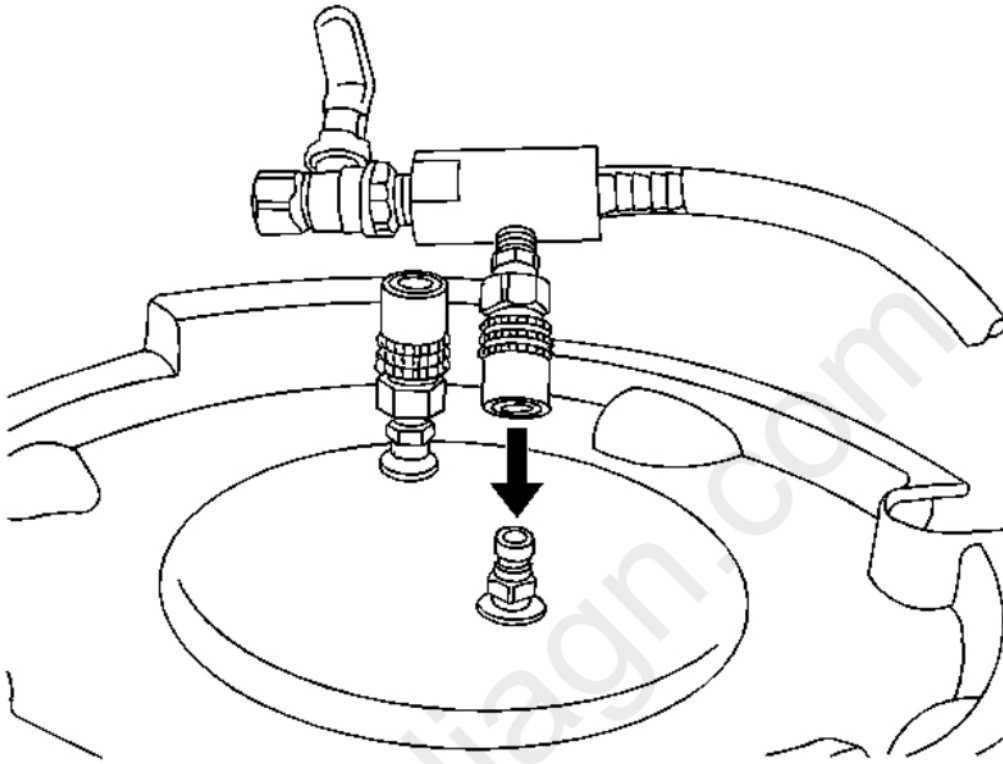


Fig. 15: Connecting Venturi Assembly To Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

8. Attach the venturi assembly to the vacuum tank.

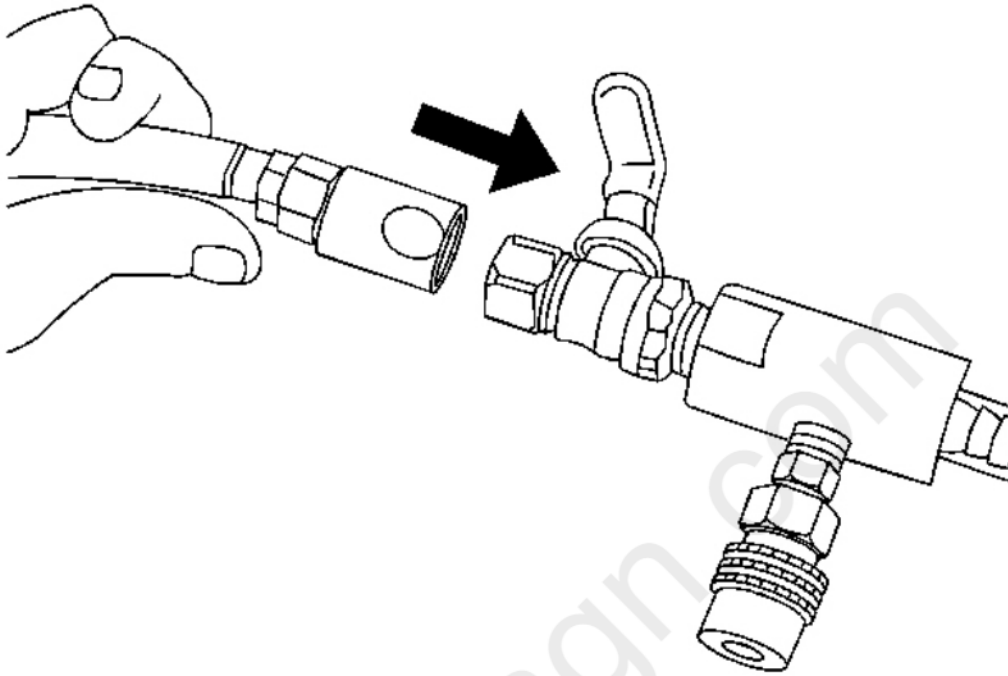


Fig. 16: Attaching Shop Air Hose To Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

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

Ensure the valve on the venturi assembly is closed.

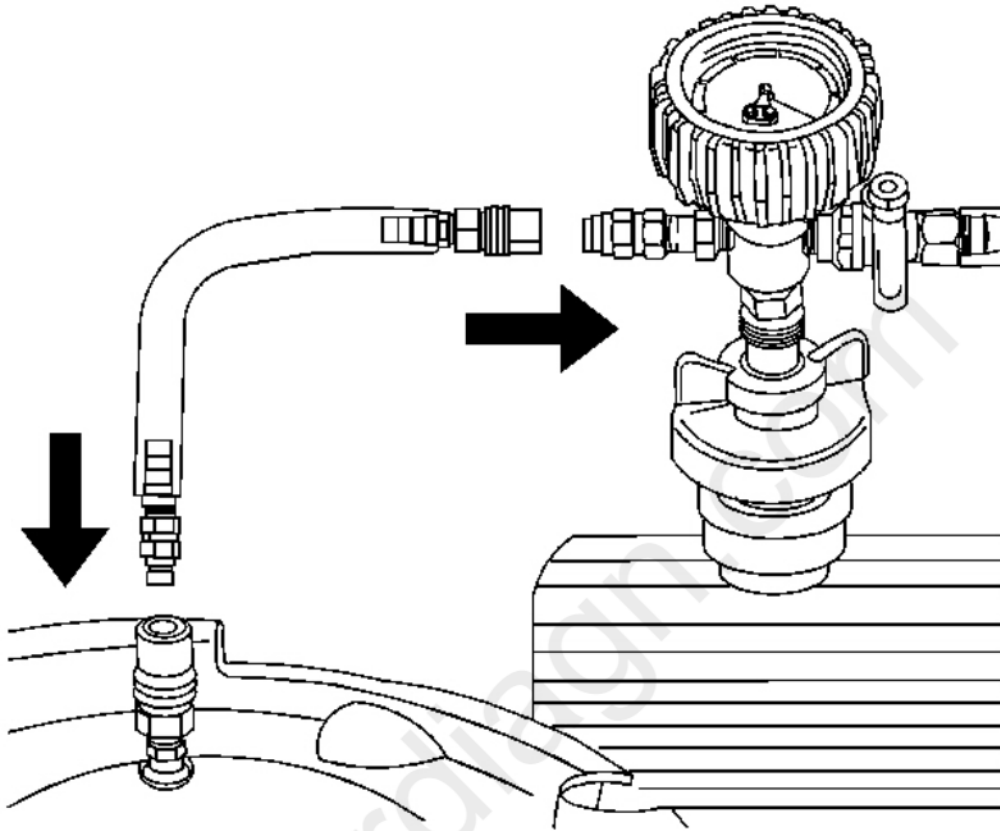


Fig. 17: Attaching Vacuum Hose To Vacuum Gauge Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

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

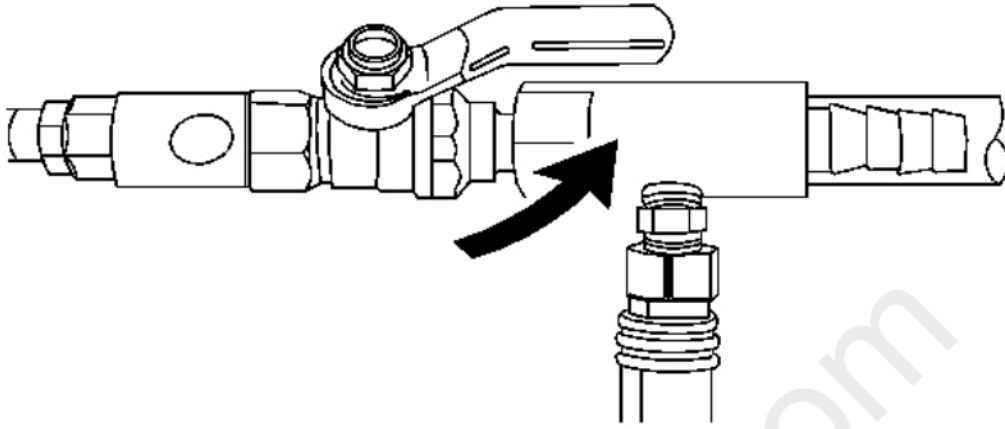


Fig. 18: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

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

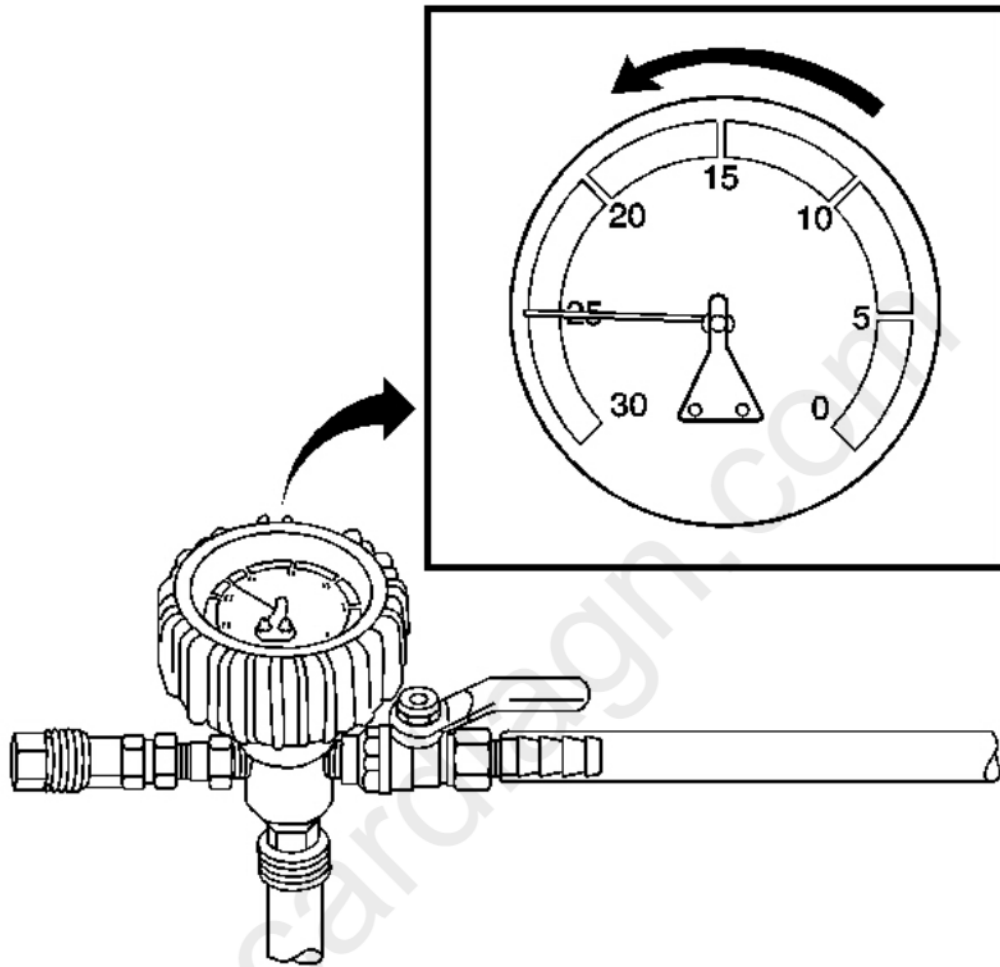


Fig. 19: View Of Vacuum Gauge
Courtesy of GENERAL MOTORS CORP.

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

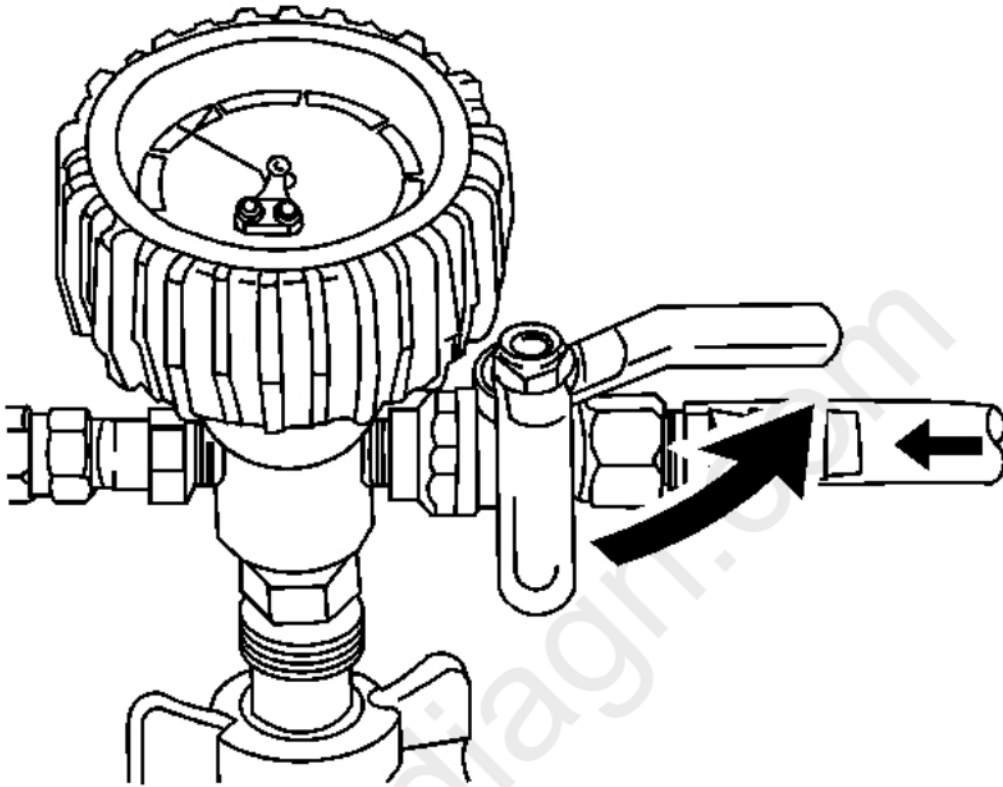


Fig. 20: Identifying Valve On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

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

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

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

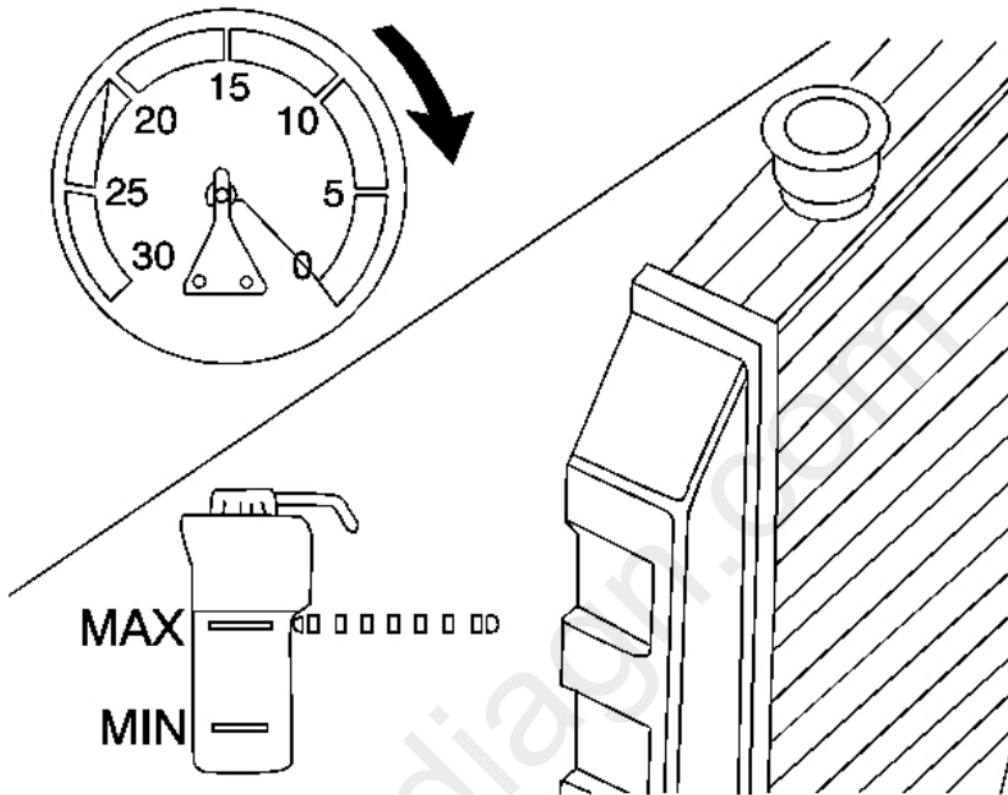


Fig. 21: View Of Vacuum Gauge & Radiator
Courtesy of GENERAL MOTORS CORP.

18. Once the vacuum gauge reaches zero, close the valve on the vacuum gauge assembly and repeat steps 11-17.
19. Detach the Vac N Fill cap from the **GE-42401-A: Radiator Cap and Surge Tank Test Adapter**.
20. Remove the **GE-42401-A: 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 **GE-26568: Coolant and Battery Fluid Tester**.

NOTE: After filling the cooling system the e traction hose can be used to remove e cess coolant to achieve the proper coolant level.

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

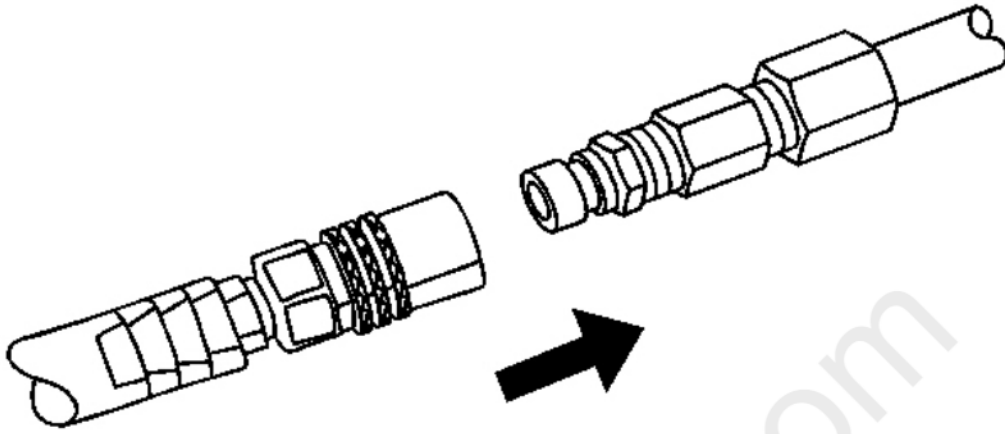


Fig. 22: Attaching Extraction Hose To Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

24. Attach the extraction hose to the vacuum hose.

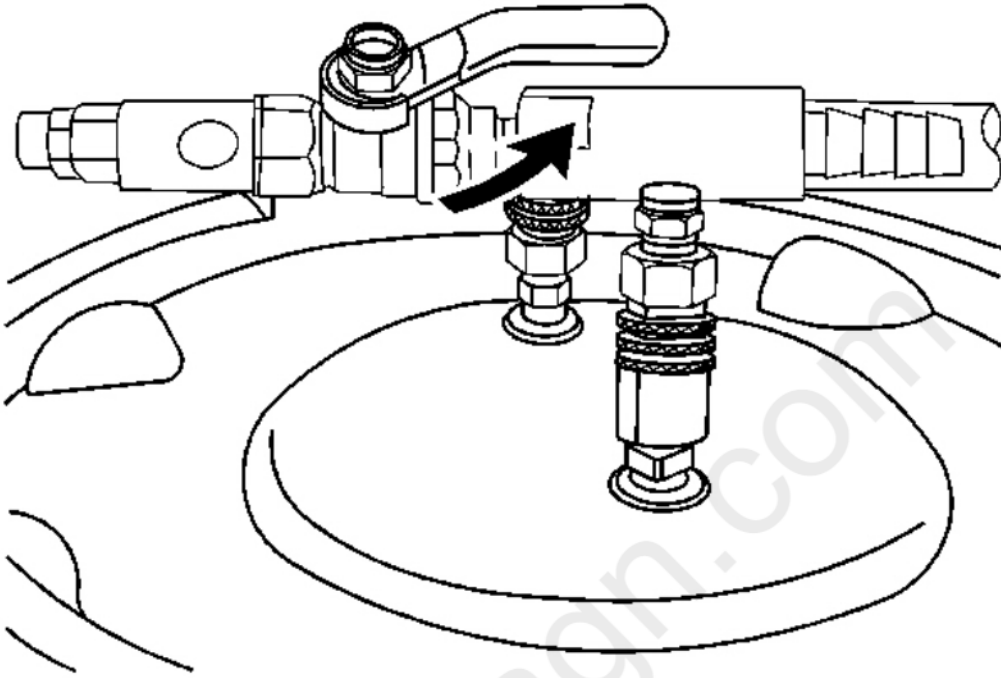


Fig. 23: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

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

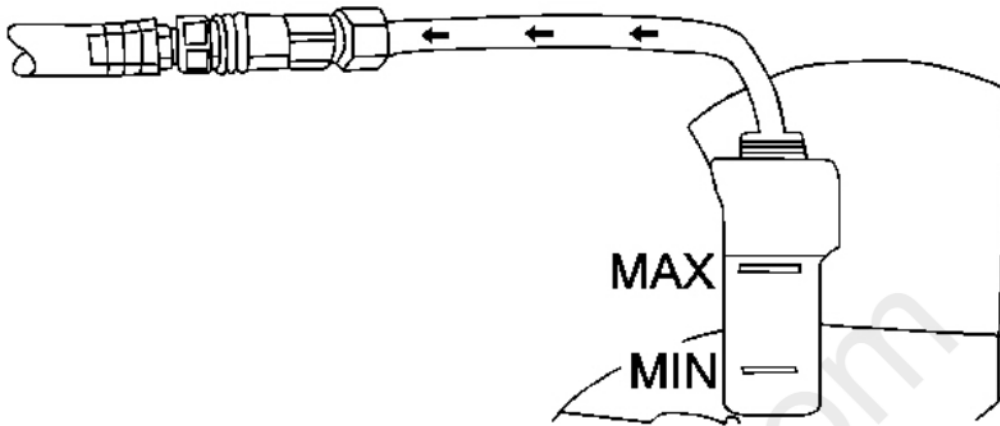


Fig. 24: Using Extraction Hose To Draw Out Coolant
Courtesy of GENERAL MOTORS CORP.

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

COOLING SYSTEM DRAINING AND FILLING (STATIC FILL METHOD)

Special Tools

GE-26568: Coolant and Battery Fluid Tester

For equivalent regional tools, Refer to Special Tools

Draining Procedure

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

1. Remove the coolant pressure cap from the radiator surge tank.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the radiator air lower deflector. Refer to Radiator Air Lower Deflector Replacement
4. Place a drain pan under the drain cock.

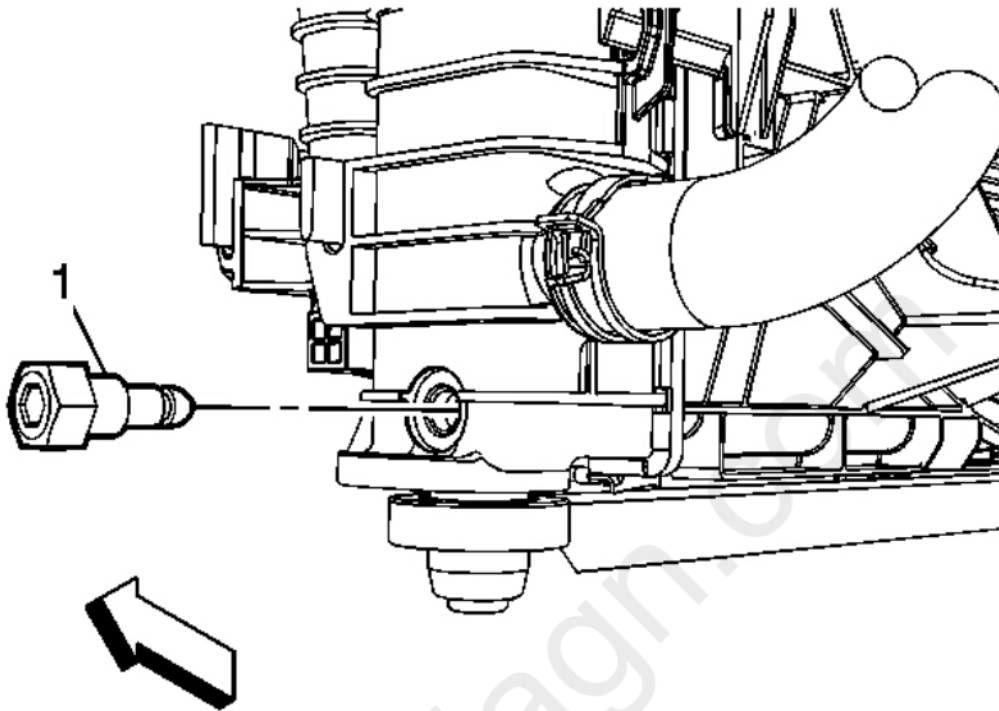


Fig. 25: Identifying Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

5. Loosen the radiator drain cock (1).
6. Drain the cooling system.
7. Lower the vehicle.
8. Inspect the coolant.
9. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.
 - Discolored-Follow the flush procedure. Refer to **Flus ing**.

Filling Procedure

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

1. Raise and support the vehicle.

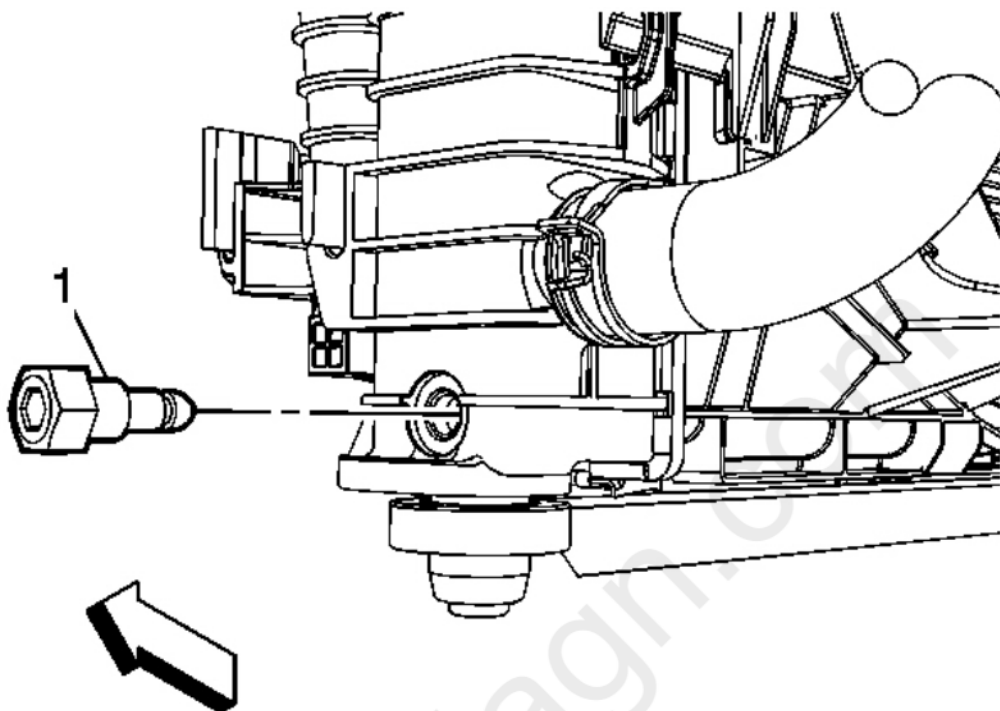


Fig. 26: Identifying Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Tighten the radiator drain cock (1) to 2 N.m (18 lb in).
3. Install the radiator air lower deflector. Refer to Radiator Air Lower Deflector Replacement
4. Lower the vehicle.

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

5. Slowly fill the radiator with a 50/50 coolant mixture until the coolant level reaches the base of the radiator surge tank. Refer to Appropriate Fluid Capacities .

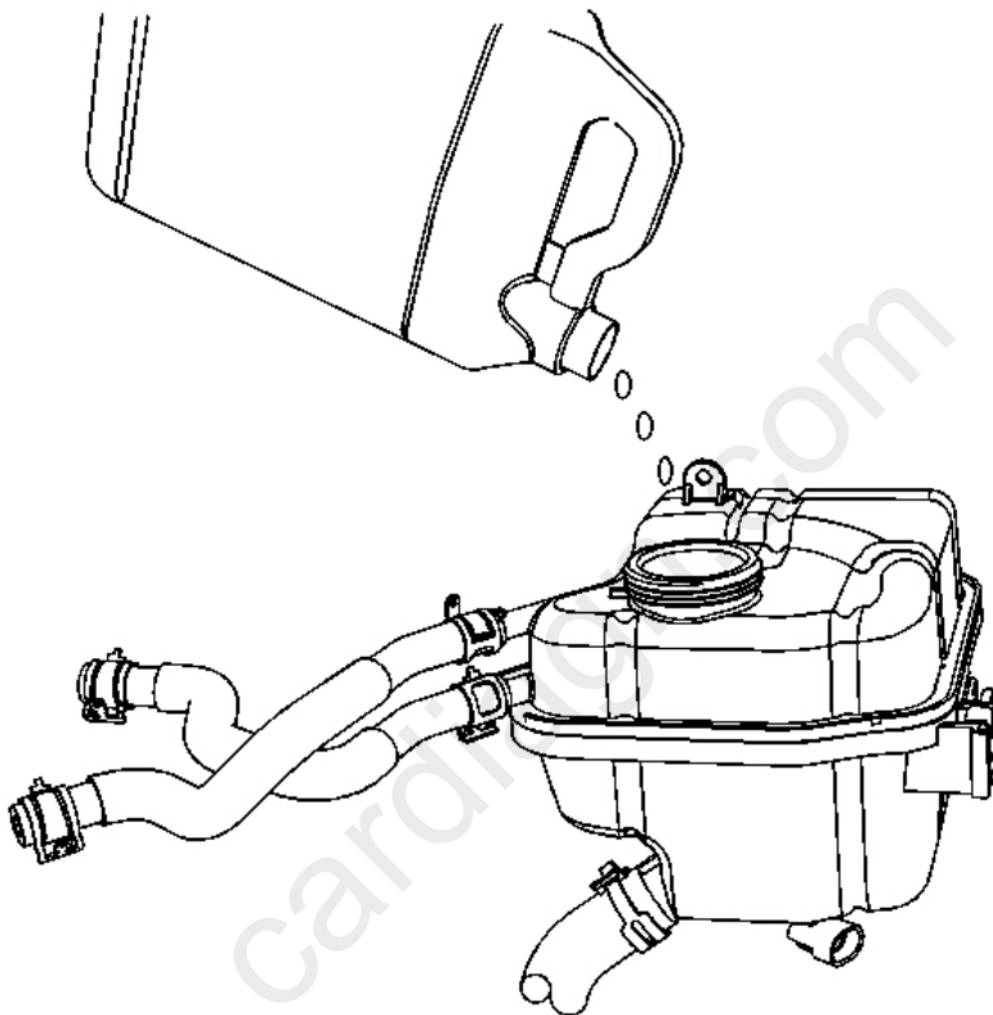


Fig. 27: Filling Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

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

FLUSHING

NOTE: Do not use a chemical flush.
Store used coolant in the proper manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.
Various methods and equipment can be used to flush the cooling system. If special equipment is used, such as a back flusher, follow the manufacturer's instruction. However, always remove the thermostat before back flushing the system.

1. Block the drive wheels.
2. Place the transmission in PARK (P).
3. Engage the park brake.
4. Run the engine until the thermostat opens.
5. Stop the engine.

WARNING: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

6. Follow the drain and fill procedure using only clean drinkable water. Repeat the procedure if necessary, until the fluid is nearly colorless. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.
7. Fill the cooling system when flushing is complete. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.

RADIATOR SURGE TANK REPLACEMENT (LF1)

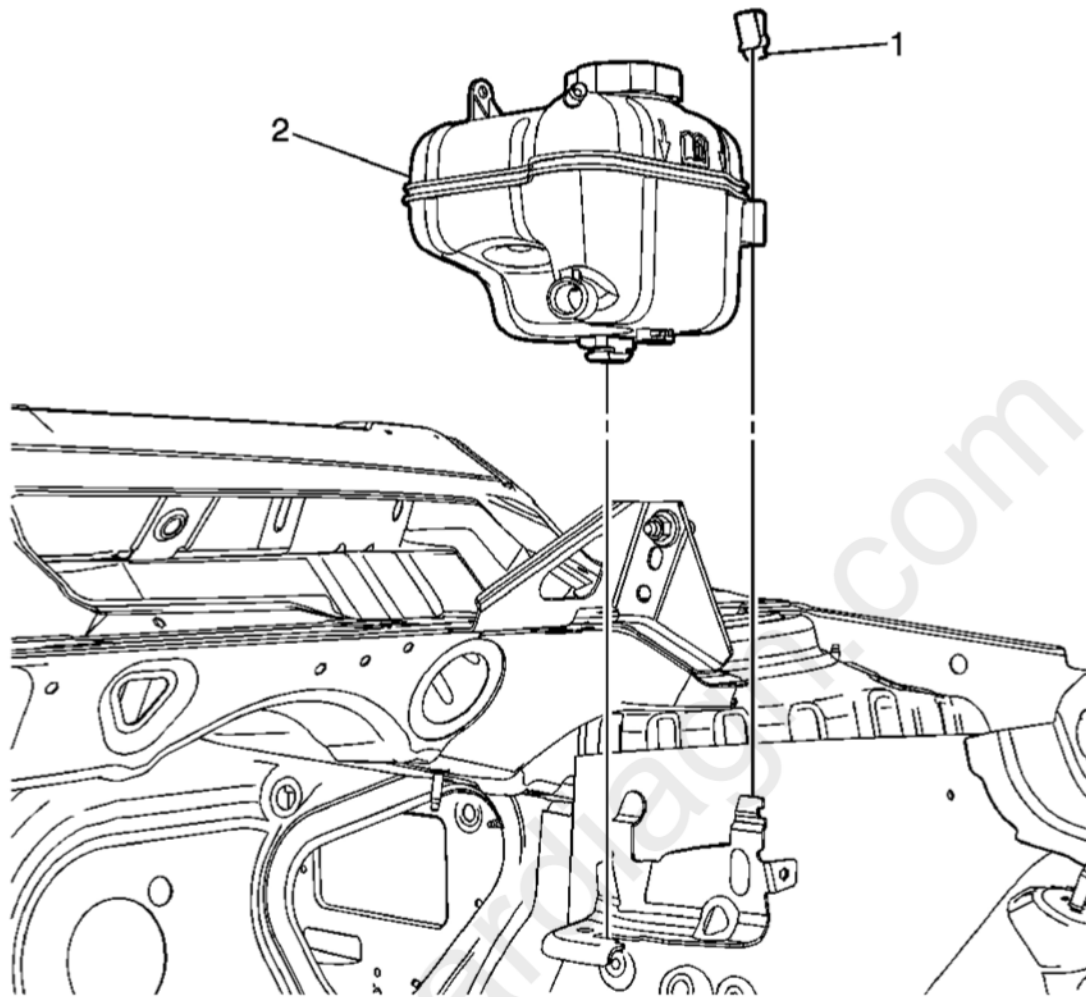
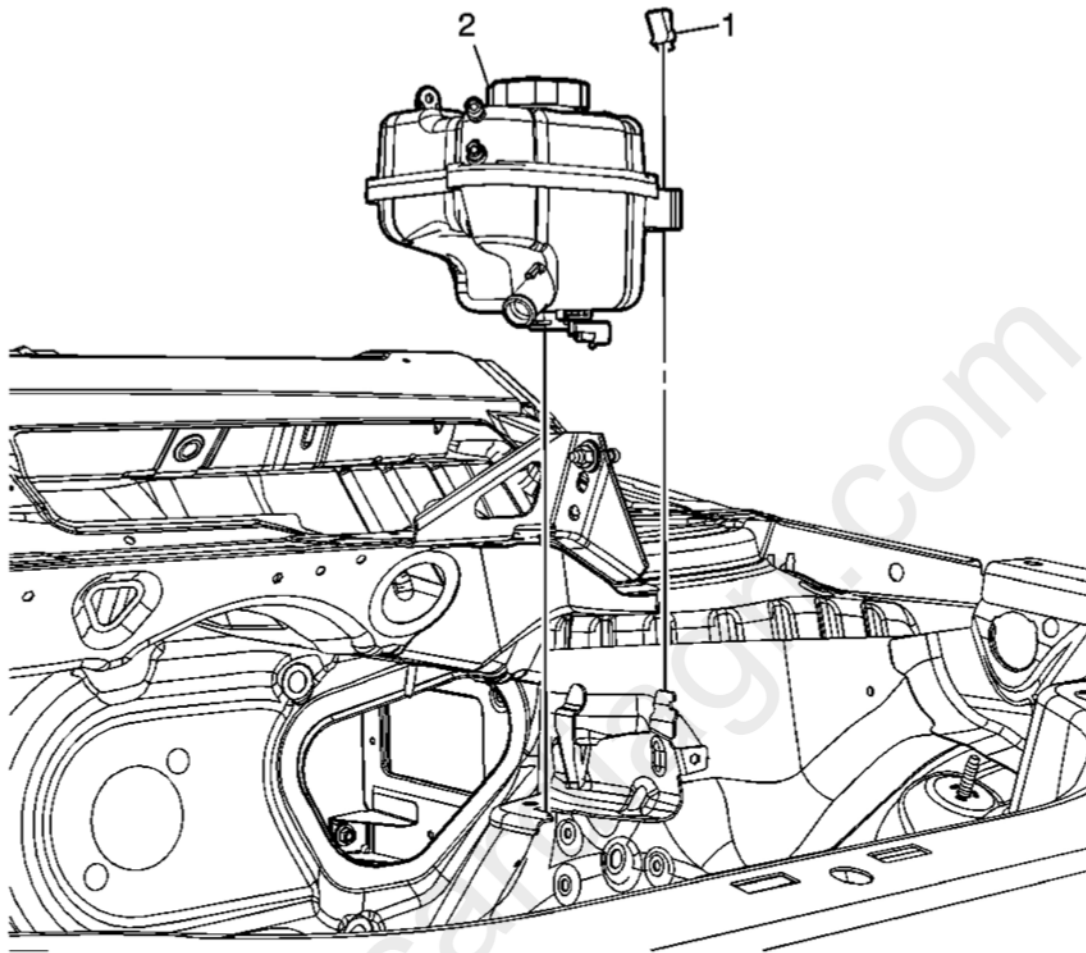


Fig. 28: Identifying Radiator Surge Tank (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Drain the coolant from the surge tank only. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU) .
2.	Remove battery tray. Refer to Battery Tray Replacement .
3.	Remove the surge tank inlet hose. Refer to Radiator Surge Tank Inlet Hose Replacement (LF1) or Radiator Surge Tank Inlet Hose Replacement (LAU) .
4.	Remove the surge tank outlet hose. Refer to Radiator Surge Tank Outlet Hose Replacement (LF1) or Radiator Surge Tank Outlet Hose Replacement (LAU) .
1	Radiator Surge Tank Clip
2	Radiator Surge Tank

RADIATOR SURGE TANK REPLACEMENT (LAU)**Fig. 29: Identifying Radiator Surge Tank (LAU)**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Drain the coolant from the surge tank only. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> .
2.	Remove battery tray. Refer to <u>Battery Tray Replacement</u> .
3.	Remove the surge tank inlet hose. Refer to <u>Radiator Surge Tank Inlet Hose Replacement (LF1)</u> or <u>Radiator Surge Tank Inlet Hose Replacement (LAU)</u> .
4.	Remove the surge tank engine hose. Refer to <u>Radiator Surge Tank Engine Hose Replacement (LAU)</u> .
5.	Remove the surge tank outlet hose. Refer to <u>Radiator Surge Tank Outlet Hose Replacement</u>

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

(LF1) or Radiator Surge Tank Outlet Hose Replacement (LAU).

- | | |
|---|--------------------------|
| 1 | Radiator Surge Tank Clip |
| 2 | Radiator Surge Tank |

RADIATOR SURGE TANK ENGINE HOSE REPLACEMENT (LAU)

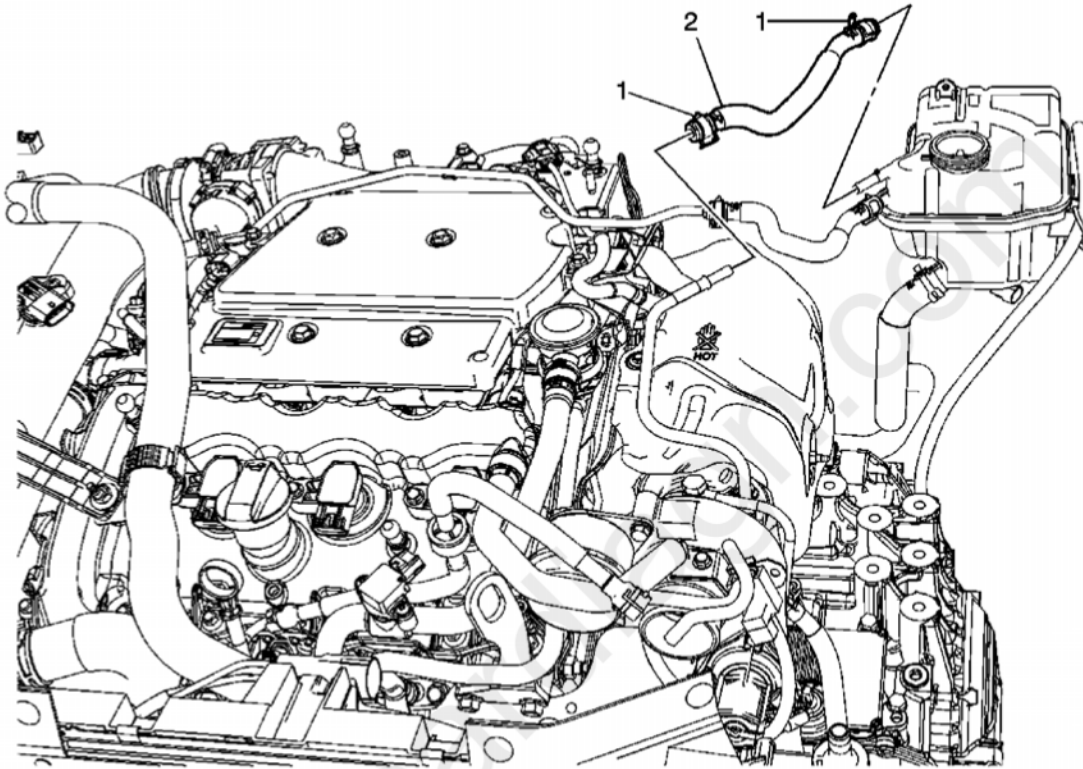


Fig. 30: Locating Radiator Surge Tank Engine Hose (LAU)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the coolant. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> .	
2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Radiator Surge Tank Engine Hose Clamp (Qty: 2) Procedure: Disengage tension on the radiator surge tank engine hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers

	or equivalent regional tools Refer to Special Tools
2	Radiator Surge Tank Inlet Hose

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LF1)

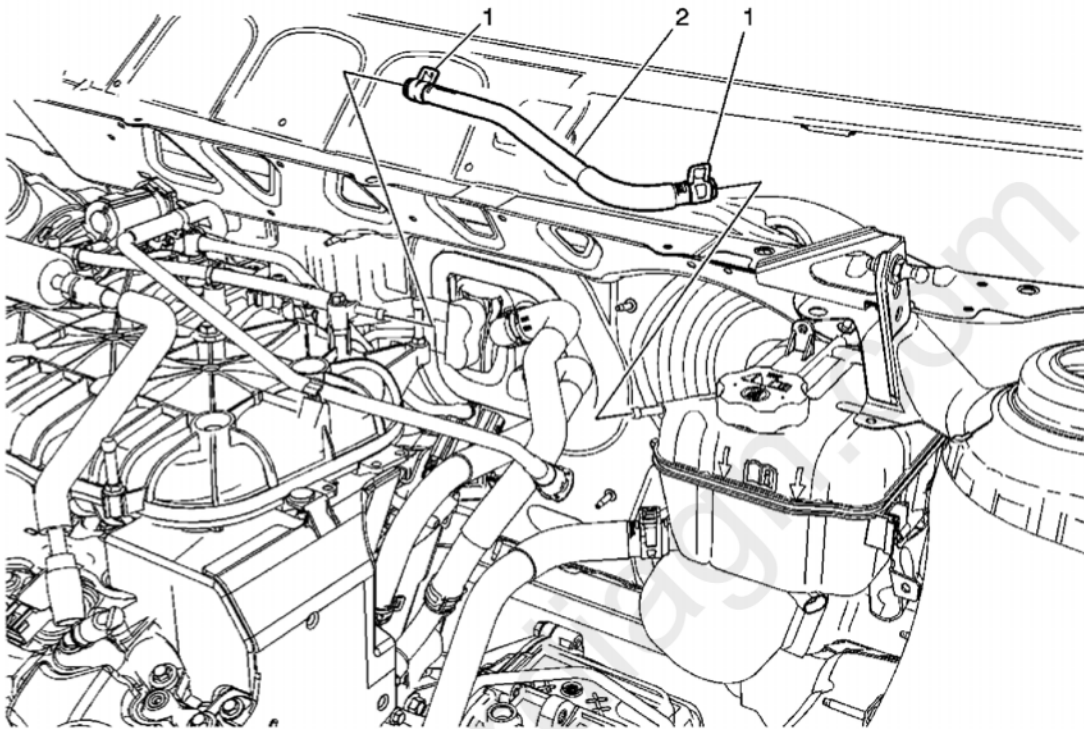


Fig. 31: Radiator Surge Tank Inlet Hose (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
- Partially drain the coolant. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU). - Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement.	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 2) Procedure: Disengage tension on the radiator surge tank inlet hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers or equivalent regional tools Refer to Special Tools
2	Radiator Surge Tank Inlet Hose

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LAU)

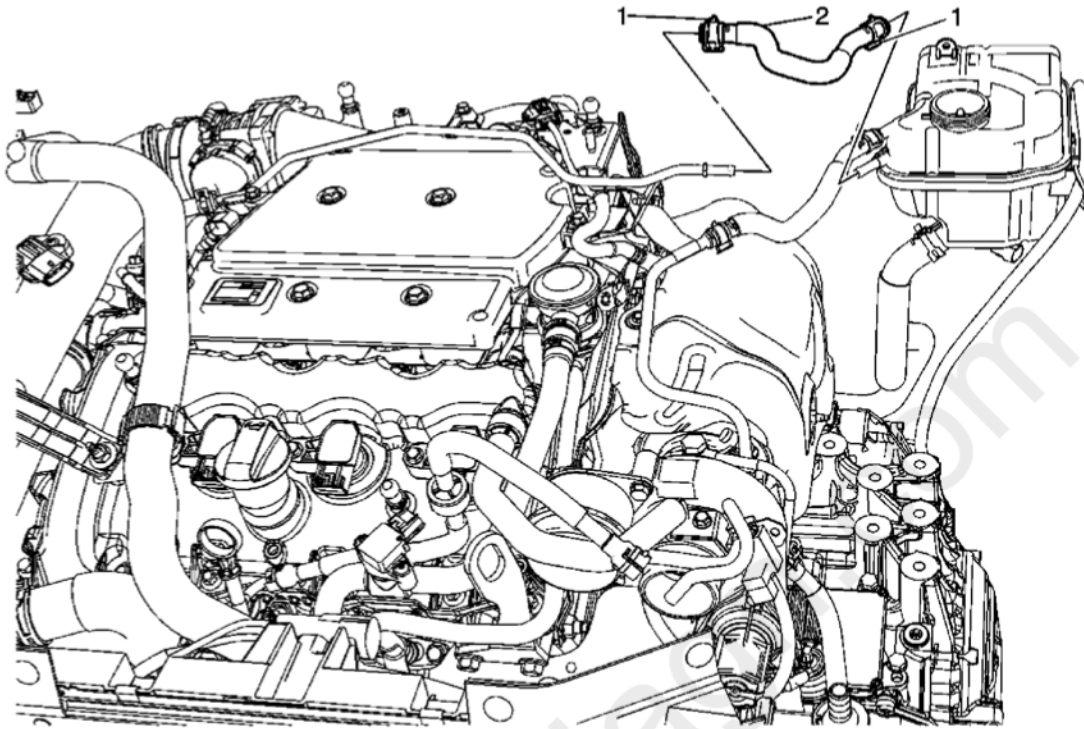


Fig. 3 : Identifying Radiator Surge Tank Inlet Hose (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Partially drain the coolant. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> .	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 2) Procedure: Disengage tension on the radiator surge tank inlet hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers or equivalent regional tools. Refer to <u>Special Tools</u>
2	Radiator Surge Tank Inlet Hose

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT (LF1)

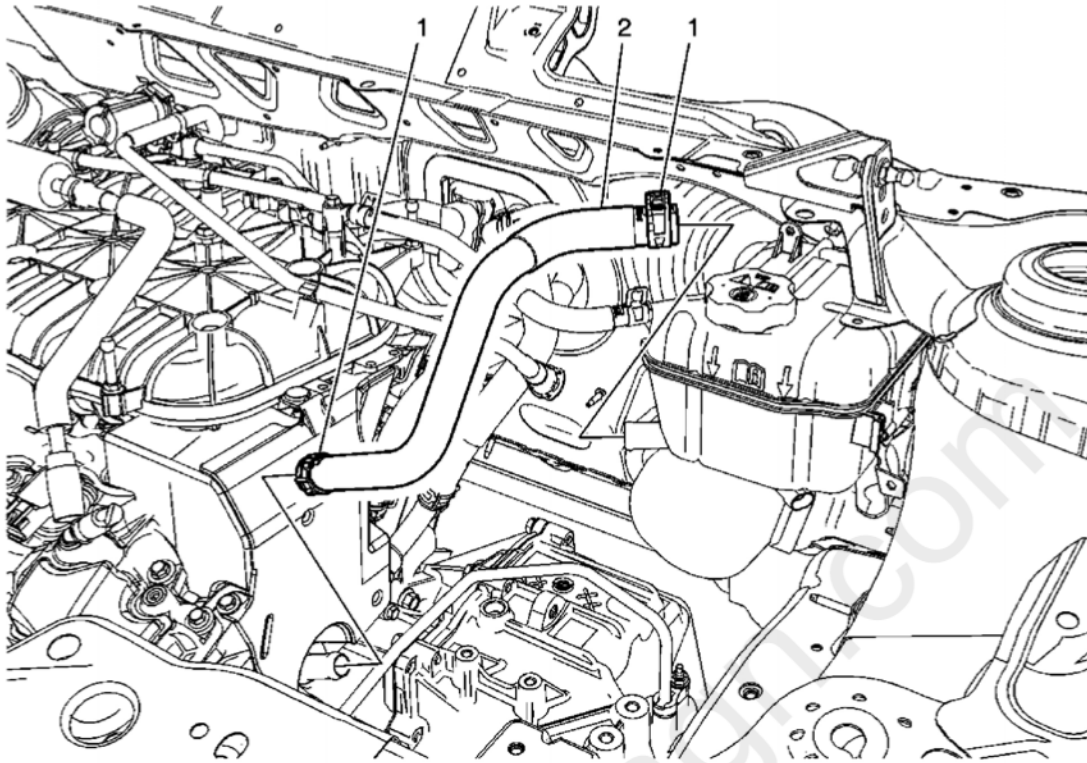


Fig. 33: Identifying Radiator Surge Tank Outlet Hose (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the coolant. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU). 2. Remove fuel pipe shield. Refer to Fuel Pipe Shield Replacement.	
1	Radiator Surge Tank Outlet Hose Clamp (Qty: 2) Procedure: Disengage tension on the radiator surge tank outlet hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers or equivalent regional tools. Refer to Special Tools
2	Radiator Surge Tank Outlet Hose

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT (LAU)

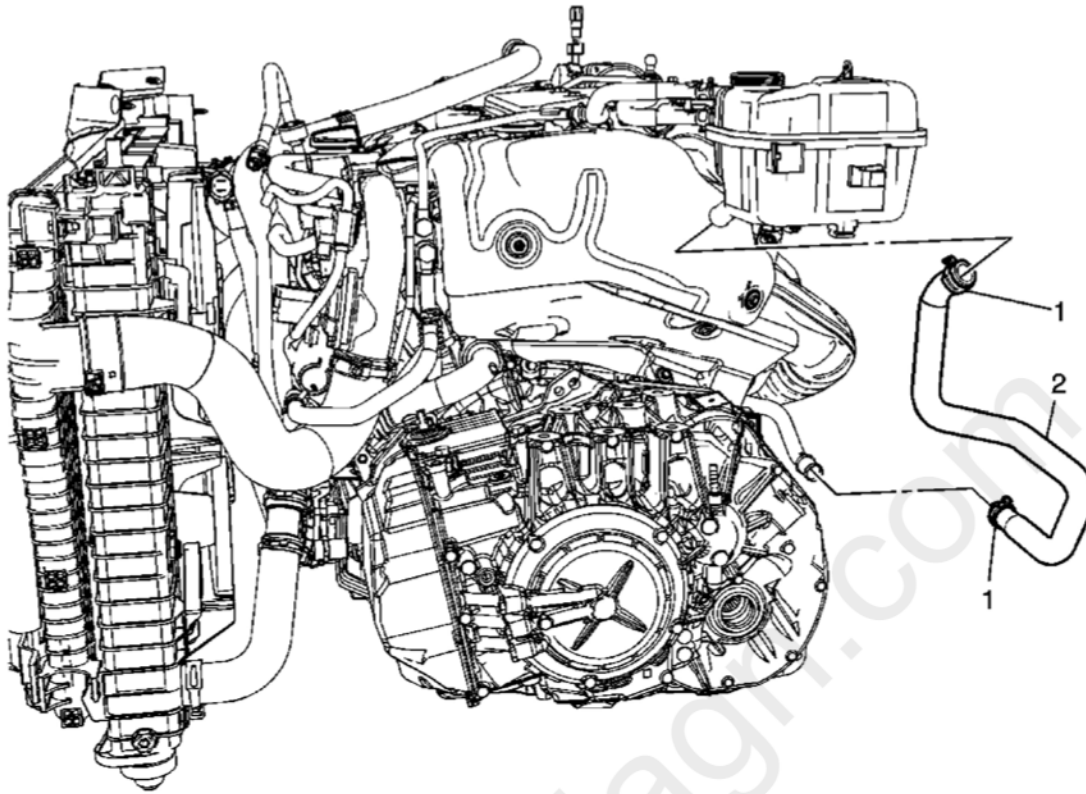


Fig. 34: View Of Radiator Surge Tank Outlet Hose (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the coolant. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU) . 2. Remove the battery tray. Refer to Battery Tray Replacement 3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .	
1	Radiator Surge Tank Outlet Hose Clamp (Qty: 2) Procedure: Disengage tension on the radiator surge tank outlet hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers or equivalent regional tools Refer to Special Tools
2	Radiator Surge Tank Outlet Hose

RADIATOR INLET HOSE REPLACEMENT (LF1)

Special Tools

BO-38185: ose Clamp Pliers

or e uivalent regional tools Refer to **Special Tools**

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

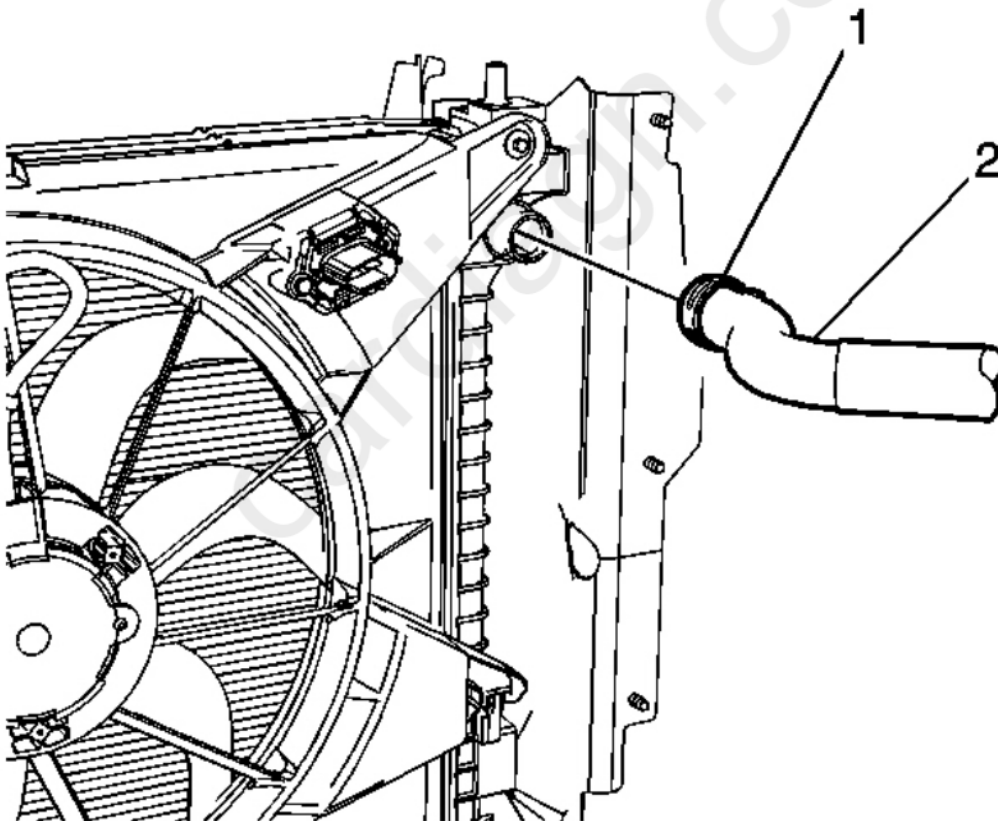


Fig. 35: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

3. Disengage tension on the radiator inlet hose clamp (1) at the radiator using **BO-38185:** ose Clamp Pliers.

4. Remove the radiator inlet hose (2) from the radiator.

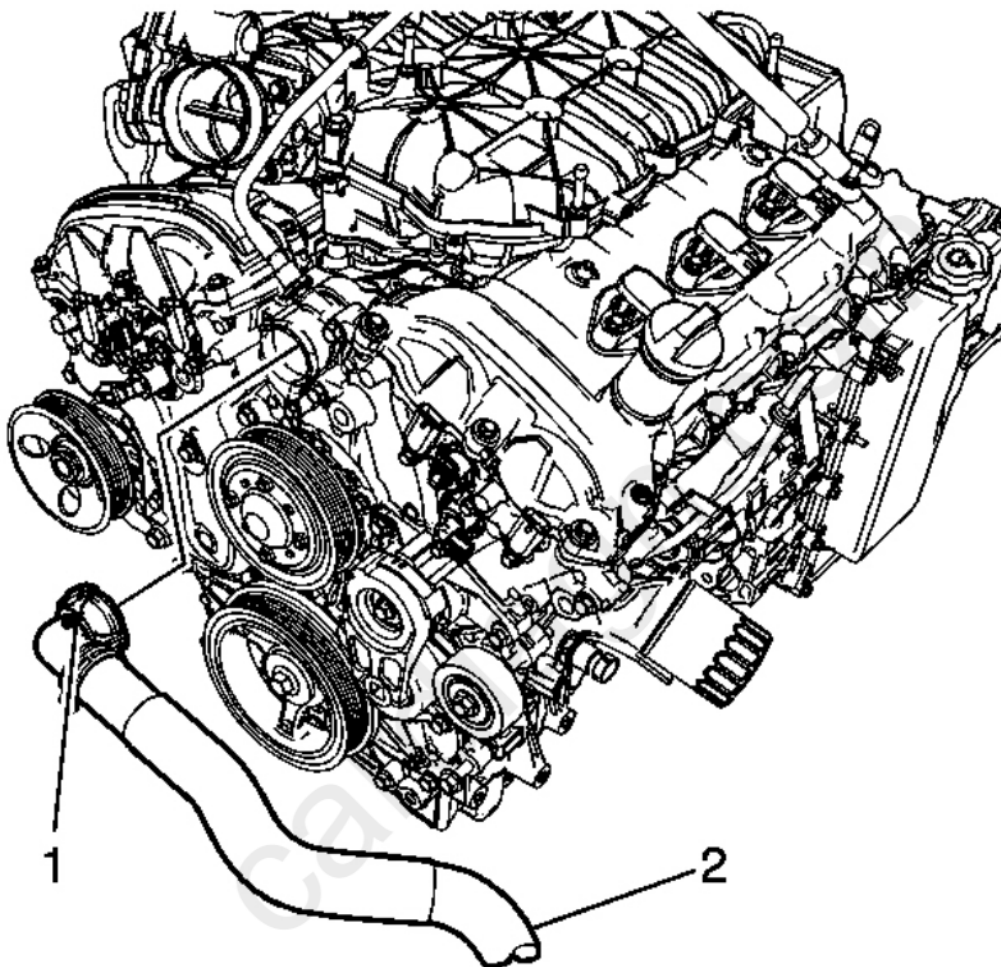


Fig. 36: Identifying Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

5. Unclip radiator inlet hose connector (1) and remove the radiator inlet hose (2) from the engine.
6. Remove the radiator inlet hose from the vehicle.

Installation Procedure

1. Install radiator inlet hose to the vehicle.

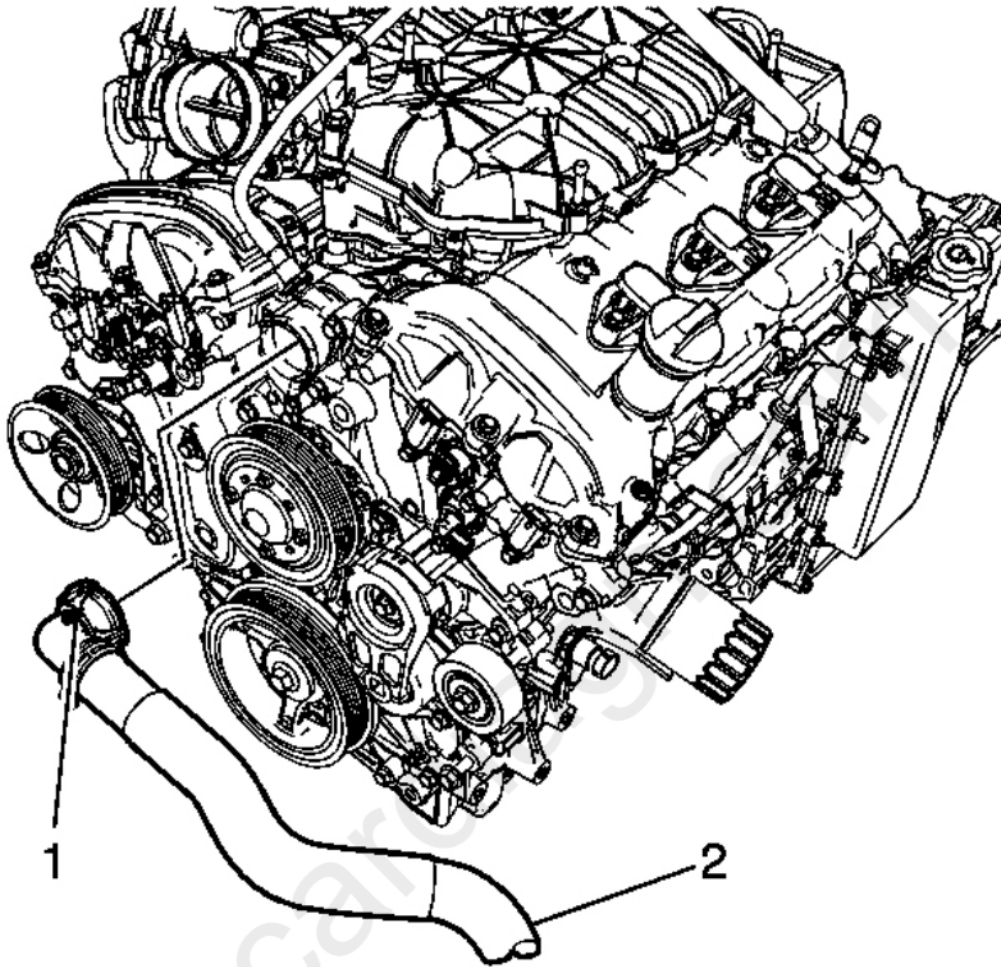


Fig. 37: Identifying Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

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

2. Clip the radiator inlet hose (2) to the engine.

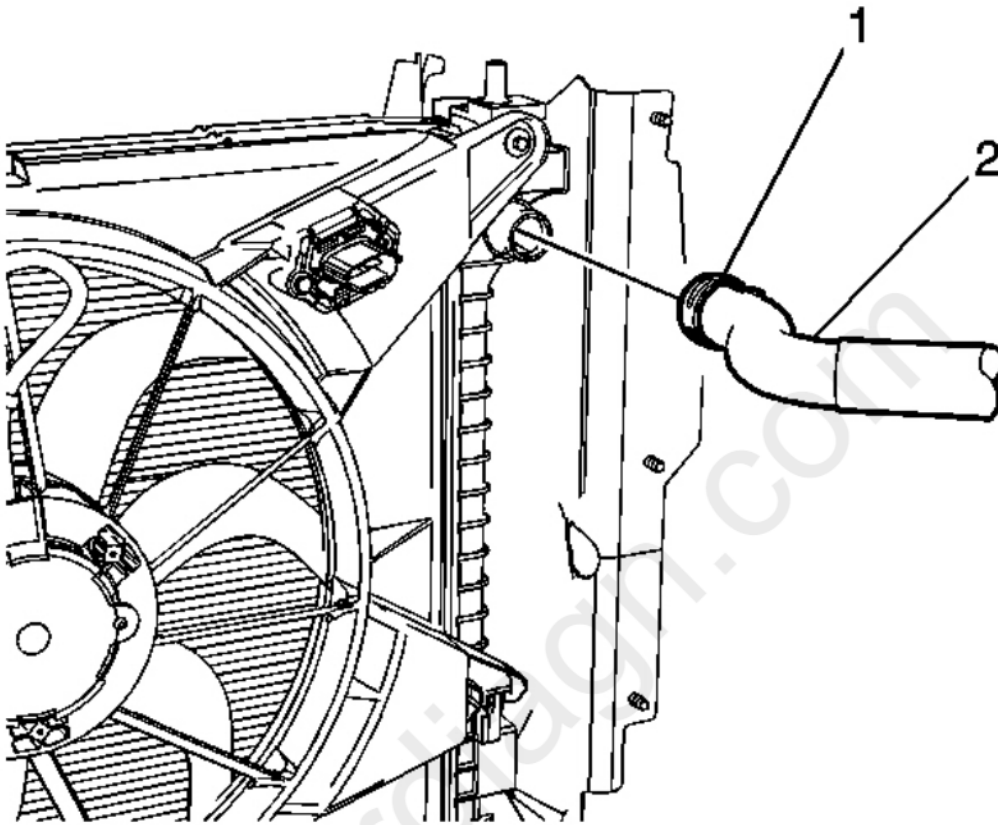


Fig. 38: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

3. Install the radiator inlet hose (2) to the radiator.
4. Engage tension on the radiator inlet hose clamp (1) at the radiator using **BO-38185: Hose Clamp Pliers**.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
6. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.

RADIATOR INLET HOSE REPLACEMENT (LAU)

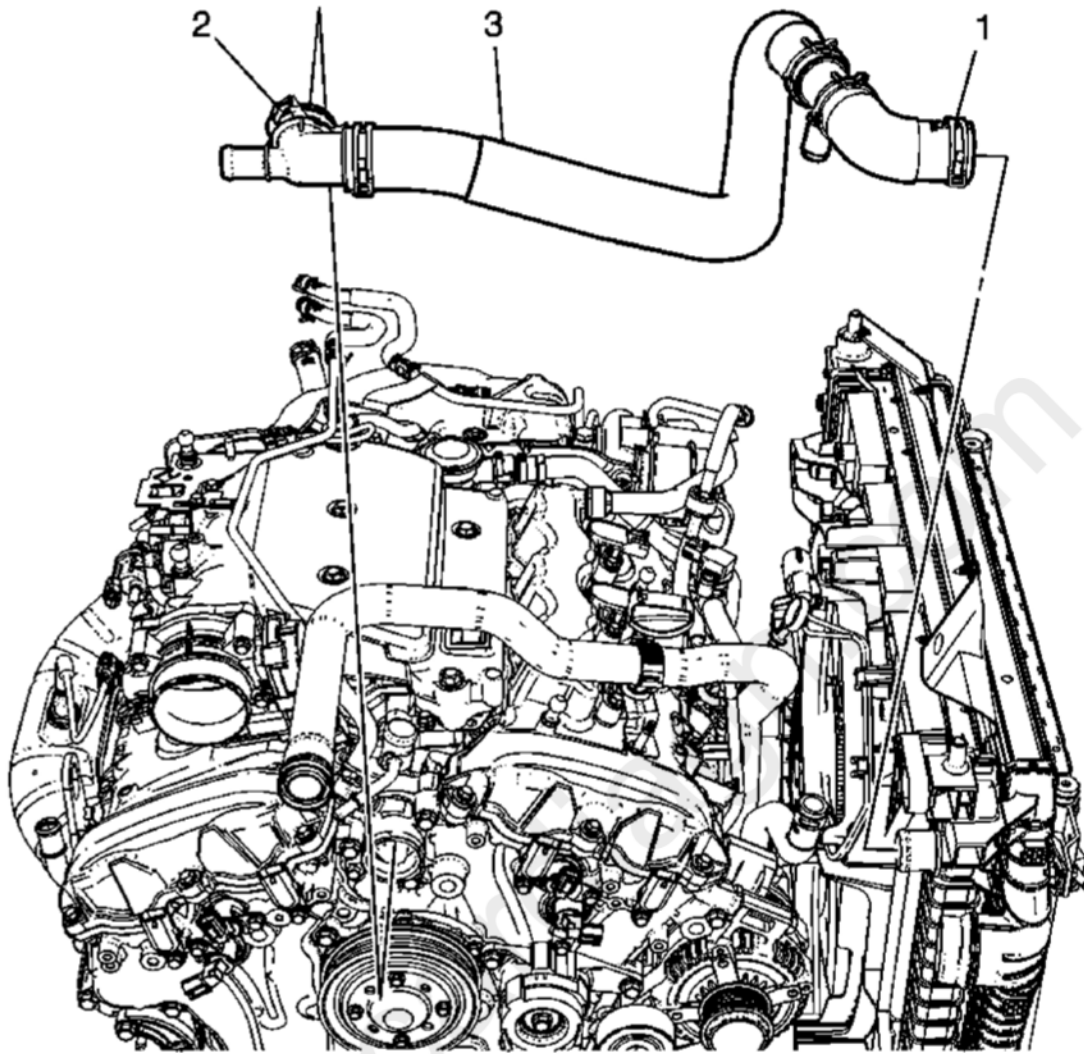


Fig. 39: View Of Radiator Inlet Hose (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> .
2.	Remove the charge air cooler outlet duct. Refer to <u>Charge Air Cooler Outlet Duct Replacement</u> .
3.	Remove the auxiliary water pump outlet upper hose. Refer to <u>Auxiliary Water Pump Outlet Upper Hose Replacement (LAU)</u> .
4.	Remove the heater inlet hose. Refer to <u>Heater Inlet Hose Replacement (LF1)</u> or <u>Heater Inlet Hose Replacement (LAU)</u> .
	Radiator Inlet Hose Clamp

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

1	Procedure: Disengage tension on the radiator inlet hose clamp using BO-38185: Hose Clamp Pliers .
	Special Tools: BO-38185: Hose Clamp Pliers For equivalent regional tools, Refer to <u>Special Tools</u>
2	Radiator Inlet Hose Connector
3	Radiator Inlet Hose

RADIATOR OUTLET HOSE REPLACEMENT (LF1)

Special Tools

BO-38185: Hose Clamp Pliers

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

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the radiator air lower deflector. Refer to **Radiator Air Lower Deflector Replacement** .

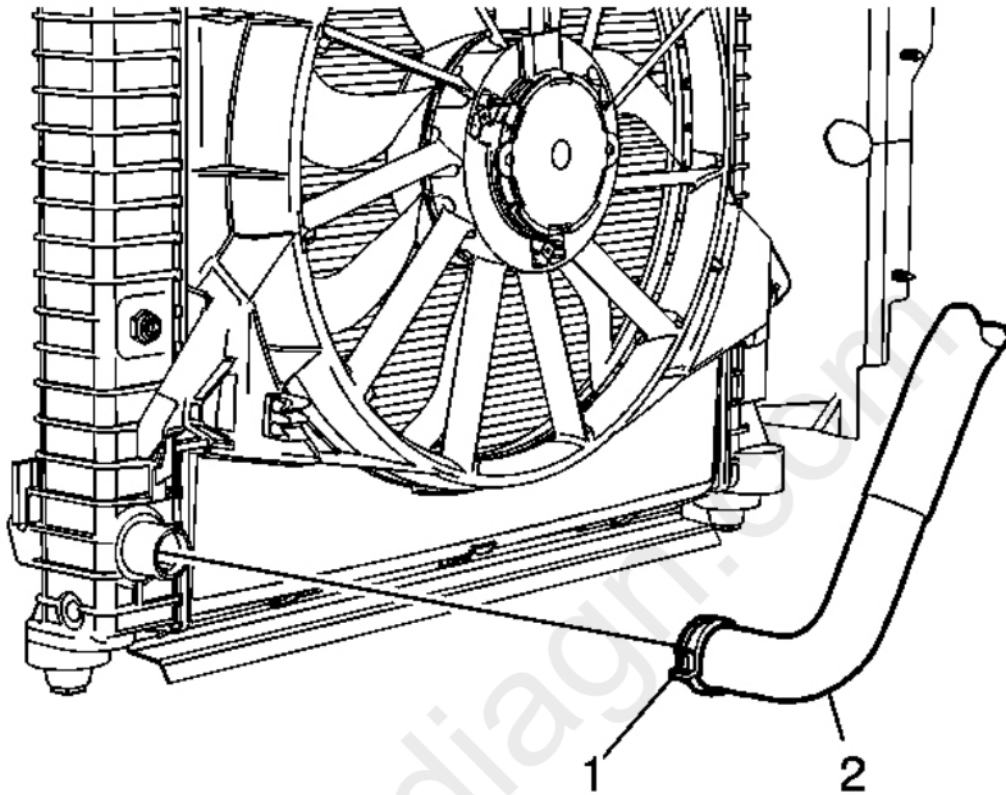


Fig. 4 : Identifying Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS CORP.

4. Disengage tension on the radiator outlet hose clamp (1) at the radiator using **BO- 8185: Hose Clamp Pliers**.
5. Remove the radiator outlet hose (2) from the radiator.

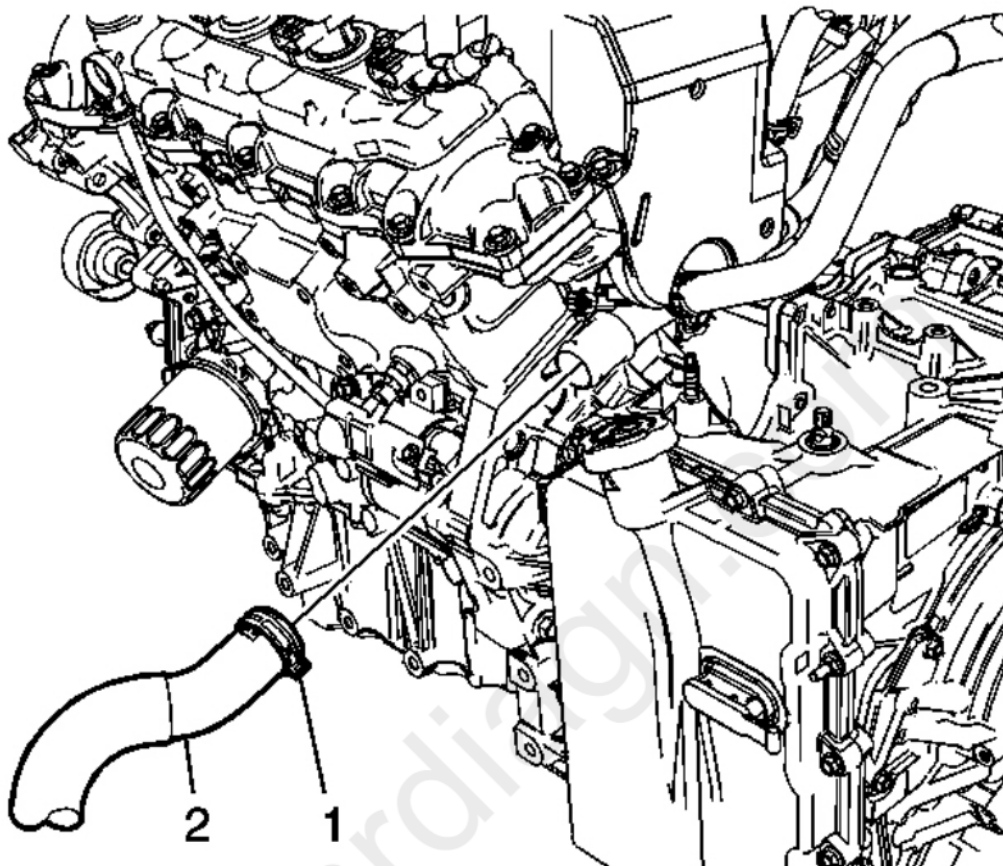


Fig. 41: Identifying Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS CORP.

6. Disengage tension on the radiator outlet hose clamp (1) at the engine using **BO- 8185: Hose Clamp Pliers**.
7. Remove the radiator outlet hose (2) from the engine.
8. Remove the radiator outlet hose from the vehicle.

Installation Procedure

1. Install radiator outlet hose to the vehicle.

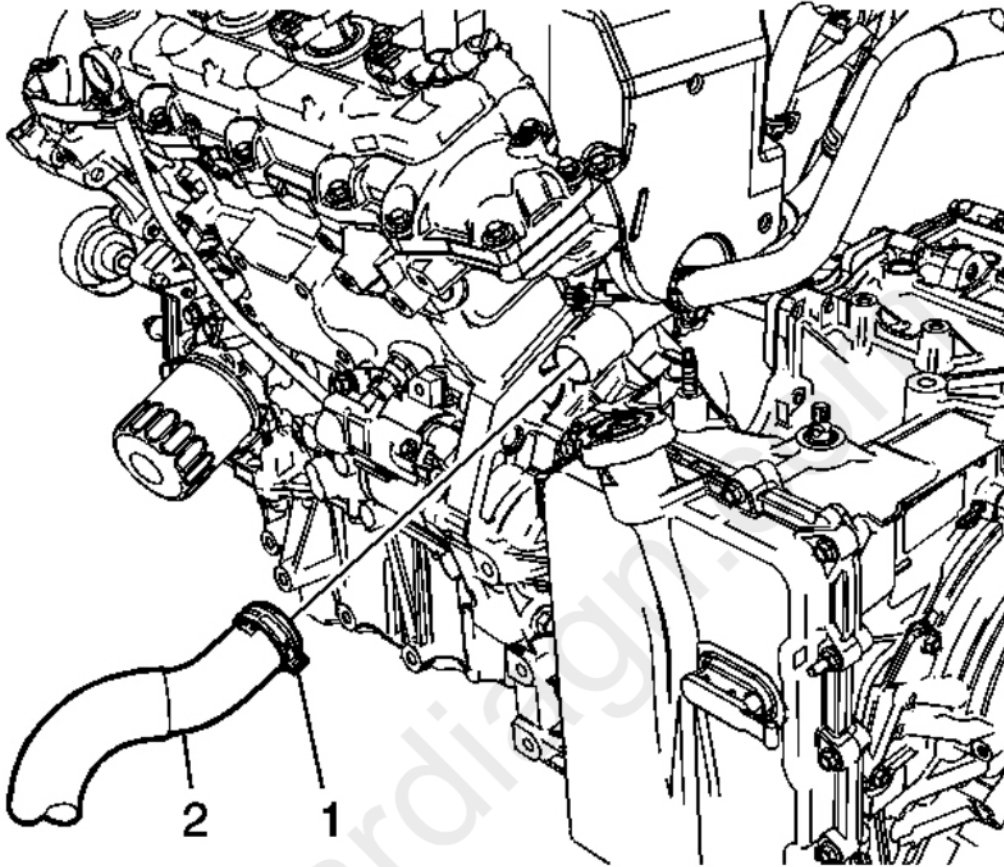


Fig. 4 : Identifying Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS CORP.

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

2. Install the radiator outlet hose (2) to the engine.
3. Engage tension on the radiator outlet hose clamp (1) at the engine using **BO- 8185: Hose Clamp Pliers**.

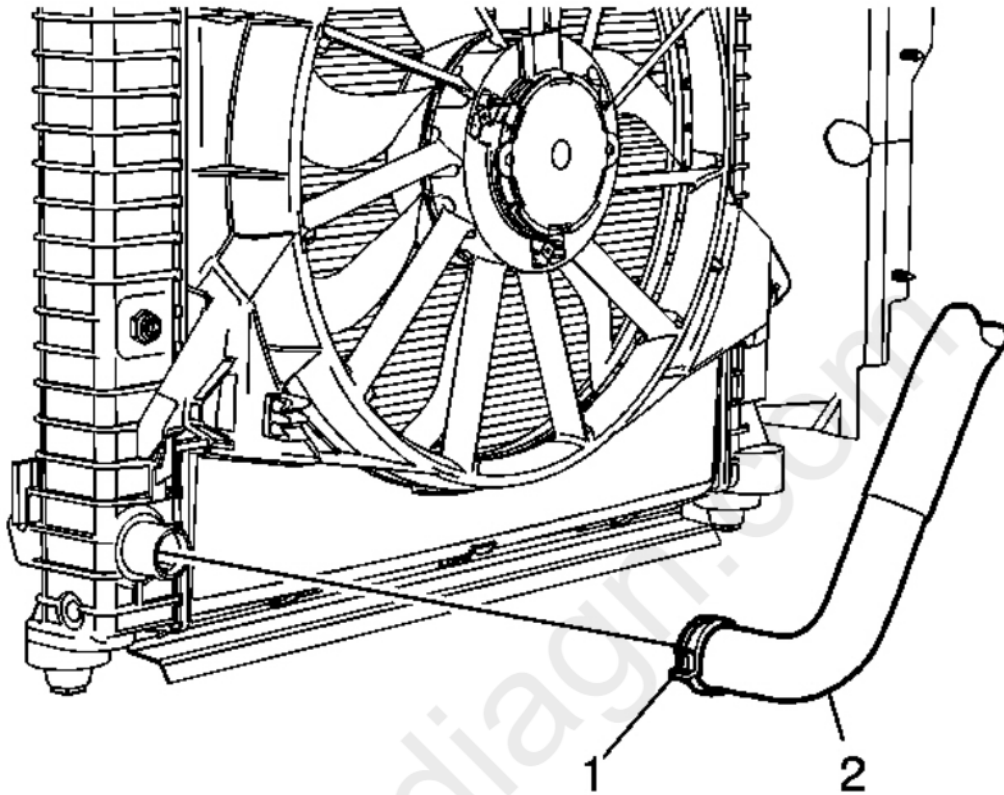


Fig. 4 : Identifying Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator outlet hose (2) to the radiator.
5. Engage tension on the radiator outlet hose clamp (1) at the radiator using **BO- 8185: Hose Clamp Pliers**.
6. Install the radiator air lower deflector. Refer to **Radiator Air Lower Deflector Replacement** .
7. Lower the vehicle.
8. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.

RADIATOR OUTLET HOSE REPLACEMENT (LAU)

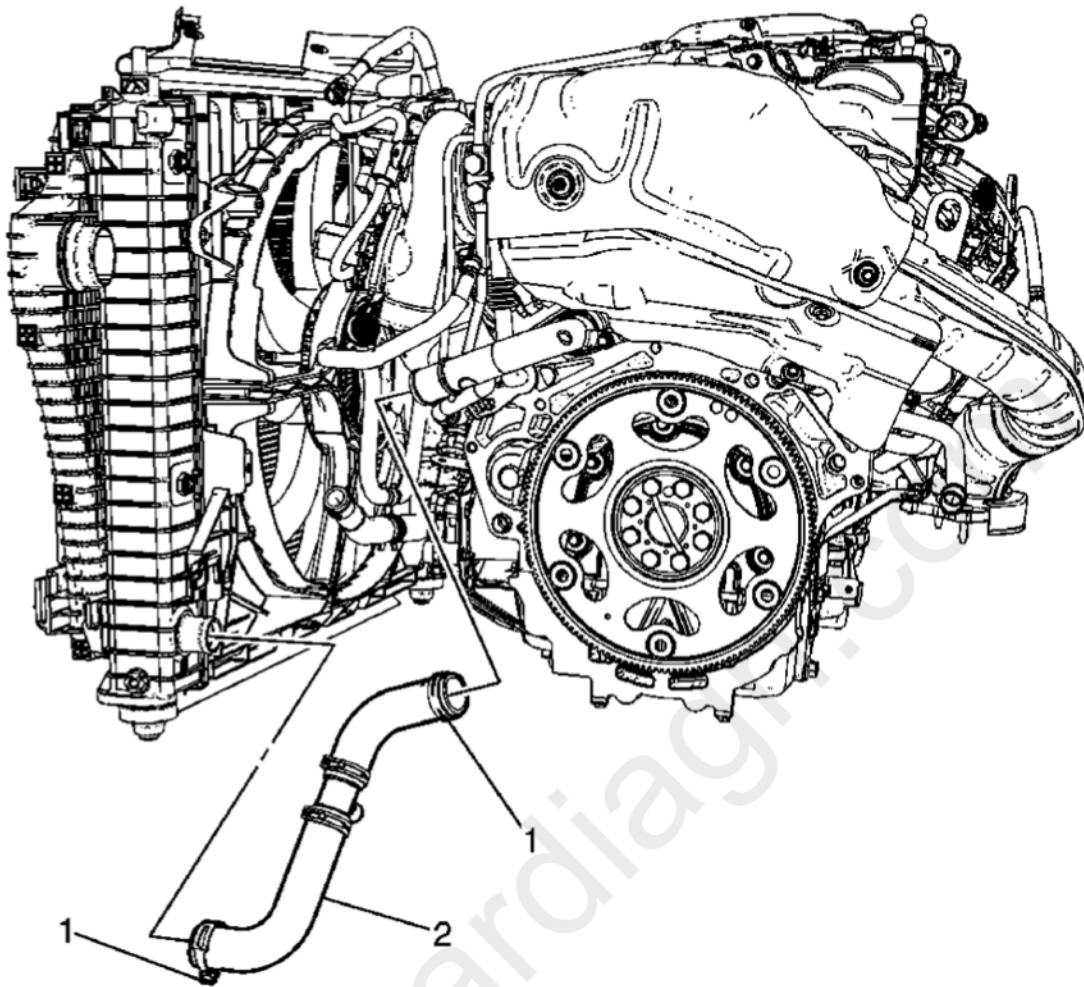


Fig. 44: View Of Radiator Outlet Hose (LAU)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> 3. Remove the auxiliary water pump inlet hose. Refer to <u>Auxiliary Water Pump Inlet Hose Replacement (LAU)</u>	
1	Radiator Outlet Hose Clamp Procedure: Disengage tension on the radiator outlet hose clamp using BO- 8185: Hose Clamp Pliers . Special Tools: BO- 8185: Hose Clamp Pliers

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

2 Radiator Outlet Hose

RADIATOR OUTLET PIPE REPLACEMENT (LAU)

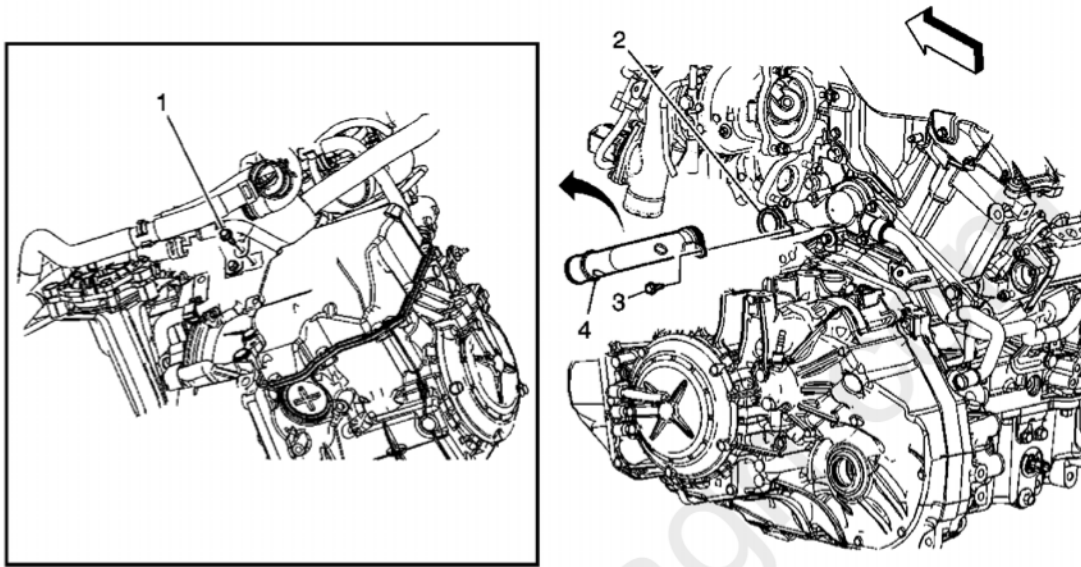


Fig. 45: Identifying Radiator Outlet Pipe (LAU)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the coolant system. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU). 2. Remove the battery tray support. Refer to Battery Tray Support Replacement. 3. Remove the engine oil cooler outlet hose. Refer to Engine Oil Cooler Outlet Hose Replacement (LAU). 4. Remove the radiator outlet hose. Refer to Radiator Outlet Hose Replacement (LF1) or Radiator Outlet Hose Replacement (LAU). 5. Remove the transmission heat shield. Refer to Transmission Heat Shield Replacement (LAU).	
1	Radiator Outlet Pipe Retainer Bolt CAUTION: Refer to Fastener Caution . Tighten: 10 N.m (7 lb ft)
2	Seal

3	Radiator Outlet Pipe Bolt Tighten: 9 N.m (6 lb ft)
4	Radiator Outlet Pipe

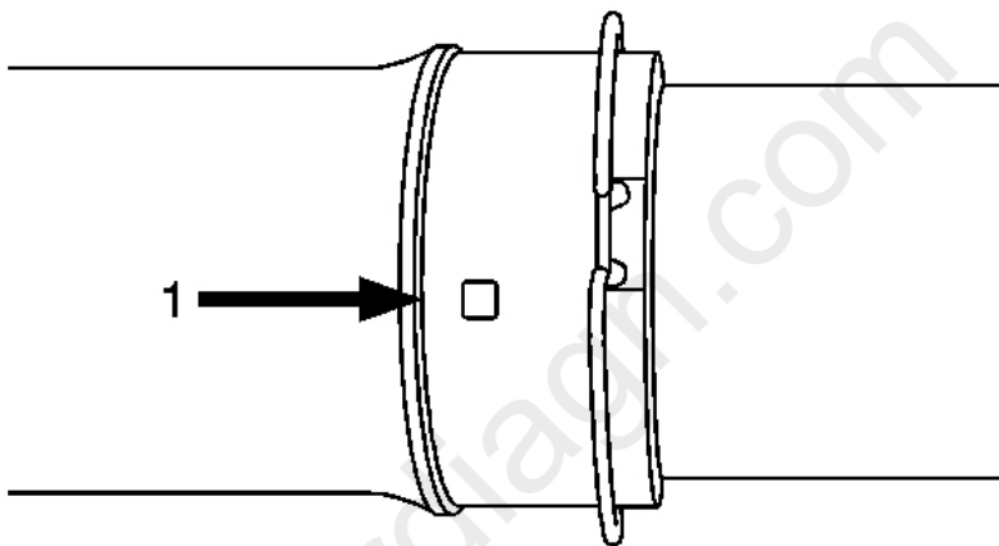
CHARGE AIR COOLER DUCT QUICK-CONNECT FITTING DISCONNECTION

Fig. 46: View Of Quick Connect Coupling
Courtesy of GENERAL MOTORS CORP.

1. Push quick connect coupling (1) in the direction shown in the picture to unlock the secondary engagement of the quick connect retaining clip.

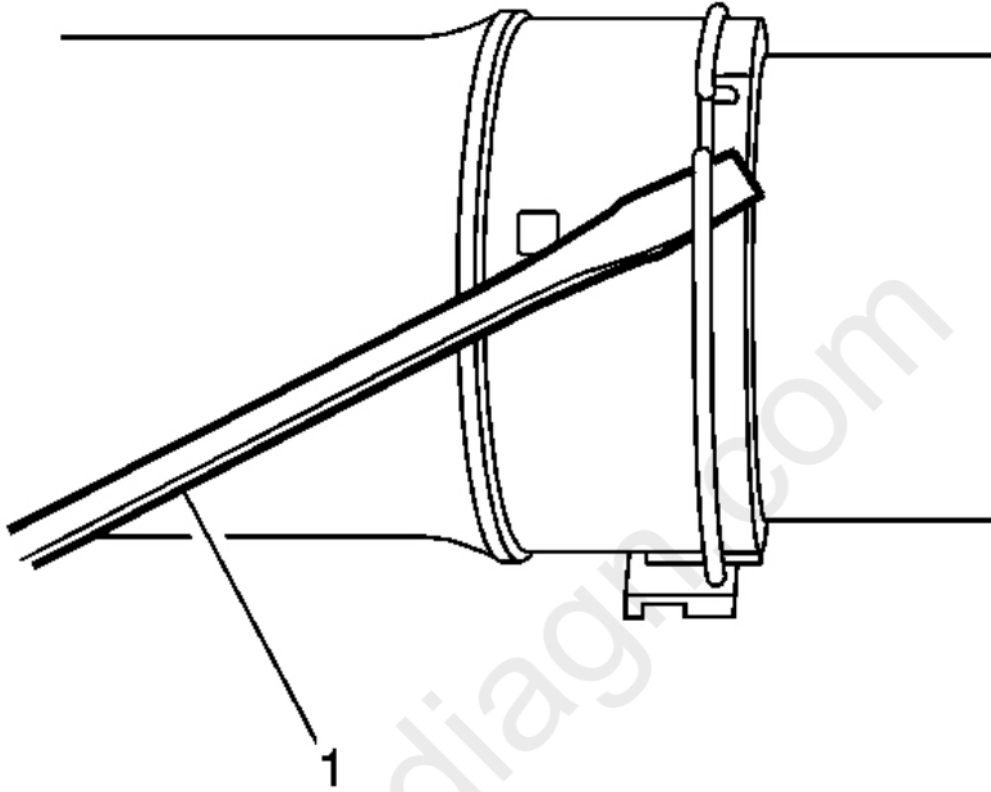


Fig. 47: View Of Quick Connect Coupling Retaining Clip
Courtesy of GENERAL MOTORS CORP.

2. Place a screw driver (1) under the quick connect retaining clip.

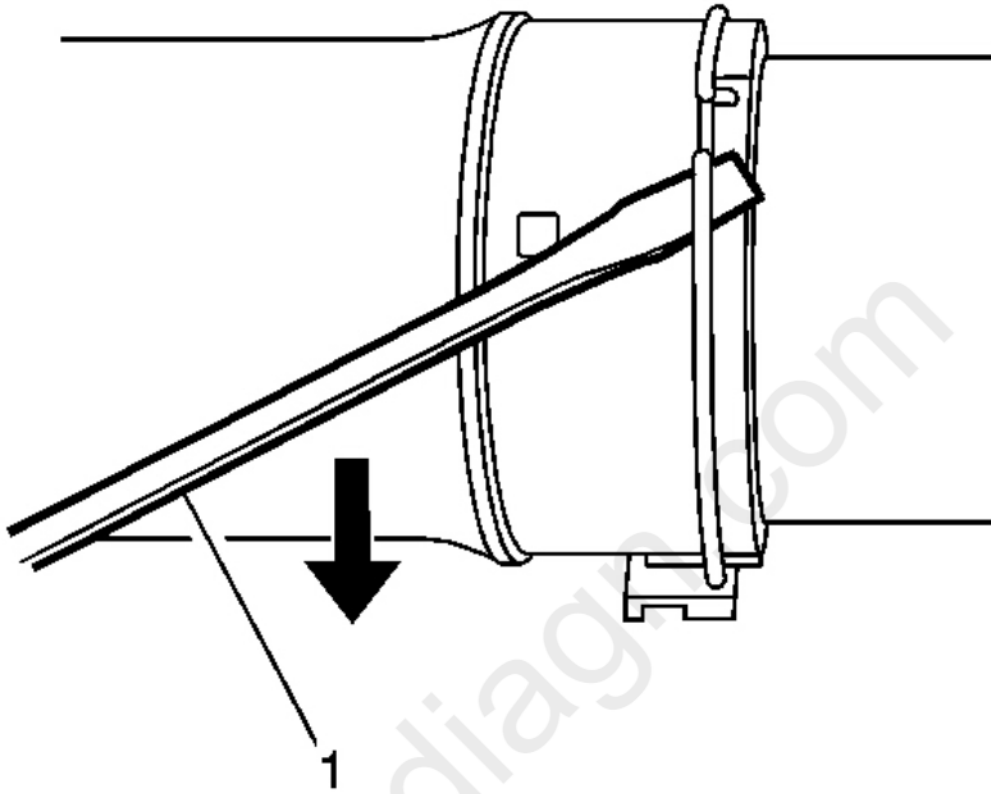


Fig. 48: Releasing Quick Connect Coupling Retaining Clip
Courtesy of GENERAL MOTORS CORP.

3. Push the screw driver (1) downwards to open the quick connect retaining clip.

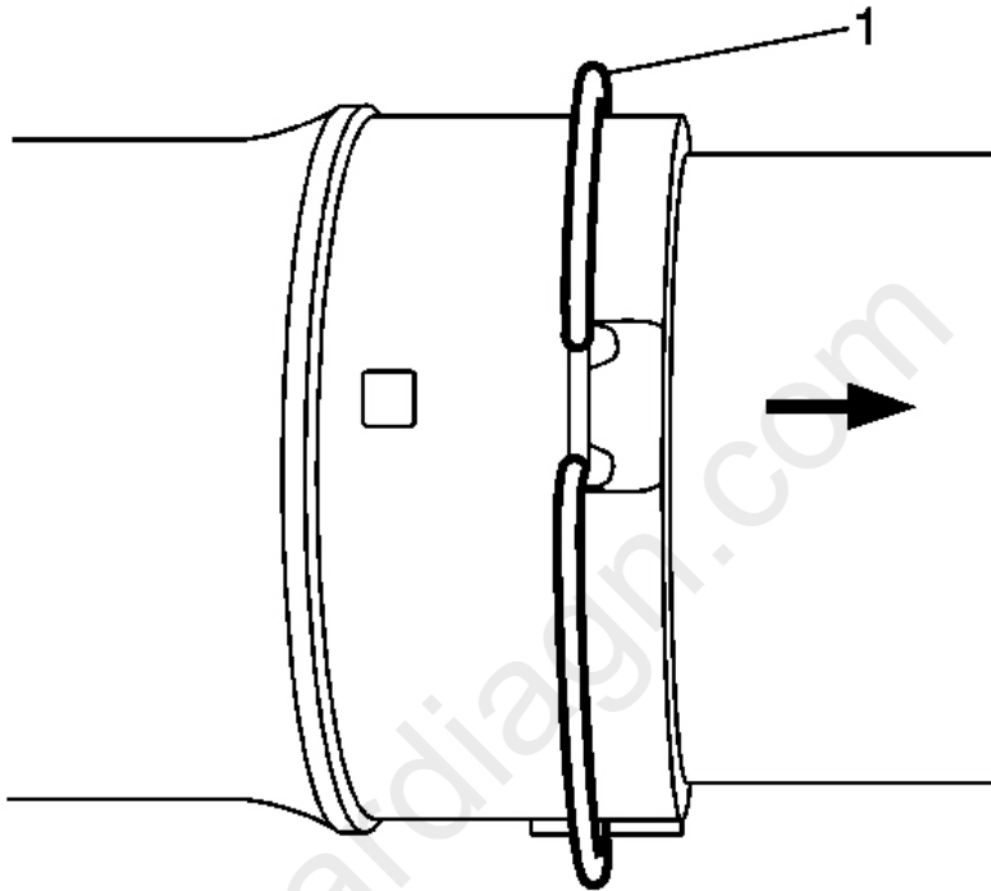


Fig. 49: Separating Quick Connect Coupling Retaining Clip
Courtesy of GENERAL MOTORS CORP.

4. With the quick connect retaining clip (1) opened the mating tube can be disconnected

CHARGE AIR COOLER REPLACEMENT (LAU)

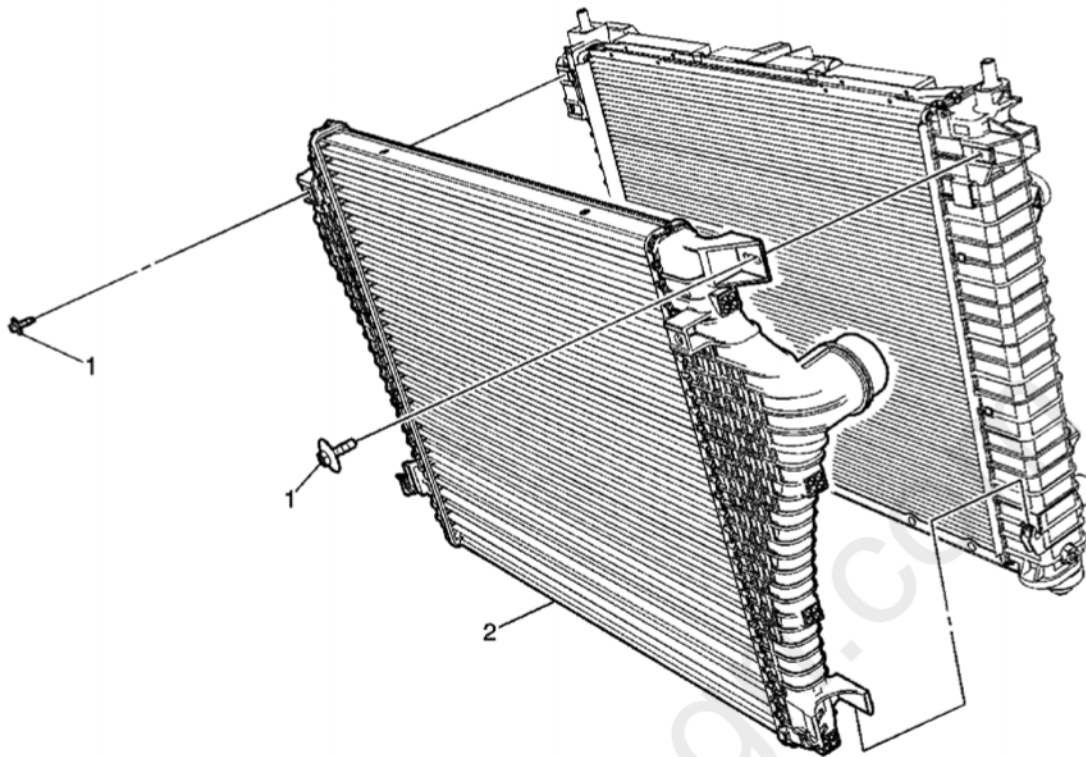


Fig. 5 : View Of Charge Air Cooler (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the air conditioning condenser. Refer to <u>Air Conditioning Condenser Replacement (LF1)</u> or <u>Air Conditioning Condenser Replacement (LAU)</u> . 2. Remove the charge air cooler inlet duct. Refer to <u>Charge Air Cooler Inlet Duct Replacement</u> . 3. Remove the charge air cooler outlet duct. Refer to <u>Charge Air Cooler Outlet Duct Replacement</u> .	
1	Charge Air Cooler Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: N.m (80 lb in)
2	Charge Air Cooler

AUXILIARY WATER PUMP INLET HOSE REPLACEMENT (LAU)

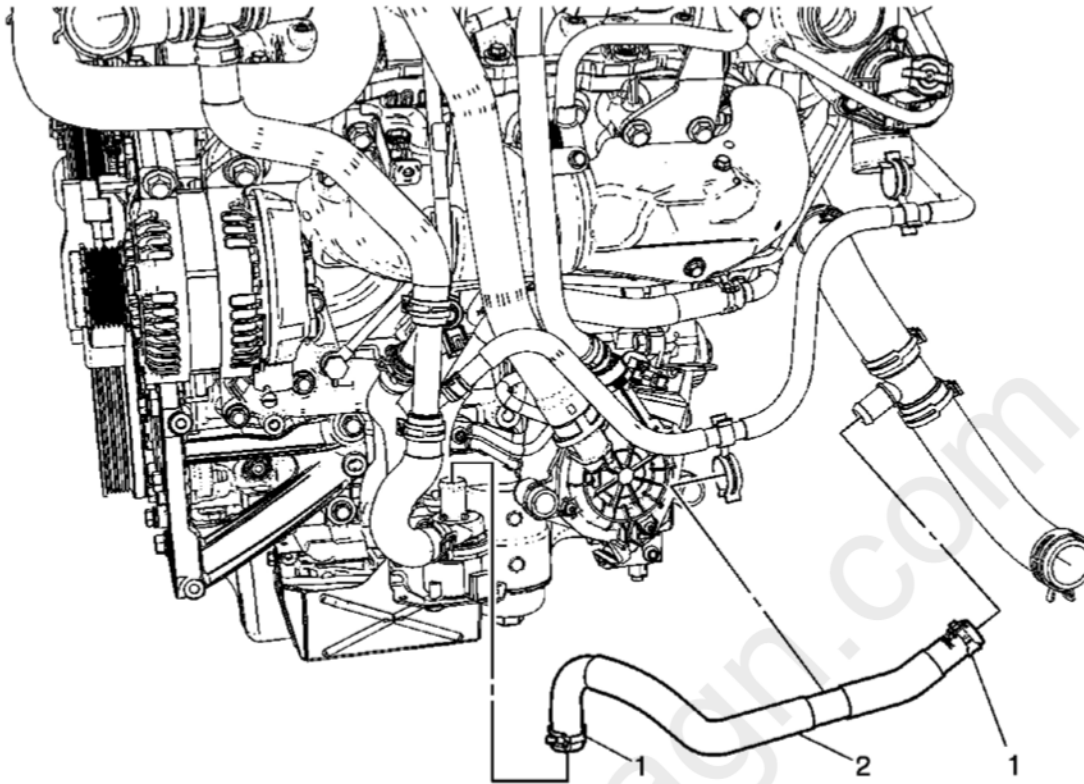


Fig. 51: Identifying Auxiliary Water Pump Inlet Hose (LAU)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>	
1	auxiliary Water Pump Inlet Hose Clamps (Qty 2) Procedure: Disengage tension on the auxiliary water pump inlet hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers For equivalent regional tools, Refer to <u>Special Tools</u>
2	auxiliary Water Pump Inlet Hose

AUXILIARY WATER PUMP OUTLET UPPER HOSE REPLACEMENT (LAU)

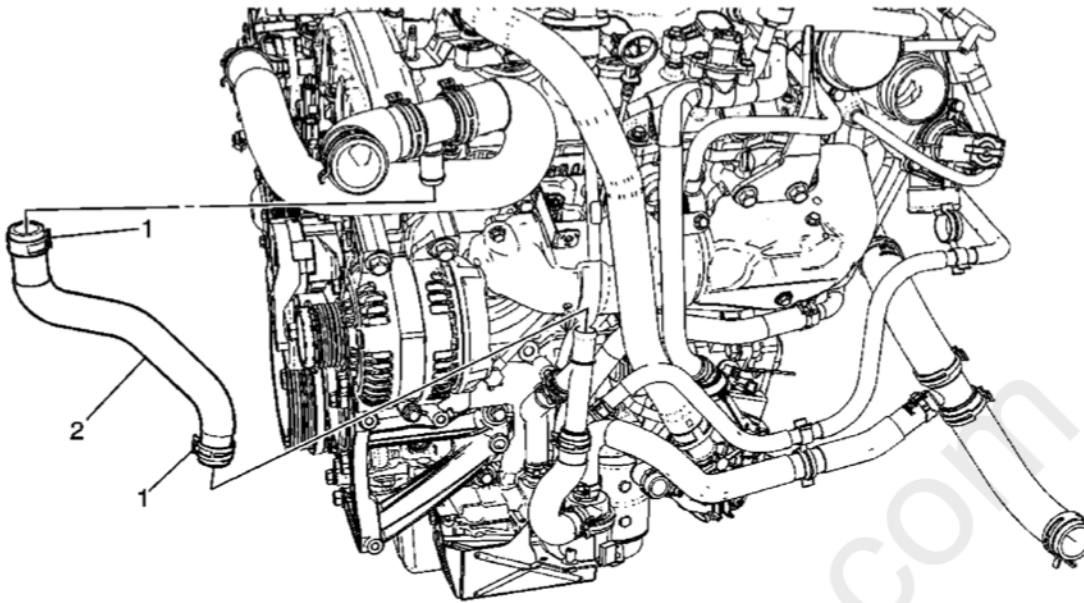


Fig. 5 : Identifying Auxiliary Water Pump Outlet Upper Hose (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU) 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle 3. Remove the secondary air in action pump. Refer to Secondary Air In action Pump Replacement	
1	auxiliary Water Pump Outlet Upper Hose Clamps (Qty 2) Procedure: Disengage tension on the auxiliary water pump outlet upper hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers For equivalent regional tools, Refer to Special Tools
2	auxiliary Water Pump Outlet Upper Hose

AUXILIARY WATER PUMP OUTLET HOSE REPLACEMENT (LAU)

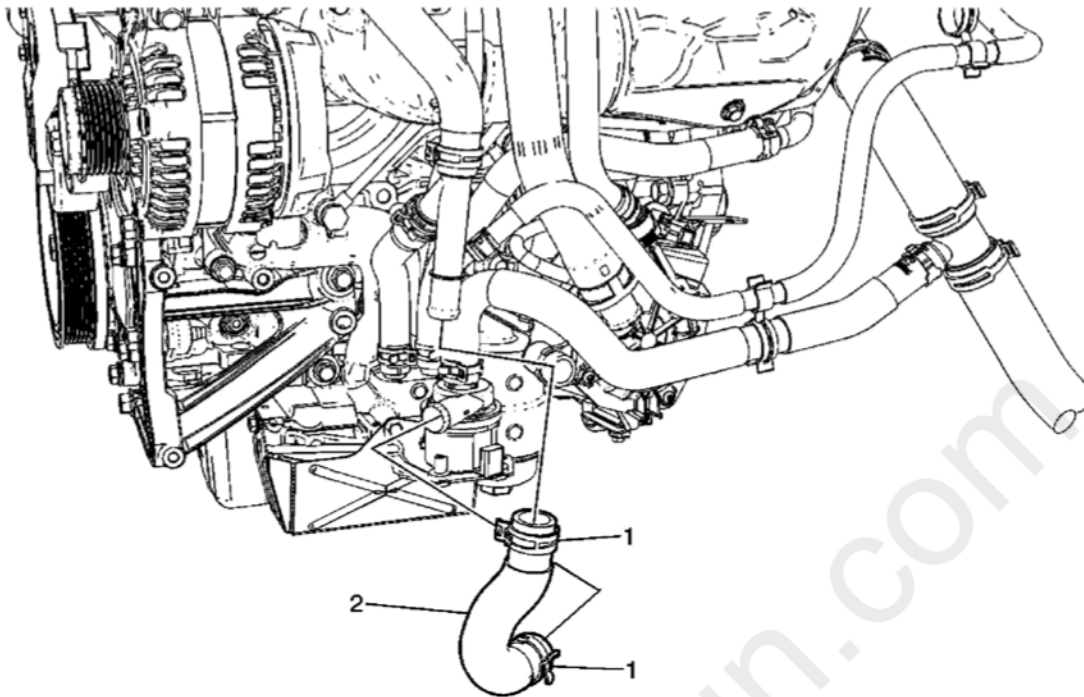


Fig. 53: Identifying Auxiliary Water Pump Outlet Hose (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU) 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle	
1	auxiliary Water Pump Outlet Hose Clamps (Qty 2) Procedure: Disengage tension on the auxiliary water pump outlet hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers For equivalent regional tools, Refer to Special Tools
2	auxiliary Water Pump Outlet Hose

ENGINE OIL COOLER OUTLET HOSE REPLACEMENT (LAU)

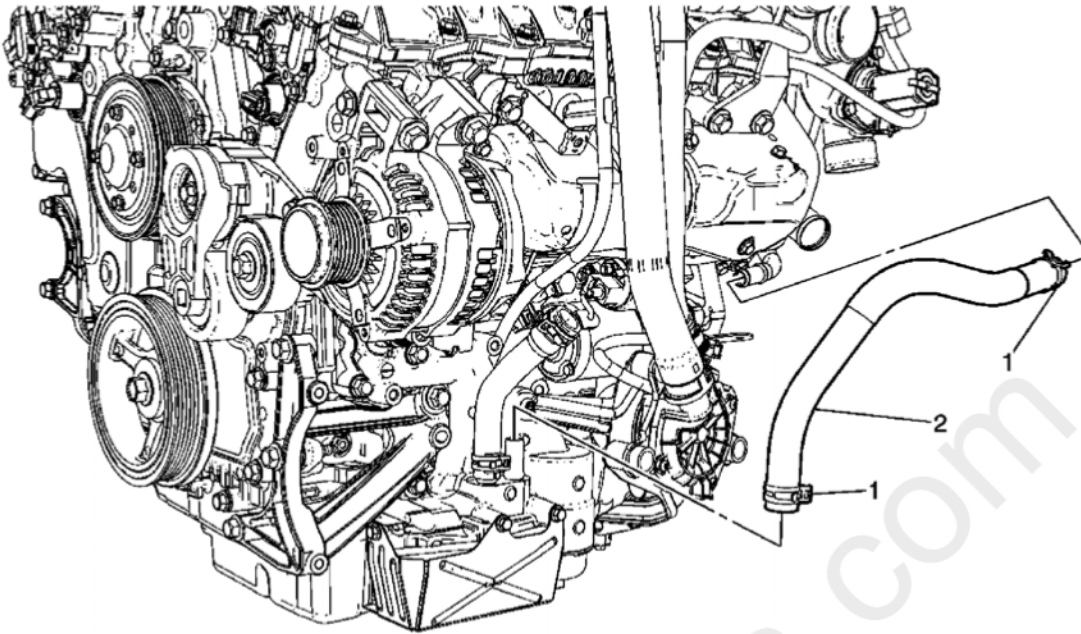


Fig. 54: Locating Engine Oil Cooler Outlet Hose (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> 3. Reposition the auxiliary water pump. Refer to <u>Auxiliary Water Pump Replacement (LAU)</u> . Remove the secondary air in action pump. Refer to <u>Secondary Air In action Pump Replacement</u>	
1	Engine Oil Cooler Outlet Hose Clamps (Qty 2) Procedure: Disengage tension on the engine oil cooler outlet hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers For equivalent regional tools, Refer to <u>Special Tools</u>
2	Engine Oil Cooler Outlet Hose

ENGINE OIL COOLER HOSE/PIPE REPLACEMENT (LAU)

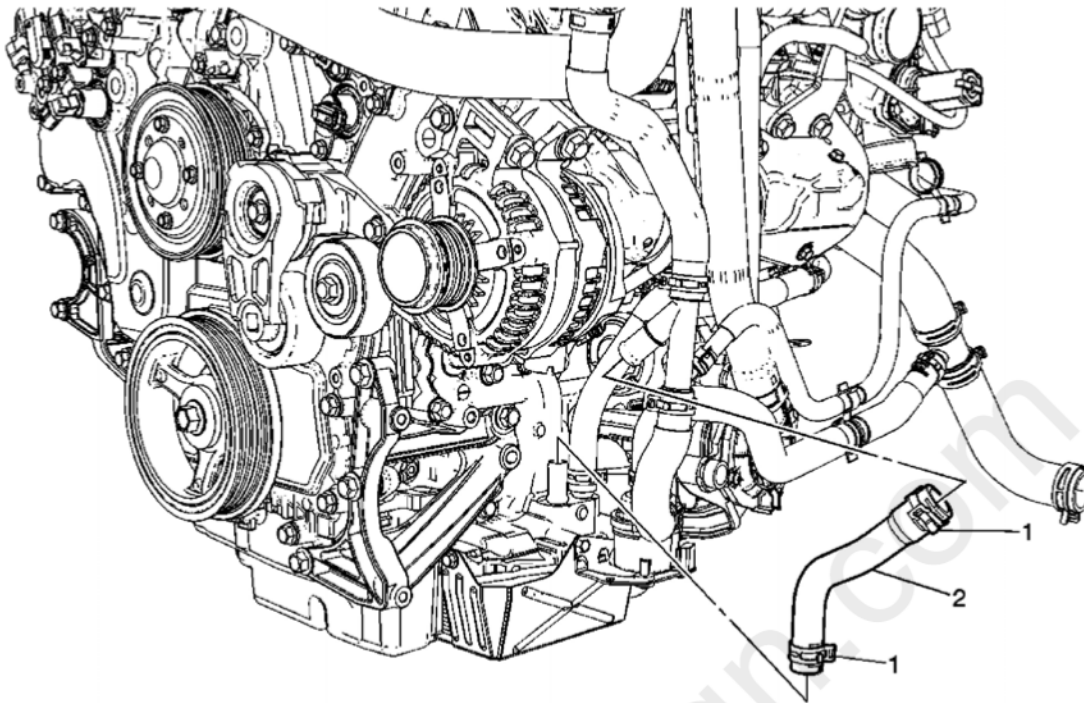


Fig. 55: Identifying Engine Oil Cooler Hose/Pipe (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> 3. Reposition auxiliary water pump. Refer to <u>Auxiliary Water Pump Replacement (LAU)</u>	
1	Engine Oil Cooler Hose Clamps (Qty 2) Procedure: Disengage tension on the engine oil cooler hose clamps using BO-38185: Hose Clamp Pliers . Special Tools: BO-38185: Hose Clamp Pliers For equivalent regional tools, Refer to <u>Special Tools</u>
2	Engine Oil Cooler Hose

ENGINE COOLANT FAN REPLACEMENT (LF1)

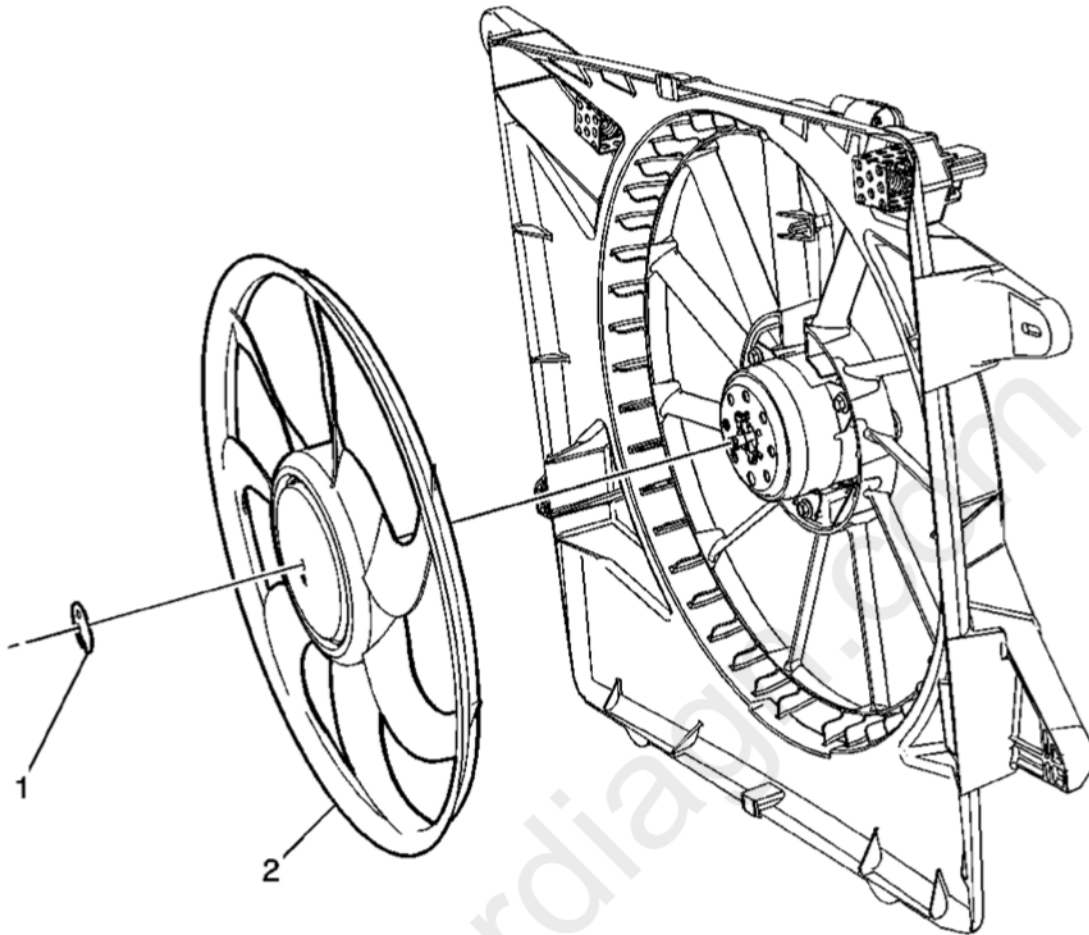


Fig. 56: View Of Engine Coolant Fan (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures:	
Remove the cooling fan shroud. Refer to <u>Cooling Fan and Shroud Replacement (LF1)</u> or <u>Cooling Fan and Shroud Replacement (LAU)</u>	
1	Cooling Fan Retainer
2	Cooling Fan

ENGINE COOLANT FAN REPLACEMENT (LAU)

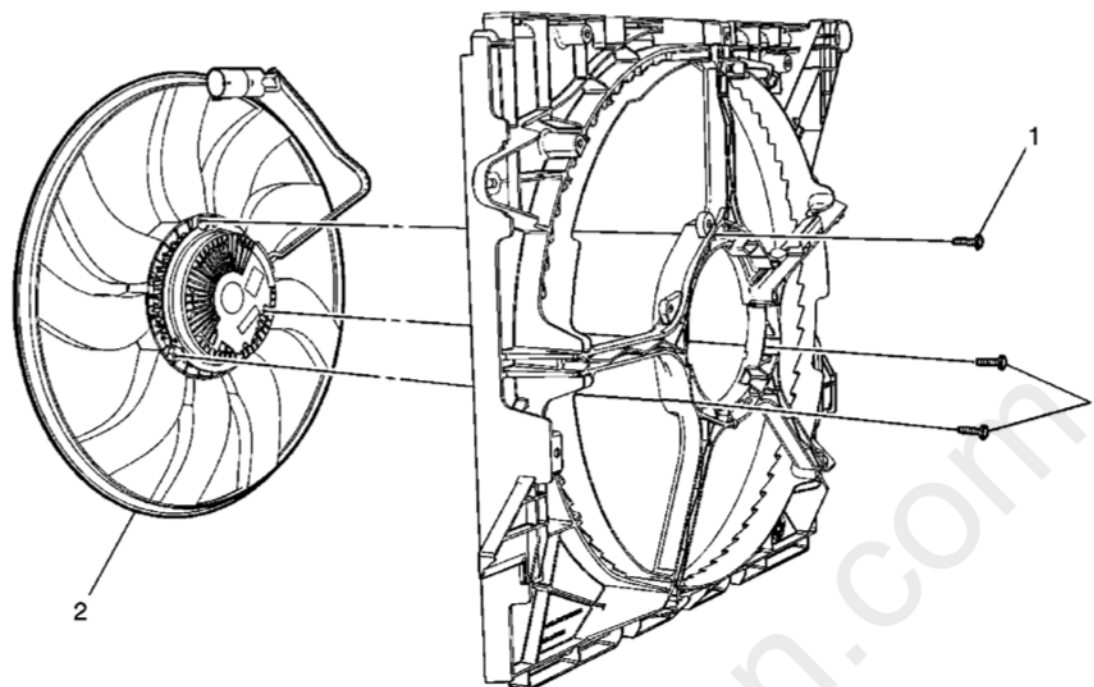


Fig. 57: Identifying Engine Coolant Fan (LAU)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the cooling fan shroud. Refer to Cooling Fan and Shroud Replacement (LF1) or Cooling Fan and Shroud Replacement (LAU) .	
1	Cooling Fan Retainer (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 7 N.m (62 lb in)
2	Cooling Fan Tip: Disconnect electrical connector from fan.

ENGINE COOLANT FAN MOTOR REPLACEMENT (LF1)

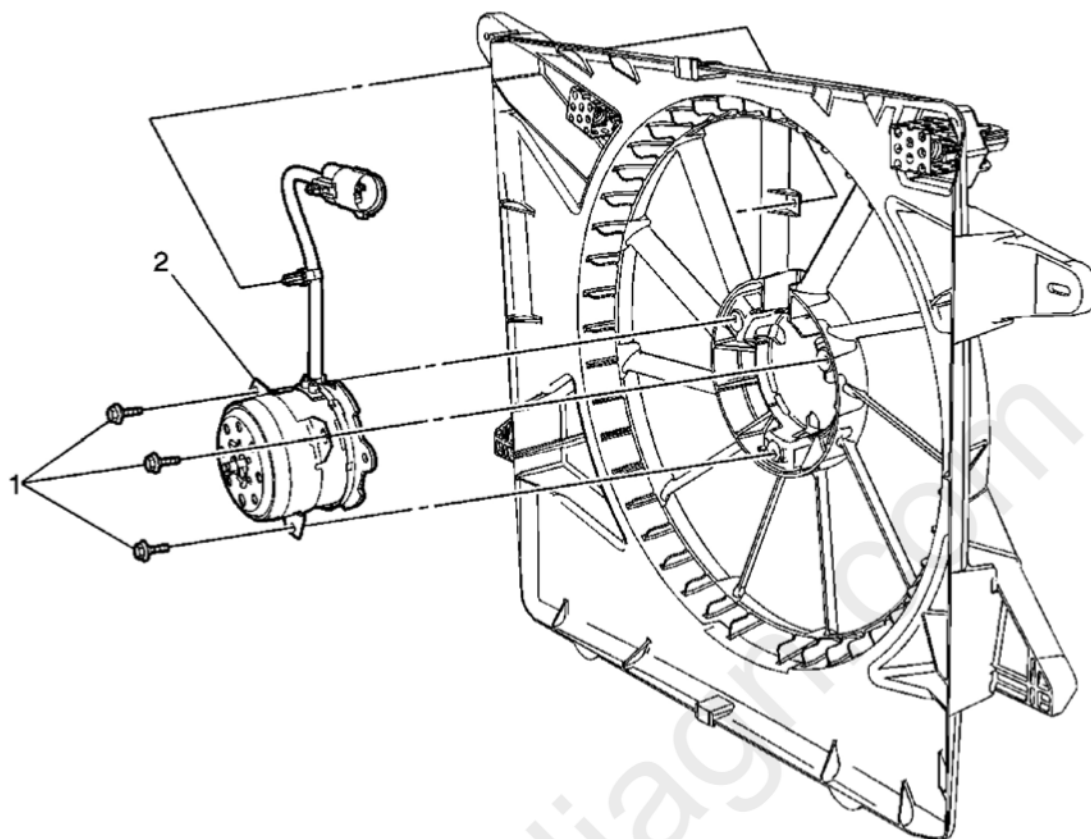


Fig. 58: View Of Engine Coolant Fan Motor (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the cooling fan. Refer to <u>Engine Coolant Fan Replacement (LF1)</u> or <u>Engine Coolant Fan Replacement (LAU)</u>	
1	Cooling Fan Motor Bolts (Qty 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 7 N.m (62 lb in)
2	Cooling Fan Motor Procedure: Unclip cooling fan motor wiring harness from cooling fan shroud.

COOLING FAN AND SHROUD REPLACEMENT (LF1)

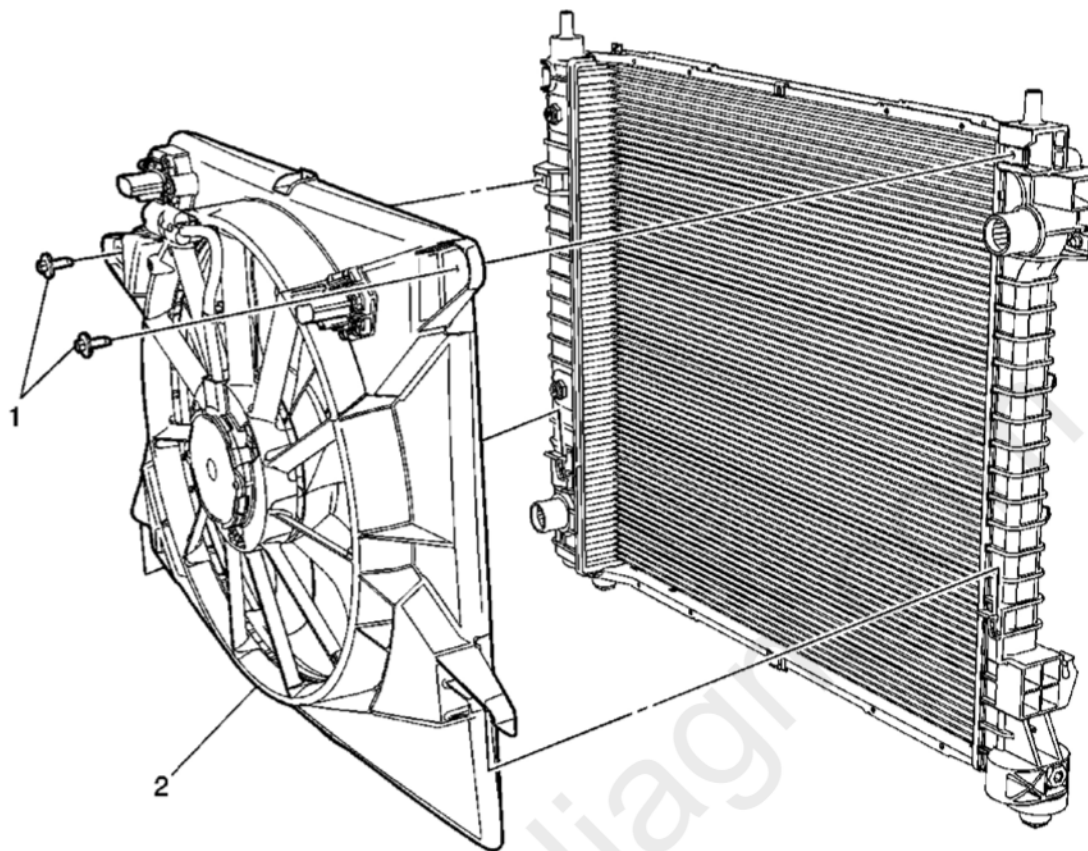


Fig. 59: View Of Cooling Fan & Shroud (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Reposition radiator forward. Refer to Radiator Replacement (LF1) or Radiator Replacement (LAU)	
1	Cooling Fan Shroud Bolts (Qty 2) CAUTION: Refer to Fastener Caution . Tighten: 8 N.m (70 lb in)
2	Cooling Fan Shroud Procedure 1. Disconnect cooling fan motor wiring harness. 2. Disconnect cooling fan resistor wiring harness.

COOLING FAN AND SHROUD REPLACEMENT (LAU)

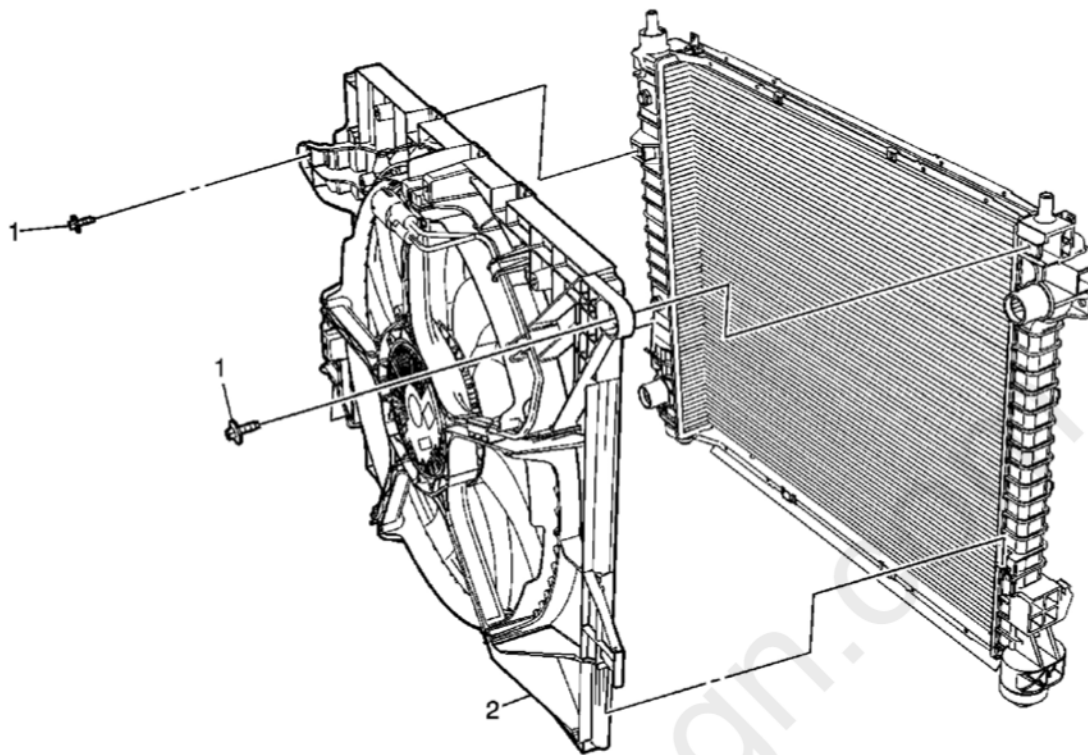


Fig. 6 : View Of Cooling Fan Shroud (LAU)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Reposition radiator forward. Refer to Radiator Replacement (LF1) or Radiator Replacement (LAU) .	
1	Cooling Fan Shroud Bolt (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten: 8 N.m (70 lb in)
2	Cooling Fan Shroud Procedure: Disconnect cooling fan motor wiring harness.

ENGINE COOLANT FAN RESISTOR REPLACEMENT - RIGHT SIDE (LF1)

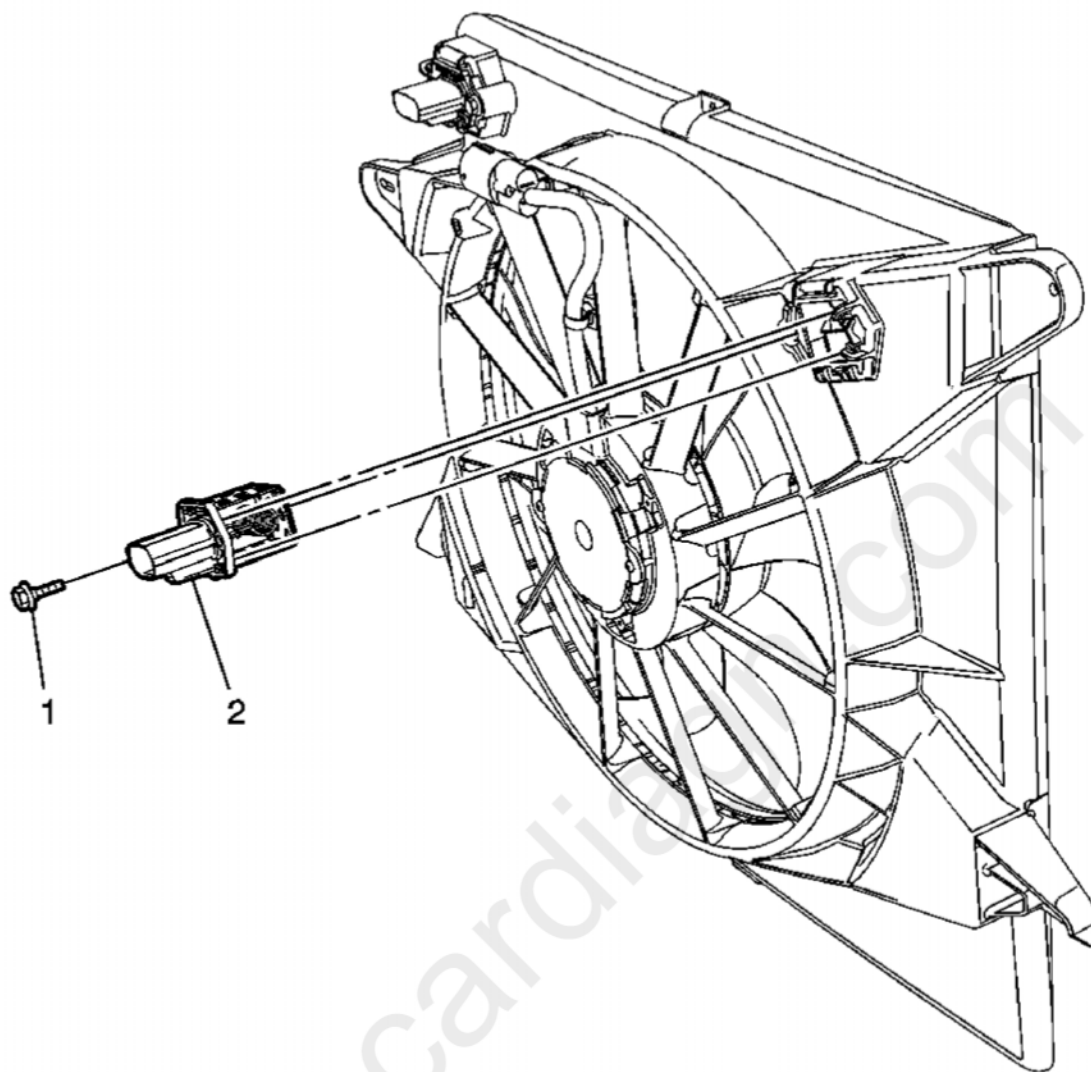


Fig. 61: Identifying Engine Coolant Fan Resistor - Right Side (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Disconnect the engine cooling fan resistor electrical connector.	
1	Engine Cooling Fan Resistor Fasteners CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 5.4 N.m (48 lb in)
2	Engine Cooling Fan Resistor

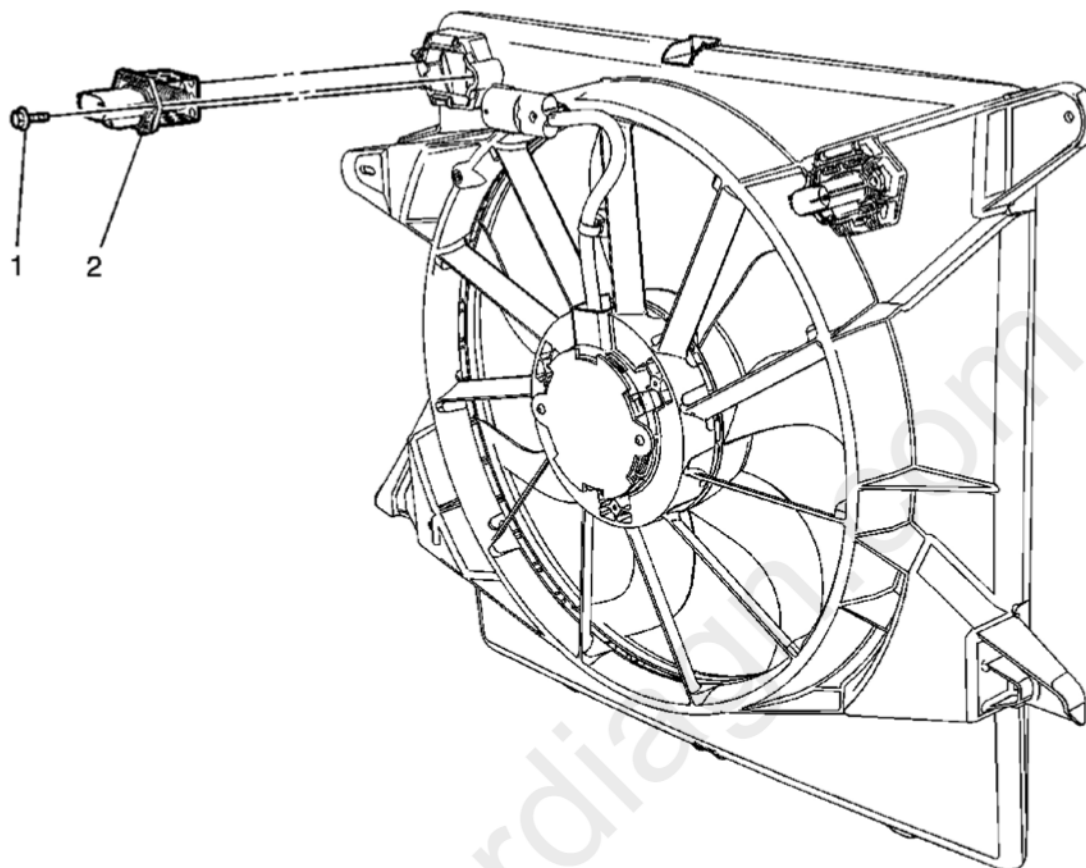
ENGINE COOLANT FAN RESISTOR REPLACEMENT - LEFT SIDE (LF1)

Fig. 6 : Identifying Engine Coolant Fan Resistor - Left Side (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Disconnect the engine cooling fan resistor electrical connector.	
1	Engine Cooling Fan Resistor Fasteners CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 5.4 N.m (48 lb in)
2	Engine Cooling Fan Resistor

ENGINE COOLANT LEVEL INDICATOR MODULE REPLACEMENT

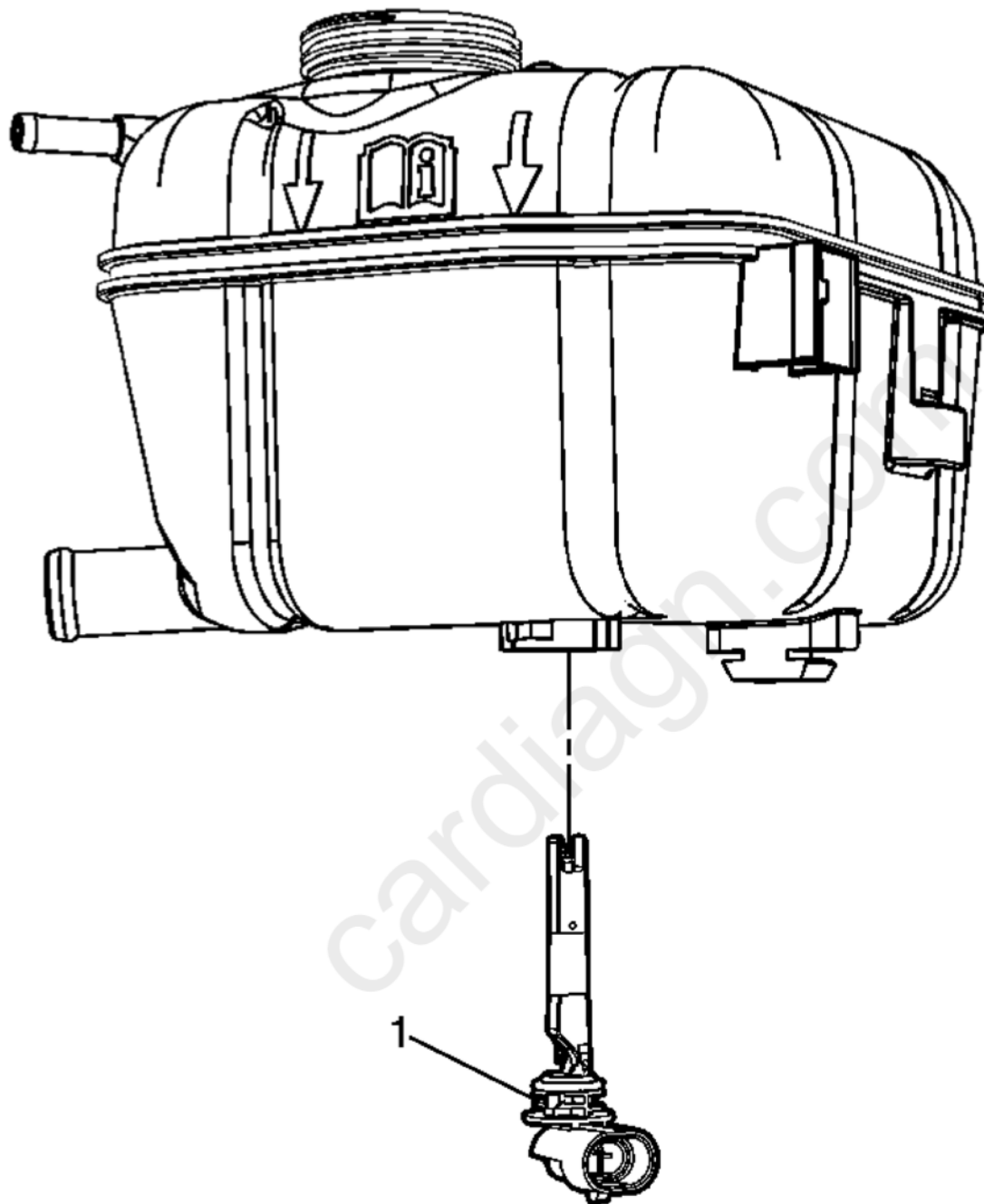


Fig. 6 : Identifying Engine Coolant Level Indicator Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures:	
Remove radiator surge tank. Refer to <u>Radiator Surge Tank Replacement (LF1)</u> or <u>Radiator Surge Tank Replacement (LAU)</u>	
	Engine Coolant Level Indicator Module

- 1 **Tip:** nplug electrical connector from engine coolant level indicator module.

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LAU)

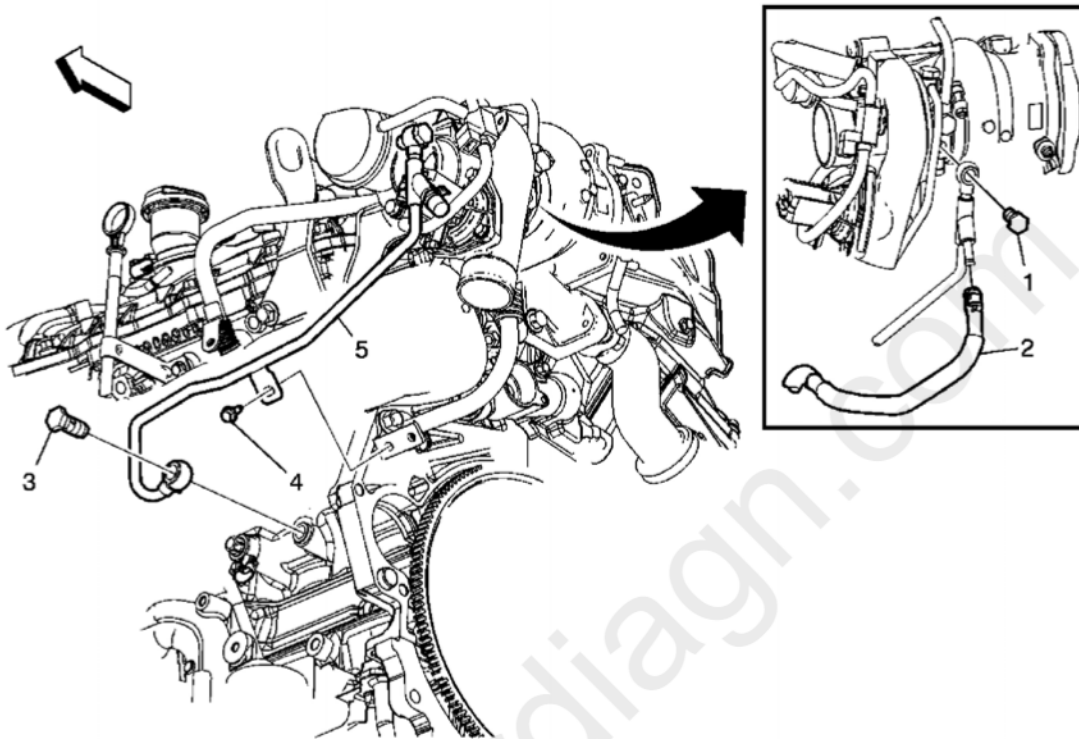


Fig. 64: Locating Turbocharger Coolant Feed Pipe (LAU)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> 2. Relocate the au iliary water pump. Refer to <u>Au iliary ater Pump Replacement (LAU)</u>. 3. Remove the secondary air injection pump. Refer to <u>Secondary Air In ection Pump Replacement</u> . 4. Remove the starter. Refer to <u>Starter Replacement (LF1)</u> or <u>Starter Replacement (LAU)</u> .	
1	Banjo Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 35 N.m (26 lb ft)

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

2	Turbocharger Outlet Hose
3	Banjo Bolt
	Tighten: 35 N.m (26 lb ft)
4	Turbocharger Coolant Feed Bracket Bolt
	Tighten: 10 N.m (7 lb ft)
5	Turbocharger Coolant Feed Pipe

TURBOCHARGER COOLANT RETURN PIPE REPLACEMENT (LAU)

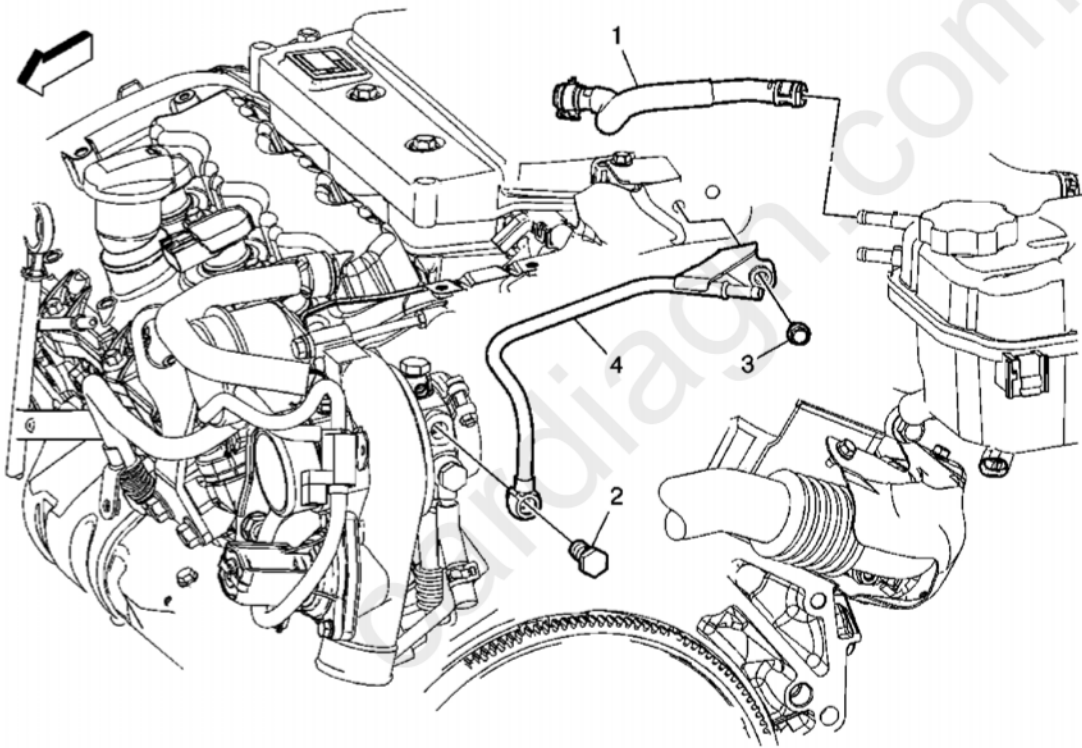


Fig. 65: Identifying Turbocharger Coolant Return Pipe (LAU)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> .
2.	Remove the radiator surge tank engine hose. Refer to <u>Radiator Surge Tank Engine Hose Replacement (LAU)</u> .
1	Radiator Surge Tank Engine Hose

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

2	Banjo Bolt
	CAUTION: Refer to <u>Fastener Caution</u> .
	Tighten: 35 N.m (26 lb ft)
3	Banjo Bolt
	Tighten: 35 N.m (26 lb ft)
4	Turbocharger Coolant Return Pipe

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LF1)

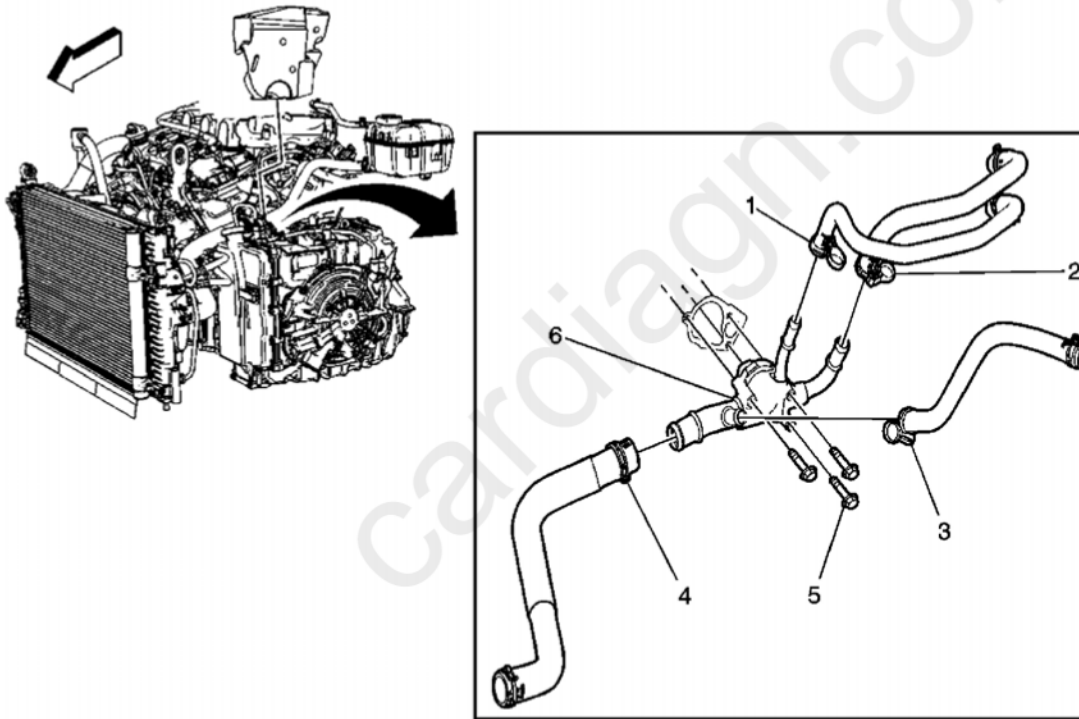


Fig. 66: View Of Engine Coolant Thermostat Housing (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> .
2.	Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .

3. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**

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

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

ENGINE COOLANT THERMOSTAT REPLACEMENT (LF1)

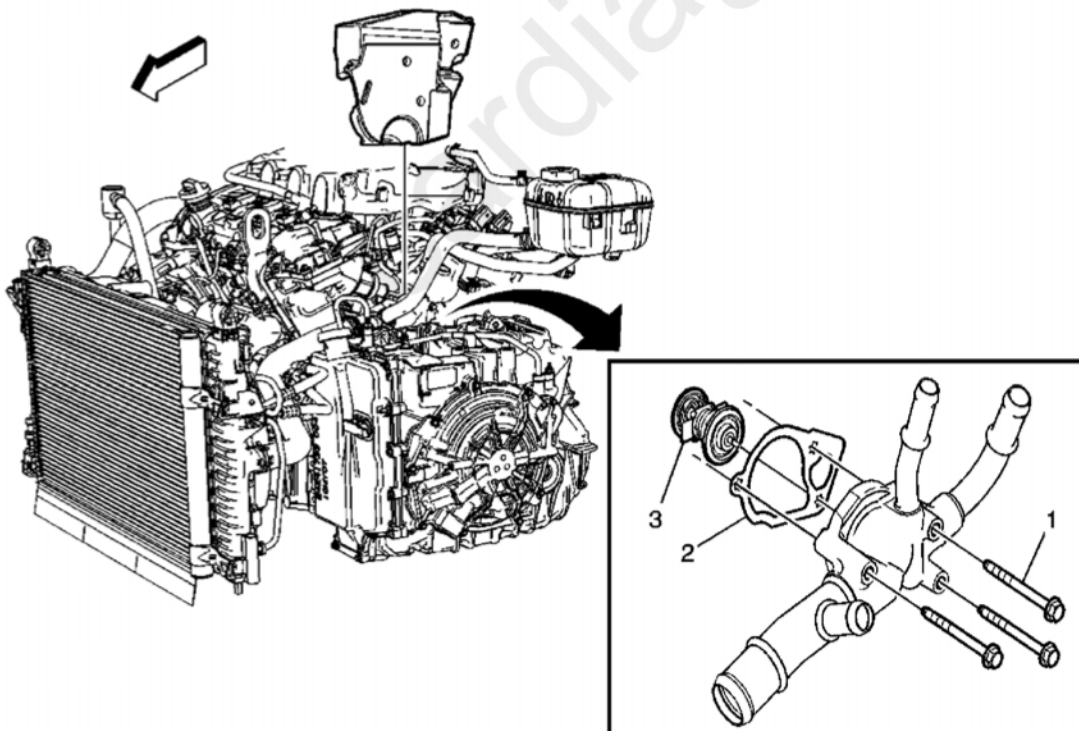


Fig. 67: View Of Engine Coolant Thermostat (LF1)

Courtesy of GENERAL MOTORS CORP.

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

Callout	Component Name
Preliminary Procedure: Remove the engine cooling thermostat housing. Refer to <u>Engine Coolant Thermostat Housing Replacement (LF1)</u> .	
1	Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (88 lb in)
2	Engine Cooling Thermostat Gasket
3	Engine Cooling Thermostat Procedure • Clean the engine block and the thermostat gasket surfaces. • Replace the gasket and any worn hoses.

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LF1)

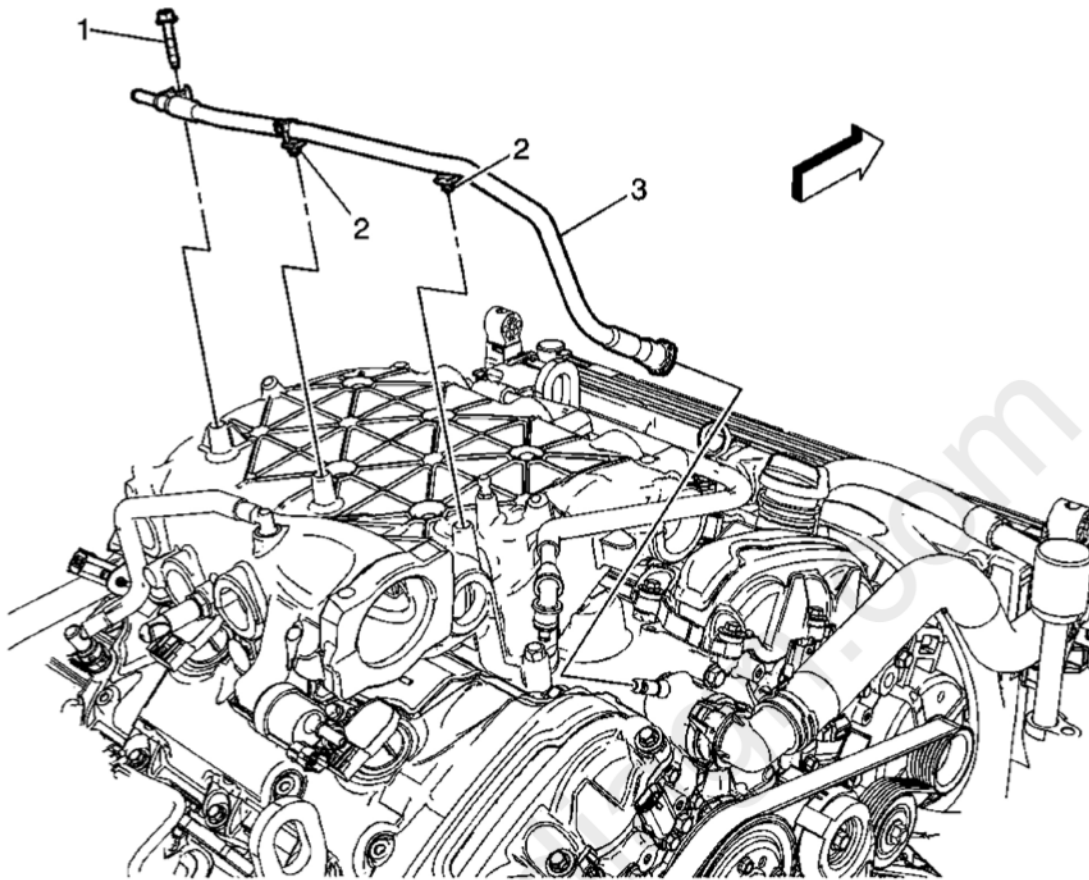
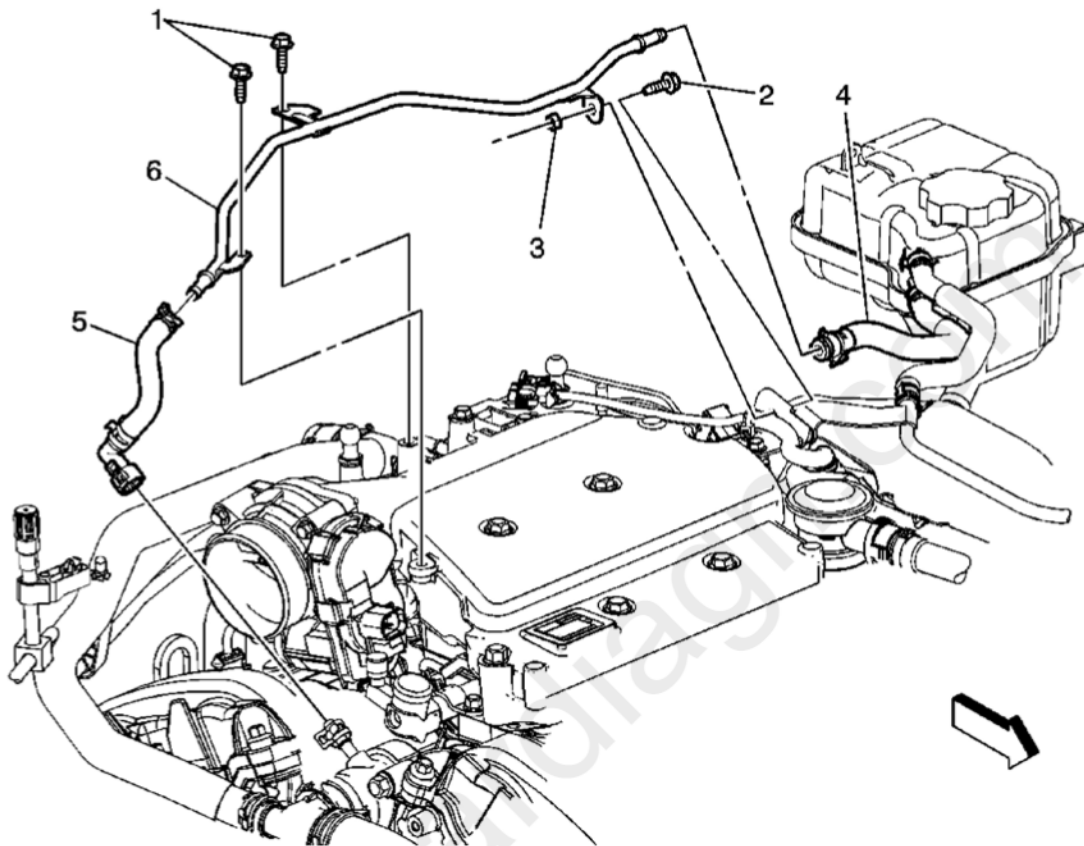


Fig. 68: Identifying Engine Coolant Air Bleed Pipe (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure - Partially drain the coolant system. - Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . - Reposition the power steering fluid reservoir. Refer to <u>Power Steering Fluid Reservoir Replacement (LAU)</u> or <u>Power Steering Fluid Reservoir Replacement (LF1)</u> - Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF1)</u> or <u>Air Cleaner Outlet Duct Replacement (LAU)</u> .	
1	Engine Coolant Air Bleed Pipe Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10N.m (88 lb in)
2	Retainer

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LAU)**Fig. 6 : Identifying Engine Coolant Air Bleed Pipe (LAU)**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Engine Coolant Air Bleed Pipe Retainer Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (7 lb ft)
2	Engine Coolant Air Bleed Pipe Retainer Bolt Tighten: 10 N.m (7 lb ft)
	Engine Coolant Air Bleed Nut

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

3	Tighten: 10 N.m (7 lb ft)
4	Radiator Surge Tank Inlet Hose
5	Engine Coolant Air Bleed Hose
6	Engine Coolant Air Bleed Pipe

WATER OUTLET REPLACEMENT

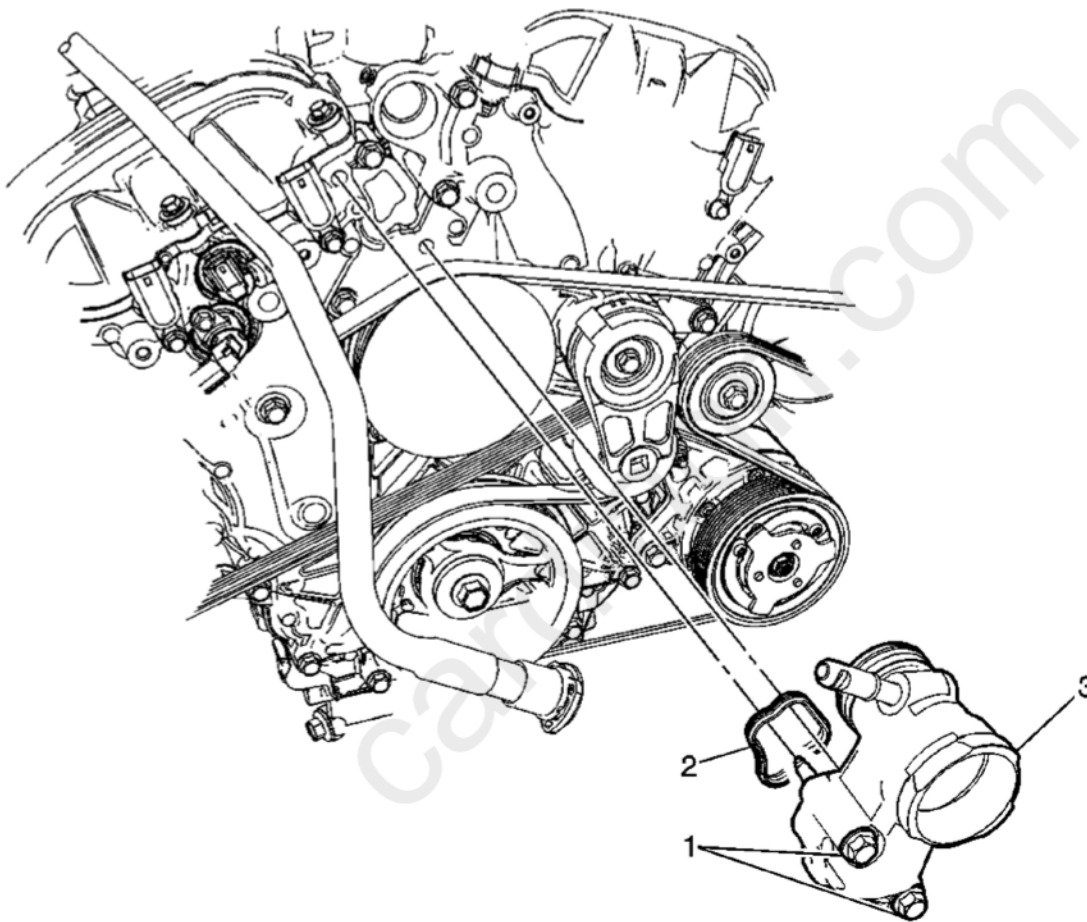


Fig. 7 : View Of Water Outlet
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1)</u> or <u>Cooling System Draining and Filling - Vac-N-Fill (GE 47716)</u> or <u>Cooling System Draining and Filling (Static Fill LAU)</u> .
2.	Remove the right engine mount bracket. Refer to <u>Engine Mount Replacement - Right Side</u>
3.	Remove the radiator inlet hose from the water outlet. Refer to <u>Radiator Inlet Hose Replacement</u>

and Filling (Static Fill LAU).

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LAU)** .
4. Remove the transmission heat shield. Refer to **Transmission Heat Shield Replacement (LAU)** .
5. Remove the radiator surge tank outlet hose. Refer to **Radiator Surge Tank Outlet Hose Replacement (LF1)** or **Radiator Surge Tank Outlet Hose Replacement (LAU)**.
6. Remove the heater outlet hose. Refer to **Heater Outlet Hose Replacement (LF1)** or **Heater Outlet Hose Replacement (LAU)** .

1	Radiator Surge tank outlet hose
2	heater outlet hose
3	heater outlet Pipe Retainer Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (7 lb ft)
4	Seal
5	heater hose outlet Pipe

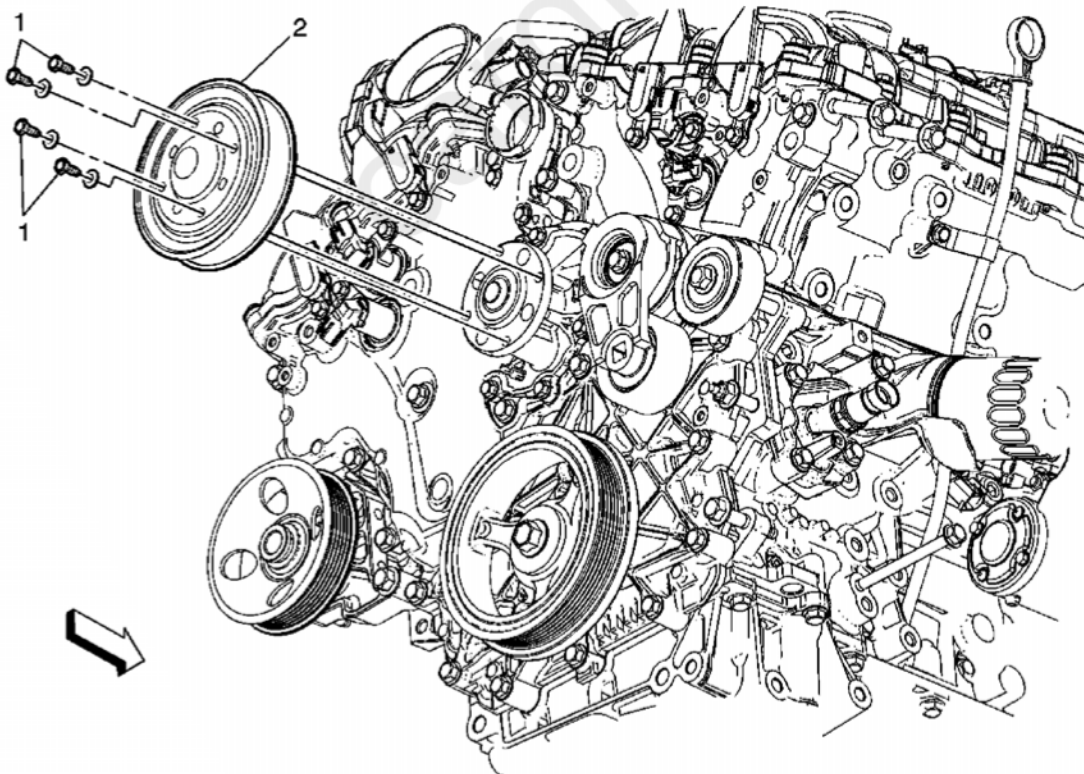
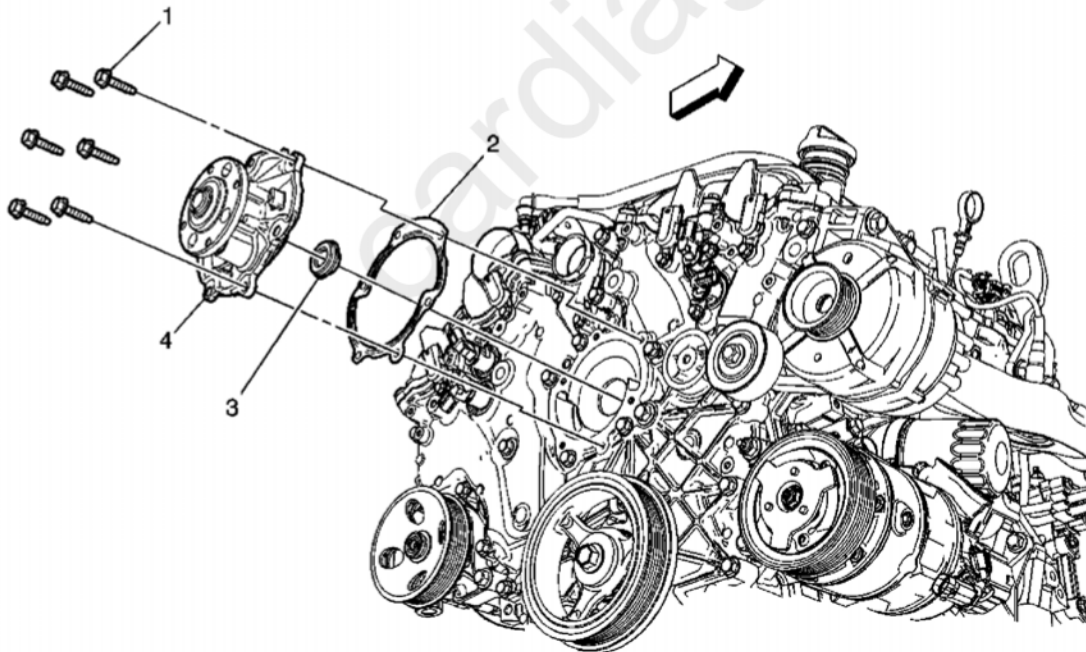
WATER PUMP PULLEY REPLACEMENT

Fig. 7 : View Of Water Pump Pulley

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary procedures: Remove the drive belt. Refer to <u>Drive Belt Replacement</u>	
1	Water Pump Pulley Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 12 N.m (9 lb ft) Tools Required: EN 461 4: water pump pulley holding tool or equivalent regional tools refer to <u>Special Tools</u>
2	Water Pump Pulley

WATER PUMP REPLACEMENT**Fig. 7 : Identifying Water Pump**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Clean gasket surfaces and replace water pump seal and gasket.

1	Water Pump Bolt (Qty: 6) CAUTION: Refer to Fastener Caution . Tighten: 10 N.m (88 lb in)
2	Water Pump Gasket
3	Water Pump Seal
4	Water Pump

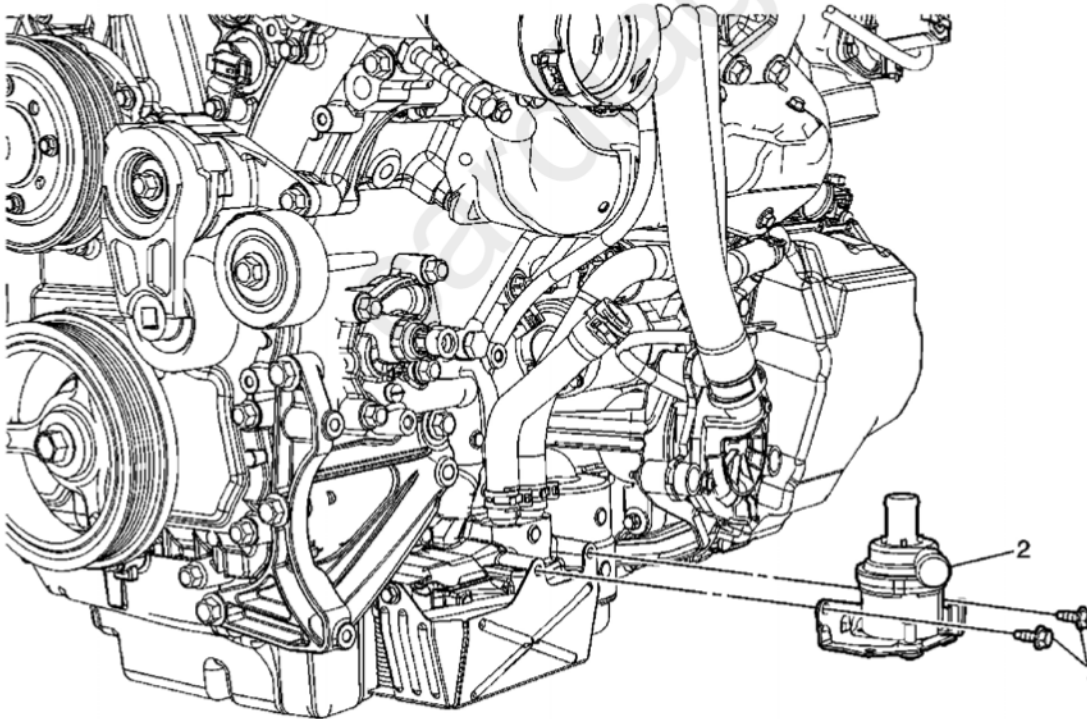
AUXILIARY WATER PUMP REPLACEMENT (LAU)

Fig. 74: Identifying Auxiliary Water Pump (LAU)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
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2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

Preliminary Procedures

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU)
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle
3. Remove the auxiliary water pump outlet hose. Refer to Auxiliary Water Pump Outlet Hose Replacement (LAU)
4. Remove the auxiliary water pump inlet hose. Refer to Auxiliary Water Pump Inlet Hose Replacement (LAU)
5. Disconnect electrical connector from auxiliary water pump.

1	Auxiliary Water Pump Bolts (Qty 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 12 N.m (8 lb ft)
2	Auxiliary Water Pump

RADIATOR DRAIN COCK REPLACEMENT (LF1)

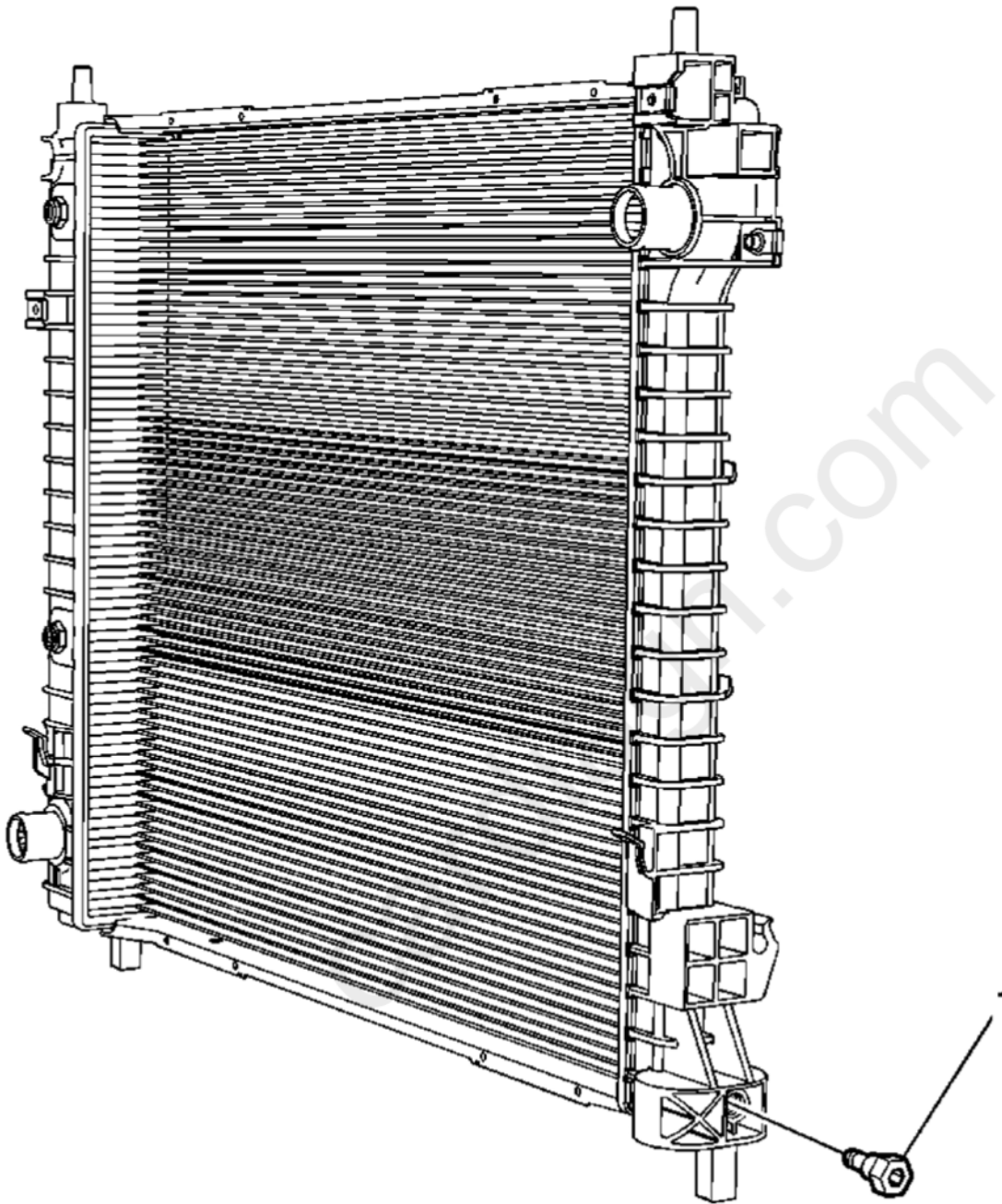


Fig. 75: View Of Radiator & Drain Cock (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>
2.	Remove the radiator air lower deflector. Refer to <u>Radiator Air Lower Deflector Replacement</u>

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

3. Place a drain pan under the right side lower radiator mount.

1	Radiator Drain Cock
---	---------------------

RADIATOR DRAIN COCK REPLACEMENT (LAU)

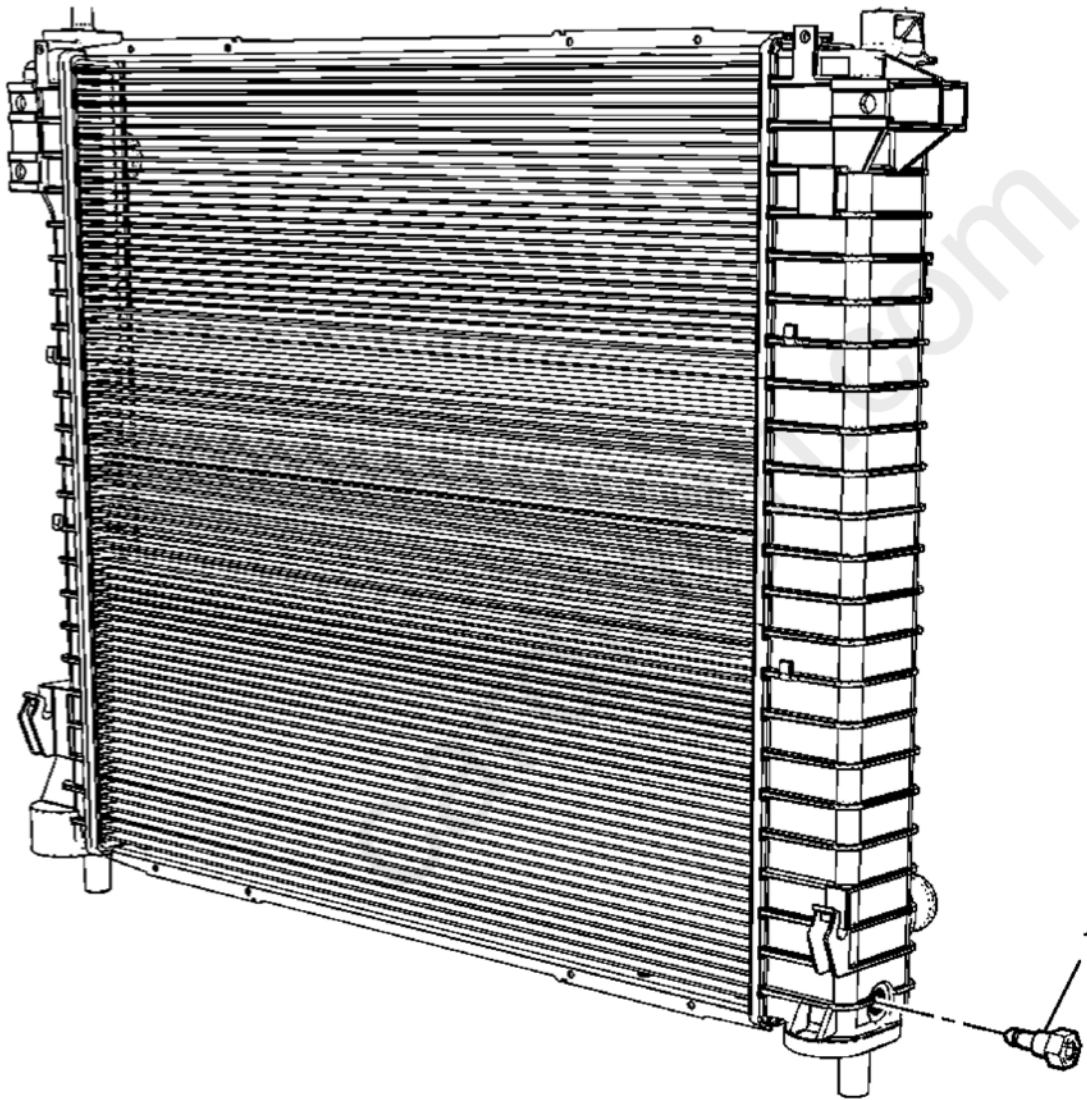


Fig. 76: View Of Radiator & Drain Cock (LAU)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>
2.	Remove the radiator air lower deflector. Refer to <u>Radiator Air Lower Deflector Replacement</u>

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

3. Place a drain pan under the left side lower radiator mount.

1	Radiator Drain Cock
---	---------------------

RADIATOR REPLACEMENT (LF1)

Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill LF1) or Cooling System Draining and Filling - Vac-N-Fill (GE 47716) or Cooling System Draining and Filling (Static Fill LAU).
2. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement
3. Remove the front compartment front sight shield. Refer to Front Compartment Front Sight Shield Replacement
4. Remove the primary latch bracket. Refer to Hood Primary Latch Bracket Replacement
5. Remove the cooling fan and shroud. Refer to Cooling Fan and Shroud Replacement (LF1) or Cooling Fan and Shroud Replacement (LAU)
6. Remove the radiator air upper seal. Refer to Radiator Air Upper Seal Replacement
7. Remove the radiator air lower seal. Refer to Radiator Air Lower Seal Replacement
8. Remove the radiator air side seal. Refer to Radiator Air Seal Replacement
9. Remove the radiator air side baffels. Refer to Radiator Air Side Baffle Replacement - Left Side and Radiator Air Side Baffle Replacement - Right Side
10. Remove the air conditioning condenser. Refer to Air Conditioning Condenser Replacement (LF1) or Air Conditioning Condenser Replacement (LAU)
11. Remove the radiator inlet hose. Refer to Radiator Inlet Hose Replacement (LF1) or Radiator Inlet Hose Replacement (LAU)
12. Remove the radiator outlet hose. Refer to Radiator Outlet Hose Replacement (LF1) or Radiator Outlet Hose Replacement (LAU)

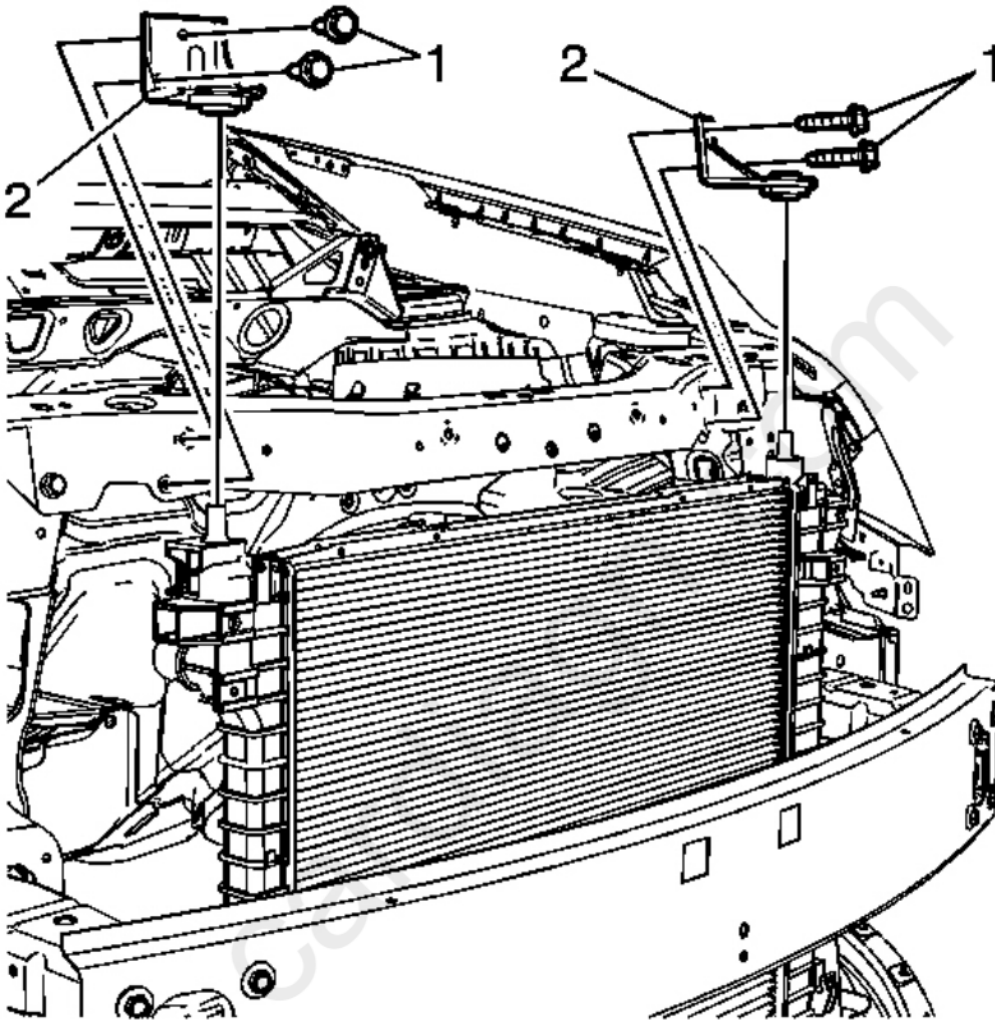


Fig. 77: Identifying Radiator Upper Support Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the radiator upper support bracket bolts (1).
14. Remove the radiator upper support brackets (2).

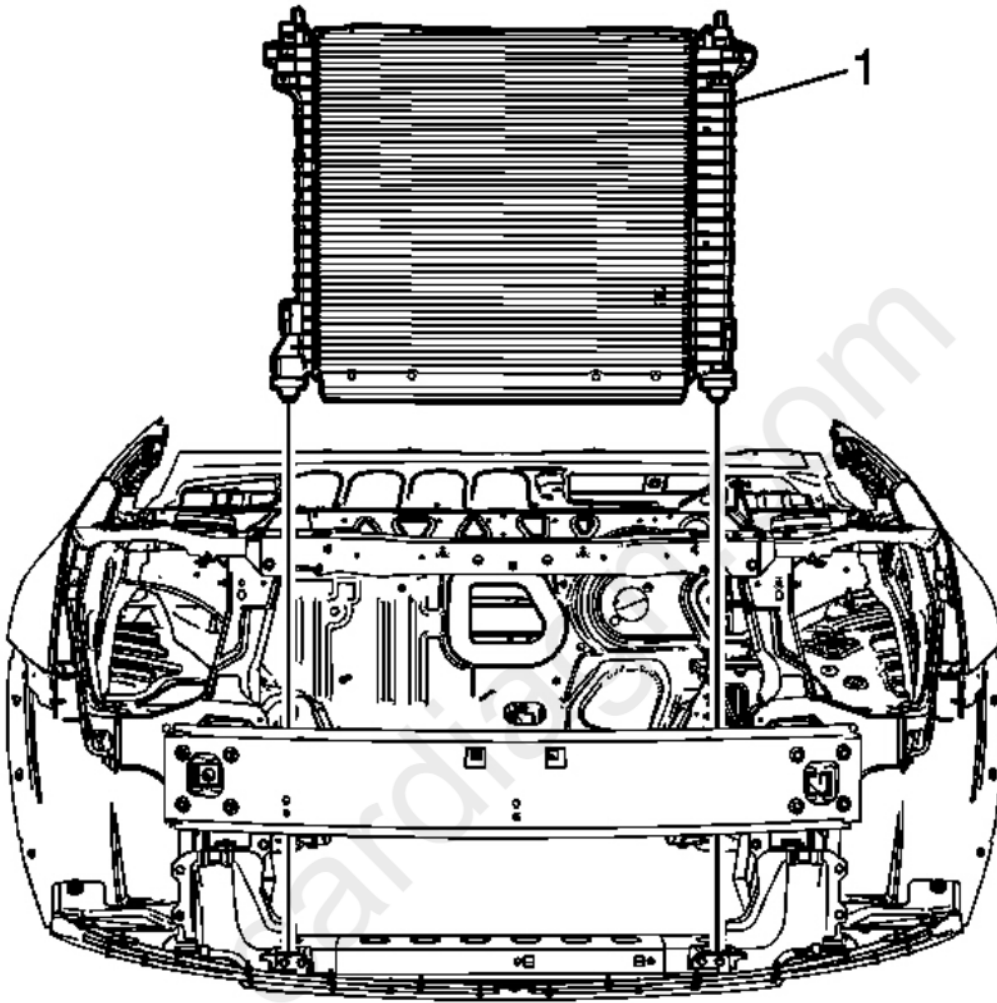


Fig. 78: View Of Radiator
Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

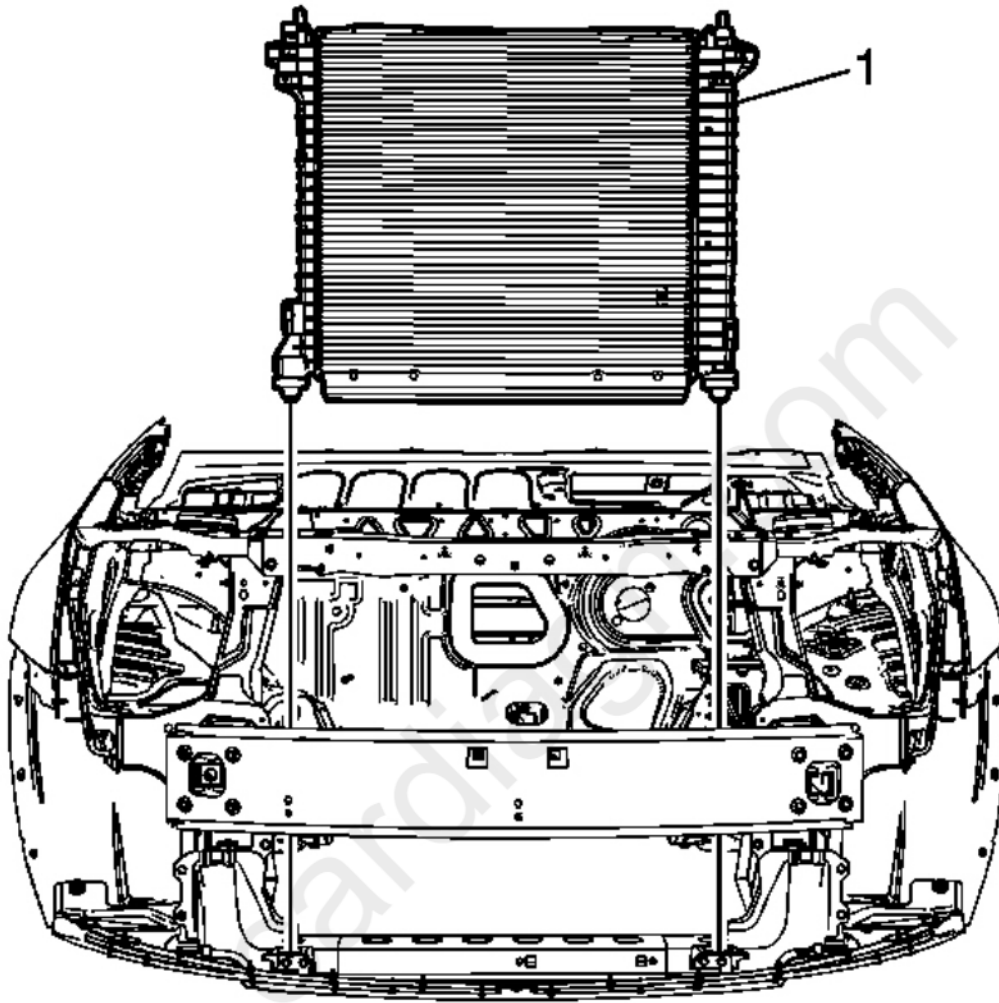


Fig. 7 : View Of Radiator

Courtesy of GENERAL MOTORS CORP.

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

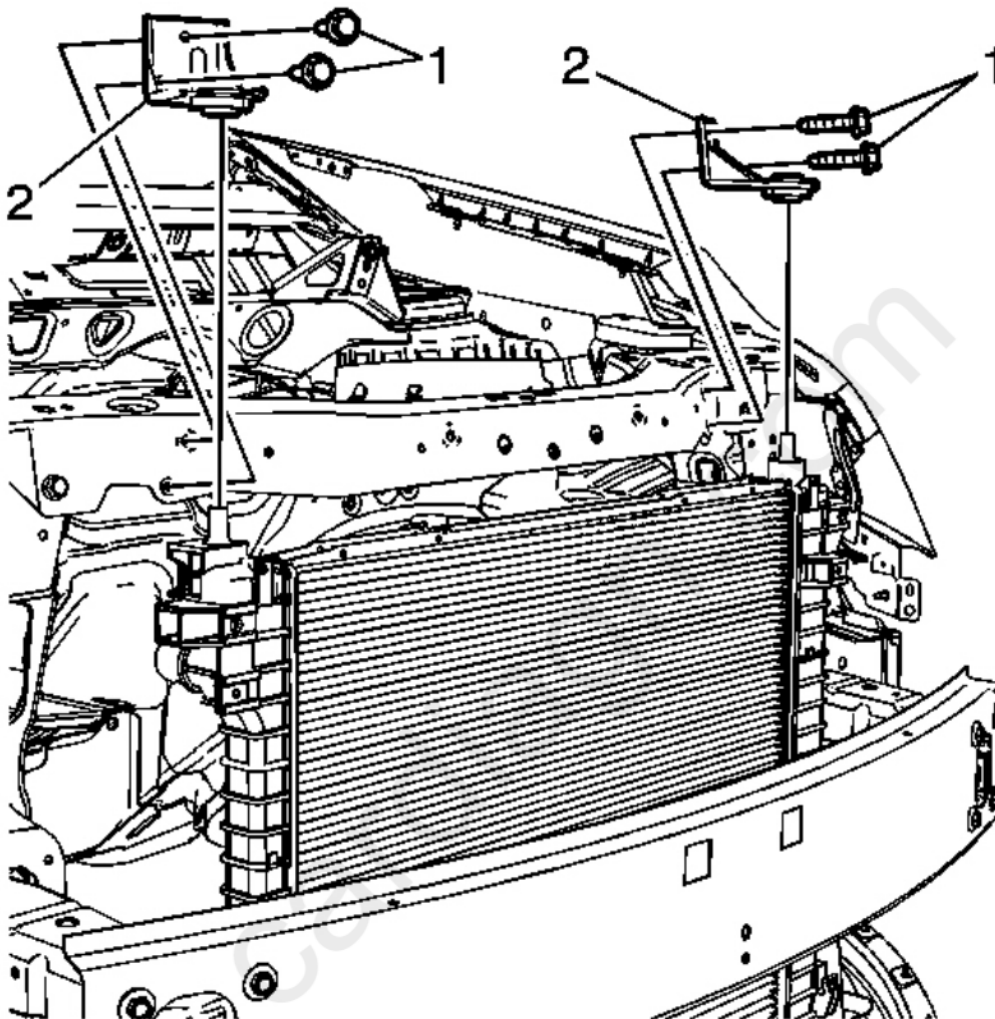


Fig. 8 : Identifying Radiator Upper Support Bracket & Bolts
 Courtesy of GENERAL MOTORS CORP.

2. Install the radiator upper support brackets (2).

CAUTION: Refer to Fastener Caution .

3. Install the radiator upper support bracket bolts (1) and tighten to 9 N.m (80 lb in).
4. Install the radiator outlet hose. Refer to Radiator Outlet Hose Replacement (LF1) or Radiator Outlet Hose Replacement (LAU)

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

5. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF1)** or **Radiator Inlet Hose Replacement (LAU)**
6. Install the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LF1)** or **Air Conditioning Condenser Replacement (LAU)**
7. Install the radiator air side baffles. Refer to **Radiator Air Side Baffle Replacement - Left Side** and **Radiator Air Side Baffle Replacement - Right Side**
8. Install the radiator air side seal. Refer to **Radiator Air Seal Replacement**
9. Install the radiator air lower seal. Refer to **Radiator Air Lower Seal Replacement**
10. Install the radiator air upper seal. Refer to **Radiator Air Upper Seal Replacement**
11. Install the cooling fan and shroud. Refer to **Cooling Fan and Shroud Replacement (LF1)** or **Cooling Fan and Shroud Replacement (LAU)**
12. Install the primary latch bracket. Refer to **Hood Primary Latch Bracket Replacement**
13. Install the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement**
14. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement**
15. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.

RADIATOR REPLACEMENT (LAU)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.
2. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement**.
3. Remove the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement**.
4. Remove the primary latch bracket. Refer to **Hood Primary Latch Bracket Replacement**.
5. Remove the cooling fan and shroud. Refer to **Cooling Fan and Shroud Replacement (LF1)** or **Cooling Fan and Shroud Replacement (LAU)**.
6. Remove the radiator air upper seal. Refer to **Radiator Air Upper Seal Replacement**.
7. Remove the radiator air lower seal. Refer to **Radiator Air Lower Seal Replacement**.
8. Remove the radiator air side seal. Refer to **Radiator Air Seal Replacement**.
9. Remove the radiator air side baffles. Refer to **Radiator Air Side Baffle Replacement - Left Side** and **Radiator Air Side Baffle Replacement - Right Side**.
10. Remove the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LF1)** or **Air Conditioning Condenser Replacement (LAU)**.
11. Remove the charge air cooler. Refer to **Charge Air Cooler Replacement (LAU)**.
12. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF1)** or **Radiator Inlet Hose Replacement (LAU)**.

13. Remove the radiator outlet hose. Refer to Radiator Outlet Hose Replacement (LF1) or Radiator Outlet Hose Replacement (LAU).

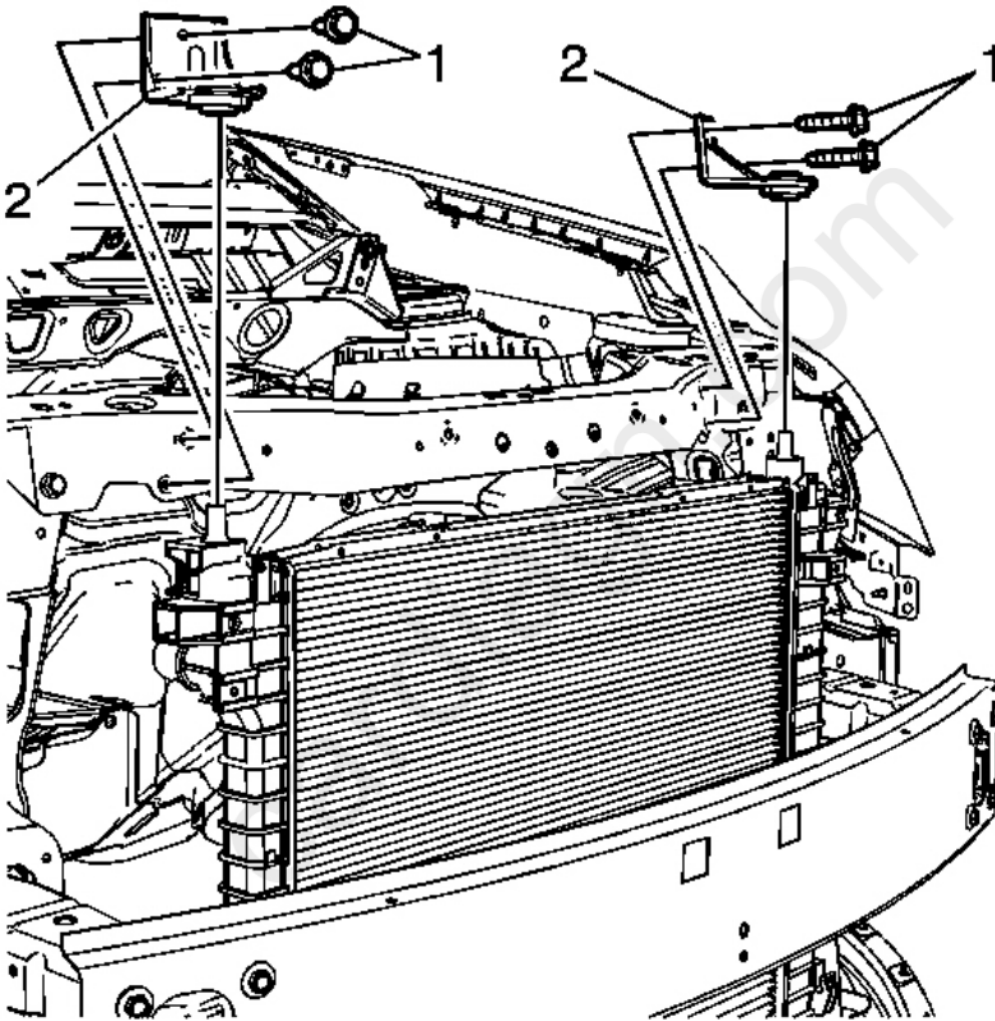


Fig. 81: Identifying Radiator Upper Support Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the radiator upper support bracket bolts (1).
15. Remove the radiator upper support brackets (2).

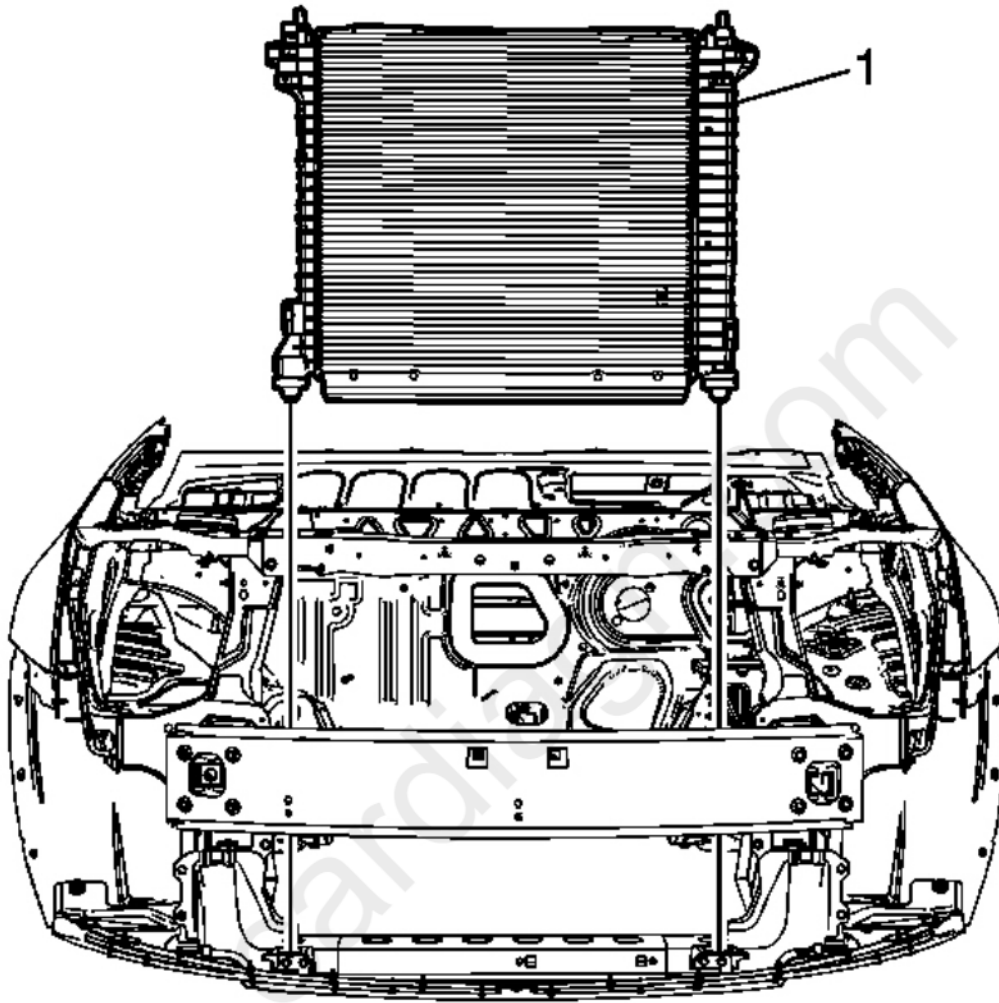


Fig. 82: View Of Radiator
Courtesy of GENERAL MOTORS CORP.

16. Remove the radiator (1) from the vehicle.

Installation Procedure

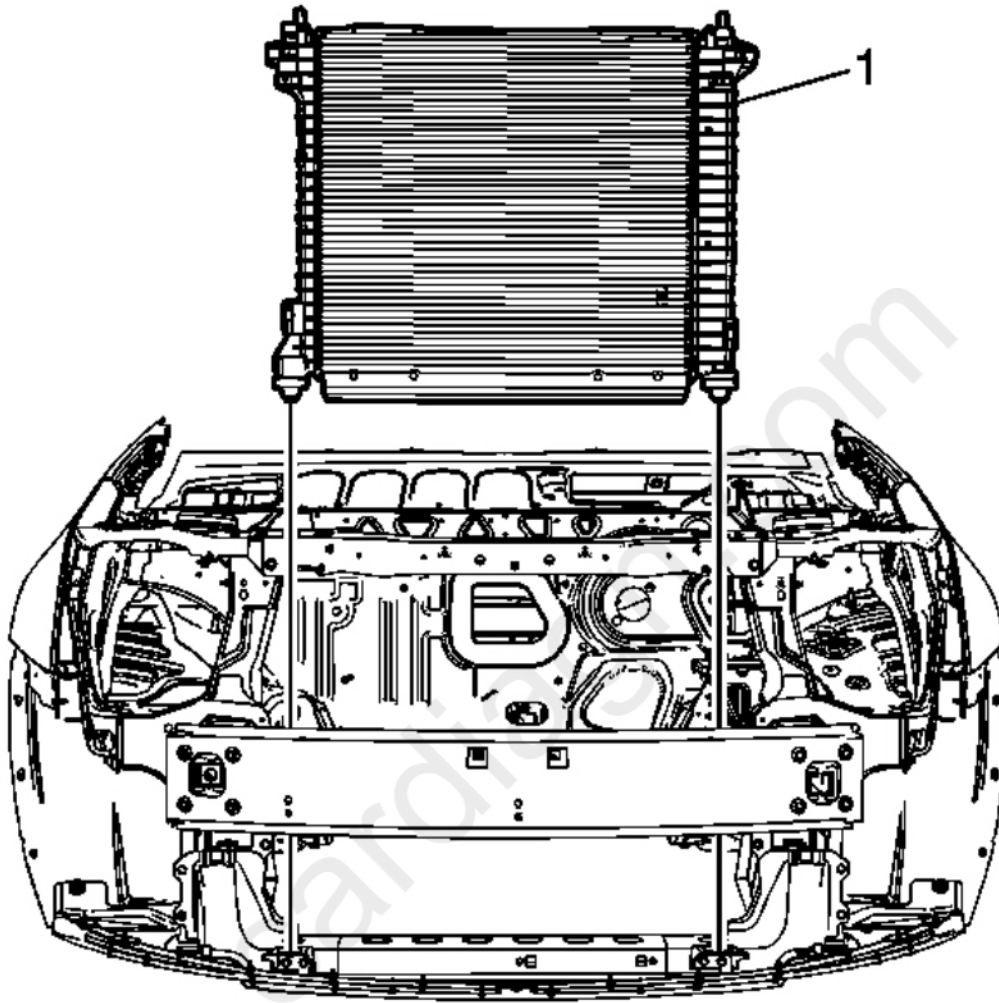


Fig. 83: View Of Radiator

Courtesy of GENERAL MOTORS CORP.

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

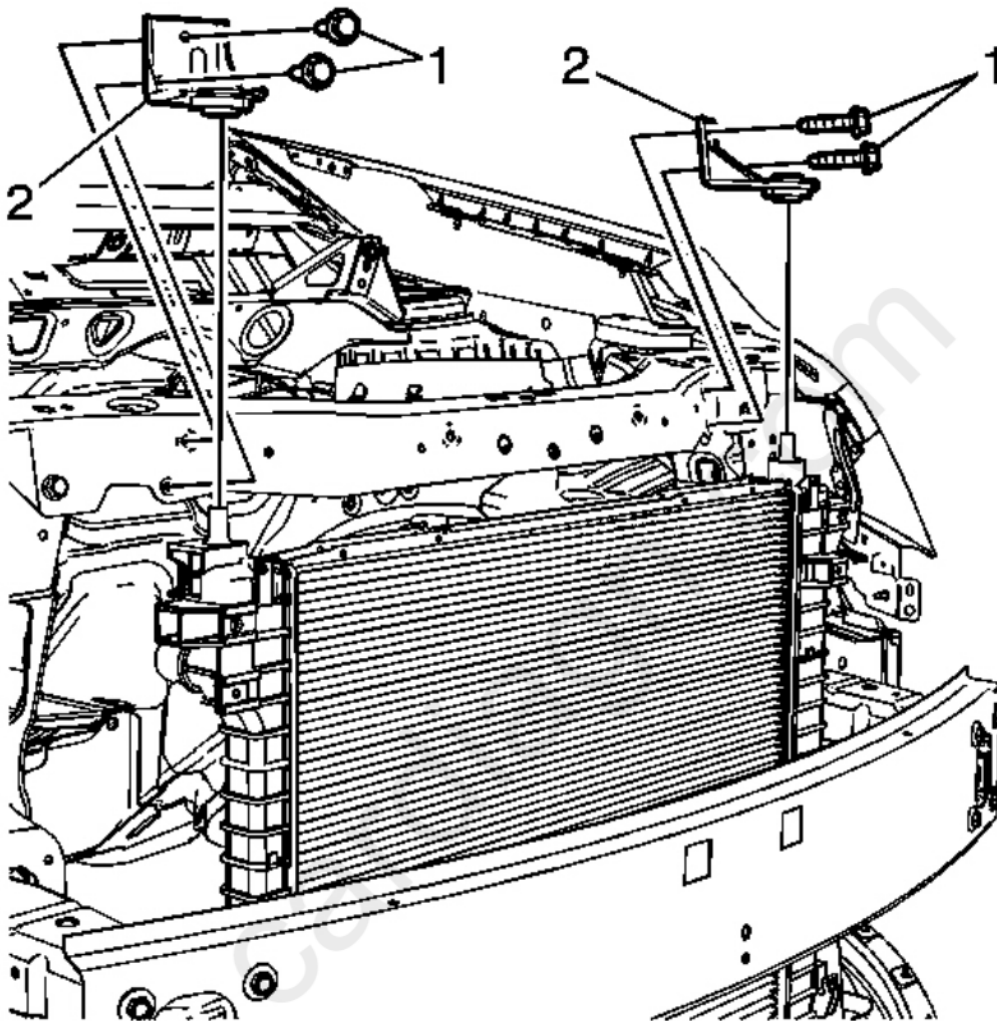


Fig. 84: Identifying Radiator Upper Support Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the radiator upper support brackets (2).

CAUTION: Refer to Fastener Caution .

3. Install the radiator upper support bracket bolts (1) and tighten to 9 N.m (80 lb in).
4. Install the radiator outlet hose. Refer to Radiator Outlet Hose Replacement (LF1) or Radiator Outlet Hose Replacement (LAU).

5. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF1)** or **Radiator Inlet Hose Replacement (LAU)**.
6. Install the charge air cooler. Refer to **Charge Air Cooler Replacement (LAU)**.
7. Install the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LF1)** or **Air Conditioning Condenser Replacement (LAU)**.
8. Install the radiator air side baffles. Refer to **Radiator Air Side Baffle Replacement - Left Side** and **Radiator Air Side Baffle Replacement - Right Side**.
9. Install the radiator air side seal. Refer to **Radiator Air Seal Replacement**.
10. Install the radiator air lower seal. Refer to **Radiator Air Lower Seal Replacement**.
11. Install the radiator air upper seal. Refer to **Radiator Air Upper Seal Replacement**.
12. Install the cooling fan and shroud. Refer to **Cooling Fan and Shroud Replacement (LF1)** or **Cooling Fan and Shroud Replacement (LAU)**.
13. Install the primary latch bracket. Refer to **Hood Primary Latch Bracket Replacement**.
14. Install the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement**.
15. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement**.
16. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1)** or **Cooling System Draining and Filling - Vac-N-Fill (GE 47716)** or **Cooling System Draining and Filling (Static Fill LAU)**.

RADIATOR AIR SIDE BAFFLE REPLACEMENT - LEFT SIDE

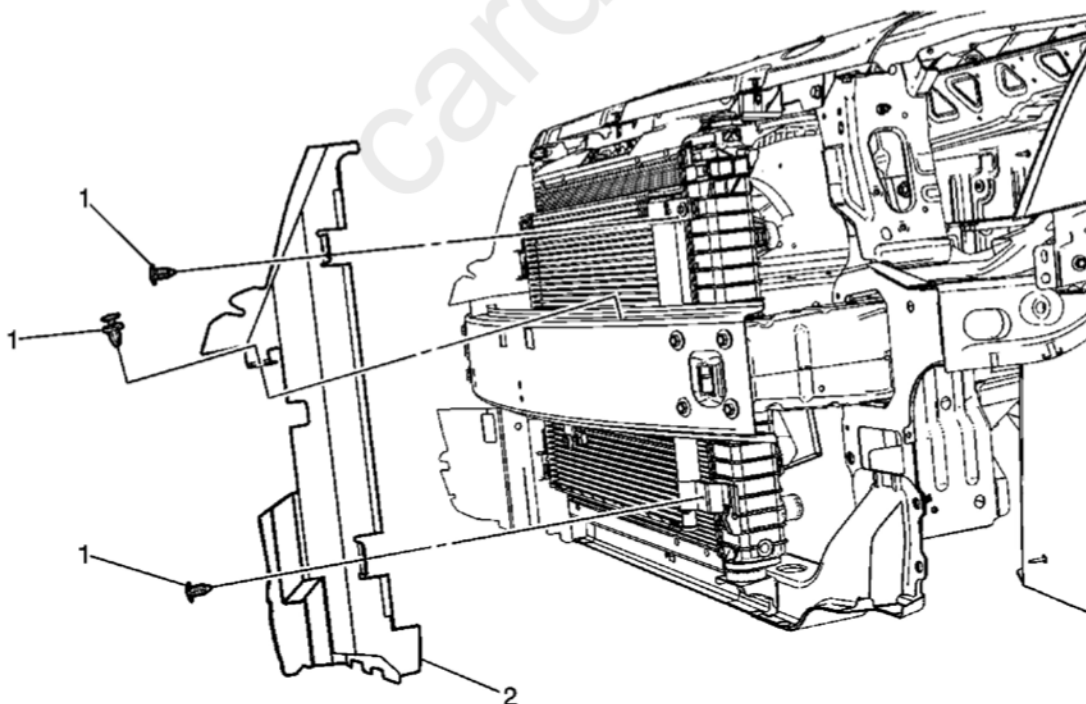


Fig. 85: Identifying Radiator Air Side Baffle \- Left Side

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

Courtesy of FINE AL AUTO SCO P

Callout	Component Name
Preliminary Procedures	
Remove front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u>	
1	Radiator Air Side Baffle And Deflector Retainers (Qty 3)
2	Radiator Air Side Baffle And Deflector Left

ADIATOR AIR SIDE Baffle And Deflector Left

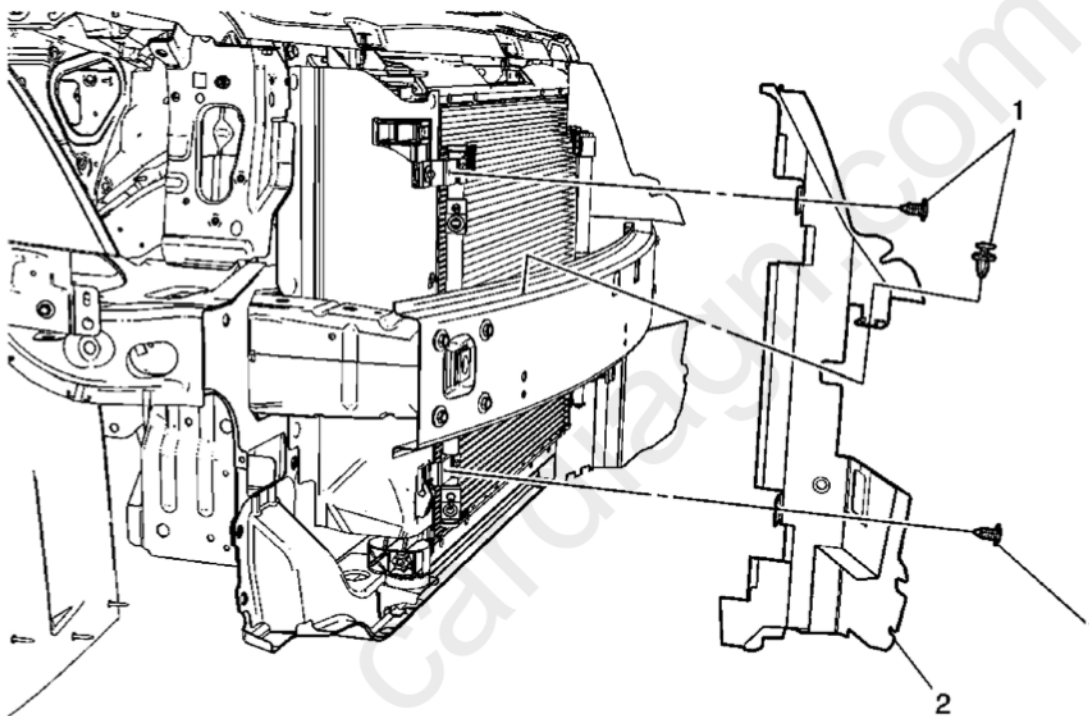


Fig. 1 Installing Radiator Air Side Baffle And Deflector Left Side
Courtesy of FINE AL AUTO SCO P

Callout	Component Name
Preliminary Procedures	
Remove front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u>	
1	Radiator Air Side Baffle And Deflector Retainers (Qty 3)
2	Radiator Air Side Baffle And Deflector Right

ADIATOR AIR SEAL Replacement

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

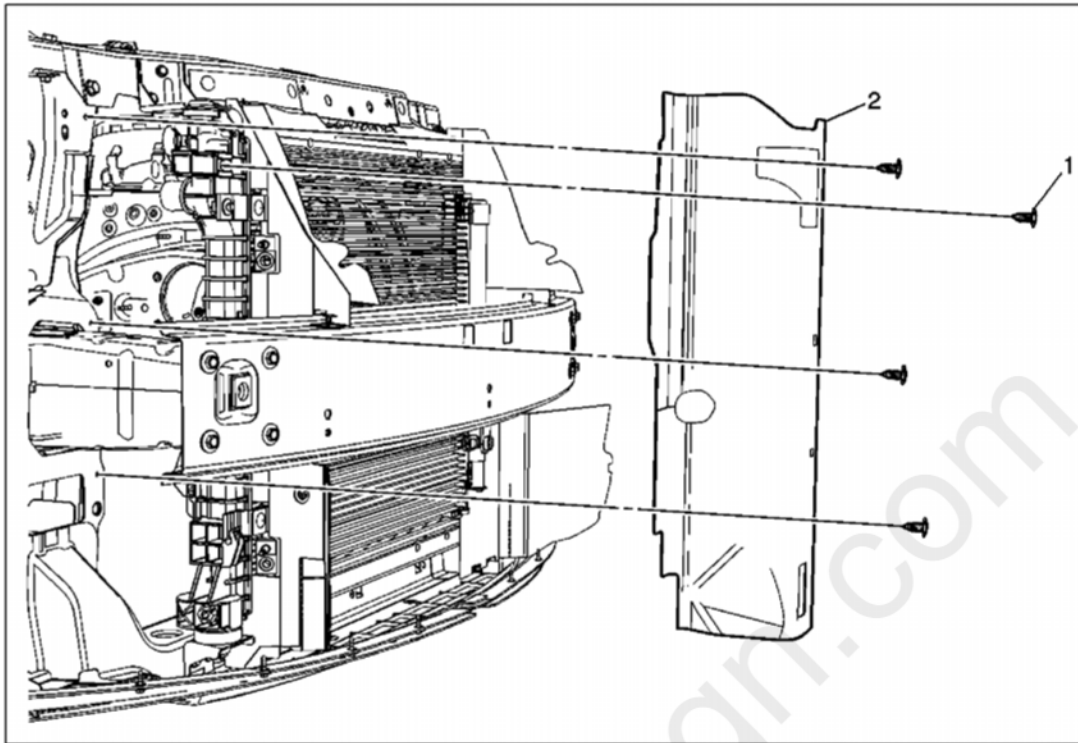


Fig. 1 Installing a Radiator Air Seal
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u>	
2. Unbolt and reposition the air conditioning condenser. Refer to <u>Air Conditioning Condenser Replacement (L)</u> or <u>Air Conditioning Condenser Replacement (LAU)</u>	
1	Radiator Air Seal Retainers (Qty 4)
2	Radiator Air Seal

RADIATOR AIR SUPPLY SEAL REPLACEMENT

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

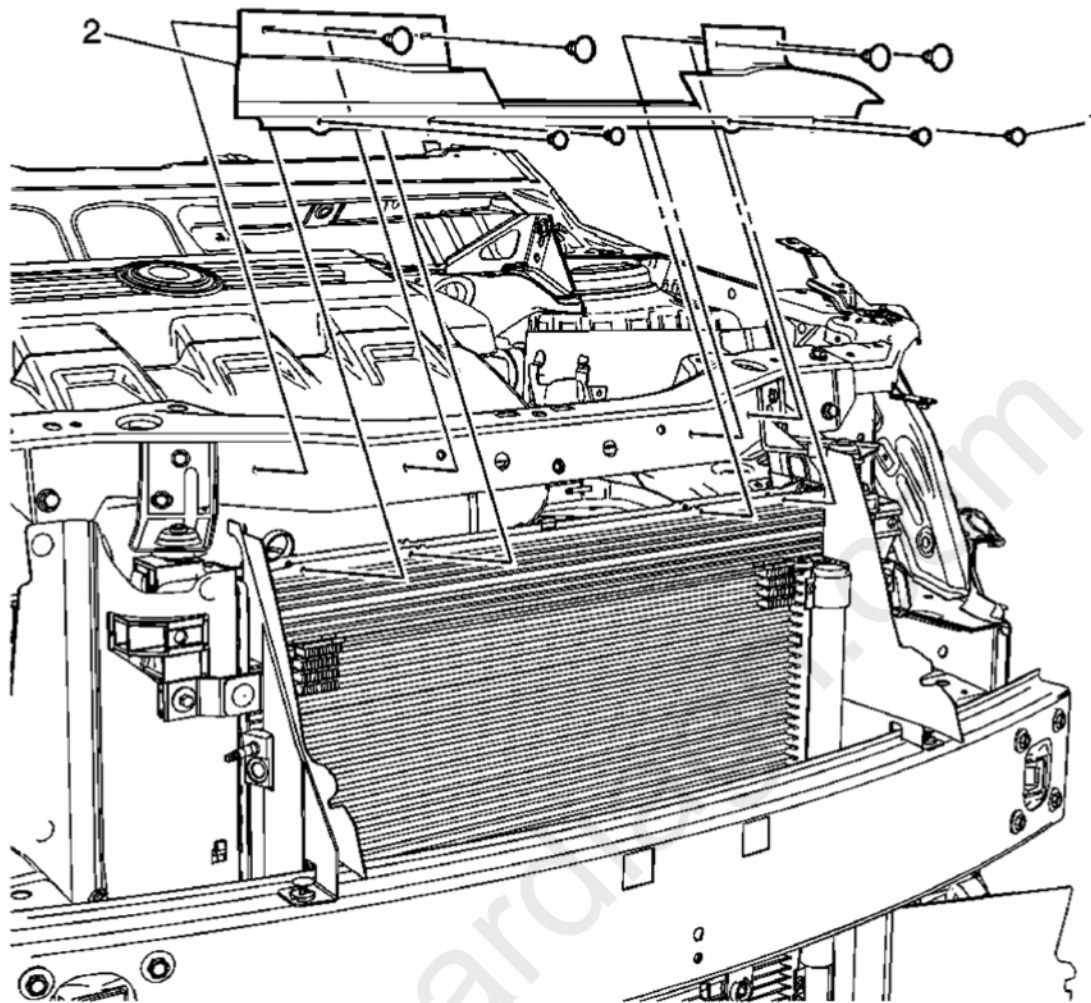


Fig. 1 Installing Radiator Air Upper Seal
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures Remove the front bumper fascia upper support. Refer to Front Bumper Fascia Upper Support Replacement	
1	Radiator Air Upper Seal Retainers (Qty 8)
2	Radiator Air Upper Seal

RADIATOR AIR UPPER SEAL REPLACEMENT

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

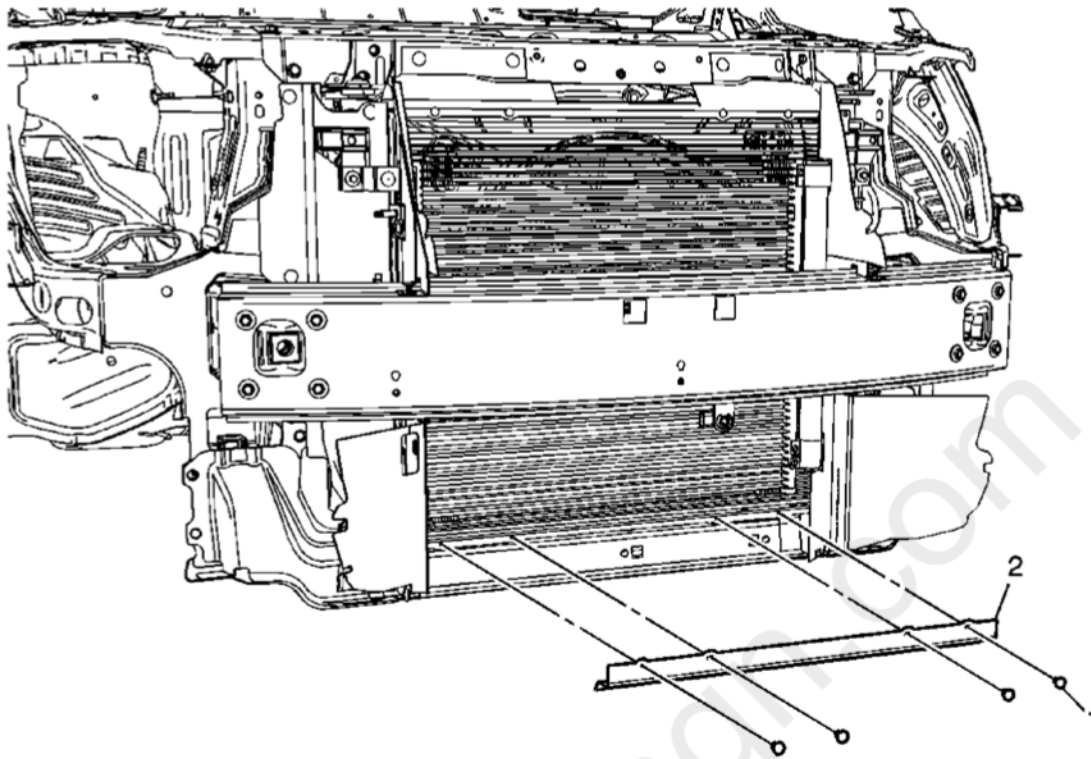


Fig. 1 Installing Radiator Air Lower Seal
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
Remove the radiator air lower deflector. Refer to <u>Radiator Air Lower Deflector Replacement</u>	
1	Radiator Air Lower Seal Retainers (Qty 4)
2	Radiator Air Lower Seal

ENGINE COOLANT HEATER REPLACEMENT (L)

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

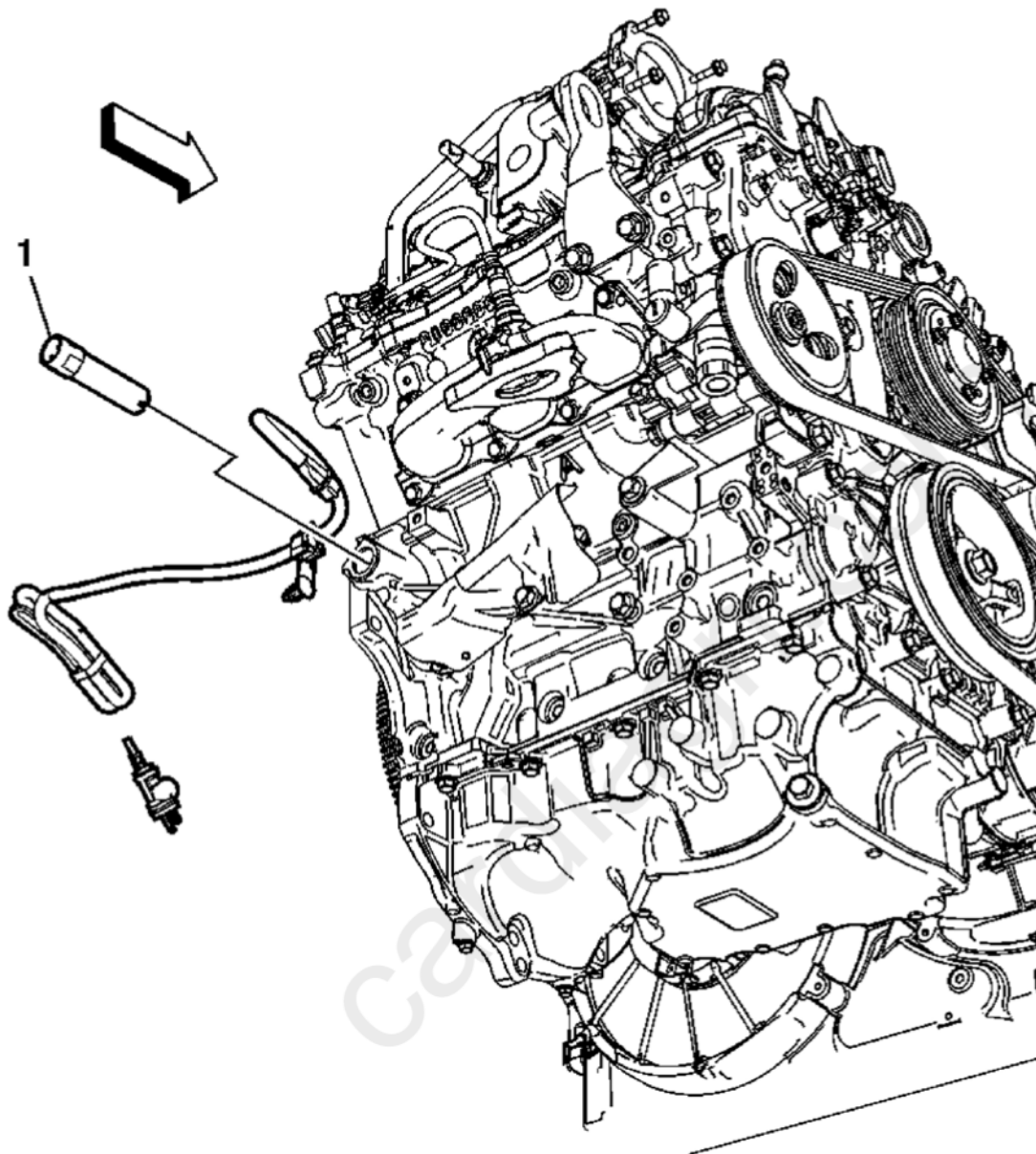


Fig. 1 Identifying Engine Coolant Heater (L)
 Courtesy of GENERAL MOTORS CORP.

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

COOLANT HEATER COOLD REPLACEMENT (L)

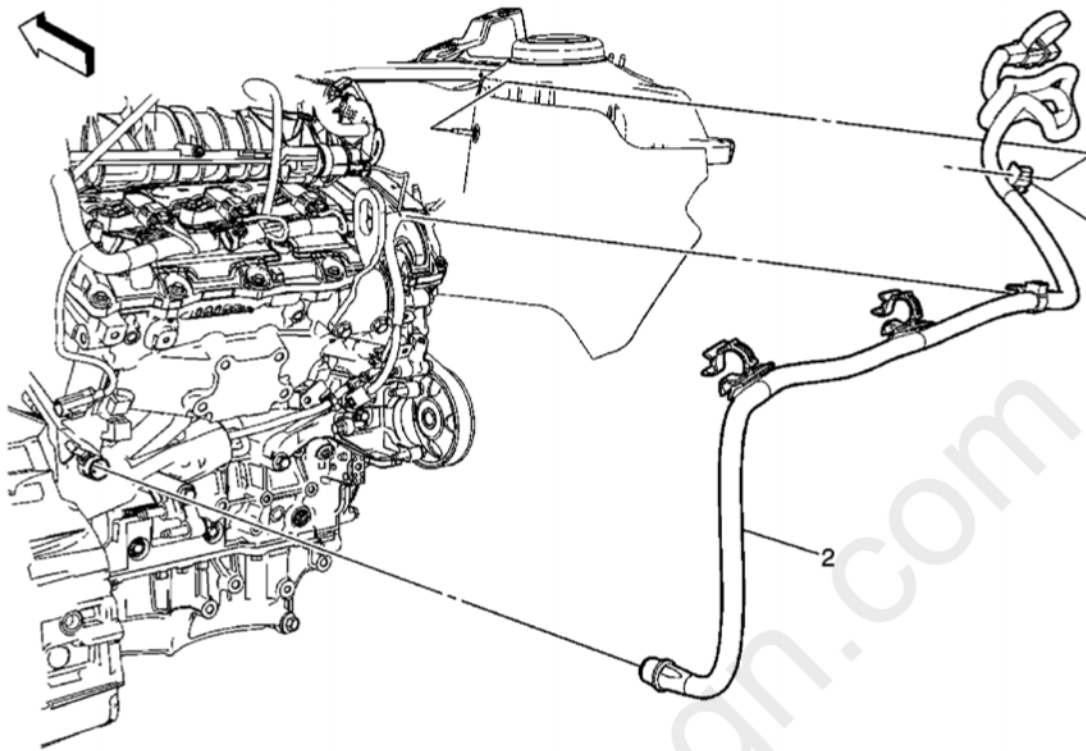


Fig. 1: Identifying Coolant Heater Cord (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Retainer CAUTION R a Ca i
2	Coolant Heater Cord

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION (LAU)

Cooling Fan Control

The engine cooling fan system is composed of one electric cooling fan and a control module, which is part of the cooling fan and motor assembly. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, which allows the cooling fan to operate at variable speeds.

The cooling fan speed is effected by many different conditions and the ECM will adjust the duty cycle from 0-100 percent based on cooling system requirements. The scan tool output control is only capable of operating the cooling fan increments, between 10- 0 percent. 0 percent is considered high speed fan. When multiple cooling fan speed requests are received, the ECM operates the fan at the highest of speed requests. The ECM commands the fans ON under the following conditions

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

COOLING FAN DESCRIPTION AND OPERATION (LF1)

The engine cooling fan system is composed of one electric cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two separate resistors mounted in the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

Low Speed Operation

The ECM applies ground at the FAN 1 control circuit for the coil side of the cooling fan relay. The energized cooling fan relay completes a ground, through the switch side of the relay, for the coils of the cooling fan low speed relay and the cooling fan speed control relay. The speed control relay activates and supplies B+ to the coil side of the cooling fan high speed relay. The high speed relay remains inactive because the ECM is not commanding the FAN 2 control circuit ON. The energized low speed relay switch closes to supply B+ through the external low speed resistor, to the engine cooling fan motor. The result is cooling fan operation at a reduced speed.

Medium Speed Operation

The ECM applies ground at the FAN 2 control circuit for the coil side of the cooling fan high speed, and medium speed relays. The high speed relay remains inactive because the ECM is not commanding the FAN 1 control circuit ON. The energized medium speed relay switch closes to supply B+ through the external medium speed resistor, to the engine cooling fan motor. The result is cooling fan operation at a medium speed.

High Speed Operation

The ECM applies ground at the FAN 1 control circuit for the coil side of the cooling fan relay. The energized cooling fan relay completes a ground, through the switch side of the relay, for the coil of the cooling fan speed control relay. The energized speed control relay switch closes to supply B+ to the coil side of cooling fan high speed relay. Simultaneously, the ECM applies ground at the FAN 2 control circuit for the coil side of the cooling fan high speed relay. The energized high speed relay switch closes to supply B+ directly to the engine cooling fan motor, by-passing the external resistors. The result is cooling fan operation at full speed.

COOLING SYSTEM DESCRIPTION AND OPERATION

Cooling Fan Description and Operation

For cooling fan description and operation, refer to **Cooling Fan Description and Operation (LAU)** or **Cooling Fan Description and Operation (LF1)**.

Engine Coolant

Engine coolant is the key element of the heating system. The engine thermostat controls the normal engine operating coolant temperature. Coolant pumped out of the engine block enters the heater core through the inlet heater hose. The air flowing through the HVAC module absorbs the heat of the coolant flowing through the heater core. The coolant then exits the heater core through the heater outlet hose. To prevent the coolant from boiling after the engine is turned off an after-boil heater coolant pump is used on the LA turbo engine only.

The HVAC control module will command the after-boil heater coolant pump on when the engine is off under the following conditions

- The engine is OFF.
- The engine coolant temperature is greater than 101 °C (214 °F).

The above coolant flow circuits are designed to show the coolant flow related to the coolant by-pass valve positions only. The thermostat function and thermostat coolant flow paths are not shown.

Coolant Warning Messages

The radio will display the following messages if the following conditions exist in the cooling system.

- Engine hot-A/C OFF, is displayed if the coolant temperature is greater than 117 °C (243 °F) for domestic vehicles or 115 °C (23 °F) for imports.
- Engine coolant hot-idle engine, is displayed if the coolant temperature is greater than 118 °C (245 °F).
- Engine overheated-stop engine, is displayed if the coolant temperature is greater than 123 °C (253 °F).

Coolant Level Control

The low engine coolant level indicator lamp is located in, and controlled by the instrument panel cluster (IPC). The engine coolant level switch is located in the engine coolant surge tank. The switch remains open when surrounded by coolant. When the engine coolant level switch is closed for greater than 10 seconds, indicating low coolant, the IPC will turn ON the Low Coolant Indicator lamp. The lamp will also illuminate for approximately 3 seconds during the display test at the start of each ignition cycle.

Coolant Heater

The optional engine coolant heater (RPO 05) operates using 110-volt AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather - 2 °C (-20 °F). The coolant heater helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. A weather shield on the cord is provided to protect the plug when not in use.

Cooling System

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

Cooling Cycle

The thermostat is located between the radiator outlet and the water pump inlet. At normal operating temperature, coolant is drawn from the radiator outlet and into the water pump inlet by the water pump. In cold conditions, the thermostat will bypass the radiator, and the pump will draw coolant directly from the engine outlet.

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

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

From the cylinder heads, the coolant is then forced to the engine outlet. Coolant leaves the engine through three different routes

1. Through the engine outlet fitting to the radiator. This path is blocked at cold conditions by the thermostat at the engine inlet fitting.
2. To the heater core for passenger compartment heat and defrost.
3. Through the vent hose to the surge tank, providing continuous direction of the cooling system.

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

Radiator

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

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

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

Pressure Cap

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

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

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

Water Pump

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX

out, dirt and water cannot get in as long as the seal is not damaged or worn.

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

Thermostat

The thermostat is a coolant flow control component. Its purpose is to regulate the operating temperature of the engine. It utilizes a temperature sensitive wax-pellet element. The element connects to a valve through a piston. When the element is heated, it expands and exerts pressure against a rubber diaphragm. This pressure forces the valve to open. As the element is cooled, it contracts. This contraction allows a spring to push the valve closed.

When the coolant temperature is below the rated thermostat opening temperature, the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches rated thermostat opening temperature, the thermostat valve will open. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after it has opened. This restriction creates a pressure difference which prevents cavitation at the water pump and forces coolant to circulate through the engine block.

Engine Oil Heat Exchanger (LAU)

The engine oil heat exchanger is mounted to the side of the engine block. Oil is pumped through the oil cooler heat exchanger then back through the engine for lubrication.

Transmission Oil Cooler

The transmission oil cooler is a heat exchanger located in the side tank of the radiator. The transmission oil temperature is regulated by the temperature of the coolant leaving the radiator and passing over the heat exchanger. Lines from the transmission bring oil pumped at a high pressure to the cooler and back to the transmission.

Transmission Oil Cooler Lines

The transmission oil cooler is an oil-to-air heat exchanger located between the transmission and the radiator. Lines from the transmission bring oil pumped to the cooler and back to the transmission. A thermal bypass valve provides uninterrupted transmission oil flow for low ambient temperature conditions.

Power Steering Oil Cooler

Vehicles are equipped with a power steering oil cooler. This cooler transfers heat from the power steering system to the air passing over the cooler.

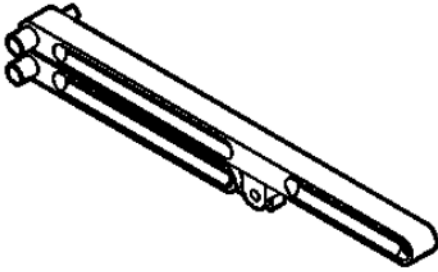
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

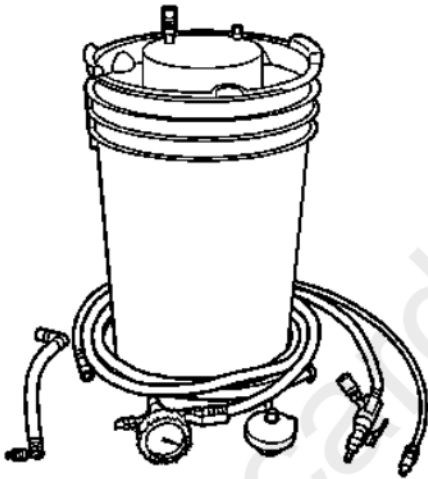
Illustration	Tool Number/Description
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2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX



EN 46104
J 46104
Water Pump Pulley Holding Tool

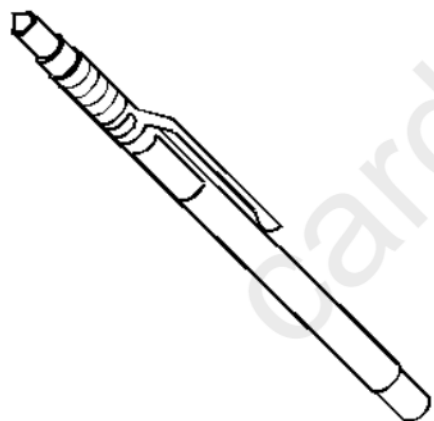
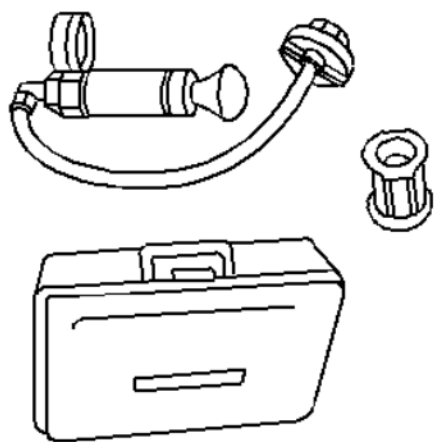


GE 47716
Vac N Fill Coolant Refill Tool

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

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX



GE 24731

J 24731

Tempilstick

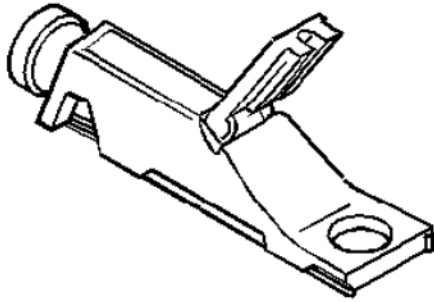
GE 26568

J 26568

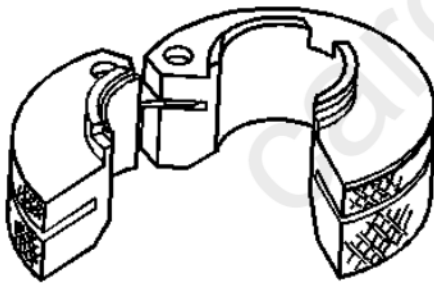
Coolant and Battery Fluid Tester

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX



EN 28410
J 28410
Gasket Remover (Aluminum Components)

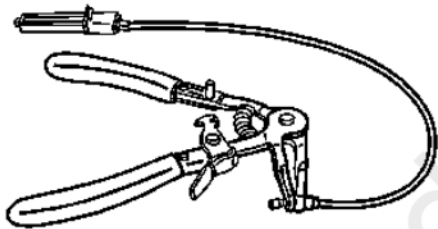
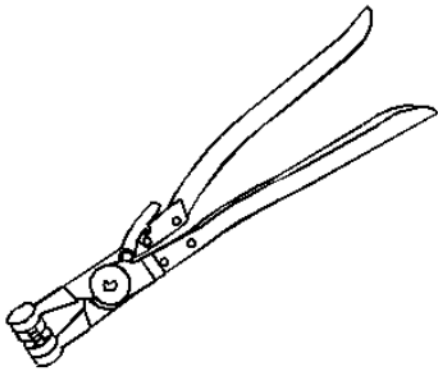


DT 41623-B
J 41623-B
Quick Connect Tool

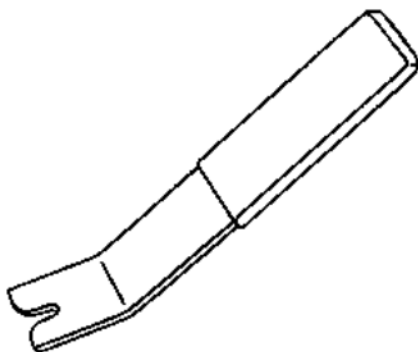
BO 38185
J 38185
Hose Clamp Pliers

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX



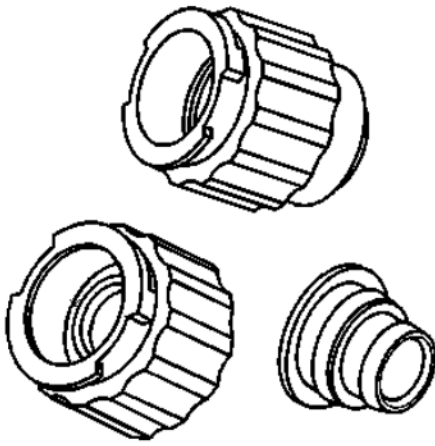
GE 47622
Hose Clamp Pliers



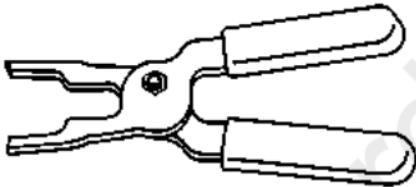
BO 38778
J 38778
Door Trim Clip Remover

2010 Cadillac SRX

2010 ENGINE Engine Cooling - SRX



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



EL 43244
J 43244
Relay Puller Pliers

