

2007 Saturn Outlook XE

2007 ENGINE Engine Cooling - Outlook

2007 ENGINE

Engine Cooling - Outlook

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Thermostat Housing Bolts	10 N.m	89 lb in
Thermostat Housing Bracket Bolt	50 N.m	37 lb ft
Water Outlet Housing Bolts	10 N.m	89 lb in
Water Pump Bolts	10 N.m	89 lb in
Water Pump Pulley Bolts	10 N.m	89 lb in

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE COOLING SCHEMATICS

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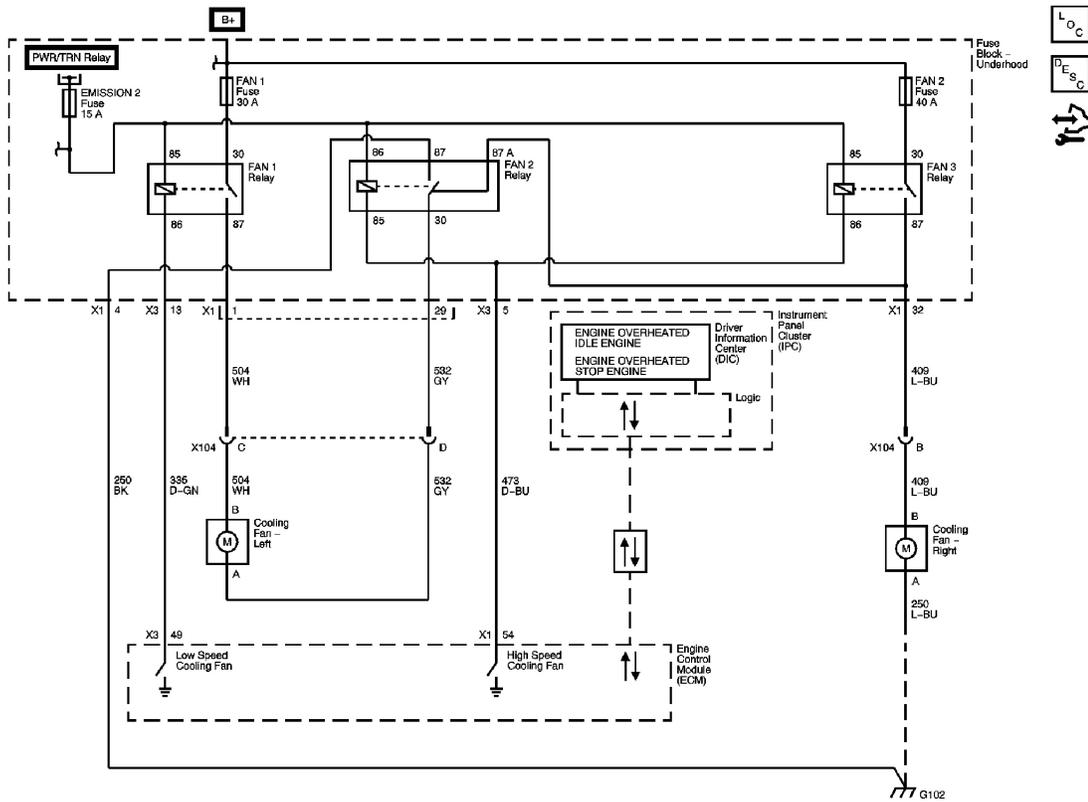


Fig. 1: Engine Cooling Schematic
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

COOLING SYSTEM COMPONENT VIEWS

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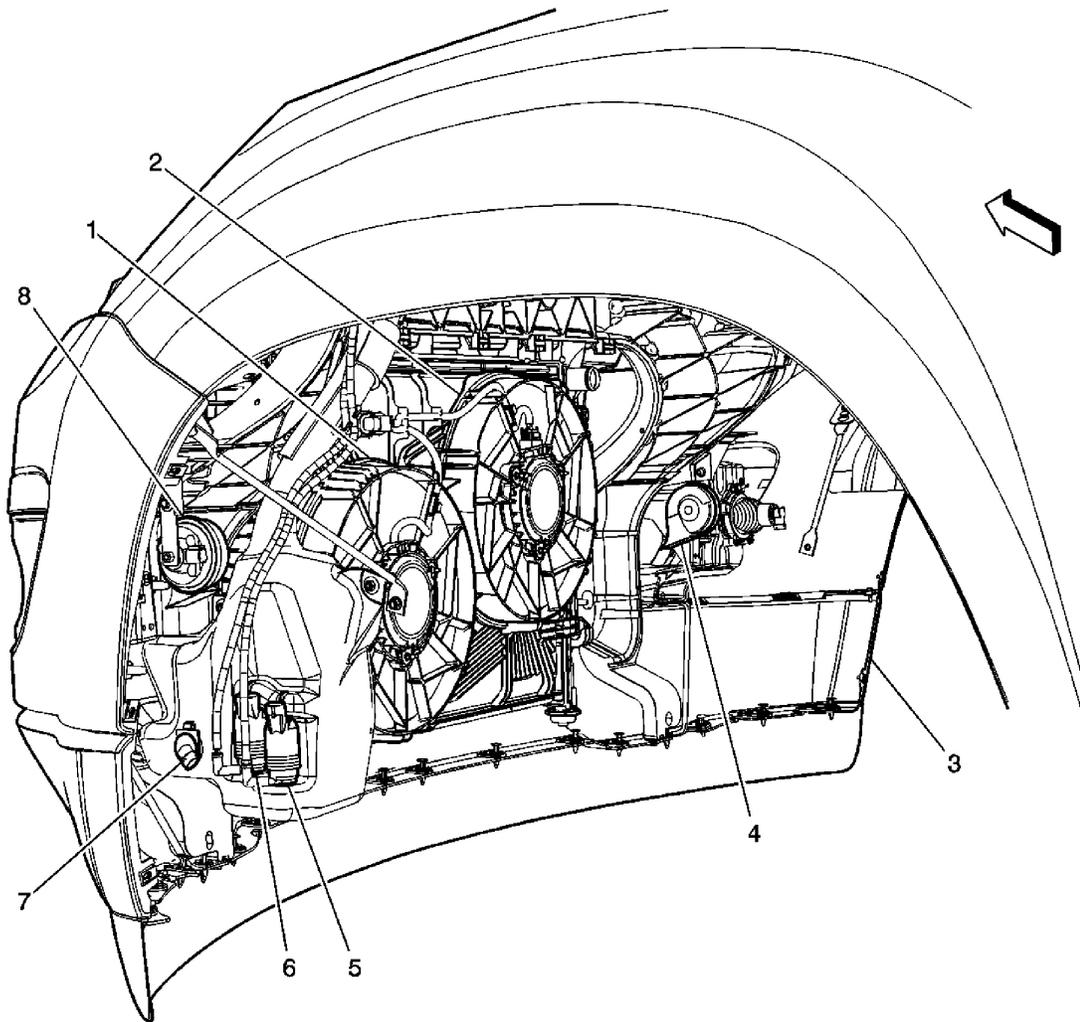


Fig. 2: Identifying Components Behind Front Fascia
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 2

Callout	Component Name
1	Cooling Fan - Left
2	Cooling Fan - Right
3	LF Fender
4	Horn - High Note
5	Windshield Washer Fluid Pump
6	Rear Window Washer Fluid Pump
7	Washer Fluid level Sensor
8	Horn - Low Note

COOLING SYSTEM CONNECTOR END VIEWS

Cooling Fan - Left

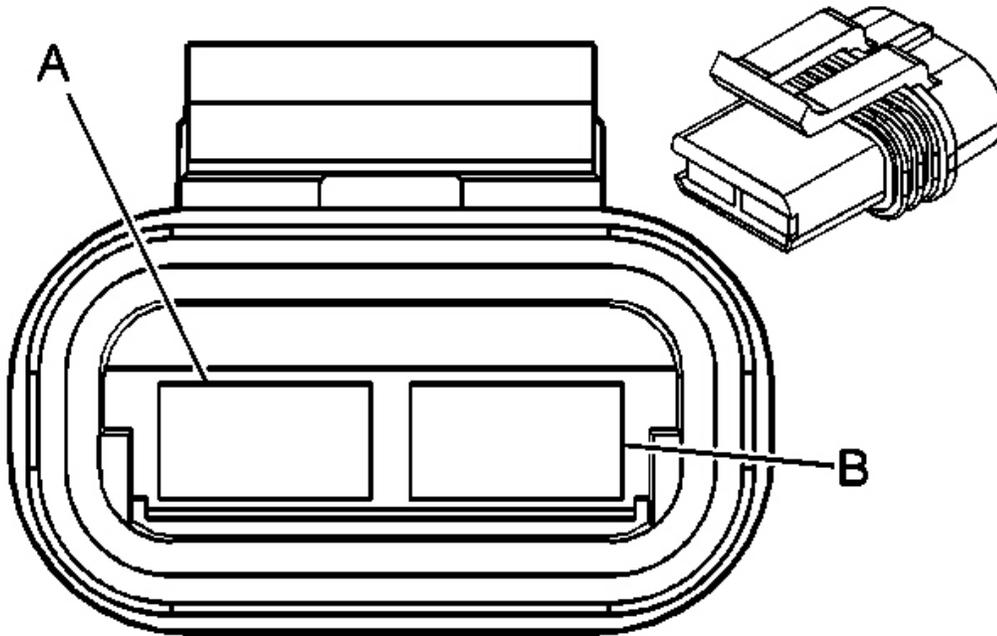


Fig. 3: Cooling Fan - Left Connector End View
Courtesy of GENERAL MOTORS CORP.

Cooling Fan - Left Connector Parts Information

Connector Part Information

- OEM: 12033769
- Service: 12101917
- Description: 2-Way F Metri-Pack 630 Series (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Cooling Fan - Left Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	3 GY	532	Left Cooling Fan Motor Low Control
B	3 WH	504	Left Cooling Fan Motor Supply Voltage

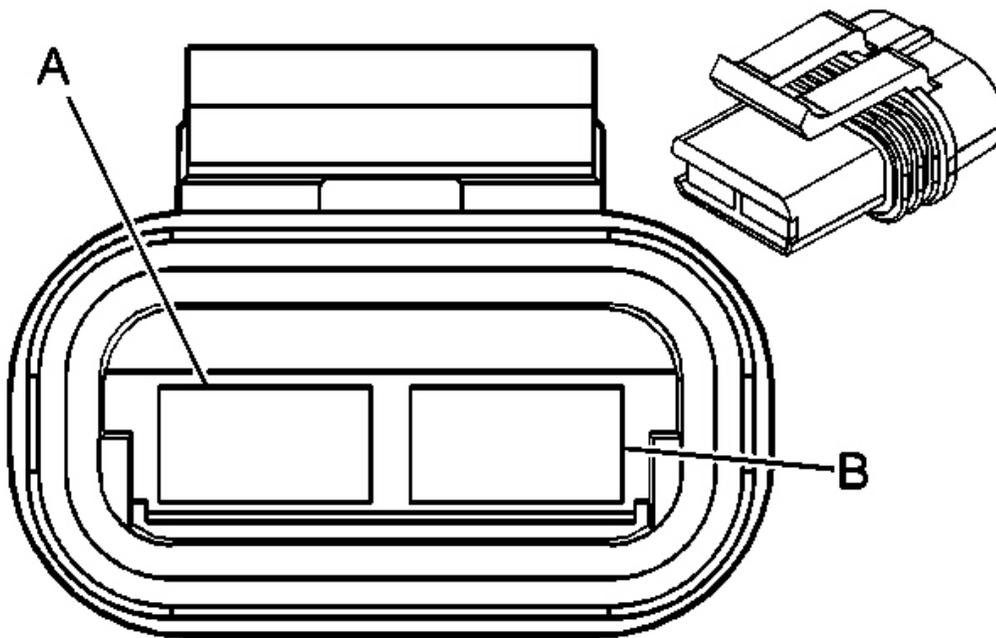
Cooling Fan - Right

Fig. 4: Cooling Fan - Right Connector End View
 Courtesy of GENERAL MOTORS CORP.

Cooling Fan - Right Connector Parts Information**Connector Part Information**

- OEM: 12033769
- Service: 12101917
- Description: 2-Way F Metri-Pack 630 Series (BK)

Terminal Part Information

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- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Cooling Fan - Right Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	3 BK	250	Ground
B	3 L-BU	409	Right Cooling Fan Motor Supply Voltage

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0480 or P0481	Cooling Fan Relay 1 Or 2 Control Circuit
DTC P1258	Engine Coolant Overtemperature - Protection Mode Active

DIAGNOSTIC STARTING POINT - ENGINE COOLING

Begin the system diagnosis with the diagnostic system check. Refer to **Diagnostic System Check - Vehicle** . The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuits
- The identification of any stored DTCs and their status

The use of the Diagnostic System Check - Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

SCAN TOOL OUTPUT CONTROLS

Powertrain Control Module (PCM) or Engine Control Module (ECM) Scan Tool Output Controls

Scan Tool Output Control	Additional Menu Selection(s)	Description
		The scan tool displays a Commanded State of Off

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Fan Relay 1	Output Control/Cooling Fan	or On. This allows you to communicate with the ECM and activate or deactivate the cooling fan 1 relay, manually turning both low speed fans On and Off.
Fan Relays 2 and 3	Output Control/Cooling Fan	The scan tool displays a Commanded State of Off or On. This allows you to activate or deactivate the cooling fan series/parallel relay and the cooling fan 2 relay. The RH cooling fan 2 turns ON and OFF in high speed.
Fan Relays 1, 2 and 3	Output Control/Cooling Fan	The scan tool displays a commanded state of OFF or ON. This allows you to activate or deactivate all of the cooling fan relays. Both cooling fans turn ON and OFF in high speed.

SCAN TOOL DATA LIST

Engine Control Module (ECM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition Switch in RUN/Engine running/Automatic Transmission in PARK/Air Conditioner is OFF			
ECT Sensor	Cooling/HVAC	°C/°F	Varies
FC Relay 1 Command	Cooling/HVAC	ON/OFF	OFF
FC Relay 2 and 3 Command	Cooling/HVAC	ON/OFF	OFF
FC Relay 1 Circuit Status	Cooling/HVAC	OK/Open/Short Gnd/Short to B+/Incomplete	OK
FC Relay 2 and 3 Circuit Status	Cooling/HVAC	OK/Open/Short Gnd/Short to B+/Incomplete	OK

SCAN TOOL DATA DEFINITIONS

ECT

The scan tool displays -40 to +151°C (-40 to +304°F). The engine coolant temperature (ECT) sensor is mounted in the coolant stream. The powertrain control module (PCM) or engine control module (ECM) applies 5 volts to the ECT sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is

cold (internal resistance high), the PCM or ECM monitors a high signal voltage and interprets it as a cold engine. As the sensor warms and internal resistance decreases, the voltage signal decreases and the PCM or ECM interprets the lower voltage as a warm engine.

FC Relay 1 Circuit Status

This parameter indicates the status for the state of the driver circuit.

FC Relay 1 Command

The scan tool displays On or Off. This parameter indicates the commanded state of the low speed fan relay driver.

FC Relay 2 and 3 Circuit Status

This parameter indicates the status for the state of the driver circuit.

FC Relay 2 and 3 Command

The scan tool displays On or Off. This parameter indicates the commanded state of the high speed fan relay driver.

DTC P0480 OR P0481

Diagnostic Instructions

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

DTC Descriptors

DTC P0480

Cooling Fan Relay 1 Control Circuit

DTC P0481

Cooling Fan Relay 2 Control Circuit

Diagnostic Fault Information

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DTC P0480 or P0481

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Speed Cooling Fan Relay Control Circuit for Fan 1 Relay	P0480	P0480	P0480	-
Fan 1 Relay Coil Voltage Supply Circuit	P0480	P0480	P0480	-
High Speed Cooling Fan Relay Control Circuit for Fan 3 Relay	P0481	P0481	P0481	-
Fan 3 Relay Coil Voltage Supply Circuit	P0481	P0481	P0481	-
High Speed Cooling Fan Relay Control Circuit for Fan 2 Relay	P0481	P0481	P0481	-
Fan 2 Relay Coil Voltage Supply Circuit	P0481	P0481	P0481	-

Circuit/System Description

The engine control module (ECM) commands the fans ON in high speed or low speed. In low speed, the fans are configured in series. In high speed, the fans are configured in parallel.

In low speed operation, the ECM applies ground to the coil side of the low speed relay, which is fan 1 relay. Voltage is applied directly to the left cooling fan through the switch side of the low speed relay. The right fan is connected in series to the left fan through the de-energized series/parallel relay, which is the fan 2 relay, so that both operate at low speed.

In high speed operation, the ECM applies a ground to the coil side of the low speed relay, the series/parallel relay and the high speed relay, which is the fan 3 relay. Voltage is applied directly to the right cooling fan through the switch side of the high speed relay. The left cooling fan obtains voltage through the low speed relay and ground through the series/parallel relay.

When the ECM is commanding a fan relay ON, the voltage of the control circuit should be low, near 0 volt. When the ECM is commanding a fan relay OFF, the voltage of the control circuit should be high, near battery voltage. If the ECM detects that the actual voltage of the relay control circuit is different than the expected voltage, DTC P0480 or P0481 will set and the affected ECM driver will be disabled.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is between 9-18 volts.
- The relay control circuit is transitioned from OFF to ON or ON to OFF.

Conditions for Setting the DTC

- An improper voltage level has been detected on the cooling fan relay control circuit.
- The condition must be present for a minimum of 30 seconds.

Action Taken When the DTC Sets

DTCs P0480 and P0481 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480 and P0481 are Type B DTCs.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Cooling System Connector End Views

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Electrical Center Identification Views**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**
- **Scan Tool Output Controls**

Circuit/System Verification

Ignition ON, command each relay ON and OFF with a scan tool. Feel or listen to verify that each relay turns ON and OFF with each command.

Circuit/System Testing

1. Ignition OFF, disconnect the series/parallel relay.
2. Connect a 30A fused jumper between the normally-open switch contact terminals at the series/parallel relay, which is fan 2 relay, connector in order to complete the fan ground circuit. Leave this jumper in place for the remainder of this procedure.
3. Ignition OFF, disconnect the affected relay.
4. Ignition ON, connect a test lamp between the positive terminal at the battery and the affected relay control circuit terminal.
5. Command the affected relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
 - If the test lamp is always ON, test the relay control circuit for a short to ground. If the circuit tests normal, replace the ECM.
 - If the test lamp is always OFF, test the relay control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
6. Connect a 30A fused jumper between the positive voltage terminal at the battery and the fan voltage supply circuit terminal at the affected relay connector and verify fan activation.
 - If the fan does not activate, test the fan voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the fan.
7. Ignition ON, connect a 30A fused jumper between the relay switch voltage supply circuit terminal and the fan voltage supply circuit terminal at the affected relay connector and verify fan activation.
 - If the fan does not activate, test the affected relay switch voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and its fuse is open, test all connected components and replace as necessary.

8. Ignition ON, verify that a test lamp illuminates between the affected relay coil voltage supply circuit terminal and ground.
 - If the test lamp does not illuminate, test the affected relay coil voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and its fuse is open, test all connected components and replace as necessary.
9. If all circuits and the ECM test normal, replace the affected 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)**
- **Underhood Electrical Center or Junction Block Replacement**
- **Control Module References** for ECM replacement, setup and programming

DTC P1258

Diagnostic Instructions

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

DTC Descriptor

DTC P1258

Engine Coolant Overtemperature - Protection Mode Active

Circuit/System Description

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

Conditions for Running the DTC

- The engine is running.

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- DTC P0116, P0117, P0118 or P0128 are not set.

Conditions for Setting the DTC

The coolant temperature is more than 131°C (267.8°F) for more than 7 seconds.

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 DTC

DTC P1258 is a type A DTC.

Reference Information

Description and Operation

- **Cooling System Description and Operation**
- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**
- **Audible Warnings Description and Operation**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

DTC Type Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**
- **Scan Tool Output Controls**

Circuit/System Verification

1. If DTC P0480 or P0481 are set, diagnose those DTCs 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**.

IMPORTANT: A small delay occurs before the ECM 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**.

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 **Engine Front Cover Cleaning and Inspection** .
4. Inspect the engine mechanical for worn, leaking or cracked cylinder heads or engine block. Refer to **Coolant in Combustion Chamber** and **Coolant in Engine Oil** .

Repair Procedures

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

SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

- Perform **Diagnostic System Check - Vehicle** and verify all of the following items:
 - Ensure that the engine control module (ECM) and indicator lamp are operating correctly.

- Ensure that there are no diagnostic trouble codes (DTCs) that are stored.
- Scan tool data is within a normal operating range. Refer to **Scan Tool Data List**.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.
- Locate the correct symptom. Perform the tests and inspections associated with the symptom.

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

Visual/Physical Inspection

NOTE: Use the connector test adapter kit J 35616-A for any test that requires probing the following items:

- The PCM 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. Refer to **Master Electrical Component List** and **Power and Grounding Connector End Views**.
- Inspect cooling system hoses and pipes for splits, kinks and proper connections. Inspect thoroughly for any type of a leak or a restriction.
- Inspect for a dirty or restricted radiator and HVAC condenser.
- Inspect for aftermarket devices which could affect the operation of the Cooling System. Refer to **Checking Aftermarket Accessories**.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

- Inspect the surge tank reservoir for the proper coolant level.

Identifying Intermittent Conditions

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

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

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

Symptom List

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

- **Engine Coolant Temperature Indicator Always On**
- **Cooling Fan Always On**
- **Cooling Fan Inoperative**

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

ENGINE COOLANT TEMPERATURE 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.

Circuit/System Description

The instrument panel cluster (IPC) illuminates the TEMP indicator when the engine control module (ECM) determines that the coolant temperature is more than 128°C (262°F). The IPC receives a discrete input from the ECM requesting illumination.

The IPC illuminates the TEMP indicator during the display test at the start of each ignition cycle.

Reference Information

Schematic Reference

- **Instrument Cluster Schematics**
- **Engine Cooling Schematics**

Connector End View Reference

- **Displays and Gages Connector End Views**
- **Cooling System Connector End Views**

Description and Operation

- **Instrument Cluster Description and Operation**
- **Cooling System Description and Operation**
- **Engine Overheating**

Electrical Information Reference

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

Scan Tool Reference

- **Scan Tool Output Controls**
- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Circuit/System Testing

With the engine running within the normal operating temperature range, the engine coolant temperature (ECT) indicator should not be illuminated.

- If the engine coolant is not within the normal operating range, repair the overheating condition.
- If the engine coolant is within the normal operating range, replace the IPC.

Repair Procedures

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

Control Module References for the IPC replacement, setup and programming

ENGINE COOLANT TEMPERATURE INDICATOR 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 instrument panel cluster (IPC) illuminates the engine coolant temperature indicator when the engine control module (ECM) determines that the coolant temperature is more than 128°C (262°F). The IPC receives a discrete input from the ECM requesting illumination.

The IPC illuminates the engine coolant temperature indicator during the display test at the start of

each ignition cycle.

Reference Information

Schematic Reference

- **Instrument Cluster Schematics**
- **Engine Cooling Schematics**

Connector End View Reference

- **Displays and Gages Connector End Views**
- **Cooling System Connector End Views**

Description and Operation

- **Instrument Cluster 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

- **Scan Tool Output Controls**
- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Circuit/System Testing

Ignition ON, perform the IPC lamp test with the scan tool. The engine coolant temperature indicator should turn on when commanded.

- If the engine coolant temperature indicator does not turn on when commanded, replace the IPC.

Repair Procedures

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

Control Module References for the IPC replacement, setup and programming

COOLING FAN ALWAYS ON

Diagnostic Instructions

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

Circuit/System Description

The engine control module (ECM) commands the fans ON in high speed or low speed. In low speed, the fans are configured in series. In high speed, the fans are configured in parallel.

In low speed operation, the ECM applies ground to the coil side of the low speed relay, which is fan 1 relay. Voltage is applied directly to the left cooling fan through the switch side of the low speed relay. The right fan is connected in series to the left fan through the de-energized series/parallel relay, which is the fan 2 relay, so that both operate at low speed.

In high speed operation, the ECM applies a ground to the coil side of the low speed relay, the series/parallel relay and the high speed relay, which is the fan 3 relay. Voltage is applied directly to the right cooling fan through the switch side of the high speed relay. The left cooling fan obtains voltage through the low speed relay and ground through the series/parallel relay.

When the ECM is commanding a fan relay ON, the voltage of the control circuit should be low, near 0 volt. When the ECM is commanding a fan relay OFF, the voltage of the control circuit should be high, near battery voltage. If the ECM detects that the actual voltage of the relay control circuit is different than the expected voltage, DTC P0480 or P0481 will set and the affected ECM driver will be disabled.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Cooling System Connector End Views

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference'

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Electrical Center Identification Views**

Circuit/System Verification

1. If DTCs P0480 or P0481 are set, then perform those diagnostics first.
2. Ignition ON, verify with a scan tool that the ECM is not commanding fan activation.
3. Ignition ON, observe that the fan is not activated.

Circuit/System Testing

IMPORTANT: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, leave the series/parallel relay in place while disconnecting the other relays.
2. Ignition ON, observe that the fan is not activated.
 - If the fan is not activated, then replace the faulty relay.
 - If the fan is activated, then test the fan voltage supply circuits for a short to voltage.

Repair Procedures

- **Cooling Fan and Shroud Replacement**
- **Control Module References**

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

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 fans ON in high speed or low speed. In low speed, the fans are configured in series. In high speed, the fans are configured in parallel.

In low speed operation, the ECM applies ground to the coil side of the low speed relay, which is fan 1 relay. Voltage is applied directly to the left cooling fan through the switch side of the low speed relay. The right fan is connected in series to the left fan through the de-energized series/parallel relay, which is the fan 2 relay, so that both operate at low speed.

In high speed operation, the ECM applies a ground to the coil side of the low speed relay, the series/parallel relay and the high speed relay, which is the fan 3 relay. Voltage is applied directly to the right cooling fan through the switch side of the high speed relay. The left cooling fan obtains voltage through the low speed relay and ground through the series/parallel relay.

When the ECM is commanding a fan relay ON, the voltage of the control circuit should be low, near 0 volt. When the ECM is commanding a fan relay OFF, the voltage of the control circuit should be high, near battery voltage. If the ECM detects that the actual voltage of the relay control circuit is different than the expected voltage, DTC P0480 or P0481 will set and the affected ECM driver will be disabled.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Cooling System 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
- Electrical Center Identification Views

Circuit/System Verification

1. If DTCs P0480 or P0481 are set, then perform those diagnostics first.
2. Ignition ON, command each relay ON and OFF with a scan tool. Feel or listen to verify that each relay turns ON and OFF with each command.

Circuit/System Testing

IMPORTANT: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the series/parallel relay, which is fan 2 relay.
2. Ignition ON, activate the cooling fan 1 relay with a scan tool. The fan should be OFF.
 - If the fan is activated, test the left fan ground circuit for a short to ground.
3. Ignition OFF, disconnect the remaining fan relays.
4. Install a 30A fused jumper between the normally-open switch contact terminals at the series/parallel relay, which is fan 2 relay, connector in order to complete the fan ground circuit. Leave this jumper in place for the remainder of this procedure.
5. One at a time, connect a 30A fused jumper between the positive terminal at the battery and the fan voltage supply circuit terminal at the fan 1 relay and the fan 3 relay connections and verify fan activation.
 - If the appropriate fan does not activate, test the fan voltage supply circuit for a short to ground or open/high resistance. If the circuit tests normal, test the fan ground circuit for an open/high resistance. If the circuits test normal, replace the fan.
6. Ignition ON, connect a 30A fused jumper between the relay switch voltage supply circuit terminal and the fan voltage supply circuit terminal at the fan 1 relay and the fan 3 relay connections and verify fan activation.
 - If the fan does not activate, test the relay switch voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and its fuse is open, test all connected components and replace as necessary.
7. If the circuits and fans test normal, replace the relay.

Repair Procedures

- **Cooling Fan and Shroud Replacement**
- **Control Module References**

Repair Verification

Ignition ON, command the relay ON and OFF with a scan tool. Observe to verify that the fan turns ON and OFF with each command.

ENGINE OVERHEATING

Engine Overheating

Step	Action	Yes	No
<p>DEFINITION: Either of the following conditions indicate a probable engine overheat condition.</p> <ul style="list-style-type: none"> • The engine temperature gage is in the red (overheat) zone and/or the engine temperature indicator is ON. • Hot engine coolant overflows from the coolant recovery reservoir and/or radiator cap onto the ground while the engine is running. 			
1	<p>1. Inspect and fill the cooling system, as necessary. Refer to <u>Draining and Filling Cooling System (Static Fill)</u> or <u>Draining and Filling Cooling System (Vac N Fill)</u>.</p> <p>2. Inspect the cooling system for leaks, as necessary.</p> <p>3. Repair the cooling system leaks, as necessary.</p> <p>Has the inspection/repair been performed?</p>	Go to Step 2	-
2	<p>1. Start the engine and allow the engine to run at approximately 1,200 RPM.</p> <p>2. Use the Scan Tool in order to verify the overheat condition.</p> <p>Does the Scan Tool verify the engine overheat condition?</p>	Go to Step 3	Go to <u>Diagnostic System Check - Vehicle</u>

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3	<ol style="list-style-type: none"> 1. Verify that the cooling fans are operating properly. 2. Repair the cooling fan system, as necessary. 		
	Does the engine still overheat?	Go to Step 4	System OK
4	<p>Perform the following inspections:</p> <ul style="list-style-type: none"> • Inspect the radiator and the A/C condenser cooling fins for debris or any other obstruction. • Inspect the drive belt system and the drive belt tensioner for proper operation in order to ensure that the coolant pump is rotating properly. • Inspect for loose, damaged and/or missing air deflector(s). • Check for a pinched or kinked cooling system hose. • Repair the systems as necessary. 		
	Does the engine still overheat?	Go to Step 5	System OK
5	<p>Inspect the thermostat for proper operation. Refer to <u>Thermostat Diagnosis</u>.</p>		
	Is the thermostat operating properly?	Go to Step 7	Go to Step 6
6	<p>Replace the thermostat. Refer to <u>Thermostat Replacement</u>.</p>		
	Does the engine still overheat?	Go to Step 7	System OK
7	<p>IMPORTANT: Excessive coolant freeze point protection MAY cause the coolant to boil at low temperatures.</p> <ol style="list-style-type: none"> 1. Inspect for the proper coolant concentration (mixture). Correct the coolant concentration as necessary. 		

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	<p>2. Remove the radiator cap.</p> <p>3. Start the engine and inspect for a constant flow of air bubbles in the engine coolant.</p> <p>Is there a constant flow of air bubbles in the engine coolant?</p>		
8	<p>The probable cause of the engine overheat is combustion chamber gasses leaking into the cooling system. This condition is usually caused by the following:</p> <ul style="list-style-type: none"> • A worn or damaged cylinder head gasket • A worn or damaged cylinder head • A worn and/or damaged engine block <p>Verify this condition by inspecting the spark plug electrodes and porcelain surrounding the spark plug electrode for signs of coolant. Replace and/or repair the engine internal component(s), as necessary, in order to repair the engine internal coolant leak.</p> <p>Does the engine still overheat?</p>	Go to Step 8	Go to Step 9
9	<p>The engine overheat may be caused by a cooling system blockage. Flush the cooling system. Refer to Flushing.</p> <p>Does the engine still overheat?</p>	Go to Step 1	System OK
10	<p>IMPORTANT: It is unlikely that the water pump is the cause of the overheat condition.</p> <p>If NONE of the cooling system passages are restricted, replace the coolant pump. Refer to Water Pump Replacement. Does the engine still overheat?</p>	Go to Step 10	System OK
		Go to Step 1	System OK

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LOSS OF COOLANT

Loss of Coolant

Step	Action	Yes	No
DEFINITION: The cooling system is losing coolant either internally or externally.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to Symptoms - Engine Cooling
2	Repair any present DTCs. Refer to <u>Diagnostic Starting Point - Engine Cooling.</u> Is the action complete?	Go to Step 3	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to Step 6	Go to Step 4
4	Fill the cooling system to the proper level. Refer to <u>Draining and Filling Cooling System (Static Fill)</u> or <u>Draining and Filling Cooling System (Vac N Fill).</u> Is the action complete?	Go to Step 5	-
5	If the engine is suspected to have a coolant leak into the cylinder, the coolant can hydraulically lock the cylinder. Does the engine crankshaft rotate?	Go to Step 6	Go to Step 28
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to Step 29	Go to Step 7
7	Extended engine operation with a low coolant level can cause engine internal component failure. Is the engine knocking?	Go to Step 31	Go to Step 8
8	1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust pipe. Is a heavy white smoke present from the exhaust pipe?	Go to Step 9	Go to Step 10
	Coolant in the exhaust system creates a		

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9	<p>distinctive, burning coolant odor in the exhaust. Condensation in the exhaust system can cause an odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?</p>	Go to Step 30	Go to Step 10
10	<p>With the engine idling, inspect the coolant recovery system. Does the coolant recovery system discharge coolant while the engine is idling?</p>	Go to Step 15	Go to Step 11
11	<p>Visually inspect the hoses, pipes and hose clamps at the following locations:</p> <ul style="list-style-type: none"> • The auxiliary heater core • The coolant reservoir • The heater core • The radiator <p>Are any of the hoses, clamps or pipes leaking?</p>	Go to Step 21	Go to Step 12
12	<p>Visually inspect the following components:</p> <ul style="list-style-type: none"> • The block heater • The coolant pressure cap • The coolant reservoir • The core plugs • The cylinder head gaskets • The engine block • The intake manifold • The radiator • The thermostat • The water pump <p>Are any of the listed components leaking?</p>	Go to Step 21	Go to Step 13

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13	<p>1. Pressure test the cooling system. Refer to Cooling System Leak Testing.</p> <p>2. Visually inspect the components listed in steps 11 and 12 again.</p> <p>Are any leaks present?</p>	Go to Step 21	Go to Step 14
14	<p>Pressure test the coolant pressure cap. Refer to Pressure Cap Testing.</p> <p>Does the coolant pressure cap hold pressure?</p>	Go to Step 16	Go to Step 22
15	<p>Pressure test the coolant pressure cap. Refer to Pressure Cap Testing.</p> <p>Does the coolant pressure cap hold pressure?</p>	Go to Step 32	Go to Step 22
16	<p>Inspect for the following conditions:</p> <ul style="list-style-type: none"> • A coolant smell inside of the vehicle • Coolant in the HVAC module assembly drain tube • Coolant on the vehicle floor covering under the HVAC module assembly <p>Is coolant present?</p>	Go to Step 23	Go to Step 17
17	<p>If equipped with auxiliary heating, inspect for the following conditions:</p> <ul style="list-style-type: none"> • A coolant smell inside of the vehicle • Coolant in the auxiliary HVAC module assembly drain tube • Coolant on the floor covering near the auxiliary HVAC module assembly <p>Is coolant present?</p>	Go to Step 24	Go to Step 18
18	<p>Inspect the underside of the oil fill cap for a gray/white milky substance.</p> <p>Is there a milky substance under the oil fill</p>		

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	cap?	Go to Step 19	Go to Step 20
19	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is there a milky substance on the engine oil fluid level indicator?	Go to Step 30	Go to Step 20
20	Inspect the automatic transmission oil fluid level indicator, if equipped, for a gray/white milky substance. Is there a milky substance on the automatic transmission fluid level indicator?	Go to Step 25	Go to Step 33
21	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to Step 33	-
22	Replace the coolant pressure cap. Is the repair complete?	Go to Step 33	-
23	Replace the heater core. Refer to <u>Heater Core Replacement</u> . Is the repair complete?	Go to Step 33	-
24	Replace the auxiliary heater core. Refer to <u>Auxiliary Heater Core Replacement</u> . Is the repair complete?	Go to Step 33	-
25	<ol style="list-style-type: none"> 1. Remove the transmission oil cooler lines from the radiator. 2. Pressure test the cooling system. Refer to <u>Cooling System Leak Testing</u>. 3. Inspect the transmission oil cooler for coolant. Is coolant present in the transmission oil cooler?	Go to Step 26	Go to Step 27
26	<ol style="list-style-type: none"> 1. Replace the radiator. Refer to <u>Radiator Replacement</u>. 2. Service the automatic transmission. Refer to <u>Engine Coolant/Water in Transmission</u> . Is the repair complete?	Go to Step 33	-

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27	Install the cooler lines to the radiator. Is the action complete?	Go to Step 33	-
28	Repair the engine no crank condition. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> . Is the repair complete?	Go to Step 33	-
29	Repair the engine overheating condition. Refer to <u>Engine Overheating</u> . Is the repair complete?	Go to Step 33	-
30	Repair the engine internal coolant leak. Refer to <u>Coolant in Combustion Chamber</u> or <u>Coolant in Engine Oil</u> . Is the repair complete?	Go to Step 33	-
31	Repair the engine knock. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u> . Is the repair complete?	Go to Step 33	-
32	Repair the combustion pressure in the cooling system problem. Refer to <u>Coolant in Combustion Chamber</u> . Is the repair complete?	Go to Step 33	-
33	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

THERMOSTAT DIAGNOSIS

Tools Required

- **J 24731** 188 Tempilstick
- **J 24731** 206 Tempilstick

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

Diagnostic Procedure

1. Use a tempilstick in order to find the opening and the closing temperatures of the

thermostat.

- **J 24731** 188 tempilstick melts at 87°C (188°F). The thermostat should begin to open at 90°C (194°F).
- **J 24731** 206 tempilstick melts at 97°C (206°F). The thermostat should be fully open at 107°C (225°F).

2. Replace the thermostat if it does not operate properly between this temperature range.

COOLANT HEATER INOPERATIVE

Diagnostic Instructions

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

Circuit/System Description

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

Reference Information

Electrical Information Reference

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

Circuit/System Testing

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

1. Test the engine coolant heater for an open or short to ground.
 - If open or shorted, replace the heater.

2. If the heater tests normal, replace the coolant heater power cord.

Repair Procedures

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

- **Coolant Heater Replacement**
- **Coolant Heater Cord Replacement**

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

Engine Fails To Reach Normal Operating Temperature

Step	Action	Yes	No
1	1. Ensure that the cooling system is full. 2. Allow the engine to cool. 3. Start the engine. 4. Turn the air conditioning system off. 5. Inspect the engine cooling fan(s). Is the electric cooling fan on?	Go to Step 2	Go to Step 3
2	1. Diagnose and repair the cooling fan system. Refer to <u>Cooling Fan Always On.</u> 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 3	System OK
3	Install the Scan Tool to the DLC. Compare the Scan Tool coolant temperature reading to the I/P cluster coolant temperature. Is the I/P cluster coolant temperature close to the reading on the Scan Tool?	Go to Step 5	Go to Step 4
4	1. Diagnose and repair the coolant temperature gage system. 2. Verify the customer complaint. Does the engine still fail to reach normal		

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	operating temperature?	Go to Step 5	System OK
5	Inspect the thermostat for proper operation. Refer to <u>Thermostat Diagnosis</u> . Is the thermostat operating properly?	Go to Step 1	Go to Step 6
6	1. Replace the thermostat. Refer to <u>Thermostat Replacement</u> . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 1	System OK

PRESSURE CAP TESTING

Tools Required

J 24460-01 Cooling System Pressure Tester. See **Special Tools**.

Test Procedure

CAUTION: 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.

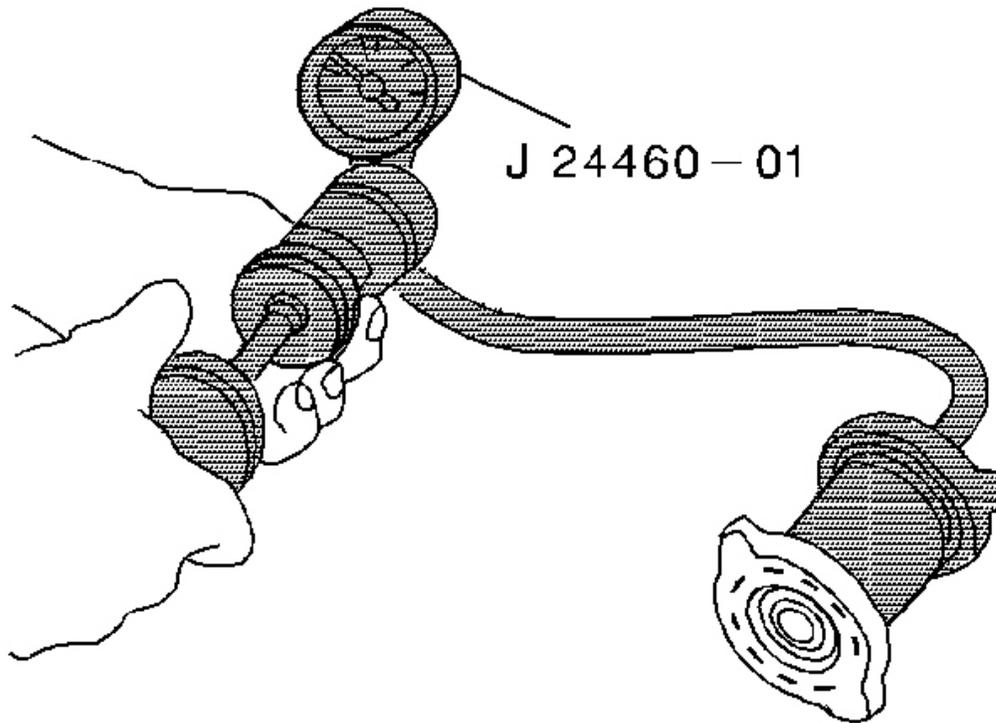


Fig. 5: Identifying Cooling System Tester J 24460-01
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 24460-01** in order to test the pressure cap. See **Special Tools**.
4. Test the pressure cap for the following conditions:
 - Pressure release when the **J 24460-01** exceeds the pressure rating of the pressure cap. See **Special Tools**.
 - Maintain the rated pressure for at least 10 seconds.
5. Replace the pressure cap under the following conditions:
 - The pressure cap does not release pressure which exceeds the rated pressure of the cap.
 - The pressure cap does not hold the rated pressure.

COOLING SYSTEM LEAK TESTING

Tools Required

J 24460-01 Cooling System Pressure Tester. See Special Tools.

Test Procedure

CAUTION: 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.

CAUTION: 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.

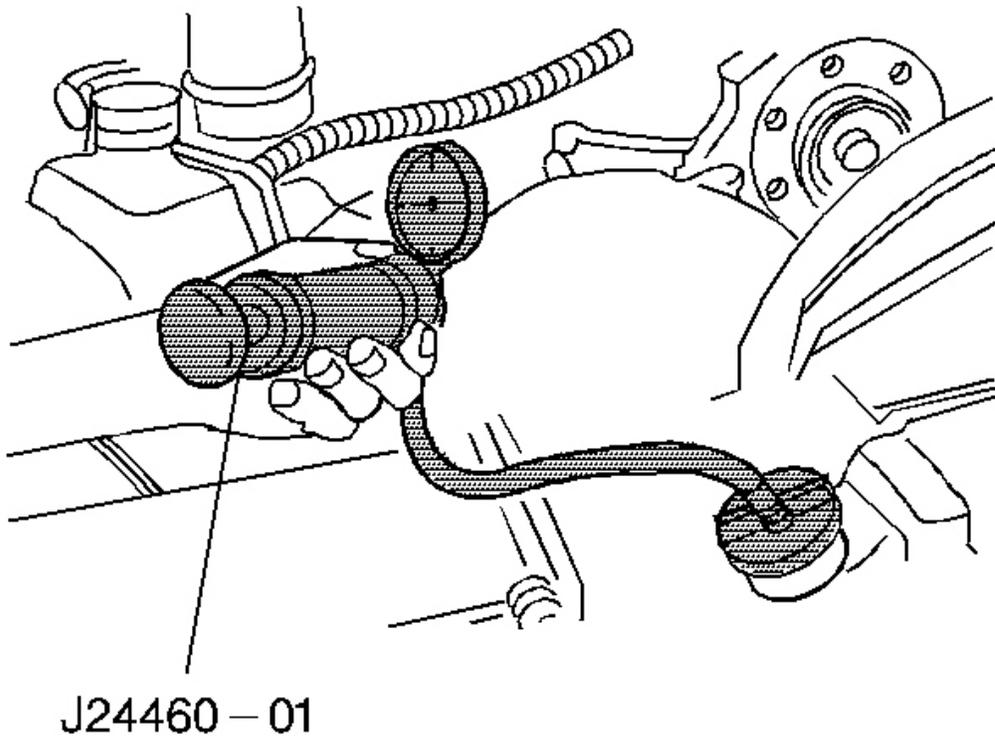


Fig. 6: View Of Radiator Pressure Tester
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 24460-01** in order to apply pressure to the cooling system. See **Special Tools**.
Do not exceed the pressure cap rating.
4. The cooling system should hold the rated pressure for at least 2 minutes.
Observe the gage for any pressure loss.
5. Repair any leaks as required.

REPAIR INSTRUCTIONS

DRAINING AND FILLING COOLING SYSTEM (STATIC FILL)

Tools Required

J 26568 Coolant and Battery Tester. See Special Tools.

CAUTION: 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.

Draining Procedure

IMPORTANT: Draining the cooling system with the pressure cap installed will siphon the coolant from the overflow tank.

1. Place a drain pan under the radiator hose.
2. Remove the radiator outlet hose from the engine. Refer to Radiator Outlet Hose Replacement.
3. Move down the end of the radiator hose to drain the radiator.
4. Drain the cooling system.
5. Remove the coolant pressure cap.
6. If a complete engine block drain is required, remove the engine drain plugs.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.
 - Discolored-Follow the flush procedure. Refer to Flushing.

Filling Procedure

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

1. Install the radiator outlet hose to the engine. Refer to Radiator Outlet Hose Replacement.

NOTE: Refer to Fastener Notice .

2. If the engine block drain plug was removed, perform the following:
 1. Apply pipe sealer to the drain plugs.

2. Install the drain plugs.

Tighten: Tighten the drain plug to 22 N.m (16 lb ft).

3. Lower the vehicle.

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

4. Slowly fill the cooling system with a 50/50 coolant mixture. Refer to Approximate Fluid Capacities.
5. Install the coolant pressure cap.
6. Start the engine.
7. Run the engine at 2,000-2,500 RPM until the engine reaches normal operating temperature.
8. Allow the engine to idle for 3 minutes.
9. Shut the engine OFF.
10. Allow the engine to cool.
11. Top off the coolant as necessary.
12. Inspect the concentration of the engine coolant, using the **J 26568**. See Special Tools.
13. Rinse away any excess coolant from the engine and the engine compartment.

DRAINING AND FILLING COOLING SYSTEM (VAC N FILL)

Tools Required

- **J 26568** Coolant and Battery Tester. See Special Tools.
- **GE-47716** Vac-N-Fill Coolant Refill Tool. See Special Tools.

Draining Procedure

CAUTION: 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 radiator cap.

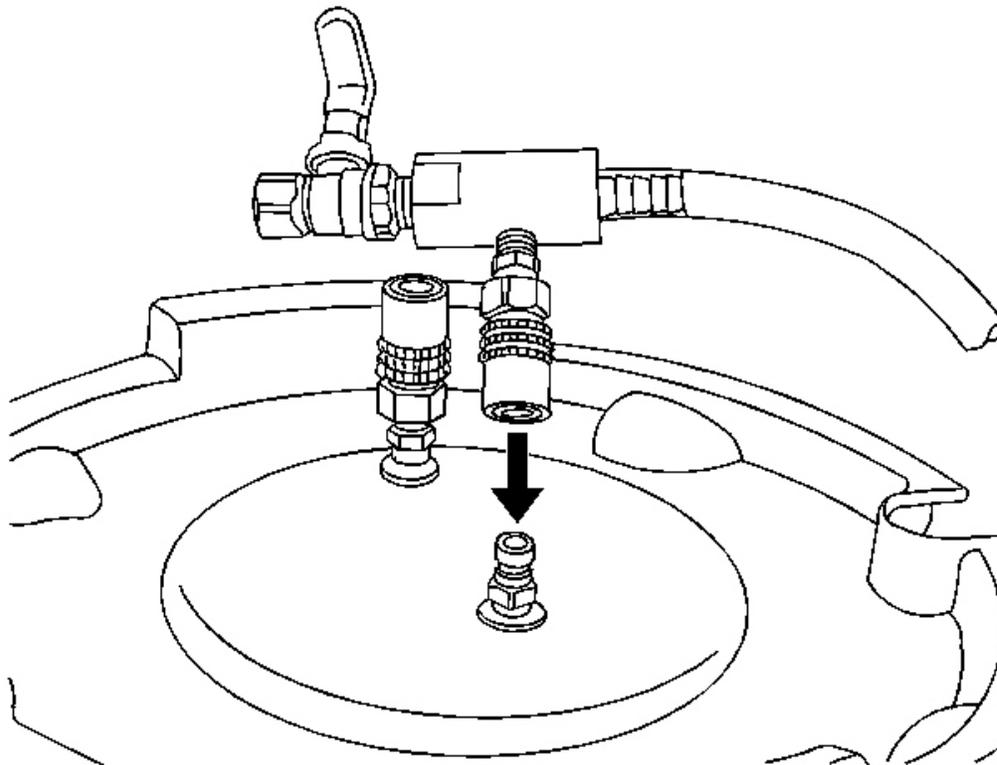


Fig. 7: Identifying Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

2. Attach the venturi assembly to the vacuum tank.

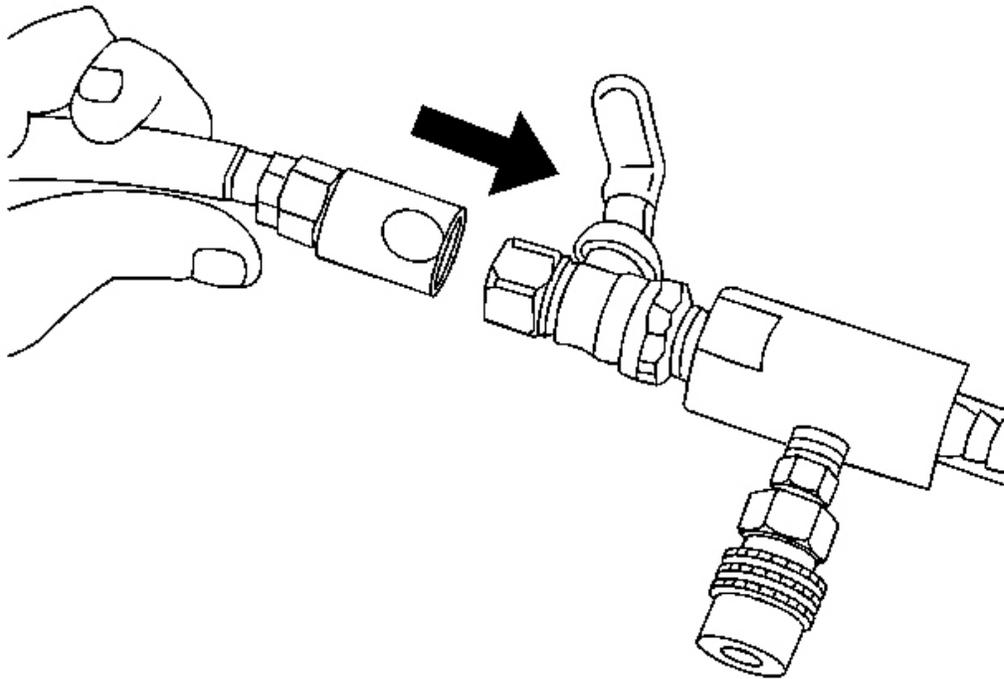


Fig. 8: View Of Shop Air Hose & Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

3. Attach a shop air hose to the venturi assembly.
Ensure the valve on the venturi assembly is closed.
4. Attach the vacuum hose to the vacuum tank.

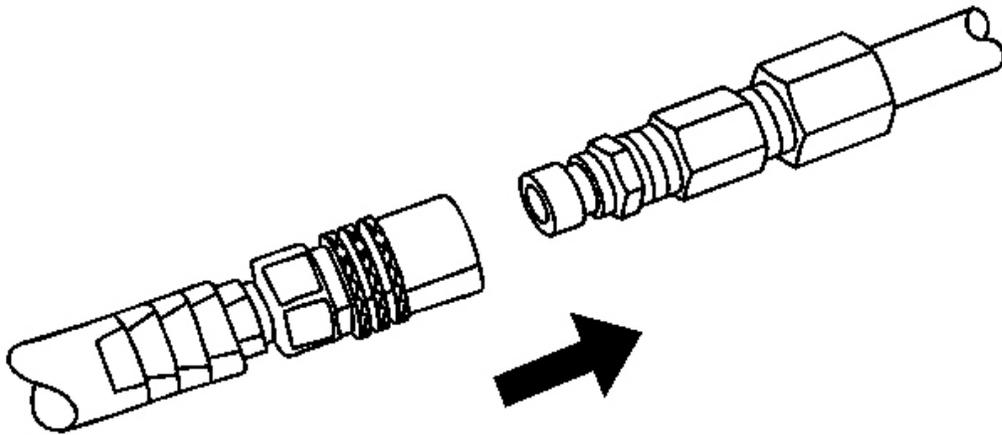


Fig. 9: Identifying Extraction Hose
Courtesy of GENERAL MOTORS CORP.

5. Attach the extraction hose to the vacuum hose.
6. Insert the extraction hose into the radiator cap opening and into the radiator until the extraction hose contacts the bottom of the radiator end tank.

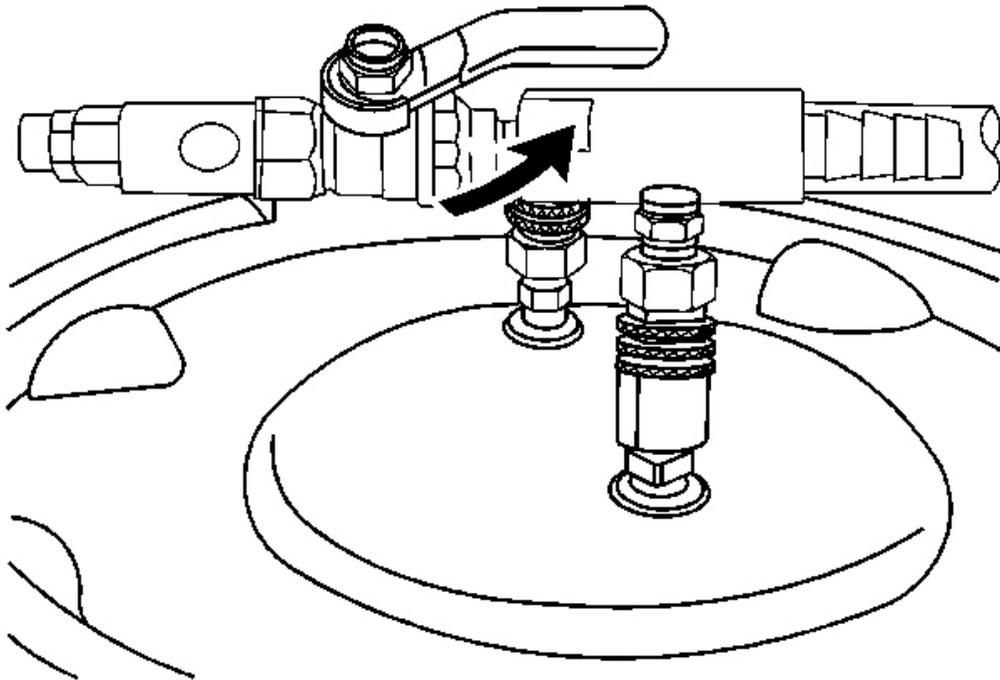


Fig. 10: Identifying Open Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

7. Open the valve on the venturi assembly to start a vacuum draw.
8. Use the extraction hose to draw out coolant until the radiator is empty.
9. 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.
10. If a complete engine block drain is required, remove the engine block drain plug.
11. Inspect the coolant.
12. 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

IMPORTANT: To prevent boiling of the coolant/water mixture in the vehicles cooling system, do not apply vacuum to a cooling system above

49°C (120°F). The tool will not operate properly when the coolant is boiling.

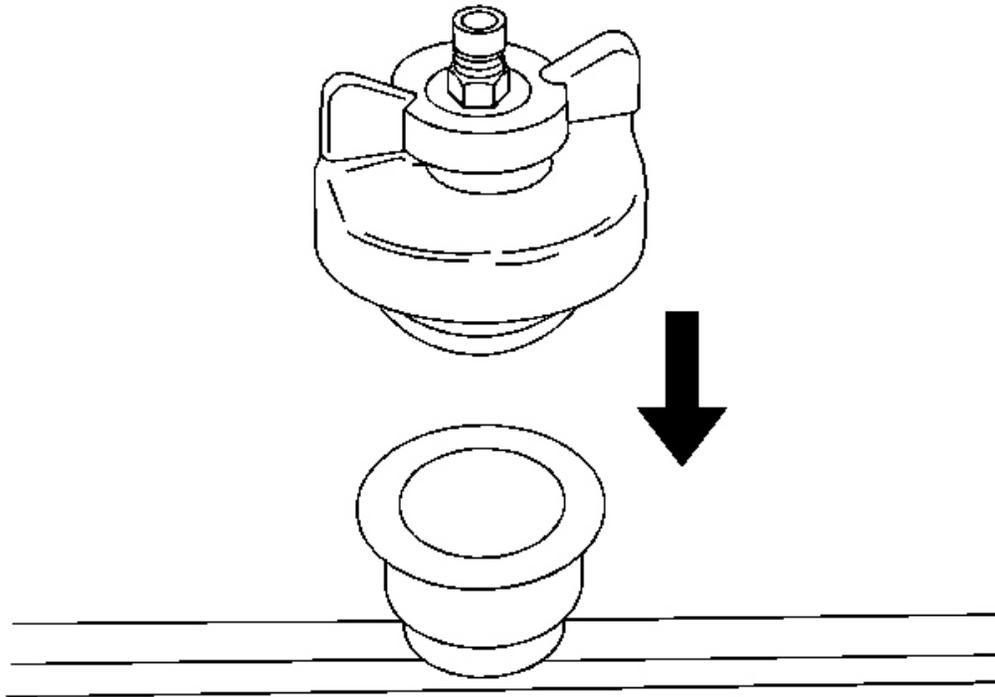


Fig. 11: Identifying Van-N-Fill Cap
Courtesy of GENERAL MOTORS CORP.

1. Attach the Vac-N-Fill cap to the vehicles coolant fill port.
2. Install the extension hose.

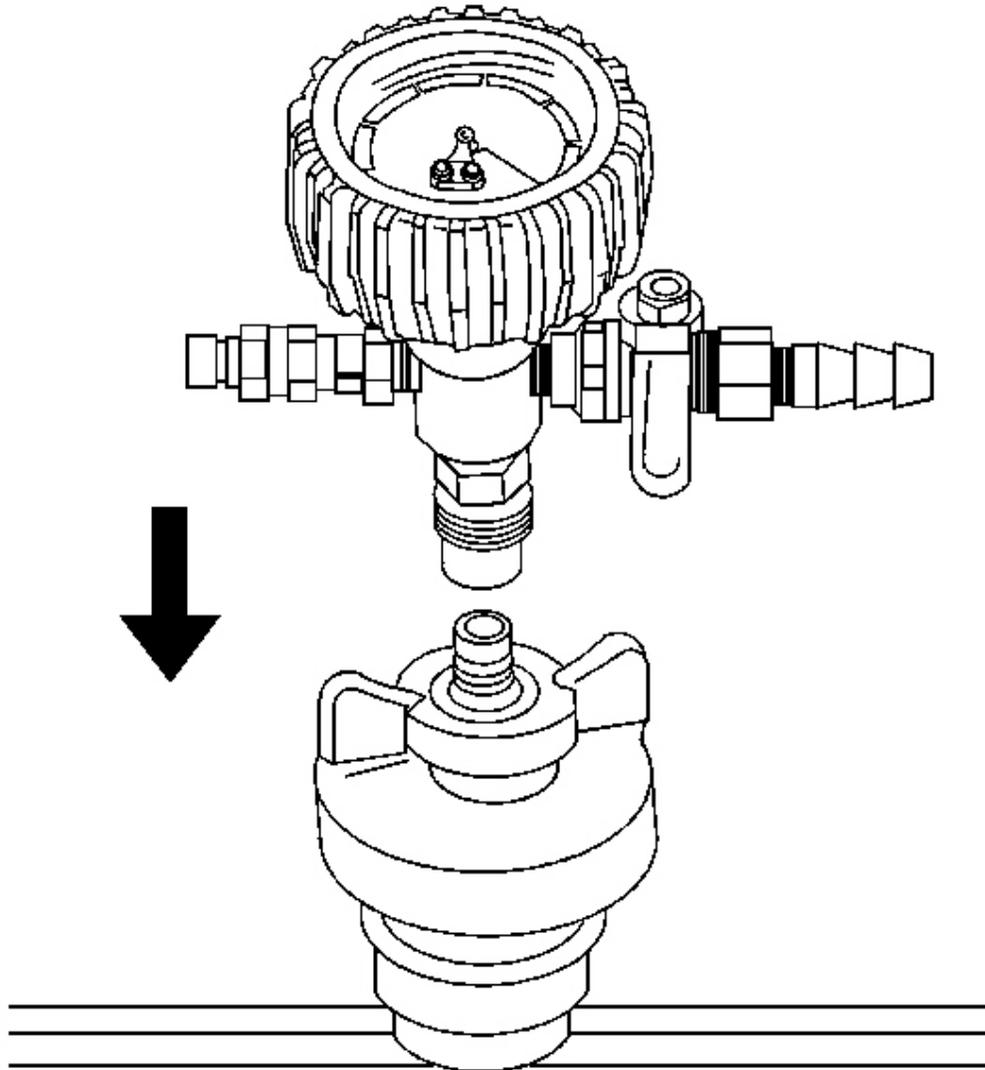


Fig. 12: View Of Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

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

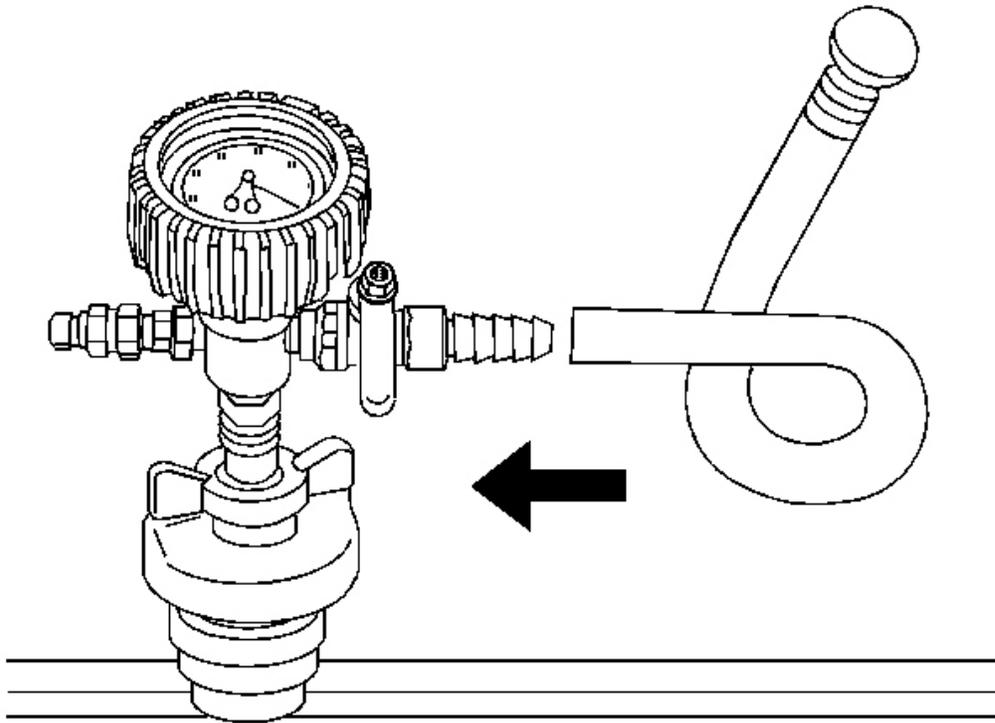


Fig. 13: Identifying Fill Hose
Courtesy of GENERAL MOTORS CORP.

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

Ensure that the valve is closed.

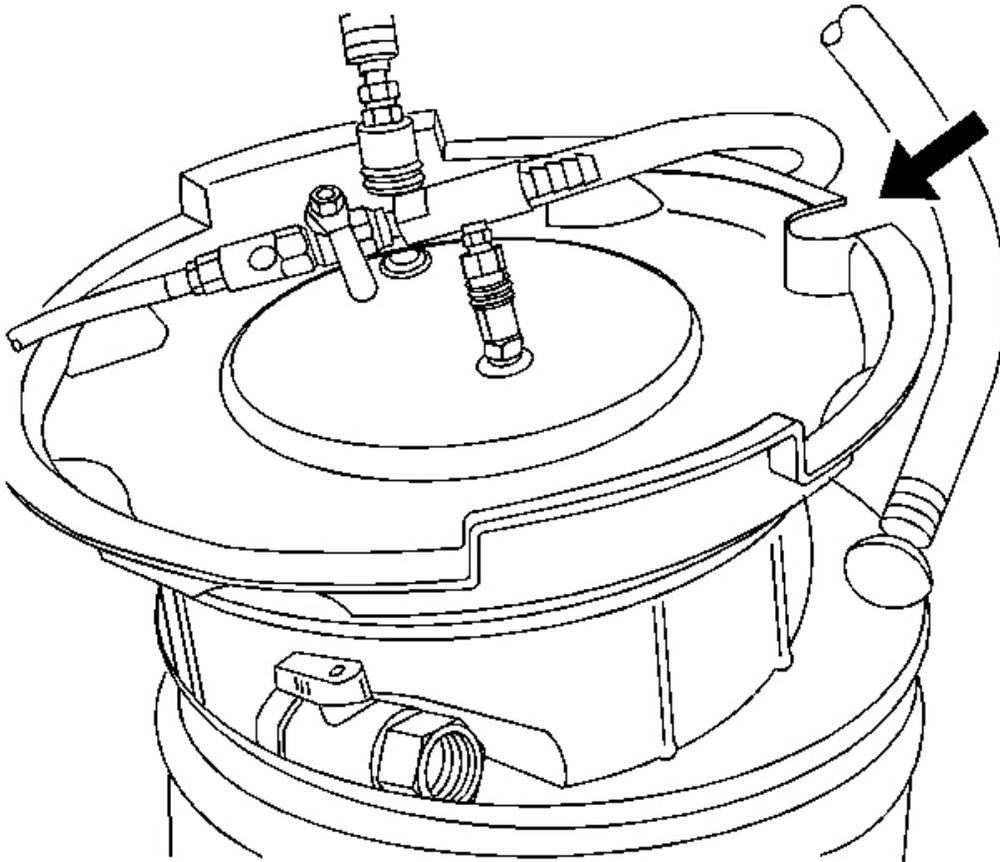


Fig. 14: View Of Graduated Reservoir & Hose
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Use a 50/50 mixture of DEX-COOL antifreeze and clean, drinkable water. Always use more coolant than necessary. This will eliminate air from being drawn into the cooling system.

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

IMPORTANT: Prior to installing the vacuum tank onto the graduated reservoir, ensure that the drain valve located on the bottom

of the tank is closed.

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

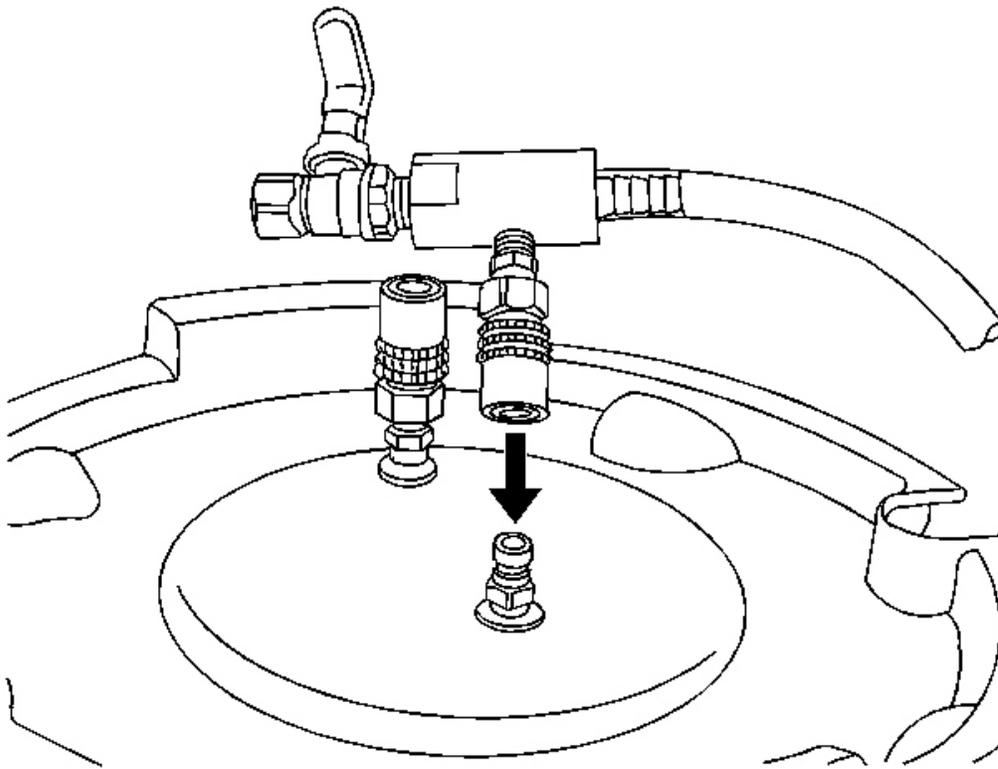


Fig. 15: Identifying Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

8. Attach the venturi assembly to the vacuum tank.

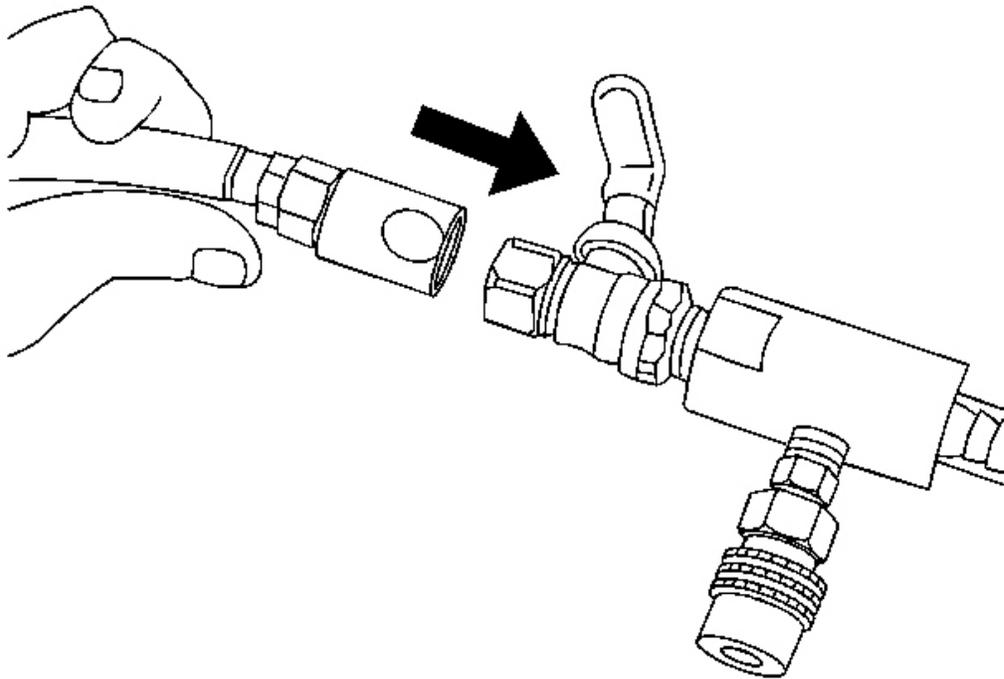


Fig. 16: View Of Shop Air Hose And Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

9. Attach a shop air hose to the venturi assembly.
Ensure the valve on the venturi assembly is closed.

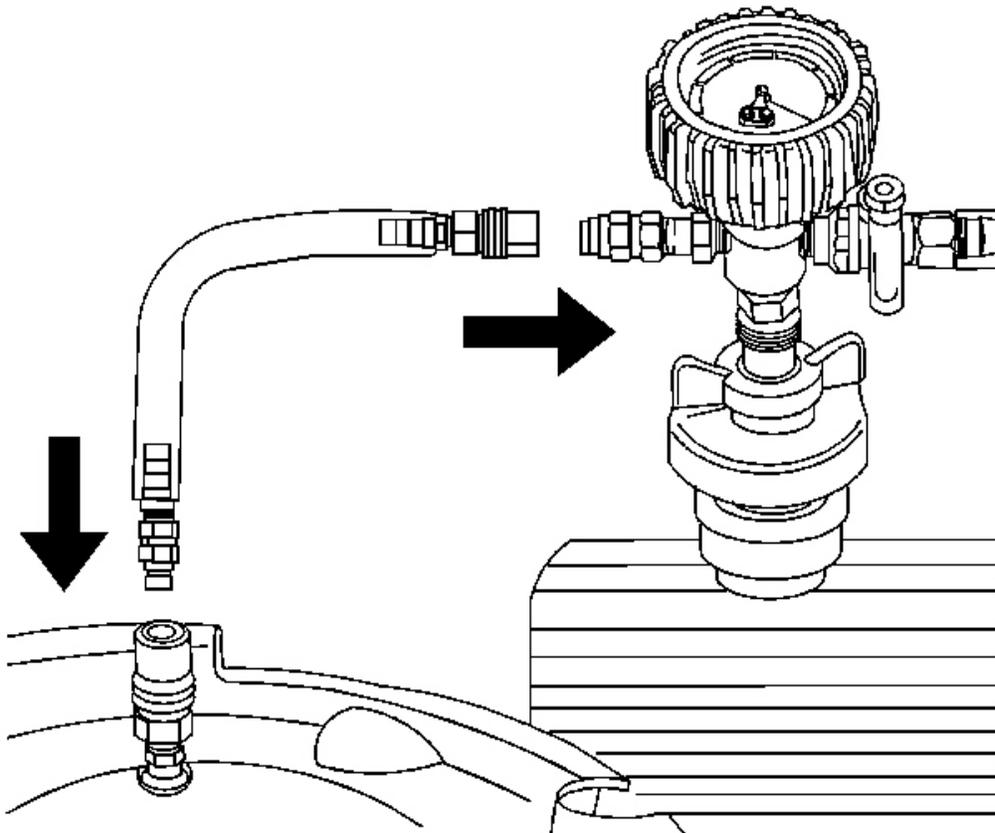


Fig. 17: Identifying Vacuum Hose, Vacuum Gage Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

10. Attach the vacuum hose to the vacuum gage assembly and the vacuum tank.
11. Clamp off the overflow hose.

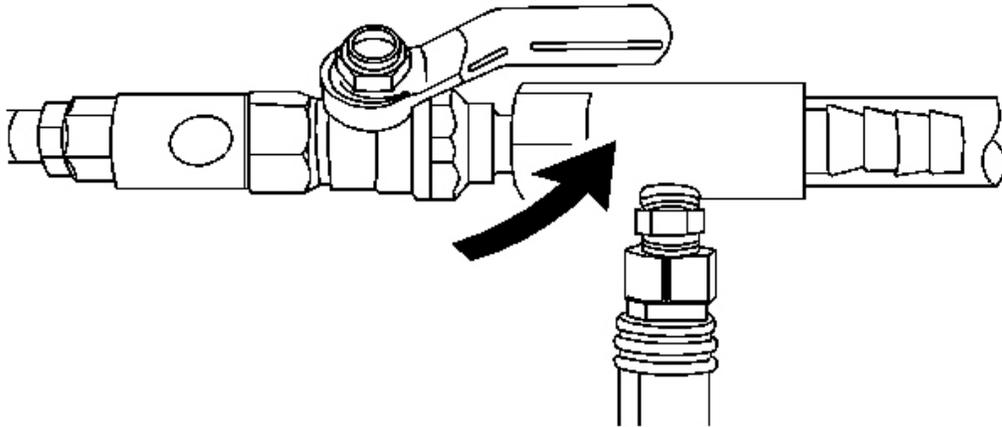


Fig. 18: Identifying Venture Assembly Valve
Courtesy of GENERAL MOTORS CORP.

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

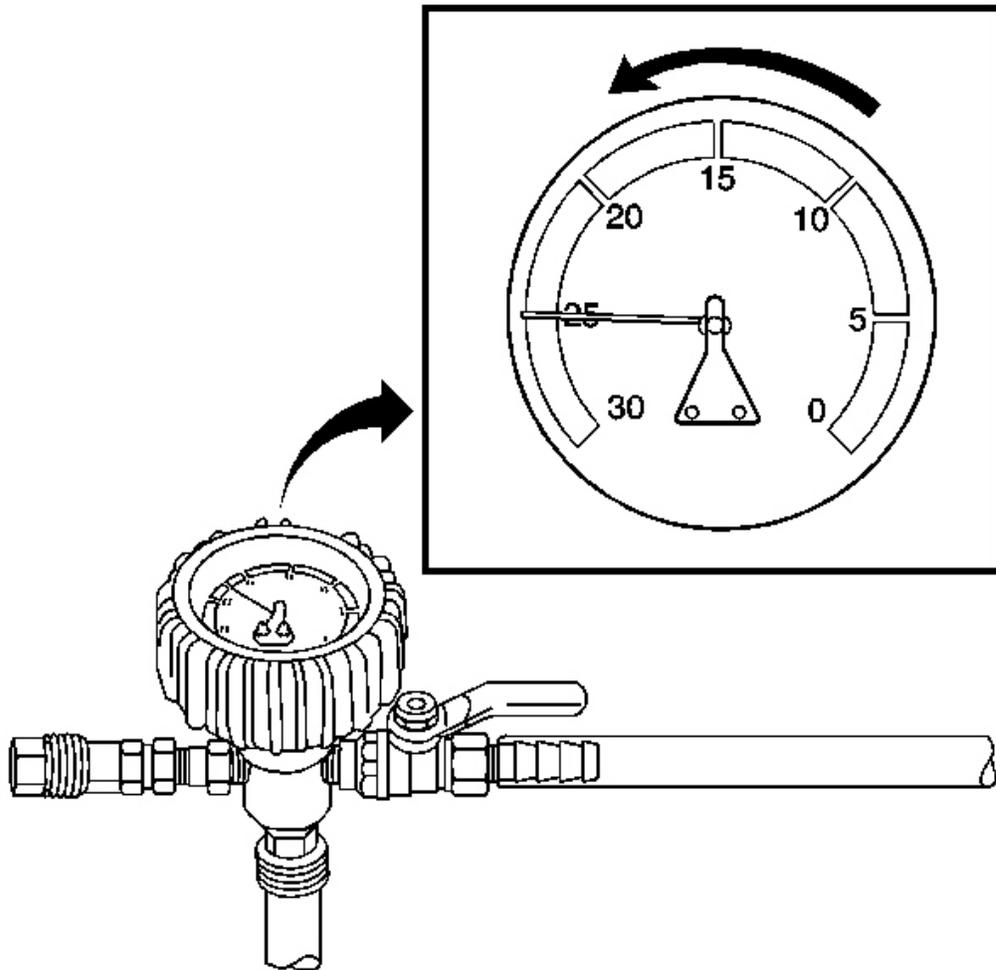


Fig. 19: Identifying Vacuum Gage
Courtesy of GENERAL MOTORS CORP.

13. 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.

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

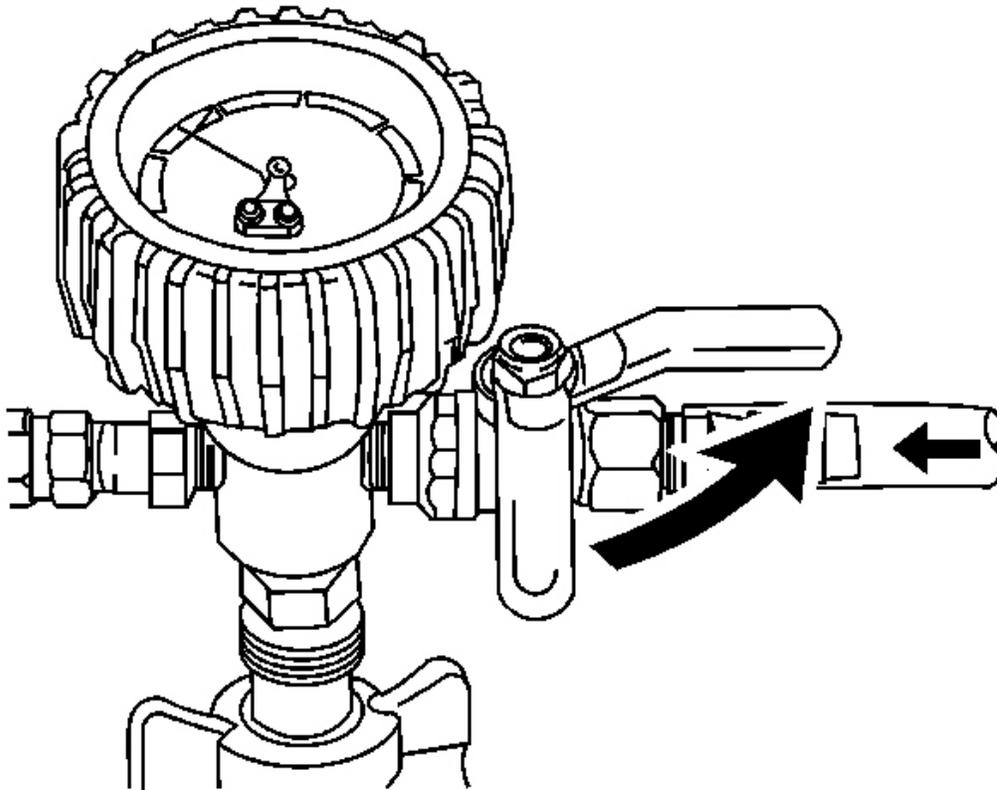


Fig. 20: Identifying Vacuum Gage Assembly Valve
Courtesy of GENERAL MOTORS CORP.

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

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

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

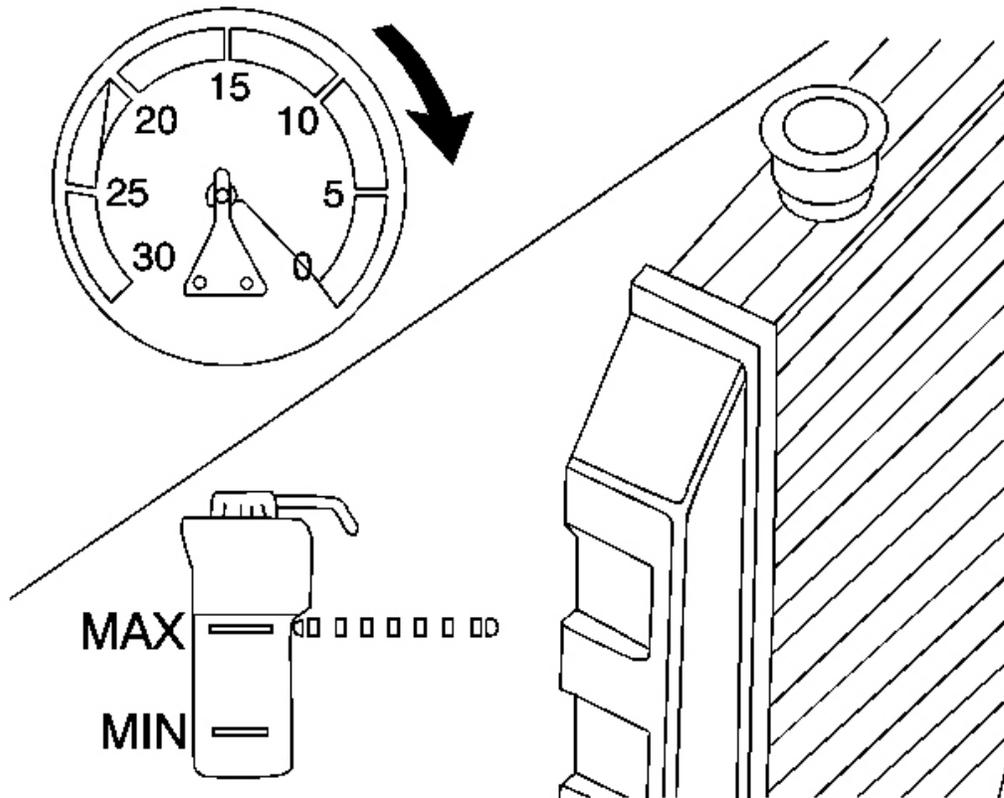


Fig. 21: Identifying Vacuum Gage Reading
Courtesy of GENERAL MOTORS CORP.

19. Once the vacuum gage reaches zero, close the valve on the vacuum gage assembly and repeat steps 11-17.

Remove the extension hose.

20. Remove the **J 42401** . See **Special Tools**.
21. Detach the Vac-N-Fill cap from the vehicles coolant fill port.
22. Add coolant to the system as necessary.
23. Inspect the concentration of the coolant mixture using **J 26568** . See **Special Tools**.

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

level.

24. Detach the vacuum hose from the vacuum gage assembly.

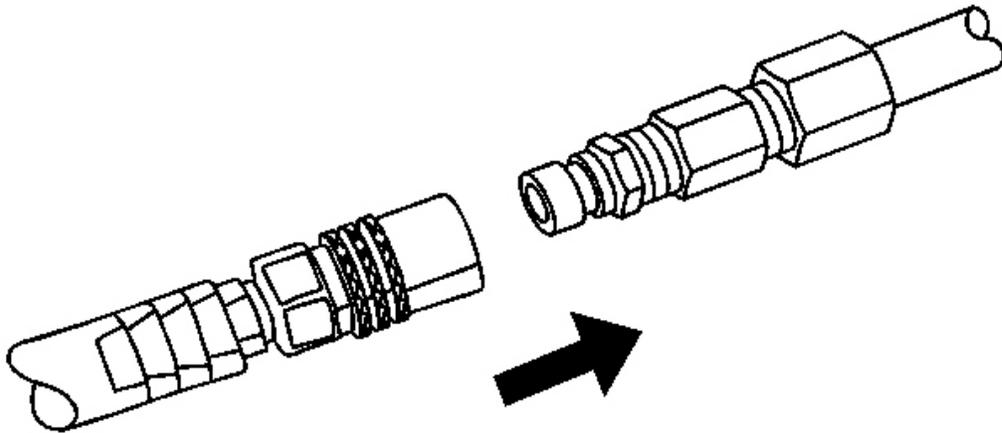


Fig. 22: Identifying Extraction Hose
Courtesy of GENERAL MOTORS CORP.

25. Attach the extraction hose to the vacuum hose.

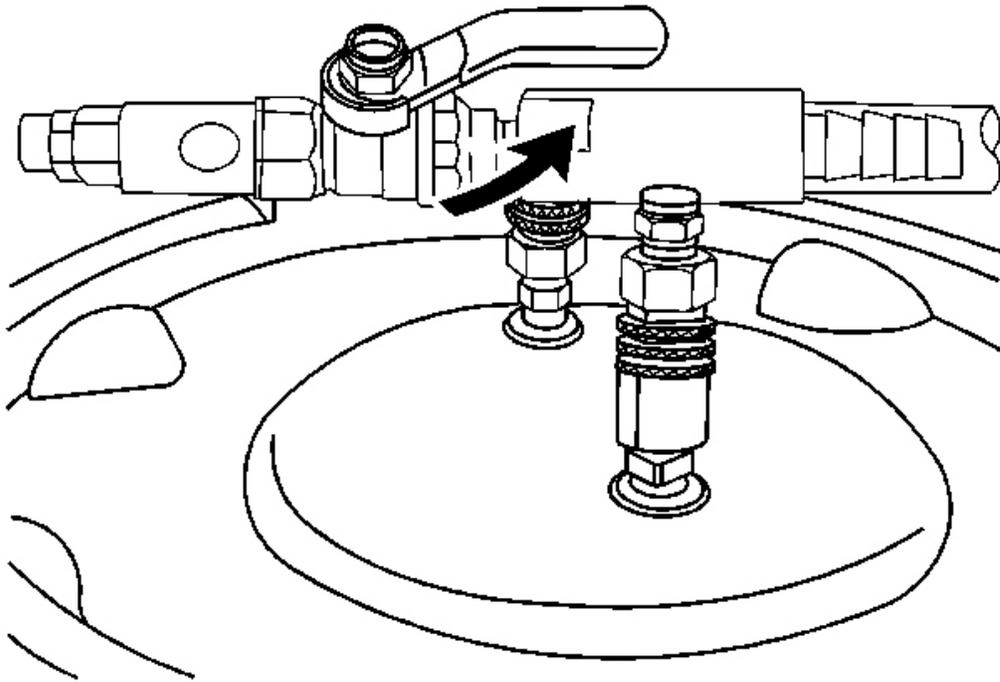


Fig. 23: Identifying Open Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

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

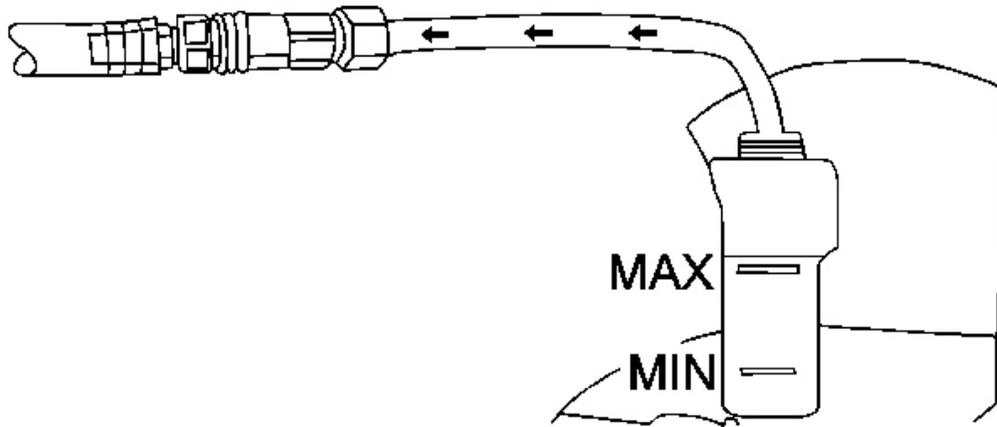


Fig. 24: Identifying Extraction Hose
Courtesy of GENERAL MOTORS CORP.

27. Use the extraction hose to draw out coolant to the proper level.
28. 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.

FLUSHING

IMPORTANT: Do not use a chemical flush.

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

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

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

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

Draining and Filling Cooling System (Vac N Fill).

2. Remove the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement.**
3. Clean and flush the coolant recovery reservoir with clean, drinkable water.
4. Install the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement.**
5. Follow the drain and fill procedure using only clean, drinkable water. Refer to **Draining and Filling Cooling System (Static Fill)** or **Draining and Filling Cooling System (Vac N Fill).**
6. Run the engine for 20 minutes.
7. Stop the engine.
8. Drain the cooling system. Refer to **Draining and Filling Cooling System (Static Fill)** or **Draining and Filling Cooling System (Vac N Fill).**
9. Repeat the procedure if necessary, until the fluid is nearly colorless.
10. Fill the cooling system. Refer to **Draining and Filling Cooling System (Static Fill)** or **Draining and Filling Cooling System (Vac N Fill).**

RADIATOR CLEANING

CAUTION: NEVER spray water on a hot radiator. The resulting steam could cause personal injury.

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

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

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

COOLANT RECOVERY RESERVOIR REPLACEMENT

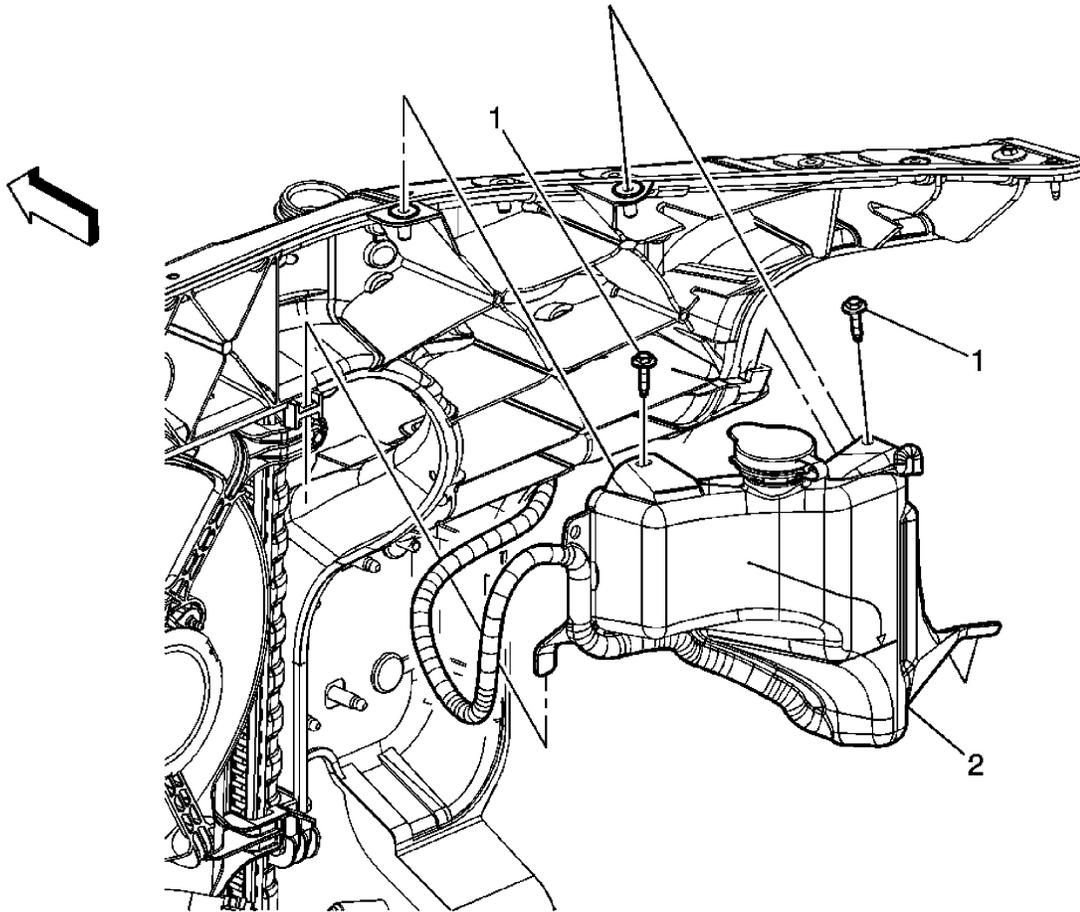


Fig. 25: View Of Coolant Recovery Reservoir
 Courtesy of GENERAL MOTORS CORP.

Coolant Recovery Reservoir Replacement

Callout	Component Name
Preliminary Procedure	
1. Drain the coolant from the recovery reservoir. 2. Remove the front compartment sight shield if necessary. Refer to <u>Front Compartment Sight Shields Replacement</u>	
1	Coolant Recovery Reservoir Bolt (Qty: 2) NOTE: Refer to <u>Fastener Notice</u> . Tighten: 5 N.m (44 lb in)

2

Coolant Recovery Reservoir

Procedure:

Remove overflow hose from reservoir

RADIATOR INLET HOSE REPLACEMENT

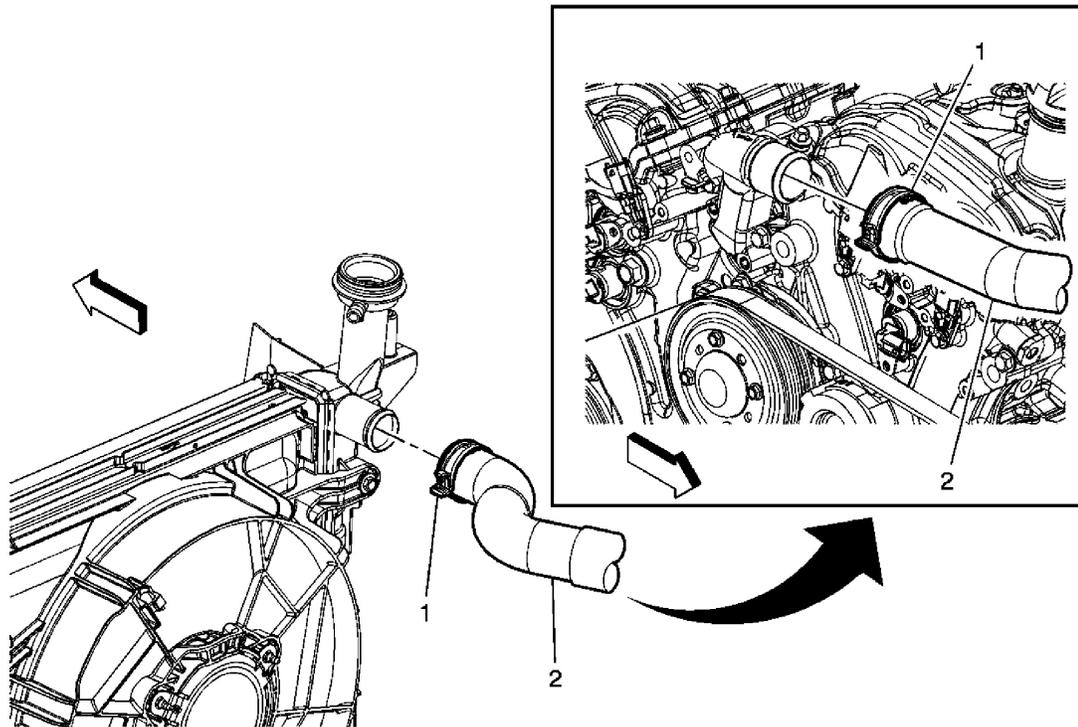


Fig. 26: Identifying Radiator Inlet Hose
 Courtesy of GENERAL MOTORS CORP.

Radiator Inlet Hose Replacement

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none"> 1. Drain the coolant. Refer to <u>Draining and Filling Cooling System (Static Fill)</u> or <u>Draining and Filling Cooling System (Vac N Fill)</u> 2. Remove the front compartment sight shield. Refer to <u>Front Compartment Sight Shields Replacement</u> 	
1	Radiator Inlet Hose Clamp (Qty: 2) Special Tools: J 38185 Hose Clamp Pliers. See Special Tools .

	Using J 38185 reposition the radiator inlet hose clamps. See Special Tools .
2	Radiator Inlet Hose

RADIATOR OUTLET HOSE REPLACEMENT

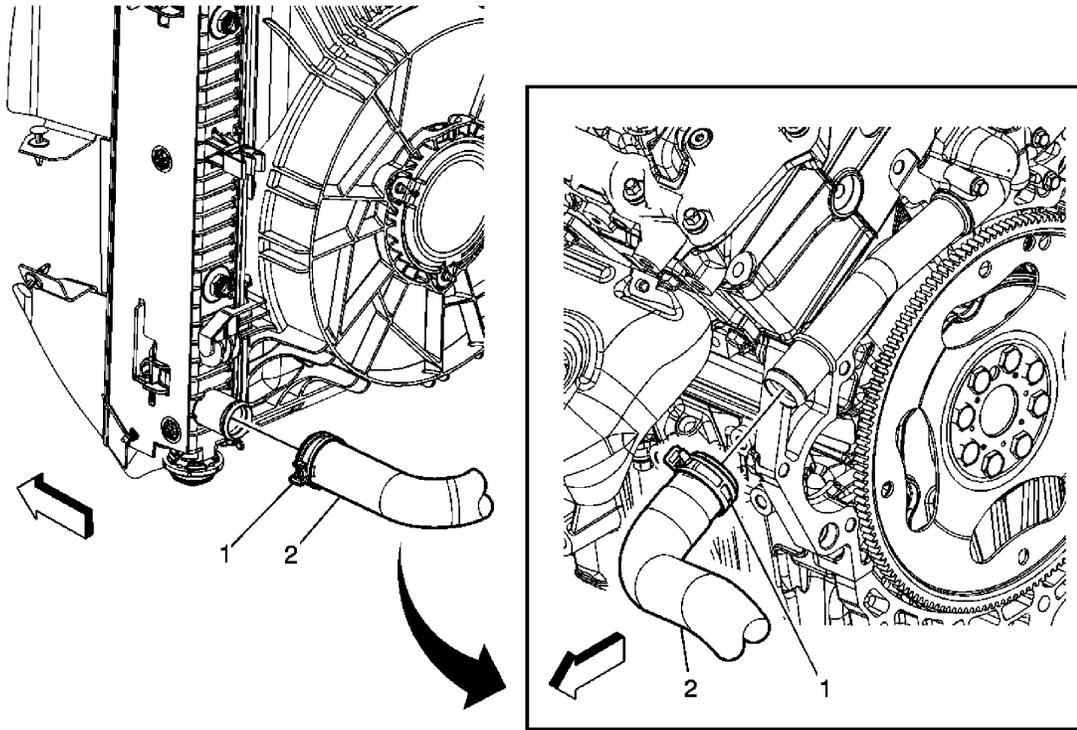


Fig. 27: Identifying Radiator Outlet Hose
 Courtesy of GENERAL MOTORS CORP.

Radiator Outlet Hose Replacement

Callout	Component Name
Preliminary Procedure	
1. Drain the coolant. Refer to Draining and Filling Cooling System (Static Fill) or Draining and Filling Cooling System (Vac N Fill) 2. Remove the front compartment sight shield. Refer to Front Compartment Sight Shields Replacement	
1	Radiator Outlet Hose Clamp (Qty: 2) Special Tools: J 38185 Hose Clamp Pliers. See Special Tools . Using J 38185 reposition the radiator outlet hose clamps. See Special

Tools.

2 Radiator Outlet Hose

COOLING FAN AND SHROUD REPLACEMENT

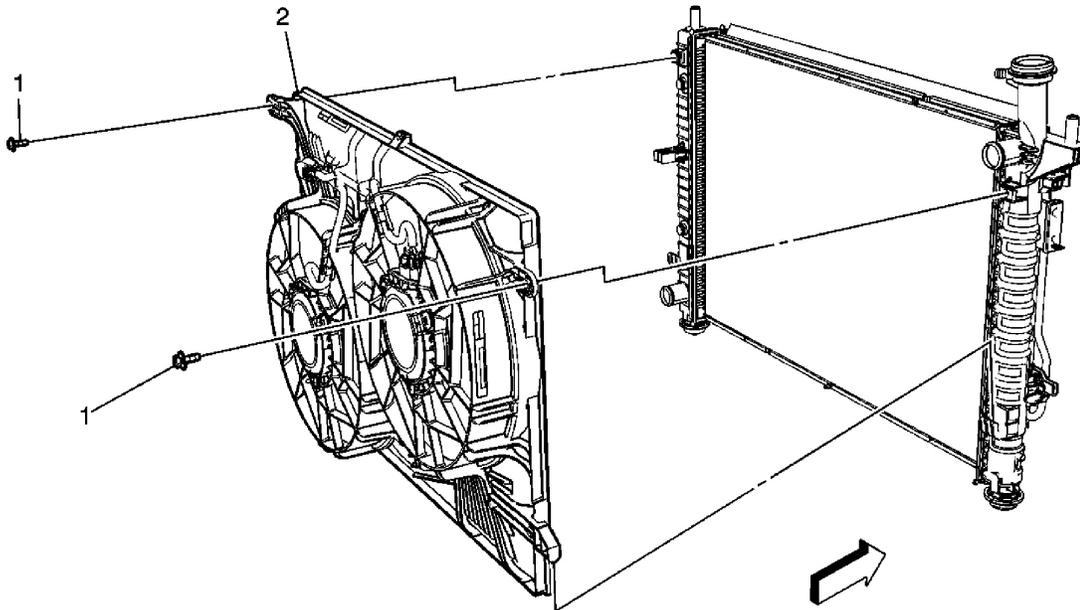


Fig. 28: View Of Cooling Fan & Shroud
 Courtesy of GENERAL MOTORS CORP.

Cooling Fan and Shroud Replacement

Callout	Component Name
Preliminary Procedure	
1. Disconnect electrical connector at fan shroud harness. 2. Remove front fascia upper support. Refer to <u>Front Bumper Fascia Upper Support Replacement</u> . 3. Remove hood latch support. Refer to <u>Hood Latch Support Replacement</u> .	
1	Fan Shroud Mounting Bolt (Qty: 2) NOTE: Refer to <u>Fastener Notice</u> . Tighten: 10 N.m (89 lb in)
	Fan Shroud

2

Procedure:

Tilt Fan Shroud rearward and upward to remove

Tip: Reposition of radiator hoses may be necessary for removal

THERMOSTAT REPLACEMENT

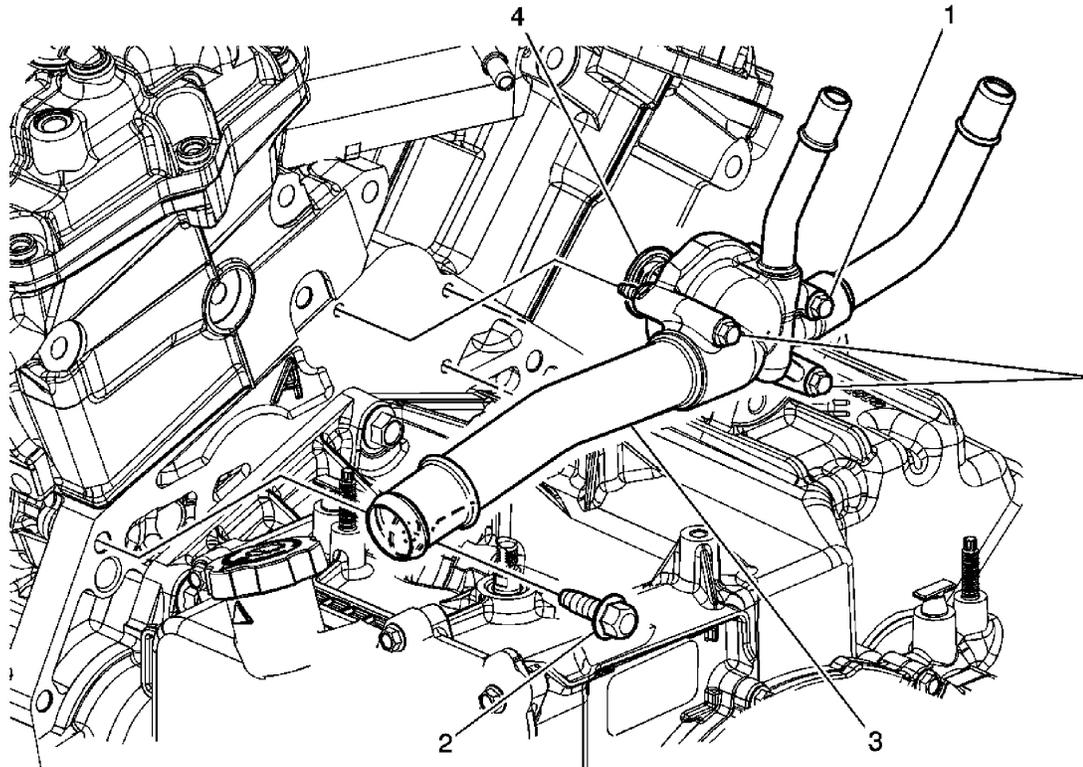


Fig. 29: View Of Thermostat Housing & Components
 Courtesy of GENERAL MOTORS CORP.

Thermostat Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Partially drain the cooling system. Refer to <u>Draining and Filling Cooling System (Static Fill)</u> or <u>Draining and Filling Cooling System (Vac N Fill)</u>. 2. Remove the heater inlet and outlet hoses. Refer to <u>Heater Inlet Hose Replacement</u> and <u>Heater Outlet Hose Replacement</u>. 	
	Thermostat Housing Bolt (Qty: 3)

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1	<p>NOTE: Refer to <u>Fastener Notice</u> .</p> <p>Procedure: Remove the thermostat housing bolts.</p> <p>Tighten: 10 N.m (89 lb in)</p>
2	<p>Thermostat Housing Bolt</p> <p>Procedure: Remove the thermostat housing bolt.</p> <p>Tighten: 50 N.m (37 lb ft)</p>
3	<p>Thermostat Housing</p>
4	<p>Thermostat</p> <p>Procedure</p> <ol style="list-style-type: none">1. Remove the thermostat and discard the thermostat gasket.2. Install a new thermostat gasket.

WATER OUTLET HOUSING REPLACEMENT

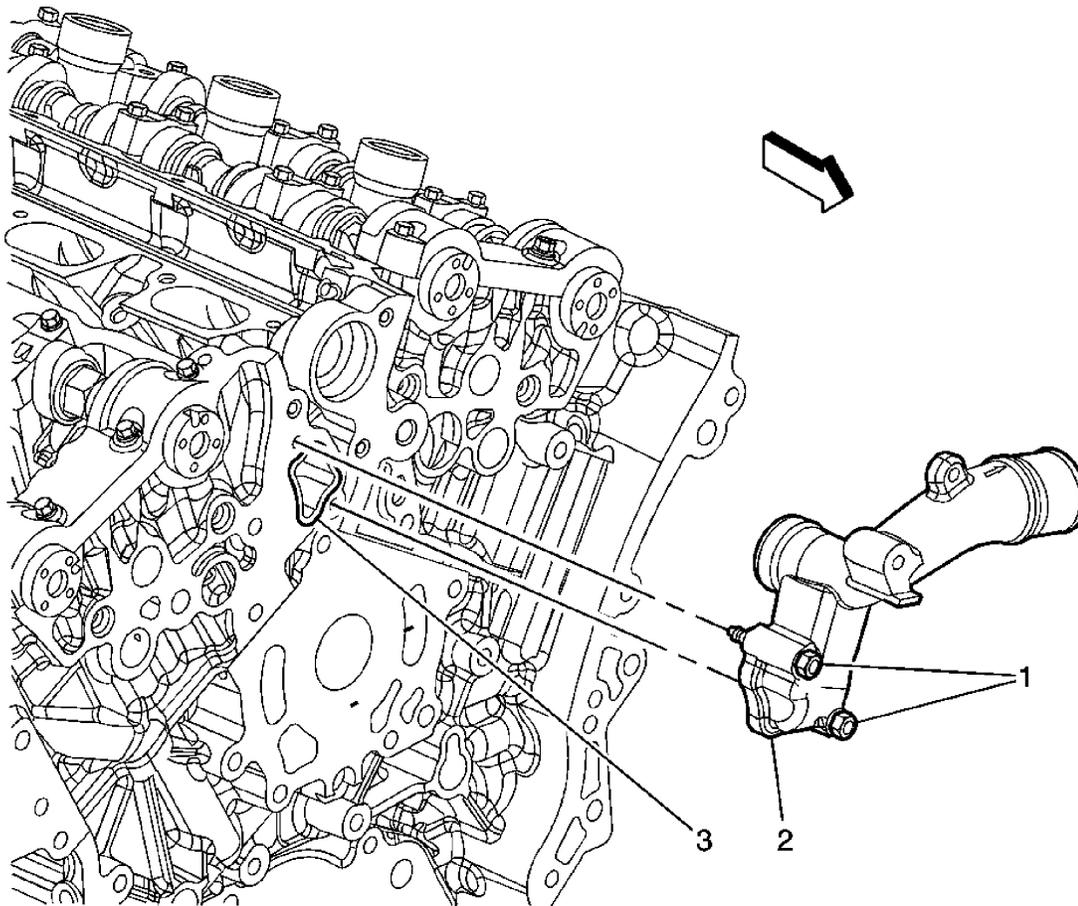


Fig. 30: Identifying Water Outlet Housing
 Courtesy of GENERAL MOTORS CORP.

Water Outlet Housing Replacement

Callout	Component Name
Preliminary Procedures:	
Remove the radiator outlet hose. Refer to <u>Radiator Outlet Hose Replacement</u> .	
1	Water Outlet Housing Bolt (Qty: 2) NOTE: Refer to <u>Fastener Notice</u> . Procedure: Remove the water outlet housing bolts.

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	Tighten: 10 N.m (89 lb in)
2	Water Outlet Housing
3	Seal Procedure <ol style="list-style-type: none">1. Remove the water outlet housing seal. Discard the seal.2. Install a new water outlet housing seal.

WATER PUMP REPLACEMENT

Tools Required

EN 46104 Water Pump Pulley Holding Tool

Removal Procedure

1. Drain the cooling system. Refer to **Draining and Filling Cooling System (Static Fill)** or **Draining and Filling Cooling System (Vac N Fill)**.
2. Remove the drive belt. Refer to **Drive Belt Replacement** .

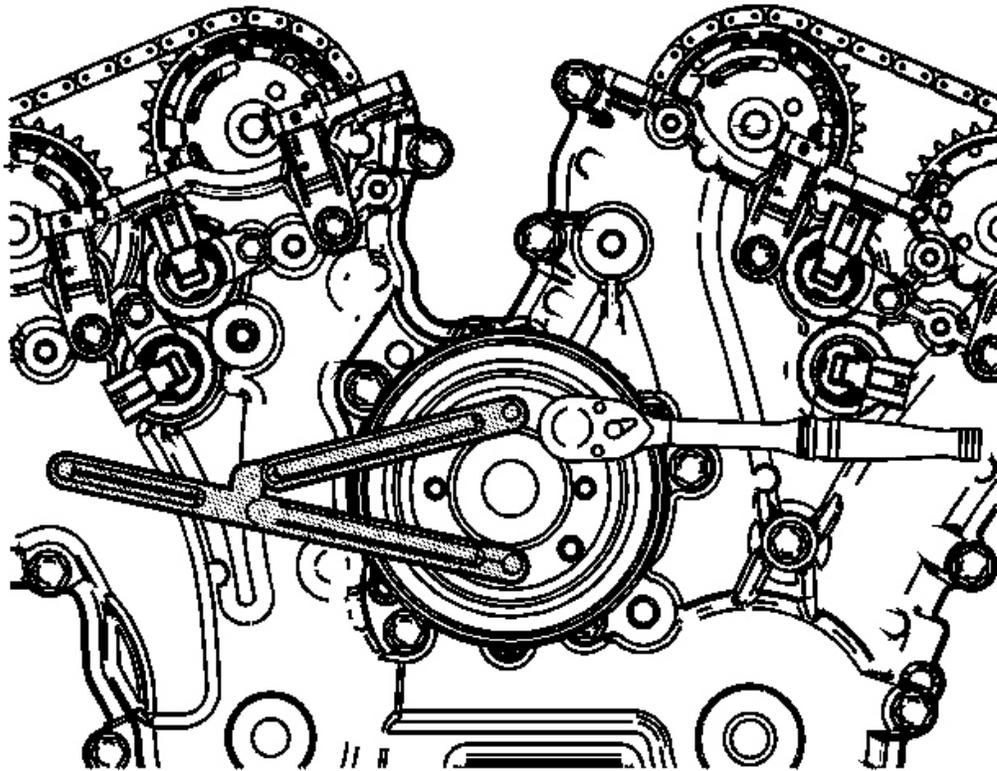


Fig. 31: View Of EN 46104 Installed On Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

3. Use the EN 46104 in order to retain the water pump pulley.

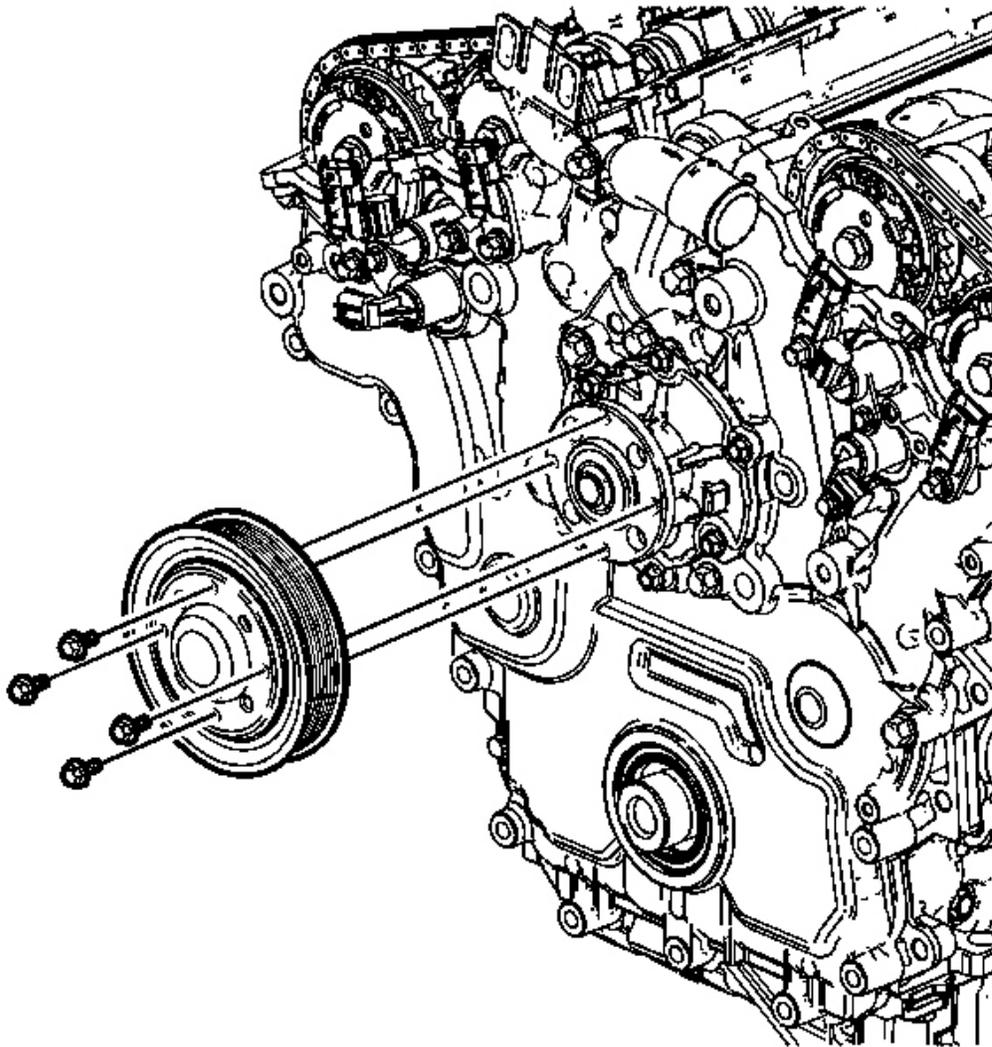


Fig. 32: Locating Water Pump Pulley & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the water pump pulley bolts.
5. Remove the water pump pulley.

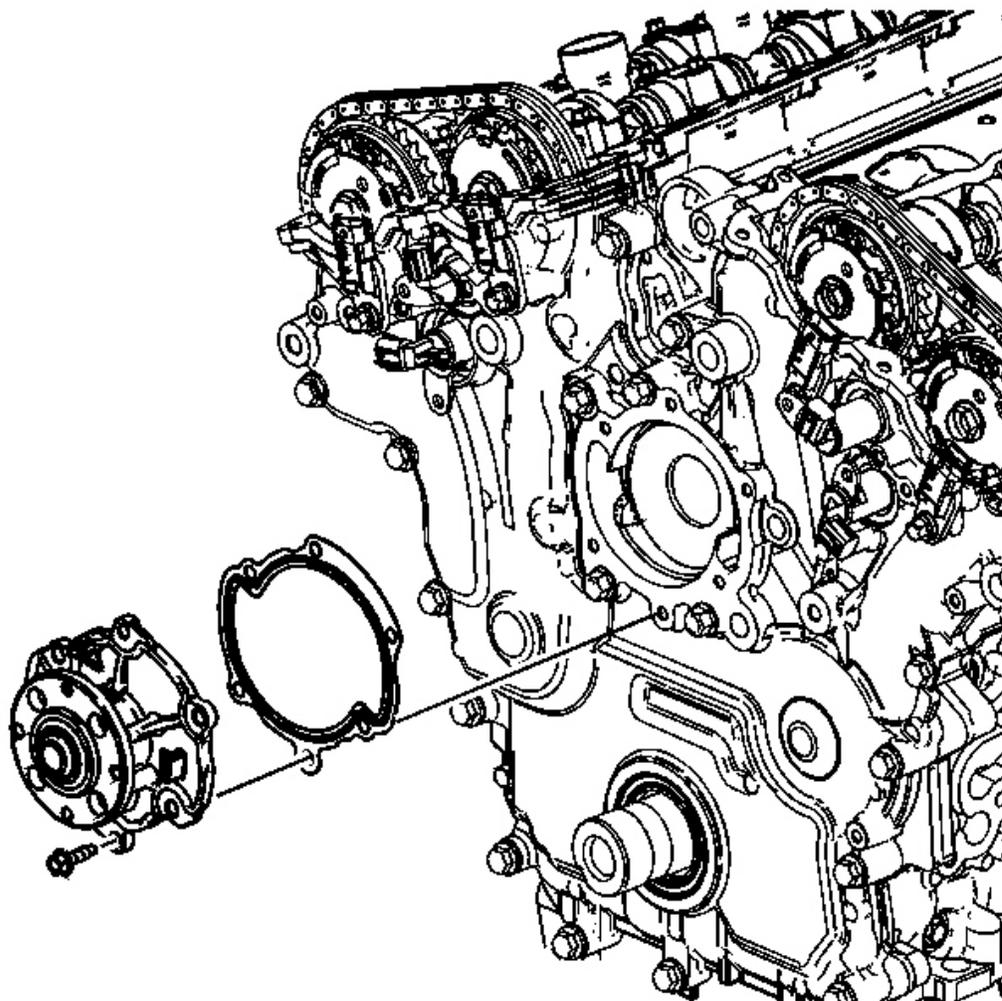


Fig. 33: Identifying Water Pump Components
Courtesy of GENERAL MOTORS CORP.

6. Remove the water pump bolts.
7. Remove the water pump.
8. Remove and DISCARD the water pump seal.
9. Carefully clean the water pump sealing surfaces.

Installation Procedure

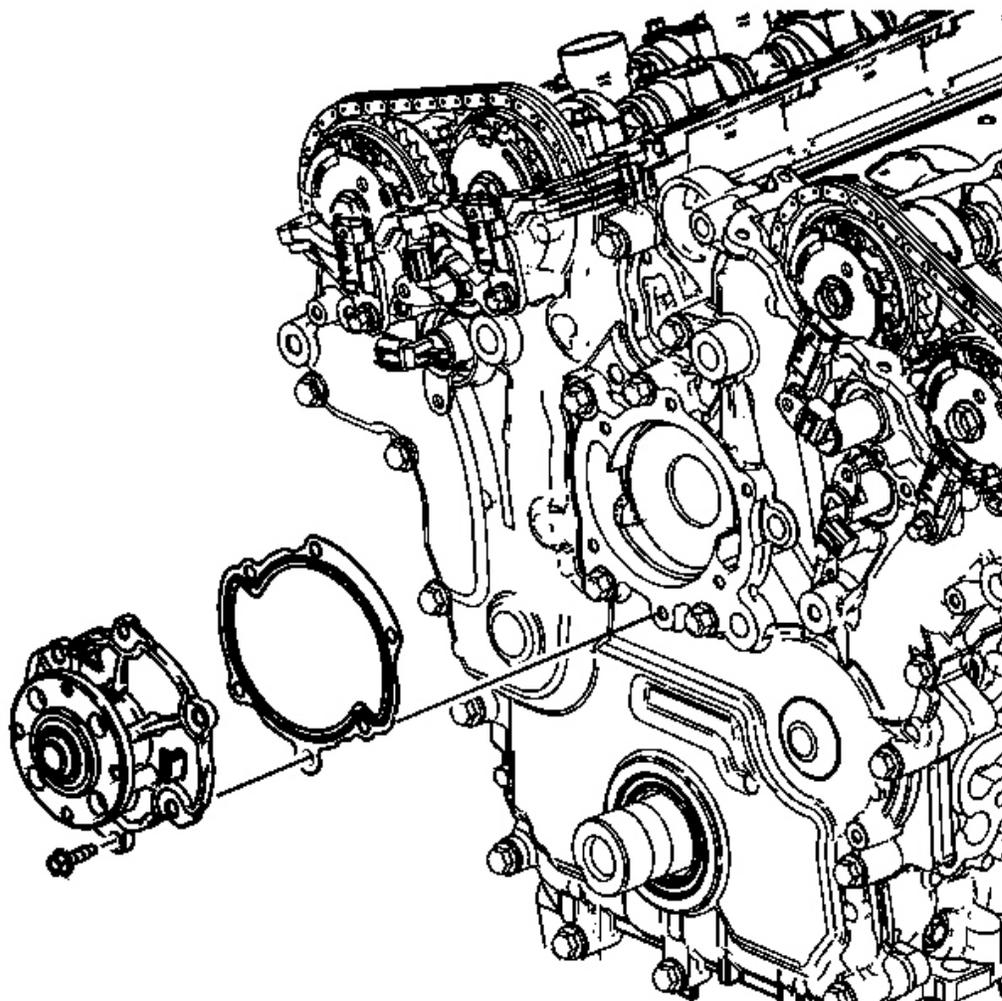


Fig. 34: Identifying Water Pump Components
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW water pump seal.
2. Install the water pump.

NOTE: Refer to Fastener Notice .

3. Install the water pump bolts.

Tighten: Tighten the water pump bolts to 10 N.m (89 lb in).

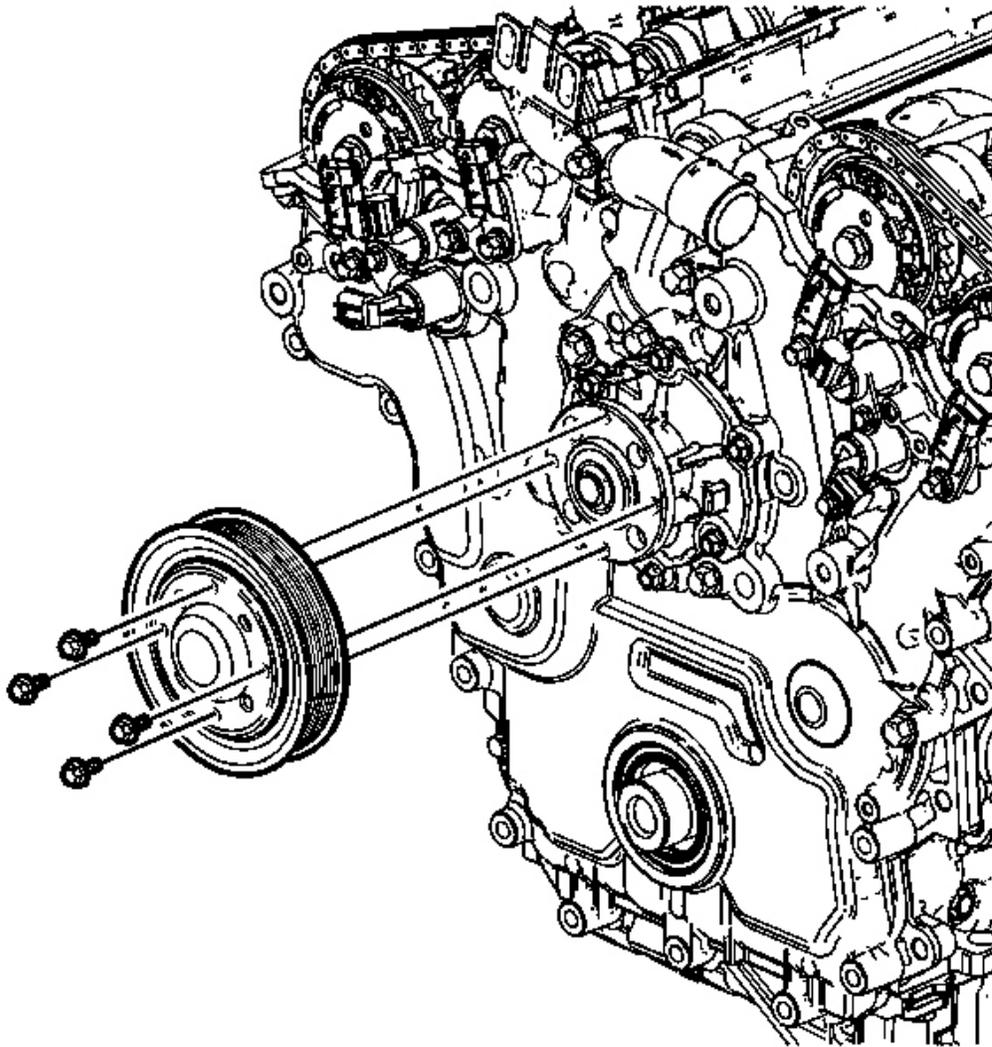


Fig. 35: Locating Water Pump Pulley & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the water pump pulley and the water pump pulley bolts.

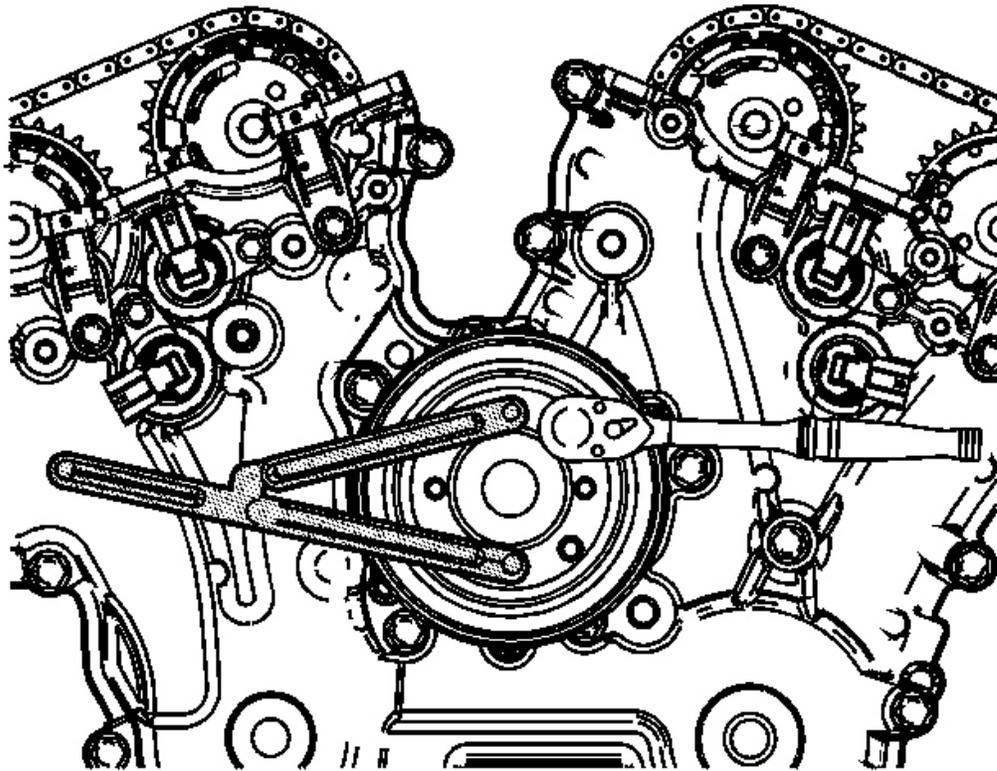


Fig. 36: View Of EN 46104 Installed On Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

5. Use the **EN 46104** in order to retain the water pump pulley.
6. Install the water pump pulley bolts.

Tighten: Tighten the water pump pulley bolts to 10 N.m (89 lb in).

7. Install the drive belt. Refer to **Drive Belt Replacement** .
8. Fill the cooling system. Refer to **Draining and Filling Cooling System (Static Fill)** or **Draining and Filling Cooling System (Vac N Fill)**.

RADIATOR REPLACEMENT

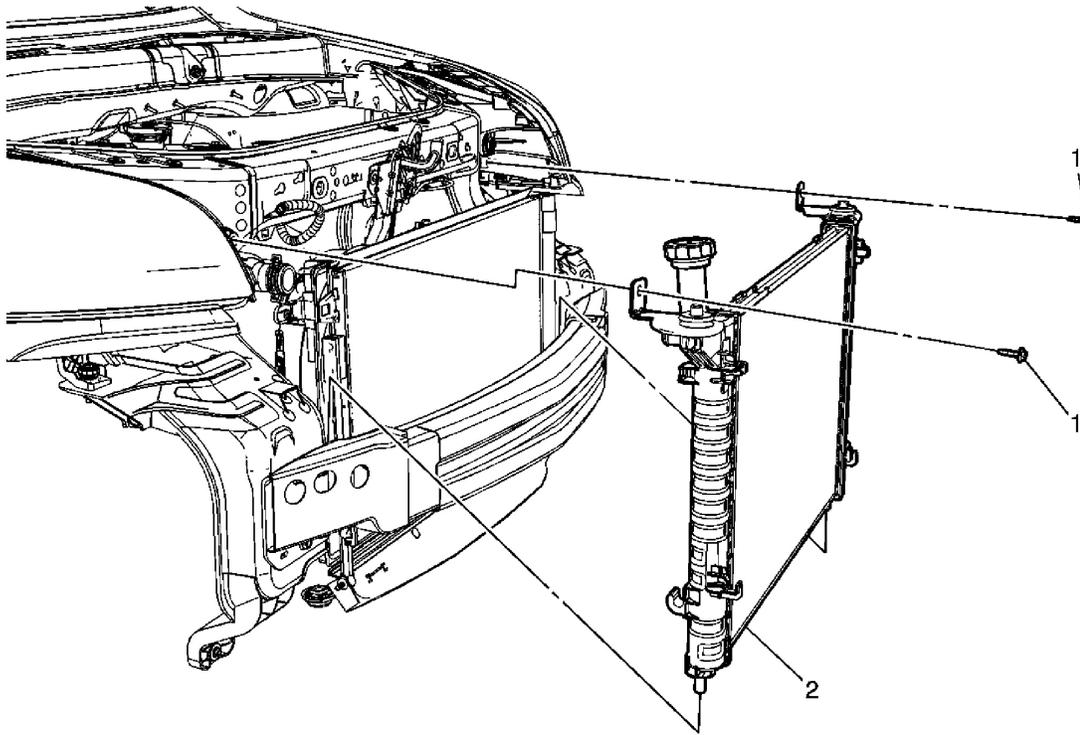


Fig. 37: Identifying Radiator

Courtesy of GENERAL MOTORS CORP.

Radiator Replacement

Callout	Component Name
Preliminary Procedure	
1.	Drain the coolant. Refer to <u>Draining and Filling Cooling System (Static Fill)</u> or <u>Draining and Filling Cooling System (Vac N Fill)</u>
2.	Remove radiator inlet hose. Refer to <u>Radiator Inlet Hose Replacement</u> .
3.	Remove radiator outlet hose. Refer to <u>Radiator Outlet Hose Replacement</u> .
4.	Remove fan shroud top mounting bolts from radiator and position fan shroud rearward. Refer to <u>Cooling Fan and Shroud Replacement</u> .
5.	Remove transmission inlet cooling line from radiator. Refer to <u>Transmission Fluid Cooler Inlet Hose Replacement</u> .
6.	Remove transmission outlet cooling line from radiator. Refer to <u>Transmission Fluid Cooler Outlet Hose Replacement</u> .
7.	Remove coolant reservoir hose from radiator filler neck.
8.	Remove the front bumper fascia upper support. Refer to <u>Front Bumper Fascia</u>

Upper Support Replacement

9. Pinch fastening tabs together at top of condenser to remove from radiator and position forward.

1	Radiator Mounting Bolt (Qty: 2) NOTE: Refer to <u>Fastener Notice</u> . Tighten: 10 N.m (89 lb in)
2	Radiator Tip: <ul style="list-style-type: none">• Bottom of condenser mounts into holding fixtures at bottom of radiator.• Radiator will slide out between the condenser and fan shroud.

COOLANT HEATER REPLACEMENT

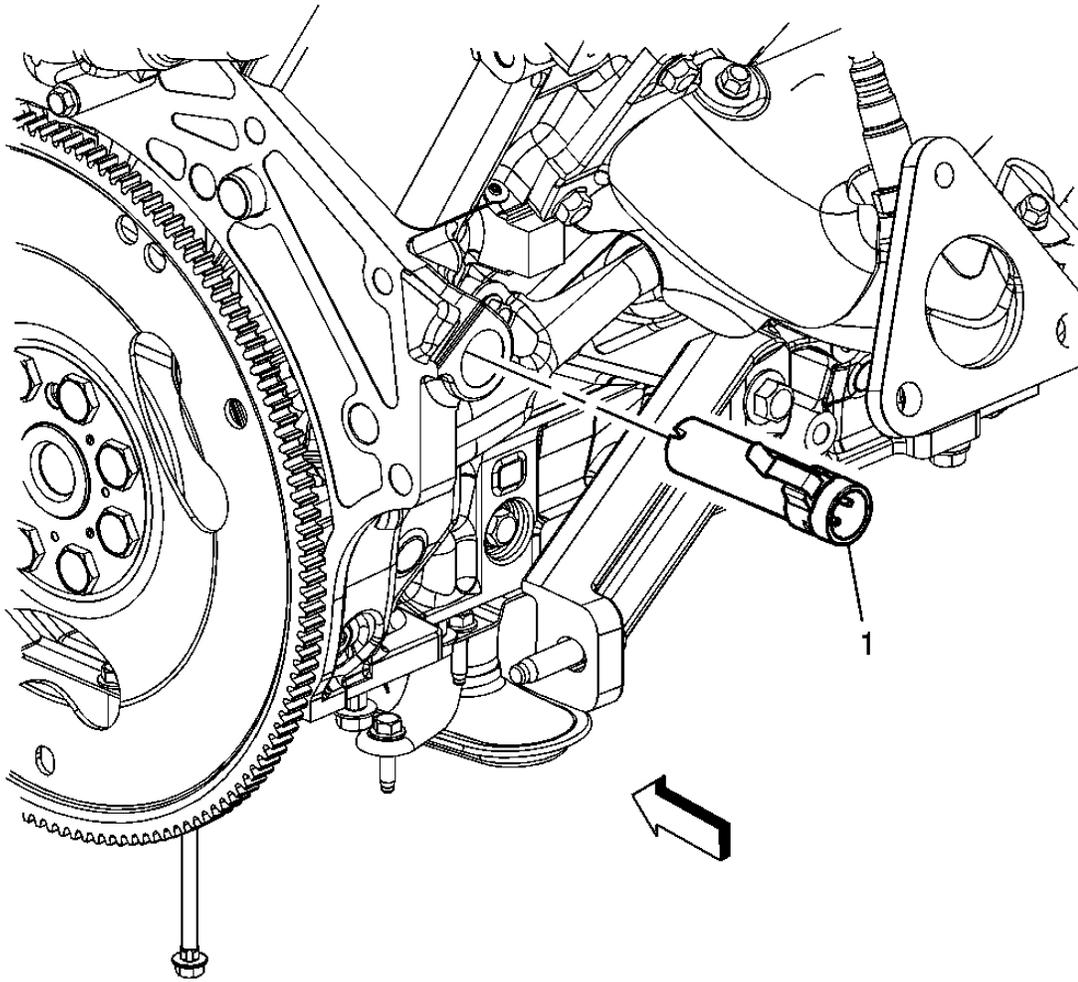


Fig. 38: View Of Coolant Heater
 Courtesy of GENERAL MOTORS CORP.

Coolant Heater Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Draining and Filling Cooling System (Static Fill)</u> or <u>Draining and Filling Cooling System (Vac N Fill)</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Coolant Heater Procedure 1. Disconnect the coolant heater cord from the coolant heater.

2. Remove the coolant heater.

COOLANT HEATER CORD REPLACEMENT

Removal Procedure

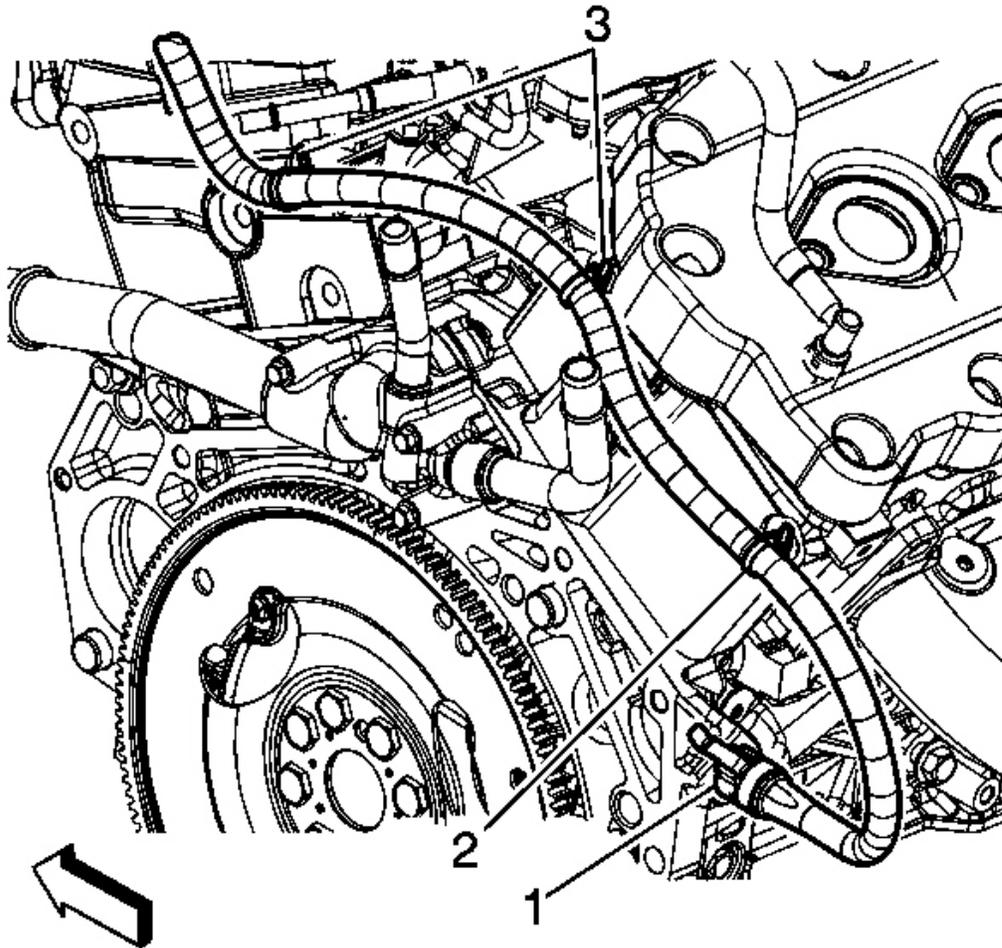


Fig. 39: Identifying Coolant Heater Cord Clips & Coolant Heater
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Disconnect the coolant heater power supply cord from the coolant heater (1).

3. Lower the vehicle.
4. Disconnect the coolant heater cord clips (2, 3) from the cylinder heads.

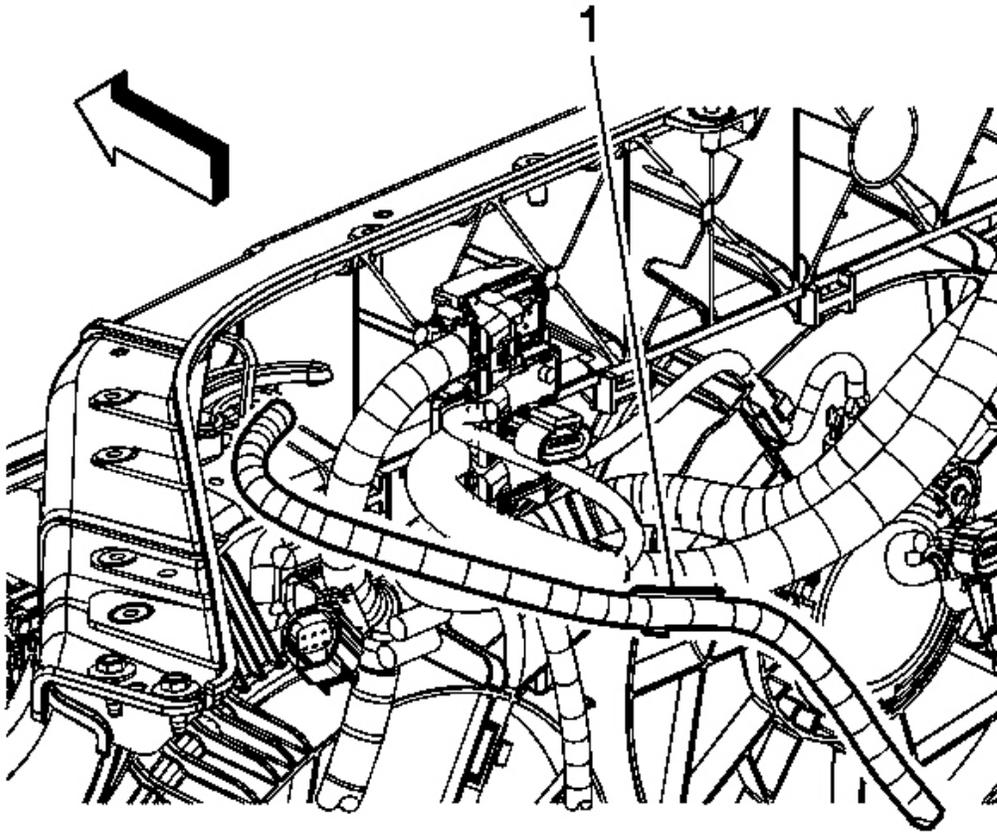


Fig. 40: Identifying Coolant Heater Cord
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the coolant heater cord clip (1) from the engine wiring harness (2).
6. Remove the coolant heater cord (3) from the vehicle.

Installation Procedure

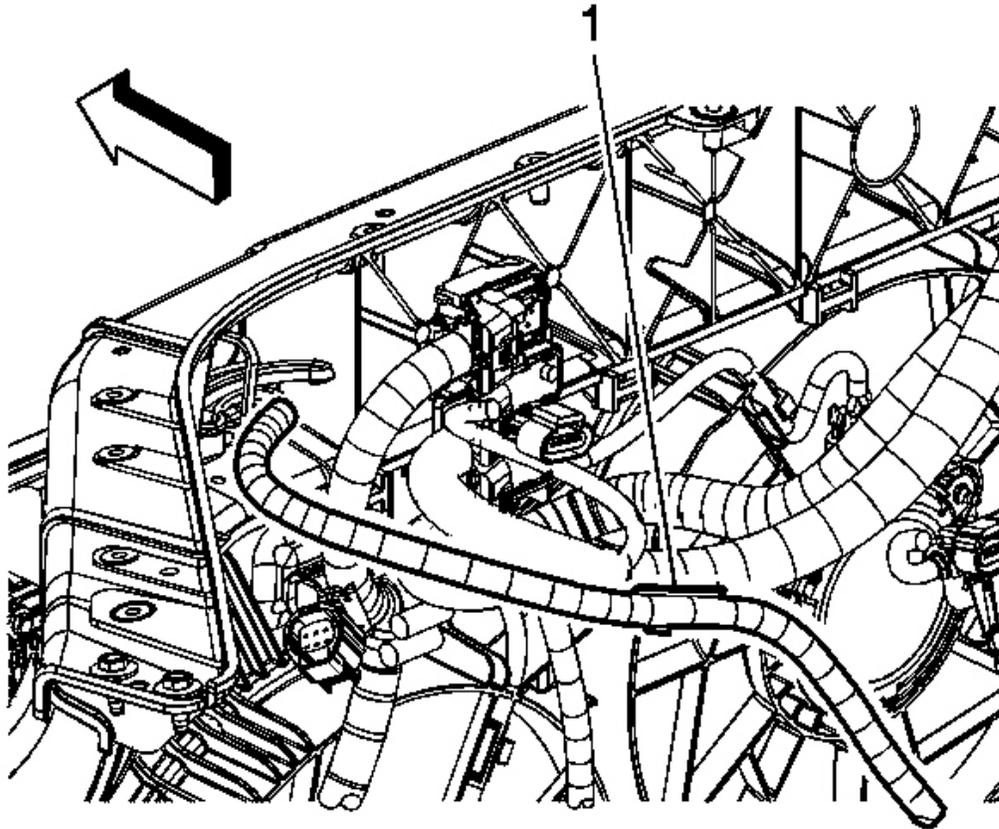


Fig. 41: Identifying Coolant Heater Cord
Courtesy of GENERAL MOTORS CORP.

1. Position the coolant heater power supply cord to the engine harness.
2. Connect the coolant heater cord clip (1) to the engine wiring harness (2).

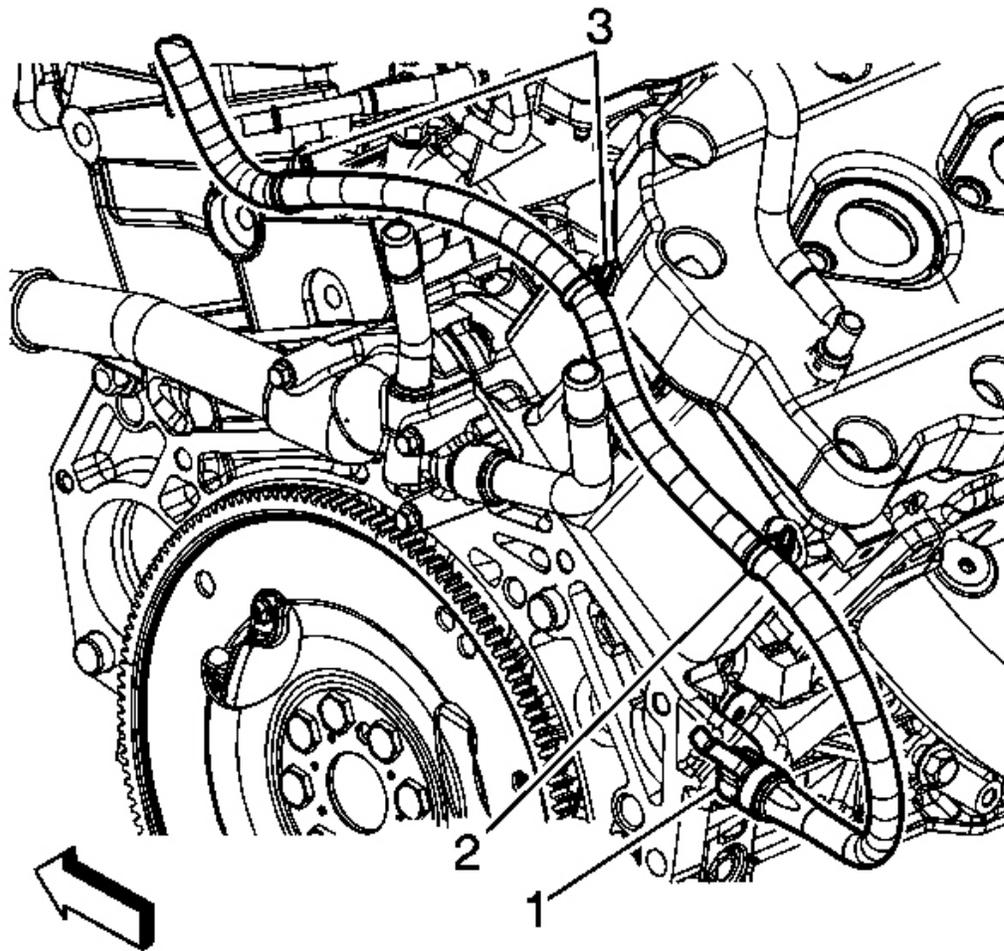


Fig. 42: Identifying Coolant Heater Cord Clips & Coolant Heater
Courtesy of GENERAL MOTORS CORP.

3. Connect the coolant heater cord clips (2, 3) to the cylinder heads.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Connect the coolant heater cord to the coolant heater (1).
6. Lower the vehicle.

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

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

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

During high speed operation the ECM supplies the ground path for the fan 1 relay through the low speed cooling fan relay control circuit. After a 3 second delay, the ECM supplies a ground path for the fan 3 relay and the fan 2 relay through the high speed cooling fan relay control circuit. This energizes the fan 2 relay coil, closes the relay contacts and provides a ground path for the left cooling fan. At the same time the fan 3 relay coil is energized closing the relay contacts and provides battery positive voltage from the cool fan 2 fuse on the cooling fan motor supply voltage circuit to the right cooling fan. During high speed fan operation, both engine cooling fans have their own ground path. The result is a parallel circuit with both fans running at high speed.

When the request for fan activation is withdrawn, the fan may not turn OFF until the ignition switch is moved to the OFF position or the vehicle speed exceeds approximately 10 mph. This is to prevent a fan from cycling ON and OFF excessively at idle.

When the request for fan activation is withdrawn, the fan may not turn OFF until the ignition switch is moved to the OFF position or the vehicle speed exceeds approximately 16 km/h (10 mph). This is to prevent a fan from cycling ON and OFF excessively at idle.

COOLING SYSTEM DESCRIPTION AND OPERATION

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

Cooling Cycle

Coolant is drawn from the radiator outlet to the thermostat. The flow of coolant will be stopped

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at the thermostat until the engine is warmed; while the thermostat is closed the water pump circulates coolant through the engine block and heater core. Coolant is returned to the water pump through the engine bypass and the heater core outlet hose. This provides the passenger compartment with heat and defrost.

After the thermostat opens, the coolant is pumped through the water pump outlet and into the engine block and heater core. 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 into the radiator where it is cooled and the coolant cycle is completed.

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

Coolant

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

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

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

Pressure Cap

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

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

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

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

As the engine cools, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open. This equalizes the pressure in the cooling system with the atmospheric pressure, preventing the radiator from collapsing.

Coolant Recovery System

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

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

Air Baffles and Seals

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

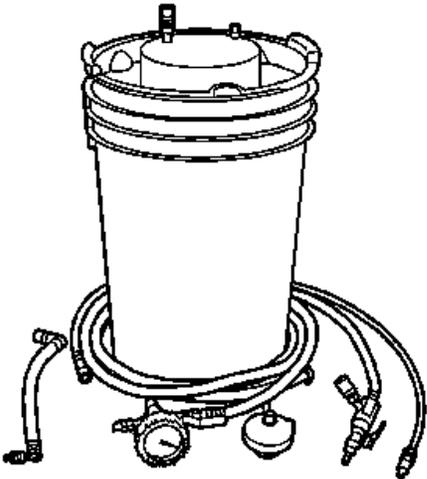
Transmission Oil Cooler

The transmission oil cooler is a heat exchanger that is located inside one of the radiator end tanks. The transmission fluid temperature is regulated by the temperature of the engine coolant in the radiator. The oil pump pumps the fluid through the transmission oil cooler feed line to the oil cooler. The fluid flows through the cooler where the engine coolant absorbs heat from the fluid. The fluid is then pumped through the oil cooler return line back to the transmission.

SPECIAL TOOLS AND EQUIPMENT

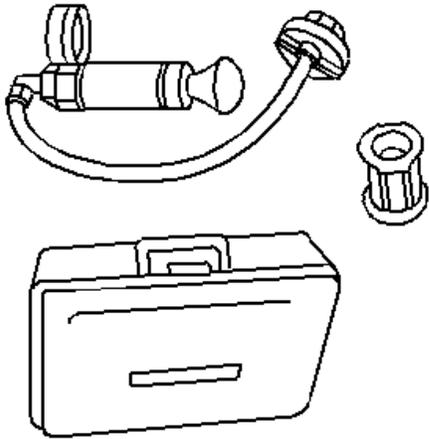
SPECIAL TOOLS

Special Tools

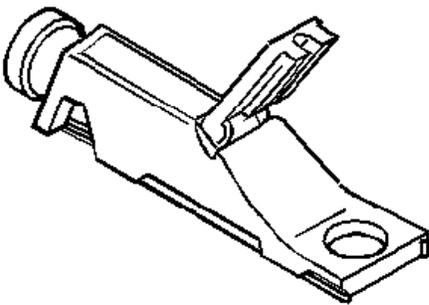
Illustration	Tool Number/Description
	<p style="text-align: center;">GE-47716 Vac N Fill Coolant Refill Tool</p>

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J-24460-01
Cooling System Pressure Tester

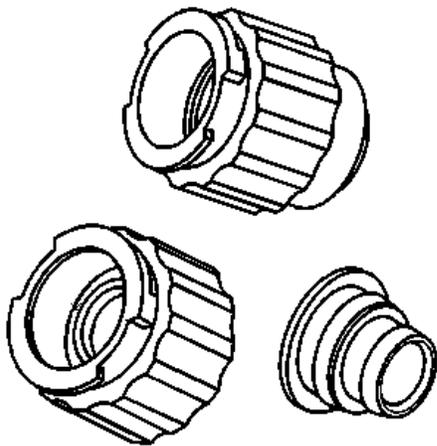
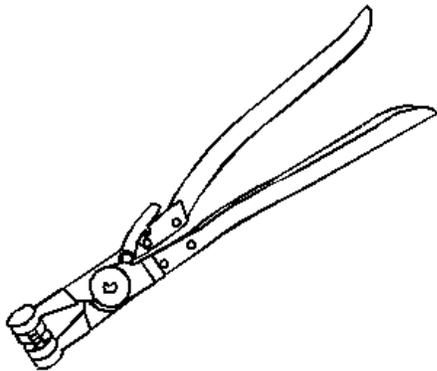


J-26568
Coolant and Battery Fluid Tester

J-38185
Hose Clamp Pliers

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J-42401
Radiator Cap and Surge Tank Test Adapter