2014 ENGINE PERFORMANCE

Engine Controls/Fuel - 3.6L (LLT) - Repair Instructions - Acadia, Enclave And Traverse

REPAIR INSTRUCTIONS

BRAKE PEDAL POSITION SENSOR LEARN

Calibration Criteria

NOTE: Do not apply the brake pedal during the brake pedal position sensor calibration procedure. Any movement of the brake pedal during this procedure will cause the calibration procedure to fail. If this occurs, the brake pedal position sensor calibration must be repeated.

Brake pedal position sensor calibration must be performed after the brake pedal position sensor, body control module (BCM) or engine control module (ECM) have been serviced. The calibration procedure will set the brake pedal position sensor home value. This value is used by the BCM and ECM to determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via serial data.

Calibration Procedure

1. Apply the parking brake.
2. Ignition ON, engine OFF, place the transmission in the PARK position for automatic transmission or NEUTRAL position for manual transmission.
3. Install a scan tool.
4. Clear all DTCs before proceeding.
5. Navigate to the Configuration/Reset Functions menu of the BCM.
6. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
7. Navigate to the Configuration/Reset Functions menu of the ECM.
8. Select the Learn Functions menu.
9. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

The Crankshaft Position Variation Learn procedure is required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- An engine replacement
- A engine control module (ECM) replacement
- A crankshaft balancer replacement
- A crankshaft replacement
- A crankshaft position sensor replacement

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- Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.

The ECM monitors certain component signals to determine if all the conditions are met to continue with the Crankshaft Position Variation Learn procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool displays the signals of the following components:

- Crankshaft position sensors activity: If there is a crankshaft position sensor condition, refer to the applicable DTC set.
- Camshaft position sensor signal activity: If there is a camshaft position sensor signal condition, refer to the applicable DTC set.
- Engine coolant temperature (ECT): If the engine coolant temperature is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.

1. Verify no DTCs are set.
    - **If any DTCs other than P0300-P0308 or P0315 are set**

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

    - **If DTC P0300-P0308, P0315 or no DTCs are set**

NOTE: The Crankshaft Position Variation Learn may have to be repeated up to 5 times before the procedure is successful.

2. Engine Running at normal operating temperature, perform the scan tool Crankshaft Position Variation Learn procedure and follow the on screen instructions.
3. Verify the scan tool displays Test Passed Successfully when completed.
    - **If Test Passed Successfully is not displayed**

      Verify that none of the following conditions exist:

      - The ignition switch is in the ON position until there is insufficient system voltage.
      - An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315
      - Interference in the signal circuit of the crankshaft position sensor
      - Debris between the crankshaft position sensor and the reluctor wheel
      - A damaged or misaligned reluctor wheel
      - Worn crankshaft main bearings.
      - Excessive crankshaft runout
      - A damaged crankshaft
    - If a condition is exists
    1. Repair or replace as necessary.
    2. Engine Running at normal operating temperature, perform the scan tool Crankshaft Position

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Variation Learn procedure and follow the on screen instructions.

- If no conditions exist, replace the K20 Engine Control Module.
- **If Test Passed Successfully is displayed**

4. Clear all DTCs.
5. Engine Running.
6. Verify a DTC is not set.
   - **If a DTC is set**

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

   - **If a DTC is not set**
7. All OK.

Repair Instructions

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

Control Module References for engine control module replacement, programming and setup

ENGINE CONTROL MODULE REPLACEMENT

CAUTION:

- **Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage.**
- **Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables or when charging the vehicle battery.**
- **In order to prevent any possible electrostatic discharge damage to the control module, do no touch the connector pins or the soldered components on the circuit board.**
- **Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.**
- **The replacement control module must be programmed.**

NOTE: **Before removing the engine control module (ECM), use the scan tool to capture the ECM data. This captured data will then need to be restored into the NEW**

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ECM. Refer to Control Module References .

Removal Procedure

1. Turn the ignition OFF.

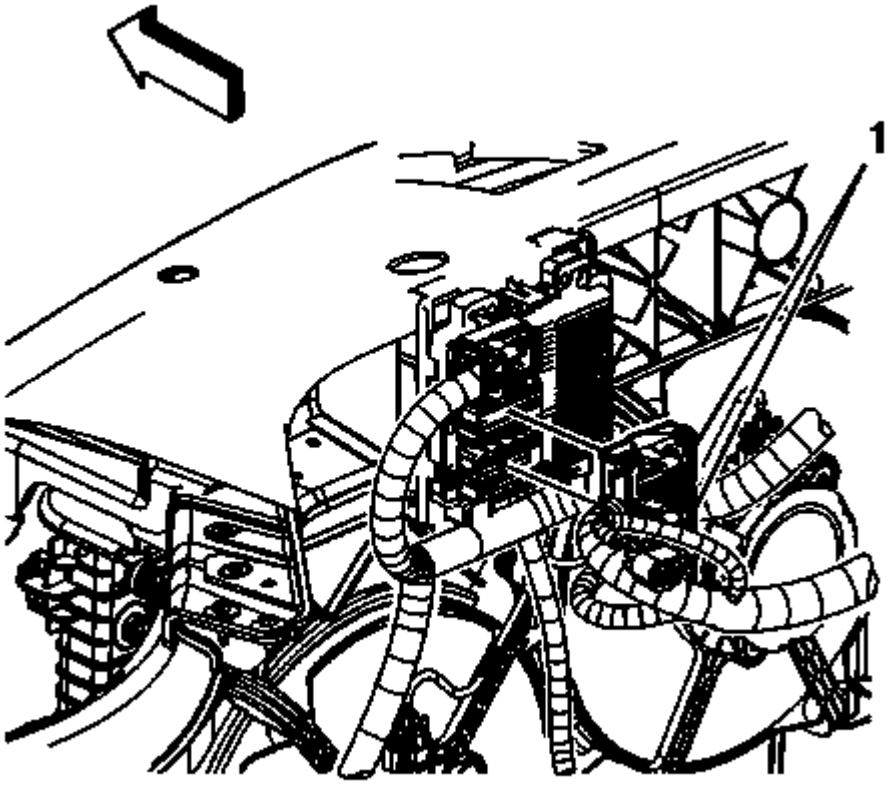

Fig. 1: Identifying ECM Middle & Lower Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

2. Using a scan tool, retrieve the percentage of remaining engine oil and the remaining automatic transmission fluid life. Record the remaining engine oil and the remaining automatic transmission fluid life.
3. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Disconnect the engine wiring harness middle and lower electrical connectors (1) from the ECM.
5. If also replacing the ECM bracket, remove the engine wiring harness clip (2) from the ECM bracket tab.

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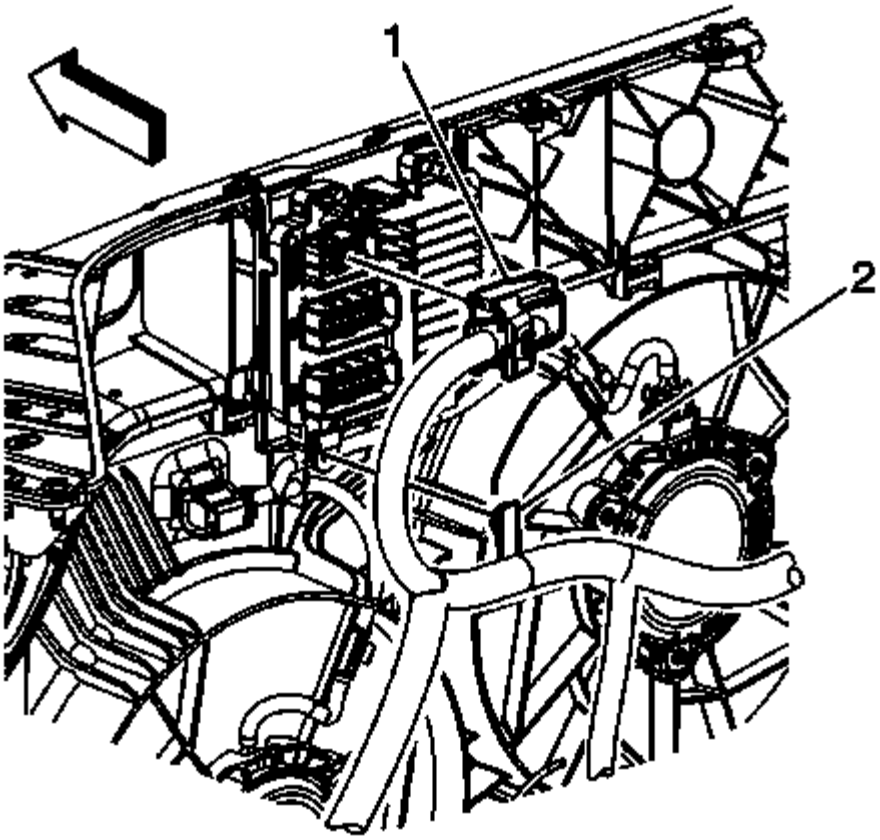

Fig. 2: View Of Engine Wiring Harness Clip & ECM Upper Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the engine wiring harness upper electrical connector (1) from the ECM.
7. Gently lift up the retaining tab (1) and lift the ECM up and out of the support brackets on the ECM bracket.

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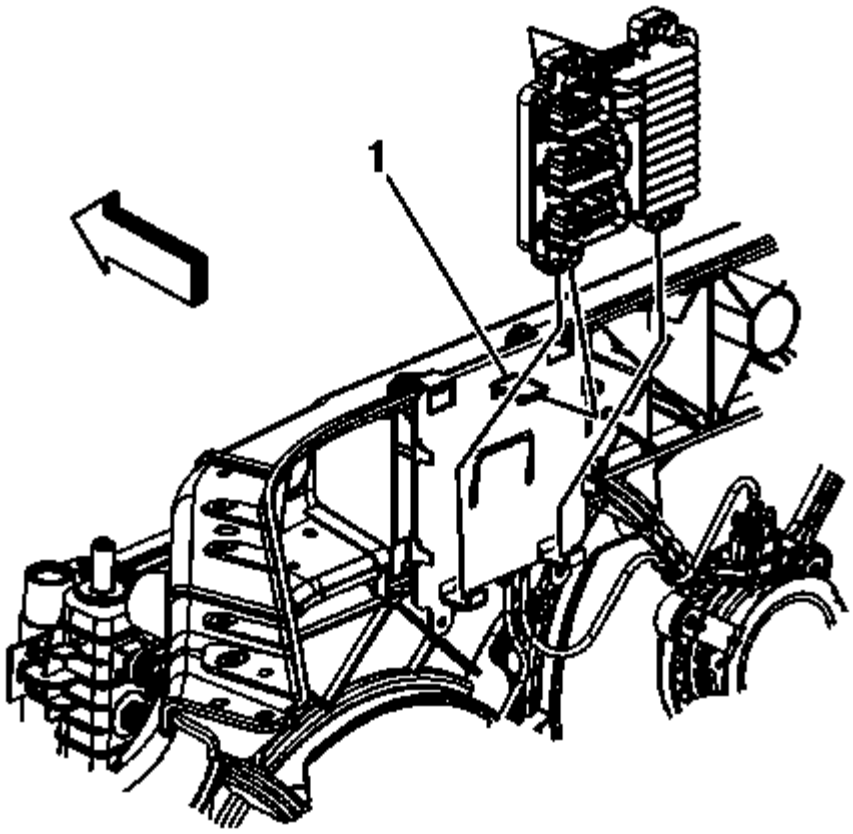

Fig. 3: Identifying ECM Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

CAUTION: In order to prevent any possible electrostatic discharge damage to the ECM, do not touch the connector pins.

8. If necessary, remove the ECM bracket bolts (1) and bracket.

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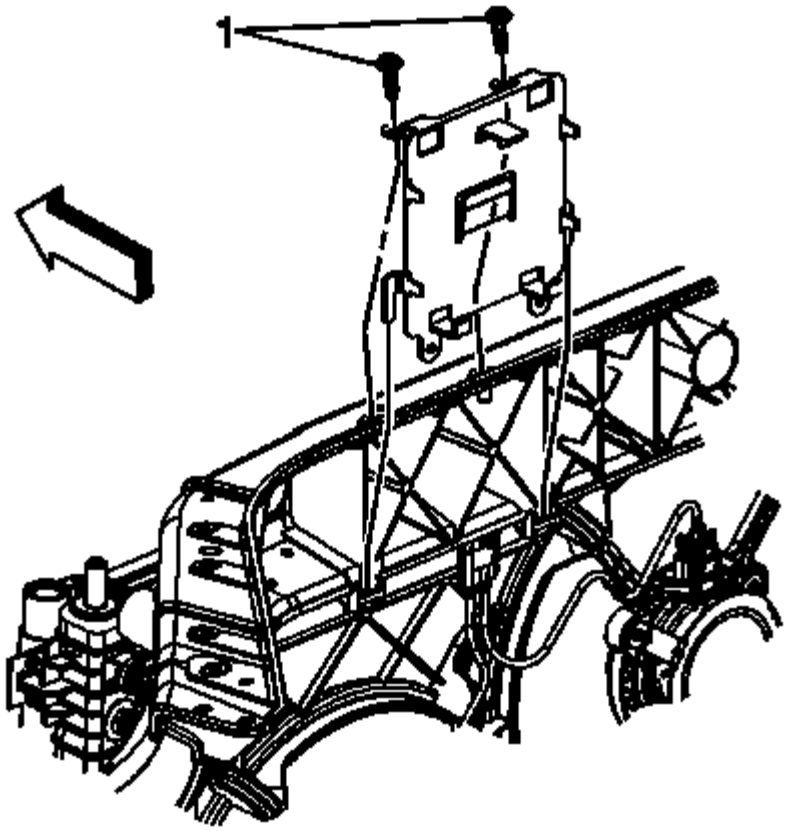

Fig. 4: View Of ECM Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. If necessary, position the ECM bracket and install the bolts (1).

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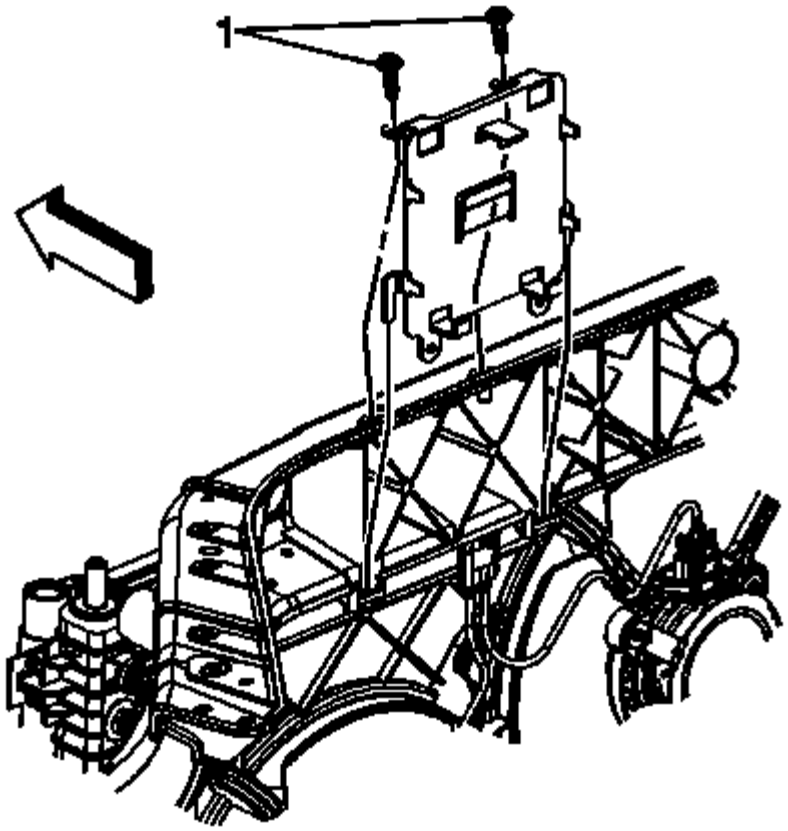

Fig. 5: View Of ECM Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolts to 6 N.m (53 lb in).

2. Install the ECM onto the ECM bracket support tabs and snap the ECM into place under the retaining tab (1).

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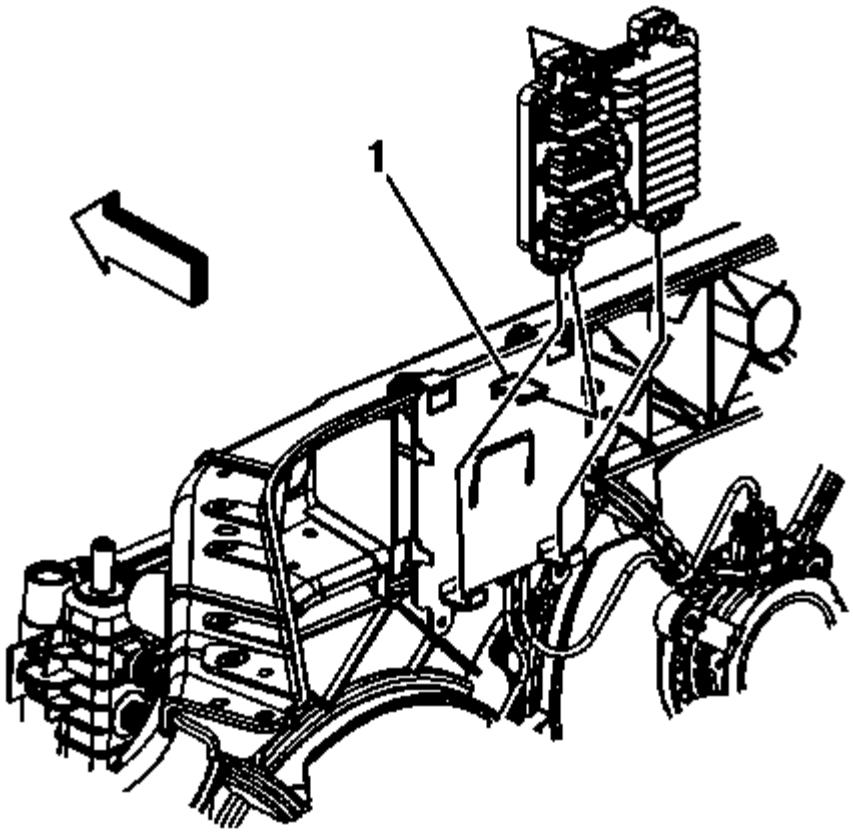

Fig. 6: Identifying ECM Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness upper electrical connector (1) to the ECM.

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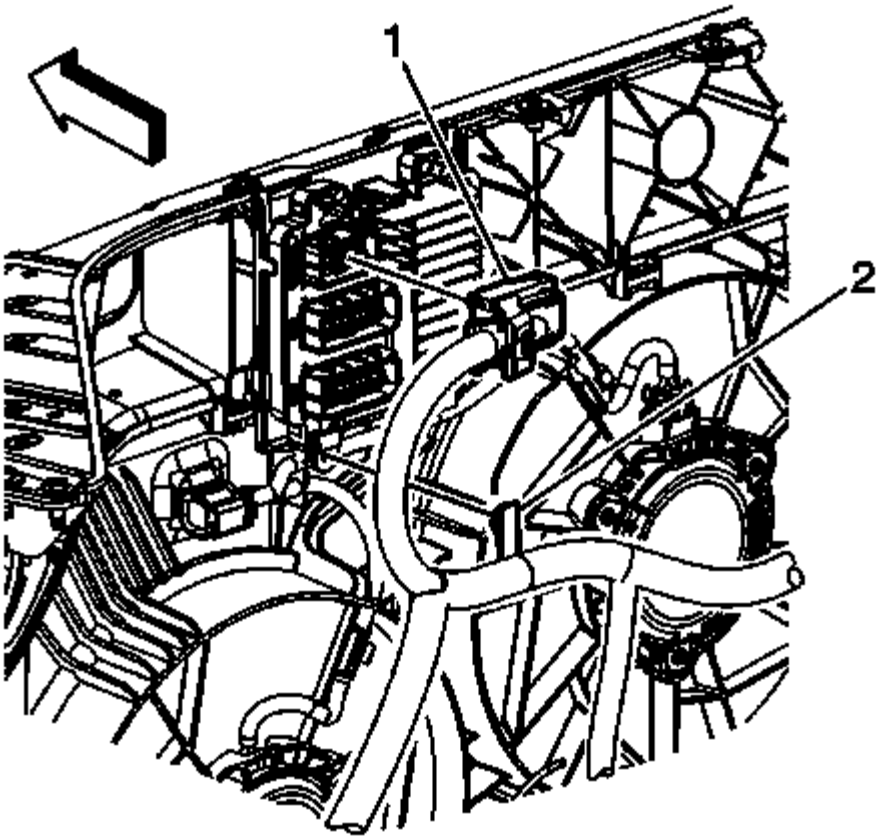

Fig. 7: View Of Engine Wiring Harness Clip & ECM Upper Electrical Connector
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4. If the ECM bracket was also replaced, install the engine wiring harness clip (2) to the ECM bracket tab.
5. Connect the engine wiring harness middle and lower electrical connectors (1) to the ECM.

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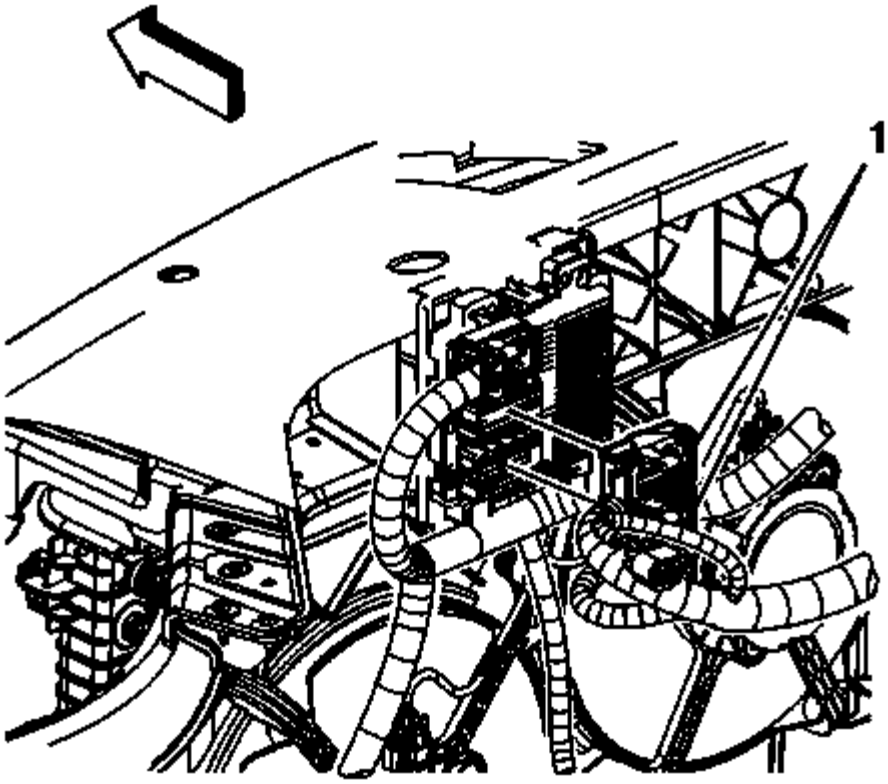

Fig. 8: Identifying ECM Middle & Lower Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

6. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
7. If a NEW ECM was installed, reprogram the ECM. Refer to **K20 Engine Control Module: Programming and Setup** .

Q38 THROTTLE BODY: THROTTLE/IDLE LEARN

Description

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to throttle body coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

An engine that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to unlearn the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

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The idle may be unstable or a DTC may set if the learned values do not match the actual airflow.

Conditions for Running the Throttle Learn Procedure

Scan Tool Idle Learn or Idle Learn Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 or P2176 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 mph).

Service Bay/On Road Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 or P2176 are not set.
- The engine speed is between 450-4, 000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition voltage is greater than 10 volts.

Throttle Learn

Scan Tool Idle Learn or Idle Learn Reset Procedure - Performed after the throttle body is cleaned or replaced

1. Ignition ON, engine OFF, perform the Idle Learn or Idle Learn Reset in Configuration/Reset or Module Setup.
2. Engine idling, observe the scan tool Throttle Body Idle Airflow Compensation parameter. The Throttle Body Idle Airflow Compensation value should equal 0% and the engine should be idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Service Bay/On Road Idle Learn Procedure - Performed after the ECM is programmed or replaced

1. Engine idling for 3 min.

NOTE: **Do NOT perform this procedure if DTCs are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle .**

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2. Observe the scan tool Desired Idle Speed and the actual Engine Speed parameters.
3. The ECM will start to learn the new idle cells and the Desired Idle Speed should start to decrease.
4. Ignition OFF for 60 s.
5. Start and idle the engine for 3 min.
6. After the 3 min run time the engine should be idling normal.
    - If the engine idle speed has not been learned the vehicle will need to be driven at speeds above 70 km/h (44 mph) with several decelerations and extended idles.

NOTE: During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.

7. After the drive cycle, the engine should be idling normally.
    - If the engine idle speed has not been learned, turn OFF the ignition for 60 s and repeat step 6.
8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

Removal Procedure

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

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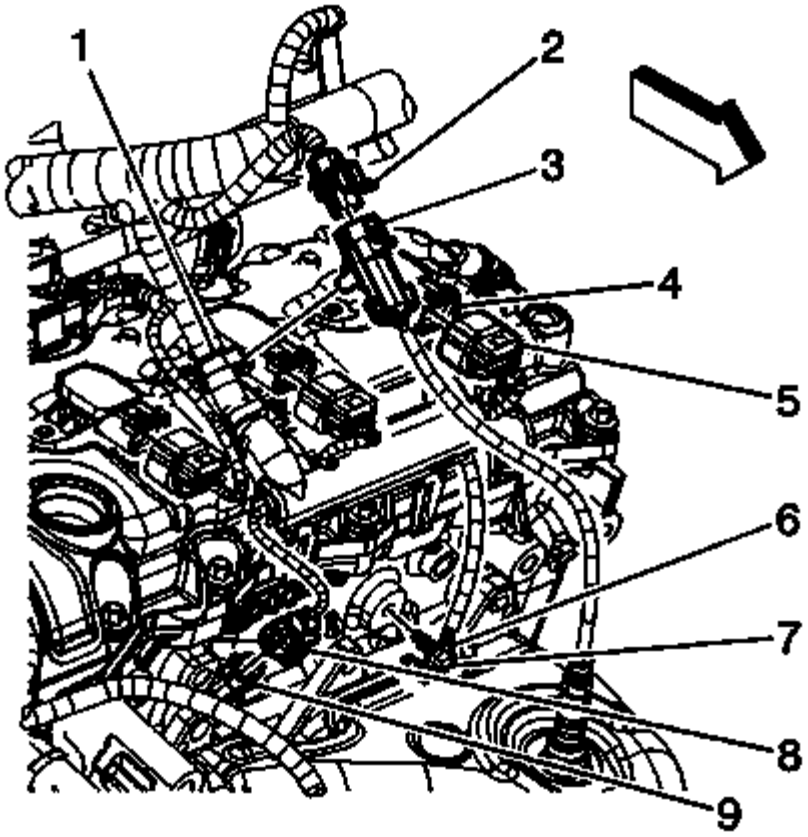

Fig. 9: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Slide the electrical connector heat shield up the wiring harness.
3. Disconnect the engine wiring harness electrical connector (8) from the engine coolant temperature (ECT) sensor (9).
4. Remove the ECT sensor.

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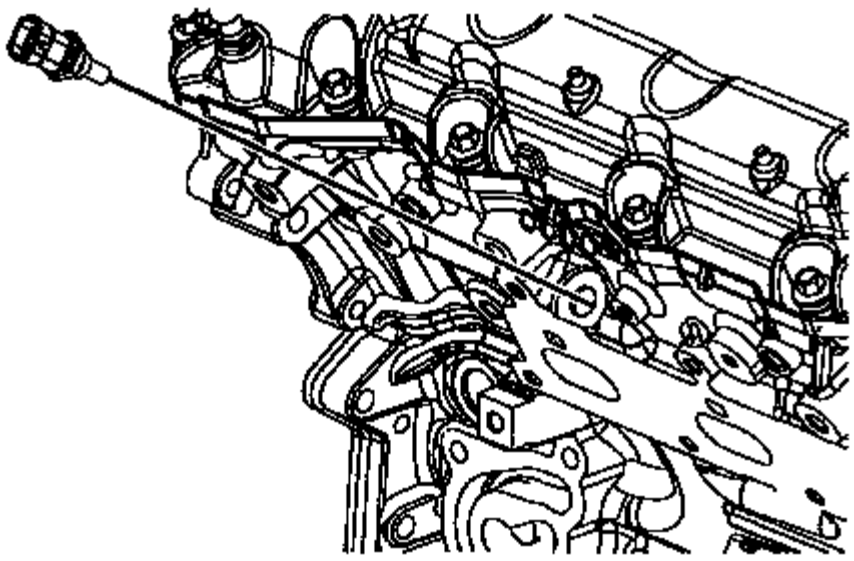

Fig. 10: View Of ECT Sensor
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Install the ECT sensor.

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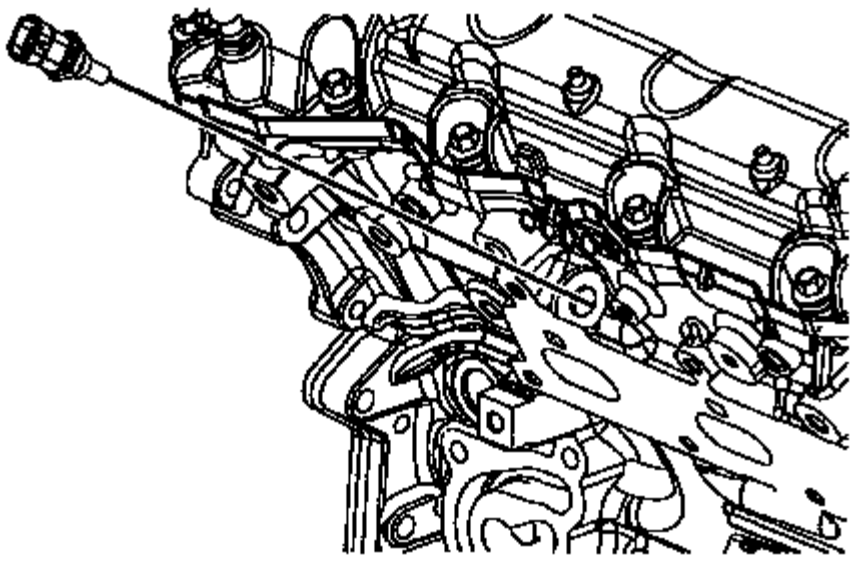

Fig. 11: View Of ECT Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the sensor to 22 N.m (16 lb ft).

2. Connect the engine wiring harness electrical connector (8) to the ECT sensor (9).

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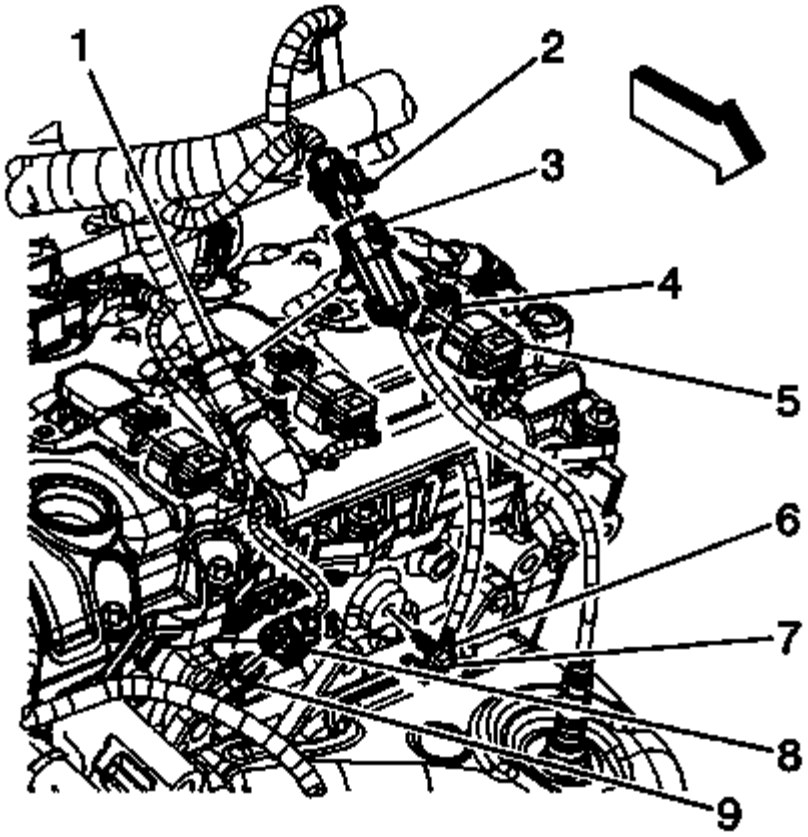

Fig. 12: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Slide the electrical connector heat shield down over the connector.
4. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (Vac N Fill)** .

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

Removal Procedure

1. Disconnect the engine wiring harness electrical connector from the mass air flow (MAF)/intake air temperature (IAT) sensor.

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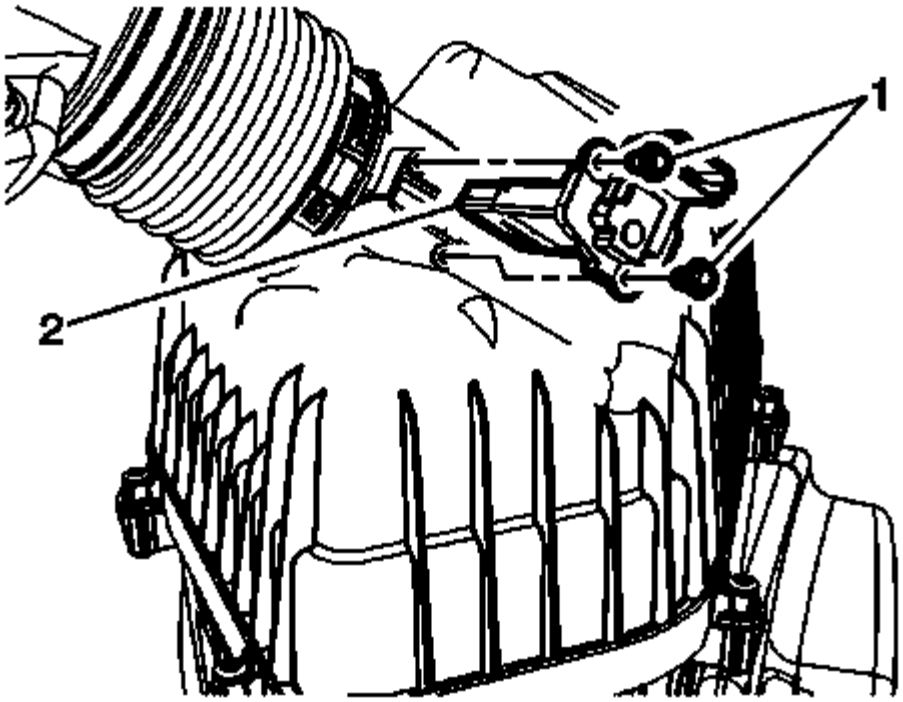

Fig. 13: MAF/IAT Sensor Screws
Courtesy of GENERAL MOTORS COMPANY

2. Remove the MAF/IAT sensor screws (1).
3. Remove the MAF/IAT sensor (2) from the air cleaner assembly.

Installation Procedure

1. Install the MAF/IAT sensor (2) to the air cleaner assembly.

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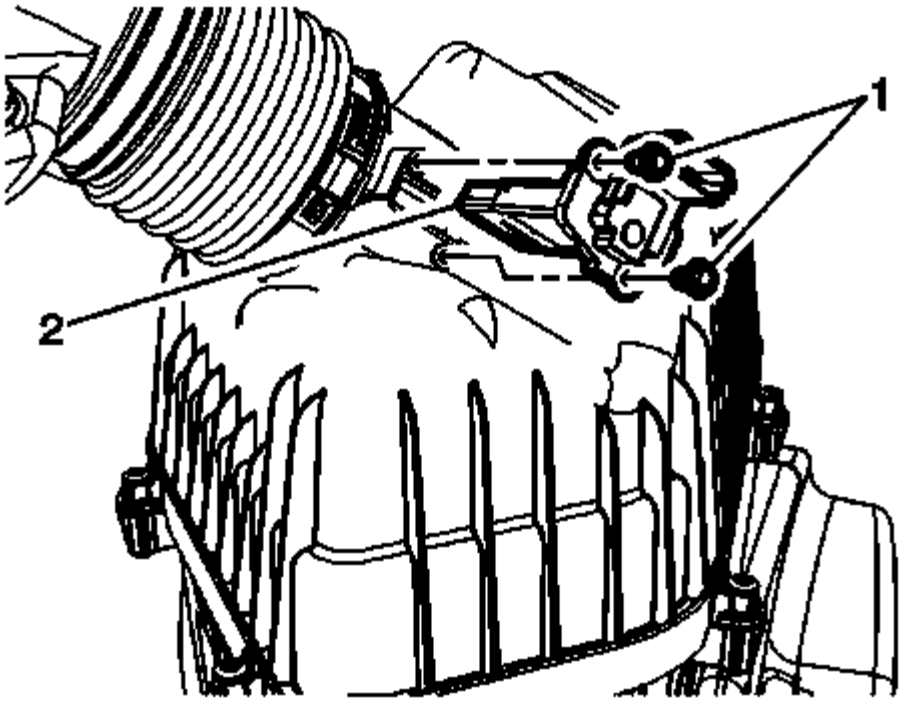

Fig. 14: MAF/IAT Sensor Screws
Courtesy of GENERAL MOTORS COMPANY

2. Install the MAF/IAT sensor screws (1).

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the screws to 4 N.m (35 lb in).

3. Connect the engine wiring harness electrical connector to the MAF/IAT sensor.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

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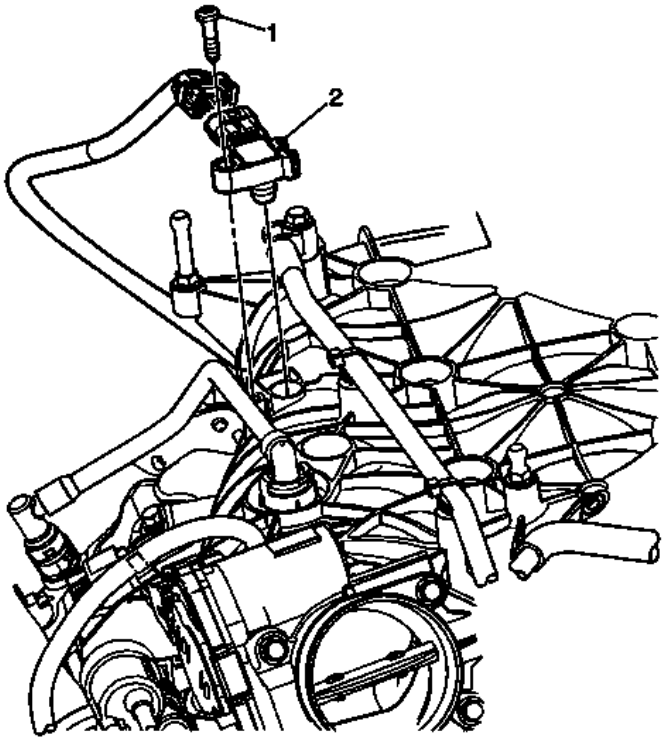

Fig. 15: Manifold Absolute Pressure Sensor (LF1)
Courtesy of GENERAL MOTORS COMPANY

Manifold Absolute Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .	
1	Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 5 N.m (44 lb in)
2	Manifold Absolute Pressure Sensor **Procedure** Disconnect the electrical connector.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

Removal Procedure

CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution .

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1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

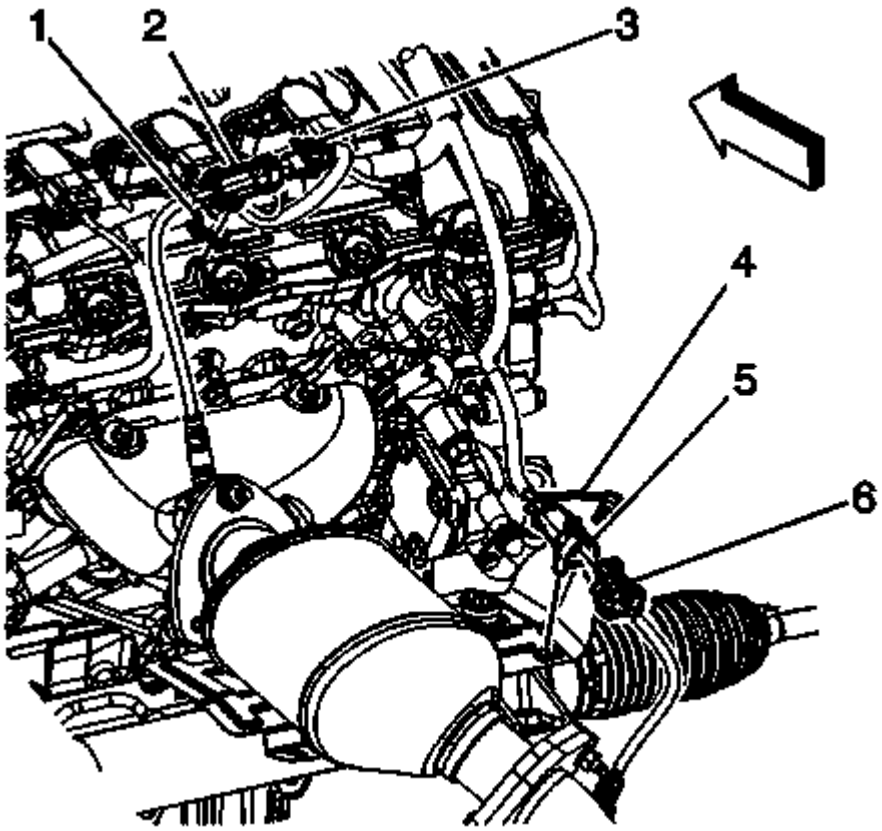

Fig. 16: View Of Heated Oxygen Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector (3) from the heated oxygen sensor (HO2S) electrical connector (2).
3. Remove the HO2S electrical connector retainer from the engine wiring harness clip (1).
4. Remove the HO2S (2) from the exhaust manifold.

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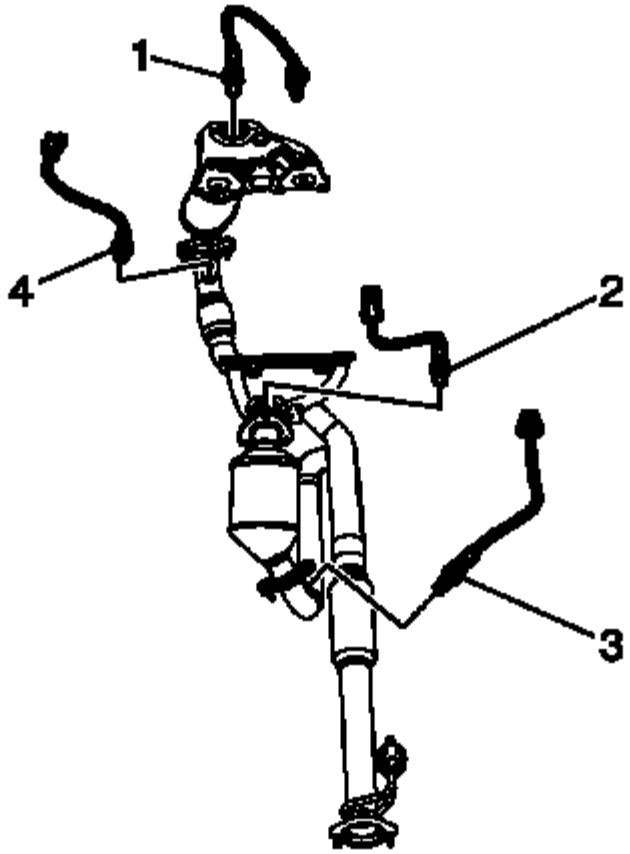

Fig. 17: Identifying Heated Oxygen Sensors & Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

NOTE: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to reinstalled, the threads must have anti-seize compound applied before the reinstallation.

1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953 or equivalent.

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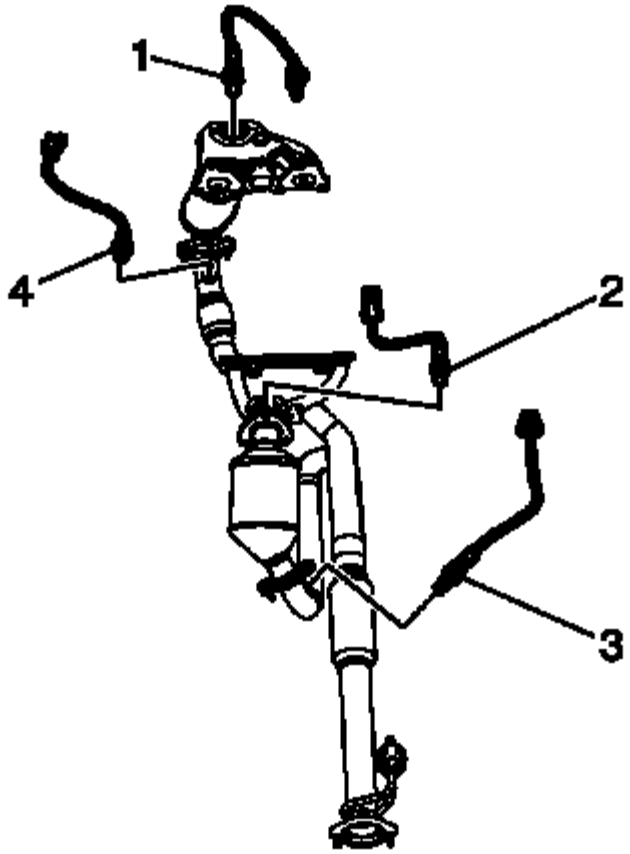

Fig. 18: Identifying Heated Oxygen Sensors & Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install the HO2S (2) to the exhaust manifold.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the sensor to 42 N.m (31 lb ft).

3. Connect the engine wiring harness electrical connector (3) to the HO2S electrical connector (2).

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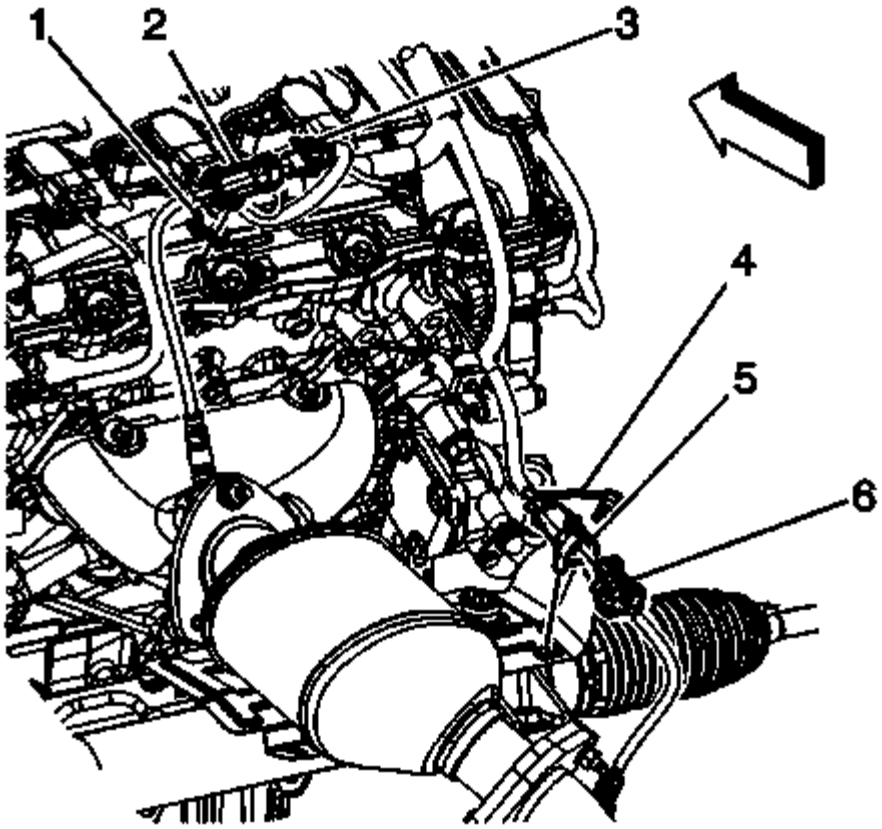

Fig. 19: View Of Heated Oxygen Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the HO2S electrical connector retainer to the engine wiring harness clip (1).
5. Lower the vehicle.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2

Removal Procedure

CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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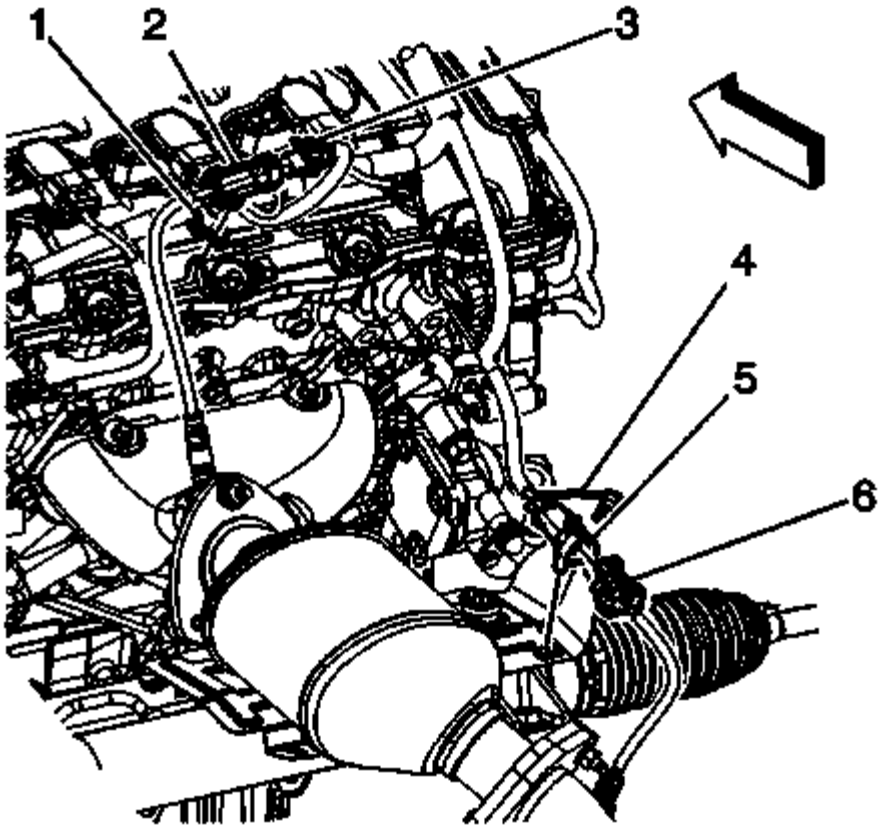

Fig. 20: View Of Heated Oxygen Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Remove the connector position assurance (CPA) retainer (4).
3. Disconnect the heated oxygen sensor (HO2S) electrical connector (6) from the engine wiring harness electrical connector (5).
4. Remove the HO2S (3) from the exhaust pipe.

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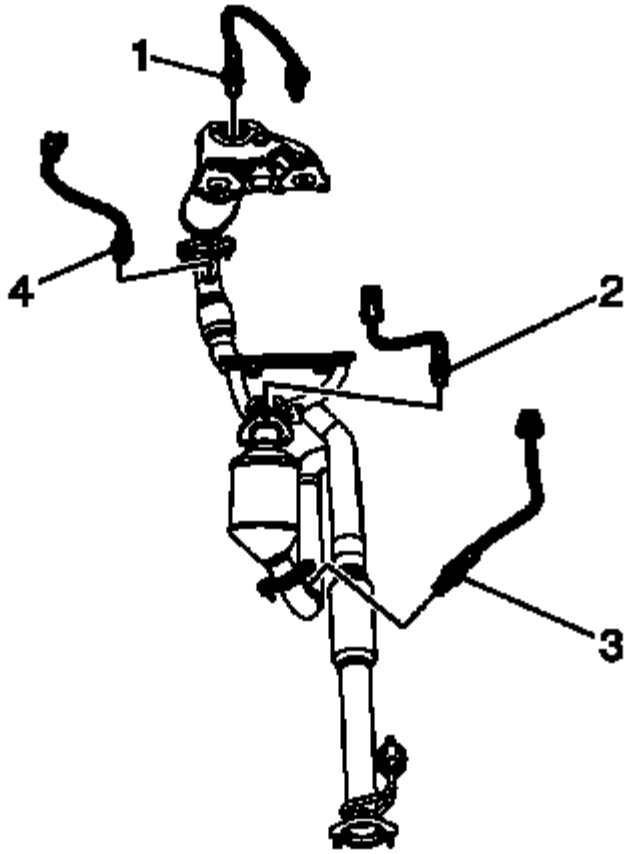

Fig. 21: Identifying Heated Oxygen Sensors & Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

NOTE: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to reinstalled, the threads must have anti-seize compound applied before the reinstallation.

1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953 or equivalent.

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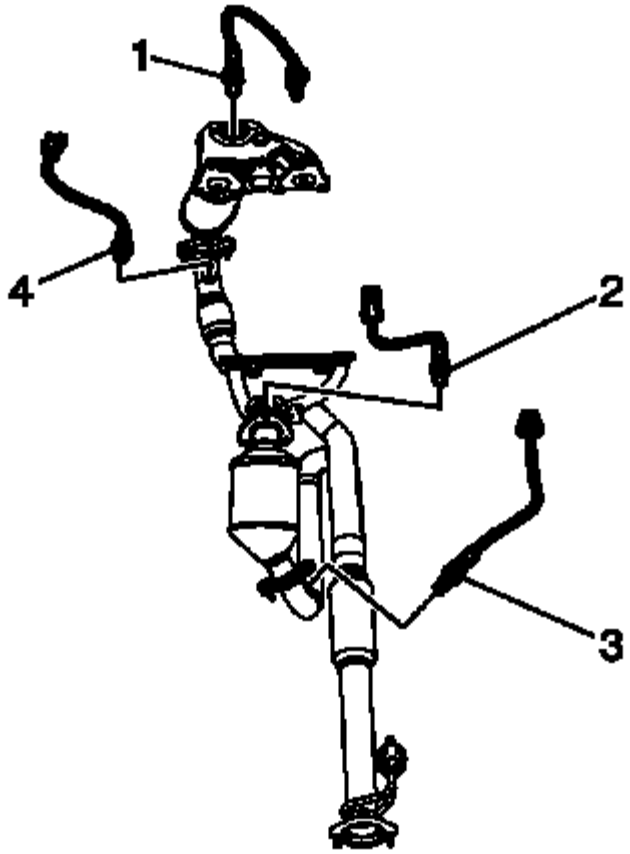

Fig. 22: Identifying Heated Oxygen Sensors & Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install the HO2S (3) to the exhaust pipe.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the sensor to 42 N.m (31 lb ft).

3. Connect the HO2S electrical connector (6) to the engine wiring harness electrical connector (5).

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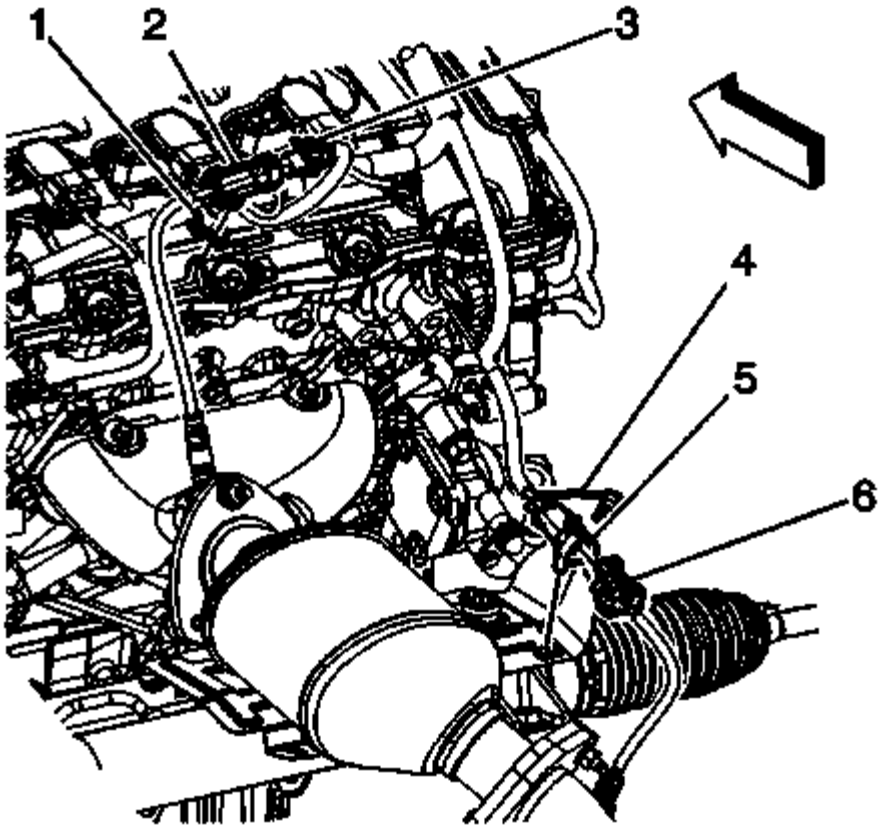

Fig. 23: View Of Heated Oxygen Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the CPA retainer (4).
5. Lower the vehicle.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

Removal Procedure

CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution .

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

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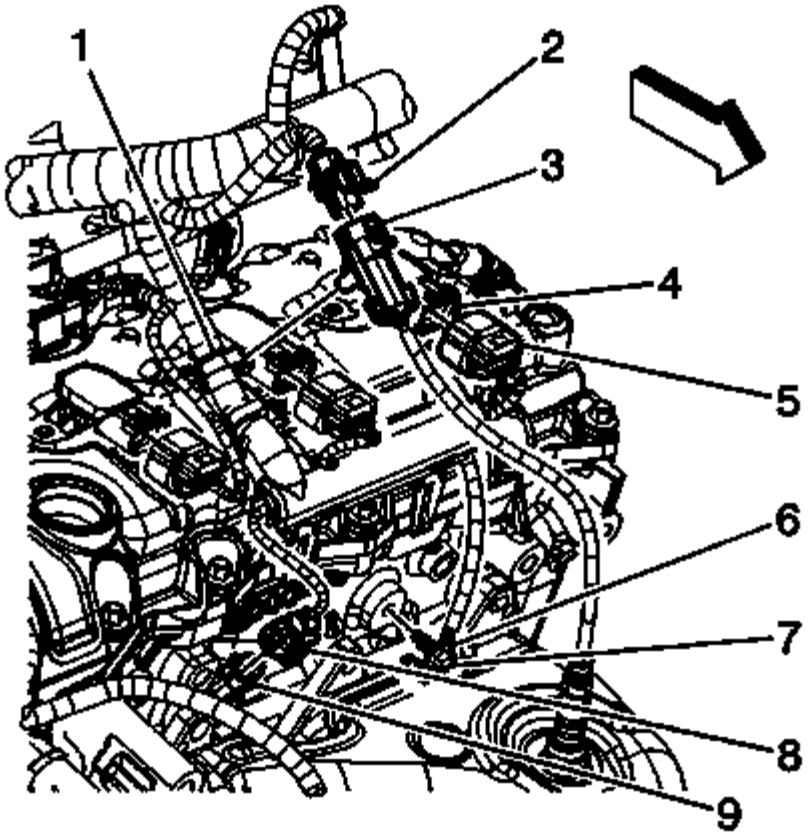

Fig. 24: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector (2) from the heated oxygen sensor (HO2S) electrical connector (3).
3. Remove the HO2S electrical connector retainer from the engine wiring harness clip (1).
4. Remove the HO2S (1) from the exhaust manifold.

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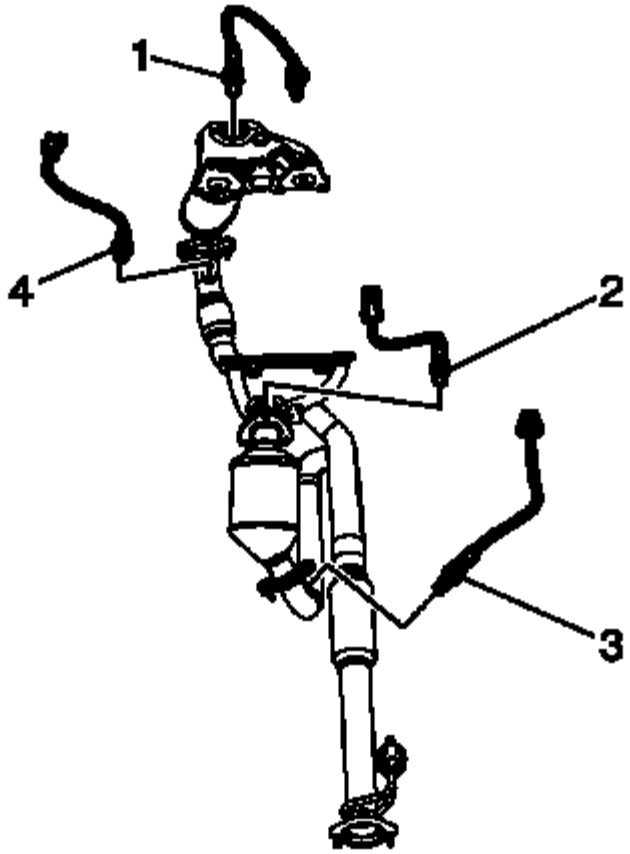

Fig. 25: Identifying Heated Oxygen Sensors & Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

NOTE: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to reinstalled, the threads must have anti-seize compound applied before the reinstallation.

1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953 or equivalent.

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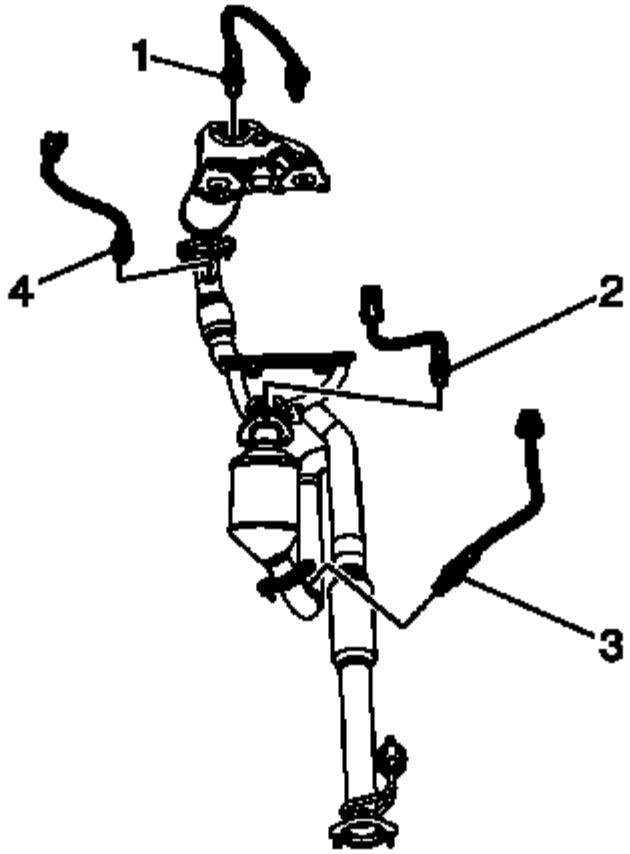

Fig. 26: Identifying Heated Oxygen Sensors & Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install the HO2S (1) to the exhaust manifold.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the sensor to 42 N.m (31 lb ft).

3. Connect the engine wiring harness electrical connector (2) to the HO2S electrical connector (3).

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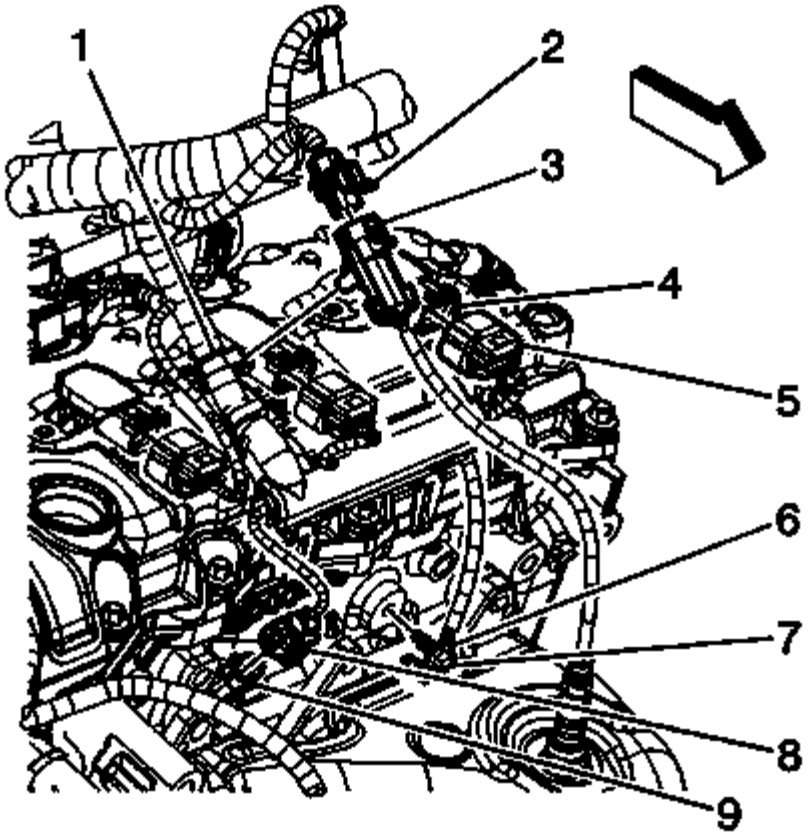

Fig. 27: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the HO2S electrical connector retainer to the engine wiring harness clip (1).
5. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

Removal Procedure

CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution .

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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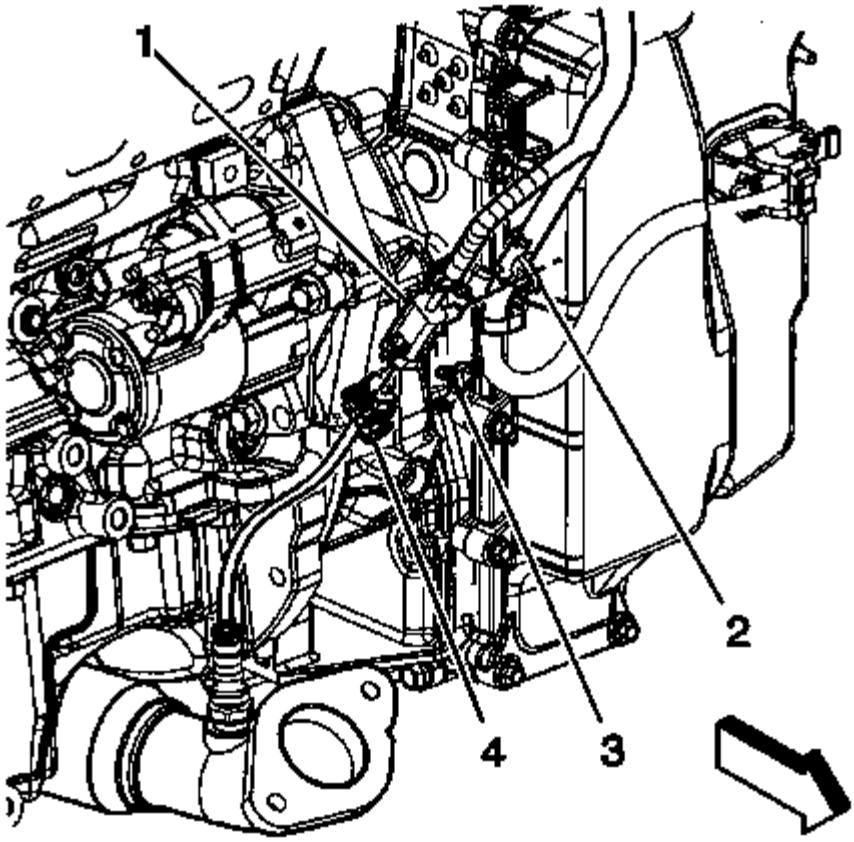

Fig. 28: Identifying Heated Oxygen Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Remove the connector position assurance (CPA) retainer (3).
3. Disconnect the heated oxygen sensor (HO2S) electrical connector (4) from the engine wiring harness electrical connector (1).
4. Remove the HO2S (4) from the exhaust pipe.

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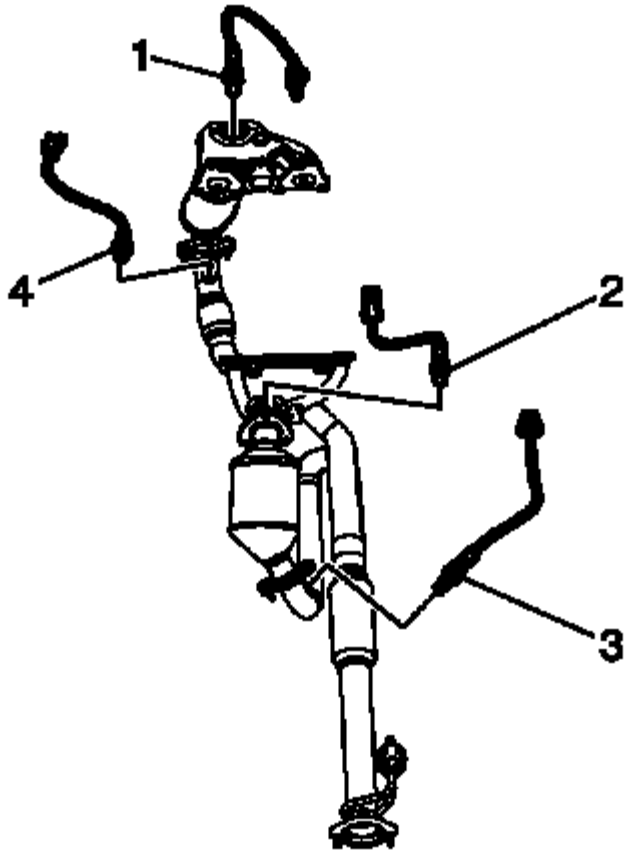

Fig. 29: Identifying Heated Oxygen Sensors & Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

NOTE: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to reinstalled, the threads must have anti-seize compound applied before the reinstallation.

1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953 or equivalent.

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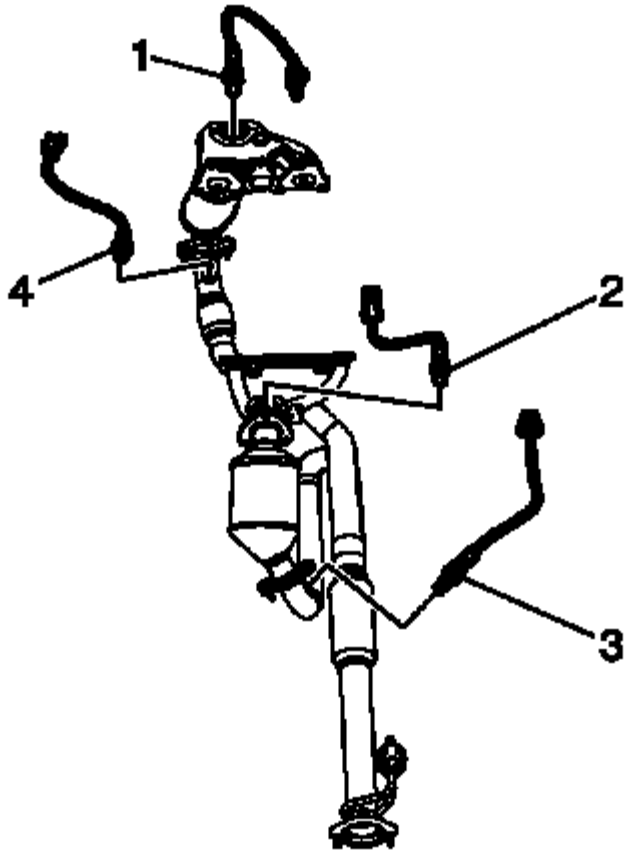

Fig. 30: Identifying Heated Oxygen Sensors & Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install the HO2S (4) to the exhaust pipe.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the sensor to 42 N.m (31 lb ft).

3. Connect the HO2S electrical connector (4) to the engine wiring harness electrical connector (1).

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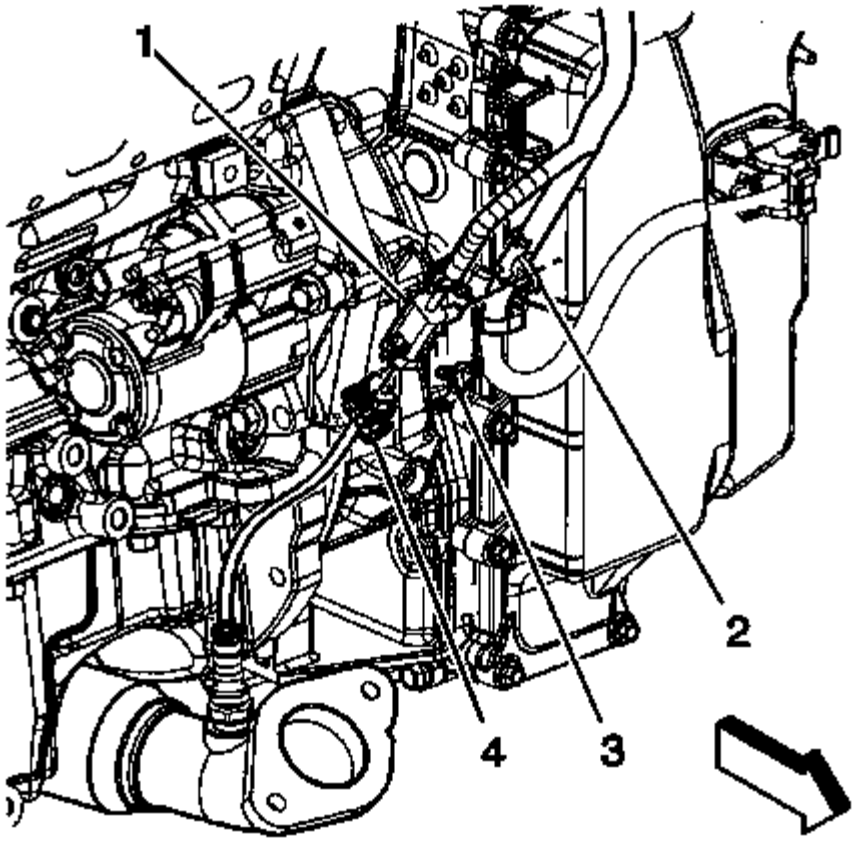

Fig. 31: Identifying Heated Oxygen Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the CPA retainer (3).
5. Lower the vehicle.

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

Removal Procedure

1. Remove the left instrument panel (I/P) insulator. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

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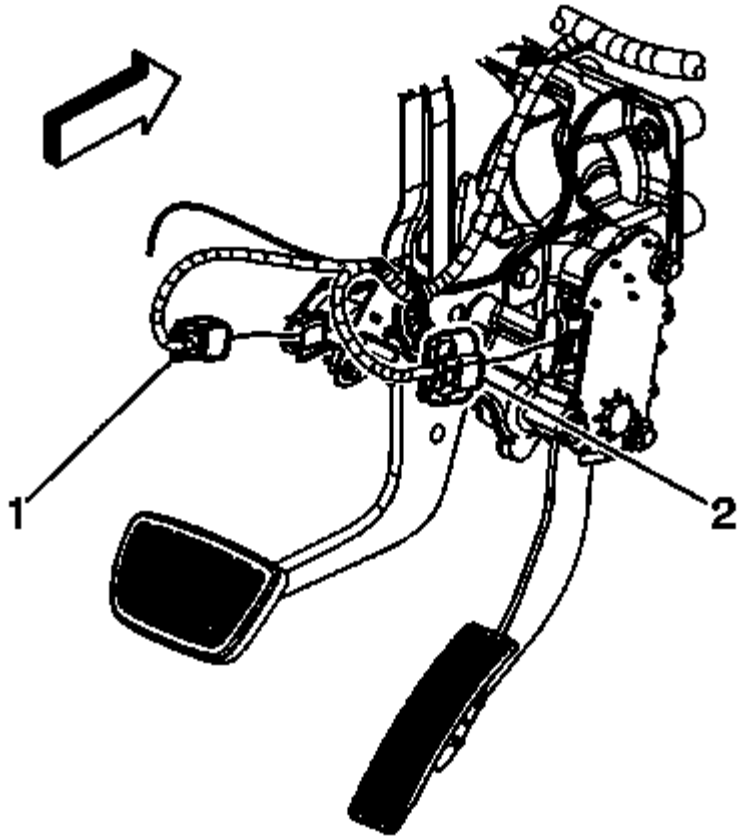

Fig. 32: Identifying Accelerator Pedal Position Sensor Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Remove the driver knee bolster. Refer to **Driver Knee Bolster Replacement (Acadia)** , **Driver Knee Bolster Replacement (Enclave)** , **Driver Knee Bolster Replacement (Traverse)** .
3. Remove the I/P wiring harness electrical connector (2) from the accelerator pedal position (APP) sensor assembly.
4. Remove the APP sensor bolts and sensor assembly from the vehicle.

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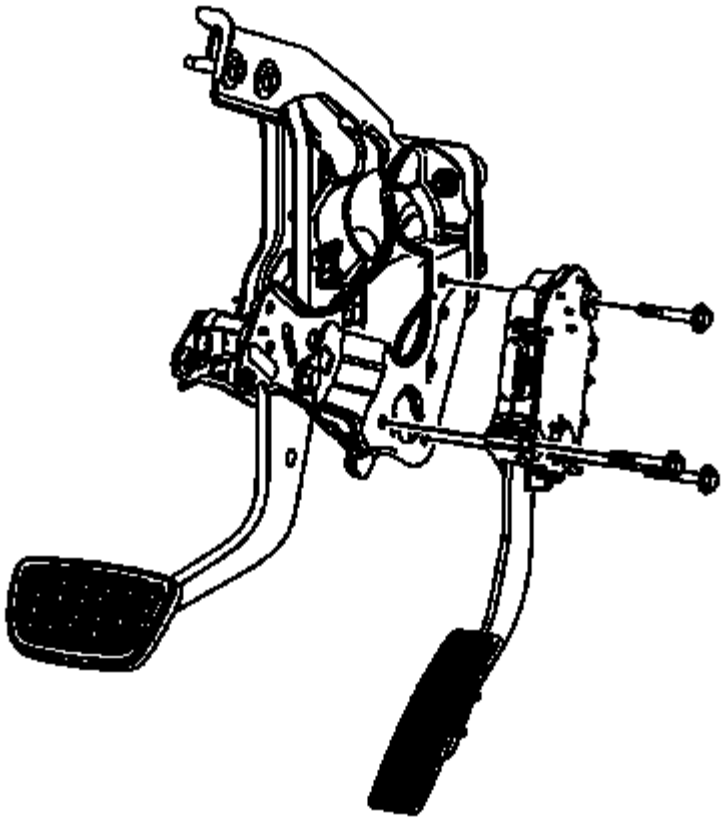

Fig. 33: View Of APP Sensor Bolts & Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: Due to clearance issues, the upper attachment bolt cannot be removed from the APP sensor assembly. Loosen the bolt completely and leave the bolt in the component until the assembly is removed from the vehicle.

Installation Procedure

1. Install the upper bolt into the APP sensor assembly.

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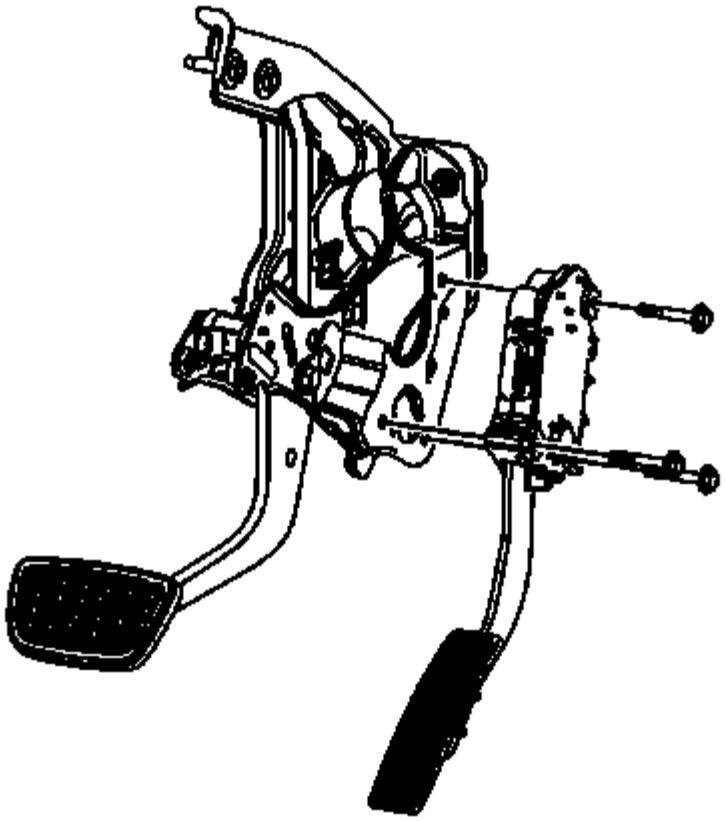

Fig. 34: View Of APP Sensor Bolts & Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Install the APP sensor assembly into the vehicle.
3. Install the remaining 2 lower APP sensor assembly bolts.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolts to 8 N.m (71 lb in).

4. Install the I/P wiring harness electrical connector (2) to the APP sensor assembly.

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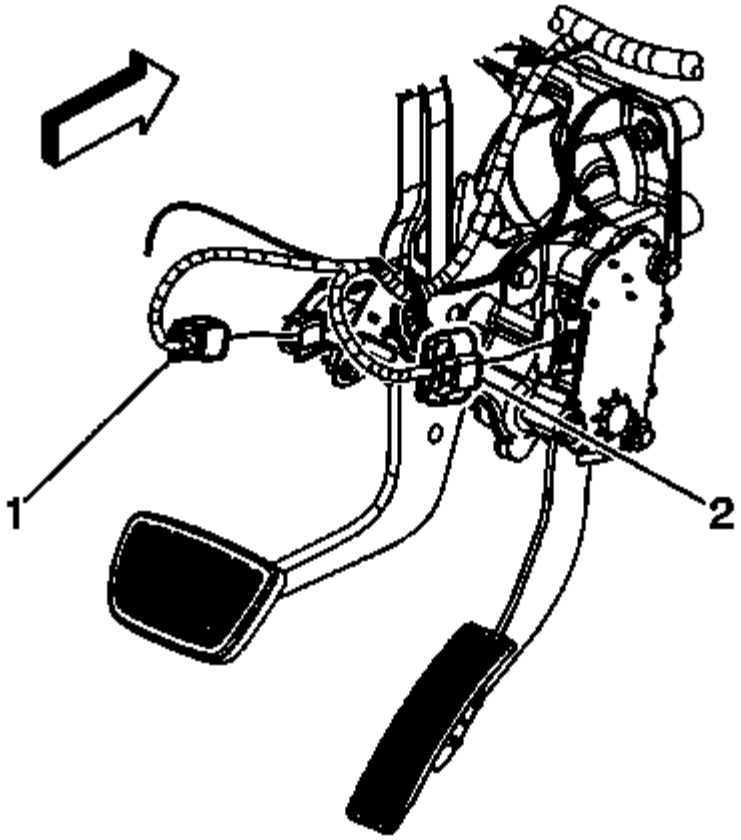

Fig. 35: Identifying Accelerator Pedal Position Sensor Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Install the driver knee bolster. Refer to **Driver Knee Bolster Replacement (Acadia)** , **Driver Knee Bolster Replacement (Enclave)** , **Driver Knee Bolster Replacement (Traverse)** .
6. Install the left I/P insulator. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

THROTTLE BODY ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

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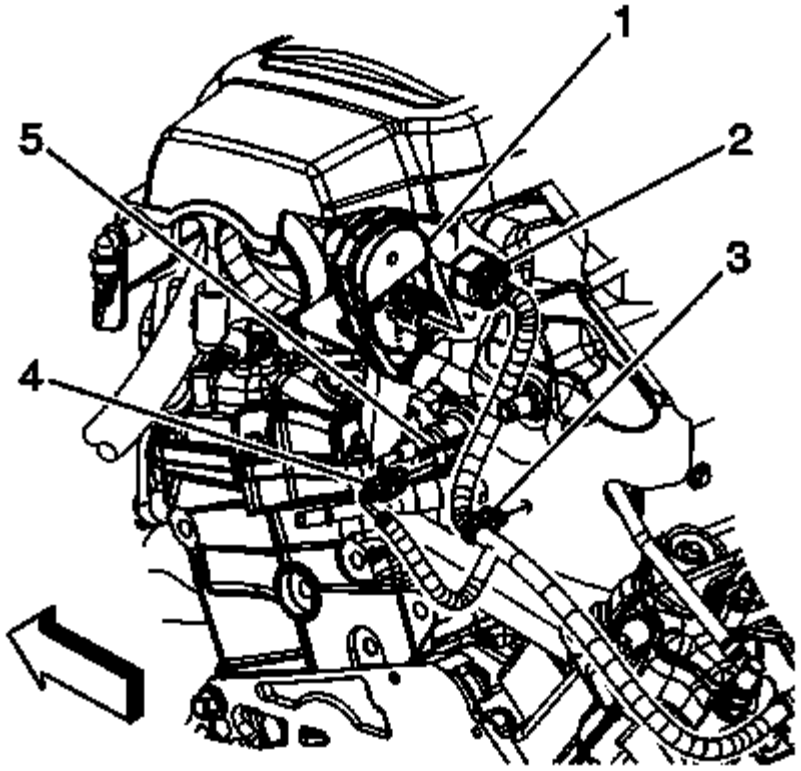

Fig. 36: Identifying Electronic Throttle Control
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector (2) from the electronic throttle control (1).
3. Remove the throttle body bolts (3).

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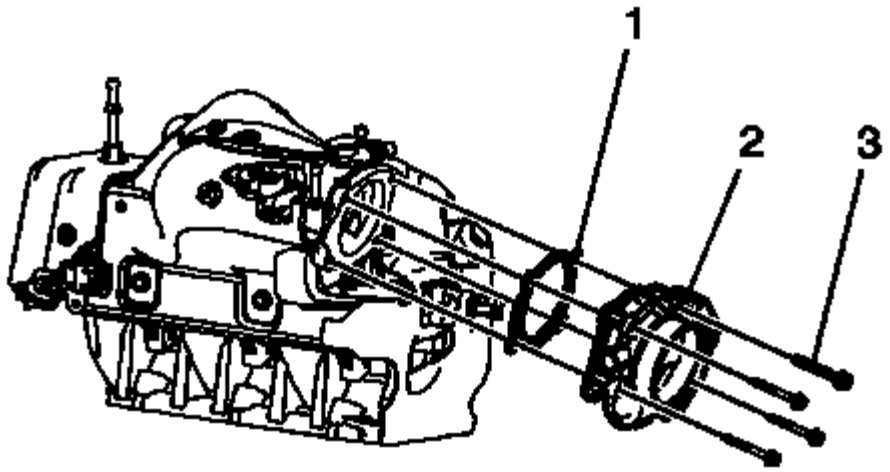

Fig. 37: View Of Throttle Body & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the throttle body (2) and gasket (2). Discard the gasket.

Installation Procedure

1. Position a NEW throttle body gasket (1) and throttle body (2) to the upper intake manifold.

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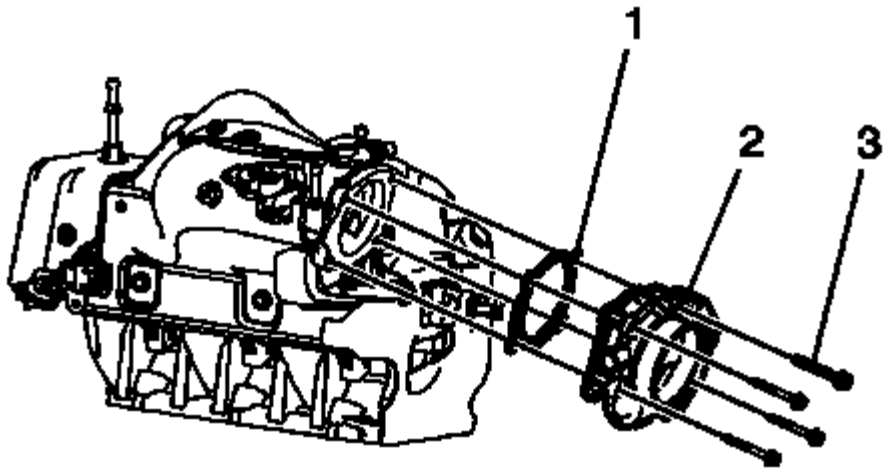

Fig. 38: View Of Throttle Body & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the throttle body bolts (3).

CAUTION: Refer to Fastener Caution .

Tighten

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

3. Connect the engine wiring harness electrical connector (2) to the electronic throttle control (1).

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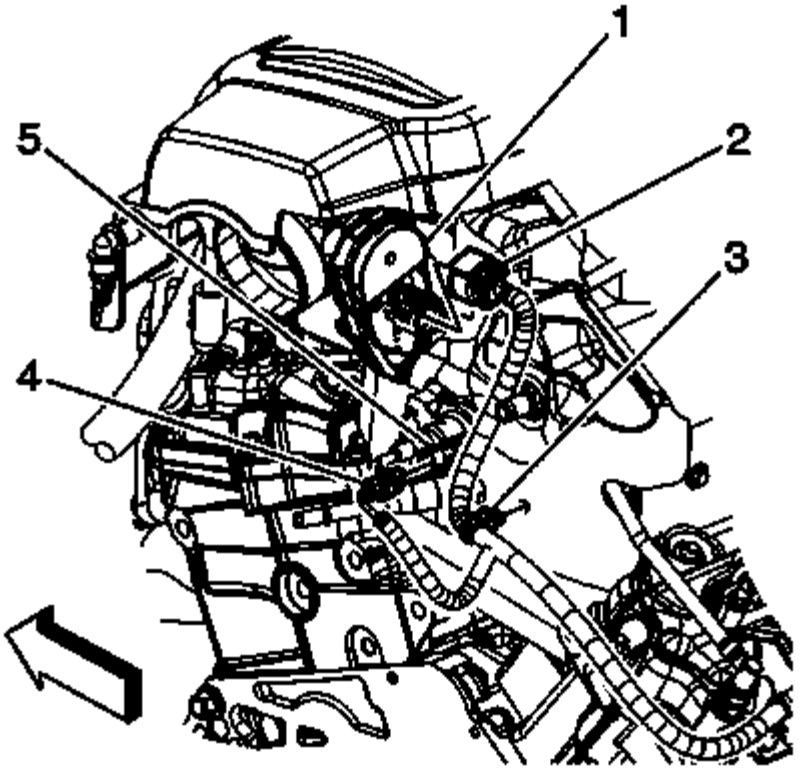

Fig. 39: Identifying Electronic Throttle Control
Courtesy of GENERAL MOTORS COMPANY

4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the throttle learn procedure. Refer to **Q38 Throttle Body: Throttle/Idle Learn**.

THROTTLE BODY INSPECTION AND CLEANING

NOTE: Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. Typically these deposits pose no problem. Occasionally the deposit may accumulate to a point where perceived pedal effort or throttle valve movement is effected.

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
2. Inspect the throttle body bore and the throttle valve plate for deposits. You will need to open the throttle valve in order to inspect all surfaces.

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

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CAUTION: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with GM Top Engine Cleaner. Refer to **Adhesives, Fluids, Lubricants and Sealers** .

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the Throttle/Idle Learn procedure. Refer to **Q38 Throttle Body: Throttle/Idle Learn**.

FUEL PRESSURE RELIEF (CH-48027)

Special Tools

CH-48027 Digital Pressure Gauge

1. If the fuel system requires repair, prevent fuel spillage by removing the fuel pump fuse. Refer to **Electrical Center Identification Views** .

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

2. Remove the engine cover, if required.

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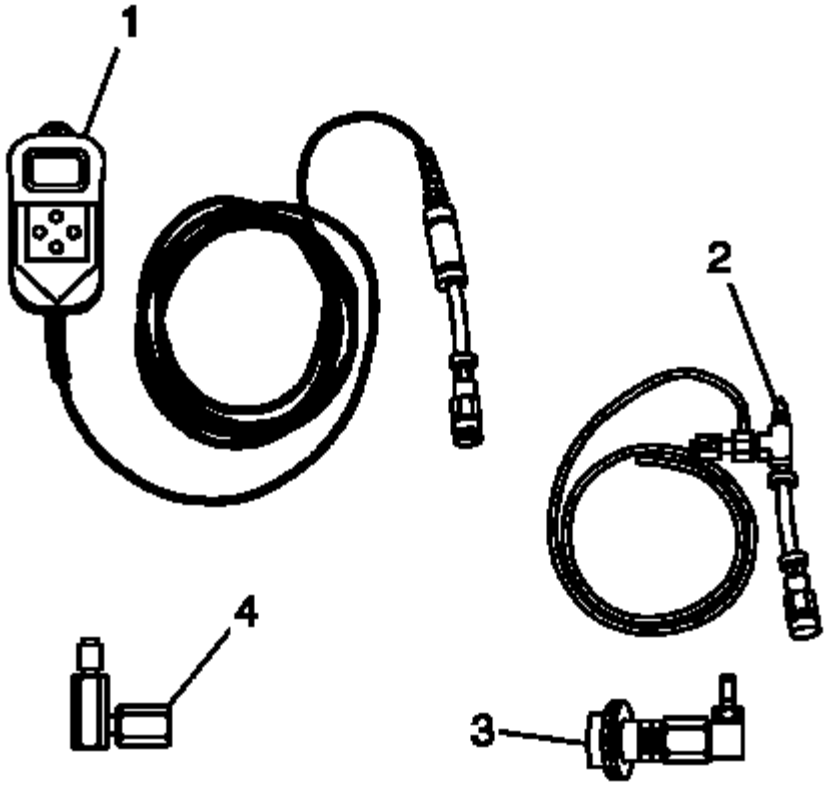

Fig. 40: View Of Digital Pressure Gauge, Special Tools & Components
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
4. Remove the fuel rail service port cap.
5. Wrap a shop towel around the fuel rail service port.

WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

6. Connect the CH-48027-3 (4) to the fuel rail service port.
7. Connect the CH-48027-2 (2) to the CH-48027-3 (4).
8. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
9. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
10. Close the valve on the CH-48027-2 (2).
11. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.

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12. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

NOTE: If relieving the fuel pressure for the fuel pressure gauge installation and removal, it is NOT necessary to proceed with the following steps.

13. Disconnect the CH-48027-3 (4) from the fuel rail service port.
14. Remove the shop towel from around the fuel rail service port and place in an approved gasoline container.
15. Install the fuel rail service port cap.
16. Install the engine cover, if required.
17. Tighten the fuel fill cap.

FUEL PRESSURE RELIEF (WITHOUT CH-48027)

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

1. If the fuel system requires repair, prevent fuel spillage by removing the fuel pump fuse. Refer to **Electrical Center Identification Views** .
2. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
3. Remove the engine cover, if required.
4. Remove the fuel rail service port cap.
5. Wrap a shop towel around the fuel rail service port and using a small flat-bladed tool, depress (open) the fuel rail test port valve.
6. Remove the shop towel from around the fuel rail service port and place in an approved gasoline container.
7. Install the fuel rail service port cap.

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8. Install the engine cover, if required.
9. Tighten the fuel fill cap.

FUEL PRESSURE RELIEF (HIGH SIDE)

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

1. Remove the fuel pump control module 20A fuse from the underhood electrical center. Refer to **Electrical Center Identification Views** .
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH-48027 Digital Pressure Gauge

Installation Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.

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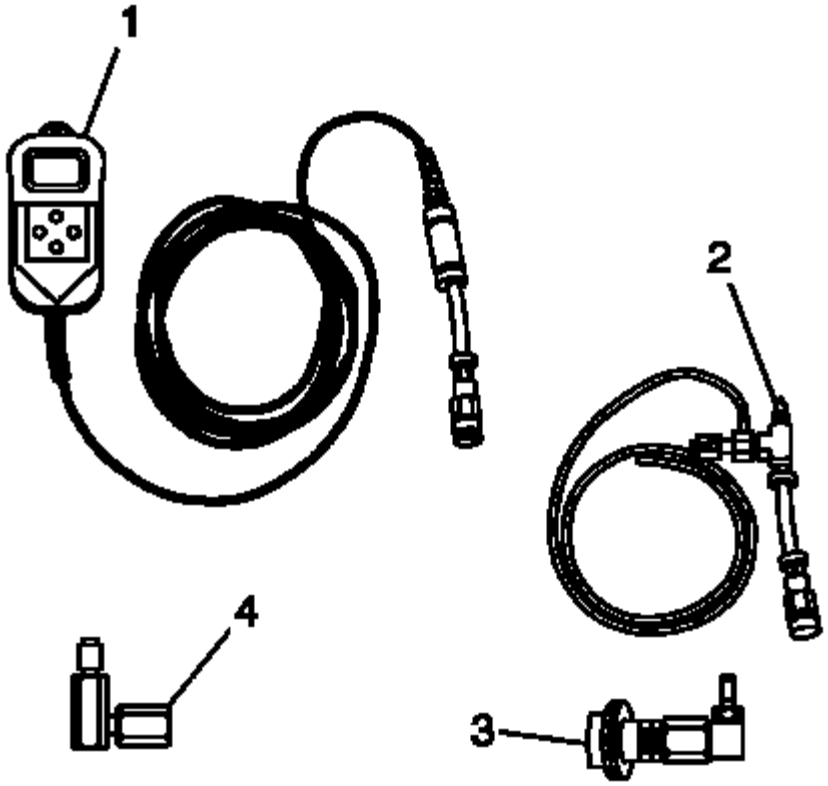

Fig. 41: View Of Digital Pressure Gauge, Special Tools & Components
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port and place in an approved gasoline container.
4. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH-48027** digital pressure gauge, refer to the manufacture's directions.

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Removal Procedure

1. Relieve the fuel system pressure, if required. Perform the following steps:

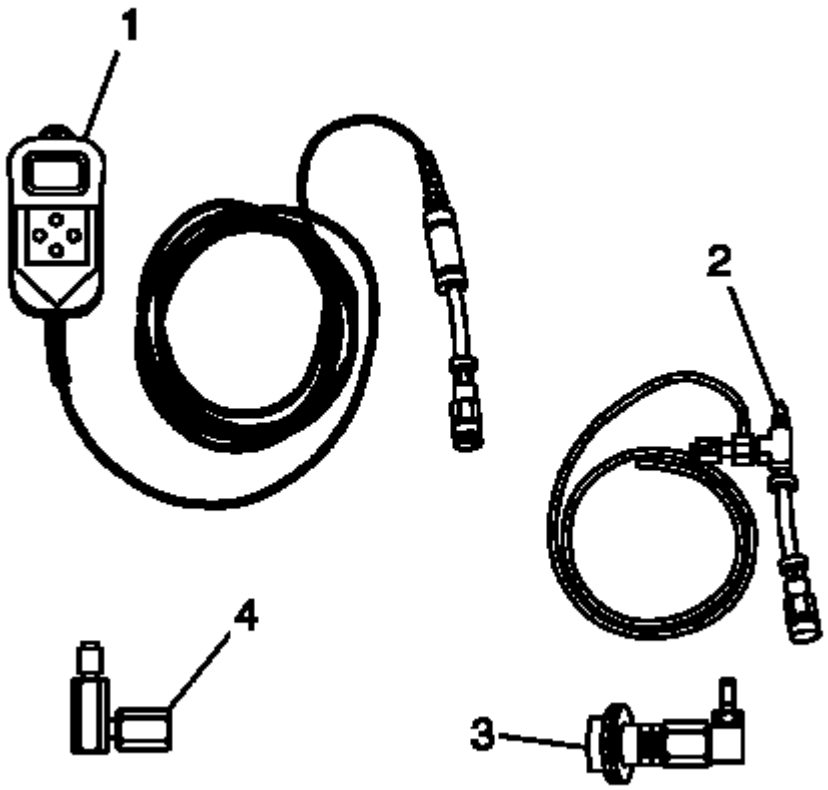

Fig. 42: View Of Digital Pressure Gauge, Special Tools & Components
Courtesy of GENERAL MOTORS COMPANY

1. Wrap a shop towel around the fuel rail service port.

WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
4. Close the valve on the CH-48027-2 (2).
5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.

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6. Remove the shop towel from around the fuel rail service port and place in an approved gasoline container.

2. Disconnect the CH-48027-1 (1) from the CH-48027-2 (2).

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).
4. Disconnect the CH-48027-3 (4) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Tighten the fuel fill cap.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

J 37088-A Fuel Line Disconnect Tool Set

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Relieve the fuel system pressure. Refer to the **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.

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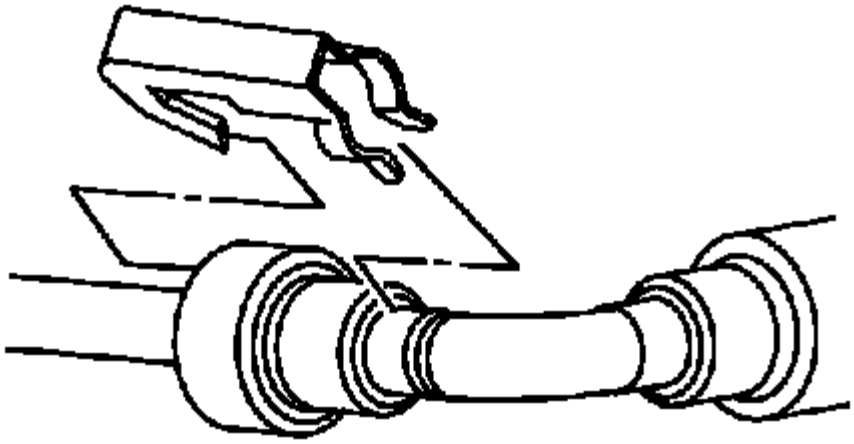

Fig. 43: View Of Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel feed line quick connect fitting retainer.
3. Blow dirt out of the fitting using compressed air.

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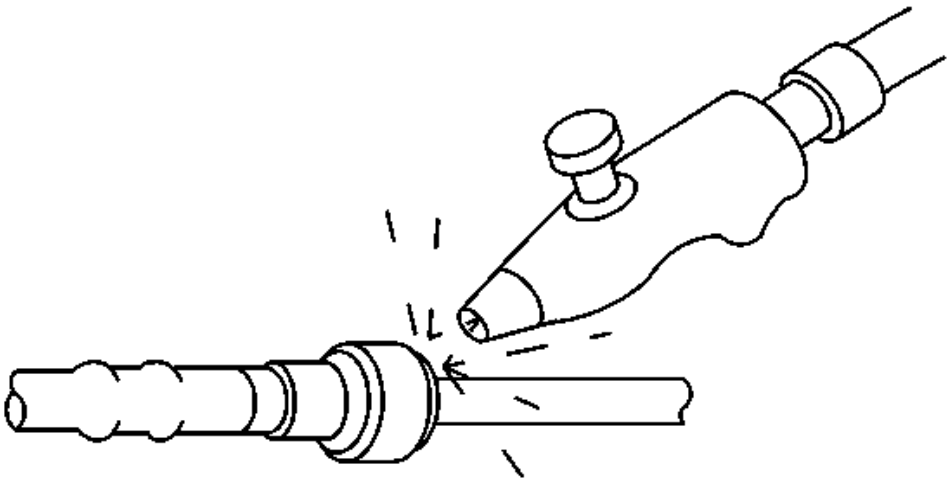

Fig. 44: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

CAUTION: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .

4. Choose the correct tool from the **J 37088-A** Tool Set for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.

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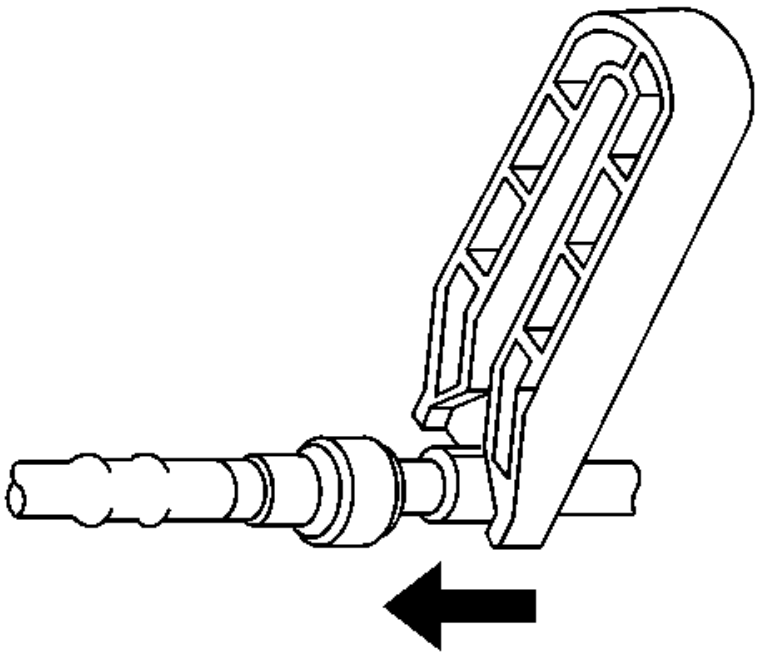

Fig. 45: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the connection apart.

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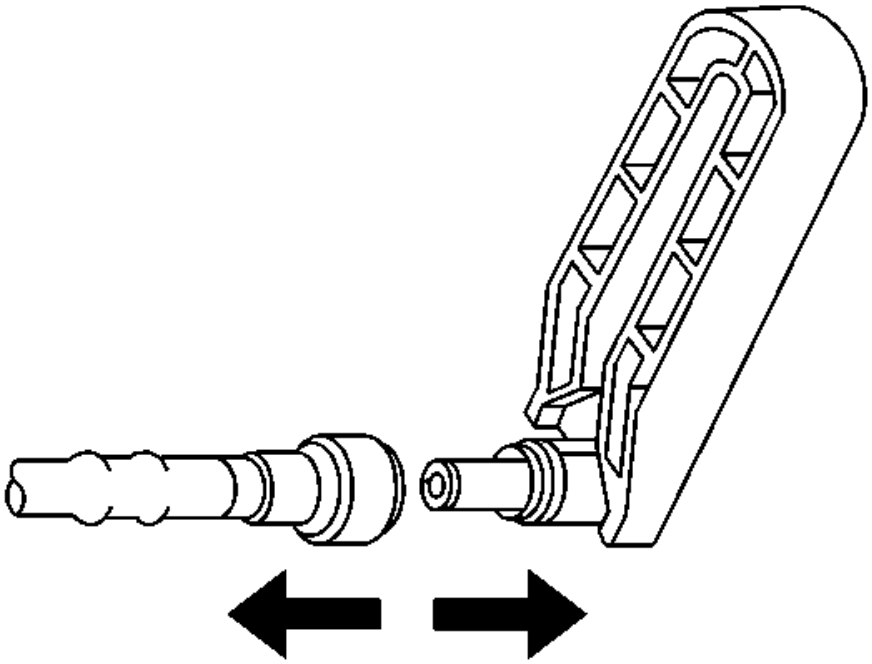

Fig. 46: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Relieving Fuel Pressure Warning .

6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

Installation Procedure

1. Apply a few drops of clean engine oil to the male pipe end.

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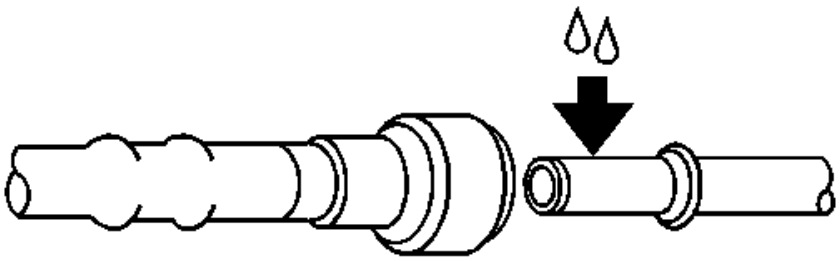

Fig. 47: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Fuel Pipe Fitting Warning .

2. Push both sides of the fitting together in order to snap the retaining tabs into place.

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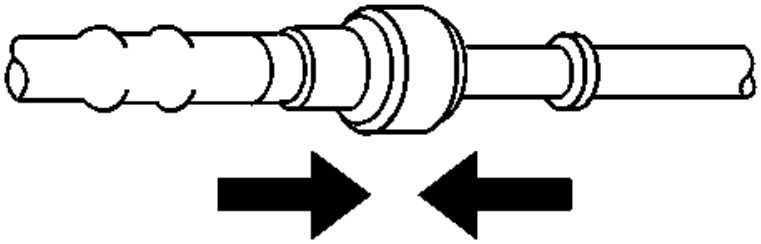

Fig. 48: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.

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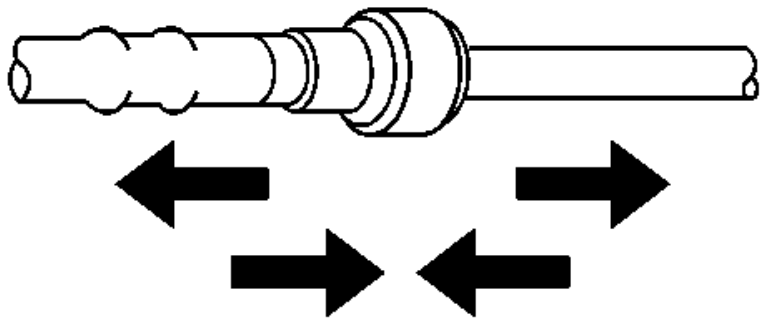

Fig. 49: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

4. Install the retainer to the quick-connect fitting.

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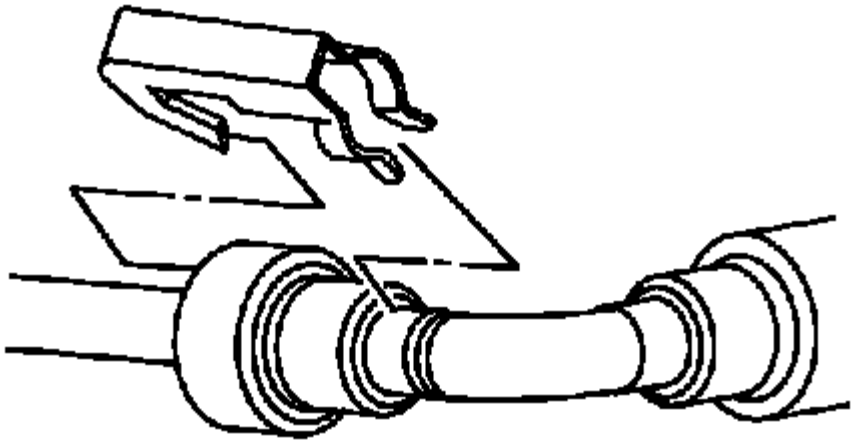

Fig. 50: View Of Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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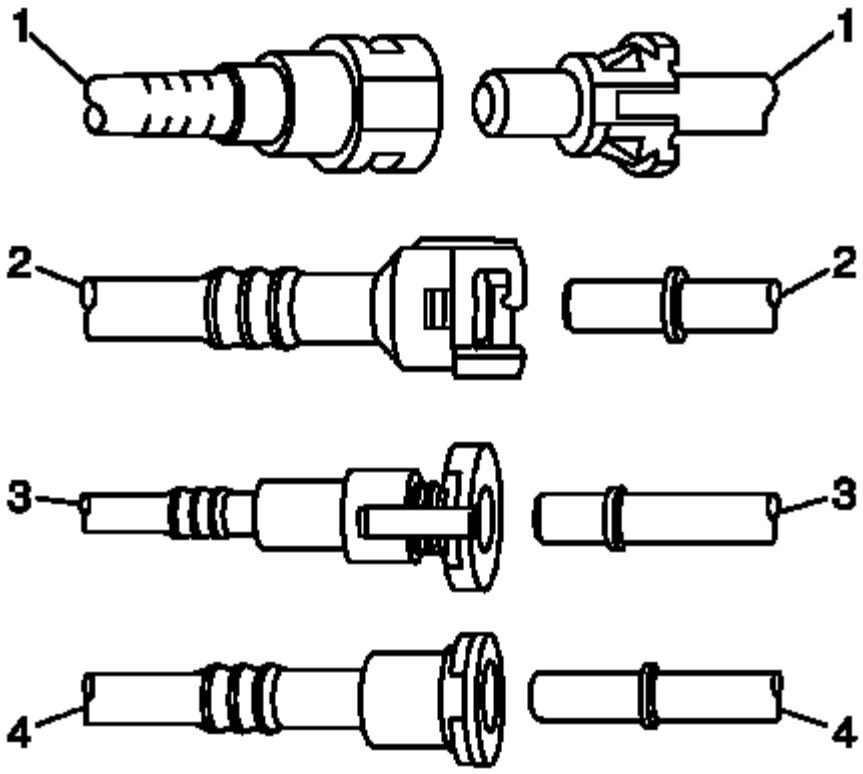

Fig. 51: View Of Plastic Collar Fuel & Evaporative Emission Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are several types of plastic collar fuel and evaporative emission quick connect fittings used on this vehicle.

- **Bartholomew (1)**
- **Q Release (2)**
- **Squeeze to Release (3)**
- **Sliding Retainer (4)**

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
2. Using compressed air, blow any dirt out of the quick-connect fitting.

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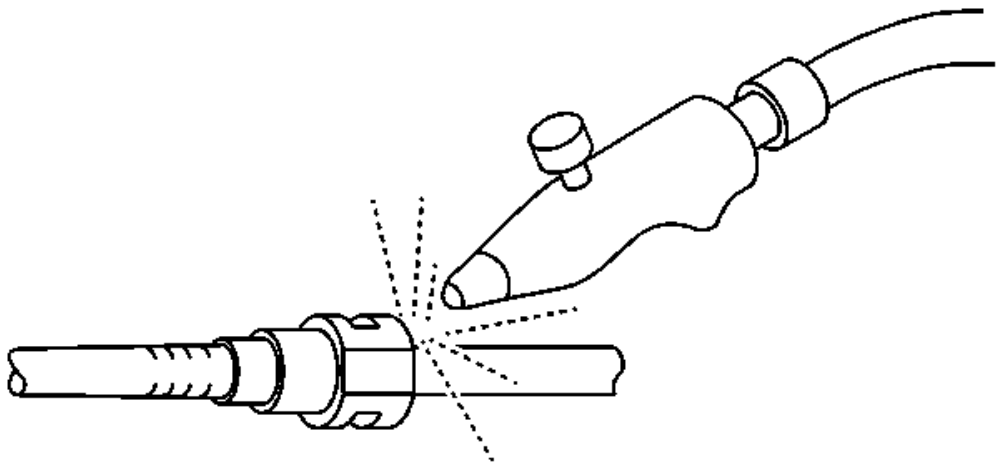

Fig. 52: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

CAUTION: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .

3. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick connect fitting release tabs.

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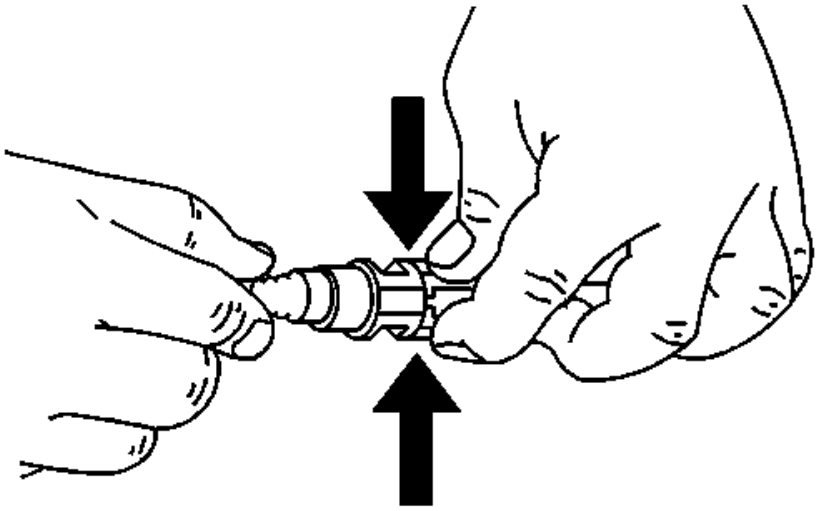

Fig. 53: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. This step applies to Q Release style connectors ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.

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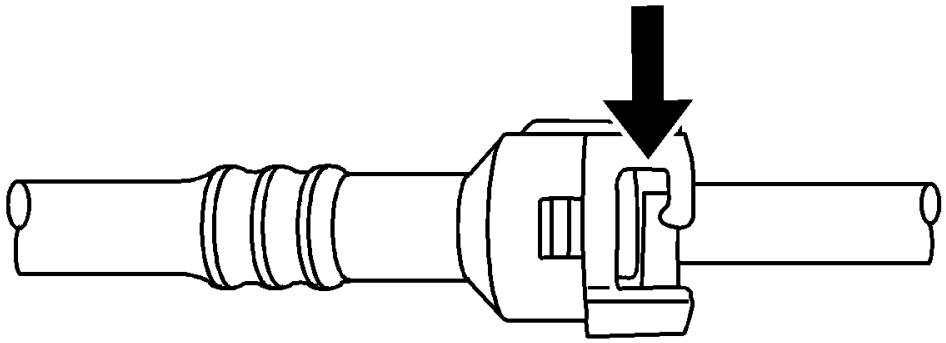

Fig. 54: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

5. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick connect fitting.

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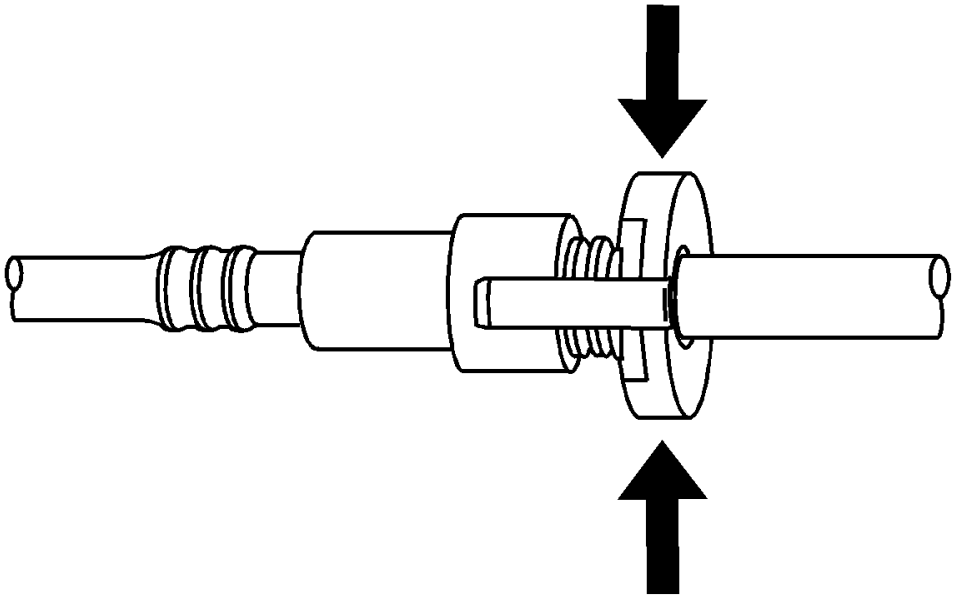

Fig. 55: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

6. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab doesn't move try pressing the tab in from the opposite side. The tab will only move in one direction.

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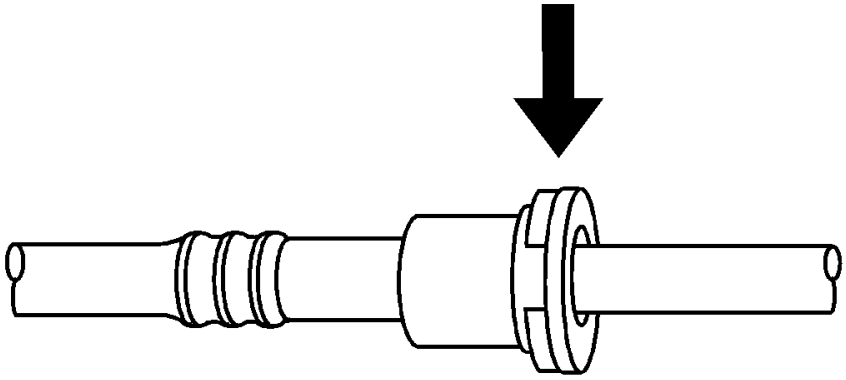

Fig. 56: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS COMPANY

7. Pull the connection apart.

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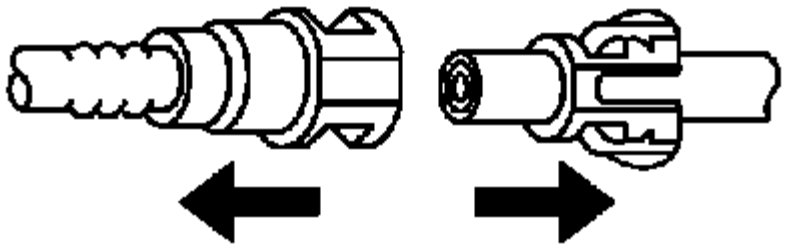

Fig. 57: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Relieving Fuel Pressure Warning .

Installation Procedure

1. Apply a few drops of clean engine oil to the male connection end.

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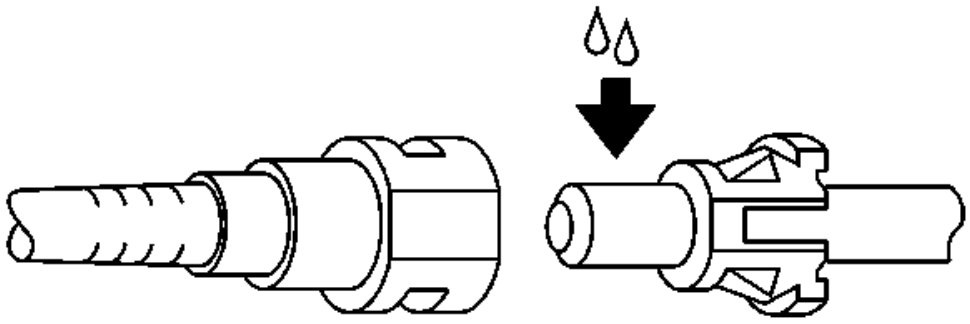

Fig. 58: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Fuel Pipe Fitting Warning .

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

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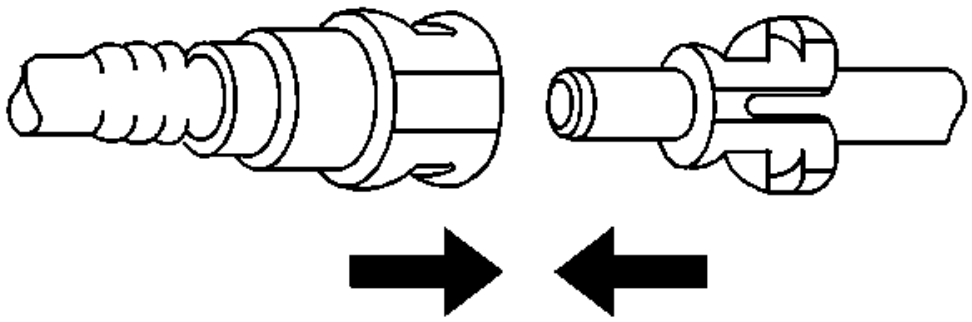

Fig. 59: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the quick-connect fitting in order to make sure the connection is secure.

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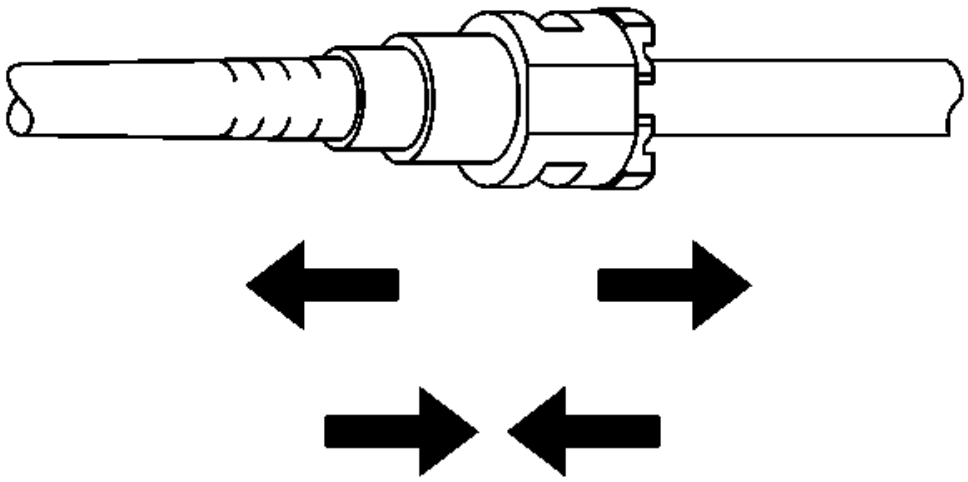

Fig. 60: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

FUEL TANK DRAINING

Special Tools

J 45004 Fuel Tank Drain Hose

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

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1. Remove the fuel fill cap.

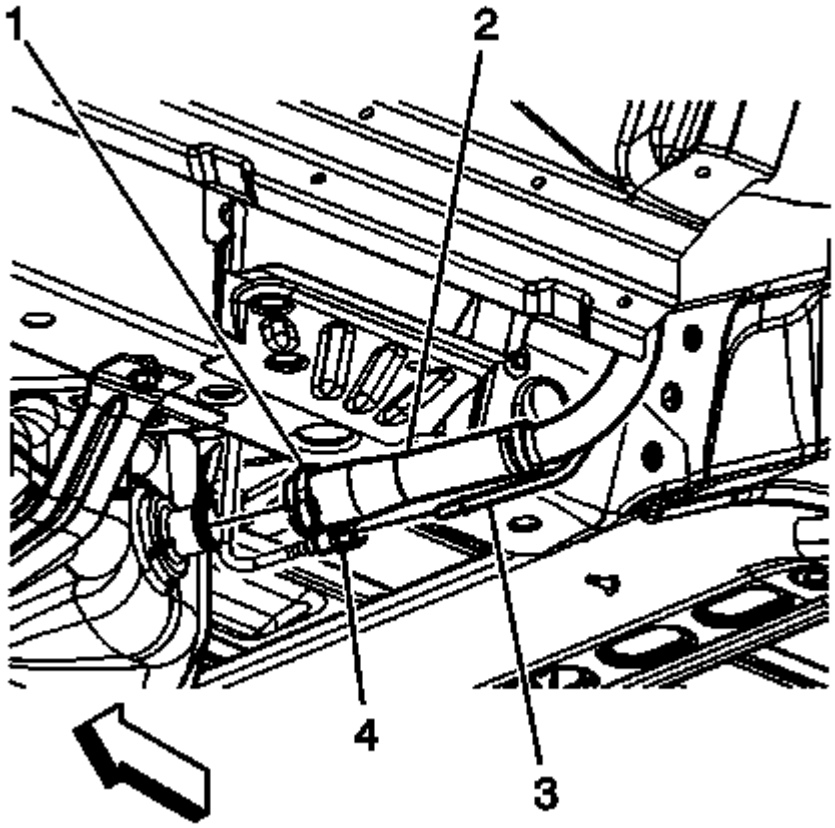

Fig. 61: Identifying Fuel Fill Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Insert the **J 45004** fuel tank drain hose into the fuel tank through the fuel tank fill pipe until the hose reaches the bottom of the fuel tank.
3. Use a hand or air operated pump device in order to drain as much fuel from the fuel tank as possible.
4. Remove the **J 45004** fuel tank drain hose from the fuel tank fill pipe.
5. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
6. Loosen the fuel tank fill hose clamp (1) at the fuel tank.
7. Disconnect the evaporative emission (EVAP) canister vent rear pipe quick connect fitting (4) from the recirculation line on the fuel fill pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Separate the fuel tank fill hose from the fuel tank.
9. Insert the **J 45004** fuel tank drain hose into the fuel tank through the fuel tank opening.
10. Use the hand or air operated pump device again, drain as much fuel from the fuel tank as possible.

FUEL TANK REPLACEMENT

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Removal Procedure

WARNING: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

WARNING: Fuel supply lines will remain pressurized for long periods of time after the engine is shutdown. This pressure must be relieved before servicing the fuel system.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.

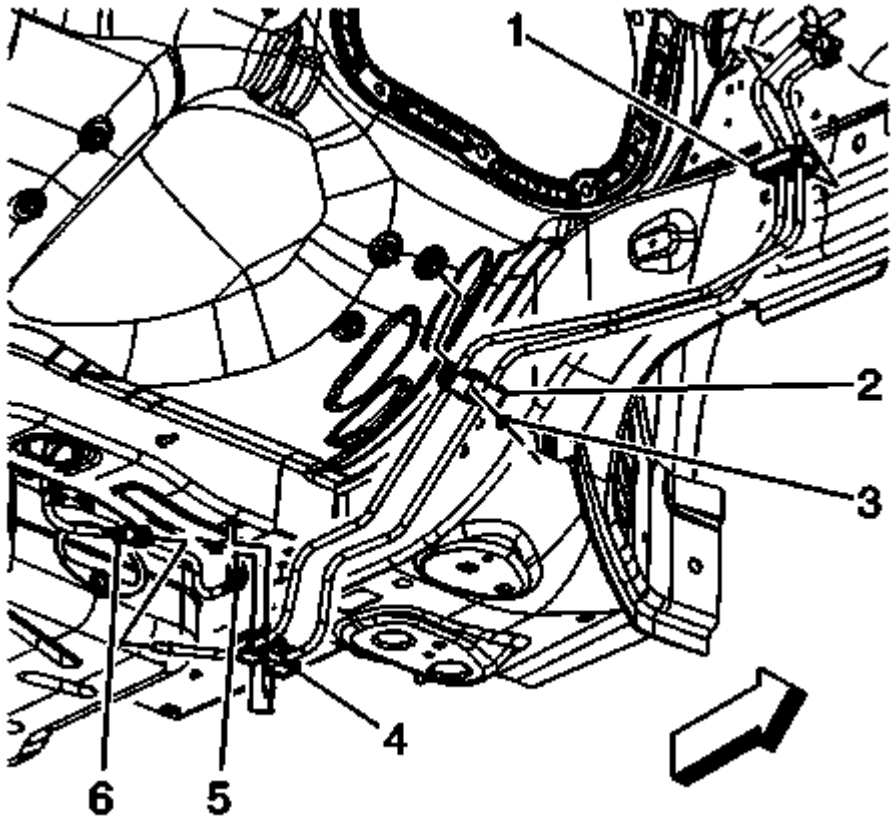

Fig. 62: View Of Fuel Tank Evaporative Emission Canister Vent Front Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

2. Drain the fuel tank. Refer to **Fuel Tank Draining**.
3. Disconnect the fuel pump fuel feed line quick connect fitting (6) from the chassis fuel line. Refer to **Plastic Collar Quick Connect Fitting Service**.

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WARNING: Whenever fuel lines are removed, catch fuel in an approved container. Container opening must be a minimum of 300 mm (12 in) diameter to adequately catch the fluid.

CAUTION: Clean all fuel pipe connections and surrounding areas before disconnecting the fuel pipes to avoid contamination of the fuel system.

4. Disconnect the fuel tank evaporative emission (EVAP) canister vent front pipe quick connect fitting (5) from the chassis EVAP line. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Disconnect the vent hose from the left rear of the fuel tank.

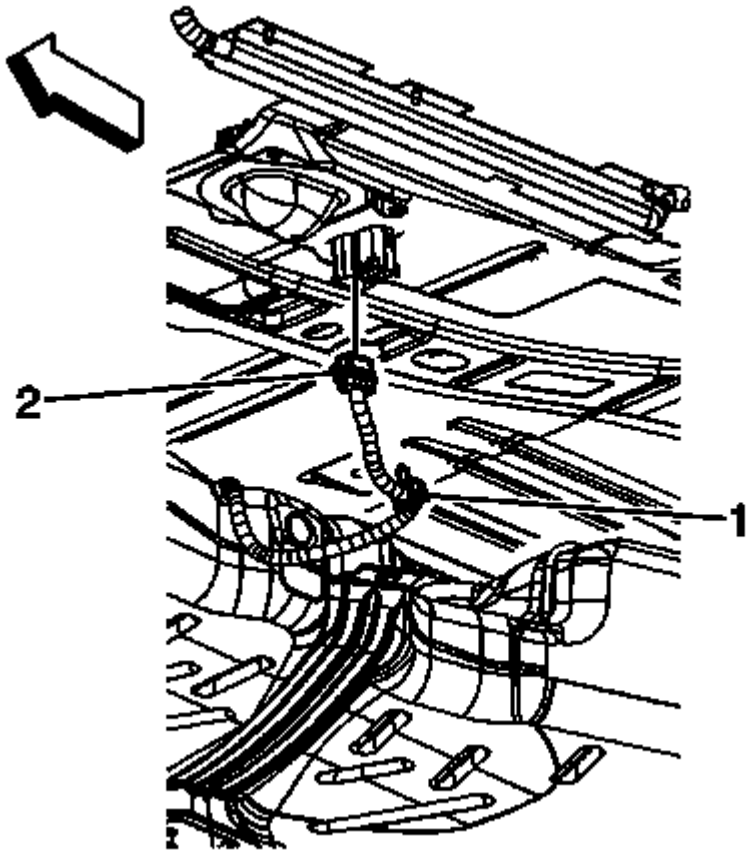

Fig. 63: Identifying Fuel Sender Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the fuel sender wiring harness electrical connector (2) from the body wiring harness electrical connector.
7. Remove the fuel sender wiring harness clip (1) from the underbody side rail extension.
8. Remove the left underbody side rail. Refer to **Underbody Rear Side Rail Replacement** .

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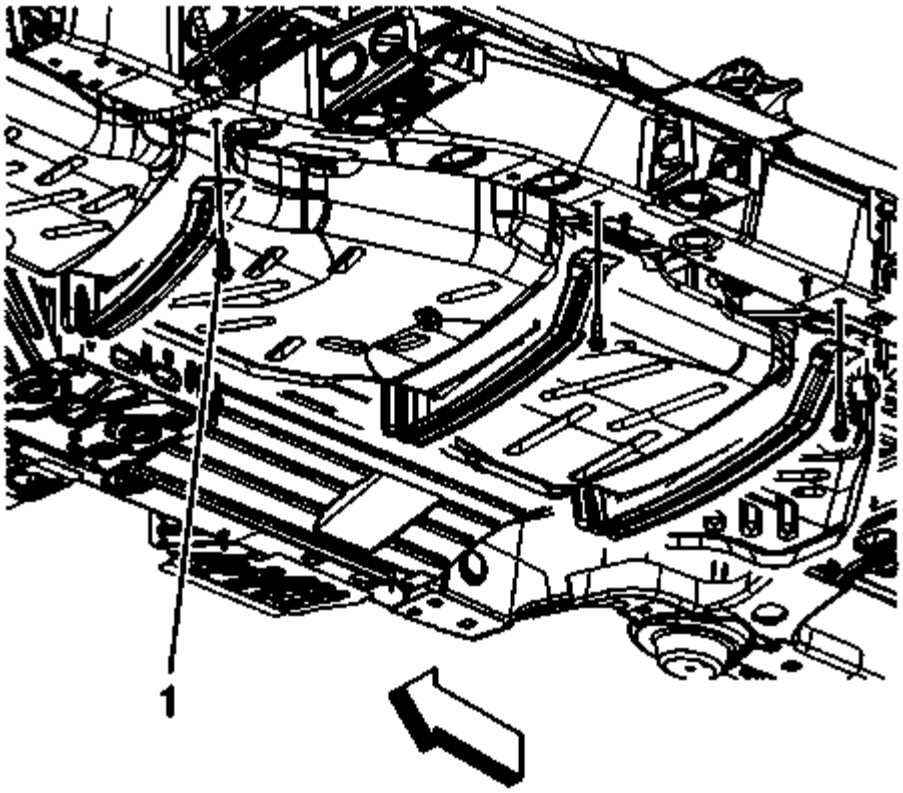

Fig. 64: Identifying Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Support the fuel tank with a suitable adjustable jack.
10. Remove the fuel tank strap bolts (1). Allow the fuel tank straps to hang.
11. Push up on the rear of the strap slightly and rotate the strap towards the rear of the vehicle, in order the remove the fuel tank straps (1).

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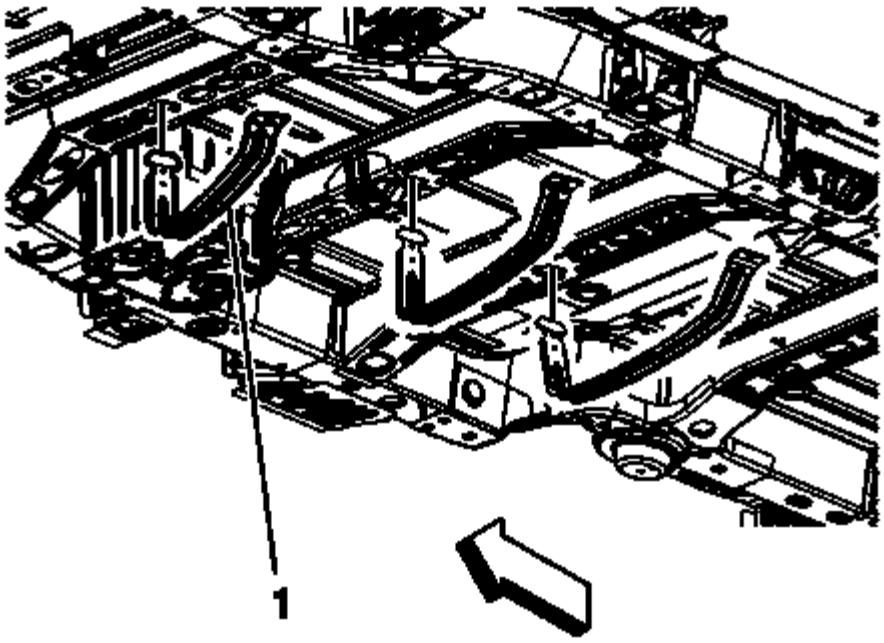

Fig. 65: Identifying Fuel Tank Straps
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not bend the fuel tank straps. Bending the fuel tank straps may cause damage to the straps.

12. Using the adjustable jack and the aid of an assistant, lower the fuel tank from the underbody of the vehicle.

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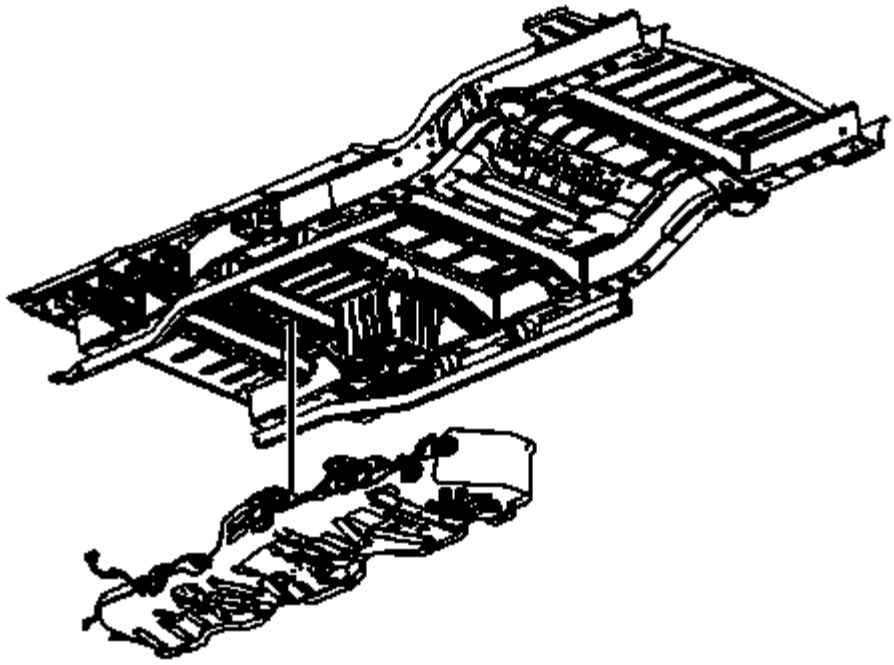

Fig. 66: View Of Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

13. With the aid of the assistant, remove the fuel tank from the adjustable jack and place on a flat work surface.
14. If replacing the fuel tank, perform the following steps, otherwise proceed to step 21 in the installation procedure.

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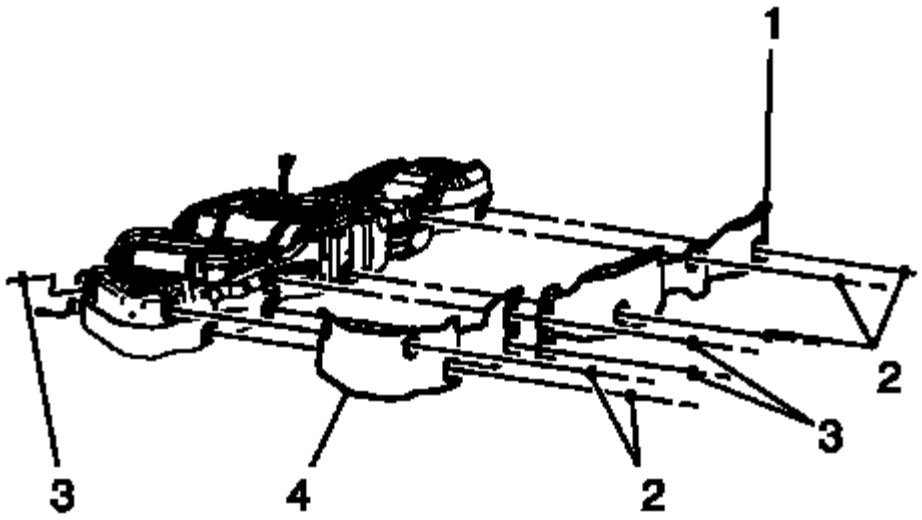

Fig. 67: Identifying Fuel Tank Shields Front & Rear
Courtesy of GENERAL MOTORS COMPANY

15. Remove the fuel tank front and rear shield push on nuts (2).
16. Remove the fuel tank front and rear shield nuts (3).
17. Remove the fuel tank front (1) and rear (4) shields.
18. Remove the foam pad insulators (1) from the top of the fuel tank.

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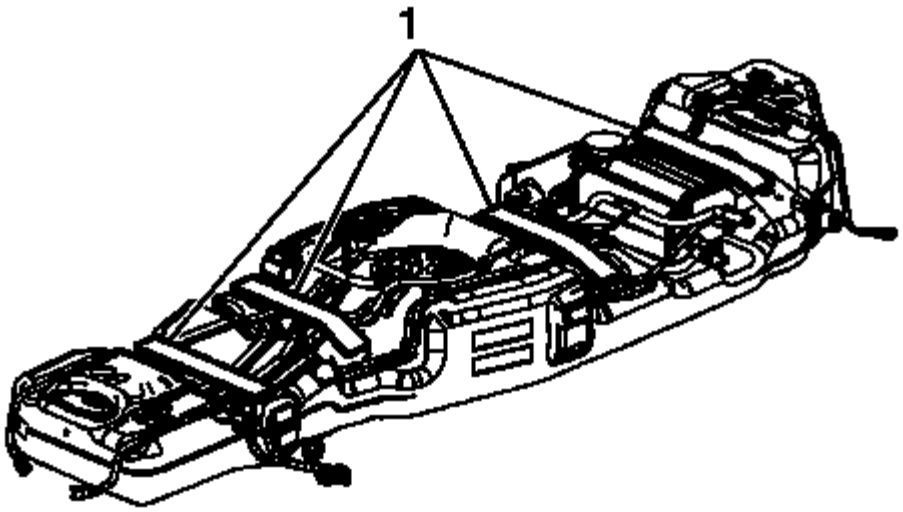

Fig. 68: View Of Foam Pad Insulators
Courtesy of GENERAL MOTORS COMPANY

19. Disconnect the fuel pump fuel feed line quick connect fitting (1) from the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.

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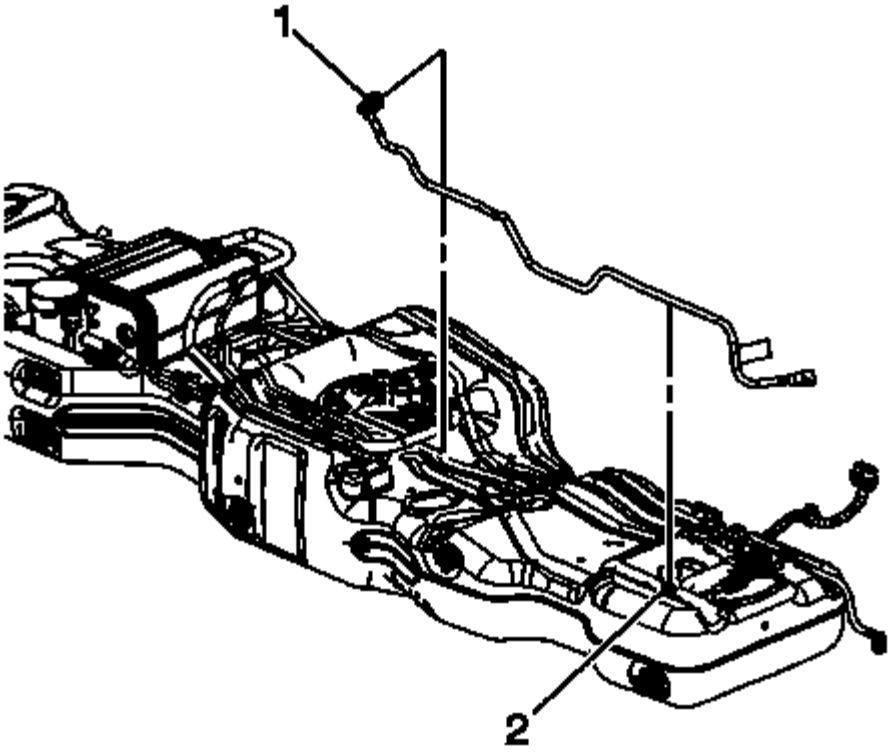

Fig. 69: Identifying Fuel Pump Fuel Feed Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

20. Remove the fuel pump fuel feed line from the retaining features (2) built into the fuel tank and out from under the EVAP canister vent rear pipe.
21. Disconnect the EVAP canister vent front pipe quick connect fitting (1) from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

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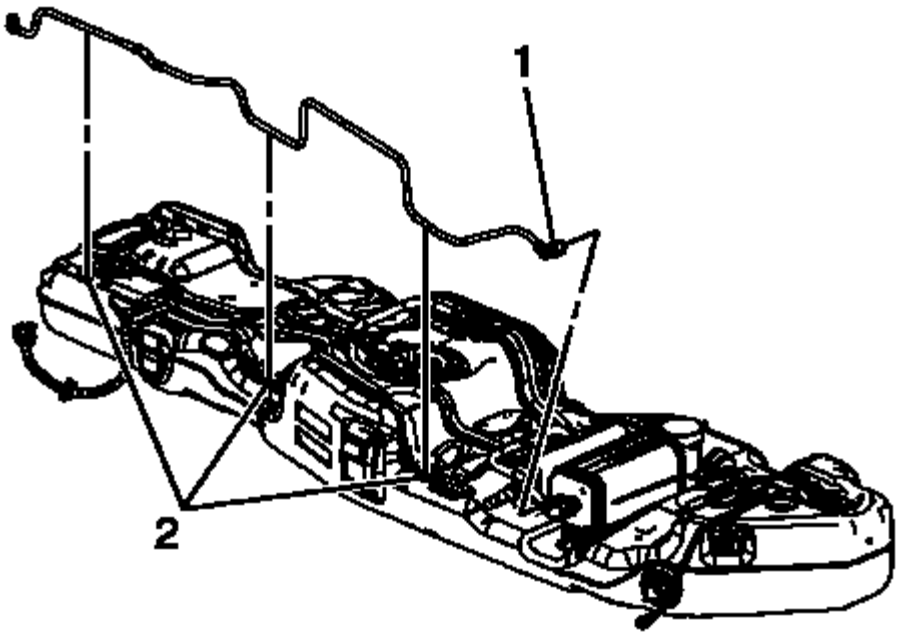

Fig. 70: View Of EVAP Canister Vent Front Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

22. Remove the EVAP canister vent front pipe from the retaining features (2) built into the fuel tank.
23. Disconnect the fuel sender wiring harness electrical connectors from the fuel tank module (1), fuel tank pressure sensor 2) and EVAP canister vent solenoid (3).

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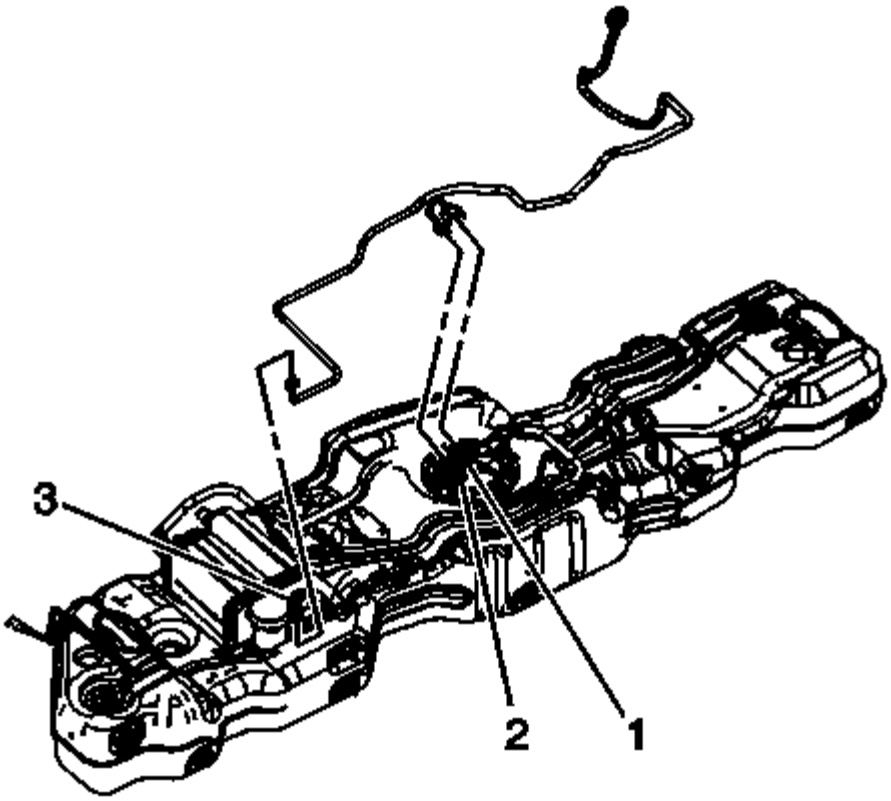

Fig. 71: Identifying Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

24. Remove the fuel sender wiring harness.
25. Disconnect the EVAP canister vent rear pipe quick connect fitting (1) from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

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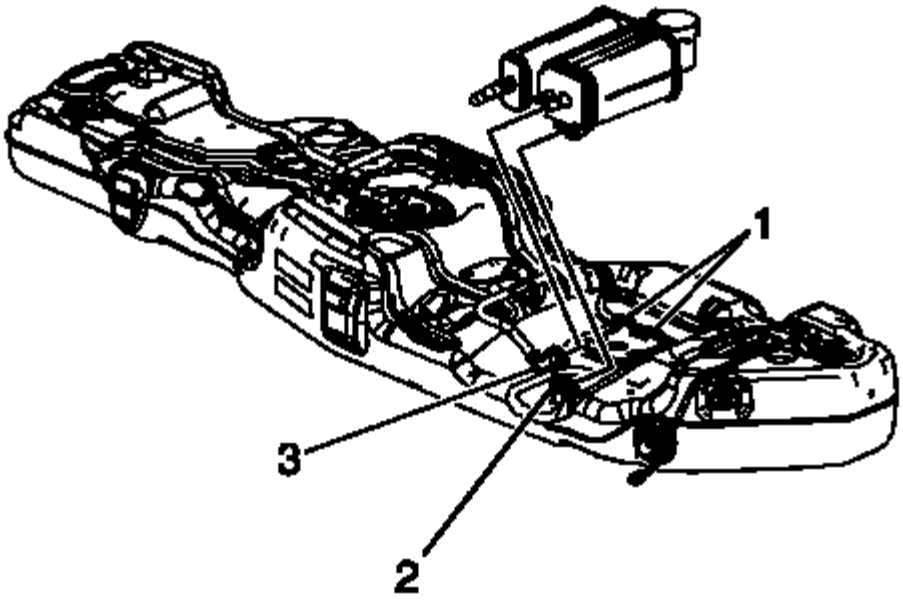

Fig. 72: View Of EVAP Canister Vent Rear Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

26. Squeeze the retainer (2) into order to disengage the retainer from the EVAP canister and remove the EVAP canister assembly from the EVAP canister bracket retainers (1).
27. Disconnect the EVAP canister vent rear pipe quick connect fittings (1) from the fuel tank rollover valves. Refer to **Plastic Collar Quick Connect Fitting Service**.

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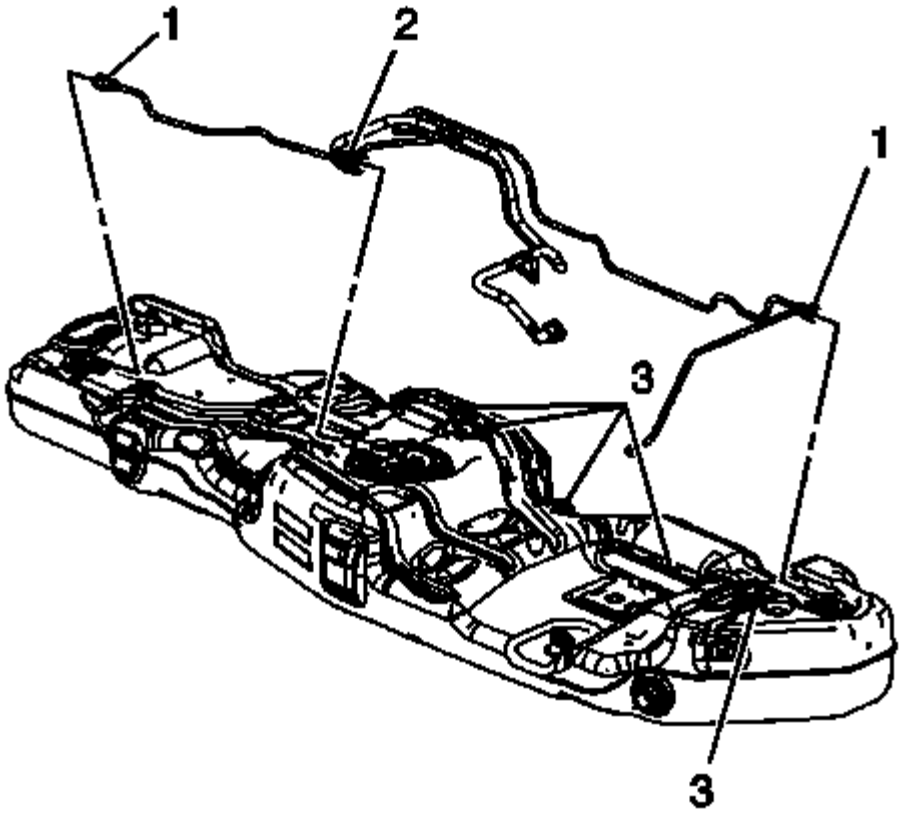

Fig. 73: Identifying EVAP Canister Vent Rear Pipe Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

28. Disconnect the EVAP canister vent rear pipe quick connect fitting (2) from the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
29. Remove the EVAP canister vent rear pipe from the retaining features (3) built into the fuel tank.
30. Remove the fuel tank module. Refer to **Fuel Tank Module Replacement**.

Installation Procedure

1. If the fuel tank was replaced, perform the following steps, otherwise proceed the step 21.

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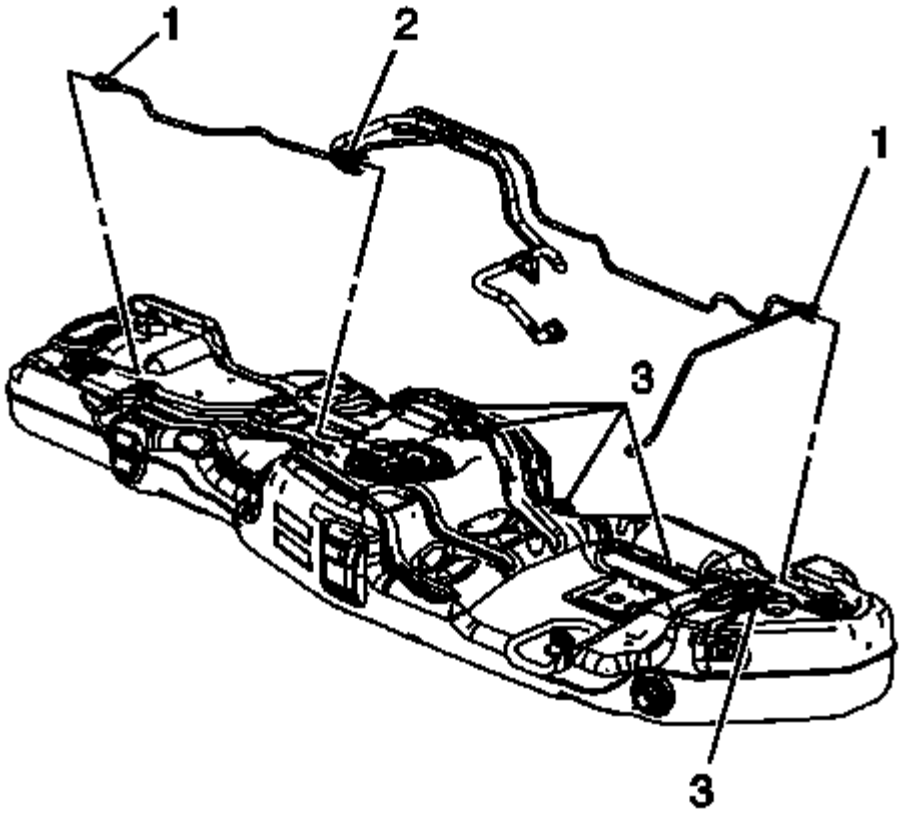

Fig. 74: Identifying EVAP Canister Vent Rear Pipe Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

2. Install the fuel tank module. Refer to **Fuel Tank Module Replacement**.
3. Lay the EVAP canister vent rear pipe into position on the fuel tank.
4. Connect the EVAP canister vent rear pipe quick connect fittings (1) to the fuel tank rollover valves. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Connect the EVAP canister vent rear pipe quick connect fitting (2) to the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Install the EVAP canister vent rear pipe to the retaining features (3) built into the fuel tank.
7. Insert the rear of the EVAP canister into the EVAP canister bracket retainers (1), squeeze the retainer (2) and set the EVAP canister assembly into place.

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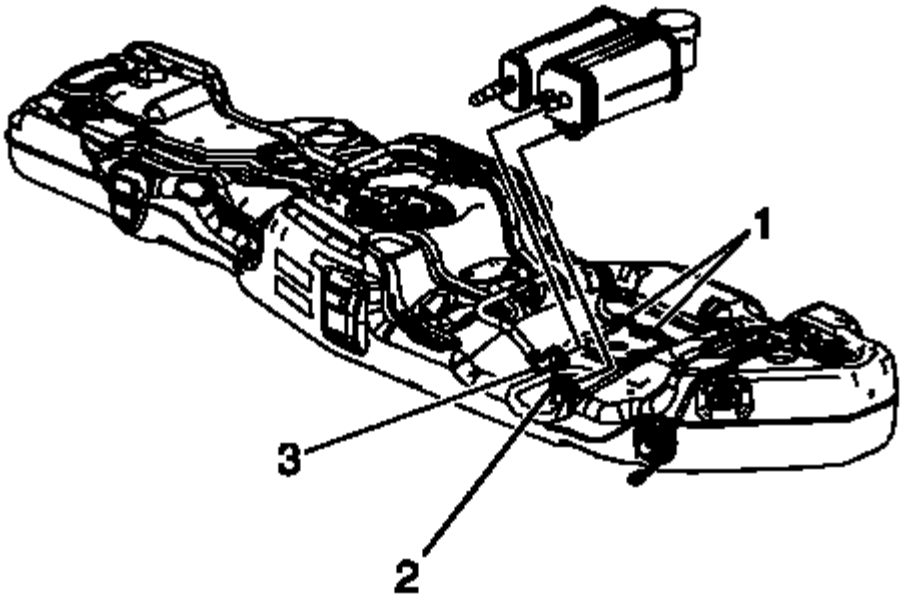

Fig. 75: View Of EVAP Canister Vent Rear Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

8. Connect the EVAP canister vent rear pipe quick connect fitting (1) to the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Place the fuel sender wiring harness into the channel in the fuel tank.

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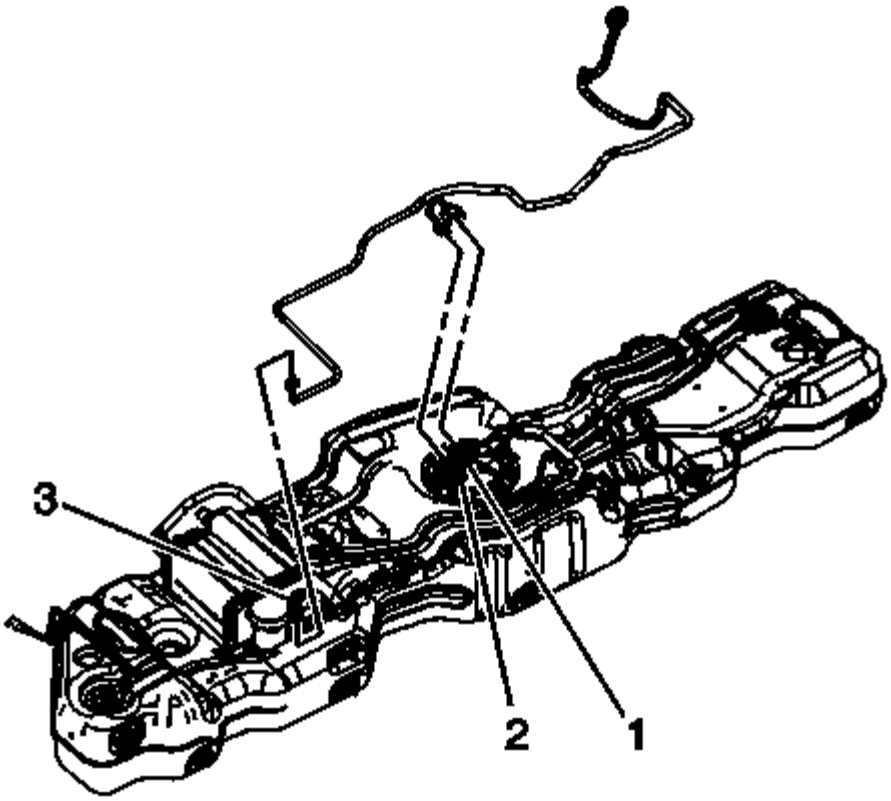

Fig. 76: Identifying Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

10. Connect the fuel sender wiring harness electrical connectors to the fuel tank module (1), fuel tank pressure sensor (2) and EVAP canister vent solenoid (3).
11. Lay the EVAP canister vent front pipe into position on the fuel tank.

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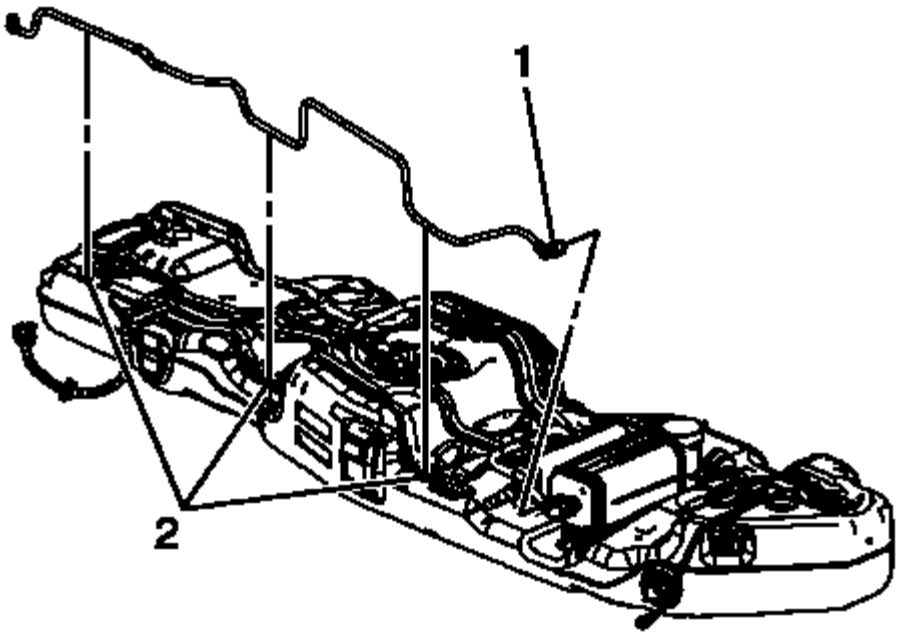

Fig. 77: View Of EVAP Canister Vent Front Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

12. Connect the EVAP canister vent rear pipe quick connect fitting (1) to the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
13. Install the EVAP canister vent rear pipe to the retaining features (2) built into the fuel tank.
14. Route the fuel pump fuel feed pipe under the EVAP canister vent rear pipe and lay into position on the fuel tank.

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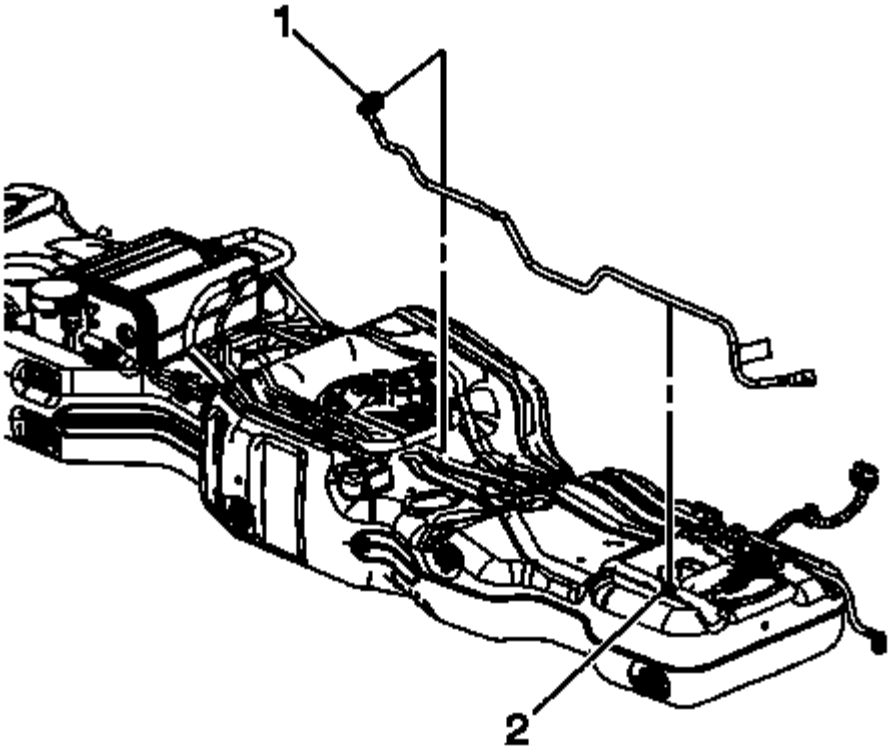

Fig. 78: Identifying Fuel Pump Fuel Feed Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

15. Connect the fuel pump fuel feed line quick connect fitting (1) to the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
16. Install the fuel pump fuel feed line to the retaining features (2) built into the fuel tank.
17. Install the foam pad insulators (1) onto the top of the fuel tank.

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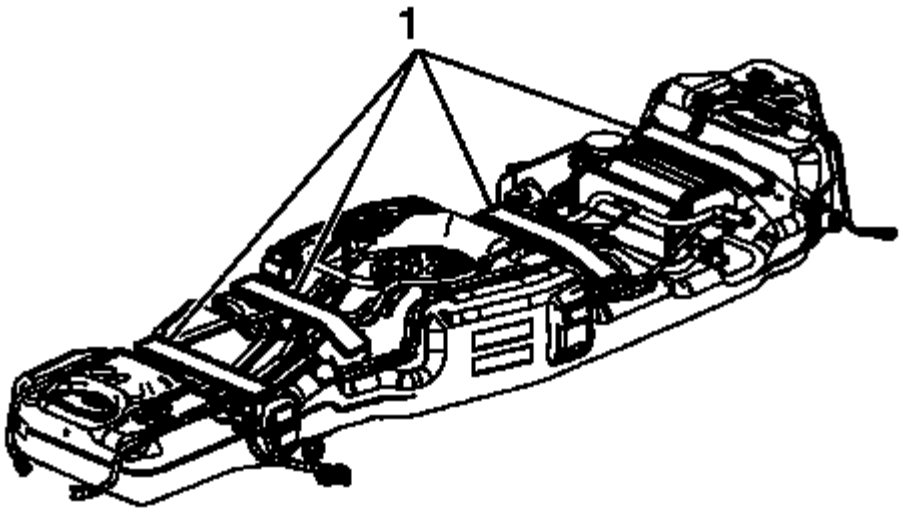

Fig. 79: View Of Foam Pad Insulators
Courtesy of GENERAL MOTORS COMPANY

18. Install the fuel tank rear (4) and front (1) shields onto the fuel tank.

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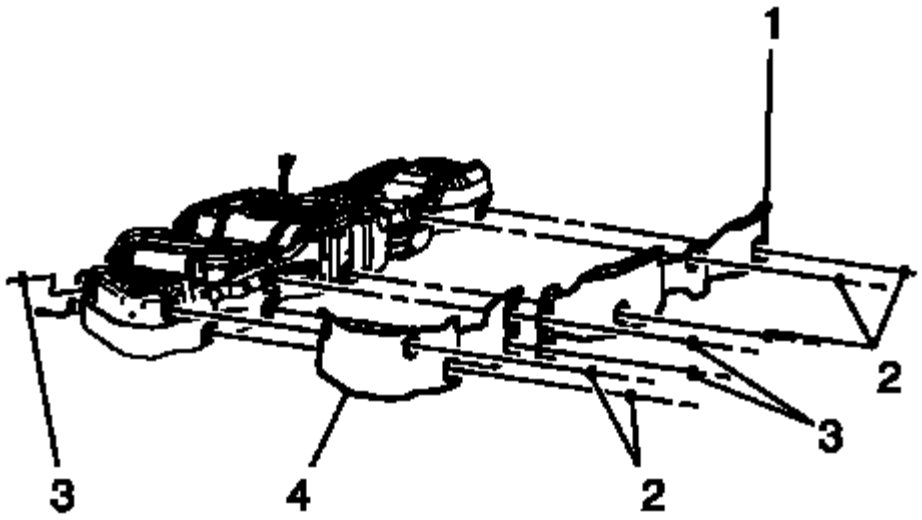

Fig. 80: Identifying Fuel Tank Shields Front & Rear
Courtesy of GENERAL MOTORS COMPANY

19. Install the fuel tank front and rear shield push on nuts (2).
20. Install the fuel tank front and rear shield nuts (3) until snug.
21. With the aid of an assistant, remove the fuel tank from the work surface and place on the adjustable jack.

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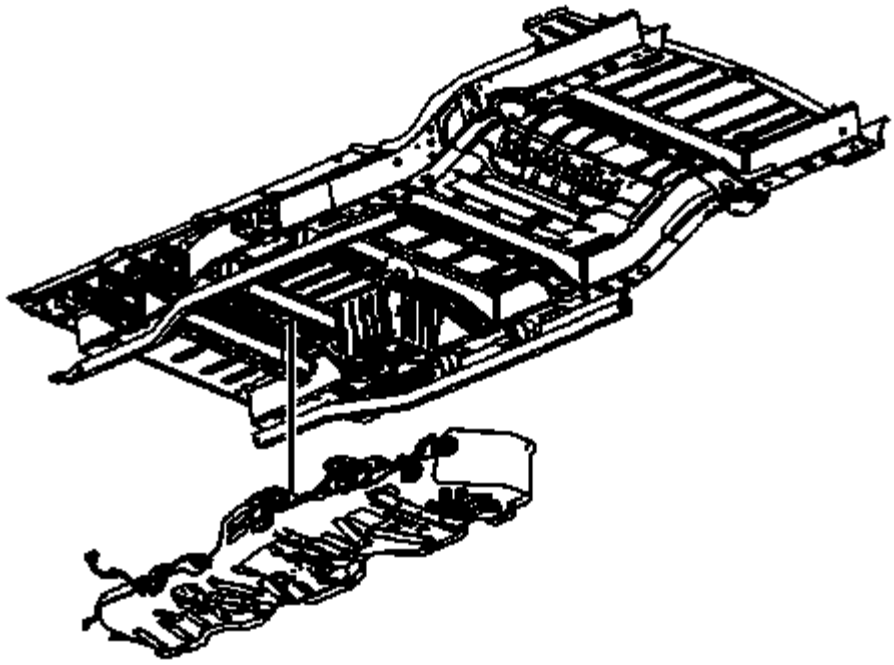

Fig. 81: View Of Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

22. With the aid of the assistant, raise the fuel tank into position under the vehicle.
23. Install the fuel tank straps (1).

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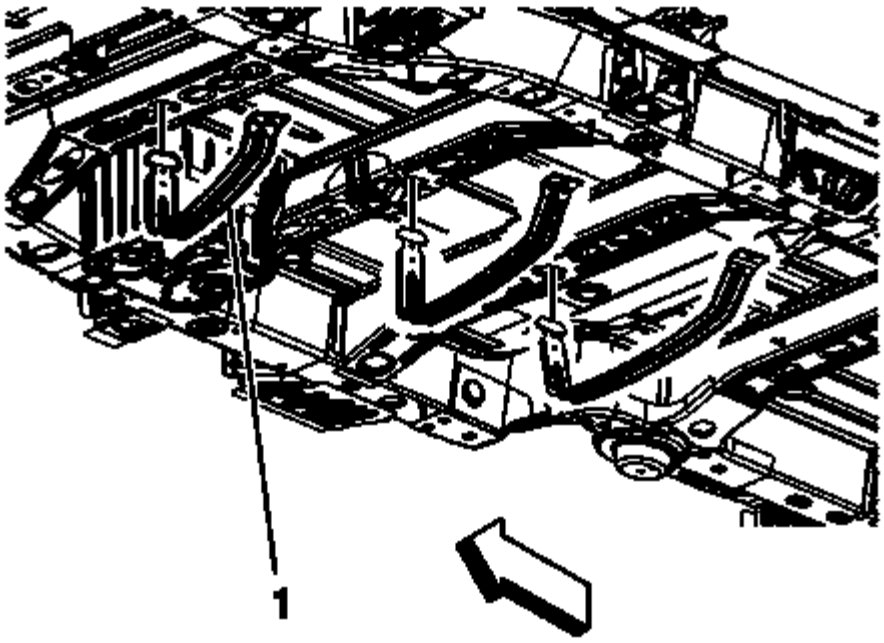

Fig. 82: Identifying Fuel Tank Straps
Courtesy of GENERAL MOTORS COMPANY

24. Install the fuel tank strap bolts (1).

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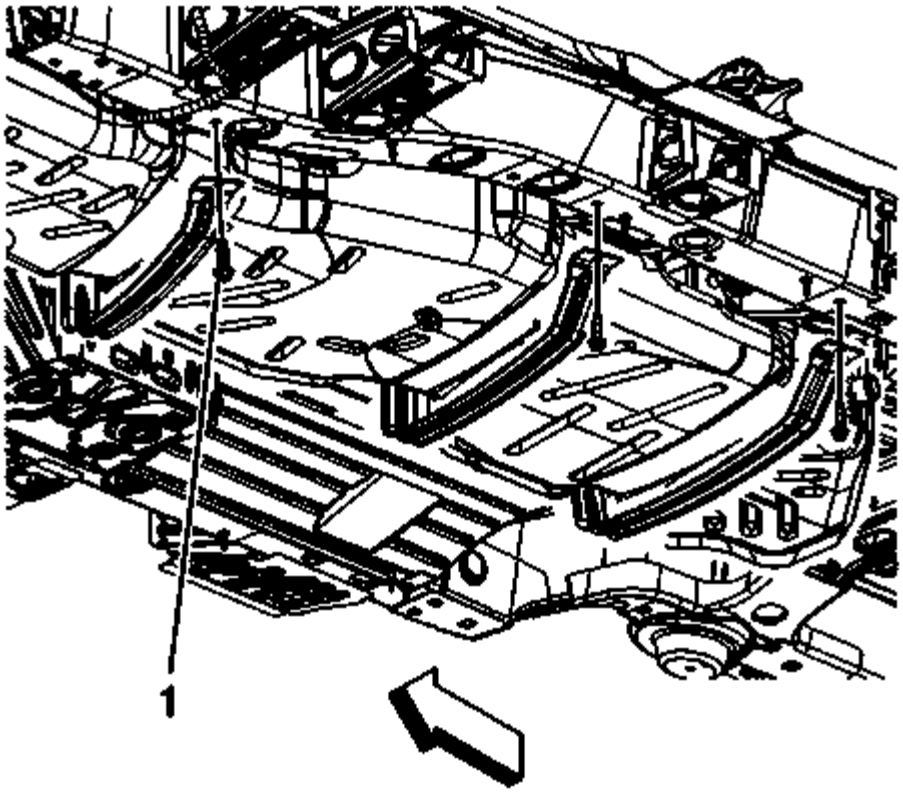

Fig. 83: Identifying Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolts to 47 N.m (35 lb ft).

25. Remove the adjustable jack from under the fuel tank.
26. Install the left underbody side rail. Refer to **Underbody Rear Side Rail Replacement** .
27. Connect the fuel sender wiring harness electrical connector (2) to the body wiring harness electrical connector.

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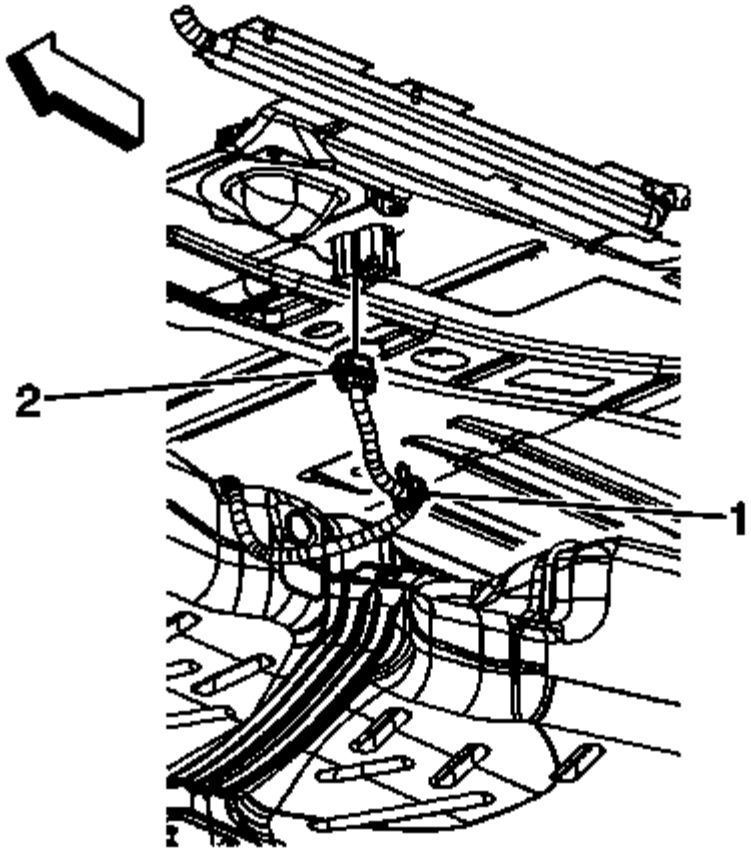

Fig. 84: Identifying Fuel Sender Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

28. Install the fuel sender wiring harness clip (1) to the underbody side rail extension.
29. Connect the vent hose to the left rear of the fuel tank.
30. Connect the fuel tank EVAP canister vent front pipe quick connect fitting (5) to the chassis EVAP line. Refer to **Plastic Collar Quick Connect Fitting Service**.

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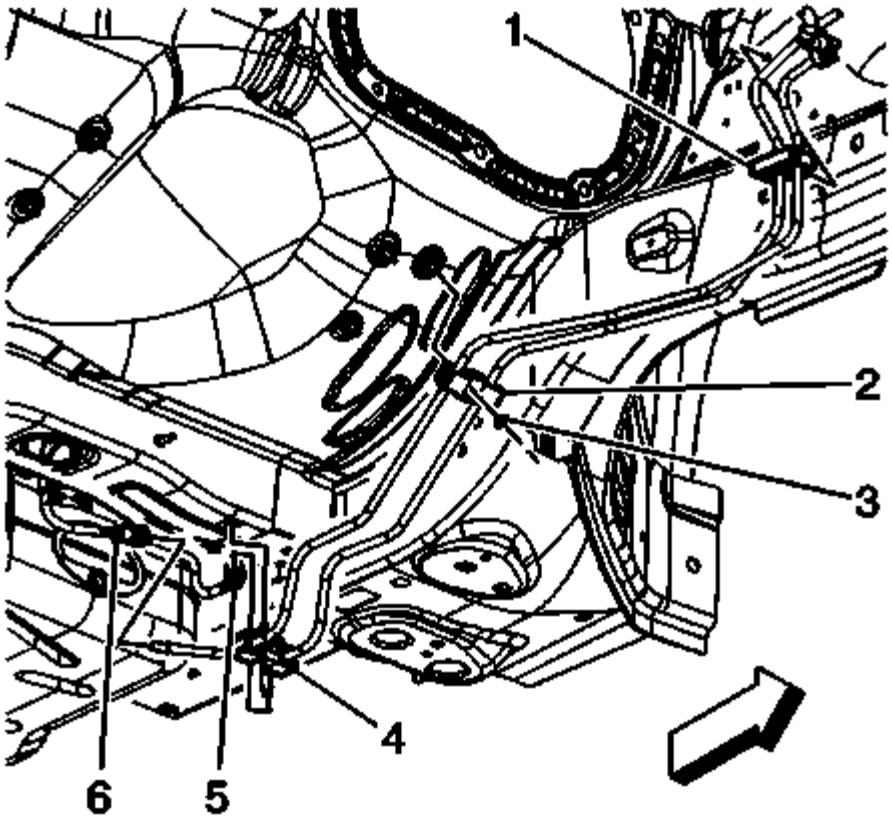

Fig. 85: View Of Fuel Tank Evaporative Emission Canister Vent Front Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

31. Connect the fuel pump fuel feed line quick connect fitting (6) to the chassis fuel line. Refer to **Plastic Collar Quick Connect Fitting Service**.
32. Position and install the fuel tank fill pipe (2) to the fuel tank.

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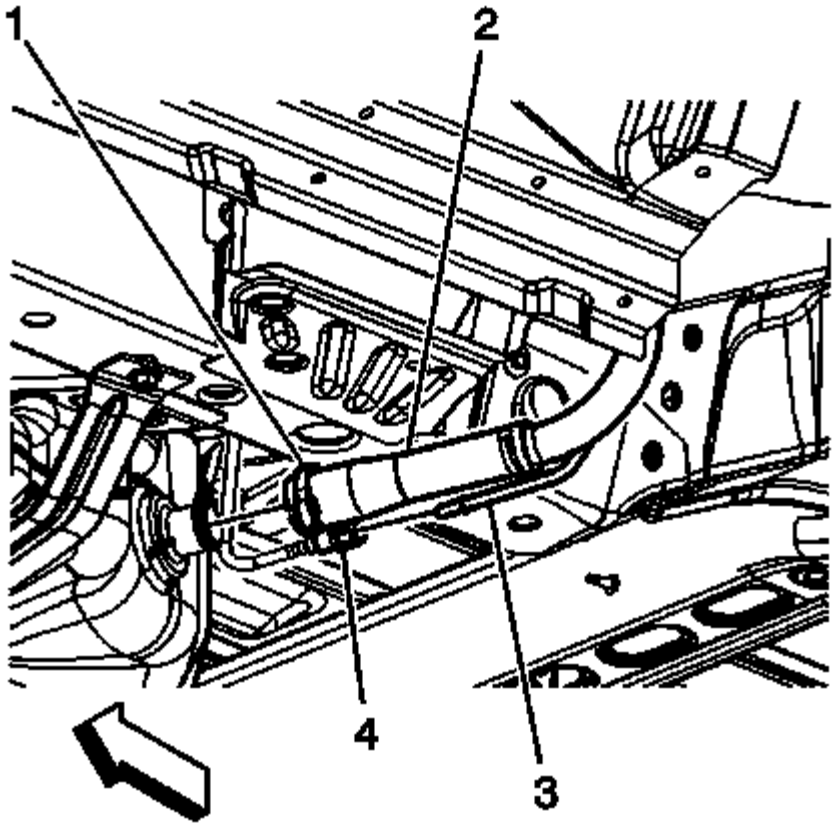

Fig. 86: Identifying Fuel Fill Pipe
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the notch in the fill hose aligns with the tab on the fuel tank.

33. Connect the EVAP canister vent rear pipe quick connect fitting (4) to the recirculation line on the fuel fill pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**.
34. Tighten the fuel tank fill hose clamp (1) at the fuel tank.

    Tighten

    Tighten the clamp to 3.3 N.m (29 lb in).

35. Lower the vehicle.
36. Refill the fuel tank.
37. Tighten the fuel fill cap.
38. Use the following procedure in order the inspect for leaks:
    1. Turn the ignition ON, with the engine OFF, for 2 seconds.
    2. Turn the ignition OFF for 10 seconds.

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3. Turn the ignition ON, with the engine OFF.
4. Inspect for fuel leaks.

39. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

CHASSIS CONTROL MODULE REPLACEMENT

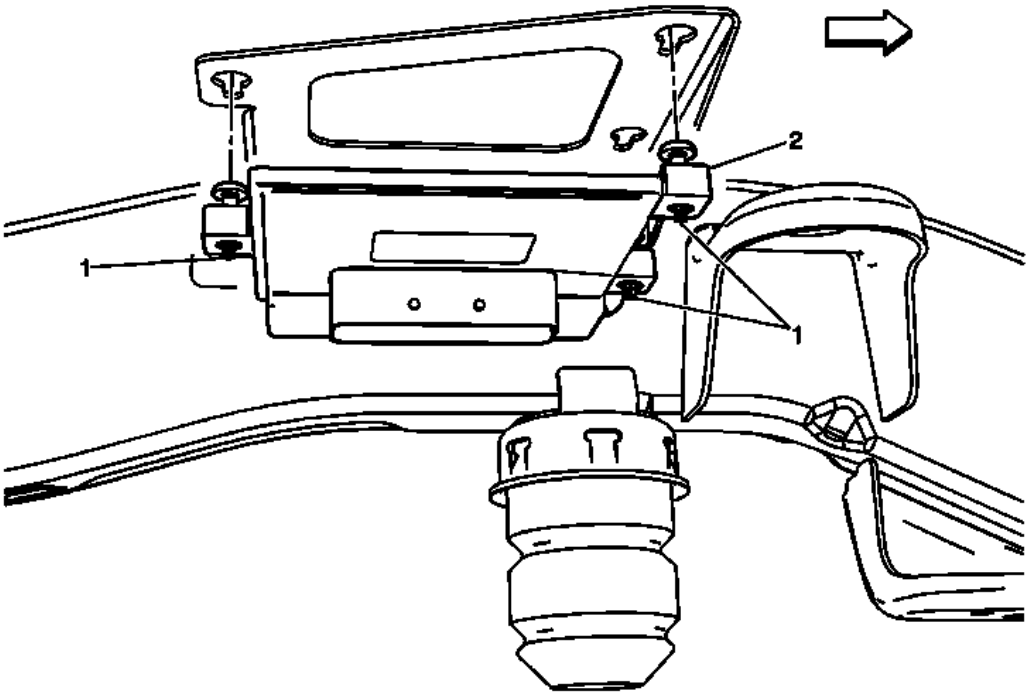

Fig. 87: View Of Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS COMPANY

Chassis Control Module Replacement

Callout	Component Name
Preliminary Procedure **Lift and support the vehicle. Refer to Lifting and Jacking the Vehicle .**	
1	Chassis Control Module Fastener (Qty: 3) **CAUTION:** **Refer to Fastener Caution** **TIP:** The bolts used are two headed and can be loosened from the module side, then maneuvered out of the slots. **Tighten** 9 N.m (80 lb in)
	Chassis Control Module

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2	**Procedure** 1. Disconnect the electrical connector. 2. If replacing the chassis control module, program the control module. Refer to **Control Module References** .

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

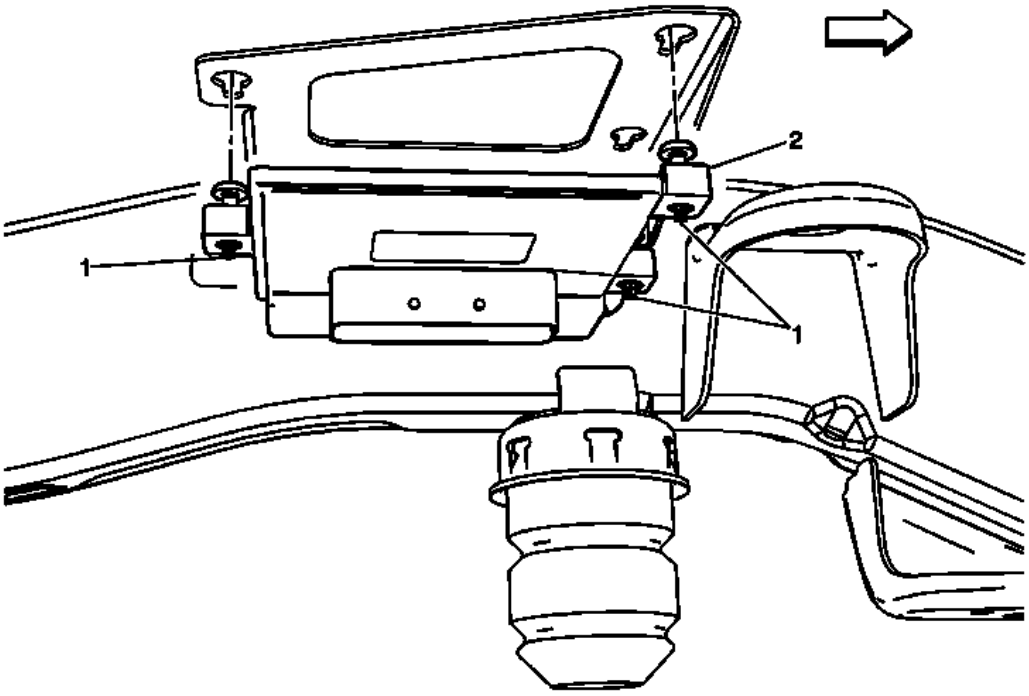

Fig. 88: View Of Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Flow Control Module Replacement

Callout	Component Name
Preliminary Procedure **Lift and support the vehicle. Refer to Lifting and Jacking the Vehicle .**	
1	Fuel Pump Flow Control Module Fastener (Qty: 3) **CAUTION:** **Refer to Fastener Caution** **TIP:** The bolts used are two headed and can be loosened from the module side, then maneuvered out of the slots.

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	Tighten 9 N.m (80 lb in)
2	Fuel Pump Flow Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing the fuel pump flow control module, program the control module. Refer to **Control Module References** .

FUEL TANK PRESSURE SENSOR REPLACEMENT

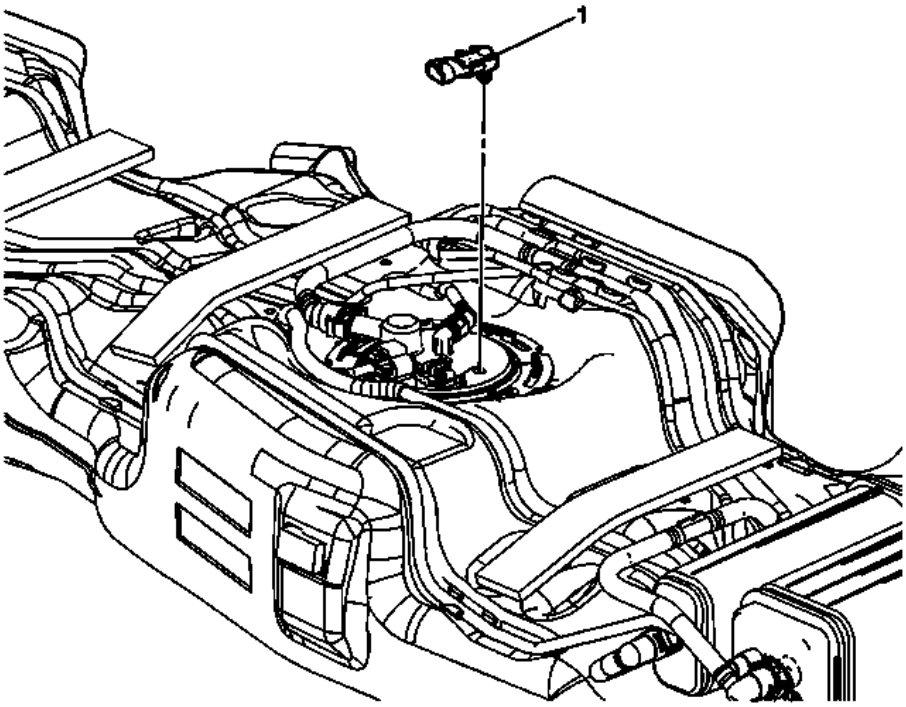

Fig. 89: Identifying Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to **Fuel Tank Replacement**.	
1	Fuel Tank Pressure Sensor **Procedure** Disconnect the fuel sender wiring harness electrical connector.

FILLER TUBE REPLACEMENT

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Removal Procedure

WARNING: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

1. Remove the fuel fill cap.

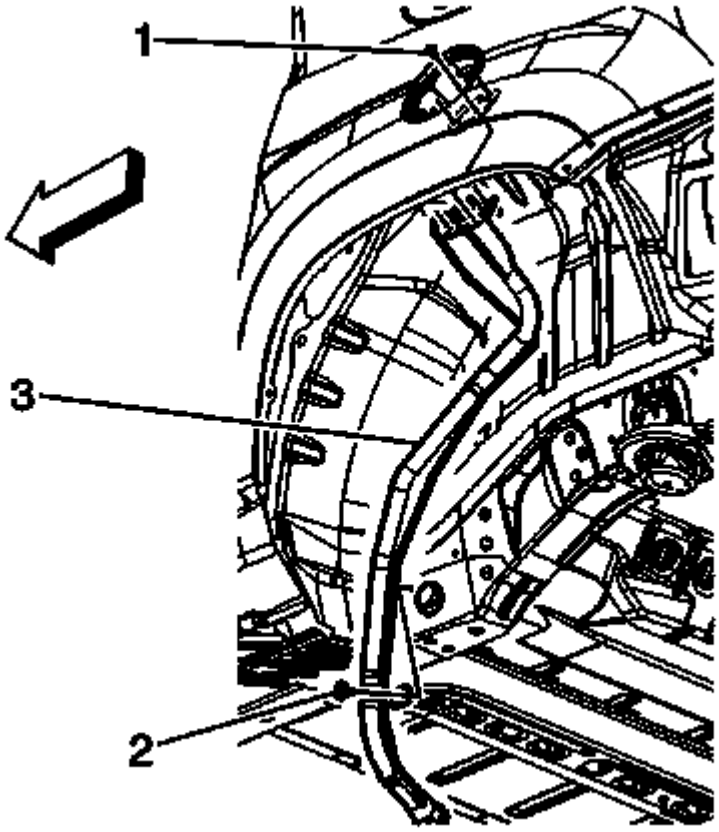

Fig. 90: Identifying Fuel Tank Fill Pipe Housing To Fuel Tank Fill Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel tank fill pipe housing to fuel tank fill pipe bolts (1).
3. Drain the fuel tank. Refer to **Fuel Tank Draining**.
4. Remove the left rear wheel and tire. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the left rear wheelhouse liner panel. Refer to **Rear Wheelhouse Liner Replacement (Traverse)** , **Rear Wheelhouse Liner Replacement (Enclave)** , **Rear Wheelhouse Liner Replacement (Acadia)** .
6. Remove the fuel tank fill pipe bracket bolt (2).
7. Remove the fuel tank fill pipe assembly (3) from the vehicle.

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8. Loosen the fuel tank fill hose clamp (2), if necessary.

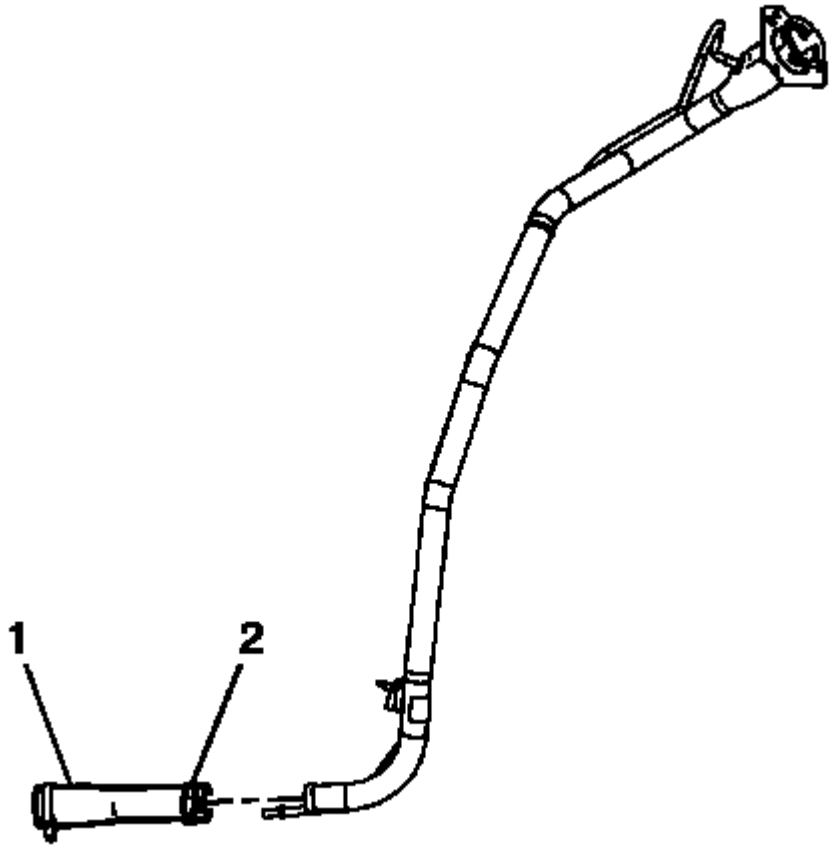

Fig. 91: View Of Fuel Tank Fill Hose
Courtesy of GENERAL MOTORS COMPANY

9. Remove the fuel tank fill hose (1), if necessary.

Installation Procedure

1. Install the fuel tank fill hose (1), if necessary.

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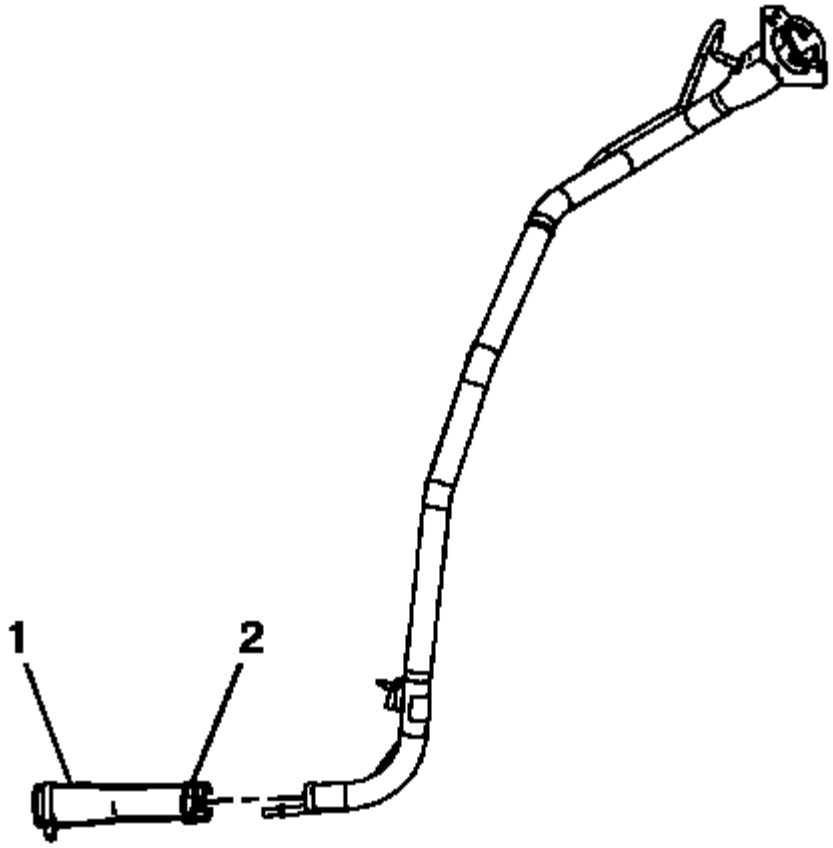

Fig. 92: View Of Fuel Tank Fill Hose
Courtesy of GENERAL MOTORS COMPANY

2. Tighten the fuel tank fill hose clamp (2), if necessary.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the clamp to 3.3 N.m (29 lb in).

3. Position and install the fuel tank fill hose (2) to the fuel tank.

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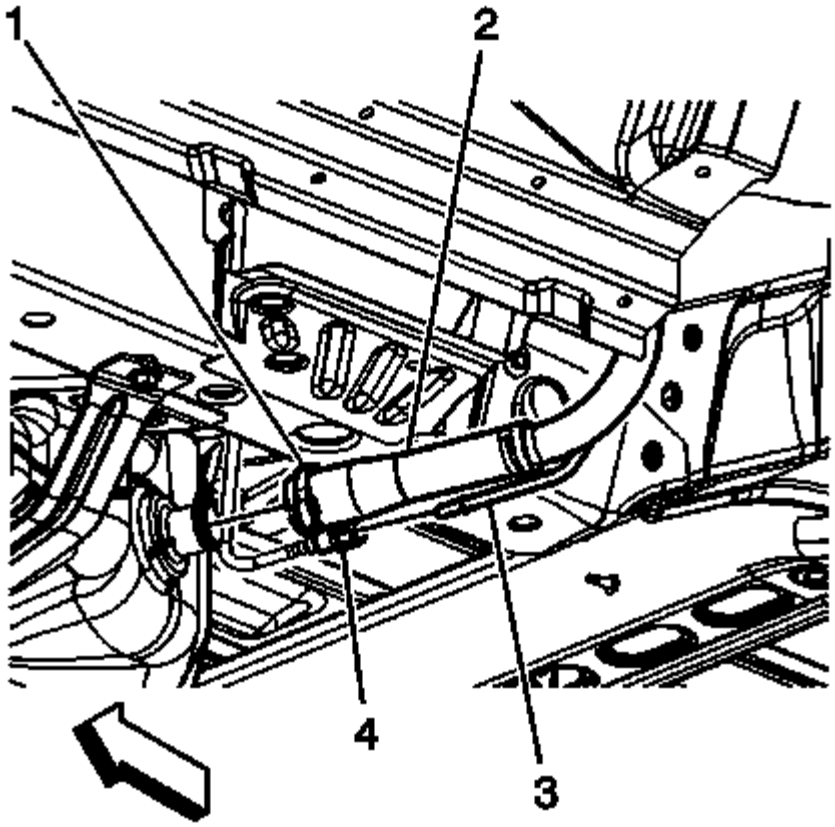

Fig. 93: Identifying Fuel Fill Pipe
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the notch in the fill hose aligns with the tab on the fuel tank.

4. Connect the evaporative emission (EVAP) canister vent rear pipe quick connect fitting (4) to the recirculation line on the fuel tank fill pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Tighten the fuel tank fill hose clamp (1) at the fuel tank.

   Tighten

   Tighten the clamp to 3.3 N.m (29 lb in).

6. Install the fuel tank fill pipe bracket bolt (2).

   Tighten

   Tighten the bolt to 12 N.m (106 lb in).

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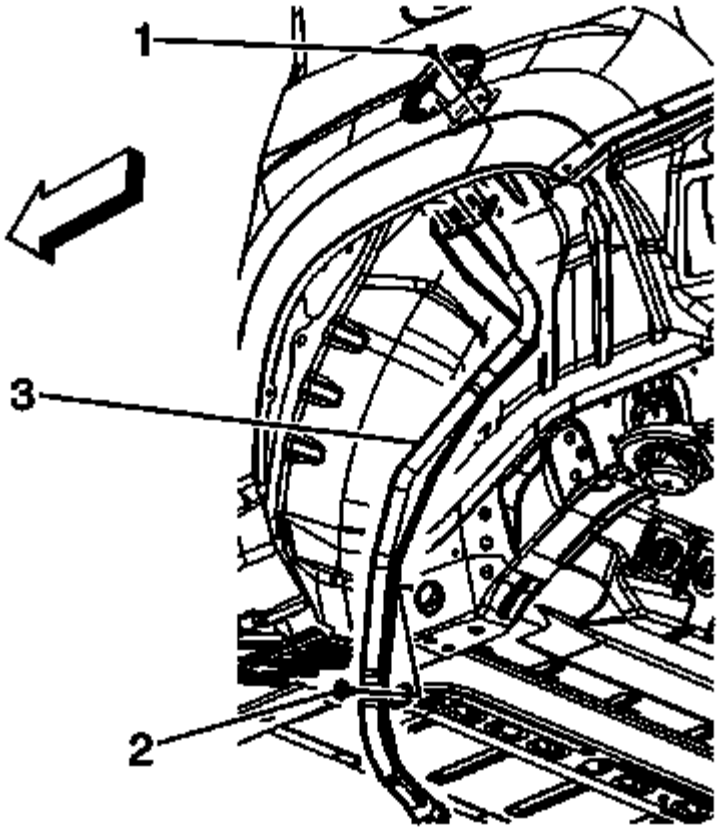

Fig. 94: Identifying Fuel Tank Fill Pipe Housing To Fuel Tank Fill Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the left rear wheelhouse liner panel. Refer to **Rear Wheelhouse Liner Replacement (Traverse)** , **Rear Wheelhouse Liner Replacement (Enclave)** , **Rear Wheelhouse Liner Replacement (Acadia)** .
8. Install the left rear wheel and tire. Refer to **Tire and Wheel Removal and Installation** .
9. Lower the vehicle.
10. Install the fuel tank fill pipe housing to fuel tank fill pipe bolts (1).

    Tighten

    Tighten the bolts to 2 N.m (18 lb in).

11. Install the fuel fill cap.

FUEL TANK MODULE REPLACEMENT

Special Tools

J 45722 Fuel Sender Lock Ring Wrench

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Removal Procedure

WARNING: Whenever fuel line fittings are loosened or removed, wrap a shop cloth around the fitting and have an approved container available to collect any fuel.

CAUTION: Clean all fuel pipe and hose connections and surrounding areas before disassembling to avoid possible contamination of the fuel system. Spray the fuel pump module cam-lock ring tang with penetrating oil prior to attempting removal.

NOTE: A NEW fuel tank module seal is necessary each time the fuel tank module is serviced. Obtain a NEW seal prior to beginning this service procedure.

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

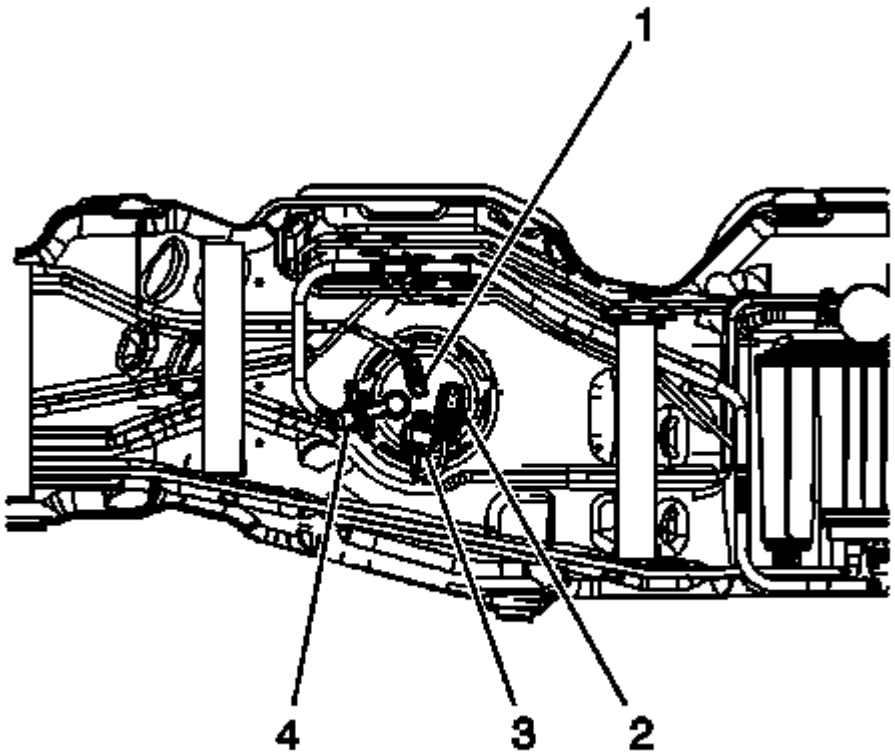

Fig. 95: Identifying Fuel Pump Fuel Feed Line Quick Connect Fitting & Fuel Sender Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

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2. Disconnect the fuel pump fuel feed line quick connect fitting (1) from the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Disconnect evaporative emission (EVAP) canister vent front pipe quick connect fitting (4) from the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Reposition the fuel pump fuel feed line and the EVAP canister vent front pipe out of the way.
5. Disconnect the fuel sender wiring harness electrical connector (2) from the fuel tank pressure sensor.
6. Disconnect the fuel sender wiring harness electrical connector (3) from the fuel tank module.
7. Install the **J 45722** fuel sender lock ring wrench (1) to the fuel tank module lock ring.

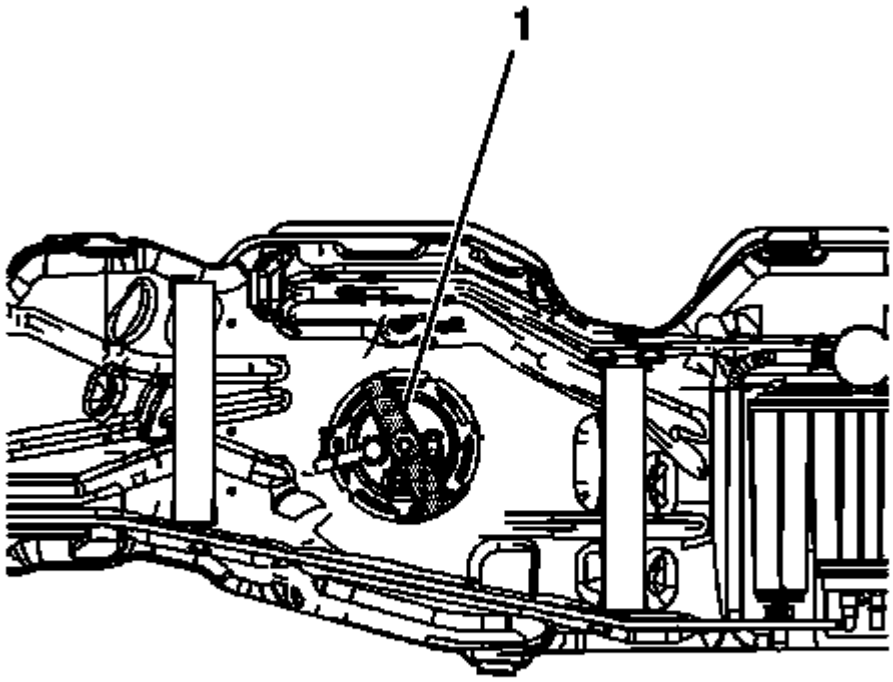

Fig. 96: Identifying Special Tools - J 45722
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.

8. Using the **J 45722** fuel sender lock ring wrench and a long breaker-bar, rotate the lock ring counterclockwise unlocking the fuel tank module lock ring.

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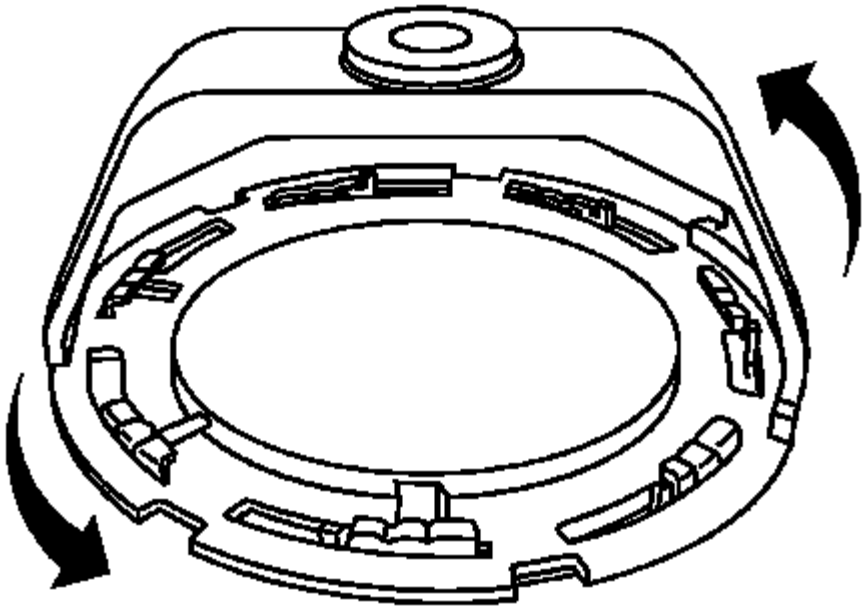

Fig. 97: Identifying Lock Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.

9. Remove the **J 45722** fuel sender lock ring wrench.
10. Remove the fuel tank module lock ring (1).

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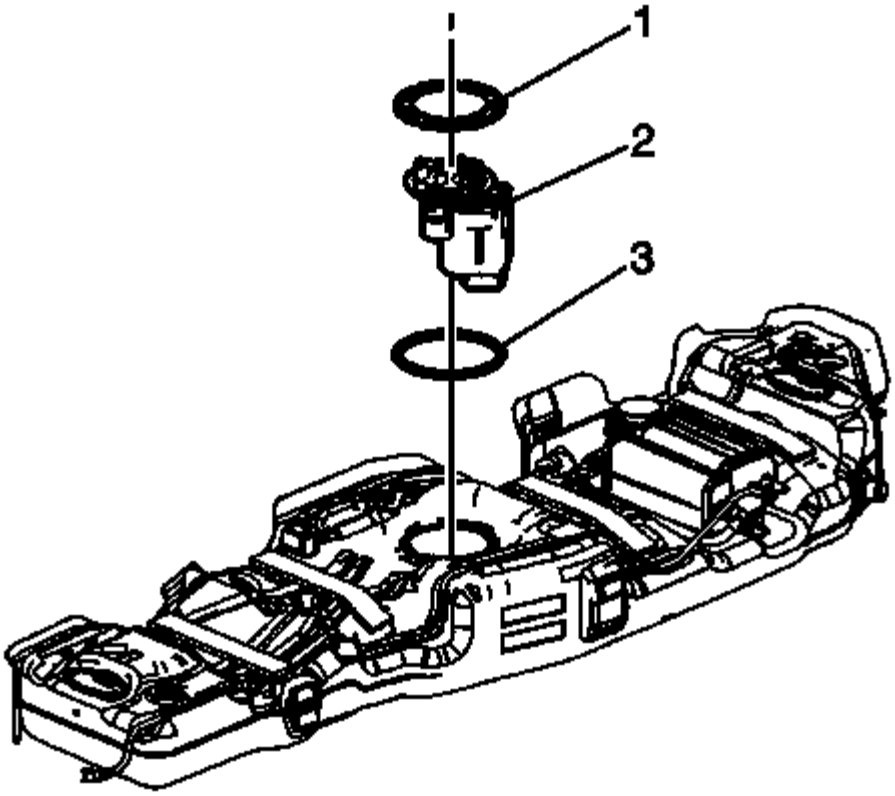

Fig. 98: View Of Fuel Tank Module Lock Ring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.

11. Slowly raise the module (2) until the fuel level sensor float arm is just visible.
12. Tilt the module towards the lower front corner of the fuel tank to allow the level sensor float arm to clear the tank opening. Remove the module from the fuel tank.

NOTE: When removing the module from the fuel tank, be aware that the module reservoir bucket is full of fuel. The module must be tipped slightly during removal to avoid bending the fuel level sensor float arm.

13. Carefully discard the fuel in the module reservoir bucket into an approved container.
14. Remove and discard the fuel tank module seal (3).
15. Remove the fuel level sensor, if required. Refer to **Fuel Level Sensor Replacement**.
16. Place the lock ring on a flat surface. Measure the clearance between to lock ring and the flat surface using

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a feeler gauge at 7 points.

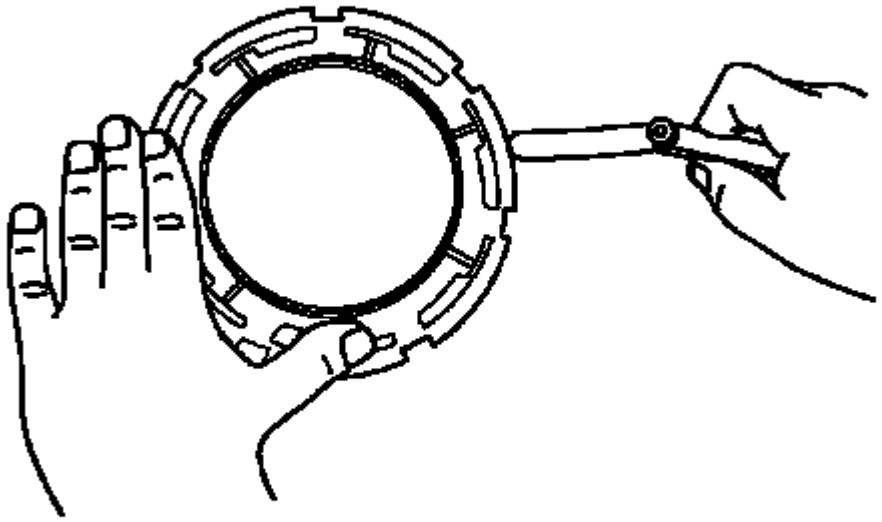

Fig. 99: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.**
- **Check the lock ring for flatness.**

17. If the warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
18. If the warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

1. Install the fuel level sensor, if required. Refer to **Fuel Level Sensor Replacement**.

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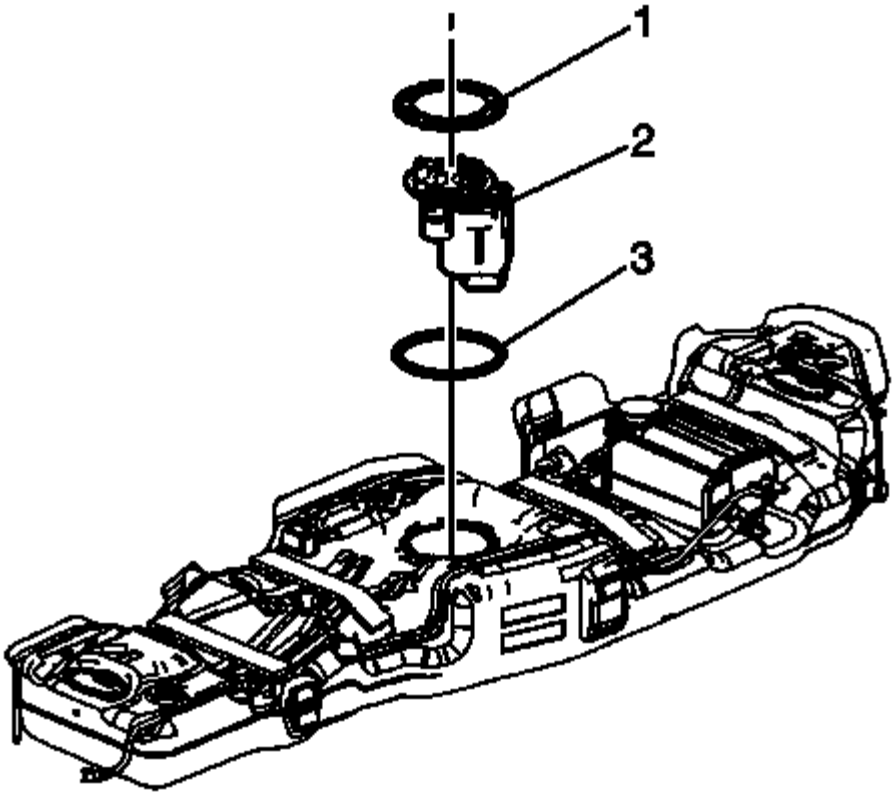

Fig. 100: View Of Fuel Tank Module Lock Ring
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW fuel tank module seal (3) onto the fuel tank.
3. Tilt the module towards the lower front corner of the fuel tank to allow the level sensor float arm to clear the tank opening. Install the module into the fuel tank.

NOTE: The bucket must be tipped slightly during installation to avoid bending the fuel level sensor bloat arm.

4. Position and install the fuel tank module lock ring (1).
5. Install the **J 45722** fuel sender lock ring wrench to the fuel tank module lock ring.

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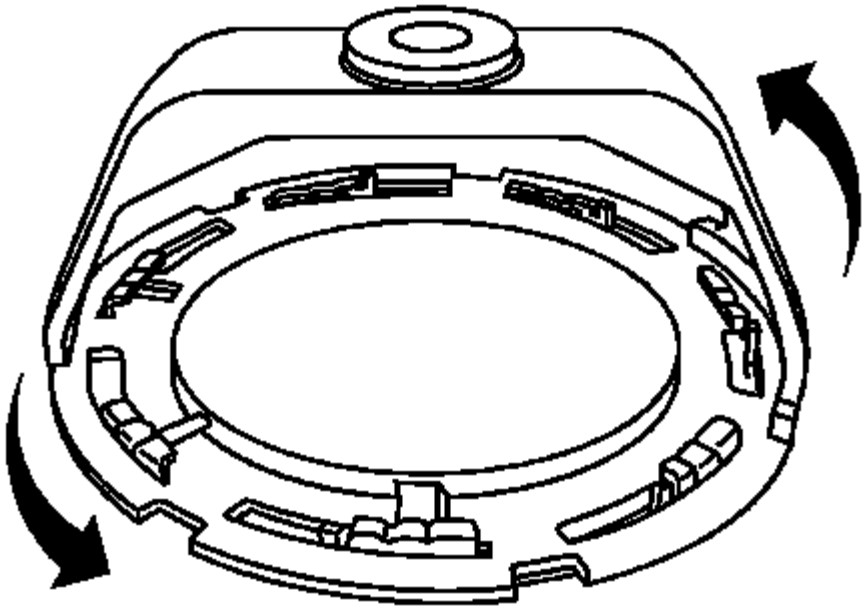

Fig. 101: Identifying Lock Ring
Courtesy of GENERAL MOTORS COMPANY

6. Using the **J 45722** fuel sender lock ring wrench and a long breaker-bar, rotate the lock ring clockwise locking the fuel tank module lock ring.
7. Remove the **J 45722** fuel sender lock ring wrench (1) from the fuel tank module lock ring.

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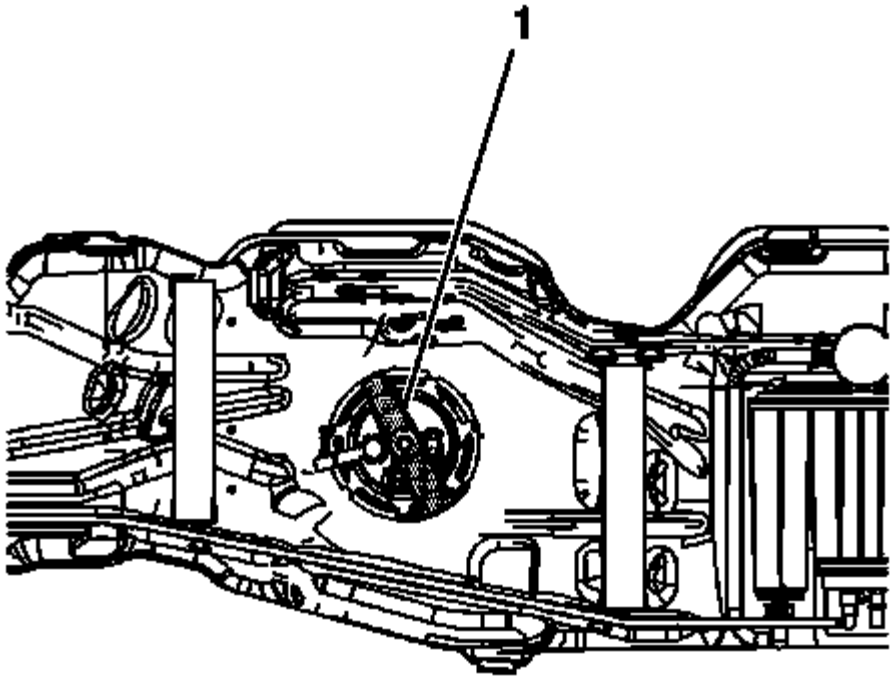

Fig. 102: Identifying Special Tools - J 45722
Courtesy of GENERAL MOTORS COMPANY

8. Connect the fuel sender wiring harness electrical connector (3) to the fuel tank module.

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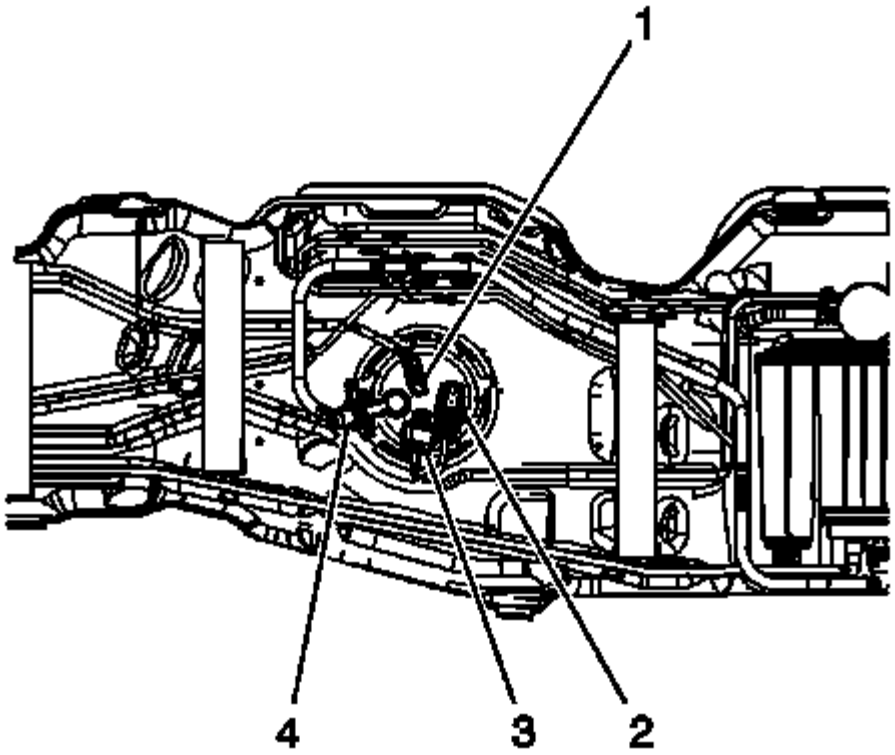

Fig. 103: Identifying Fuel Pump Fuel Feed Line Quick Connect Fitting & Fuel Sender Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

9. Connect the fuel sender wiring harness electrical connector (2) to the fuel tank pressure sensor.
10. Position the fuel pump fuel feed line and the EVAP canister vent front pipe to the fuel tank.
11. Connect EVAP canister vent front pipe quick connect fitting (4) to the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
12. Connect the fuel pump fuel feed line quick connect fitting (1) to the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
13. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL LEVEL SENSOR REPLACEMENT

Removal Procedure

1. Remove the fuel tank module. Refer to **Fuel Tank Module Replacement**.

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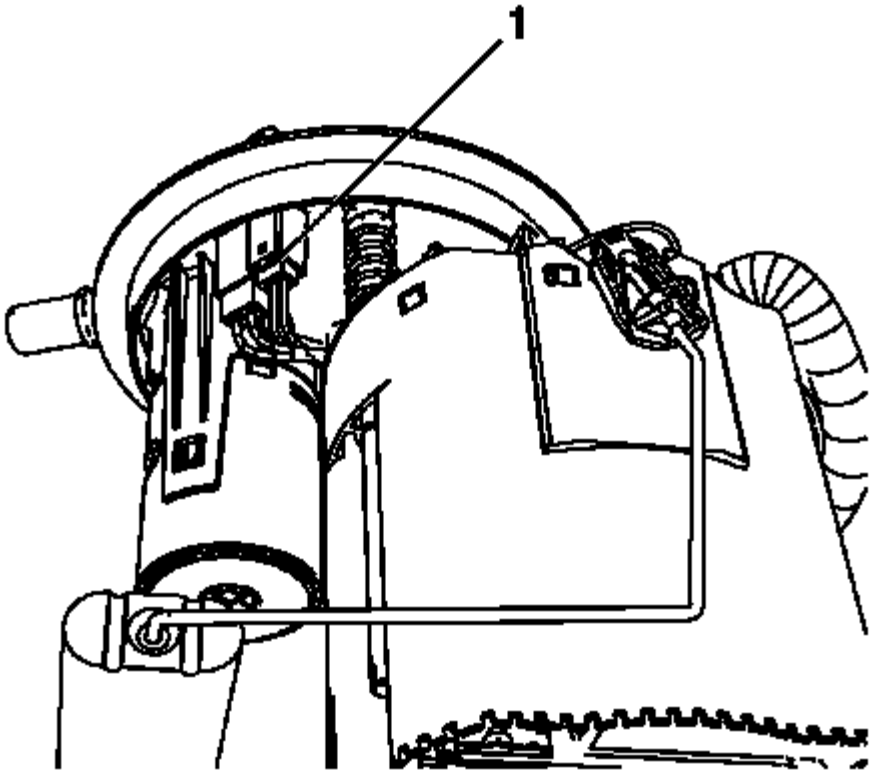

Fig. 104: View Of Fuel Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Push down on the fuel level sensor electrical connector tab (1), disengaging the retainer and disconnect the electrical connector.
3. Remove the fuel level sensor wiring from under the module clip (2).

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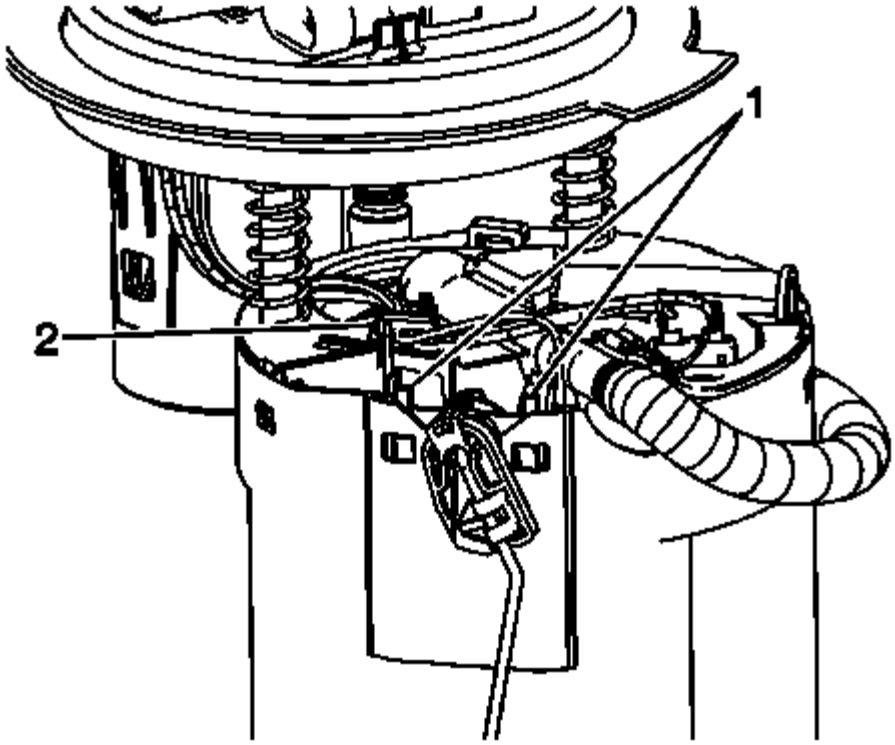

Fig. 105: View Of Module Wiring Clip
Courtesy of GENERAL MOTORS COMPANY

4. Push in the fuel level sensor tabs (1) disengaging the sensor clips from the module bucket.
5. Slide the fuel level sensor up out from the module bucket.

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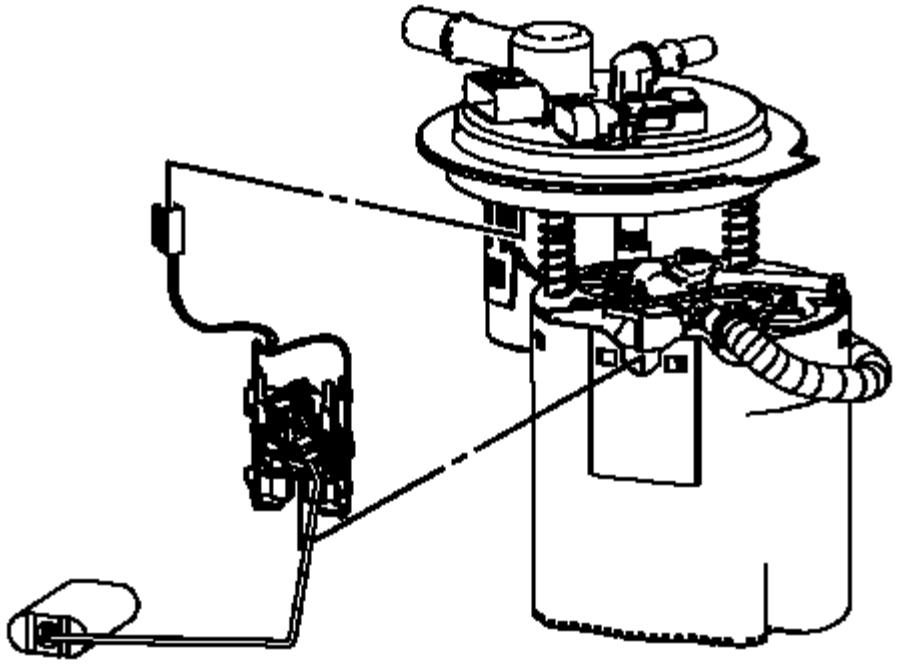

Fig. 106: Identifying Fuel Module Bucket
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Position the fuel level sensor to the module bucket and slide the sensor down.

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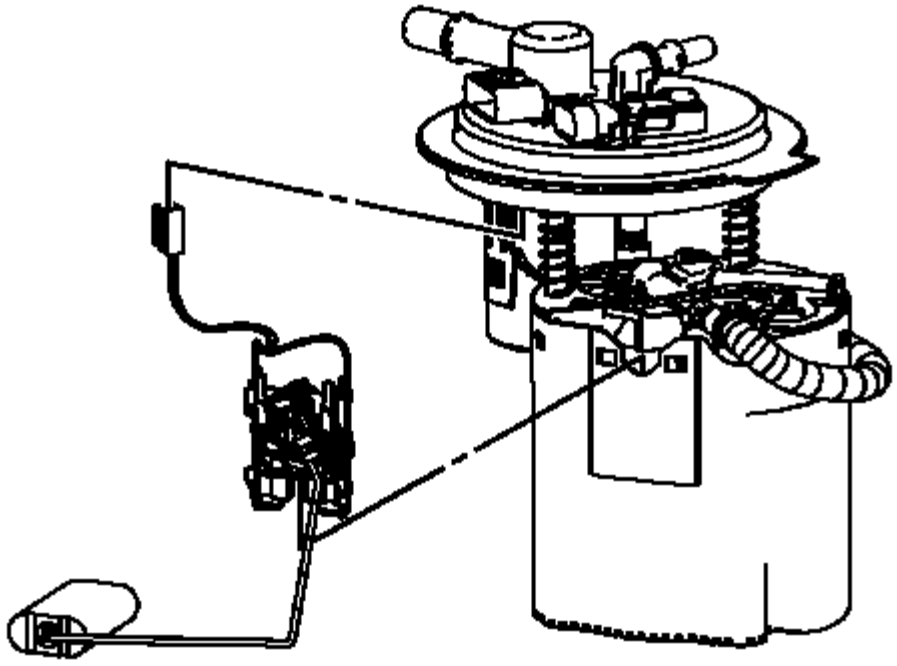

Fig. 107: Identifying Fuel Module Bucket
Courtesy of GENERAL MOTORS COMPANY

2. Ensure that the fuel level sensor tabs (1) engage the module bucket.

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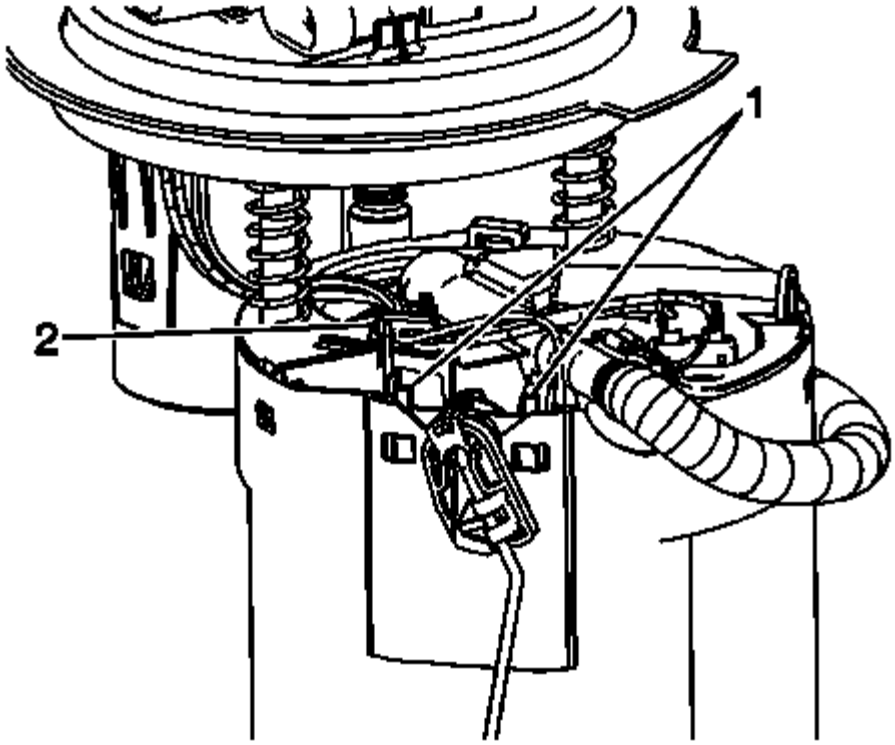

Fig. 108: View Of Module Wiring Clip
Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel level sensor wiring under the module clip (2).
4. Connect the fuel level sensor electrical connector (1) to the module cover.

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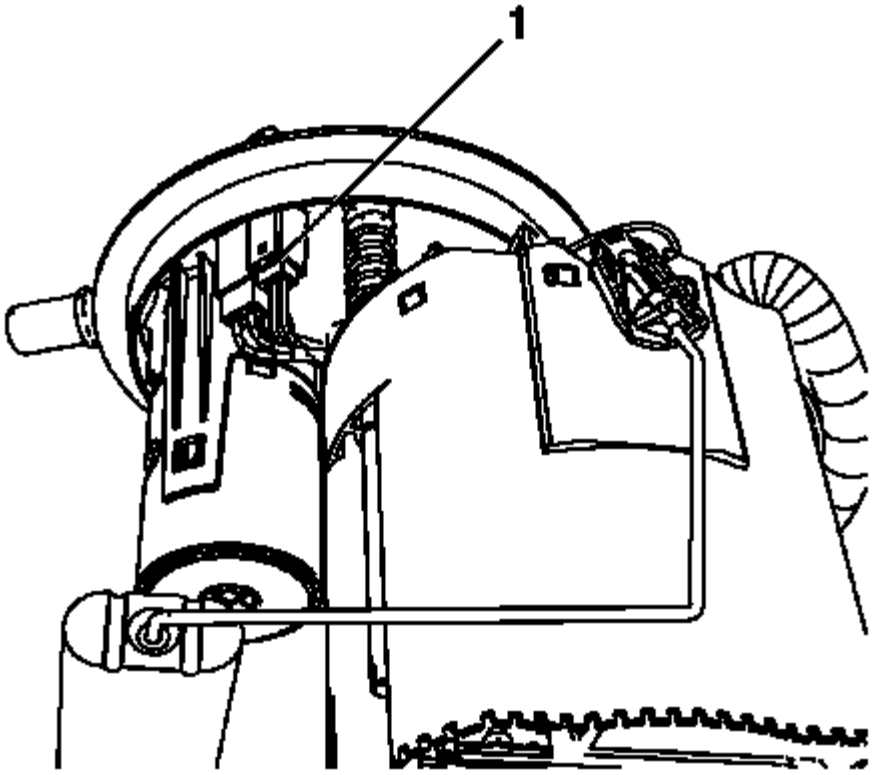

Fig. 109: View Of Fuel Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Install the fuel tank module. Refer to **Fuel Tank Module Replacement**.

FUEL PUMP FUEL FEED HOSE REPLACEMENT

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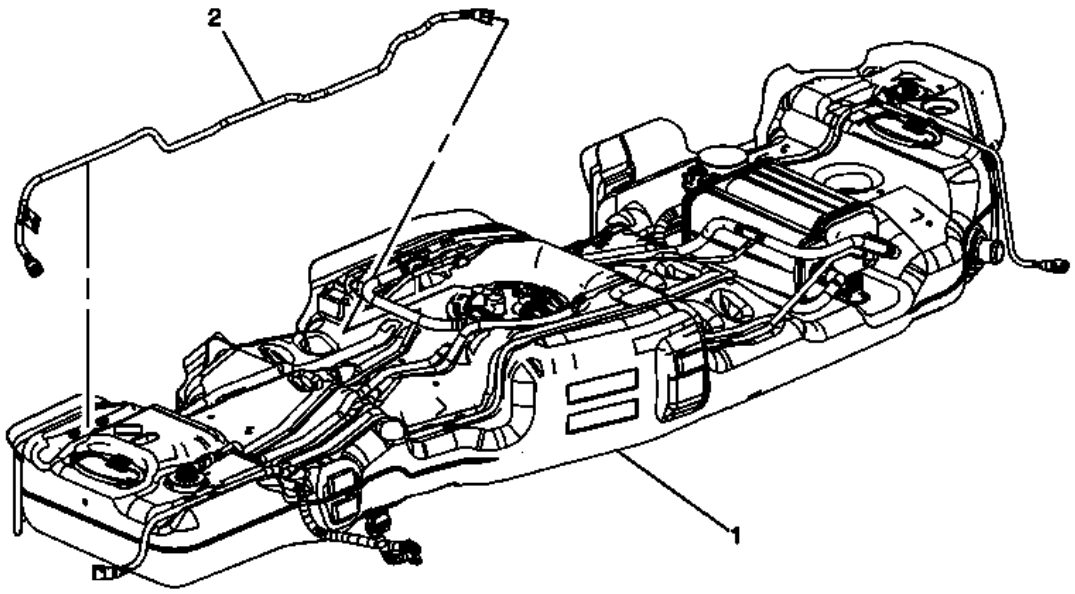

Fig. 110: View Of Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Fuel Feed Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the fuel tank. Refer to **Fuel Tank Replacement**. 2. Remove the foam pad insulators.	
1	Fuel Tank
2	Fuel Pump Fuel Feed Hose **Procedure** 1. Disconnect the quick connect fitting from the module. Refer to **Plastic Collar Quick Connect Fitting Service**. 2. Disengage from the tank retaining features. 3. When installing, route under the evaporative emission (EVAP) canister vent front pipe.

FUEL LINE REPLACEMENT - CHASSIS

Removal Procedure

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1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.

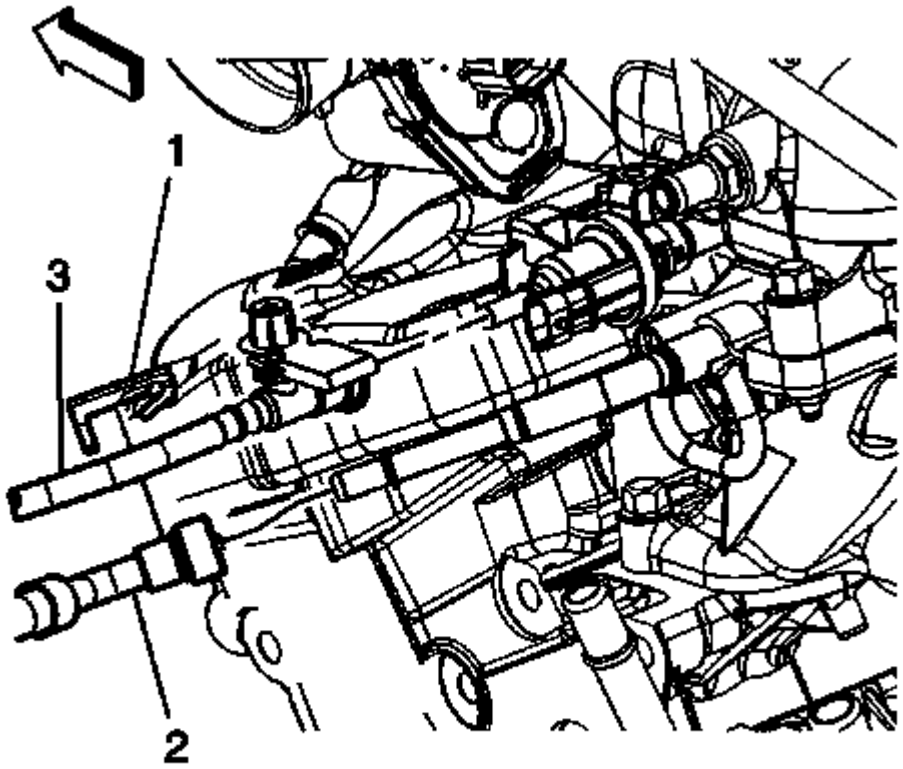

Fig. 111: View Of EVAP Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .
3. Remove air cleaner assembly. Refer to **Fuel Injector Sight Shield Replacement** .
4. Disconnect the brake pressure modulator valve from the body to provide clearance for the fuel pipes. Refer to **Brake Pressure Modulator Valve Replacement**
5. Disconnect the fuel feed pipe (2) quick connect fitting from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
6. Disconnect the evaporative emission (EVAP) pipe (3) quick connect fitting from the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Cap the fuel rail and the EVAP purge solenoid in order to prevent possible fuel and/or EVAP system contamination.
8. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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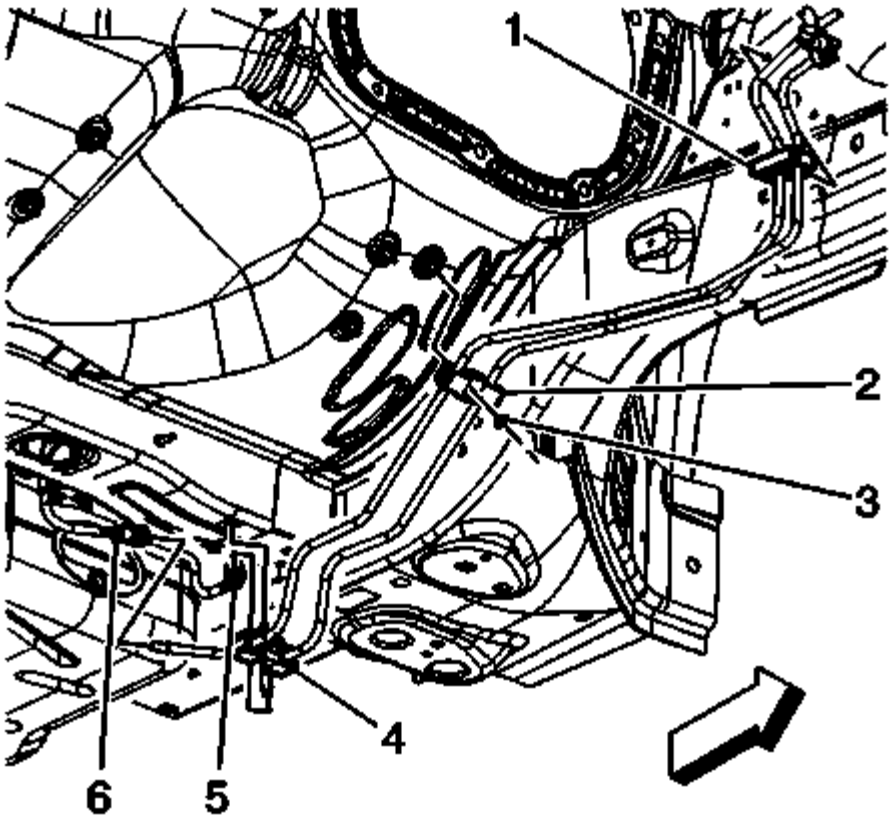

Fig. 112: View Of Fuel Tank Evaporative Emission Canister Vent Front Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

9. Remove the intermediate steering shaft. Refer to **Intermediate Steering Shaft Replacement** .
10. Disconnect the fuel pump fuel feed pipe quick connect fitting (6) from the chassis fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
11. Disconnect the EVAP canister vent front pipe quick connect fitting (5) from the chassis EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
12. Remove the fuel feed/EVAP pipe assembly clip (1) from the body.
13. Remove the fuel feed/EVAP pipe assembly clip nut (3) and clip (2) from the stud.
14. Loosen the fuel feed/EVAP pipe clip (4) bolt and remove the fuel feed/EVAP pipe assembly from the vehicle.
15. Mark the location of the retainers on the new pipes and remove the plastic retainers from the old pipes using a soapy solution.

Installation Procedure

1. Position the fuel feed and EVAP pipes to the vehicle individually and install the plastic retainers to the marked locations. Tighten the fuel feed/EVAP pipe clip (4) bolt to 8 N.m (71 lb in).

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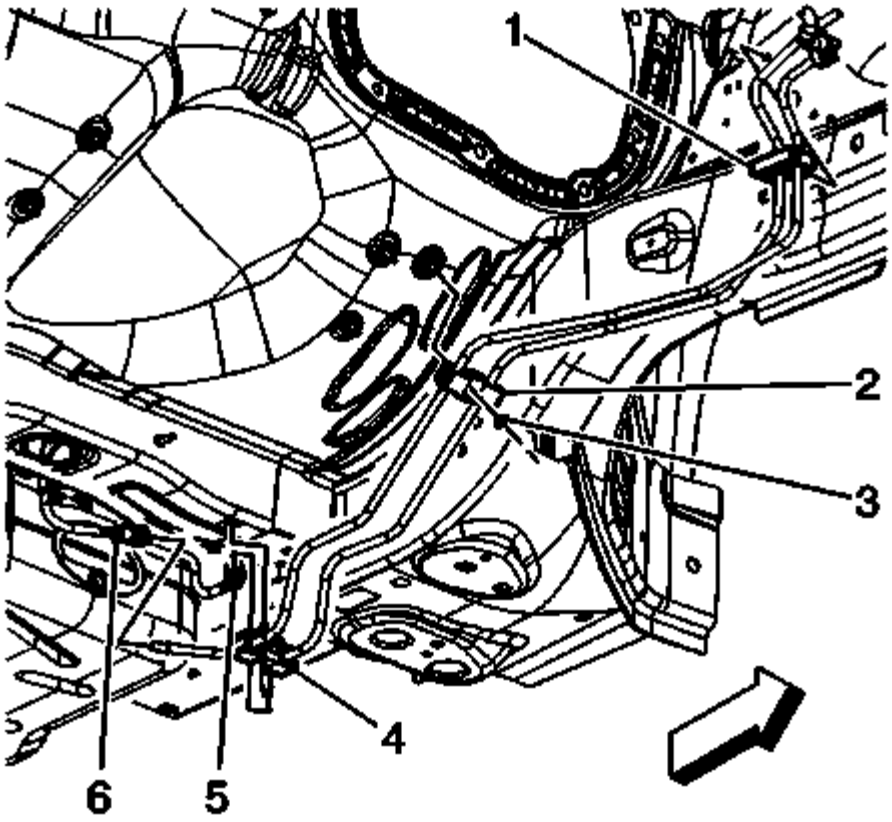

Fig. 113: View Of Fuel Tank Evaporative Emission Canister Vent Front Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution

2. Install the fuel feed/EVAP pipe clip (2) and nut (3) to the stud and tighten to 9 N.m (80 lb in).
3. Install the fuel feed/EVAP pipe clip (1) to the body.
4. Connect the EVAP canister vent front pipe quick connect fitting (5) to the chassis EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Connect the fuel pump fuel feed pipe quick connect fitting (6) to the chassis fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Install the intermediate steering shaft. Refer to **Intermediate Steering Shaft Replacement** .
7. Remove the caps from the fuel rail and the EVAP purge solenoid.

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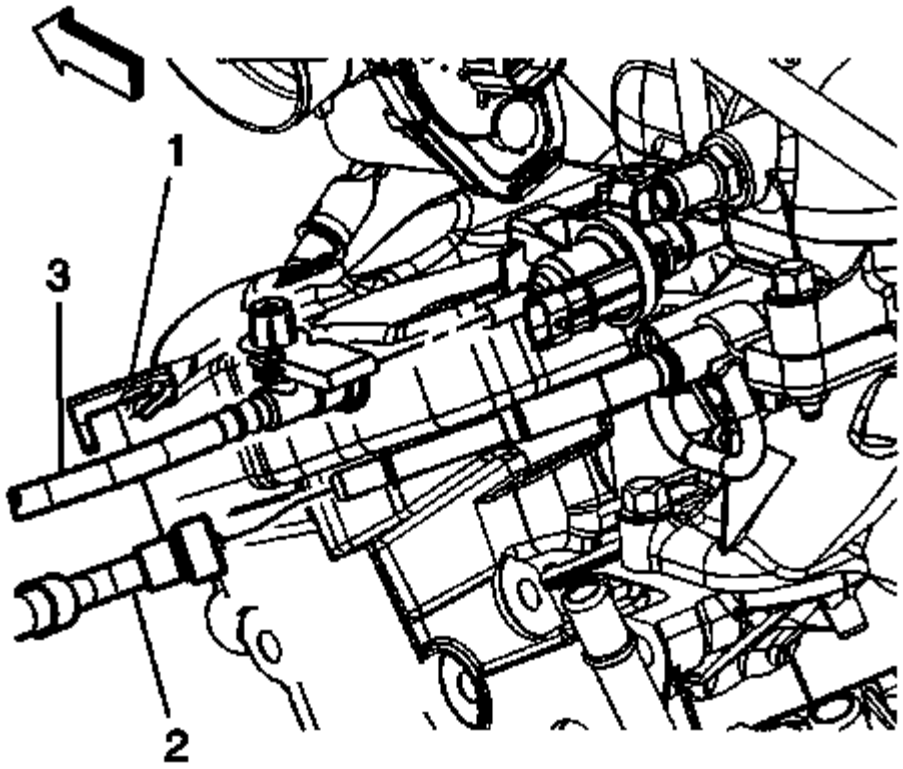

Fig. 114: View Of EVAP Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Connect the EVAP pipe (3) quick connect fitting to the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Connect the fuel feed pipe (2) quick connect fitting to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
10. Tighten the fuel fill cap.
11. Use the following procedure in order to inspect for leaks:
    - Turn the ignition ON, with the engine OFF, for 2 seconds.
    - Turn the ignition OFF for 10 seconds.
    - Turn the ignition ON, with the engine OFF.
    - Inspect for fuel leaks.
12. Reconnect the brake pressure modulator valve from the body to provide clearance for the fuel pipes. Refer to **Brake Pressure Modulator Valve Replacement**
13. Install the air cleaner assembly. Refer to **Fuel Injector Sight Shield Replacement** .
14. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

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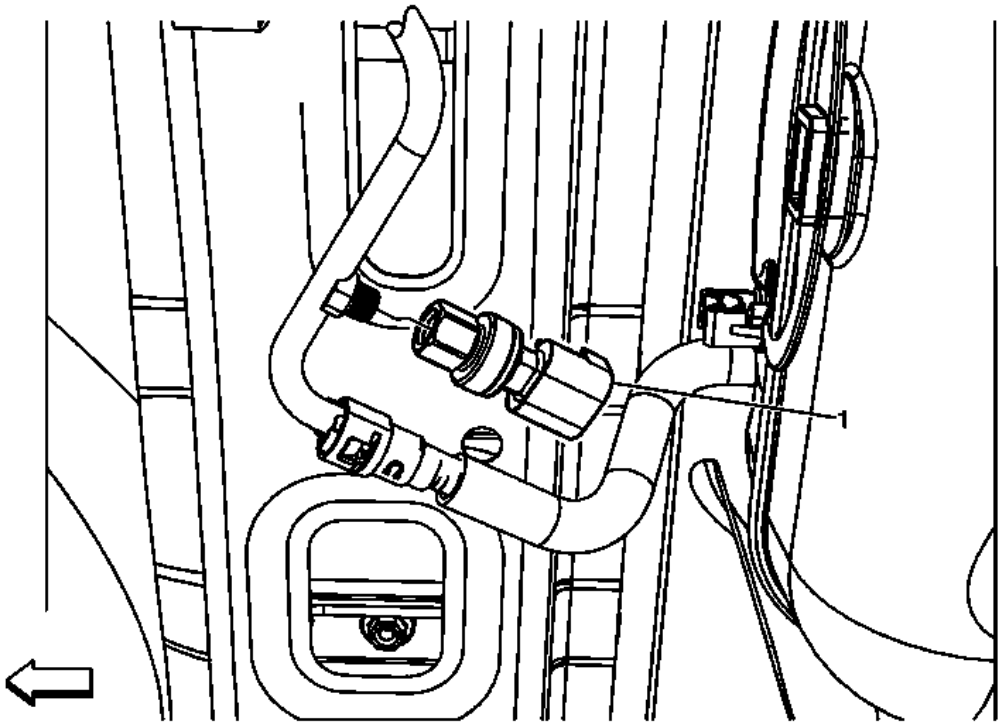

Fig. 115: Identifying Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Pressure Sensor Replacement - Fuel Feed Pipe

Callout	Component Name
Preliminary Procedure 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**	
1	Fuel Pressure Sensor **CAUTION:** **To avoid fuel system contamination clean the area where the sensor connects to the fuel line or fuel injection fuel rail before removing the sensor.** **Procedure** 1. Use a NEW O-ring seal. 2. Disconnect the electrical connector.

FUEL FEED PIPE REPLACEMENT (LLT)

Removal Procedure

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1. Remove the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement** .
2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve the low side fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
4. Disconnect the fuel feed line quick connect fitting from the fuel feed pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**.

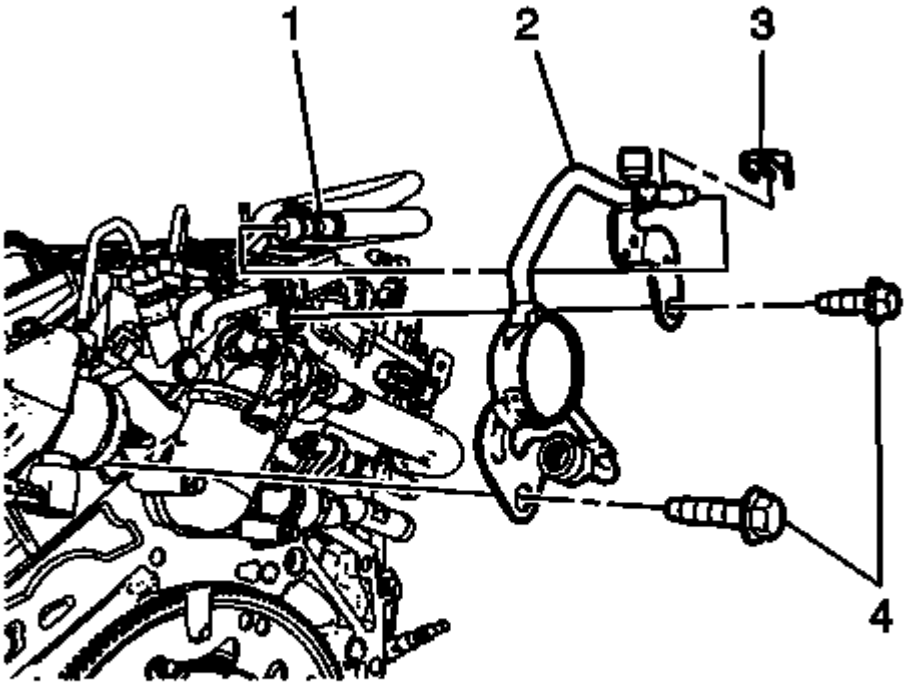

Fig. 116: Identifying Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the fuel feed pipe fitting to the high pressure fuel pump.
6. Remove the fuel feed pipe bolts (4) from the cylinder heads.
7. Remove the fuel feed pipe from the engine and high pressure fuel pump. Discard the pipe.

Installation Procedure

1. Ensure that the fuel feed pipe and fuel pump fittings are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
3. Position the NEW fuel feed pipe (2) to the cylinder head and high pressure fuel pump.

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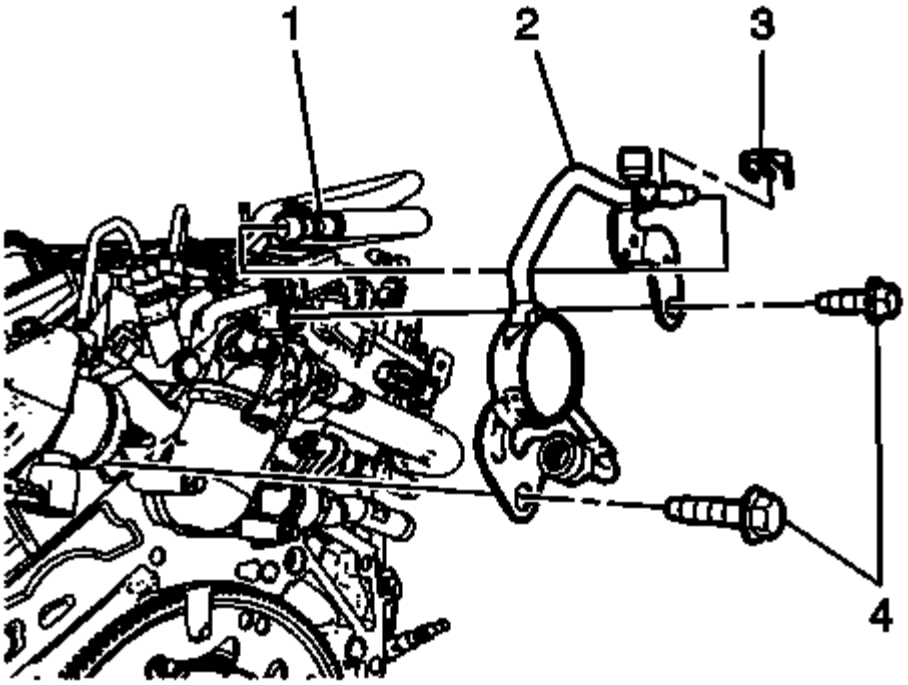

Fig. 117: Identifying Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS COMPANY

4. Install the fuel feed pipe fitting to the high pressure fuel pump hand tight.
5. Install the fuel feed pipe bolts (4).

CAUTION: Refer to Fastener Caution .

1. Tighten the bolts to 50 N.m (37 lb ft).
2. Tighten the fitting to 28 N.m (20 lb ft).

6. Connect the fuel feed line quick connect fitting to the fuel feed pipe (2). Refer to **Fuel Pipe Shield Replacement**.
7. Inspect for leaks using the following procedure:

NOTE: If a fuel leak accrues at the high pressure fuel pump, the pump will need to be replaced.

1. Turn ON the ignition, with the engine OFF for 2 seconds.

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2. Turn OFF the ignition, for 10 seconds.
3. Turn ON the ignition, with the engine OFF.
4. Inspect for fuel leaks.

8. Install the low side fuel pressure service port cap.
9. Install the fuel tank cap.
10. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
11. Install the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

FUEL SYSTEM CLEANING

IMPORTANT: If the fuel filter is plugged, the fuel tank should be inspected internally and cleaned if necessary.

1. Remove the fuel tank module. Refer to **Fuel Tank Module Replacement**.
2. Inspect the fuel pump module strainer. Replace the pump module assembly if the fuel strainer is contaminated.
3. Flush the fuel tank with hot water.

IMPORTANT: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water in accordance with all applicable local, state and federal laws and regulations.

4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to be sure that the removal of the water from the fuel tank is complete.
5. Allow the tank to dry completely before reassembly.
6. Disconnect the fuel feed pipe at the engine fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
7. Clean the fuel pipes by applying air pressure in the opposite direction of the fuel flow.

IMPORTANT: Only use oil-free compressed air to blow out the fuel pipes.

8. Connect the fuel feed pipe to the engine fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
9. Install the fuel tank module. Refer to **Fuel Tank Module Replacement**.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement**
3. Remove the foam insulator from the fuel rails.

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4. Disconnect the fuel pressure sensor electrical connector.

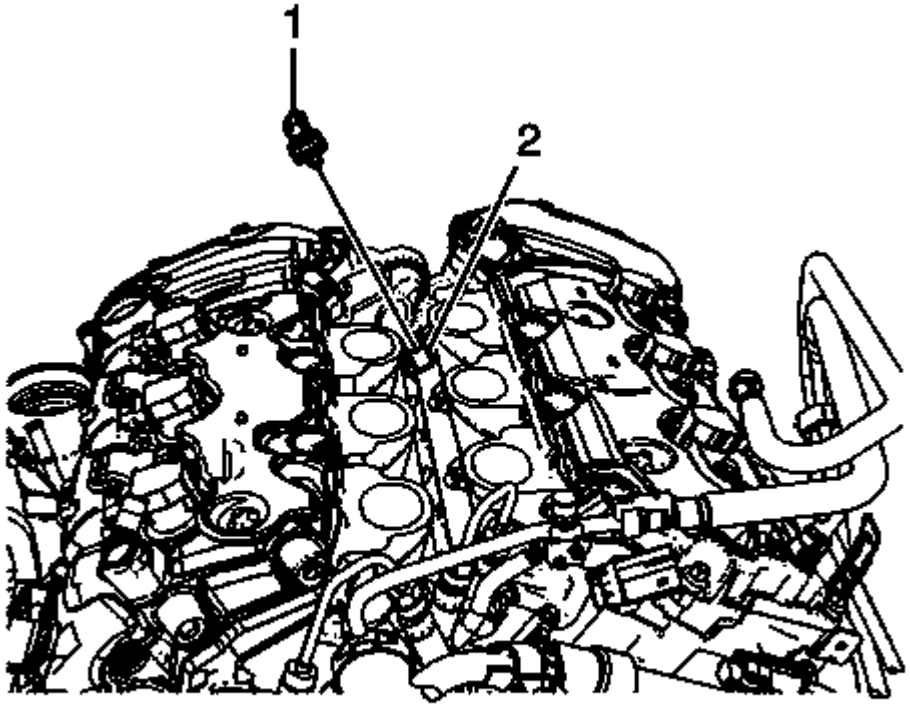

Fig. 118: Removing/Installing Fuel Pressure Sensor From Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

CAUTION: To avoid fuel system contamination clean the area where the sensor connects to the fuel line or fuel injection fuel rail before removing the sensor.

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

5. Using a 27 mm socket, remove the fuel pressure sensor (1) from the fuel injection fuel rail (2). Discard the fuel pressure sensor.
6. Allow any fuel to drain from the fuel rail and pressure sensor location.
7. Dry the sealing cone in the fuel rail and the area around the sensor joint with a lint free cloth.
8. Inspect the sealing cone in the fuel rail. The surface should be free of fuel, debris and burrs.

Installation Procedure

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NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

NOTE: Ensure that the fuel rail threads have been cleaned of any excess fuel or the NEW fuel injection fuel rail fuel pressure sensor will NOT seal properly.

1. Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
2. Lubricate the threads and sealing cone on the NEW fuel injection fuel rail fuel pressure sensor with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
3. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) hand tight.

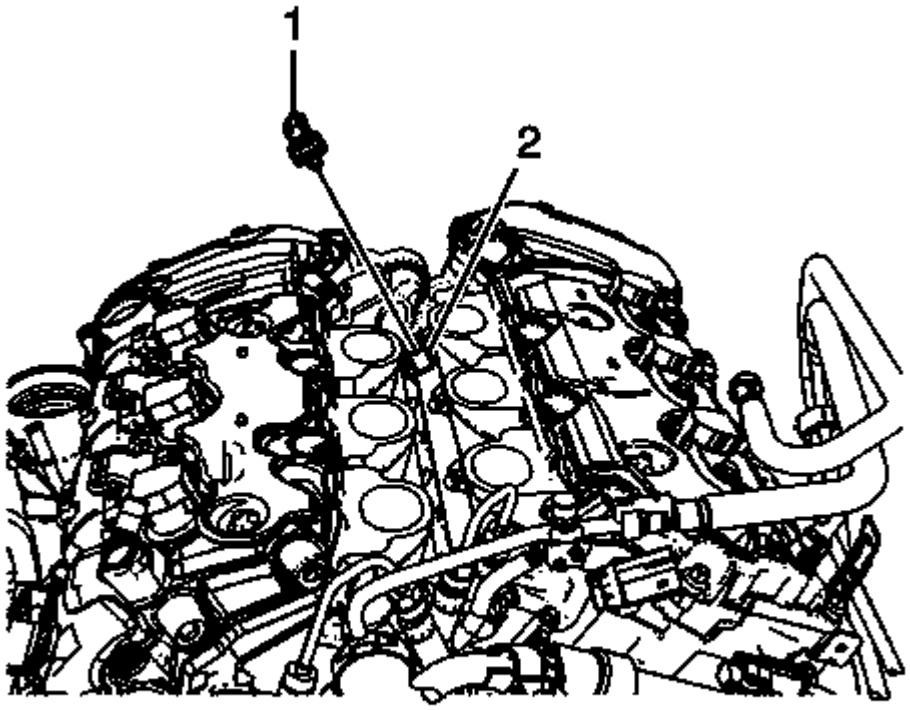

Fig. 119: Removing/Installing Fuel Pressure Sensor From Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

4. Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.
5. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) and tighten to 33 N.m (25 lb ft).

CAUTION: Refer to Fastener Caution

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6. Connect the fuel pressure sensor electrical connector.
7. Install the foam insulator from the fuel rails.
8. Install the intake manifold. Refer to **Intake Manifold Replacement**
9. Inspect for fuel leaks using the following procedure:

NOTE: If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

1. Turn ON the ignition, with the engine OFF for 2 seconds.
2. Turn OFF the ignition, for 10 seconds.
3. Turn ON the ignition, with the engine OFF.
4. Inspect for fuel leaks.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1 (LLT)

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the high pressure fuel pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
5. Remove the fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)**. Discard the pipe.
6. Remove the bank 2 fuel injection rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)**.
7. Remove the foam insulator from the fuel rails.
8. Disconnect the fuel pressure sensor electrical connector and cut the wire harness tie straps.

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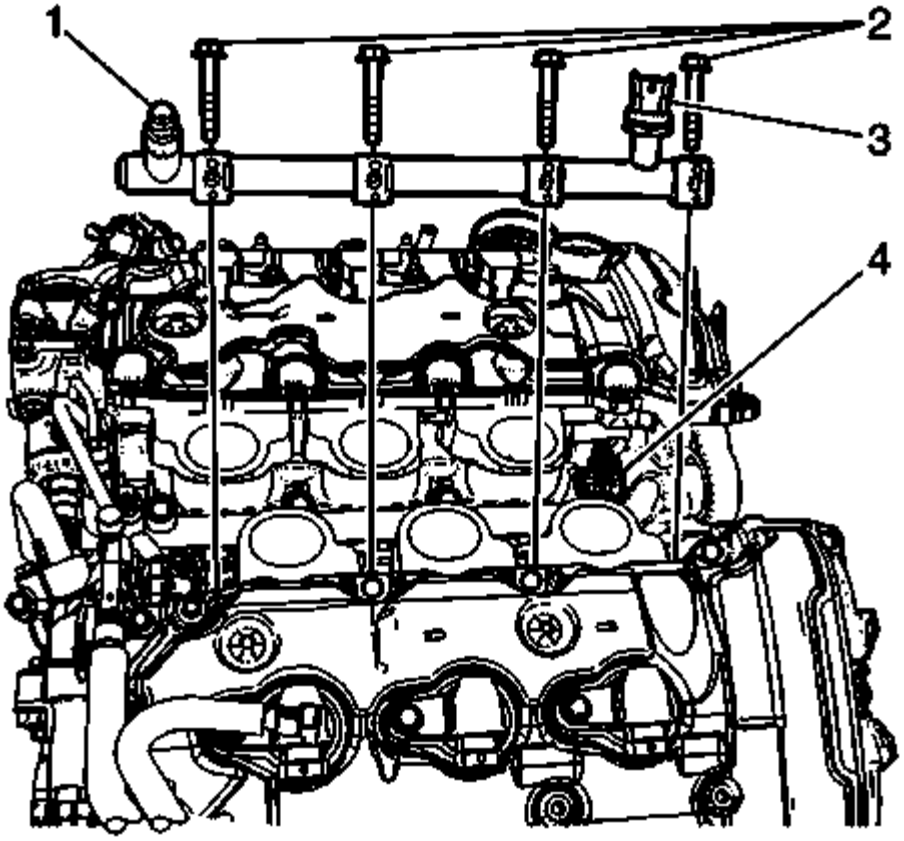

Fig. 120: Removing/Installing Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the fuel rail bolts (2) from both rails, for clearance purposes.
10. Remove the fuel pressure sensor (1). Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.

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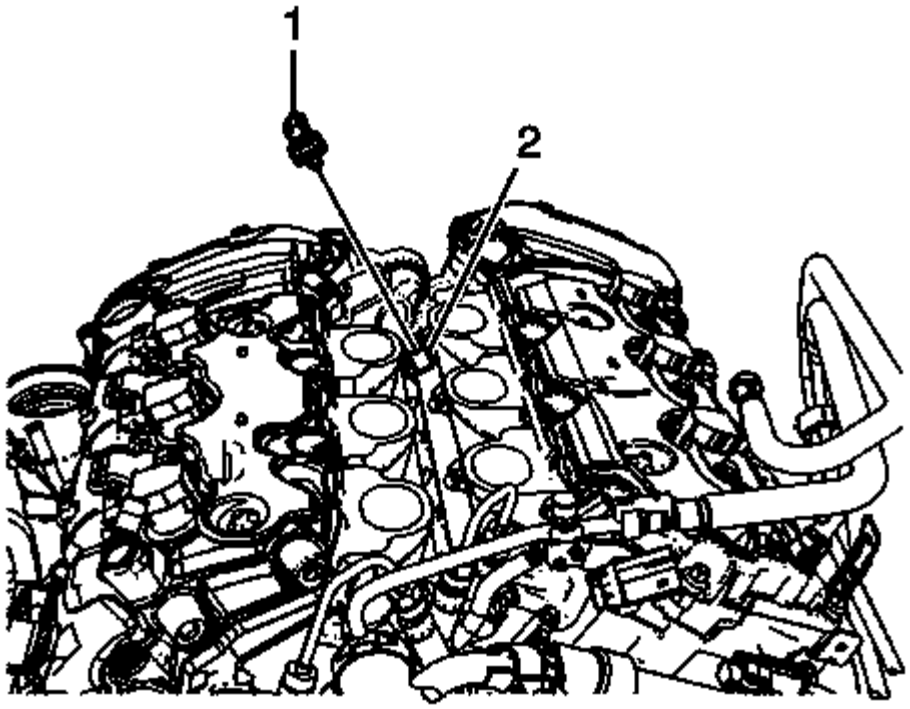

Fig. 121: Removing/Installing Fuel Pressure Sensor From Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

11. Remove the fuel rail from the cylinder head.
12. Remove and discard the direct fuel injector hold down clamps.
13. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Injector Replacement (LLT)**.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

Installation Procedure

1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to **Fuel Injector Replacement (LLT)**.

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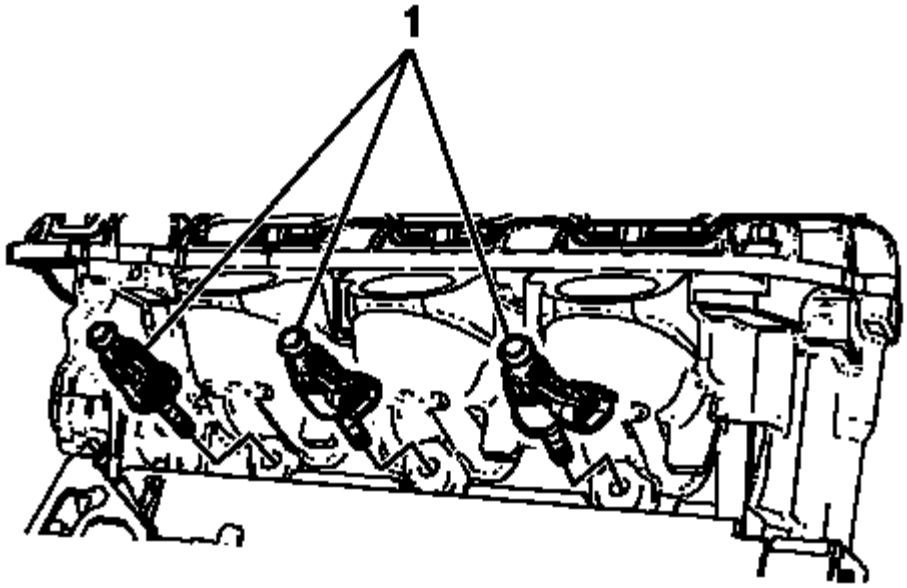

Fig. 122: Removing/Installing Rebuilt Direct Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

2. Install NEW direct injector hold down clamps to the injector.
3. On a new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.

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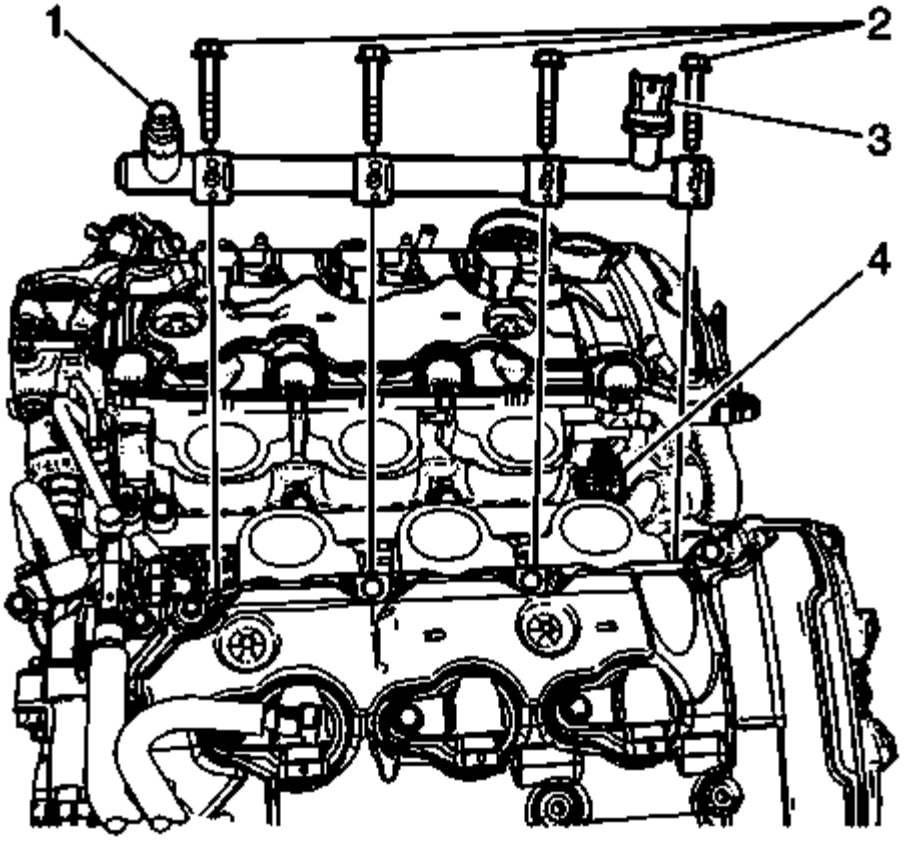

Fig. 123: Removing/Installing Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Carefully place the fuel rail (1) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts and hand tighten.
6. Install the bank 2 fuel injection rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)**.
7. Tighten the fuel rail bolts in the sequence shown:

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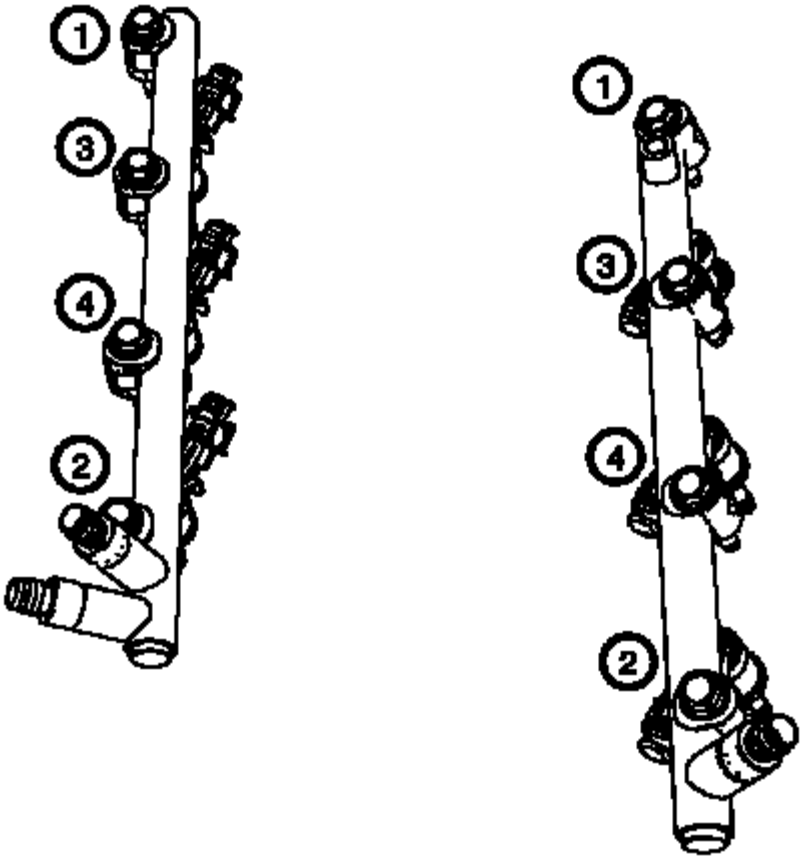

Fig. 124: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
2. Tighten the Bank 1 fuel rail bolts final pass to 23 N.m (17 lb ft).

8. Install a NEW fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)**.
9. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
10. Install the high pressure fuel sensor (1). Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.

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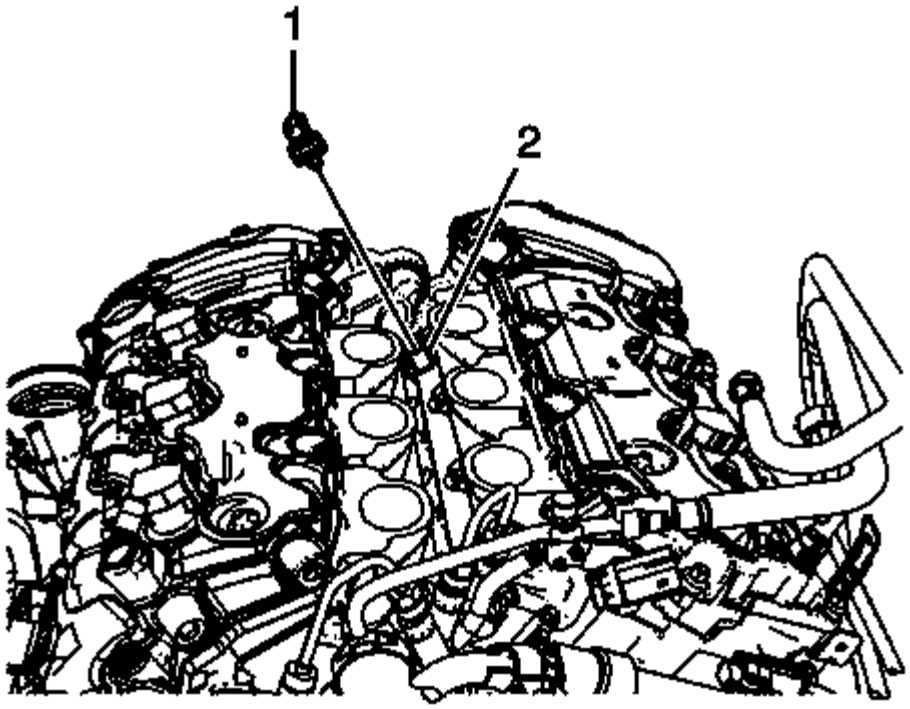

Fig. 125: Removing/Installing Fuel Pressure Sensor From Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

11. Connect the fuel injector wiring harness electrical connector (1) to the fuel injectors, fuel rail and fuel pressure sensor.
12. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
13. Install the foam insulator from the fuel rails.
14. Install the intake manifold. Refer to **Intake Manifold Replacement** .
15. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
16. Install the low side fuel pressure service port cap.
17. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2 (LLT)

Removal Procedure

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1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
3. Remove the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.

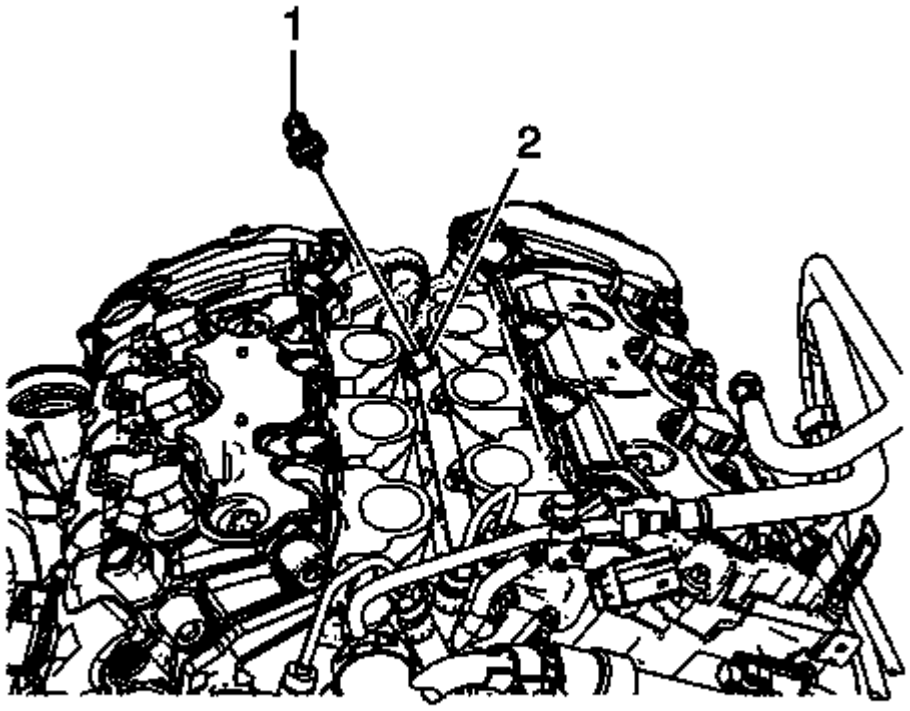

Fig. 126: Removing/Installing Fuel Pressure Sensor From Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

4. Remove the high pressure fuel pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
5. Remove the crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)**. Discard this pipe.
6. Remove the fuel rail bolts (1) from both rails for clearances purposes.

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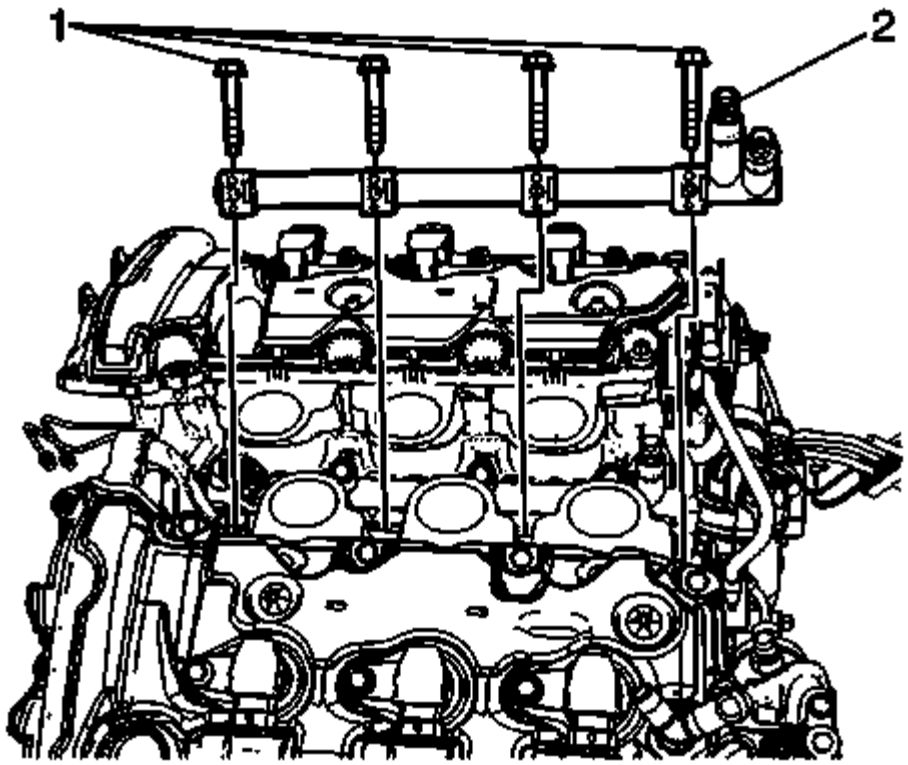

Fig. 127: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Carefully remove the Bank 2 fuel rail (2) from the engine. Lift the rear of the rail to ease removal.
8. Remove and discard the direct fuel injector hold down clamps.
9. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection** .

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

Installation Procedure

1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to **Fuel Rail and Injectors Cleaning and Inspection** .

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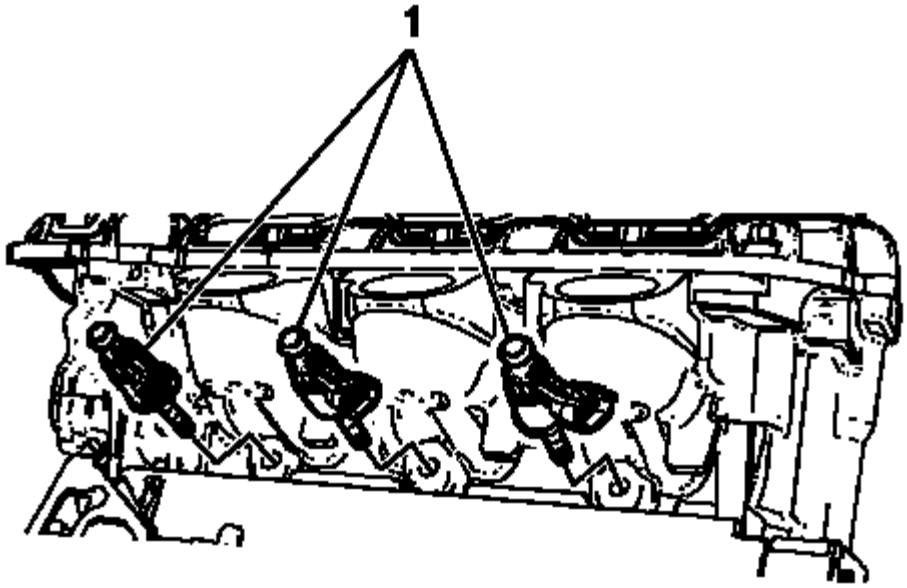

Fig. 128: Removing/Installing Rebuilt Direct Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

2. Install new direct injector hold down clamps to the injectors.
3. On the new fuel rail, lubricate the fuel injector cups with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants and Sealers**

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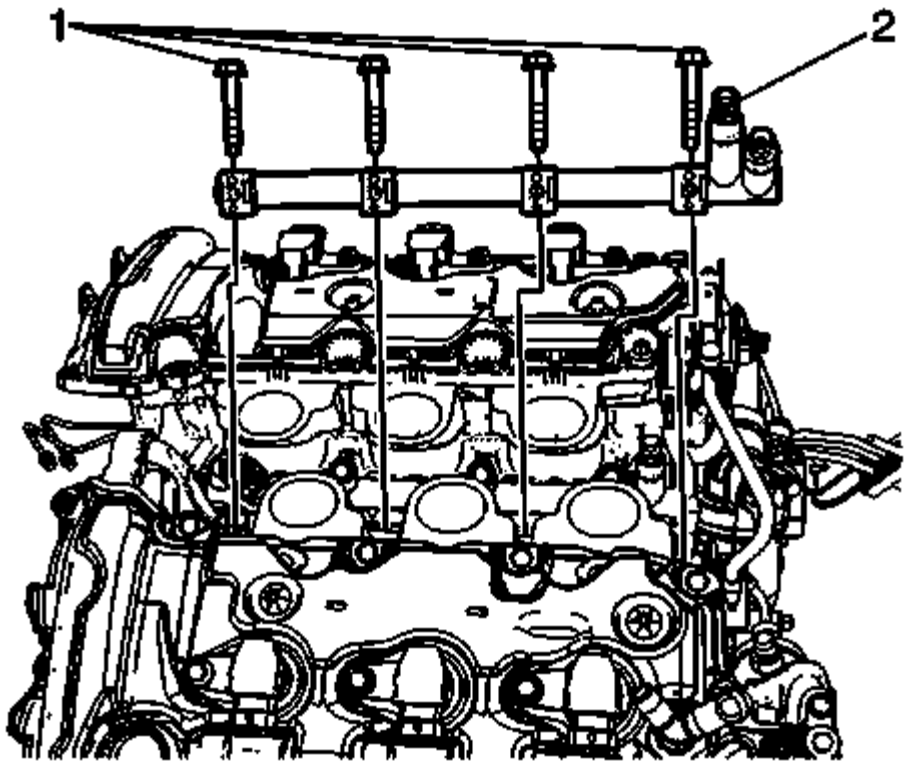

Fig. 129: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Carefully place the fuel rail (2) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts and hand tighten.
6. Tighten the fuel rail bolts in the sequence shown:

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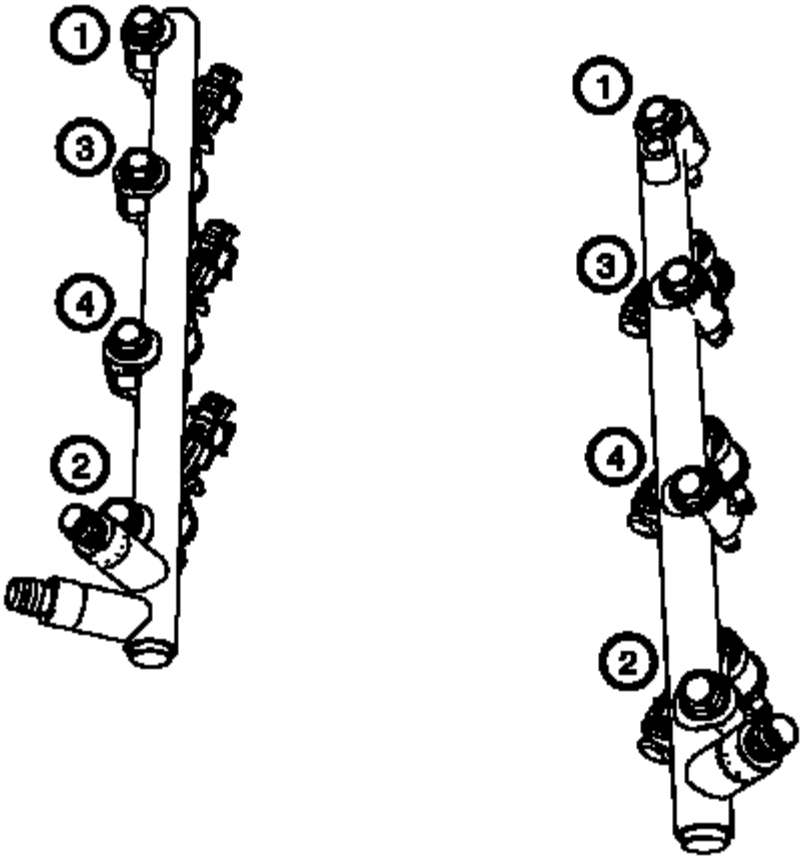

Fig. 130: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
2. Tighten the Bank 1 fuel rail bolts a final pass to 23 N.m (17 lb ft).

7. Install a NEW fuel rail crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)**.
8. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
9. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.

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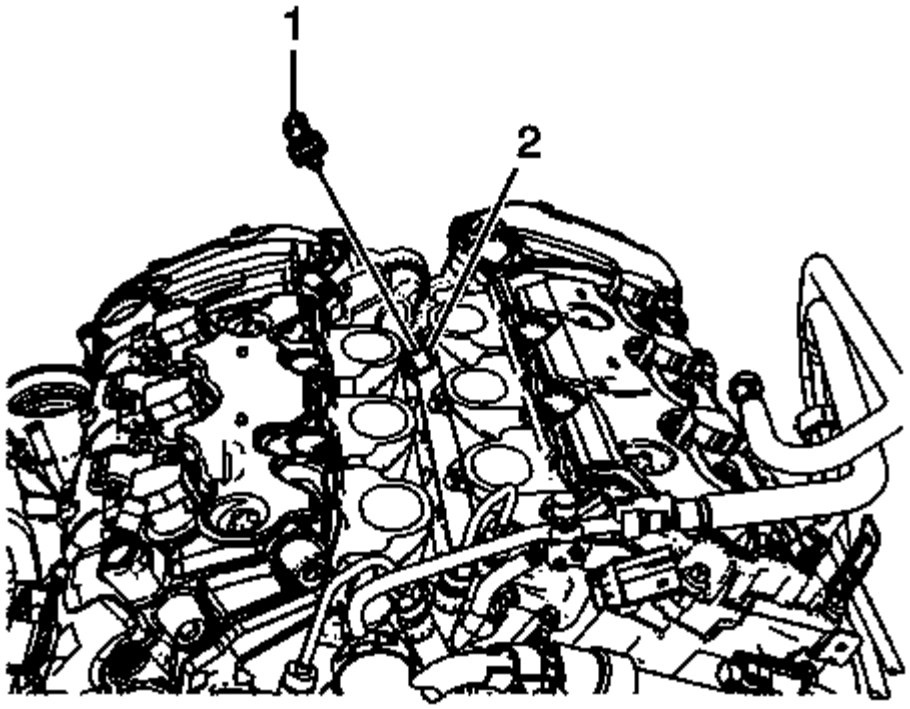

Fig. 131: Removing/Installing Fuel Pressure Sensor From Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

10. Connect the fuel injector wiring harness electrical connector (1) from the fuel injectors, fuel rail and fuel pressure sensor.
11. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
12. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
13. Install the low side fuel pressure service port cap.
14. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL CROSSOVER TUBE REPLACEMENT (LLT)

Removal Procedure

1. Remove the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

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2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
4. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (2).

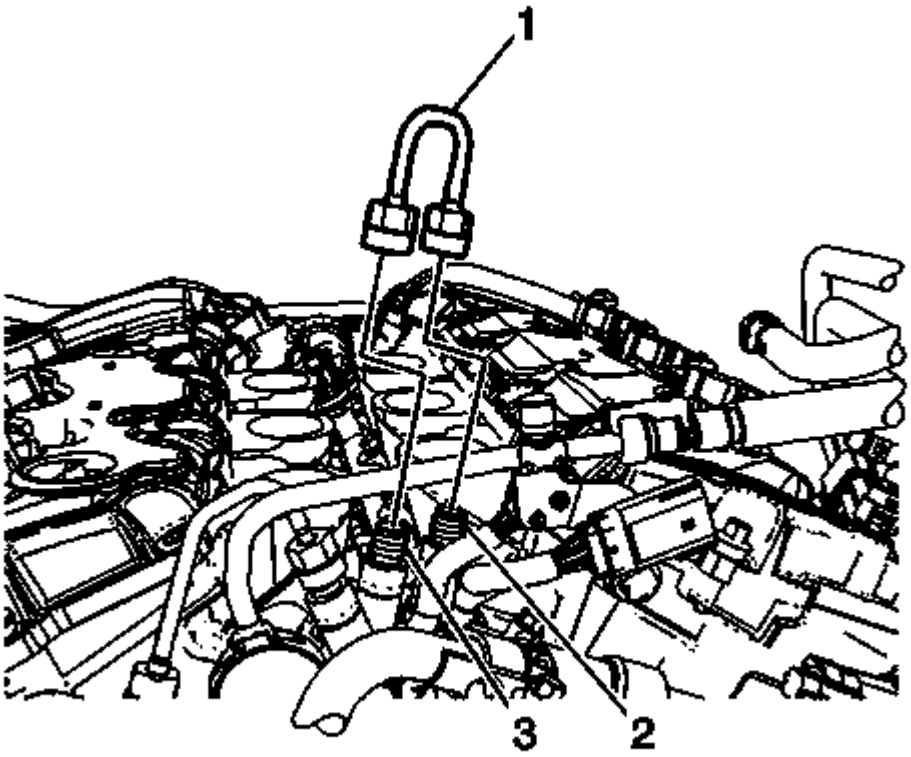

Fig. 132: Identifying Fuel Rail Crossover Pipe & Right Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the fuel rail crossover pipe (1) fitting to the left fuel rail (3).
6. Remove the fuel rail crossover pipe (1) from the vehicle. Discard the pipe.

Installation Procedure

1. Ensure that the fuel rail crossover pipe, right fuel rails fittings and left fuel rail fittings are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
3. Position the fuel rail crossover pipe (1) to the right fuel rails fitting (2) and left fuel rail fitting (3).

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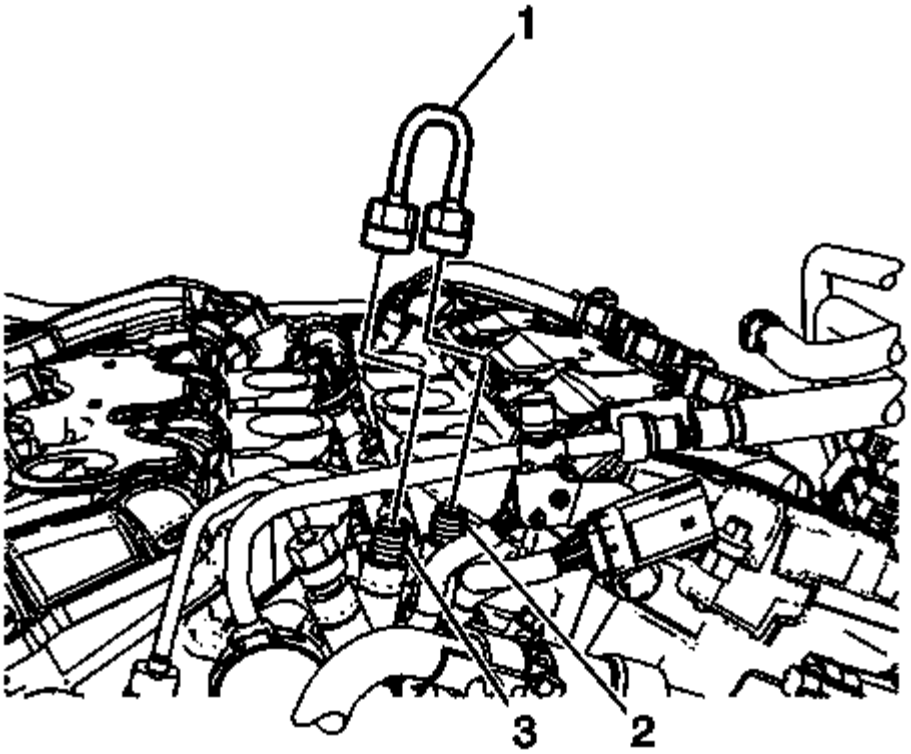

Fig. 133: Identifying Fuel Rail Crossover Pipe & Right Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

4. Tighten the fuel rail crossover pipe fittings.

CAUTION: Refer to Fastener Caution .

1. Tighten the fittings first pass to 16 N.m (12 lb ft).
2. Tighten the fittings final pass to 32 N.m (24 lb ft).

5. Inspect for leaks using the following procedure:

NOTE: If a fuel leak accrues at the right fuel rail fitting (2) or left fuel rail fitting (3), that component will need to be replaced.

1. Turn ON the ignition, with the engine OFF for 2 seconds.
2. Turn OFF the ignition, for 10 seconds.
3. Turn ON the ignition, with the engine OFF.
4. Inspect for fuel leaks.

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6. Install the low side fuel pressure service port cap.
7. Install the fuel tank cap.
8. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
9. Install the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

FUEL FEED INTERMEDIATE PIPE REPLACEMENT (LLT)

Removal Procedure

1. Remove the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement** .
2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
4. Remove the foam insulator from the pipes.

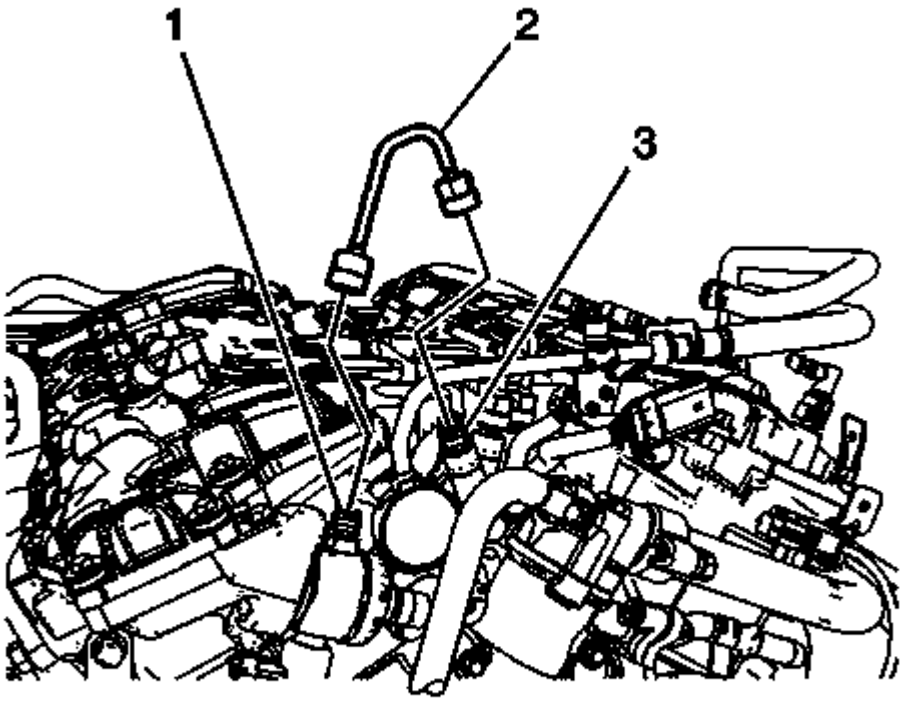

Fig. 134: Identifying High Pressure Pipe Fitting, Left Fuel Rail & High Pressure Fuel Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the high pressure pipe fitting to the high pressure fuel pump (1).

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6. Loosen the high pressure pipe fitting to the left fuel rail (3).
7. Remove the high pressure fuel pipe (2) from the vehicle. Discard the pipe.

Installation Procedure

1. Ensure that the NEW high pressure fuel pipe, fuel rail fitting and fuel pump fitting are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
3. Position the NEW high pressure fuel pipe (2) to the high pressure fuel pump fitting (1) and left fuel rail (3). hand tighten the fitting.

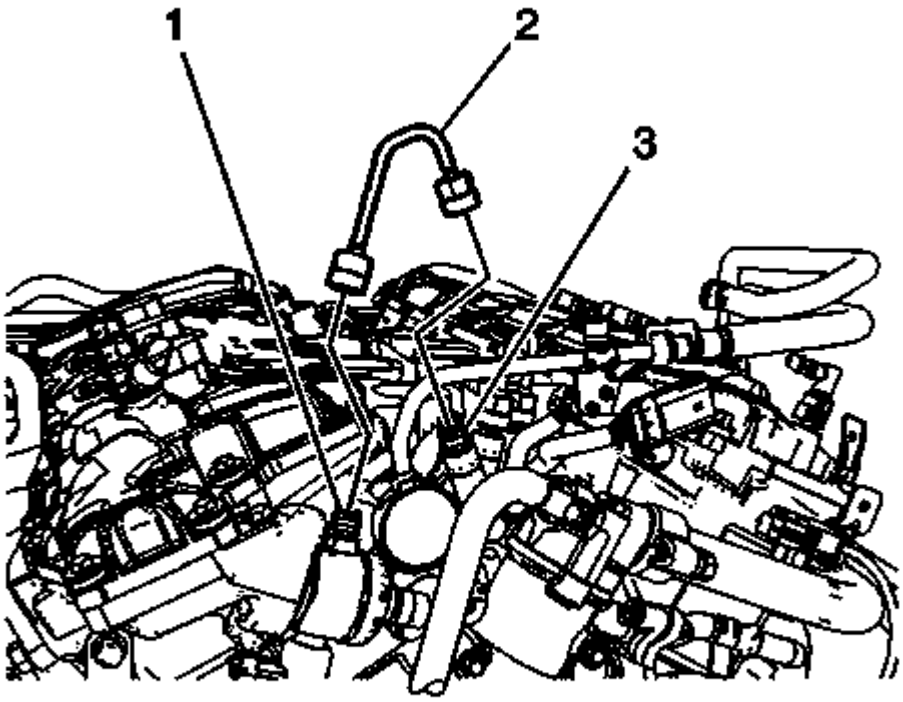

Fig. 135: Identifying High Pressure Pipe Fitting, Left Fuel Rail & High Pressure Fuel Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Tighten the high pressure fuel pipe fitting.

CAUTION: Refer to Fastener Caution .

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1. Tighten the fitting a first pass to 16 N.m (12 lb ft).
2. Tighten the fitting a final pass to 32 N.m (24 lb ft).

5. Inspect for leaks using the following procedure:

NOTE: If a fuel leak accrues at the high pressure fuel pump or the fuel rail, that component will need to be replaced.

1. Turn ON the ignition, with the engine OFF for 2 seconds.
2. Turn OFF the ignition, for 10 seconds.
3. Turn ON the ignition, with the engine OFF.
4. Inspect for fuel leaks.

6. Install the low side fuel pressure service port cap.
7. Install the fuel tank cap.
8. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
9. Install the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

FUEL PIPE SHIELD REPLACEMENT

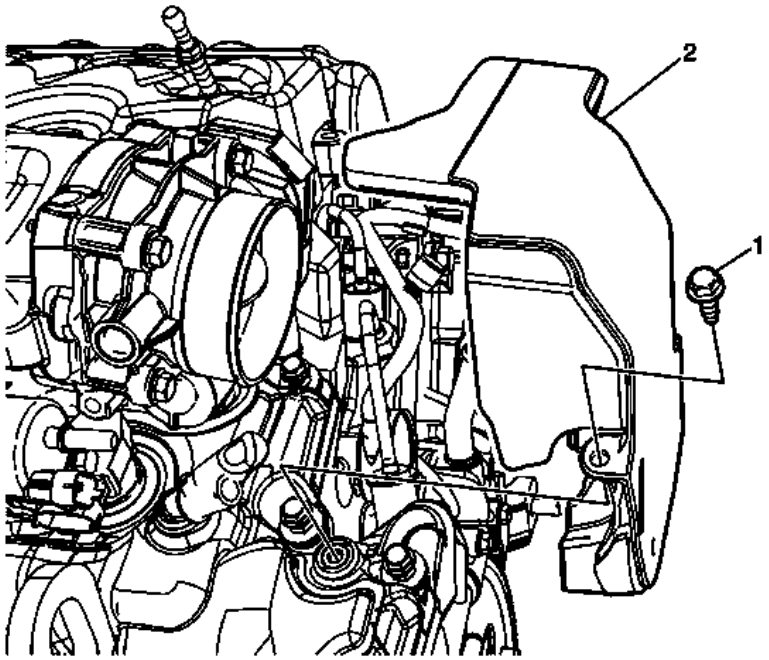

Fig. 136: View Of Fuel Pipe Shield
Courtesy of GENERAL MOTORS COMPANY

Fuel Pipe Shield Replacement

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Callout	Component Name
Preliminary Procedures 1. Remove the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement** . 2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.	
1	Fuel Pump Shield Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10Y (89 lb in)
2	Fuel Pump Shield

FUEL PUMP REPLACEMENT (LLT)

Special Tools

EN-48896 High Pressure Fuel Pump Installation Alignment Gauge

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
2. Remove the thermostat housing. Refer to **Engine Coolant Thermostat Replacement** .
3. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.

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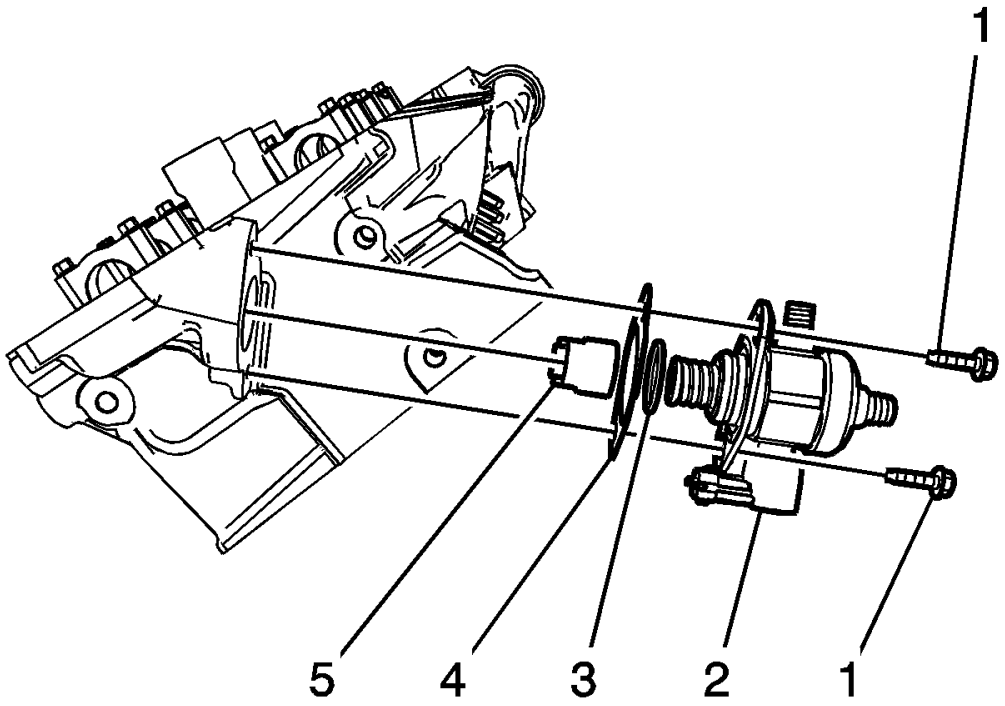

Fig. 137: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

4. Remove the low pressure feed pipe. Discard the pipe. Refer to **Fuel Feed Pipe Replacement (LLT)**.
5. Remove the high pressure pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**. Discard this pipe.
6. Remove and discard the high pressure fuel pump bolts (1).
7. Remove the high pressure fuel pump (2).
8. Remove and discard the high pressure fuel pump O-ring (3).
9. Remove and discard the high pressure fuel pump gasket (4).
10. Remove the high pressure fuel pump roller lifter (5).

Installation Procedure

1. Use the **EN-48896** alignment gauge to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head.

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NOTE: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube GM P/N 12345501 (Canadian P/N 992704) or equivalent.
3. Install the high pressure fuel pump roller lifter (5).

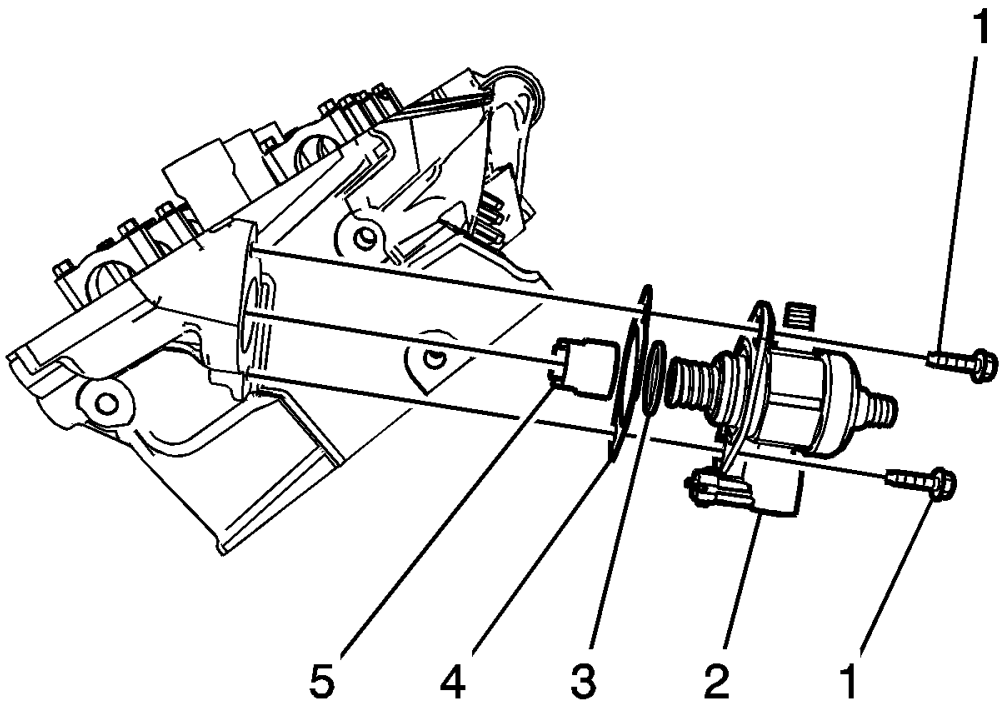

Fig. 138: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.

4. Install a NEW high pressure fuel pump O-ring (3).
5. Position the NEW high pressure fuel pump gasket (4) and bolts (1) to the fuel pump.
6. Install the high pressure fuel pump (2). Force will be required while hand tightening the bolts.
7. Tighten the high pressure fuel pump retaining bolts to 15 (11 lb ft).

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CAUTION: Refer to Fastener Caution .

8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
9. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
10. Install a NEW fuel feed pipe to the high pressure fuel pump. Refer to **Fuel Feed Pipe Replacement (LLT)**.
11. Connect the high pressure fuel pump wiring harness.
12. Install the thermostat housing. Refer to **Engine Coolant Thermostat Replacement** .
13. Install the fuel tank cap.
14. Inspect for leaks using the following procedure:

NOTE: If a fuel leak occurs at the fuel rail, the fuel rail will need to be replaced.

1. Turn ON the ignition, with the engine OFF for 2 seconds.
2. Turn OFF the ignition, for 10 seconds.
3. Turn ON the ignition, with the engine OFF.
4. Inspect for fuel leaks.

15. Install the pressure relief cap to the fuel feed pipe.

FUEL INJECTOR REPLACEMENT (LLT)

Removal Procedure

1. Relieve the high side fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.
2. Remove the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LLT)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)**.

NOTE: The fuel injectors have an alignment feature, note the position of the injectors alignment for installation.

3. For removal of the fuel injectors, refer to **Fuel Rail and Injectors Cleaning and Inspection** .

Installation Procedure

1. Prepare the fuel injectors for assembly, refer to **Fuel Rail and Injectors Cleaning and Inspection** .
2. Install the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LLT)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)**.

NOTE: The fuel injectors have an alignment feature and must be reinstalled as noted during removal.

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3. Pressure up the fuel system and check for leaks.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

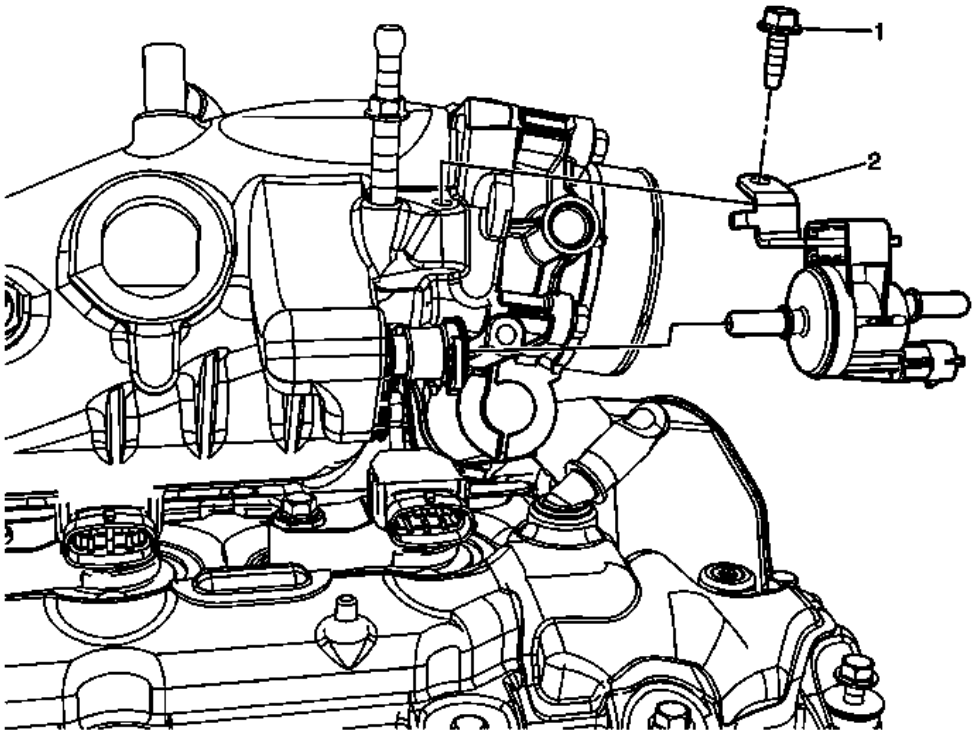

Fig. 139: View Of Evaporative Emission Canister Purge Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure Disconnect the canister purge tube quick connect fittings from the purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.	
1	Evaporative Emission Canister Purge Solenoid Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Evaporative Emission Canister Purge Solenoid Valve **Procedure** Disconnect the electrical connector.

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EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

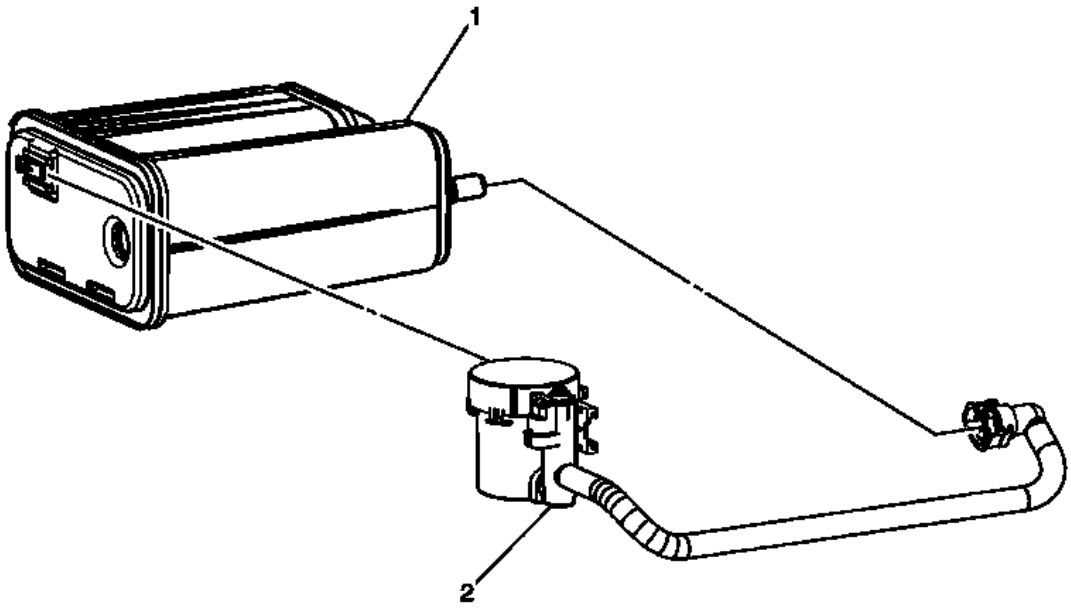

Fig. 140: Identifying Evaporative Emission Canister Vent Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Vent Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure Remove the evaporative emission (EVAP) canister. Refer to **Evaporative Emission Canister Replacement**.	
1	Evaporative Emission Canister
2	Evaporative Emission Canister Vent Solenoid Valve Hose **Procedure** 1. Disconnect the quick connect fitting at the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**. 2. Push in the retainer on the rear of the EVAP canister disengaging the vent solenoid valve.

EVAPORATIVE EMISSION LINE REPLACEMENT - CHASSIS TO CANISTER

Removal Procedure

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1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH-48027)**, **Fuel Pressure Relief (Without CH-48027)**, **Fuel Pressure Relief (High Side)**.

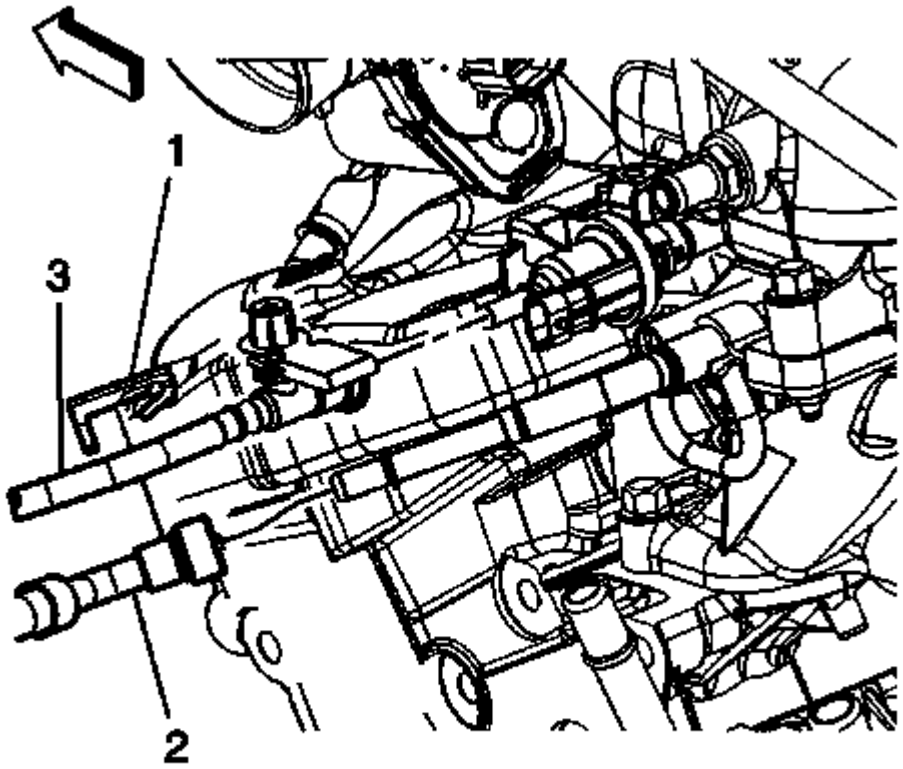

Fig. 141: View Of EVAP Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .
3. Remove the intermediate steering shaft. Refer to **Intermediate Steering Shaft Replacement** .
4. Disconnect the fuel feed pipe (2) quick connect fitting from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
5. Disconnect the evaporative emission (EVAP) pipe (3) quick connect fitting from the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Cap the fuel rail and the EVAP purge solenoid in order to prevent possible fuel and/or EVAP system contamination.
7. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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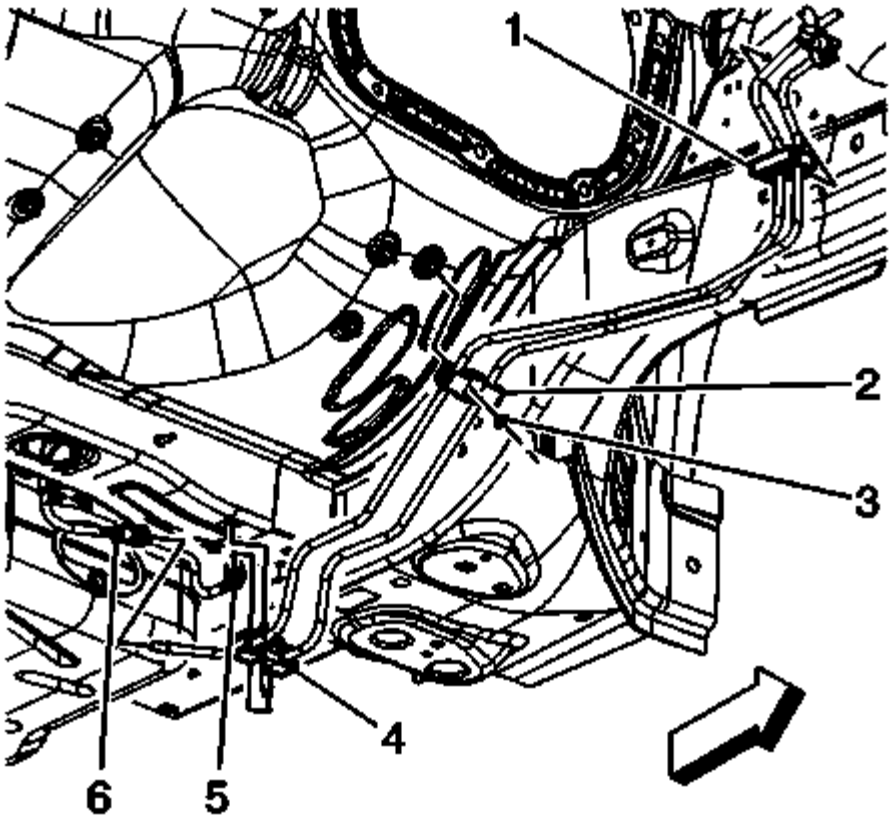

Fig. 142: View Of Fuel Tank Evaporative Emission Canister Vent Front Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the fuel pump fuel feed pipe quick connect fitting (6) from the chassis fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Disconnect the EVAP canister vent front pipe quick connect fitting (5) from the chassis EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
10. Remove the fuel feed/EVAP pipe assembly clip (1) from the body.
11. Remove the fuel feed/EVAP pipe assembly clip nut (3) and clip (2) from the stud.
12. Loosen the fuel feed/EVAP pipe clip (4) bolt and remove the fuel feed/EVAP pipe assembly from the vehicle.

Installation Procedure

1. Position the fuel feed/EVAP pipe assembly to the vehicle and tighten the fuel feed/EVAP pipe clip (4) bolt.

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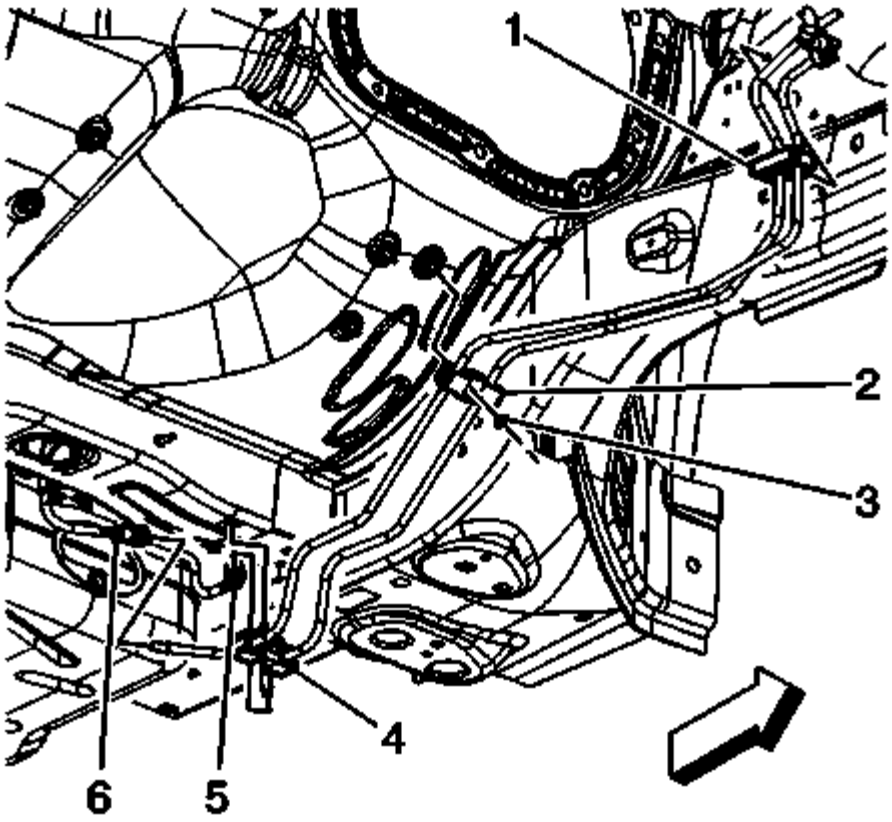

Fig. 143: View Of Fuel Tank Evaporative Emission Canister Vent Front Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 8 N.m (71 lb in).

2. Install the fuel feed/EVAP pipe clip (2) and nut (3) to the stud.

Tighten

Tighten the nut to 9 N.m (80 lb in).

3. Install the fuel feed/EVAP pipe clip (1) to the body.
4. Connect the EVAP canister vent front pipe quick connect fitting (5) to the chassis EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.

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5. Connect the fuel pump fuel feed pipe quick connect fitting (6) to the chassis fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Lower the vehicle.
7. Remove the caps from the fuel rail and the EVAP purge solenoid.

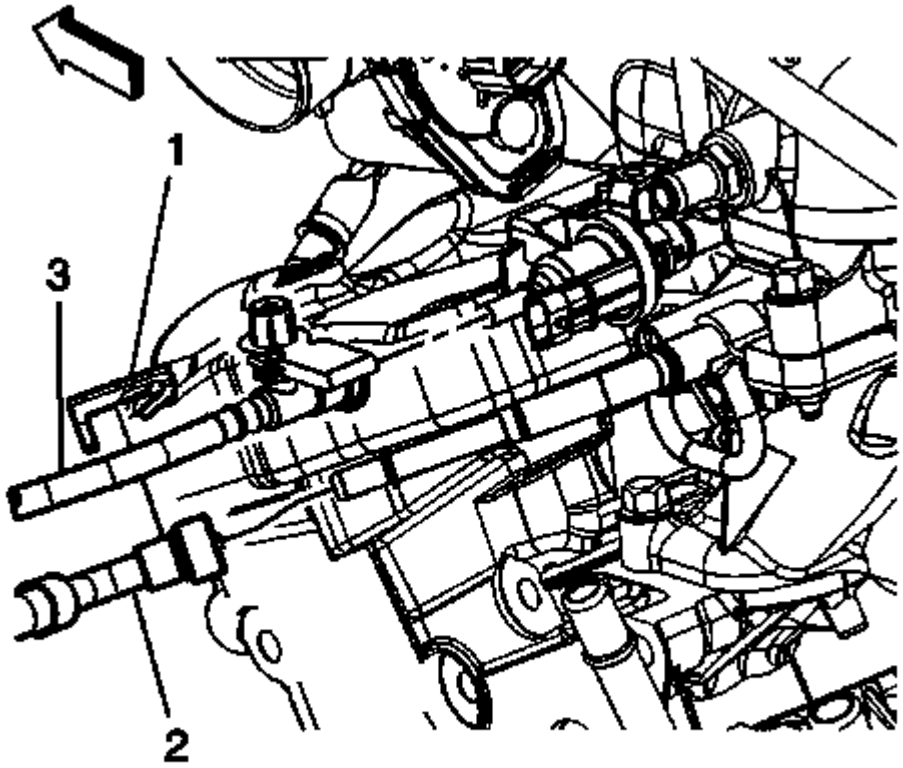

Fig. 144: View Of EVAP Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Connect the EVAP pipe (3) quick connect fitting to the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Connect the fuel feed pipe (2) quick connect fitting to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
10. Tighten the fuel fill cap.
11. Use the following procedure in order to inspect for leaks:
    - Turn the ignition ON, with the engine OFF, for 2 seconds.
    - Turn the ignition OFF for 10 seconds.
    - Turn the ignition ON, with the engine OFF.
    - Inspect for fuel leaks.

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12. Install the intermediate steering shaft. Refer to **Intermediate Steering Shaft Replacement** .
13. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

EVAPORATIVE EMISSION CANISTER VENT FRONT PIPE REPLACEMENT

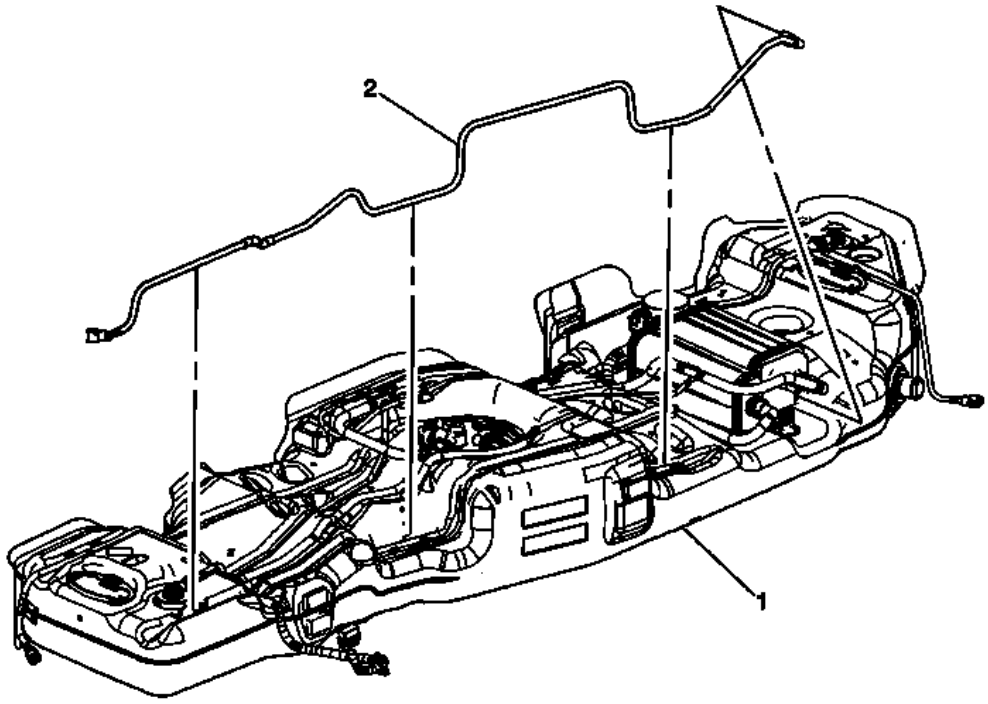

Fig. 145: Identifying Evaporative Emission Canister Vent Front Pipe
Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Vent Front Pipe Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the fuel tank. Refer to **Fuel Tank Replacement**. 2. Remove the foam pad insulators, as required.	
1	Fuel Tank
2	Evaporative Emission Canister Vent Front Pipe **Procedure** 1. Disconnect the quick connect fitting from the evaporative emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**. 2. Disengage from the tank retaining features.

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EVAPORATIVE EMISSION CANISTER VENT REAR PIPE REPLACEMENT

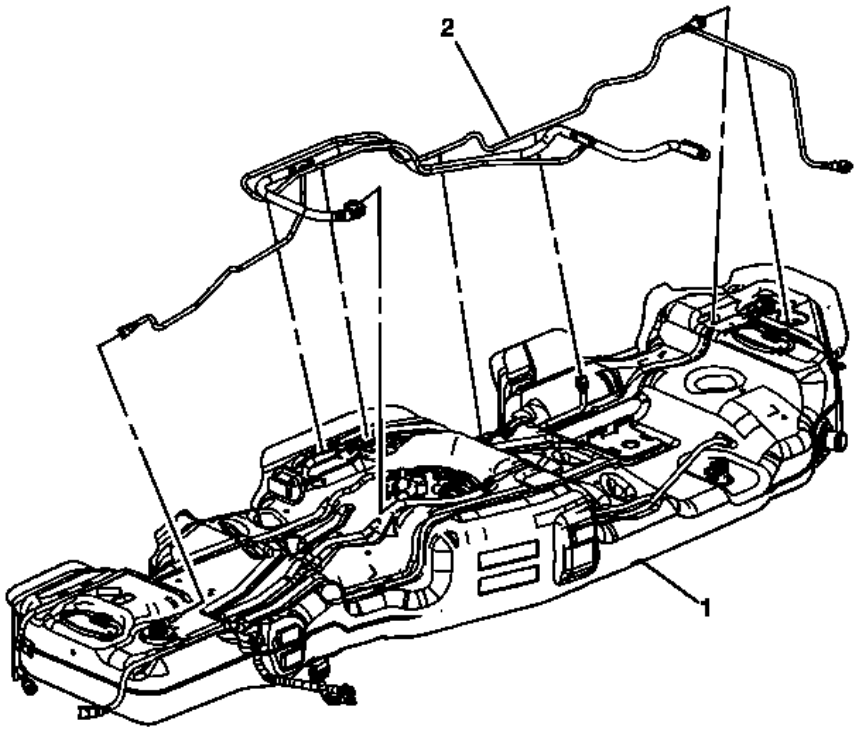

Fig. 146: View Of Evaporative Emission Canister Vent Rear Pipe
Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Vent Rear Pipe Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the EVAP canister. Refer to **Evaporative Emission Canister Replacement**. 2. Remove the foam pad insulators.	
1	Fuel Tank
2	Evaporative Emission Canister Vent Rear Pipe **Procedure** 1. Disconnect the quick connect fitting from the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**. 2. Disconnect the quick connect fittings from the rollover valves. Refer to **Plastic Collar Quick Connect Fitting Service**. 3. Disengage from the tank retaining features.

EVAPORATIVE EMISSION CANISTER REPLACEMENT

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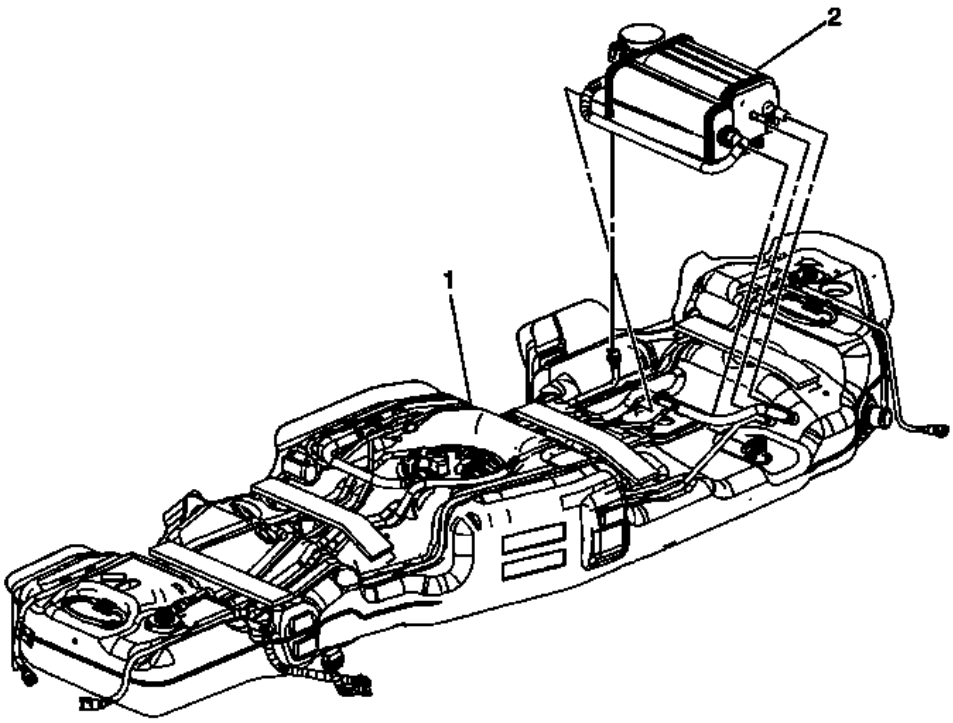

Fig. 147: View Of Evaporative Emission Canister
Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to **Fuel Tank Replacement**.	
1	Fuel Tank
2	Evaporative Emission Canister **Procedure** 1. Disconnect the fuel sender wiring harness electrical connector from the EVAP canister vent solenoid valve. 2. Disconnect the EVAP canister vent front pipe quick connect fitting from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**. 3. Disconnect the EVAP canister vent rear pipe quick connect fitting from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**. 4. Disengage the EVAP canister retainer on the fuel tank.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

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J 41413 EVAP Pressure and Purge Station

Inspection Procedure

CAUTION: Use the Evaporative Emission (EVAP) System Tester (EEST) GE 41413-A in order to provide a clean, dry, low pressure nitrogen gas source. Do not substitute any other pressurized source, gas or otherwise. Damage may result to the EVAP system, test equipment or cause a safety risk.

1. Turn OFF the ignition.

NOTE: Proceed with the following procedure only if referenced by an evaporative emission (EVAP) diagnostic or repair procedure.

2. Remove the EVAP canister purge valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
   - If no carbon particles were detected, but a blockage was detected during a diagnostic procedure, install the original EVAP canister purge valve. Continue with the cleaning procedure.
   - If carbon particles are found during the inspection procedure, continue with the cleaning procedure.
   - If a diagnostic procedure directed you to replace the EVAP canister purge valve and no carbon particles were detected, replace the EVAP canister purge valve. Return to the published service procedure.

Cleaning Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the EVAP canister. Refer to **Evaporative Emission Canister Replacement**.
3. Turn OFF the main valve on the **J 41413** EVAP pressure and purge station.
4. Disconnect the hose from the diagnostic station pressure regulator.
5. Using a section of vacuum hose, connect one end onto the EVAP pressure/purge diagnostic station pressure regulator.
6. Connect the other end of the vacuum hose to the canister side of the purge pipe.
7. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
8. If the nitrogen does not clear the blockage, replace the purge pipe.
9. Return the EVAP pressure/purge diagnostic station to the stations original condition.
10. Install a new EVAP canister. Refer to **Evaporative Emission Canister Replacement**.
11. Lower the vehicle.
12. Install a new EVAP canister purge valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.
13. Return to the diagnostic table that sent you here.

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IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

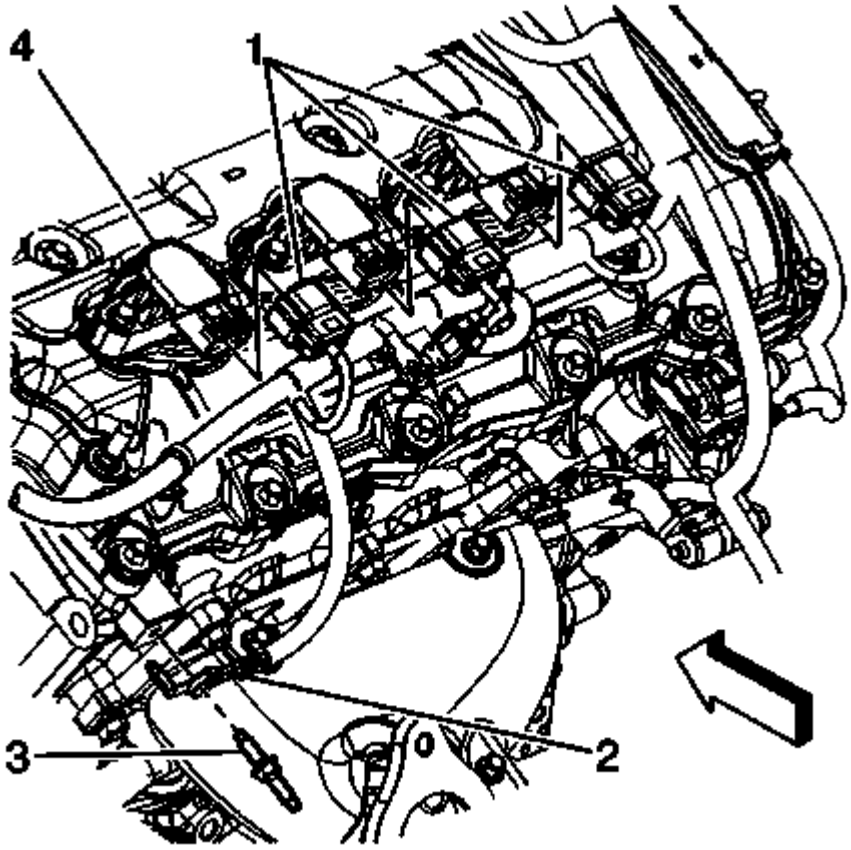

Fig. 148: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector(s) (1) from the ignition coil(s) (4).
3. Remove the ignition coil bolt(s).

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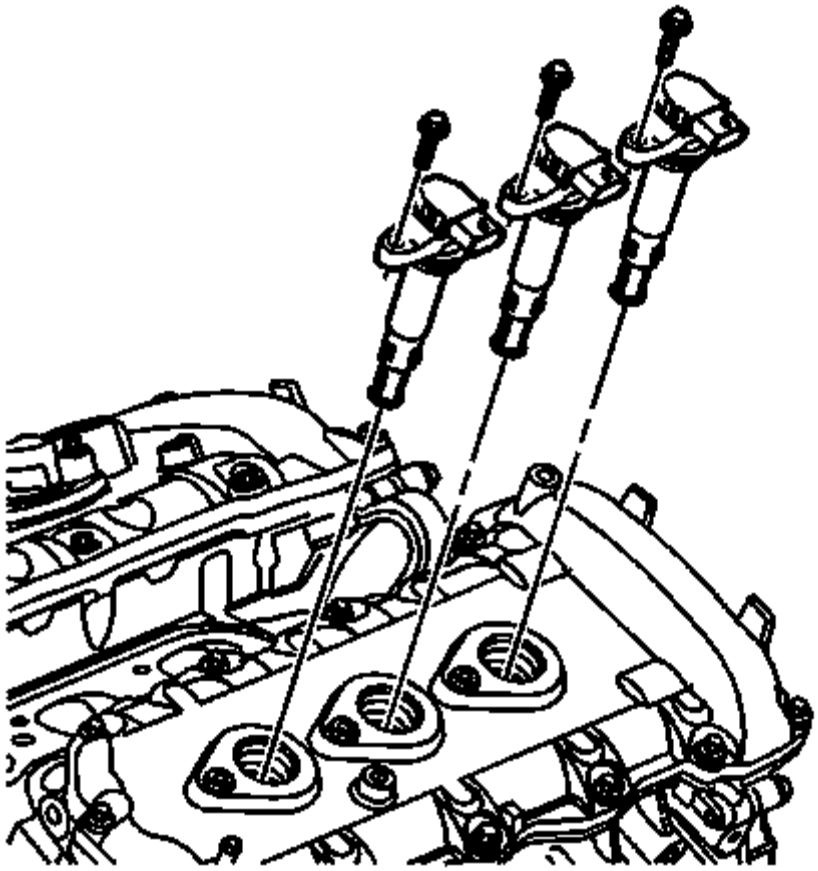

Fig. 149: Ignition Coil View
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coil(s).

Installation Procedure

1. Install the ignition coil(s).

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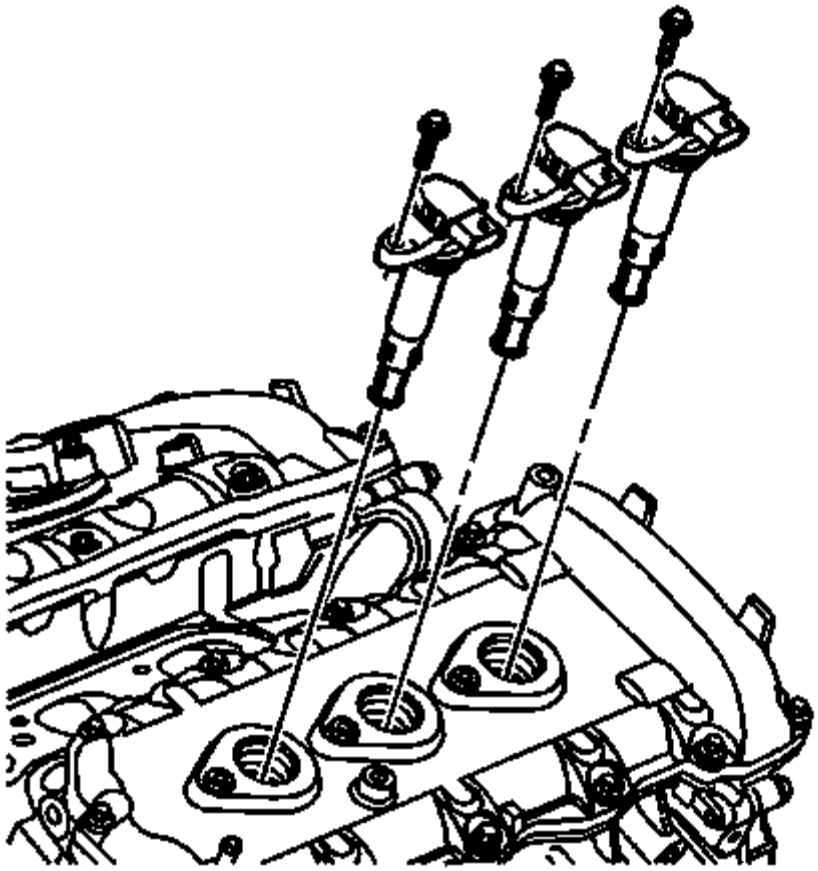

Fig. 150: Ignition Coil View
Courtesy of GENERAL MOTORS COMPANY

2. Install the ignition coil bolt(s).

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt(s) to 10 N.m (89 lb in).

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s) (4).

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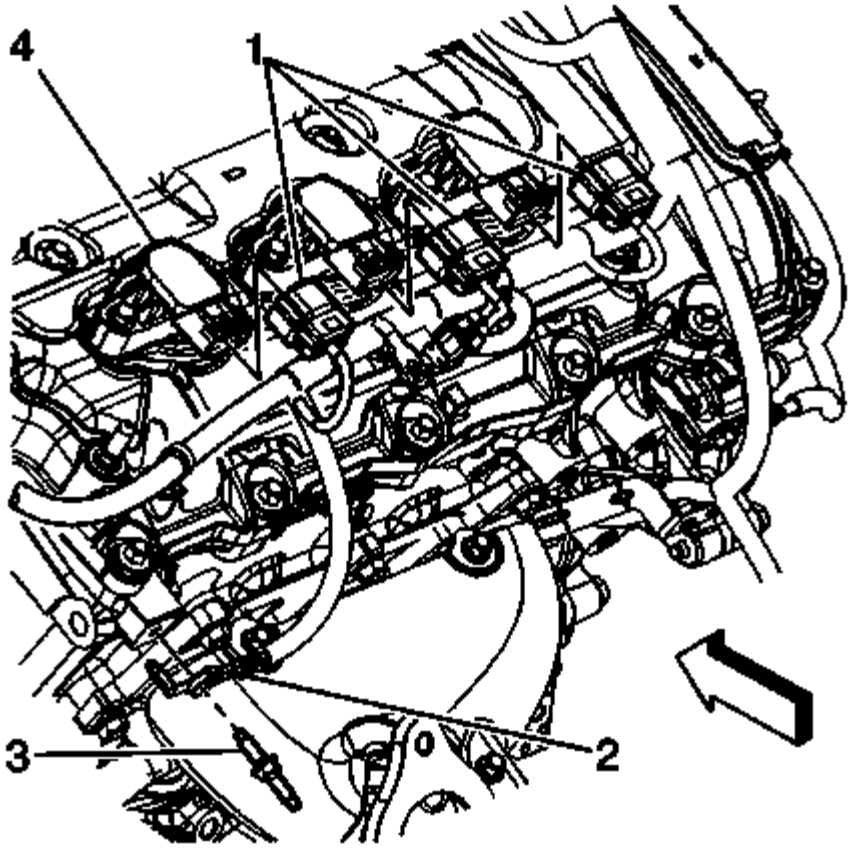

Fig. 151: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

IGNITION COIL REPLACEMENT - BANK 2

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**

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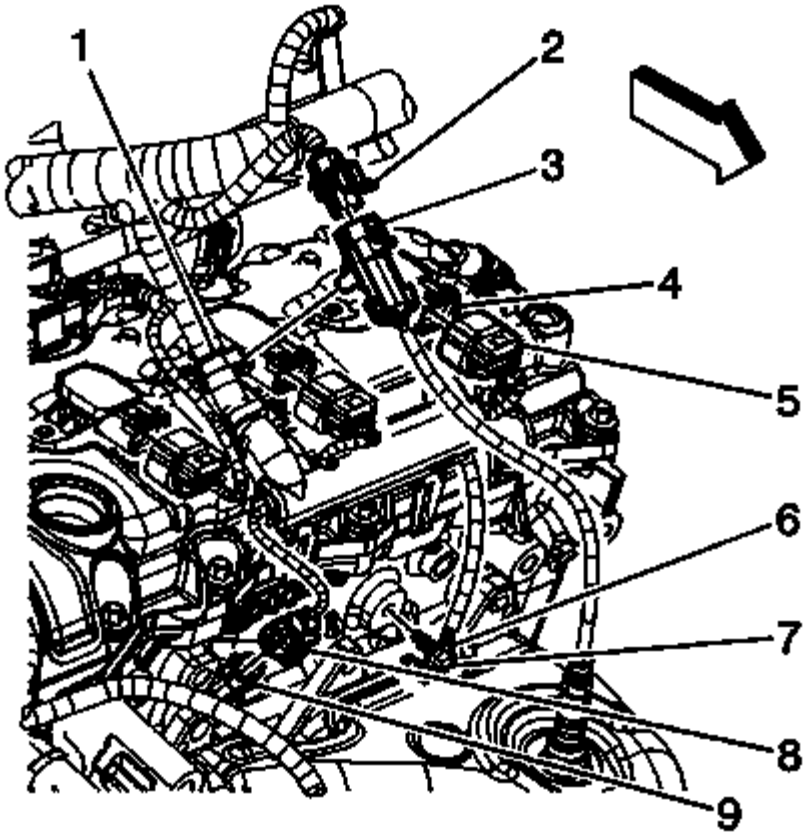

Fig. 152: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector(s) (5) from the ignition coil(s) (4).
3. Remove the ignition coil bolt(s).

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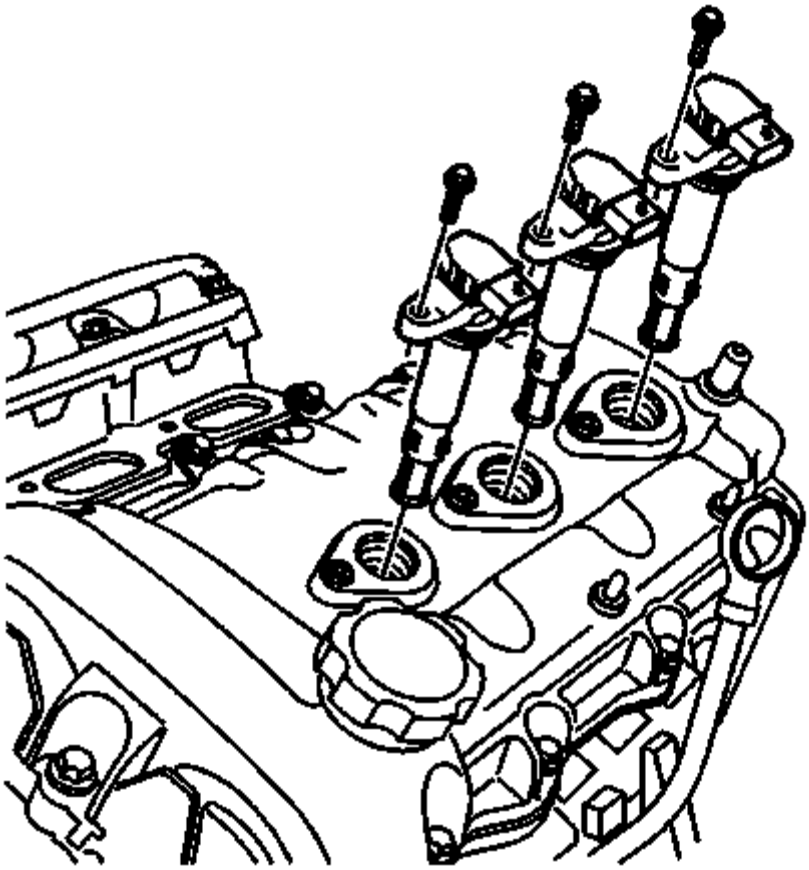

Fig. 153: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coil(s).

Installation Procedure

1. Install the ignition coil(s).

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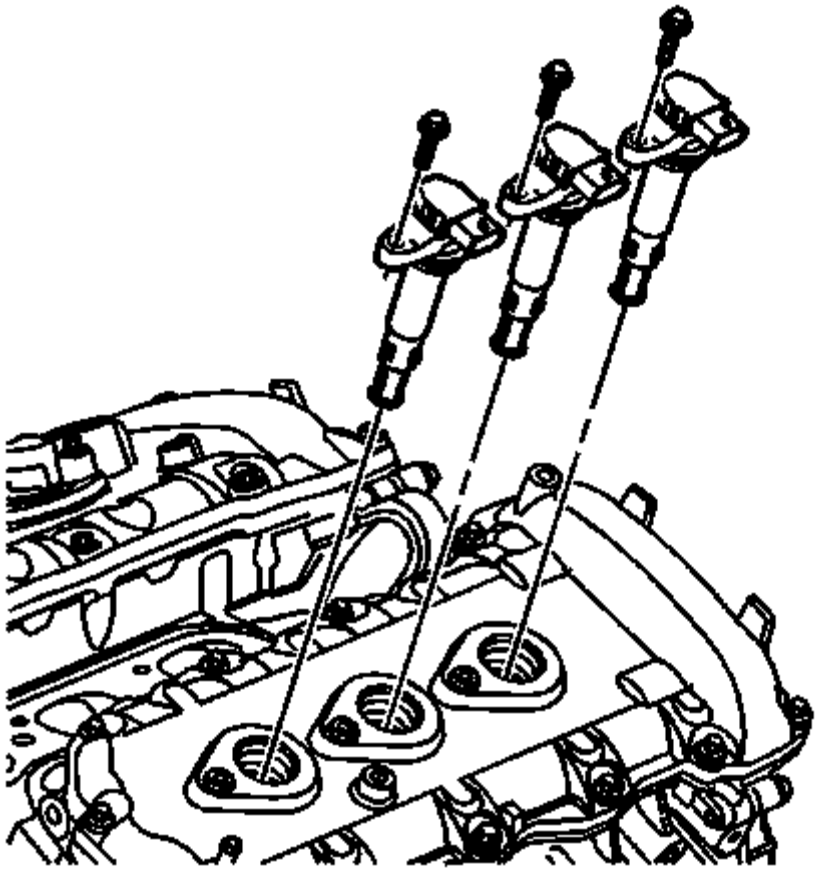

Fig. 154: Ignition Coil View
Courtesy of GENERAL MOTORS COMPANY

2. Install the ignition coil bolt(s).

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt(s) to 10 N.m (89 lb in).

3. Connect the engine wiring harness electrical connector(s) (5) to the ignition coil(s) (4).

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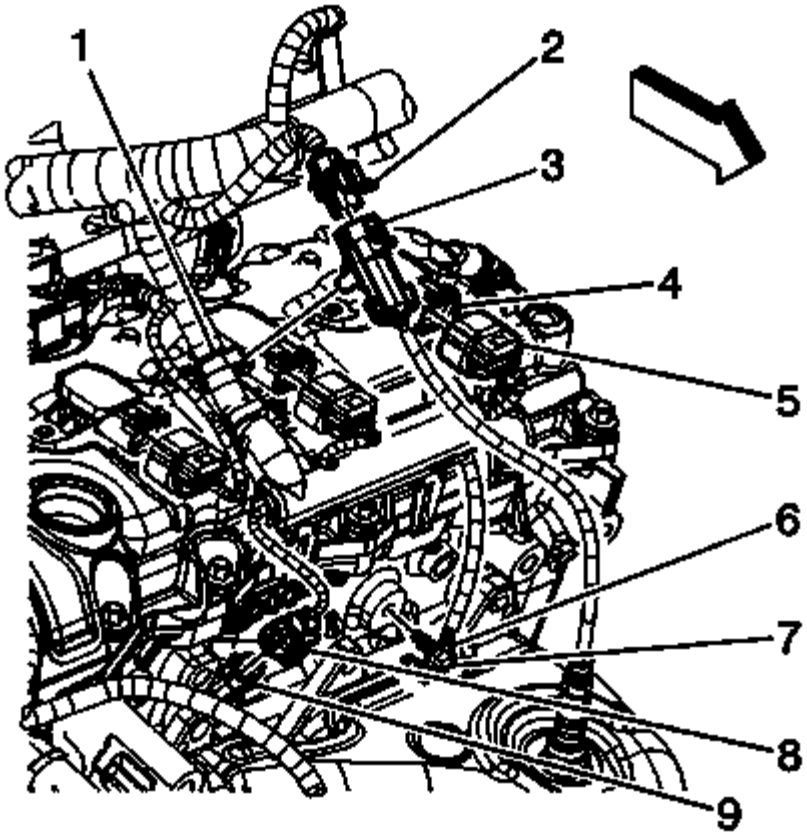

Fig. 155: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the intake manifold. Refer to **Intake Manifold Replacement**

SPARK PLUG INSPECTION

Spark Plug Usage

Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to the Electronic Parts Catalog.

Spark Plug Inspection

- Inspect the terminal post (1) for damage.

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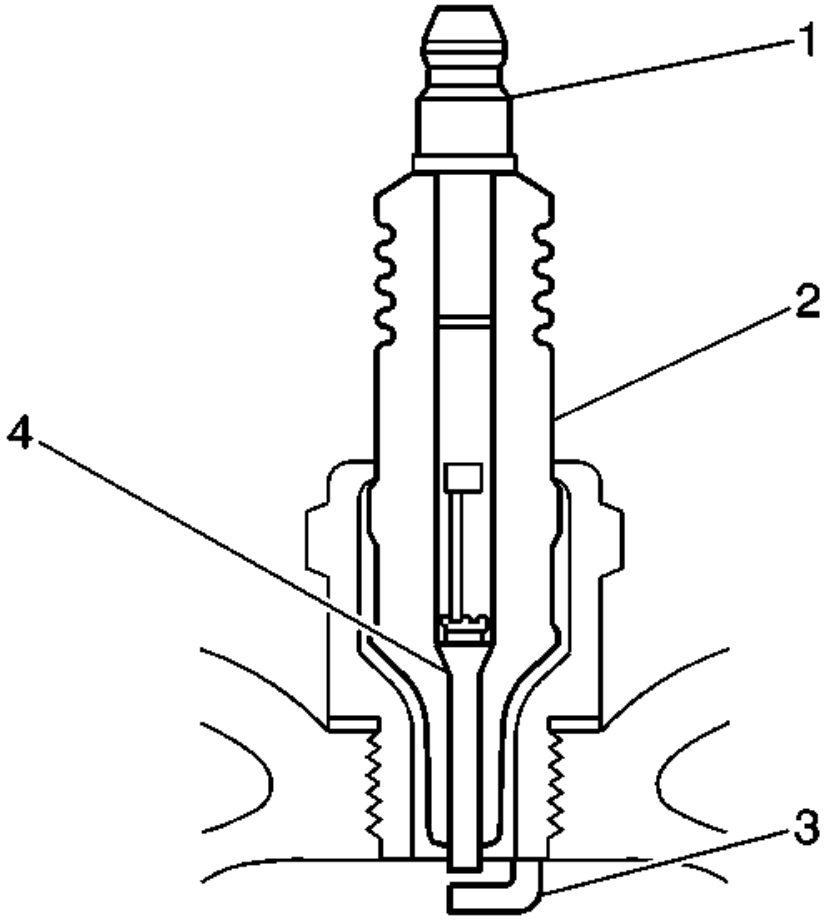

Fig. 156: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- Inspect for a bent or broken terminal post (1).
- Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.

- Inspect the insulator (2) for flashover or carbon tracking, soot. This condition is often mistakenly identified as a cracked insulator. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
  - Inspect the spark plug boot for damage.
  - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant or water. A spark plug boot that is saturated causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).
- Inspect for evidence of improper arcing.
  - Measure the gap between the center electrode (4) and the side electrode (3) terminals. This must be

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done carefully in order to avoid damaging the small diameter Iridium center electrode. Refer to **Ignition System Specifications** . An excessively wide electrode gap can prevent correct spark plug operation.

- Inspect for the correct spark plug torque. Refer to **Ignition System Specifications** . Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
- Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
- Inspect for a broken or worn side electrode (3).
- Inspect for a broken, worn or loose center electrode (4) by shaking the spark plug.
  - A rattling sound indicates internal damage.
  - A loose center electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 4) If equipped.
- Inspect for excessive fouling.

- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal operation - Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives. Reddish orange deposits can indicate MMT fuel additive which is still used in some markets around the world (will cause misfire and cannot be burned off). MMT fuel additive use should be avoided.
- Carbon Fouled - Dry, fluffy black carbon or soot caused by the following conditions:
  - Rich fuel mixtures
    - Leaking fuel injectors
    - Excessive fuel pressure
    - Restricted air filter element
    - Incorrect combustion
  - Reduced ignition system voltage output
    - Weak coils
    - Worn ignition wires
    - Incorrect spark plug gap
  - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling - Oil, coolant or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

SPARK PLUG REPLACEMENT

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Removal Procedure

1. Remove the ignition coil(s). Refer to **Ignition Coil Replacement - Bank 1**, and/or **Ignition Coil Replacement - Bank 2**.

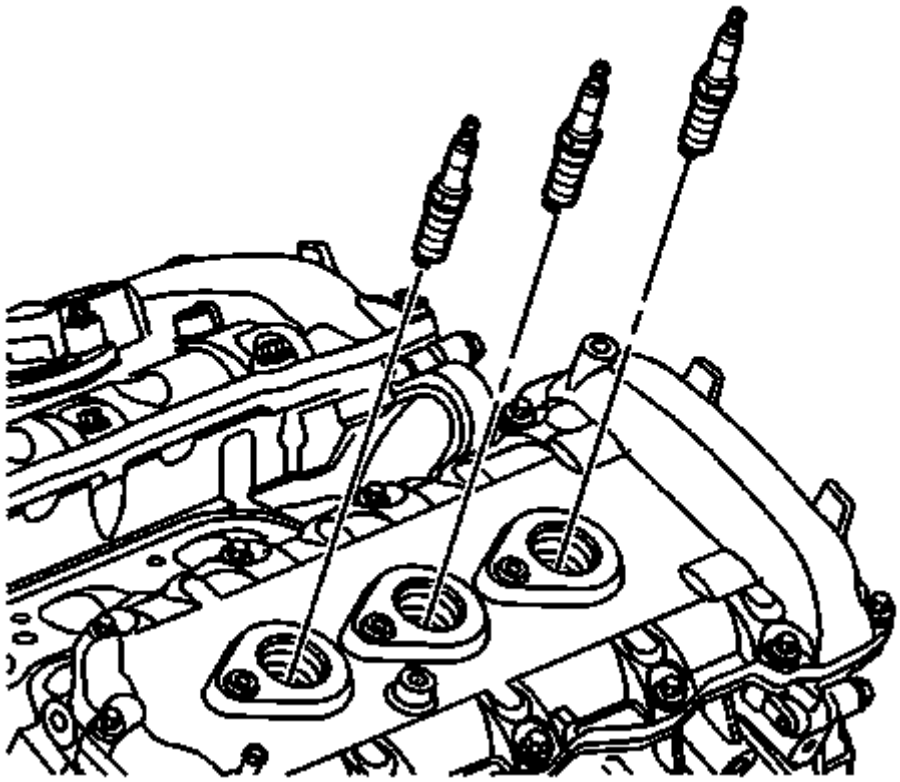

Fig. 157: View Of Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

2. Use compressed air in order to remove debris from the spark plug cavity.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

CAUTION: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

3. Remove the spark plug.

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CAUTION: Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to seize, causing damage to cylinder head threads.

Installation Procedure

1. Ensure that the spark plug gap is equivalent to the spark plug gap specification. Refer to **Ignition System Specifications** .

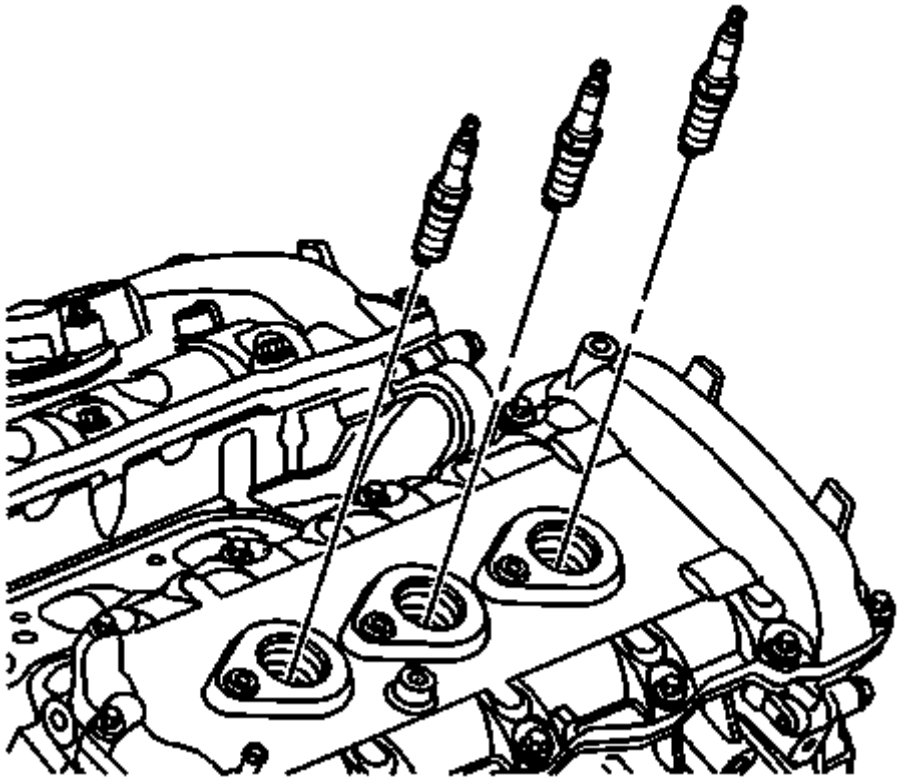

Fig. 158: View Of Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

CAUTION: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gauge to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance

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and may even damage the engine.

2. Install the spark plug and tighten to 18 N.m (13 lb ft).

CAUTION: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by or thread damage.

CAUTION: Refer to Fastener Caution .

3. Install the ignition coil(s). Refer to **Ignition Coil Replacement - Bank 1** and/or **Ignition Coil Replacement - Bank 2**.

CRANKSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

1. Remove the exhaust manifold lower heat shield. Refer to **Exhaust Manifold Lower Heat Shield Replacement** .

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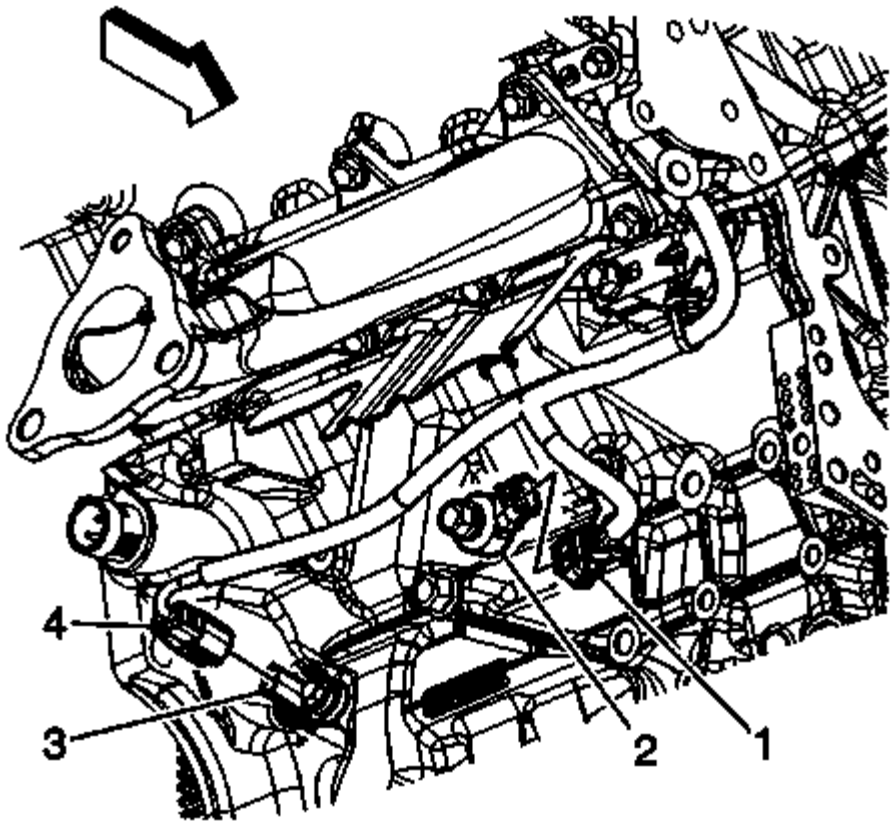

Fig. 159: Identifying Knock Sensor & Crankshaft Position (CKP) Sensor Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector (3) from the crankshaft position (CKP) sensor (4).
3. Remove the crankshaft sensor bolt.

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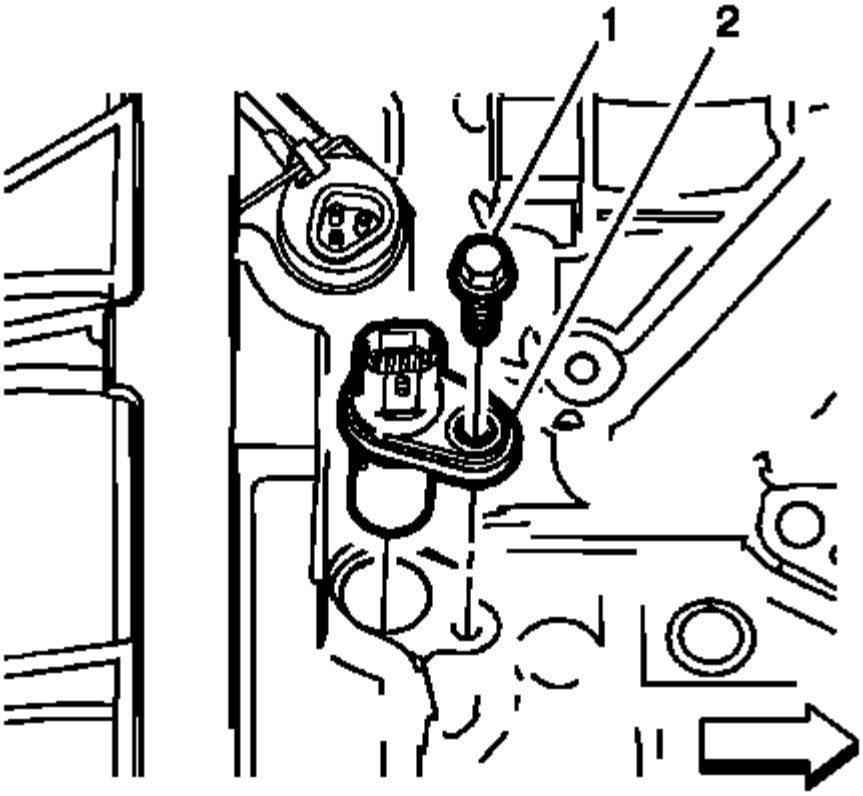

Fig. 160: Identifying Crankshaft Position (CKP) Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft sensor.

Installation Procedure

1. Install the crankshaft position sensor.

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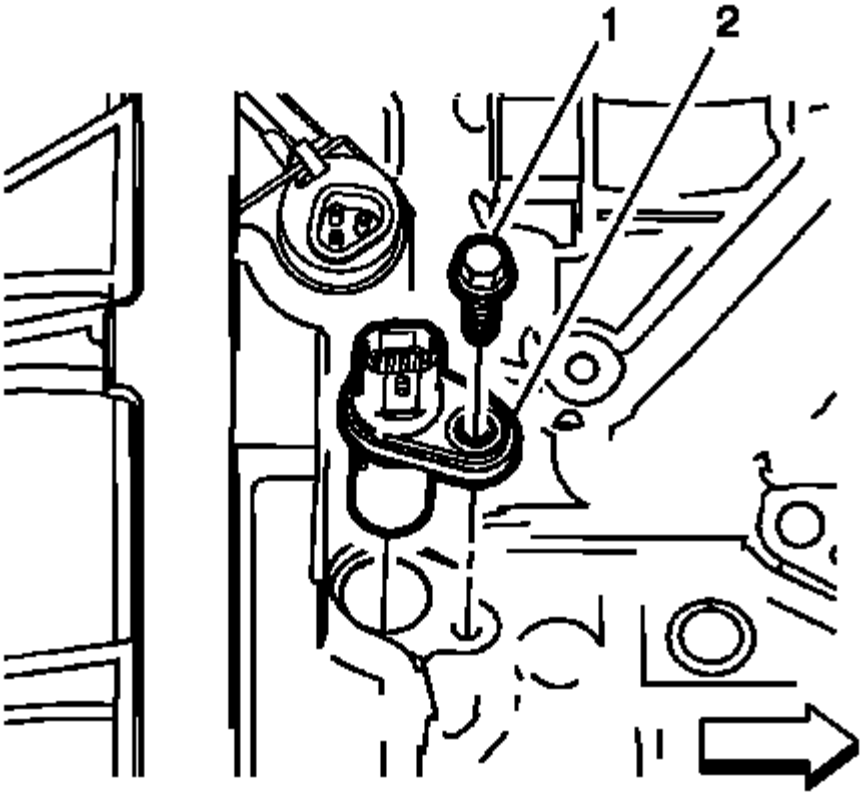

Fig. 161: Identifying Crankshaft Position (CKP) Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Install the crankshaft position sensor bolt and tighten to 10 N.m (89 lb in).

CAUTION: Refer to Fastener Caution .

3. Connect the engine wiring harness electrical connector (3) to the CKP sensor (4).

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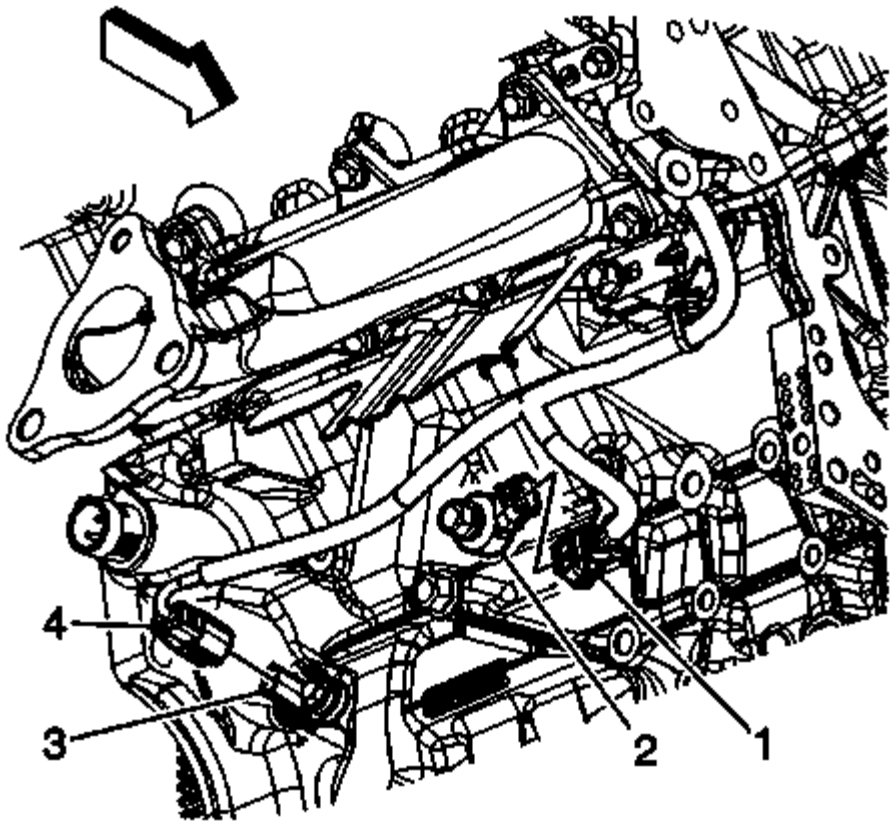

Fig. 162: Identifying Knock Sensor & Crankshaft Position (CKP) Sensor Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

4. Install the exhaust manifold lower heat shield. Refer to **Exhaust Manifold Lower Heat Shield Replacement** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

Removal Procedure

1. Remove the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side** .

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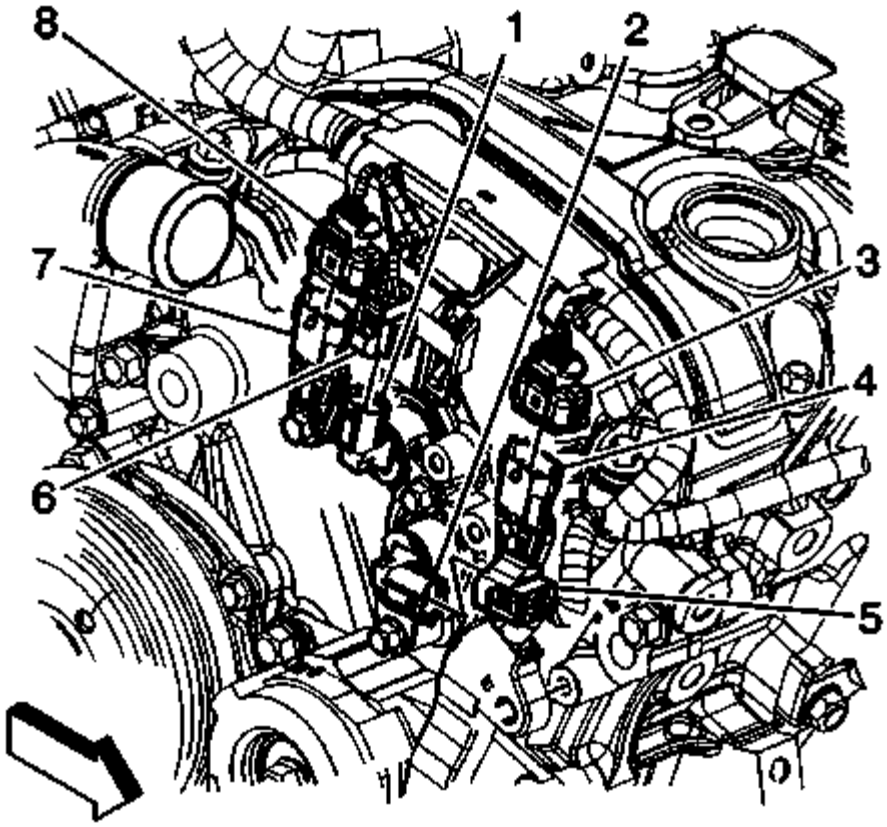

Fig. 163: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector (3) from the bank 2 exhaust camshaft position (CMP) sensor (4).
3. Remove the CMP sensor bolt and sensor (4).

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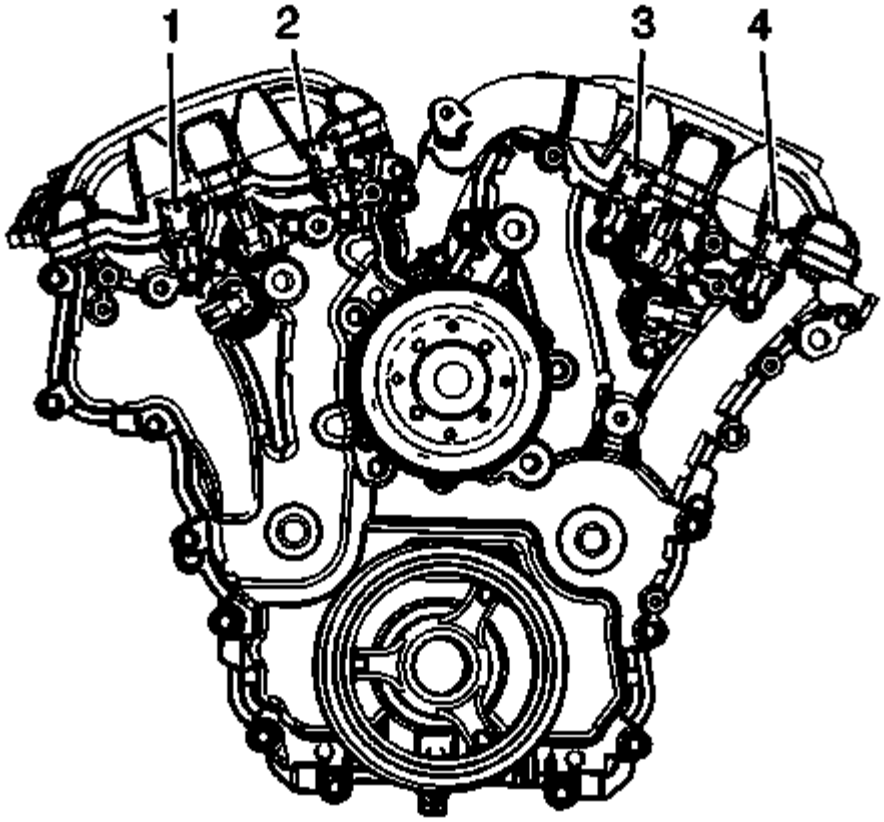

Fig. 164: View Of CMP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Install the CMP sensor (4) and bolt.

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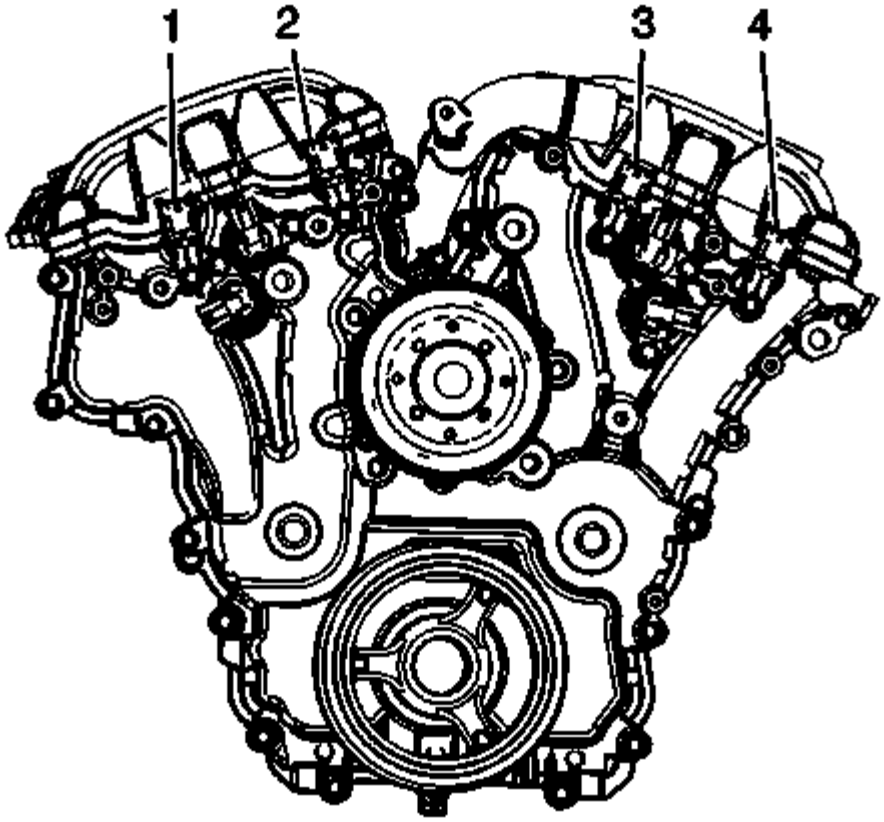

Fig. 165: View Of CMP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 10 N.m (89 lb in).

2. Connect the engine wiring harness electrical connector (3) to the bank 2 exhaust CMP sensor (4).

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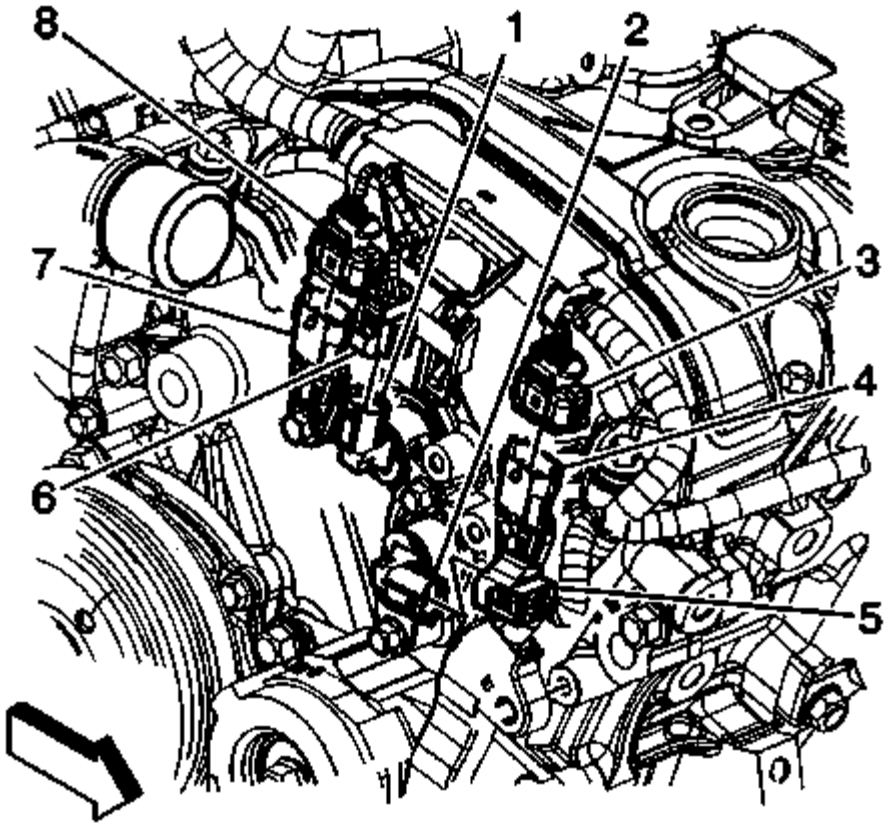

Fig. 166: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

Removal Procedure

1. Remove the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side** .

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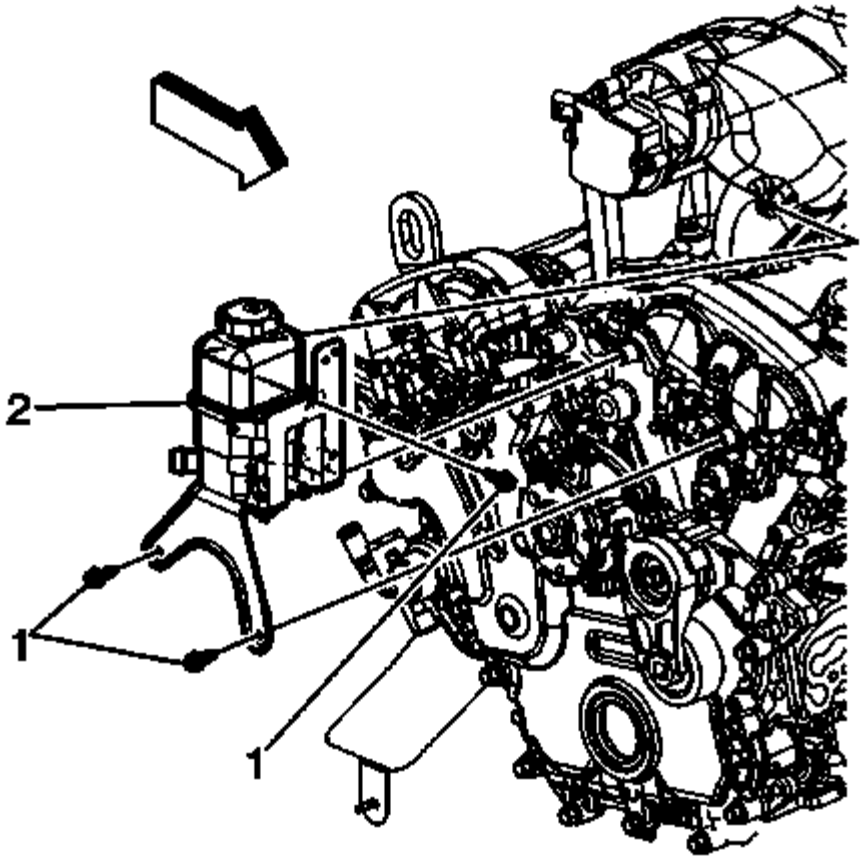

Fig. 167: Identifying Remote Power Steering Fluid Reservoir, Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the radiator inlet hose from the water outlet. Refer to **Radiator Inlet Hose Replacement** .
3. Remove the power steering fluid reservoir bracket bolts (1).
4. Remove and reposition the power steering fluid reservoir bracket (2) out of the way.
5. Disconnect the engine wiring harness electrical connector (8) from the bank 2 intake camshaft position (CMP) sensor (7).

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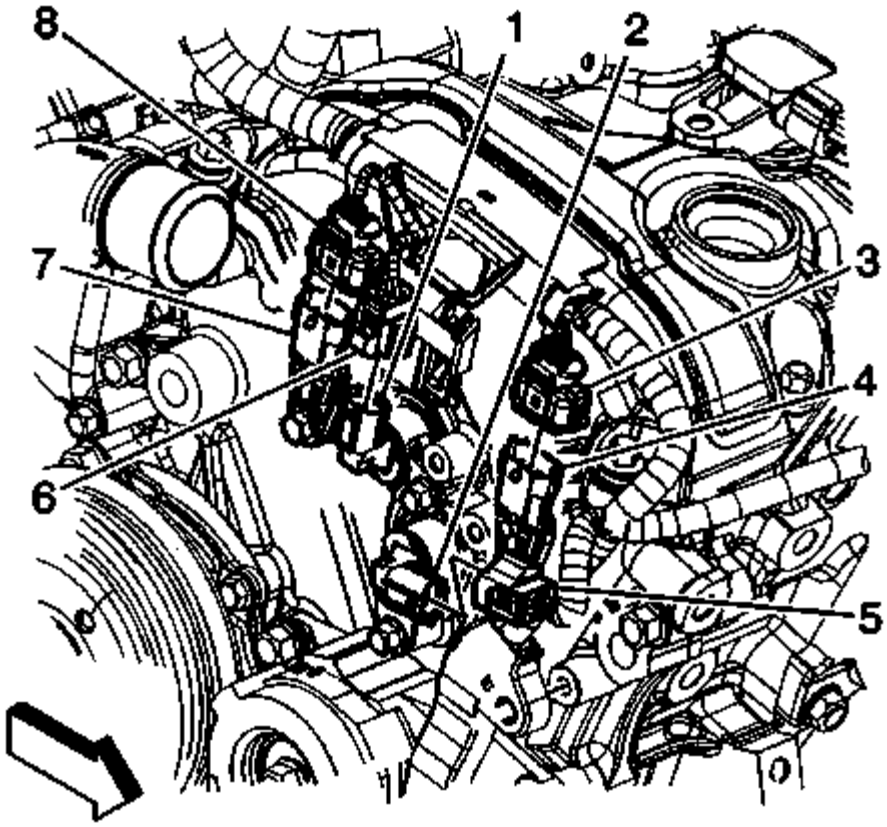

Fig. 168: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

6. Remove the CMP sensor bolt and sensor (3).

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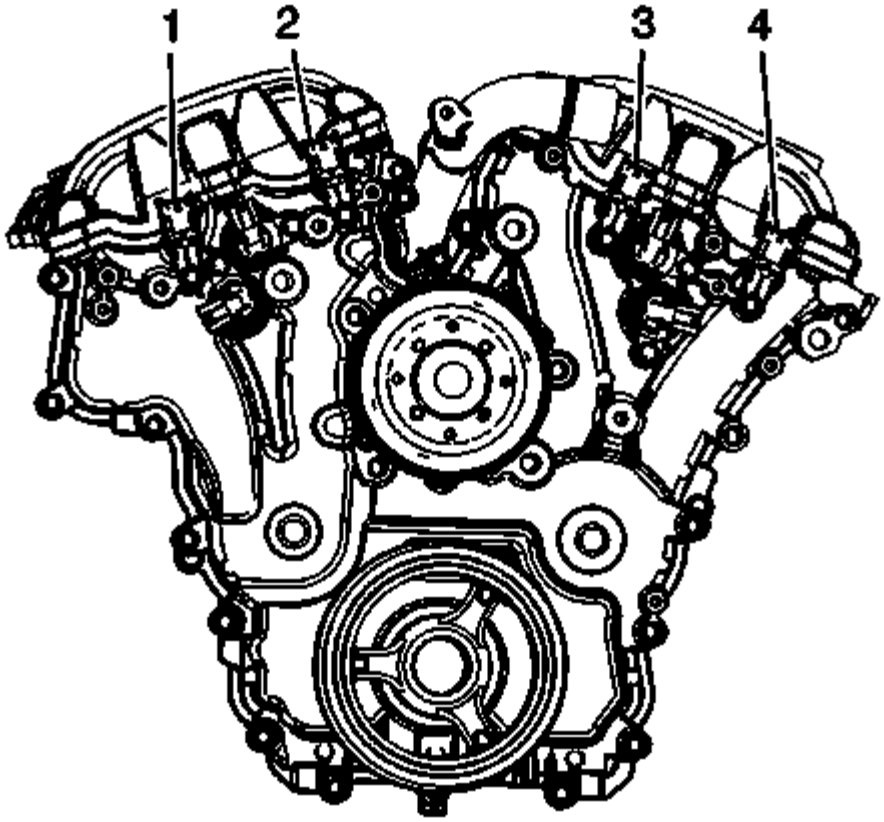

Fig. 169: View Of CMP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Install the CMP sensor (3) and bolt.

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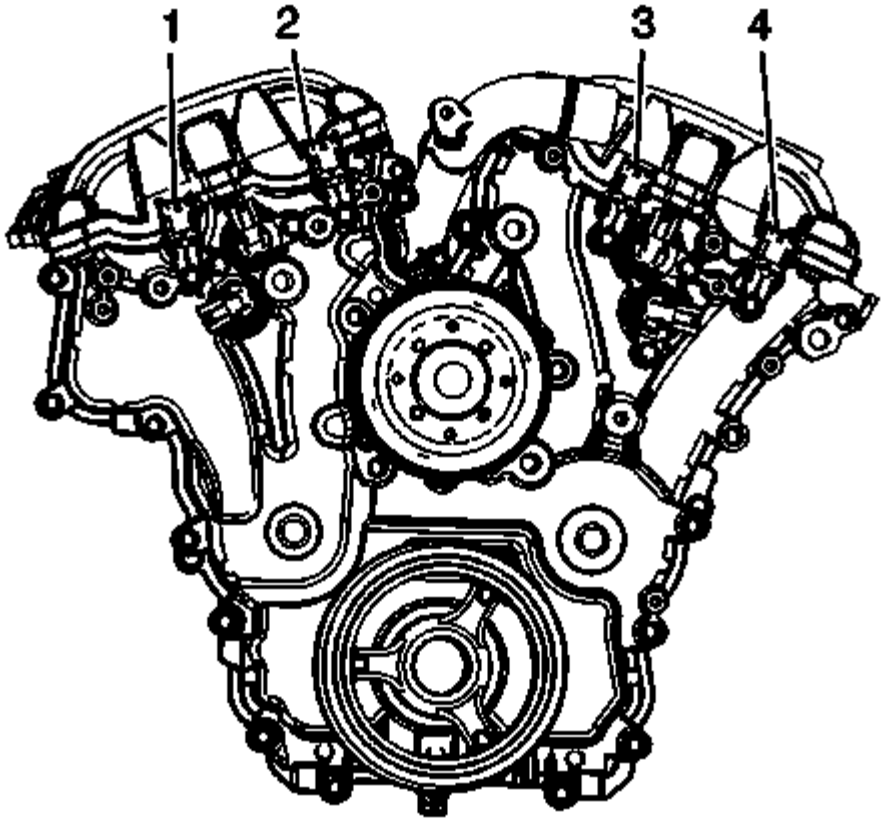

Fig. 170: View Of CMP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 10 N.m (89 lb in).

2. Connect the engine wiring harness electrical connector (8) to the bank 2 intake CMP sensor (7).

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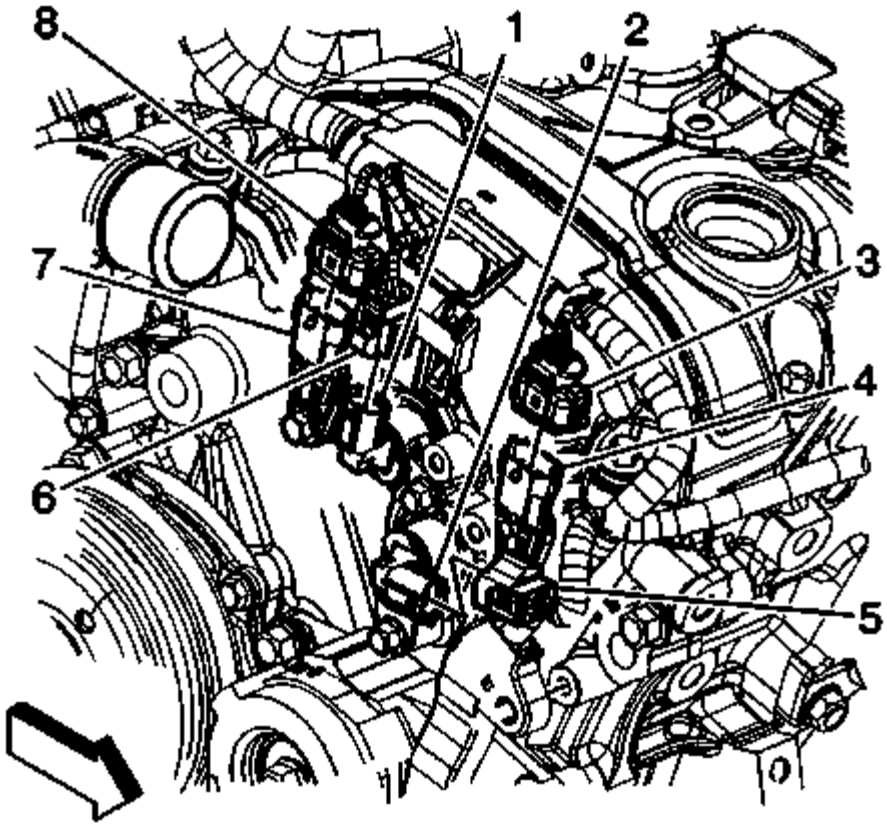

Fig. 171: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

3. Position and install the power steering fluid reservoir bracket (2).

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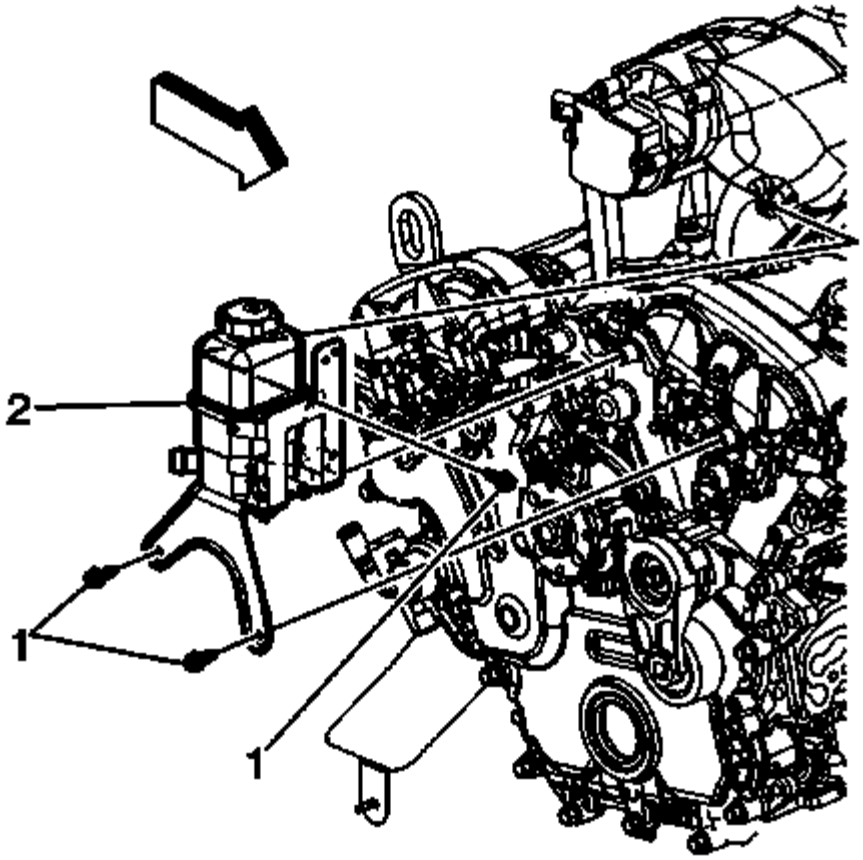

Fig. 172: Identifying Remote Power Steering Fluid Reservoir, Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the power steering fluid reservoir bracket bolts (1).

   Tighten

   Tighten the bolts to 9 N.m (8 lb in).

5. Install the radiator inlet hose to the water outlet. Refer to **Radiator Inlet Hose Replacement** .
6. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

Removal Procedure

1. Disconnect the engine wiring harness electrical connector (7) from the bank 1 exhaust camshaft position (CMP) sensor (6).

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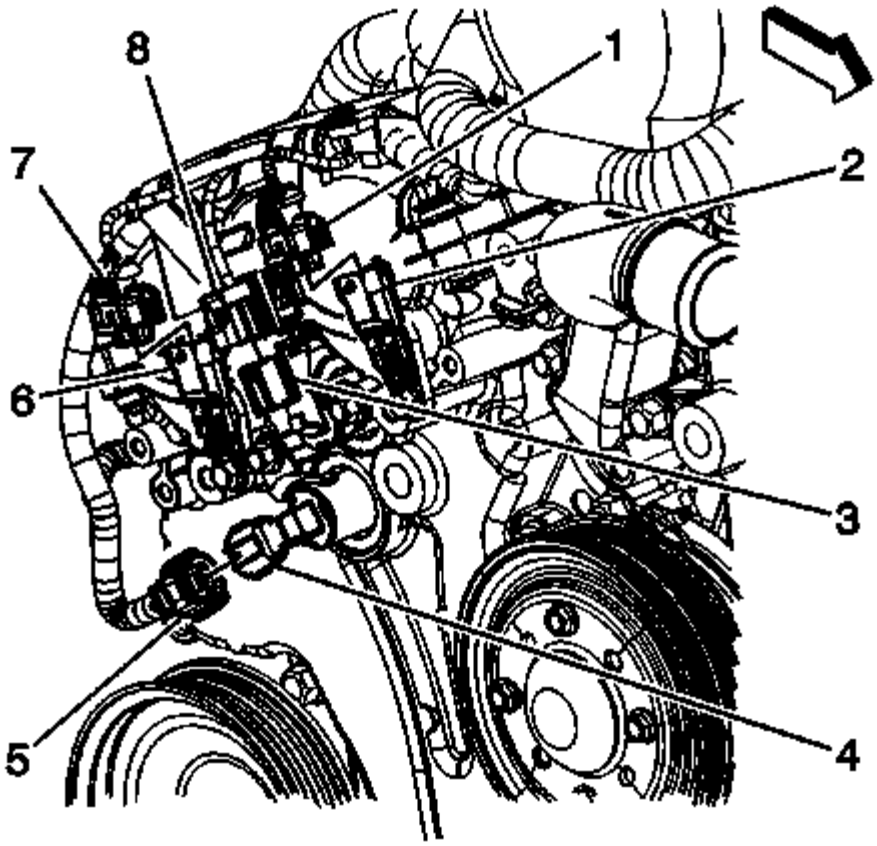

Fig. 173: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

2. Remove the CMP sensor bolt and sensor (1).

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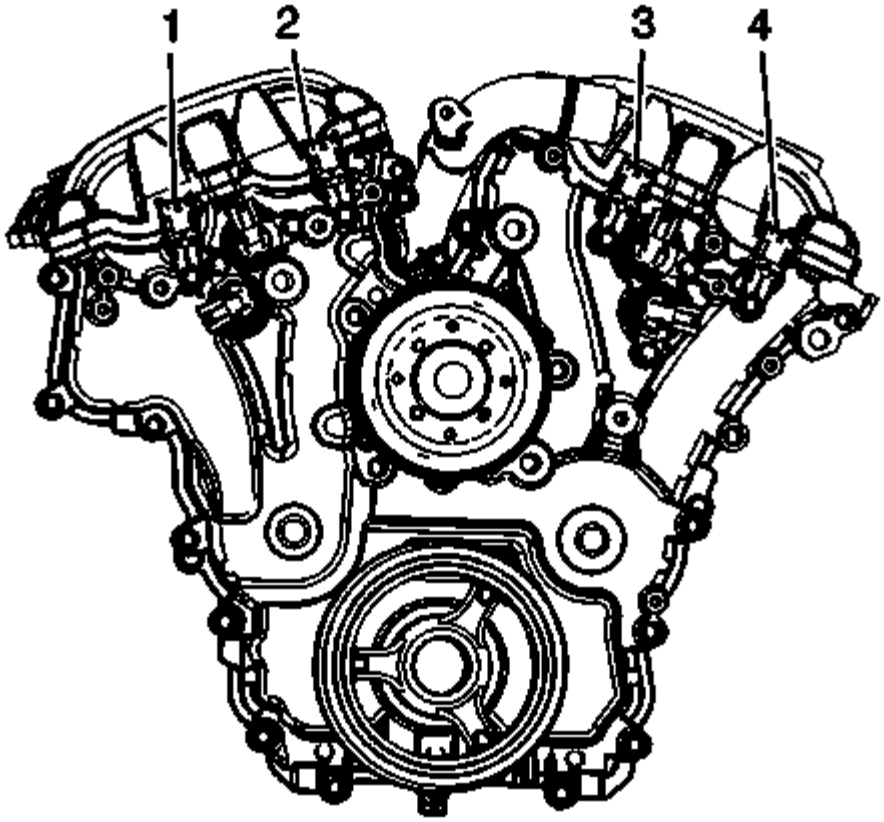

Fig. 174: View Of CMP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Install the CMP sensor (1) and bolt. Tighten the bolt to 10 N.m (89 lb in).

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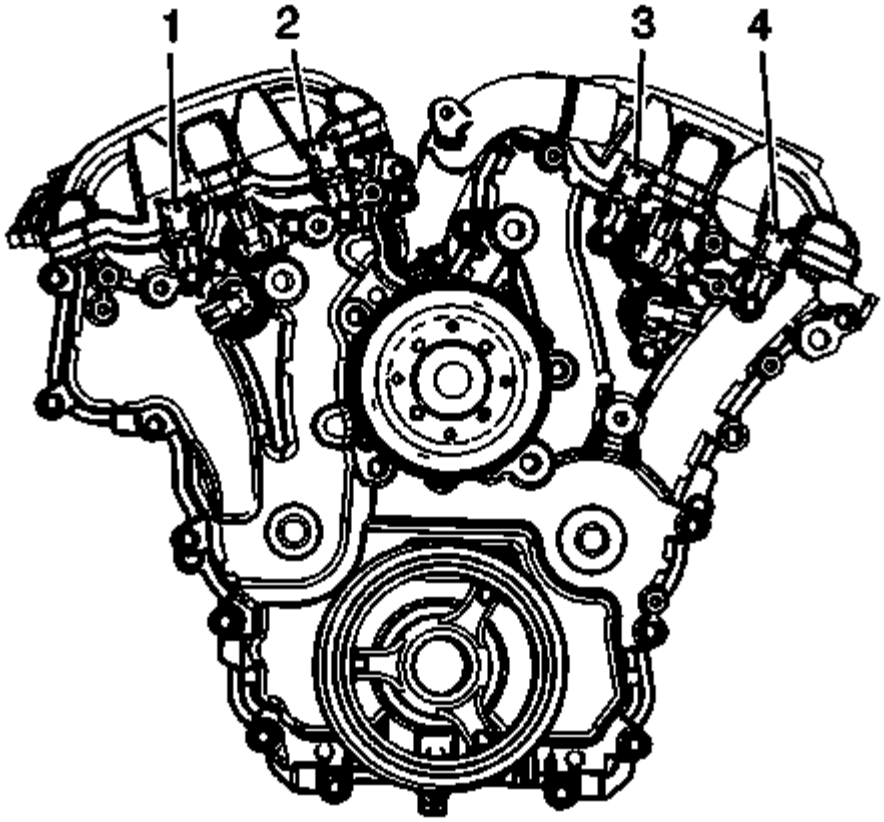

Fig. 175: View Of CMP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Connect the engine wiring harness electrical connector (7) to the bank 1 exhaust CMP sensor (6).

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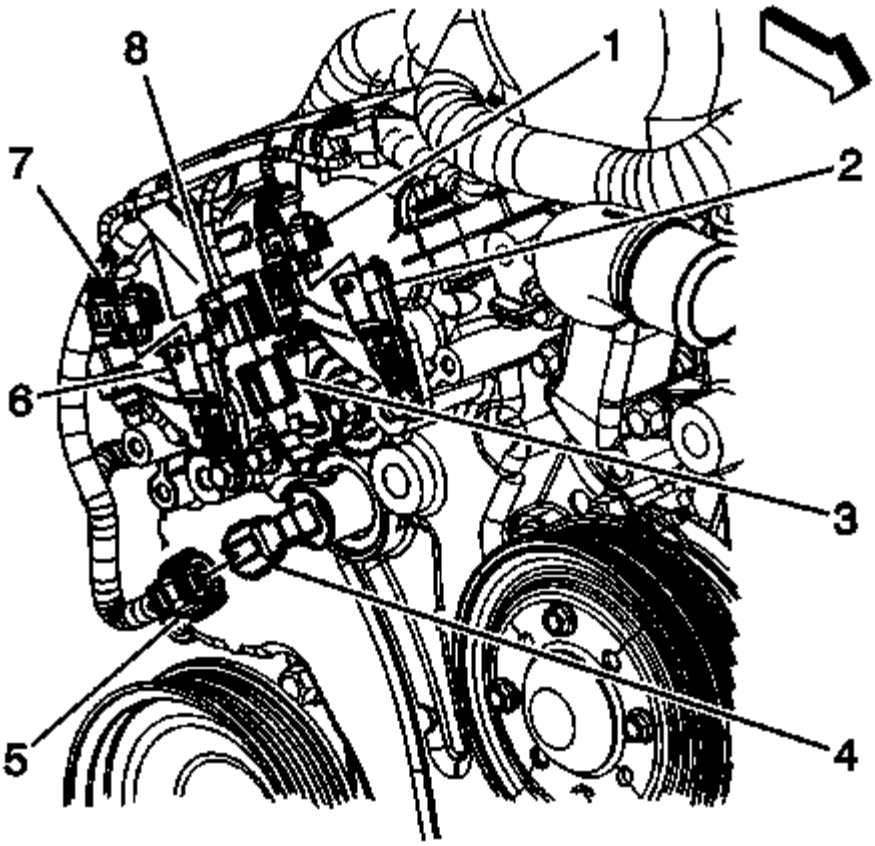

Fig. 176: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

Removal Procedure

1. Disconnect the engine wiring harness electrical connector (1) from the bank 1 intake camshaft position (CMP) sensor (2).

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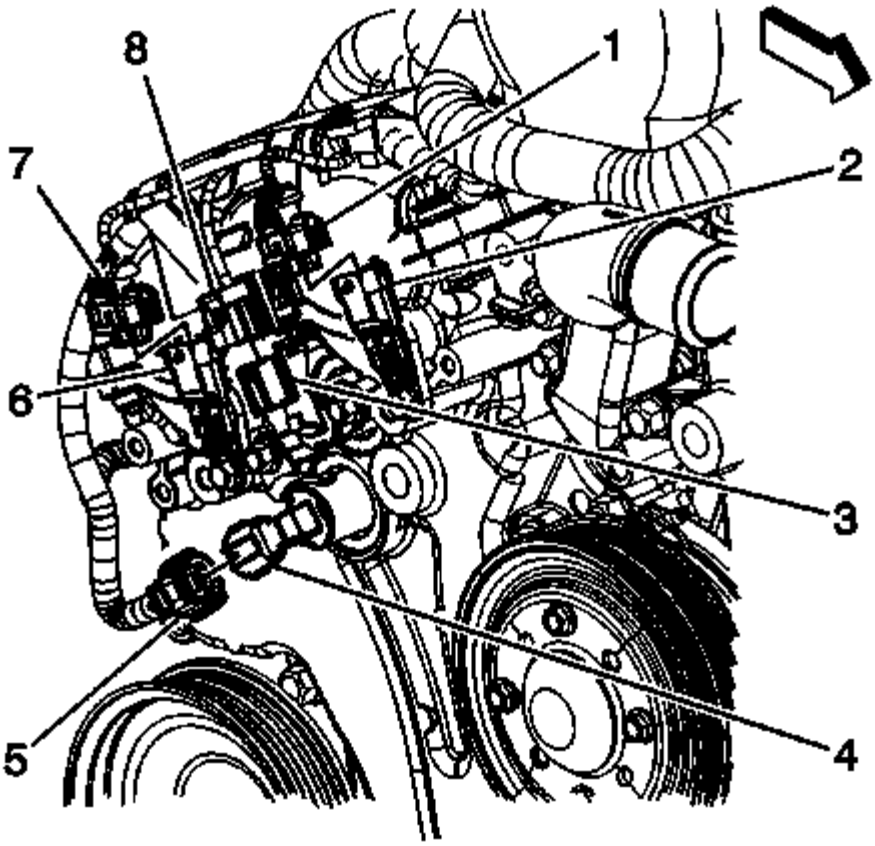

Fig. 177: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

2. Remove the CMP sensor bolt and sensor (2).

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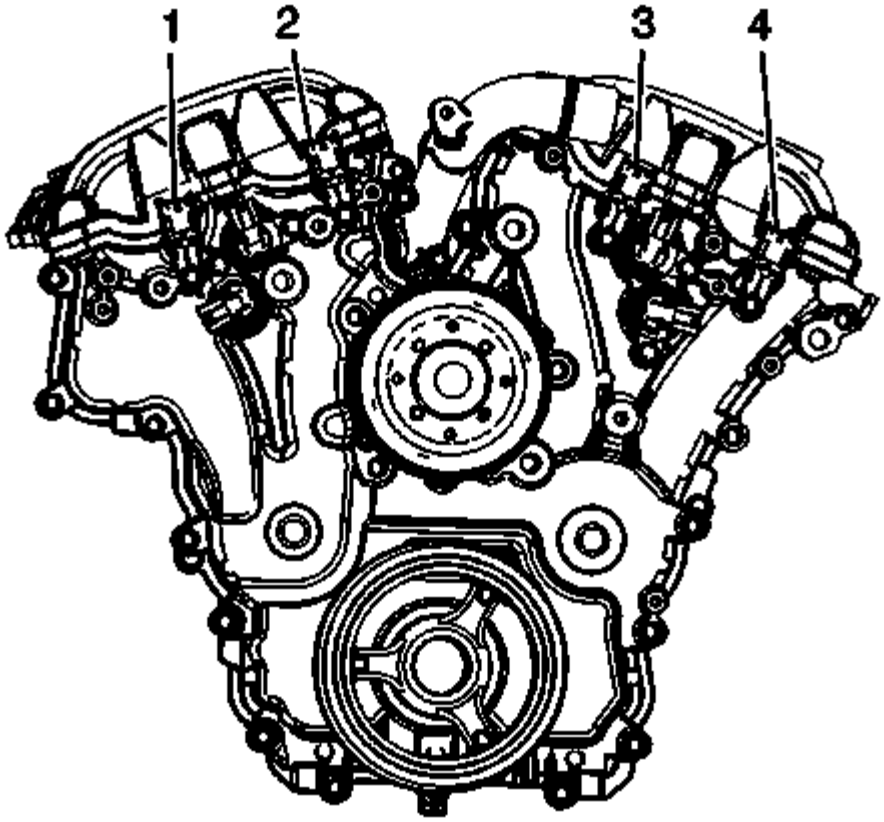

Fig. 178: View Of CMP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Install the CMP sensor (2) and bolt. Tighten the bolt to 10 N.m (89 lb in).

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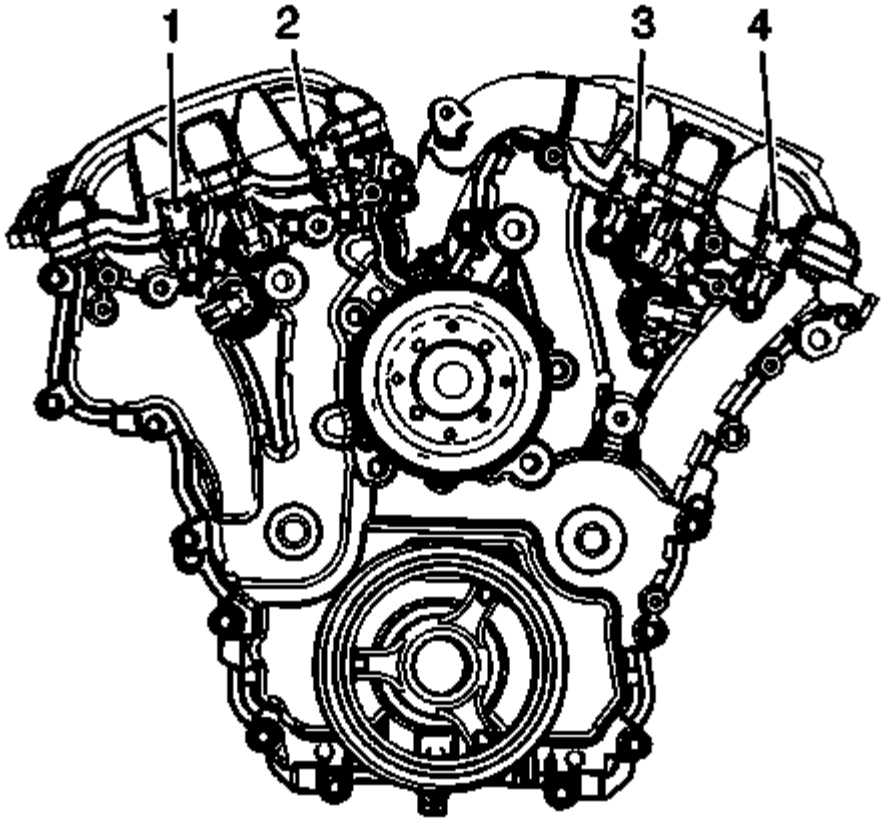

Fig. 179: View Of CMP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Connect the engine wiring harness electrical connector (1) to the bank 1 intake CMP sensor (2).

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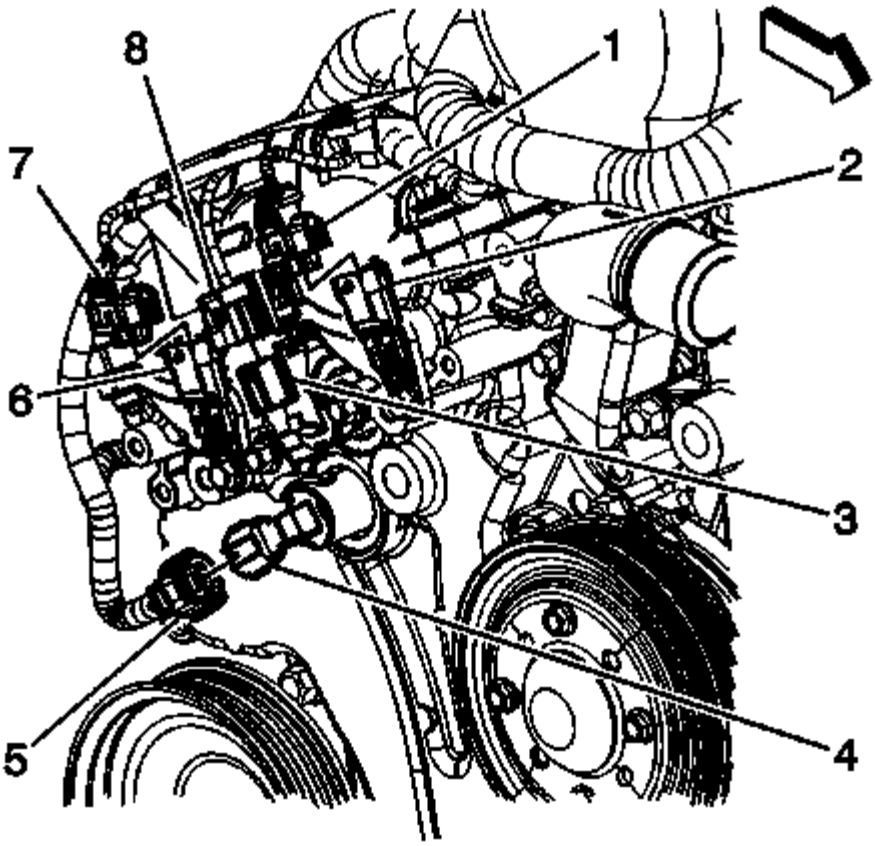

Fig. 180: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

Removal Procedure

1. Disconnect the engine wiring harness electrical connector (8) from the bank 1 intake CMP actuator solenoid valve.

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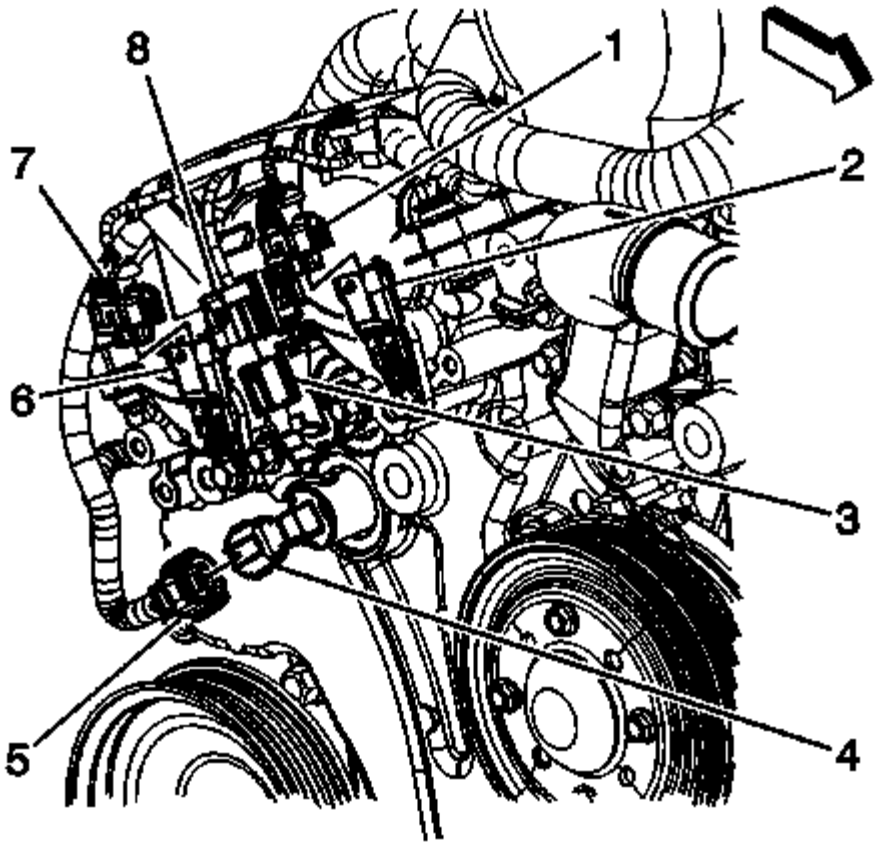

Fig. 181: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

2. Remove the CMP actuator solenoid valve bolt and valve (2).

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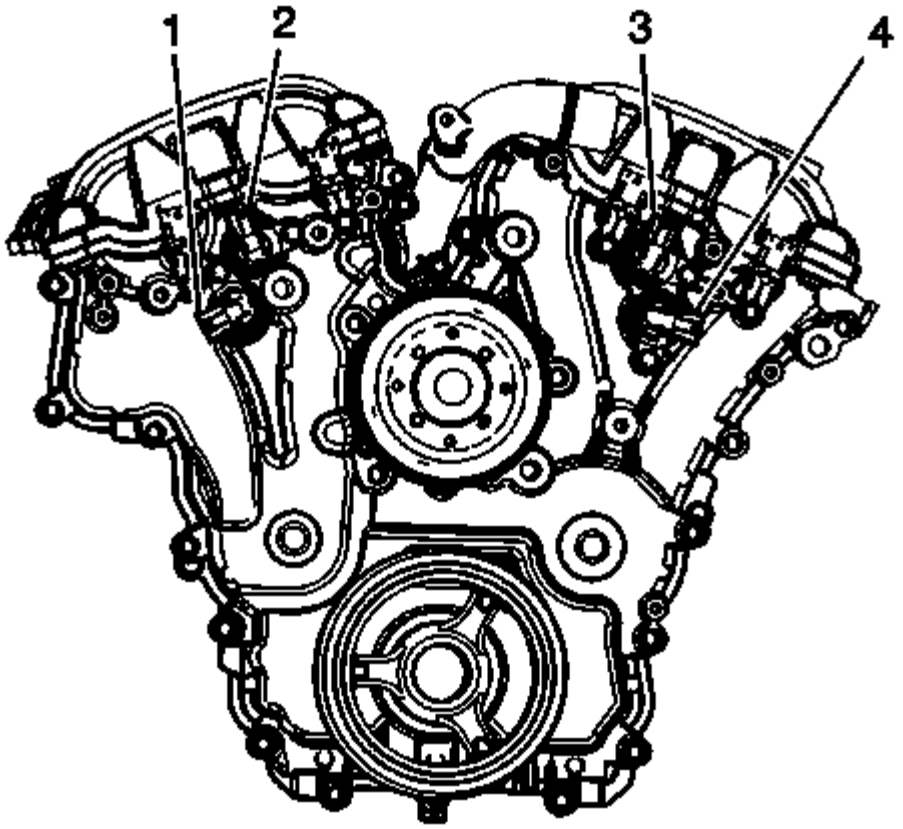

Fig. 182: Identifying CMP Actuator Solenoid Valve Bolt & Valve
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the CMP actuator solenoid valve seal and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.

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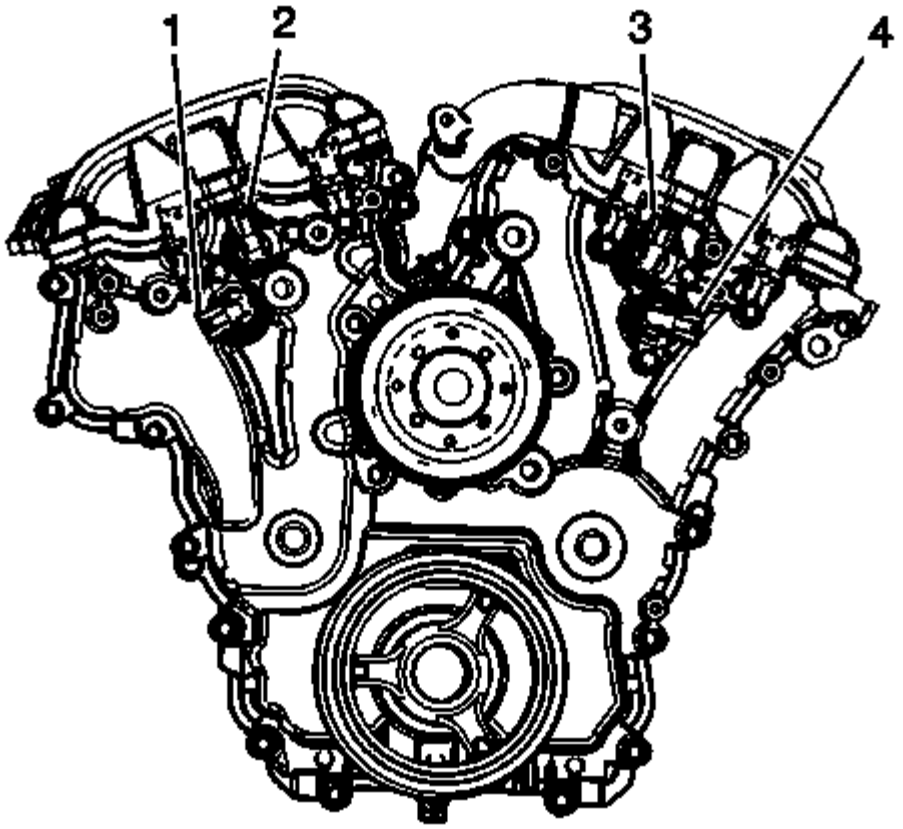

Fig. 183: Identifying CMP Actuator Solenoid Valve Bolt & Valve
Courtesy of GENERAL MOTORS COMPANY

2. Install the CMP actuator solenoid valve (2) and bolt.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 10 N.m (89 lb in).

3. Connect the engine wiring harness electrical connector (8) to the bank 1 intake CMP actuator solenoid valve.

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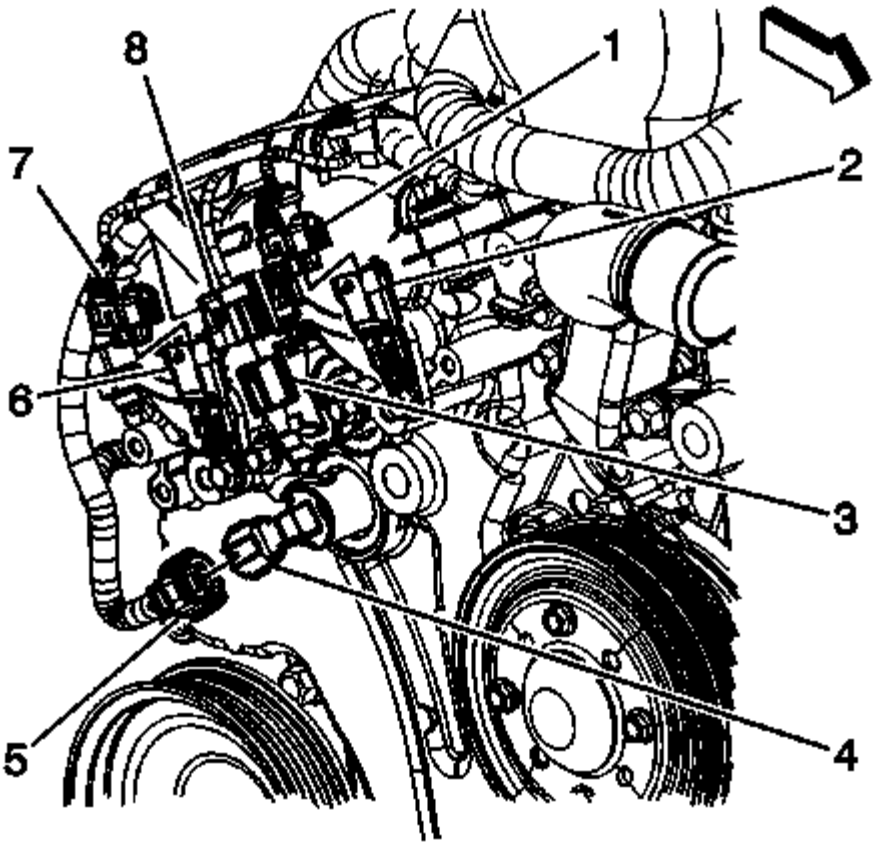

Fig. 184: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

Removal Procedure

1. Disconnect the engine wiring harness electrical connector (5) from the bank 1 exhaust camshaft position (CMP) actuator solenoid valve.

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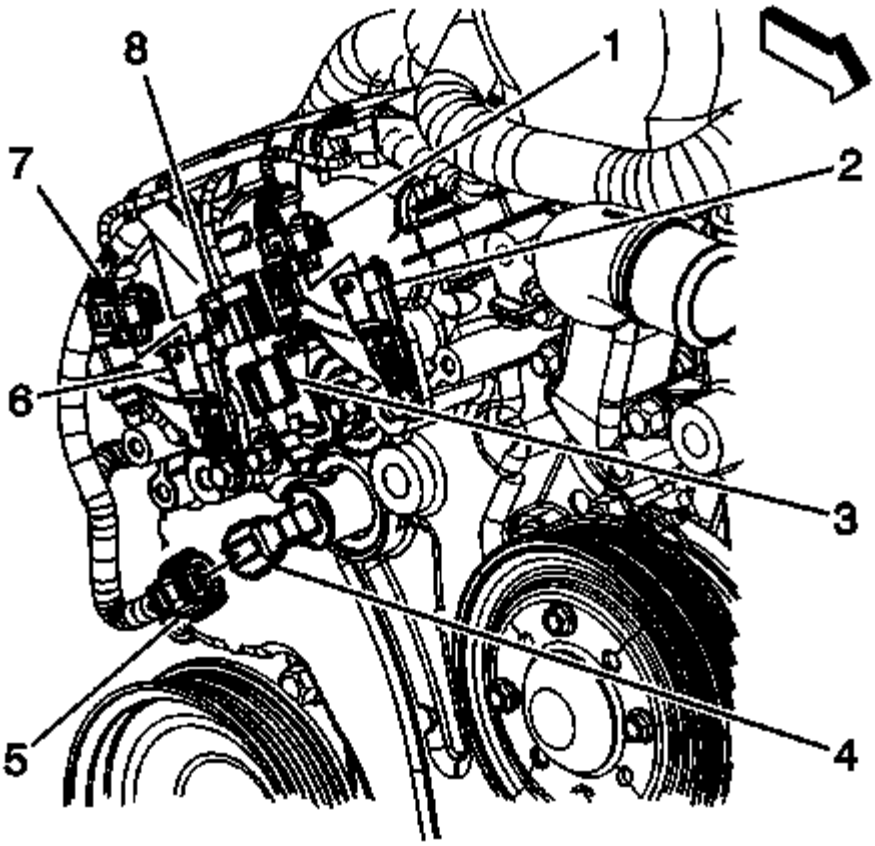

Fig. 185: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

2. Remove the CMP actuator solenoid valve bolt and valve (1).

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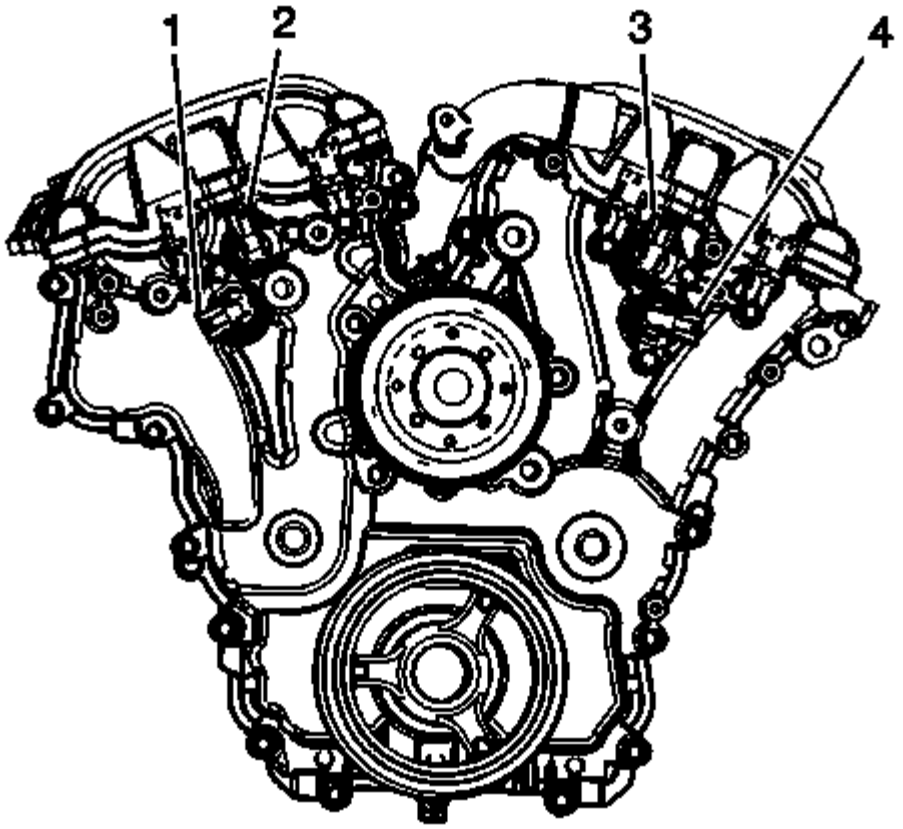

Fig. 186: Identifying CMP Actuator Solenoid Valve Bolt & Valve
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the CMP actuator solenoid valve seal and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.

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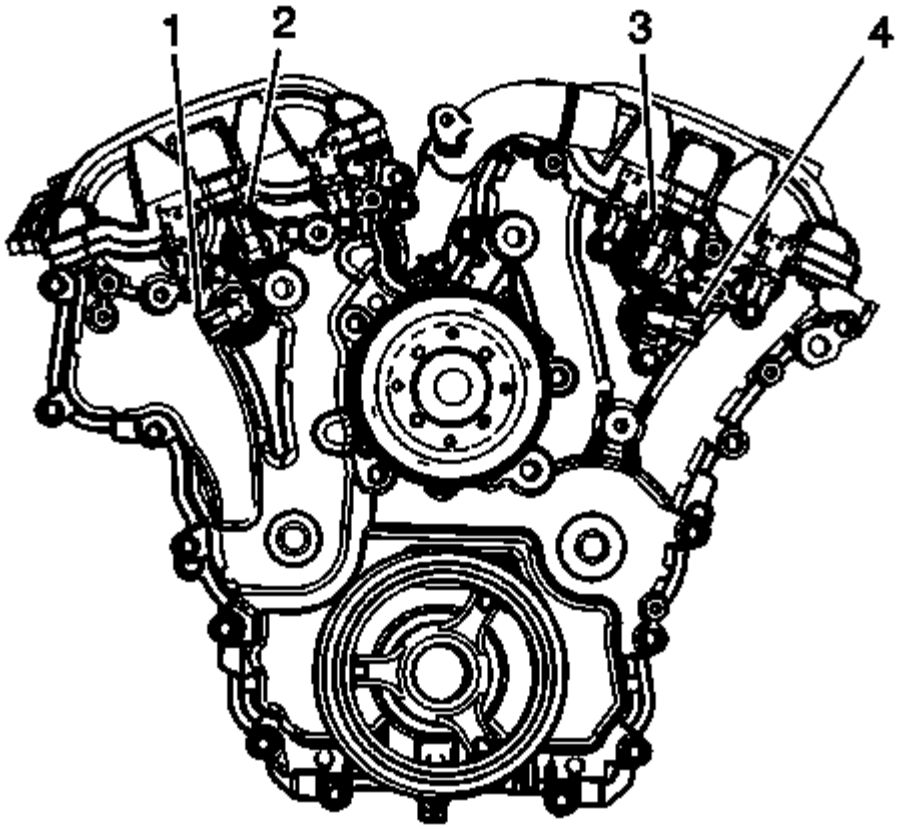

Fig. 187: Identifying CMP Actuator Solenoid Valve Bolt & Valve
Courtesy of GENERAL MOTORS COMPANY

2. Install the CMP actuator solenoid valve (1) and bolt.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 10 N.m (89 lb in).

3. Connect the engine wiring harness electrical connector (5) to the bank 1 exhaust CMP actuator solenoid valve.

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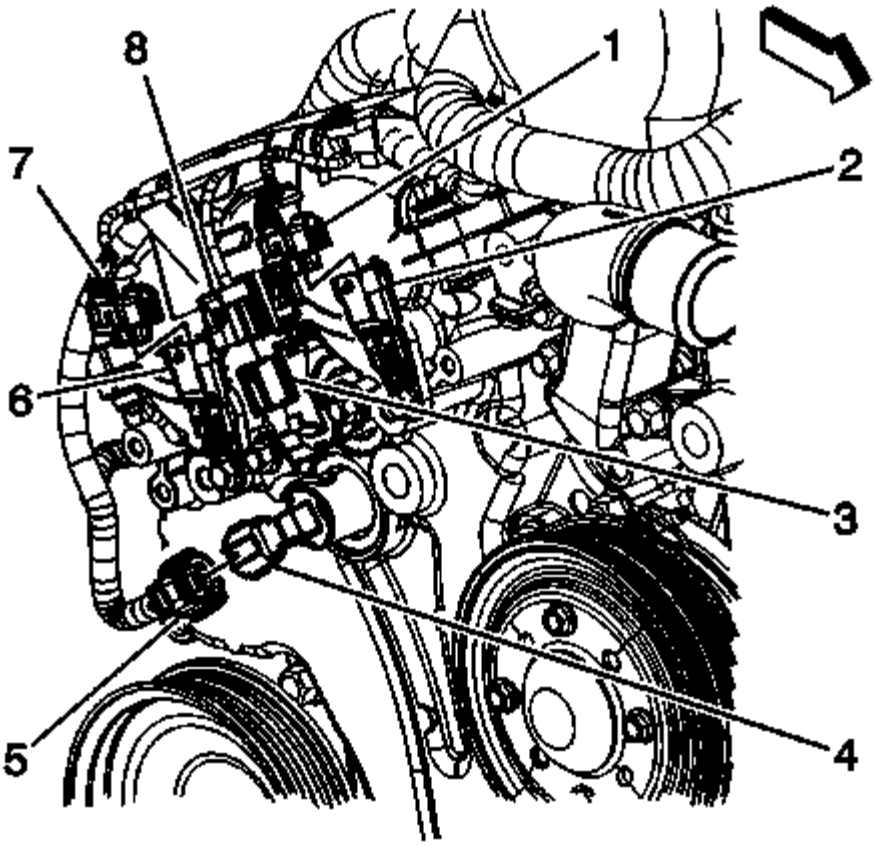

Fig. 188: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

Removal Procedure

1. Remove the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side** .

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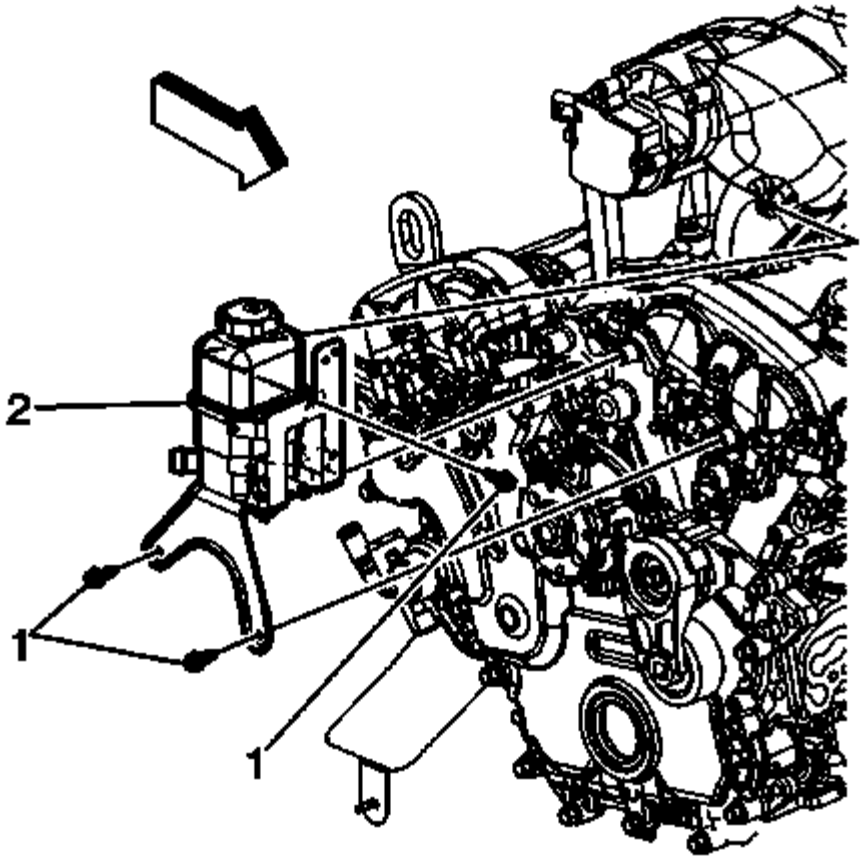

Fig. 189: Identifying Remote Power Steering Fluid Reservoir, Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the radiator inlet hose from the water outlet. Refer to **Radiator Inlet Hose Replacement** .
3. Remove the power steering fluid reservoir bracket bolts (1).
4. Remove and reposition the power steering fluid reservoir bracket (2) out of the way.
5. Disconnect the engine wiring harness electrical connector (6) from the bank 2 intake camshaft position (CMP) actuator solenoid valve.

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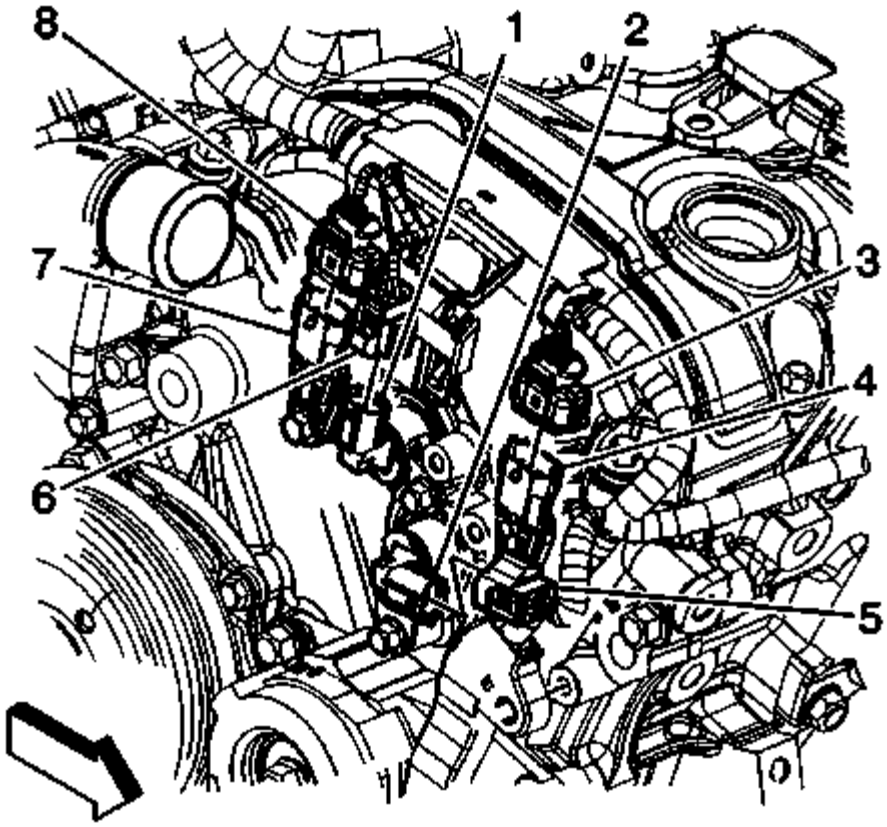

Fig. 190: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

6. Remove the CMP actuator solenoid valve bolt and valve (3).

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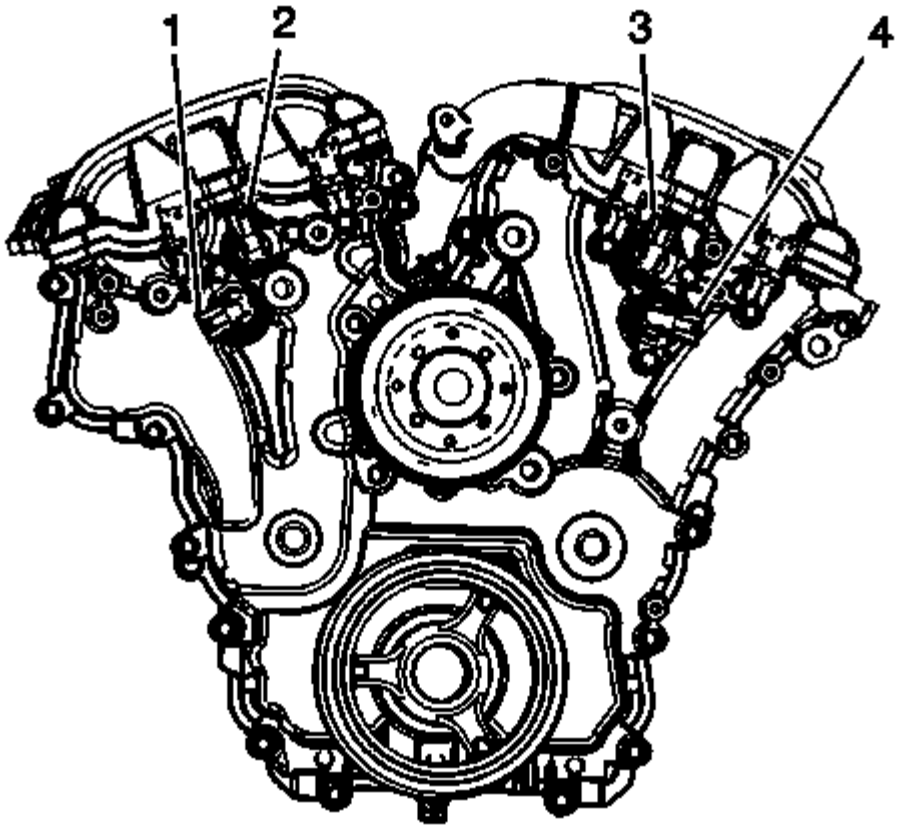

Fig. 191: Identifying CMP Actuator Solenoid Valve Bolt & Valve
Courtesy of GENERAL MOTORS COMPANY

7. Inspect the CMP actuator solenoid valve seal for damage and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.

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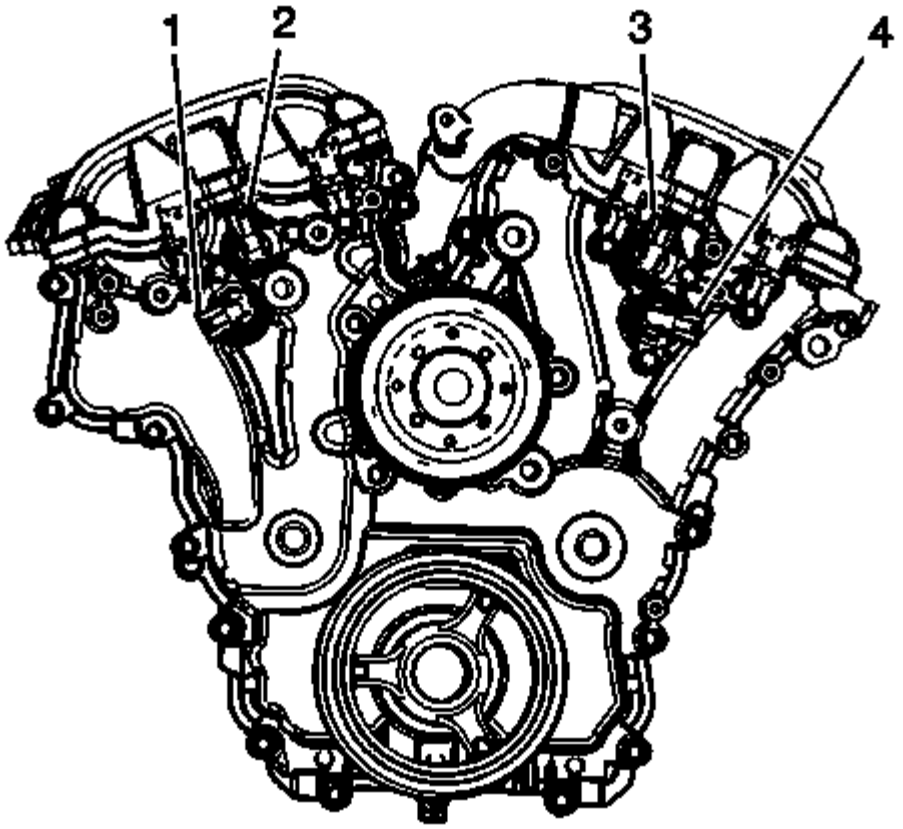

Fig. 192: Identifying CMP Actuator Solenoid Valve Bolt & Valve
Courtesy of GENERAL MOTORS COMPANY

2. Install the CMP actuator solenoid valve (3) and bolt.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 10 N.m (89 lb in).

3. Connect the engine wiring harness electrical connector (6) to the bank 2 intake CMP actuator solenoid valve.

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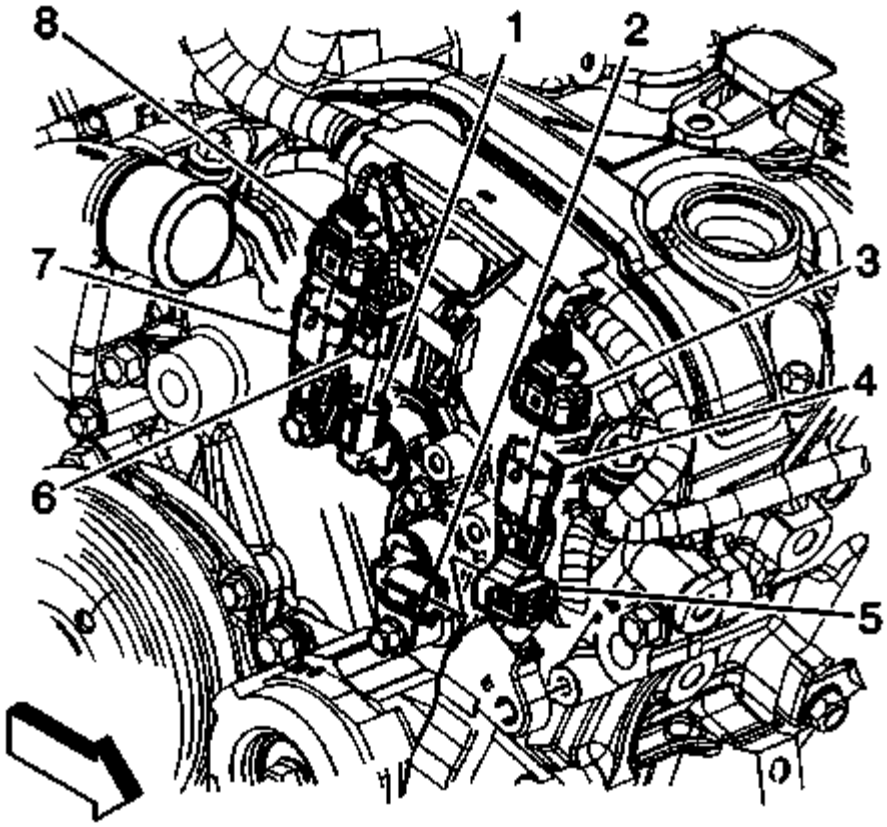

Fig. 193: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

4. Position and install the power steering fluid reservoir bracket (2).

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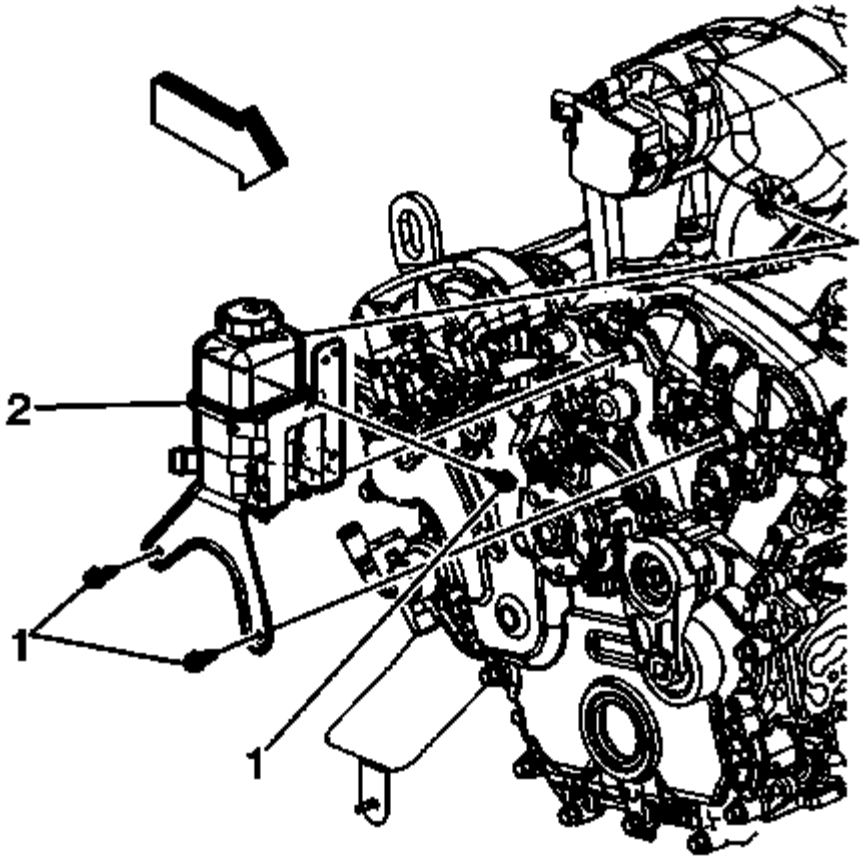

Fig. 194: Identifying Remote Power Steering Fluid Reservoir, Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the power steering fluid reservoir bracket bolts (1).

   Tighten

   Tighten the bolts to 9 N.m (80 lb in).

6. Install the radiator inlet hose to the water outlet. Refer to **Radiator Inlet Hose Replacement** .
7. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side** .

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

Removal Procedure

1. Remove the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side** .

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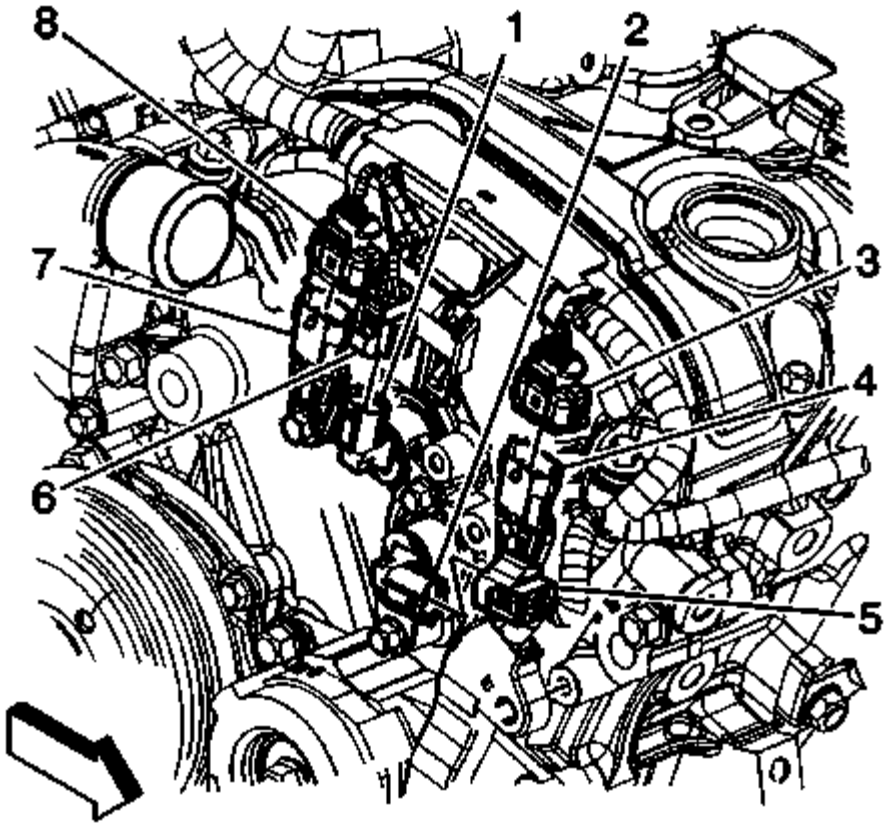

Fig. 195: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector (5) from the bank 2 exhaust camshaft position (CMP) actuator solenoid valve.
3. Remove the CMP actuator solenoid valve bolt and valve (4).

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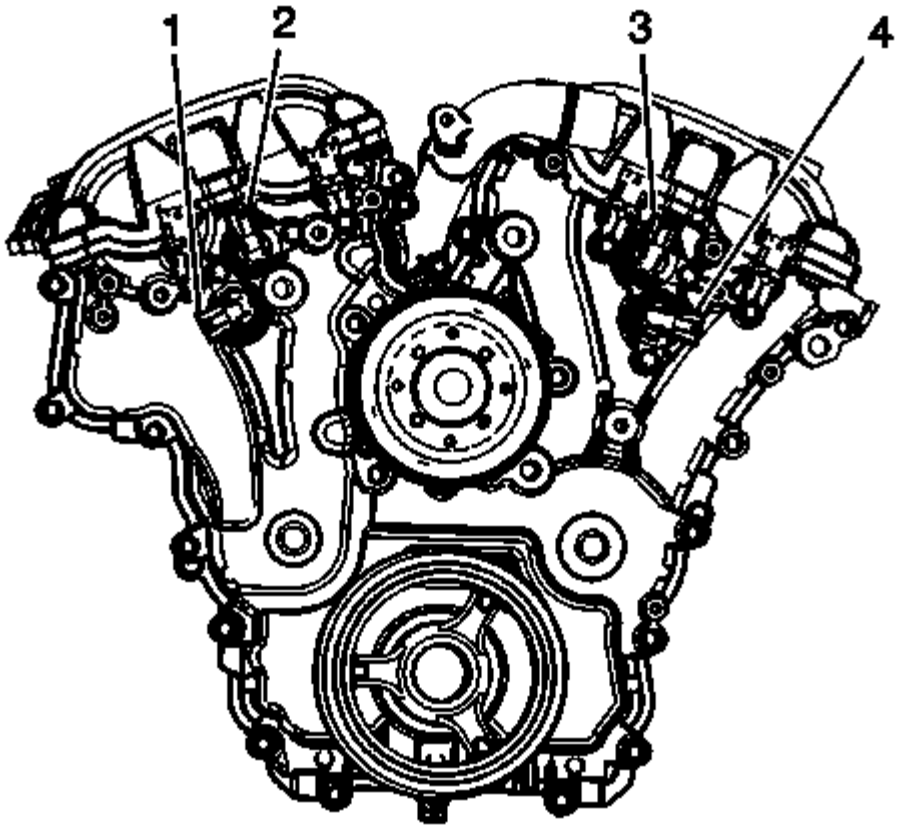

Fig. 196: Identifying CMP Actuator Solenoid Valve Bolt & Valve
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the CMP actuator solenoid valve seal for damage and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.

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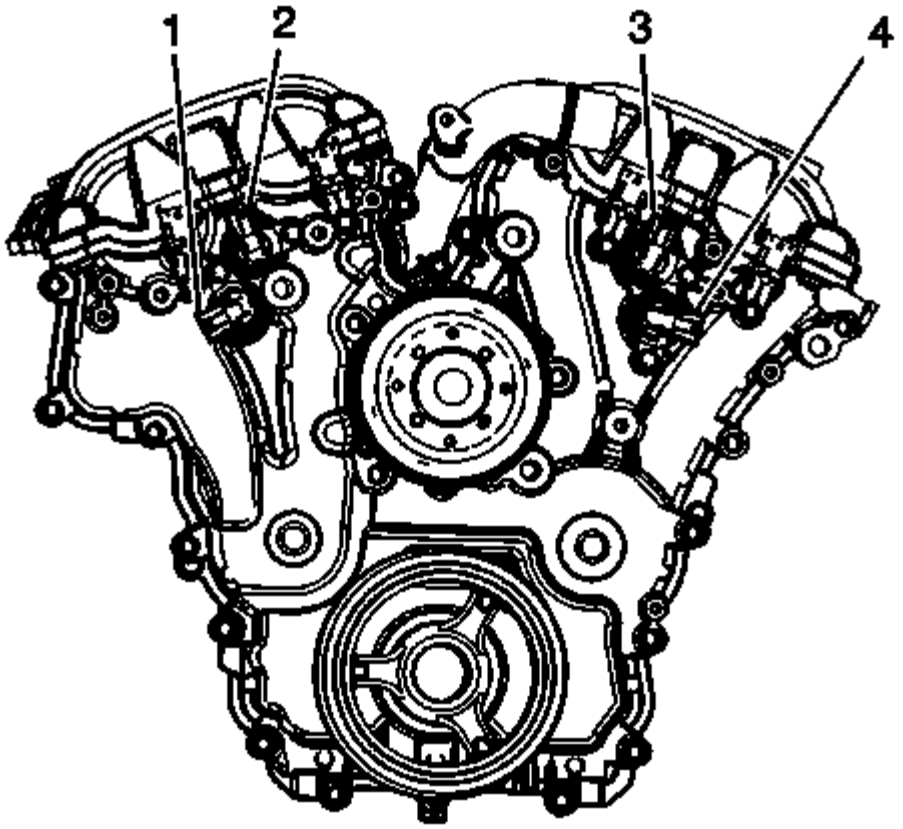

Fig. 197: Identifying CMP Actuator Solenoid Valve Bolt & Valve
Courtesy of GENERAL MOTORS COMPANY

2. Install the CMP actuator solenoid valve (4) and bolt.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 10 N.m (89 lb in).

3. Connect the engine wiring harness electrical connector (5) to the bank 2 exhaust CMP actuator solenoid valve.

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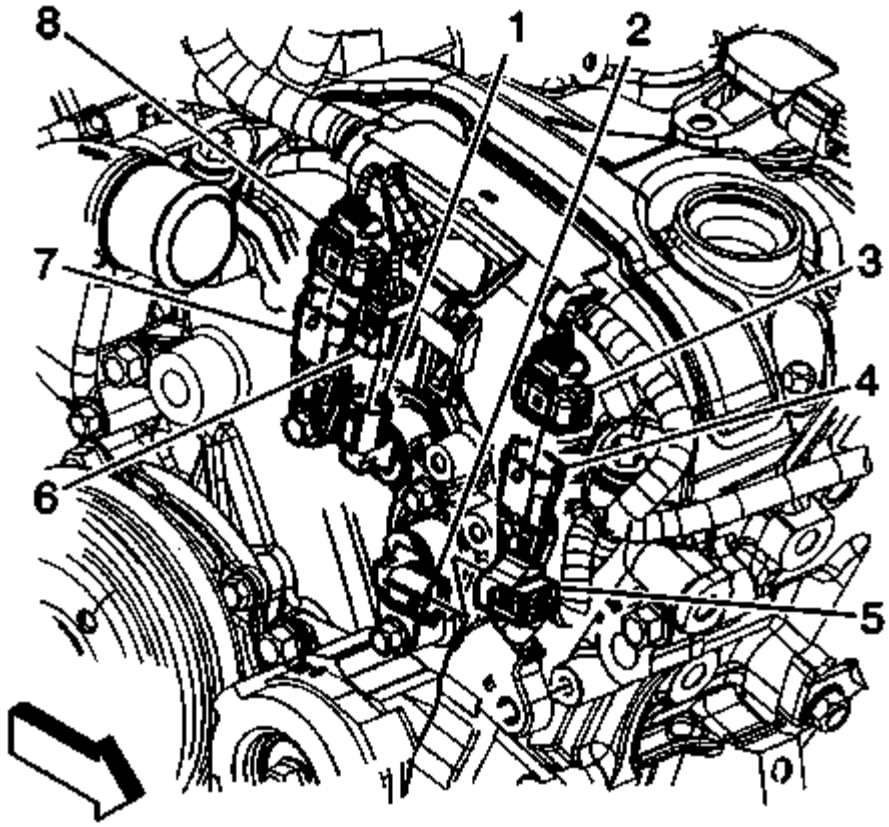

Fig. 198: Identifying Intake & Exhaust Camshaft Position (CMP) Sensors
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side** .

KNOCK SENSOR REPLACEMENT - BANK 1

Removal Procedure

1. Remove the exhaust manifold lower heat shield. Refer to **Exhaust Manifold Lower Heat Shield Replacement** .

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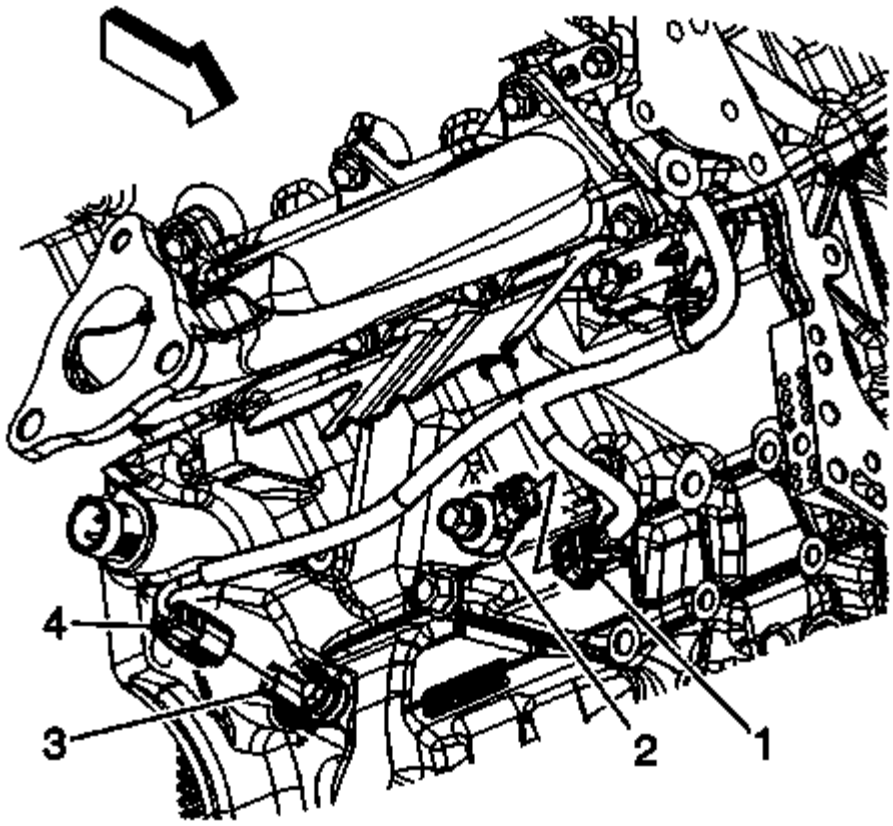

Fig. 199: Identifying Knock Sensor & Crankshaft Position (CKP) Sensor Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector (1) from the bank 1 knock sensor (2).
3. Loosen the knock sensor bolt and remove the knock sensor.

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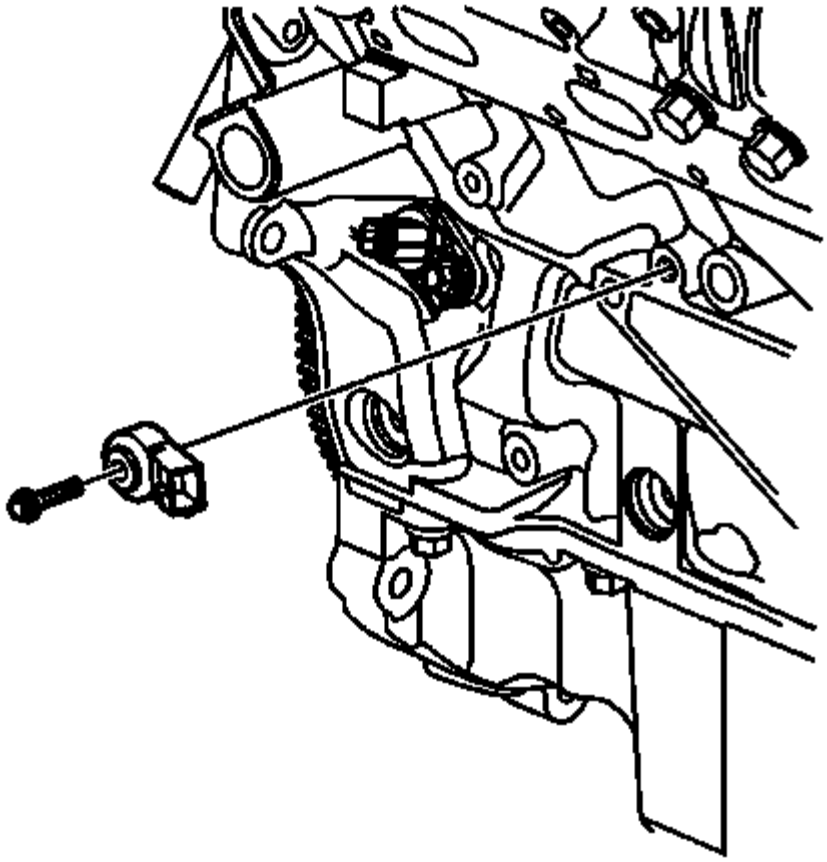

Fig. 200: View Of Right Knock Sensor & Bolt
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Position the knock sensor and tighten the knock sensor bolt.

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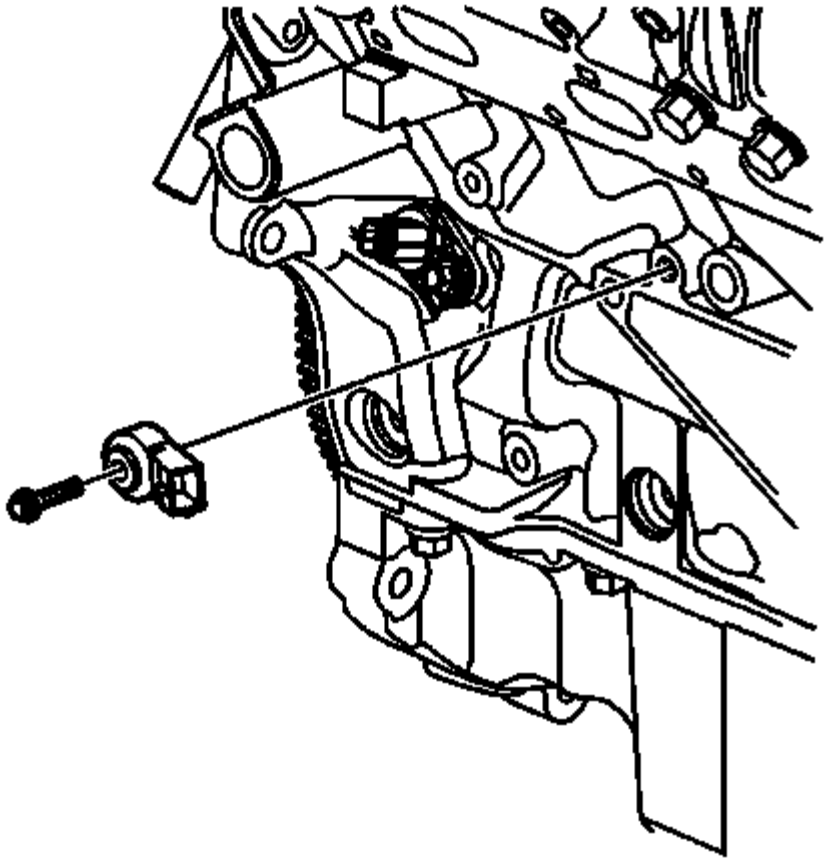

Fig. 201: View Of Right Knock Sensor & Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 23 N.m (17 lb ft).

2. Connect the engine wiring harness electrical connector (1) to the bank 1 knock sensor (2).

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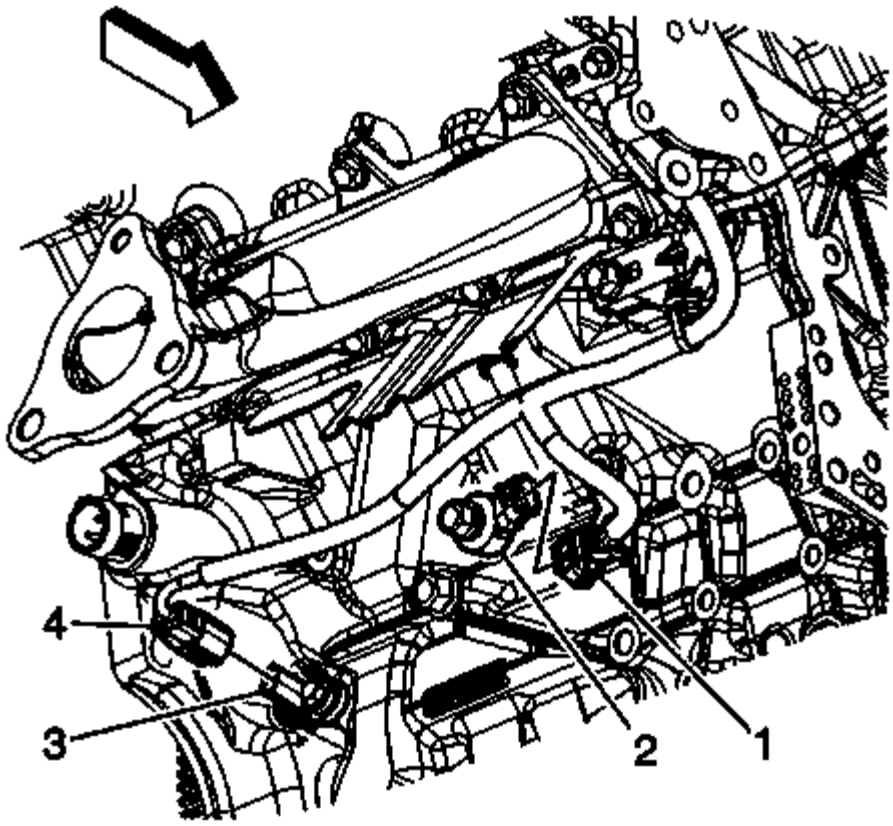

Fig. 202: Identifying Knock Sensor & Crankshaft Position (CKP) Sensor Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Install the exhaust manifold lower heat shield. Refer to **Exhaust Manifold Lower Heat Shield Replacement** .

KNOCK SENSOR REPLACEMENT - BANK 2

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

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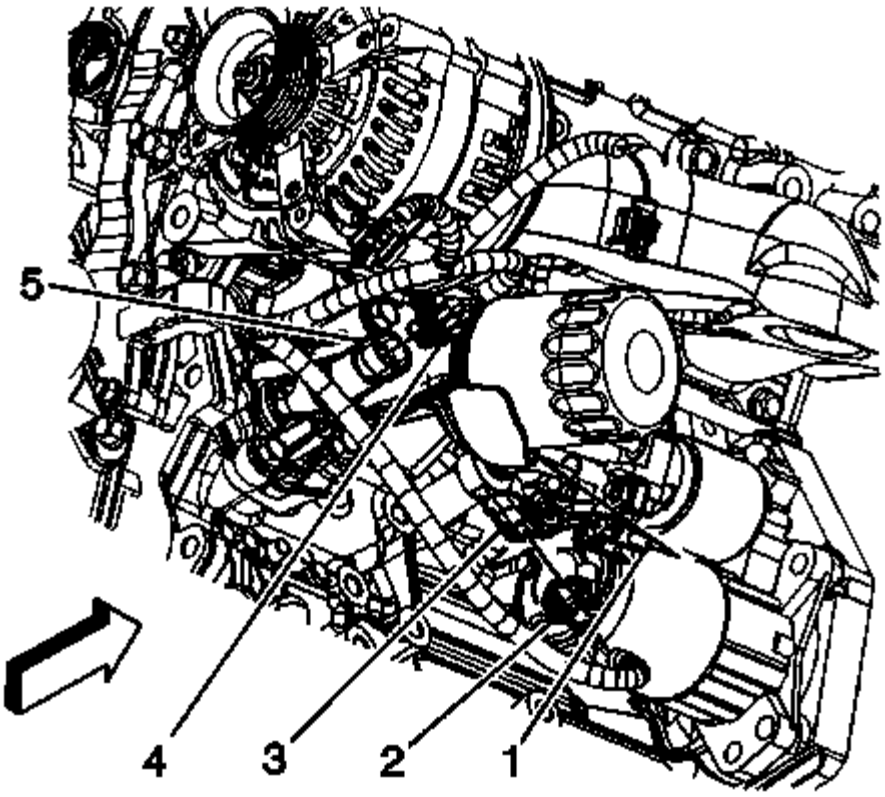

Fig. 203: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil filter. Refer to **Engine Oil and Oil Filter Replacement** .
3. Lower the vehicle.
4. Disconnect the engine wiring harness electrical connector (2) from the bank 2 knock sensor (3).
5. Loosen the knock sensor bolt and remove the knock sensor.

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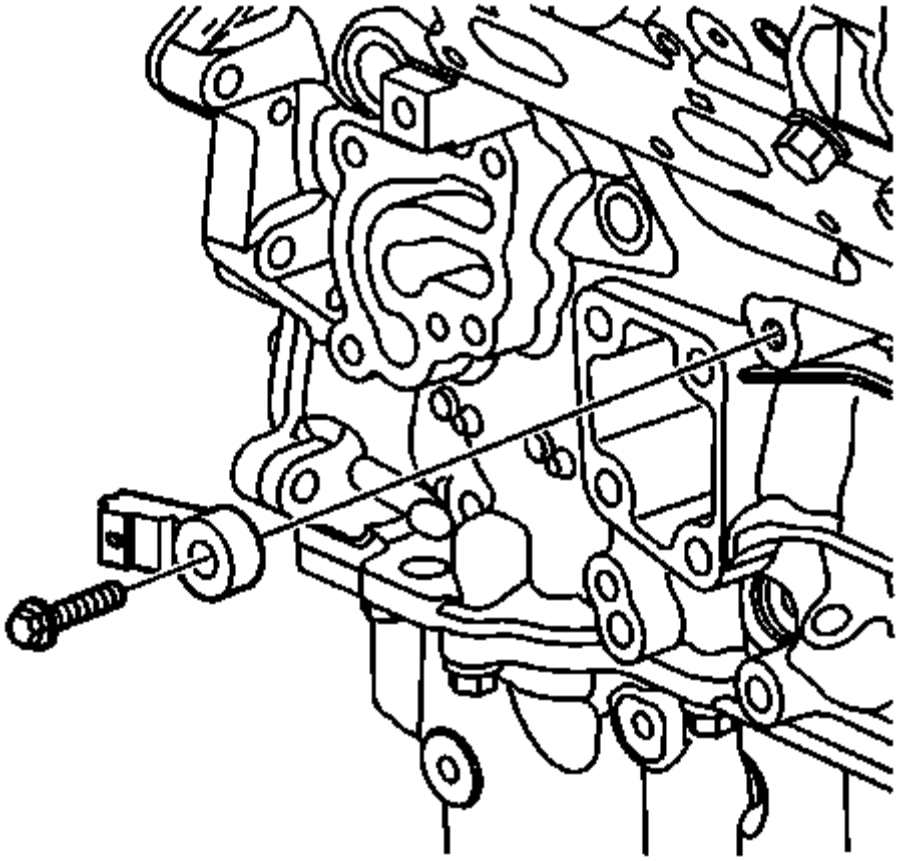

Fig. 204: View Of Left Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Position the knock sensor and tighten the knock sensor bolt.

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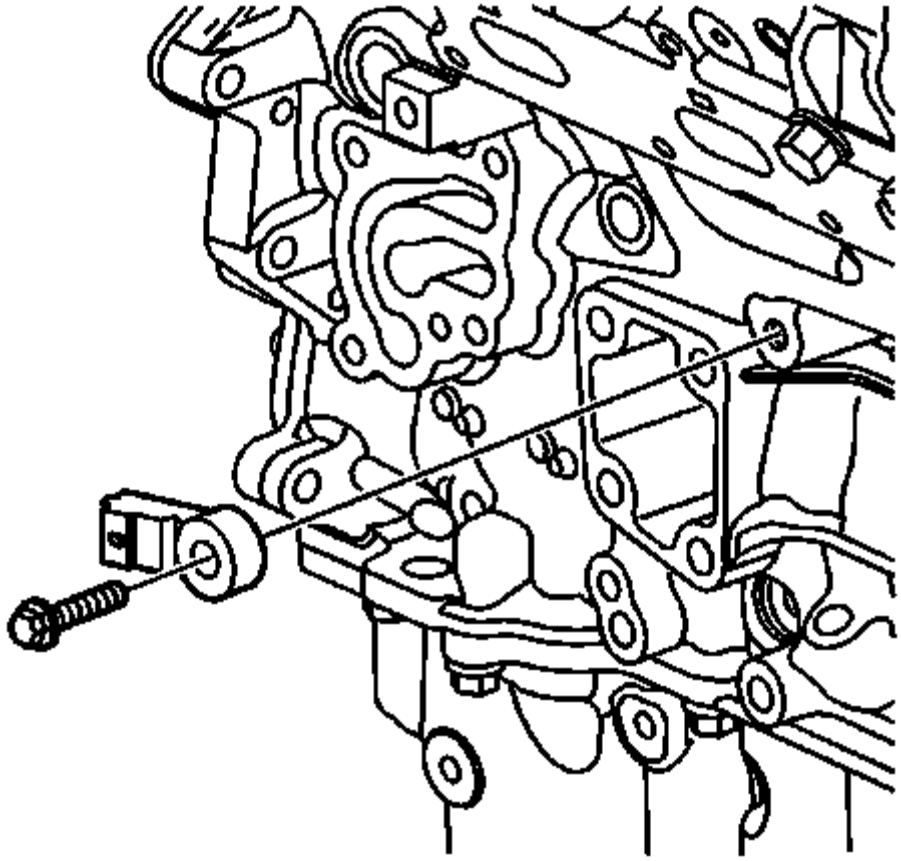

Fig. 205: View Of Left Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the bolt to 23 N.m (17 lb ft).

2. Connect the engine wiring harness electrical connector (2) to the bank 2 knock sensor (3).

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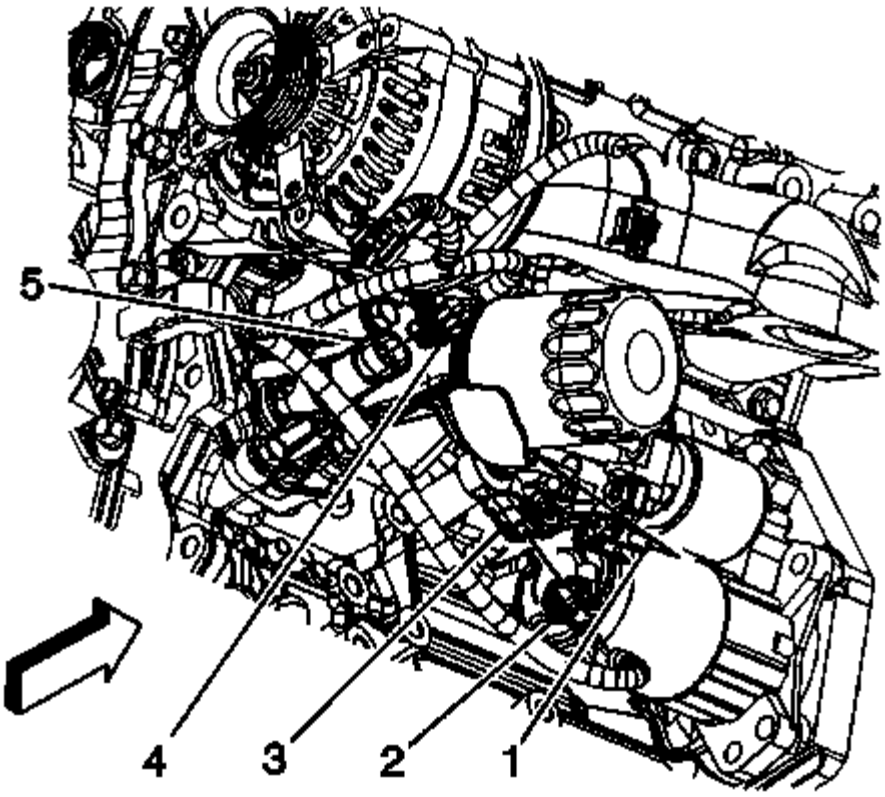

Fig. 206: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Install a NEW engine oil filter. Refer to **Engine Oil and Oil Filter Replacement** .
5. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

AIR CLEANER ELEMENT REPLACEMENT

Removal Procedure

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

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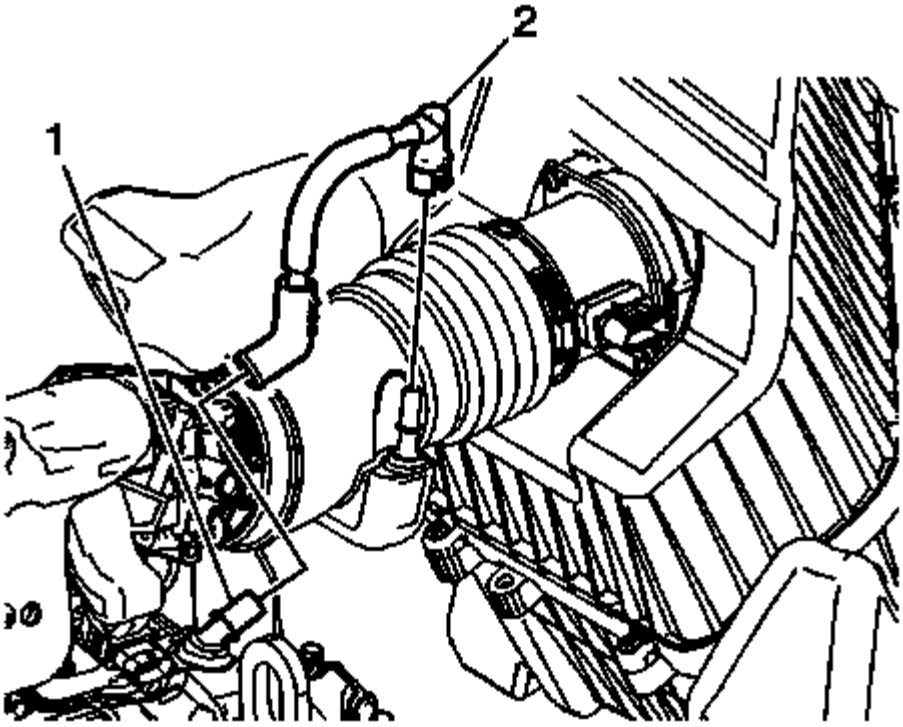

Fig. 207: Identifying Fresh Air Tube & Related Components
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the PCV quick disconnect (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Disconnect the engine wiring harness electrical connector from the mass airflow (MAF)/intake air temperature (IAT) sensor.
4. Disconnect the windshield washer hose clip from the corner of the air cleaner housing.
5. Loosen the air cleaner outlet duct clamp (1) at the throttle body.

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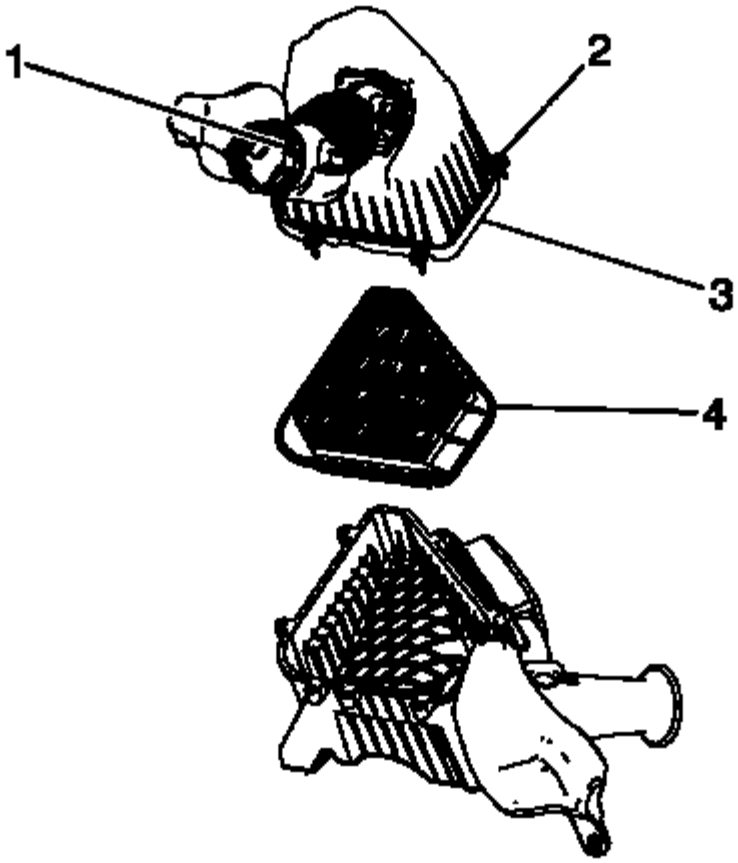

Fig. 208: Identifying Air Cleaner Components
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the 6 air cleaner housing cover screws (2).
7. Separate the air cleaner outlet duct from the throttle body.
8. Remove the air cleaner housing cover (3) (with outlet duct).
9. Remove and discard the air cleaner element (4).

Installation Procedure

1. Install a NEW air cleaner element (4).

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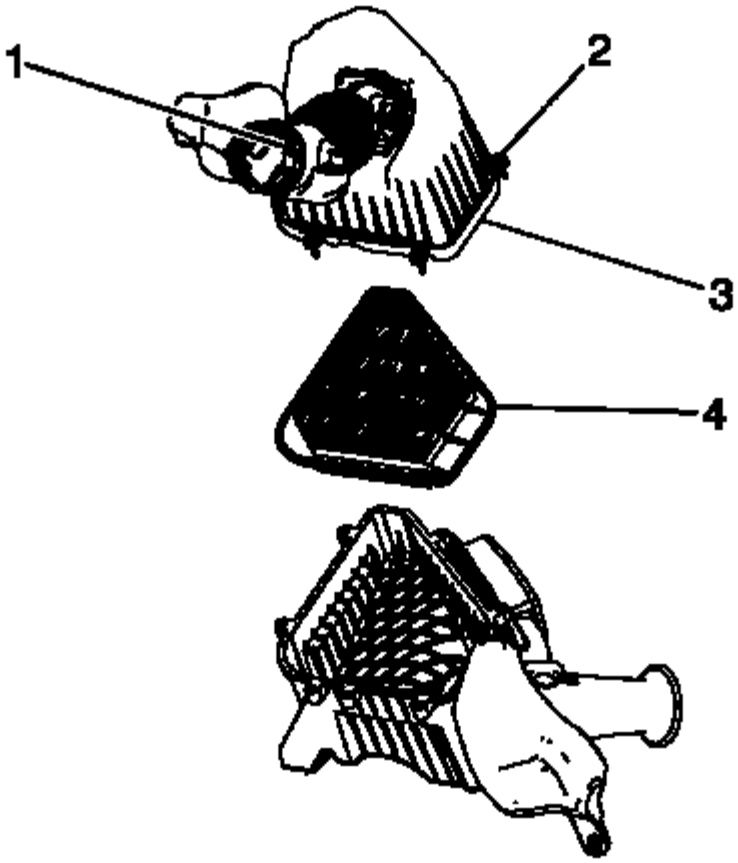

Fig. 209: Identifying Air Cleaner Components
Courtesy of GENERAL MOTORS COMPANY

2. Position the air cleaner housing cover (3) (with outlet duct) onto the air cleaner lower housing.
3. Connect the windshield washer hose clip to the air cleaner housing cover.

NOTE: Ensure the windshield washer hose is routed properly and not trapped between the upper cover and lower housing.

4. Install the air cleaner outlet duct onto the throttle body.
5. Tighten the 6 air cleaner housing cover screws (2).
6. Tighten the air cleaner outlet duct clamp (1) at the throttle body.

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the clamp to 4 N.m (35 lb in).

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7. Connect the engine wiring harness electrical connector to the MAF/IAT sensor.

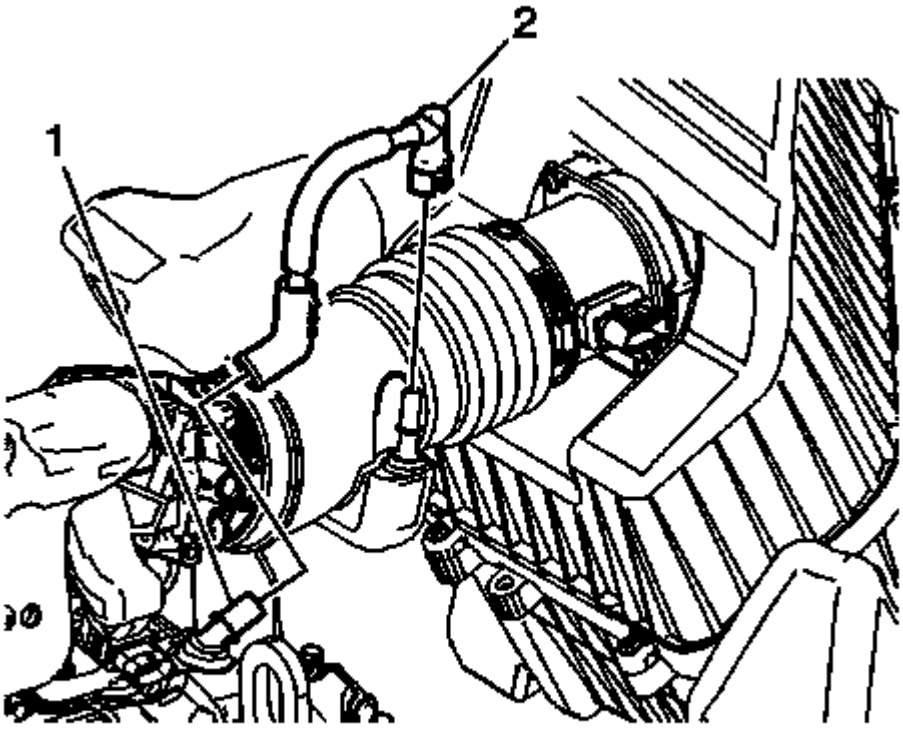

Fig. 210: Identifying Fresh Air Tube & Related Components
Courtesy of GENERAL MOTORS COMPANY

8. Connect the PCV quick disconnect (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

AIR CLEANER ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the air cleaner element. Refer to **Air Cleaner Element Replacement**.

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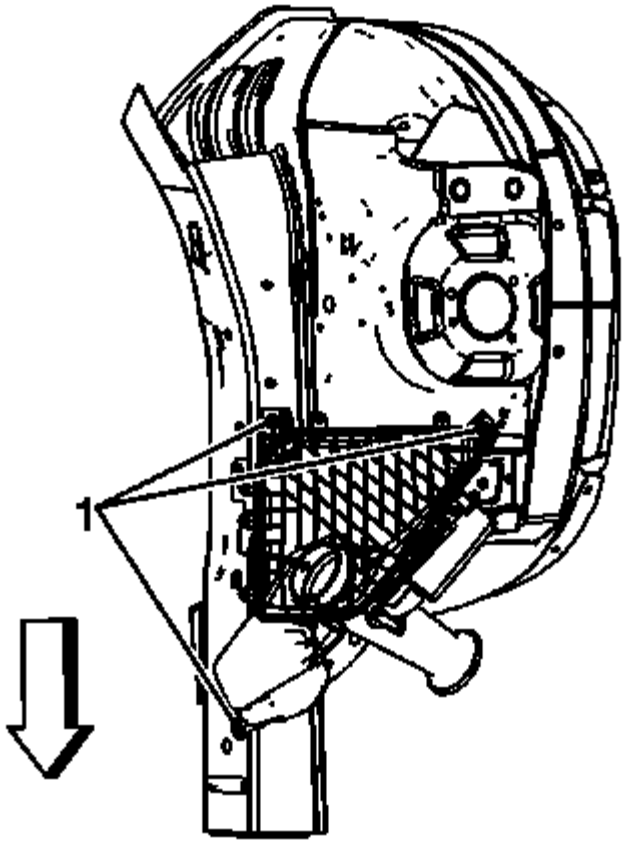

Fig. 211: Identifying Air Cleaner Lower Housing Screws
Courtesy of GENERAL MOTORS COMPANY

2. Remove the air cleaner lower housing screws (1).
3. Remove the hood release cable clip (1) from the air cleaner lower housing.

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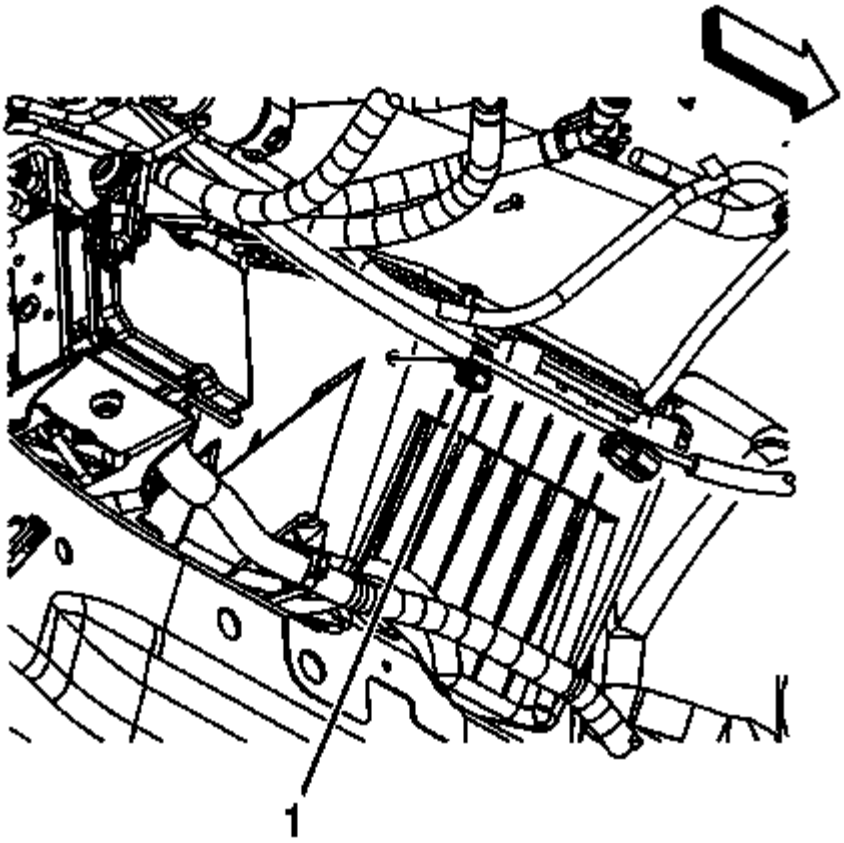

Fig. 212: Identifying Hood Release Cable Clip
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel feed pipe (2) quick connect fitting from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.

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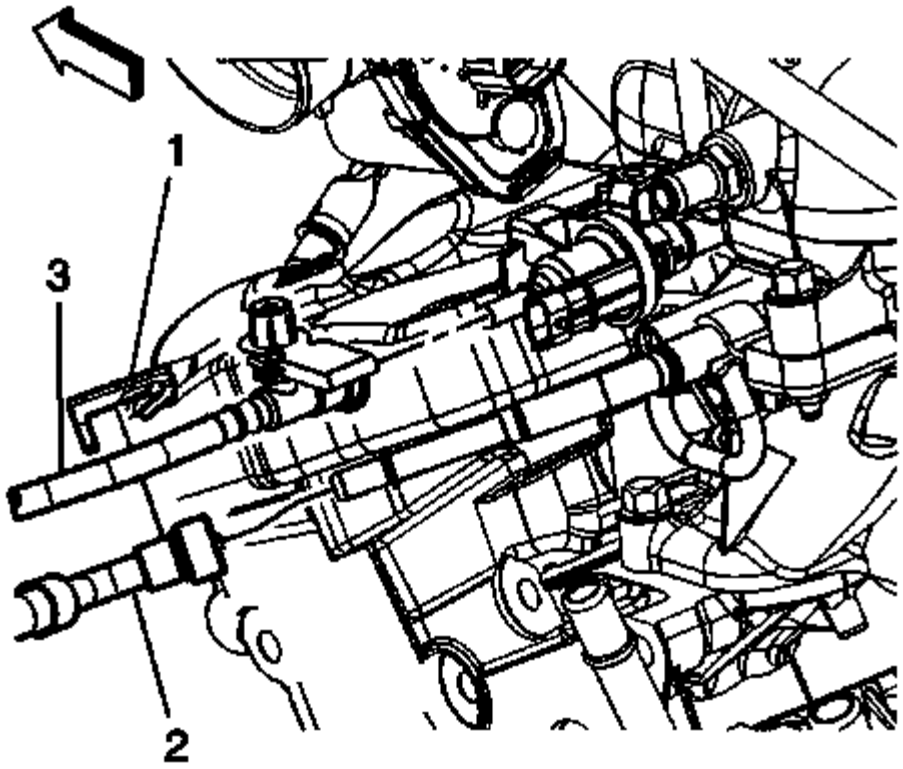

Fig. 213: View Of EVAP Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the evaporative emission (EVAP) pipe (3) quick connect fitting from the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Gently lift up the retaining tab (1) and remove the ECM from the bracket, reposition out of the way.

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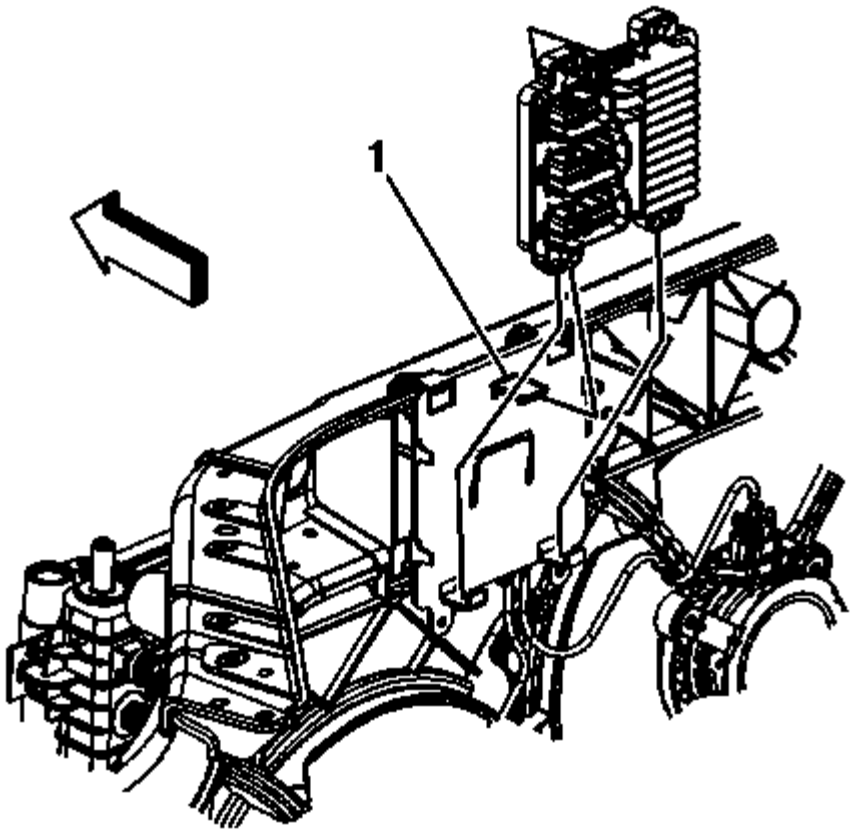

Fig. 214: Identifying ECM Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

NOTE: The engine control module (ECM) electrical connector do not need to be disconnected in order to reposition the ECM.

7. Remove the air cleaner lower housing.

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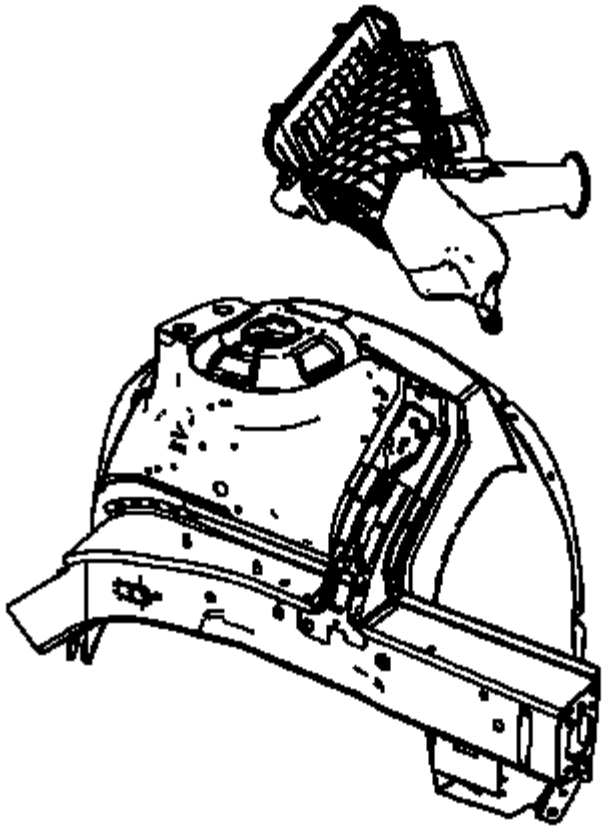

Fig. 215: Identifying Air Cleaner Lower Housing
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Position the air cleaner lower housing to the side rail.

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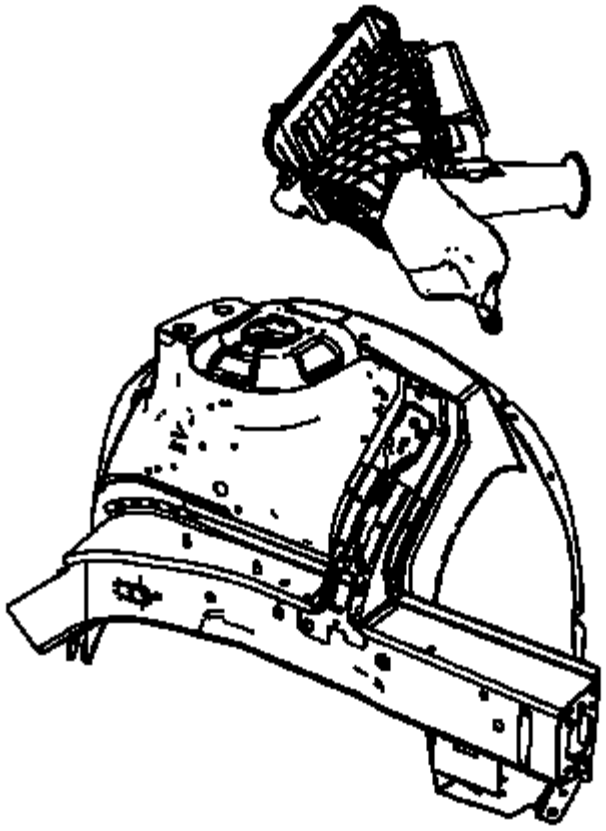

Fig. 216: Identifying Air Cleaner Lower Housing
Courtesy of GENERAL MOTORS COMPANY

2. Position and install the ECM to the bracket.

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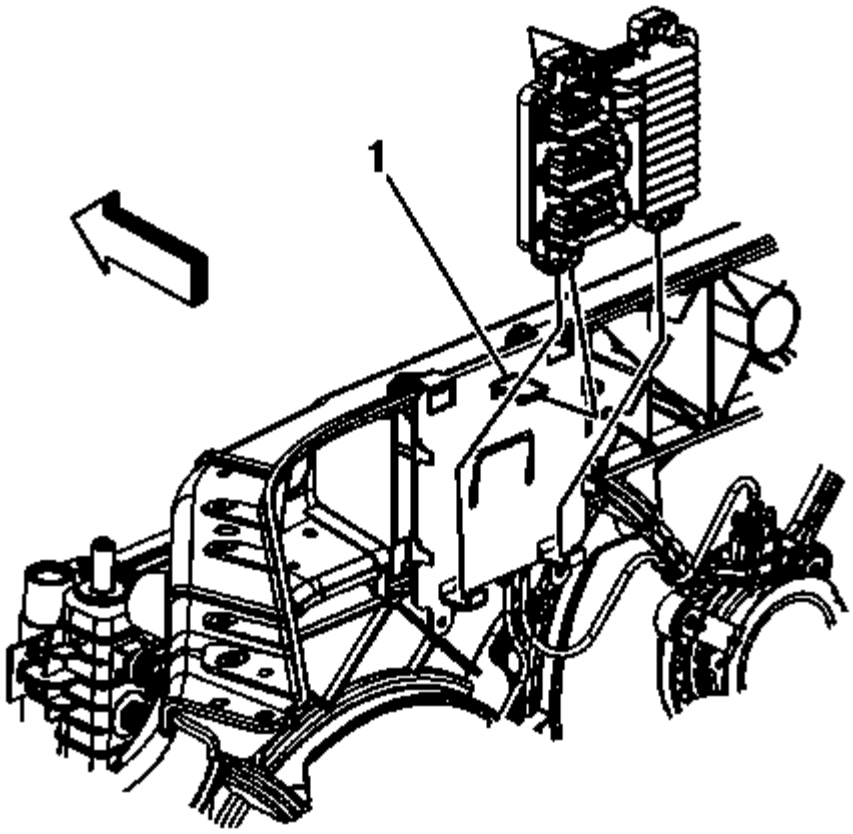

Fig. 217: Identifying ECM Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

3. Connect the evaporative emission (EVAP) pipe (3) quick connect fitting to the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.

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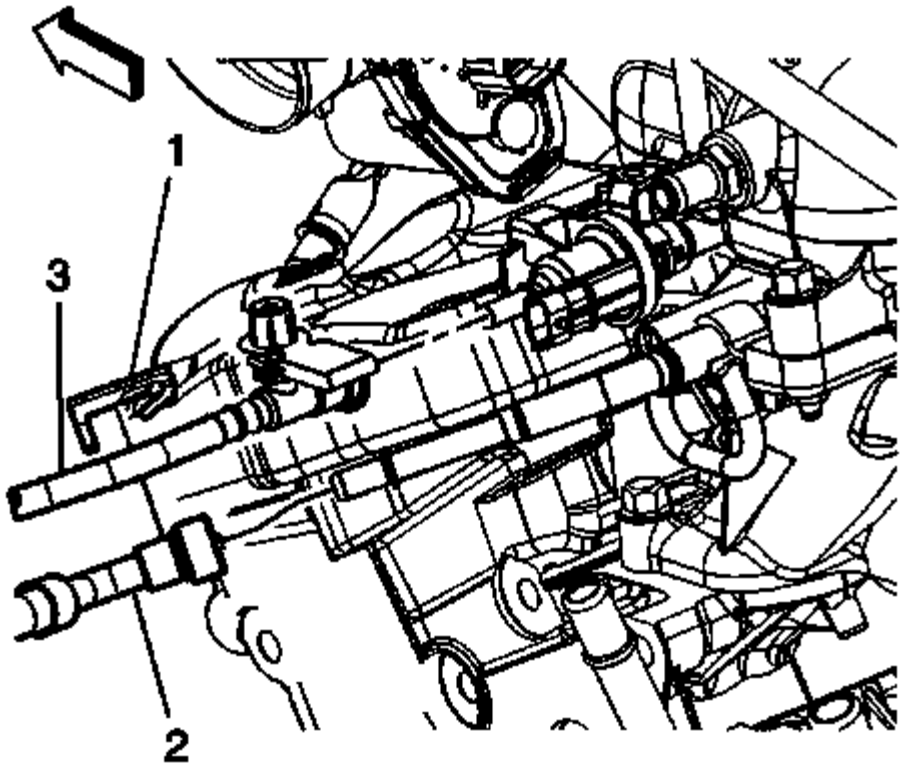

Fig. 218: View Of EVAP Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Connect the fuel feed pipe (2) quick connect fitting to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
5. Install the hood release cable clip (1) to the air cleaner lower housing.

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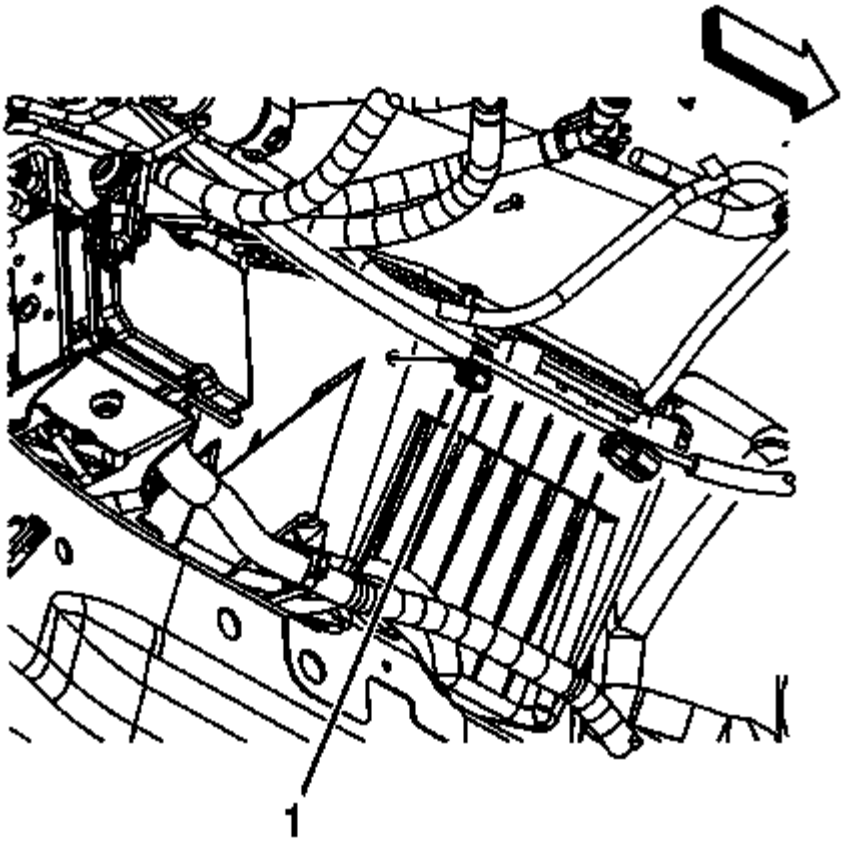

Fig. 219: Identifying Hood Release Cable Clip
Courtesy of GENERAL MOTORS COMPANY

6. Install the air cleaner lower housing screws (1).

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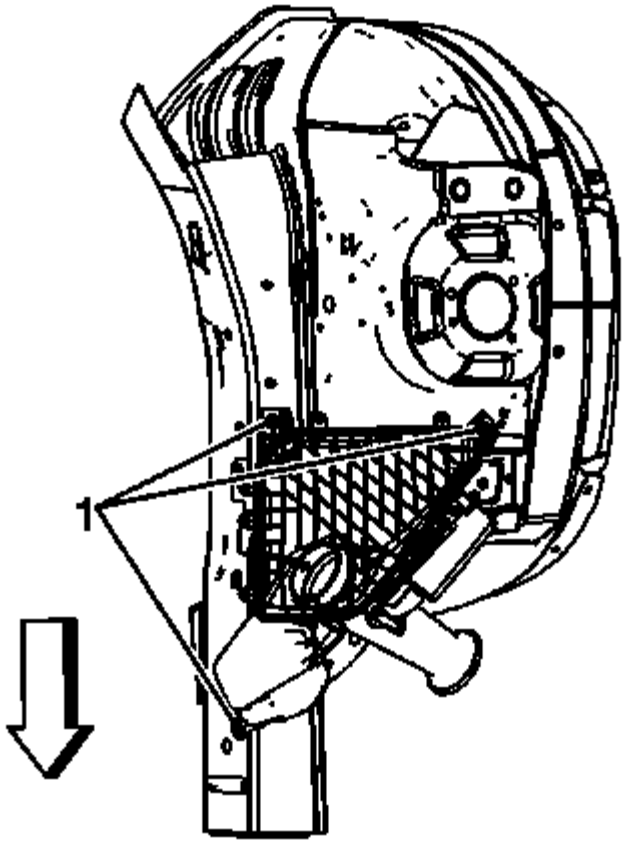

Fig. 220: Identifying Air Cleaner Lower Housing Screws
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Tighten

Tighten the screws to 9 N.m (80 lb in).

7. Install the air cleaner element. Refer to **Air Cleaner Element Replacement**.

AIR CLEANER OUTLET DUCT REPLACEMENT

Removal Procedure

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

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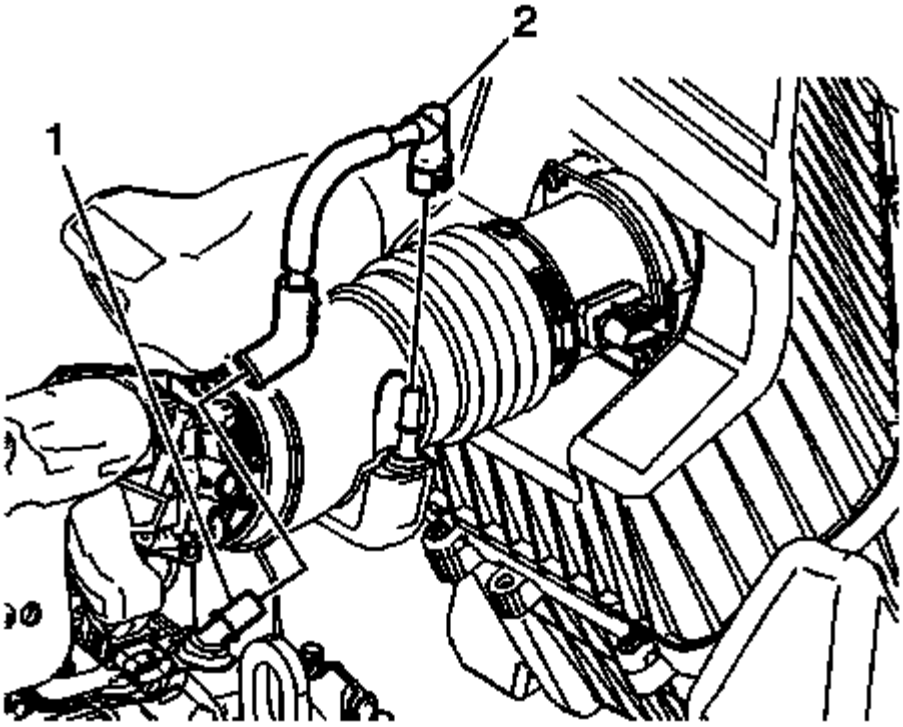

Fig. 221: Identifying Fresh Air Tube & Related Components
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the PCV quick disconnect (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Loosen the air cleaner outlet duct clamps (1) at the mass air flow (MAF)/intake air temperature (IAT) sensor and throttle body.

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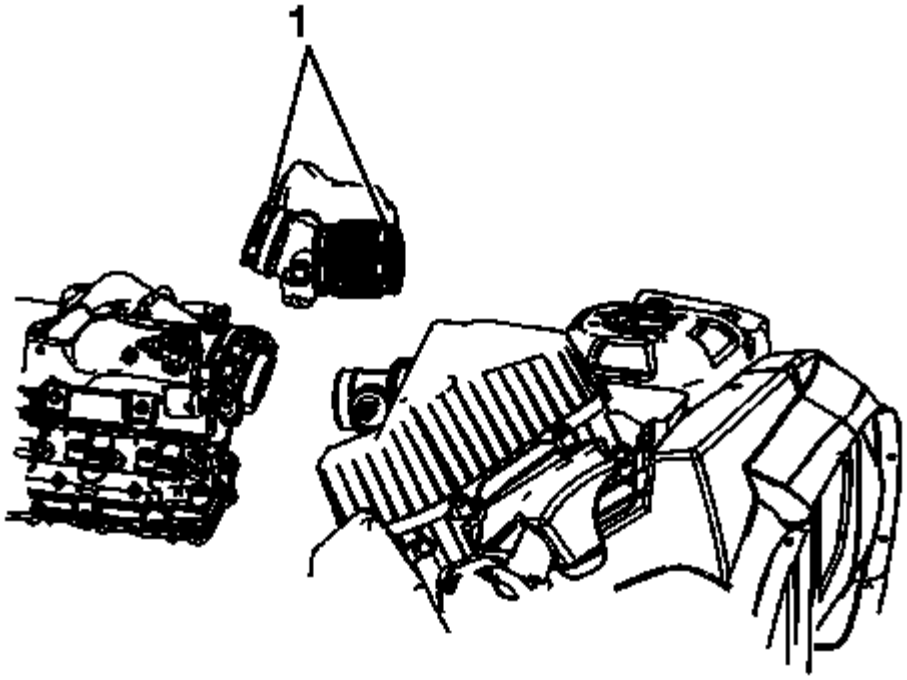

Fig. 222: View Of Air Cleaner Outlet Duct Clamps
Courtesy of GENERAL MOTORS COMPANY

4. Remove the air cleaner outlet duct.

Installation Procedure

1. Loosely Install the air cleaner outlet duct then install the fuel injector sight shield to ensure proper clearance.

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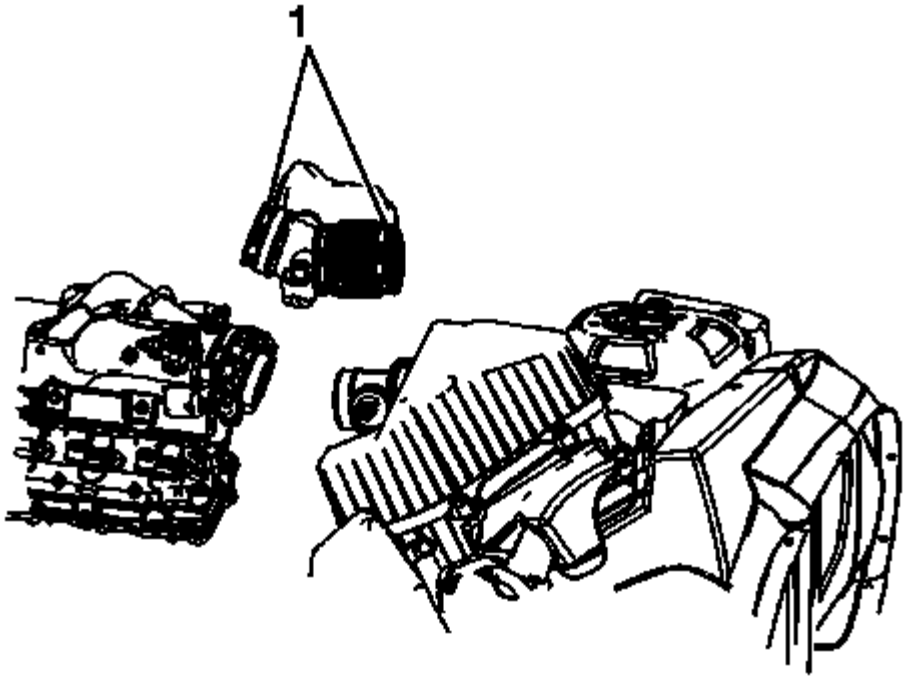

Fig. 223: View Of Air Cleaner Outlet Duct Clamps
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel injector sight shield.
3. Tighten the air cleaner outlet duct clamps (1) to 4 N.m (35 lb in) at the MAF/IAT sensor and throttle body.

CAUTION: Refer to Fastener Caution .

4. Connect the PCV quick disconnect (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

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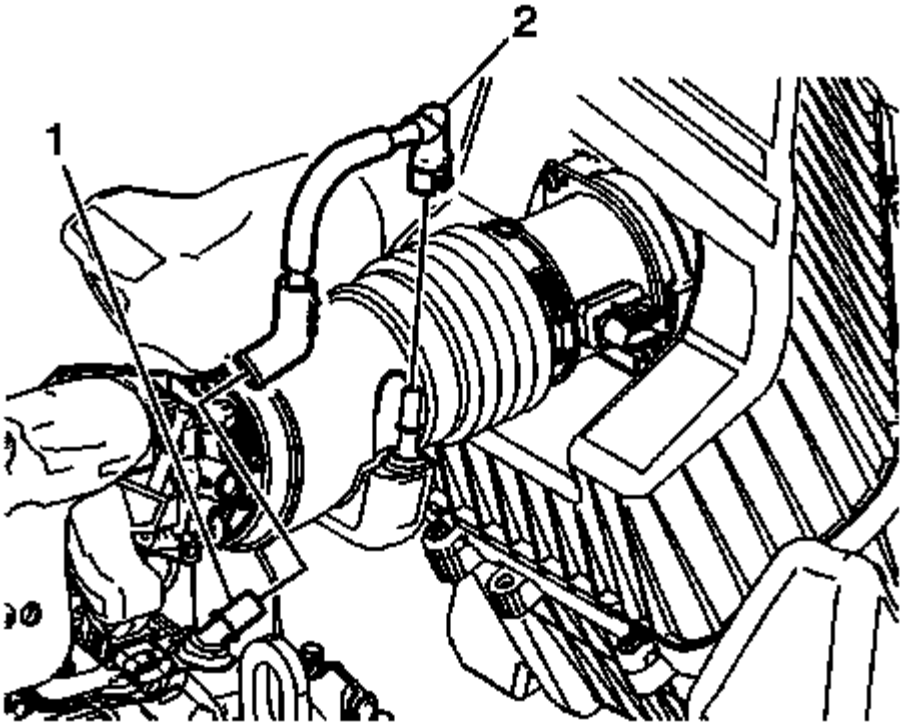

Fig. 224: Identifying Fresh Air Tube & Related Components
Courtesy of GENERAL MOTORS COMPANY

5. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .

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