

Engine

Engine Controls and Fuel - 3.6L (LFX LF3) - Repair Instructions - CTS Sedan

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
- 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. Ignition ON.

2. 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.**

3.

4. Engine Running at normal operating temperature, perform the scan tool Crankshaft Position Variation Learn procedure and follow the on screen instructions.

5. 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 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**
6. Clear all DTCs.
 7. Engine Running.
 8. 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**
9. 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

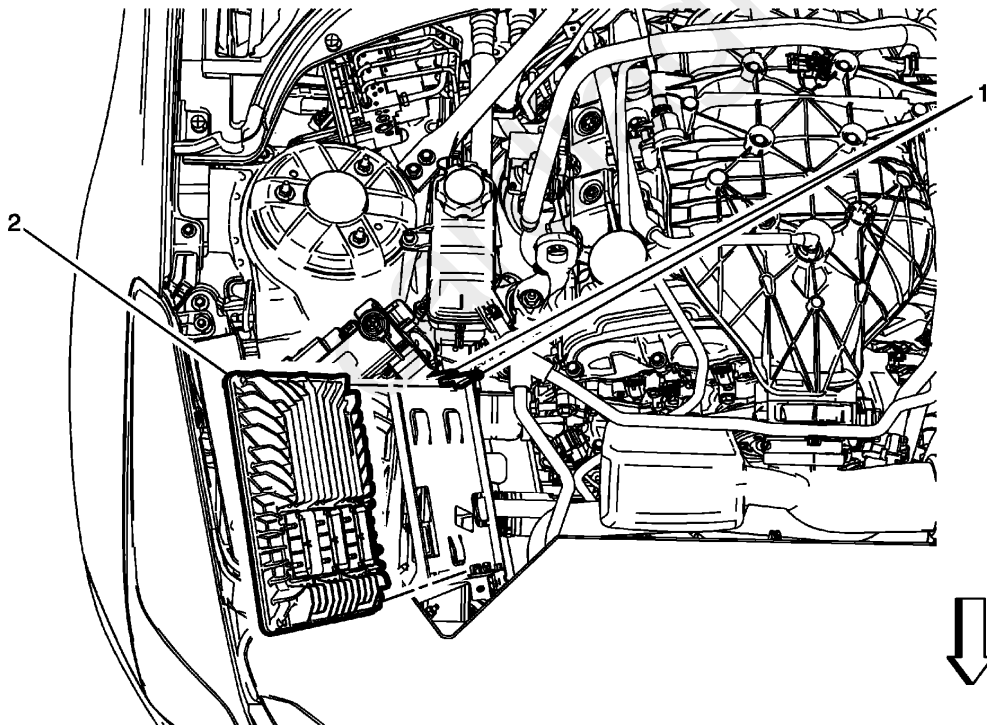


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS COMPANY

Engine Control Module Replacement

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the front compartment fuse block housing. Refer to <u>Front Compartment Fuse Block Housing Replacement</u> .	
1	Electronic Control Module Bracket Retaining Tabs
2	Electronic Control Module WARNING: Refer to <u>Safety Glasses Warning</u> . CAUTION: Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components. 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 not 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. Procedure 1. Disconnect the electrical connectors. 2. If replacing, program the ECM. Refer to <u>Control Module References</u> . NOTE: Before removing the engine control module (ECM), record the oil life percentage remaining. Use the scan tool to reset the Engine Oil Life remaining back to the original percentage recorded.

ENGINE CONTROL MODULE BRACKET REPLACEMENT

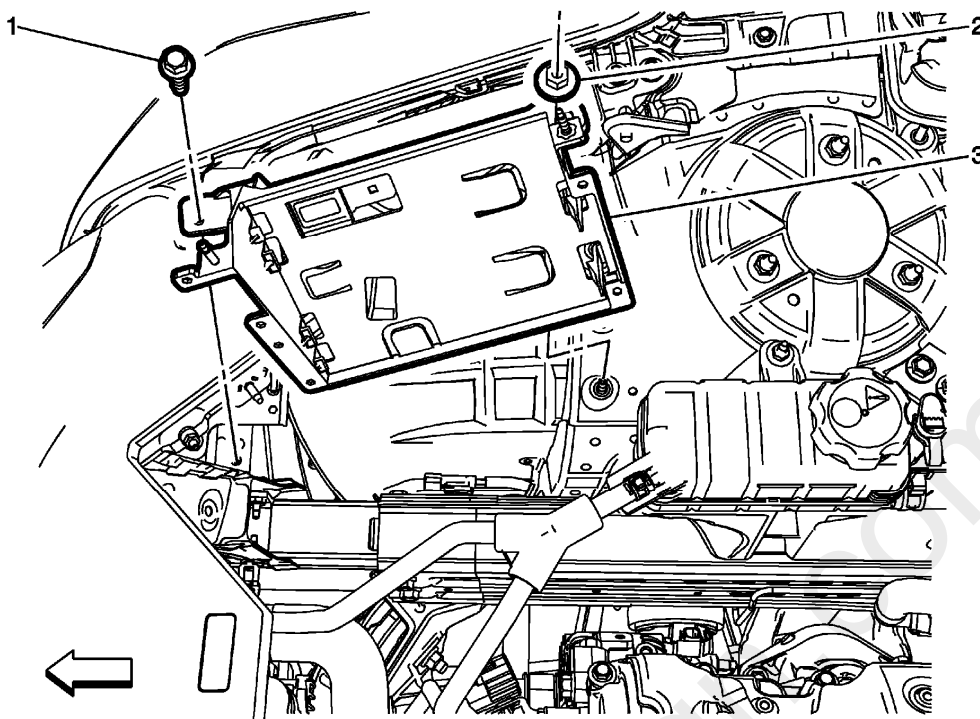


Fig. 2: Engine Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

Engine Control Module Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the engine control module. Refer to <u>Engine Control Module Replacement</u> .	
1	Engine Control Module Bracket Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7 (62 lb in)
2	Engine Control Module Bracket Nut Tighten 7 (62 lb in)
3	Engine Control Module Bracket

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.

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

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

1. Engine idling for 3 min.
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.

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.**

- 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.
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 (LFX)

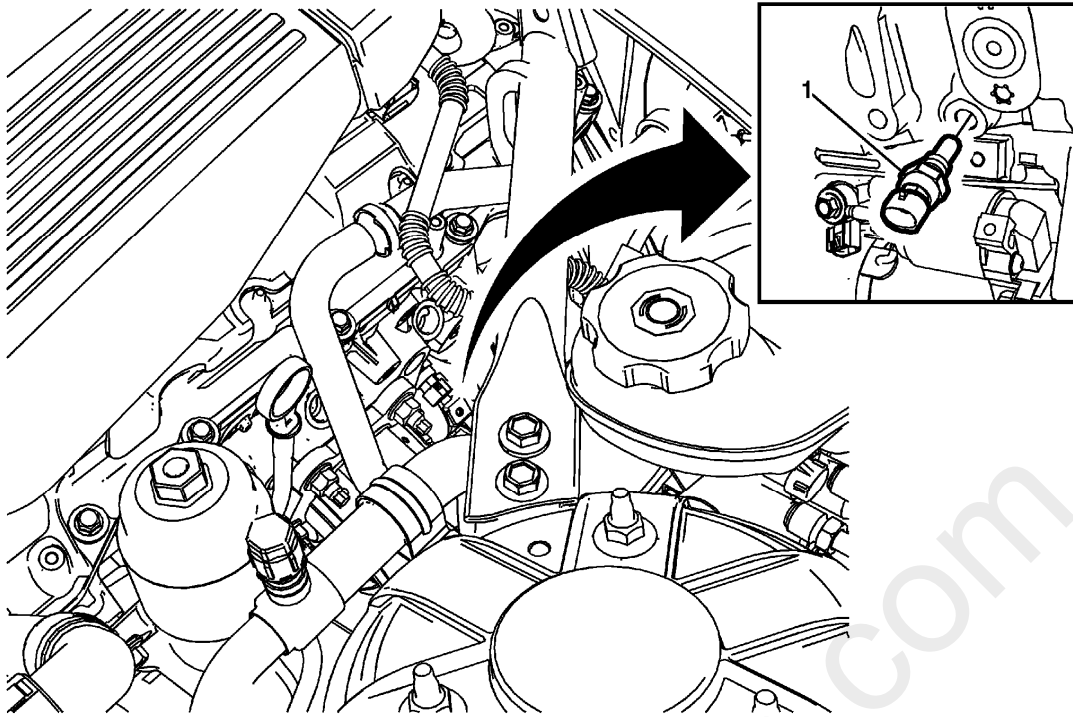


Fig. 3: Engine Coolant Temperature Sensor (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Temperature Sensor Replacement (LFX)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Engine Coolant Temperature Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the electrical wiring harness connector from the engine coolant temperature sensor. Tighten 20 N.m (35 lb ft)

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT (LF3)

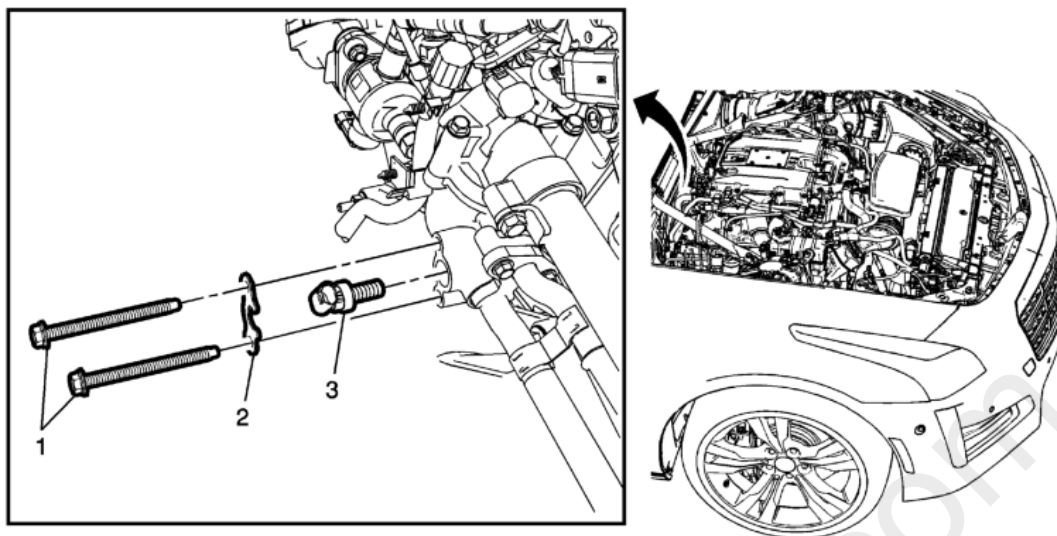
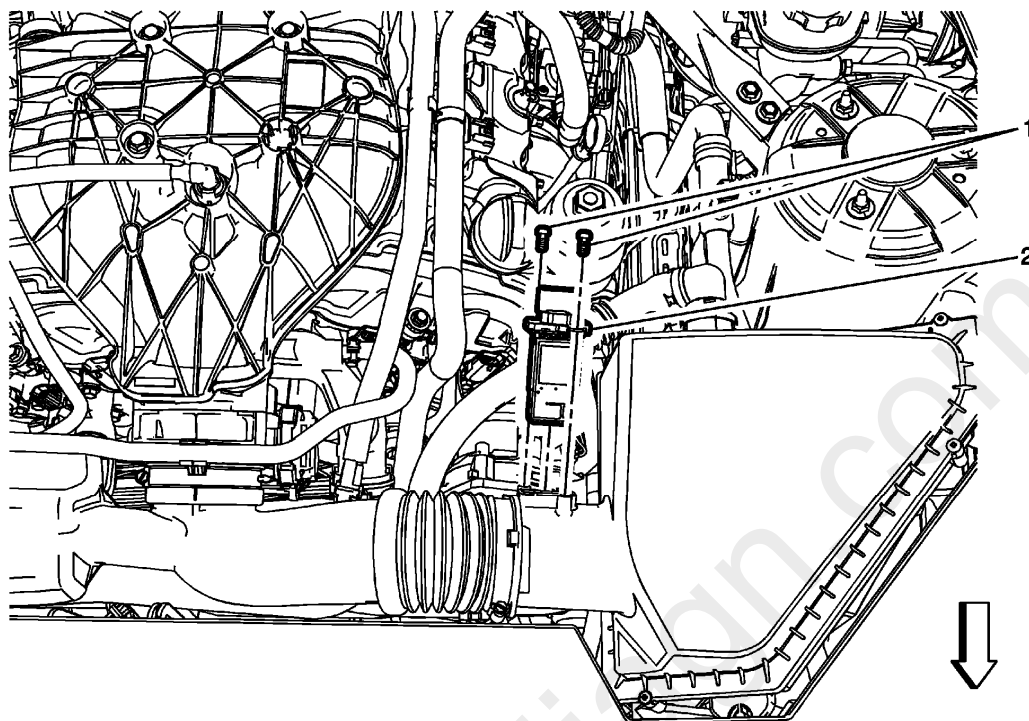


Fig. 4: Engine Coolant Temperature Sensor (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Temperature Sensor Replacement (LF3)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) . 2. Remove the plenum front panel. Refer to Plenum Front Panel Replacement .	
1	Coolant Temperature Sensor Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 10 (89 lb in)
2	Coolant Temperature Sensor Retainer NOTE: Ensure that the retainer is properly positioned prior to tightening the coolant temperature sensor fasteners.
	Coolant Temperature Sensor

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT (LFX)**Fig. 5: Mass Airflow Sensor with Intake Air Temperature Sensor (LFX)**

Courtesy of GENERAL MOTORS COMPANY

Mass Airflow Sensor with Intake Air Temperature Sensor Replacement (LFX)

Callout	Component Name
1	Mass Air Flow Sensor Fasteners (Qty :2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Mass Air Flow Sensor Procedure Disconnect the electrical connector.

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT (FRONT LF3)

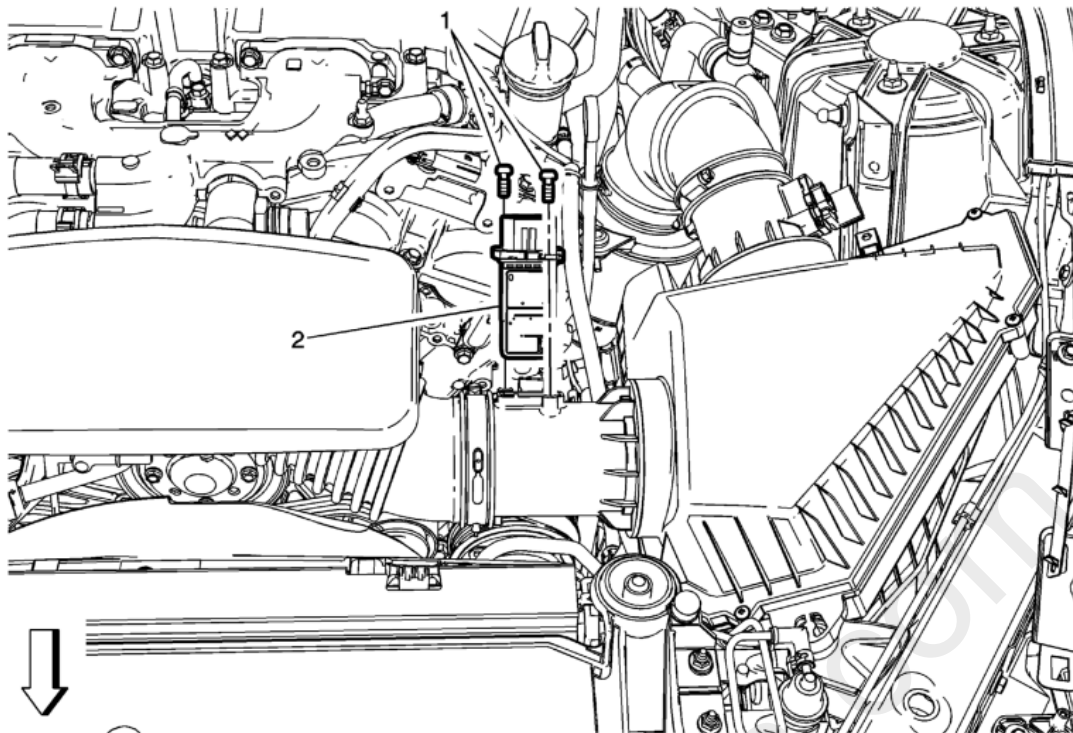


Fig. 6: Mass Airflow Sensor with Intake Air Temperature Sensor (Front LF3)
Courtesy of GENERAL MOTORS COMPANY

Mass Airflow Sensor with Intake Air Temperature Sensor Replacement (Front LF3)

Callout	Component Name
1	Mass Air Flow Sensor Fasteners (Qty :2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Mass Air Flow Sensor Procedure Disconnect the electrical connector.

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT (REAR LF3)

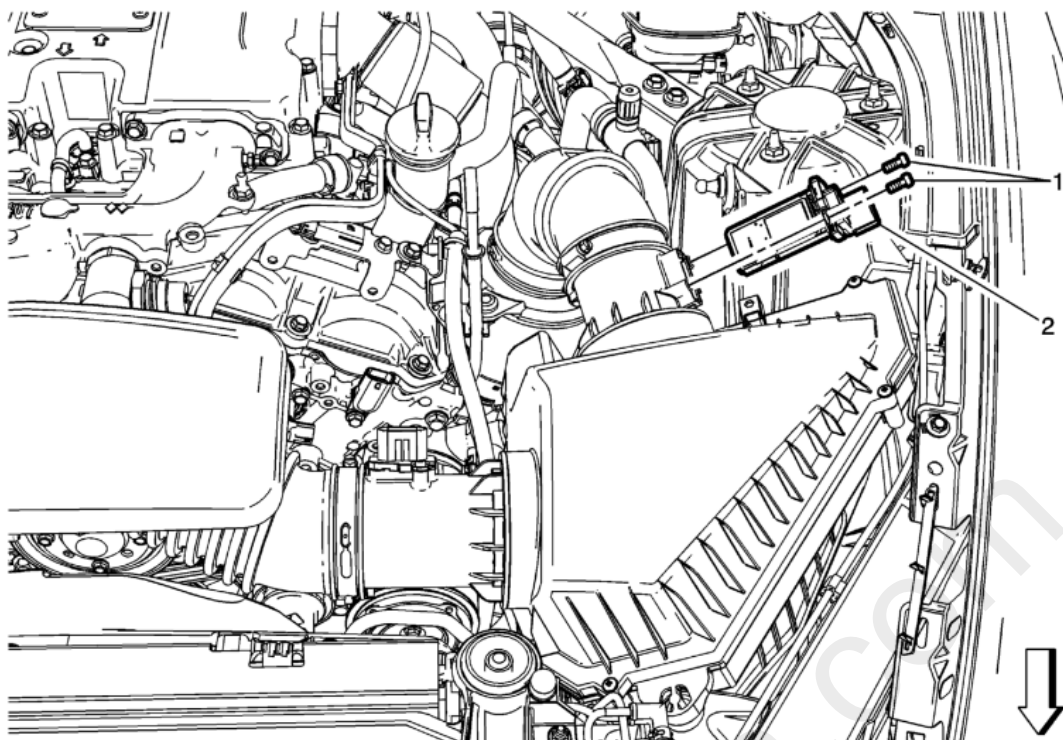


Fig. 7: Mass Airflow Sensor with Intake Air Temperature Sensor (Rear LF3)
Courtesy of GENERAL MOTORS COMPANY

Mass Airflow Sensor with Intake Air Temperature Sensor Replacement (Rear LF3)

Callout	Component Name
1	Mass Air Flow Sensor Fasteners (Qty :2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Mass Air Flow Sensor Procedure Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT (LFX)

Removal Procedure

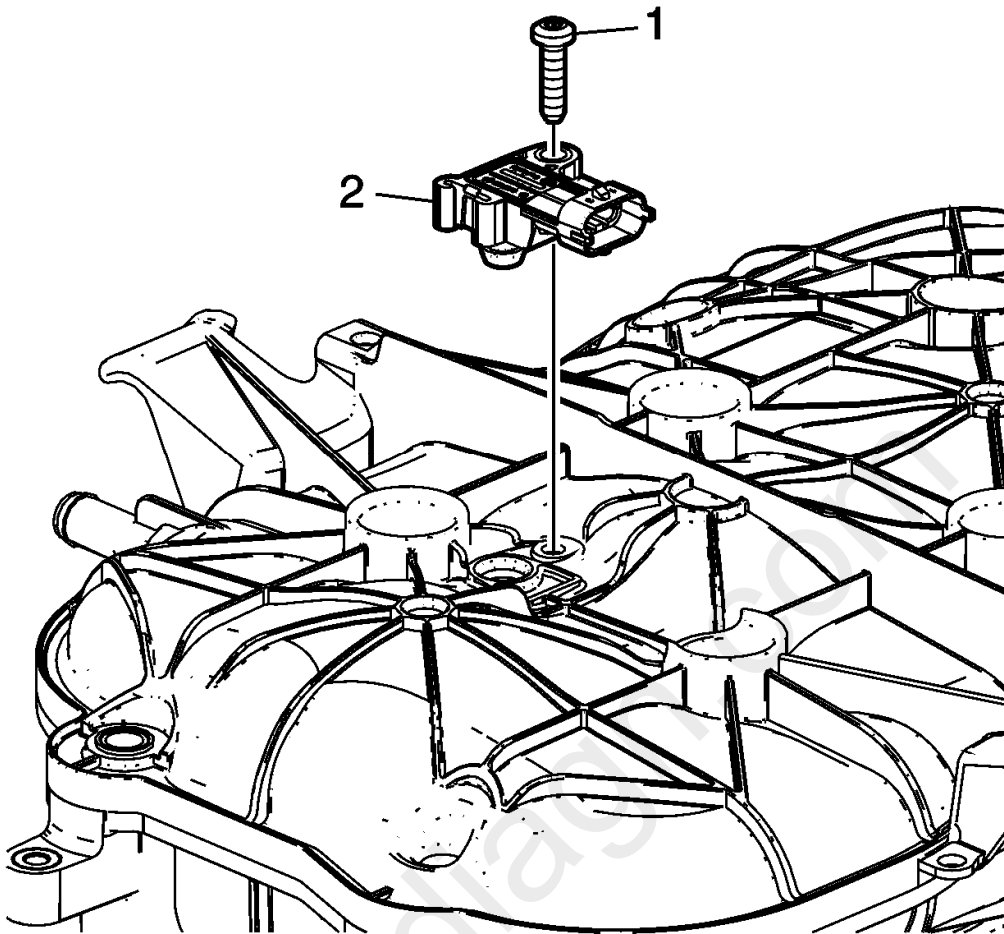


Fig. 8: MAP Sensor & Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Ignition OFF.
2. Remove the intake manifold sight shield.
3. Disconnect the engine wiring harness from the manifold absolute pressure (MAP) sensor (2).
4. Remove the MAP sensor to intake manifold retaining bolt (1).
5. Remove the MAP sensor (2) from the intake manifold assembly.
6. Discard the MAP sensor seal.

Installation Procedure

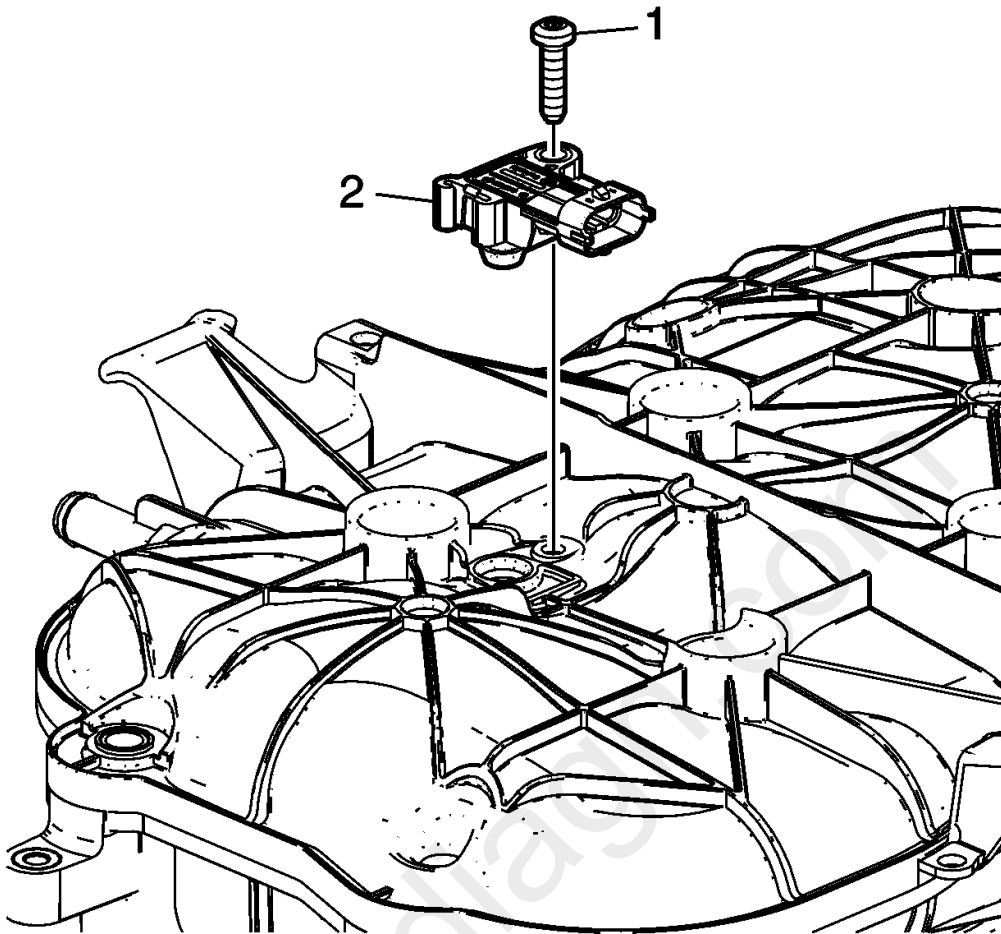


Fig. 9: MAP Sensor & Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW MAP sensor seal.
2. Install the MAP sensor (2) to the intake manifold assembly.

CAUTION: Refer to Fastener Caution .

3. Install the MAP sensor to intake manifold retaining bolt (1) and tighten to 4 N.m (35 lb in).
4. Connect the engine wiring harness to the manifold absolute pressure (MAP) sensor (2).
5. Install the intake manifold sight shield.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT (LF3)

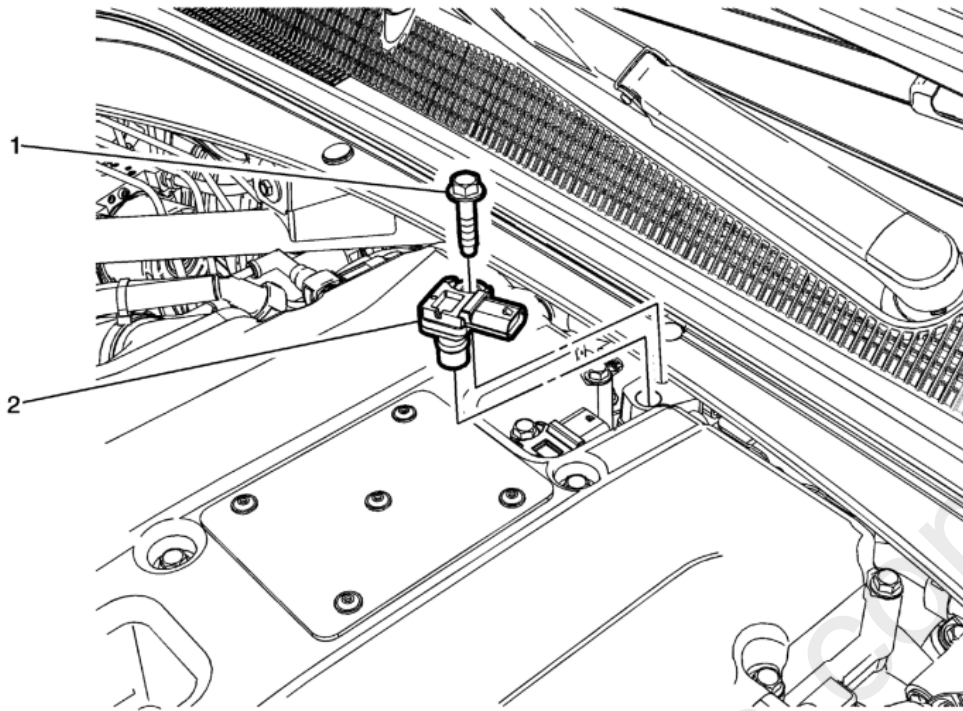


Fig. 10: Manifold Absolute Pressure Sensor (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Manifold Absolute Pressure Sensor Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Manifold Absolute Pressure Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 (89 lb in)
2	Manifold Absolute Pressure Sensor Procedure Disconnect the electrical wiring harness connector from the manifold absolute pressure sensor. NOTE: Always install the seal supplied with the manifold absolute pressure sensor.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1 (LFX)

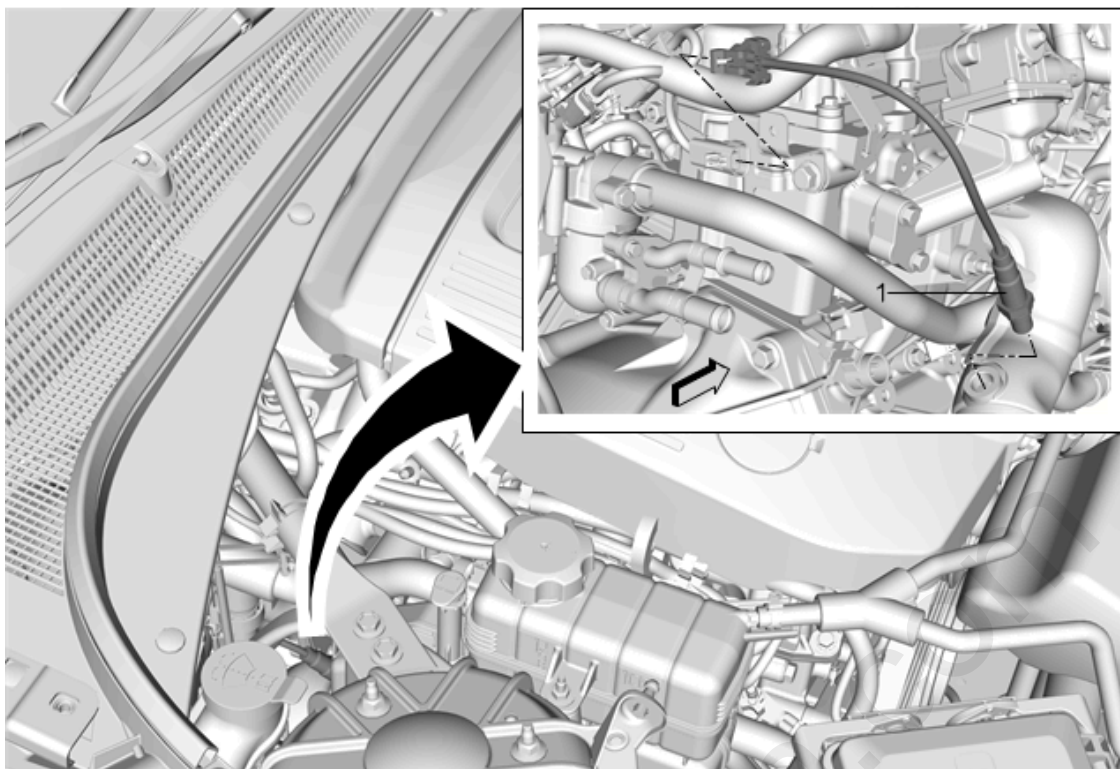


Fig. 11: Heated Oxygen Sensor - Bank 1 Sensor 1 (LFX)

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LFX)

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the electrical connector.

NOTE:

- The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S).
- The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F).
- A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation.

Tighten

42 (31 lb ft)

Special Tools

J 39194 Oxygen Sensor Wrench

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

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1 (LF3)

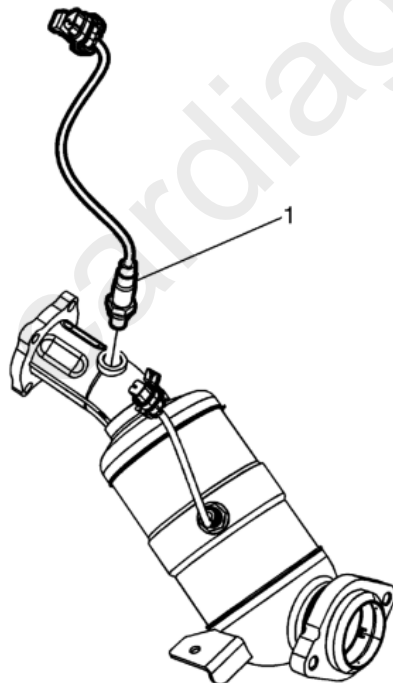


Fig. 12: Heated Oxygen Sensor - Bank 1 Sensor 1 (LF3)

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF3)

Callout	Component Name
Preliminary Procedures Remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side (LF3)</u> .	
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . NOTE: • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F). • A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> . Tighten 42 (31 lb ft) Special Tools J 39194 Oxygen Sensor Wrench For equivalent regional tools, refer to <u>Special Tools</u> .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2 (LFX)

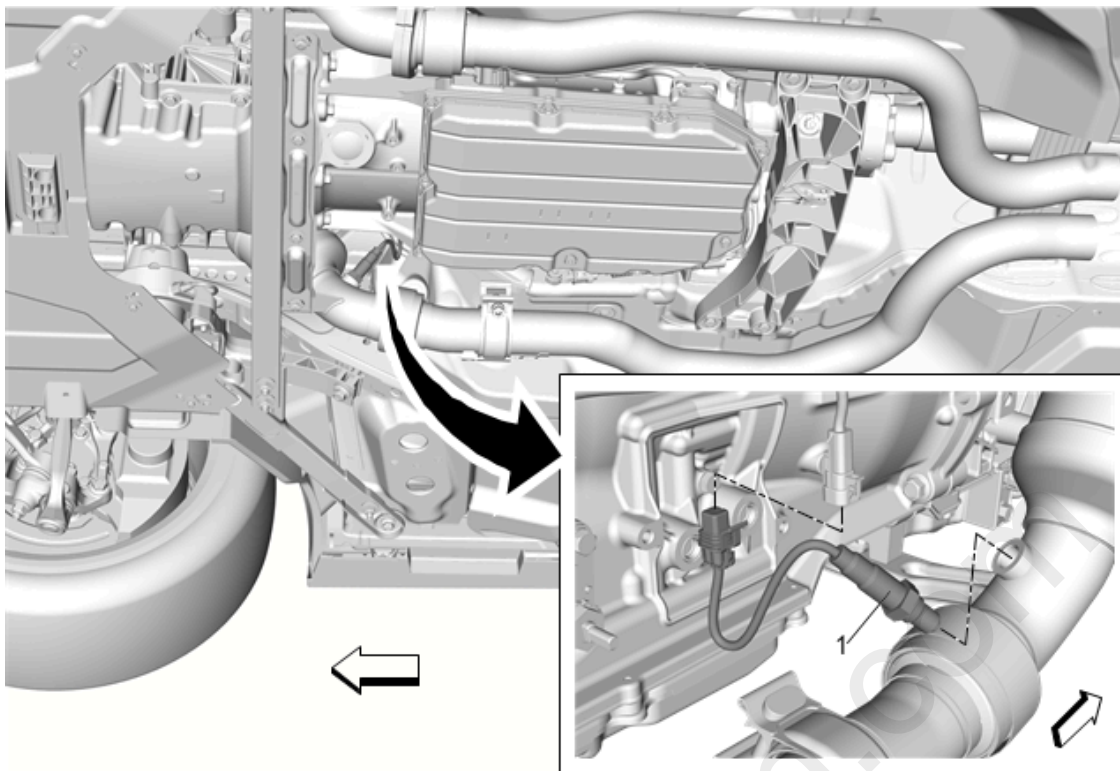


Fig. 13: Heated Oxygen Sensor - Bank 1 Sensor 2 (LFX)

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LFX)

Callout	Component Name
Preliminary Procedure	
Raise and properly support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .

Procedure

Disconnect the electrical connector.

NOTE:

- The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S).
- The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F).
- A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation.

1

Tighten

42 (31 lb ft)

Special Tools

J 39194 Oxygen Sensor Wrench

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

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2 (LF3)

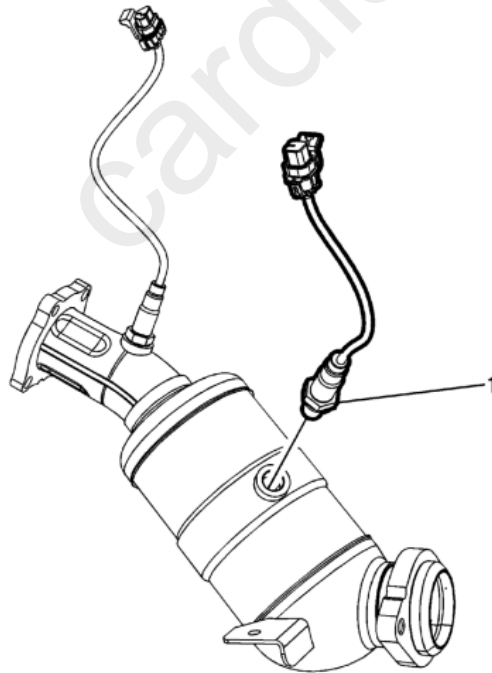


Fig. 14: Heated Oxygen Sensor - Bank 1 Sensor 2 (LF3)

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF3)

Callout	Component Name
Procedure Remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side (LF3)</u> .	
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . NOTE: • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F). • A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> . Tighten 42 (31 lb ft) Special Tools J 39194 Oxygen Sensor Wrench For equivalent regional tools, refer to <u>Special Tools</u> .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1 (LFX)

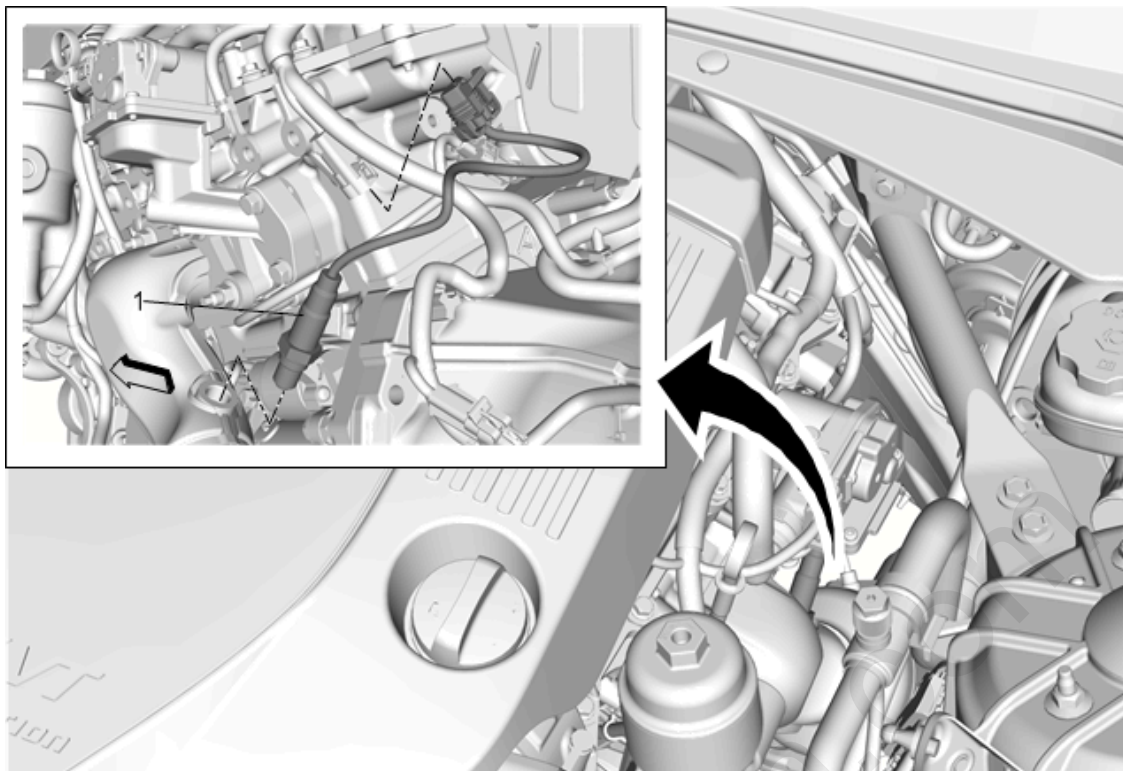


Fig. 15: Heated Oxygen Sensor - Bank 2 Sensor 1 (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LFX)

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the electrical connector.

NOTE:

- The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S).
- The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F).
- A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation.

Tighten

42 (31 lb ft)

Special Tools

EN-6179 Oxygen Sensor Wrench

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

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1 (LF3)

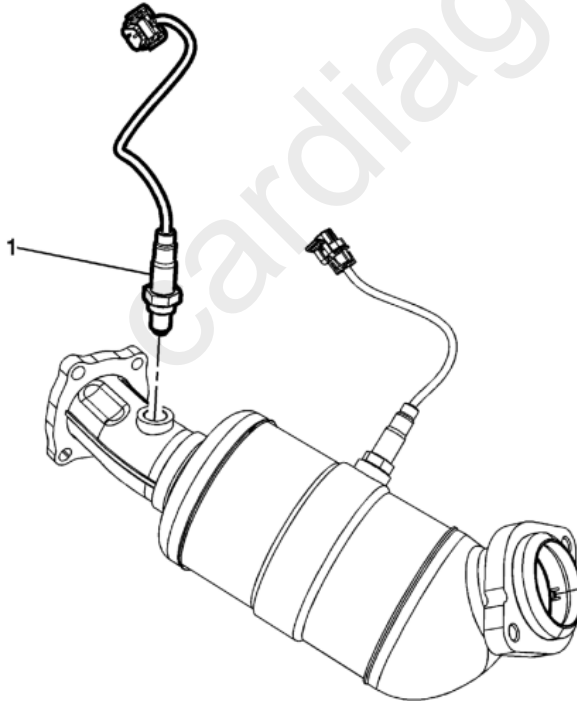


Fig. 16: Heated Oxygen Sensor - Bank 2 Sensor 1 (LF3)

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF3)

Callout	Component Name
Procedure	Remove the left side catalytic converter. Refer to <u>Catalytic Converter Replacement - Left Side (LF3)</u> .
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . NOTE: • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F). • A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> . Tighten 42 (31 lb ft) Special Tools J 39194 Oxygen Sensor Wrench For equivalent regional tools, refer to <u>Special Tools</u> .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2 (LFX)

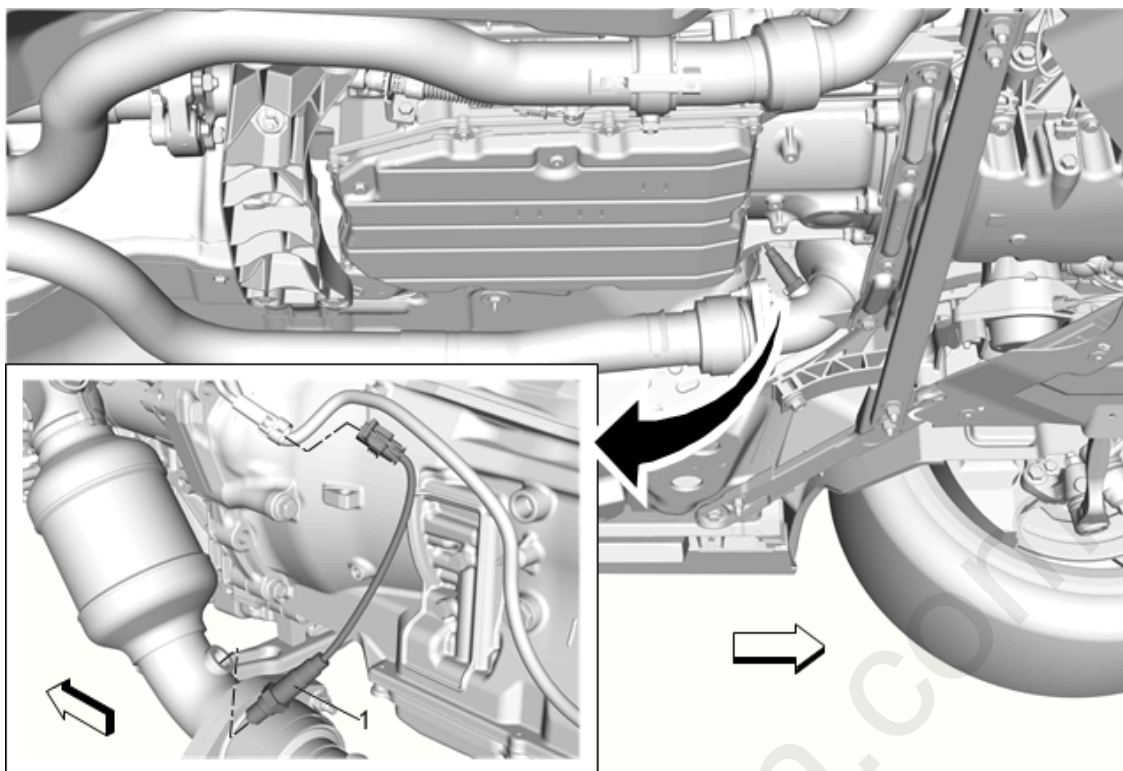


Fig. 17: Heated Oxygen Sensor - Bank 2 Sensor 2 (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 (LFX)

Callout	Component Name
Preliminary Procedure	
Raise and properly support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .

Procedure

Disconnect the electrical connector.

NOTE:

- The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S).
- The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F).
- A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation.

1

Tighten

42 (31 lb ft)

Special Tools

EN-6179 Oxygen Sensor Wrench

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

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2 (LF3)

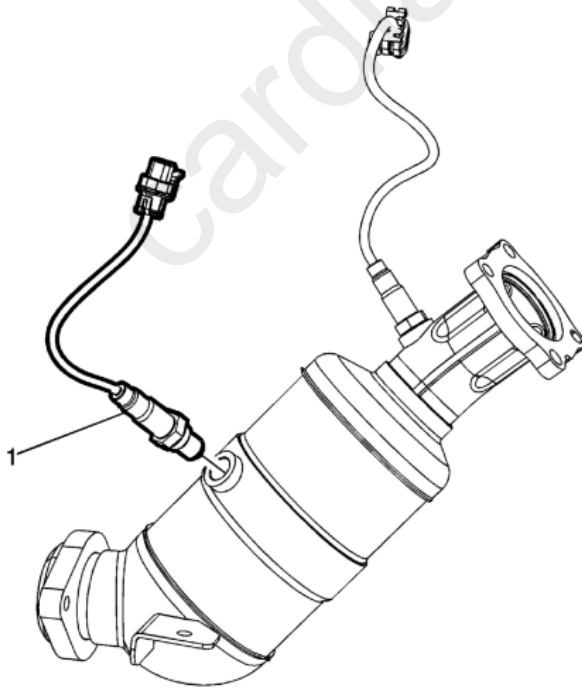


Fig. 18: Heated Oxygen Sensor - Bank 2 Sensor 2 (LF3)

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 (LF3)

Callout	Component Name
Procedure	
Remove the left side catalytic converter. Refer to <u>Catalytic Converter Replacement - Left Side (LF3)</u> .	
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . NOTE: • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F). • A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> . Tighten 42 (31 lb ft) Special Tools J 39194 Oxygen Sensor Wrench For equivalent regional tools, refer to <u>Special Tools</u> .

ACCELERATOR PEDAL WITH POSITION SENSOR ASSEMBLY REPLACEMENT

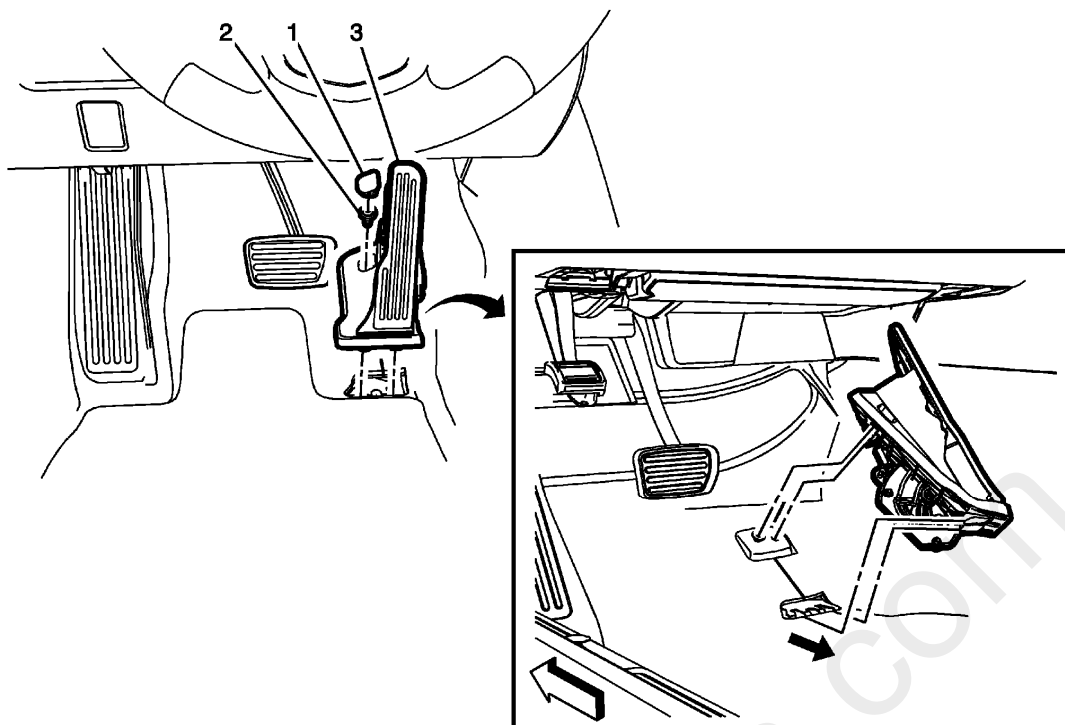


Fig. 19: Accelerator Pedal with Position Sensor Assembly
Courtesy of GENERAL MOTORS COMPANY

Accelerator Pedal with Position Sensor Assembly Replacement

Callout	Component Name
1	Accelerator Pedal Position Sensor Cover
2	Accelerator Pedal Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
3	Accelerator Pedal Position Sensor Procedure 1. Disconnect the connector from the Accelerator Pedal Position Sensor. 2. Tilt the top of the Accelerator Pedal Position Sensor rearward. 3. Slide the Accelerator Pedal Position Sensor back to disengage its lower retaining tabs.

THROTTLE BODY ASSEMBLY REPLACEMENT (LFX)

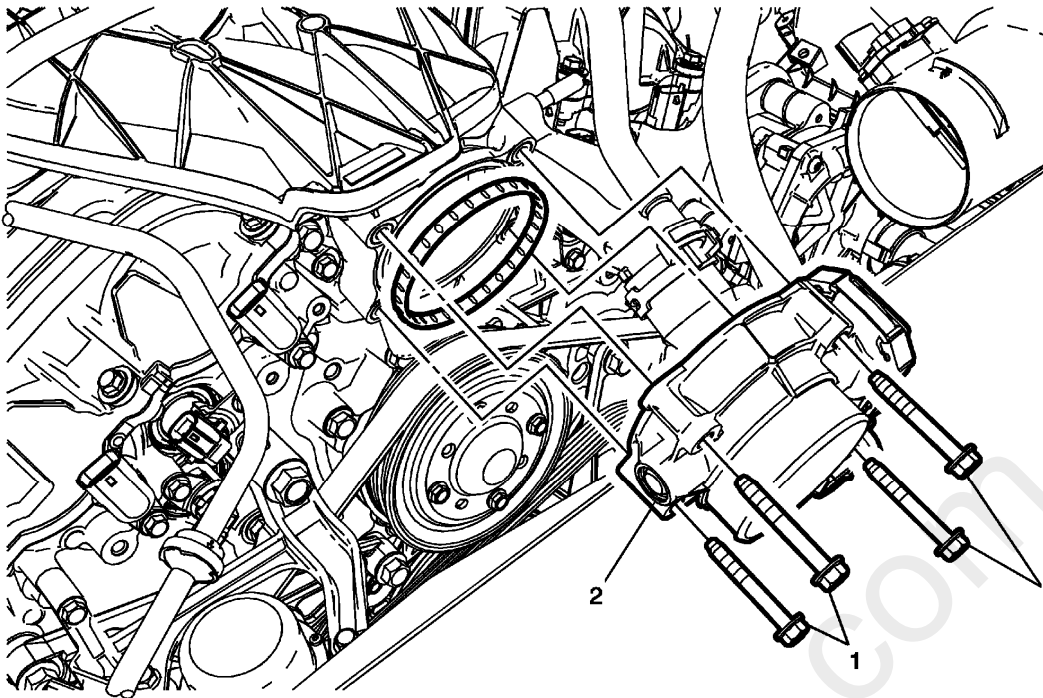


Fig. 20: Throttle Body Assembly (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Throttle Body Assembly Replacement (LFX)

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> . 2. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LFX)</u> .	
1	Throttle Body Assembly Bolts (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Throttle Body Assembly Procedure 1. Disconnect the throttle body assembly harness connector. 2. Install a NEW throttle body assembly seal. 3. Perform the throttle learn procedure. Refer to <u>Q38 Throttle Body: Throttle/Idle</u>

THROTTLE BODY ASSEMBLY REPLACEMENT (LF3)

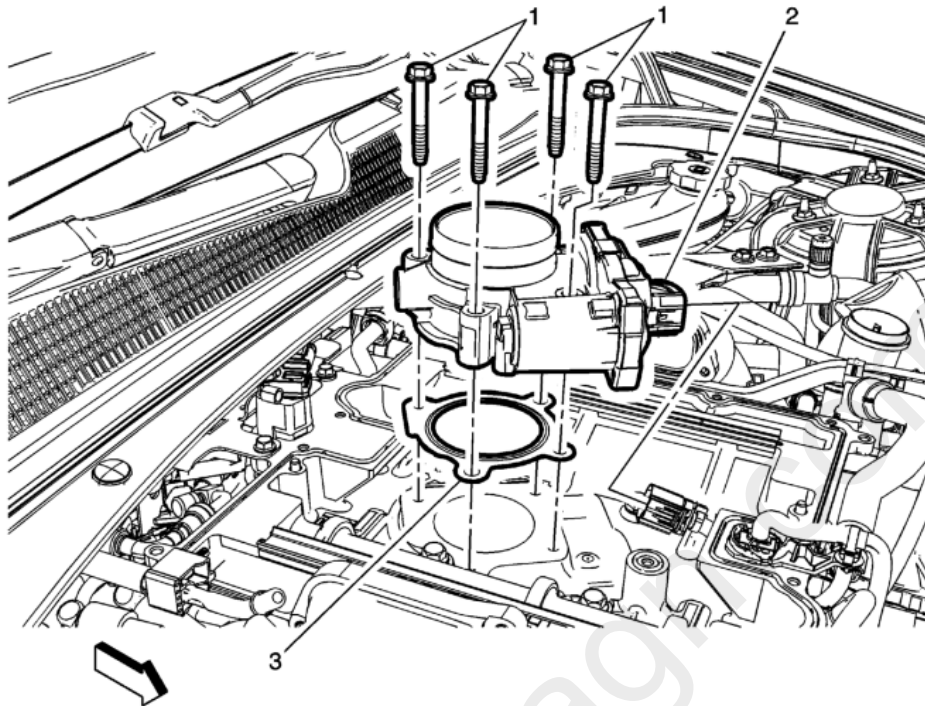


Fig. 21: Throttle Body Assembly (LF3)
Courtesy of GENERAL MOTORS COMPANY

Throttle Body Assembly Replacement (LF3)

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

	Clean any debris prior to removing the throttle body. Cover any openings to prevent debris from entering into the intake manifold.
3	Throttle Body Gasket Install a new throttle body gasket when installing the throttle body.

THROTTLE BODY INSPECTION AND CLEANING (LFX)

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LFX)**.
2. Fully open the throttle valve in order to Inspect the throttle body bore and the throttle valve plate for any deposits.

CAUTION: Do not subject a throttle body assembly which contains the following components to an immersion cleaner or a strong solvent:

- Throttle position (TP) sensor
- Idle air control (IAC) valve
- Sealed throttle shaft bearings

The cleaners will damage the electric components or sensors.

The cleaners will damage some of these components that contain seals or O-rings.

Solvents can wash away or break down the grease used on non-serviceable throttle shaft bearings.

Never use a wire brush or scraper to clean the throttle body. A wire brush or sharp tools may damage the throttle body components.

Do not use a cleaner that contains methyl ethyl ketone. This extremely strong solvent may damage components and is not necessary for this type of cleaning.

3. Use a clean shop towel and Top Engine Cleaner GM P/N 1052626 or equivalent product in order to clean the throttle body bore and the throttle valve plate.

If necessary, use a parts cleaning brush in order to remove heavy deposits.

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

THROTTLE BODY INSPECTION AND CLEANING (LF3)

1. Remove the charge air cooler cover. Refer to **Charge Air Cooler Cover Replacement**.

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

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

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.

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

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 .
4. Install the charge air cooler cover. Refer to Charge Air Cooler Cover Replacement .
5. Perform the Throttle/Idle Learn procedure. Refer to Q38 Throttle Body: Throttle/Idle Learn.

FUEL PRESSURE RELIEF

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.

NOTE: If a scan tool is not available, WAIT at LEAST 2 hours after the engine has been run, before removing the high pressure fuel line.

1. Engine at idle, with a scan tool enable the Control Functions Depressurize Fuel System.
2. Verify the engine stalls, if engine does not stall repeat step 1.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH 48027 Digital Pressure Gauge

For equivalent regional tools, refer to Special Tools (Diagnostic Tools)

Installation Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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.

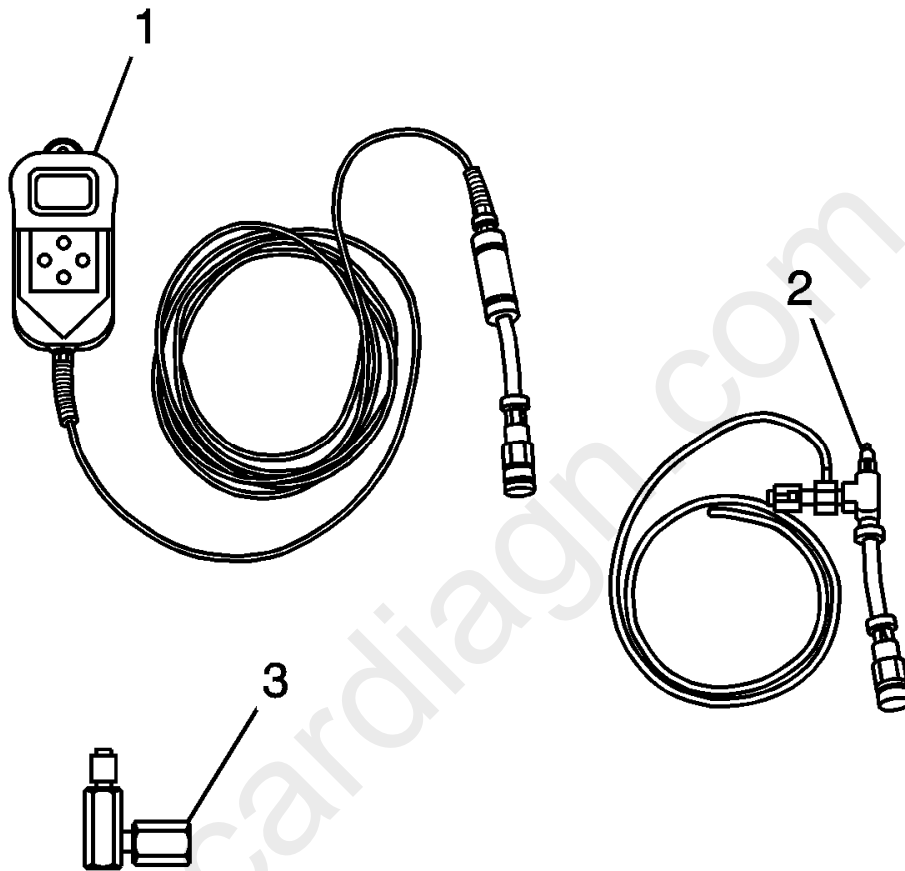


Fig. 22: Digital Fuel Pressure Gauge And Components
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** , **Intake Manifold Cover Replacement (LF3)** .
3. For LFX only, remove the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .
4. Wrap a shop towel around the fuel rail service port.
5. Connect the **CH 48027** gauge (1) to the **CH 48027** adapter (2).
6. Connect the **CH 48027** adapter (3) to the fuel rail service port.
7. Connect the **CH 48027** adapter (2) to **CH 48027** adapter (3).

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

Removal Procedure

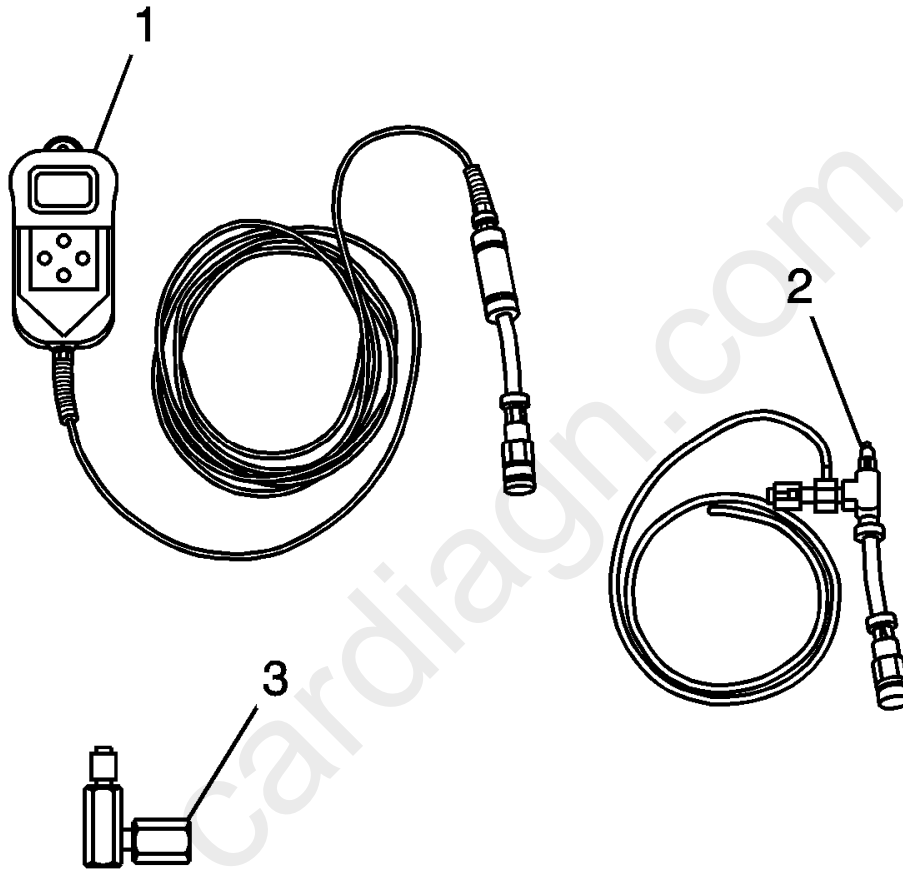


Fig. 23: Digital Fuel Pressure Gauge And Components
Courtesy of GENERAL MOTORS COMPANY

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.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
 1. Wrap a shop towel around the fuel rail service port.

2. Place the hose on the **CH 48027** adapter (2) into an approved gasoline container.
3. Open the valve on the **CH 48027** adapter (2) in order to bleed any fuel from the fuel rail.
4. Close the valve on the **CH 48027** adapter (2).
5. Remove the hose on the **CH 48027** adapter (2) from the approved gasoline container.
6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

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

2. Disconnect the **CH 48027** gauge (1) from the **CH 48027** gauge (2).
3. Disconnect the **CH 48027** adapter (2) from the **CH 48027** adapter (3).
4. Disconnect the **CH 48027** adapter (3) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. For LFX only, install the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .
7. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** , **Intake Manifold Cover Replacement (LF3)** .

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **CH-41769** Fuel Line Disconnect Tool Set
- **CH-44581** Fuel Line Disconnect Tool

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** .

Removal Procedure

WARNING: Refer to **Gasoline/Gasoline Vapors Warning** .

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

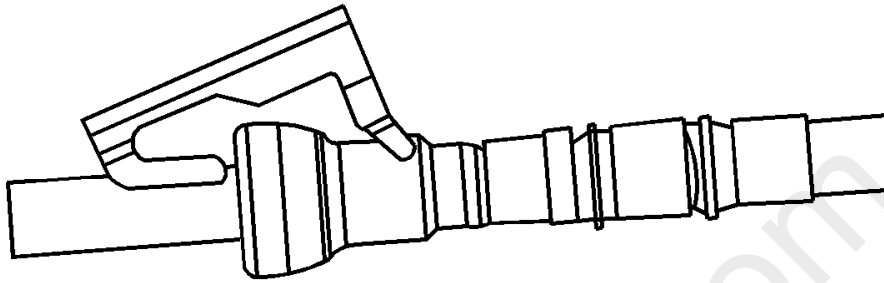


Fig. 24: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove the retainer from the quick-connect fitting.

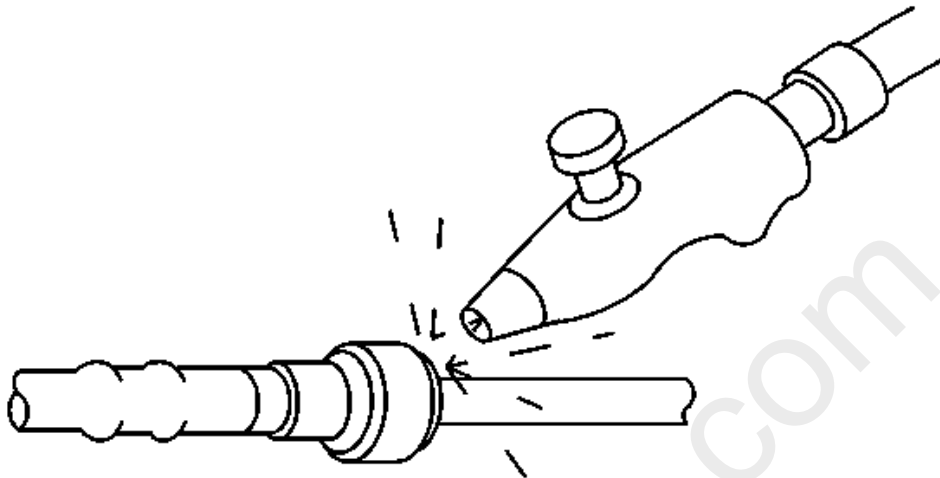


Fig. 25: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

3. Blow dirt out of the fitting using compressed air.

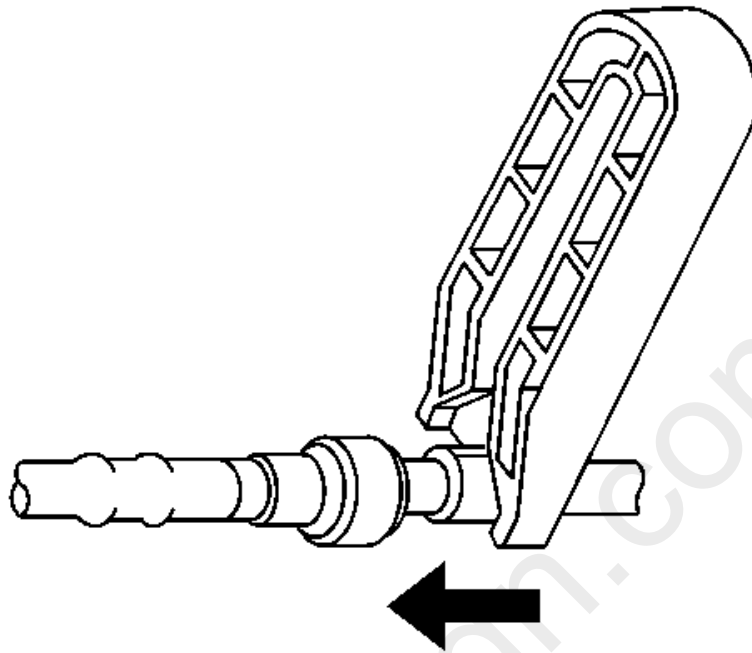


Fig. 26: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool. Insert the **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool into the female connector, then push inward to release the locking tabs.

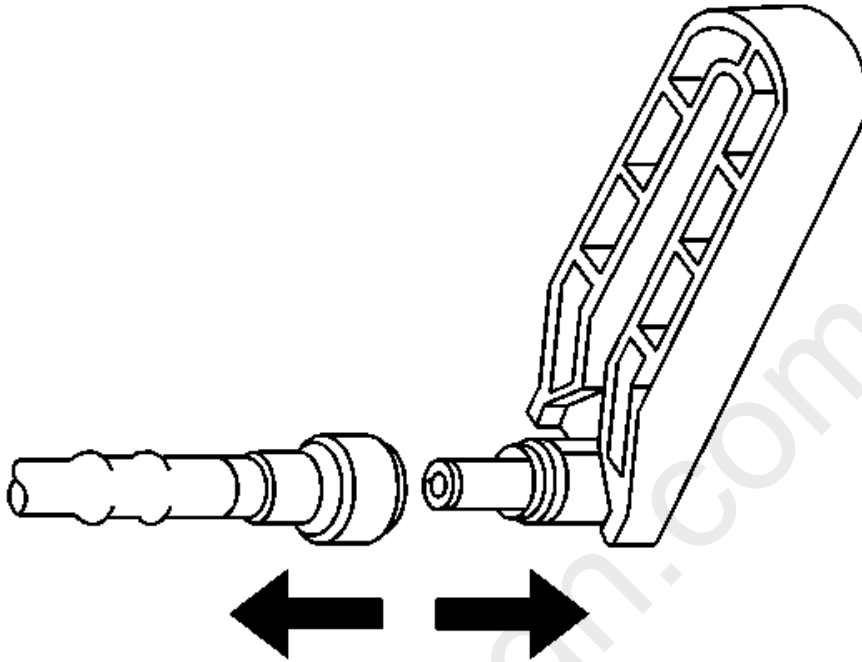


Fig. 27: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the connection apart.

CAUTION: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

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

Installation Procedure

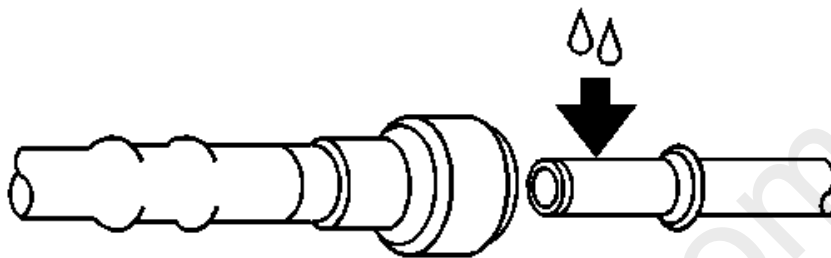


Fig. 28: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.

This will ensure proper reconnection and prevent a possible fuel leak.

During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

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

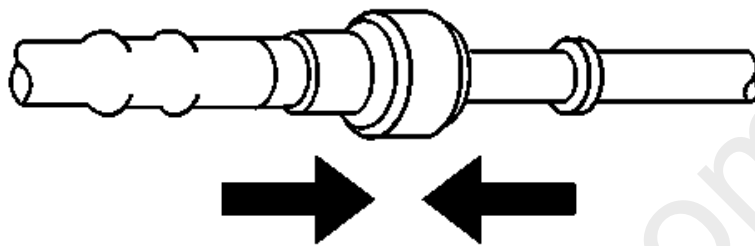


Fig. 29: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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

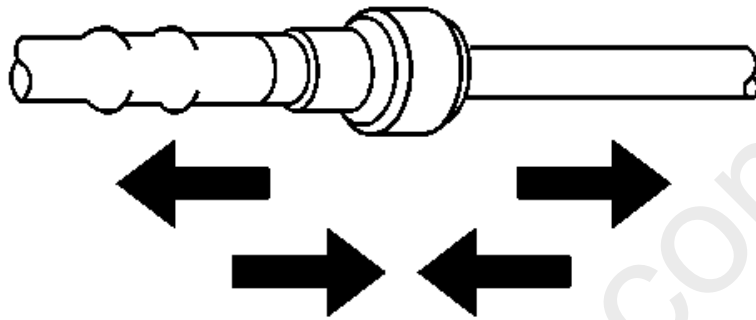


Fig. 30: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

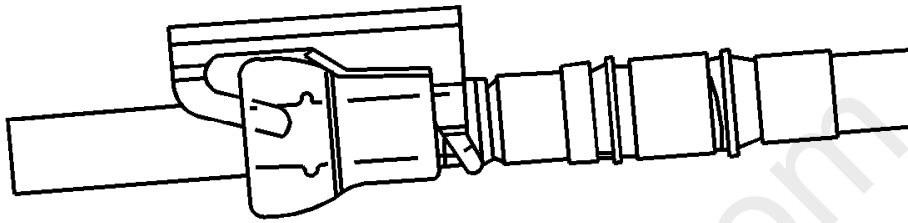


Fig. 31: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install the retainer to the quick-connect fitting.
5. Inspect for leaks using the following procedure:
 1. Turn the ignition ON, with the engine OFF for 2 seconds.
 2. Turn the ignition OFF, for 10 seconds.
 3. Turn the ignition ON, with the engine OFF for 2 seconds.
 4. Turn the ignition OFF.
 5. Inspect for leaks.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

NOTE: If servicing a fuel system, insure the fuel pressure has been relieved.

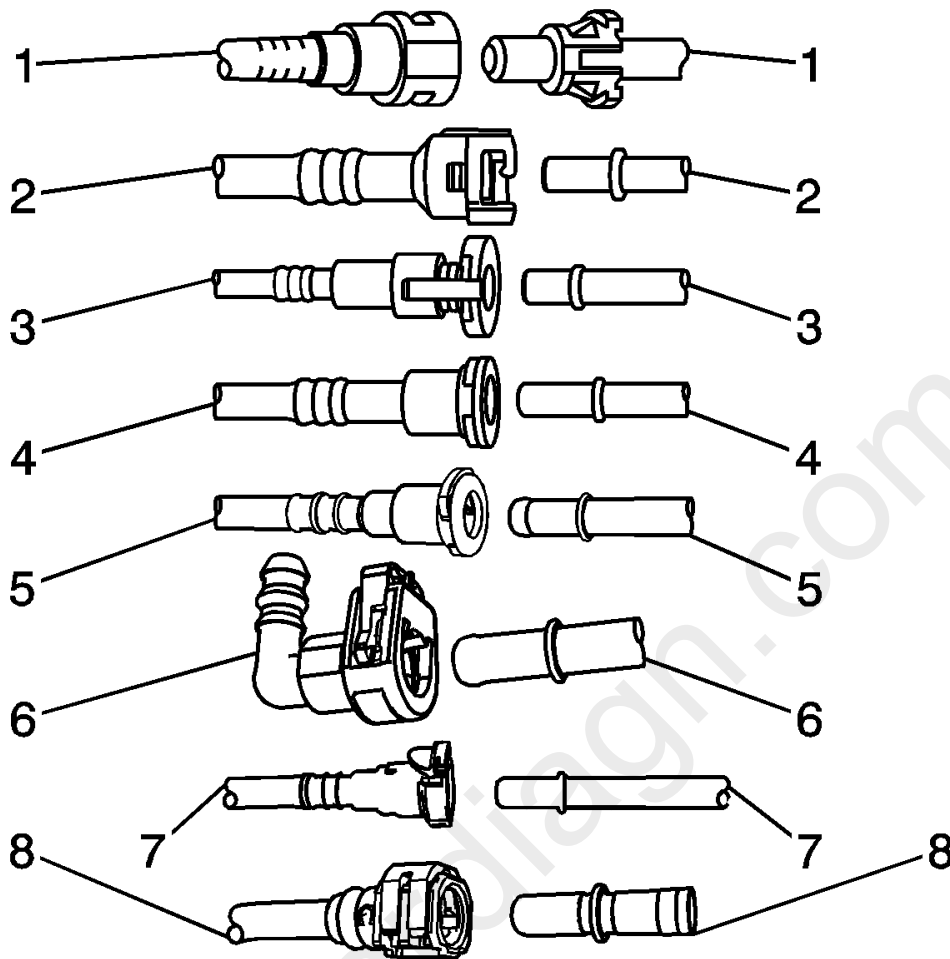


Fig. 32: Plastic Collar Quick Connect Fitting Service
Courtesy of GENERAL MOTORS COMPANY

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)
- Global Connect (5)
- TI Loc (6)
- Safe Lock (7)
- Plastic Connector (8)

The following instructions apply to all of these types of plastic collar quick connect fittings except where indicated.

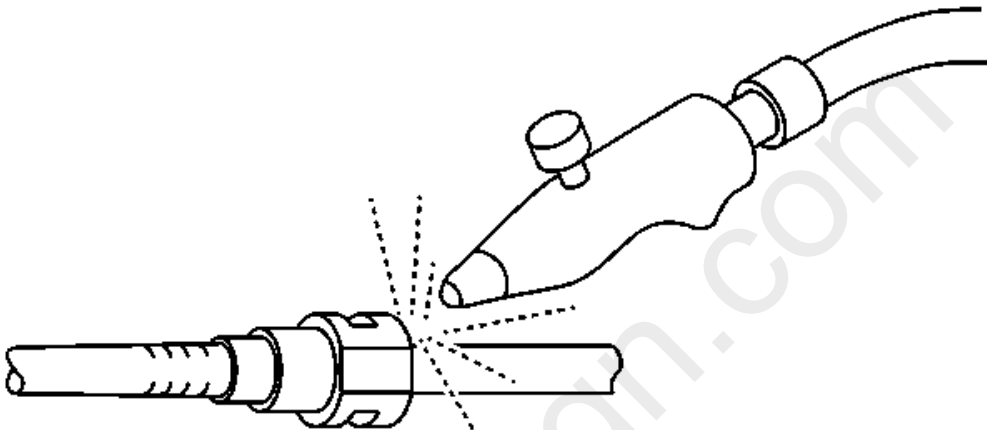


Fig. 33: Blowing Dirt Out Of Fitting (Plastic Collar)

Courtesy of GENERAL MOTORS COMPANY

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

1. Using compressed air, blow any dirt out of the quick-connect fitting.

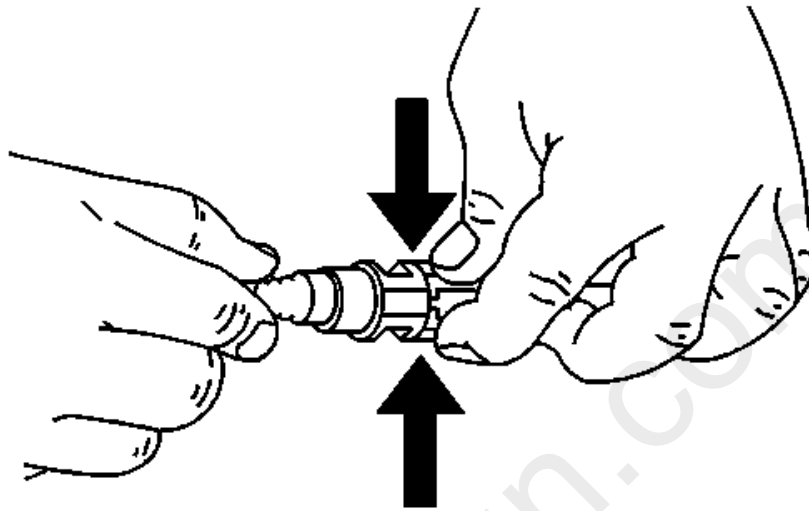


Fig. 34: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

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

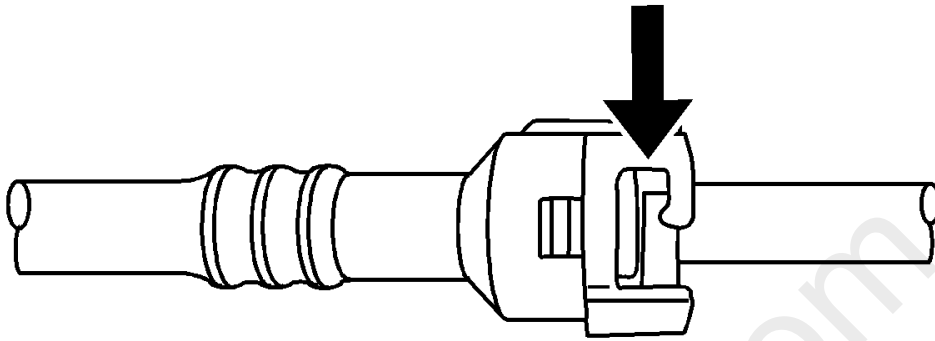


Fig. 35: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

3. 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.

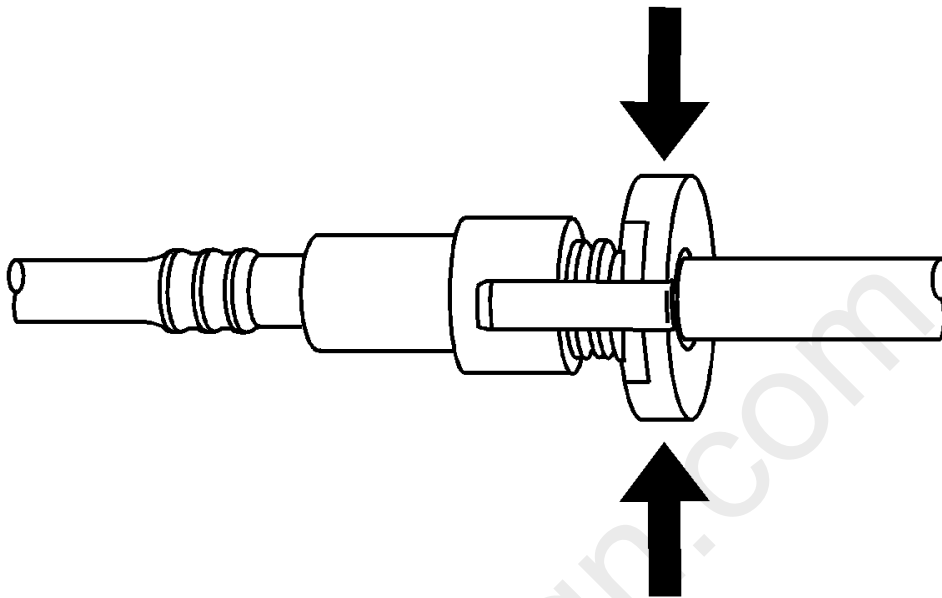


Fig. 36: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. 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.

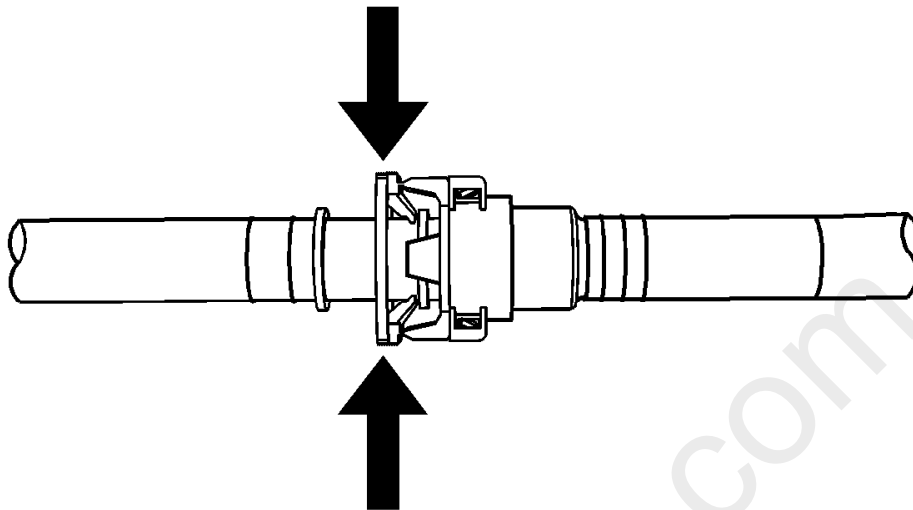


Fig. 37: Pushing In Male Side Of Connector
Courtesy of GENERAL MOTORS COMPANY

5. This step applies to Squeeze to Release style connectors ONLY. Push in the male side slightly in order to slide the retainer away from the retainers, squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

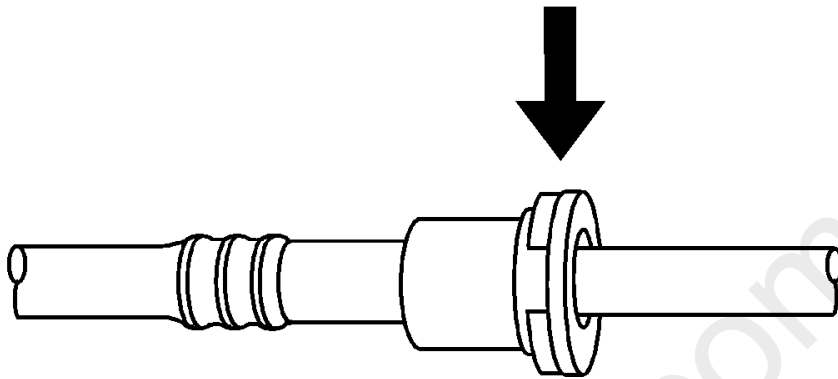


Fig. 38: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS COMPANY

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.

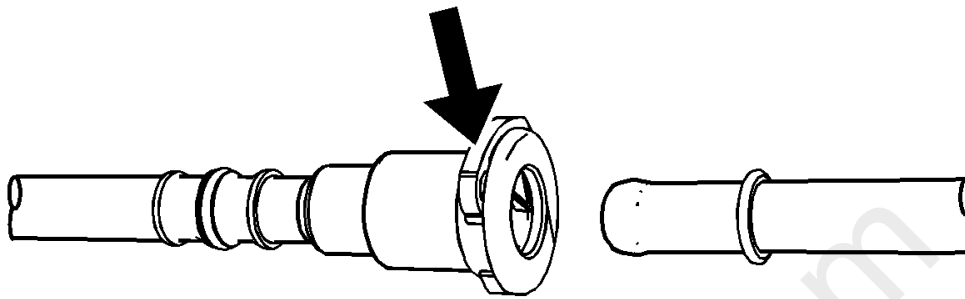


Fig. 39: Global Connector Style
Courtesy of GENERAL MOTORS COMPANY

7. This step applies to the Global Connector style only. Push the connector toward the tube in order to release the pressure. Press and hold down the release mechanism, and pull the connector straight out.

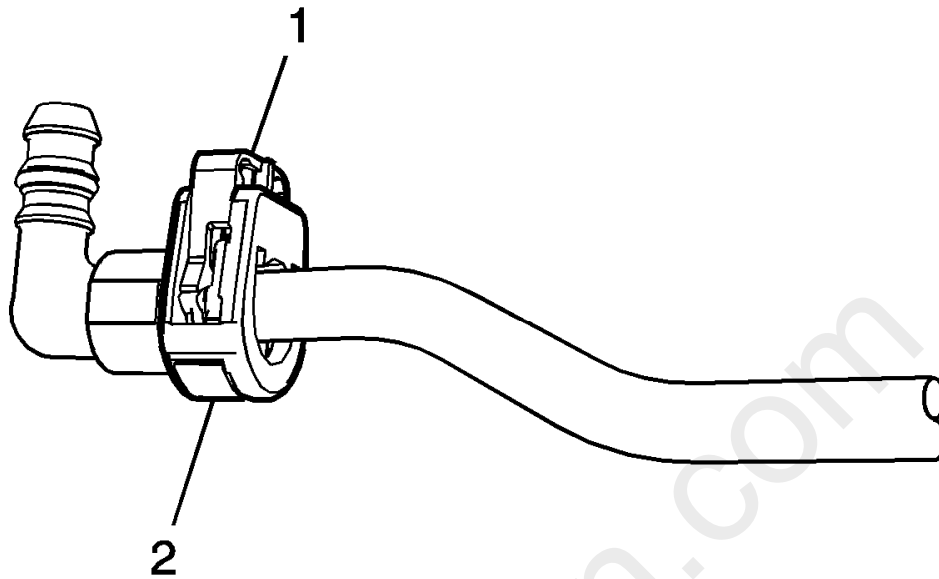


Fig. 40: TI Loc style

Courtesy of GENERAL MOTORS COMPANY

8. This step applies to the TI Loc style only. Push the connector toward the tube in order to release the pressure. Release the redundant latch (1) with two fingers or a flat bladed tool. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

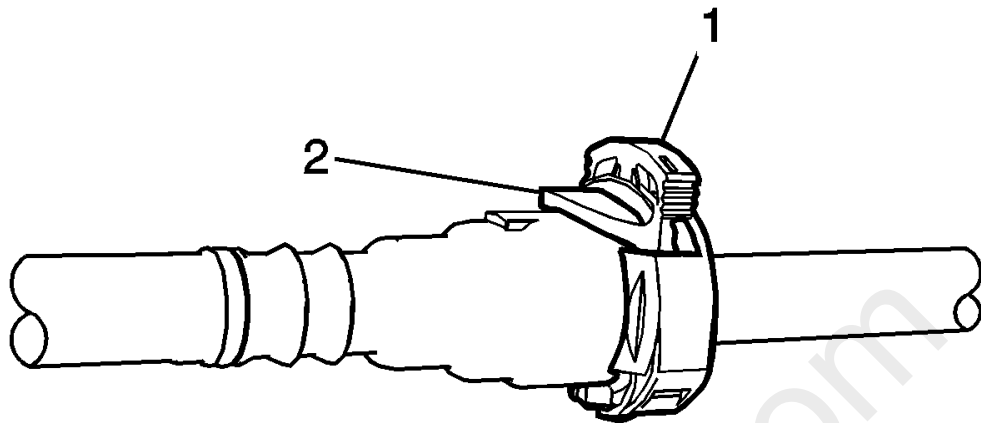


Fig. 41: Safe Lock Style
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Relieving Fuel Pressure Warning .

9. This step applies to the Safe Lock style only. Push the connector toward the tube in order to release the pressure. Release the second latch (1) with two fingers. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

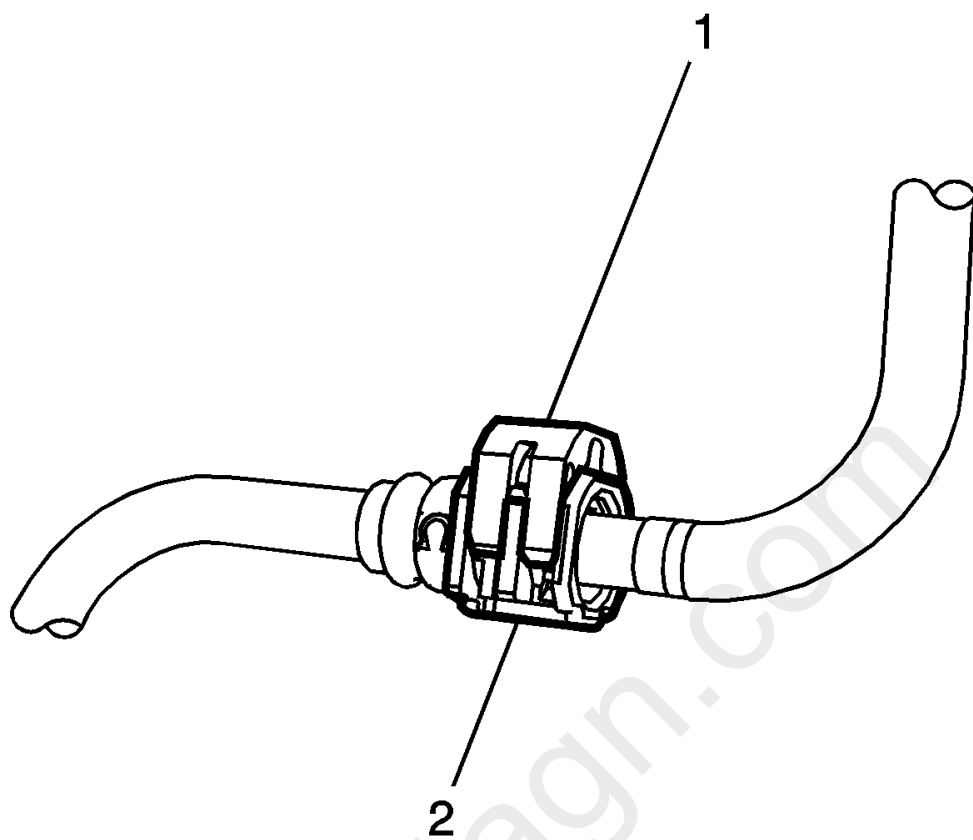


Fig. 42: Releasing Latch And Pulling Connector Straight Out
Courtesy of GENERAL MOTORS COMPANY

10. This step applies to the Plastic Connector style 8, push the connector toward the tube in order to release the pressure. Press the latch (1) inward in order to release the pipe, while pulling the connector (2) straight out.
11. Using a clean shop towel, wipe off the male pipe end.
12. Inspect both ends of the fitting for dirt and burrs.
13. Clean or replace components as necessary.

Installation Procedure

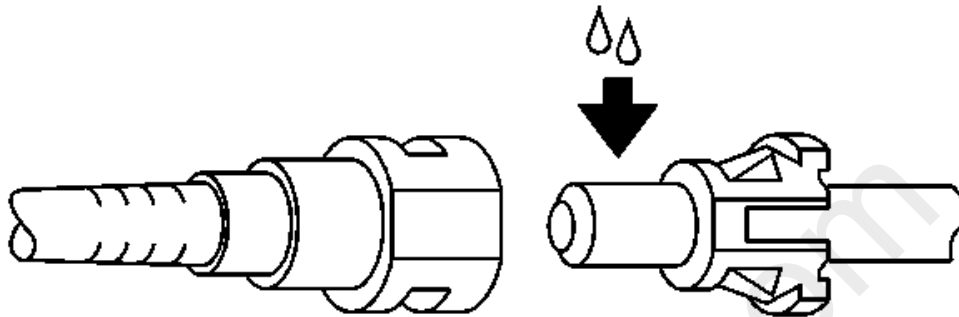


Fig. 43: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

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

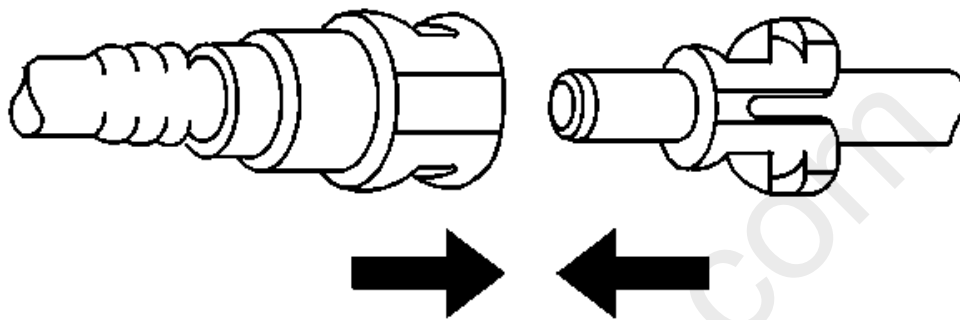


Fig. 44: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

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

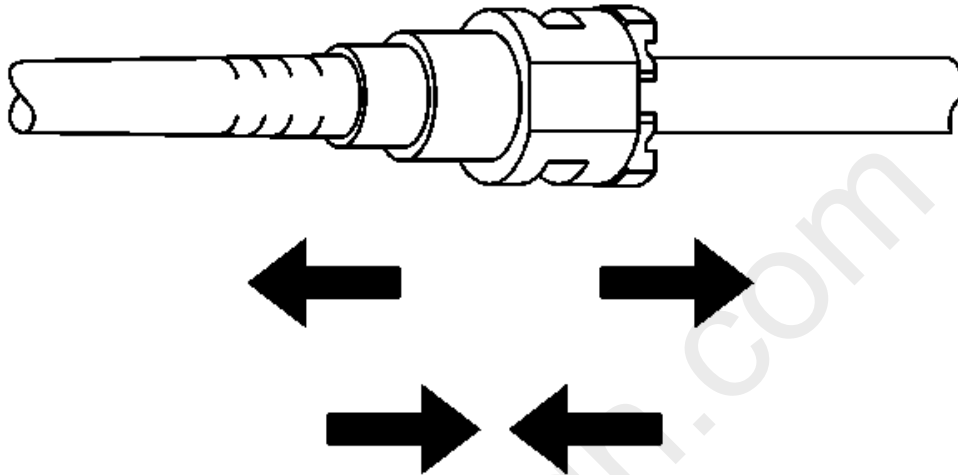


Fig. 45: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

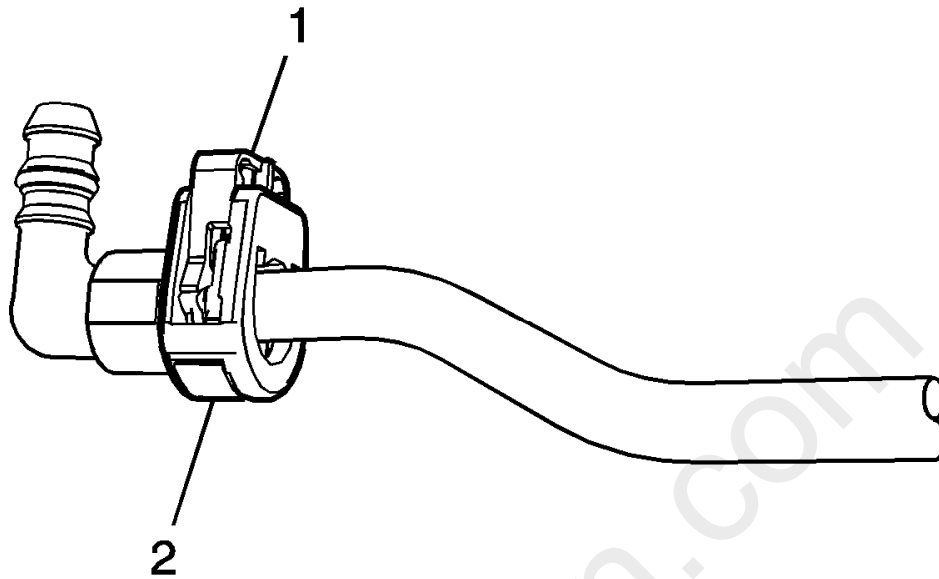


Fig. 46: TI Loc style
Courtesy of GENERAL MOTORS COMPANY

4. Insert the tube in the connector until the retainer snaps in place.
5. Push down on the redundant latch (1) until it is fully engaged and snapped into position.

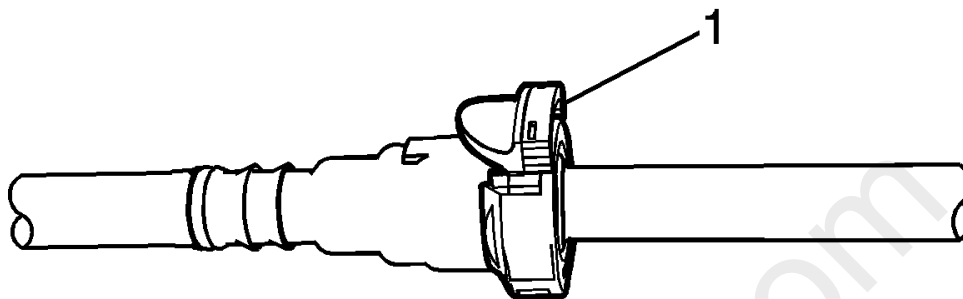


Fig. 47: Push Down On Redundant Latch (1) Until It Is Fully Engaged And Snapped Into Position.
Courtesy of GENERAL MOTORS COMPANY

6. Insert the tube in the connector until the retainer snaps in place.
7. Push down on the second latch (1) in order to secure the connection.

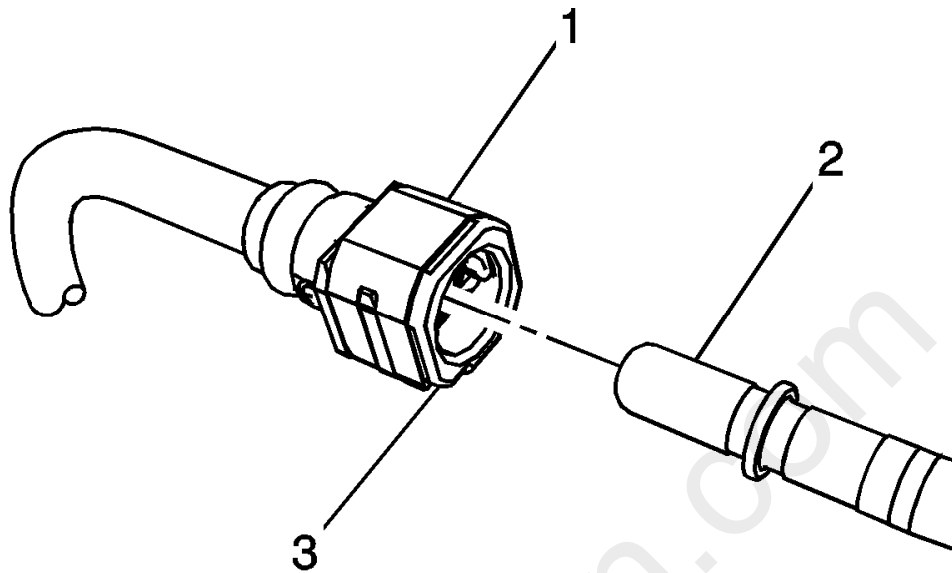


Fig. 48: Latch And Connector

Courtesy of GENERAL MOTORS COMPANY

8. For the plastic connector type 8, depress the latch (1) while inserting the connector (3) on to the pipe (2) .
9. Move the latch (1) upward in order to secure the connection.
10. Inspect for leaks using the following procedure:
 1. Turn the ignition ON, with the engine OFF for 2 seconds.
 2. Turn the ignition OFF, for 10 seconds.
 3. Turn the ignition ON, with the engine OFF for 2 seconds.
 4. Turn the ignition OFF.
 5. Inspect for leaks.

FUEL FILTER REPLACEMENT

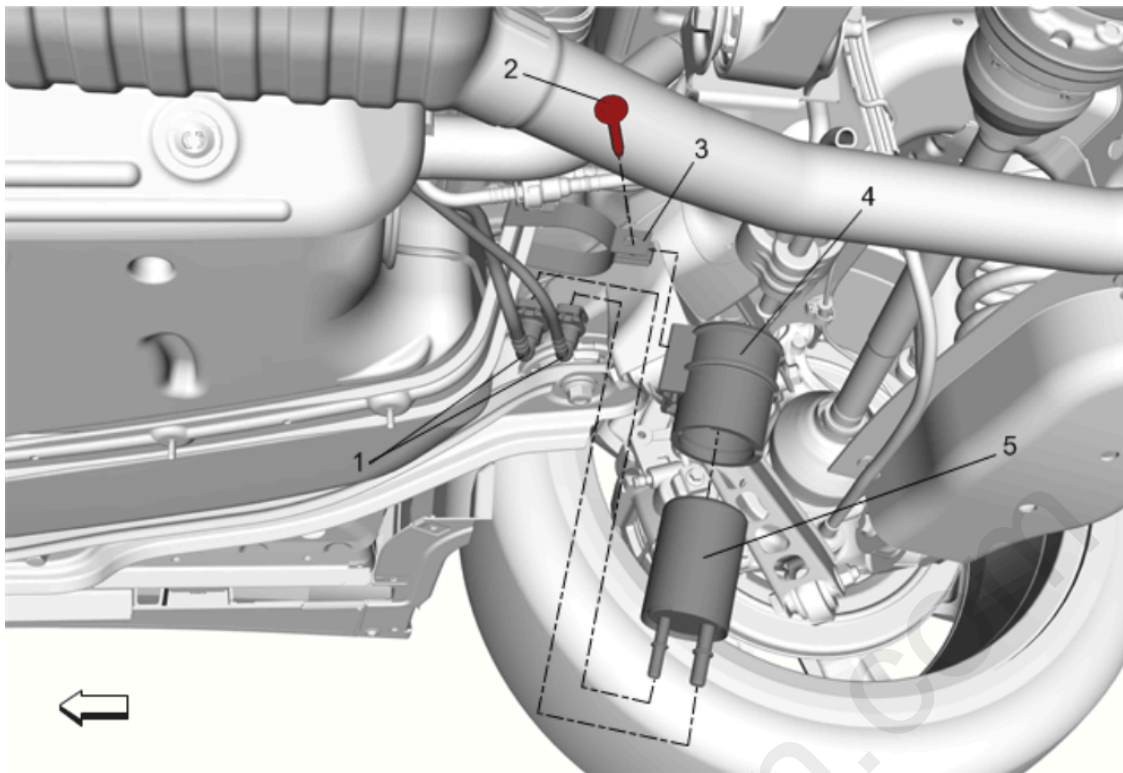


Fig. 49: Fuel Filter

Courtesy of GENERAL MOTORS COMPANY

Fuel Filter Replacement

Callout	Component Name
Preliminary Procedure 1. Relieve the fuel pressure. Refer to <u>Fuel Pressure Relief</u> 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Fuel Pipes Procedure Disconnect the fuel pipes from the fuel filter. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .
2	Fuel Filter Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
3	Fuel Filter Bracket
4	Fuel Filter Housing
5	Fuel Filter

FUEL TANK DRAINING

Special Tools

- **DT 36850** Transjel Lubricant
- **CH 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.

1. Raise and Support the Vehicle. Refer to Lifting and Jacking the Vehicle

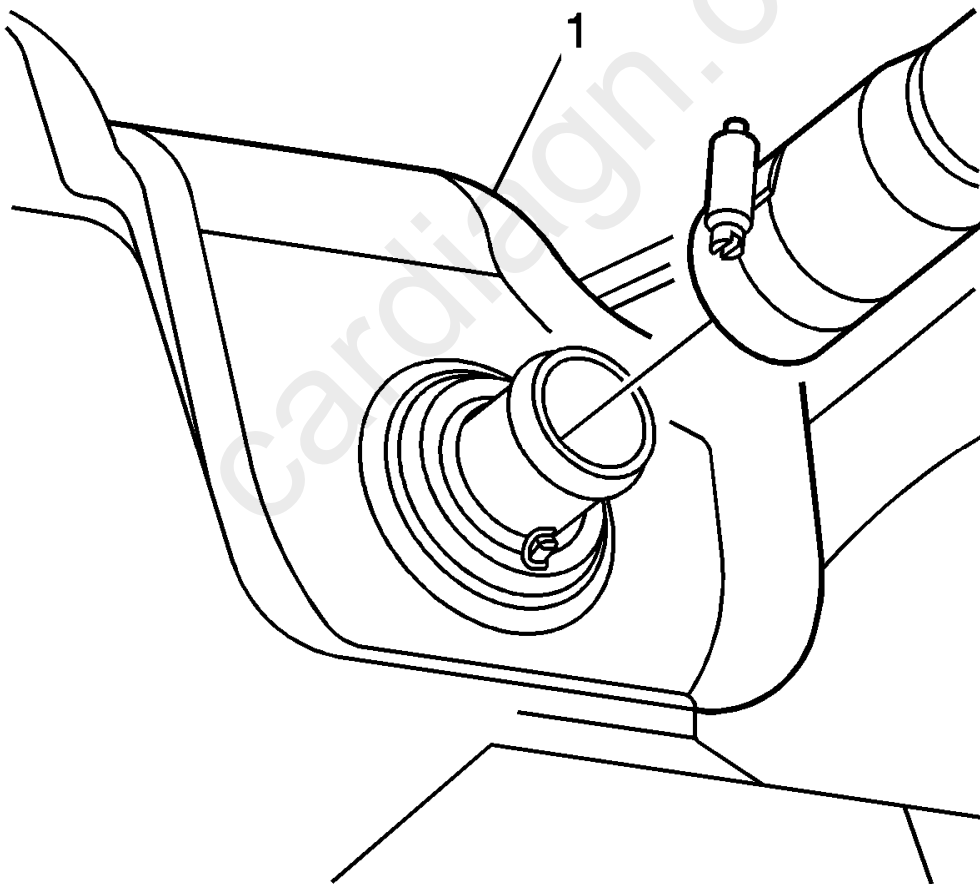


Fig. 50: Insert J 45004 Into The Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

NOTE: Place a clean drain pan large enough to capture the fuel that may be expelled once the hose is removed and the CH 45004 Fuel Tank Drain Hose is inserted opening the fill check valve. If the fuel tank is over half full, a large quantity of fuel may be expelled.

NOTE: Lubricate the fuel drain hose with DT 36850 Transjel Lubricant or equivalent to aid in hose insertion. Do not use an unapproved lubricant.

2. Loosen the lower fill hose clamp in order to separate the fill hose from the fuel tank (1).
3. Insert the **CH 45004** Fuel Tank Drain Hose into the fuel tank (1) until the hose reaches the bottom of the fuel tank.
4. Use a hand or air operated pump device in order to drain as much fuel from the fuel tank as possible.

FUEL TANK PROTECTOR REPLACEMENT

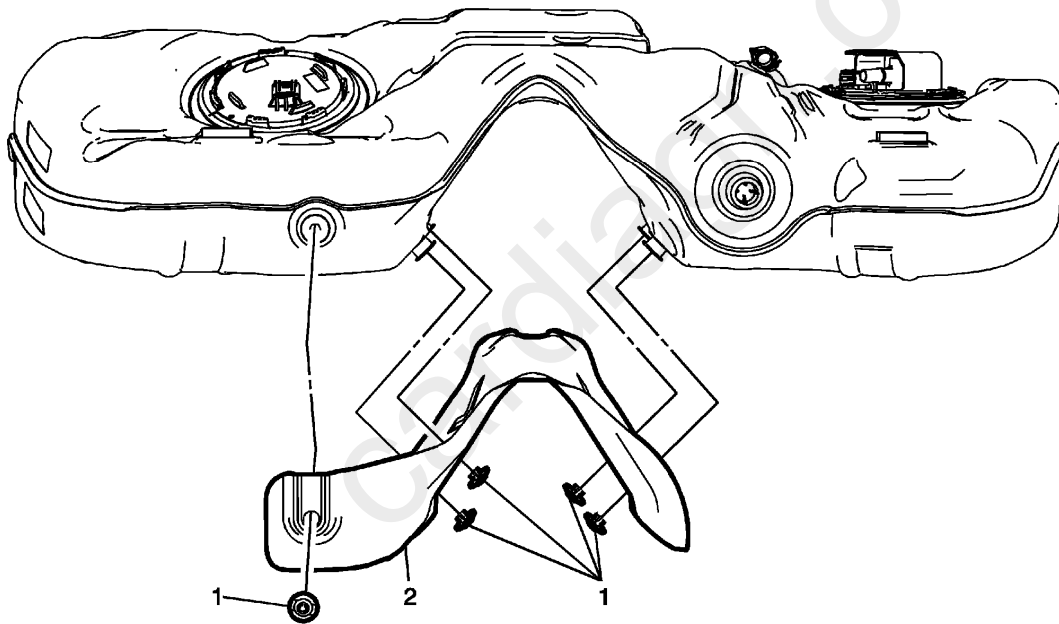


Fig. 51: Fuel Tank Protector
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Protector Replacement

Callout	Component Name
Preliminary Procedure Remove the two piece propeller shaft. Refer to <u>Two-Piece Propeller Shaft Replacement (LFX, LF3)</u> , <u>Two-Piece Propeller Shaft Replacement (LTG, LCV, LKW)</u> .	
1	Fuel Tank Protector Retainers (Qty: 5)

FUEL TANK REPLACEMENT

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the system fuel pressure. Refer to Fuel Pressure Relief
2. Drain the fuel tank. Refer to Fuel Tank Draining.
3. Remove the left and right side rear air deflectors. Refer to Underbody Rear Air Deflector Replacement - Left Side , and Underbody Rear Air Deflector Replacement - Right Side .
4. Remove the two piece propeller shaft. Refer to Two-Piece Propeller Shaft Replacement (LFX, LF3) , Two-Piece Propeller Shaft Replacement (LTG, LCV, LKW) .

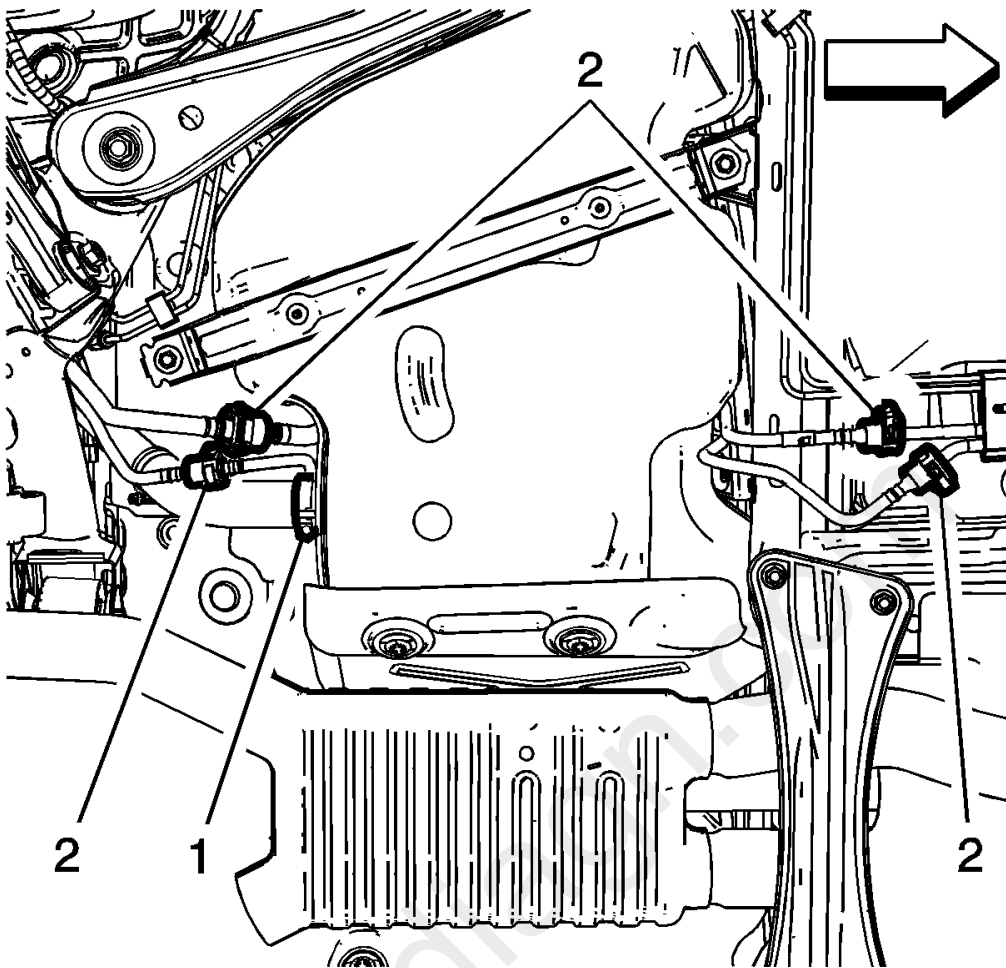


Fig. 52: Evaporative Emission And Fuel Pipes
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the evaporative emission and fuel pipes (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Loosen the hose clamps (1) and remove the filler pipe.

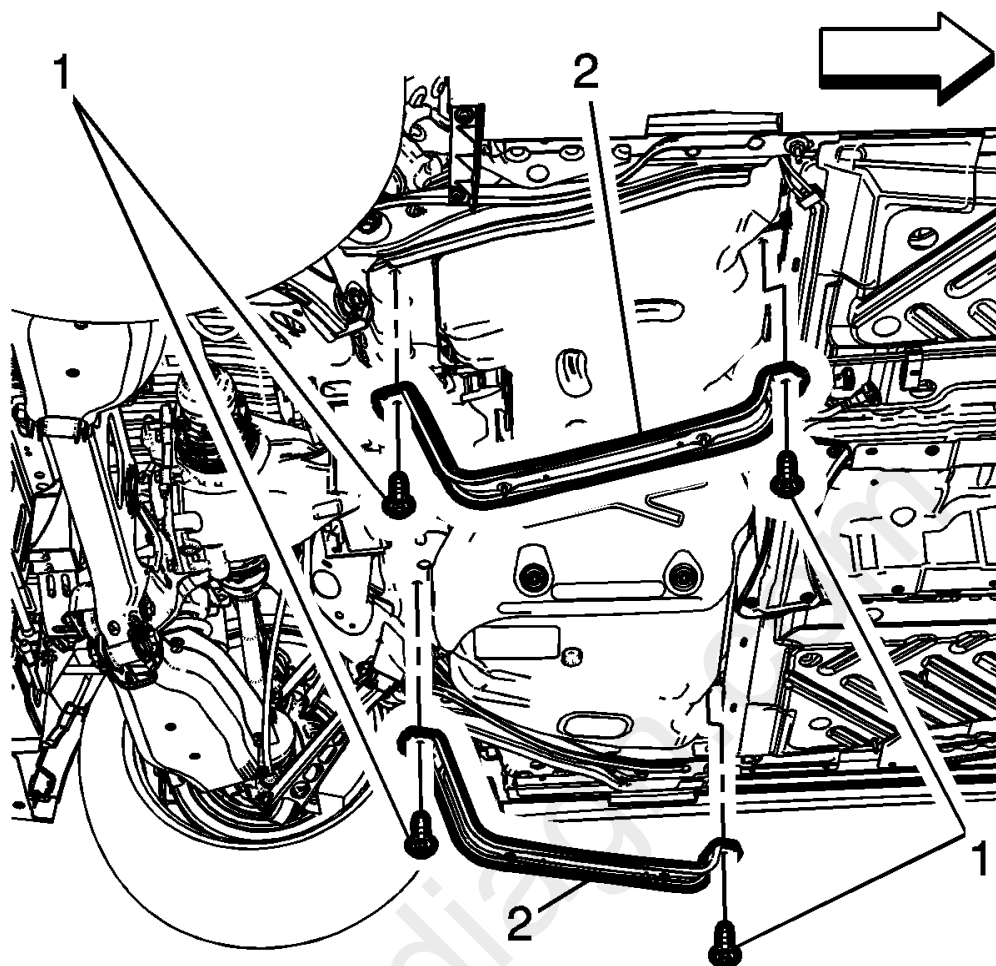


Fig. 53: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

7. Support the fuel tank with a suitable jack.
8. Remove the fuel tank strap bolts (1).
9. Remove the fuel tank straps (2).
10. Disconnect the fuel tank electrical connector.

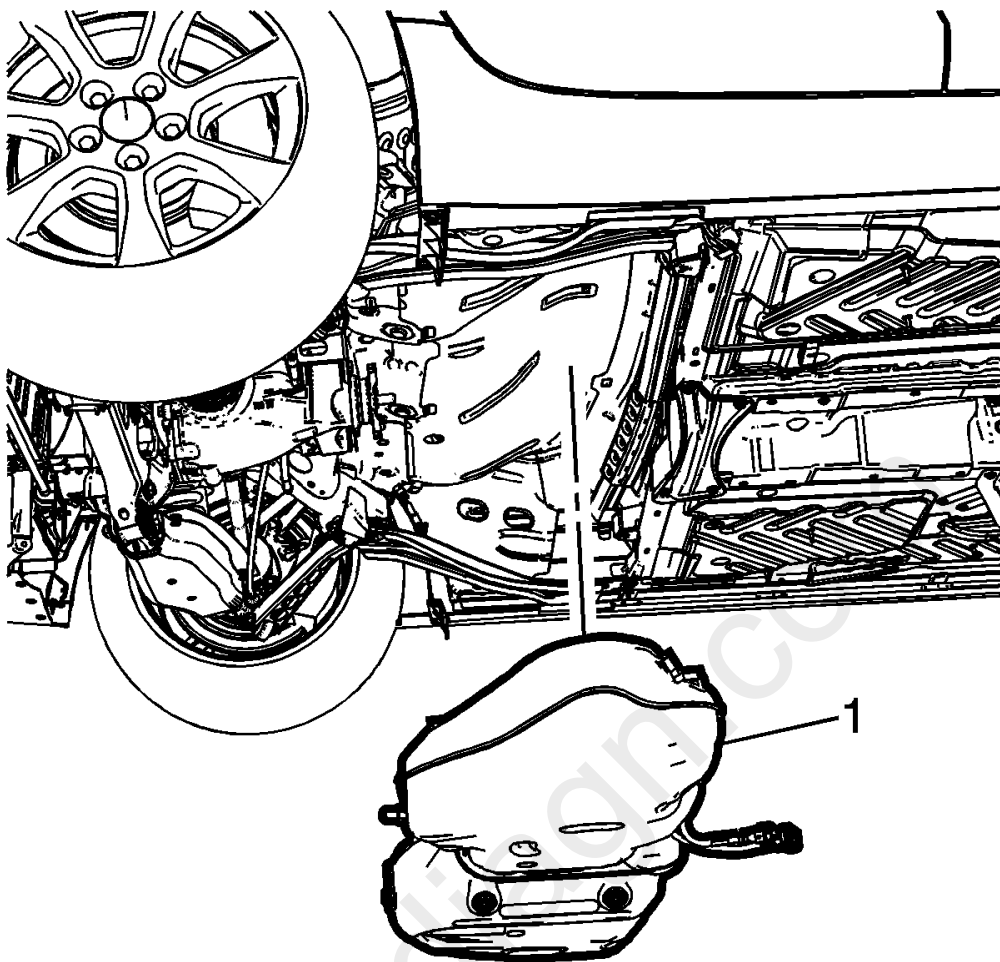


Fig. 54: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

11. Remove the fuel tank (1).
12. Remove the following components if replacing just the fuel tank.
 1. Fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.
 2. Transfer components as necessary.

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
 1. Fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

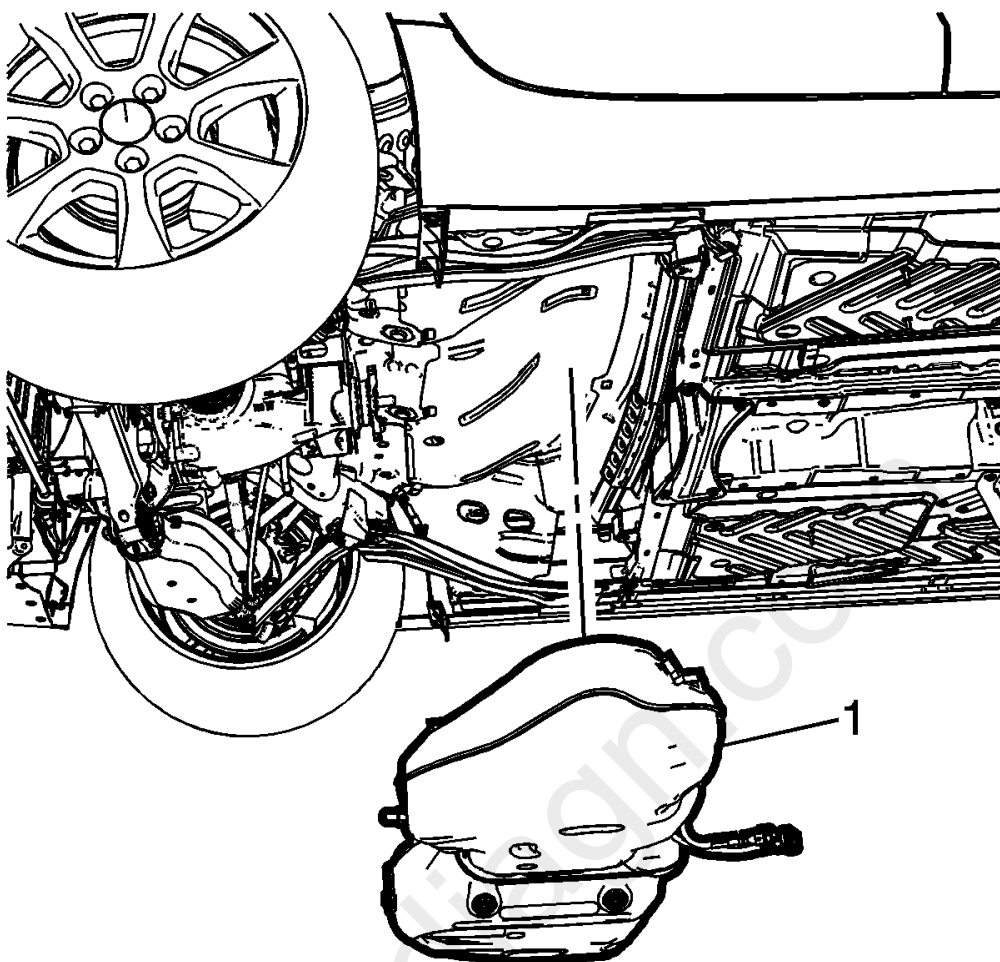


Fig. 55: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

2. Use a suitable jack and install the fuel tank (1).

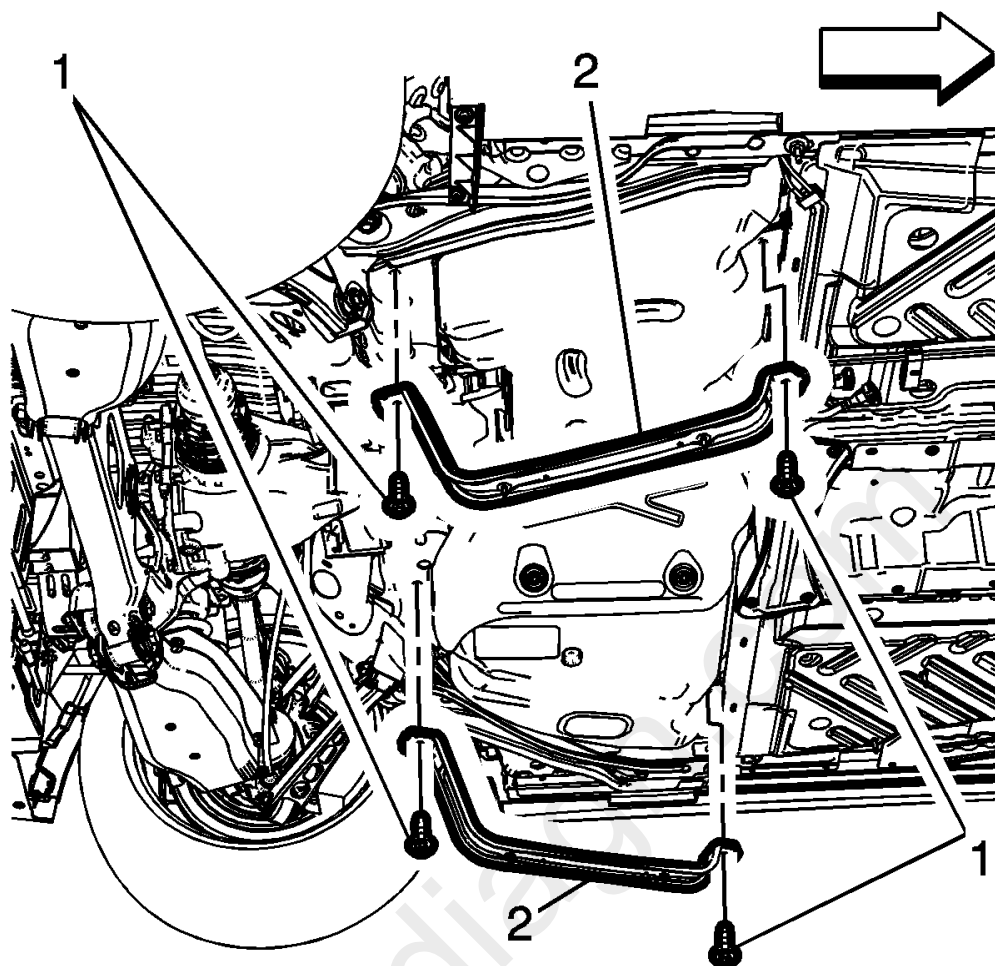


Fig. 56: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel tank straps (2).

CAUTION: Refer to Fastener Caution .

4. Install the fuel tank strap bolts (1) and tighten to 20 N.m (15 lb ft).
5. Connect the fuel tank electrical connector.

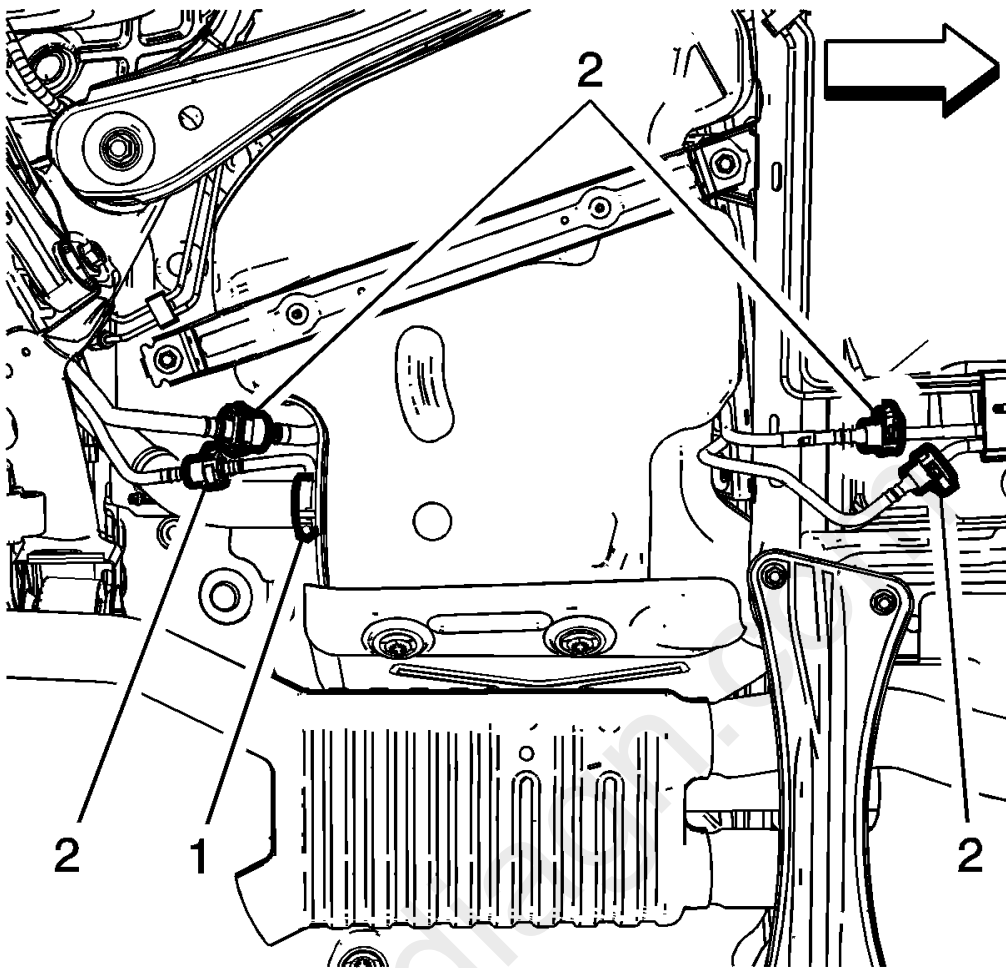


Fig. 57: Evaporative Emission And Fuel Pipes
 Courtesy of GENERAL MOTORS COMPANY

6. Install the filler pipe and tighten the hose clamps (1).
7. Connect the evaporative emission and fuel pipes (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Install the two piece propeller shaft. Refer to **Two-Piece Propeller Shaft Replacement (LFX, LF3) , Two-Piece Propeller Shaft Replacement (LTG, LCV, LKW) .**
9. Install the left and right side rear air deflectors. Refer to **Underbody Rear Air Deflector Replacement - Left Side** , and **Underbody Rear Air Deflector Replacement - Right Side** .
10. Refill the fuel tank.
11. Inspect for fuel leaks.

FUEL TANK FUEL PUMP MODULE REPLACEMENT

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)**

Removal Procedure

WARNING: Refer to **Gasoline/Gasoline Vapors Warning** .

WARNING: Refer to **Safety Glasses Warning** .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement** .
2. Disconnect the fuel pump electrical connector and the quick connects. Refer to **Plastic Collar Quick Connect Fitting Service** .

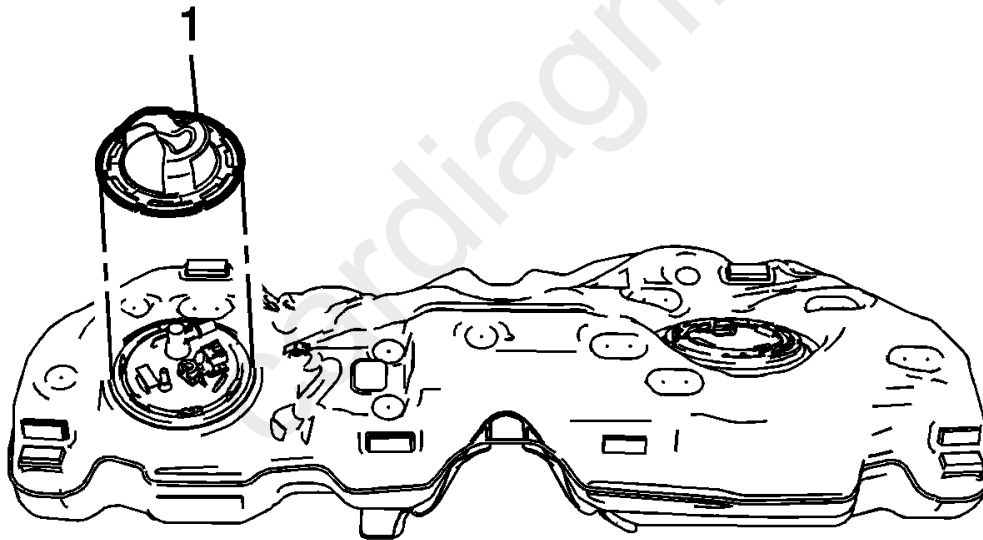


Fig. 58: Fuel Tank Fuel Pump Module Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning counter clockwise and remove the lock ring (1).

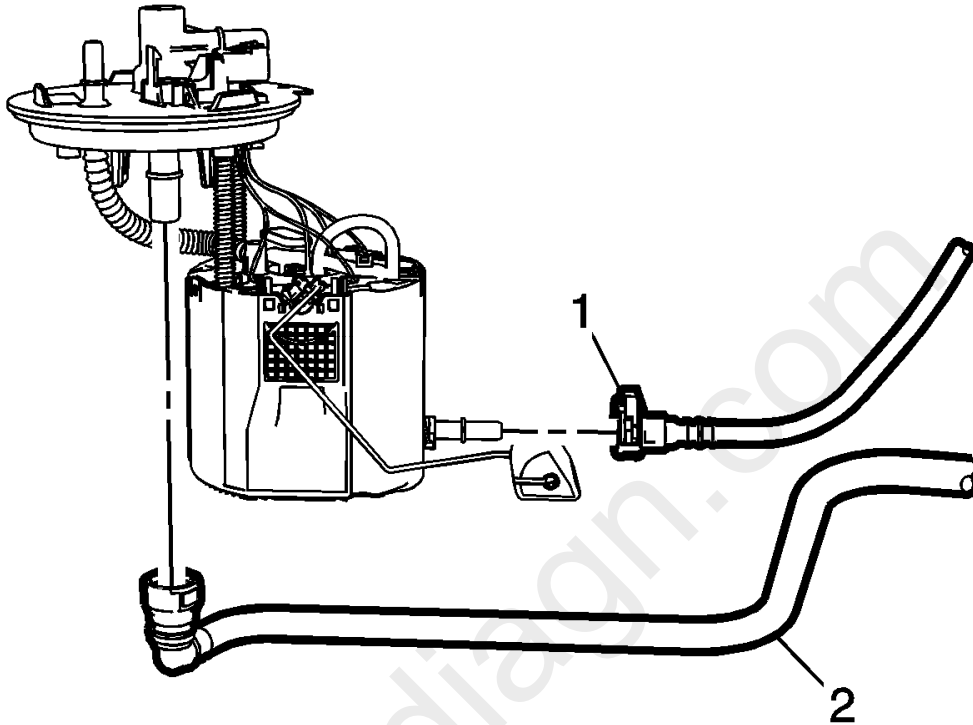


Fig. 59: Pump Vent Hose And Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel pump vent hose (1) and transfer hose (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

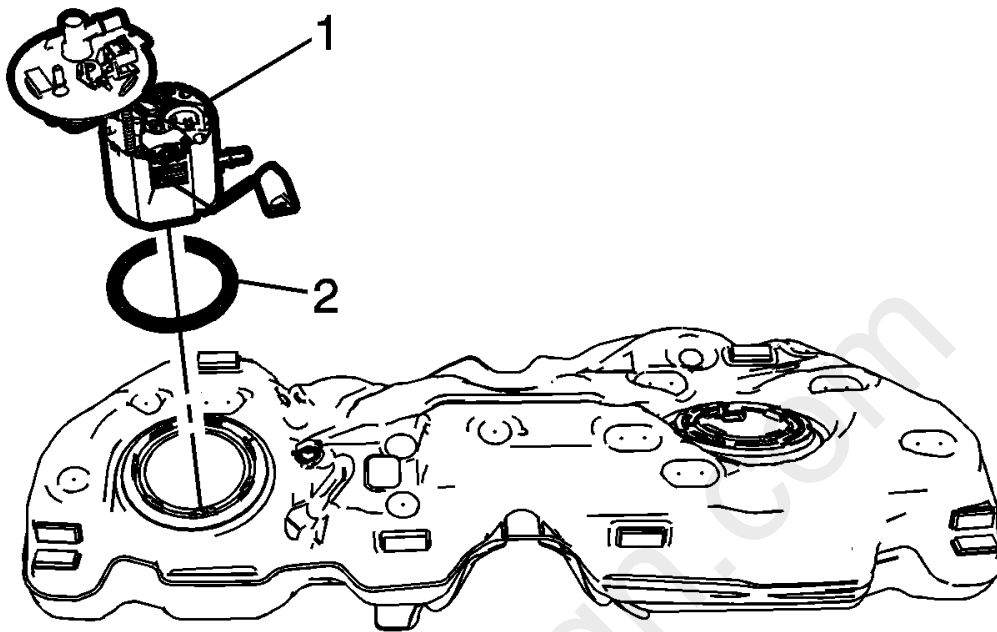


Fig. 60: Fuel Tank Module
Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel tank module (1) and the O-ring (2).

Installation Procedure

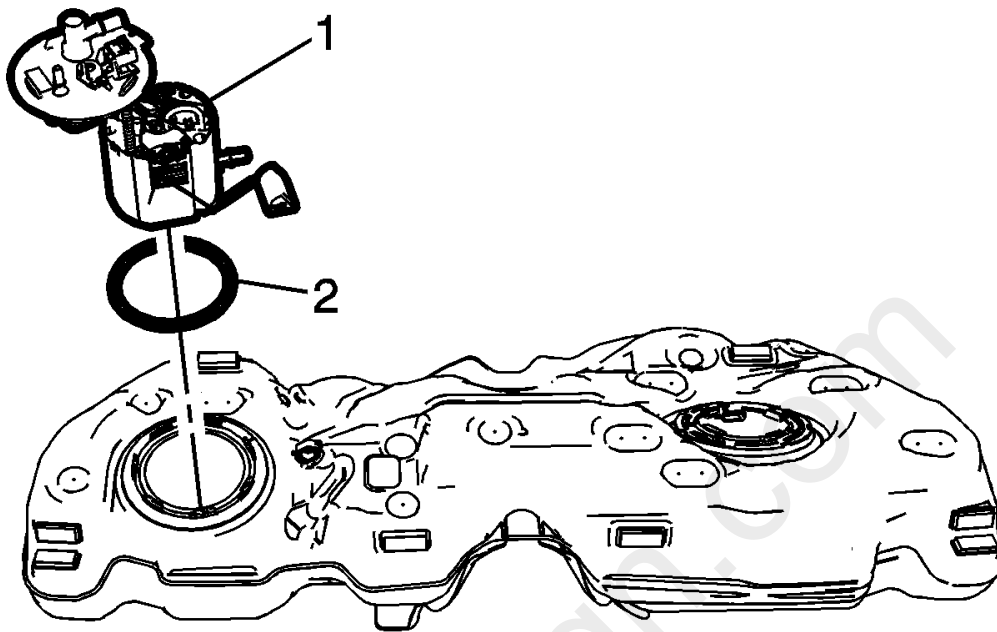


Fig. 61: Fuel Tank Module

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel tank module (1).

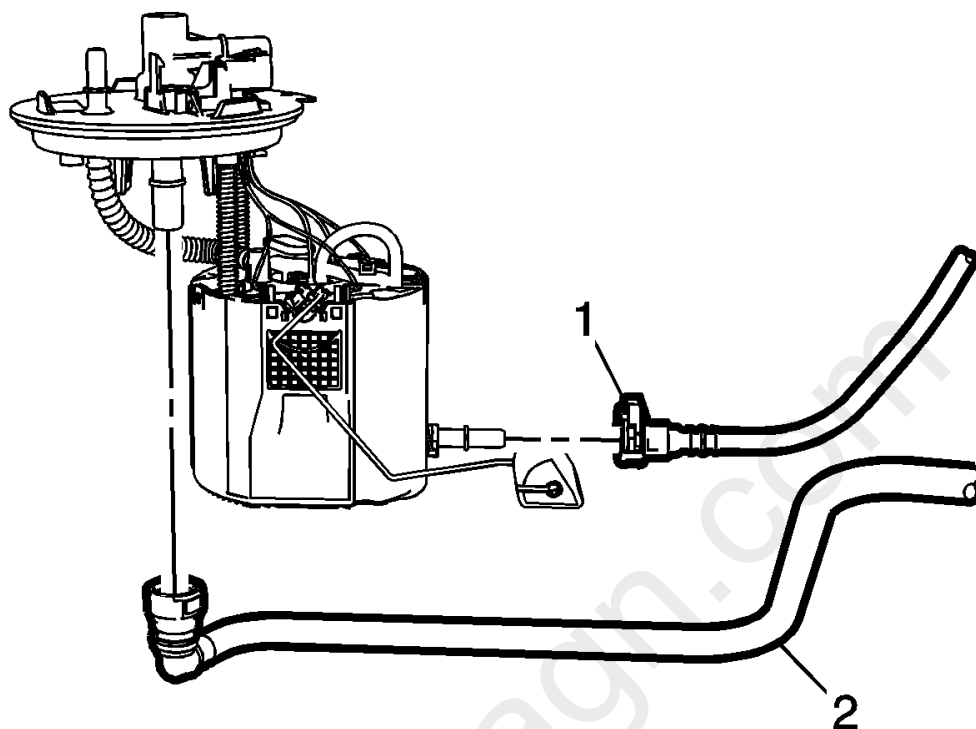


Fig. 62: Pump Vent Hose And Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel pump vent hose (1) and transfer hose (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

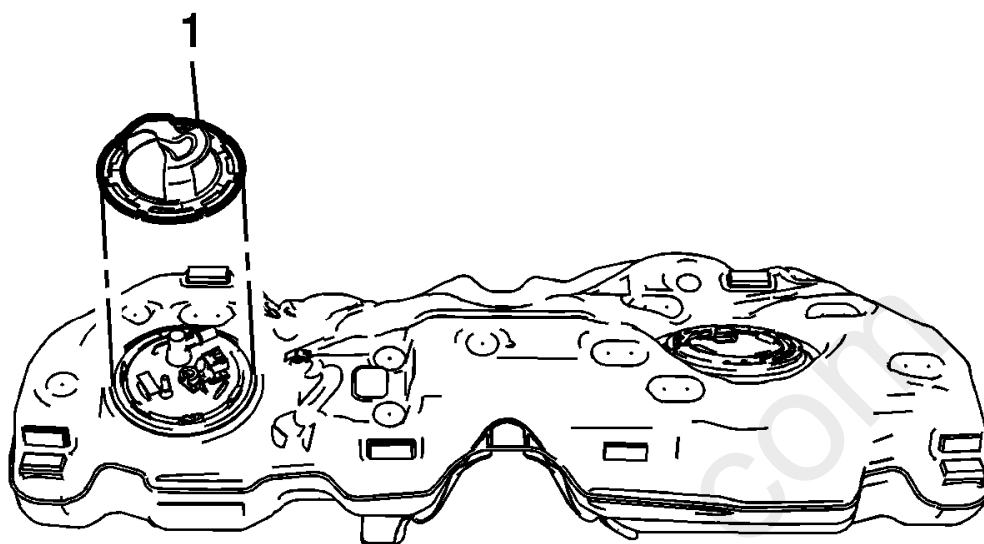


Fig. 63: Fuel Tank Fuel Pump Module Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning clockwise and install the lock ring (1).
4. Connect the fuel pump electrical connector and the quick connects. Refer to **Plastic Collar Quick Connect Fitting Service** .
5. Install the fuel tank. Refer to **Fuel Tank Replacement** .

FUEL PUMP POWER CONTROL MODULE REPLACEMENT

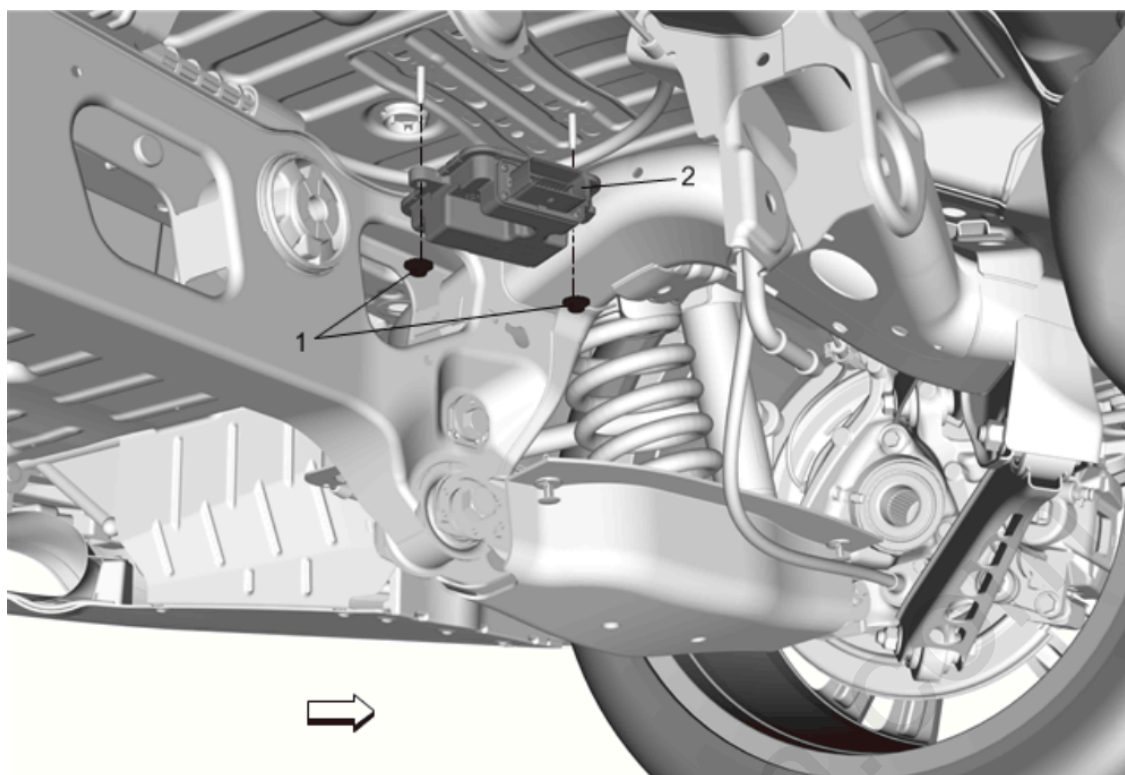


Fig. 64: Fuel Pump Power Control Module
Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Power Control Module Replacement

Callout	Component Name
Preliminary Procedure Raise and support vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Fuel Pump Power Control Module Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m(80 lb in)
2	Fuel Pump Power Control Module Procedure 1. Disconnect the electrical connector. 2. If replacing, reprogram the control module. Refer to <u>Service Programming System (SPS)</u> .

CHASSIS CONTROL MODULE REPLACEMENT

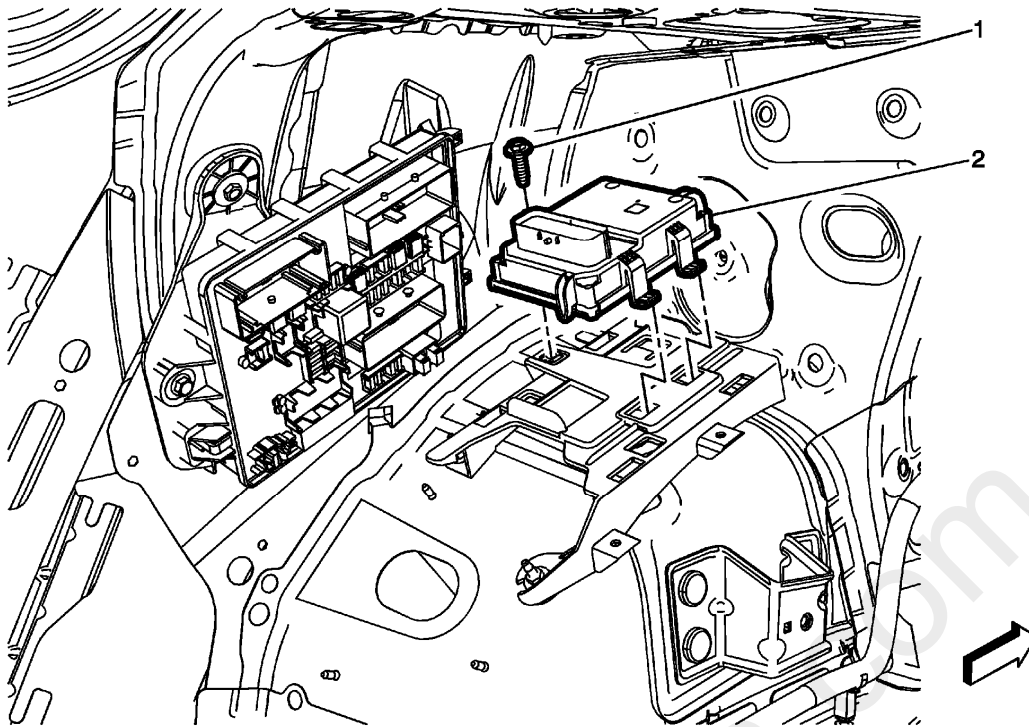


Fig. 65: Chassis Control Module
 Courtesy of GENERAL MOTORS COMPANY

Chassis Control Module Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment left side fuse access panel.	
1	Fuel Pump Flow Control Module Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7 (62 lb in)
2	Fuel Pump Flow Control Module Procedure 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to <u>Control Module References</u> .

FUEL TANK PRESSURE SENSOR REPLACEMENT

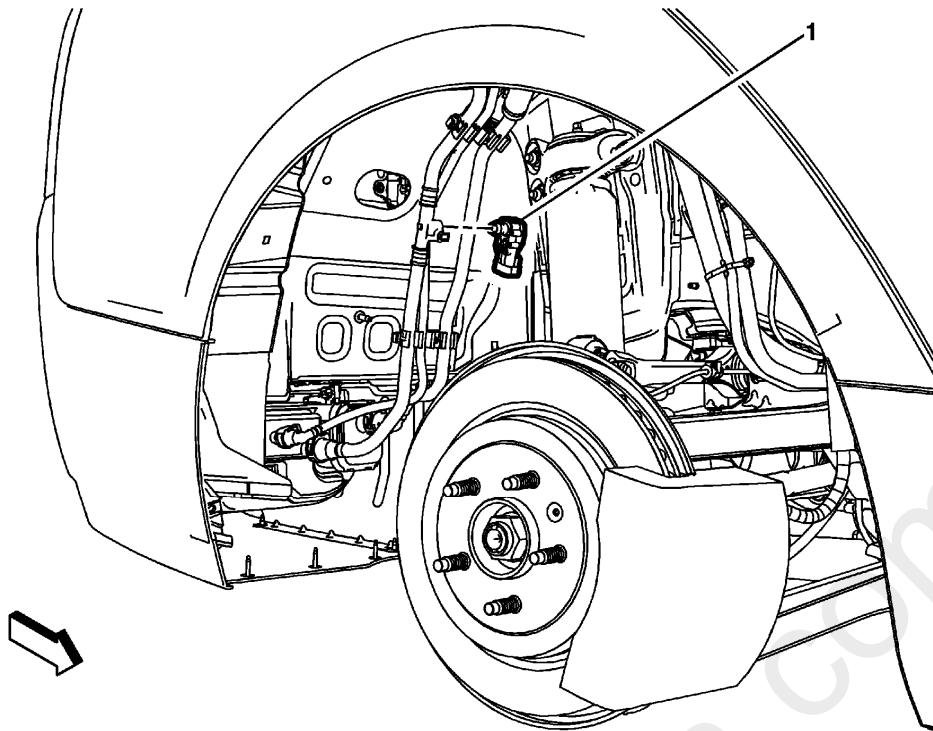


Fig. 66: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure	
Remove the right rear wheelhouse panel liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> .	
1	Fuel Tank Pressure Sensor Procedure Disconnect the FTP sensor electrical connector.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

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

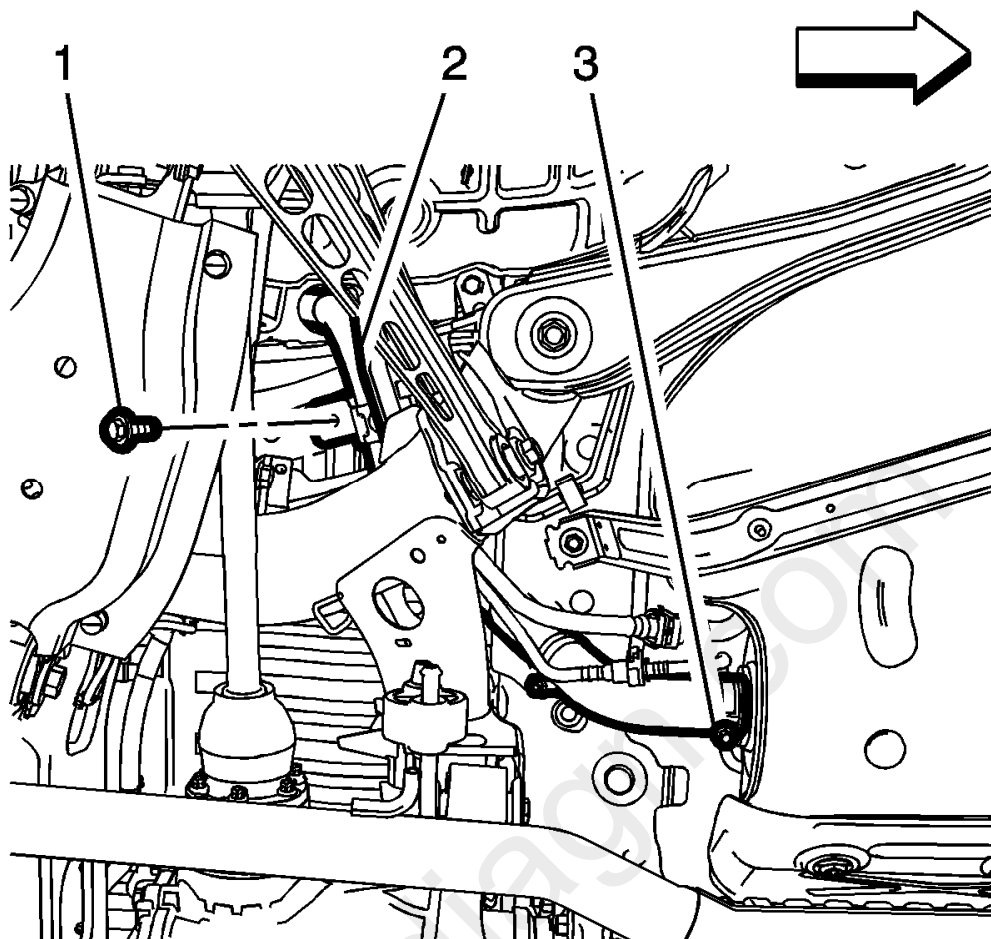


Fig. 67: Fuel Tank Filler Pipe Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel tank filler pipe fastener (1).
3. Remove the fuel tank filler pipe clamp (2).
4. Place a clean drain pan large enough to capture the fuel that may be expelled once the hose is removed.
5. Remove the fuel tank filler pipe (3) from the fuel tank.
6. Remove the fuel tank filler pipe housing. Refer to **Fuel Tank Filler Pipe Housing Replacement** .
7. Remove the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .

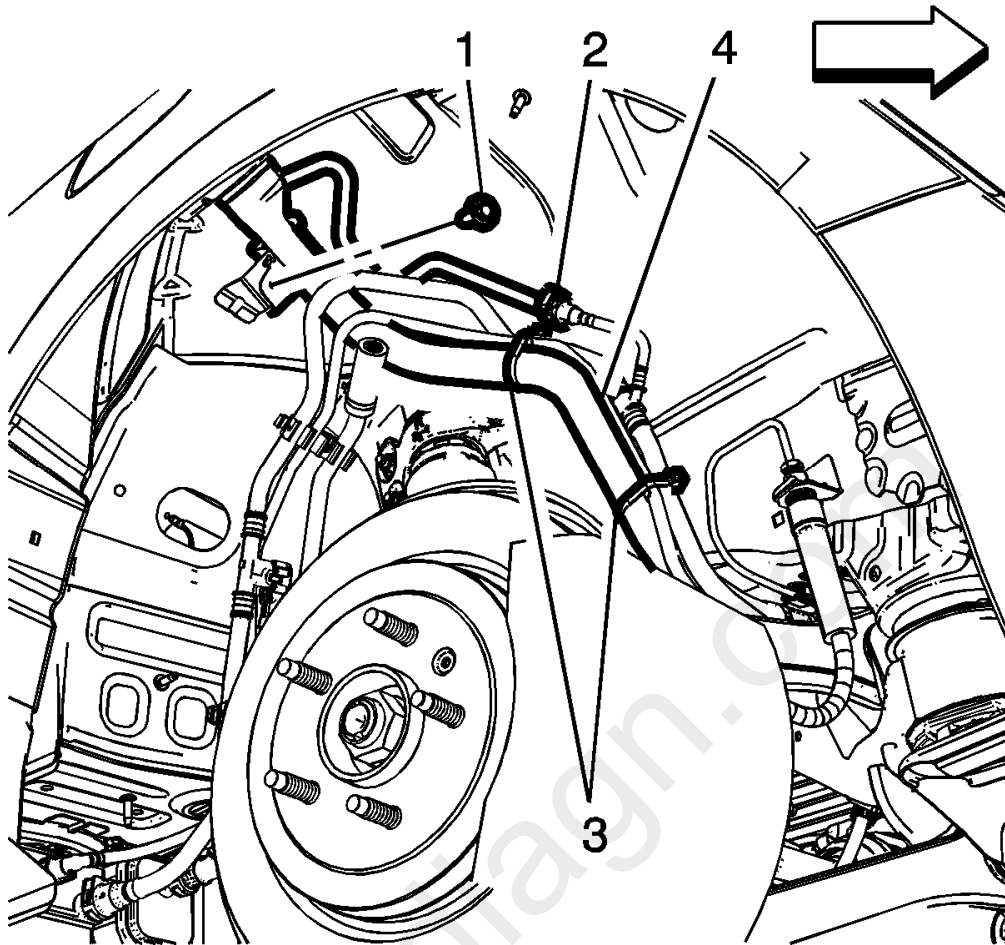


Fig. 68: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Remove the tie straps (3) attaching the evaporative emission canister purge pipe and fuel tank vent hose to the fuel tank filler pipe.
9. Remove the fuel tank filler pipe fastener (1).
10. Remove the fuel tank vent hose (2) from the fuel tank filler pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
11. Remove the fuel tank filler pipe (4) from the vehicle.

Installation Procedure

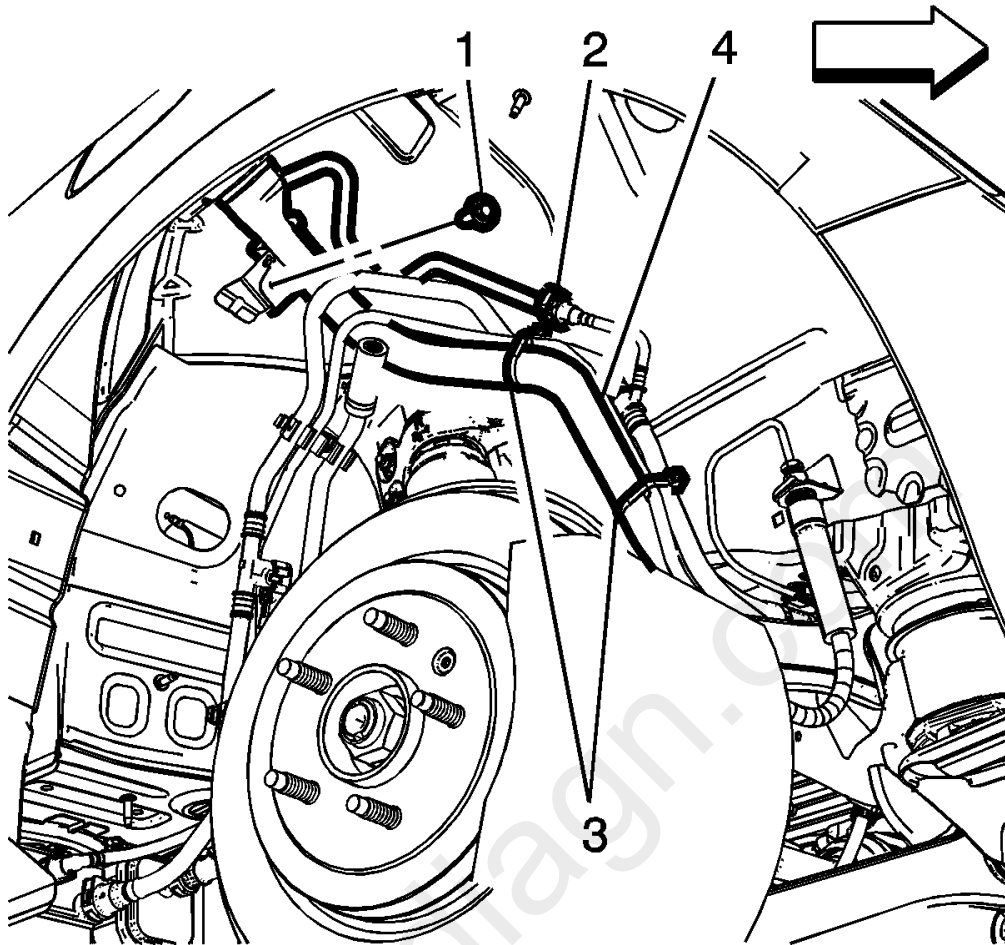


Fig. 69: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank filler pipe (4) to the vehicle.
2. Install the fuel tank vent hose (2) to the fuel tank filler pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.

CAUTION: Refer to Fastener Caution .

3. Install the fuel tank filler pipe fastener (1) and tighten to 9 (80 lb in).
4. Install NEW tie straps (3) that attach the evaporative emission canister purge pipe and fuel tank vent hose to the fuel tank filler pipe.
5. Install the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .
6. Install the fuel tank filler pipe housing. Refer to **Fuel Tank Filler Pipe Housing Replacement** .

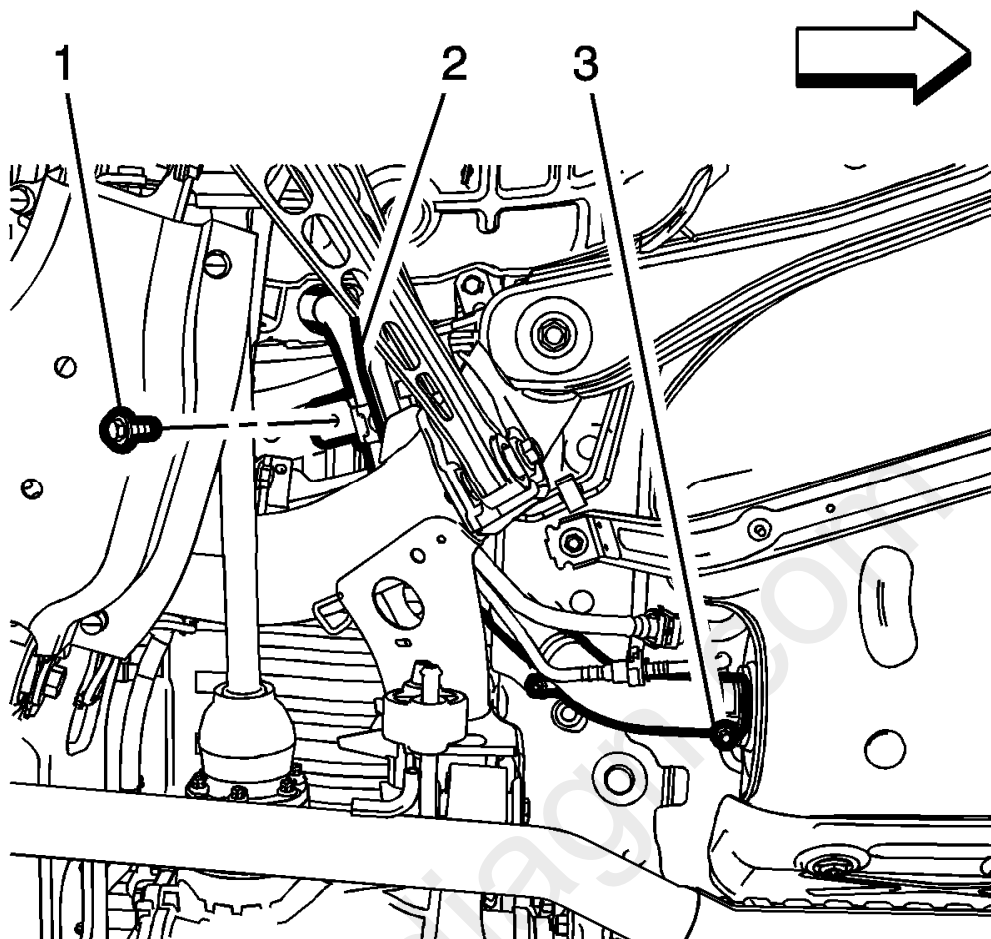


Fig. 70: Fuel Tank Filler Pipe Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Install the fuel tank filler pipe (3) to the fuel tank.
8. Install the fuel tank filler pipe clamp (2).
9. Install the fuel tank filler pipe fastener (1) and tighten to 9 (80 lb in).
10. Remove the drain pan.
11. Lower the vehicle.

FUEL TANK VENT HOSE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

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

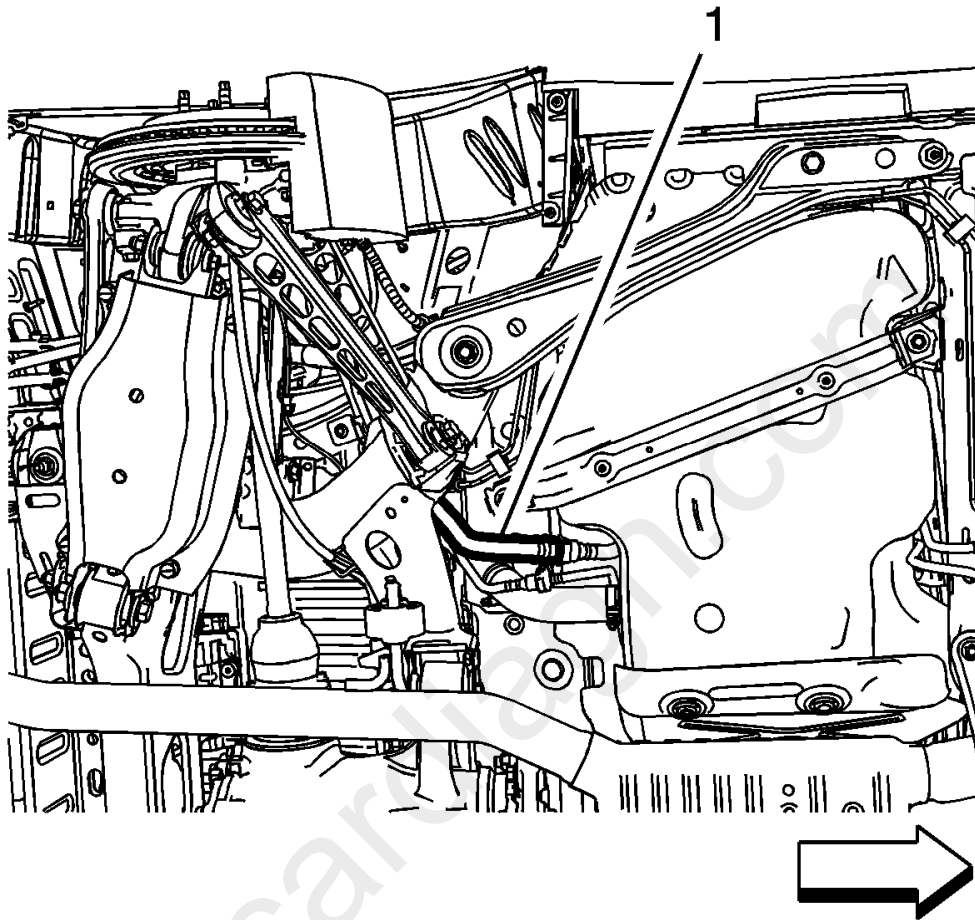


Fig. 71: Fuel Tank Vent Hose

Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the fuel tank vent hose (1) from the fuel tank vent valve hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Remove the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .
4. Disconnect the fuel tank pressure sensor electrical connector.

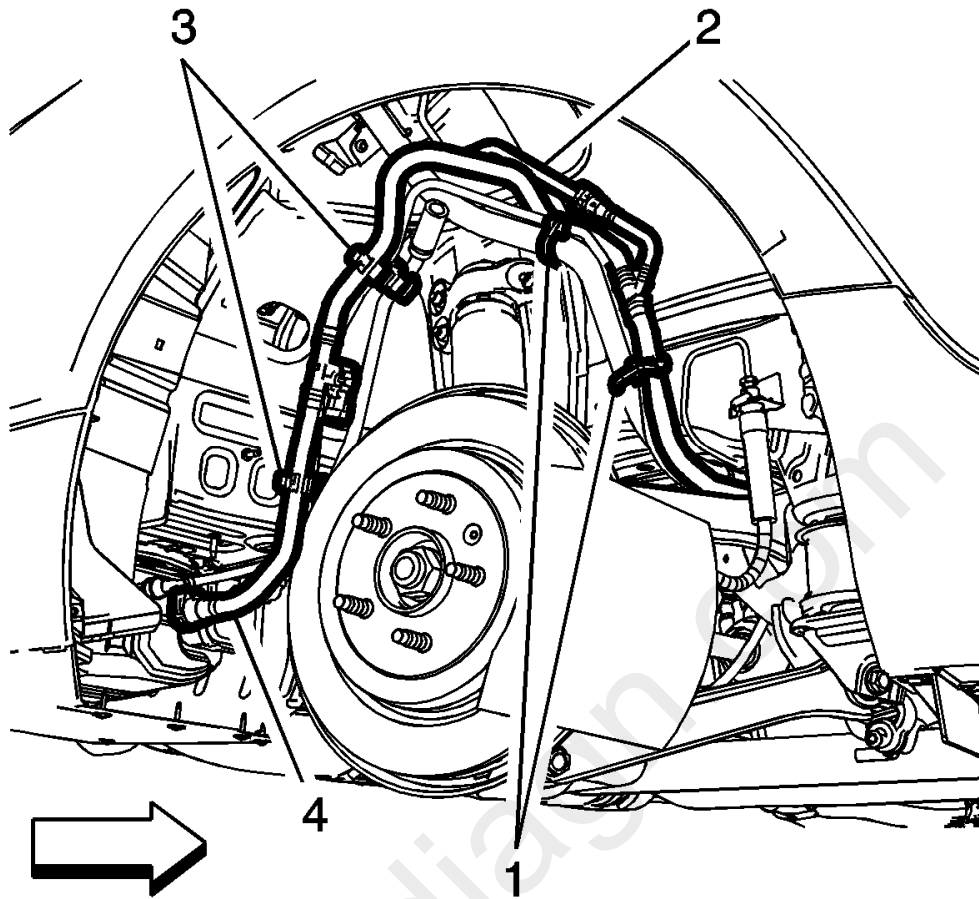


Fig. 72: Fuel Tank Filler Pipe And Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove the tie straps (1) attaching the fuel tank vent hose to the fuel tank filler pipe.
6. Remove the fuel tank vent hose (4) from the fuel tank filler pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Remove the fuel tank vent hose (4) from the retainers (3).
8. Remove the fuel tank vent hose (4) from the EVAP emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

Installation Procedure

1. If replacing hose then transfer the fuel tank pressure sensor. Refer to **Fuel Tank Pressure Sensor Replacement**.

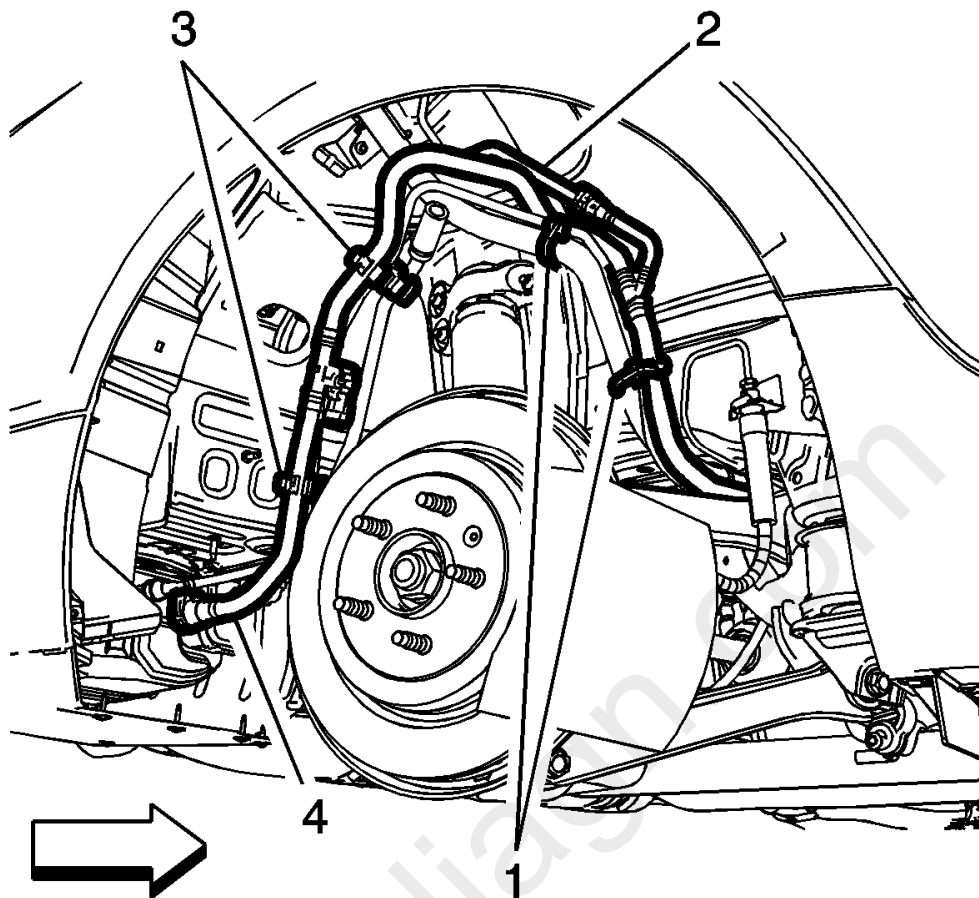


Fig. 73: Fuel Tank Filler Pipe And Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

2. Install the fuel tank vent hose (4) to the EVAP emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the fuel tank vent hose (4) to the retainers (3).
4. Install the fuel tank vent hose (4) to the fuel tank filler pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install NEW tie straps (1) to attach the fuel tank vent hose to the fuel tank filler pipe.
6. Connect the fuel tank pressure sensor electrical connector.
7. Install the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .

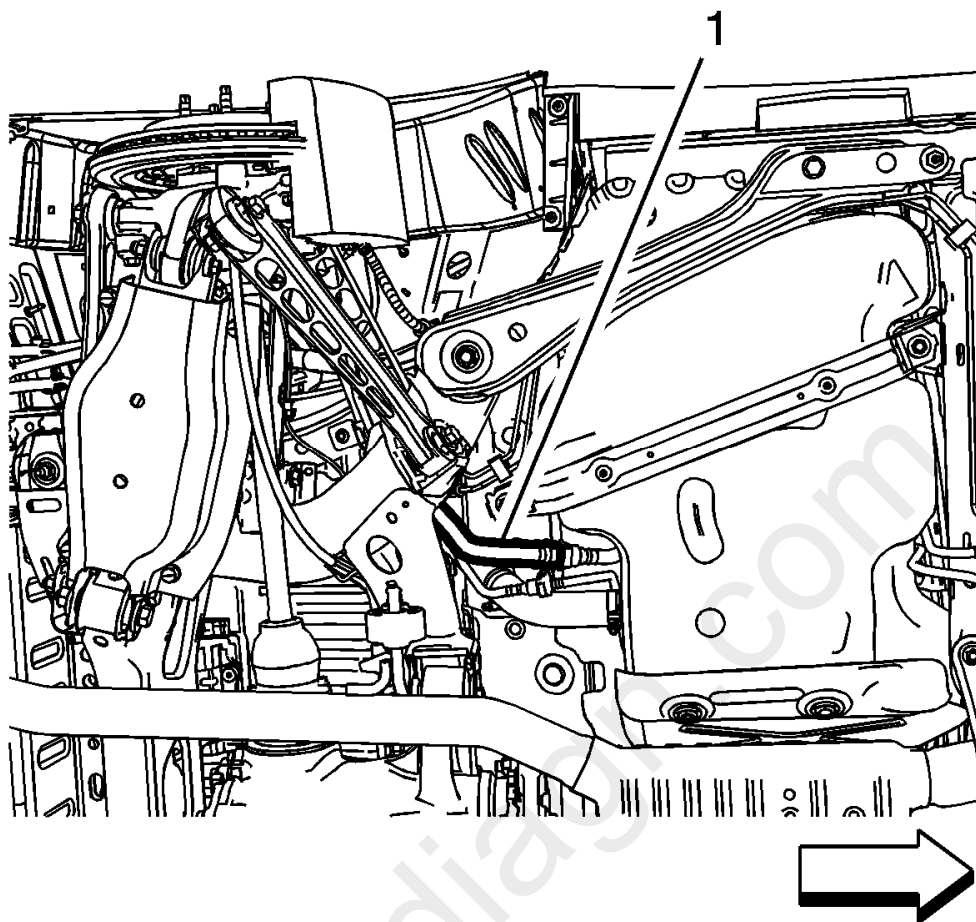


Fig. 74: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

8. Connect the fuel tank vent hose (1) to the fuel tank vent valve hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Lower the vehicle.

FUEL LEVEL SENSOR REPLACEMENT

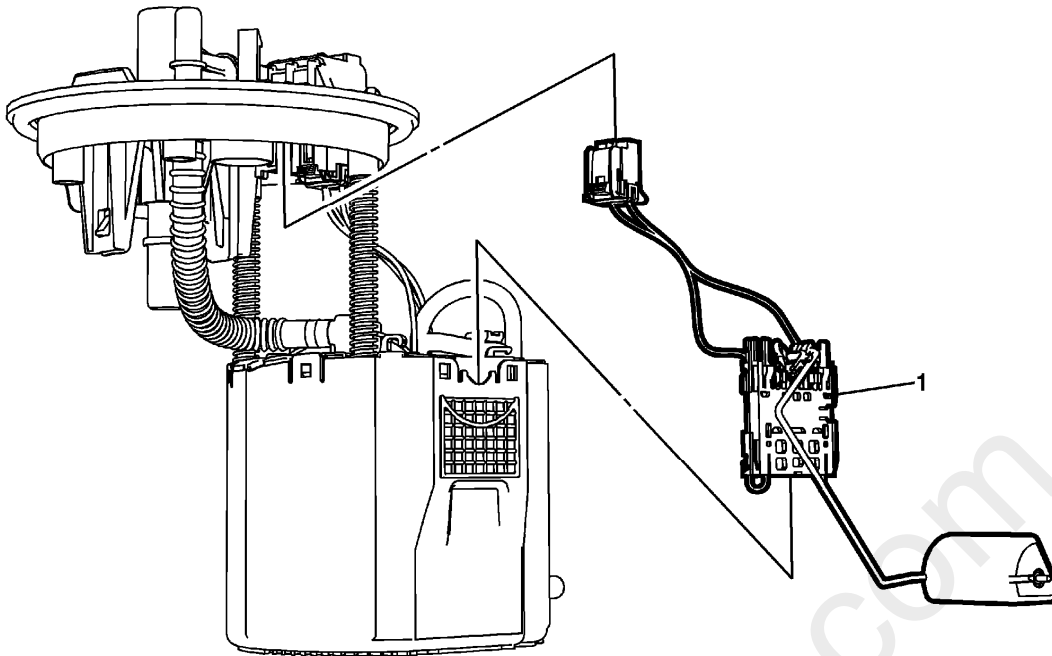


Fig. 75: Fuel Level Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Level Sensor Replacement

Callout	Component Name
Preliminary Procedure	
Remove the fuel tank fuel pump module. Refer to <u>Fuel Tank Fuel Pump Module Replacement</u>.	
1	Fuel Level Sensor Procedure Release the fuel level sensor tabs and disconnect the electrical connector.

FUEL PUMP FUEL FEED HOSE REPLACEMENT

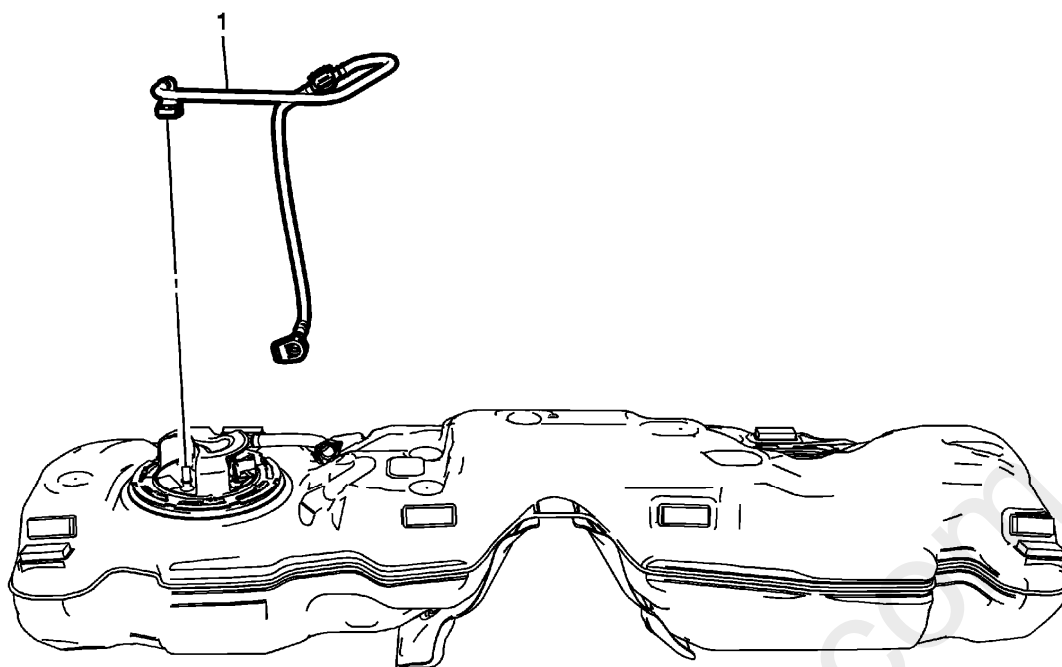


Fig. 76: Fuel Pump Fuel Feed Hose
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Fuel Feed Hose Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to <u>Fuel Tank Replacement</u> .	
1	Fuel Pump Fuel Feed Hose Procedure 1. Disconnect the fuel pressure sensor electrical connector. If replacing hose transfer fuel pressure sensor. Refer to <u>Fuel Pressure Sensor Replacement - Fuel Feed Pipe</u>. 2. Disconnect the fuel pump fuel feed hose from the fuel tank fuel pump module. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

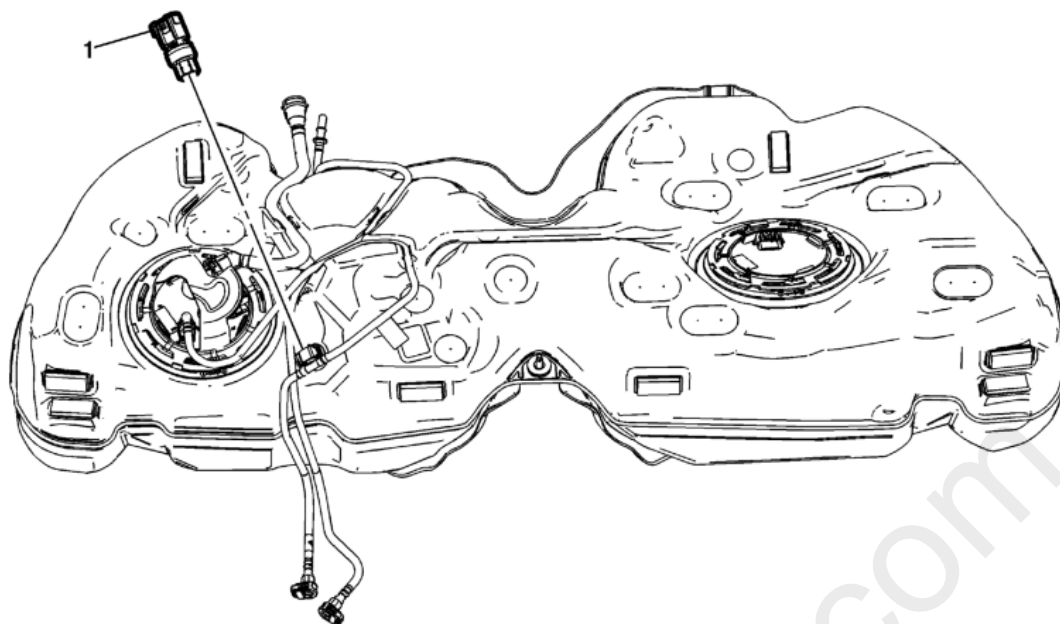


Fig. 77: Fuel Pressure Sensor - Fuel Feed Pipe
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pressure Sensor Replacement - Fuel Feed Pipe

Callout	Component Name
WARNING: Refer to <u>Gasoline/Gasoline Vapors Warning</u> .	
WARNING: Refer to <u>Safety Glasses Warning</u> .	
Preliminary Procedure Remove the fuel tank. Refer to <u>Fuel Tank Replacement</u> .	
1	Fuel Tank Pressure Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect electrical connector and unclip sensor from retainer.

FUEL FEED PIPE REPLACEMENT (LFX)

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the system fuel pressure. Refer to Fuel Pressure Relief .
2. Remove the intake manifold insulator. Refer to Intake Manifold Insulator Replacement .

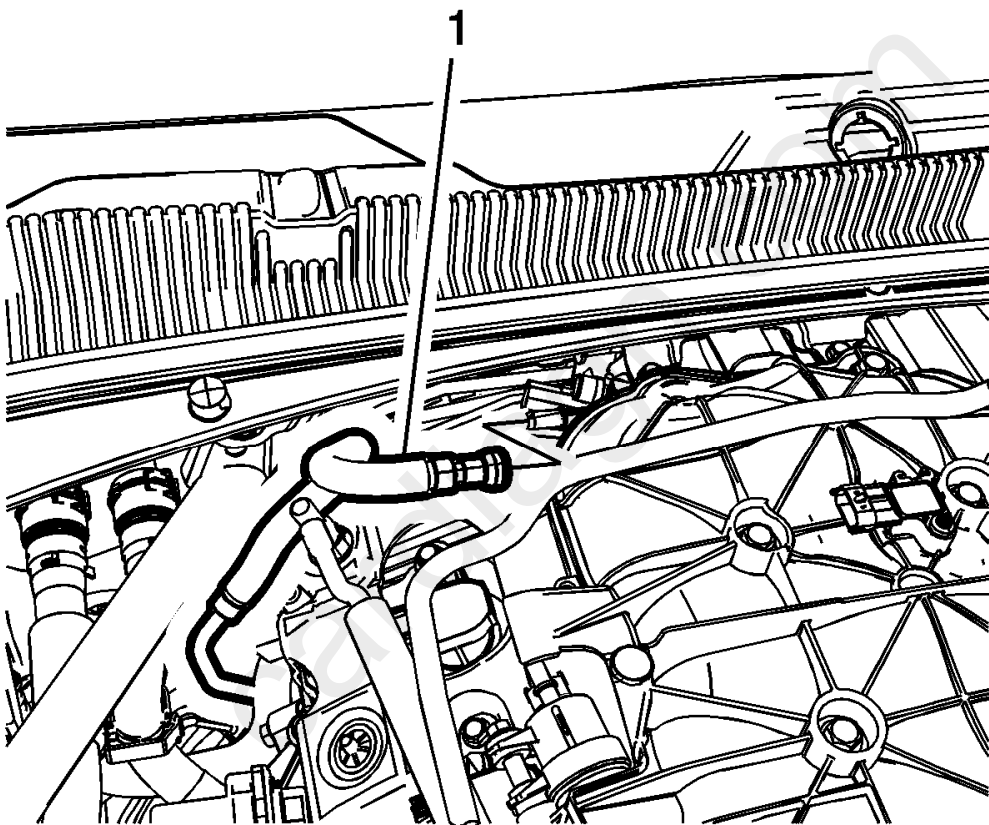


Fig. 78: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel feed pipe (1) from the engine and retainers. Refer to Metal Collar Quick Connect Fitting Service.
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
5. Remove the underbody front air deflector right side. Refer to Underbody Front Air Deflector Replacement - Right Side .

6. Remove the front body exhaust heat shield right side. Refer to **Front Body Exhaust Heat Shield Replacement (Right)** , **Front Body Exhaust Heat Shield Replacement (Left)** .
7. Remove the right side catalytic converter and exhaust. Refer to **Exhaust System Replacement (LFX)** .

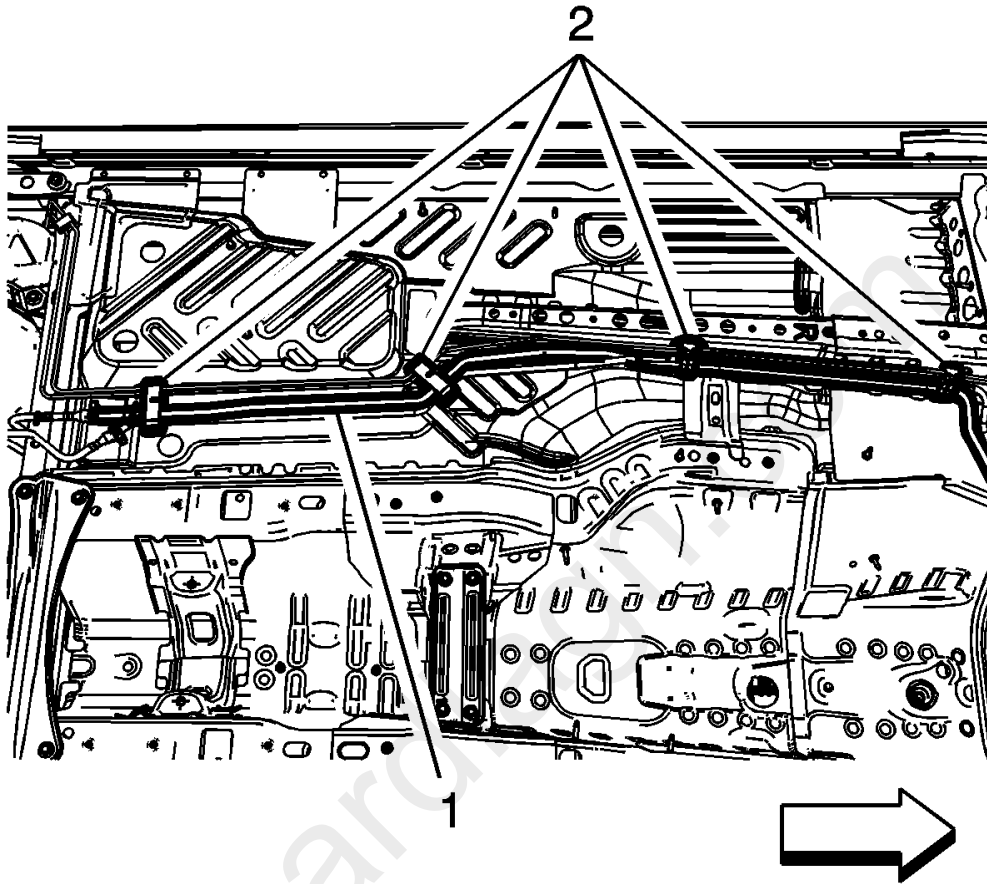


Fig. 79: Fuel Feed Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the fuel feed pipe (1) and remove from retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Remove the fuel feed pipe (1) from the vehicle.

Installation Procedure

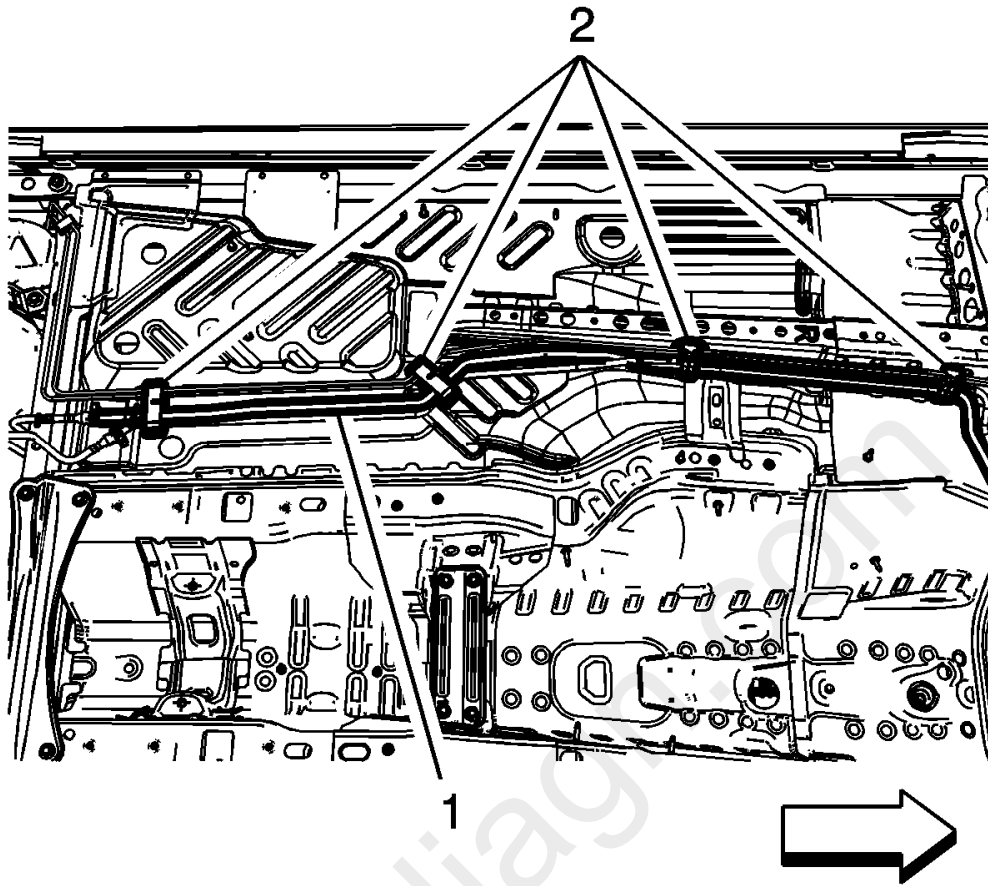


Fig. 80: Fuel Feed Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel feed pipe (1) to the vehicle.
2. Connect the fuel feed pipe (1) and install to the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the right side catalytic converter and exhaust. Refer to **Exhaust System Replacement (LFX)**.
4. Install the front body exhaust heat shield right side. Refer to **Front Body Exhaust Heat Shield Replacement (Right)**, **Front Body Exhaust Heat Shield Replacement (Left)**.
5. Install the underbody front air deflector right side. Refer to **Underbody Front Air Deflector Replacement - Right Side**.
6. Lower the vehicle.

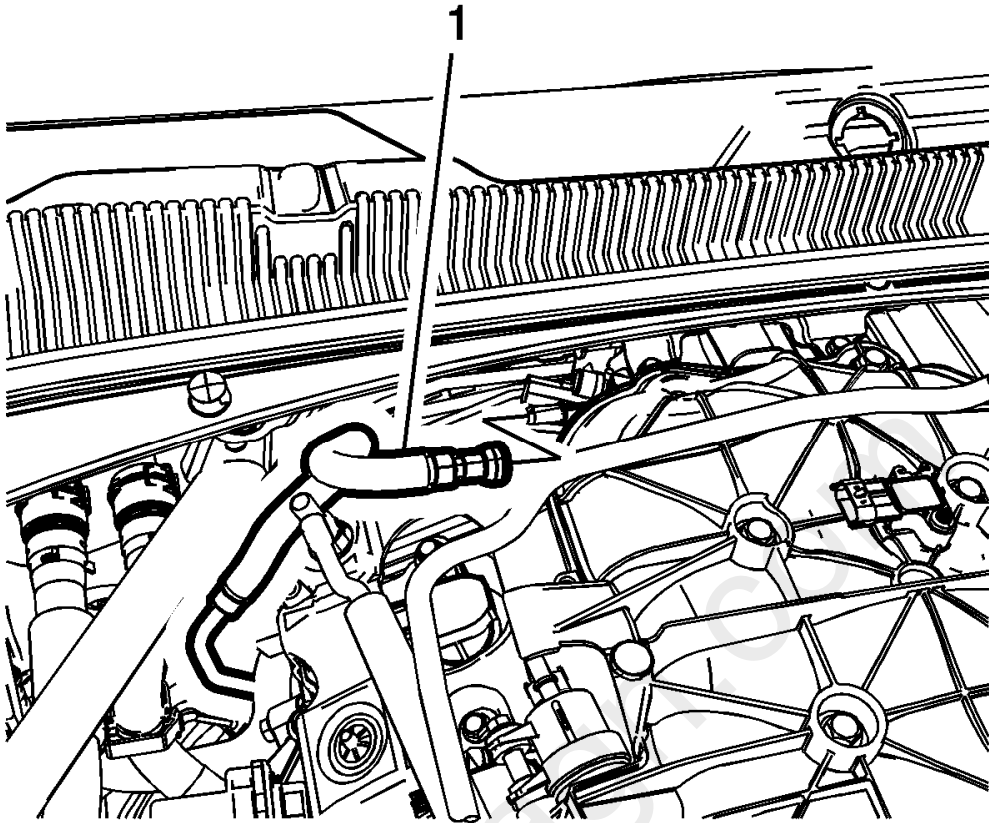


Fig. 81: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Install the fuel feed pipe (1) to the engine and retainers. Refer to **Metal Collar Quick Connect Fitting Service.**
8. Install the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement .**

FUEL FEED PIPE REPLACEMENT (LF3)

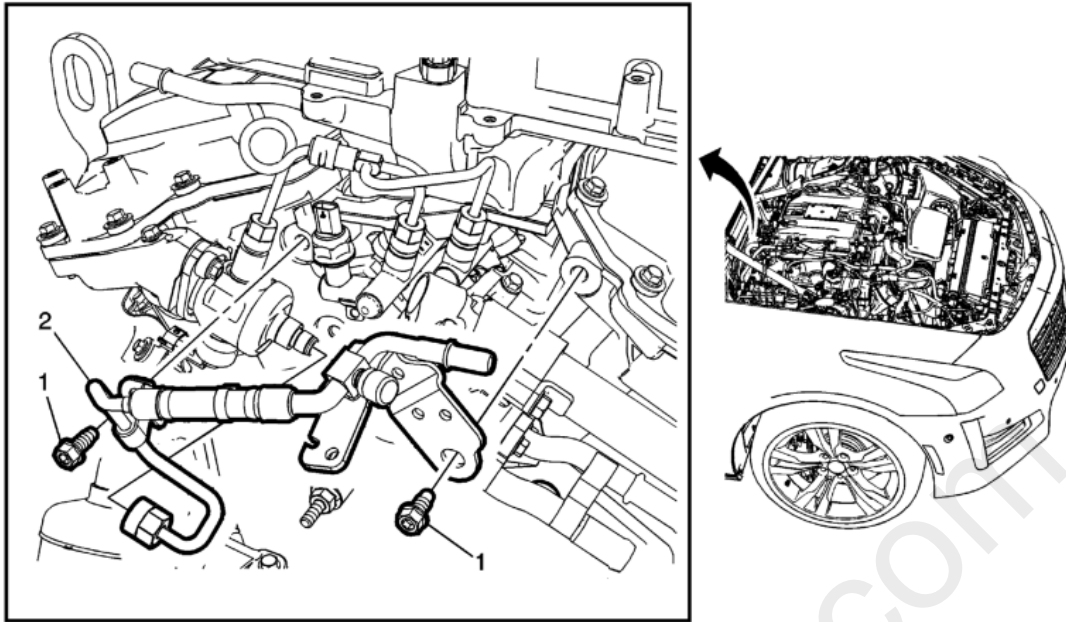


Fig. 82: Fuel Feed Pipe (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Pipe Replacement (LF3)

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u>. 2. Remove the engine rear noise shield. Refer to <u>Engine Rear Noise Shield Replacement (LF3)</u>. 3. Disconnect the fuel feed line quick connect. Refer to <u>Metal Collar Quick Connect Fitting Service</u>.	
1	Fuel Feed Pipe Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 50 (37 lb ft)
	Fuel Feed Pipe CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .

2	Procedure 1. Unclip the electrical harness from the feed pipe bracket. 2. DISCARD the pipe when removed, and install a NEW pipe. 3. Ensure that the high pressure fuel pipe, and fuel pump fittings are clean and dry prior to assembly. 4. Pressure up the fuel system and check for leaks. Tighten 28 (21 lb ft)
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FUEL SYSTEM CLEANING

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

NOTE: Whenever the fuel tank is cleaned, inspect the fuel pump fuel strainer. If the fuel pump fuel strainer is contaminated, replace the fuel pump fuel strainer and inspect the fuel pump.

NOTE: Always maintain cleanliness when servicing fuel system components.

1. Remove the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.
2. Inspect the fuel pump inlet for dirt and debris. If dirt and debris are found, replace the fuel pump.
3. Flush fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to ensure that the removal of the water from the fuel tank is complete.
5. Allow tank to dry completely before reassembly.
6. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL (LFX)

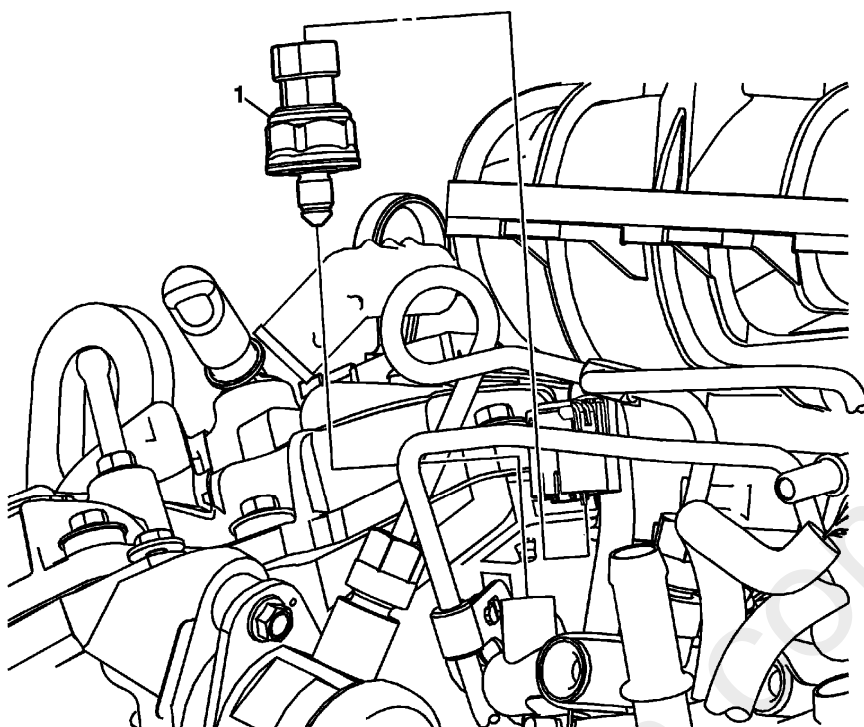


Fig. 83: Fuel Pressure Sensor - Fuel Injection Fuel Rail (LFX)

Courtesy of GENERAL MOTORS COMPANY

Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LFX)

Callout	Component Name
Preliminary Procedure 1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u>. 2. Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement (LFX)</u>.	
1	Fuel Injection Fuel Rail Fuel Pressure Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the electrical connector. Tighten 33 N.m (25 lb ft)

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL (LF3)

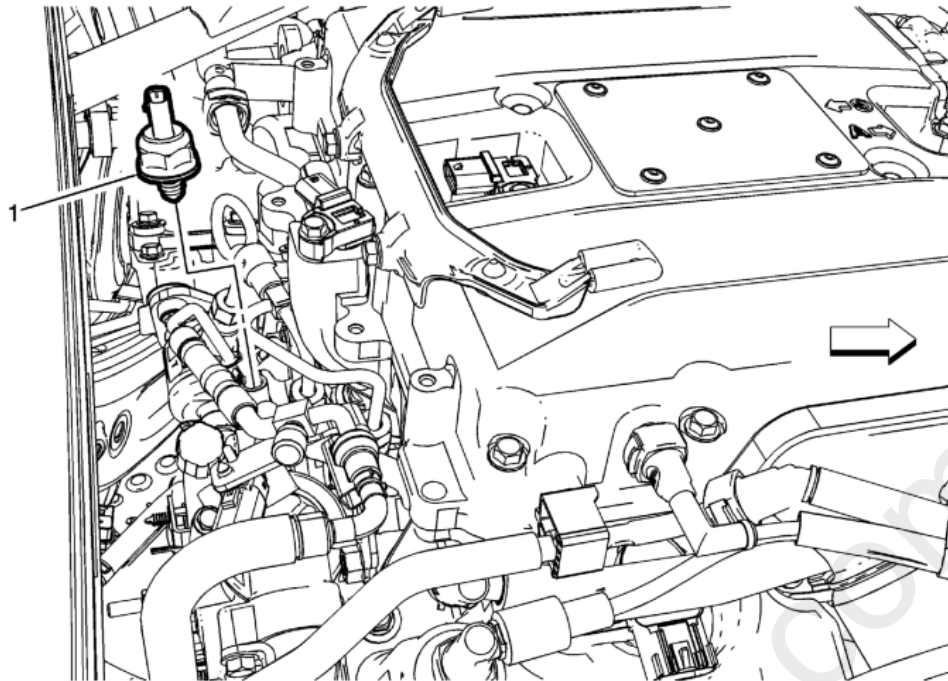


Fig. 84: Fuel Pressure Sensor - Fuel Injection Fuel Rail (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF3)

Callout	Component Name
Preliminary Procedure	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief . 2. Remove the rear engine noise shield. Refer to Engine Rear Noise Shield Replacement (LF3) .	
1	Fuel Pressure Sensor CAUTION: Refer to Component Fastener Tightening Caution . Tighten: 33 (24 lb ft) Procedure Disconnect the fuel pressure sensor electrical connector.

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

Special Tools

EN-49248 Injector Rail Assembly Remover

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LFX)**, **Fuel Pipe Shield Replacement (LF3)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement (LFX)**.
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFX)**.
5. Remove the foam insulator from the fuel rails.

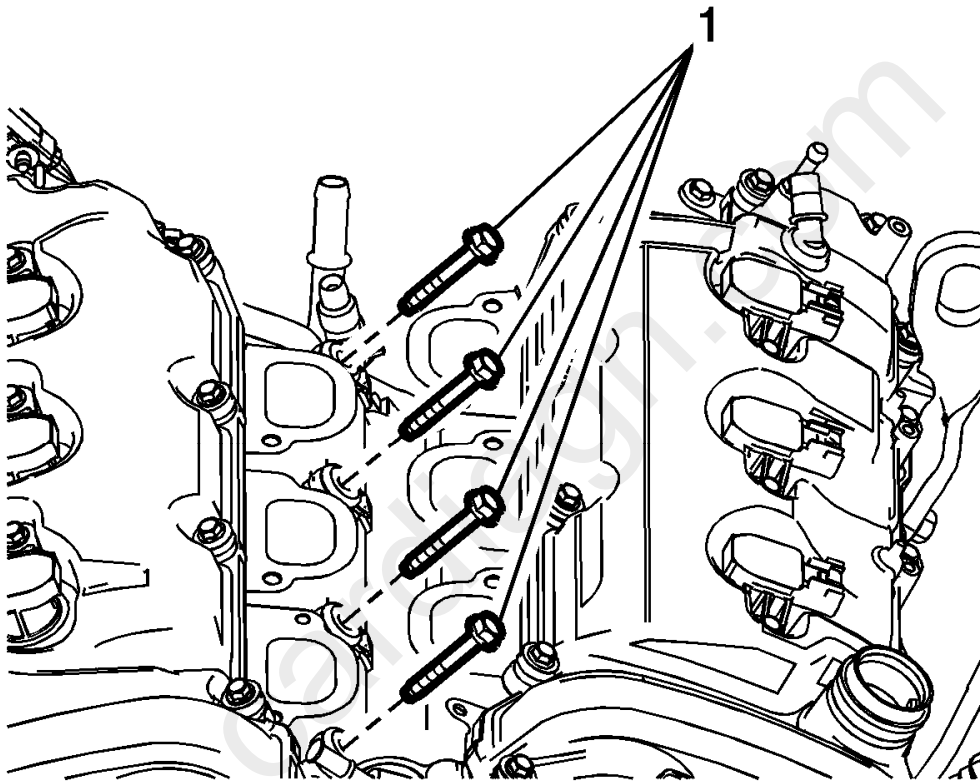


Fig. 85: Right Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the bank 1 fuel rail fasteners (1).

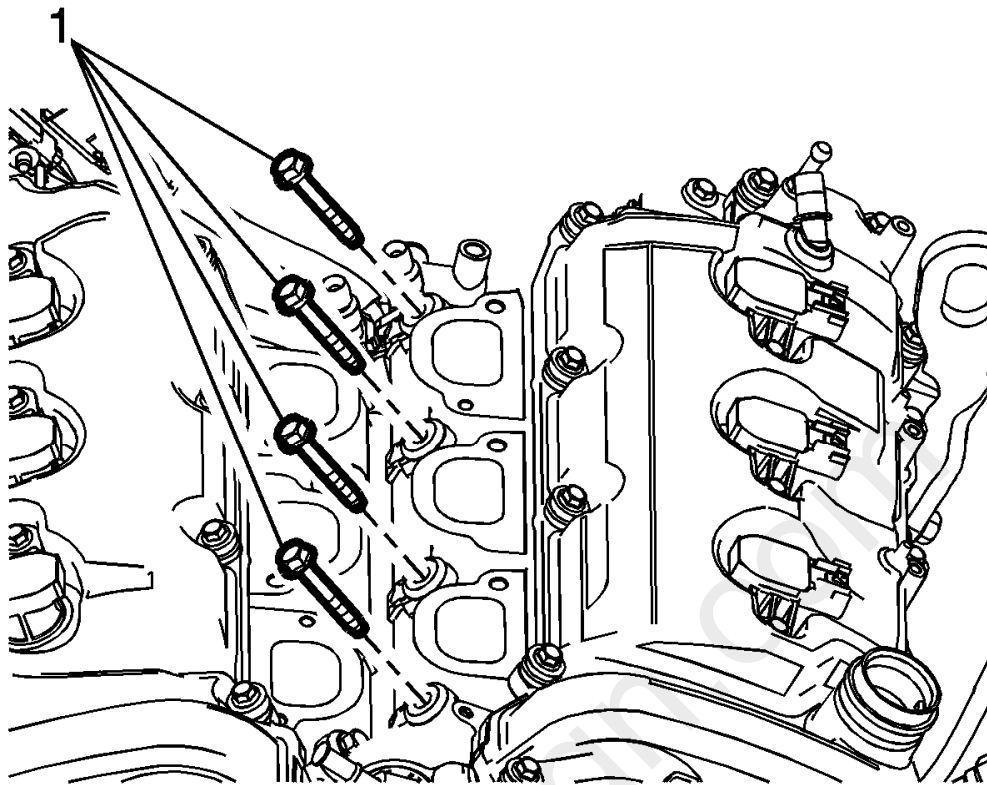


Fig. 86: Left Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the bank 2 fuel rail fasteners (1) for clearance purposes.

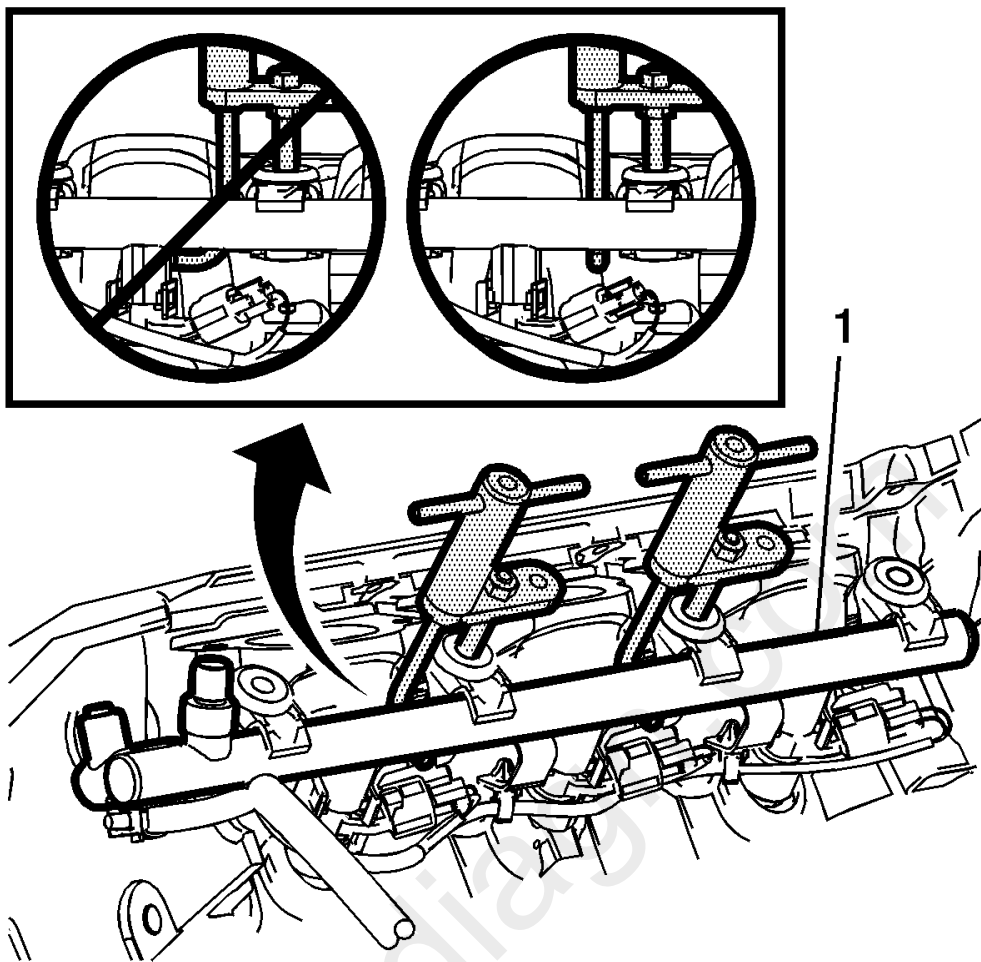


Fig. 87: Raising The Fuel Rail With Special Tool
Courtesy of GENERAL MOTORS COMPANY

8. Using the **EN-49248-4** hook , raise the fuel rail (1) as an assembly.
9. Once the fuel rail is free, remove the **EN-49248** remover.

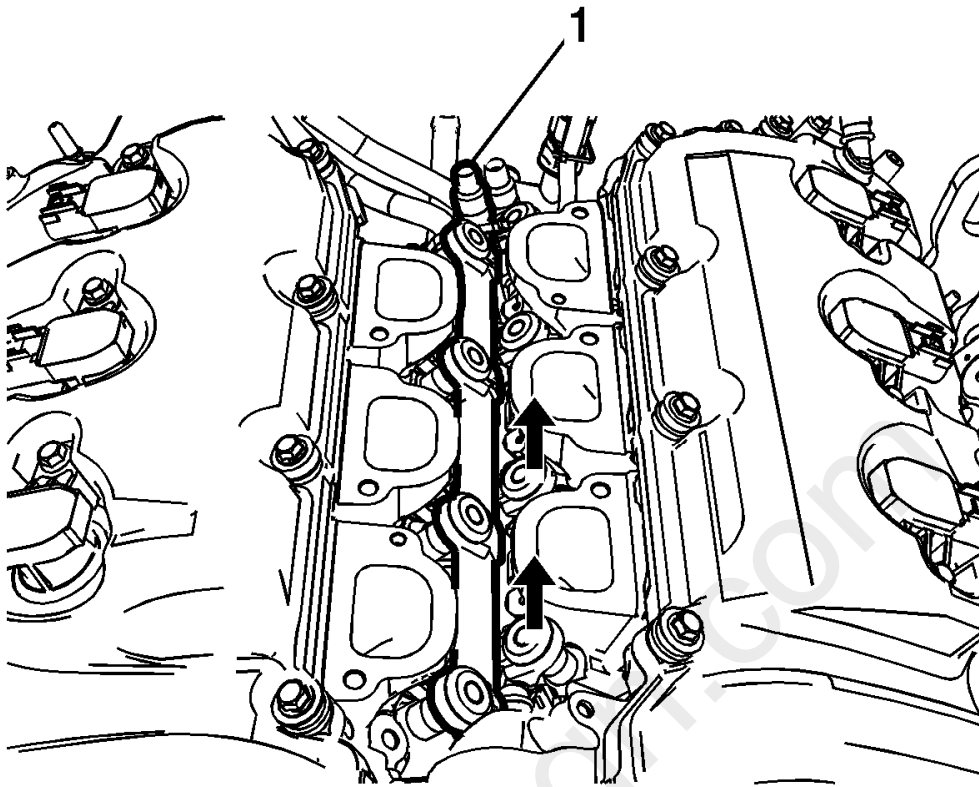


Fig. 88: Sliding The Fuel Rail Toward The Rear Of Engine
Courtesy of GENERAL MOTORS COMPANY

10. Slide the fuel rail (1) toward the rear of the engine approximately 1 inch (25.4 mm), in order to clear the center injector bore.

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

11. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LFX)**.

Installation Procedure

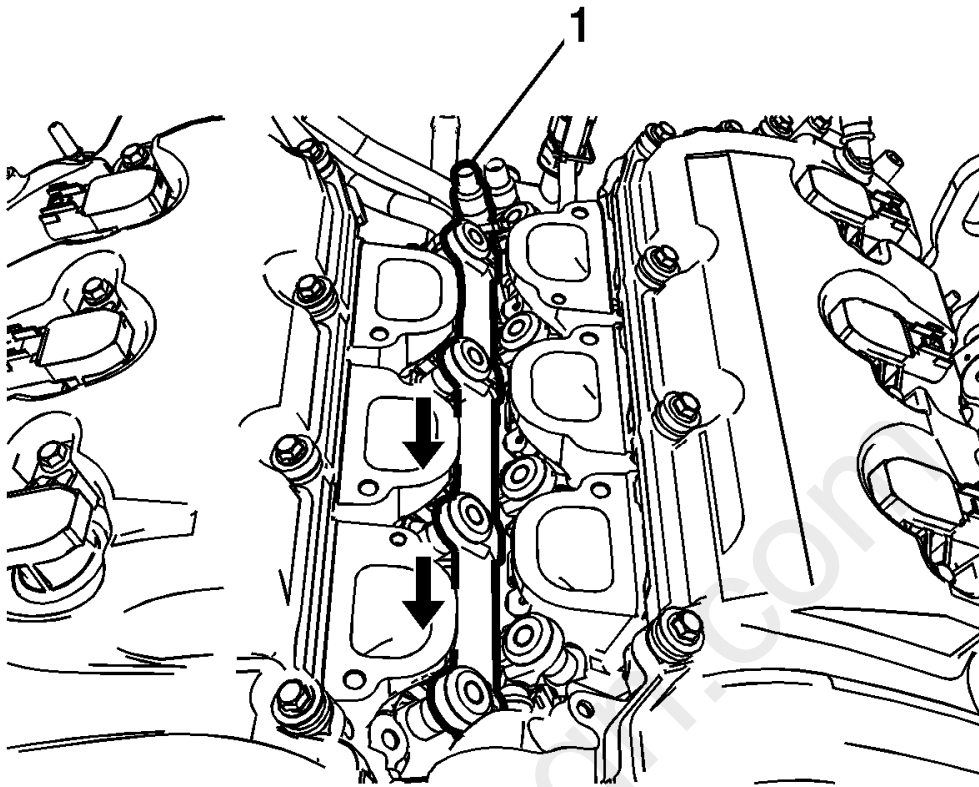


Fig. 89: Sliding The Fuel Rail Toward The Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

1. Slide the fuel rail (1) toward the front of the engine approximately 1 inch (25.4 mm), in order to align the center injector bore.

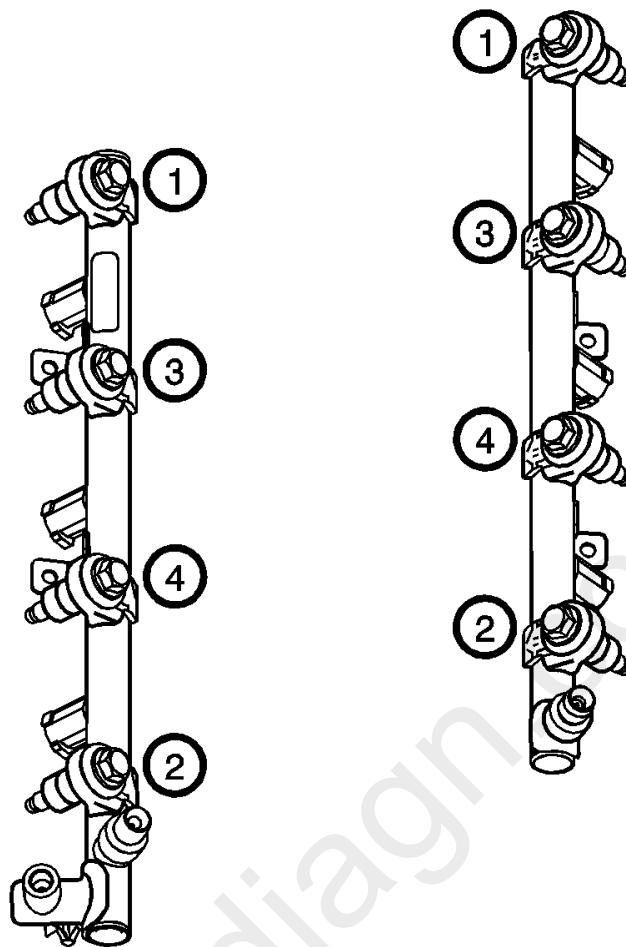


Fig. 90: Identifying Fuel Rail Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
 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).
5. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFX)**.
6. 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.
7. Install the foam insulator to the fuel rails.
8. Install the intake manifold. Refer to **Intake Manifold Replacement (LFX)** .
9. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LFX)**.
10. Install the low side fuel pressure service port cap.
11. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1 (LF3)

Special Tools

EN-49248 Injector Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** .

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement (LF3)** .
3. Remove and DISCARD the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF3)**.

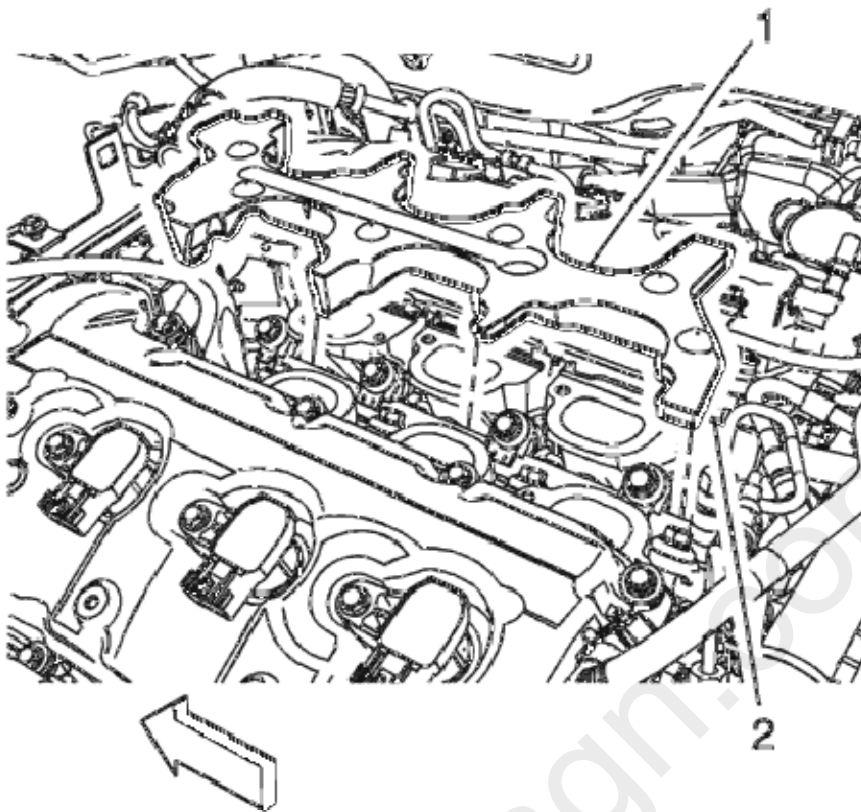


Fig. 91: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel injection fuel rail noise shield (1) from the engine (2).

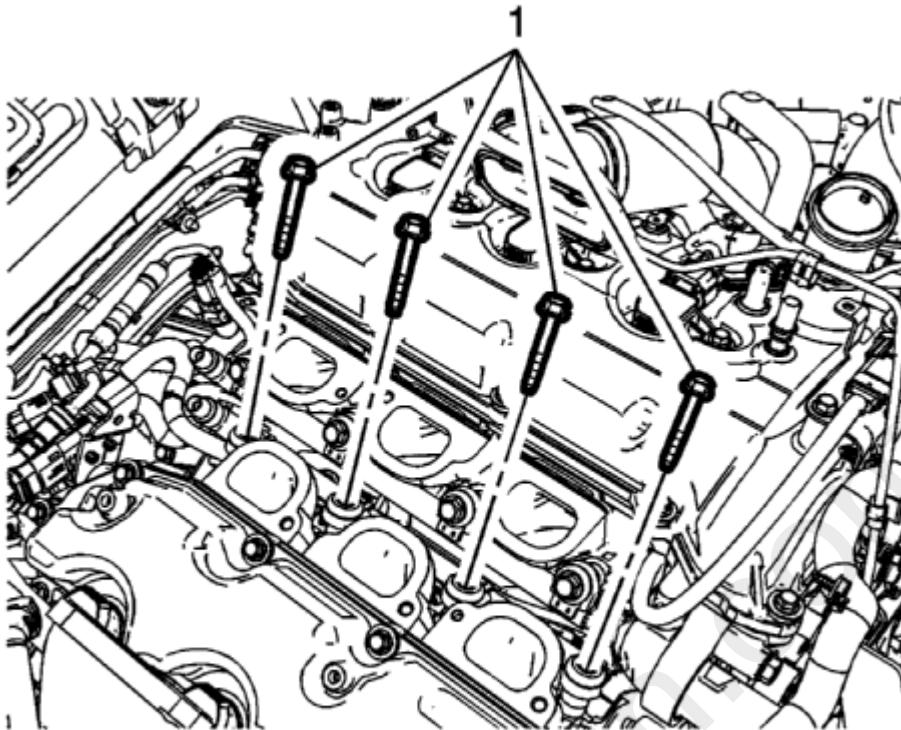


Fig. 92: Bank 1 Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the bank 1 fuel rail fasteners (1).

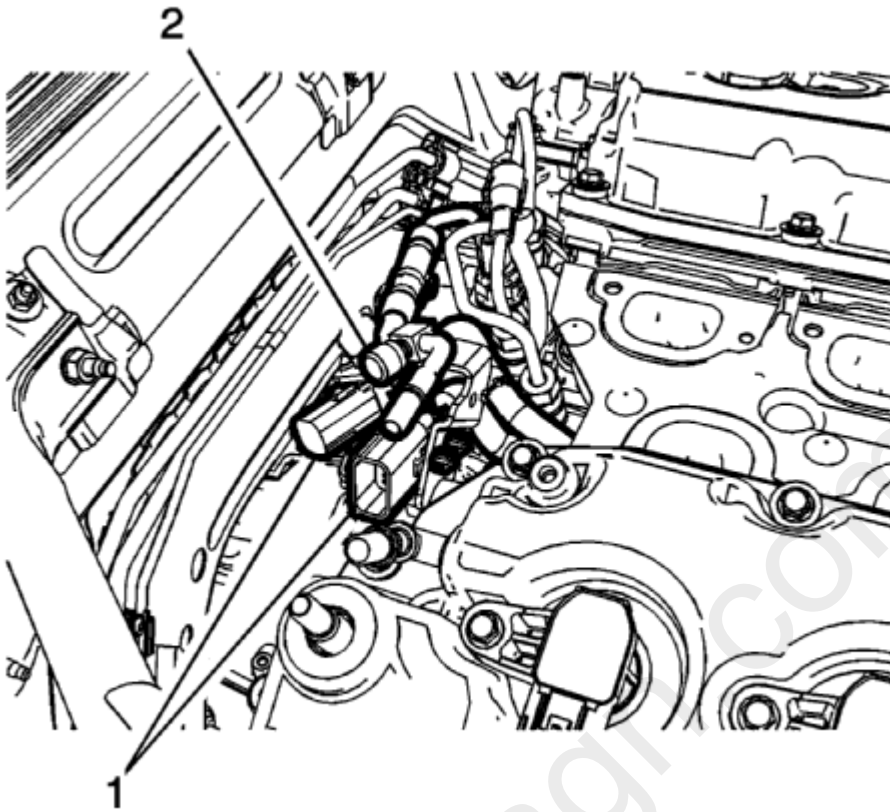


Fig. 93: Fuel Rail Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the fuel rail electrical connectors (1) and remove their retainers from the fuel feed pipe bracket (2).

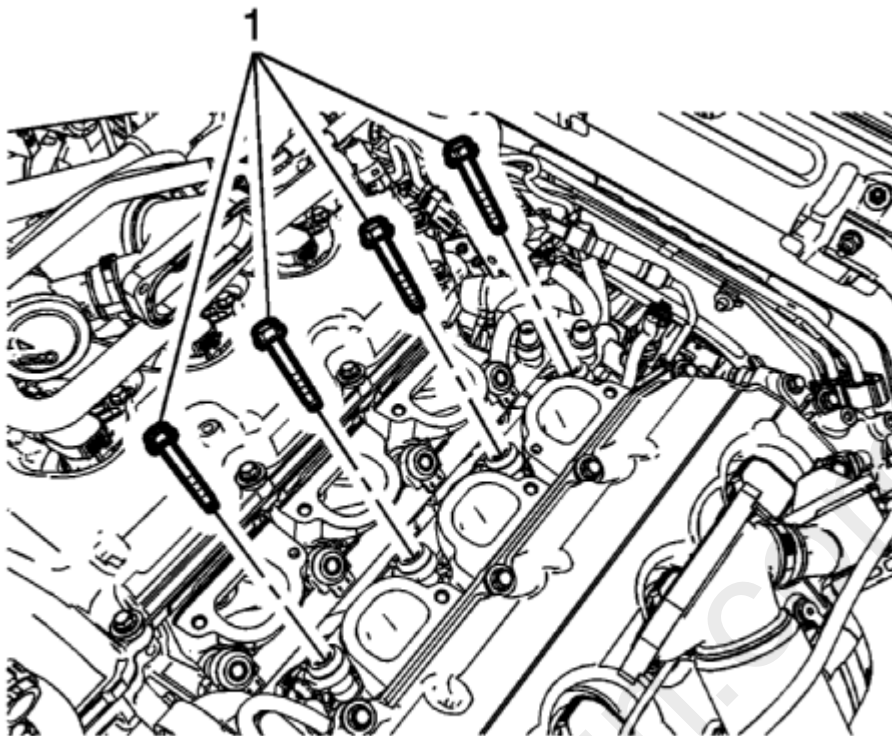


Fig. 94: Bank 2 Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the bank 2 fuel rail fasteners (1) for clearance purposes.

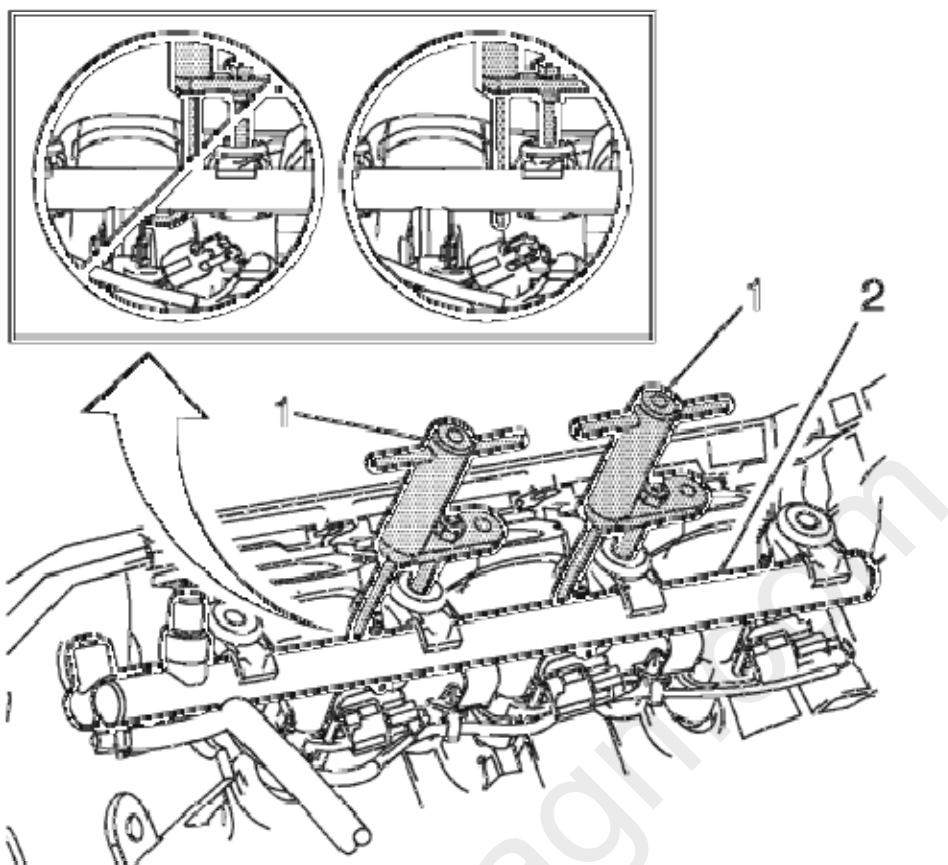


Fig. 95: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

8. Using the **EN-49248-4** hook (1), raise the fuel rail (2) as an assembly.
9. Once the fuel rail is free, remove the **EN-49248** remover (1).

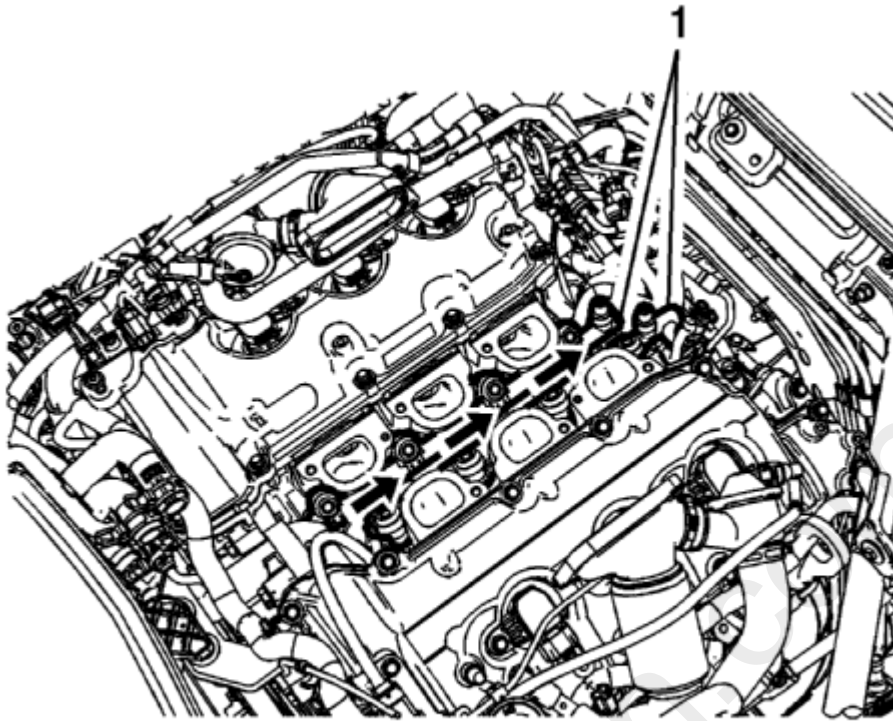


Fig. 96: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

10. Individually slide each fuel rail (1,) toward the rear of the engine approximately 1 inch (25.4mm), in order to clear the center injector bore.

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

11. Once the fuel rails are removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF3)** .

Installation Procedure

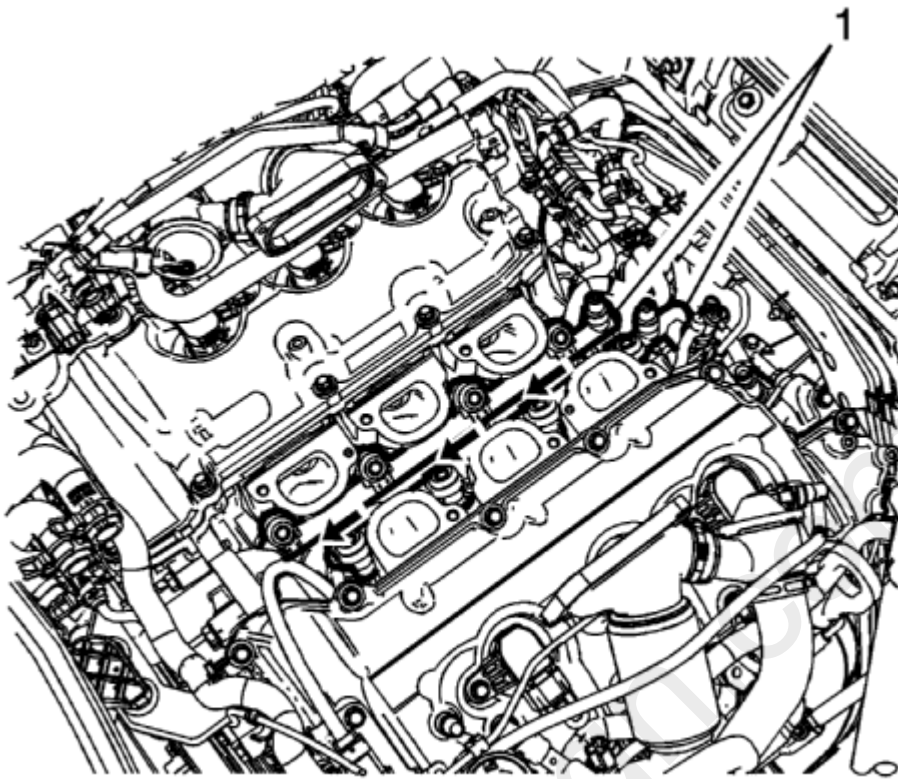


Fig. 97: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

1. Individually slide each fuel rail (1) toward the front of the engine approximately 1 inch (25.4mm), in order to align the center injector bore.

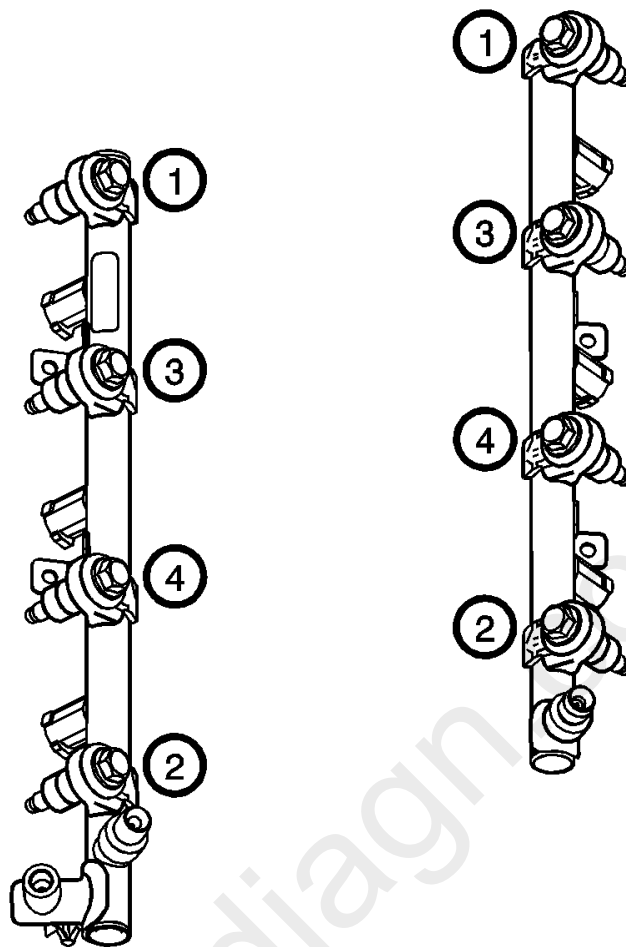


Fig. 98: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
 1. Tighten the fuel rail fasteners first pass to 12 (9 lb ft).
 2. Tighten the fuel rail fasteners a final pass to 25 (18 lb ft).
5. Install the NEW fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF3)**.

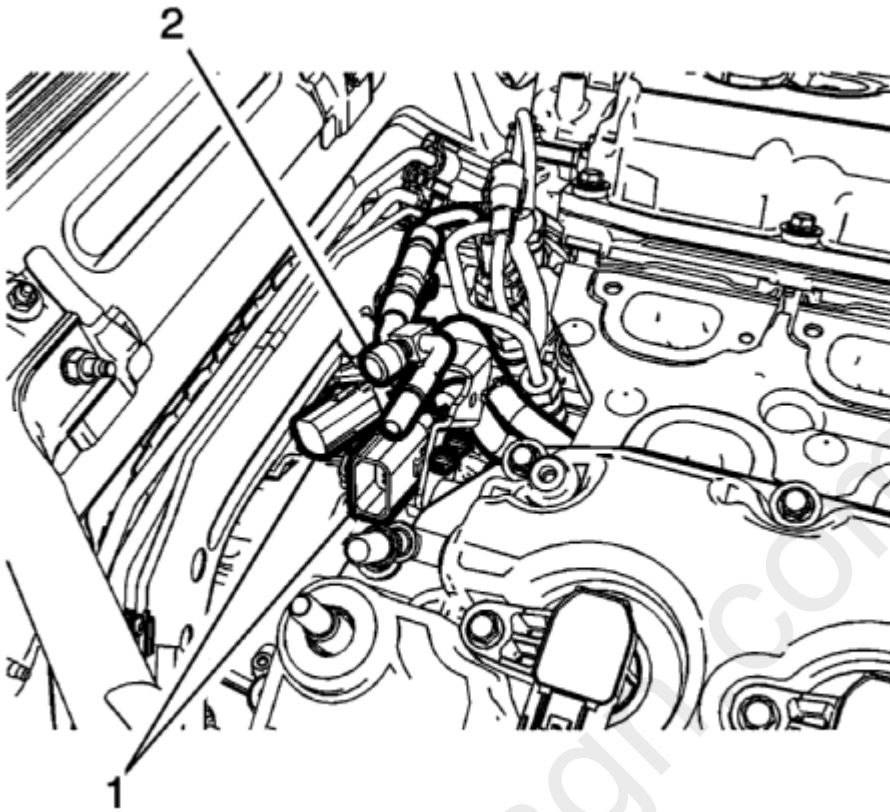


Fig. 99: Fuel Rail Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

6. Connect the fuel rail electrical connectors (1) then connect the harness retainers to the fuel feed bracket (2).
7. 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.

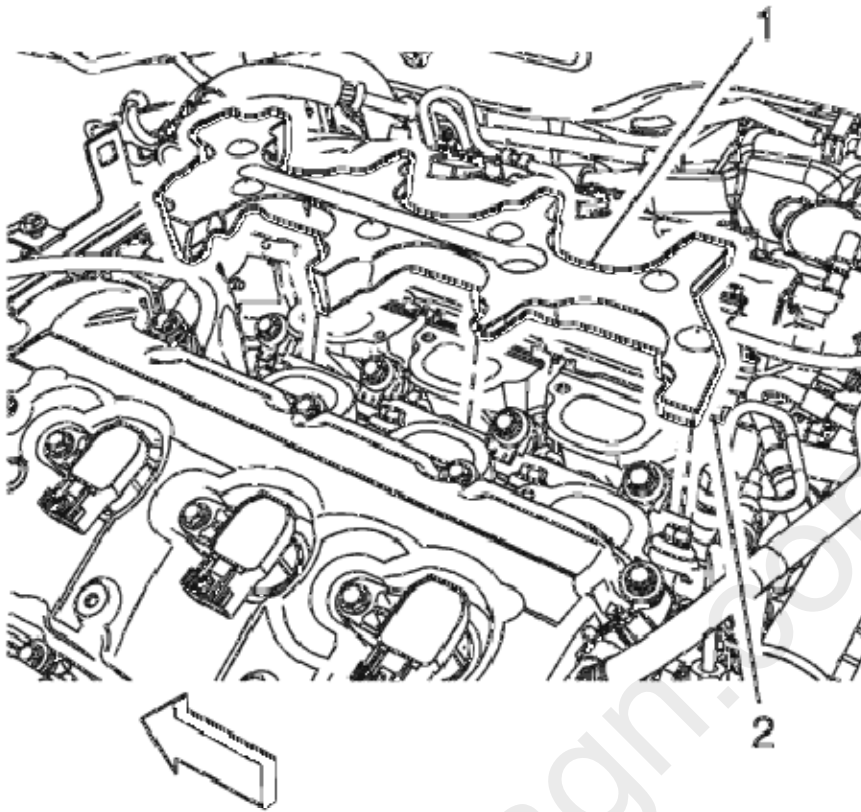


Fig. 100: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

8. Install the fuel injection fuel rail noise shield (1) onto the engine (2).
9. Install the intake manifold. Refer to **Intake Manifold Replacement (LF3)** .
10. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF3)**.
11. If removed, install the low side fuel pressure service port cap.

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

Special Tools

EN-49248 Injector Rail Assembly Remover

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LFX)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement (LFX)** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFX)**.

5. Remove the foam insulator from the fuel rails.

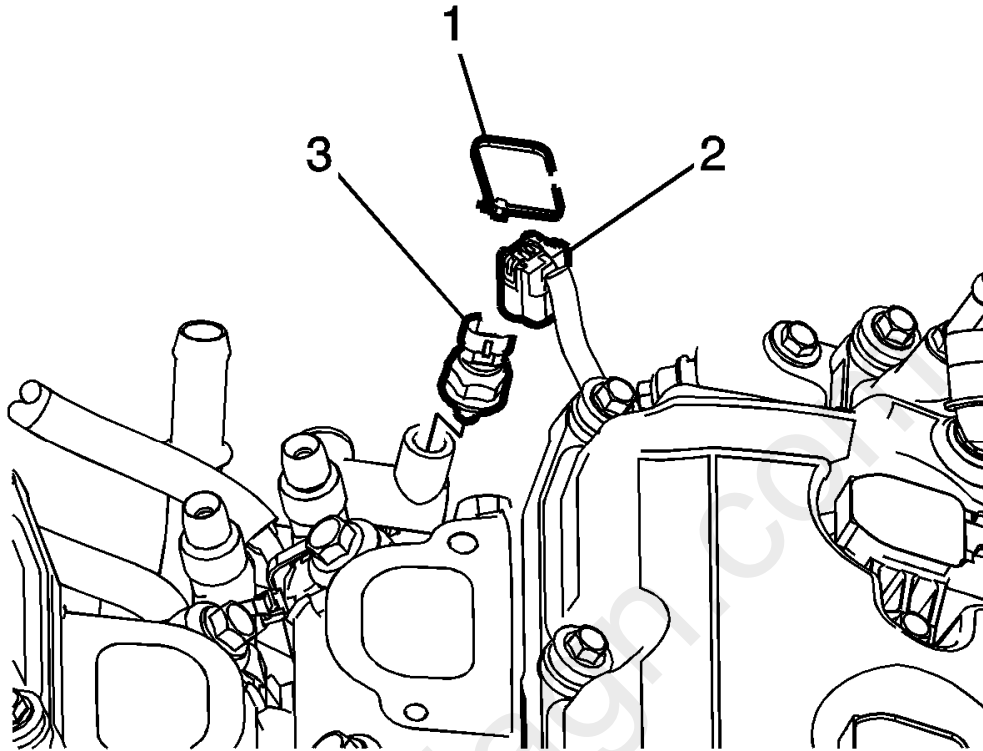


Fig. 101: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Cut the plastic tie strap (1).
7. Disconnect the fuel pressure sensor electrical connector (2).
8. Remove the fuel pressure sensor (3).

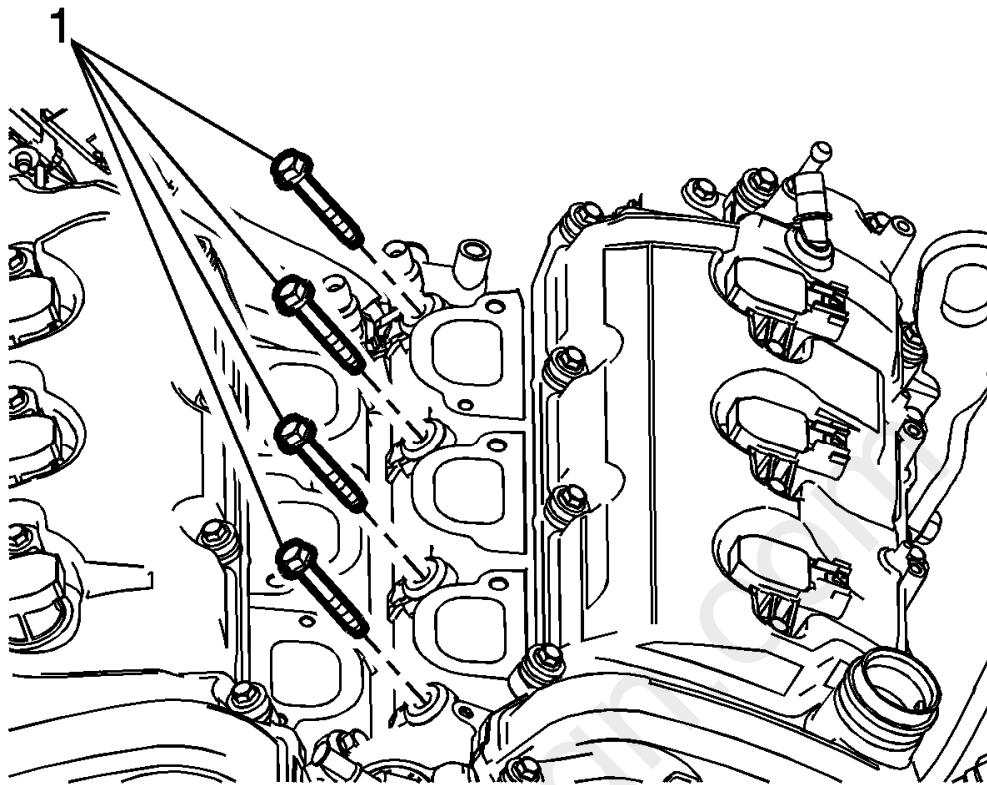


Fig. 102: Left Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Remove the bank 2 fuel rail fasteners (1).

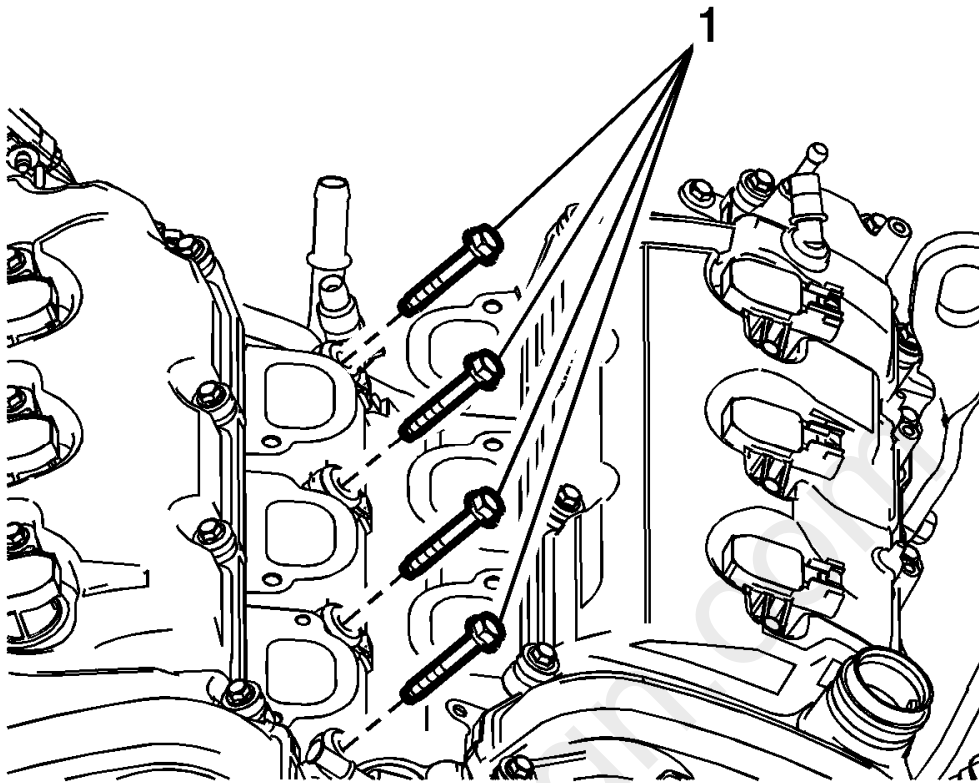


Fig. 103: Right Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the bank 1 fuel rail fasteners (1) for clearance purposes.

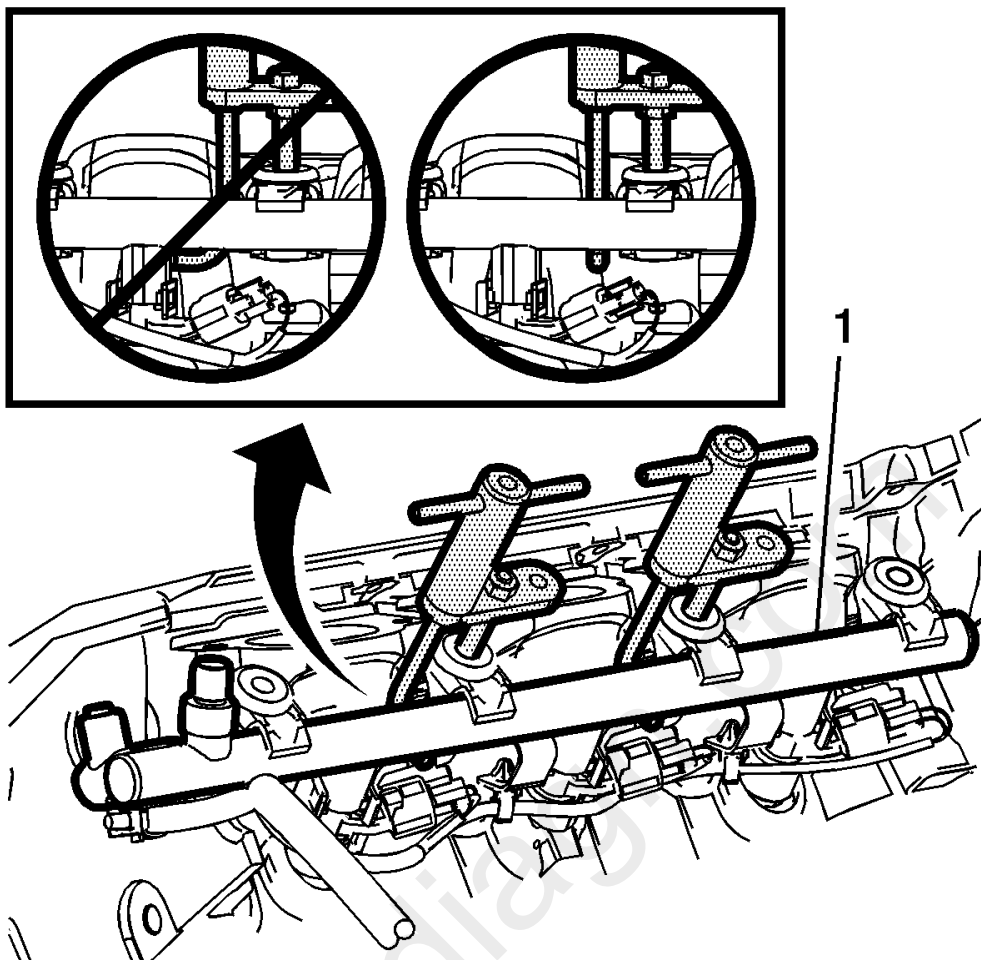


Fig. 104: Raising The Fuel Rail With Special Tool
Courtesy of GENERAL MOTORS COMPANY

11. Using the **EN-49248-4** hook , raise the fuel rail (1) as an assembly.
12. Once the fuel rail is free, remove the **EN-49248** special tool.

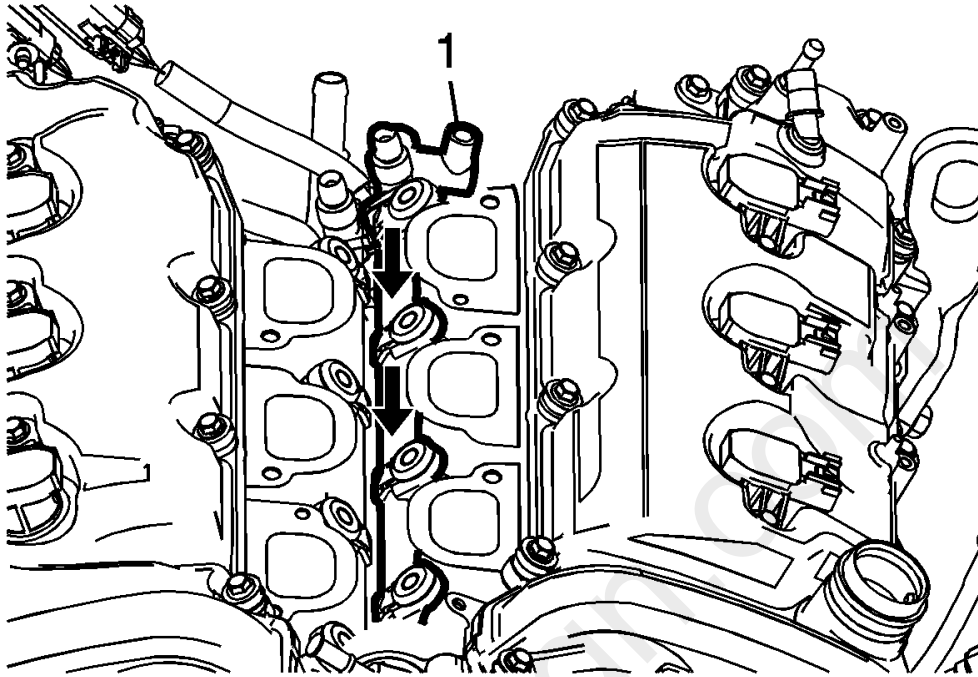


Fig. 105: Sliding The Fuel Rail Toward The Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

13. Slide the fuel rail (1) toward the front of the engine approximately 1 inch (25.4 mm), in order to clear the center injector bore.

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

14. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LFX)** .

Installation Procedure

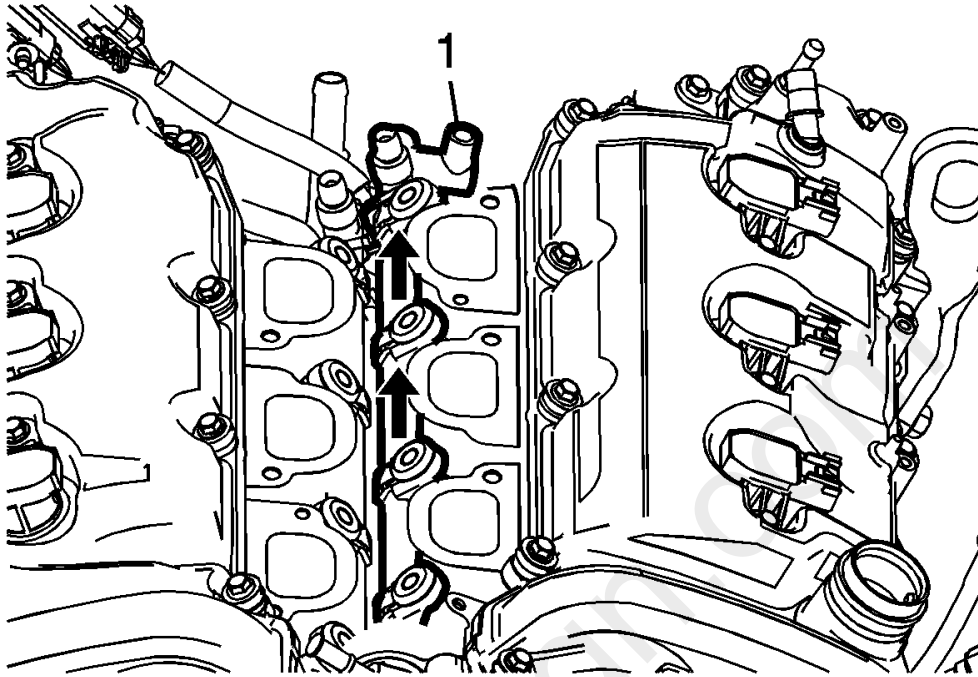


Fig. 106: Sliding The Fuel Rail Toward The Rear Of Engine
Courtesy of GENERAL MOTORS COMPANY

1. Slide the fuel rail (1) toward the rear of the engine approximately 1 inch (25.4 mm), in order to align the center injector bore.

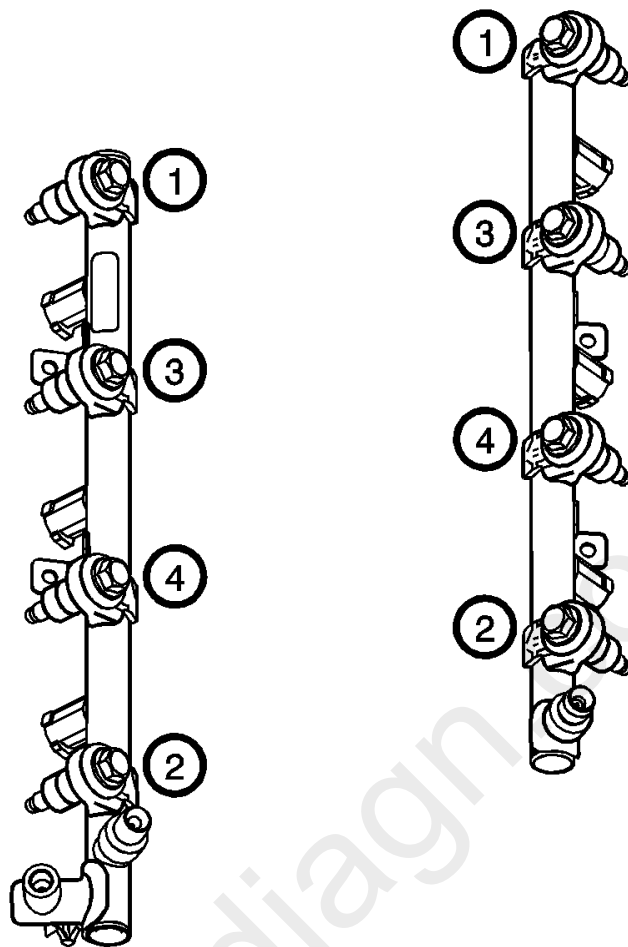


Fig. 107: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
 1. First pass 12 N.m (106 lb in).
 2. Final pass 23 N.m (17 lb ft).

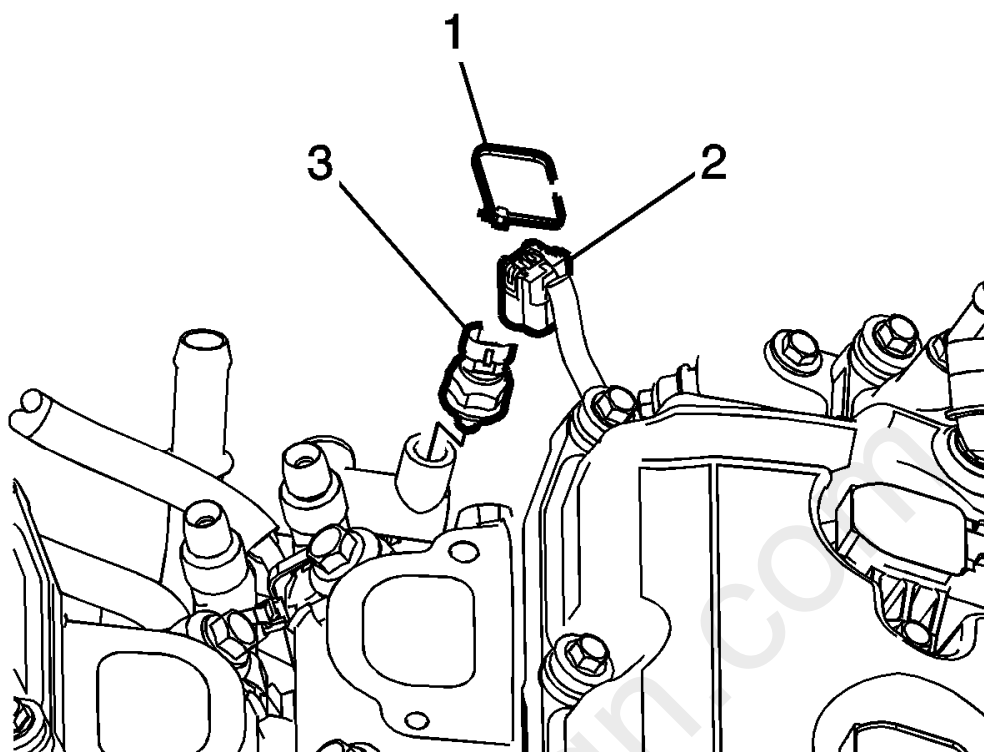


Fig. 108: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the fuel pressure sensor (3) to 33 N.m (25 lb ft).
6. Connect the fuel pressure sensor electrical connector (2) and secure it with a new plastic zip tie.
7. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFX)**.
8. 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.
9. Install the foam insulator to the fuel rails.
10. Install the intake manifold. Refer to **Intake Manifold Replacement (LFX)** .
11. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LFX)**, **Fuel Pipe Shield Replacement (LF3)**.
12. Install the low side fuel pressure service port cap.

13. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2 (LF3)

Special Tools

EN-49248 Injector Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** .

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement (LF3)** .
3. Remove and DISCARD the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF3)**.

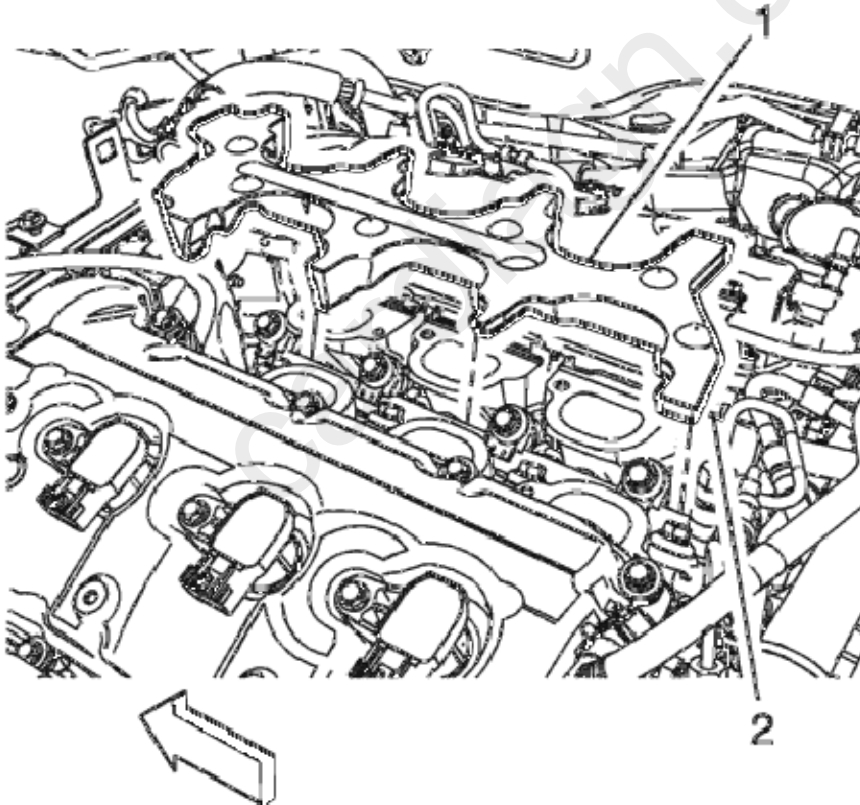


Fig. 109: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel injection fuel rail noise shield (1) from the engine (2).

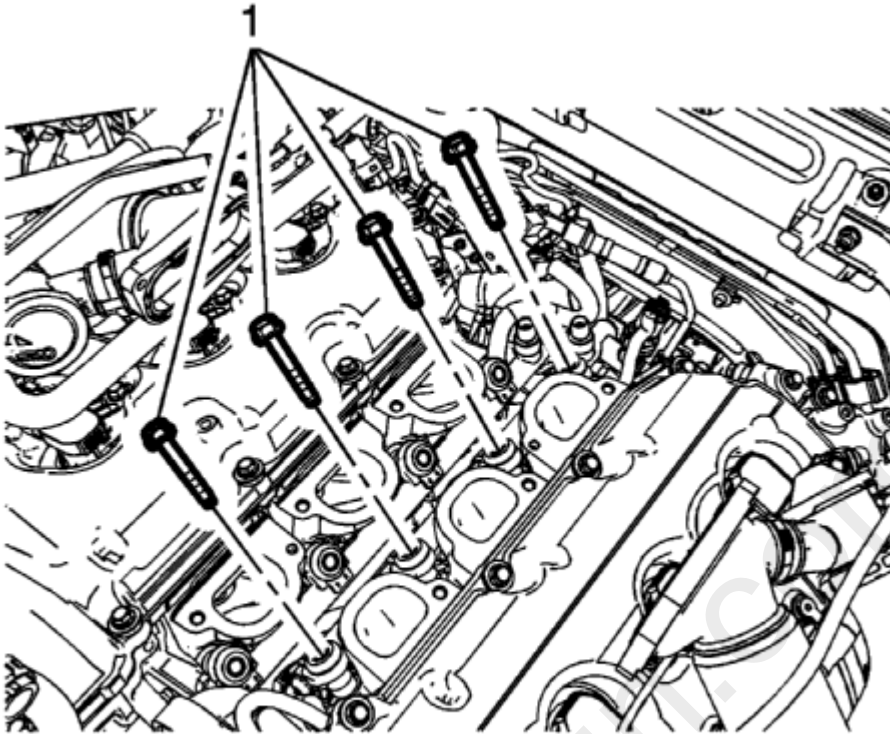


Fig. 110: Bank 2 Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the bank 2 fuel rail fasteners (1).

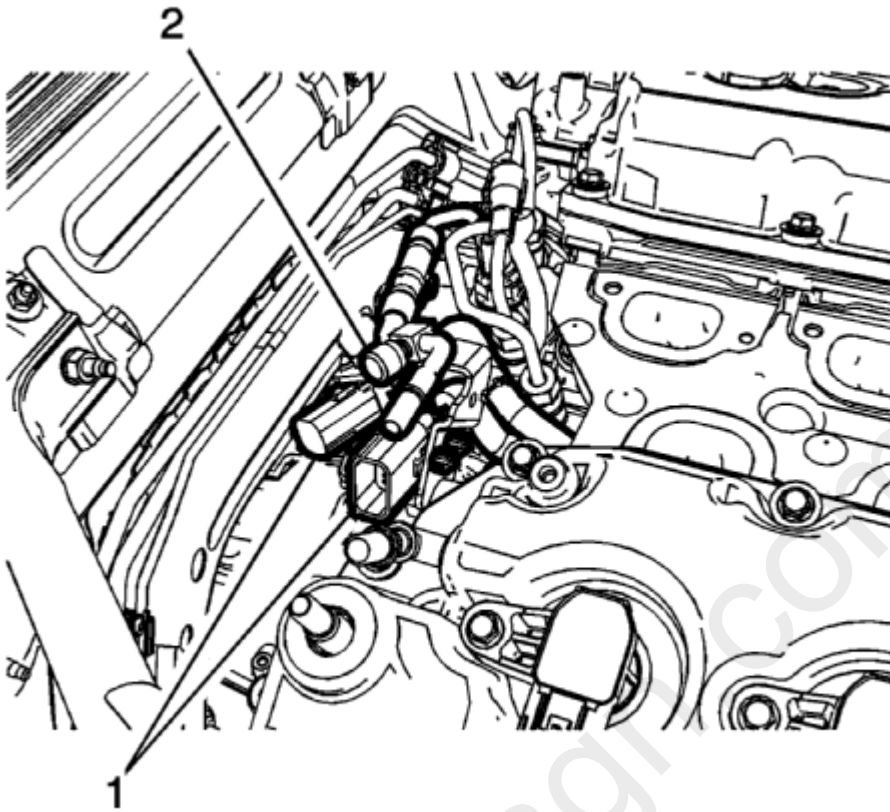


Fig. 111: Fuel Rail Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the fuel rail electrical connectors (1) and remove their retainers from the fuel feed pipe bracket (2).

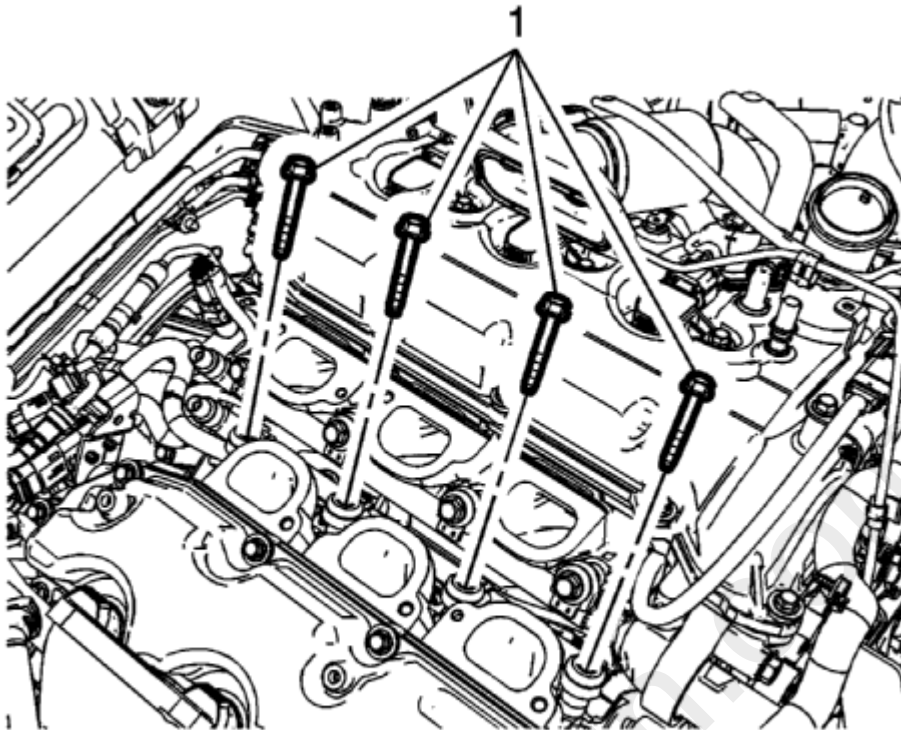


Fig. 112: Bank 1 Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the bank 1 fuel rail fasteners (1) for clearance purposes.

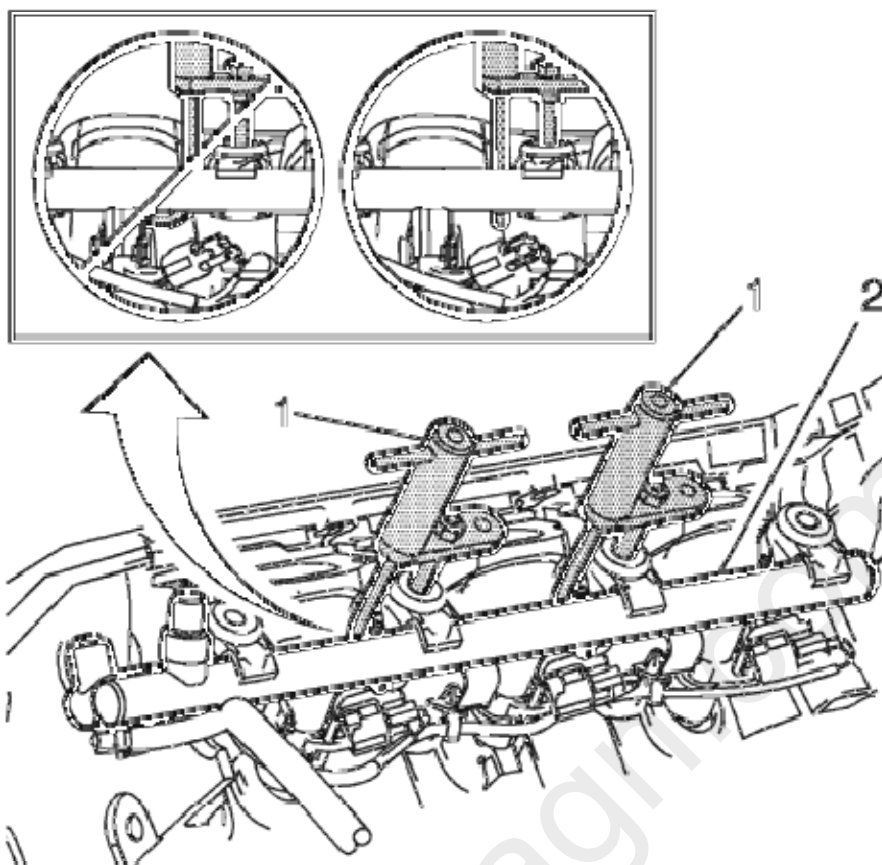


Fig. 113: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

8. Using the **EN-49248-4** hook (1), raise the fuel rail (2) as an assembly.
9. Once the fuel rail is free, remove the **EN-49248** remover (1).

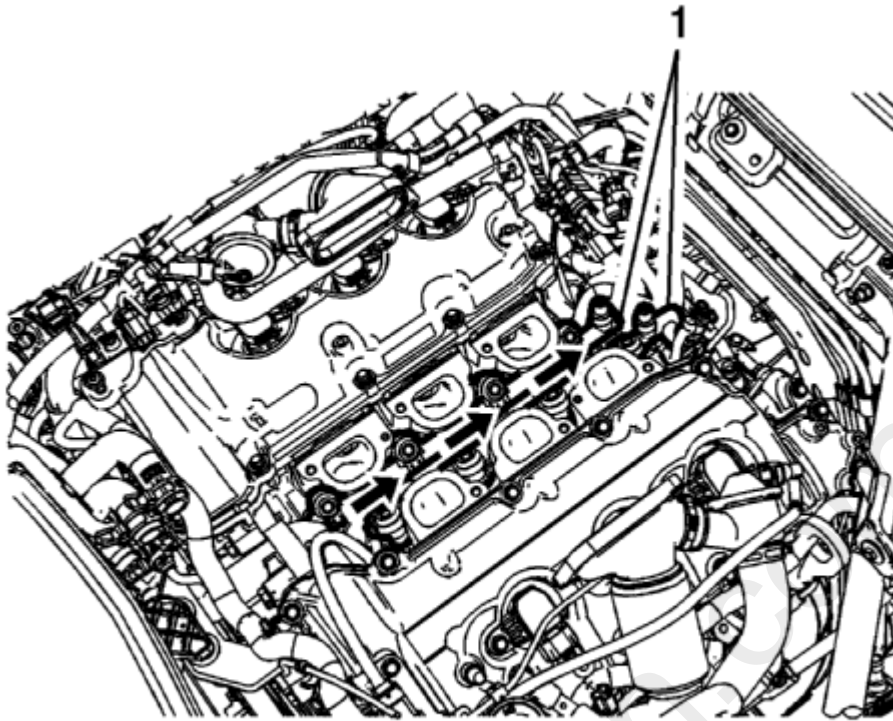


Fig. 114: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

10. Individually slide each fuel rail (1,) toward the rear of the engine approximately 1 inch (25.4mm), in order to clear the center injector bore.

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

11. Once the fuel rails are removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF3)** .

Installation Procedure

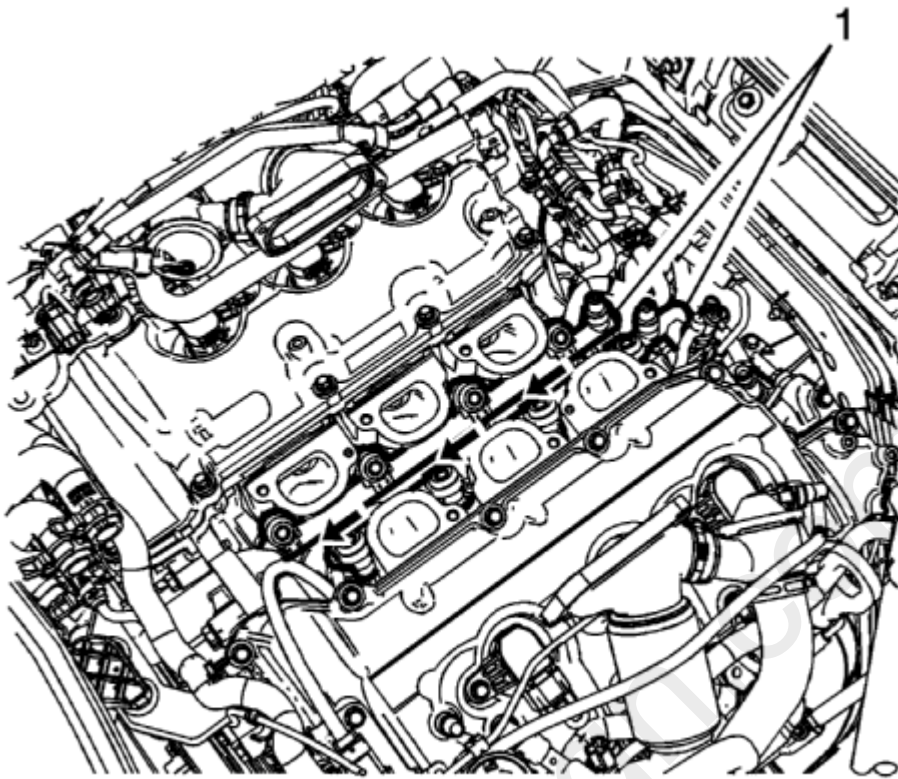


Fig. 115: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

1. Individually slide each fuel rail (1) toward the front of the engine approximately 1 inch (25.4mm), in order to align the center injector bore.

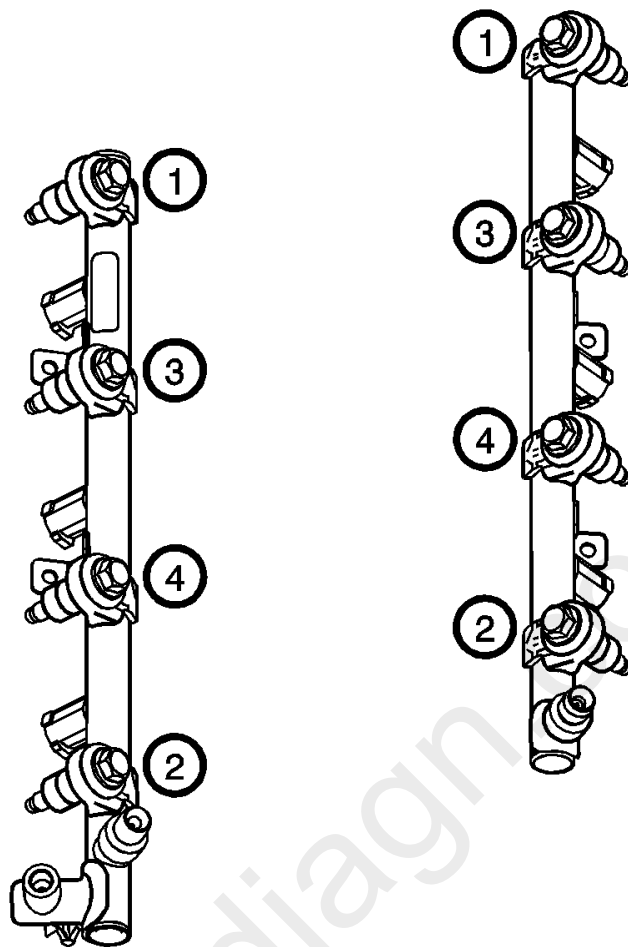


Fig. 116: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
 1. Tighten the fuel rail fasteners first pass to 12 (9 lb ft).
 2. Tighten the fuel rail fasteners a final pass to 25 (18 lb ft).
5. Install the NEW fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF3)**.

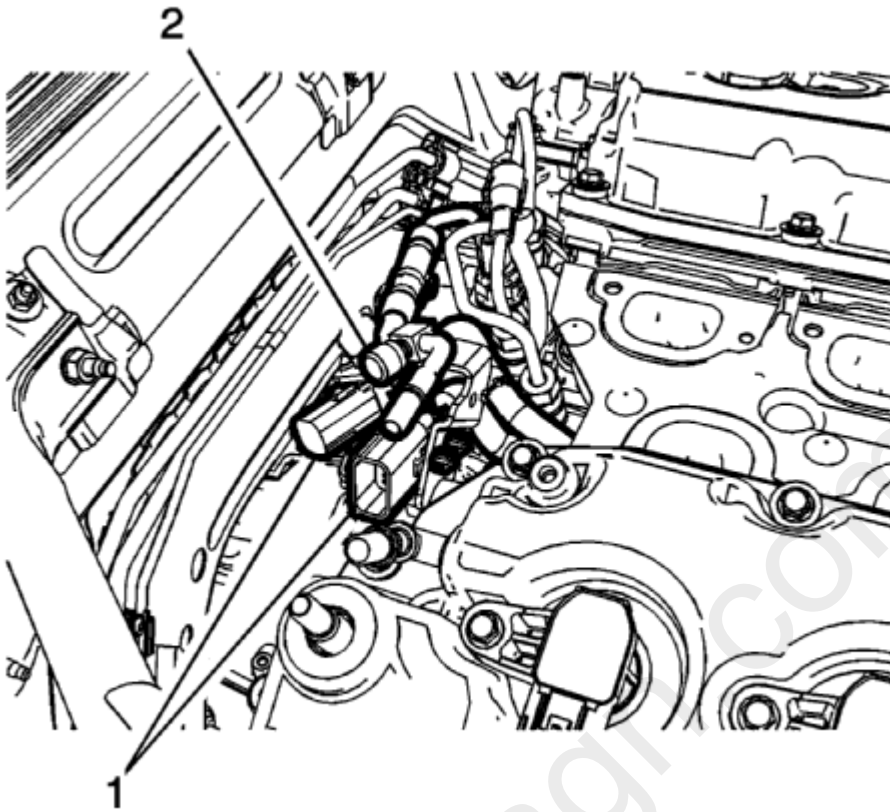


Fig. 117: Fuel Rail Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

6. Connect the fuel rail electrical connectors (1) then connect the harness retainers to the fuel feed bracket (2).
7. 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.

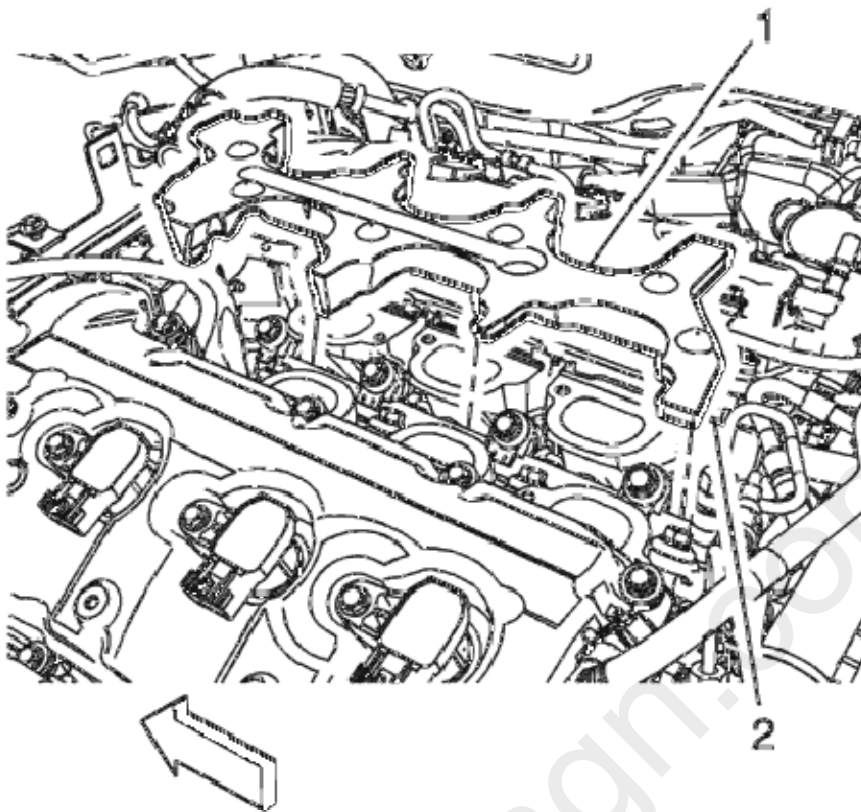


Fig. 118: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

8. Install the fuel injection fuel rail noise shield (1) onto the engine (2).
9. Install the intake manifold. Refer to **Intake Manifold Replacement (LF3)** .
10. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF3)**.
11. If removed, install the low side fuel pressure service port cap.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT (LFX)

Removal Procedure

WARNING: Refer to **Safety Glasses Warning** .

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LFX)**.

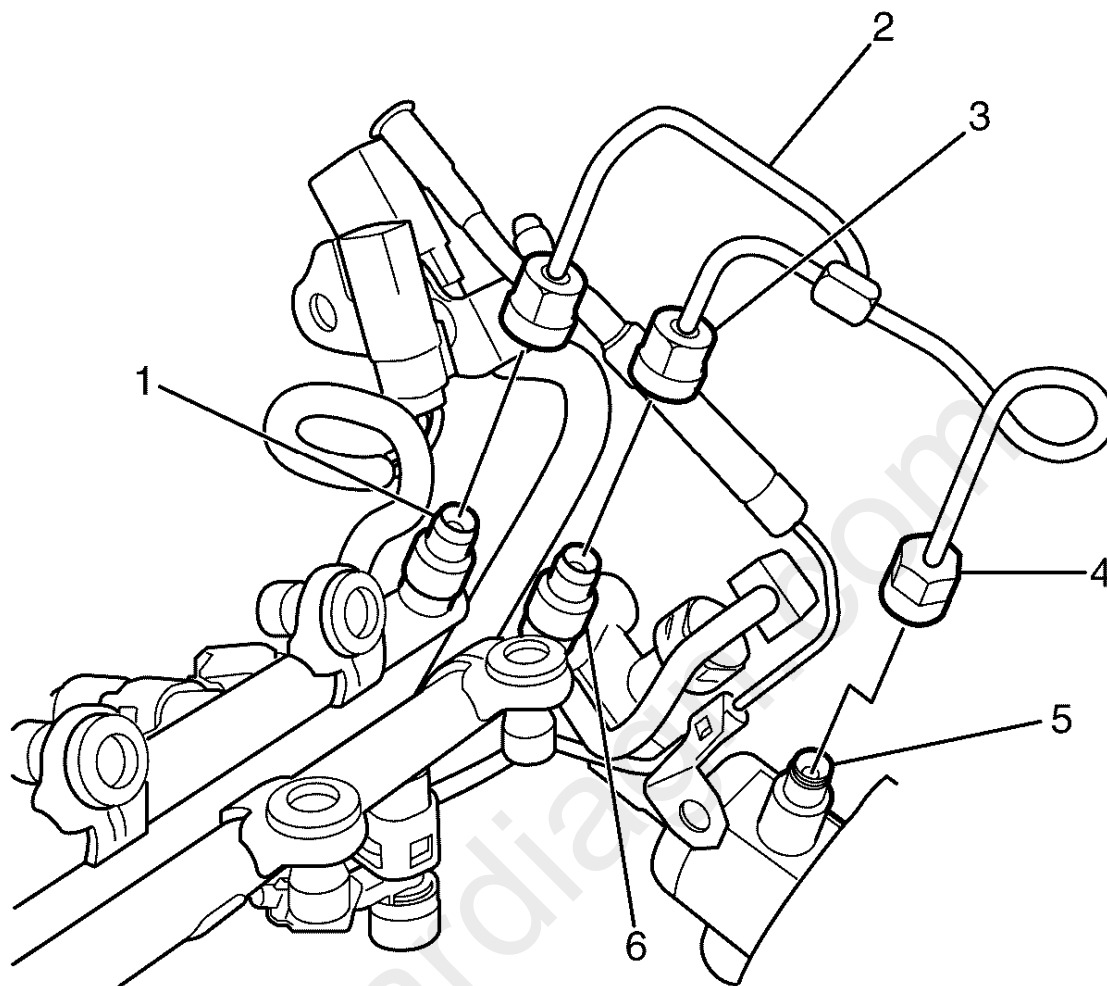


Fig. 119: Fuel Feed Intermediate Pipe & Components
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the fuel feed intermediate pipe (2) from the right fuel rail (1).
4. Loosen the fuel feed intermediate pipe (2) from the left fuel rail (6).
5. Loosen the fuel feed intermediate pipe (2) from the high pressure fuel pump (5).
6. Remove the fuel feed intermediate pipe (2) from the engine. Discard the pipe.

Installation Procedure

1. Make sure that the following components are free of damage, clean and dry before installation. Replace any damaged components.
 - Fuel feed intermediate pipe connections
 - Right fuel rail high pressure fuel connection
 - Left fuel rail high pressure fuel connection
 - High pressure fuel pump high pressure fuel connection

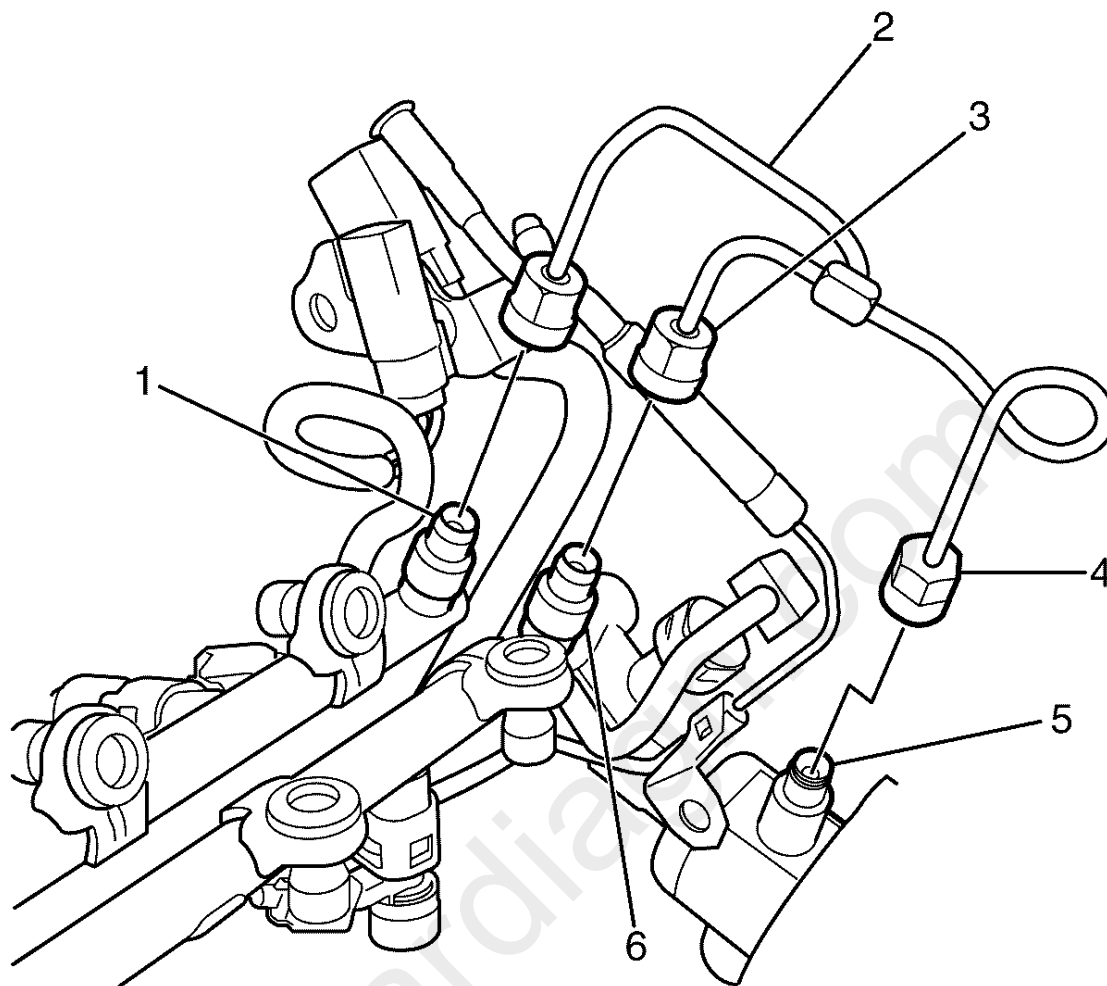


Fig. 120: Fuel Feed Intermediate Pipe & Components
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW fuel feed intermediate pipe (2) to the engine.
3. Hand tighten the fuel feed intermediate pipe (2) to the high pressure fuel pump (5).
4. Hand tighten the fuel feed intermediate pipe (2) to the left fuel rail (6).
5. Hand tighten the fuel feed intermediate pipe (2) to the right fuel rail (1).

CAUTION: Refer to Fastener Caution .

6. Tighten all the fuel feed intermediate pipe connections.
 1. Tighten the connections first pass to 16 N.m (12 lb ft).
 2. Tighten the connections final pass to 32 N.m (24 lb ft).
7. Inspect for leaks using the following procedure:

1. Start the engine and run the engine for 5 seconds.
2. Turn the engine OFF, for 10 seconds.
3. Inspect for fuel leaks.
8. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LFX)**.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT (LF3)

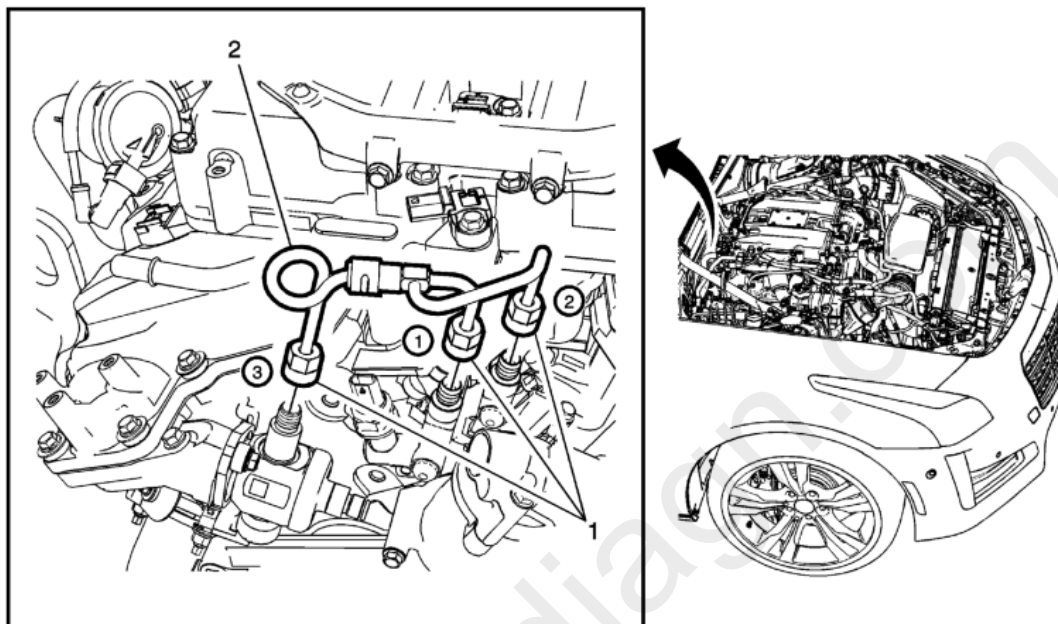


Fig. 121: Fuel Feed Intermediate Pipe (LF3)
Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Intermediate Pipe Replacement (LF3)

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u>. 2. Remove the engine rear noise shield. Refer to <u>Engine Rear Noise Shield Replacement (LF3)</u>.	
1	Fitting (Qty: 3) CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten 1. Start and hand tighten the NEW fuel feed intermediate pipe fittings (1) in sequence as

	numbered. 2. Tighten the fittings evenly in sequence as numbered (1,2,3) to 30 (22 lb ft).
2	Fuel Feed Intermediate Pipe Procedure 1. DISCARD the pipe when removed and install a NEW pipe. 2. Lubricate the pipe fittings and threads with silicon free engine oil. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> . 3. Pressure up the fuel system and check for leaks.

FUEL PIPE SHIELD REPLACEMENT (LFX)

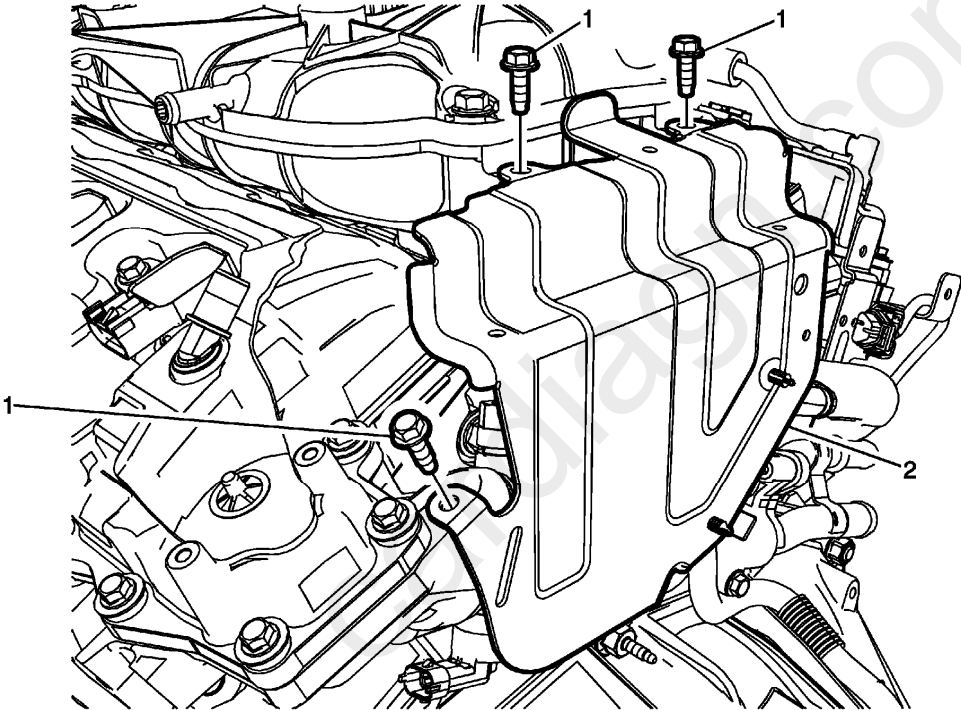


Fig. 122: Fuel Pipe Shield (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pipe Shield Replacement (LFX)

Callout	Component Name
Preliminary Procedures	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> . 2. Remove the plenum front panel. Refer to <u>Plenum Front Panel Replacement</u> . 3. Remove the intake manifold isolator. Refer to <u>Intake Manifold Insulator Replacement</u> .	
	Fuel Pipe Shield Fasteners (Qty: 3)

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Fuel Pipe Shield

FUEL PIPE SHIELD REPLACEMENT (LF3)

Removal Procedure

1. Remove the plenum front panel. Refer to **Plenum Front Panel Replacement** .

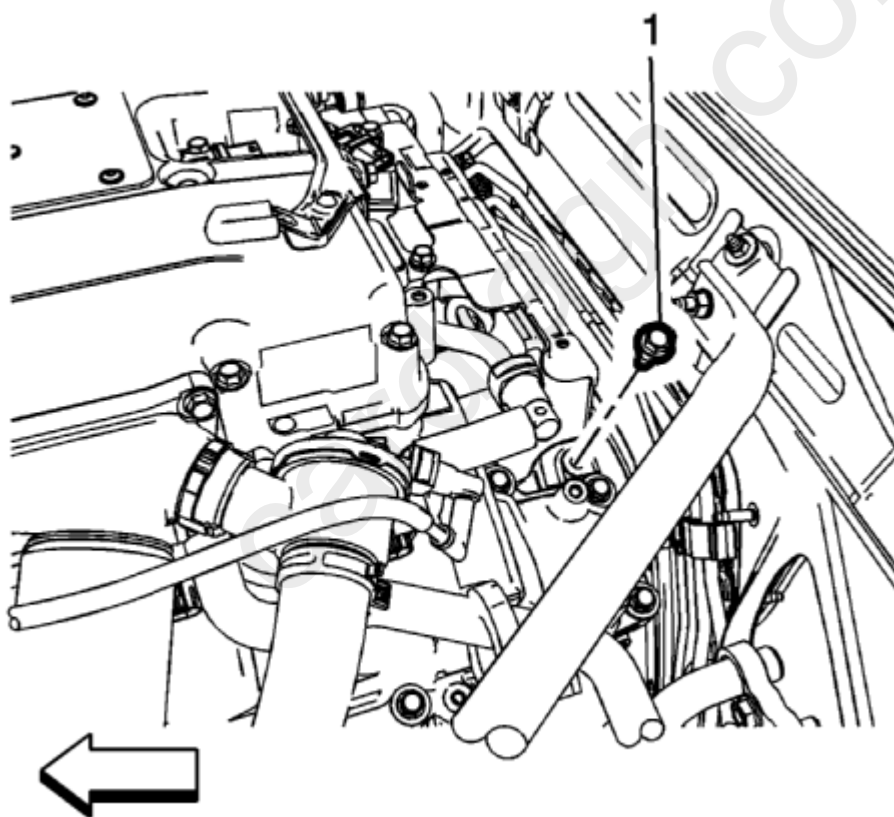


Fig. 123: Fuel Pipe Shield Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel pipe shield fastener (1).

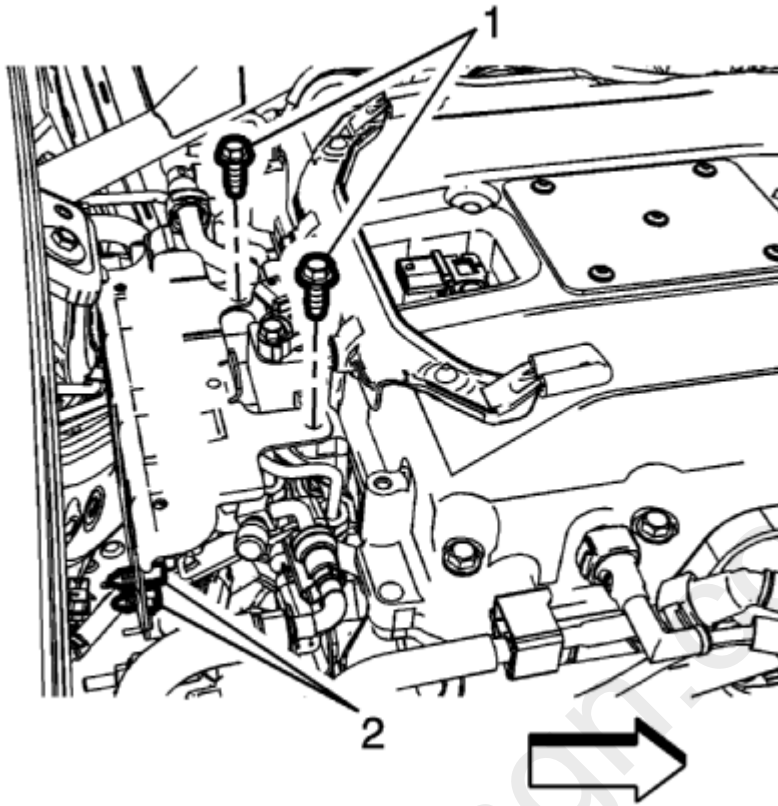


Fig. 124: Electrical Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel pipe shield fasteners (1) then disengage the electrical wiring harness retainers (2) from the fuel pipe shield.

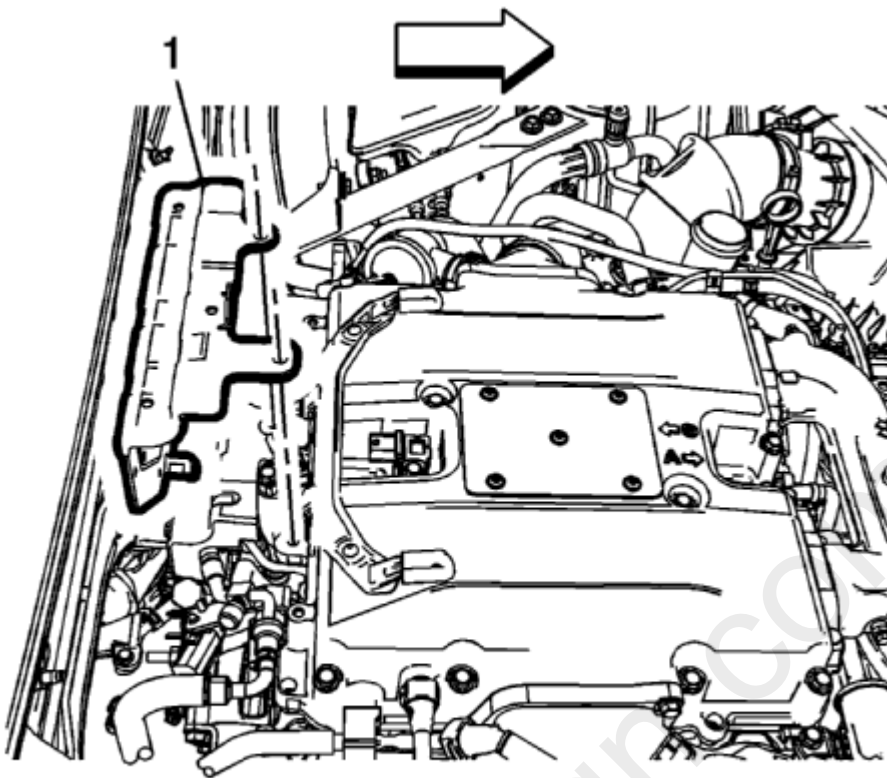


Fig. 125: Fuel Pipe Shield

Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel pipe shield (1).

Installation Procedure

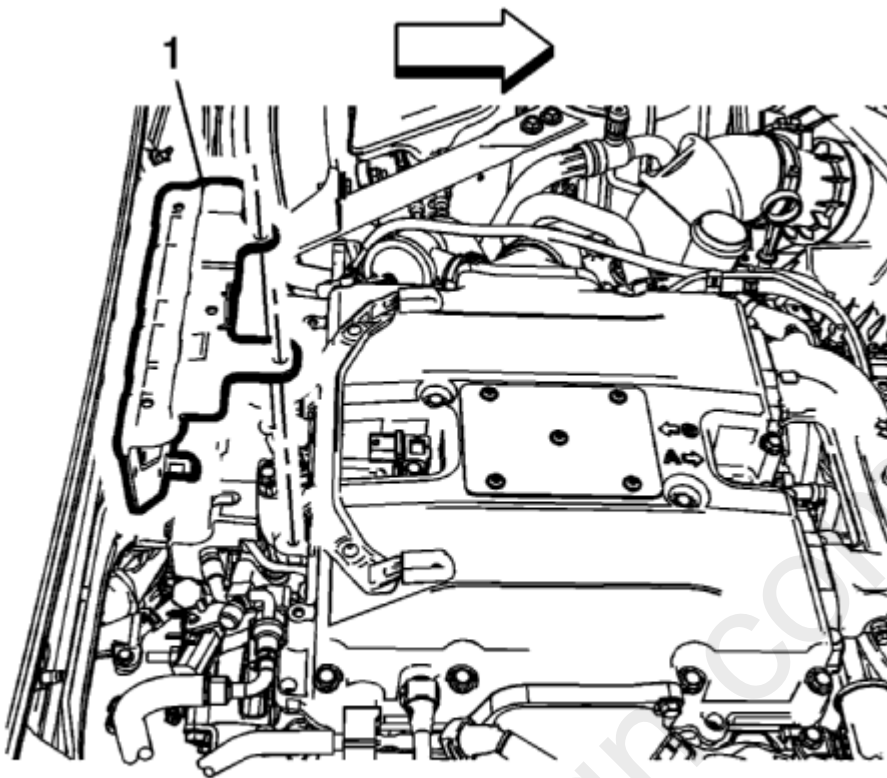


Fig. 126: Fuel Pipe Shield

Courtesy of GENERAL MOTORS COMPANY

1. Position the fuel pipe shield (1) at the rear of the engine.

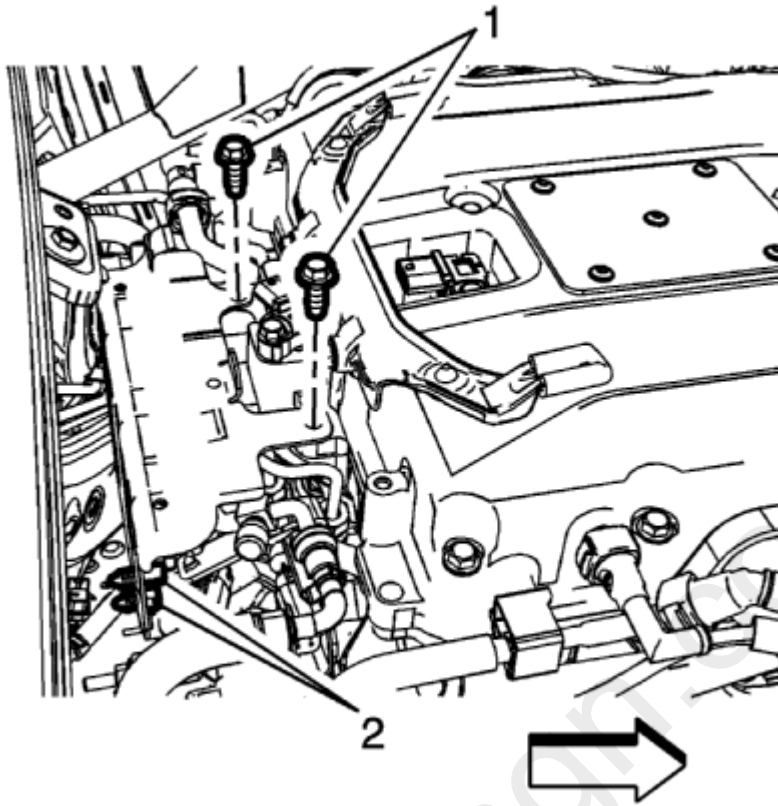


Fig. 127: Electrical Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Install the electrical wiring harness retainers (2) into the fuel pipe shield then hand start the fuel pipe shield fasteners (1).

CAUTION: Refer to Fastener Caution .

3. Tighten the fuel pipe shield fasteners to 10 (7 lb ft).

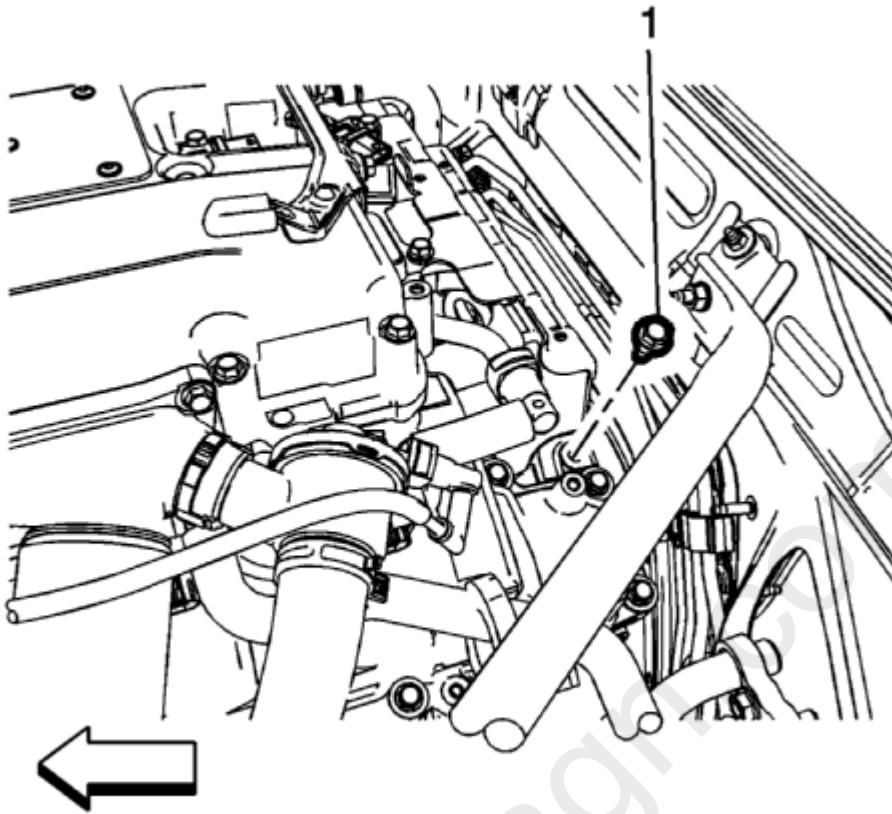


Fig. 128: Fuel Pipe Shield Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Hand start then tighten the remaining fuel pipe shield fastener (1) to 10 (7 lb ft).
5. Install the plenum front panel. Refer to Plenum Front Panel Replacement .

ENGINE REAR NOISE SHIELD REPLACEMENT (LF3)

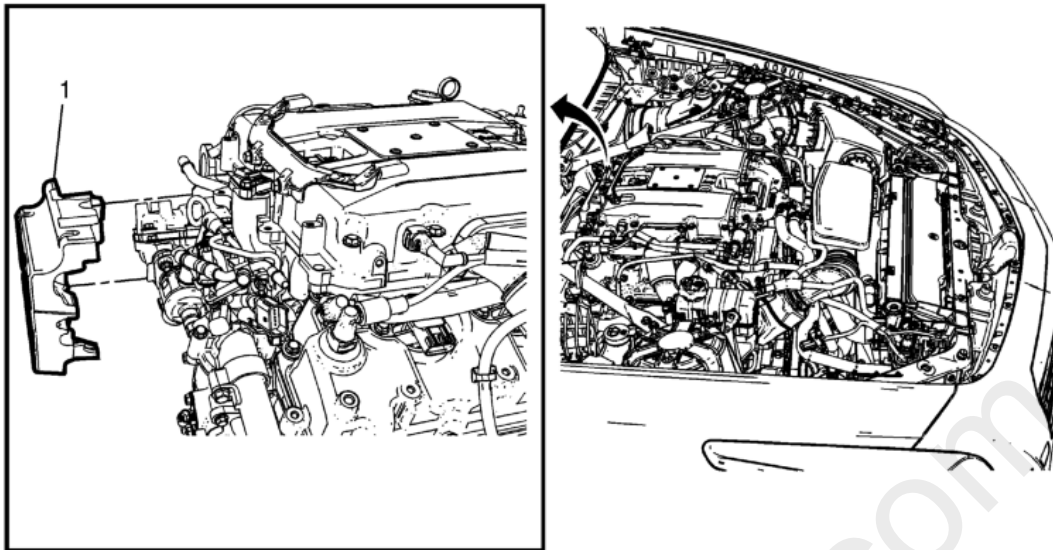


Fig. 129: Engine Rear Noise Shield (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Engine Rear Noise Shield Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement (LF3) .	
1	Engine Rear Noise Shield Procedure Unsnap the engine noise shield from the rear of the engine. NOTE: The engine noise shield snaps into place once the fuel pipe shield is removed.

FUEL PUMP REPLACEMENT (LFX)

Special Tools

EN-48896 High Pressure Fuel Pump Installation Alignment Gauge

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** .

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to **Fuel Pressure Relief**.

2. Remove the thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement (LFX, LF3)** .
3. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
4. Remove the low pressure fuel feed pipe. Refer to **Fuel Feed Pipe Replacement (LFX)**.
5. Remove the high pressure fuel feed pipe. DISCARD the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFX)**.

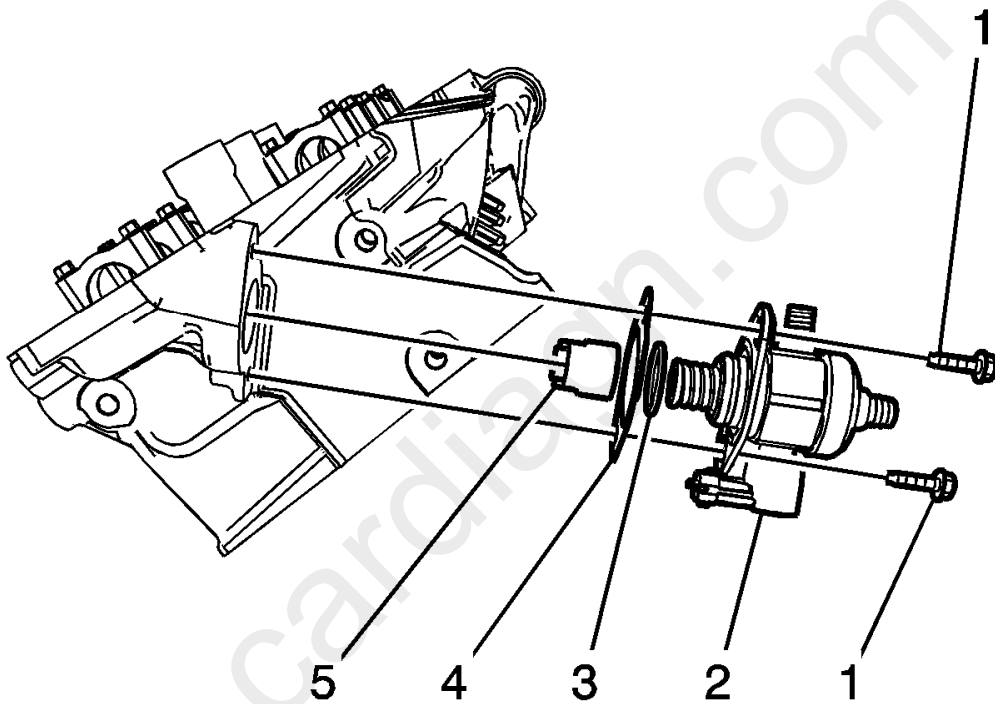


Fig. 130: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage

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

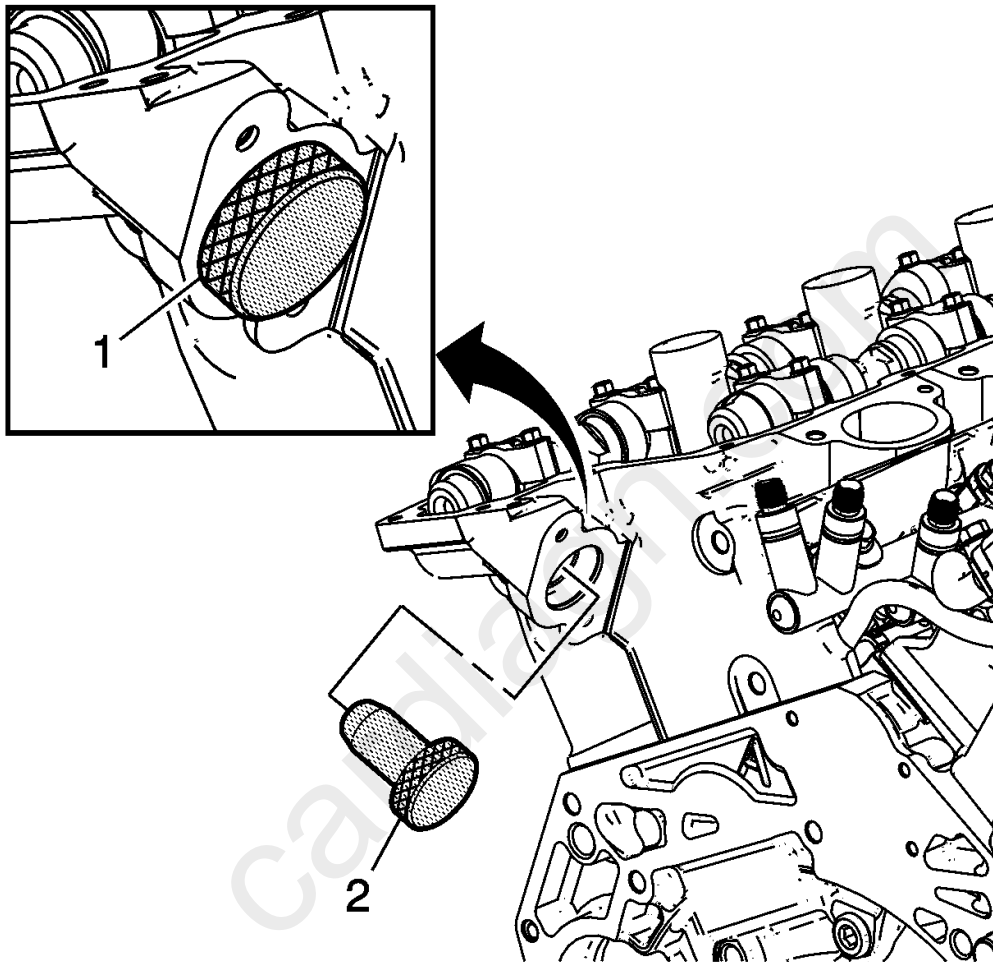


Fig. 131: View Of Alignment Gauge

Courtesy of GENERAL MOTORS COMPANY

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

1. Use the **EN-48896** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head (1).
2. Lubricate the high pressure fuel pump cylinder head bore with 5W30 engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

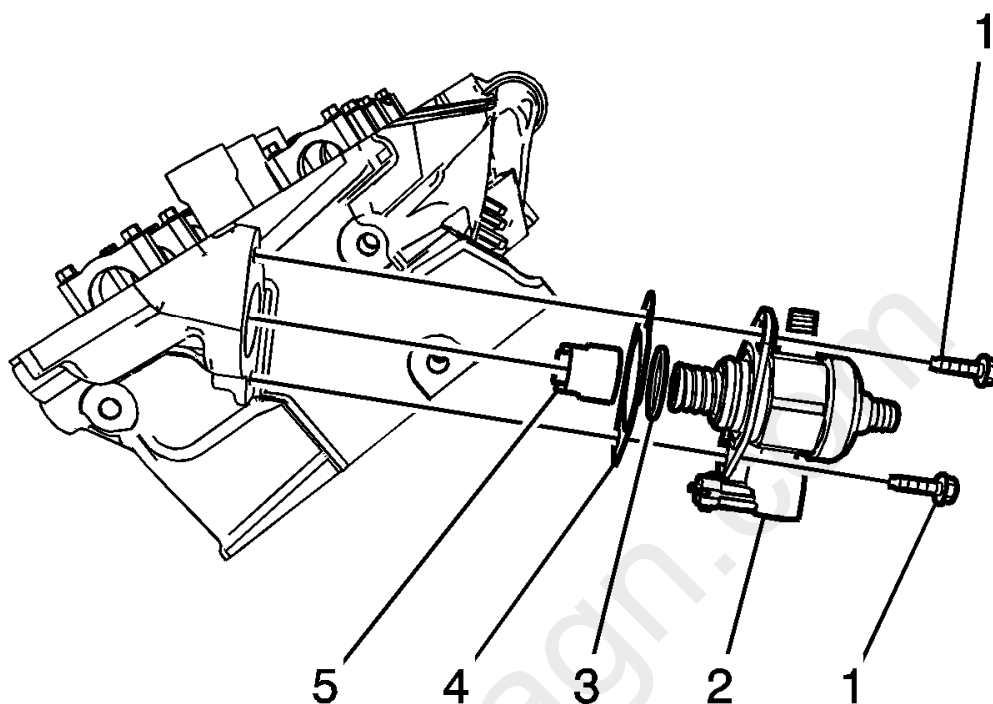


Fig. 132: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The high pressure fuel pump gasket (4) has a retaining feature to hold the pump retaining bolts in place.

3. Using 5W30 engine oil, lubricate then install the high pressure fuel pump roller lifter (5).
4. Install a NEW high pressure fuel pump O-ring (3).
5. Position the NEW high pressure fuel pump gasket (4) and NEW bolts (1) to the fuel pump.
6. Install the high pressure fuel pump (2). Force will be required while HAND tightening the bolts.

CAUTION: Refer to Fastener Caution .

CAUTION: Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger

damage.

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

1. Start and hand-tighten the NEW high pressure fuel pump bolts (1) evenly.
2. Tighten the high pressure fuel pump retaining bolts (1) to 15 (11 lb ft).
7. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to installing the NEW high pressure pipe.
8. Install a NEW high pressure fuel feed pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFX)**.
9. Install the fuel feed pipe to the high pressure fuel pump. Refer to **Fuel Feed Pipe Replacement (LFX)**.
10. Connect the high pressure fuel pump wiring harness.
11. Install the thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement (LFX, LF3)**.
12. Install the fuel tank cap.

NOTE: If a fuel leak occurs at the fuel rail, the fuel rail will need to be replaced along with the one time use high pressure pipe.

13. Inspect for 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.
14. Install the pressure relief cap to the fuel feed pipe.

FUEL PUMP REPLACEMENT (LF3)

Removal

Special Tools

EN 48896 HP Fuel Pump Installation Alignment Gauge

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

1. Relieve the fuel pressure. Refer to **Fuel Pressure Relief**.
2. Remove and DISCARD the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF3)**.

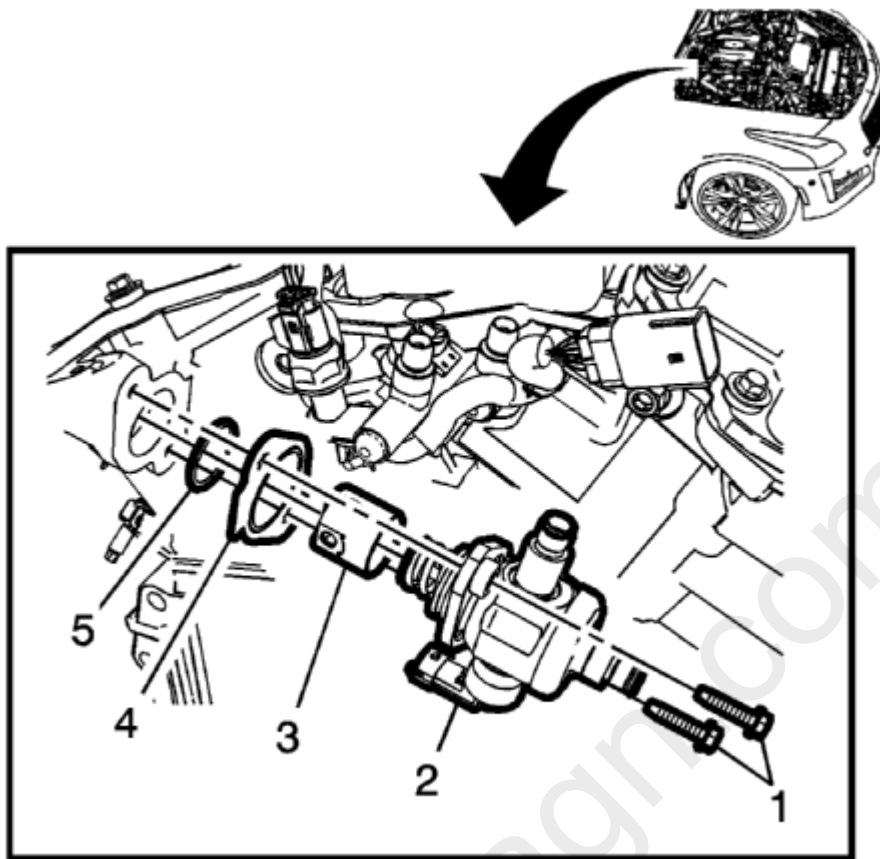


Fig. 133: Fuel Pump

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage

3. Remove and DISCARD the high pressure fuel pump bolts (1).
 1. Remove the high pressure fuel pump (2).
 2. Remove the valve lifter follower (3).
 3. Remove and DISCARD the high pressure fuel pump gasket (4).
 4. Remove and DISCARD the high pressure fuel pump O-ring (5).

Installation

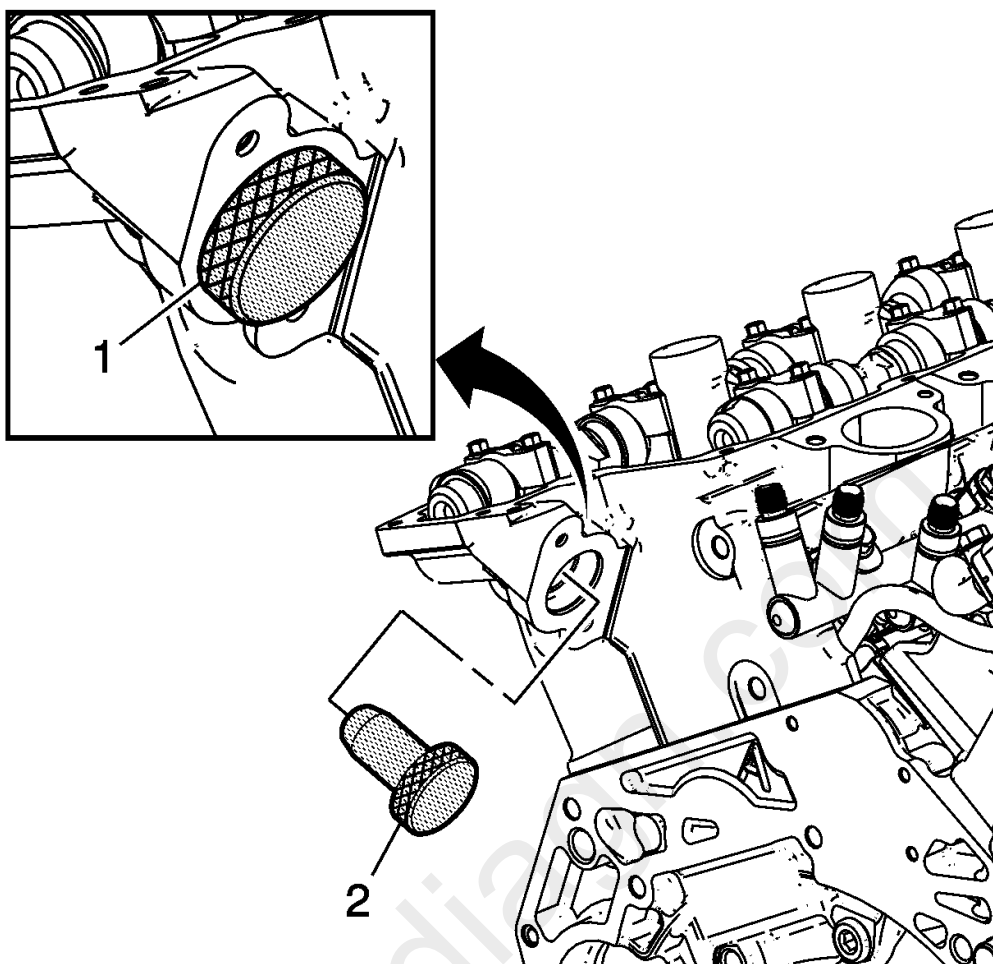


Fig. 134: View Of Alignment Gauge
Courtesy of GENERAL MOTORS COMPANY

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

1. Use the **EN 48896** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the head (1).

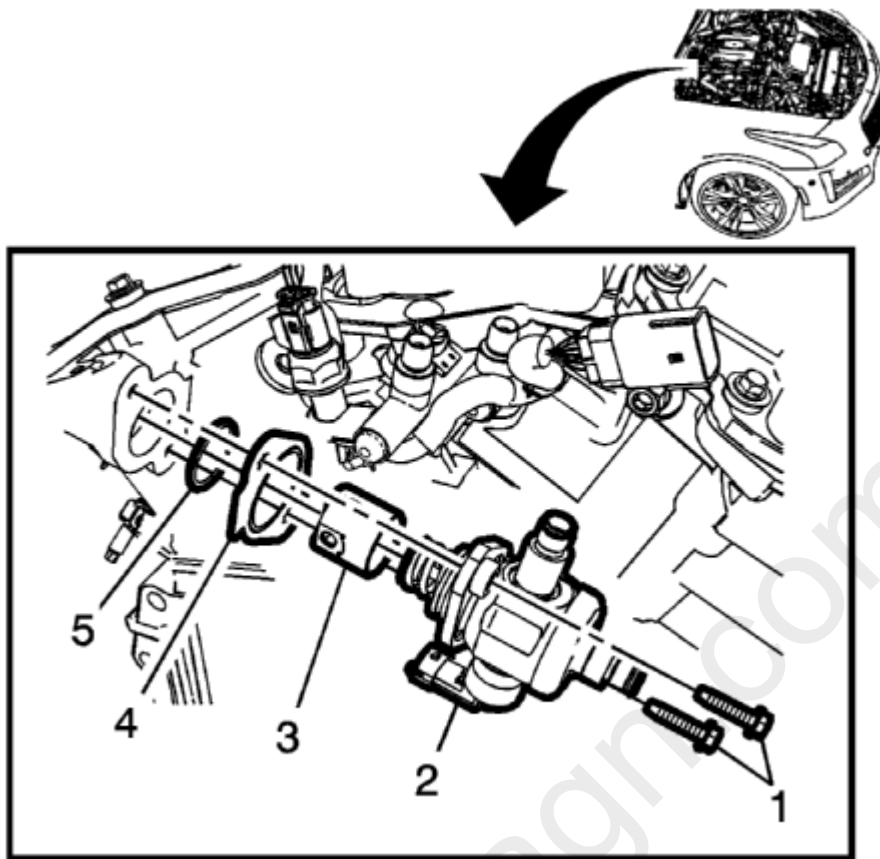


Fig. 135: Fuel Pump

Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the high pressure fuel pump cylinder head bore with 5W30 engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

NOTE: Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke.

3. Lubricate the high pressure fuel pump roller lifter with 5W30 engine oil and install into the cylinder head bore.
4. Install a NEW high pressure fuel pressure fuel pump gasket (4).

NOTE: The locator tab on the fuel pump gasket should be positioned away from the engine block.

5. Install a NEW high pressure fuel pump O-ring (5).

NOTE: Ensure the plastic bolt retainers are installed in the high pressure fuel pump mounting holes before installing.

6. Install the valve lifter follower (3).
7. Install the high pressure fuel pump (2).

CAUTION: Refer to Fastener Caution .

CAUTION: Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.

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

8. Start and hand-tighten the NEW high pressure fuel pump bolts (1) evenly.
 1. Tighten the fuel pump bolts (1) a first pass in sequence to 15 (11 lb ft) .
 2. Tighten the fuel pump bolts (1) a final pass of an additional 60 degrees .
9. Install the NEW fuel feed intermediate pipe. Refer to Fuel Feed Intermediate Pipe Replacement (LF3).
10. Install the NEW fuel feed pipe and fuel feed pipe shield. Refer to Fuel Feed Pipe Replacement (LF3).

FUEL INJECTOR REPLACEMENT

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-48266** Injector Seal Installer and Sizer
- **J-37281-A** Injector Remover
- **J 39313** Spark Plug Port Adapter

Removal Procedure

1. Ignition OFF.

WARNING: Refer to Battery Disconnect Warning .

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement (LFX), Fuel Pipe Shield Replacement (LF3).

WARNING: Refer to Safety Glasses Warning .

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Relieving Fuel Pressure Warning .

4. Relieve the high side fuel pressure. Refer to Fuel Pressure Relief.
5. Relieve the low side fuel pressure. Refer to Fuel Pressure Relief.
6. Remove the intake manifold. Refer to Intake Manifold Replacement (LFX) , Intake Manifold Replacement (LF3) .
7. Remove and discard the fuel feed intermediate pipe. Refer to Fuel Feed Intermediate Pipe Replacement (LFX), Fuel Feed Intermediate Pipe Replacement (LF3).
8. Remove the noise insulator from the fuel injection fuel rail assembly.

NOTE: Care should be taken not to damage the fuel injectors when removing the fuel injection fuel rails.

9. Remove the right bank fuel rail assembly from the cylinder head. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LFX), Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF3).
10. Remove the left bank fuel rail assembly from the cylinder head. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LFX), Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF3).

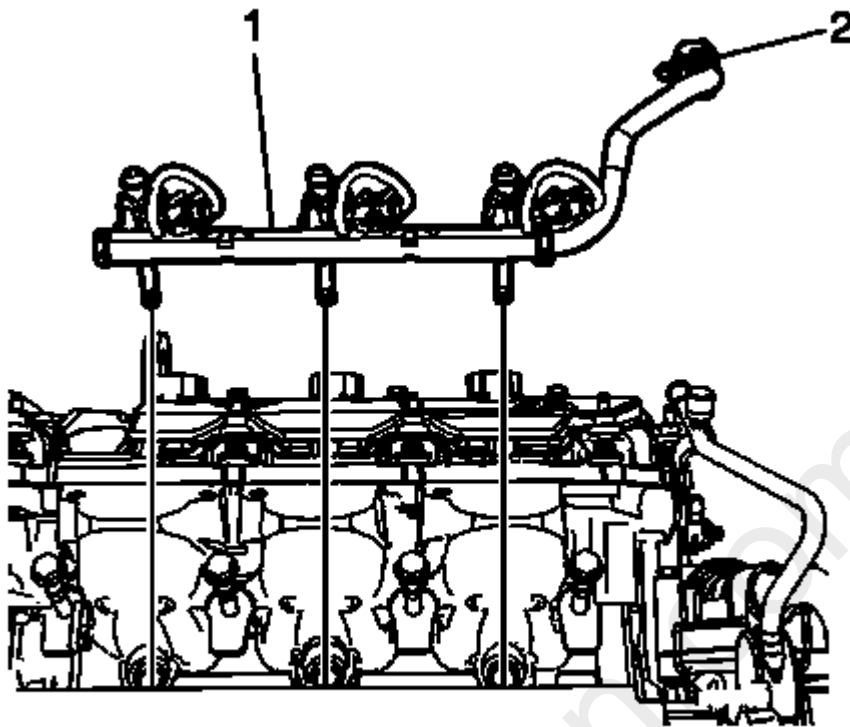


Fig. 136: Identifying Direct Fuel Injector & Harness Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: Care should be taken not to damage the fuel injectors when removing the fuel injectors from the cylinder heads.

NOTE: Before removing the fuel injectors, note the orientation of the injectors and the injector wiring harness.

11. Detach the right bank fuel injector wiring harness electrical connector (2) from the engine wiring harness.
12. Using the **J-37281-A** injector remover release the right bank fuel injectors from the cylinder head.
13. Remove the right bank fuel injectors and wiring harness (1), as an assembly, from the cylinder head.
14. Detach the right bank fuel injectors from the right bank fuel injector wiring harness.
15. Detach the right bank fuel injectors from the fuel injector retainers on the right bank fuel injector wiring harness.

NOTE: Care should be taken not to damage the fuel injectors when removing the fuel injectors from the cylinder heads.

NOTE: Before removing the fuel injectors, note the orientation of the injectors and the injector wiring harness.

16. Detach the left bank fuel injector wiring harness electrical connector (2) from the engine wiring harness.
17. Using the **J-37281-A** injector remover , release the left bank fuel injectors from the cylinder head.
18. Remove the left bank fuel injectors and wiring harness (1), as an assembly, from the cylinder head.
19. Detach the left bank fuel injectors from the left bank fuel injector wiring harness.
20. Detach the left bank fuel injectors from the fuel injector retainers on the left bank fuel injector wiring harness.

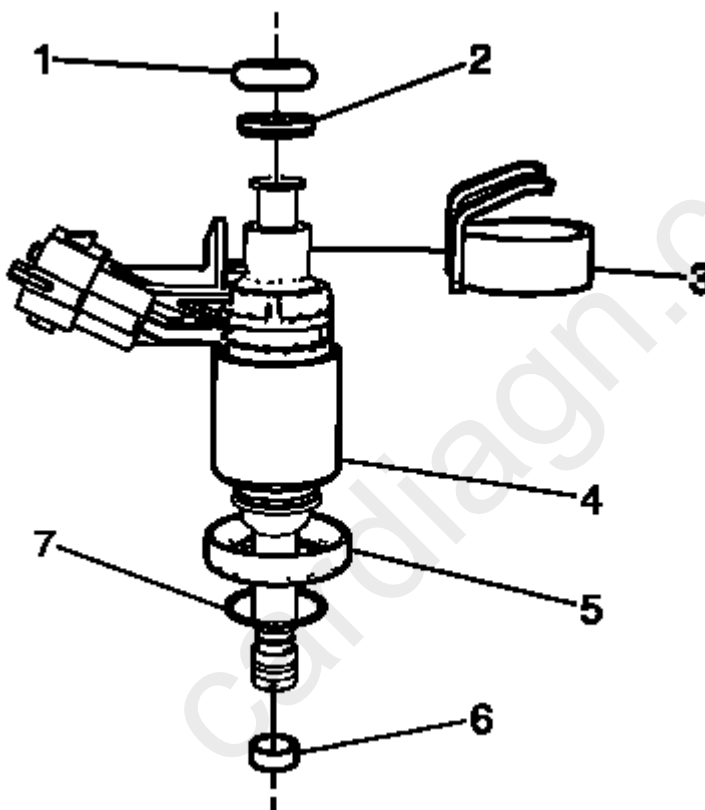


Fig. 137: Direct Fuel Injector & Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: Discard the fuel injector (4) if the fuel injector is damaged.

21. Remove and discard the following components from the fuel injectors:
 - Upper O-ring Seal (1)
 - Plastic Spacer (2)
 - Retaining Ring (3)

NOTE: Use a suitable tool to cut the teflon seal.

- Teflon Seal (6)
- Circlip (7)
- Isolator Cup (5)

Installation Procedure

1. If required, clean the fuel injector bores using the injector bore and sleeve cleaning kit **EN-47909** injector bore and sleeve cleaning kit.

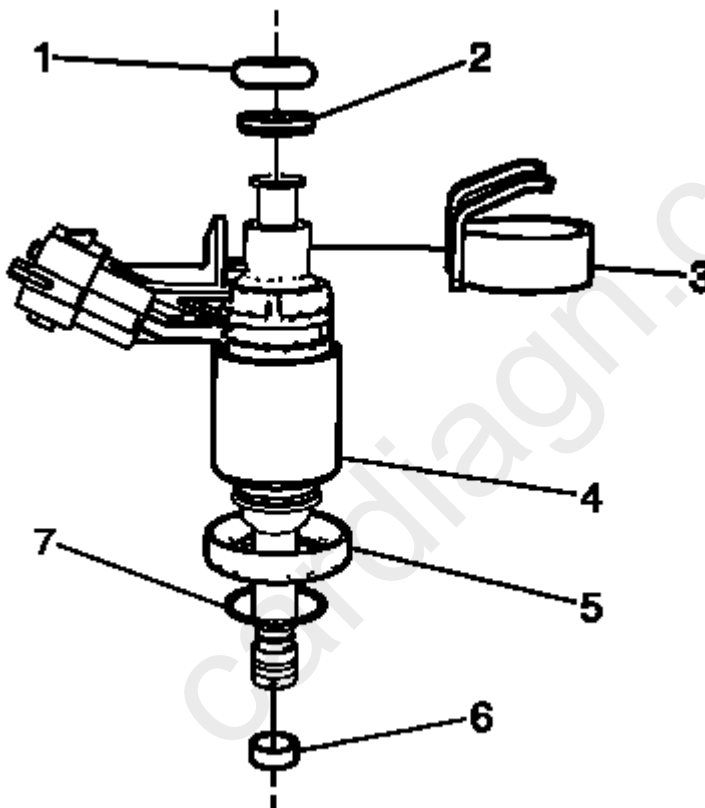


Fig. 138: Direct Fuel Injector & Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate a NEW O-ring seal (1) with silicon free engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers .

2. Install the following NEW components to the fuel injectors (4).
 - Upper O-ring Seal (1)
 - Plastic Spacer (2)
 - Retaining Ring (3)

- Isolator Cup (5)
- Circlip (7)

NOTE: Use the procedure described below to install the teflon seal to the fuel injectors (4).

- Teflon Seal (6)

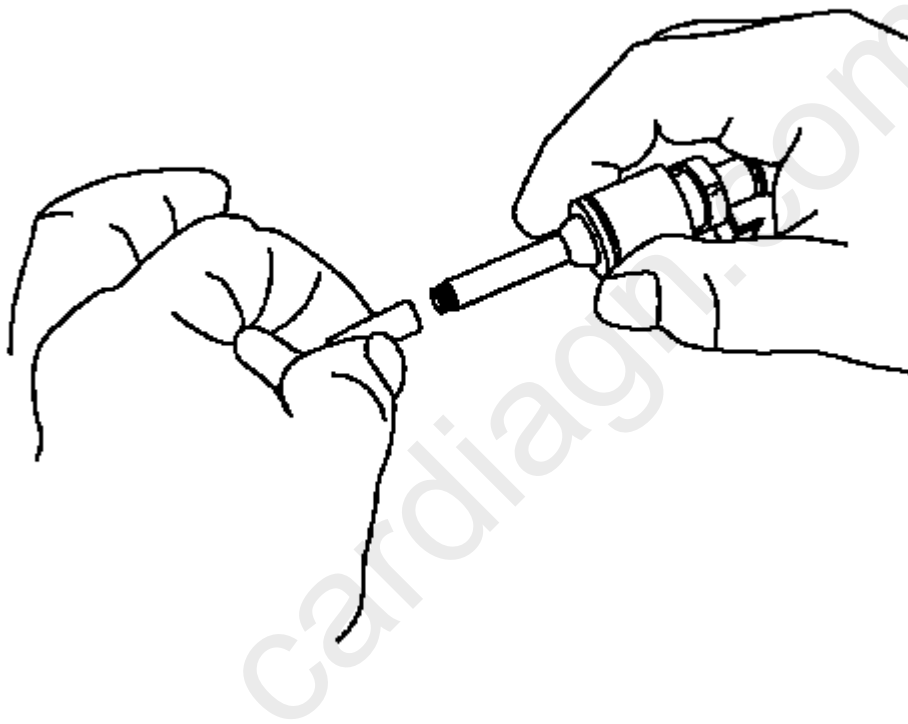


Fig. 139: View Of Injector Tip & Injector Seal Installer and Sizer
Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel injector teflon seal installer of the **EN-48266** injector seal installer and sizer to the nozzle end of the fuel injector.

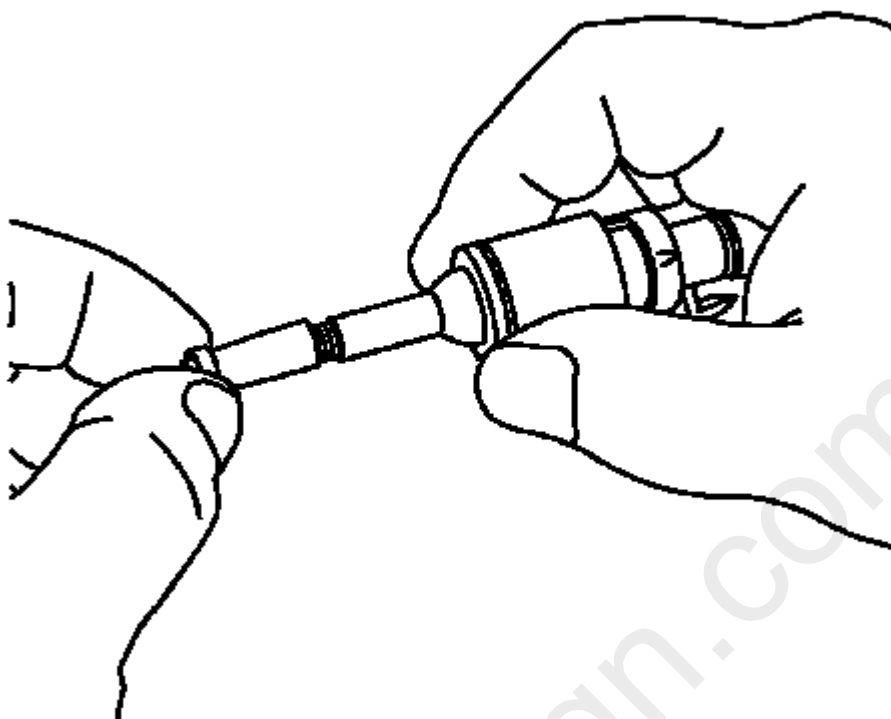


Fig. 140: Using Special Tool EN 48266-1
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT** lubricate the NEW teflon seal.

4. Install a NEW teflon seal over the fuel injector teflon seal installer of the **EN-48266** injector seal installer and sizer.

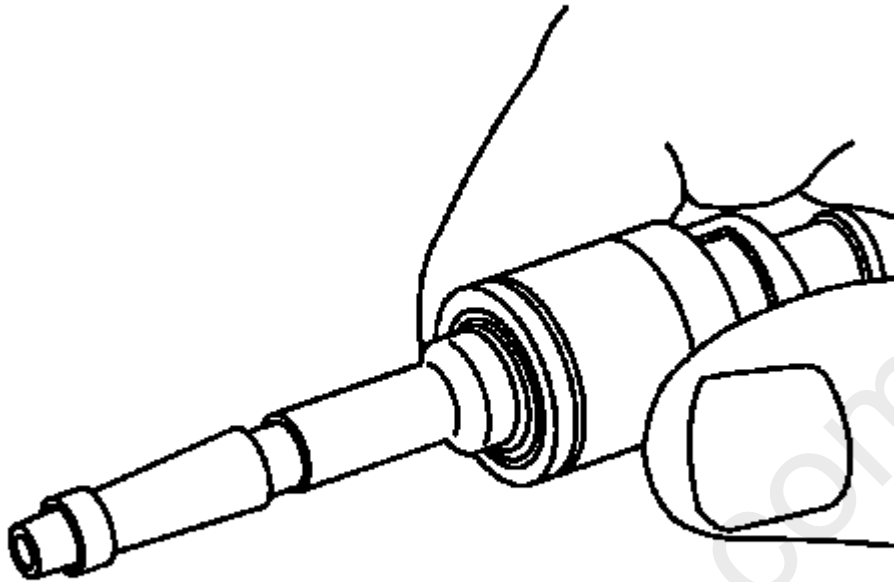


Fig. 141: View Of Special Tool EN 48266-1
Courtesy of GENERAL MOTORS COMPANY

5. Carefully push the NEW teflon seal along the fuel injector teflon seal installer of the **EN-48266** injector seal installer and sizer and into the groove of the fuel injector by hand.
6. Remove the fuel injector teflon seal installer of the **EN-48266** injector seal installer and sizer from the nozzle end of the fuel injector.

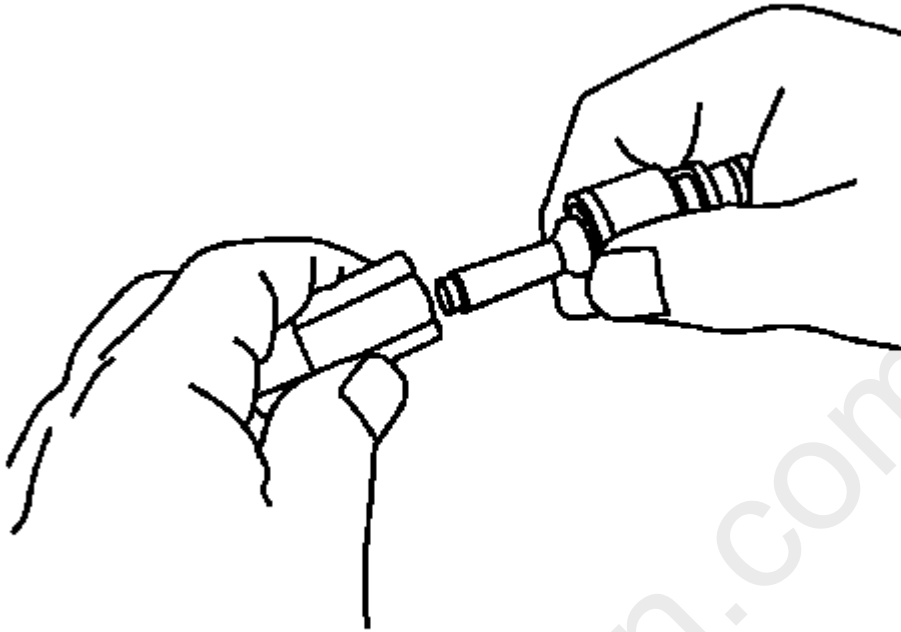


Fig. 142: Injector And Seal Installer & Sizer
Courtesy of GENERAL MOTORS COMPANY

7. Install the teflon seal sizer of the **EN-48266** injector seal installer and sizer to the nozzle end of the fuel injector tip.

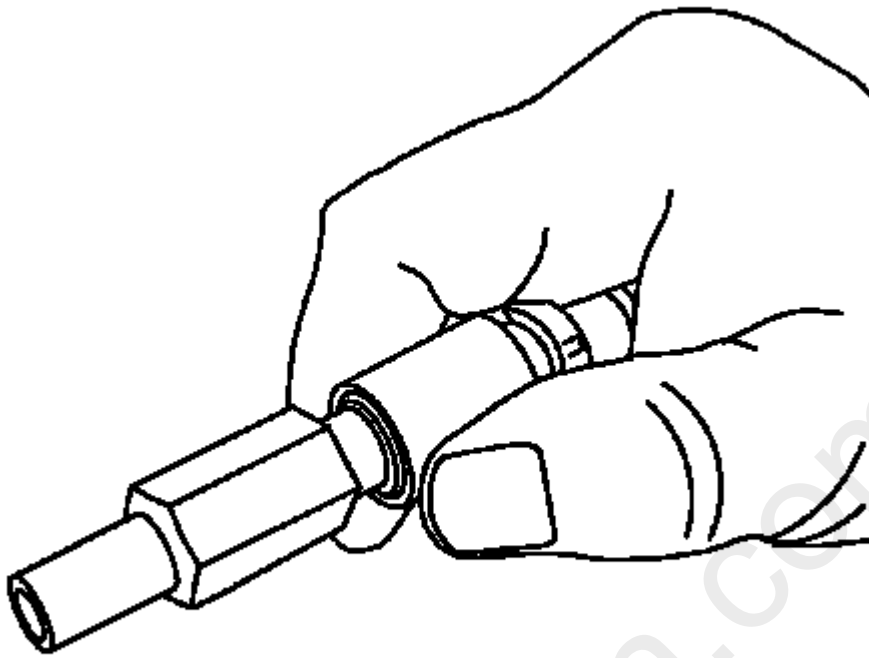


Fig. 143: View Of Special Tool EN 48266-2
Courtesy of GENERAL MOTORS COMPANY

8. Using the teflon seal sizer of the **EN-48266** injector seal installer and sizer , resize the teflon seal.
9. Remove the teflon seal sizer of the **EN-48266** injector seal installer and sizer from the nozzle end of the fuel injector tip.

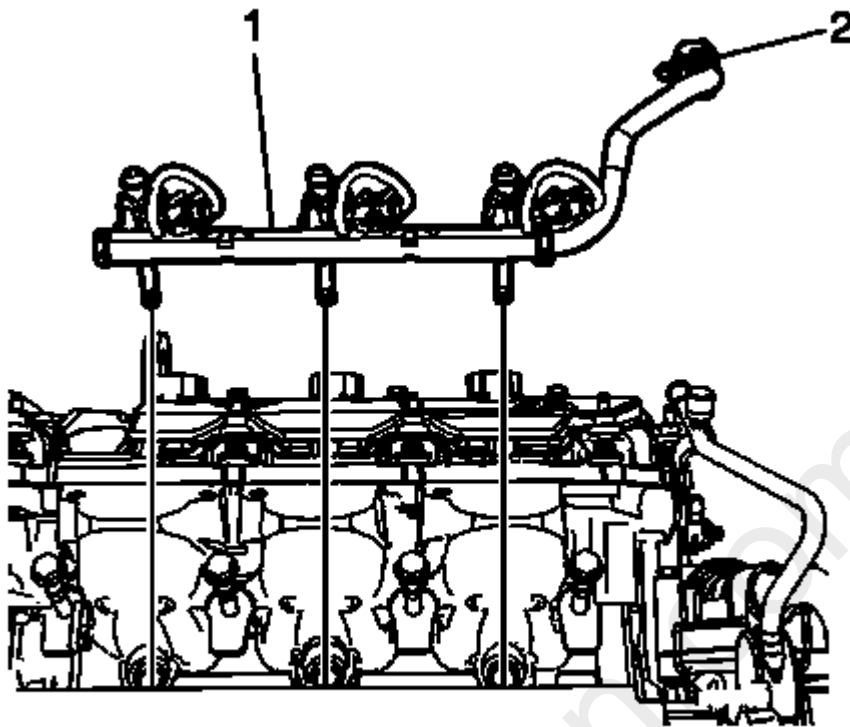


Fig. 144: Identifying Direct Fuel Injector & Harness Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

NOTE: Make sure that the fuel injector wiring harness is routed correctly. Failure to comply may cause damage to the wiring harness.

NOTE: Care should be taken not to damage the fuel injectors when installing the fuel injectors to the cylinder heads.

10. Attach the left bank fuel injectors to the fuel injector retainers on the left bank fuel injector wiring harness.
11. Connect the left bank fuel injectors to the left bank fuel injector wiring harness.
12. Install the left bank fuel injectors and wiring harness (1) as an assembly to the cylinder head.
13. Connect the left bank fuel injector wiring harness electrical connector (2) to the engine wiring harness.

NOTE: Make sure that the fuel injectors wiring harness is routed correctly. Failure

to comply may cause damage to the wiring harness.

NOTE: Care should be taken not to damage the fuel injectors when installing the fuel injectors to the cylinder heads.

14. Install the right bank fuel injectors to the fuel injector retainers on the right bank fuel injector wiring harness.
15. Connect the right bank fuel injectors to the right bank fuel injector wiring harness.
16. Install the right bank fuel injectors and wiring harness (1) as an assembly to the cylinder head.
17. Connect the right bank fuel injector wiring harness electrical connector (2) to the engine wiring harness.

NOTE: Care should be taken not to damage the fuel injectors when installing the fuel injection fuel rails.

18. Install the left bank fuel rail assembly to the cylinder head. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LFX), Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF3).
19. Install the right bank fuel rail assembly to the cylinder head. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LFX), Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF3).
20. Install the noise insulator to the fuel injection fuel rail assembly.
21. Install a NEW fuel feed pipe. Refer to Fuel Feed Pipe Replacement (LFX), Fuel Feed Pipe Replacement (LF3).
22. Install the intake manifold. Refer to Intake Manifold Replacement (LFX) , Intake Manifold Replacement (LF3) .
23. Install the fuel pipe shield. Refer to Fuel Pipe Shield Replacement (LFX), Fuel Pipe Shield Replacement (LF3).
24. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT (LFX)

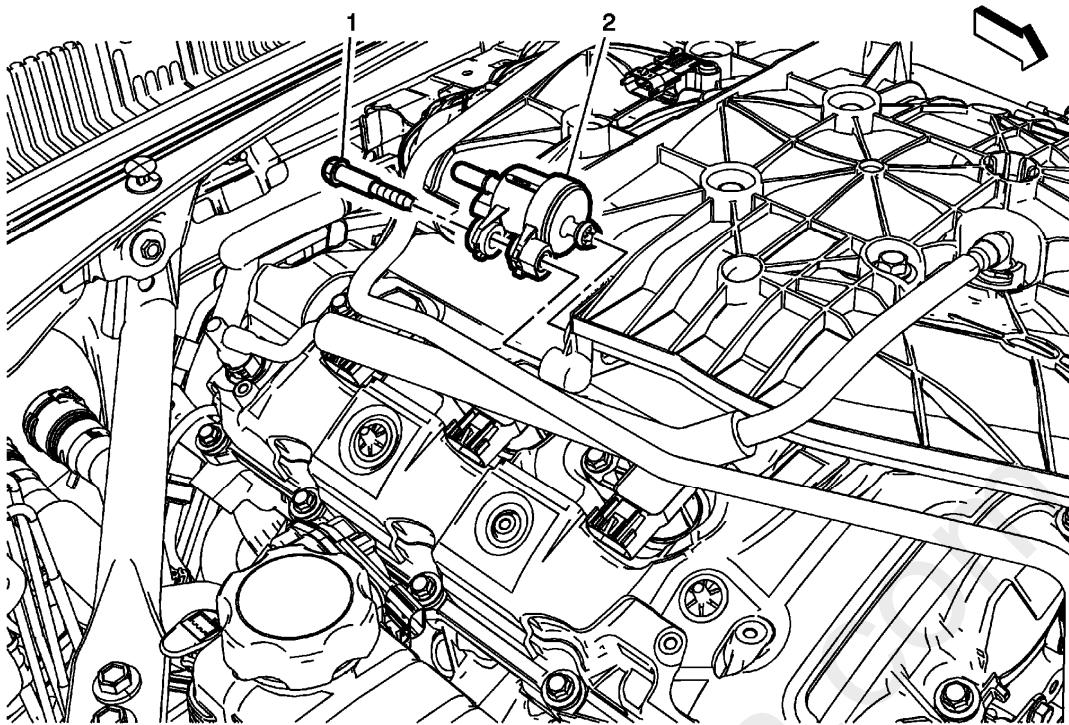


Fig. 145: Evaporative Emission Canister Purge Solenoid Valve (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Solenoid Valve Replacement (LFX)

Callout	Component Name
WARNING: Refer to <u>Gasoline/Gasoline Vapors Warning</u> .	
WARNING: Refer to <u>Safety Glasses Warning</u> .	
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> . 2. Disconnect the evaporative emission pipe. Refer to <u>Evaporative Emission Pipe Replacement</u> .	
1	Evaporative Emission Canister Purge Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
	Evaporative Emission Canister Purge Solenoid Valve

Procedure

Disconnect the evaporative emission canister purge solenoid valve electrical connector.

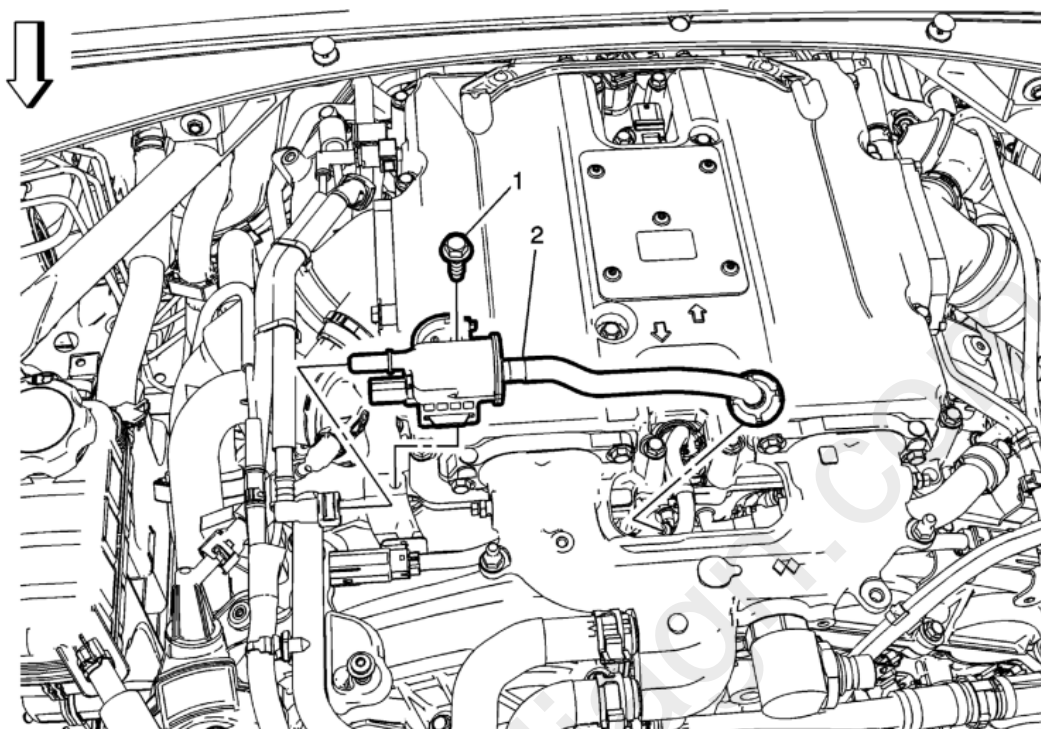
EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT (LF3)

Fig. 146: Evaporative Emission Canister Purge Solenoid Valve (LF3)

Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Solenoid Valve Replacement (LF3)

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Disconnect the evaporative emission canister purge solenoid valve electrical connector. 3. Disconnect EVAP pipe from purge solenoid. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>.	
1	Evaporative Emission Canister Purge Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)

2

Evaporative Emission Canister Purge Solenoid Valve

Procedure

Disconnect quick connect fitting at engine. Refer to **Plastic Collar Quick Connect Fitting Service**.

TURBOCHARGER WASTEGATE ACTUATOR VACUUM TANK REPLACEMENT (LF3)

Removal Procedure

1. Remove the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement**.

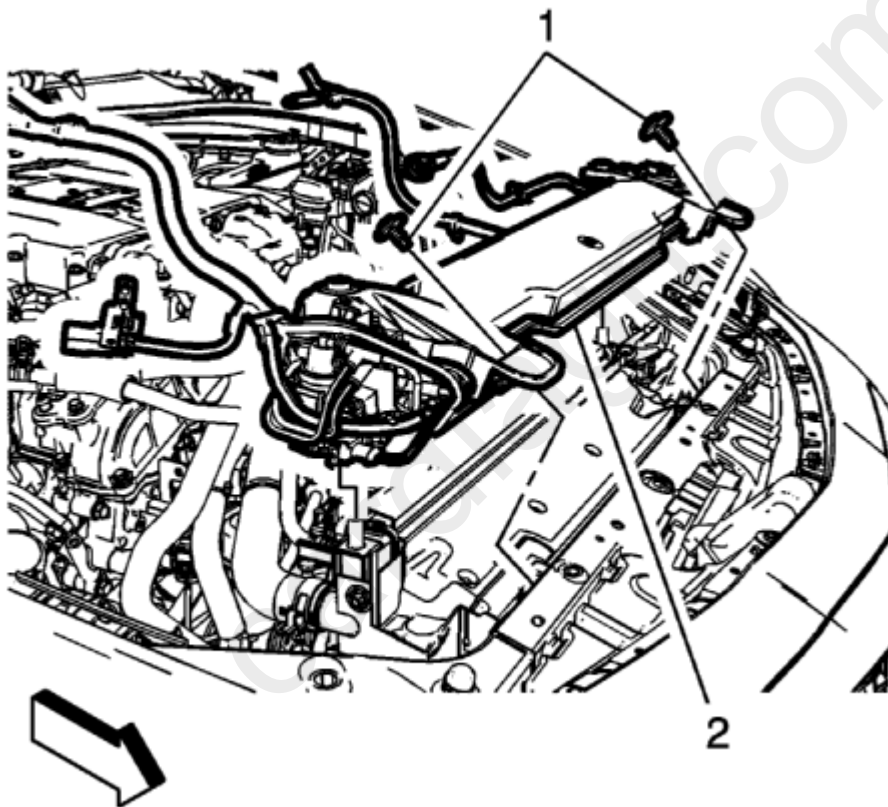


Fig. 147: Turbocharger Wastegate Actuator Vacuum Tank
Courtesy of GENERAL MOTORS COMPANY

2. Remove the turbocharger wastegate actuator vacuum tank bolts (1).
3. Rotate the vacuum tank up, to gain access to the actuator and vacuum tank lines.
4. Disconnect the vacuum lines from the turbocharger wastegate actuator vacuum tank.
5. Remove the turbocharger wastegate actuator vacuum tank (2) from vehicle.

Installation Procedure

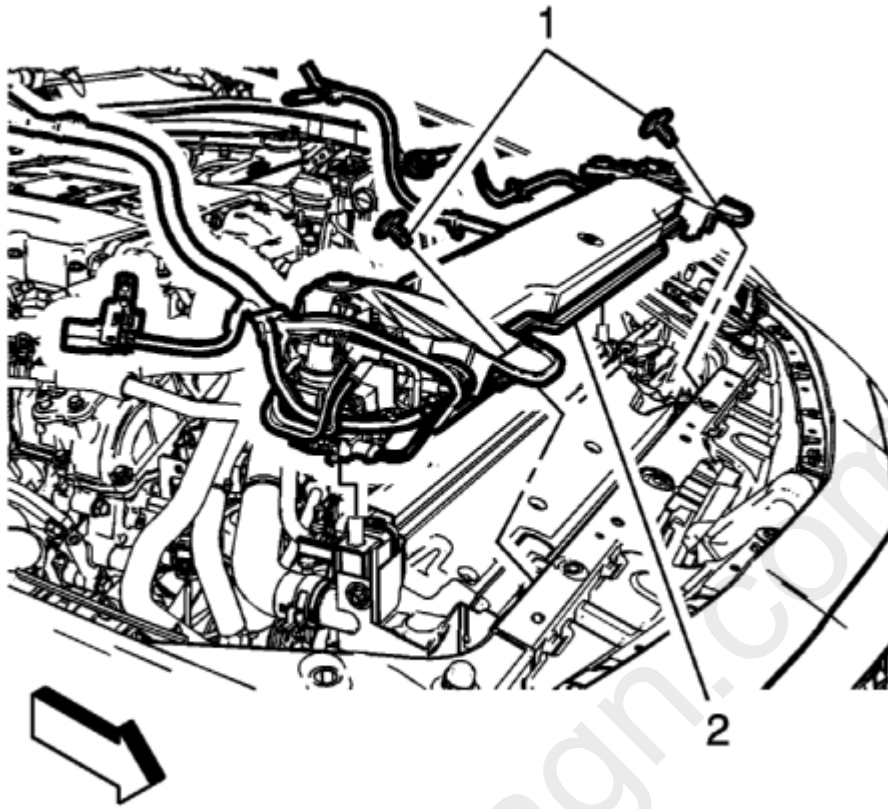


Fig. 148: Turbocharger Wastegate Actuator Vacuum Tank
Courtesy of GENERAL MOTORS COMPANY

1. Connect the vacuum lines to the turbocharger wastegate actuator vacuum tank.
2. Install the turbocharger wastegate actuator vacuum tank (2) to the vehicle.

CAUTION: Refer to Fastener Caution .

3. Install the turbocharger wastegate actuator vacuum tank bolts (1) and tighten to 9 (80 lb in).
4. Install the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement** .

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE REPLACEMENT (LF3)

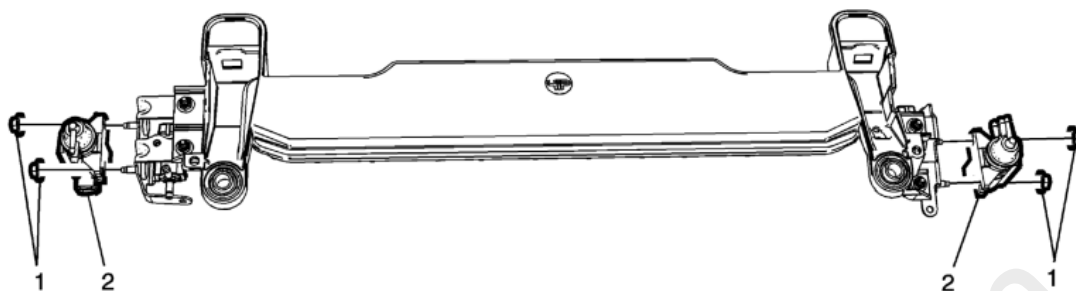


Fig. 149: Turbocharger Wastegate Regulator Solenoid Valve (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Wastegate Regulator Solenoid Valve Replacement (LF3)

Callout	Component Name
Preliminary Procedure 1. Remove the turbocharger wastegate actuator vacuum tank. Refer to <u>Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)</u>. 2. Disconnect the electrical connector from turbocharger wastegate regulator solenoid valve. 3. Disconnect vacuum lines from turbocharger wastegate regulator solenoid valve.	
1	Turbocharger Wastegate Regulator Solenoid Valve Nuts (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Turbocharger Wastegate Regulator Solenoid Valve (Qty: 2)

TURBOCHARGER WASTEGATE ACTUATOR VACUUM SOURCE TUBE REPLACEMENT (LEFT SOLENOID BANK LF3)

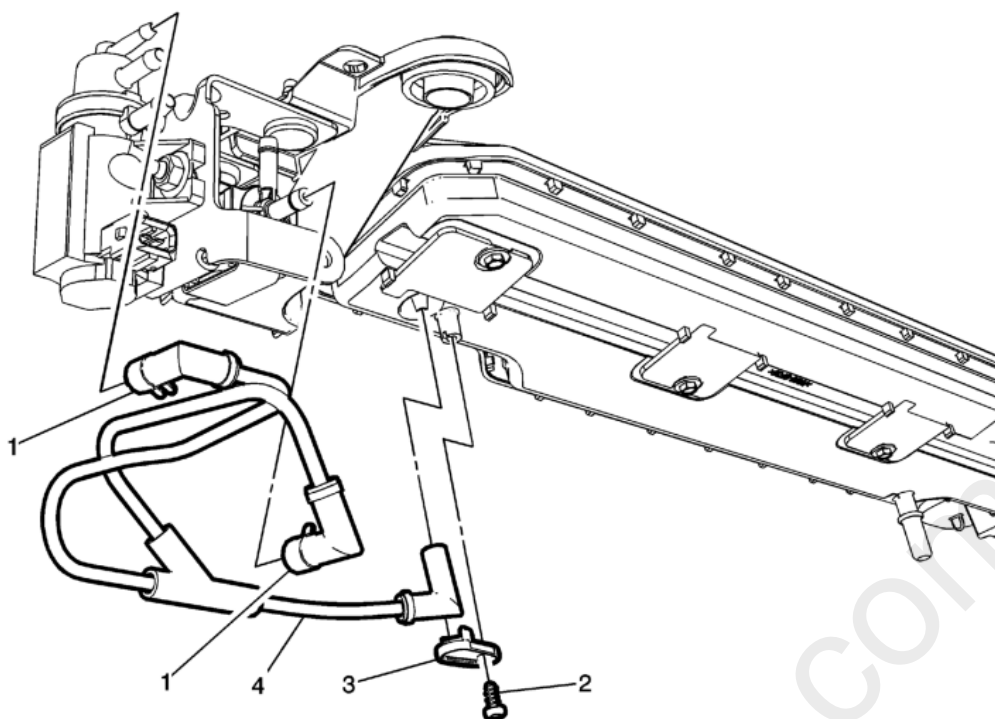


Fig. 150: Turbocharger Wastegate Actuator Vacuum Source Tube (Left Solenoid Bank LF3)
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Wastegate Actuator Vacuum Source Tube Replacement (Left Solenoid Bank LF3)

Callout	Component Name
Preliminary Procedure Remove the turbocharger wastegate actuator vacuum tank. Refer to <u>Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)</u> .	
1	Turbocharger Wastegate Actuator Vacuum Source Tube Clamps (Qty: 2)
2	Turbocharger Wastegate Actuator Vacuum Source Tube Fastener CAUTION: Refer to <u>Fastener Caution</u> .
3	Turbocharger Wastegate Actuator Vacuum Source Tube Retainer
4	Turbocharger Wastegate Actuator Vacuum Source Tube

TURBOCHARGER WASTEGATE ACTUATOR VACUUM SOURCE TUBE REPLACEMENT (RIGHT SOLENOID BANK LF3)

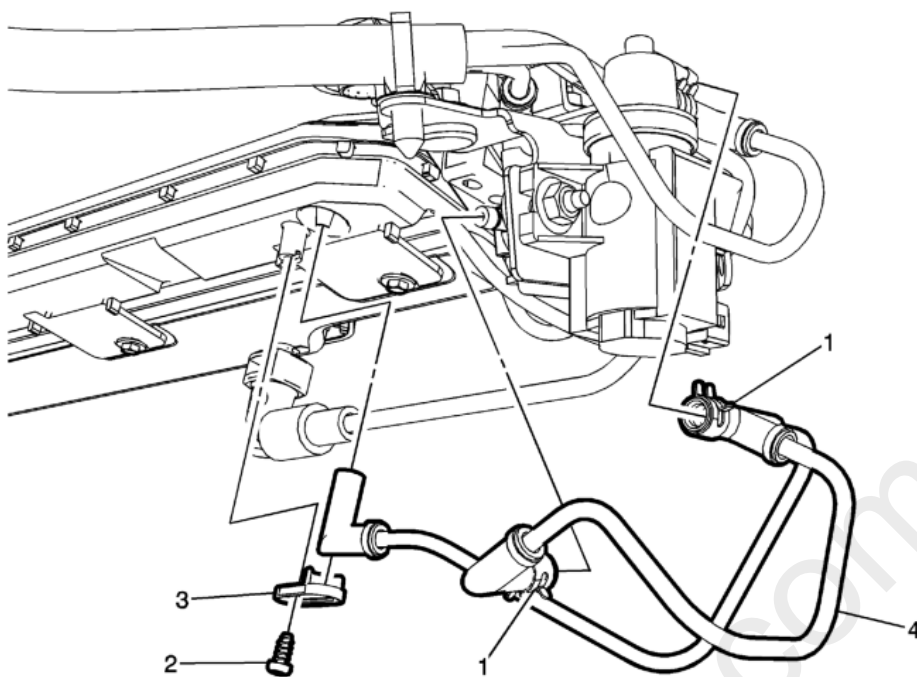


Fig. 151: Turbocharger Wastegate Actuator Vacuum Source Tube (Right Solenoid Bank LF3)
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Wastegate Actuator Vacuum Source Tube Replacement (Right Solenoid Bank LF3)

Callout	Component Name
Preliminary Procedure	
Remove the turbocharger wastegate actuator vacuum tank. Refer to <u>Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)</u> .	
1	Turbocharger Wastegate Actuator Vacuum Source Tube Clamps (Qty: 2)
2	Turbocharger Wastegate Actuator Vacuum Source Tube Fastener CAUTION: Refer to <u>Fastener Caution</u> .
3	Turbocharger Wastegate Actuator Vacuum Source Tube Retainer
4	Turbocharger Wastegate Actuator Vacuum Source Tube

TURBOCHARGER WASTEGATE ACTUATOR REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove bank 1 turbocharger air inlet adapter. Refer to **Turbocharger Air Inlet Adapter Replacement - Bank 1**.
2. Remove the bank 1 turbocharger heat shield. Refer to **Turbocharger Heat Shield Replacement (LF3 Bank 1)** , **Turbocharger Heat Shield Replacement (LF3 Bank 2)** .

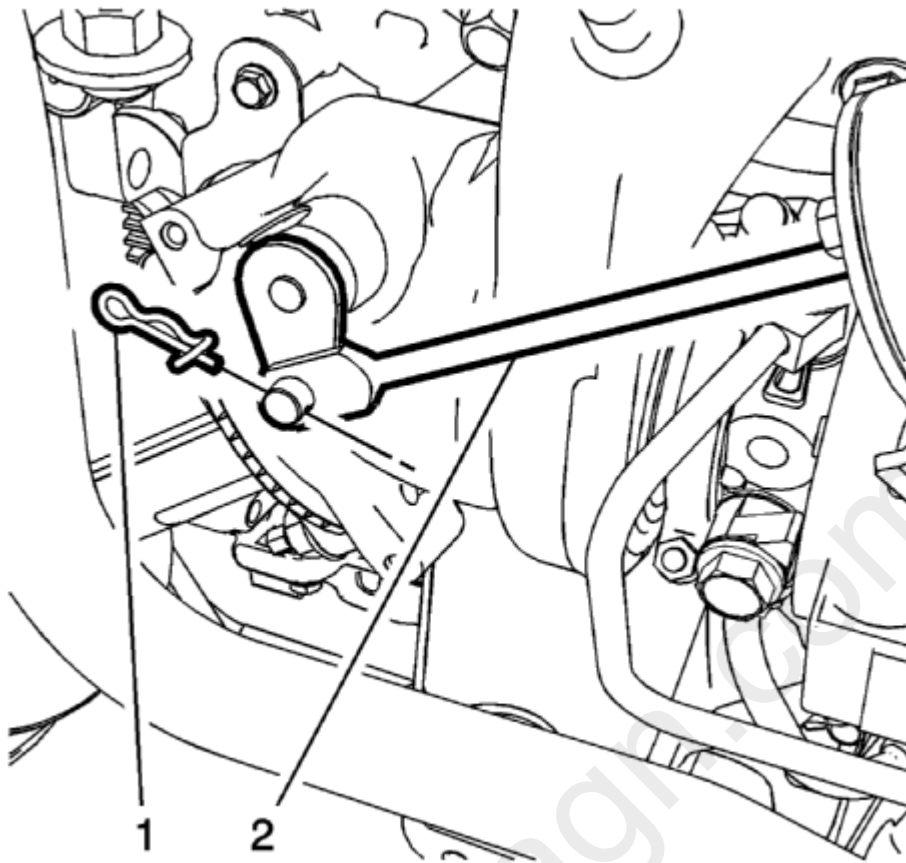


Fig. 152: Turbocharger Wastegate Actuator Arm Retainer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the position of the retainer for future installation.

3. Remove the turbocharger wastegate actuator arm retainer (1) securing the actuator arm (2).

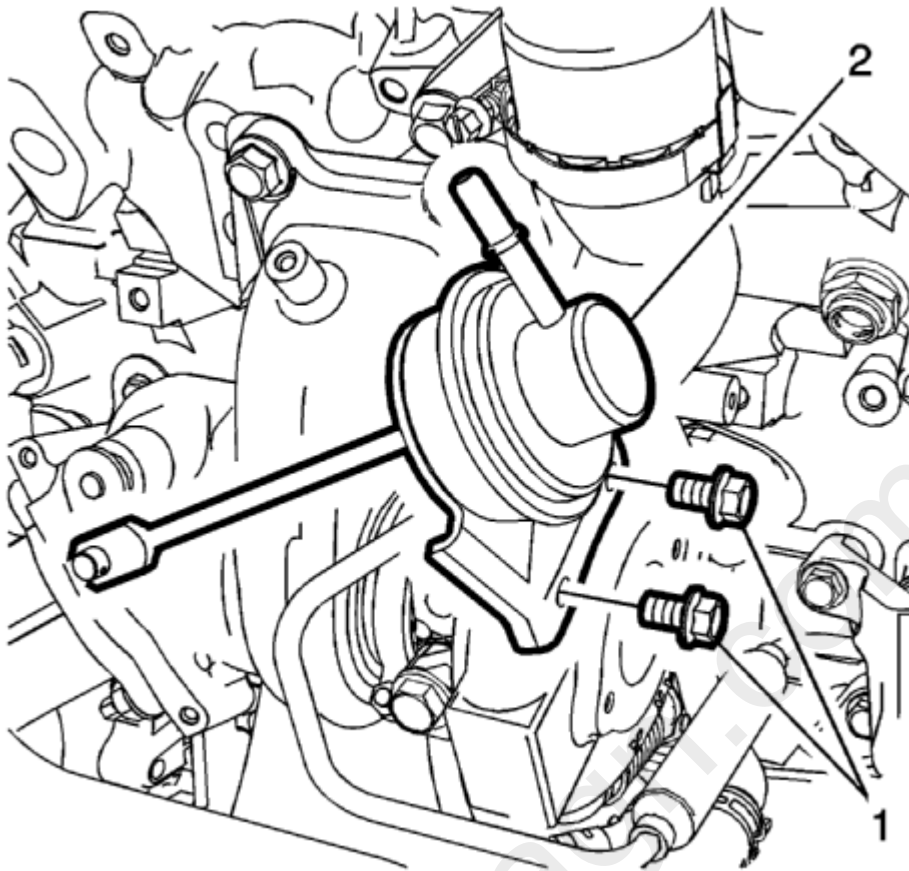


Fig. 153: Turbocharger Wastegate Actuator
Courtesy of GENERAL MOTORS COMPANY

4. Remove the turbocharger wastegate actuator fasteners (1) from the turbocharger wastegate actuator (2).
 1. Disconnect the charge air bypass valve vacuum tube from the turbocharger wastegate actuator.
Refer to **Plastic Collar Quick Connect Fitting Service**.
 2. Remove the turbocharger wastegate actuator.

Installation Procedure

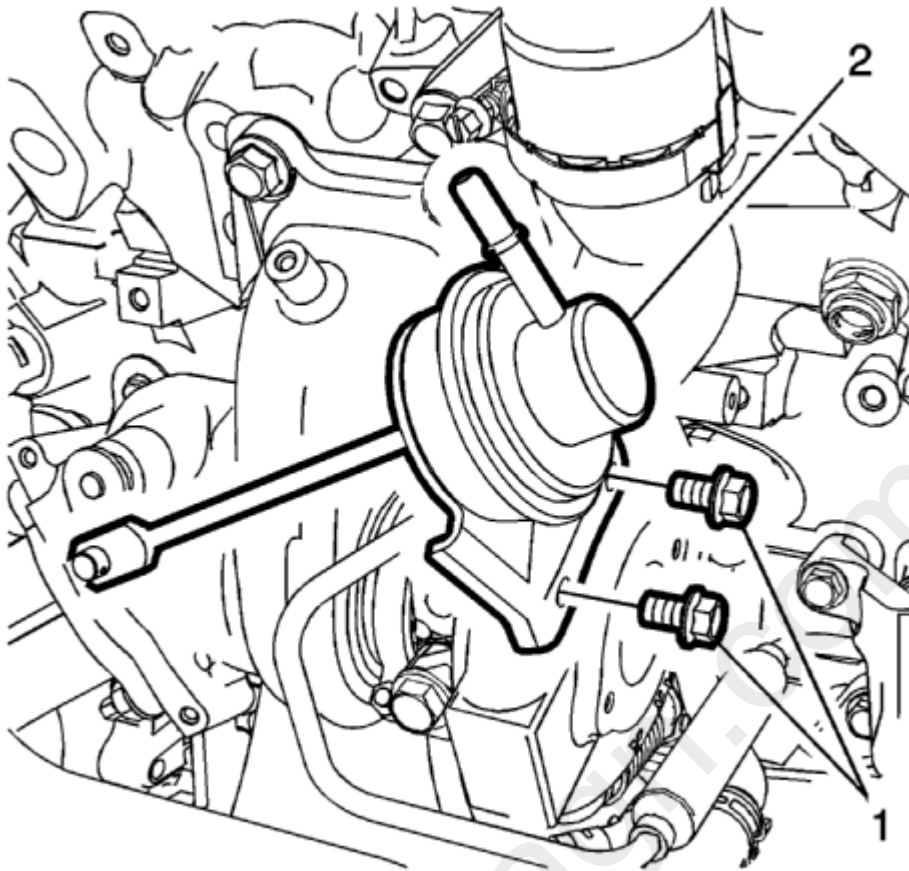


Fig. 154: Turbocharger Wastegate Actuator
Courtesy of GENERAL MOTORS COMPANY

1. Position the turbocharger wastegate actuator (2) in place then hand start the fasteners (1).

CAUTION: Refer to Fastener Caution .

2. Tighten the wastegate actuator fasteners (1) to 25 (18 lb ft).

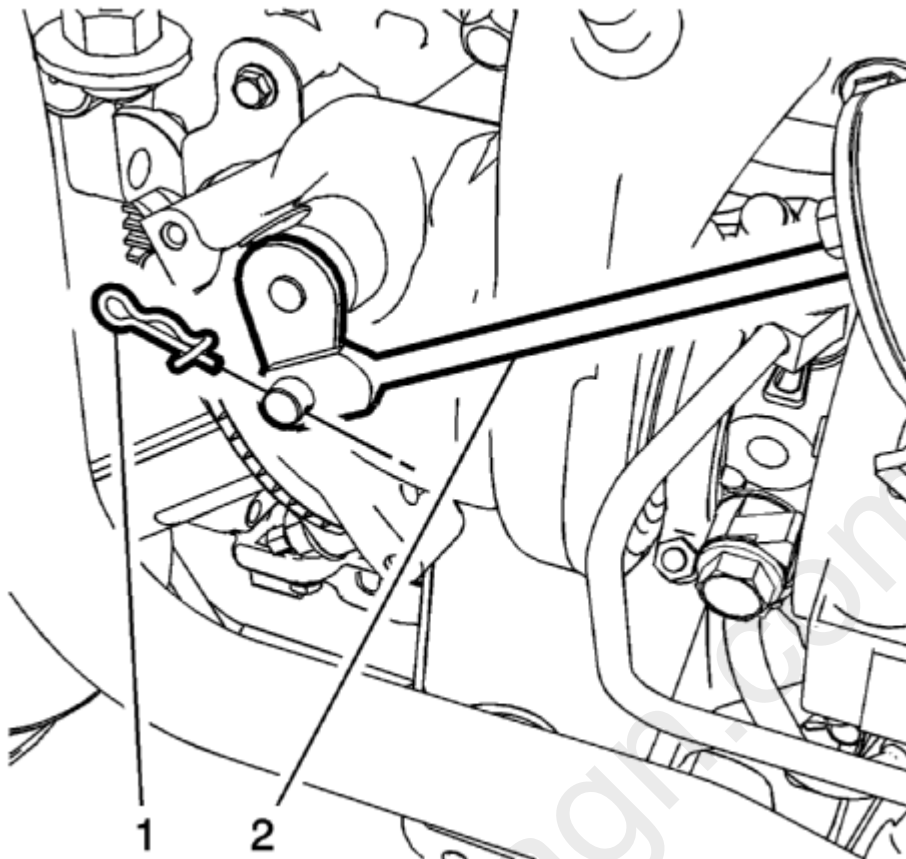


Fig. 155: Turbocharger Wastegate Actuator Arm Retainer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the actuator arm retainer is installed as previously noted.

3. Install the turbocharger wastegate actuator arm (2) then install its retainer (1) to secure the actuator arm.
4. Connect the charge air bypass valve vacuum tube to the turbocharger wastegate actuator. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install the turbocharger heat shield. Refer to **Turbocharger Heat Shield Replacement (LF3 Bank 1)** , **Turbocharger Heat Shield Replacement (LF3 Bank 2)** .
6. Install bank 1 turbocharger air inlet adapter. Refer to **Turbocharger Air Inlet Adapter Replacement - Bank 1**.

TURBOCHARGER WASTEGATE ACTUATOR REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LFX)**, **Air Cleaner Outlet Duct Replacement (LF3)**.
2. Remove the charge air bypass valve. Refer to **Charge Air Bypass Valve Replacement - Left Side (LF3)**.

3. Remove the bank 2 turbocharger heat shield. Refer to **Turbocharger Heat Shield Replacement (LF3 Bank 1)** , **Turbocharger Heat Shield Replacement (LF3 Bank 2)** .

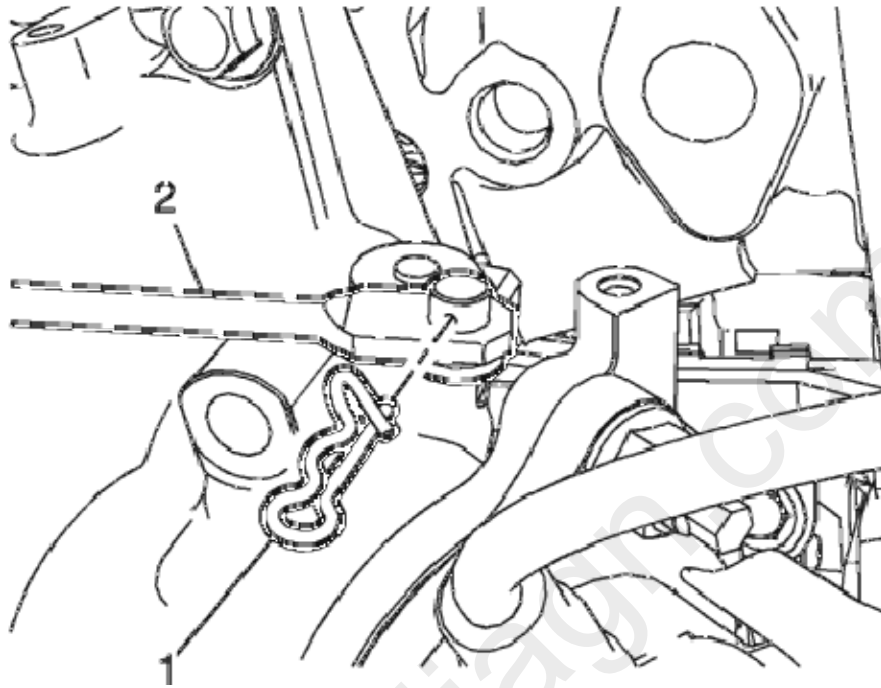


Fig. 156: Turbocharger Wastegate Actuator Arm Retainer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the position of the retainer for future installation.**

4. Remove the turbocharger wastegate actuator arm retainer (1) securing the actuator arm (2).

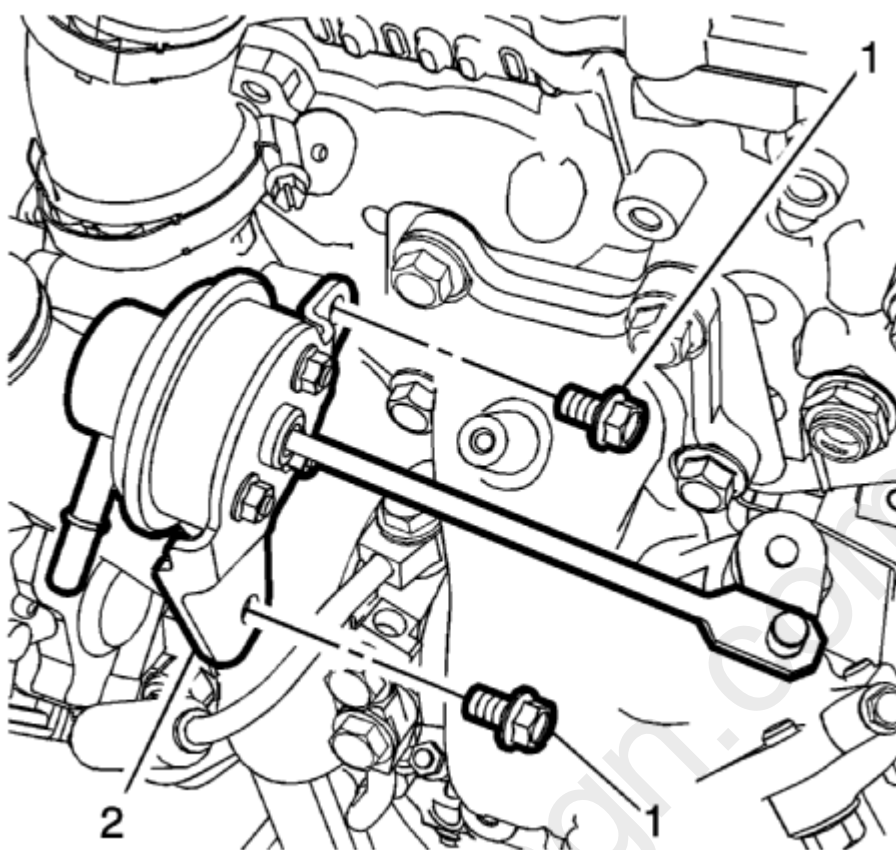


Fig. 157: Turbocharger Wastegate Actuator
Courtesy of GENERAL MOTORS COMPANY

5. Remove the turbocharger wastegate actuator fasteners (1) from the turbocharger wastegate actuator (2).
 1. Disconnect the charge air bypass valve vacuum tube from the turbocharger wastegate actuator.
Refer to **Plastic Collar Quick Connect Fitting Service**.
 2. Remove the turbocharger wastegate actuator.

Installation Procedure

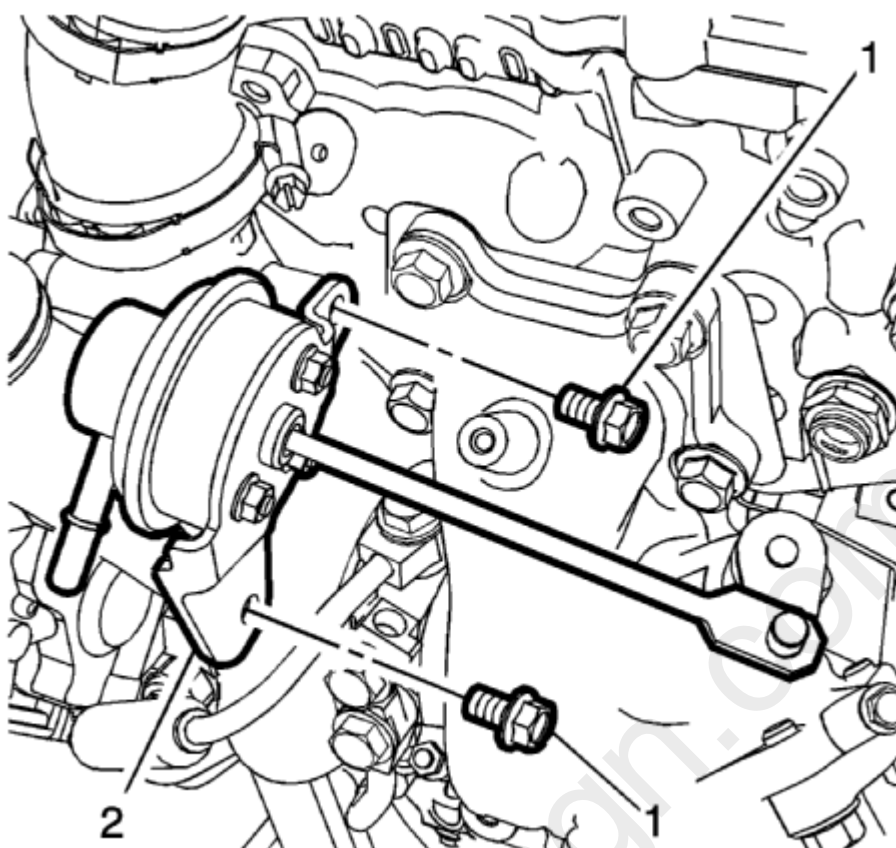


Fig. 158: Turbocharger Wastegate Actuator
Courtesy of GENERAL MOTORS COMPANY

1. Position the turbocharger wastegate actuator (2) in place then hand start the fasteners (1).

CAUTION: Refer to Fastener Caution .

2. Tighten the wastegate actuator fasteners (1) to 25 (18 lb ft).

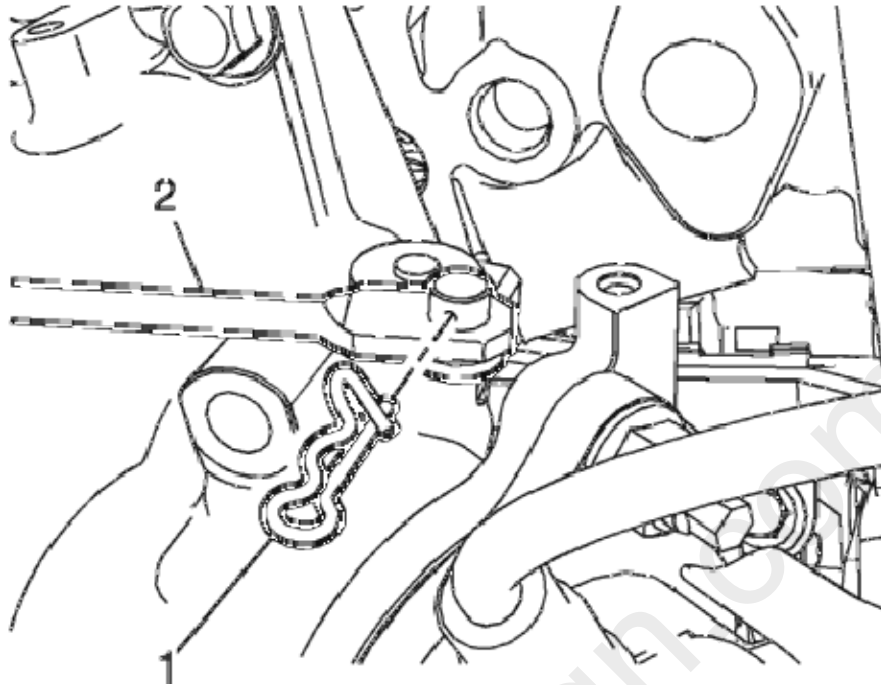


Fig. 159: Turbocharger Wastegate Actuator Arm Retainer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the actuator arm retainer is installed as previously noted.

3. Install the turbocharger wastegate actuator arm (2) then install its retainer (1) to secure the actuator arm.
4. Connect the charge air bypass valve vacuum tube to the turbocharger wastegate actuator. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install the turbocharger heat shield. Refer to **Turbocharger Heat Shield Replacement (LF3 Bank 1)** , **Turbocharger Heat Shield Replacement (LF3 Bank 2)** .
6. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LFX)**, **Air Cleaner Outlet Duct Replacement (LF3)**.
7. Install the charge air bypass valve. Refer to **Charge Air Bypass Valve Replacement - Left Side (LF3)**.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

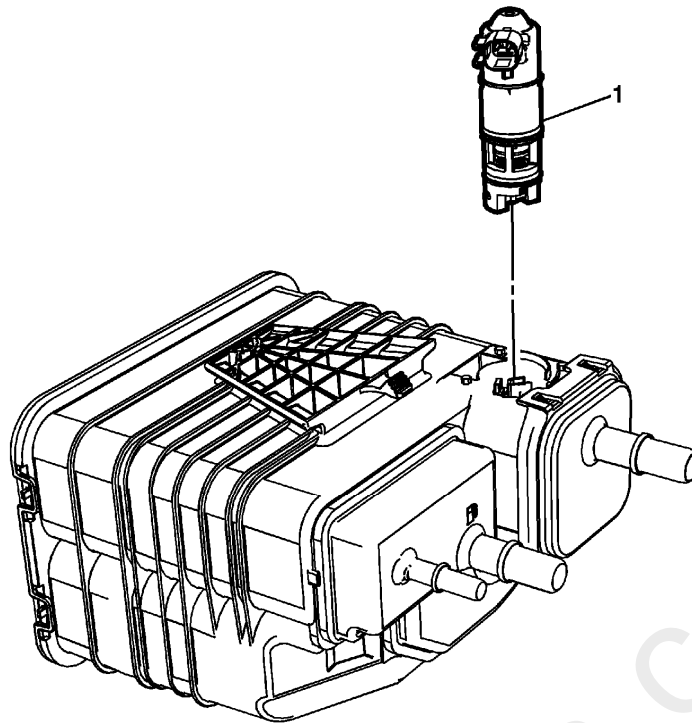


Fig. 160: Evaporative Emission Canister Vent Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Vent Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure	
Remove the evaporative emission canister. Refer to <u>Evaporative Emission Canister Replacement</u> .	
1	Evaporative Emission Canister Vent Solenoid Valve
Procedure	
Disconnect the evaporative emission canister vent solenoid valve electrical connector.	

EVAPORATIVE EMISSION PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) , Intake Manifold Cover Replacement (LF3) .

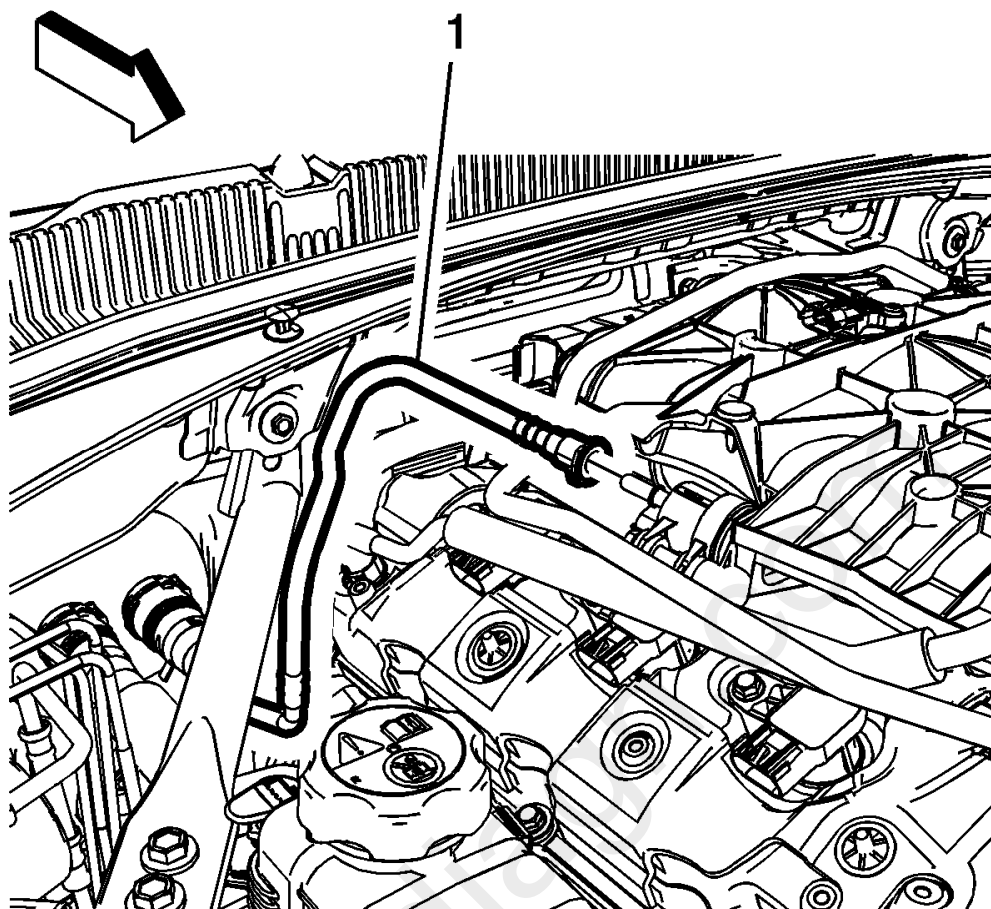


Fig. 161: Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Remove the evaporative emission pipe (1) from the evaporative emission canister purge solenoid valve and retainers. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the underbody front air deflector right side. Refer to **Underbody Front Air Deflector Replacement - Right Side** .
5. Remove the front body exhaust heat shield right side. Refer to **Front Body Exhaust Heat Shield Replacement (Right)** , **Front Body Exhaust Heat Shield Replacement (Left)** .
6. Remove the right side catalytic converter and exhaust. Refer to **Exhaust System Replacement (LF3)** , **Exhaust System Replacement (LFX)** .

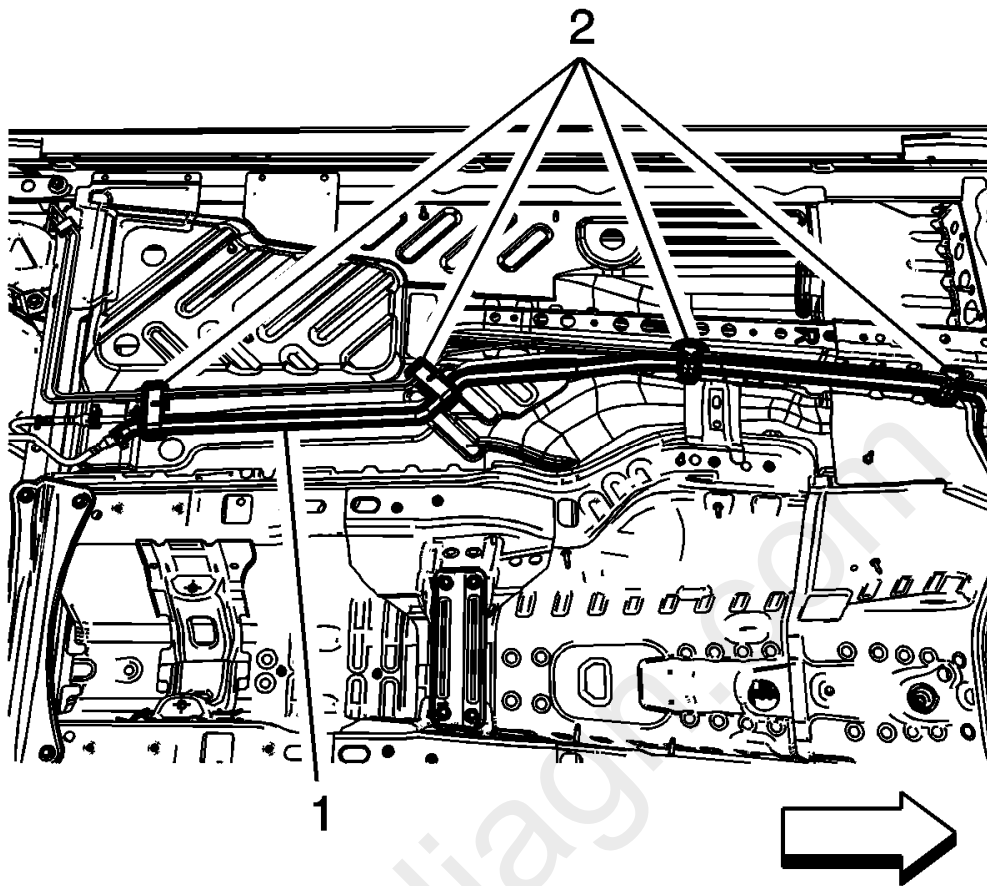


Fig. 162: Evaporative Emission Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the evaporative emission pipe (1) and remove from retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Remove the evaporative emission pipe (1) from the vehicle.

Installation Procedure

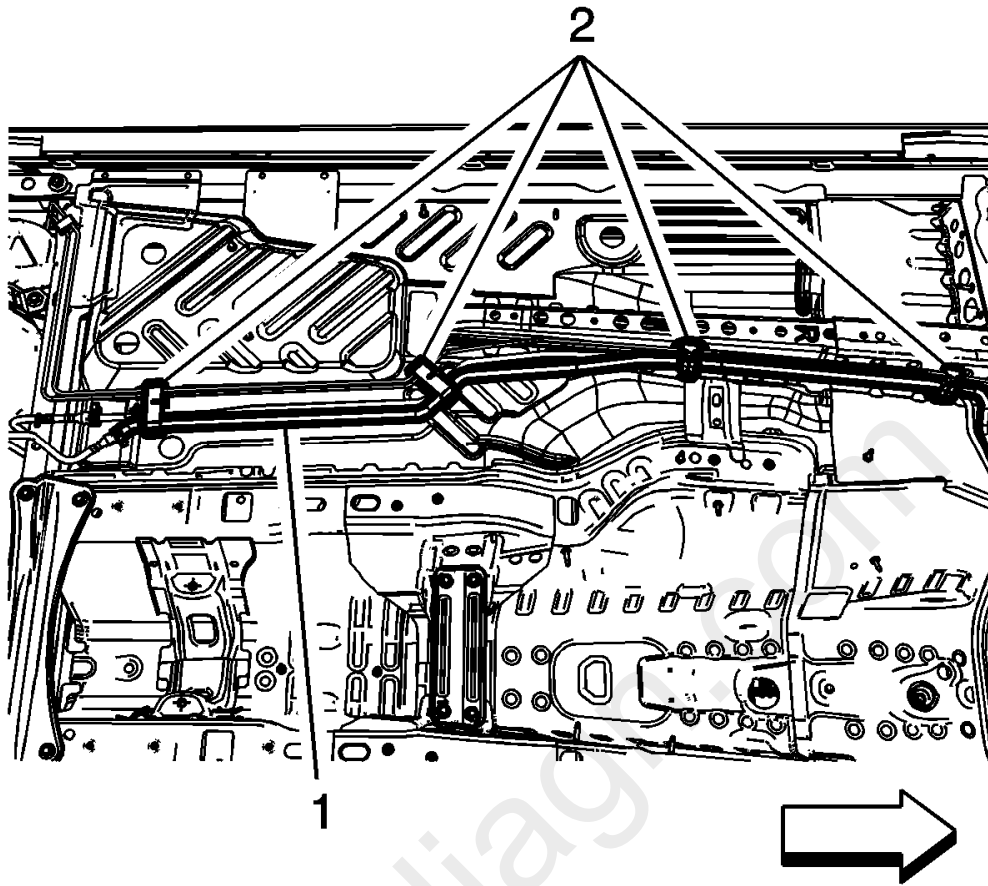


Fig. 163: Evaporative Emission Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission pipe (1) to the vehicle.
2. Connect the evaporative emission pipe (1) and install to the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the right side catalytic converter and exhaust. Refer to **Exhaust System Replacement (LF3)** , **Exhaust System Replacement (LFX)** .
4. Install the front body exhaust heat shield right side. Refer to **Front Body Exhaust Heat Shield Replacement (Right)** , **Front Body Exhaust Heat Shield Replacement (Left)** .
5. Install the underbody front air deflector right side. Refer to **Underbody Front Air Deflector Replacement - Right Side** .
6. Lower the vehicle.

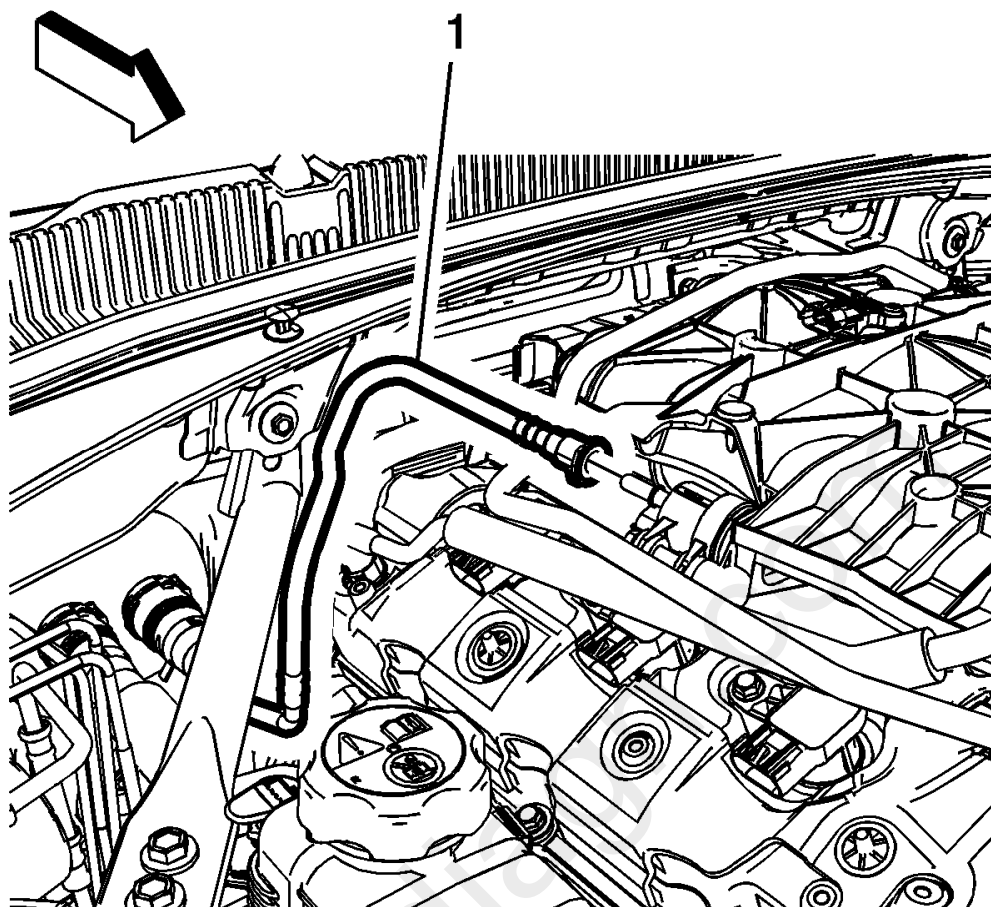


Fig. 164: Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Install the evaporative emission pipe (1) to the evaporative emission canister purge solenoid valve and retainers. Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** , **Intake Manifold Cover Replacement (LF3)** .

EVAPORATIVE EMISSION CANISTER PURGE TUBE REPLACEMENT (LF3)

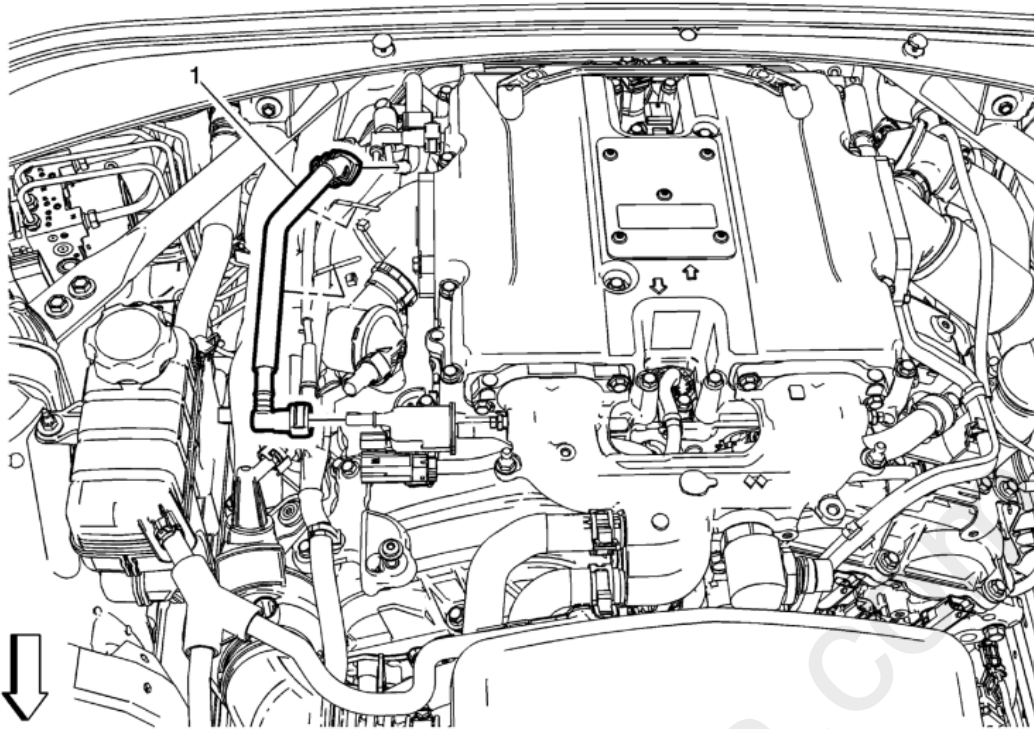


Fig. 165: Evaporative Emission Canister Purge Tube (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Tube Replacement (LF3)

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Remove the tie straps from evaporative emission canister purge tube.	
1	Evaporative Emission Canister Purge Tube Procedure Disconnect the quick connect fittings. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

EVAPORATIVE EMISSION CANISTER AIR INLET HOSE REPLACEMENT

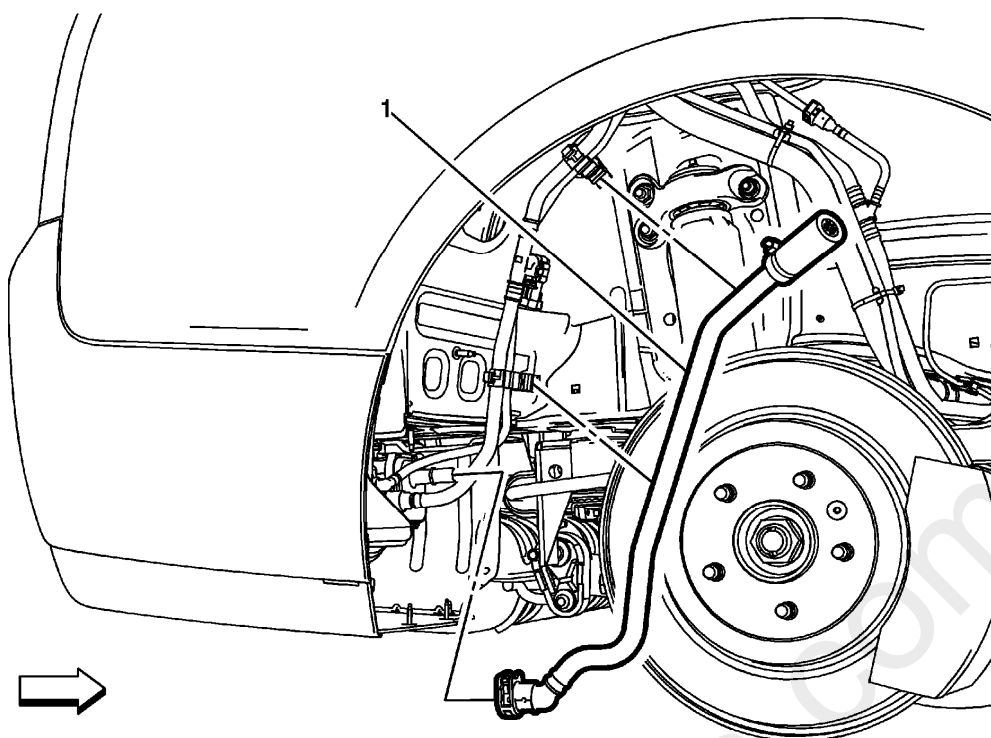


Fig. 166: Evaporative Emission Canister Air Inlet Hose
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Air Inlet Hose Replacement

Callout	Component Name
Preliminary Procedure	
Remove the right rear wheelhouse panel liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> .	
1	Evaporative Emission Canister Air Inlet Hose Procedure Disconnect the EVAP emission canister air inlet hose from the EVAP canister and retainers. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

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

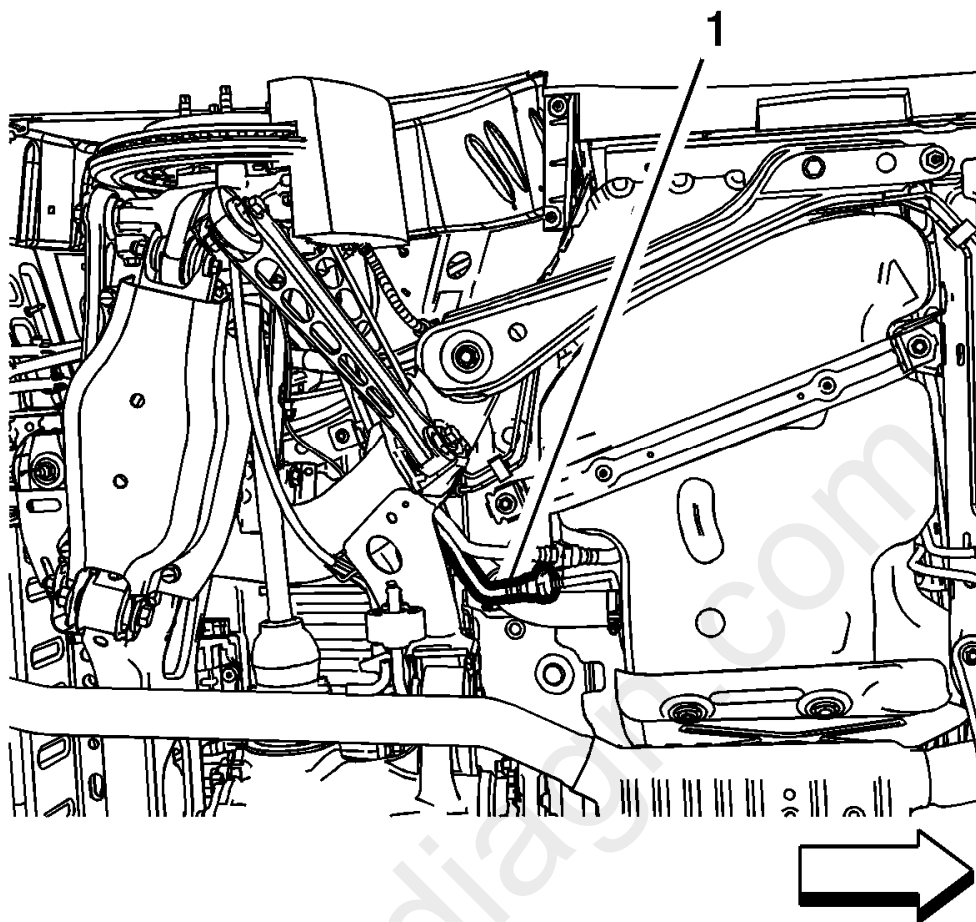


Fig. 167: Evaporative Emission Canister Purge Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the evaporative emission canister purge pipe (1) from the fuel tank vent valve hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Remove the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement**.

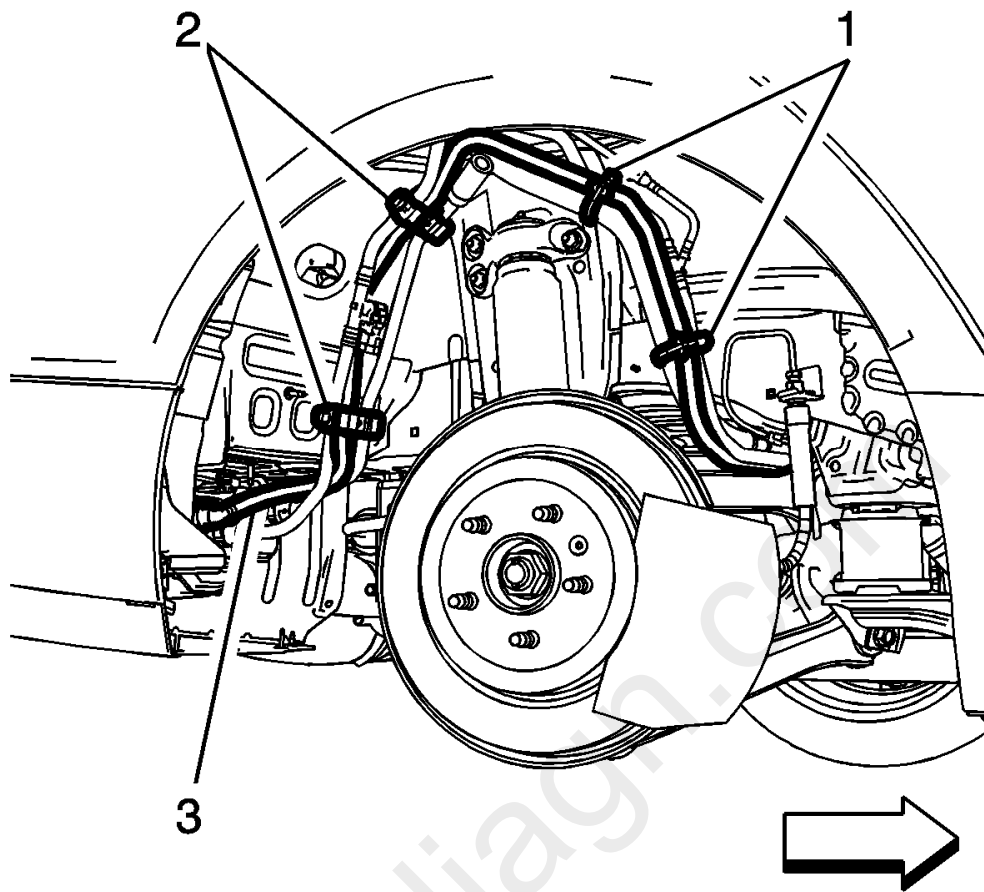


Fig. 168: Fuel Line Tie Straps

Courtesy of GENERAL MOTORS COMPANY

4. Remove the tie straps (1) attaching the evaporative emission canister purge pipe to the fuel tank filler pipe.
5. Remove the evaporative emission canister purge pipe (3) from the retainers (2).
6. Remove the evaporative emission canister purge pipe (3) from the EVAP emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

Installation Procedure

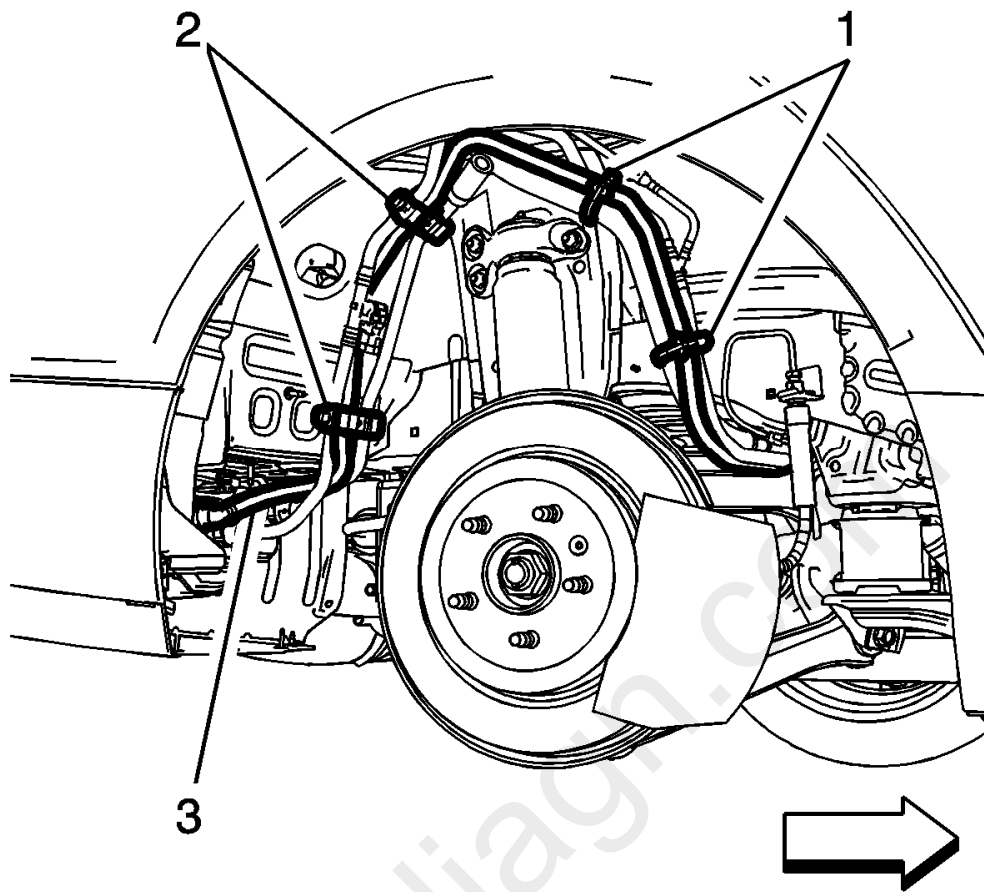


Fig. 169: Fuel Line Tie Straps

Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission canister purge pipe (3) to the EVAP emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
2. Install the evaporative emission canister purge pipe (3) to the retainers (2).
3. Install NEW tie straps (1) to attach the evaporative emission canister purge pipe to the fuel tank filler pipe.
4. Install the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement**.

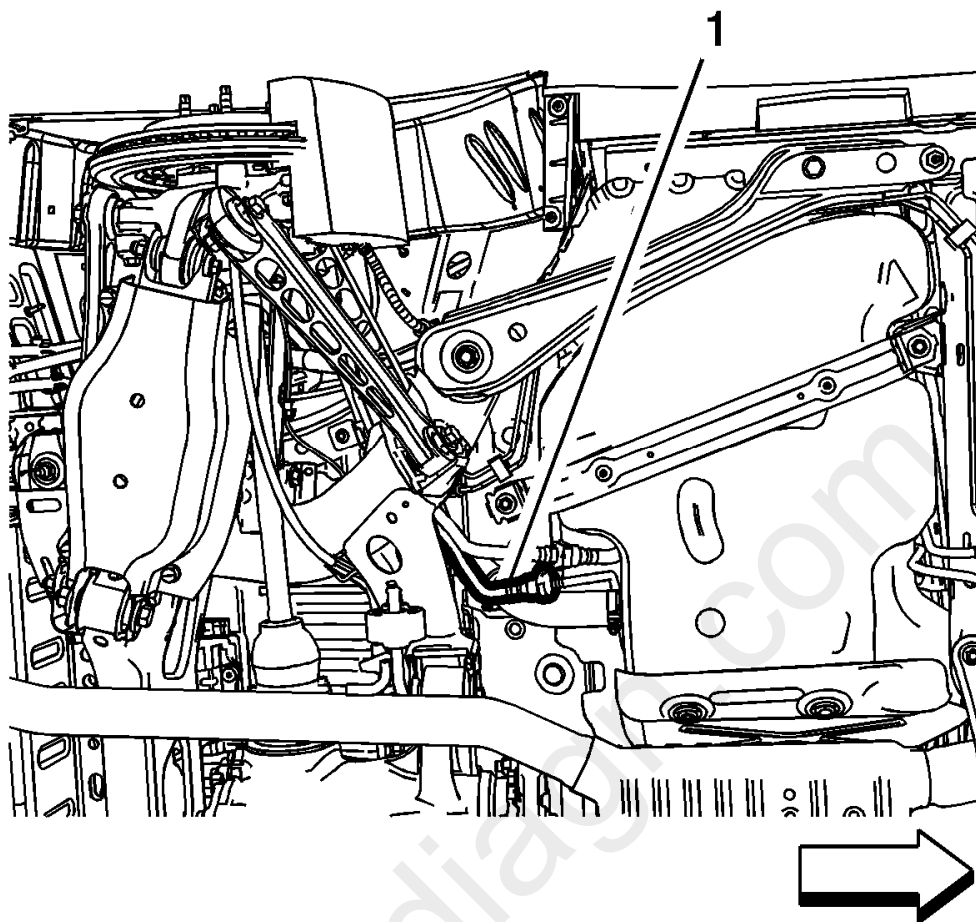


Fig. 170: Evaporative Emission Canister Purge Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Connect the evaporative emission canister purge pipe (1) to the fuel tank vent valve hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Lower the vehicle.

EVAPORATIVE EMISSION CANISTER REPLACEMENT

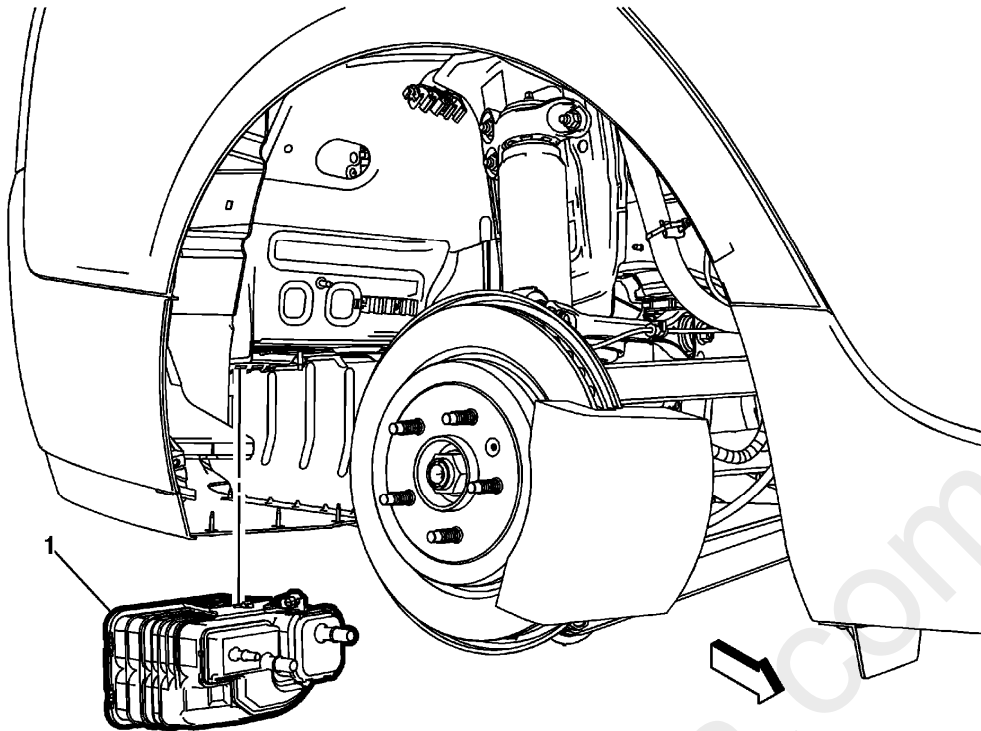


Fig. 171: Evaporative Emission Canister
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the right rear wheelhouse panel liner. Refer to <u>Rear Wheelhouse Liner Replacement</u>. 2. Remove the evaporative emission canister purge pipe. Refer to <u>Evaporative Emission Canister Purge Pipe Replacement</u>. 3. Remove the fuel tank vent hose. Refer to <u>Fuel Tank Vent Hose Replacement</u>. 4. Remove the evaporative emission canister air inlet hose. Refer to <u>Evaporative Emission Canister Air Inlet Hose Replacement</u>. 5. Disconnect electrical connector.	
1	Evaporative Emission Canister Procedure Depress retaining tab to release EVAP canister.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

GE 41413-200 Evaporative Pressure and Purge Station

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** .

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.

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

1. Turn OFF the ignition.
2. Remove the EVAP canister purge valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement (LFX)**, **Evaporative Emission Canister Purge Solenoid Valve Replacement (LF3)**.
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 **GE 41413-200** 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 (LFX)**, **Evaporative Emission Canister Purge Solenoid Valve Replacement (LF3)**.

13. Return to the diagnostic table that sent you here.

IGNITION COIL REPLACEMENT - BANK 1 (LFX)

Removal Procedure

WARNING: Refer to Safety Glasses and Compressed Air Warning .

1. Ignition OFF.
2. Remove the intake manifold insulator. Refer to Intake Manifold Insulator Replacement .
3. If replacing the number three cylinder coil, remove the evaporative emissions canister purge solenoid valve. Refer to Evaporative Emission Canister Purge Solenoid Valve Replacement (LFX).

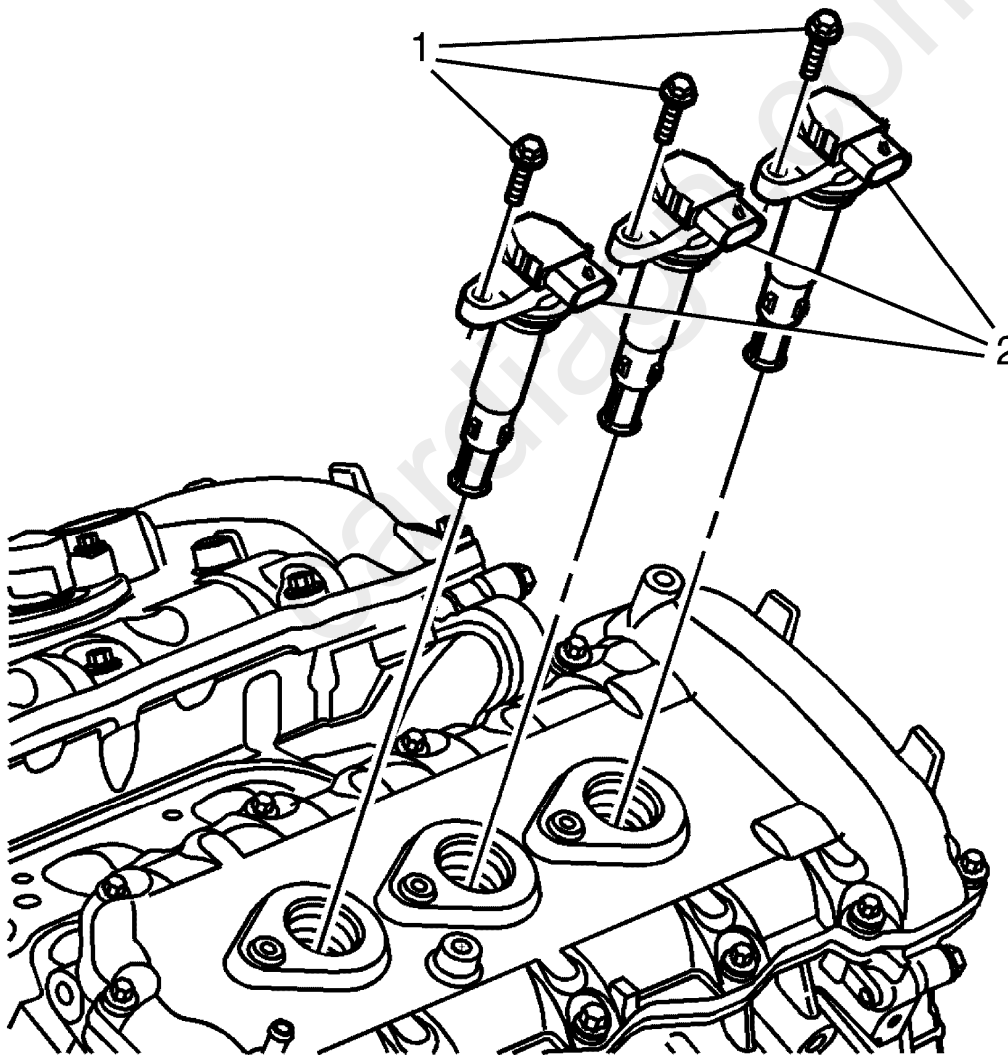


Fig. 172: Identifying Ignition Coil To Camshaft Cover Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the ignition coil harness connectors from the ignition coils.
5. Remove the ignition coil to camshaft cover retaining bolts (1).
6. Remove the ignition coils (2) from the vehicle.

Installation Procedure

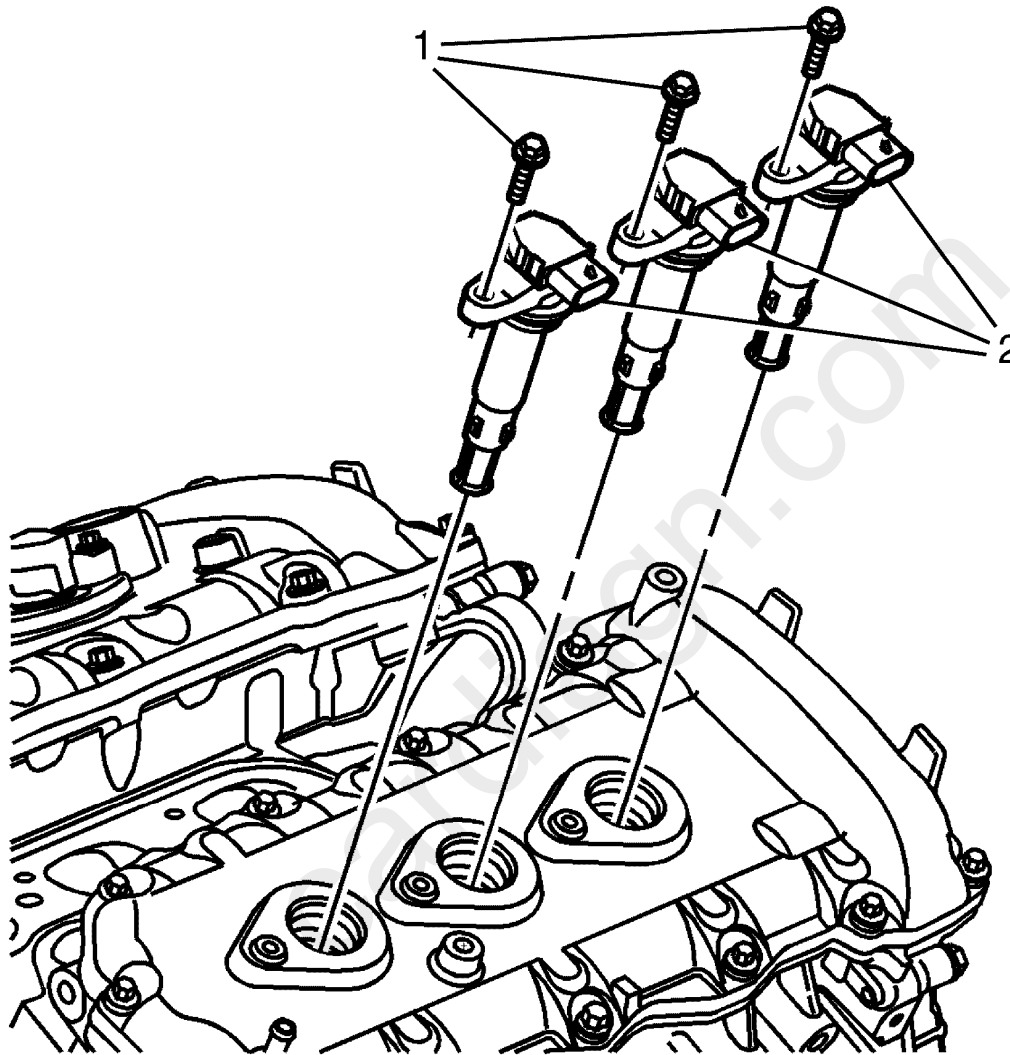


Fig. 173: Identifying Ignition Coil To Camshaft Cover Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coils (2) to the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil to camshaft cover retaining bolts (1) and tighten to 10 N.m (89 lb in).
3. Connect the ignition coil harness connectors to the ignition coils.

4. If replacing the number three cylinder coil, install the evaporative emissions canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement (LFX)**.
5. Install the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .

IGNITION COIL REPLACEMENT - BANK 1 (LF3)

Removal Procedure

1. Remove the charge air cooler inlet pipe (right). Refer to **Charge Air Cooler Inlet Pipe Replacement - Right Side (LF3)**.
2. Remove the positive crankcase ventilation tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LF3 (Front))** , **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LF3 (Rear))** .

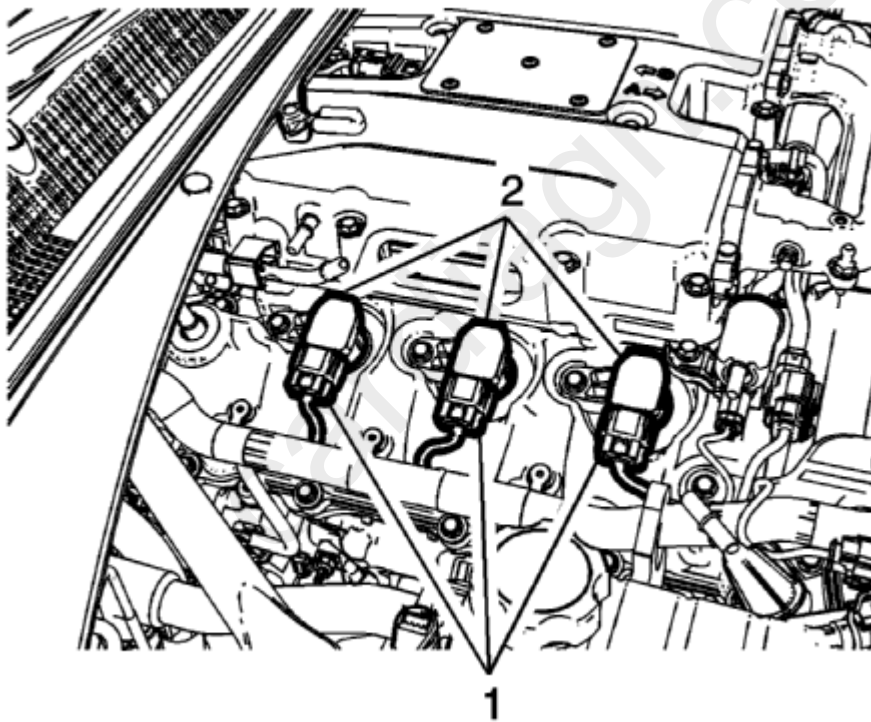


Fig. 174: Ignition Coil - Bank 1 (LF3)
Courtesy of GENERAL MOTORS COMPANY

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

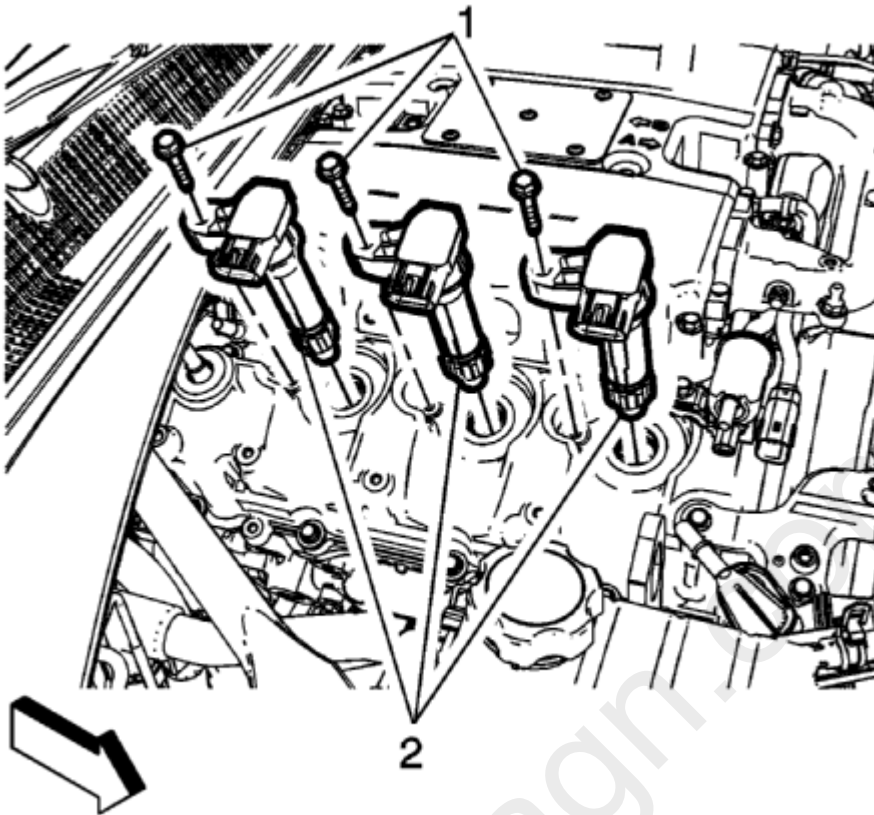


Fig. 175: Ignition Coil Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coil bolt(s) (1).
5. Remove the ignition coil(s) (2).

Installation Procedure

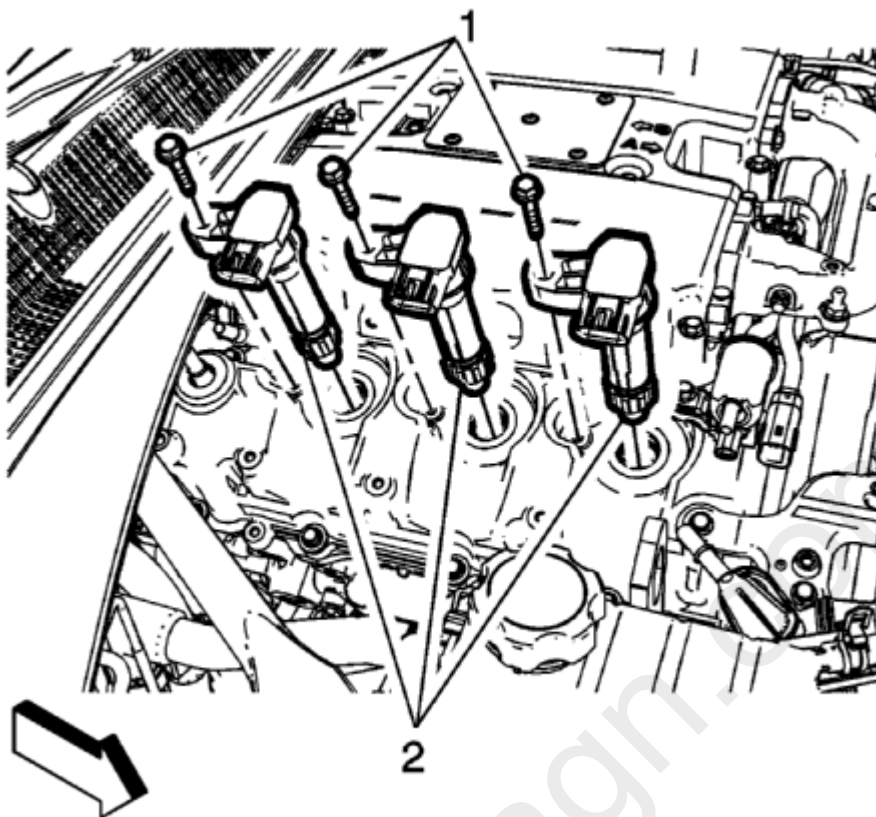


Fig. 176: Ignition Coil Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s) (2).

CAUTION: Refer to Fastener Caution .

2. Hand start the ignition coil bolt(s) (1).

Tighten

the bolt(s) to 10 (89 lb in)

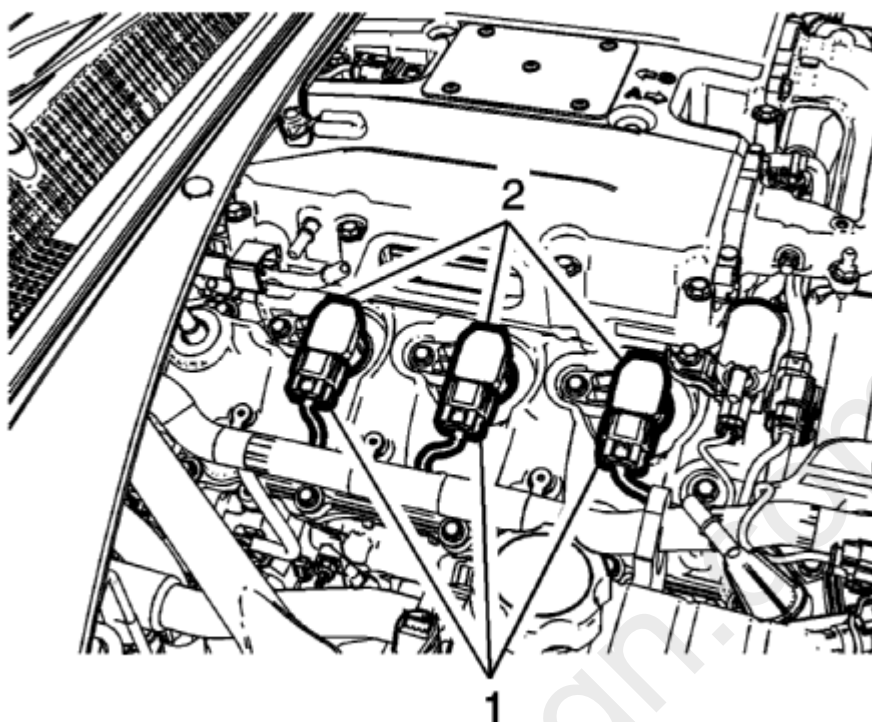


Fig. 177: Ignition Coil - Bank 1 (LF3)
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s) (2).
4. Install the positive crankcase ventilation tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LF3 (Front))** , **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LF3 (Rear))** .
5. Install the charge air cooler inlet pipe (right). Refer to **Charge Air Cooler Inlet Pipe Replacement - Right Side (LF3)**.

IGNITION COIL REPLACEMENT - BANK 2 (LFX)

Removal Procedure

WARNING: Refer to **Safety Glasses and Compressed Air Warning** .

1. Ignition OFF.

WARNING: Refer to **Battery Disconnect Warning** .

2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the intake manifold sight shield.

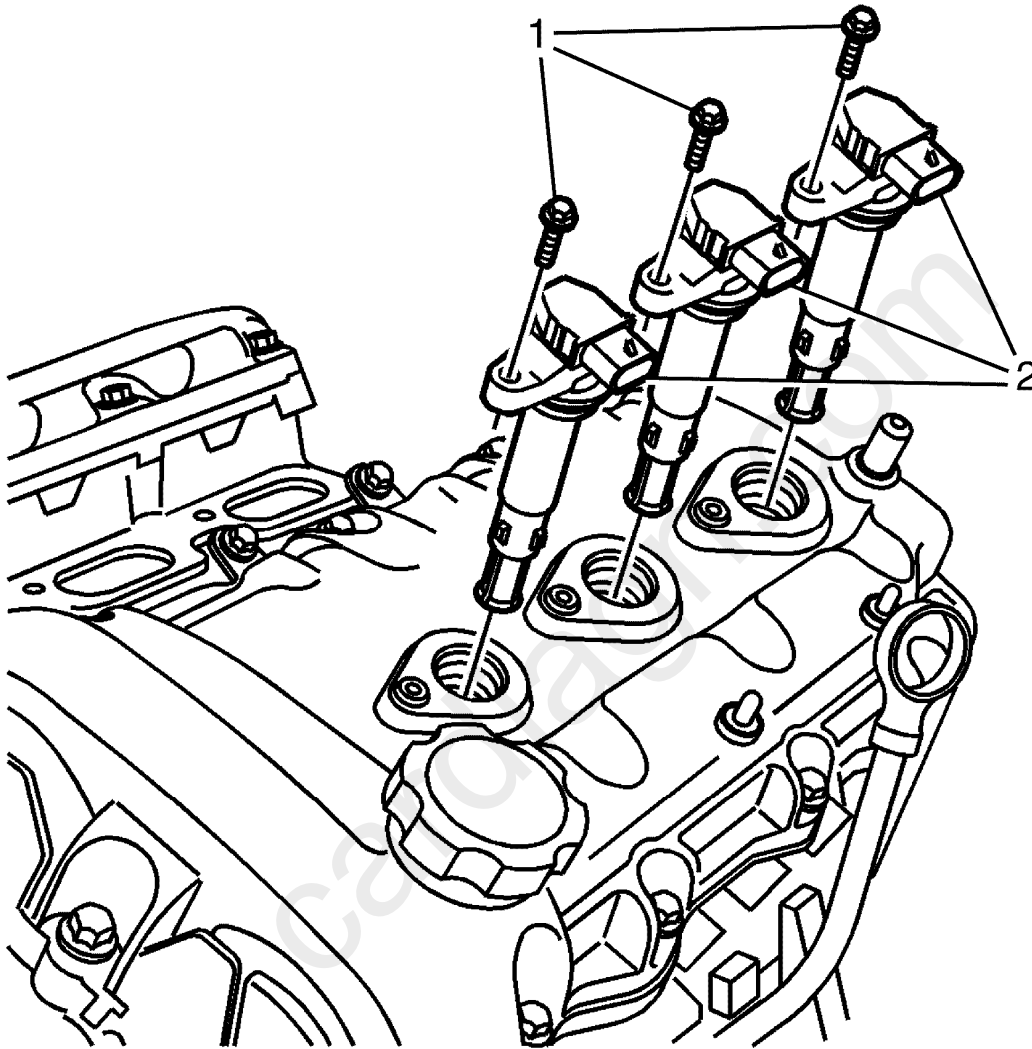


Fig. 178: Identifying Ignition Coil To Camshaft Cover Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coil harness connectors from the ignition coils.
5. Remove the ignition coil to camshaft cover retaining bolts (1).
6. Remove the ignition coils (2) from the vehicle.

Installation Procedure

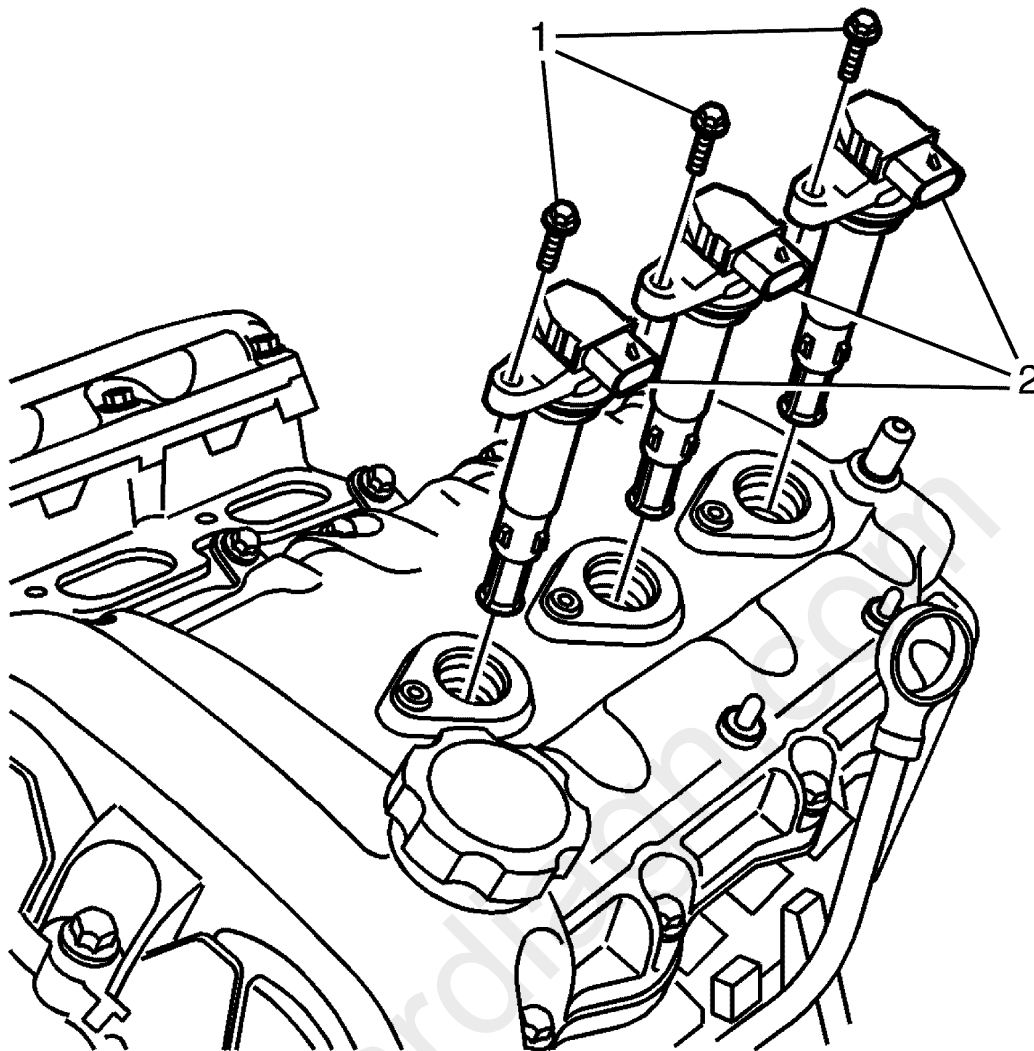


Fig. 179: Identifying Ignition Coil To Camshaft Cover Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coils (2) to the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil to camshaft cover retaining bolts (1) and tighten to 10 N.m (89 lb in)..
3. Install the ignition coil harness connectors to the ignition coils.
4. Install the intake manifold sight shield.
5. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .

IGNITION COIL REPLACEMENT - BANK 2 (LF3)

Removal Procedure

1. Remove the charge air cooler inlet pipe (left). Refer to **Charge Air Cooler Inlet Pipe Replacement - Left Side (LF3)**.

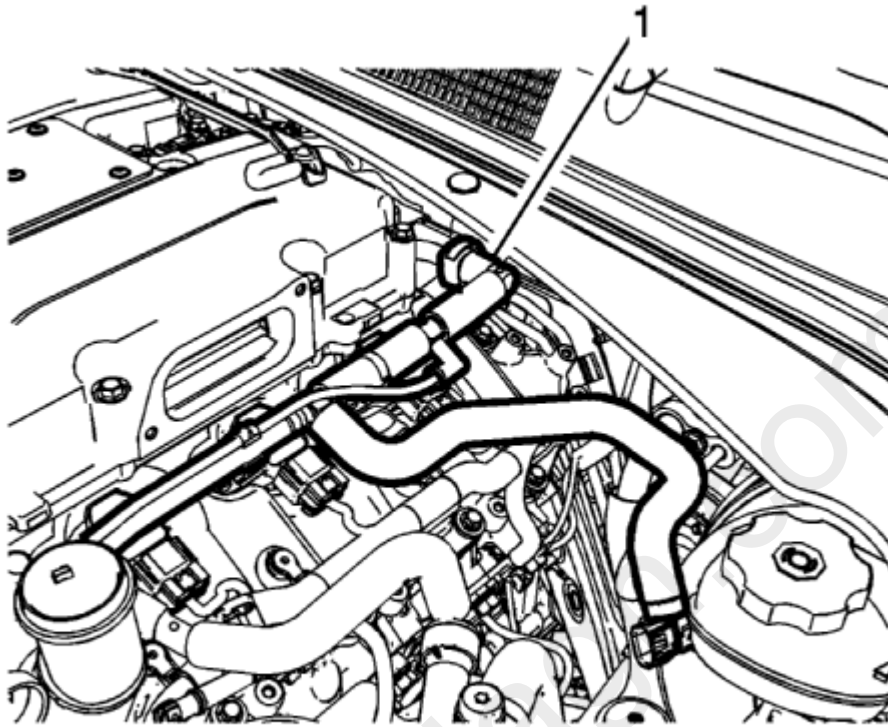


Fig. 180: Ignition Coil - Bank 2 (LF3)
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect and reposition the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

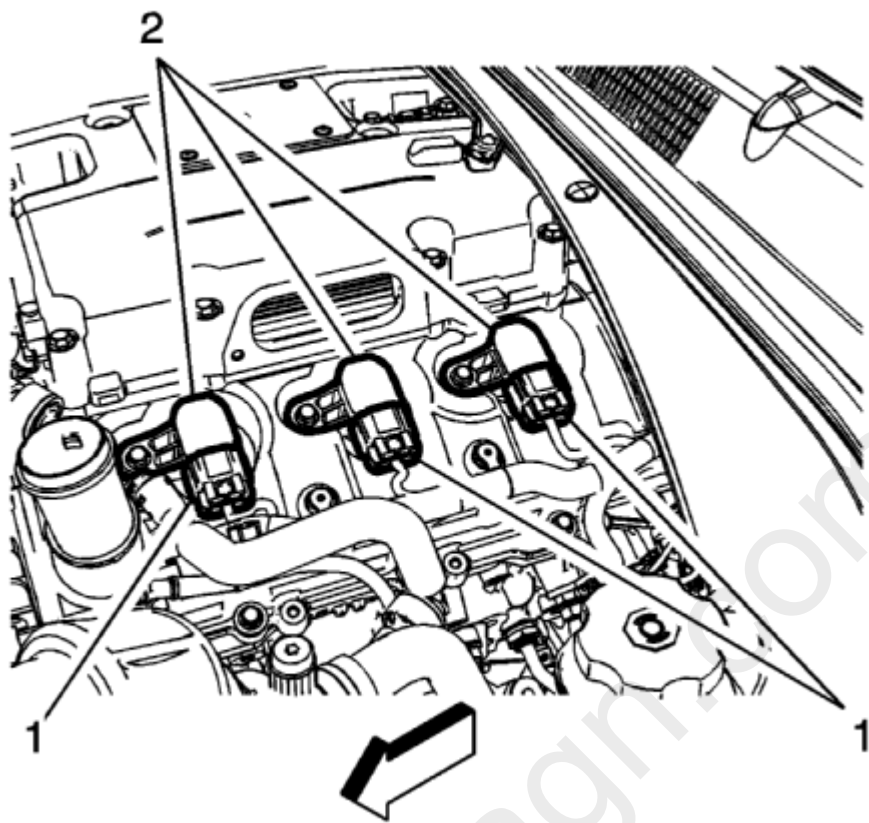


Fig. 181: Ignition Coil Connectors
Courtesy of GENERAL MOTORS COMPANY

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

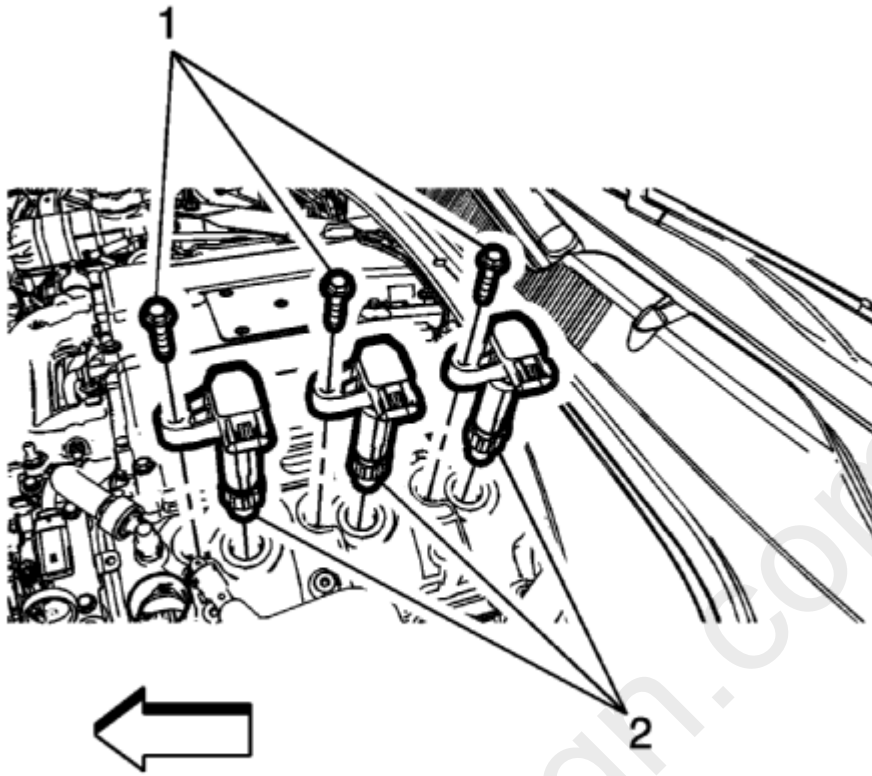


Fig. 182: Ignition Coil Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coil bolt(s) (1).
5. Remove the ignition coil(s) (2).

Installation Procedure

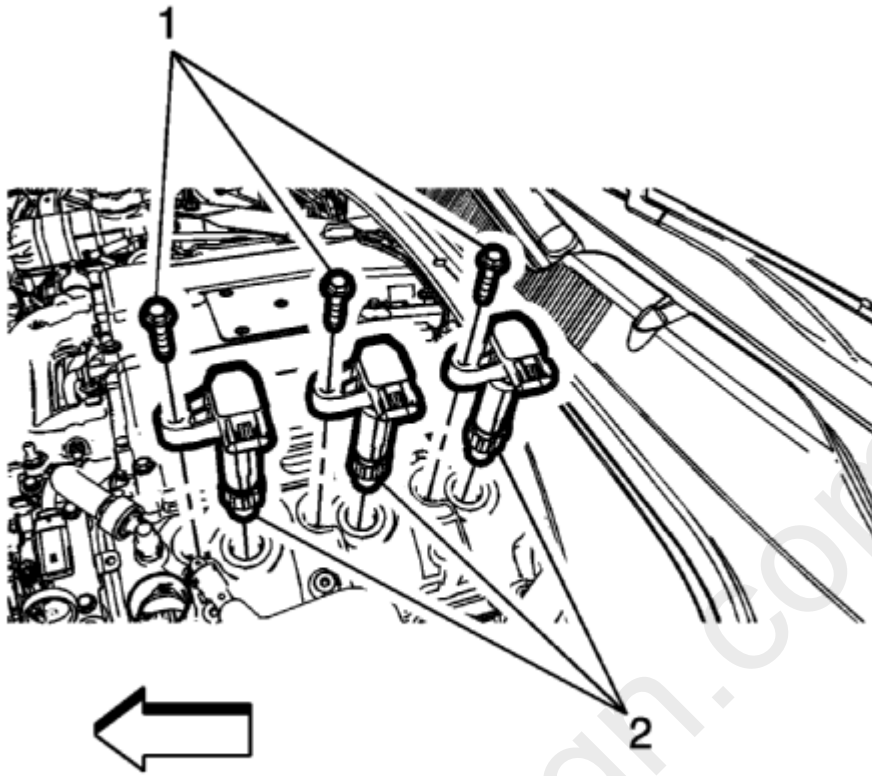


Fig. 183: Ignition Coil Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s) (2).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) (1).

Tighten

the bolt(s) to 10 (89 lb in)

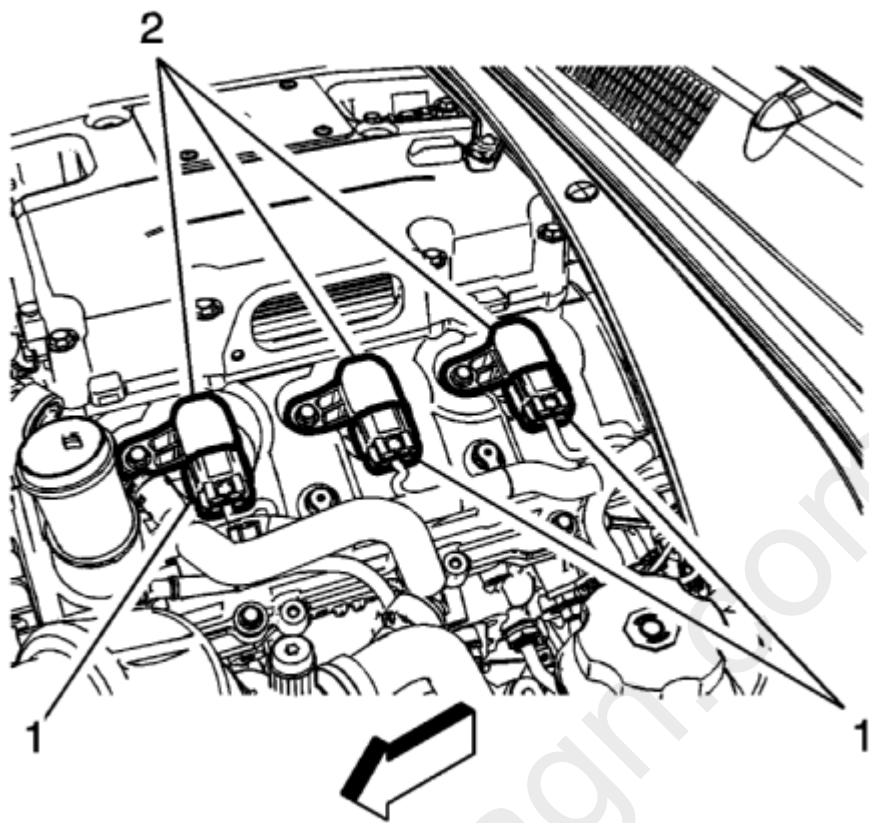


Fig. 184: Ignition Coil Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s) (2).

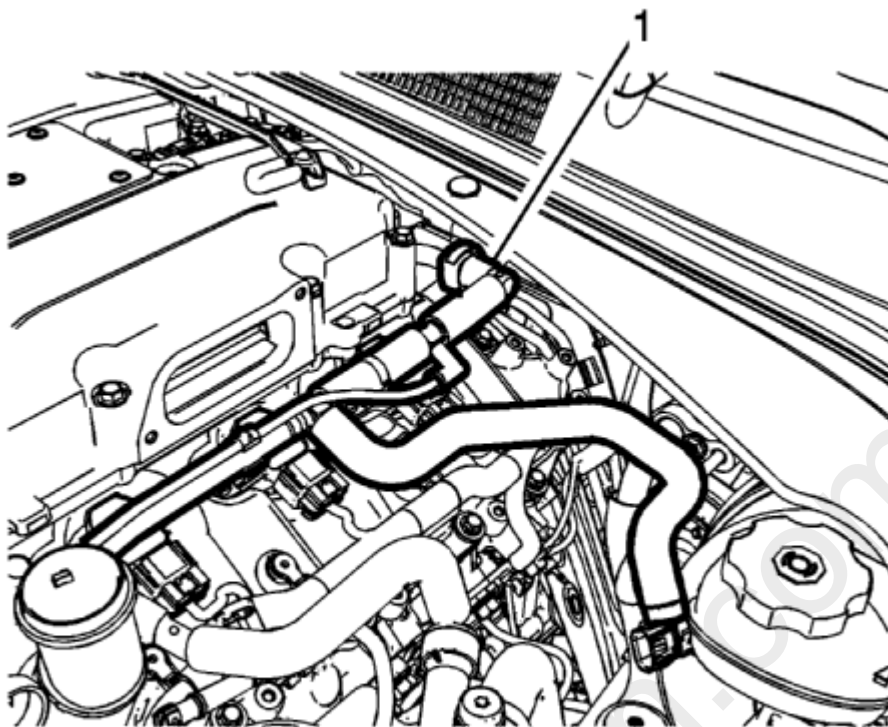


Fig. 185: Ignition Coil - Bank 2 (LF3)
Courtesy of GENERAL MOTORS COMPANY

4. Connect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install the charge air cooler inlet pipe (left). Refer to **Charge Air Cooler Inlet Pipe Replacement - Left Side (LF3)**.

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

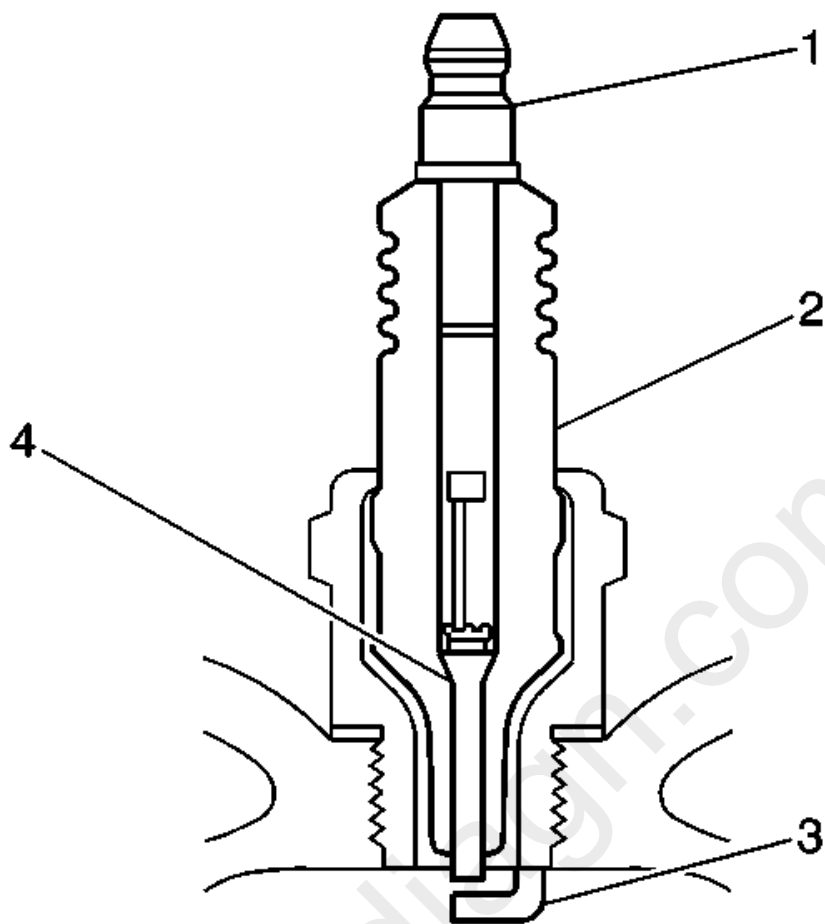


Fig. 186: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- Inspect the terminal post (1) for damage.
 - 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 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 (LFX)

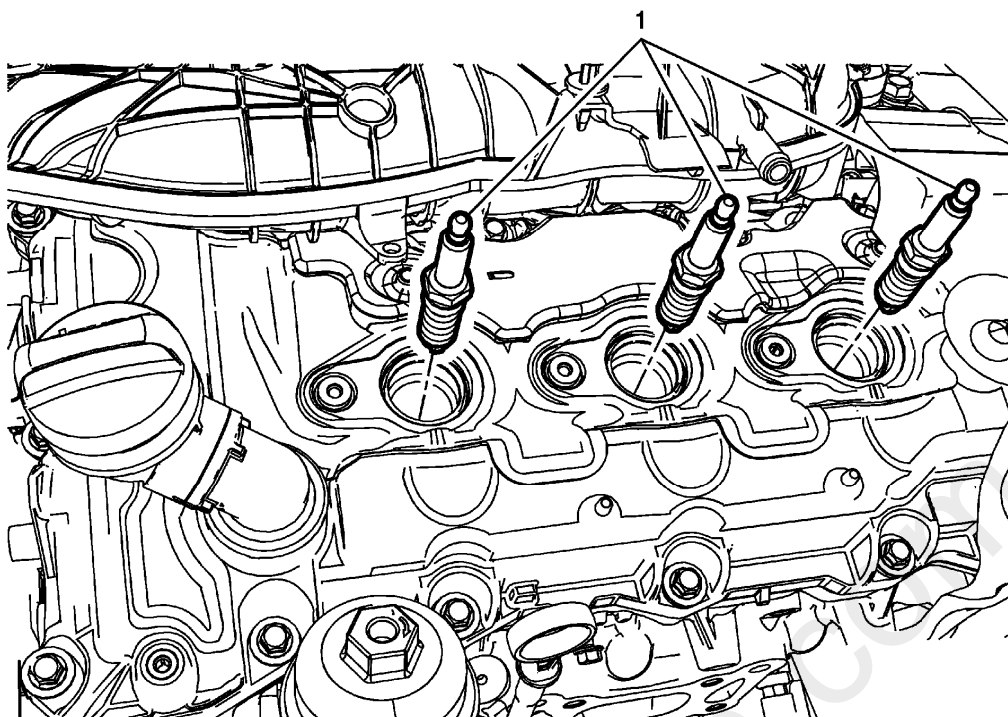


Fig. 187: Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

Spark Plug Replacement (LFX)

Callout	Component Name
Preliminary Procedure Remove the ignition coil. Refer to <u>Ignition Coil Replacement - Bank 1 (LFX)</u> and <u>Ignition Coil Replacement - Bank 2 (LFX)</u> .	
1	Spark Plugs CAUTION: Refer to <u>Component Fastener Tightening Caution</u> Tighten 25 (18 lb ft) Special Tools EN-194-E Spark Plug Remover For equivalent regional tools, refer to <u>Special Tools</u> .

SPARK PLUG REPLACEMENT (LF3)

Removal Procedure

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.

1. Use compressed air in order to remove debris from the area of the ignition coils.
2. Remove the ignition coil(s). Refer to Ignition Coil Replacement - Bank 1 (LF3), and/or Ignition Coil Replacement - Bank 2 (LF3).

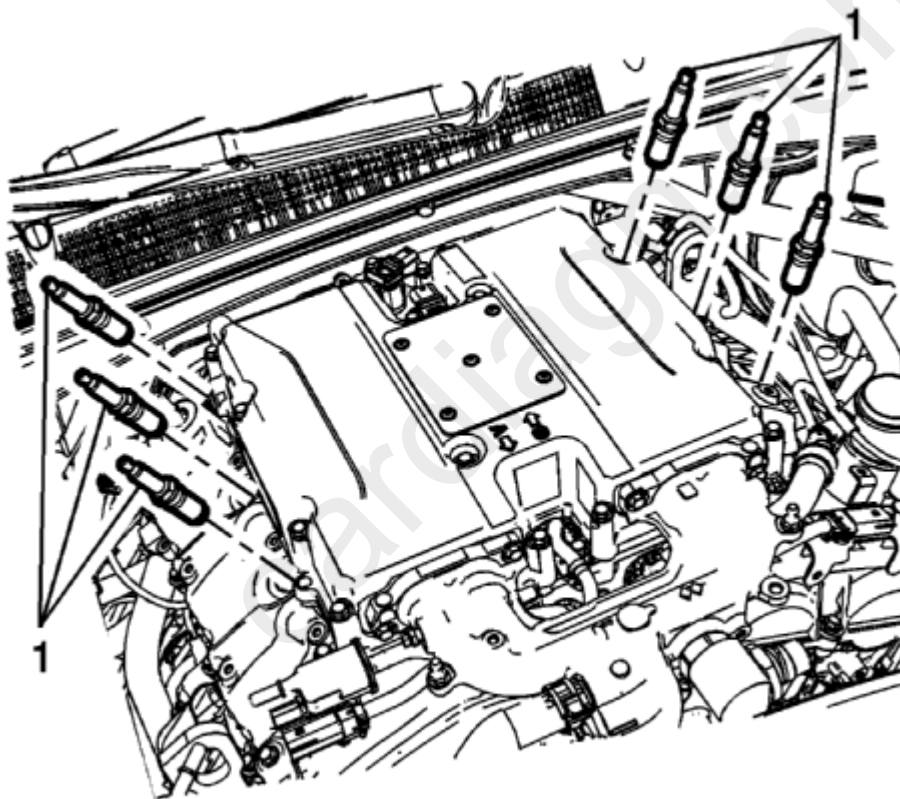


Fig. 188: Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

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.

3. Remove the spark plug(s).

Installation Procedure

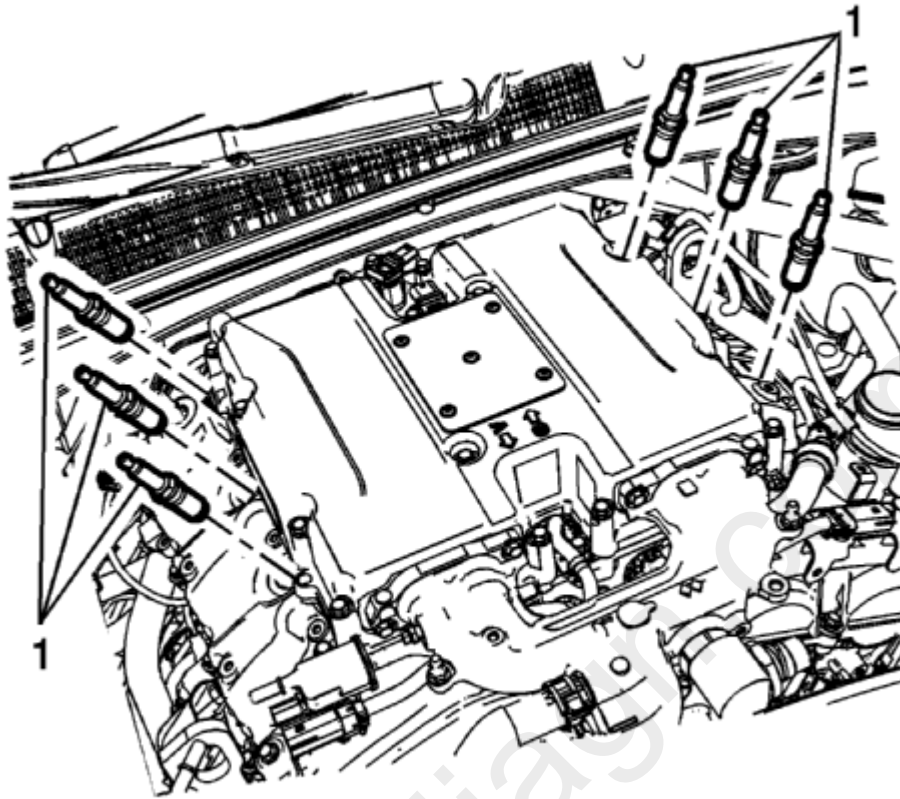


Fig. 189: Spark Plugs

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 and may even damage the engine.

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

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 Component Fastener Tightening Caution .

2. Install the spark plug(s) and tighten to 18 (13 lb ft).
3. Install the ignition coil(s). Refer to Ignition Coil Replacement - Bank 1 (LF3), and/or Ignition Coil Replacement - Bank 2 (LF3).

CRANKSHAFT POSITION SENSOR REPLACEMENT (LFX)

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Safety Glasses Warning .

1. Turn the ignition OFF.

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

2. If equipped with all-wheel drive, remove the right side catalytic converter. Refer to Catalytic Converter Replacement - Right Side (LFX) .

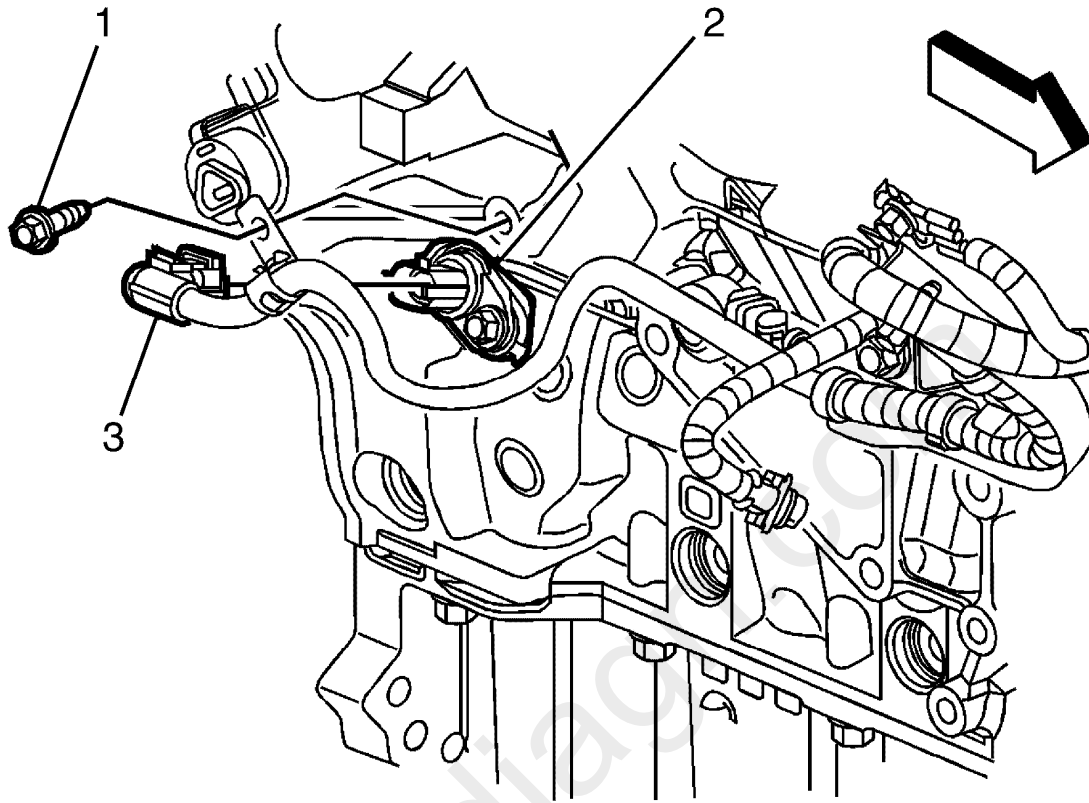


Fig. 190: Identifying CKP Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Reposition the wiring harness heat shield to obtain access.
4. Disconnect the crankshaft position (CKP) harness connector (3) from the CKP.

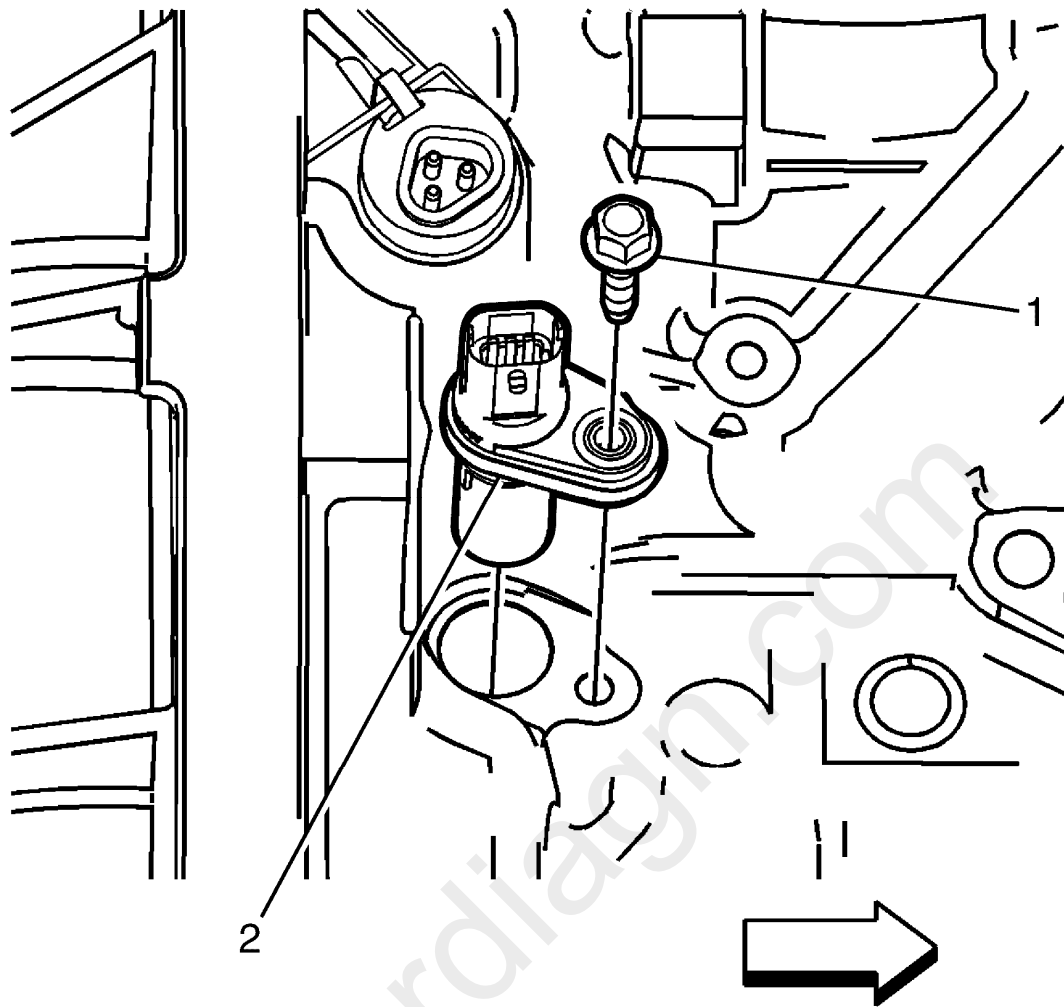


Fig. 191: Identifying CKP Sensor To Engine Block Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the CKP to engine block retaining bolt (1) from the CKP sensor (2).
6. Remove the CKP sensor (2) from the engine block.

Installation Procedure

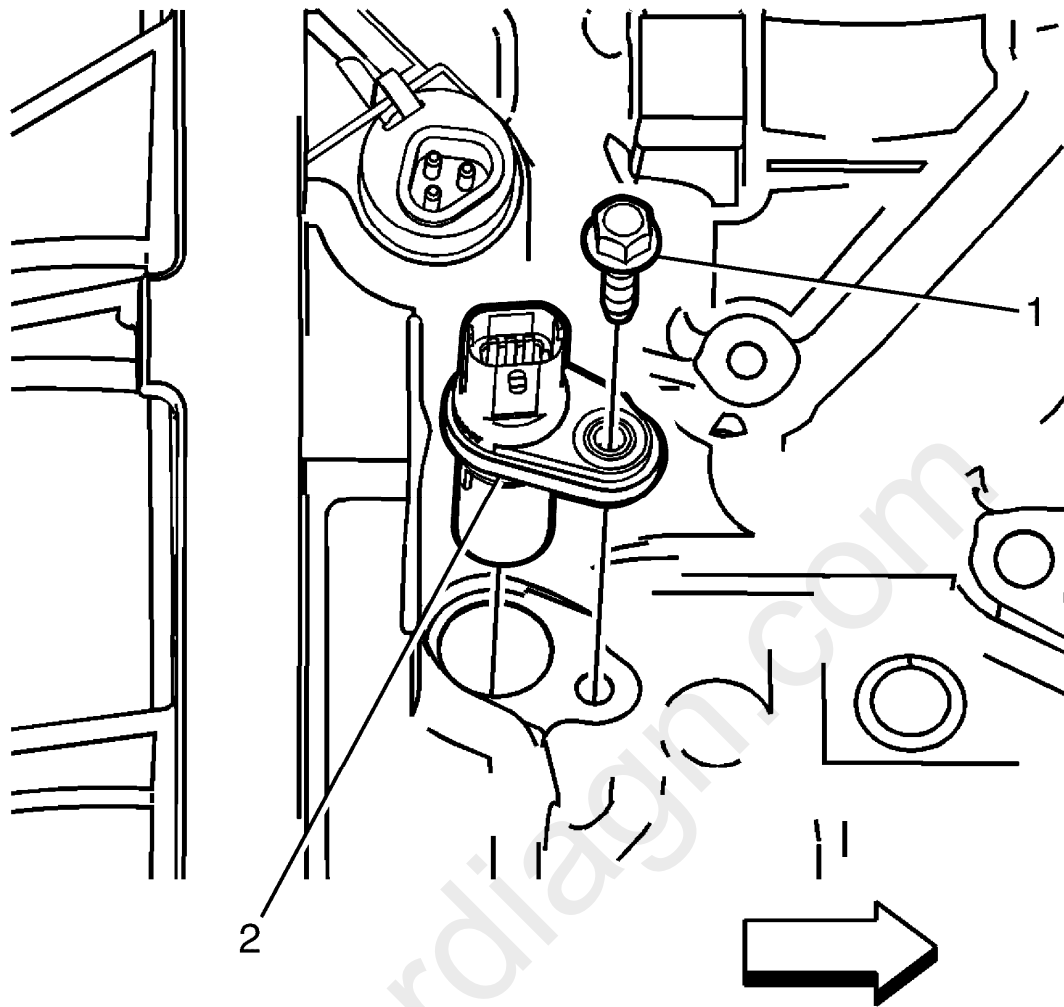


Fig. 192: Identifying CKP Sensor To Engine Block Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the CKP sensor (2) to the engine block.

CAUTION: Refer to Fastener Caution .

2. Install the CKP sensor to engine block retaining bolt (1) and tighten to 10 N.m (89 lb in).

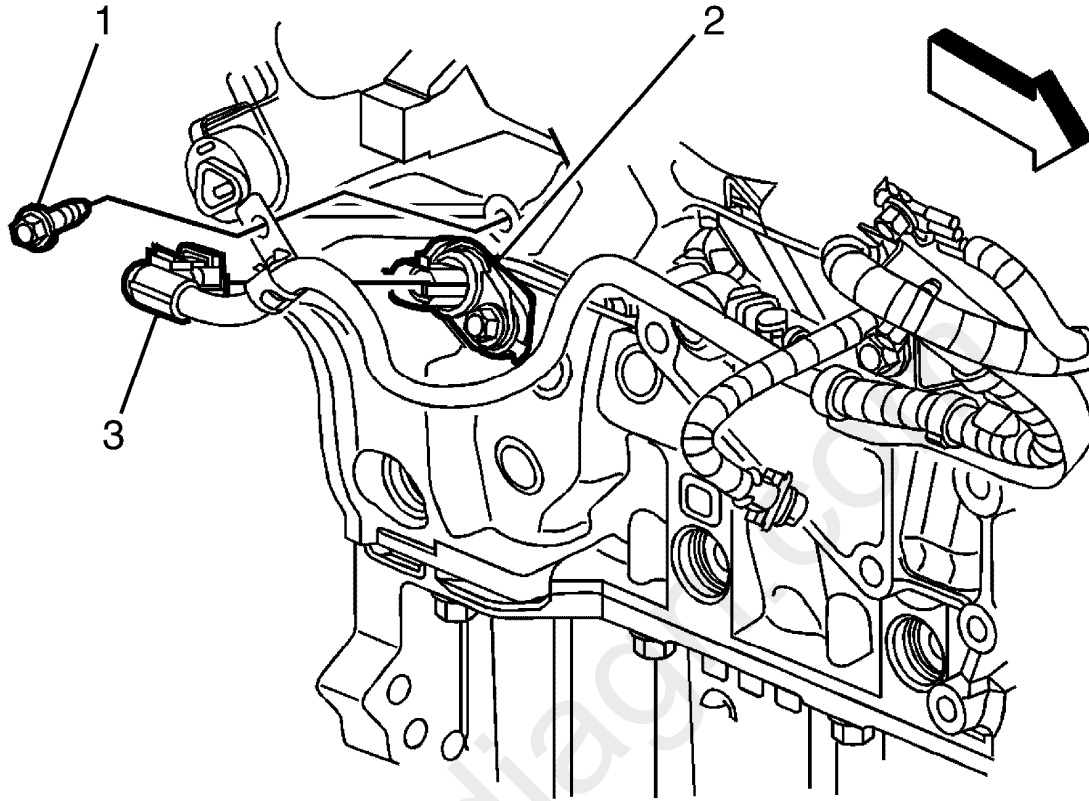


Fig. 193: Identifying CKP Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the CKP electrical connector (3) to the CKP sensor.
4. If equipped with all-wheel drive, install the right side catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LFX)**.
5. Lower the vehicle.
6. Perform the crankshaft variation learn procedure. Refer to **Control Module References**.

CRANKSHAFT POSITION SENSOR REPLACEMENT (LF3)

Removal Procedure

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

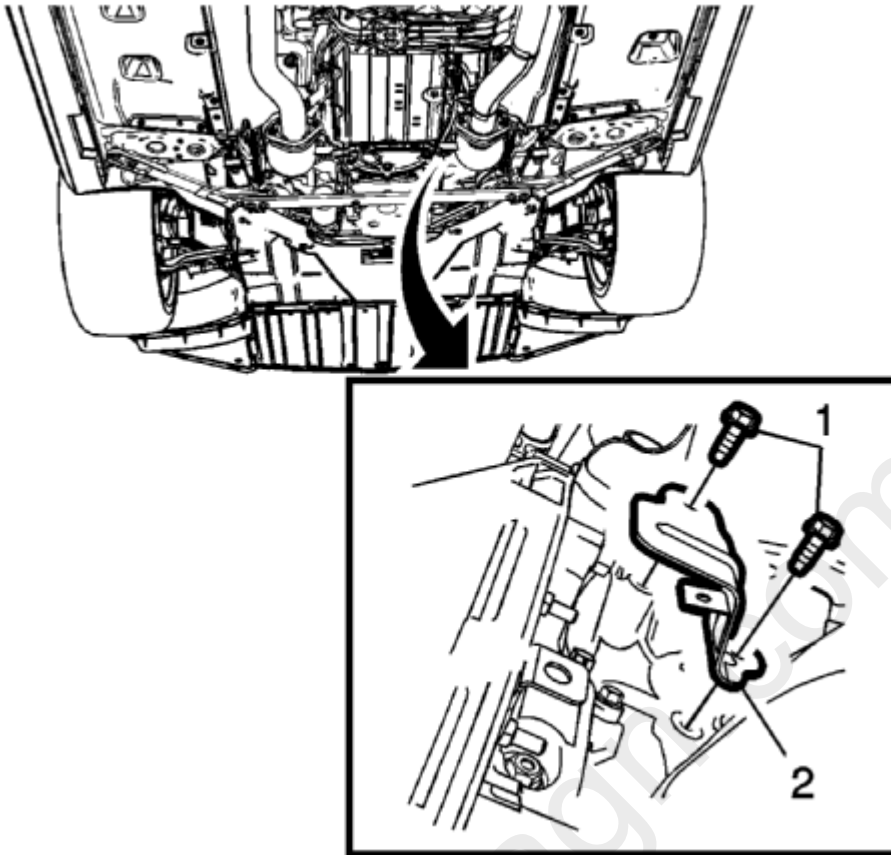


Fig. 194: Crankshaft Position Sensor Shield
Courtesy of GENERAL MOTORS COMPANY

NOTE: The crankshaft position sensor shield (2) can be repositioned while allowing it to remain attached to the engine wiring harness retainer.

2. Remove the crankshaft position sensor shield fasteners (1) then reposition the shield (2).
3. Disconnect the crankshaft position sensor electrical connector.

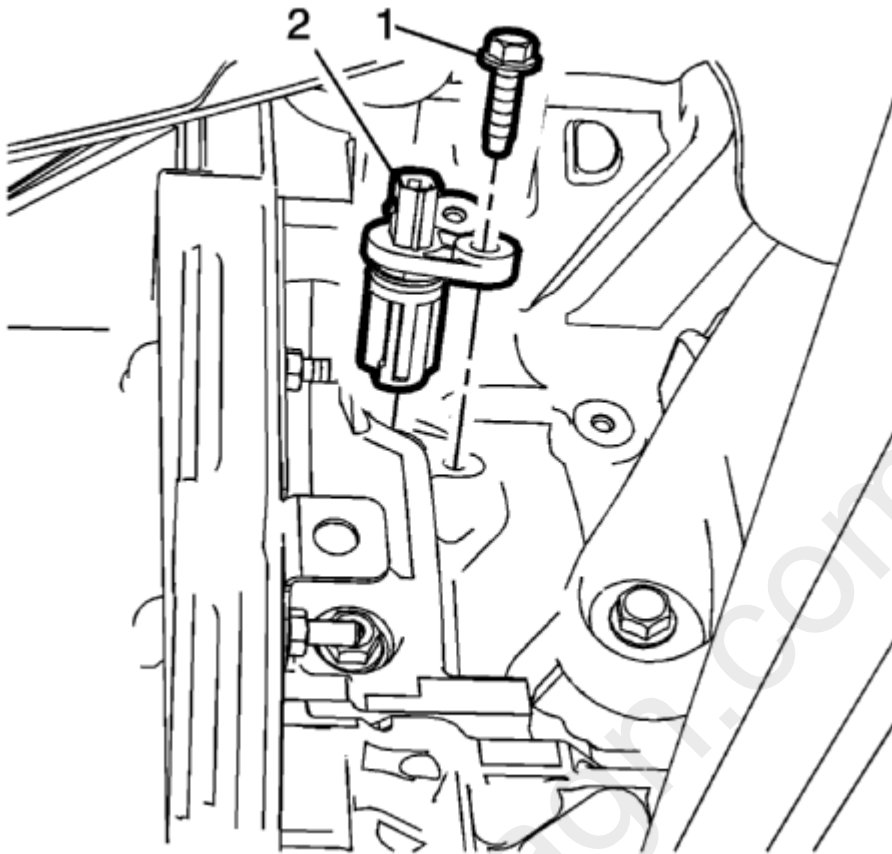


Fig. 195: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft position sensor fastener (1).
5. Remove the crankshaft position sensor (2).

Installation Procedure

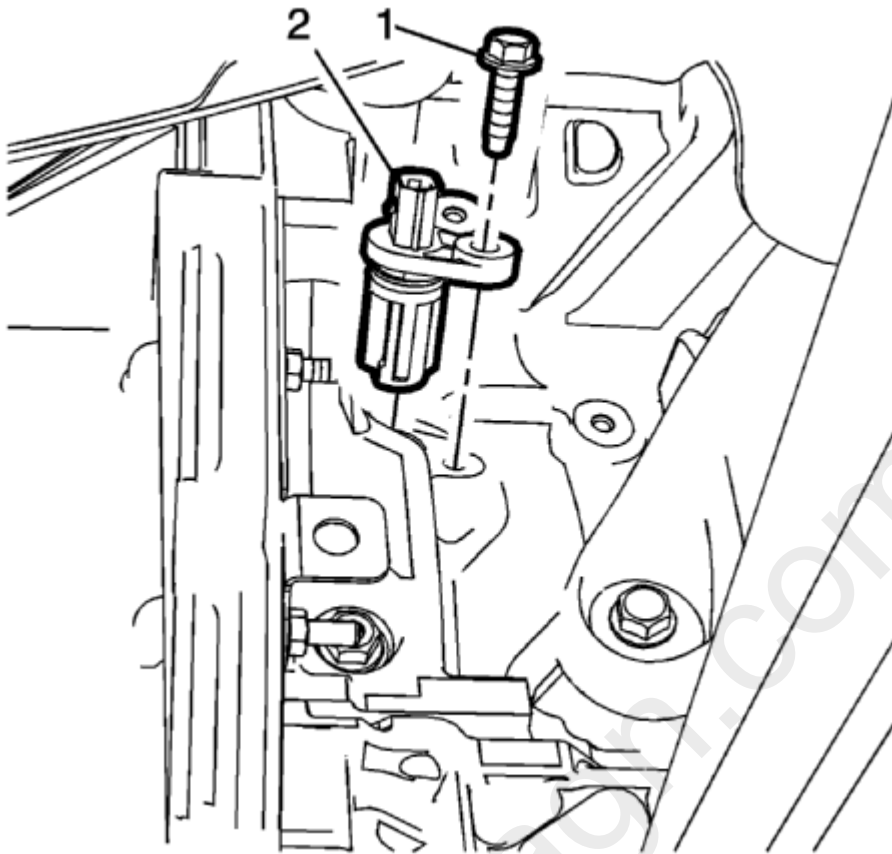


Fig. 196: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft position sensor (2).

CAUTION: Refer to Fastener Caution .

2. Install and hand start the crankshaft position sensor fastener (1).

Tighten

the fasteners to 10 (89 lb in)

3. Connect the crankshaft position sensor electrical connector.

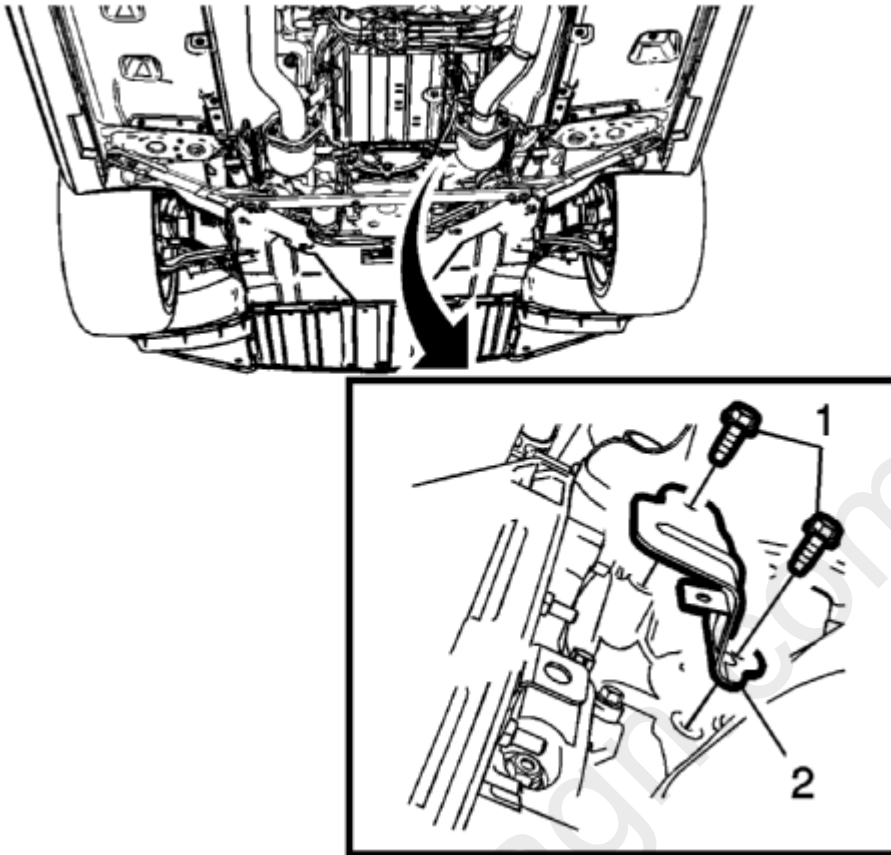


Fig. 197: Crankshaft Position Sensor Shield
Courtesy of GENERAL MOTORS COMPANY

4. Reposition the crankshaft position sensor shield (2) then hand start the fasteners (1).

Tighten

the fasteners to 10 (89 lb in)

5. Perform the crankshaft position sensor variation learn. Refer to **Crankshaft Position System Variation Learn.**

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

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .

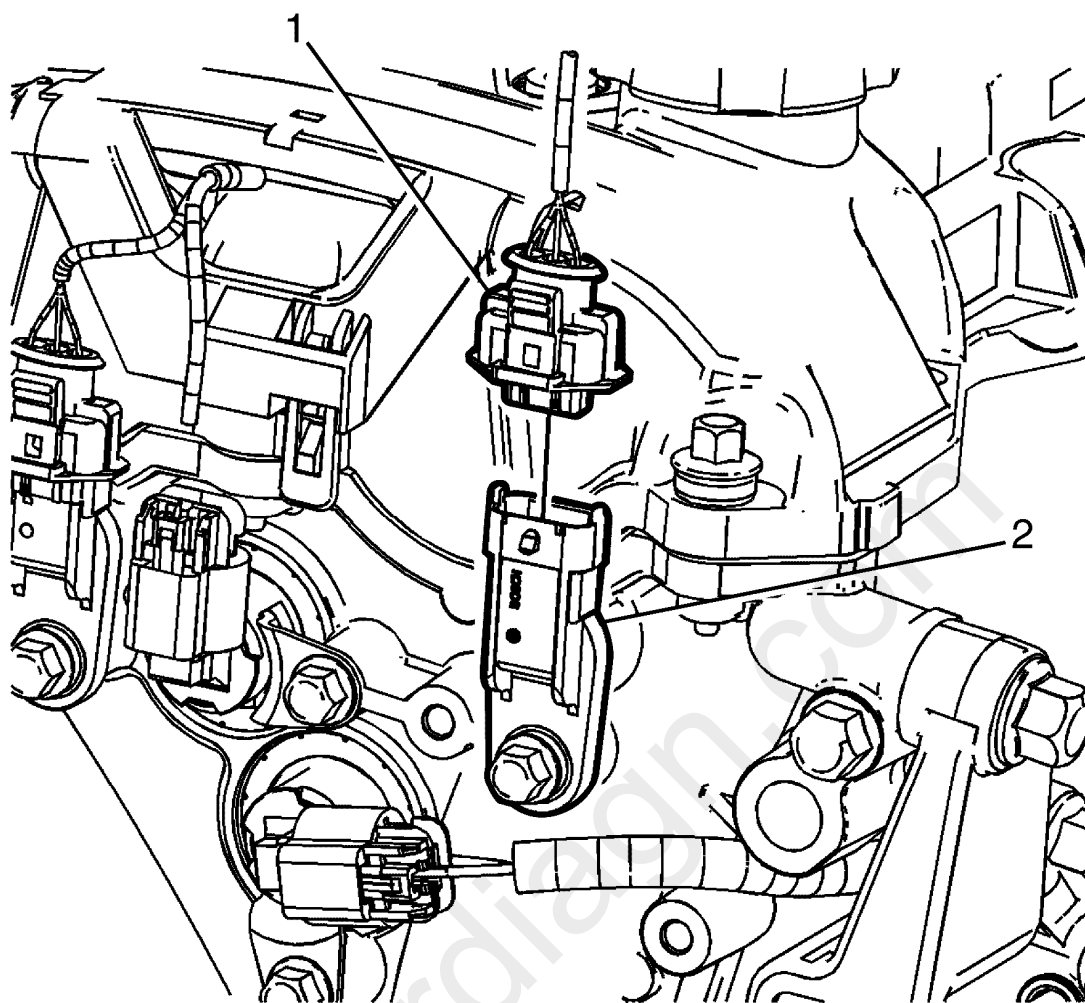


Fig. 198: Identifying CMP Sensor & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

3. Use compressed air to remove debris from the CMP sensor and surrounding cavities.
4. Remove the CMP sensor electrical connector (1) from the CMP sensor (2).

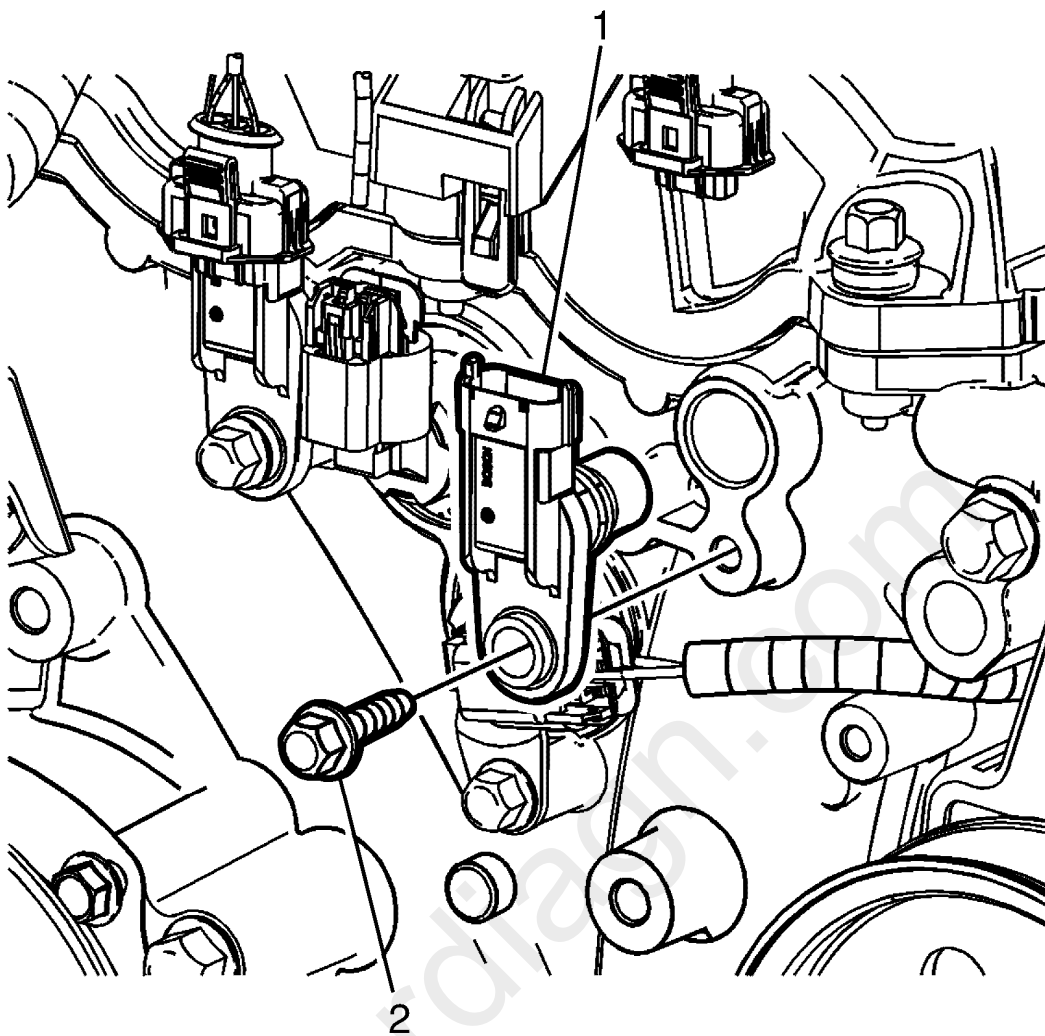


Fig. 199: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the CMP sensor to engine front cover retaining bolt (2).
6. Remove the CMP sensor (1) from the engine.

Installation Procedure

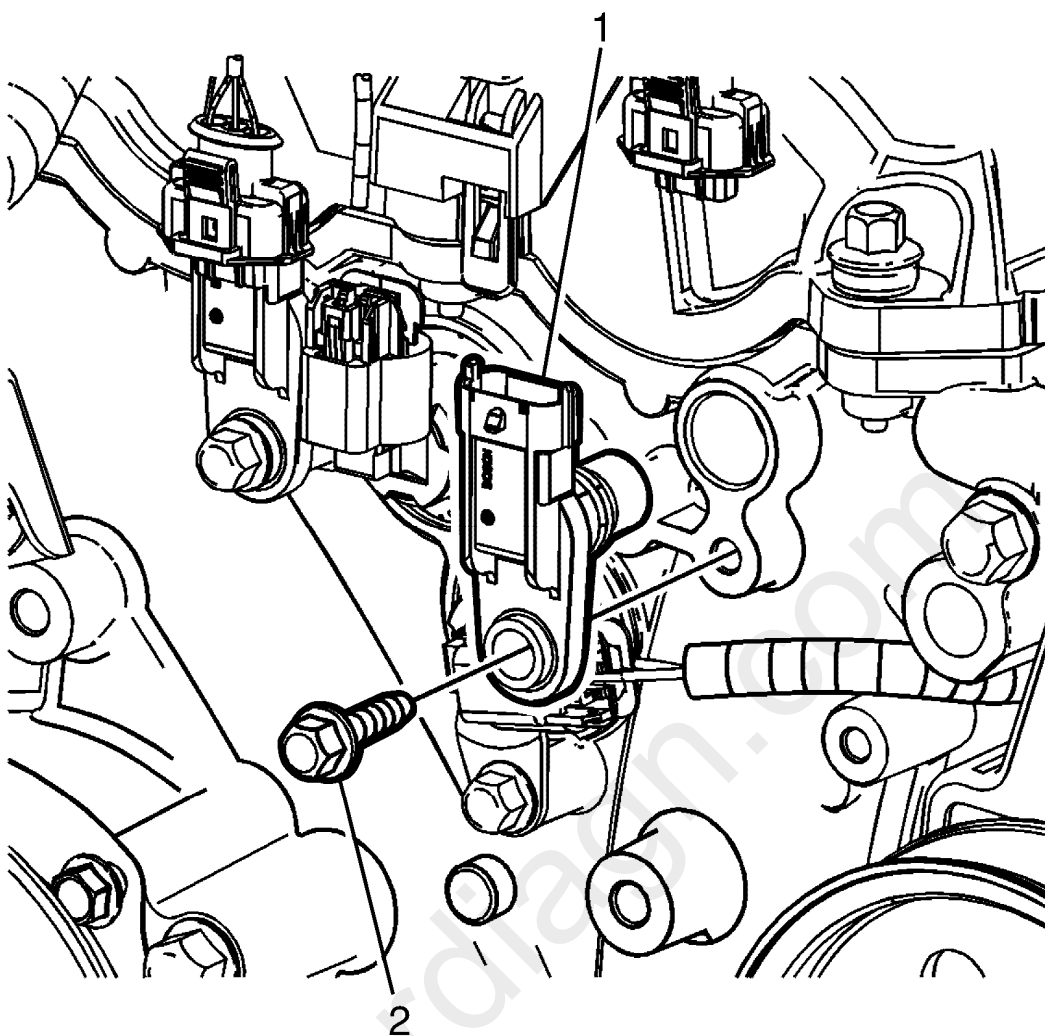


Fig. 200: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the CMP sensor (1) to the engine.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor (1) to engine front cover retaining bolt (2) and tighten to 10 (89 lb in).

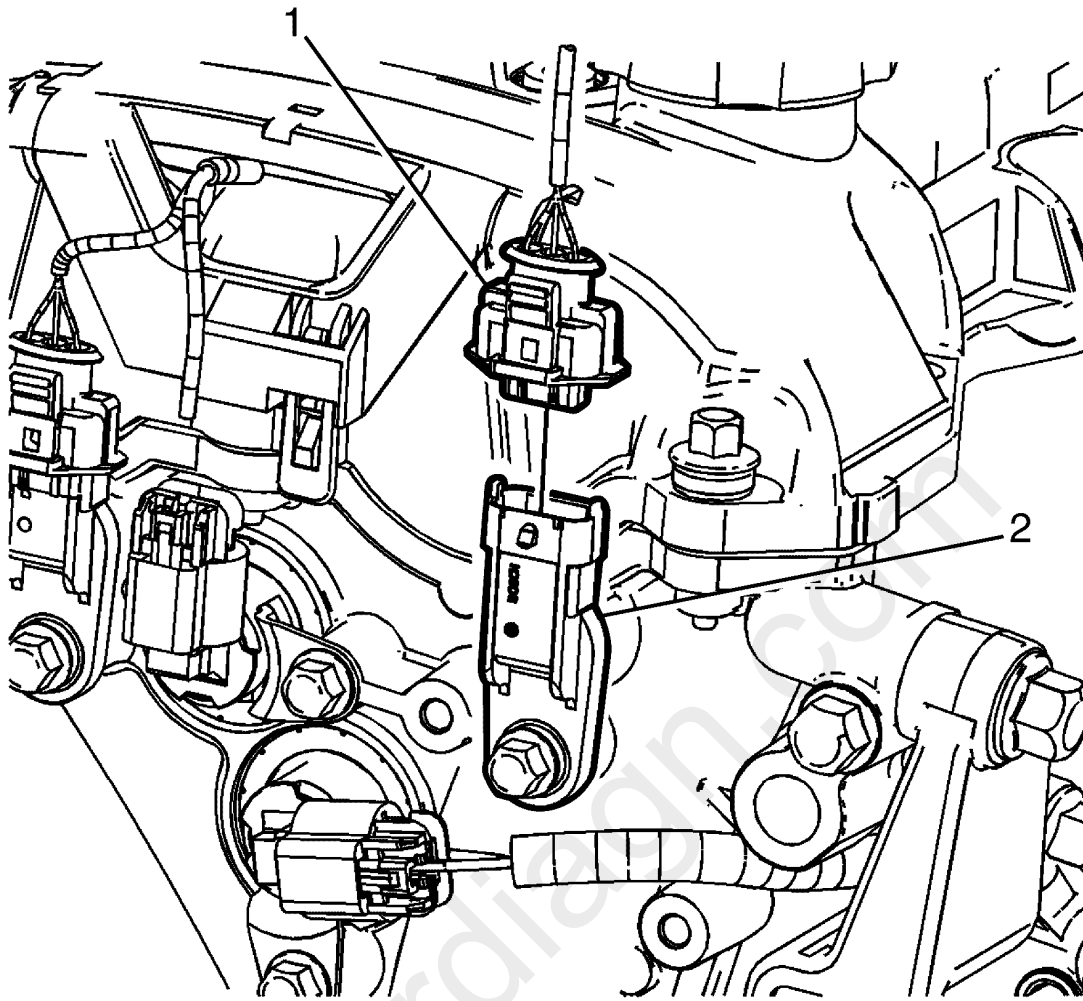


Fig. 201: Identifying CMP Sensor & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the CMP sensor electrical connector (1) to the CMP sensor (2).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST (LF3)

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

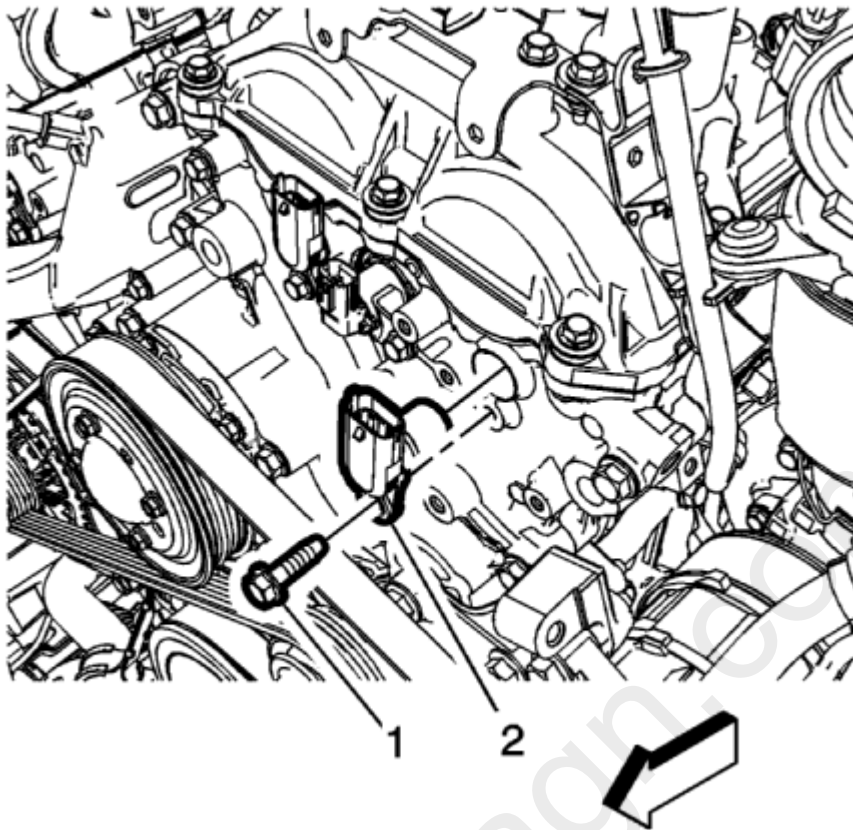


Fig. 202: Camshaft Position Sensor - Bank 2 (Left Side) Exhaust (LF3)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

3. Use compressed air to remove debris from the CMP sensor and surrounding cavities.
4. Disconnect the camshaft position (CMP) sensor electrical connector.
5. Remove the CMP sensor to engine front cover retaining bolt (1).
6. Remove the CMP sensor (2) from the engine front cover.

Installation Procedure

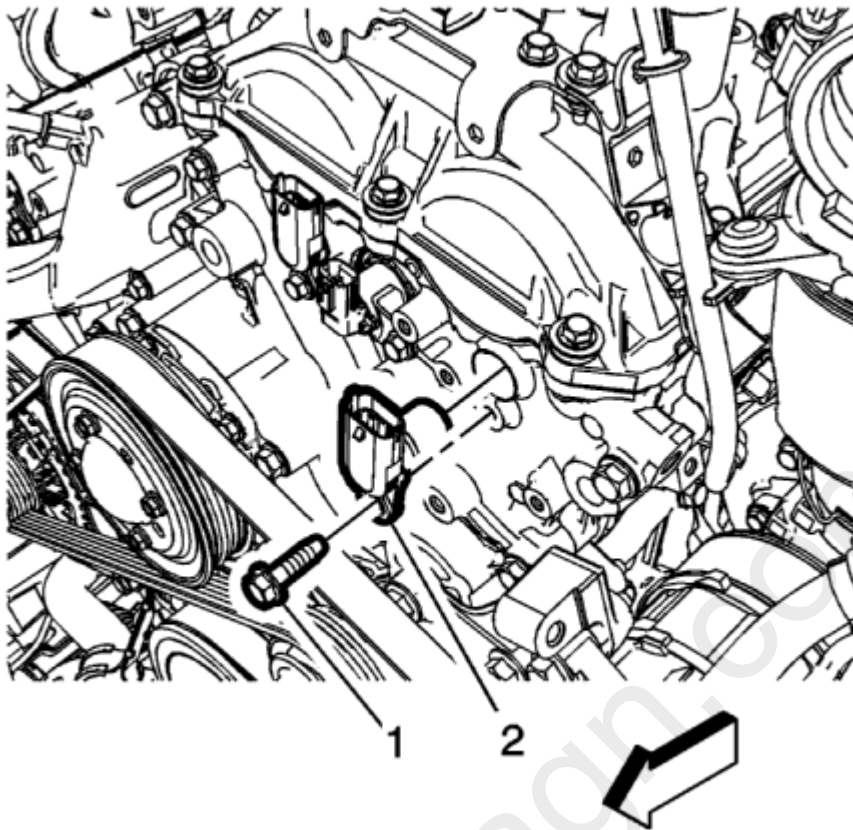


Fig. 203: Camshaft Position Sensor - Bank 2 (Left Side) Exhaust (LF3)
Courtesy of GENERAL MOTORS COMPANY

1. Install the CMP sensor (2) into to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).
3. Connect the CMP sensor electrical connector.
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

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

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .

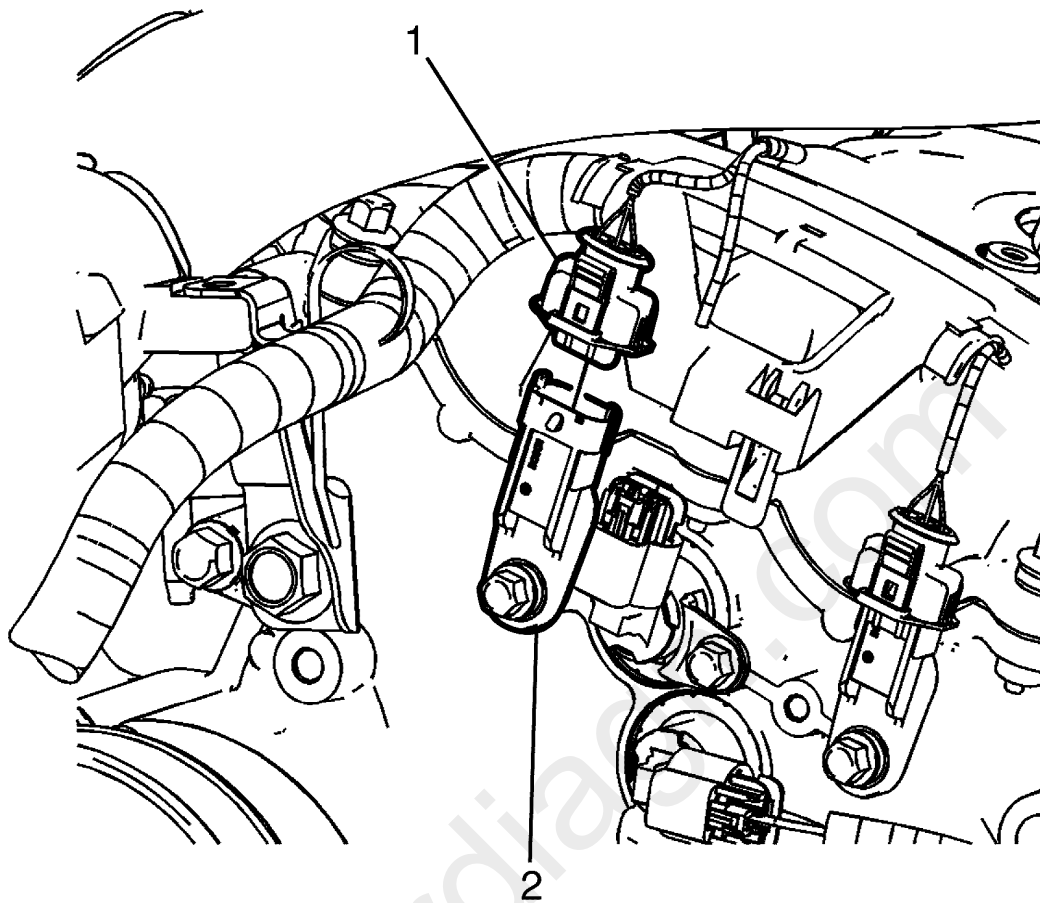


Fig. 204: Identifying CMP Sensor & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

3. Use compressed air to remove debris from the CMP sensor and surrounding cavities.
4. Remove the camshaft position (CMP) sensor electrical connector (1) from the CMP sensor (2).

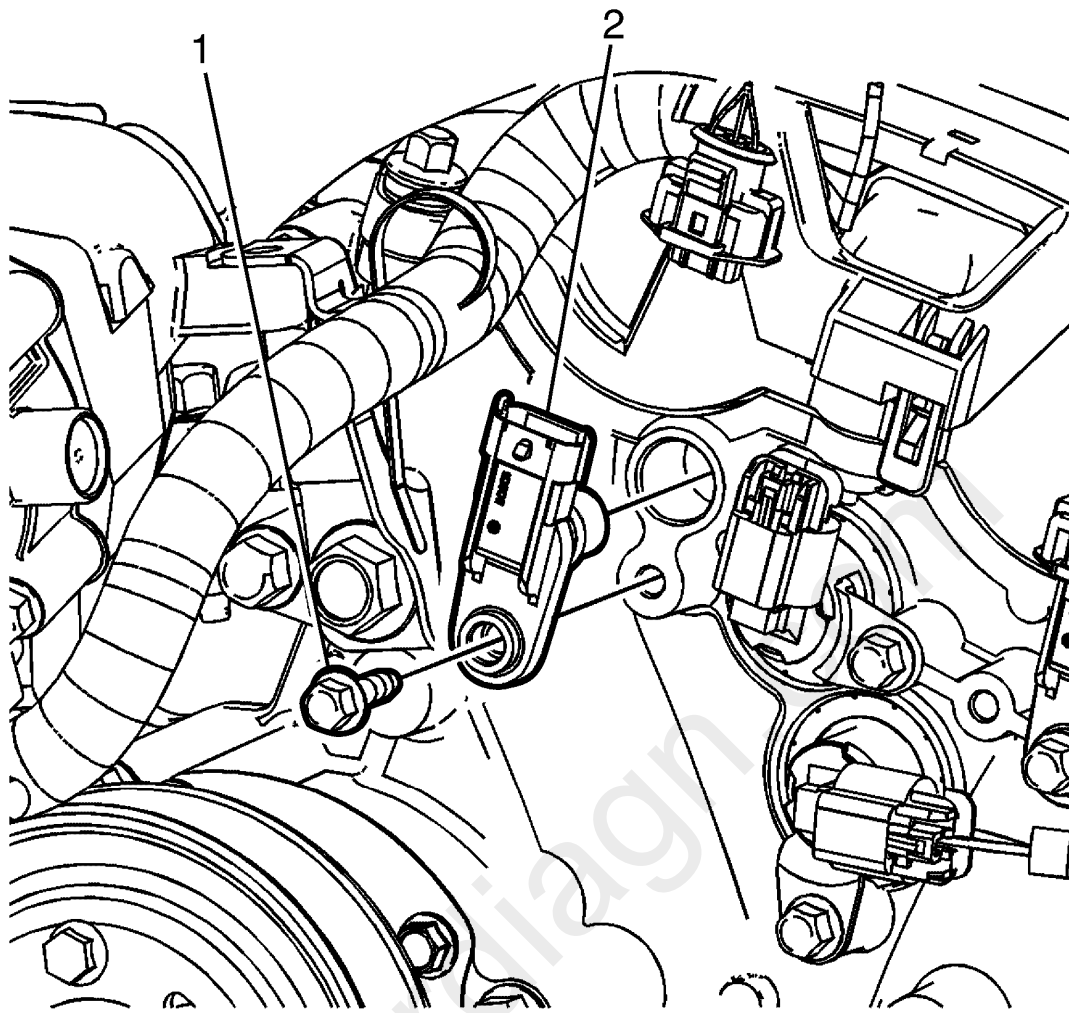


Fig. 205: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the CMP sensor to engine front cover retaining bolt (1).
6. Remove the CMP sensor (2) from the engine.

Installation Procedure

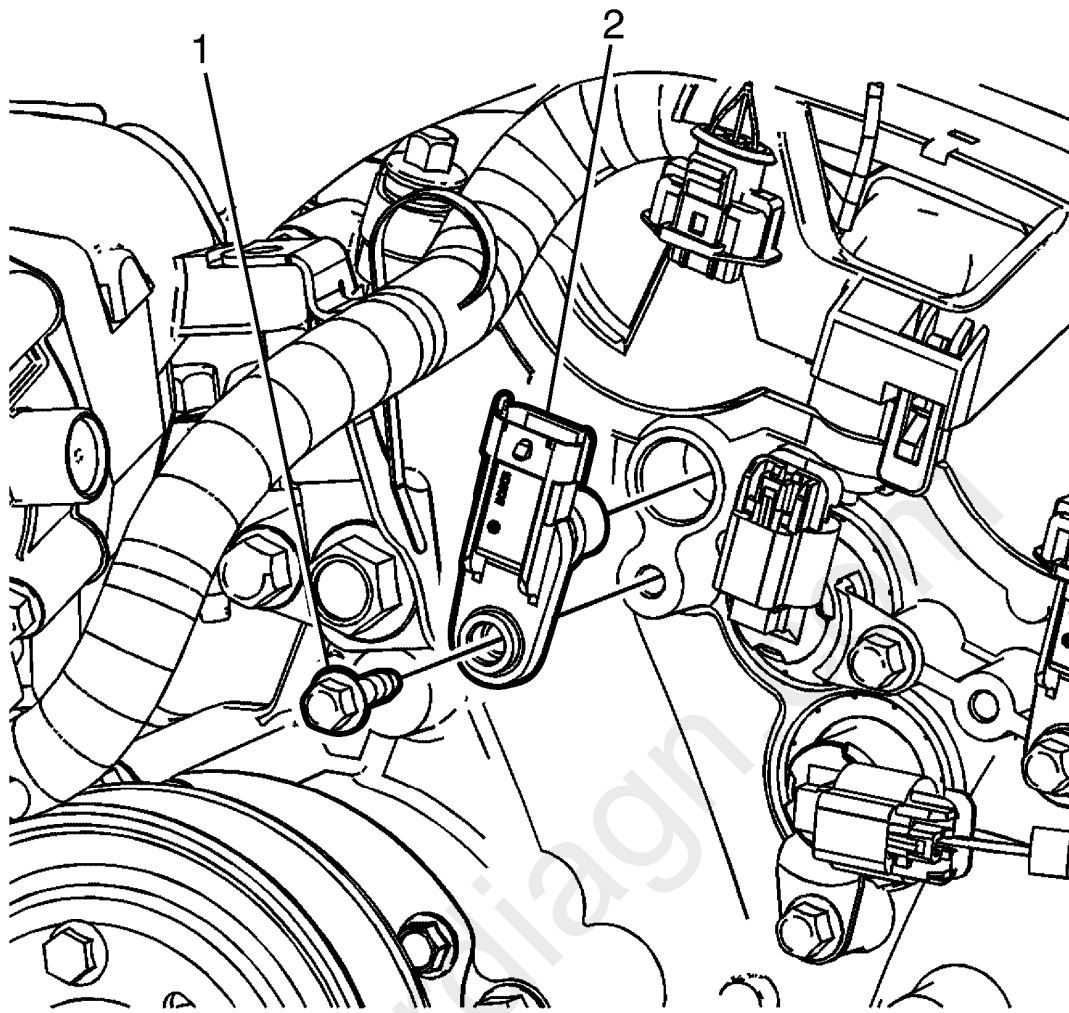


Fig. 206: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the CMP sensor (2) to the engine.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to 10 N.m (89 lb in).

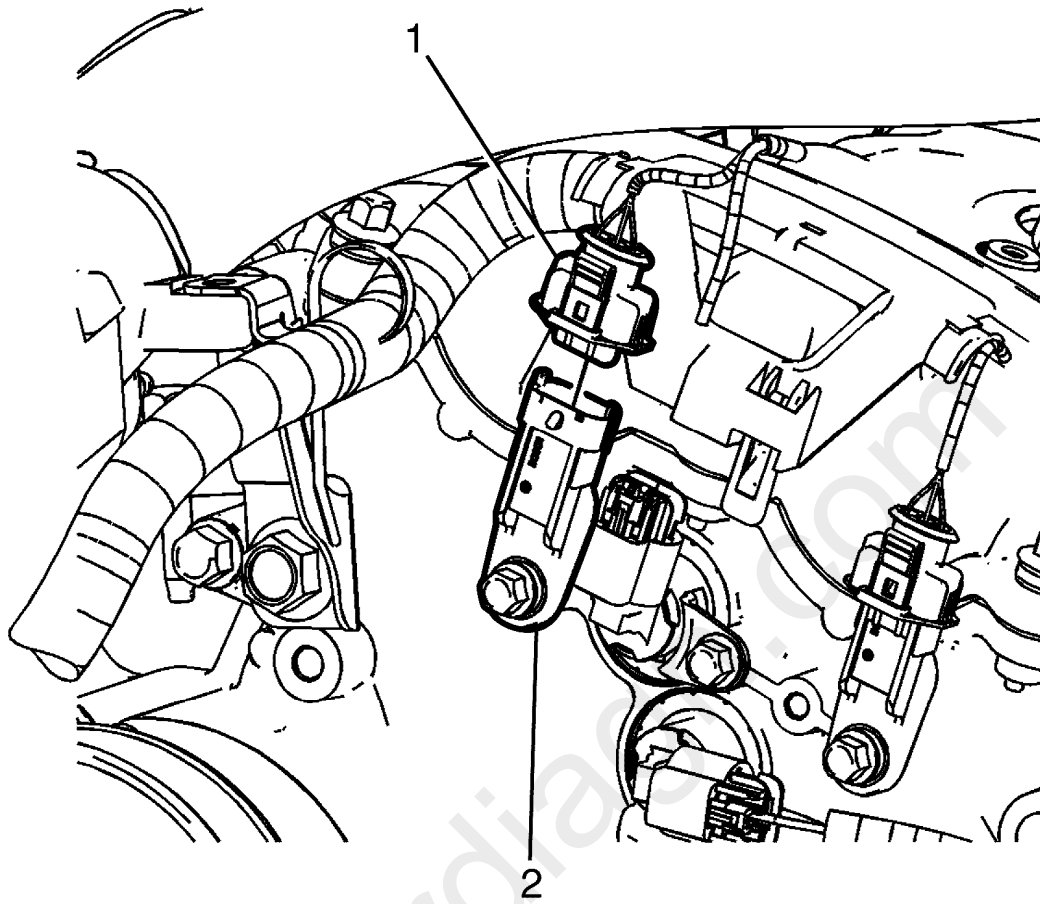


Fig. 207: Identifying CMP Sensor & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the CMP sensor electrical connector (1) to the CMP sensor (2).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE (LF3)

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

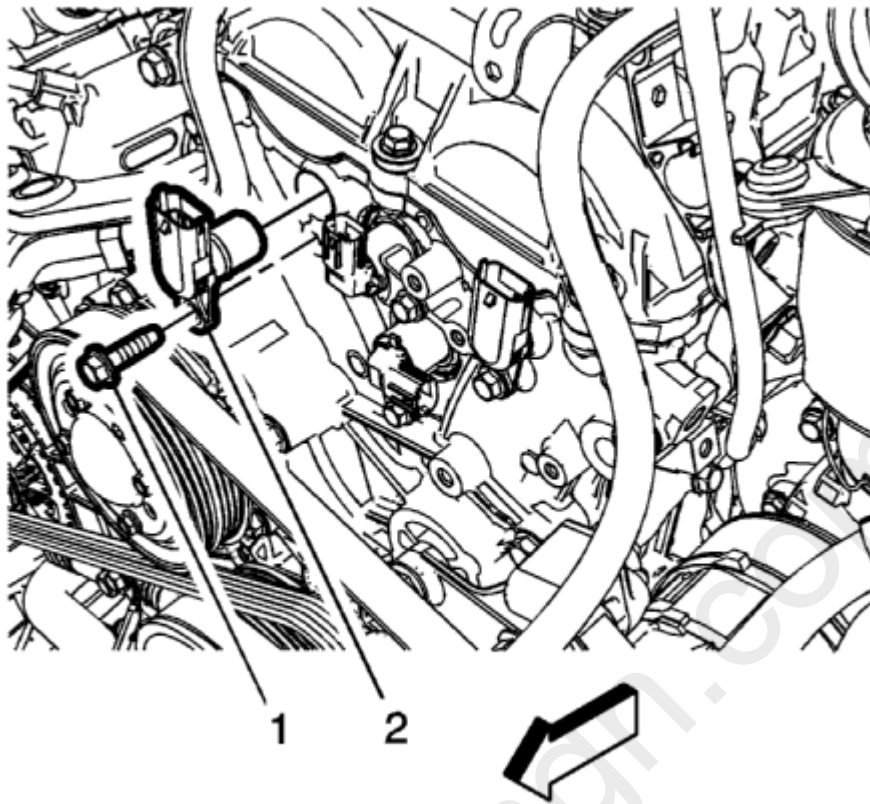


Fig. 208: Camshaft Position Sensor - Bank 2 (Left Side) Intake (LF3)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

3. Use compressed air to remove debris from the CMP sensor and surrounding cavities.
4. Disconnect the camshaft position (CMP) sensor electrical connector.
5. Remove the CMP sensor to engine front cover retaining bolt (1).
6. Remove the CMP sensor (2) from the engine front cover.

Installation Procedure

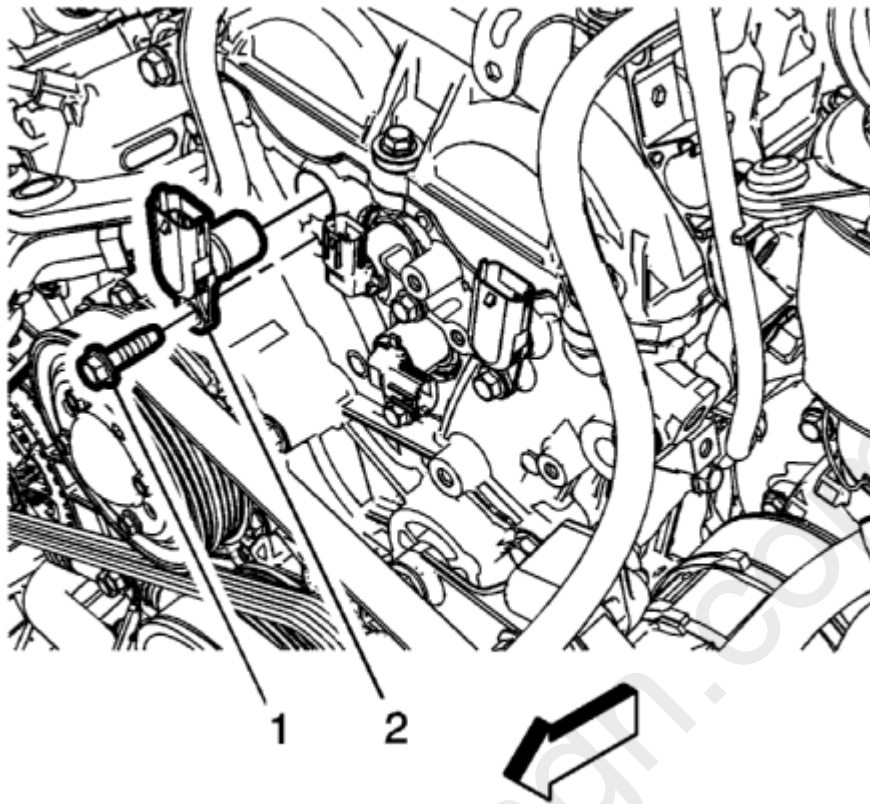


Fig. 209: Camshaft Position Sensor - Bank 2 (Left Side) Intake (LF3)
Courtesy of GENERAL MOTORS COMPANY

1. Install the CMP sensor (2) into to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).
3. Connect the CMP sensor electrical connector.
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

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

Removal Procedure

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .
3. Reposition the vacuum brake booster hose.

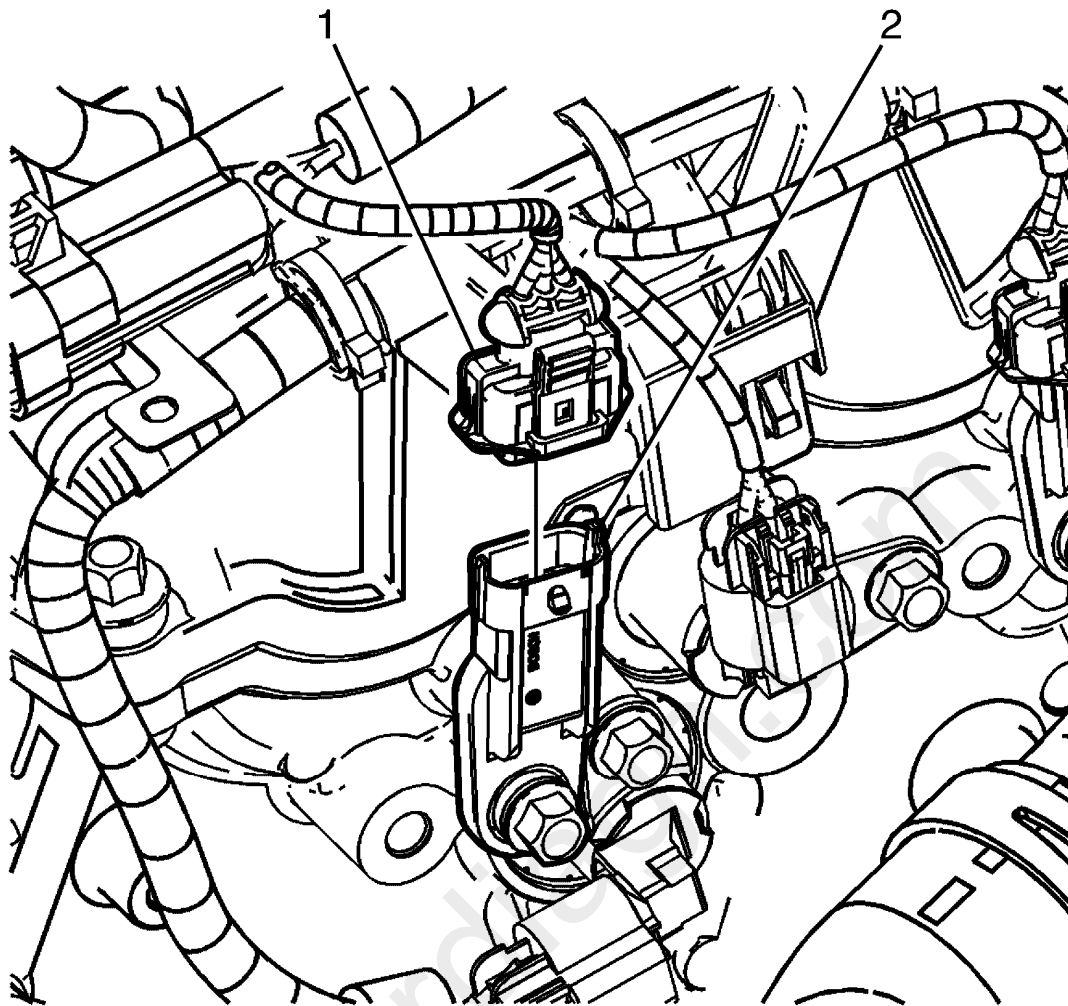


Fig. 210: Identifying CMP Sensor & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

4. Use compressed air to remove debris from the CMP sensor and surrounding cavities.
5. Remove the camshaft position (CMP) sensor electrical connector (1) from the CMP sensor (2).

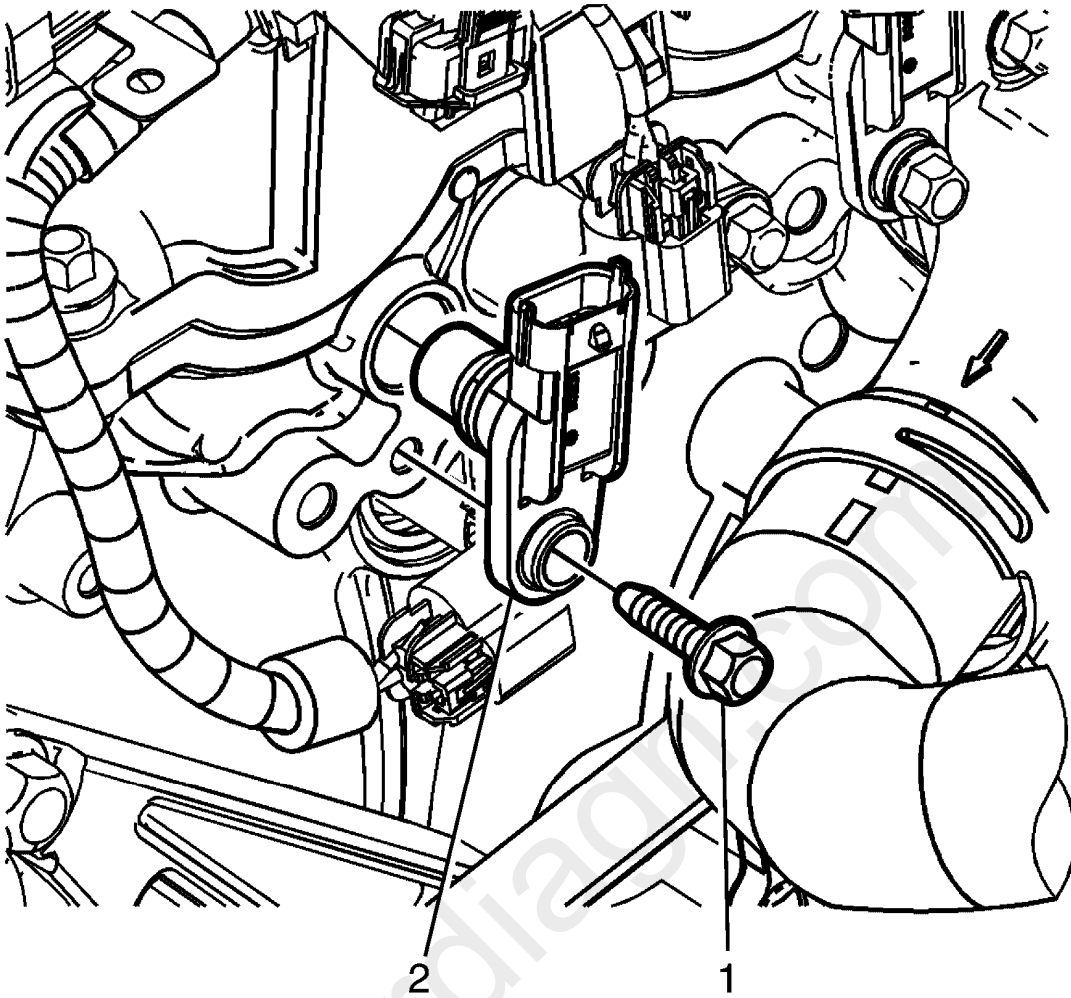


Fig. 211: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the CMP sensor to engine front cover retaining bolt (1).
7. Remove the CMP sensor (2) from the engine.

Installation Procedure

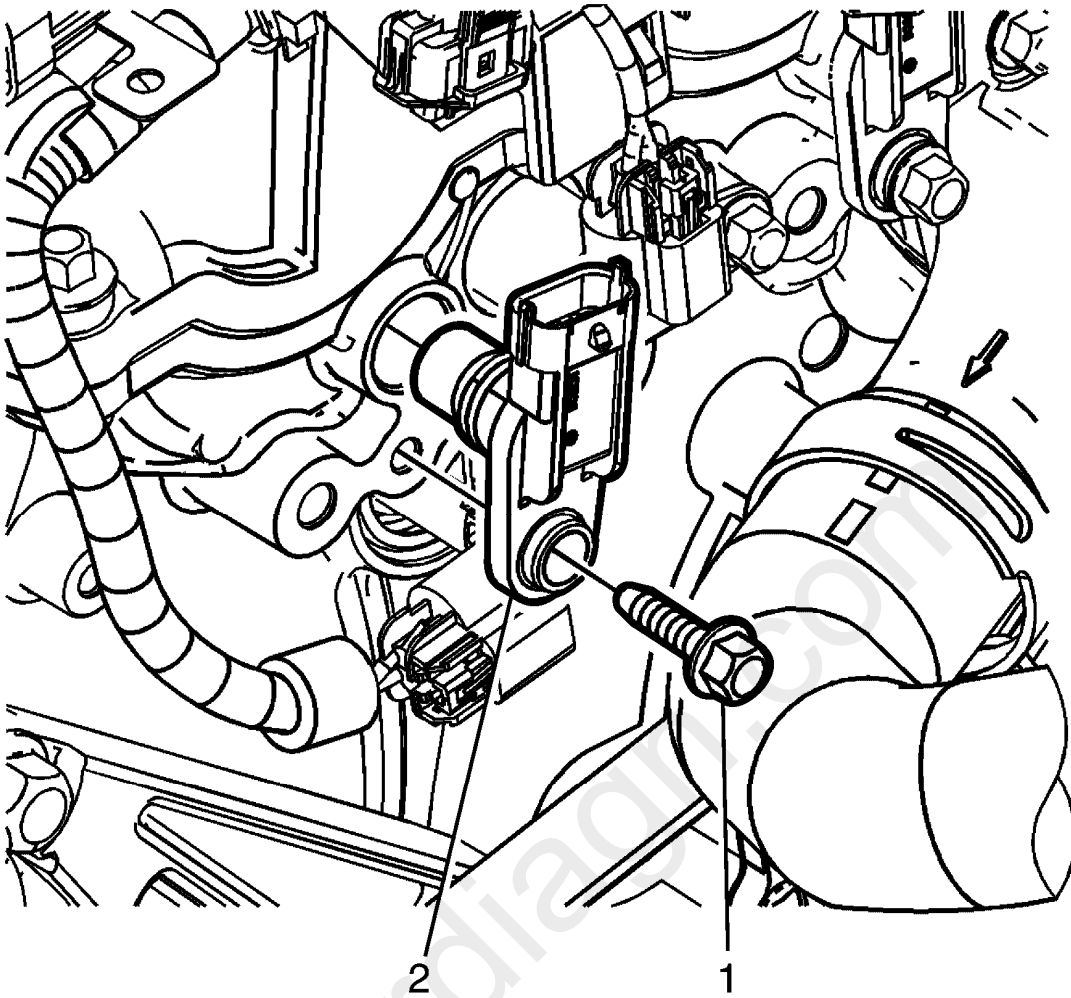


Fig. 212: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the CMP sensor (2) to the engine.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to 10 N.m (89 lb in).

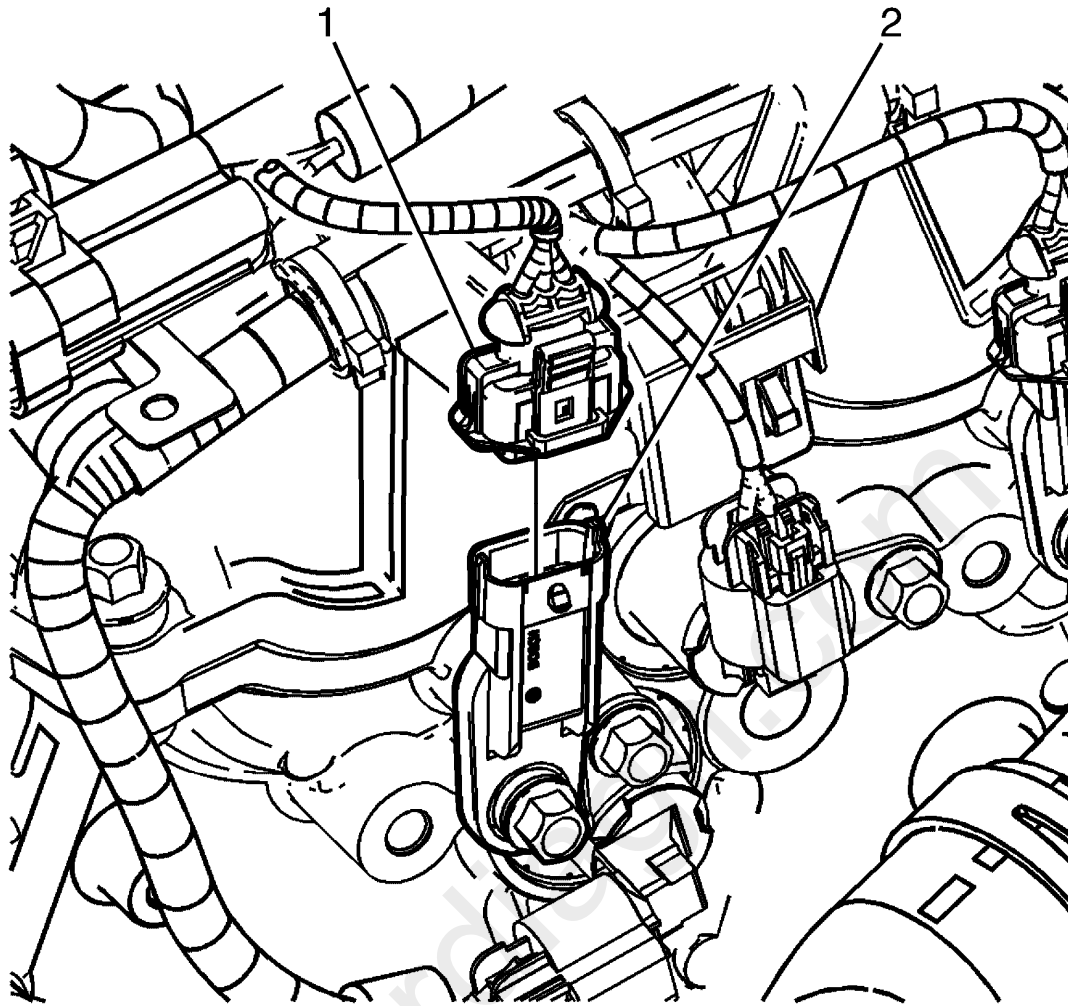


Fig. 213: Identifying CMP Sensor & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the CMP sensor electrical connector (1) to the CMP sensor (2).
4. Reposition the vacuum brake booster hose.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST (LF3)

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .
3. Disconnect and reposition the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)** .

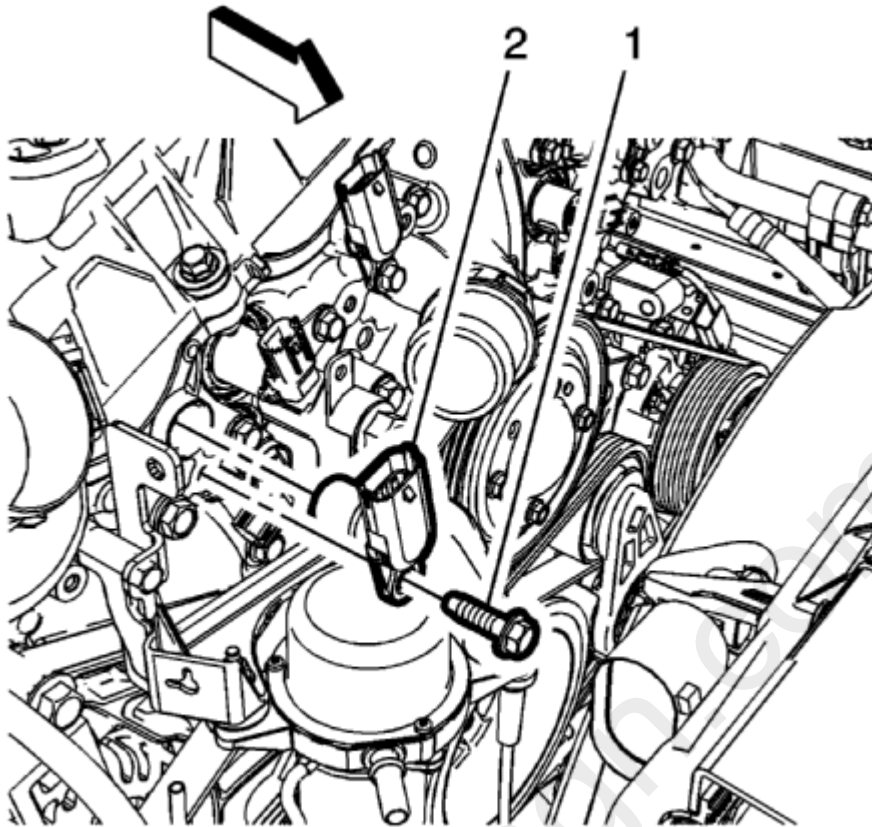


Fig. 214: Camshaft Position Sensor - Bank 1 (Right Side) Exhaust (LF3)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

4. Use compressed air to remove debris from the CMP sensor and surrounding cavities.
5. Disconnect the CMP sensor electrical connector.
6. Remove the CMP sensor to engine front cover retaining bolt (1).
7. Remove the CMP sensor (2) from the engine front cover.

Installation Procedure

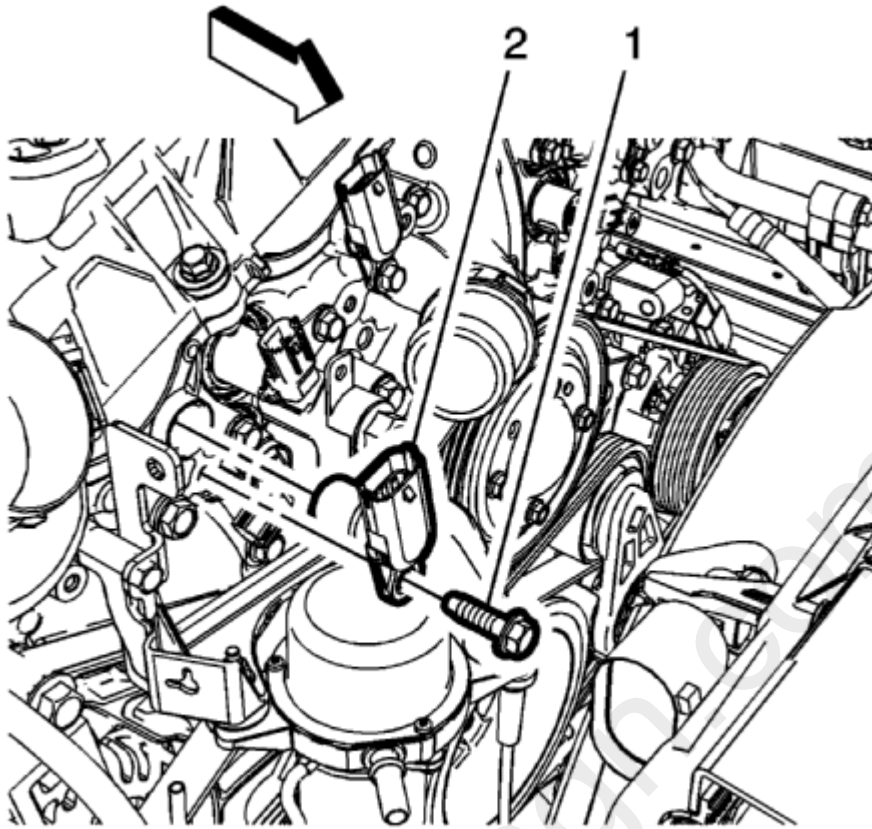


Fig. 215: Camshaft Position Sensor - Bank 1 (Right Side) Exhaust (LF3)
Courtesy of GENERAL MOTORS COMPANY

1. Install the CMP sensor (2) into to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).
3. Connect the CMP sensor electrical connector.
4. Connect the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)** .
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

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

Removal Procedure

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .
3. Reposition the vacuum brake booster hose.

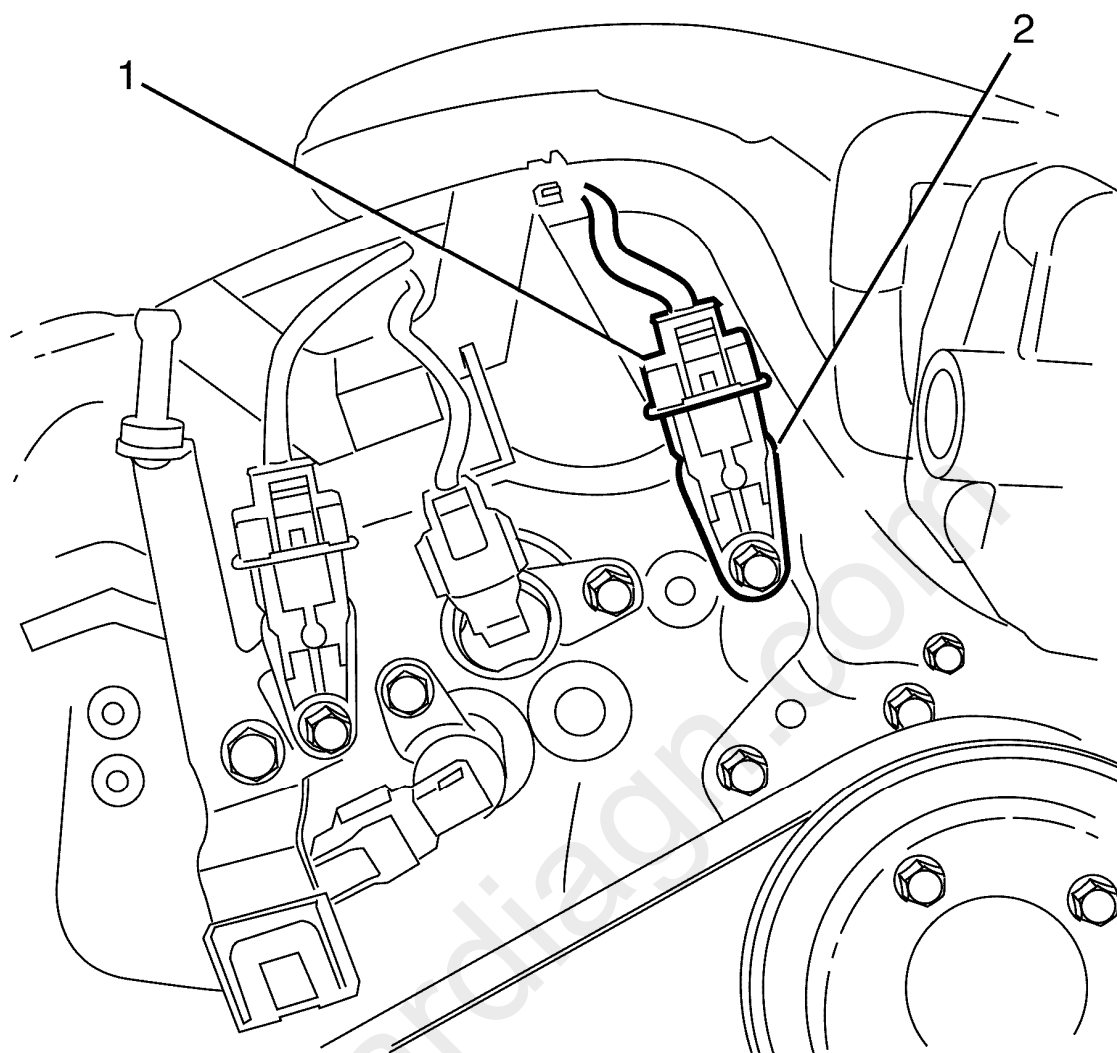


Fig. 216: Identifying CMP Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove the camshaft position (CMP) sensor electrical connector (1) from the CMP sensor (2).

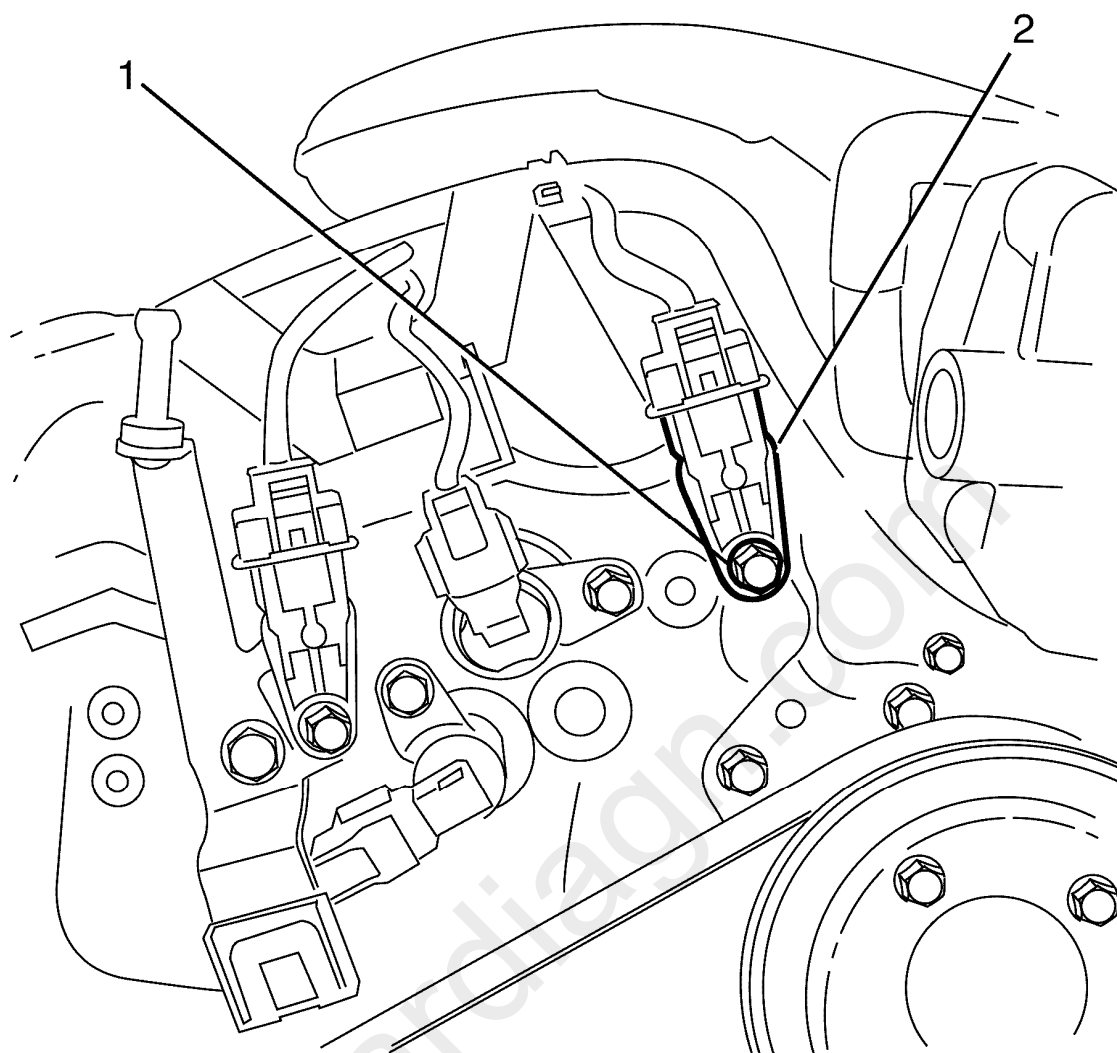


Fig. 217: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the CMP sensor to engine front cover retaining bolt (1).
6. Remove the CMP sensor from the engine front cover.

Installation Procedure

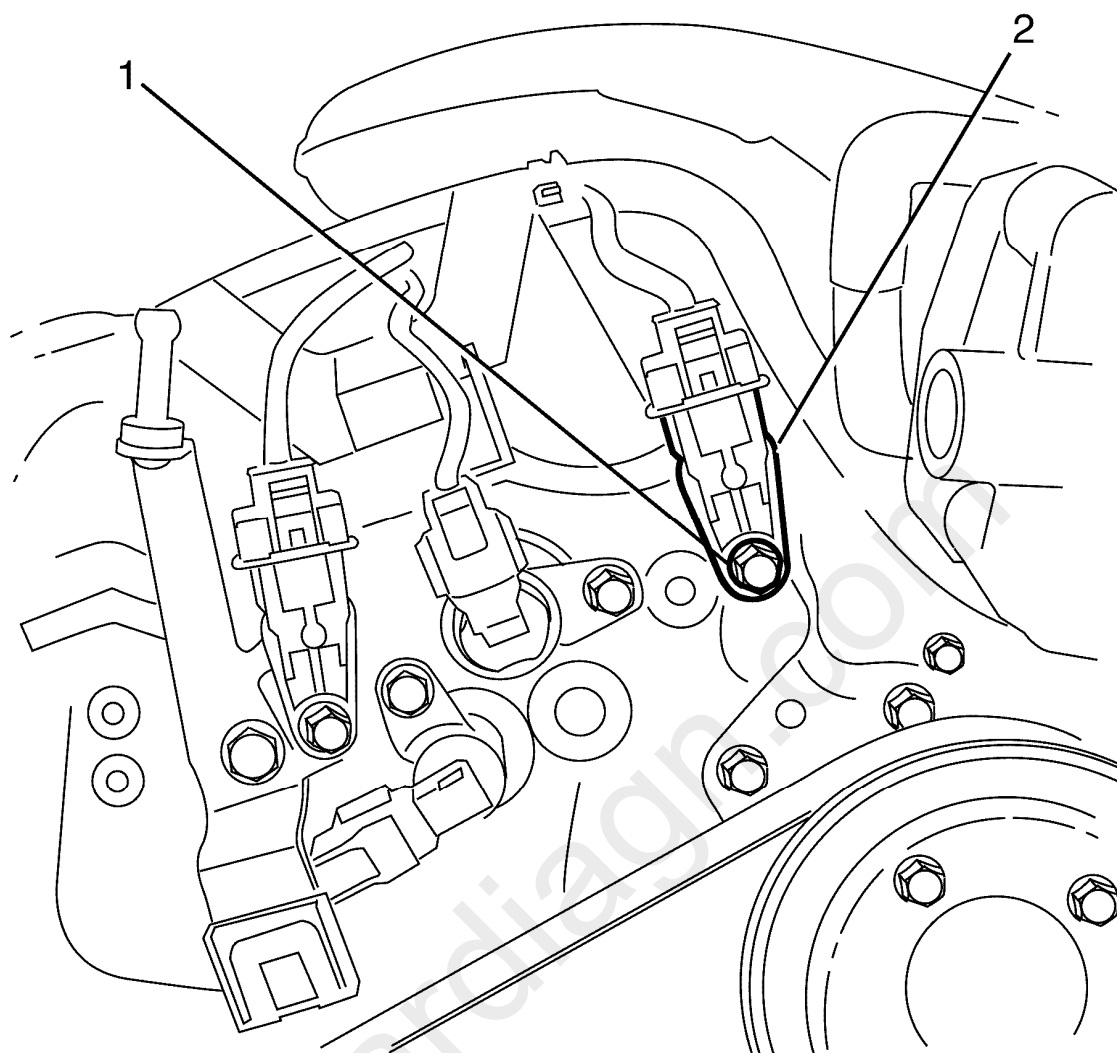


Fig. 218: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the CMP sensor (2) to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).

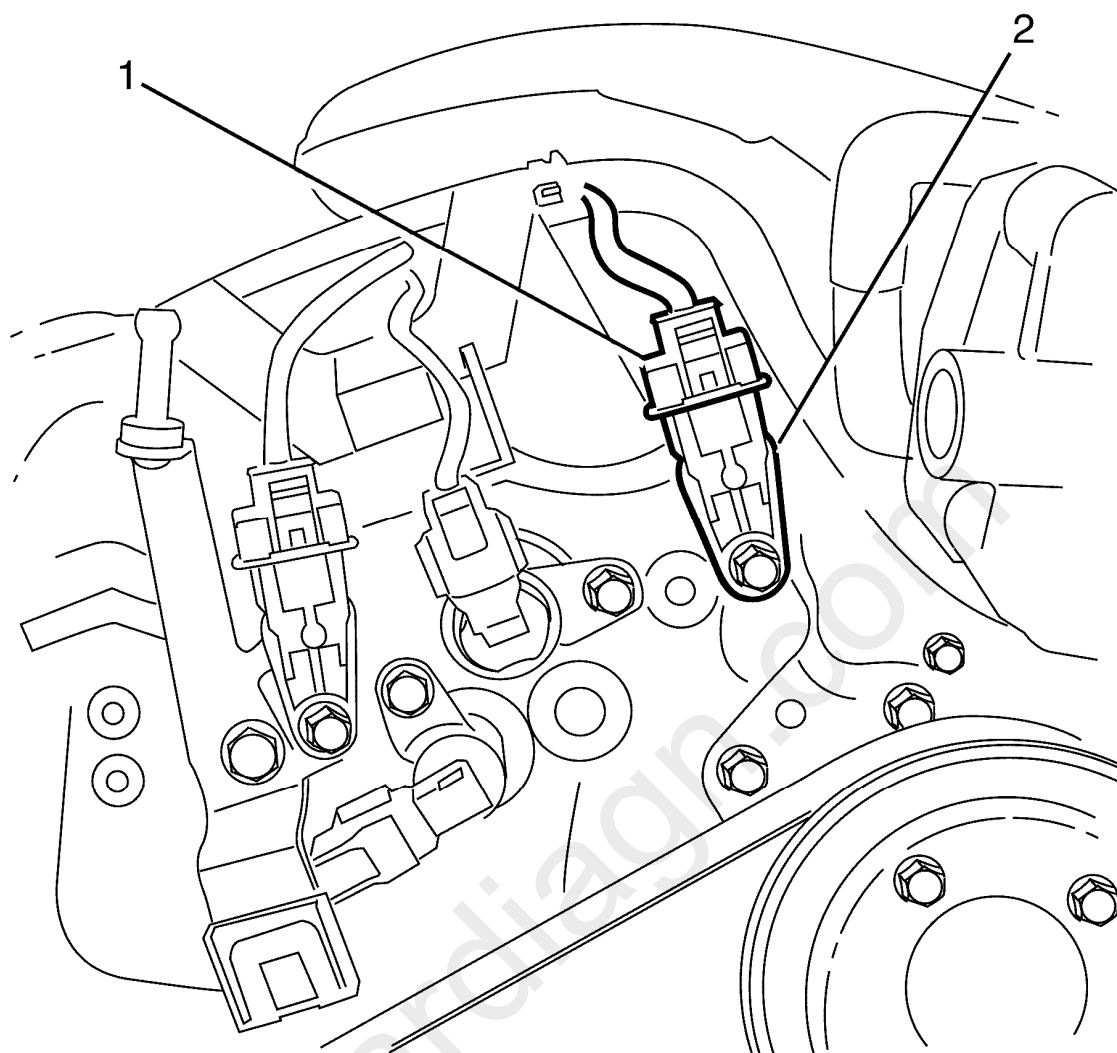


Fig. 219: Identifying CMP Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the CMP sensor electrical connector (1) to the CMP sensor.
4. Reposition the vacuum brake booster hose.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE (LF3)

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .
3. Disconnect and reposition the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)** .

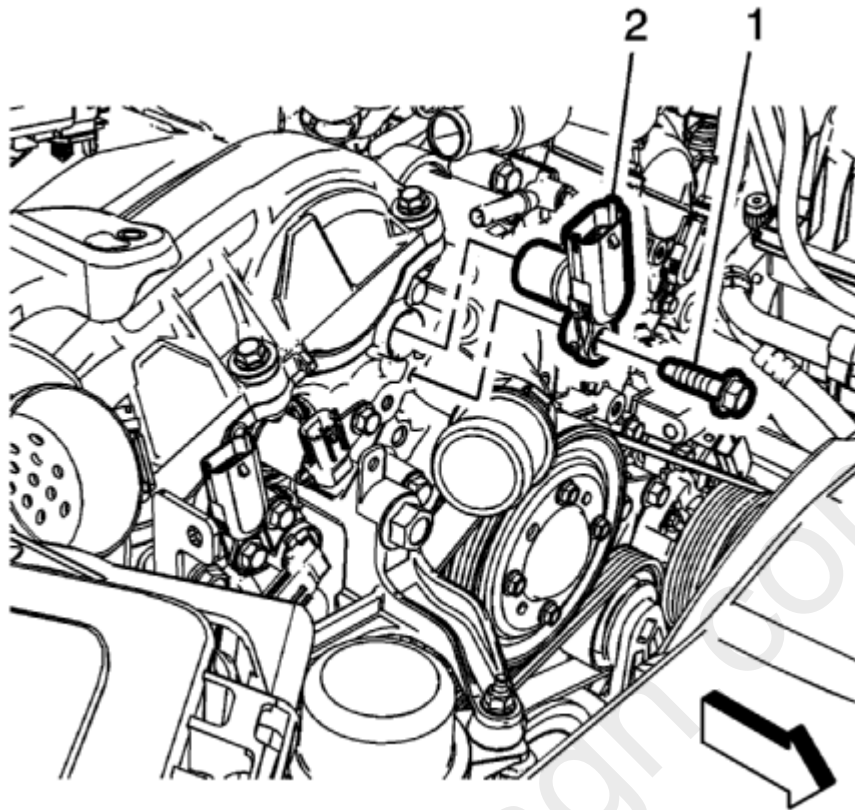


Fig. 220: Camshaft Position Sensor - Bank 1 (Right Side) Intake (LF3)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

4. Use compressed air to remove debris from the CMP sensor and surrounding cavities.
5. Disconnect the CMP sensor electrical connector.
6. Remove the CMP sensor to engine front cover retaining bolt (1).
7. Remove the CMP sensor (2) from the engine front cover.

Installation Procedure

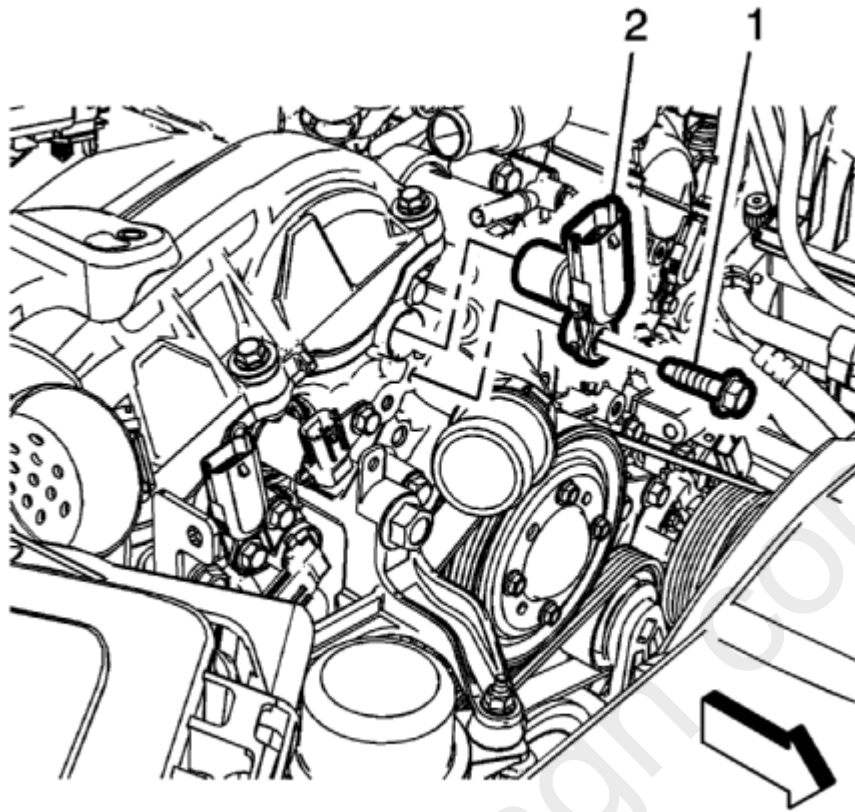


Fig. 221: Camshaft Position Sensor - Bank 1 (Right Side) Intake (LF3)
Courtesy of GENERAL MOTORS COMPANY

1. Install the CMP sensor (2) into to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).
3. Connect the CMP sensor electrical connector.
4. Connect the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)** .
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

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

Removal Procedure

1. Turn the ignition OFF.

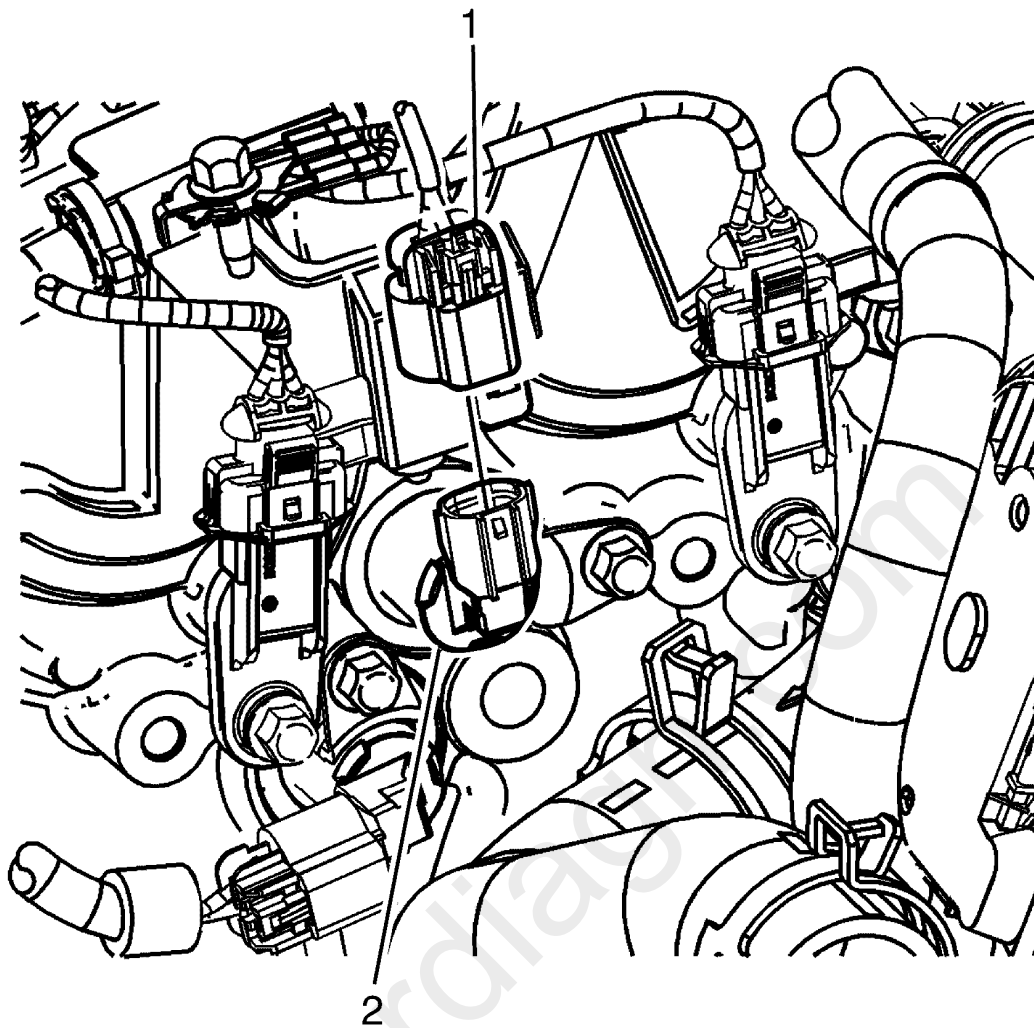


Fig. 222: Identifying CMP Sensor & Actuator Valve Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP sensor (2).

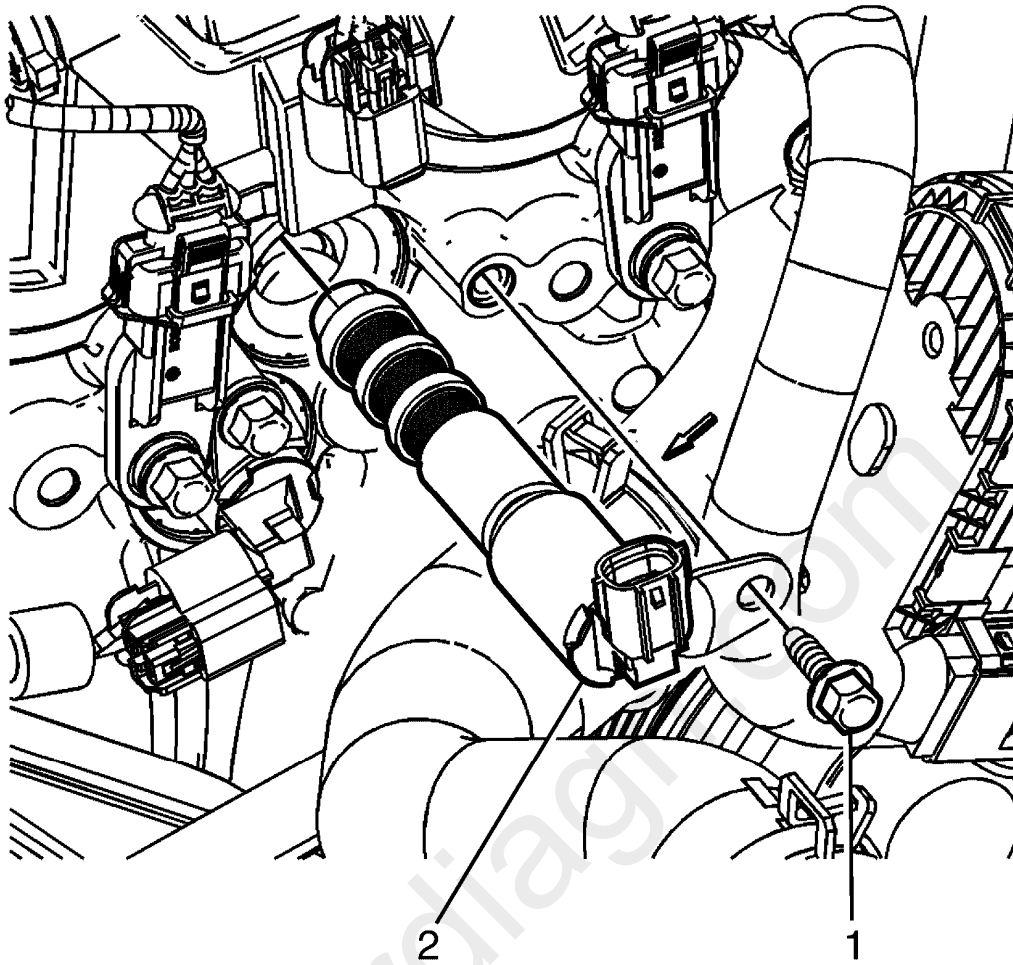


Fig. 223: Identifying CMP Actuator Solenoid Valve To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1).
4. Remove the CMP actuator valve (2) from the engine front cover.
5. Inspect the CMP actuator valve seal and replace as necessary.

Installation Procedure

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

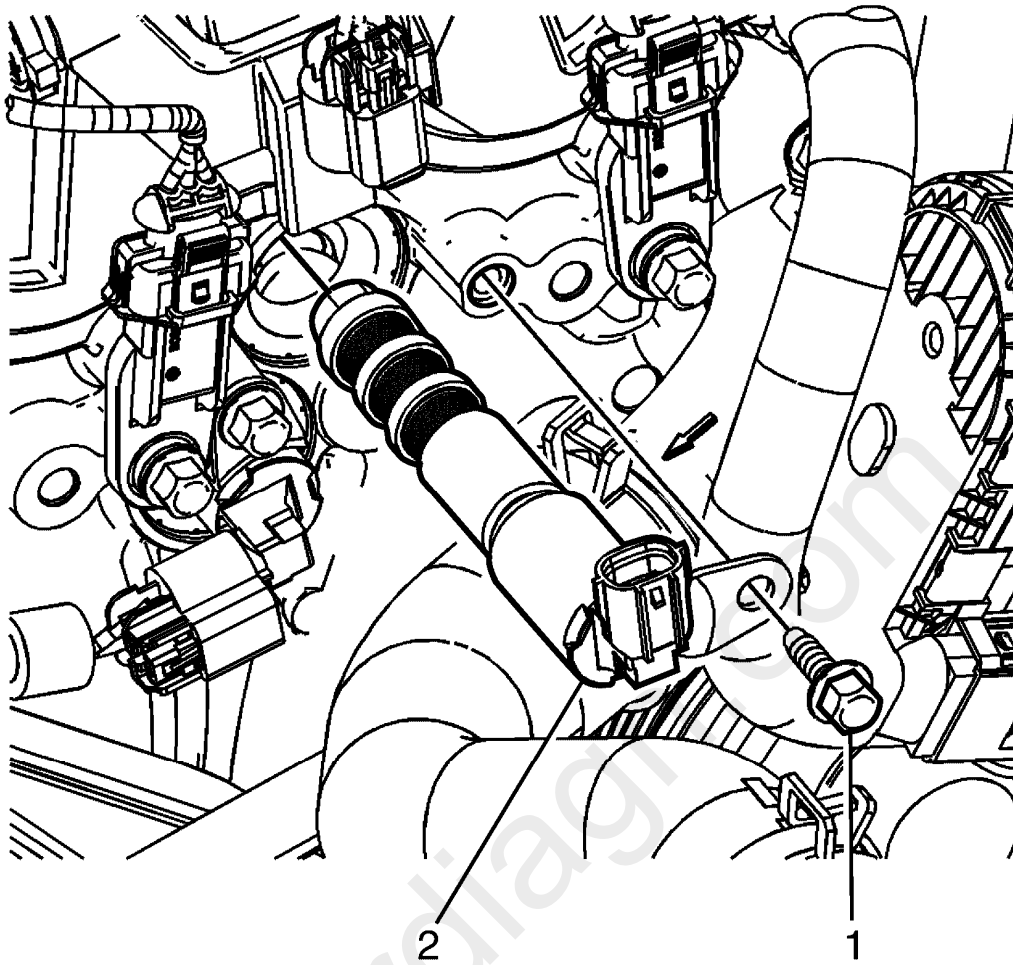


Fig. 224: Identifying CMP Actuator Solenoid Valve To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the CMP actuator valve (2) to the engine front cover.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator solenoid valve to engine front cover retaining bolt (1) and tighten to 9 (80 lb in).

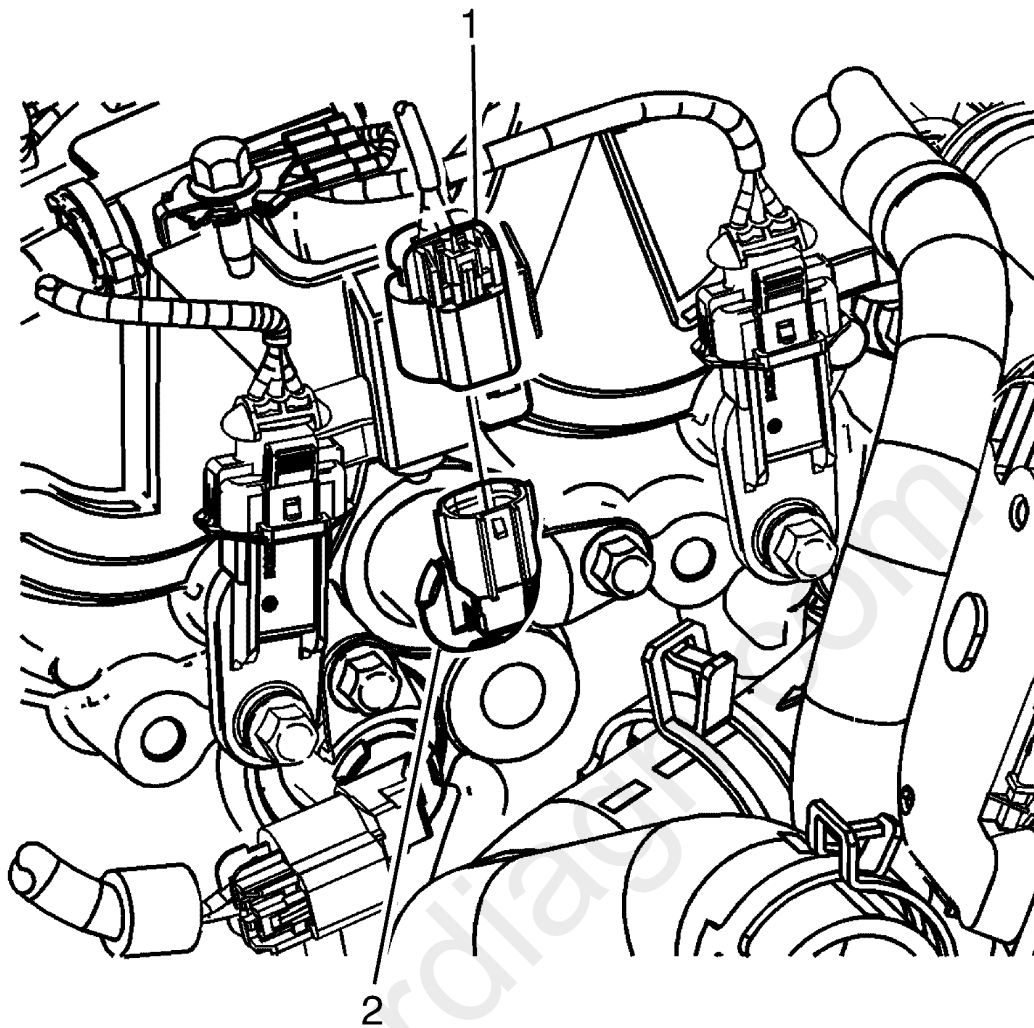


Fig. 225: Identifying CMP Sensor & Actuator Valve Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the CMP actuator valve electrical connector (1) to the CMP sensor (2).

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE (LF3)

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .
3. Disconnect and reposition the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)** .

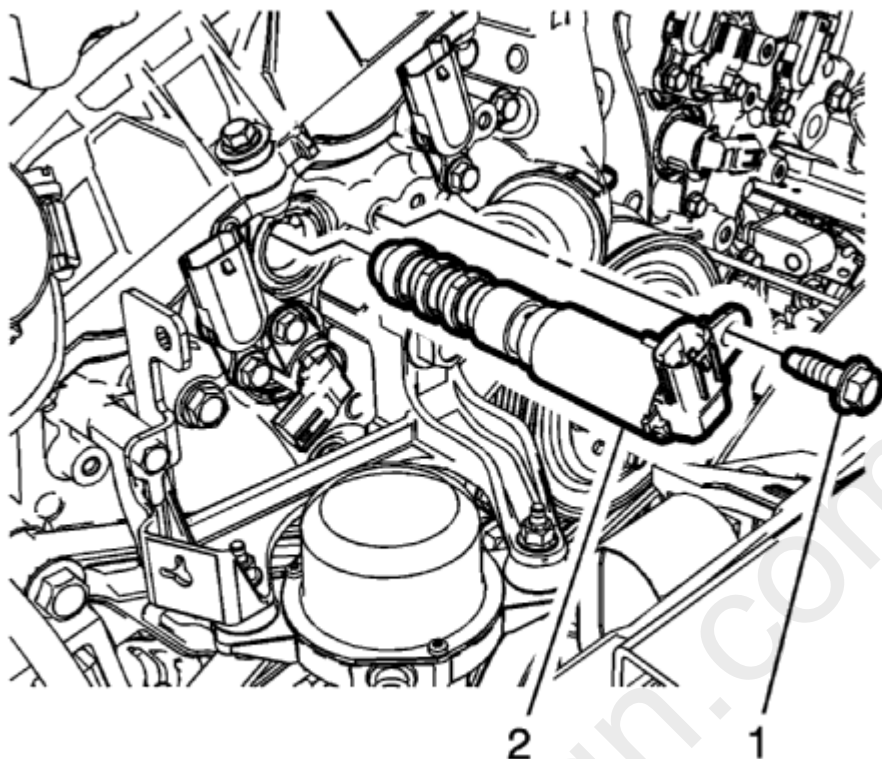


Fig. 226: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Intake (LF3)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

4. Use compressed air to remove debris from the camshaft position actuator solenoid valve solenoid and surrounding cavities.
5. Disconnect the camshaft position actuator solenoid valve solenoid electrical connector.
6. Remove the camshaft position actuator solenoid valve solenoid to engine front cover retaining bolt (1).
7. Remove the camshaft position actuator solenoid valve solenoid (2) from the engine front cover.

Installation Procedure

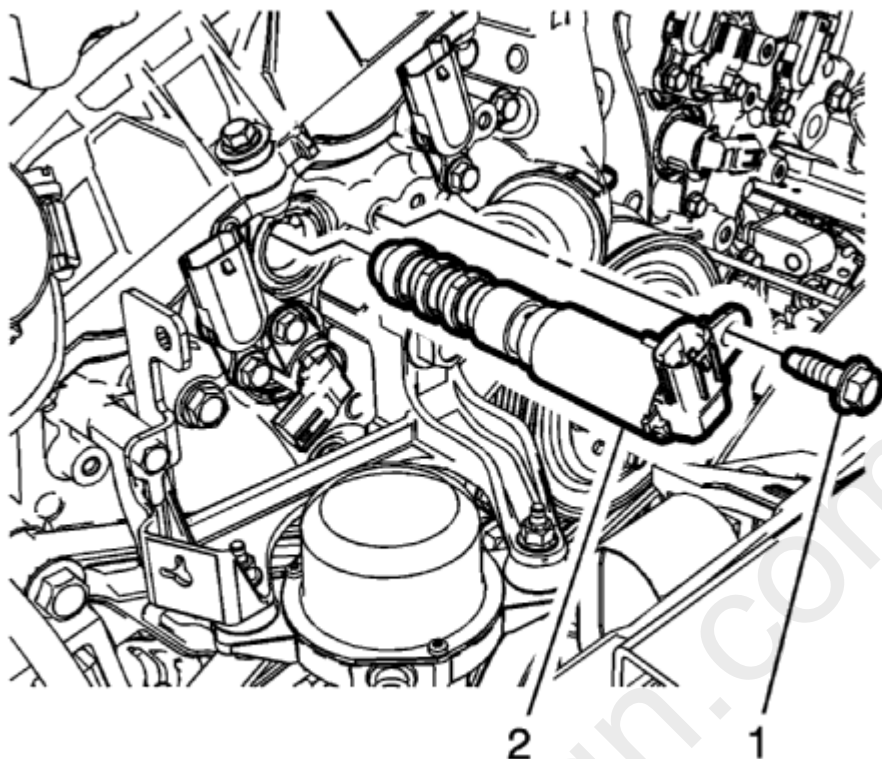


Fig. 227: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Intake (LF3)
Courtesy of GENERAL MOTORS COMPANY

NOTE: Inspect the solenoid valve seals and replace as needed.

1. Install the camshaft position actuator solenoid valve solenoid (2) into to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the camshaft position actuator solenoid valve solenoid to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).
3. Connect the camshaft position actuator solenoid valve solenoid electrical connector.
4. Connect the radiator inlet hose. Refer to Radiator Inlet Hose Replacement (LF3) .
5. Install the intake manifold cover. Refer to Intake Manifold Cover Replacement (LF3) .

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

Removal Procedure

WARNING: Refer to Safety Glasses Warning .

1. Turn the ignition OFF.
2. Remove the power brake booster auxiliary pump. Refer to Power Brake Booster Pump Replacement (LFX, LF3) .

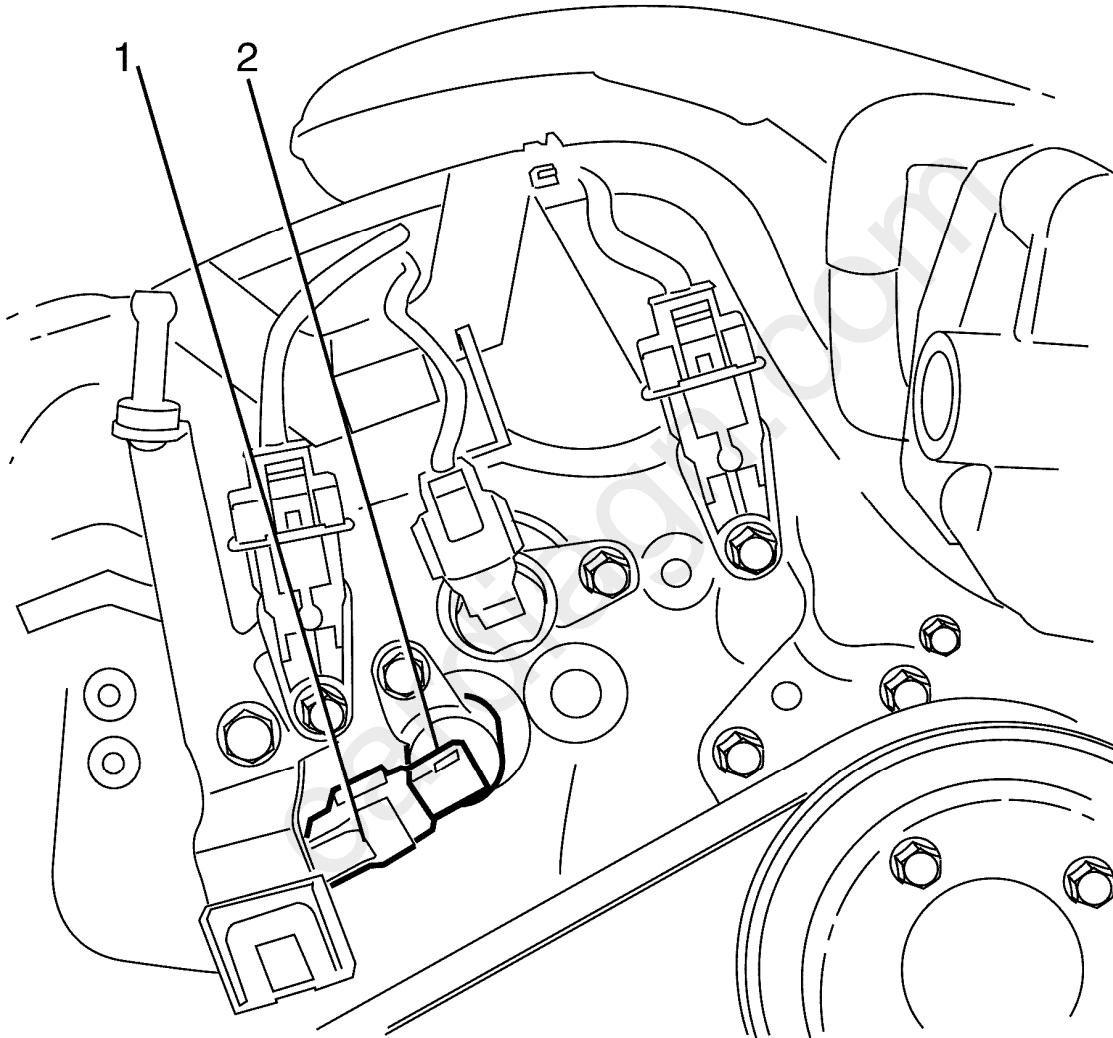


Fig. 228: Identifying CMP Actuator Valve & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP (2).

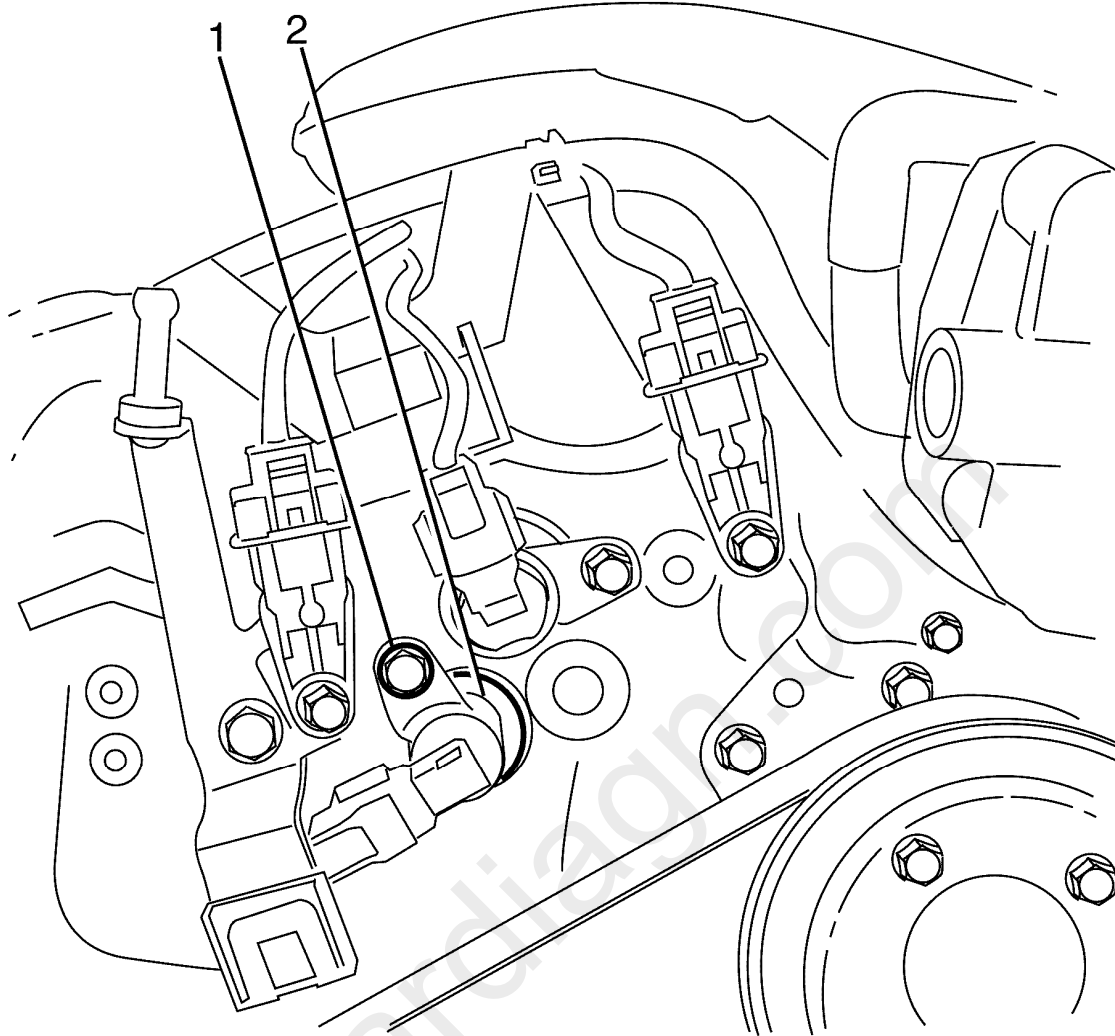


Fig. 229: Identifying CMP Actuator Solenoid Valve To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1).
5. Remove the CMP actuator valve (2).
6. Inspect the CMP actuator valve seal and replace as necessary.

Installation Procedure

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

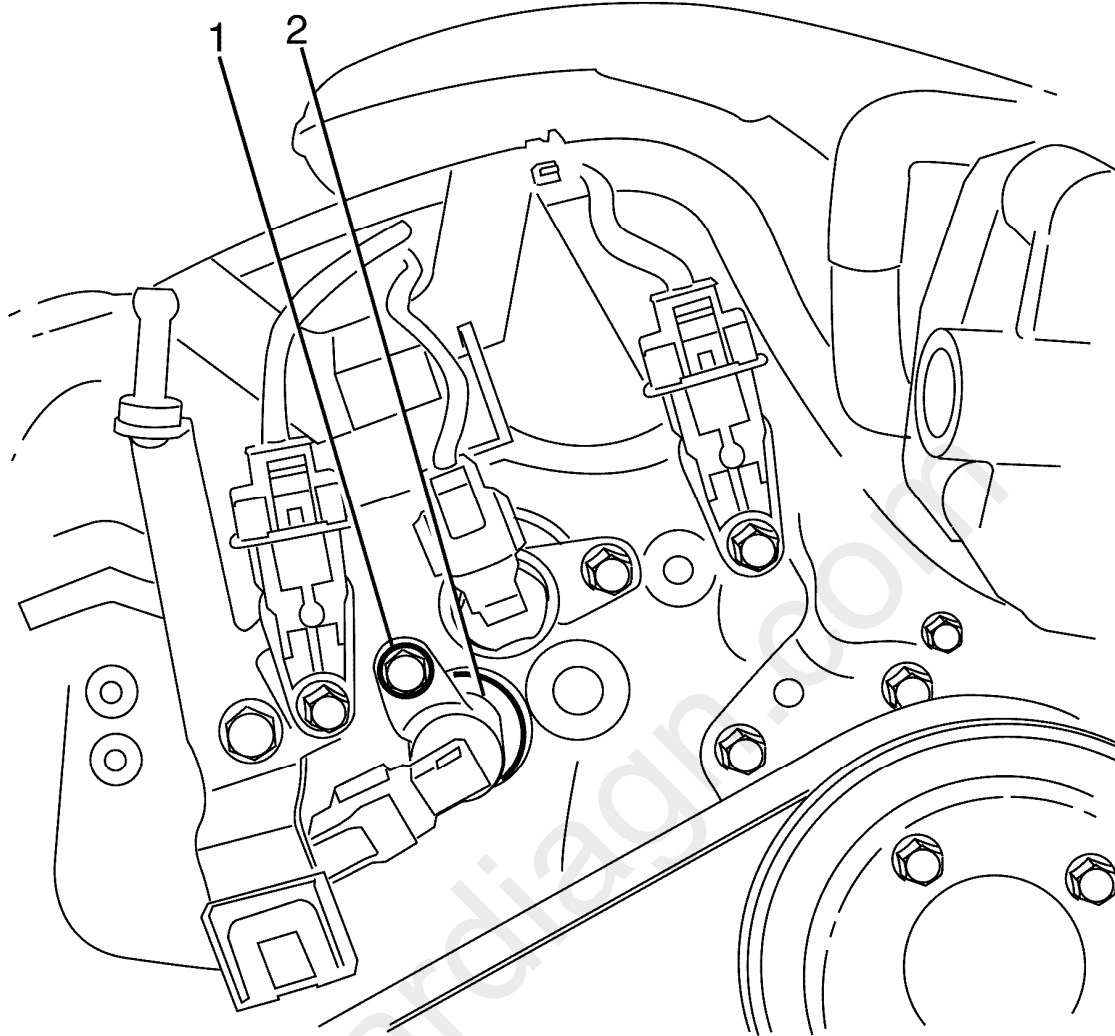


Fig. 230: Identifying CMP Actuator Solenoid Valve To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the CMP actuator valve (2) to the engine front cover.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator solenoid valve to engine front cover retaining bolt (1).

Tighten

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

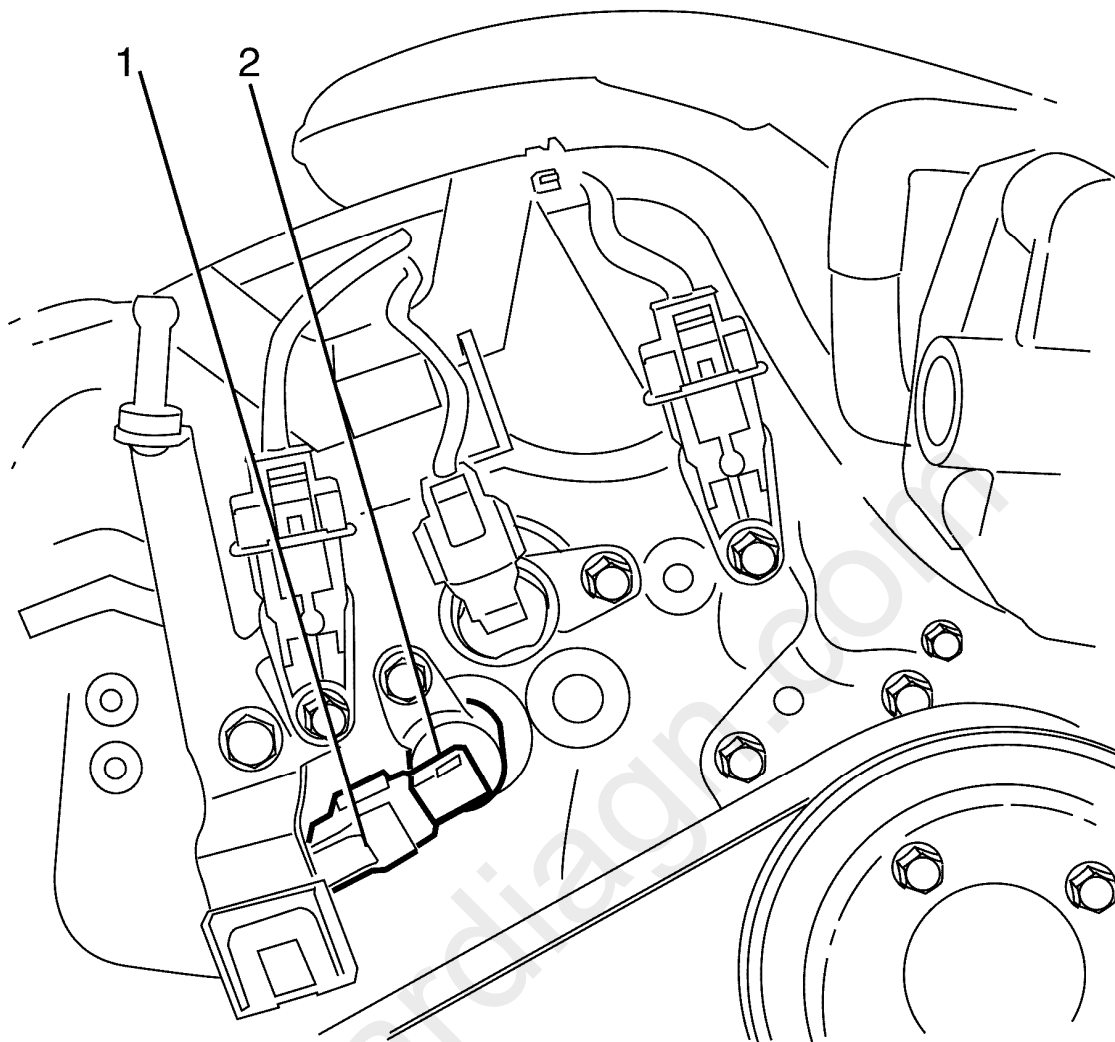


Fig. 231: Identifying CMP Actuator Valve & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the CMP valve electrical connector (1) to the CMP actuator valve.
5. Install the power brake booster auxiliary pump. Refer to **Power Brake Booster Pump Replacement (LFX, LF3)**.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST (LF3)

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)**.
3. Disconnect and reposition the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)**.

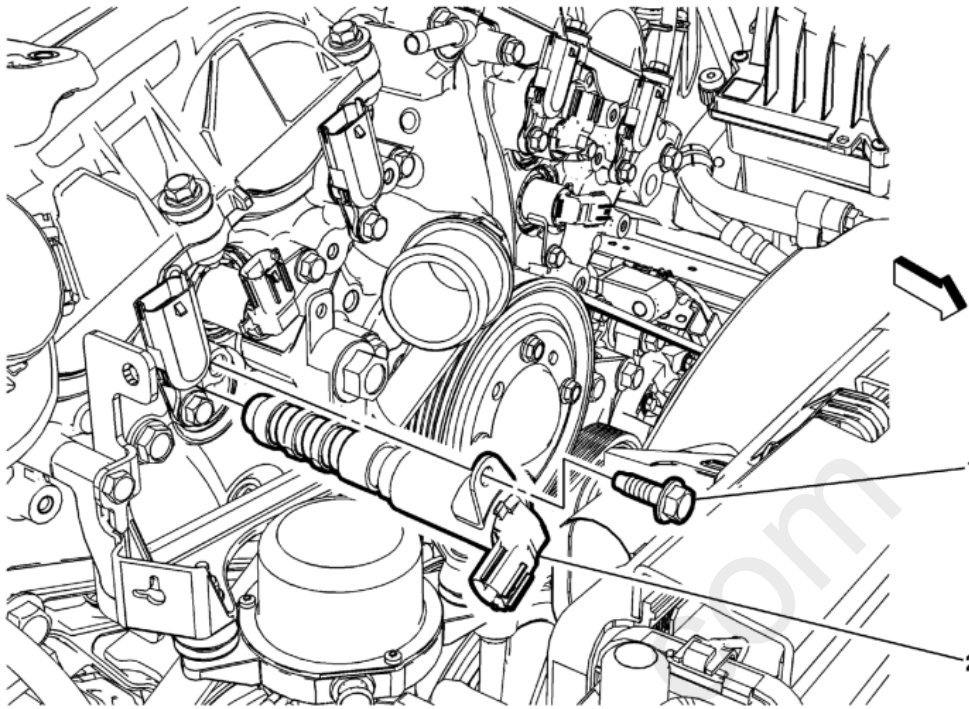


Fig. 232: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Exhaust (LF3)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

4. Use compressed air to remove debris from the camshaft position actuator solenoid valve solenoid and surrounding cavities.
5. Disconnect the camshaft position actuator solenoid valve solenoid electrical connector.
6. Remove the camshaft position actuator solenoid valve solenoid to engine front cover retaining bolt (1).
7. Remove the camshaft position actuator solenoid valve solenoid (2) from the engine front cover.

Installation Procedure

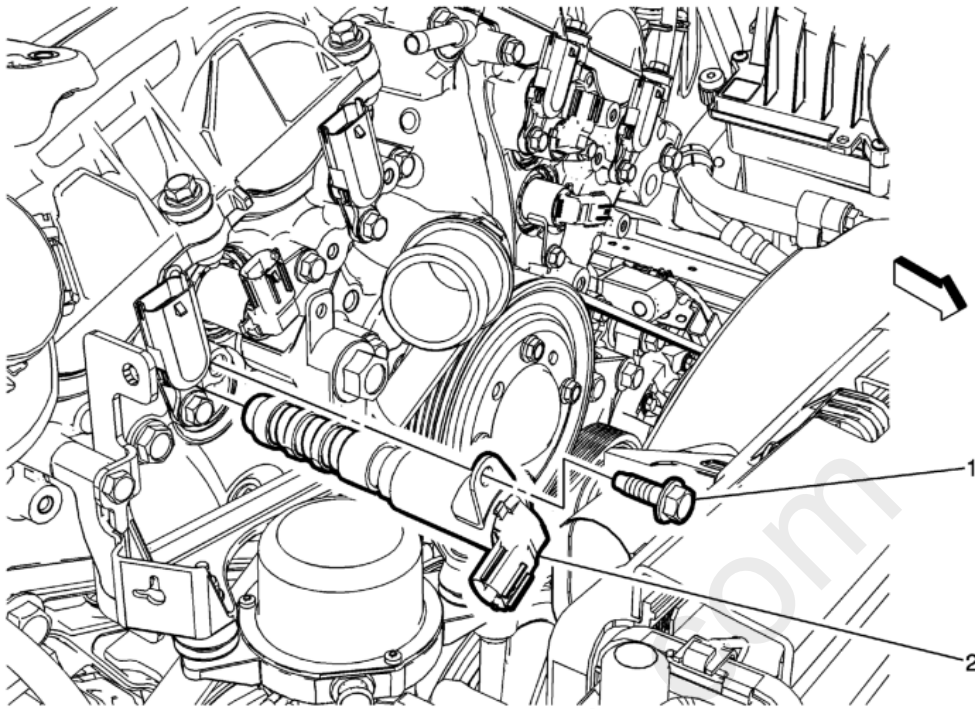


Fig. 233: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Exhaust (LF3)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Inspect the solenoid valve seals and replace as needed.**

1. Install the camshaft position actuator solenoid valve solenoid (2) into to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the camshaft position actuator solenoid valve solenoid to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).
3. Connect the camshaft position actuator solenoid valve solenoid electrical connector.
4. Connect the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)** .
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

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

Removal Procedure

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .

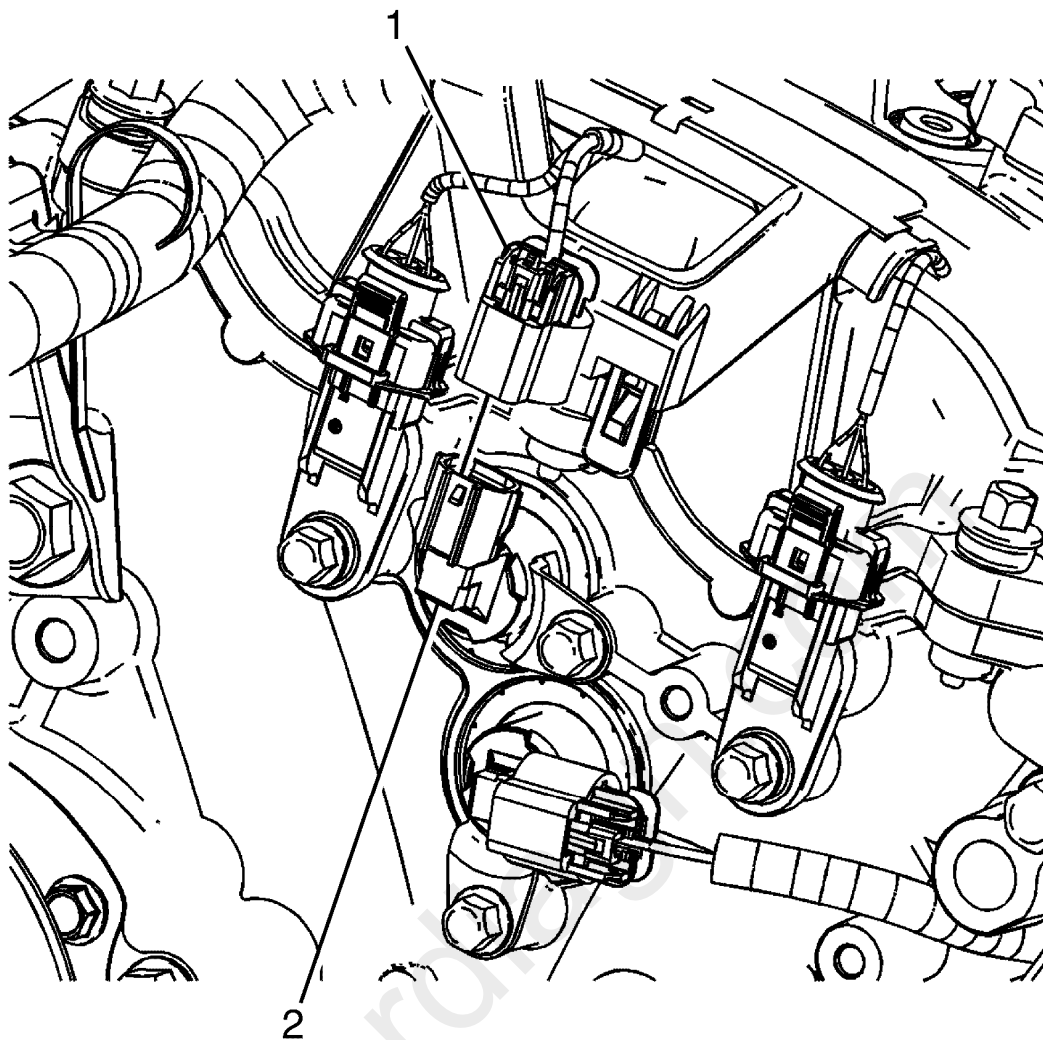


Fig. 234: Identifying CMP Actuator Valve & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP actuator (2).

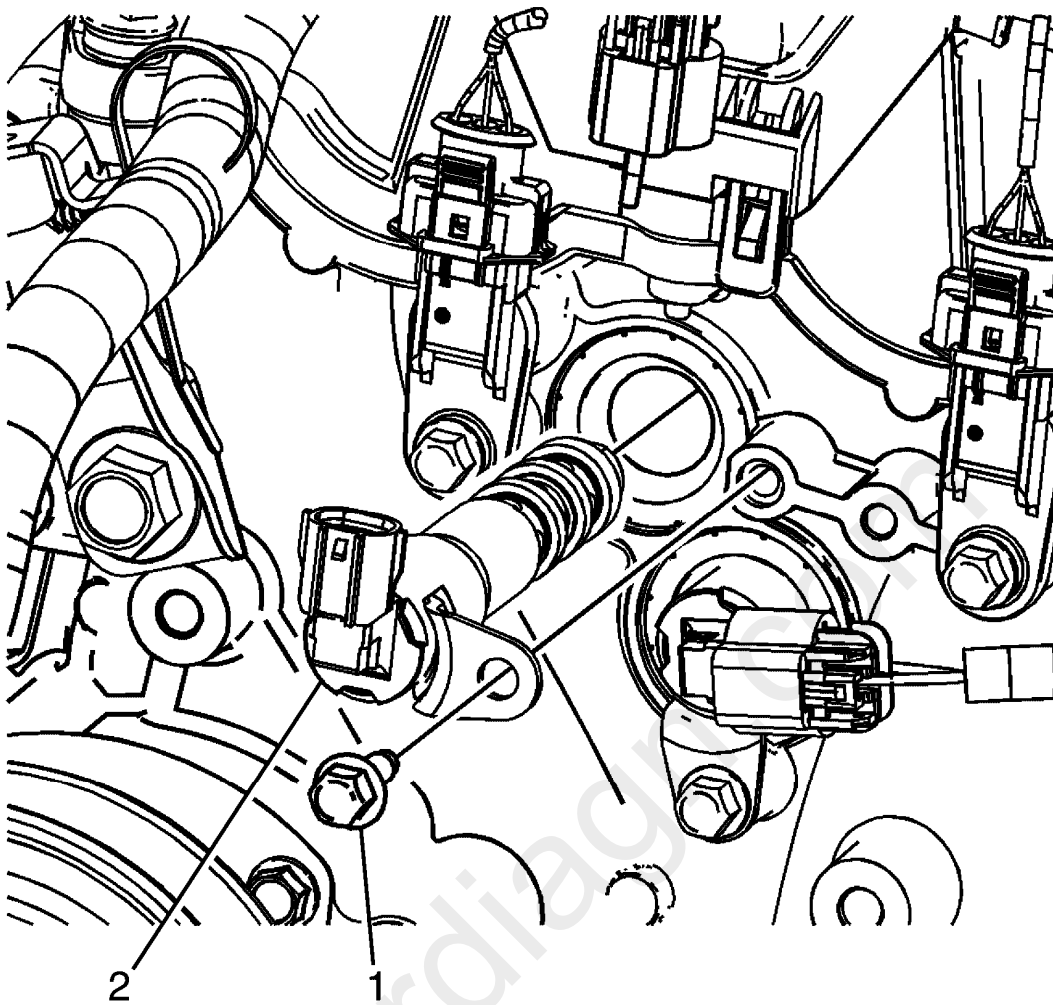


Fig. 235: Identifying CMP Actuator Solenoid Valve To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1).
5. Remove the CMP actuator valve (2) from the engine front cover.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

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

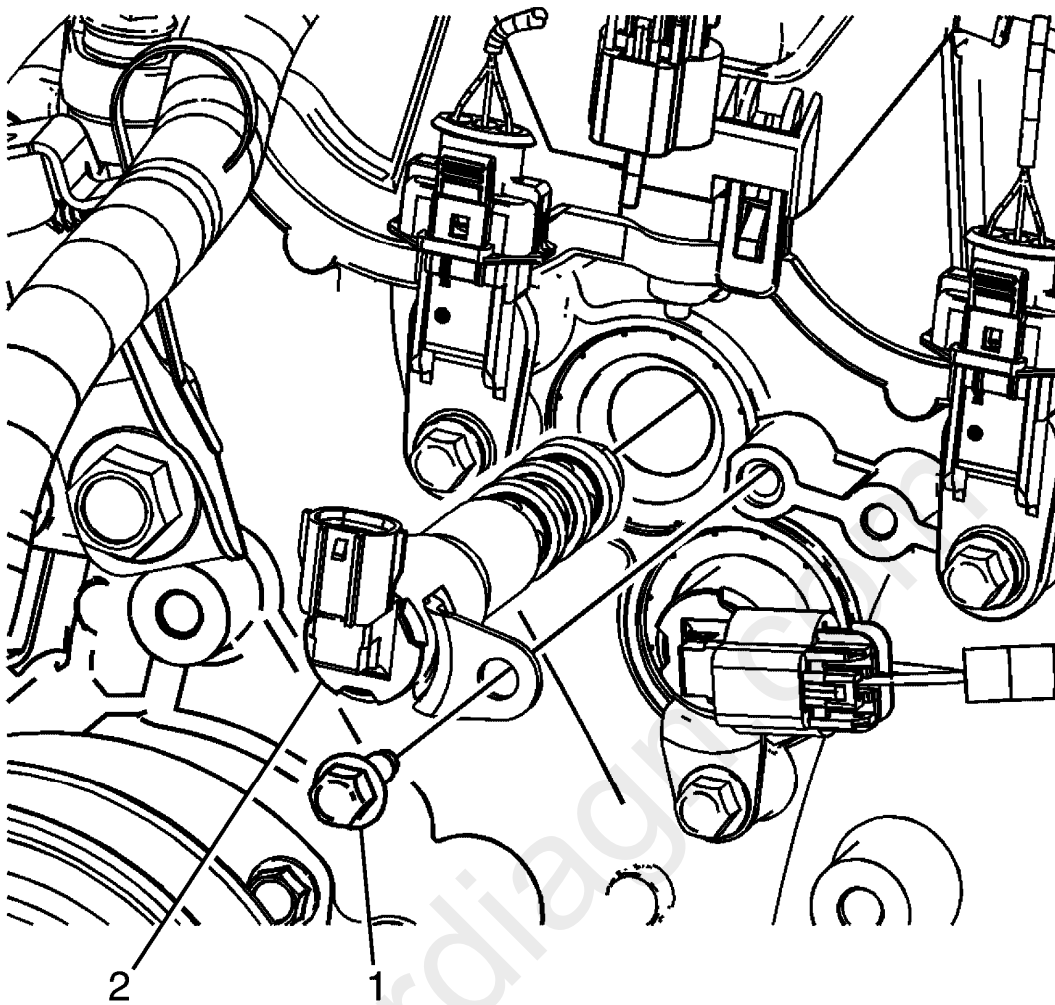


Fig. 236: Identifying CMP Actuator Solenoid Valve To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the CMP actuator valve (2) to the engine front cover.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator solenoid valve to engine front cover retaining bolt (1) and tighten to 9 N.m (80 lb in).

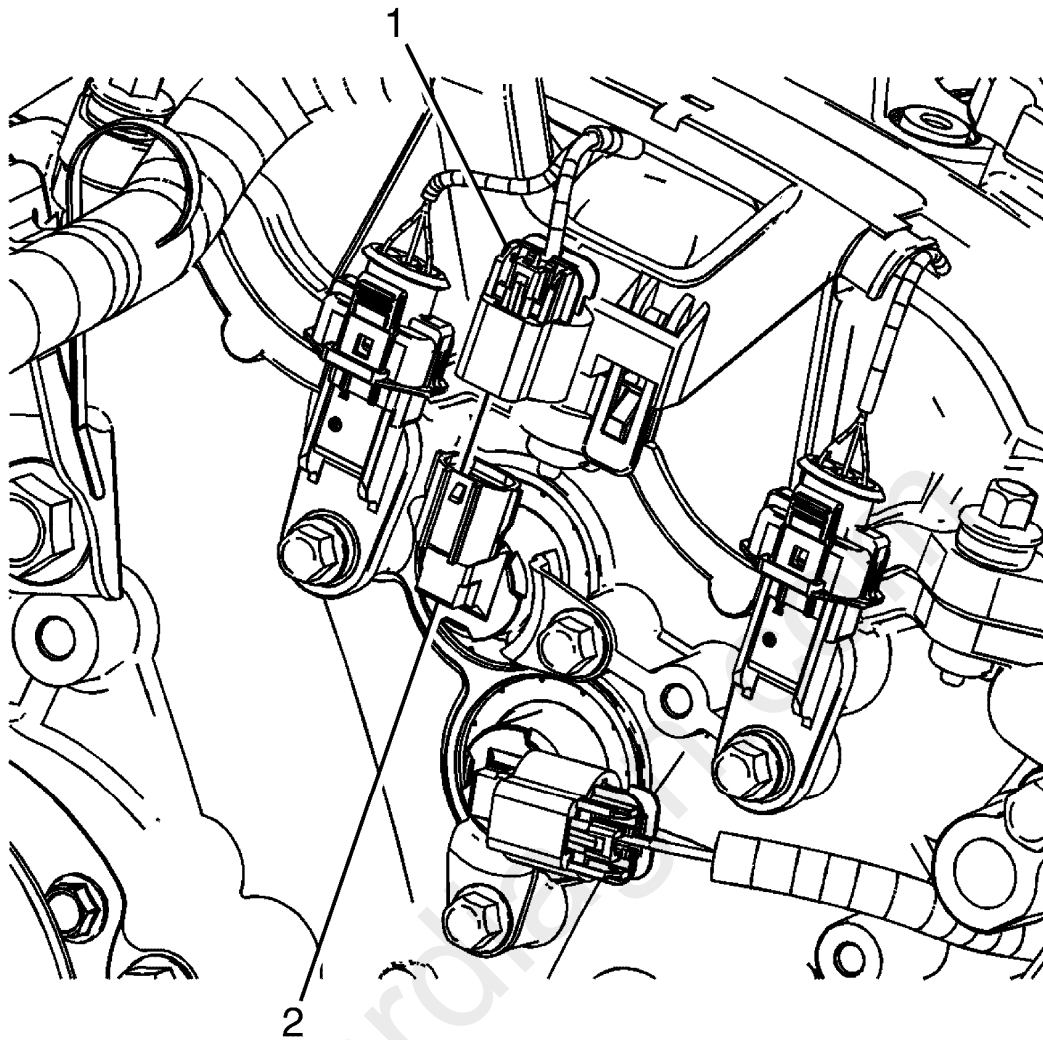


Fig. 237: Identifying CMP Actuator Valve & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the CMP actuator valve electrical connector (1) to the CMP actuator valve (2).
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE (LF3)

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

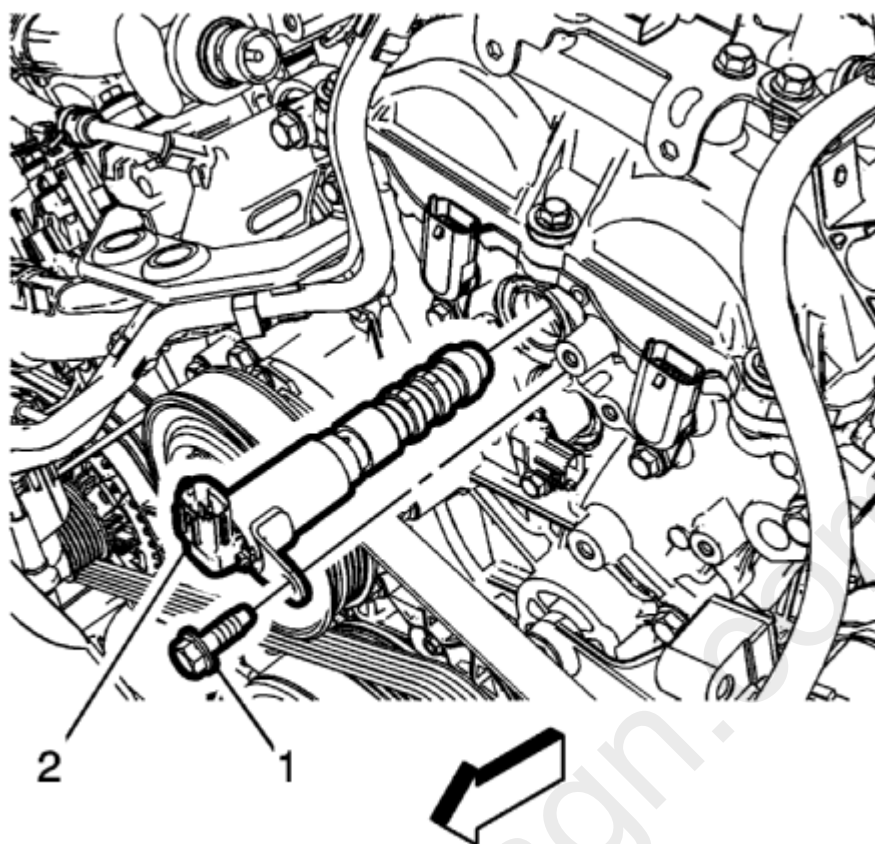


Fig. 238: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Intake (LF3)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

3. Use compressed air to remove debris from the camshaft position actuator solenoid valve solenoid and surrounding cavities.
4. Disconnect the camshaft position actuator solenoid valve solenoid electrical connector.
5. Remove the camshaft position actuator solenoid valve solenoid to engine front cover retaining bolt (1).
6. Remove the camshaft position actuator solenoid valve solenoid (2) from the engine front cover.

Installation Procedure

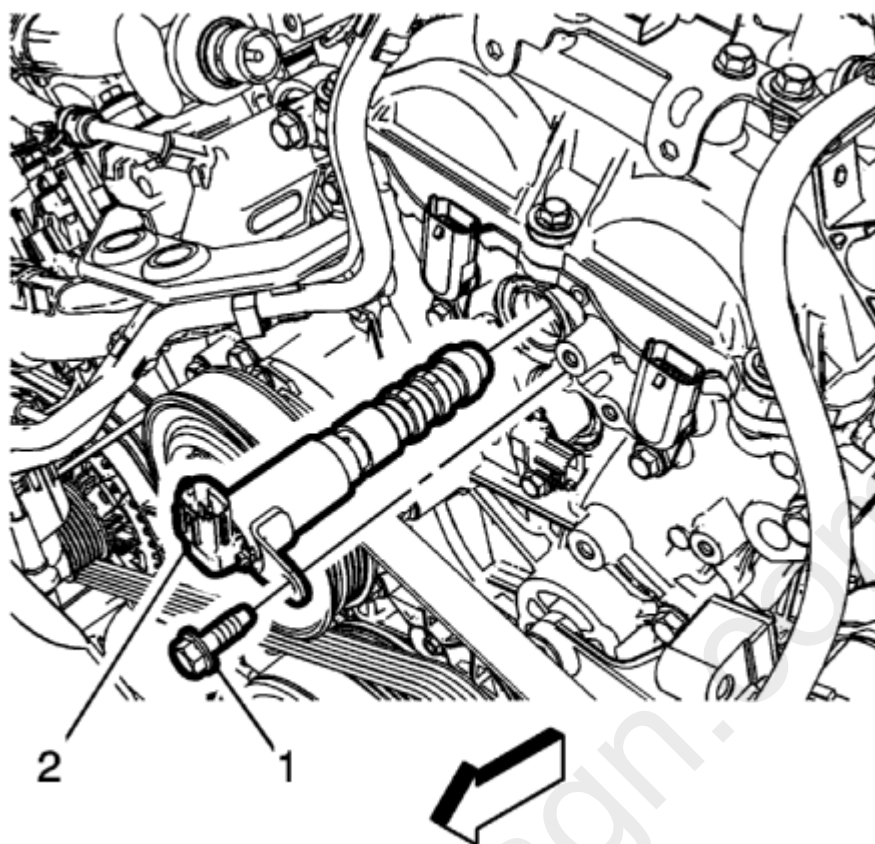


Fig. 239: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Intake (LF3)
Courtesy of GENERAL MOTORS COMPANY

NOTE: Inspect the solenoid valve seals and replace as needed.

1. Install the camshaft position actuator solenoid valve solenoid (2) into to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the camshaft position actuator solenoid valve solenoid to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).
3. Connect the camshaft position actuator solenoid valve solenoid electrical connector.
4. Install the intake manifold cover. Refer to Intake Manifold Cover Replacement (LF3) .

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

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) .

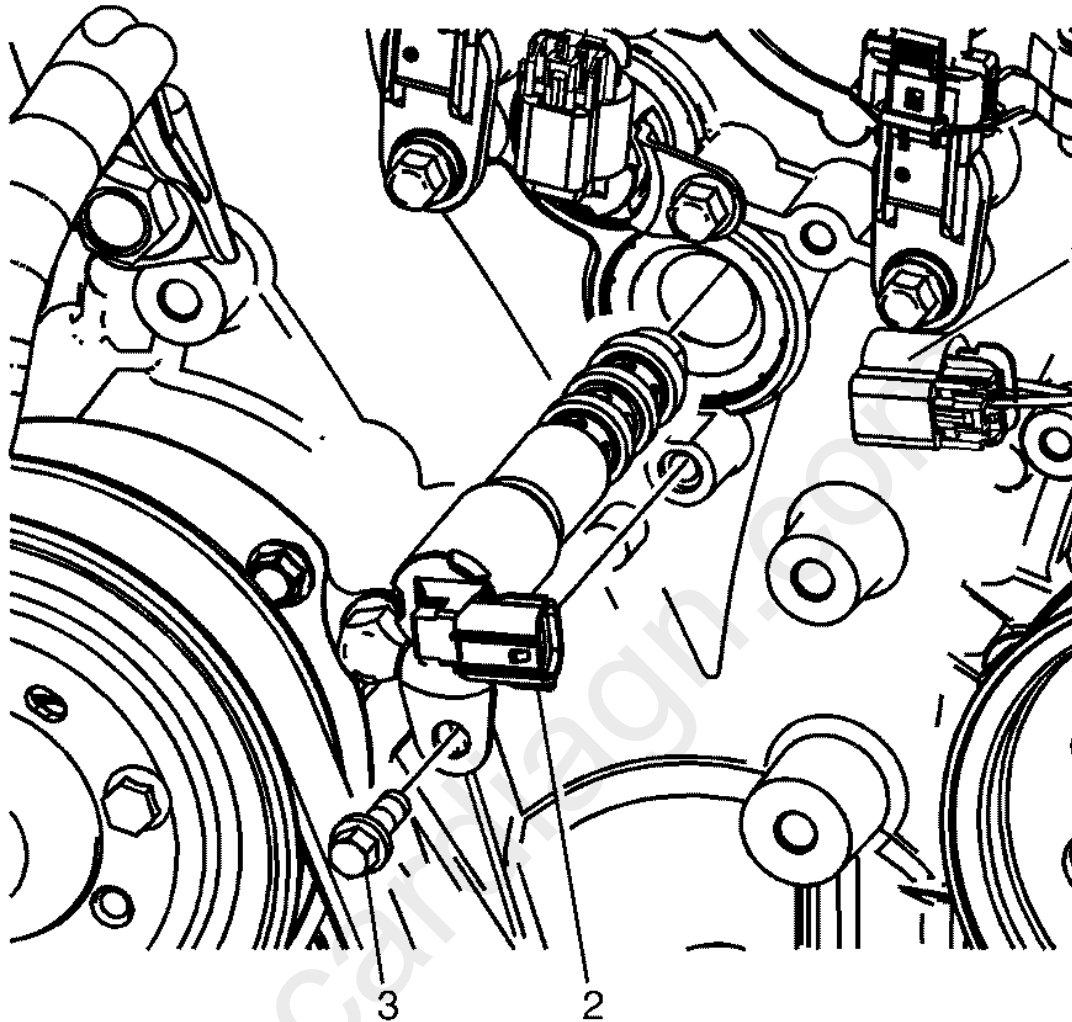


Fig. 240: CMP Actuator Solenoid Valve, Electrical Connector & Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

3. Use compressed air to remove debris from the camshaft position (CMP) actuator solenoid valve and surrounding cavities.
4. Remove the CMP actuator solenoid valve electrical connector (1) from the CMP actuator solenoid valve (2).
5. Remove the CMP actuator solenoid valve to engine front cover retaining bolt (3).
6. Remove the CMP actuator solenoid valve (2) from the engine.

Installation Procedure

1. Inspect the CMP actuator solenoid valve seal for damage. Replace the CMP actuator solenoid valve seal if necessary. Refer Engine Front Cover Disassemble

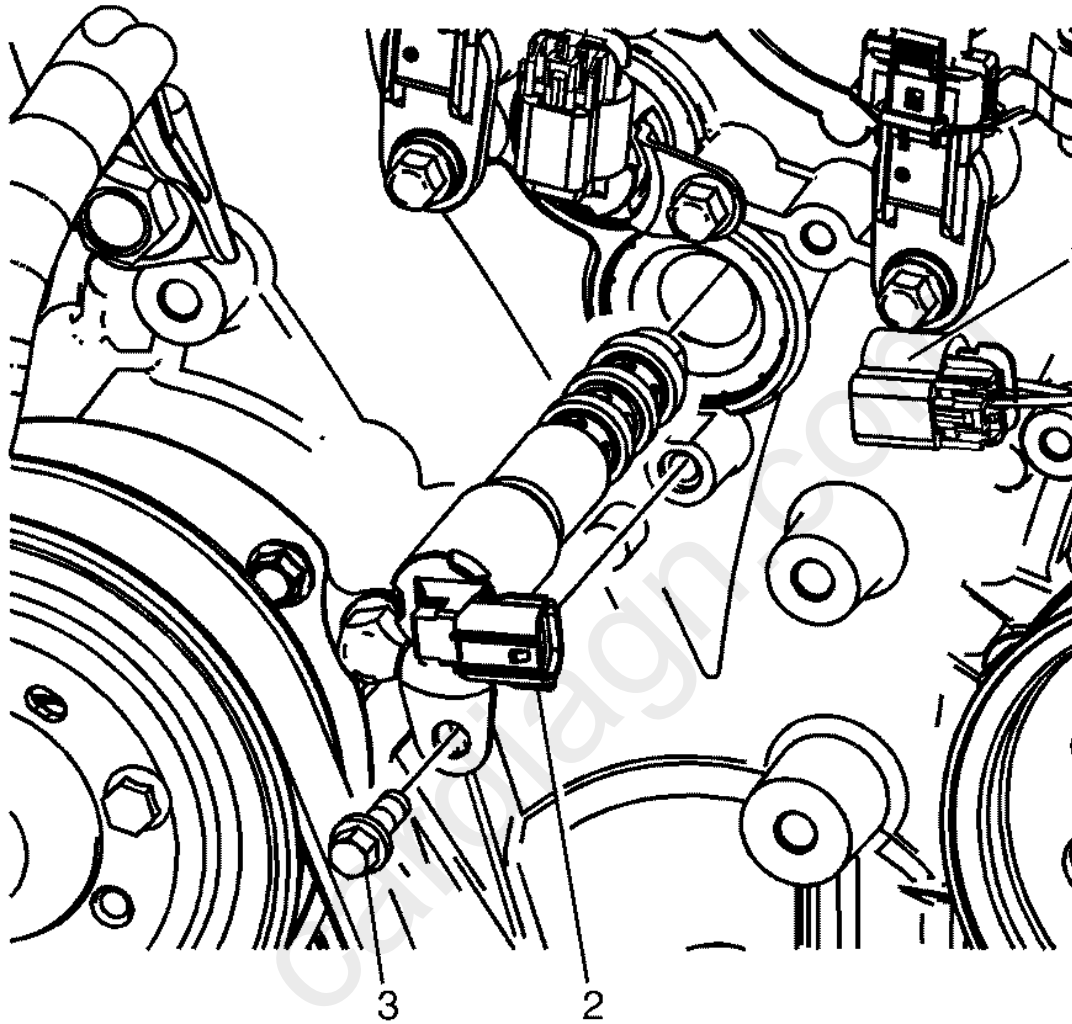


Fig. 241: CMP Actuator Solenoid Valve, Electrical Connector & Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the CMP actuator solenoid valve (2) to the engine.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator solenoid valve to engine front cover retaining bolt (3) and tighten to 9 N.m (80 lb in).
4. Connect the CMP actuator solenoid valve electrical connector (1) to the CMP actuator solenoid valve (2).

5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST (LF3)

Removal Procedure

1. Ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

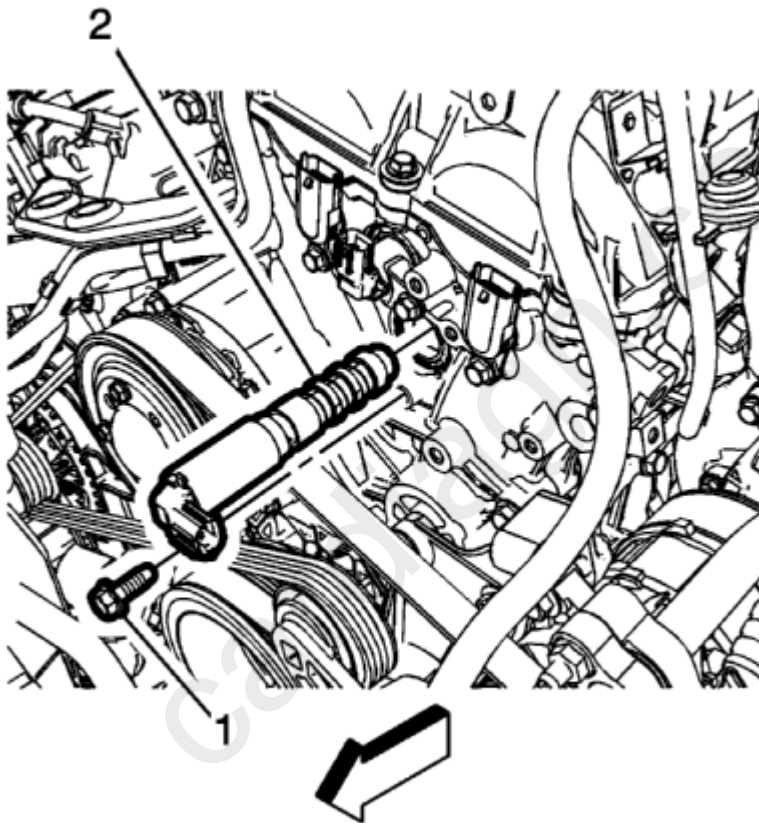


Fig. 242: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Exhaust (LF3)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to **Safety Glasses Warning** .

3. Use compressed air to remove debris from the camshaft position actuator solenoid valve solenoid and surrounding cavities.
4. Disconnect the camshaft position actuator solenoid valve solenoid electrical connector.
5. Remove the camshaft position actuator solenoid valve solenoid to engine front cover retaining bolt (1).

6. Remove the camshaft position actuator solenoid valve solenoid (2) from the engine front cover.

Installation Procedure

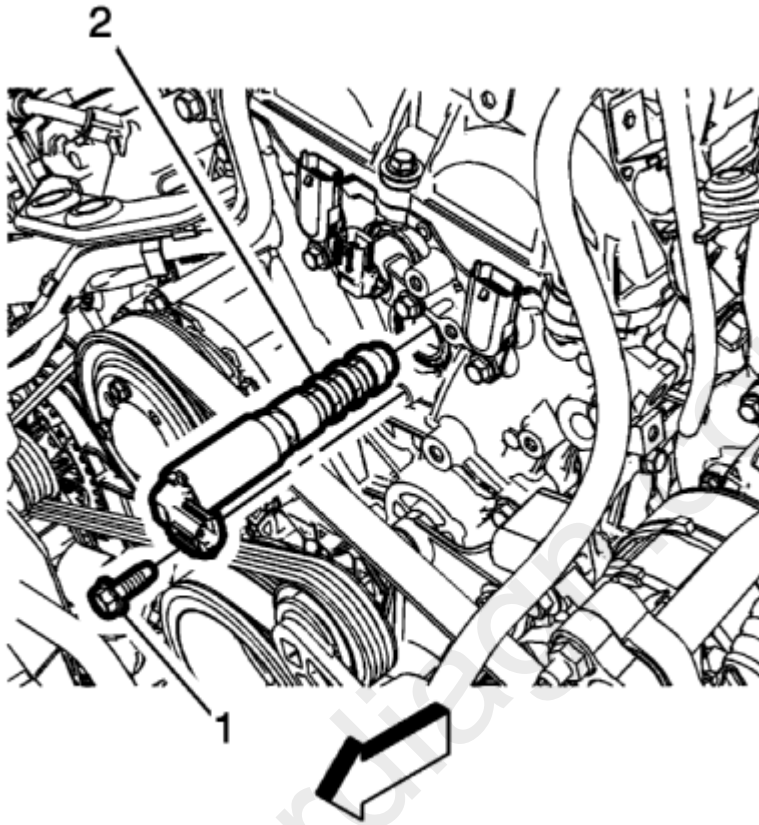


Fig. 243: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Exhaust (LF3)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Inspect the solenoid valve seals and replace as needed.**

1. Install the camshaft position actuator solenoid valve solenoid (2) into to the engine front cover.

CAUTION: Refer to **Fastener Caution** .

2. Install the camshaft position actuator solenoid valve solenoid to engine front cover retaining bolt (1) and tighten to 10 (89 lb in).
3. Connect the camshaft position actuator solenoid valve solenoid electrical connector.
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LF3)** .

KNOCK SENSOR REPLACEMENT - BANK 1 (LFX)

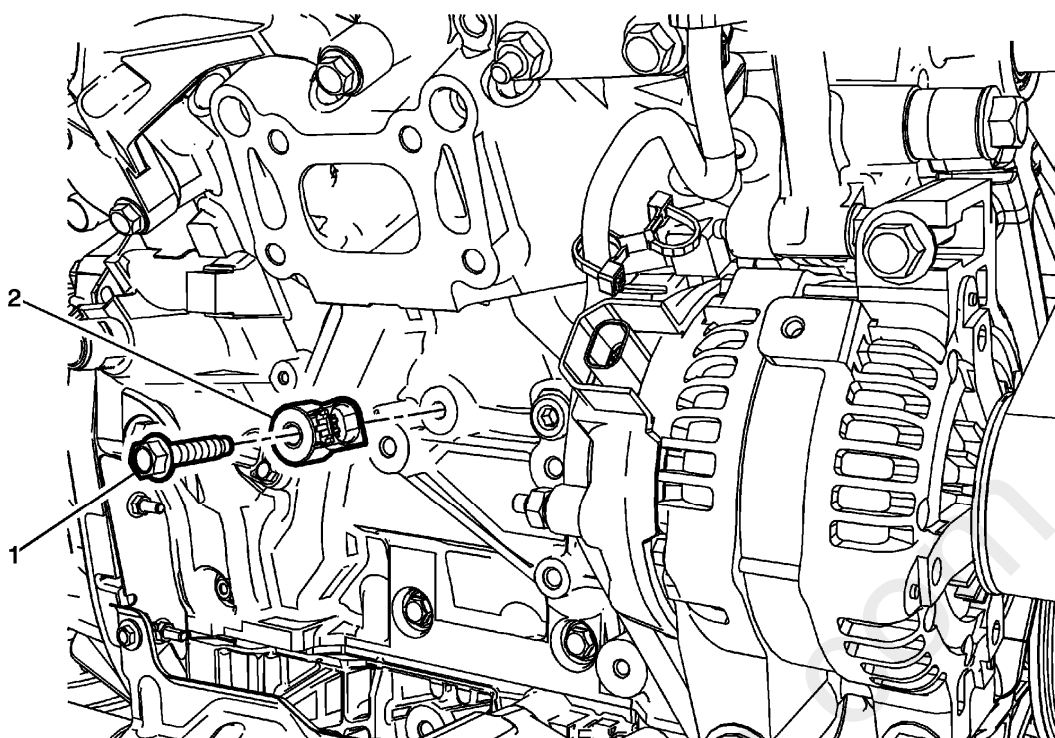


Fig. 244: Knock Sensor & Fastener - Bank 1
 Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Replacement - Bank 1 (LFX)

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side (LFX)</u> .	
1	Knock Sensor Fastener Tighten 23 (17 lb ft)
2	Knock Sensor Procedure Disconnect the knock sensor electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 1 (FRONT LF3)

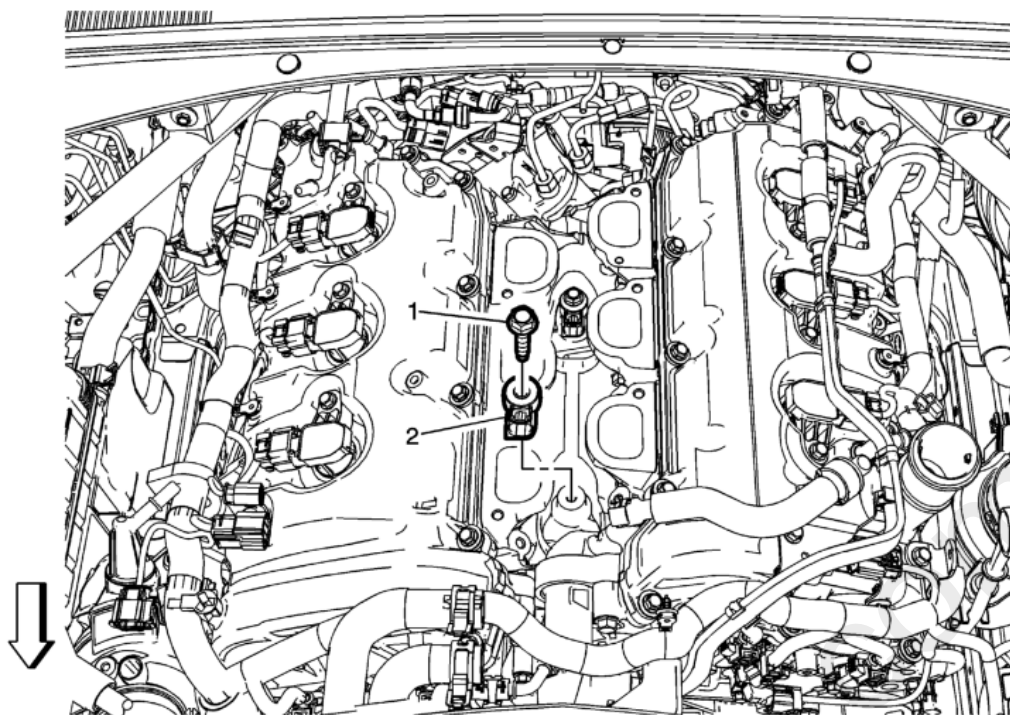


Fig. 245: Knock Sensor - Bank 1 (Front LF3)
 Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Replacement - Bank 1 (Front LF3)

Callout	Component Name
Preliminary Procedure Remove the fuel injection fuel rail assemblies bank 1 and bank 2. Refer to <u>Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF3)</u> , and <u>Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF3)</u> .	
1	Knock Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Knock Sensor Procedure 1. Disconnect the knock sensor electrical connector. 2. Ensure that the knock sensor connector opening is directed toward the front of the engine.

KNOCK SENSOR REPLACEMENT - BANK 2 (LFX)

Removal Procedure

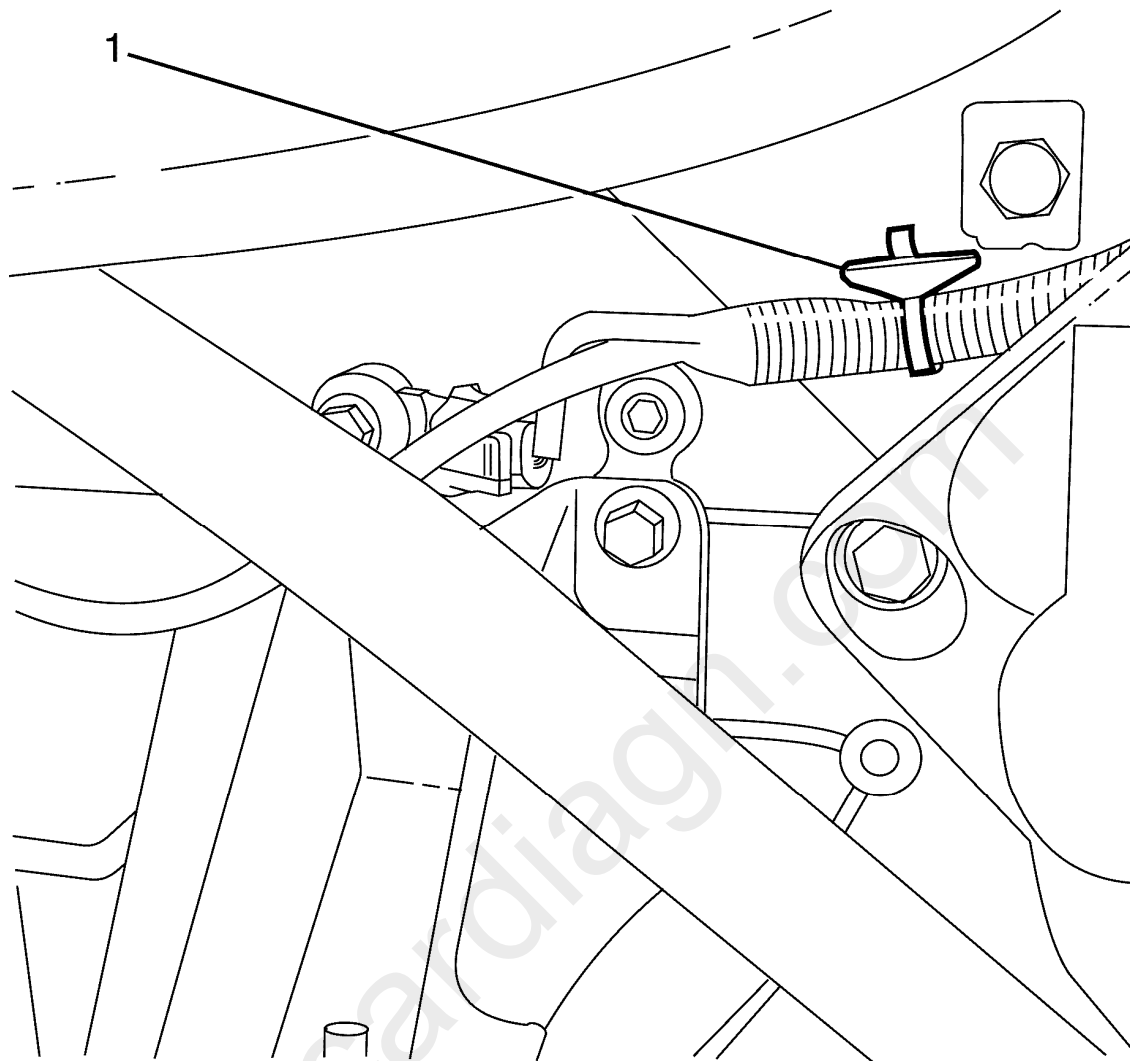


Fig. 246: Identifying Wiring Harness Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Disconnect the wiring harness retaining clip.

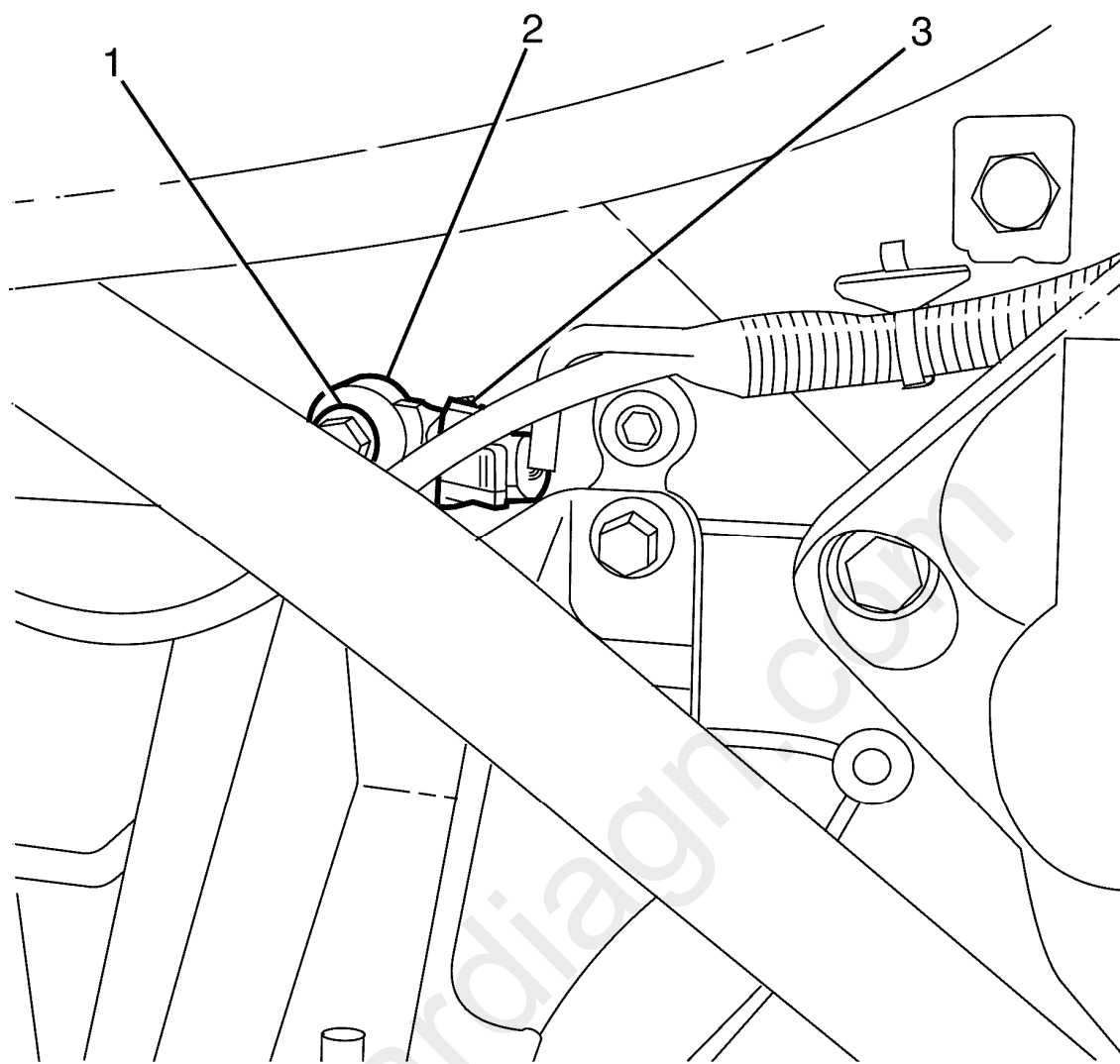


Fig. 247: Identifying Knock Sensor (KS) Electrical Connector & Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the knock sensor electrical connector (3) from the knock sensor (2).
4. Remove the sensor retaining bolt (1).

Installation Procedure

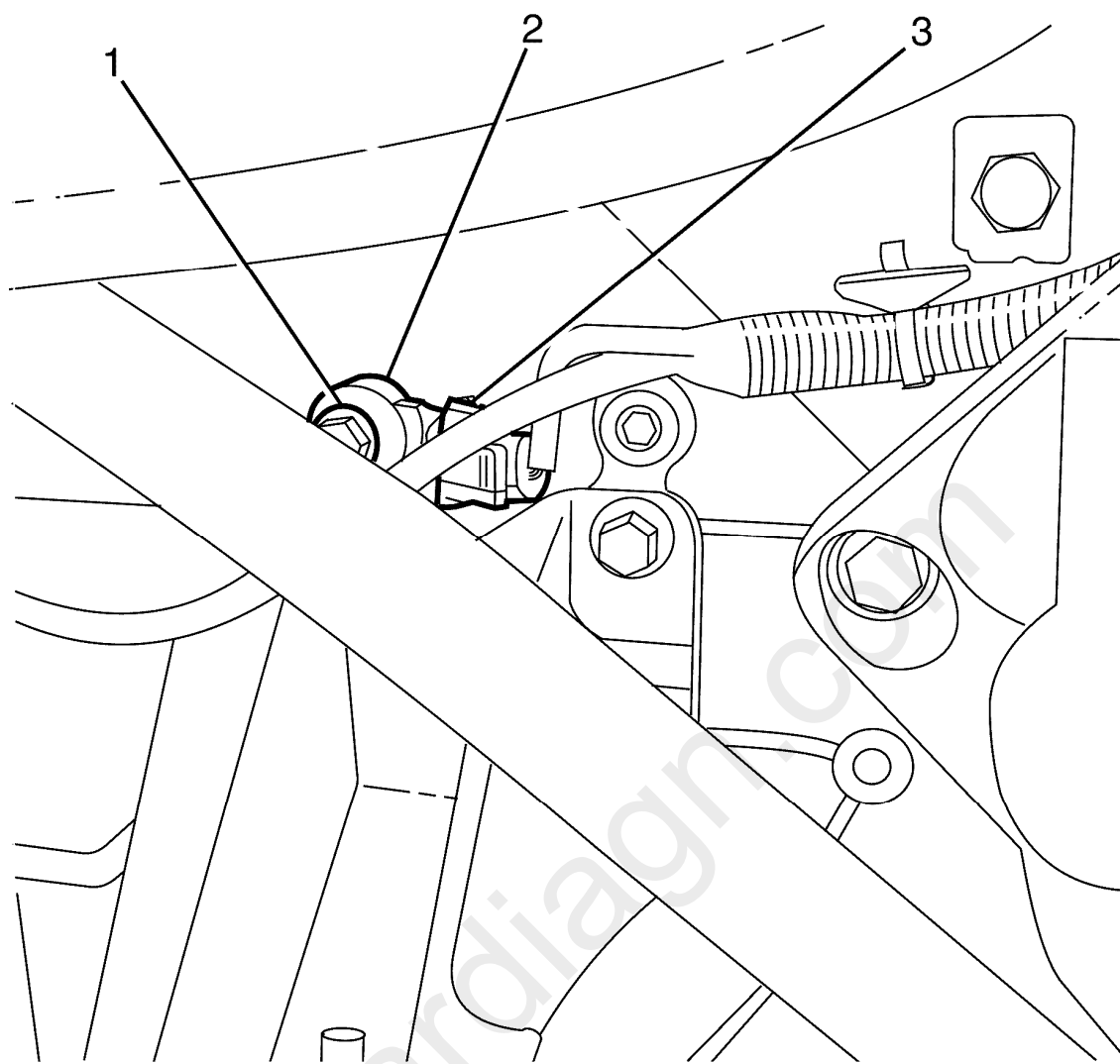


Fig. 248: Identifying Knock Sensor (KS) Electrical Connector & Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the knock sensor (2) to the engine block and tighten the retaining bolt (1) to 23 N.m (17 lb ft).
2. Install the knock sensor electrical (3) connector to the KS.
3. Lower the vehicle.

KNOCK SENSOR REPLACEMENT - BANK 2 (REAR LF3)

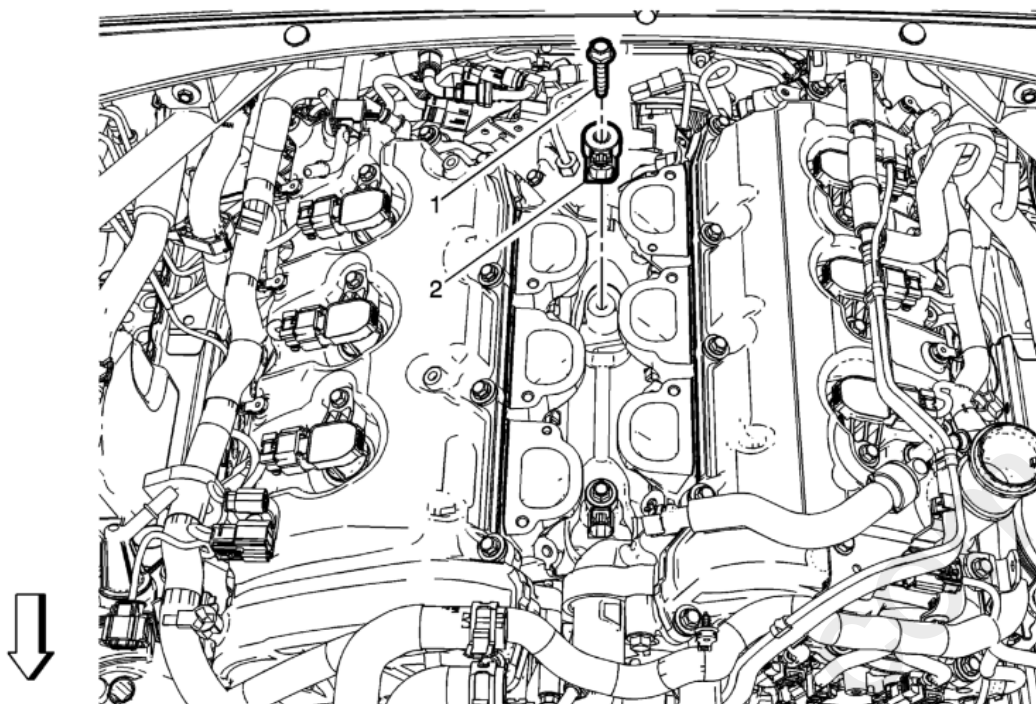


Fig. 249: Knock Sensor - Bank 2 (Rear LF3)
 Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Replacement - Bank 2 (Rear LF3)

Callout	Component Name
Preliminary Procedure Remove the fuel injection fuel rail assemblies bank 1 and bank 2. Refer to <u>Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF3)</u> , and <u>Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF3)</u> .	
1	Knock Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Knock Sensor Procedure 1. Disconnect the knock sensor electrical connector. 2. Ensure that the knock sensor connector opening is directed toward the front of the engine.

CHARGE AIR BYPASS VALVE SOLENOID REPLACEMENT (LF3)

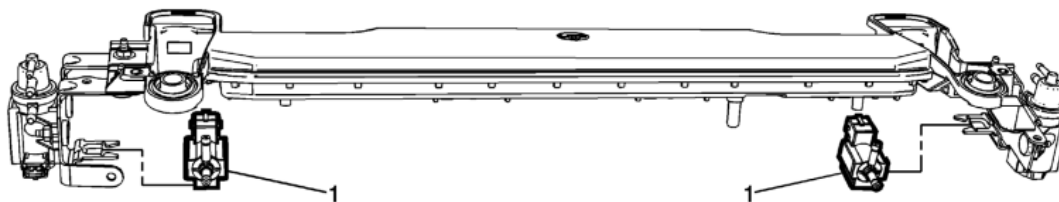


Fig. 250: Charge Air Bypass Valve Solenoid (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Bypass Valve Solenoid Replacement (LF3)

Callout	Component Name
Preliminary Procedure	
1. Remove the turbocharger wastegate actuator vacuum tank. Refer to <u>Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)</u> . 2. Disconnect the electrical connectors from charge air bypass valve solenoids. 3. Disconnect vacuum lines from charge air bypass valve solenoids.	
1	Charge Air Bypass Valve Solenoid (Qty: 2) Procedure Release tabs to remove solenoids from brackets.

CHARGE AIR BYPASS VALVE VACUUM TANK TUBE REPLACEMENT (LEFT SIDE WASTEGATE TO VACUUM TUBE LF3)

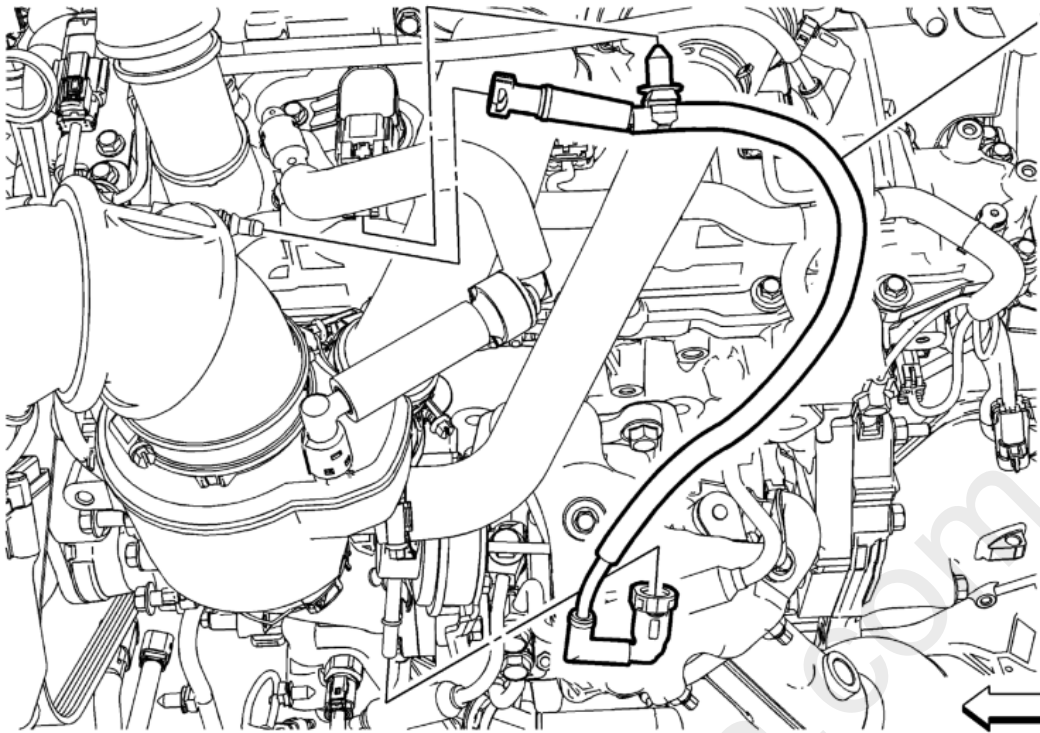


Fig. 251: Charge Air Bypass Valve Vacuum Tank Tube (Left Side Wastegate to Vacuum Tube LF3)
Courtesy of GENERAL MOTORS COMPANY

Charge Air Bypass Valve Vacuum Tank Tube Replacement (Left Side Wastegate to Vacuum Tube LF3)

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF3)</u> .	
1	Charge Air Bypass Valve Vacuum Tank Tube Procedure Disconnect the retainer and disconnect the quick connect fittings. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

CHARGE AIR BYPASS VALVE VACUUM TANK TUBE REPLACEMENT (RIGHT SIDE WASTEGATE TO VACUUM TUBE LF3)

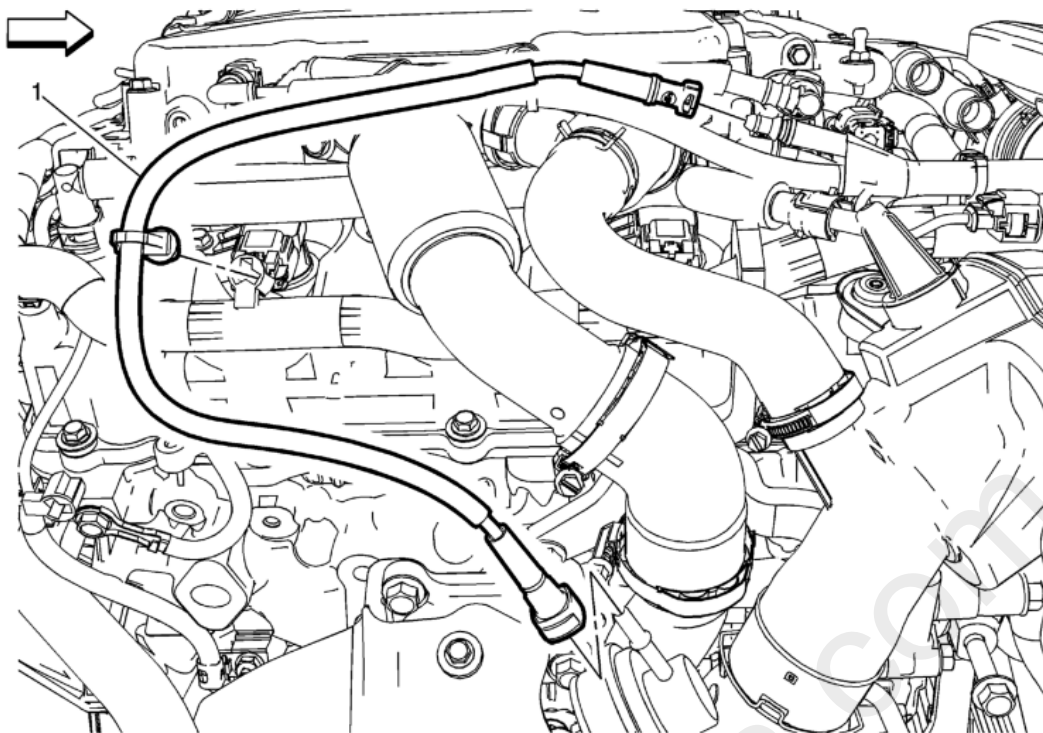


Fig. 252: Charge Air Bypass Valve Vacuum Tank Tube (Right Side Wastegate to Vacuum Tube LF3)
Courtesy of GENERAL MOTORS COMPANY

Charge Air Bypass Valve Vacuum Tank Tube Replacement (Right Side Wastegate to Vacuum Tube LF3)

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Charge Air Bypass Valve Vacuum Tank Tube Procedure Disconnect the retainer and disconnect the quick connect fittings. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

CHARGE AIR BYPASS VALVE VACUUM TANK TUBE REPLACEMENT (BUNDLE RIGHT SECTION LF3)

Removal Procedure

1. Remove the turbocharger wastegate actuator vacuum tank. Refer to **Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)**.

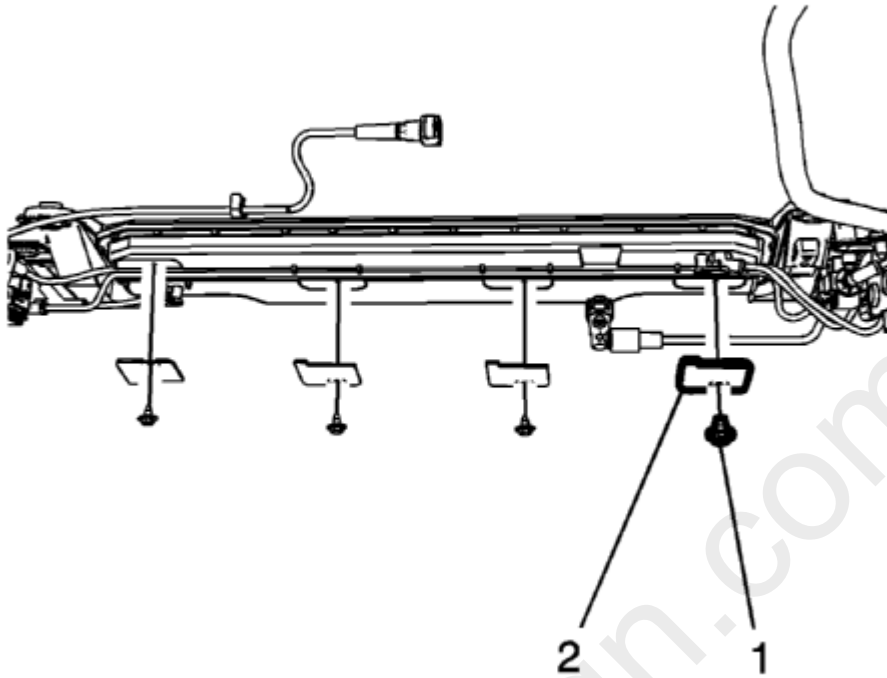


Fig. 253: Turbocharger Wastegate Actuator Vacuum Tank Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the turbocharger wastegate actuator vacuum tank bracket bolts (1).
3. Remove the turbocharger wastegate actuator vacuum tank brackets (2).

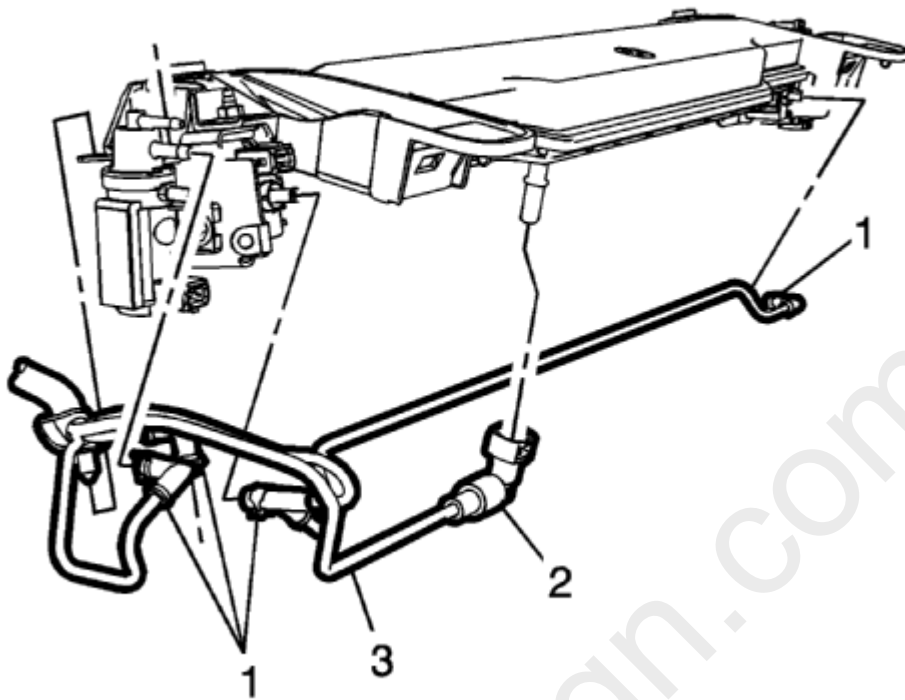


Fig. 254: Charge Air Cooler Bypass Valve Vacuum Tank Tube Clamps
Courtesy of GENERAL MOTORS COMPANY

4. Remove the charge air cooler bypass valve vacuum tank tube clamps (1).
5. Disconnect the charge air cooler bypass valve vacuum tank tube quick disconnect fitting (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Disconnect retainer and remove the charge air cooler bypass valve vacuum tank tube (3).

Installation Procedure

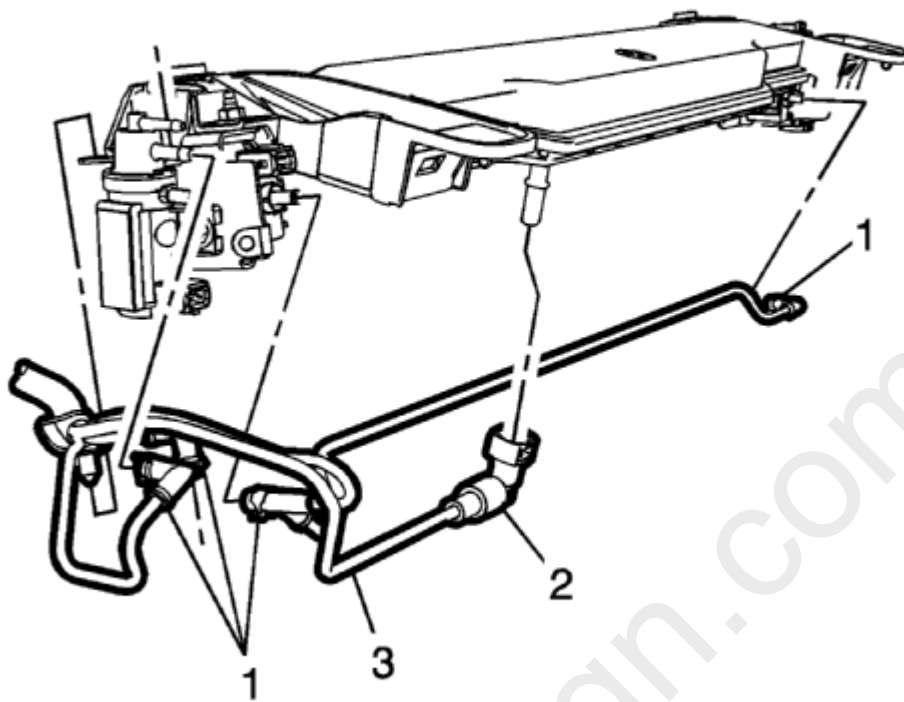


Fig. 255: Charge Air Cooler Bypass Valve Vacuum Tank Tube Clamps
Courtesy of GENERAL MOTORS COMPANY

1. Connect retainer and install the charge air cooler bypass valve vacuum tank tube (3).
2. Connect the charge air cooler bypass valve vacuum tank tube quick disconnect fitting (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the charge air cooler bypass valve vacuum tank tube clamps (1).

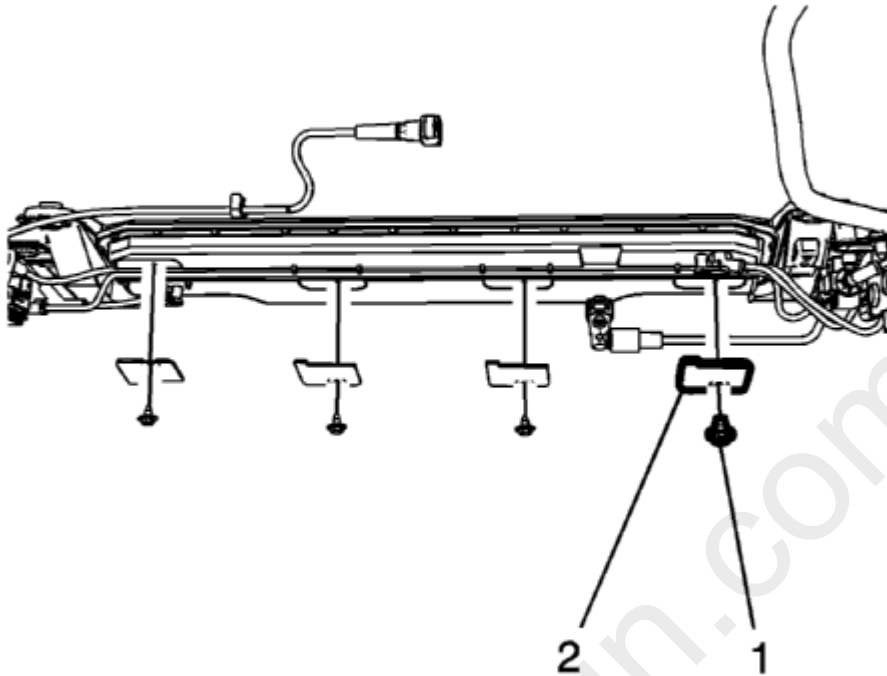


Fig. 256: Turbocharger Wastegate Actuator Vacuum Tank Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the turbocharger wastegate actuator vacuum tank brackets (2).

CAUTION: Refer to Fastener Caution .

5. Install the turbocharger wastegate actuator vacuum tank bracket bolts (1) and tighten to 9 (80 lb in).
6. Install the turbocharger wastegate actuator vacuum tank. Refer to **Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)**.

CHARGE AIR BYPASS VALVE VACUUM TANK TUBE REPLACEMENT (BUNDLE LEFT SECTION LF3)

Removal Procedure

1. Remove the turbocharger wastegate actuator vacuum tank. Refer to **Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)**.

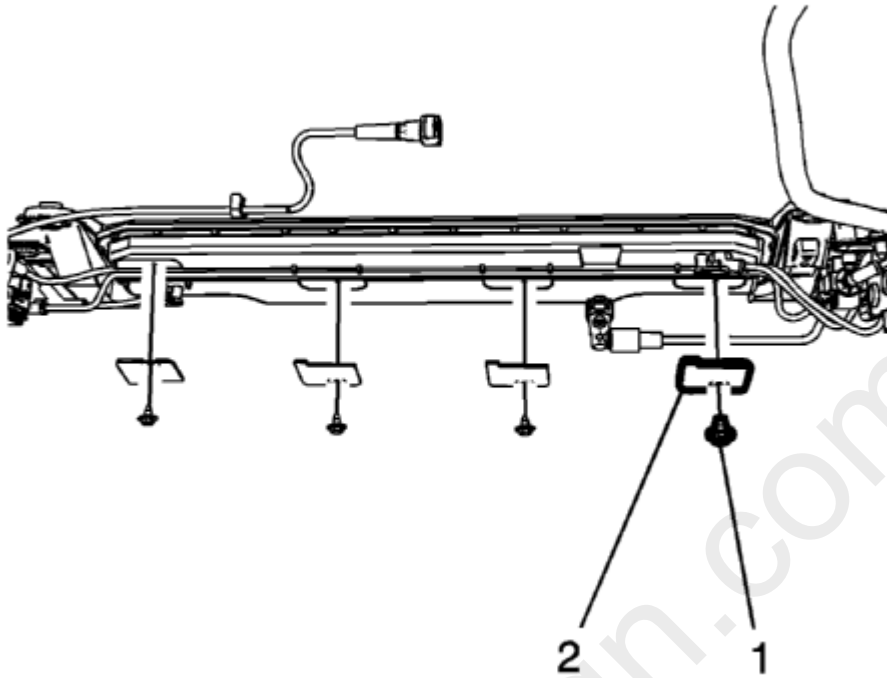


Fig. 257: Turbocharger Wastegate Actuator Vacuum Tank Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the turbocharger wastegate actuator vacuum tank bracket bolts (1).
3. Remove the turbocharger wastegate actuator vacuum tank brackets (2).

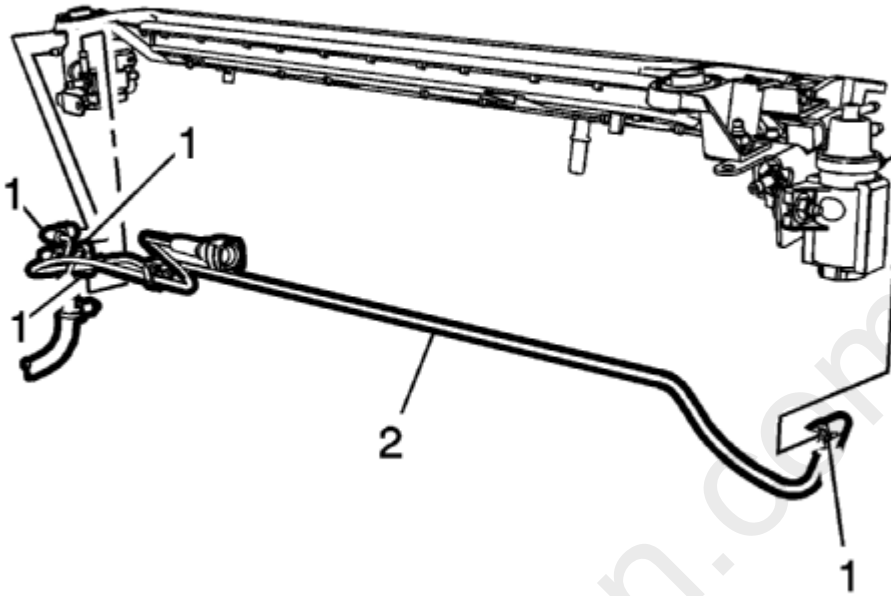


Fig. 258: Charge Air Cooler Bypass Valve Vacuum Tank Tube Clamps
Courtesy of GENERAL MOTORS COMPANY

4. Remove the charge air cooler bypass valve vacuum tank tube clamps (1).
5. Remove the charge air cooler bypass valve vacuum tank tube (2).

Installation Procedure

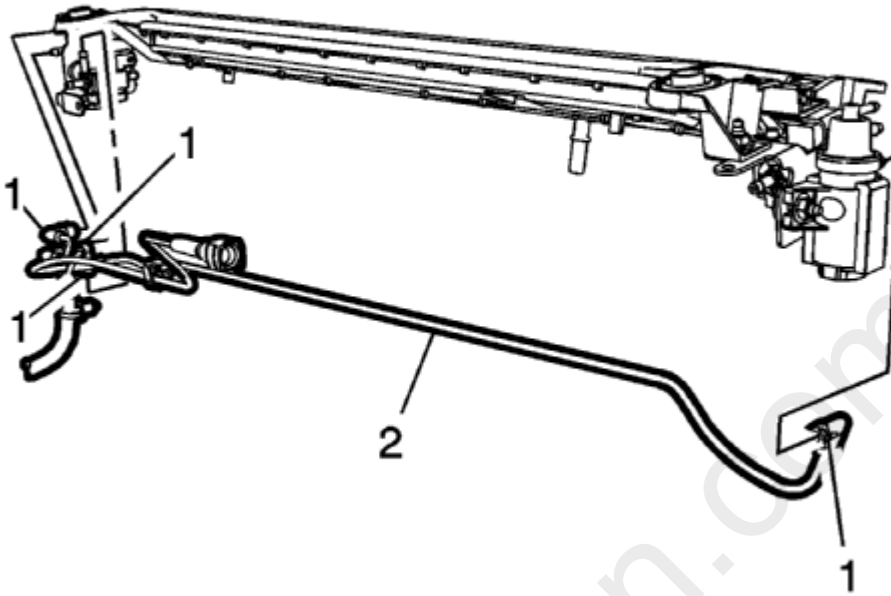


Fig. 259: Charge Air Cooler Bypass Valve Vacuum Tank Tube Clamps
Courtesy of GENERAL MOTORS COMPANY

1. Install the charge air cooler bypass valve vacuum tank tube (2).
2. Install the charge air cooler bypass valve vacuum tank tube clamps (1).

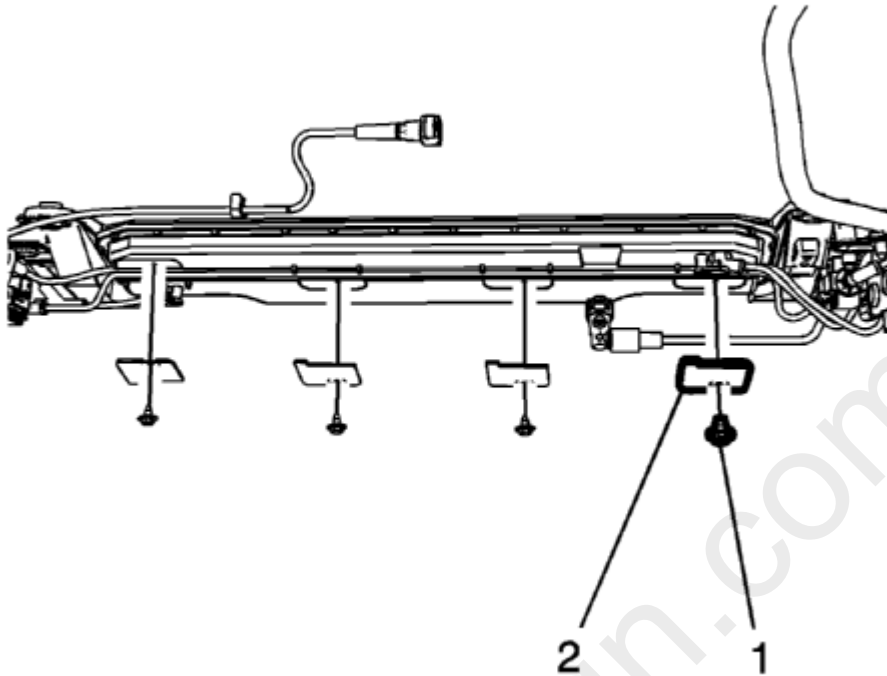


Fig. 260: Turbocharger Wastegate Actuator Vacuum Tank Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the turbocharger wastegate actuator vacuum tank brackets (2).

CAUTION: Refer to Fastener Caution .

4. Install the turbocharger wastegate actuator vacuum tank bracket bolts (1) and tighten to 9 (80 lb in).
5. Install the turbocharger wastegate actuator vacuum tank. Refer to **Turbocharger Wastegate Actuator Vacuum Tank Replacement (LF3)**.

CHARGE AIR BYPASS VALVE REPLACEMENT - RIGHT SIDE (LF3)

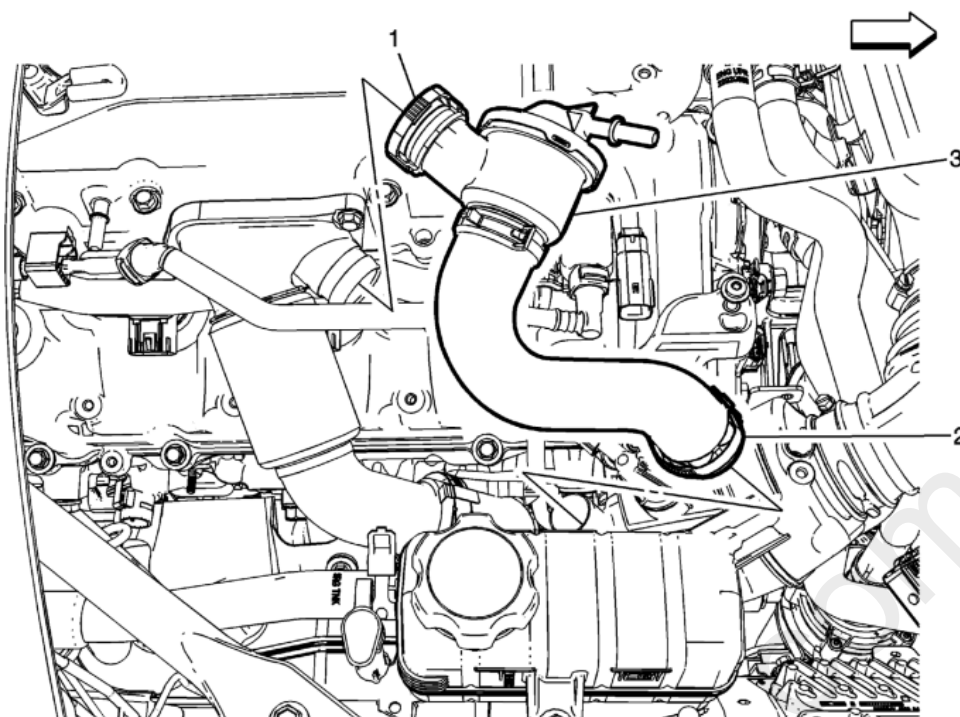


Fig. 261: Charge Air Bypass Valve - Right Side (LF3)

Courtesy of GENERAL MOTORS COMPANY

Charge Air Bypass Valve Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Disconnect vacuum line from charge air bypass valve. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>.	
1	Charge Air Bypass Valve Quick Disconnect Procedure Disconnect the quick connect fitting by squeezing both ends.
2	Charge Air Bypass Valve Clamp CAUTION: Refer to <u>Fastener Caution</u> .
3	Charge Air Bypass Valve

CHARGE AIR BYPASS VALVE REPLACEMENT - LEFT SIDE (LF3)

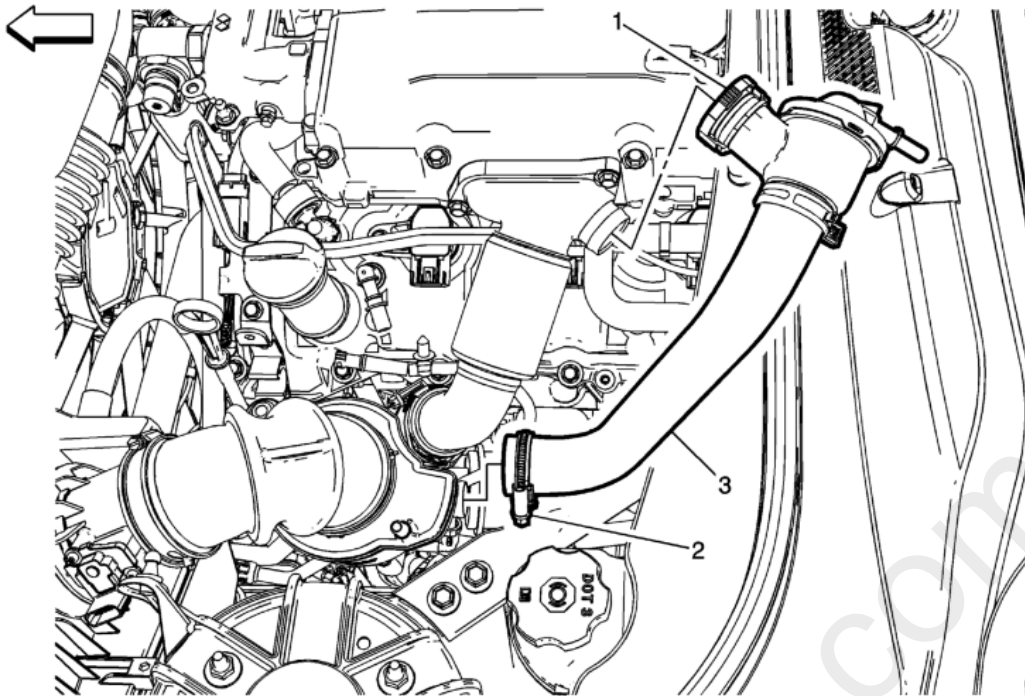


Fig. 262: Charge Air Bypass Valve - Left Side (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Bypass Valve Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Disconnect vacuum line from charge air bypass valve. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Charge Air Bypass Valve Quick Disconnect Procedure Disconnect the quick connect fitting by squeezing both ends.
2	Charge Air Bypass Valve Clamp CAUTION: Refer to <u>Fastener Caution</u> .
3	Charge Air Bypass Valve

CHARGE AIR COOLER INLET AIR HOSE REPLACEMENT - RIGHT SIDE (LF3)

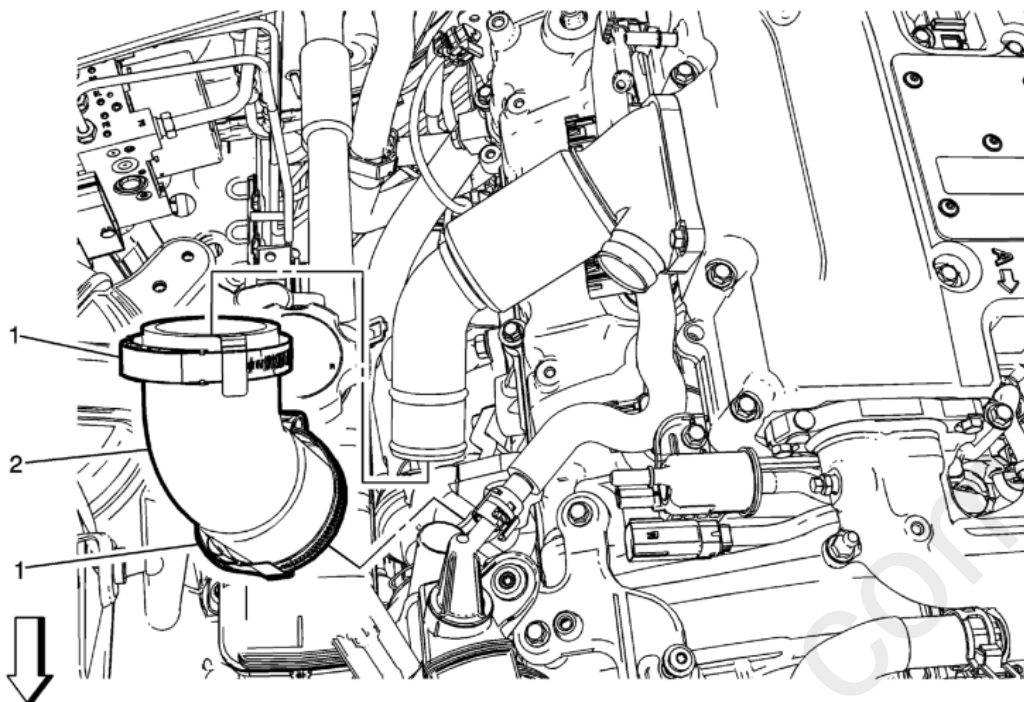


Fig. 263: Charge Air Cooler Inlet Air Hose - Right Side (LF3)

Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Inlet Air Hose Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedure Remove the charge air cooler inlet pipe right side. Refer to <u>Charge Air Cooler Inlet Pipe Replacement - Right Side (LF3)</u> .	
1	Charge Air Cooler Inlet Air Hose Clamp (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Charge Air Cooler Inlet Air Hose

CHARGE AIR COOLER INLET AIR HOSE REPLACEMENT - LEFT SIDE (LF3)

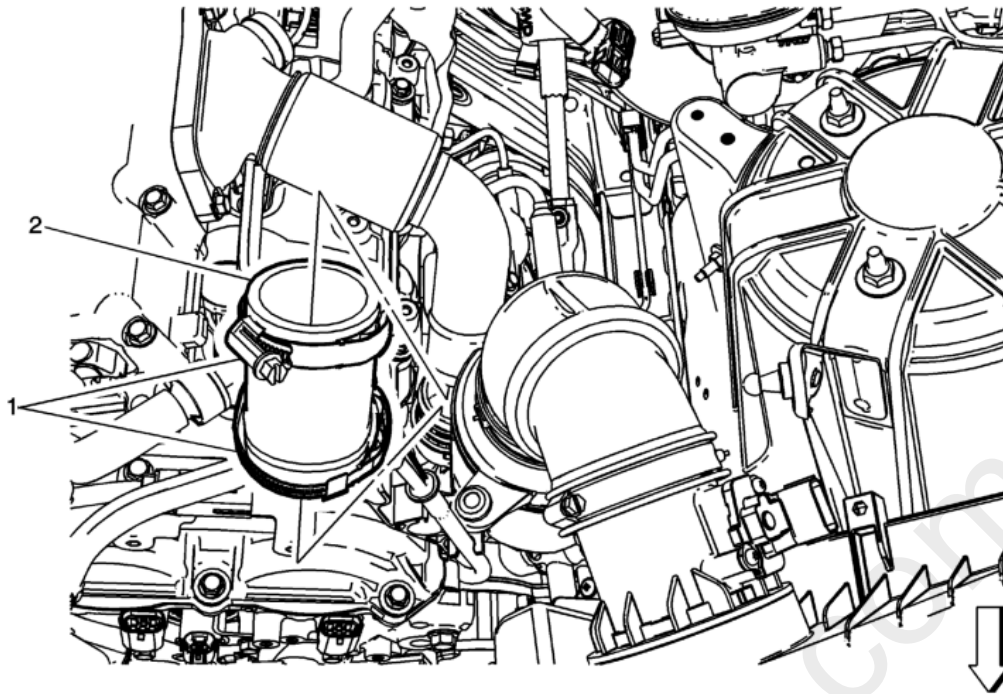


Fig. 264: Charge Air Cooler Inlet Air Hose - Left Side (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Inlet Air Hose Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedure Remove the charge air cooler inlet pipe left side. Refer to <u>Charge Air Cooler Inlet Pipe Replacement - Left Side (LF3).</u>	
1	Charge Air Cooler Inlet Air Hose Clamp (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Charge Air Cooler Inlet Air Hose

CHARGE AIR COOLER INLET PIPE REPLACEMENT - RIGHT SIDE (LF3)

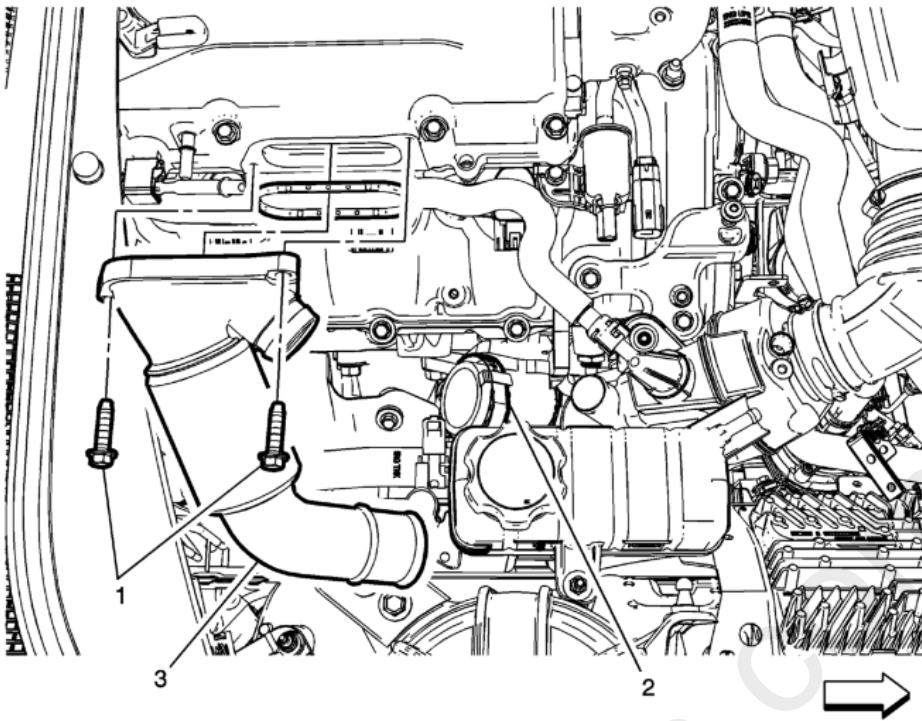


Fig. 265: Charge Air Cooler Inlet Pipe - Right Side (LF3)

Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Inlet Pipe Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Disconnect the charge air bypass valve right side from charge air cooler inlet pipe. Refer to <u>Charge Air Bypass Valve Replacement - Right Side (LF3)</u>.	
1	Charge Air Cooler Inlet Pipe Bolts (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Charge Air Cooler Inlet Pipe Clamp
3	Charge Air Cooler Inlet Pipe Procedure Install NEW charge air cooler inlet pipe seal.

TURBOCHARGER AIR INLET ADAPTER REPLACEMENT - BANK 1

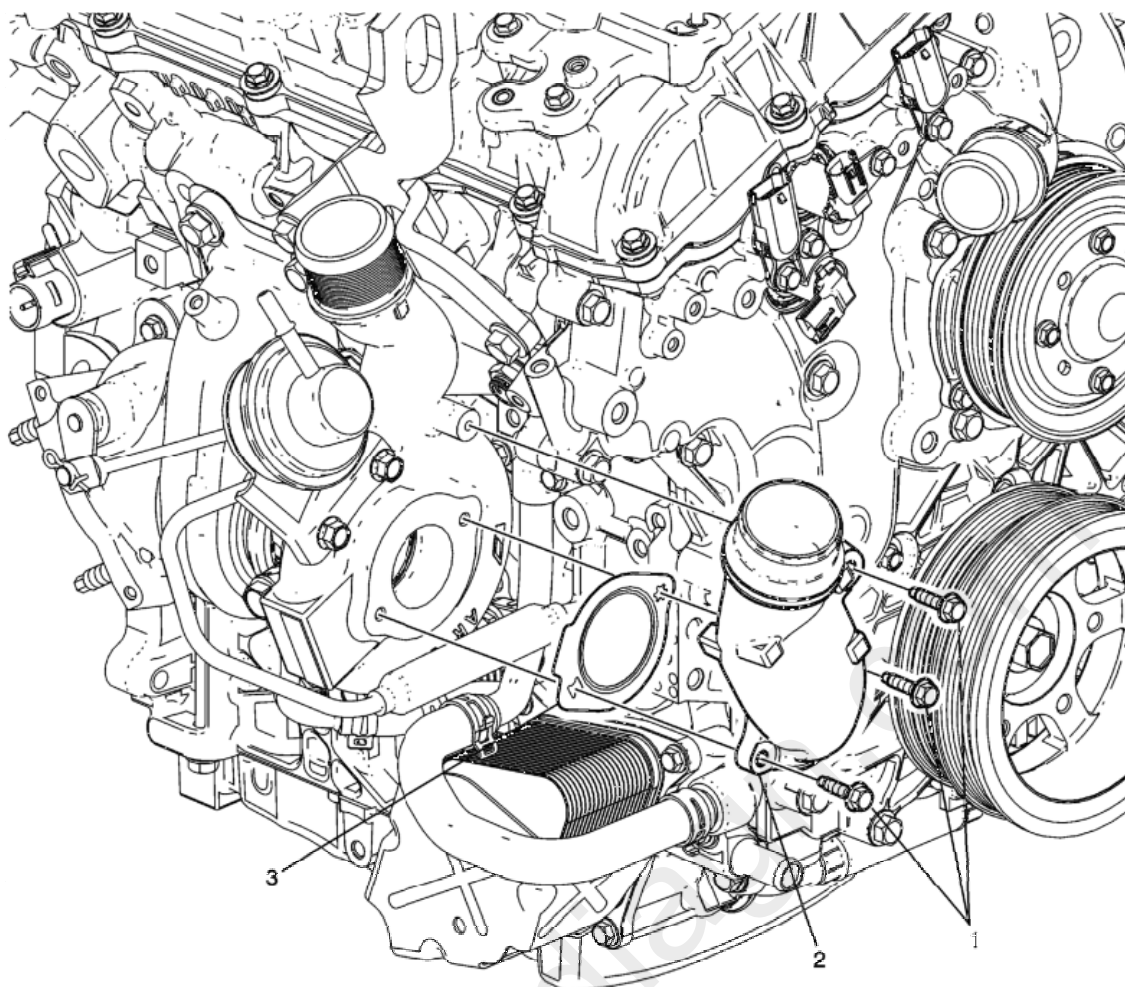


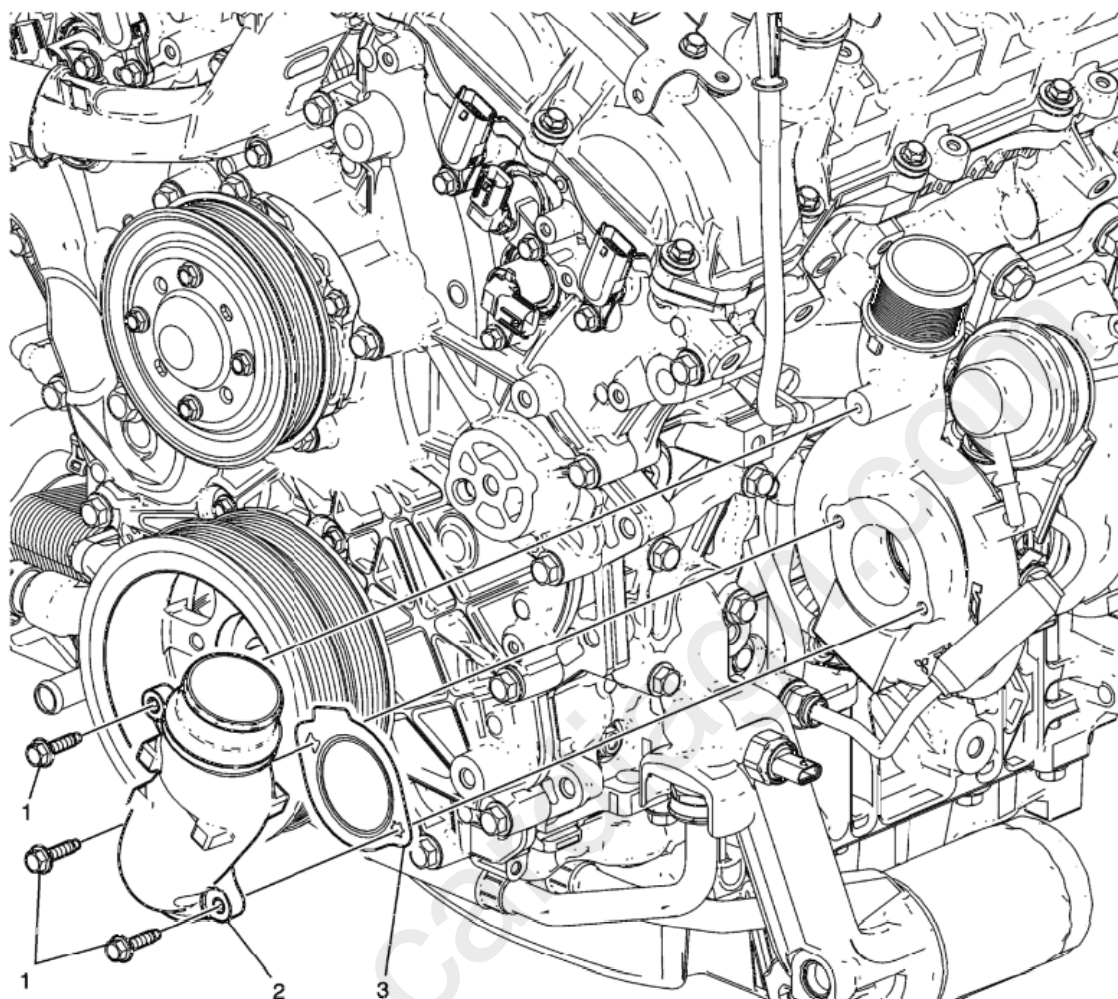
Fig. 266: Turbocharger Air Inlet Adapter - Bank 1
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Air Inlet Adapter Replacement - Bank 1

Callout	Component Name
Preliminary Procedures Remove the generator. Refer to <u>Generator Replacement (LFX)</u> , <u>Generator Replacement (LTG)</u> , <u>Generator Replacement (LF3)</u> .	
1	Turbocharger Air Inlet Adapter Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Turbocharger Air Inlet Adapter
	Turbocharger Air Inlet Adapter

Procedure

Install a NEW turbocharger air inlet adapter seal.

TURBOCHARGER AIR INLET ADAPTER REPLACEMENT - BANK 2**Fig. 267: Turbocharger Air Inlet Adapter - Bank 2**

Courtesy of GENERAL MOTORS COMPANY

Turbocharger Air Inlet Adapter Replacement - Bank 2

Callout	Component Name
Preliminary Procedures Remove the air conditioning compressor. Refer to <u>Air Conditioning Compressor Replacement (LTG)</u> , <u>Air Conditioning Compressor Replacement (LFX)</u> , <u>Air Conditioning Compressor Replacement (LF3)</u> .	
1	Turbocharger Air Inlet Adapter Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 (89 lb in)
2	Turbocharger Air Inlet Adapter
3	Procedure Install a NEW turbocharger air inlet adapter seal.

CHARGE AIR COOLER INLET PIPE REPLACEMENT - LEFT SIDE (LF3)

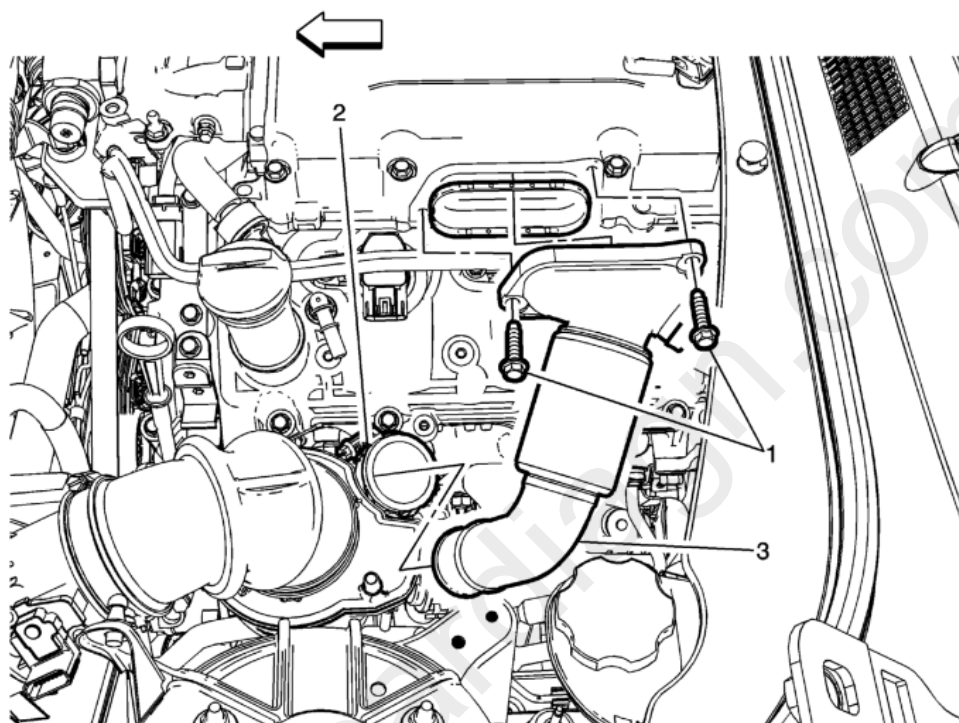


Fig. 268: Charge Air Cooler Inlet Pipe - Left Side (LF3)
Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Inlet Pipe Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Disconnect the charge air bypass valve left side from charge air cooler inlet pipe. Refer to <u>Charge Air Bypass Valve Replacement - Left Side (LF3)</u>.	
1	Charge Air Cooler Inlet Pipe Bolts (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 9 (80 lb in)
2	Charge Air Cooler Inlet Pipe Clamp
3	Charge Air Cooler Inlet Pipe Procedure Install NEW charge air cooler inlet pipe seal.

INTAKE AIR PRESSURE AND TEMPERATURE SENSOR REPLACEMENT

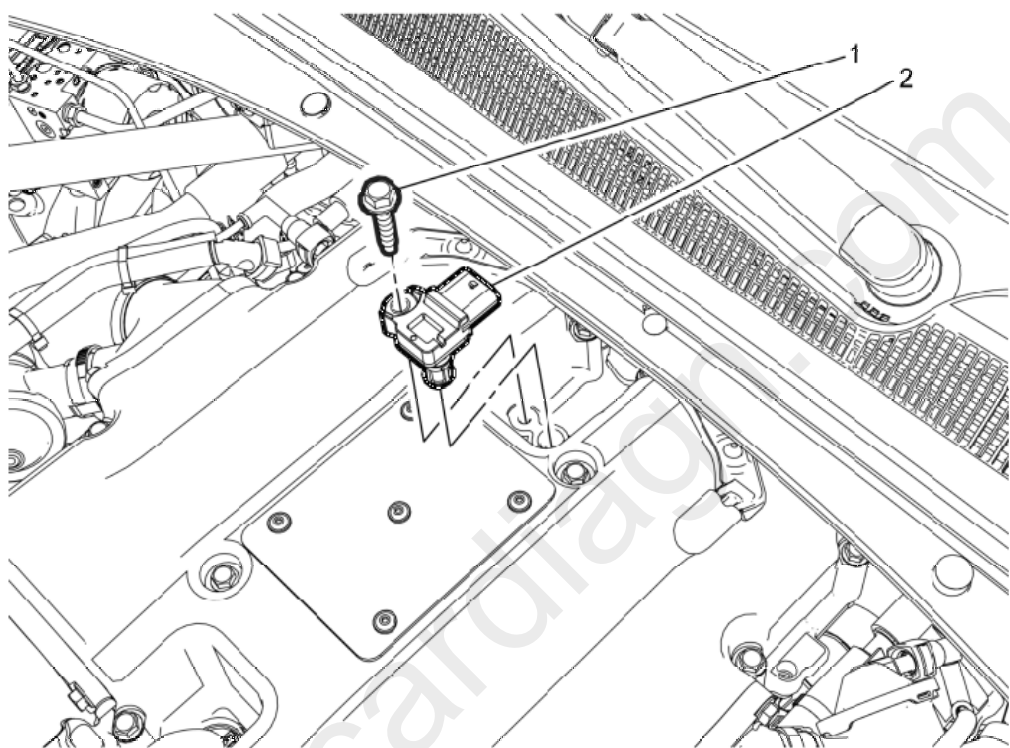


Fig. 269: Intake Air Pressure and Temperature Sensor
 Courtesy of GENERAL MOTORS COMPANY

Intake Air Pressure and Temperature Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Intake Air Pressure and Temperature Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 (89 lb in)
2	Intake Air Pressure and Temperature Sensor Procedure Disconnect the electrical wiring harness connector from the Intake Air Pressure and Temperature sensor. NOTE: Always install the seal supplied with the intake air pressure and temperature sensor.

SECONDARY AIR INJECTION PIPE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** , **Intake Manifold Cover Replacement (LF3)** .
2. Remove the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .

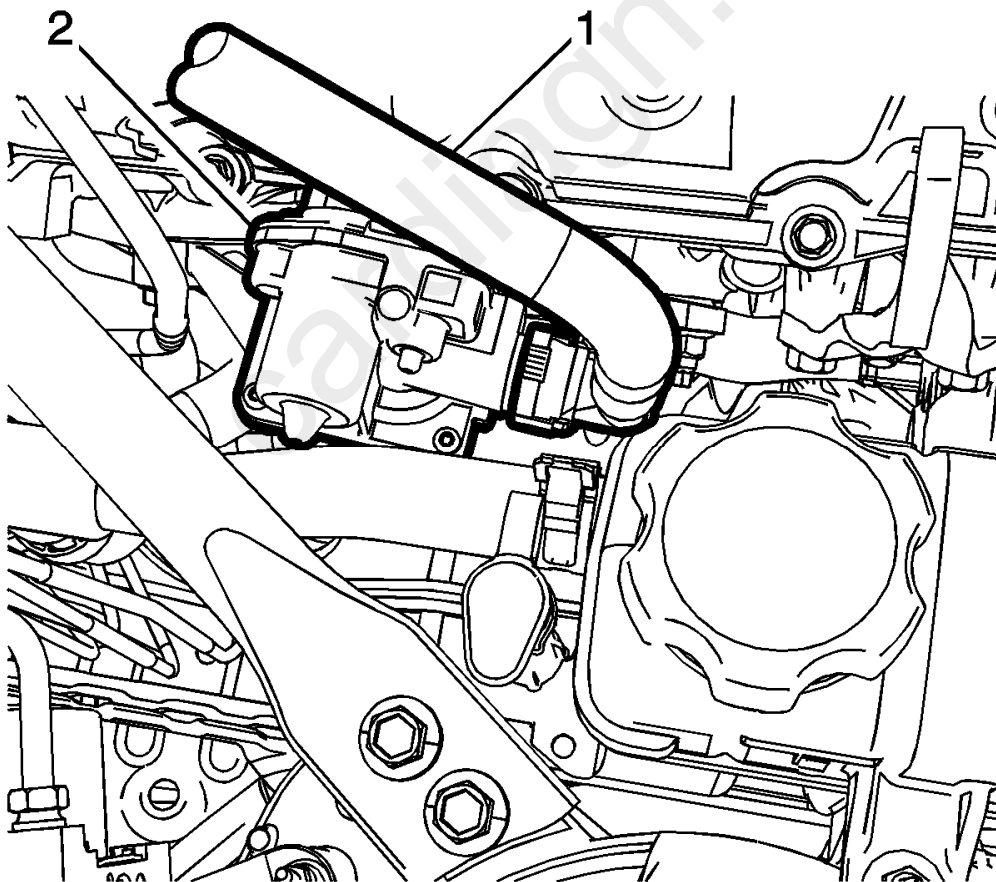


Fig. 270: Right Side Secondary Air Injection Bypass Valve
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the secondary air injection pipe (1) from the right side secondary air injection bypass valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

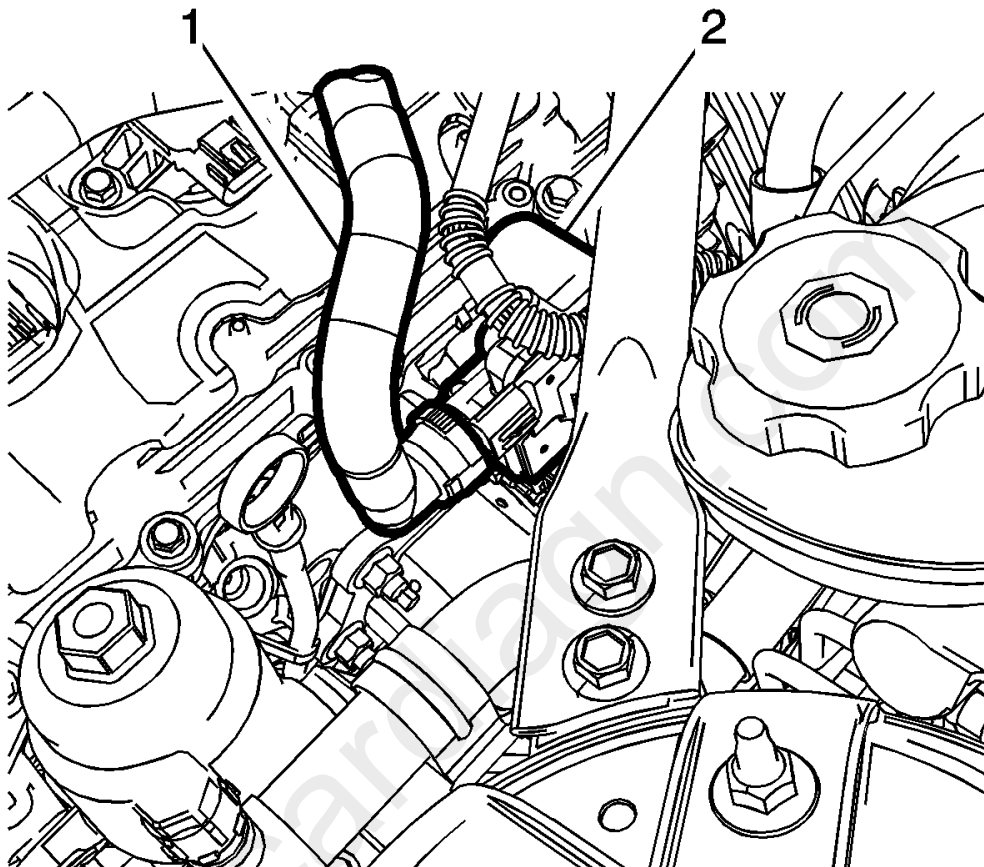


Fig. 271: Left Side Secondary Air Injection Bypass Valve
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the secondary air injection pipe (1) from the left side secondary air injection bypass valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

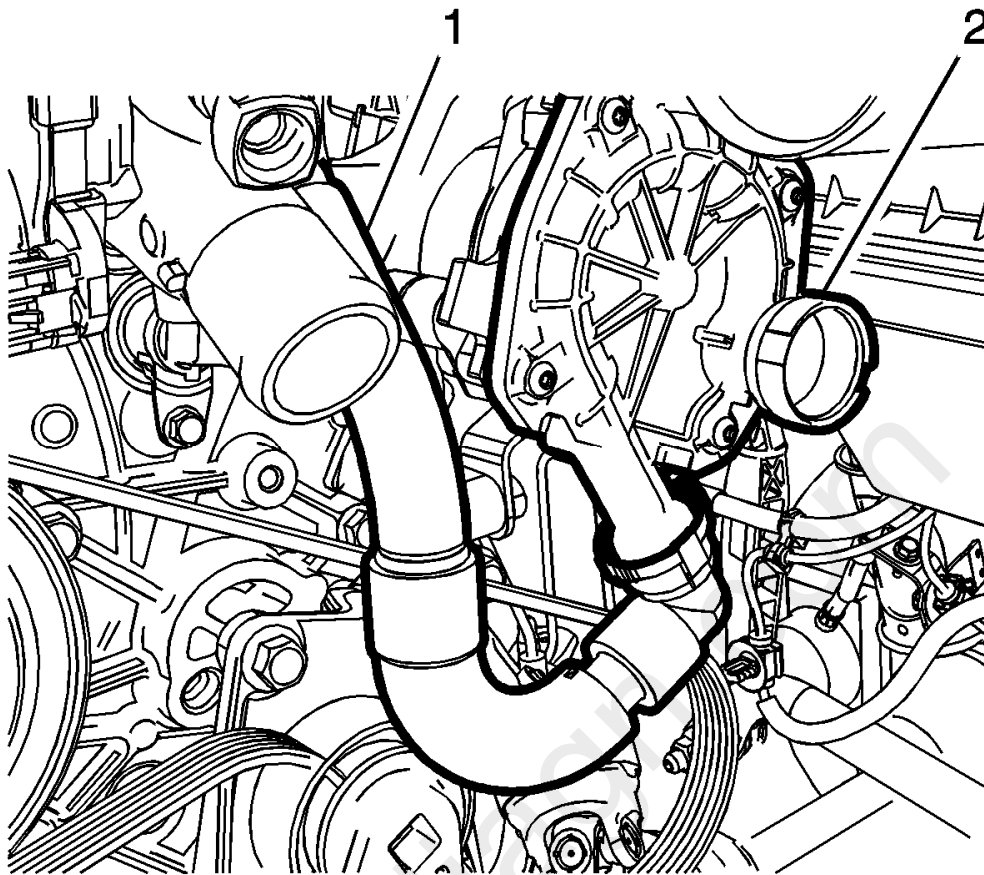


Fig. 272: Secondary Air Injection Pump
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the secondary air injection pipe (1) from the secondary air injection pump (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

Installation Procedure

1. Reposition the secondary air injection pipe to the vehicle.

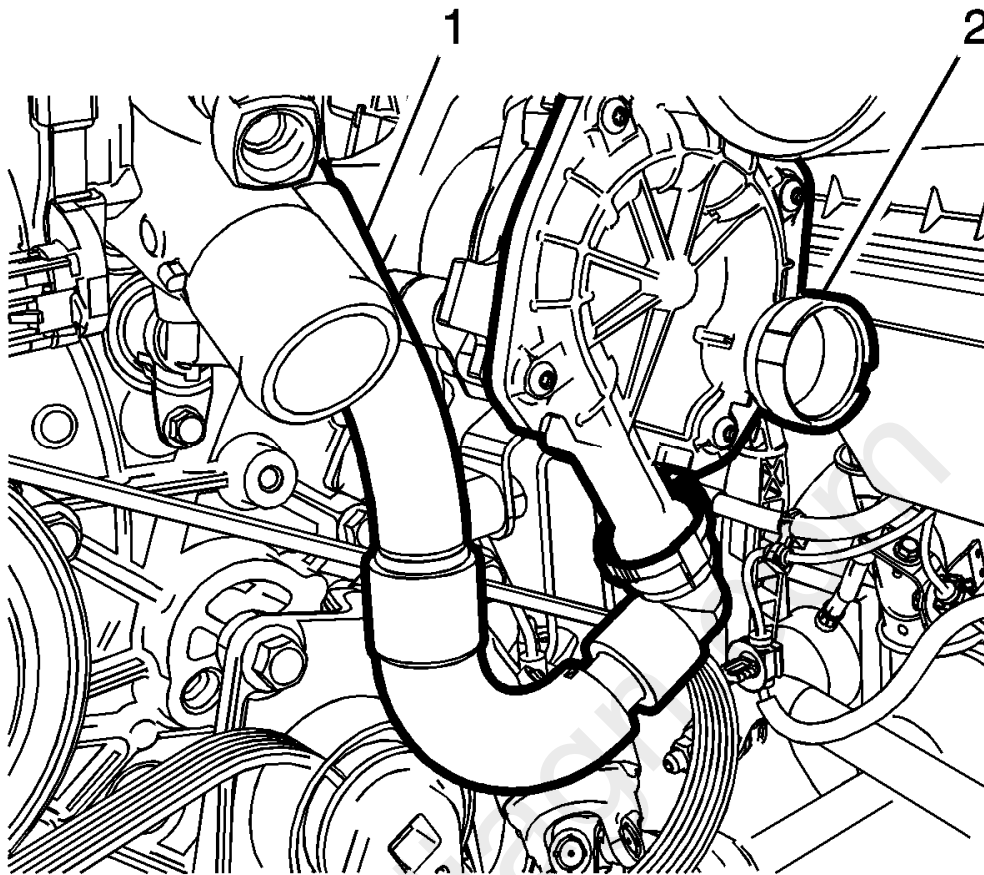


Fig. 273: Secondary Air Injection Pump
Courtesy of GENERAL MOTORS COMPANY

2. Connect the secondary air injection pipe (1) to the secondary air injection pump (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

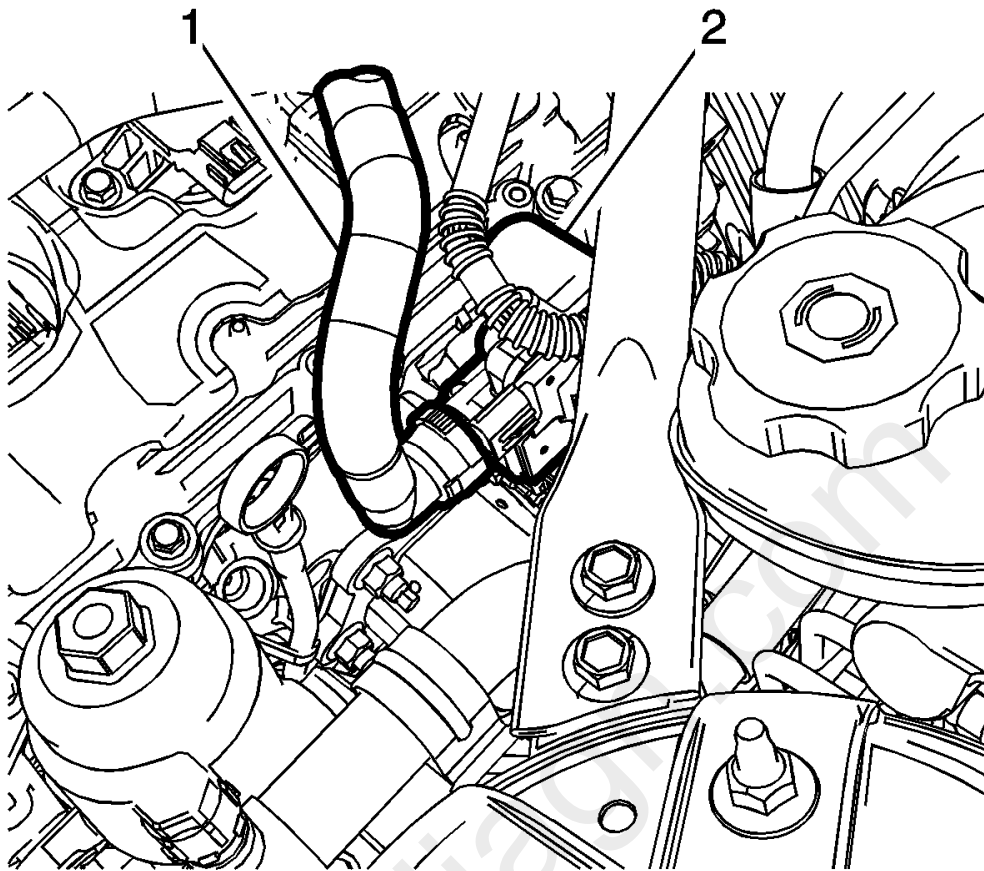


Fig. 274: Left Side Secondary Air Injection Bypass Valve
Courtesy of GENERAL MOTORS COMPANY

3. Connect the secondary air injection pipe (1) to the left side secondary air injection bypass valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

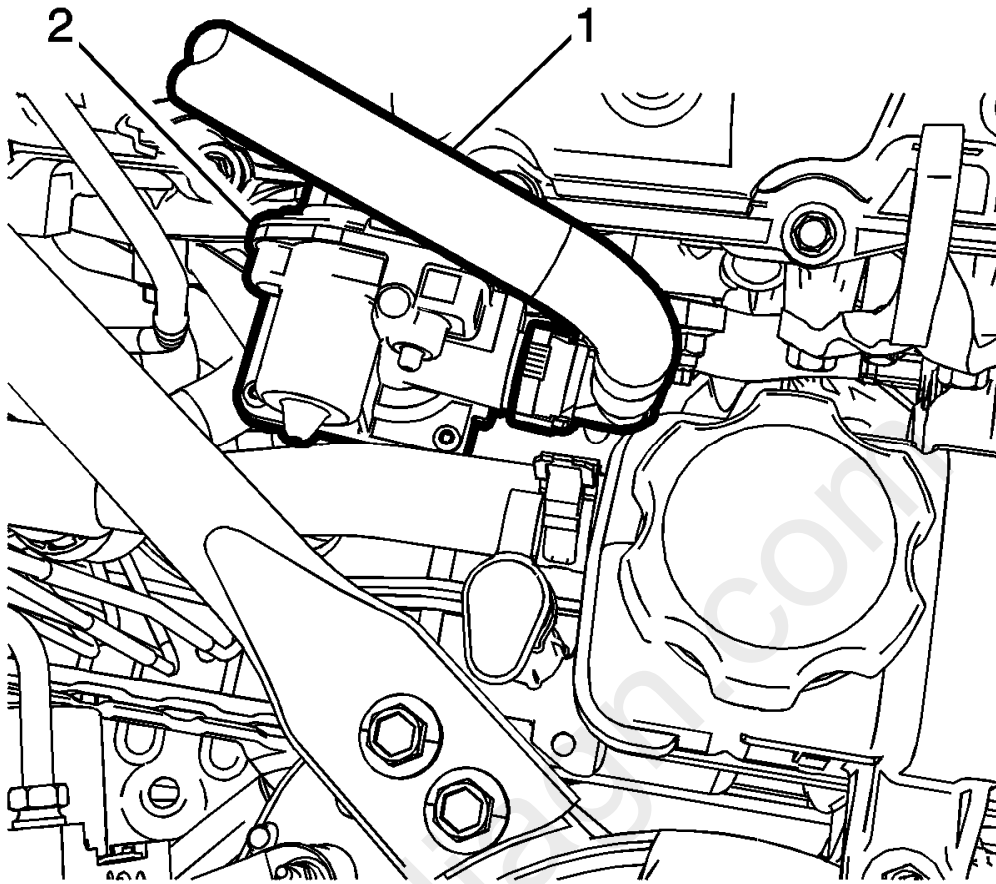


Fig. 275: Right Side Secondary Air Injection Bypass Valve
Courtesy of GENERAL MOTORS COMPANY

4. Connect the secondary air injection pipe (1) to the right side secondary air injection bypass valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .
5. Install the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .
6. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** , **Intake Manifold Cover Replacement (LF3)** .

SECONDARY AIR INJECTION PUMP INLET HOSE REPLACEMENT

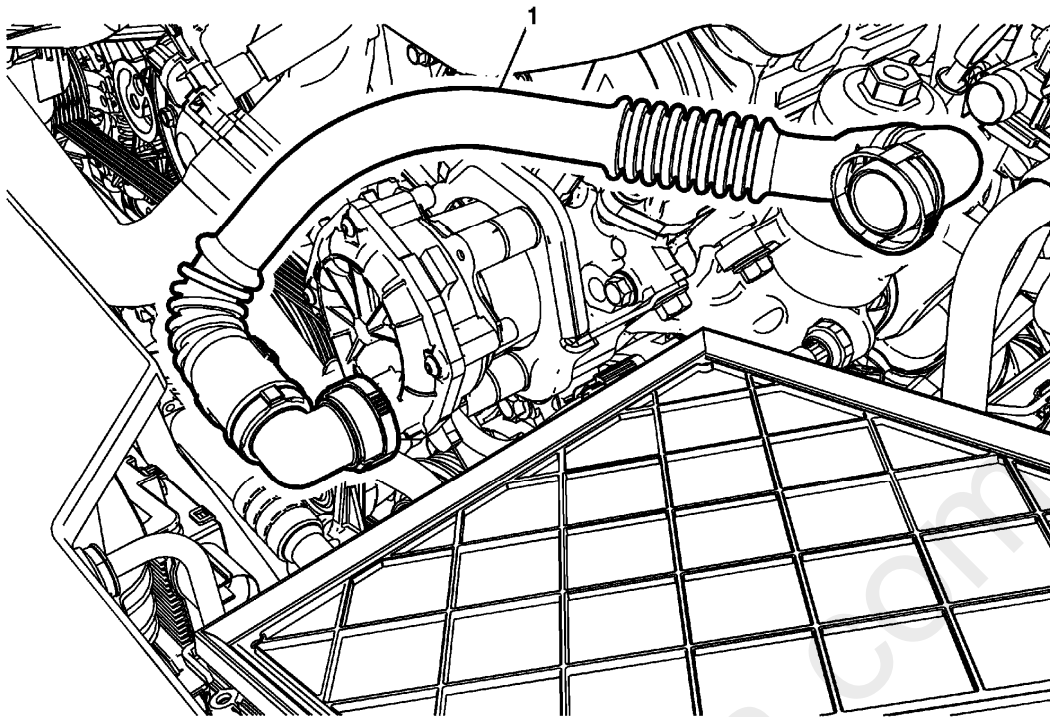


Fig. 276: Secondary Air Injection Pump Inlet Hose
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Pump Inlet Hose Replacement

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LFX)</u> , <u>Air Cleaner Outlet Duct Replacement (LF3)</u> .	
1	Secondary Air Injection Pump Inlet Hose Procedure Disconnect the secondary air injection inlet hose from the air cleaner assembly and the secondary air injection pump. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

SECONDARY AIR INJECTION BYPASS VALVE REPLACEMENT - BANK 2

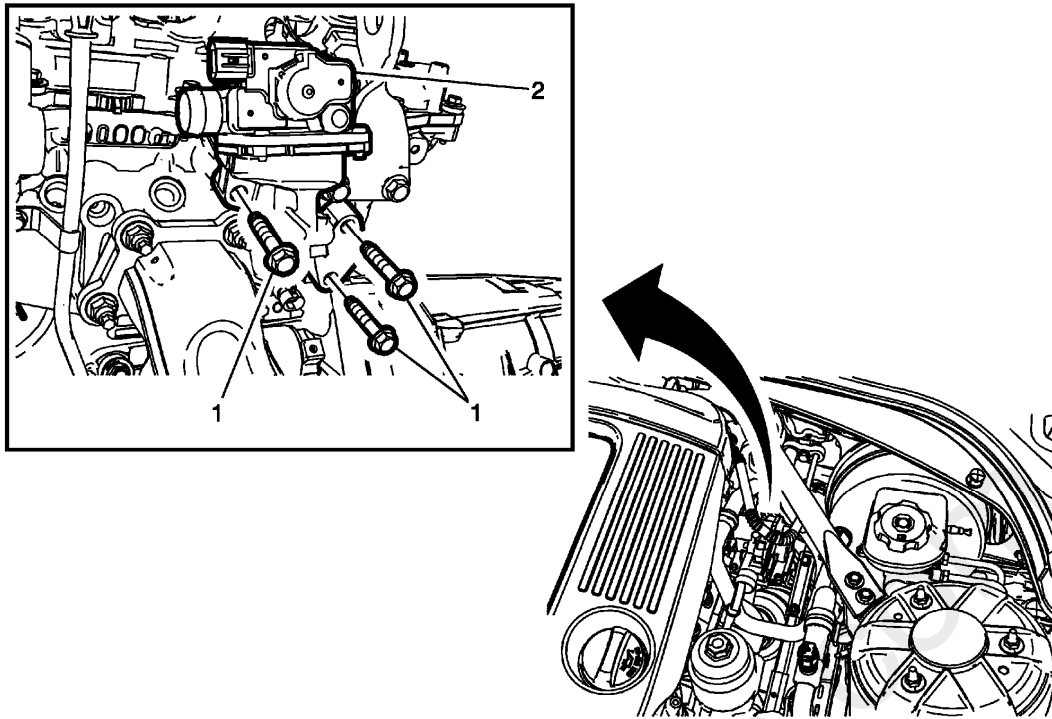


Fig. 277: Secondary Air Injection Bypass Valve - Bank 2
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Bypass Valve Replacement - Bank 2

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Disconnect the secondary air injection pipe from the secondary air injection bypass valve. Refer to <u>Secondary Air Injection Bypass Valve Replacement - Bank 2.</u>	
1	Secondary Air Injection Check Valve Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 (16 lb ft).
2	Secondary Air Injection Bypass Valve Procedure Disconnect the electrical wiring harness connector from the secondary air injection check valve.

SECONDARY AIR INJECTION BYPASS VALVE REPLACEMENT - BANK 1

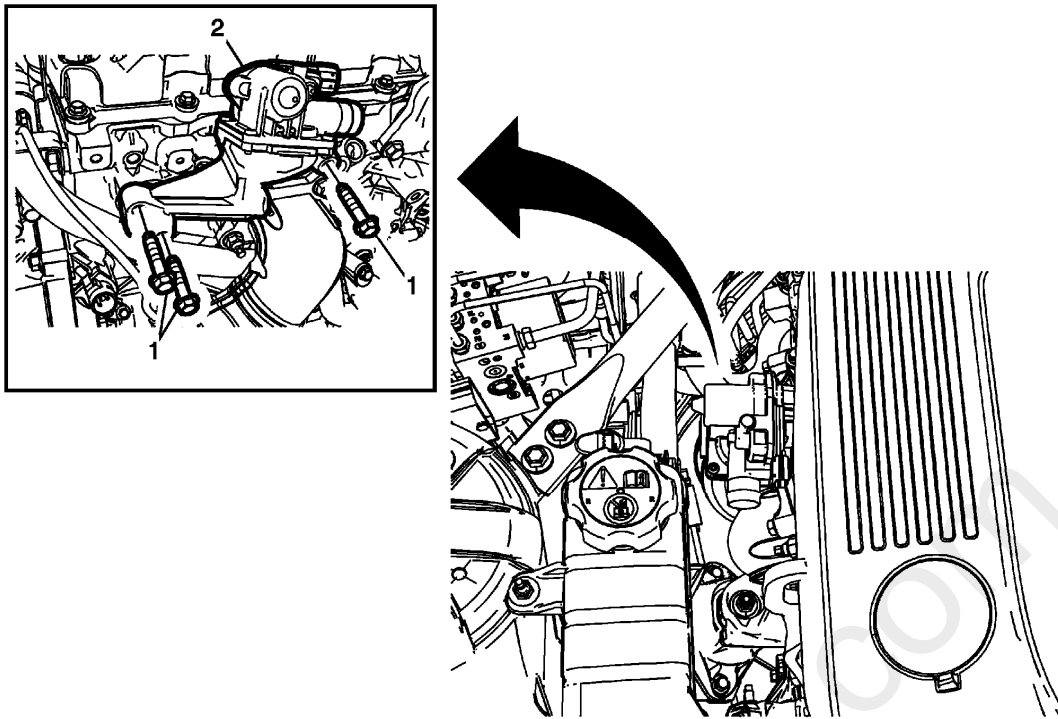


Fig. 278: Secondary Air Injection Bypass Valve - Bank 1
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Bypass Valve Replacement - Bank 1

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Disconnect the secondary air injection pipe from the secondary air injection bypass valve. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>.	
1	Secondary Air Injection Bypass Valve Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 (16 lb ft).
2	Secondary Air Injection Bypass Valve Procedure Disconnect the electrical wiring harness connector from the secondary air injection check valve.

SECONDARY AIR INJECTION PUMP REPLACEMENT

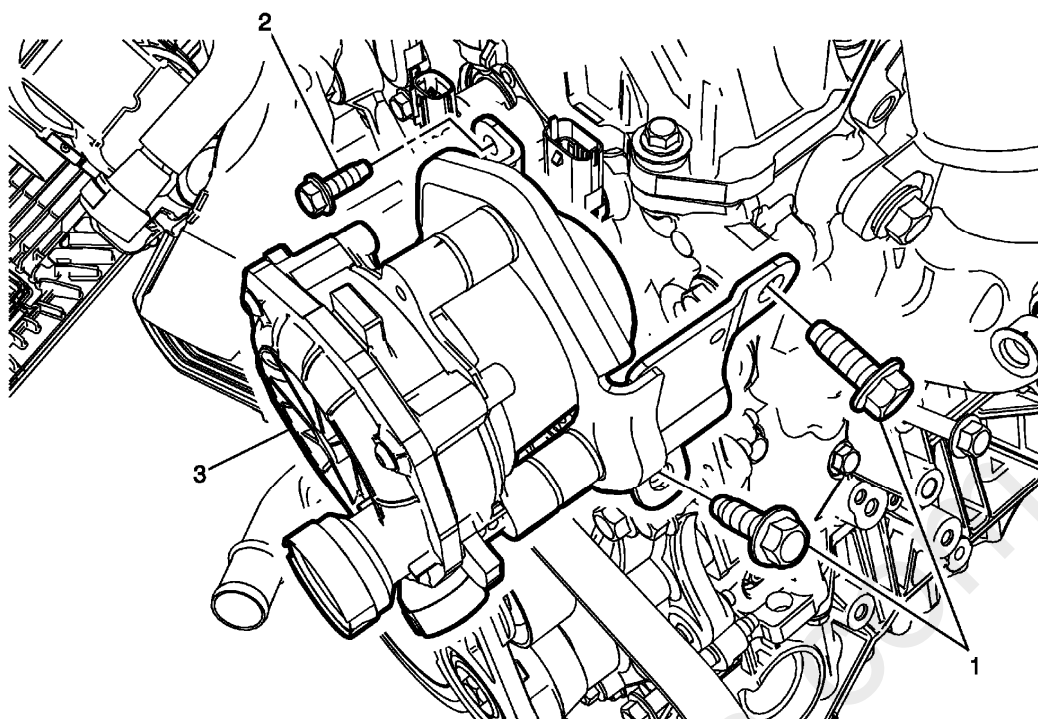


Fig. 279: Secondary Air Injection Pump
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Pump Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LFX)</u>, <u>Air Cleaner Outlet Duct Replacement (LF3)</u>. 3. Disconnect the secondary air injection pump inlet hose. Refer to <u>Secondary Air Injection Pump Inlet Hose Replacement</u>. 4. Disconnect the secondary air injection pipe. Refer to <u>Secondary Air Injection Pipe Replacement</u>.	
1	Secondary Air Injection Pump Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
	Secondary Air Injection Pump Fastener

2	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
3	Secondary Air Injection Pump Procedure Disconnect the electrical wiring harness connectors from the secondary air injection pump.

AIR CLEANER ELEMENT REPLACEMENT (LFX)

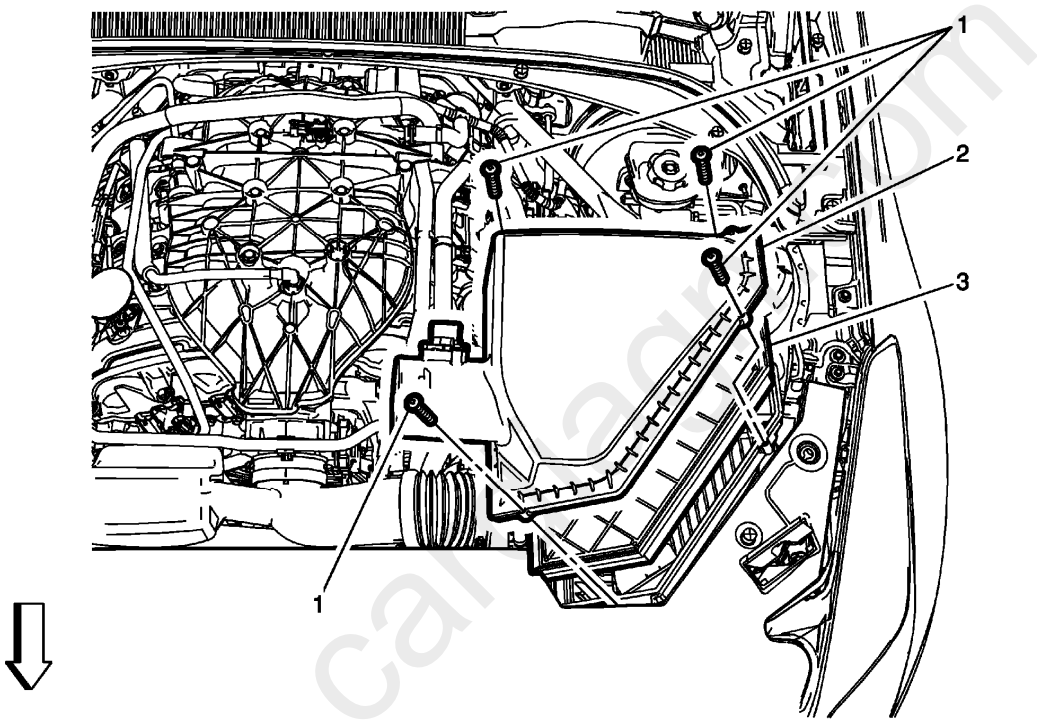


Fig. 280: Air Cleaner Element (LFX)
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Element Replacement (LFX)

Callout	Component Name
Preliminary Procedure 1. Disconnect the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LFX)</u> . 2. Disconnect the mass airflow sensor electrical connector. 3. Disconnect the secondary air injection pump inlet hose, if equipped. Refer to <u>Secondary Air Injection Pump Inlet Hose Replacement</u> .	
	Air Cleaner Assembly Fasteners (Qty: 4)

1	CAUTION: Refer to <u>Fastener Caution</u> .
2	Air Cleaner Upper Cover
3	Air Cleaner Element

AIR CLEANER ELEMENT REPLACEMENT (LF3)

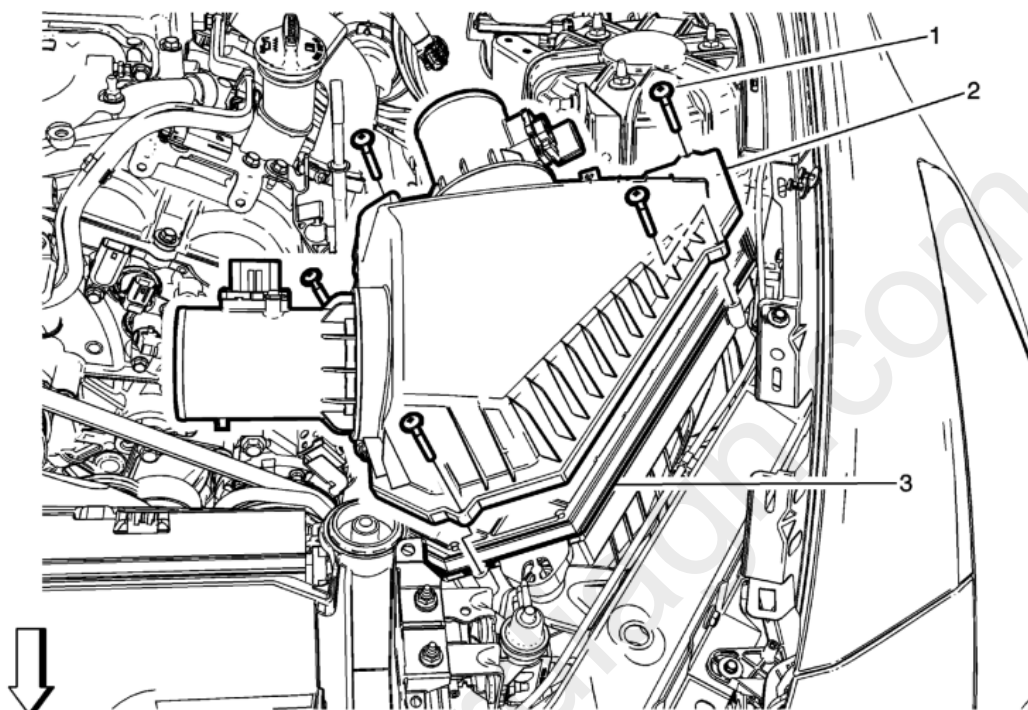


Fig. 281: Air Cleaner Element (LF3)
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Element Replacement (LF3)

Callout	Component Name
Preliminary Procedure	
1. Disconnect the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF3)</u> . 2. Disconnect the air cleaner outlet front duct. Refer to <u>Air Cleaner Outlet Front Duct Replacement (LF3)</u> .	
1	Air Cleaner Assembly Fasteners (Qty: 5) CAUTION: Refer to <u>Fastener Caution</u> .
2	Air Cleaner Upper Cover Procedure Disconnect the electrical connector.

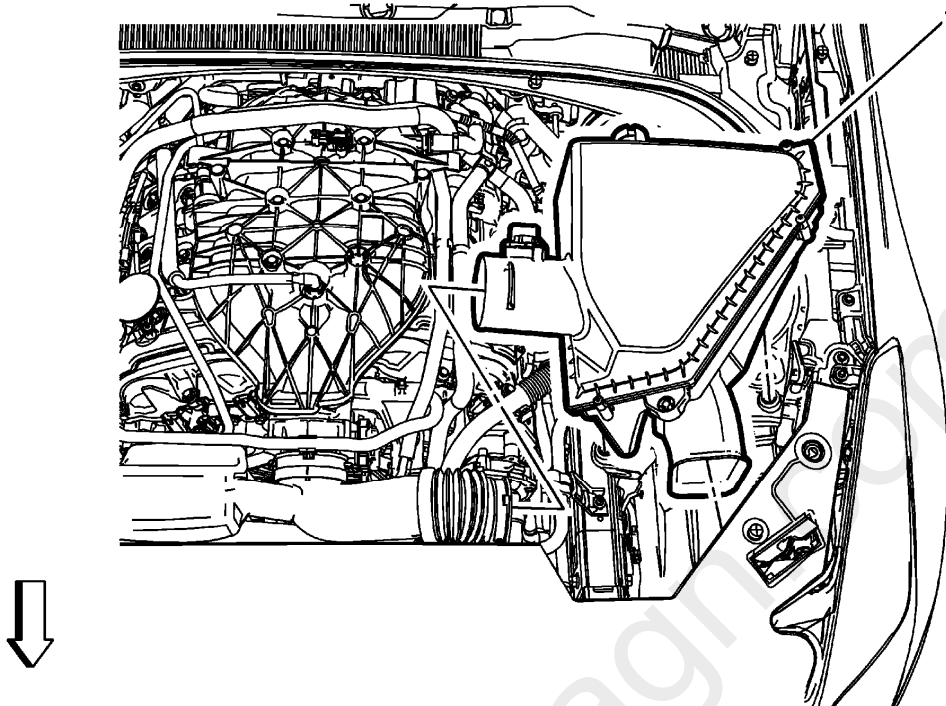
AIR CLEANER ASSEMBLY REPLACEMENT (LFX)

Fig. 282: Air Cleaner Assembly (LFX)
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Assembly Replacement (LFX)

Callout	Component Name
Preliminary Procedures	
1. Disconnect the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LFX)</u>. 2. Disconnect the mass airflow sensor electrical connector. 3. Disconnect the secondary air injection pump inlet hose, if equipped. Refer to <u>Secondary Air Injection Pump Inlet Hose Replacement</u>.	
1	Procedure Air Cleaner Assembly 1. Remove the air cleaner housing from the retainers. 2. Transfer parts as necessary.

AIR CLEANER ASSEMBLY REPLACEMENT (LF3)

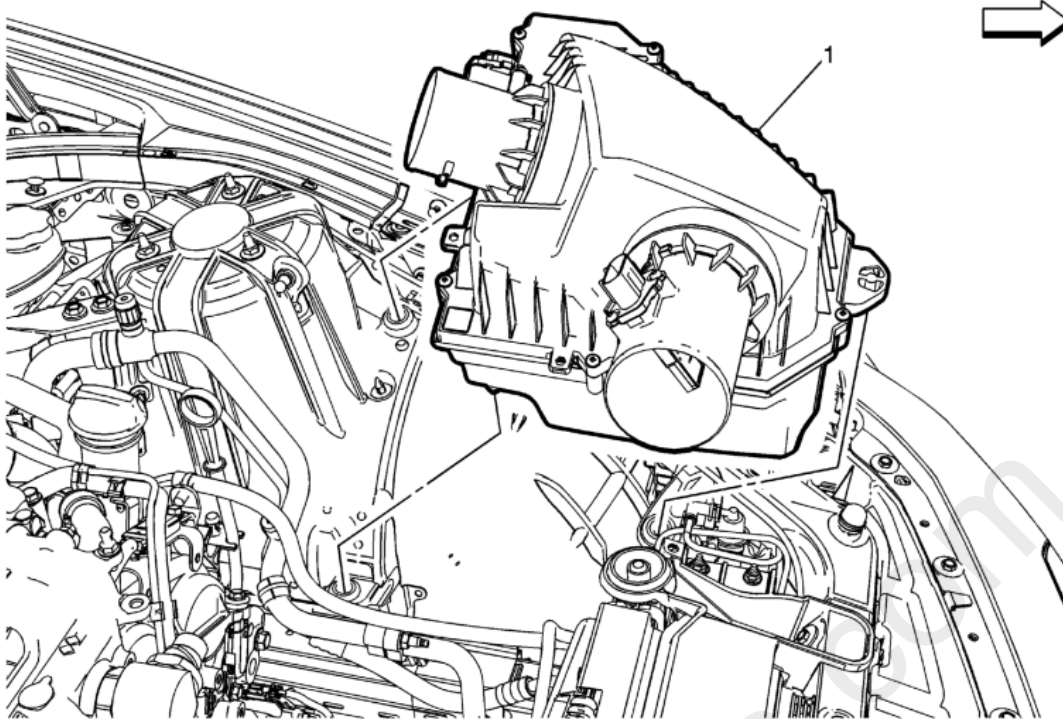


Fig. 283: Air Cleaner Assembly (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Assembly Replacement (LF3)

Callout	Component Name
Preliminary Procedure	
1. Disconnect the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF3)</u> . 2. Disconnect the air cleaner outlet front duct. Refer to <u>Air Cleaner Outlet Front Duct Replacement (LF3)</u> . 3. Disconnect the mass air flow electrical connectors.	
1	Air Cleaner Assembly Procedure Lift up on the air cleaner assembly to remove from retainers.

AIR CLEANER OUTLET DUCT REPLACEMENT (LFX)

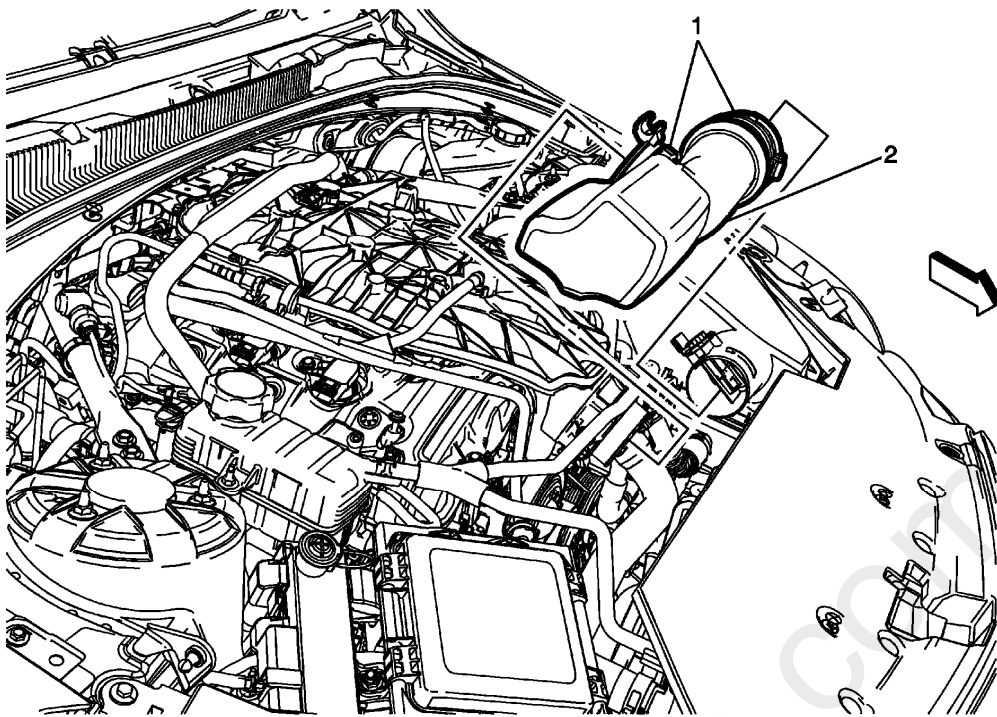


Fig. 284: Air Cleaner Outlet Duct (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Duct Replacement (LFX)

Callout	Component Name
Preliminary Procedure	
Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>	
1	Air Cleaner Outlet Duct Clamps (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Air Cleaner Outlet Duct Procedure Disconnect the surge tank inlet hose from the outlet duct.

AIR CLEANER OUTLET DUCT REPLACEMENT (LF3)

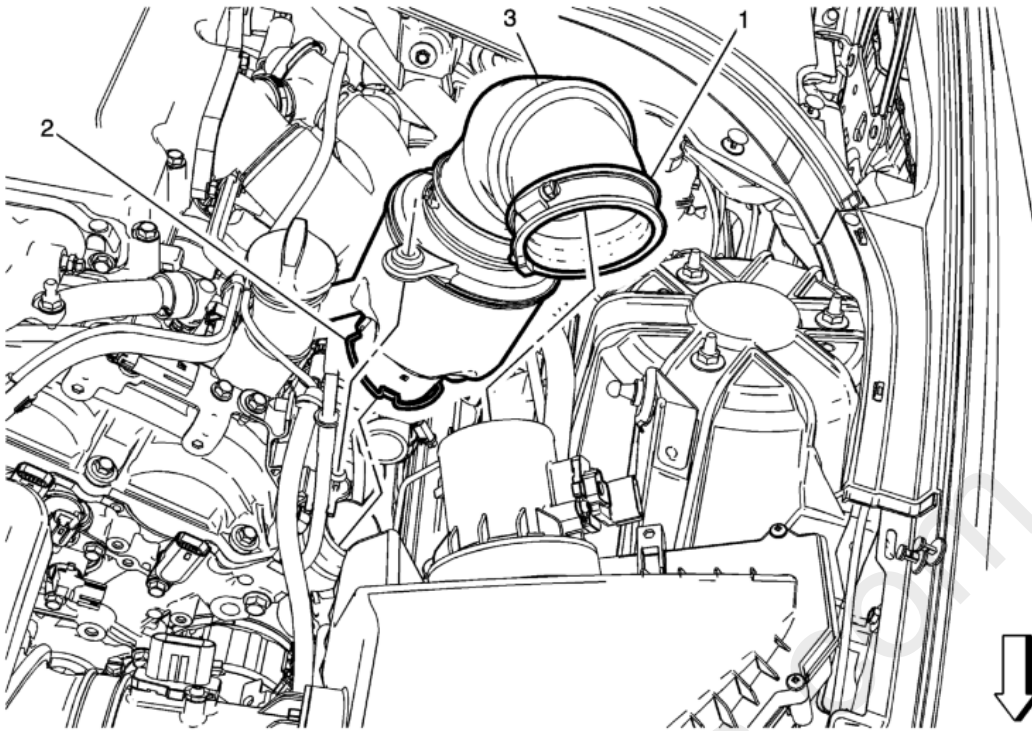


Fig. 285: Air Cleaner Outlet Duct (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Duct Replacement (LF3)

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Disconnect the charge air bypass valve left side from air cleaner outlet duct. Refer to <u>Charge Air Bypass Valve Replacement - Left Side (LF3)</u> .	
1	Air Cleaner Outlet Duct Clamp CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 (35 lb in)
2	Air Cleaner Outlet Duct Spring Clip Procedure Use a flat bladed tool to disengage clip.
3	Air Cleaner Outlet Duct Procedure Lift up on the air cleaner assembly to remove from retainer.

AIR CLEANER OUTLET REAR DUCT REPLACEMENT (LF3)

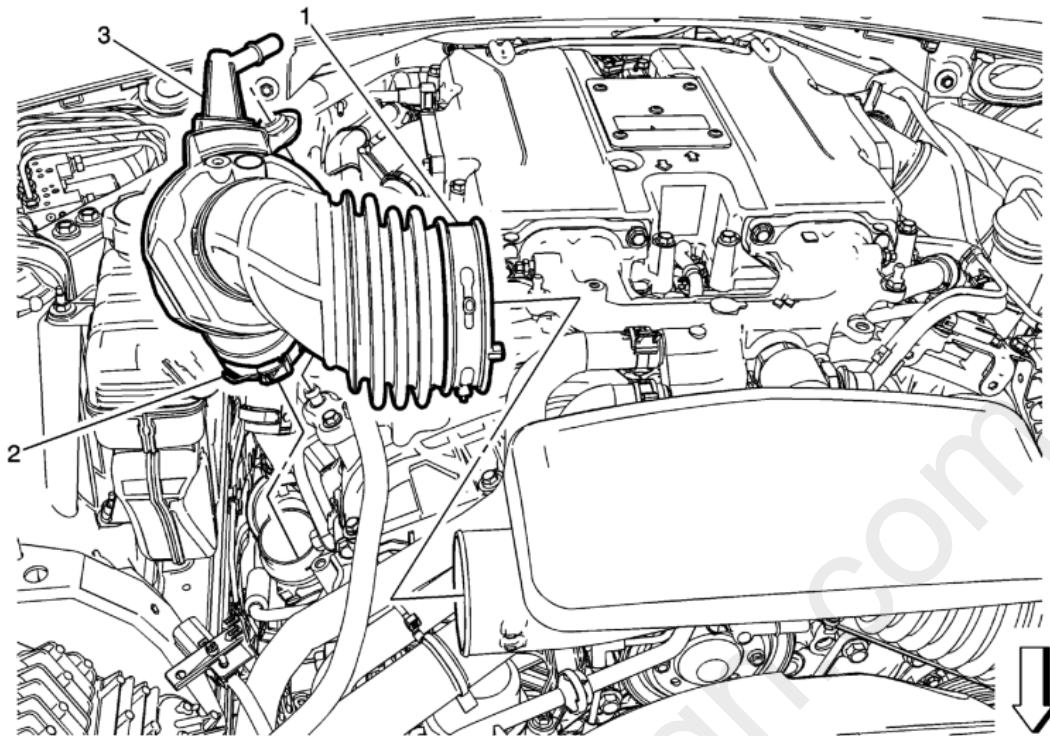


Fig. 286: Air Cleaner Outlet Rear Duct (LF3)
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Rear Duct Replacement (LF3)

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> . 2. Disconnect the charge air bypass valve right side from air cleaner outlet rear duct. Refer to <u>Charge Air Bypass Valve Replacement - Right Side (LF3)</u>. 3. Disconnect the PCV tube from air cleaner outlet rear duct. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>.	
1	Air Cleaner Outlet Rear Duct Clamp CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 (35 lb in)
2	Air Cleaner Outlet Rear Duct Spring Clip Procedure

	Use a flat bladed tool to disengage clip.
3	Air Cleaner Outlet Rear Duct Procedure Lift up on the air cleaner assembly to remove from retainer.

AIR CLEANER OUTLET FRONT DUCT REPLACEMENT (LF3)

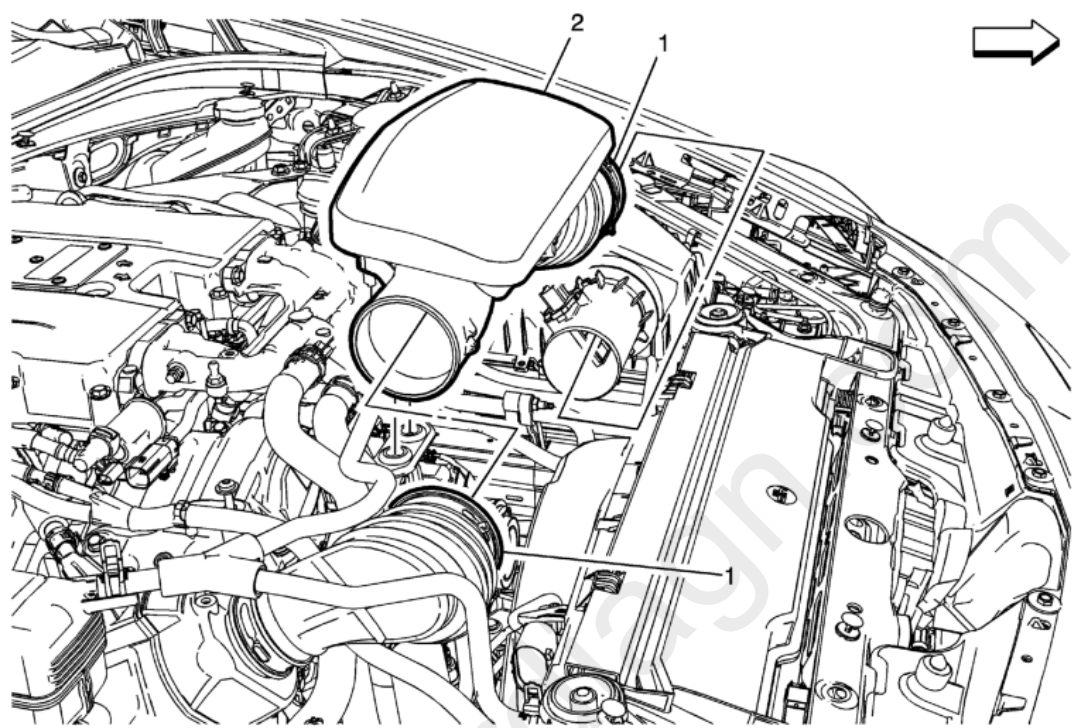


Fig. 287: Air Cleaner Outlet Front Duct (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Front Duct Replacement (LF3)

Callout	Component Name
Preliminary Procedure Disconnect the vacuum hose from the air cleaner outlet front duct. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Air Cleaner Outlet Front Duct Clamps (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 (35 lb in)
2	Air Cleaner Outlet Front Duct Procedure

Lift up on the air cleaner outlet front duct to remove from retainers.

INTAKE AIR SPLASH SHIELD REPLACEMENT

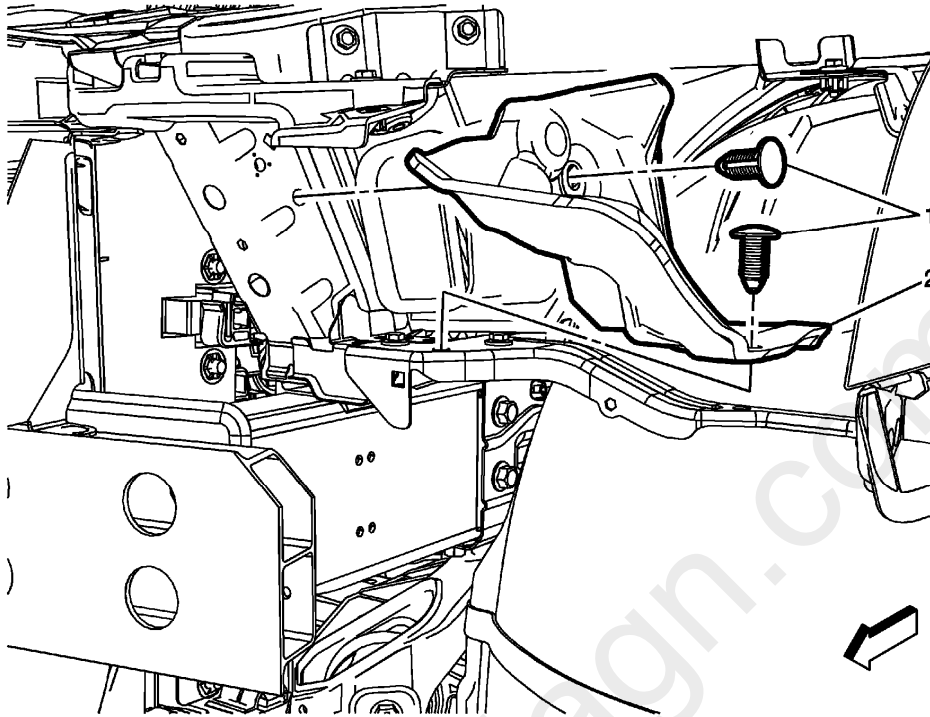


Fig. 288: Intake Air Splash Shield
Courtesy of GENERAL MOTORS COMPANY

Intake Air Splash Shield Replacement

Callout	Component Name
Preliminary Procedure Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LFX)</u> , <u>Air Cleaner Assembly Replacement (LF3)</u> .	
1	Intake Air Splash Shield Retainers (Qty: 2)
2	Intake Air Splash Shield

FUEL SENDER ASSEMBLY REPLACEMENT

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

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

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove the fuel tank. Refer to Fuel Tank Replacement.
2. Disconnect the fuel sender assembly electrical connector.

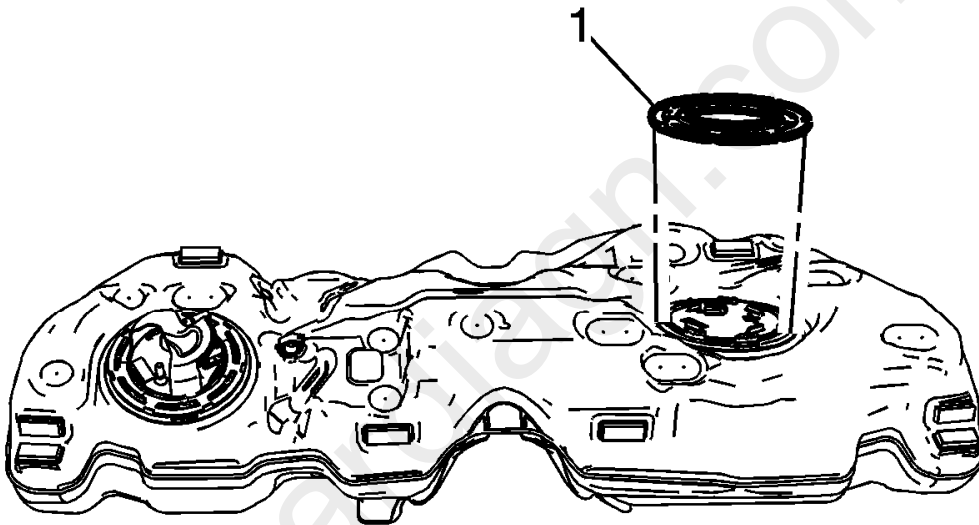


Fig. 289: Fuel Sender Assembly Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning counter clockwise and remove the lock ring (1).

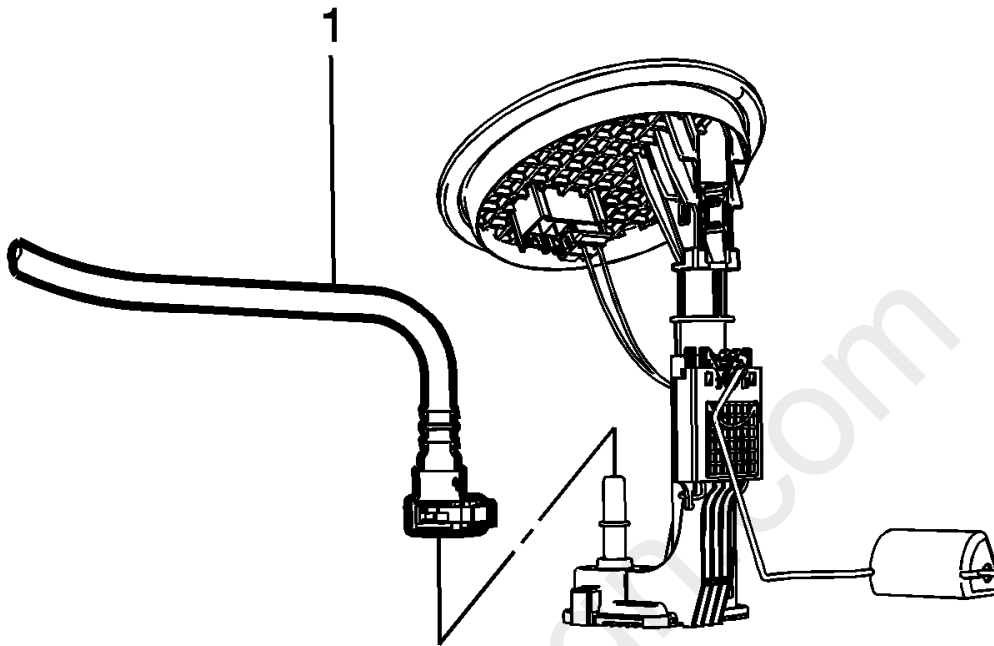


Fig. 290: Fuel Sender Assembly Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel sender assembly transfer hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

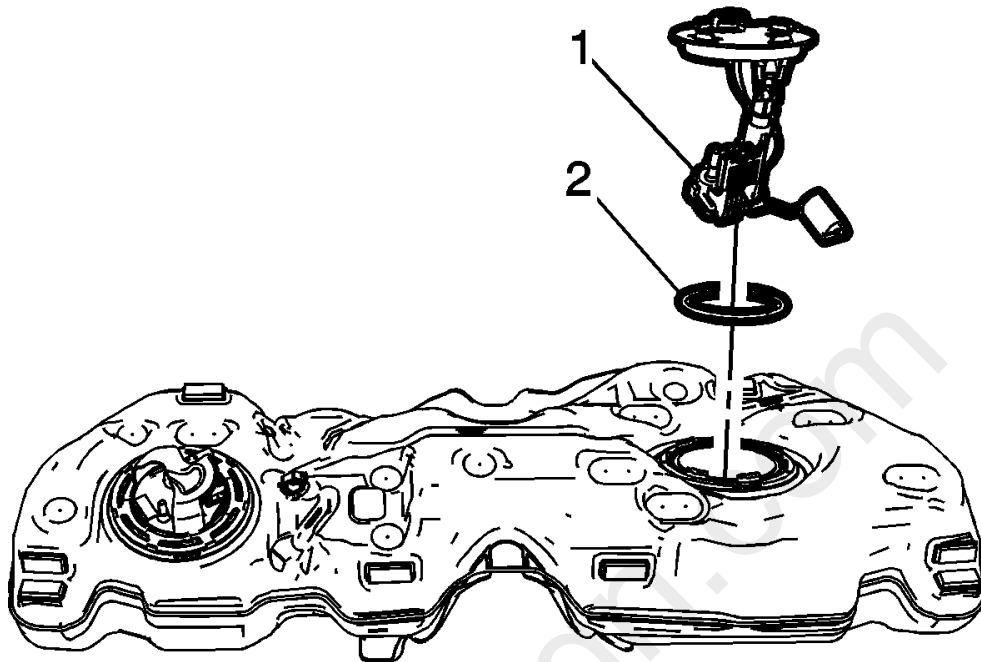


Fig. 291: Fuel Sender Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel sender assembly (1) and the O-ring (2).

Installation Procedure

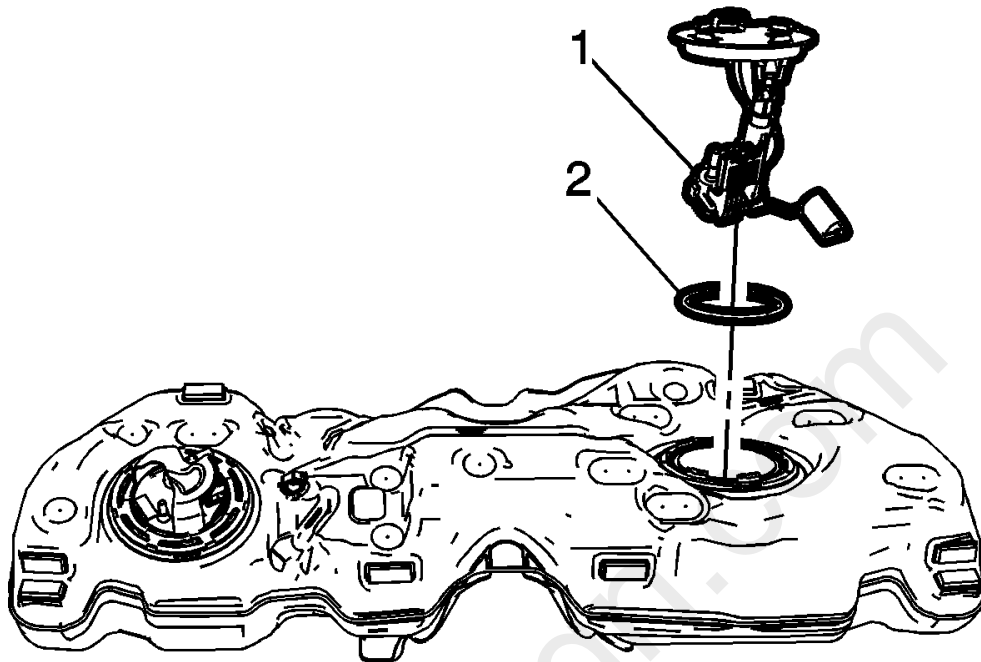


Fig. 292: Fuel Sender Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel sender assembly (1).

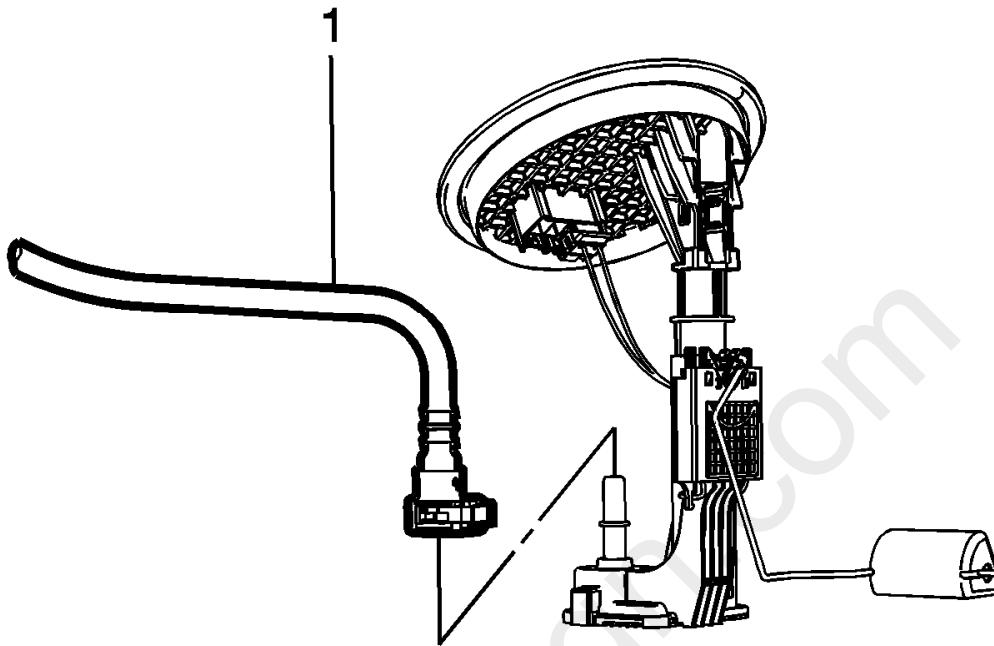


Fig. 293: Fuel Sender Assembly Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel sender assembly transfer hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

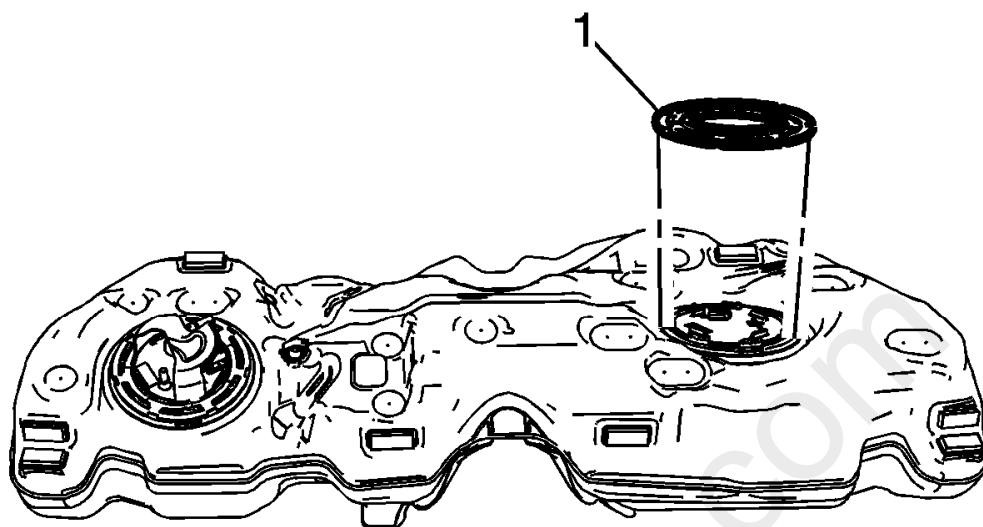


Fig. 294: Fuel Sender Assembly Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning clockwise and install the lock ring (1).
4. Connect the fuel sender assembly electrical connector.
5. Install the fuel tank. Refer to **Fuel Tank Replacement**.