

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

REPAIR INSTRUCTIONS

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

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

- An engine replacement
- An 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.

NOTE: The ECM monitors certain component signals to determine if all the conditions are met to continue with the crankshaft position System Variation Learn Procedure.

1. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P0315, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
3. With a scan tool, select the Crankshaft Position System Variation Learn Procedure and perform the following:
 1. Block drive wheels.
 2. Set parking brake.
 3. DO NOT apply brake pedal.
 4. Cycle ignition from OFF to ON.
 5. Apply and hold brake pedal for the duration of the procedure.
 6. Start and idle engine.
 7. Turn the air conditioning (A/C) OFF.
 8. The vehicle must remain in Park or Neutral.

NOTE: While the learn procedure is in progress, release the throttle immediately when the engine starts to decelerate. The engine control is returned to the operator and the engine responds to throttle position after the learn procedure is complete.

9. Accelerate to wide open throttle (WOT) and release when the fuel cut-off occurs.
4. The scan tool displays Test In Progress.
5. The scan tool displays Learn Successful.
6. Verify DTC P0315 ran and passed This Ignition Cycle.
 - If DTC P0315 failed or did not run This Ignition Cycle, or another DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
7. Once the Learn Procedure has successfully completed, and in order to store the crankshaft position system variation values in the ECM, turn OFF the ignition and verify all vehicle systems are OFF. This may take up to 2 minutes.

ENGINE CONTROL MODULE REPLACEMENT

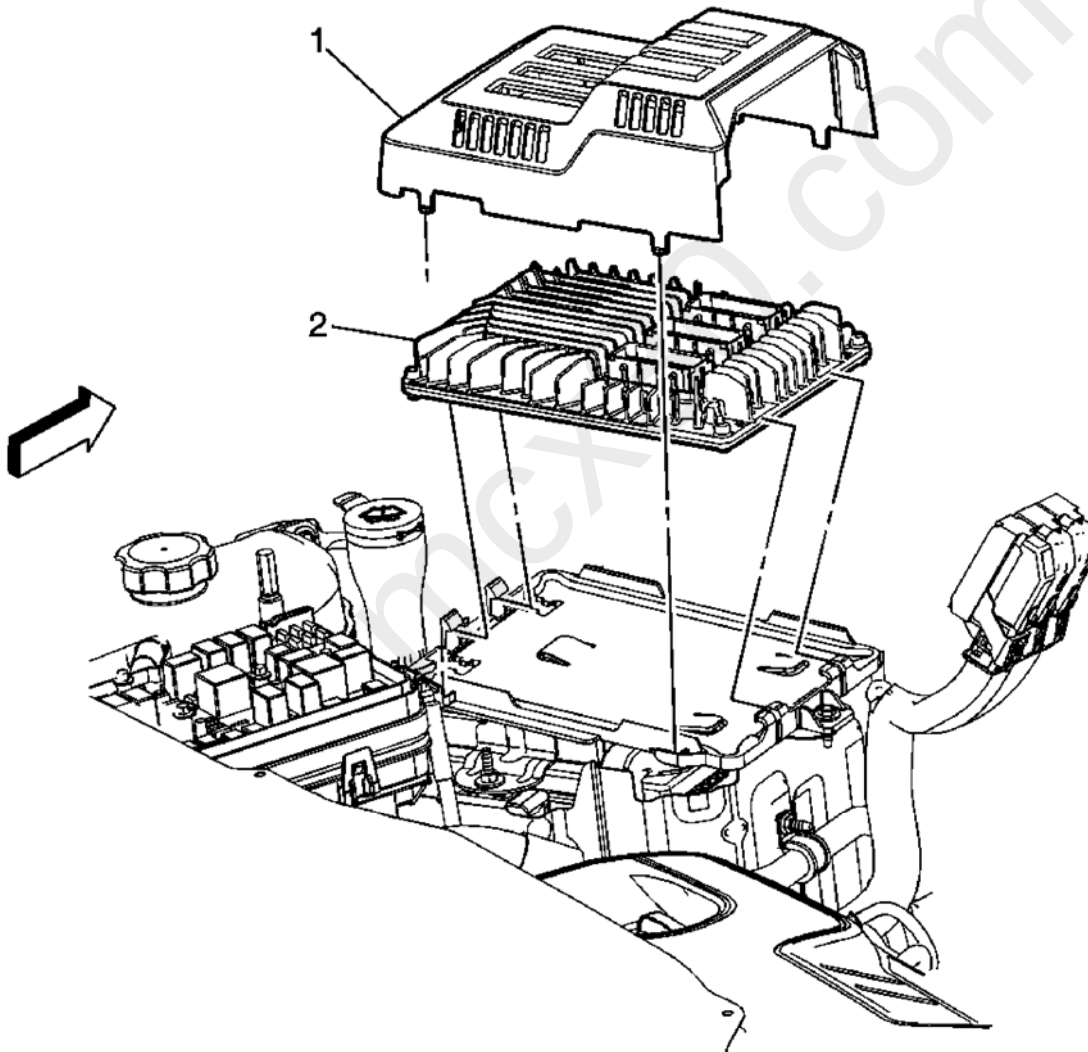


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Control Module Cover
2	Engine Control Module CAUTION: • Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage. • Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery. • In order to prevent any possible electrostatic discharge damage to the control module, do no touch the connector pins or the soldered components on the circuit board. • Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module. • The replacement control module must be programmed. CAUTION: In order to prevent any possible electrostatic discharge damage to the ECM, do not touch the connector pins. Procedure 1. Tip: It is necessary to record the remaining engine oil life. If the replacement module is not programed with the remaining engine oil life, the engine oil life will default to 100 percent. If the replacement module is not programmed with the remaining engine oil life, the engine oil will need to be changed at 5000 km (3,000 mi) from the last engine oil change. Tip: It is necessary to record the remaining automatic transmission fluid life. If the replacement module is not programed with the remaining automatic transmission fluid life, the automatic transmission fluid life will default to 100 percent. If the replacement module is not programmed with the remaining automatic transmission fluid life, the automatic transmission fluid will need to be changed at 83000 km (50,000 mi) from the last automatic transmission fluid change.

2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
3. Disconnect the electrical connectors.
4. If replacing ECM, reprogram the ECM. Refer to **Control Module References**

THROTTLE/IDLE LEARN (LF1, LFW)

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 learn out 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

Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, 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).

Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, 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

Reset Procedure (Performed after the throttle body is cleaned or replaced)

1. Ignition ON, engine OFF, perform the Idle Learn Reset in Module Setup with a scan tool.
2. Start the engine and monitor the TB Idle Airflow Compensation parameter. The TB Idle Airflow Compensation value should equal 0 percent and the engine should be idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Learn Procedure (Performed after the ECM is flashed or replaced)

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

1. Start and idle the engine for 3 minutes.
2. With a scan tool, monitor the Desired Idle Speed and the actual Engine Speed.
3. The ECM will start to learn the new idle cells and Desired Idle Speed should start to decrease.
4. Ignition OFF for 60 seconds.
5. Start and idle the engine for 3 minutes.
6. After the 3 minute 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 seconds 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 (LF1)

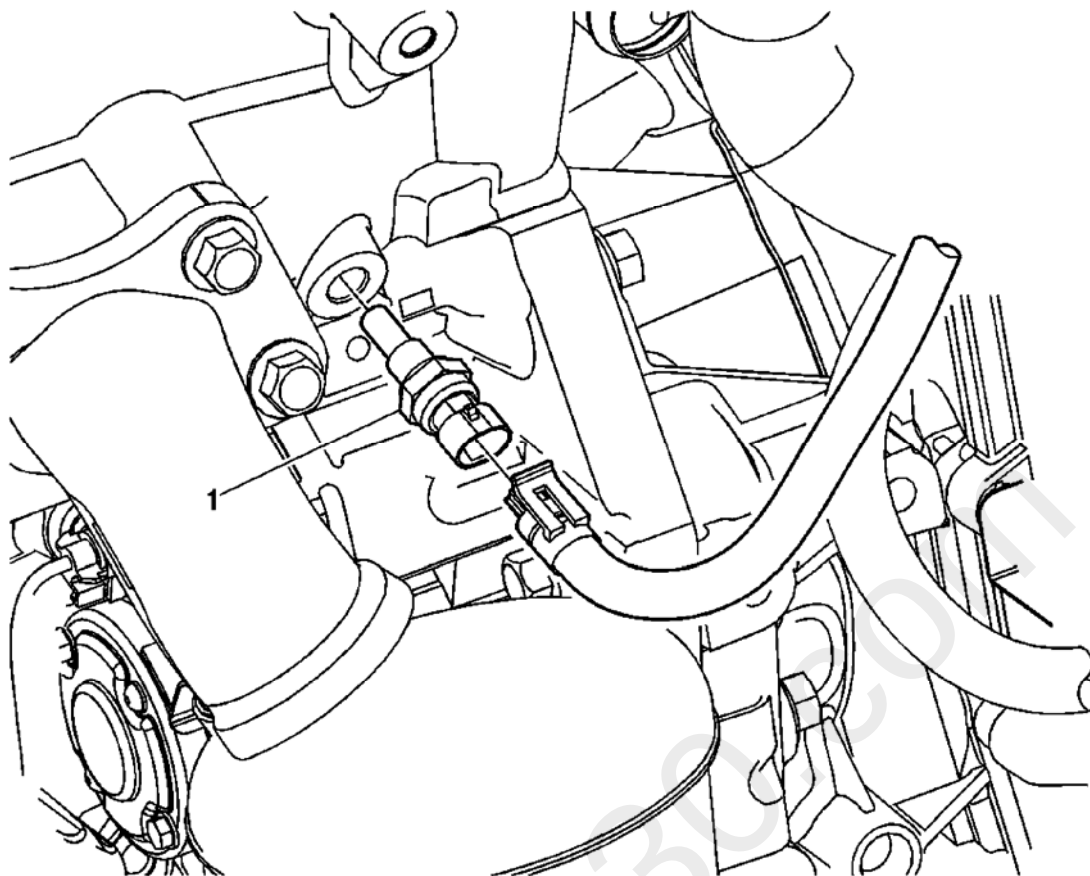


Fig. 2: Engine Coolant Temperature Sensor (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Partially drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Engine Coolant Temperature Sensor CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Reposition the sensor heat shield. 2. Disconnect the ECT sensor harness connector. Tighten: 20 N.m (35 lb in)

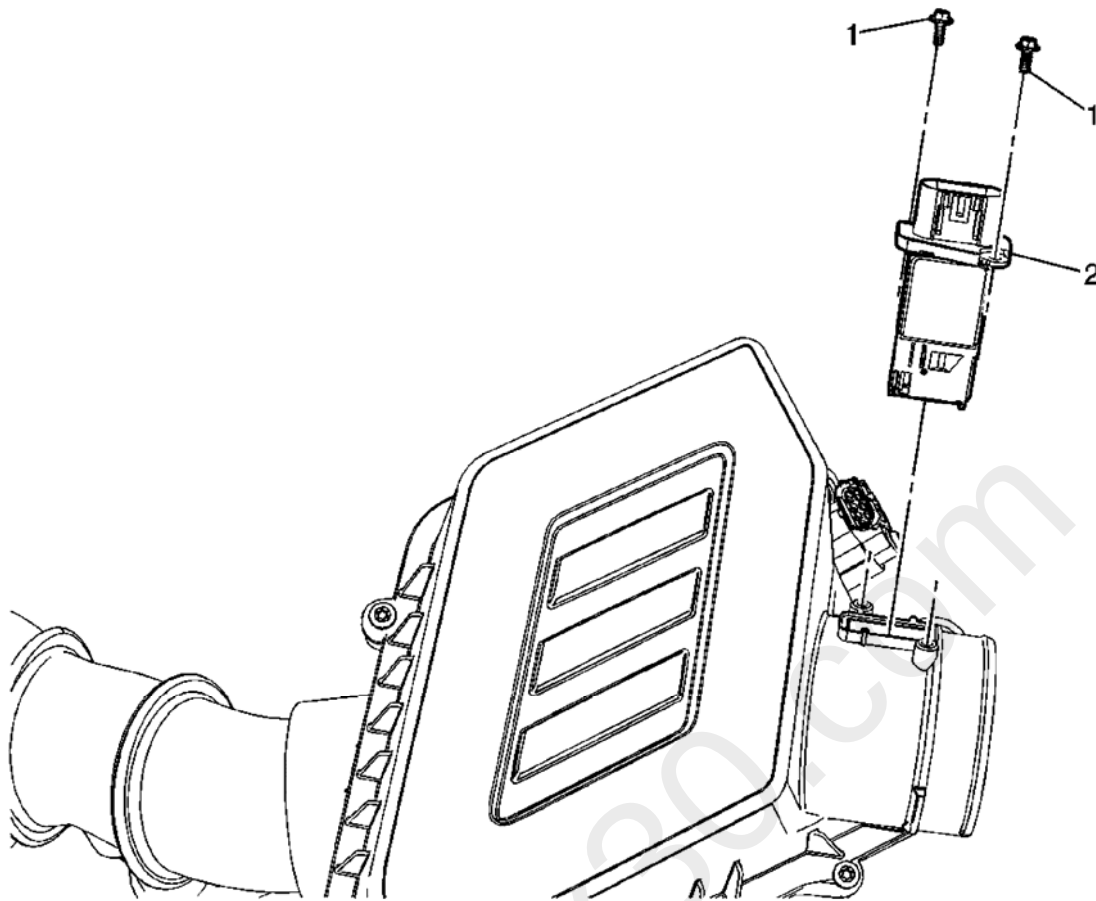


Fig. 3: Mass Airflow Sensor With Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Mass Airflow Sensor Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 4 N.m (35 lb in)
2	Mass Airflow Sensor with Intake Air Temperature Sensor Procedure: Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

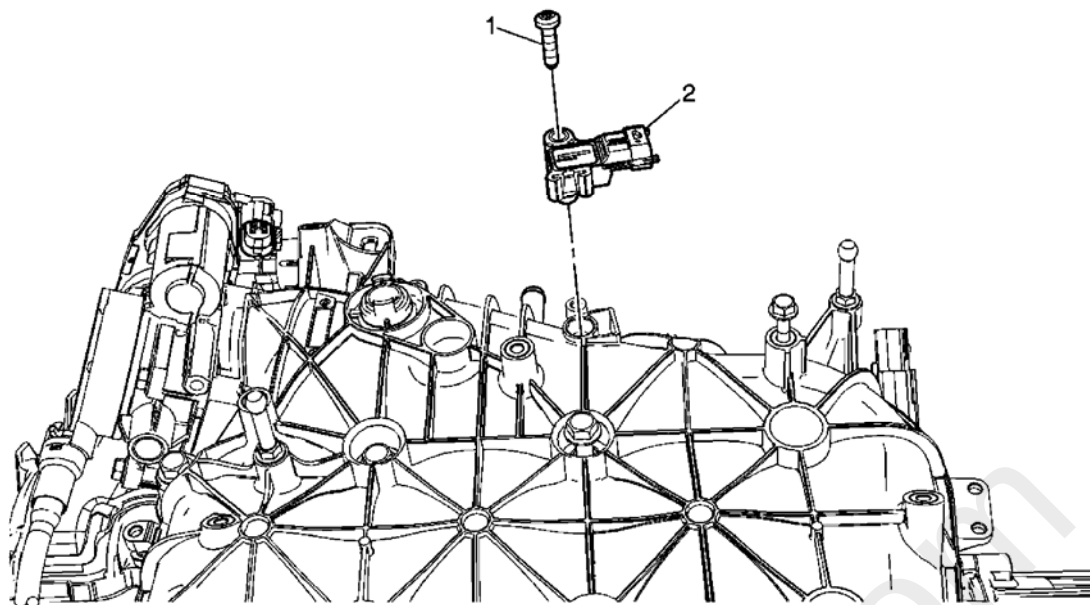


Fig. 4: Manifold Absolute Pressure Sensor
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Manifold Absolute Pressure Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 4 N.m(35 lb in)
2	Manifold Absolute Pressure Sensor Procedure: Disconnect the electrical connector.

THROTTLE INLET ABSOLUTE PRESSURE SENSOR REPLACEMENT

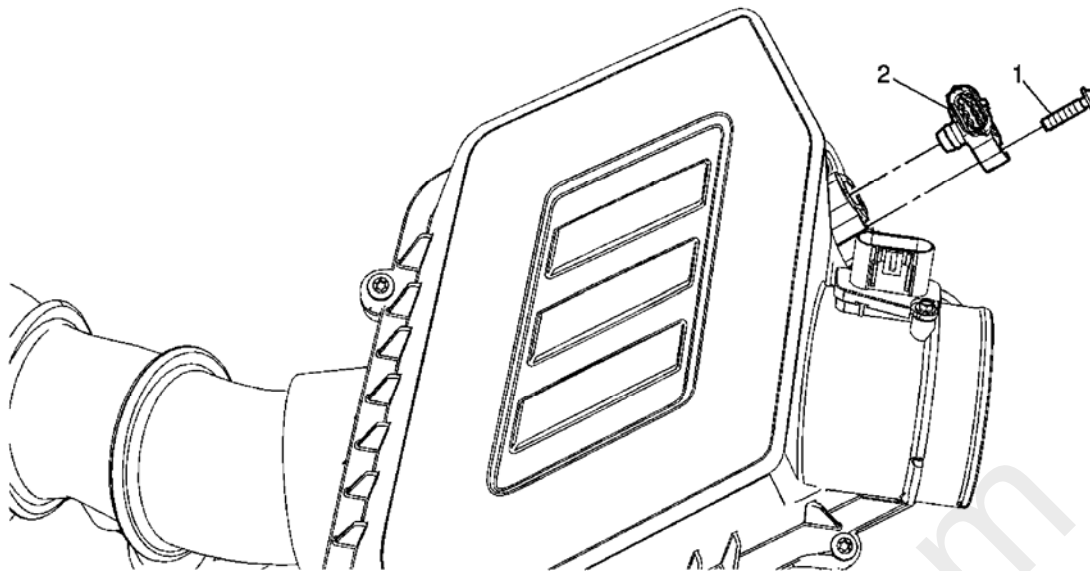


Fig. 5: Throttle Inlet Absolute Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Throttle Inlet Absolute Pressure Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 4 N.m (35 lb in)
2	Throttle Inlet Absolute Pressure Sensor Procedure: Disconnect the electrical connector.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1 (LF1)

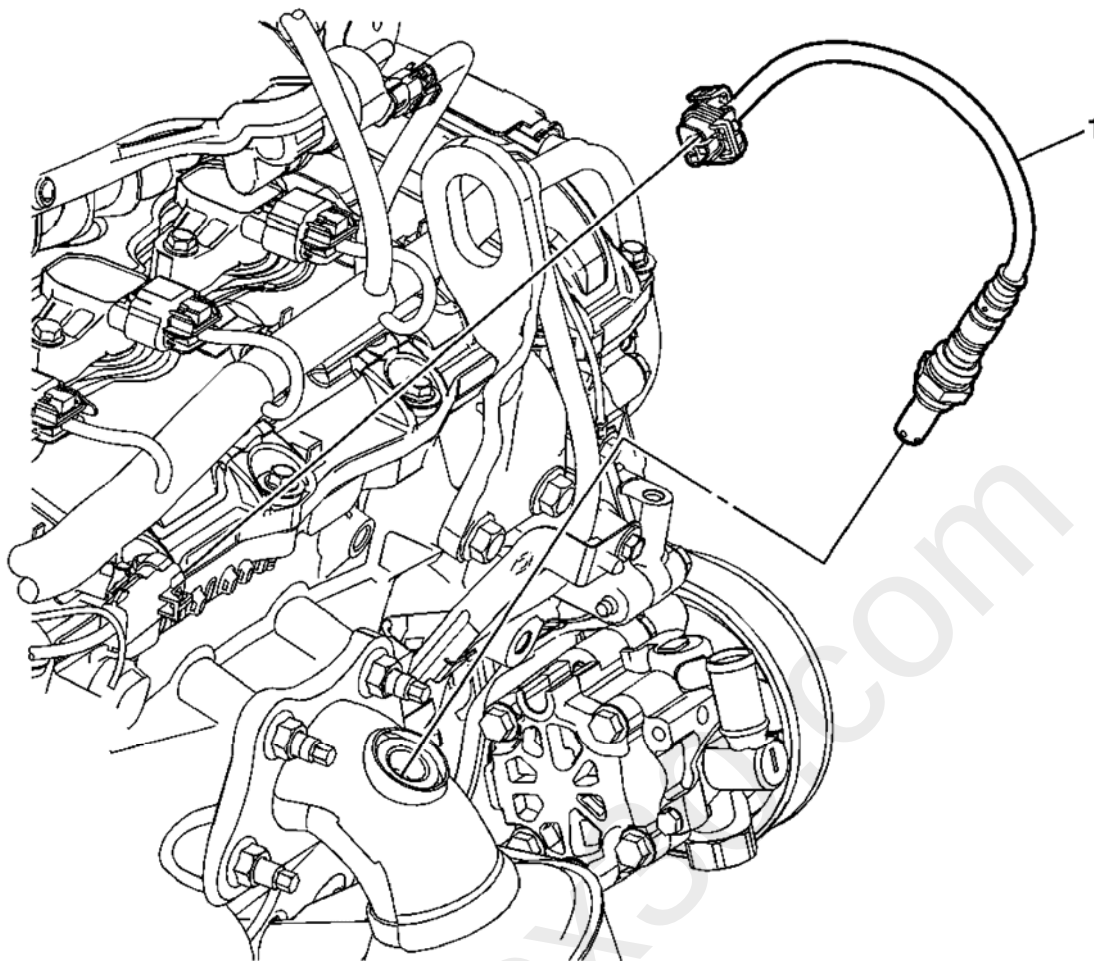


Fig. 6: Heated Oxygen Sensor - Bank 1 Sensor 1 (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. If equipped with FWD, raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. If equipped with AWD, lower the front suspension frame. Refer to <u>Drivetrain and Front Suspension Frame Replacement</u>	
	Heated Oxygen Sensor CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> . CAUTION: Refer to <u>Fastener Caution</u> .

Procedure

- Disconnect the heated oxygen sensor harness connector.
- If reinstalling the old sensor, coat the threads with anti-sieze compound. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

1

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

Tighten: 42 N.m (31 lb in)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2 (LF1)

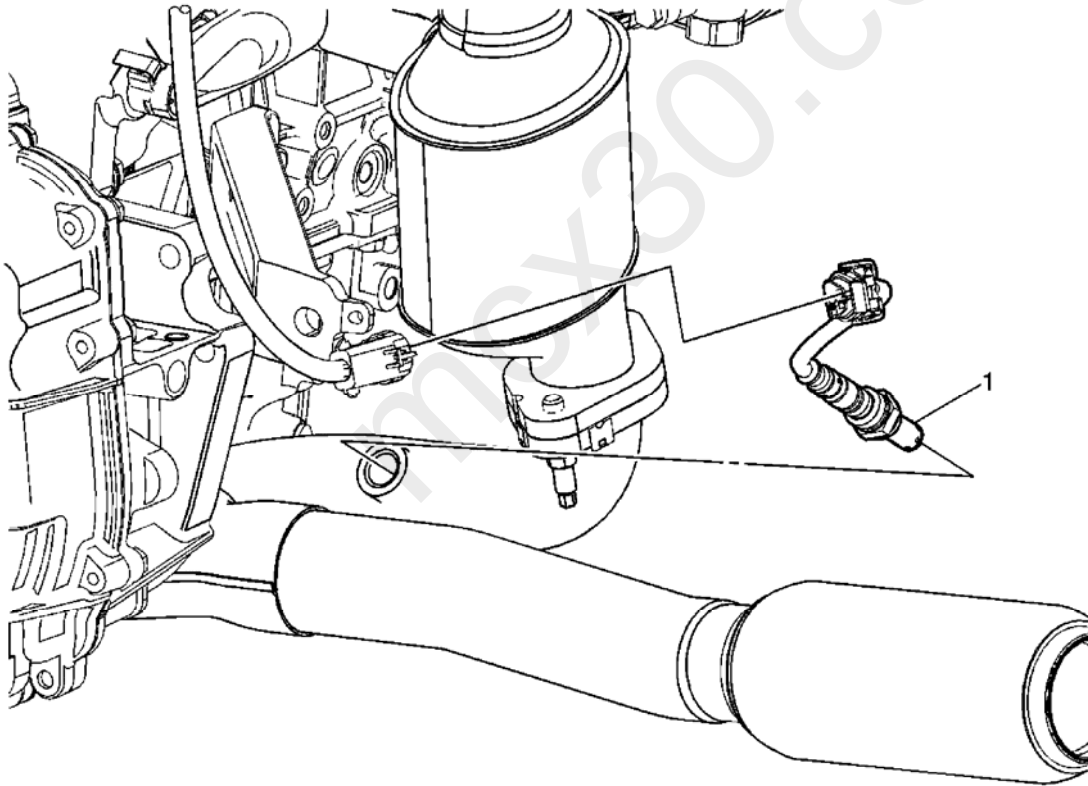


Fig. 7: Heated Oxygen Sensor - Bank 1 Sensor 2 (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedure:

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

Heated Oxygen Sensor

CAUTION:

Refer to **Heated Oxygen and Oxygen Sensor Caution** .

CAUTION:

Refer to **Fastener Caution** .

Procedure

1

- Disconnect the heated oxygen sensor harness connector.
- If reinstalling the old sensor, coat the threads with anti-sieze compound. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

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

Tighten: 42 N.m (31 lb in)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1 (LF1)

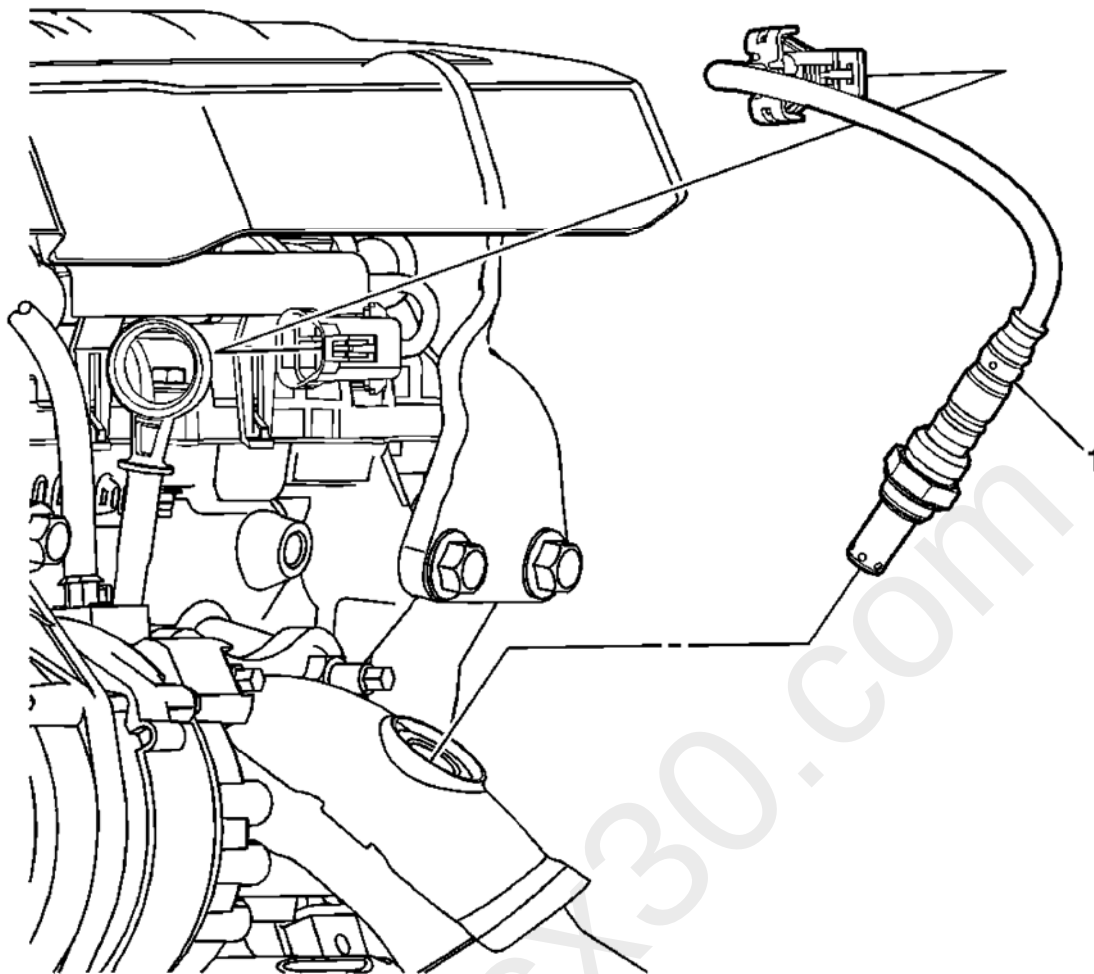


Fig. 8: Heated Oxygen Sensor - Bank 2 Sensor 1 (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> . CAUTION: Refer to <u>Fastener Caution</u> . Procedure • Disconnect the heated oxygen sensor harness connector. • If reinstalling the old sensor, coat the threads with anti-sieze compound. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .

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

Tighten: 42 N.m (31 lb in)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

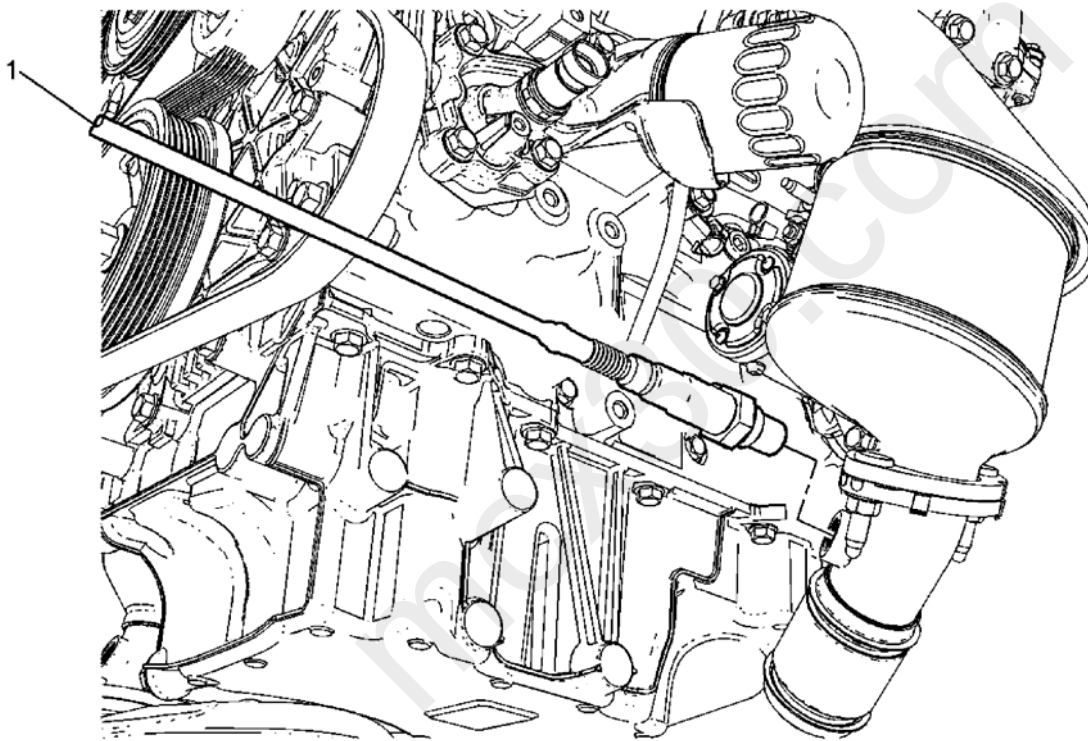


Fig. 9: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
	Heated Oxygen Sensor
	CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> .

CAUTION:

Refer to Fastener Caution .

Procedure

1. Disconnect the heated oxygen sensor harness connector.
2. If reinstalling the old sensor, coat the threads with anti-seize compound. Refer to Adhesives, Fluids, Lubricants, and Sealers .

1

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

Tighten: 42 N.m (31 lb in)

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

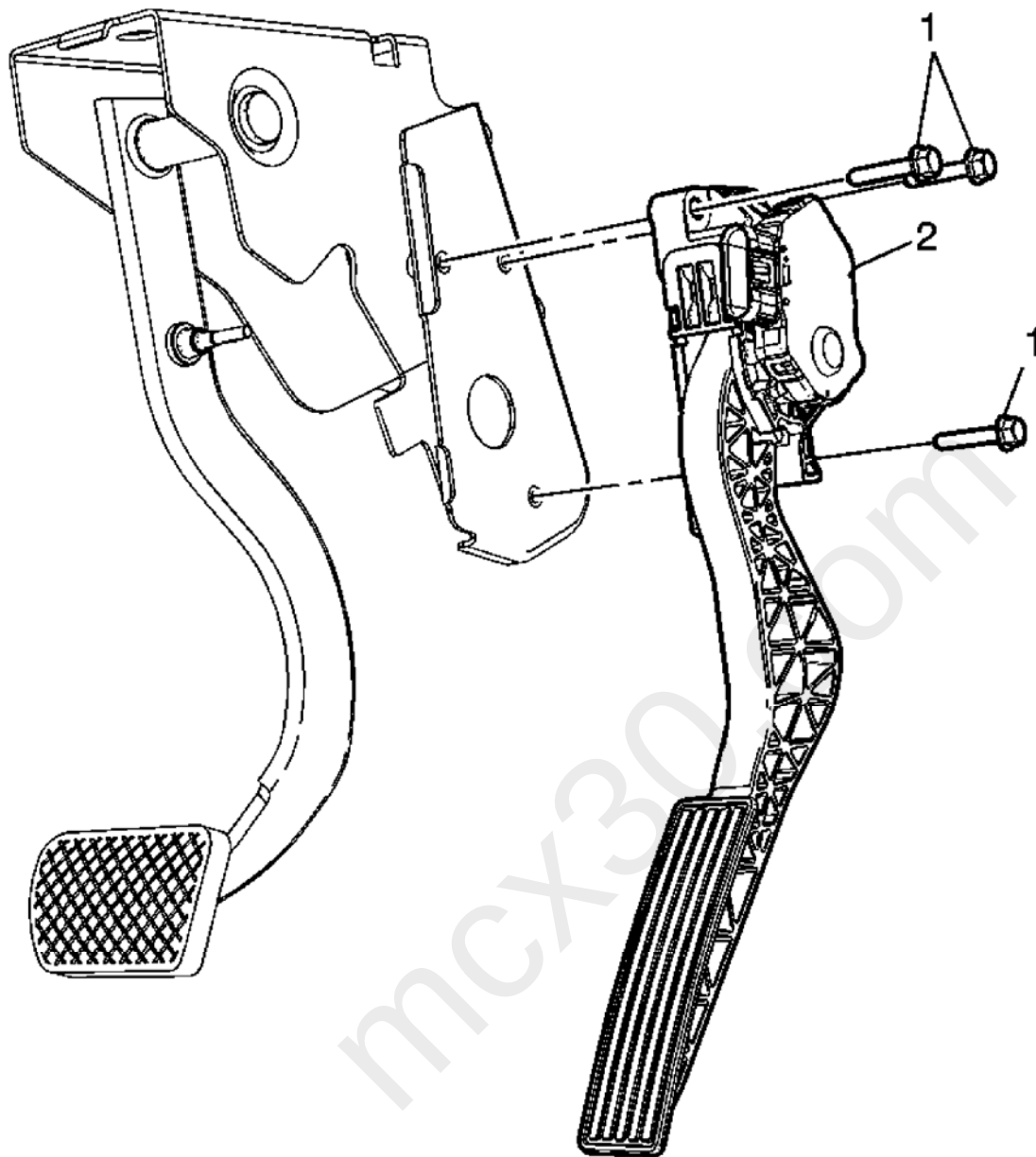


Fig. 10: Accelerator Pedal Position Sensor
 Courtesy of GENERAL MOTORS CORP.

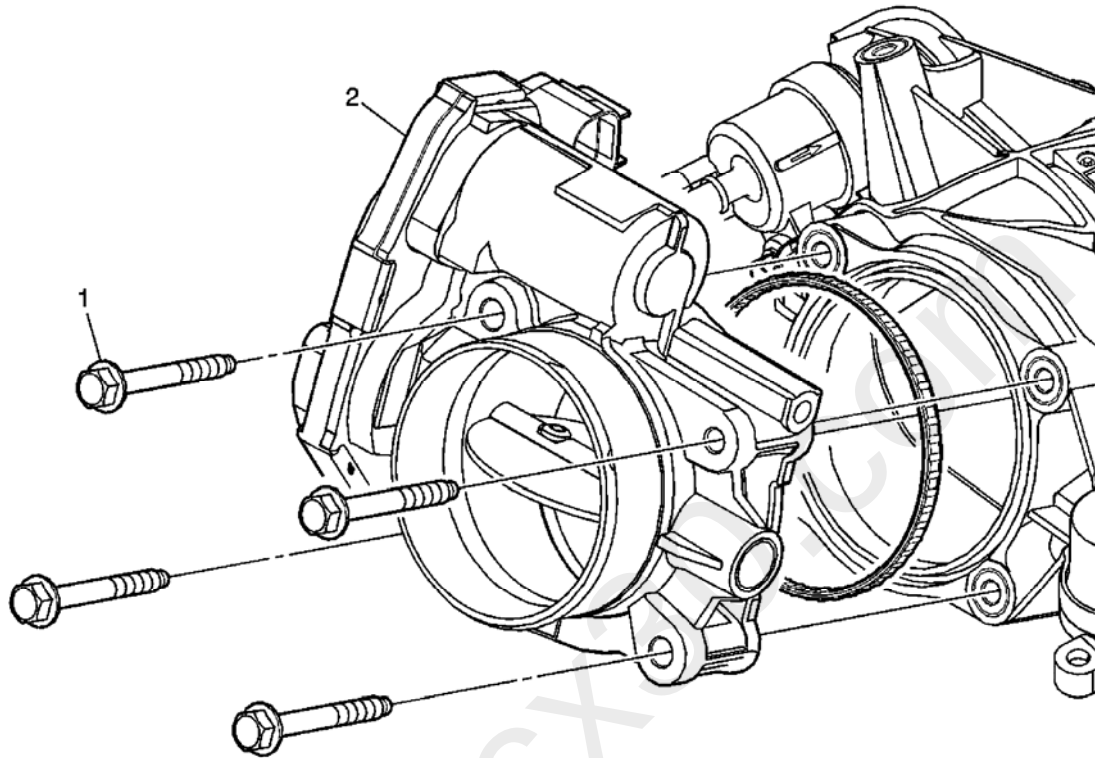
Callout	Component Name
1	Accelerator Pedal Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 25 N.m (18 lb ft)

2

Accelerator Pedal Position Sensor

Procedure:

Disconnect the electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT (LF1)**Fig. 11: Throttle Body Assembly (LF1)**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Throttle Body Procedure 1. Disconnect the throttle body harness connector.

- | | |
|--|---|
| | <ol style="list-style-type: none">2. Install a NEW throttle body seal.3. Perform the throttle learn procedure. Refer to <u>Throttle/Idle Learn (LF1, LFW)</u>. |
|--|---|

THROTTLE BODY INSPECTION AND CLEANING

NOTE: Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. The source of the deposit is exhaust gas recirculation (EGR) gas. Typically these deposits pose no problem. Occasionally the deposit may accumulate to a point where perceived pedal effort or throttle valve movement is effected. This procedure should not be performed on vehicles with mileage under 80 450 km (50,000 mi).

1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct 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, GM P/N 1052626 (Canadian P/N 993026) or AC-Delco Carburetor Tune-Up Conditioner, P/N X66-P, or an equivalent product.
4. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
5. Perform the idle learn procedure. Refer to Throttle/Idle Learn (LF1, LFW).

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. Install a scan tool to the vehicle and command the fuel pump relay OFF, allowing the low pressure fuel

pump to shut off.

2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.
4. Using the scan tool, verify that there is little to no fuel pressure, if there still is fuel pressure repeat step 2.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH-48027-100 Digital Pressure Gauge

Installation Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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

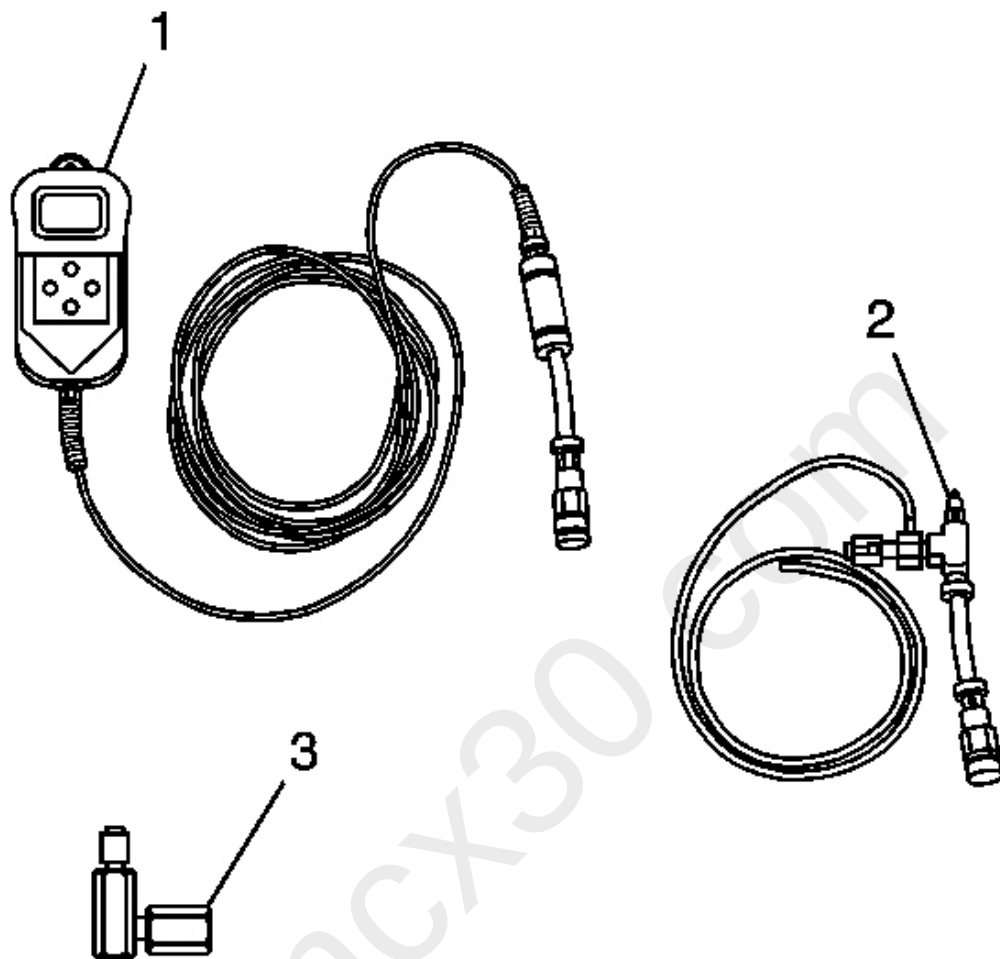


Fig. 12: Identifying CH-48027-100 Components
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
4. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH-48027-100** , refer to the manufacture's directions.

Removal Procedure

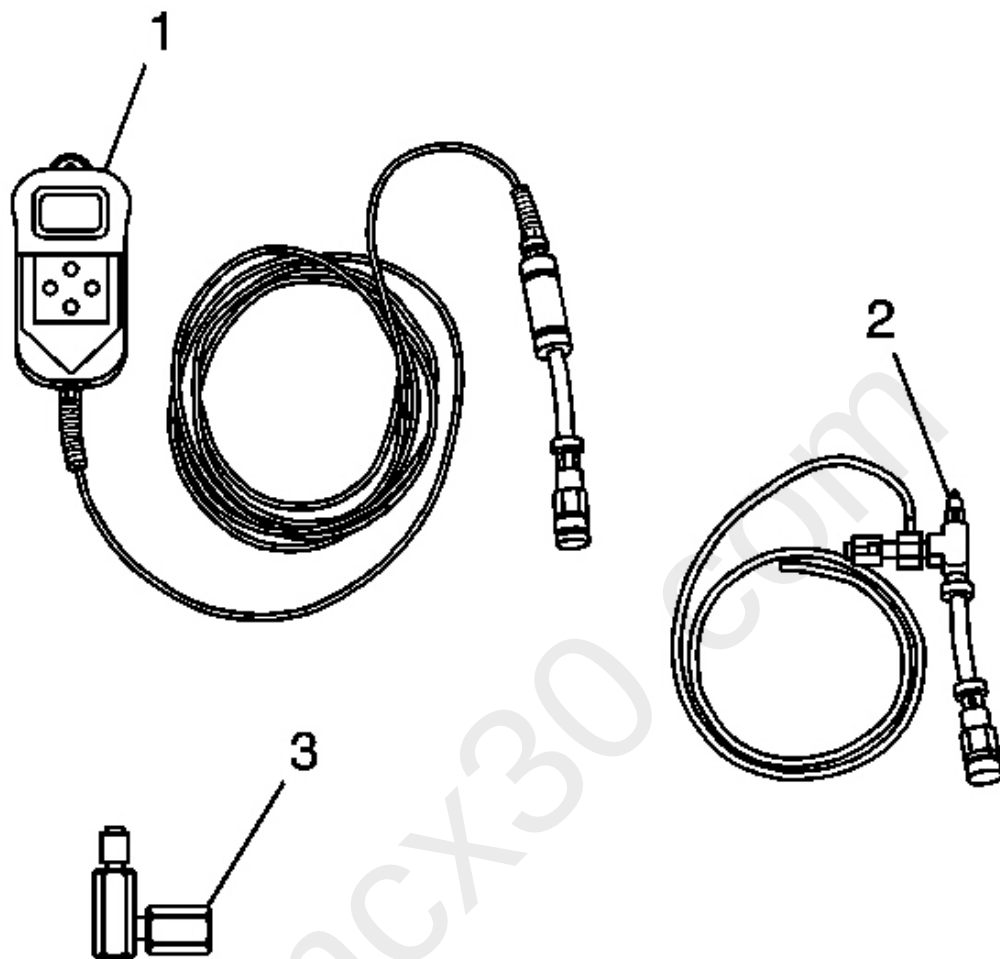


Fig. 13: Identifying CH-48027-100 Components
Courtesy of GENERAL MOTORS CORP.

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, if required. Perform the following steps:
 1. Wrap a shop towel around the fuel rail service port.
 2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.

3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
4. Close the valve on the CH-48027-2 (2).
5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.
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-48027-1 (1) from the CH-48027-2 (2).
3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (3).
4. Disconnect the CH-48027-3 (3) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Install the engine cover, if required.
7. Tighten the fuel fill cap.

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** .

Removal Procedure

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

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

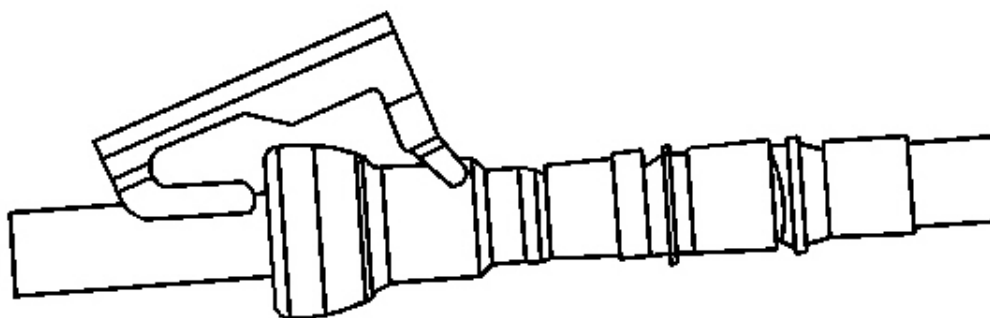


Fig. 14: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS CORP.

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

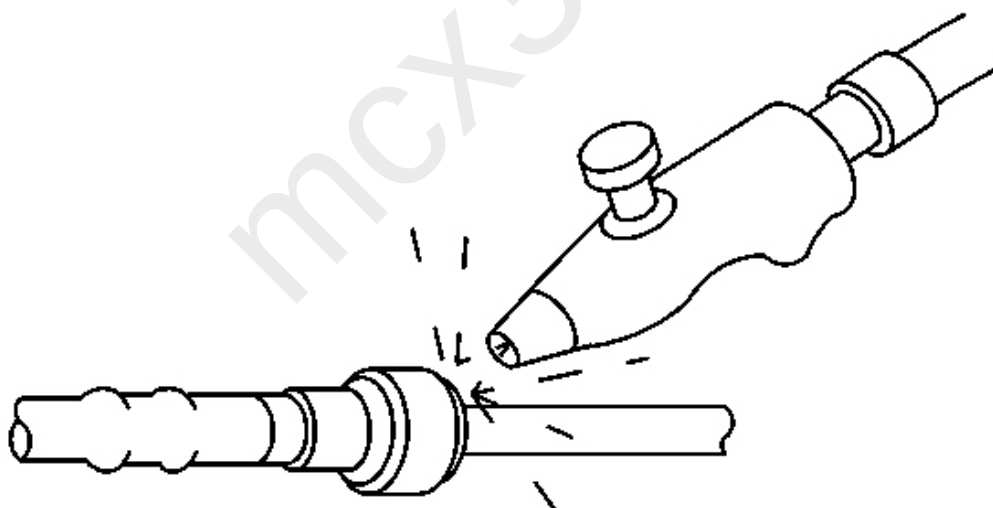


Fig. 15: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

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.

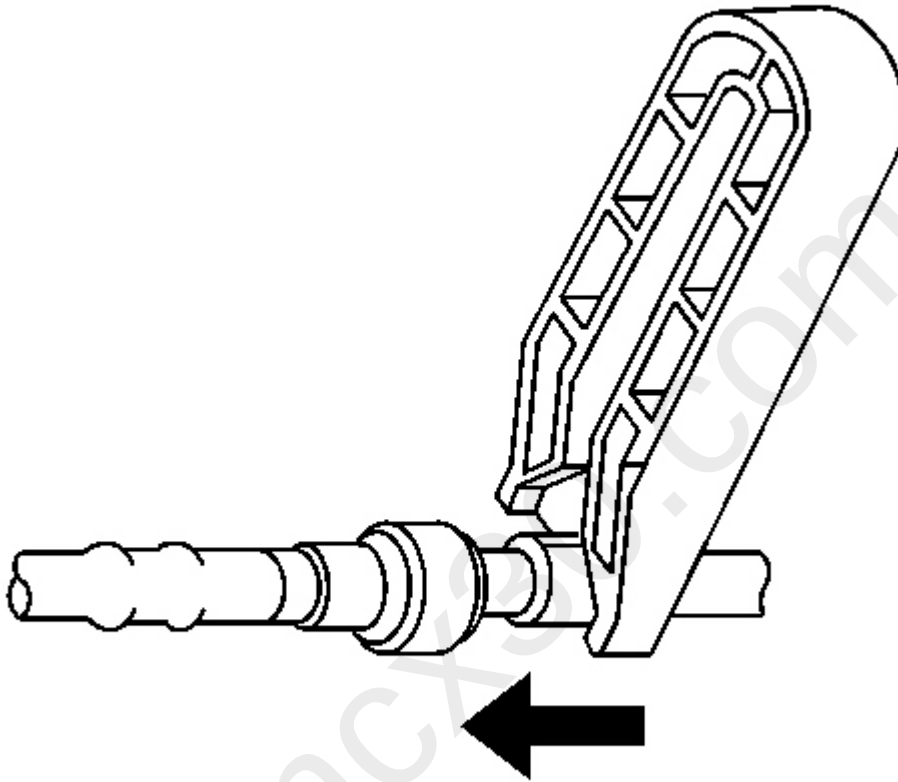


Fig. 16: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

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.

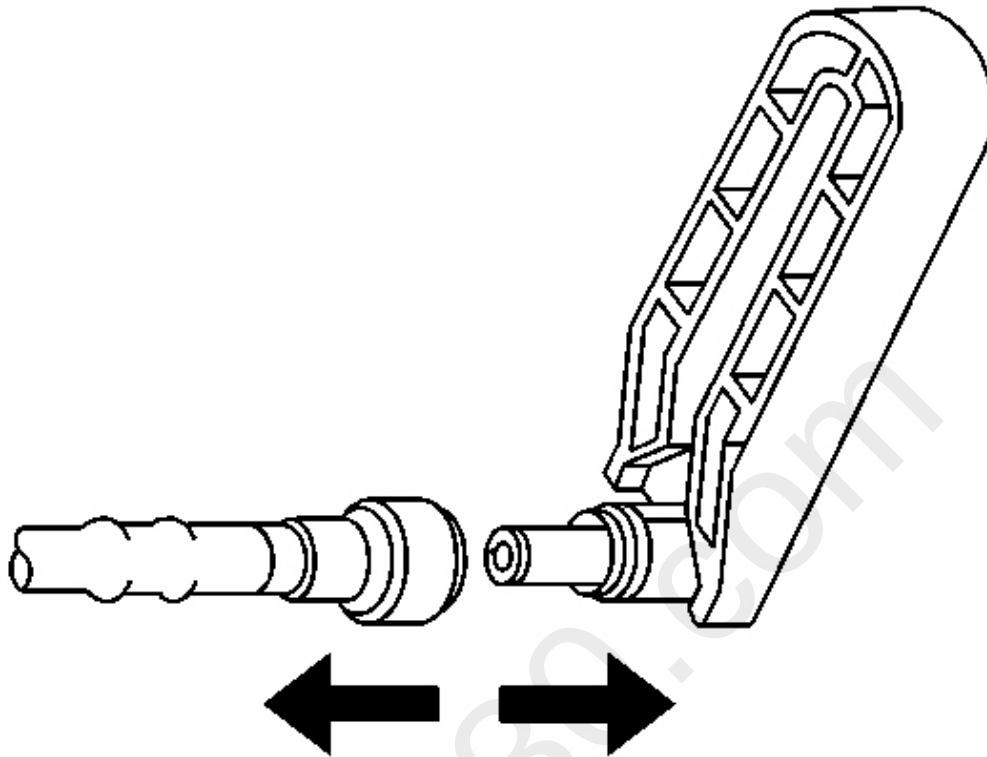


Fig. 17: Pulling Connection Apart
Courtesy of GENERAL MOTORS CORP.

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

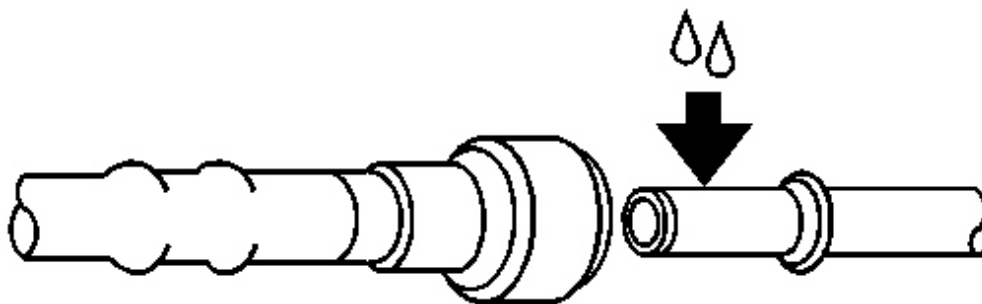


Fig. 18: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

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.

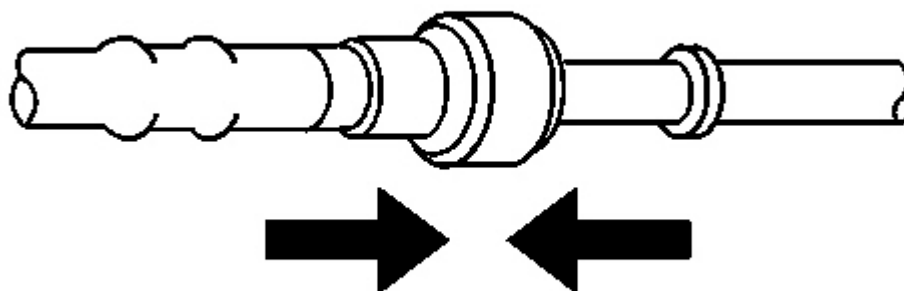


Fig. 19: Pushing Fittings Together
Courtesy of GENERAL MOTORS CORP.

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

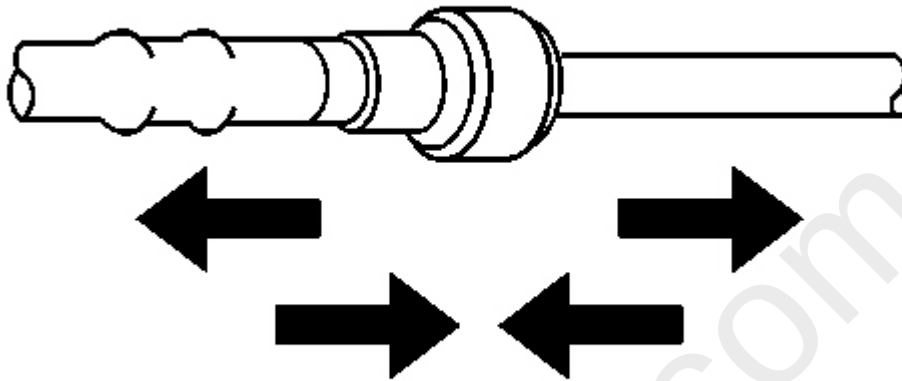


Fig. 20: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS CORP.

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

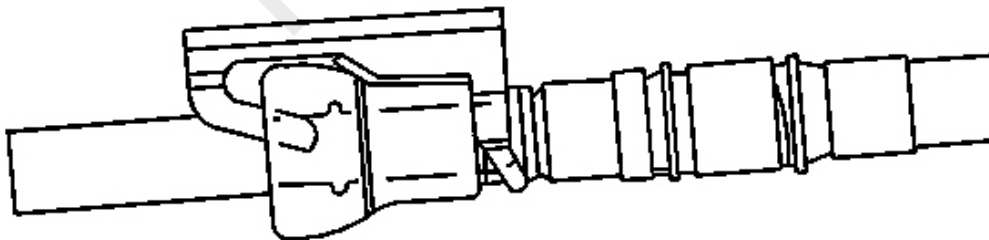


Fig. 21: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS CORP.

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

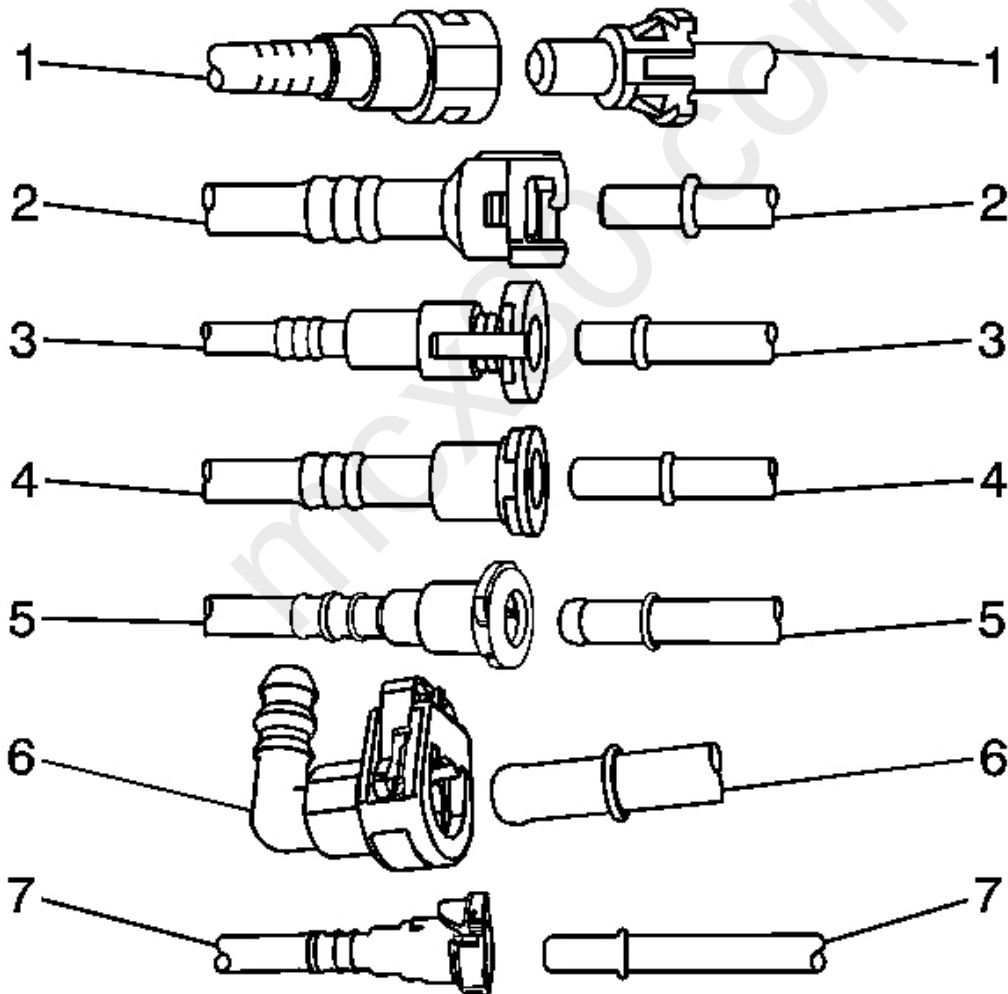


Fig. 22: Identifying Plastic Collar Quick Connect Fitting Types
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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)

The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the Fuel Pressure Relief .

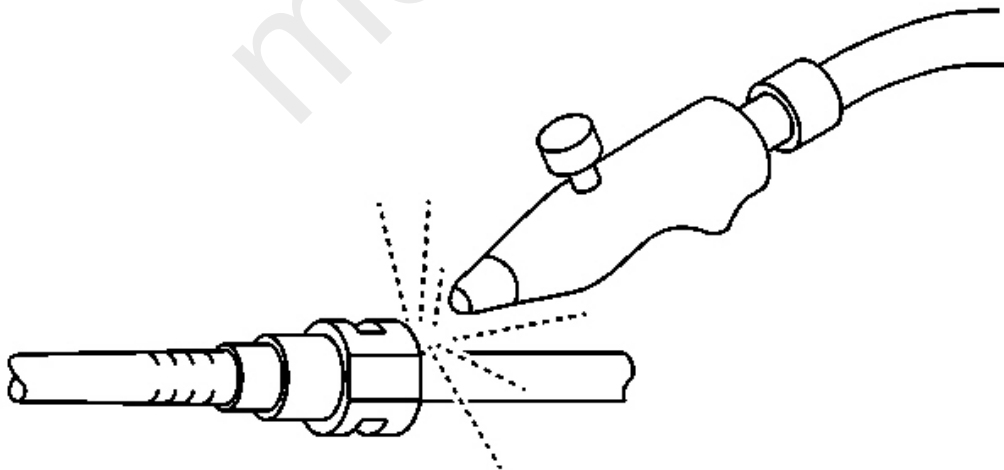


Fig. 23: Blowing Dirt Out Of Fitting (Plastic Collar)

Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

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

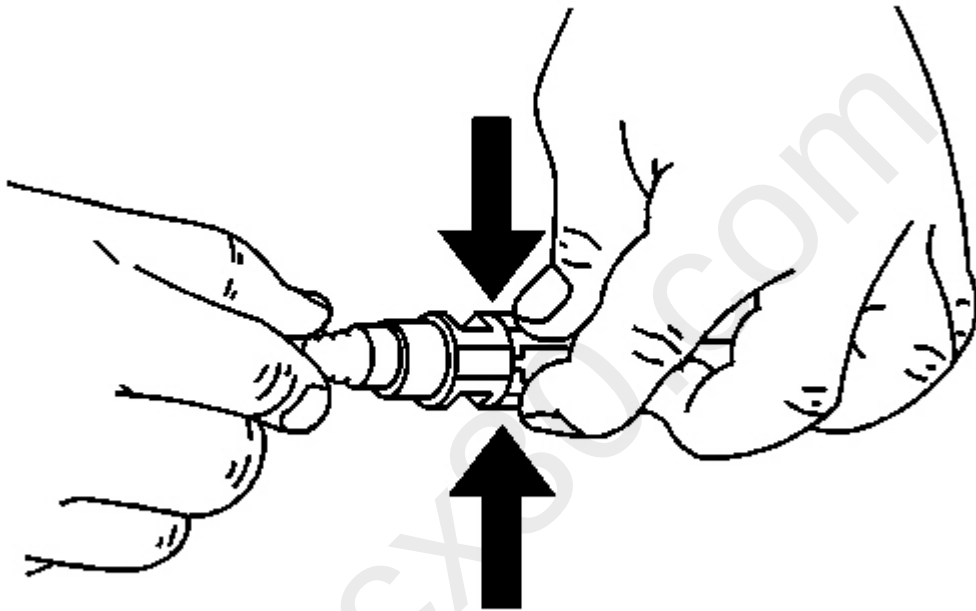


Fig. 24: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

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

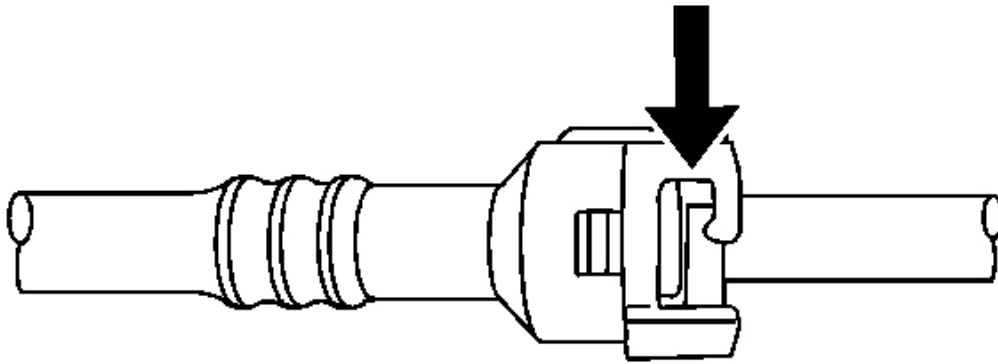


Fig. 25: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

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

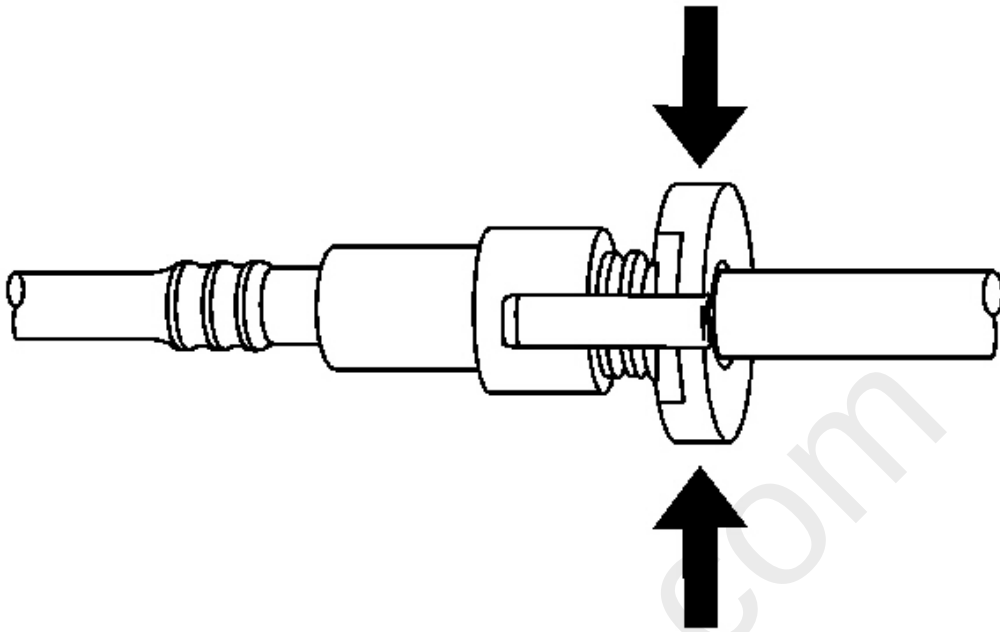


Fig. 26: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

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

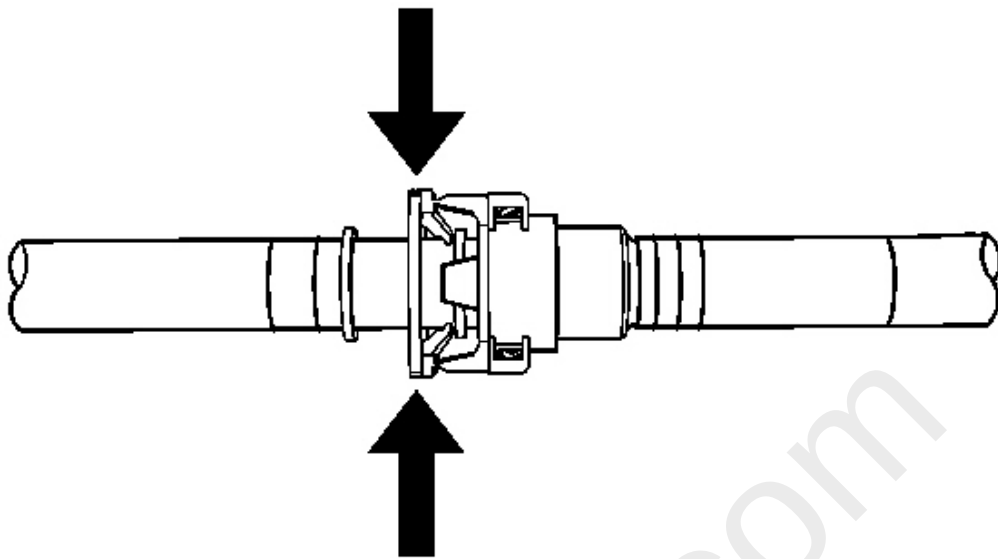


Fig. 27: Pushing In Male Side Of Connector
Courtesy of GENERAL MOTORS CORP.

6. 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.

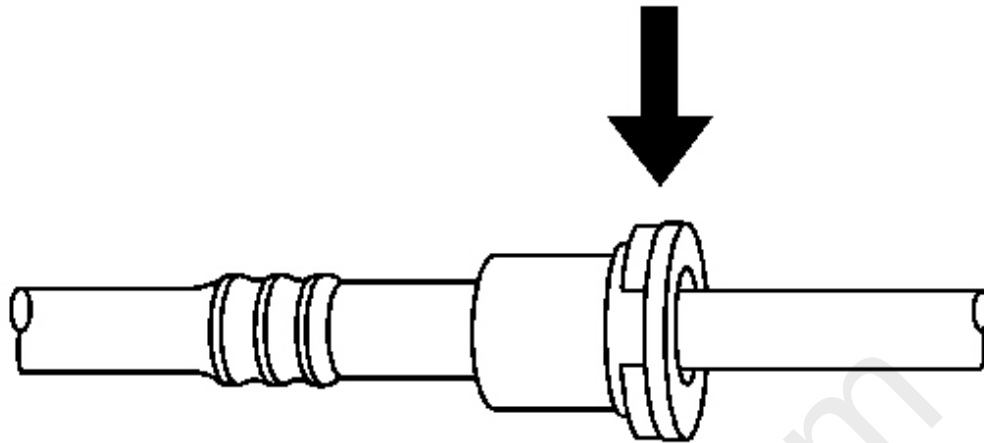


Fig. 28: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS CORP.

7. 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.

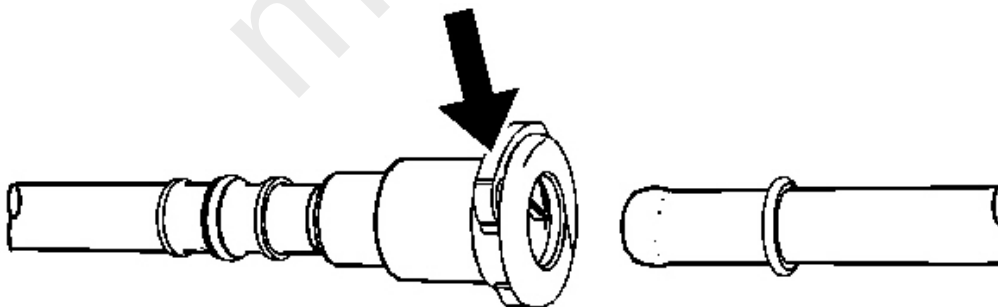


Fig. 29: Global Connector Style
Courtesy of GENERAL MOTORS CORP.

8. 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.

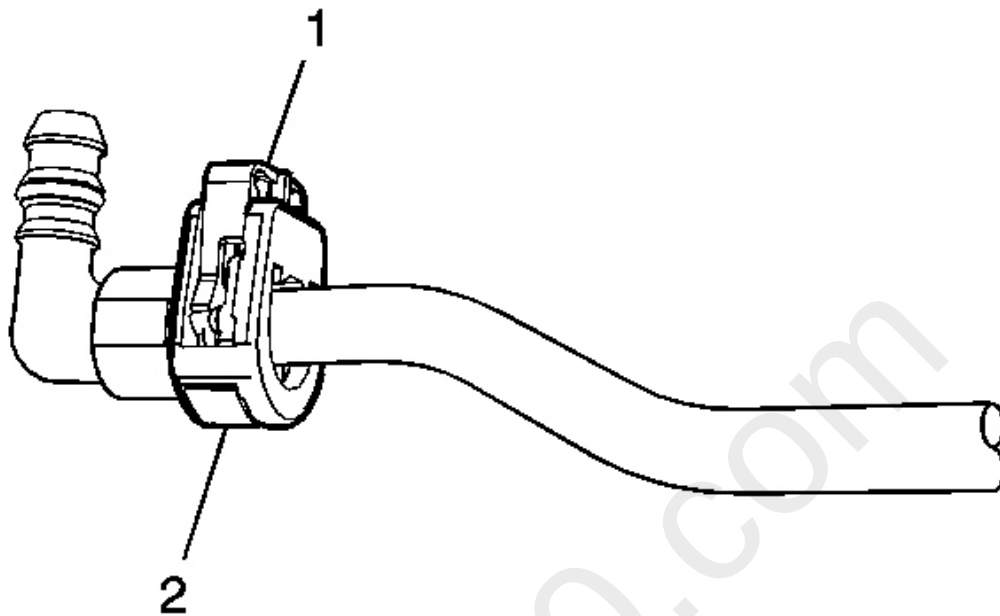


Fig. 30: TI Loc style

Courtesy of GENERAL MOTORS CORP.

9. 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.

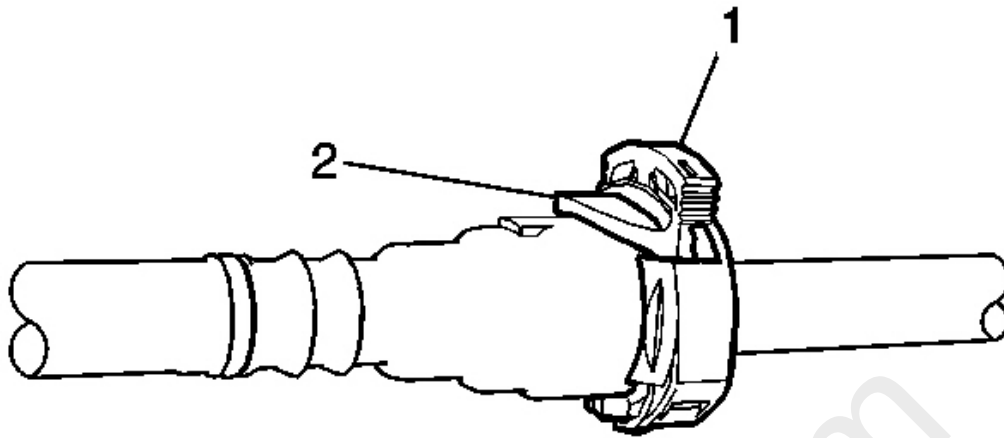


Fig. 31: Safe Lock Style
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Relieving Fuel Pressure Warning .

10. 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.
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

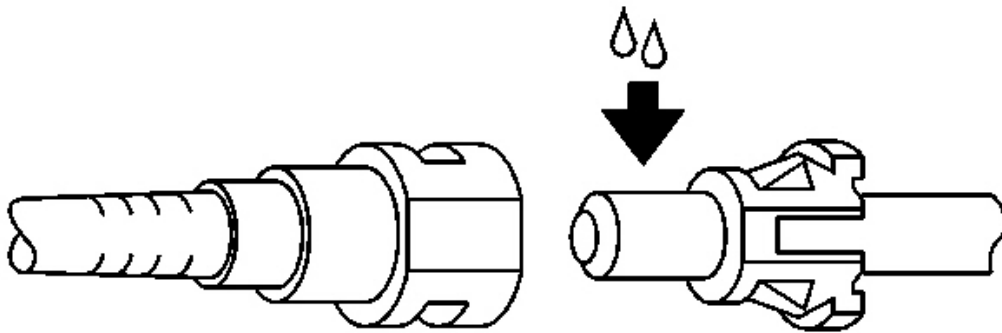


Fig. 32: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Pipe Fitting Warning .

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

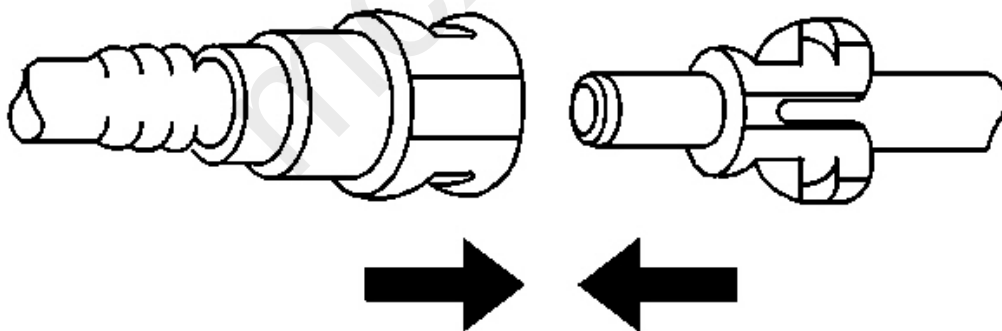


Fig. 33: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS CORP.

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

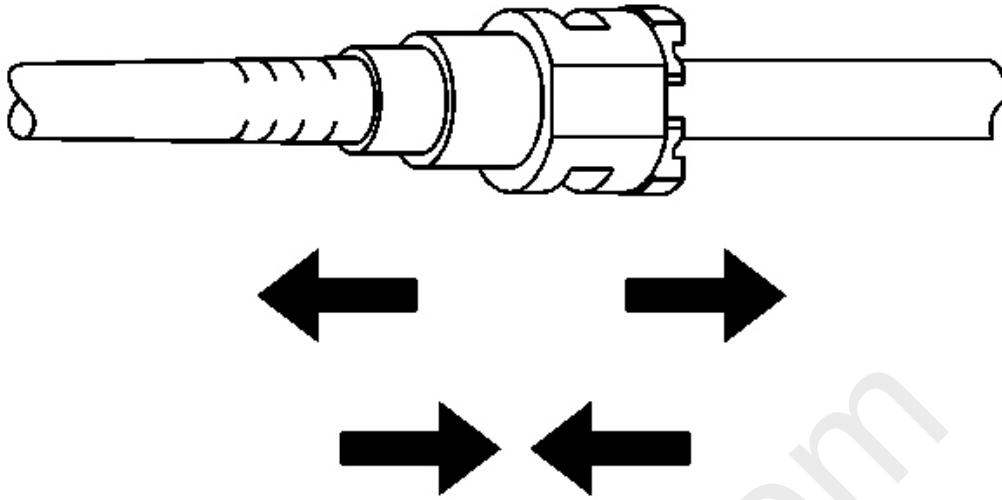


Fig. 34: Ensuring Quick-Connect Fitting Is Secure
Courtesy of GENERAL MOTORS CORP.

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

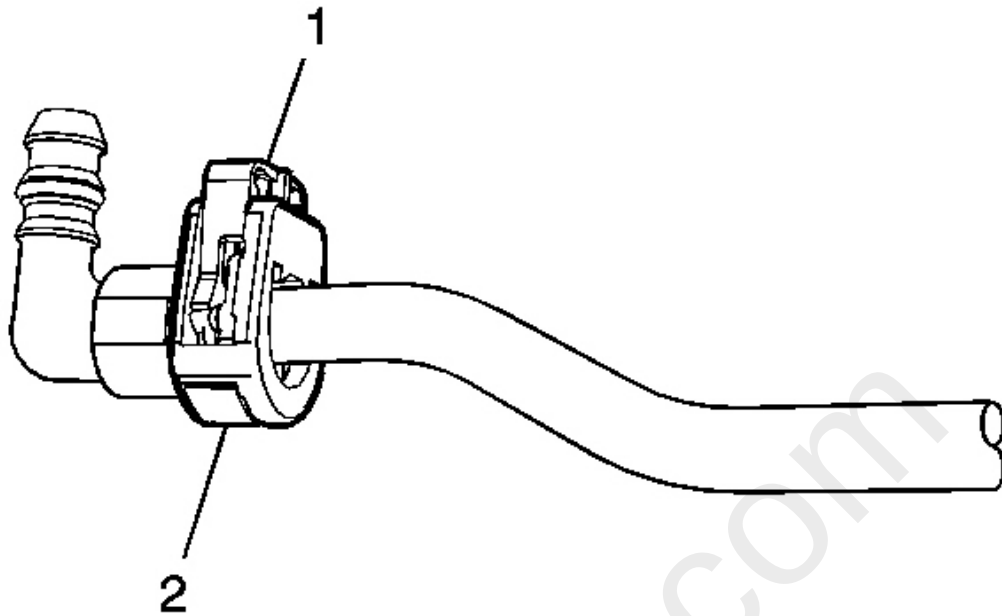


Fig. 35: TI Loc style

Courtesy of GENERAL MOTORS CORP.

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.

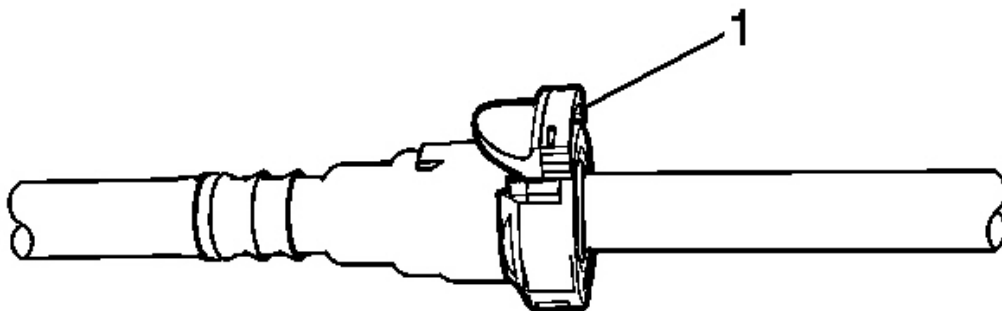


Fig. 36: Securing Connection

Courtesy of GENERAL MOTORS CORP.

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.
8. 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 TANK DRAINING

Special Tools

CH-45004: Fuel Tank Drain Hose

For equivalent regional tools, refer to Special Tools .

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.

Drain

1. Remove the fuel fill cap.
2. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Loosen the fuel fill pipe hose clamps and slide the fill pipe hose up the filler pipe.
4. Insert the **CH-45004:** fuel tank drain hose into the fuel tank until the hose reaches the bottom of the fuel tank.
5. Use an hand or air operated pump device in order to drain as much fuel as possible.

FUEL TANK REPLACEMENT (AWD)

Removal Procedure

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

1. Ensure that the fuel level in the tank is less than 1/4 full. If necessary, drain the fuel tank to at least this level. Refer to **Fuel Tank Draining**.

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

2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
3. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
5. Remove the exhaust system. Refer to **Exhaust Muffler Replacement**.
6. Remove the propeller shaft. Refer to **Propeller Shaft Replacement**.

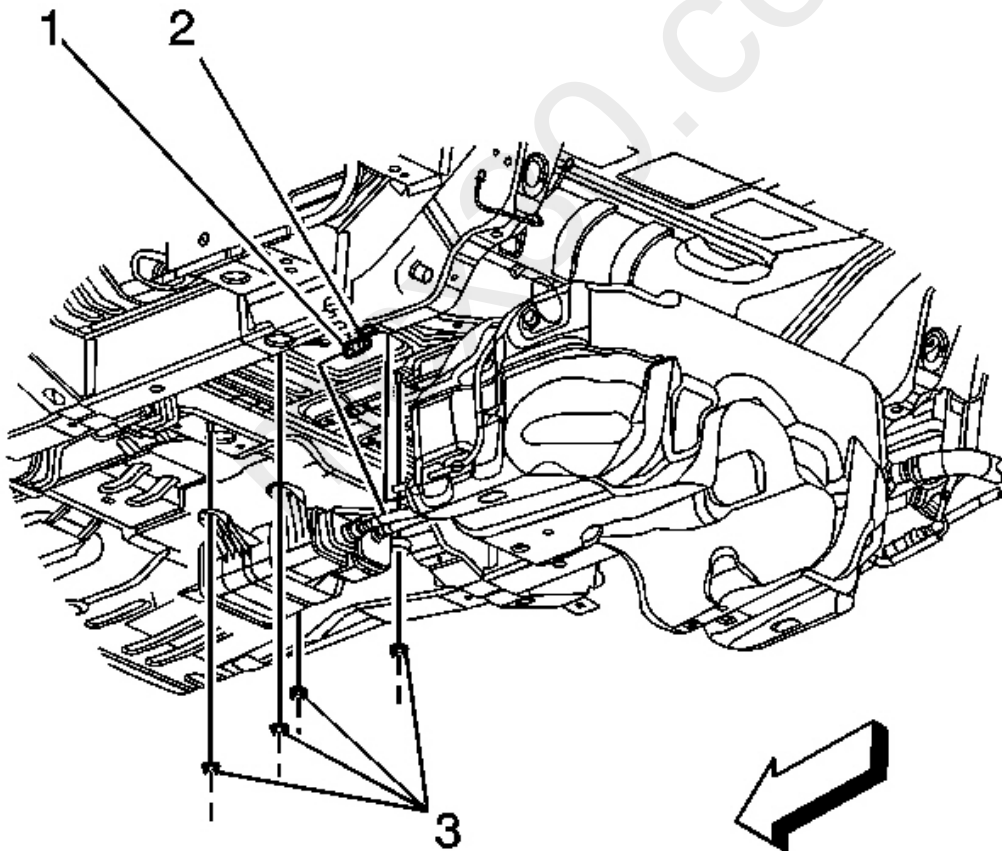


Fig. 37: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-

Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

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

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

7. Place a suitable container under the fuel line connection in order to catch any dripping fuel.
8. Remove the evaporative emission canister. Refer to **Evaporative Emission Canister Replacement**.
9. Disconnect the chassis fuel supply line (2) from the fuel tank.

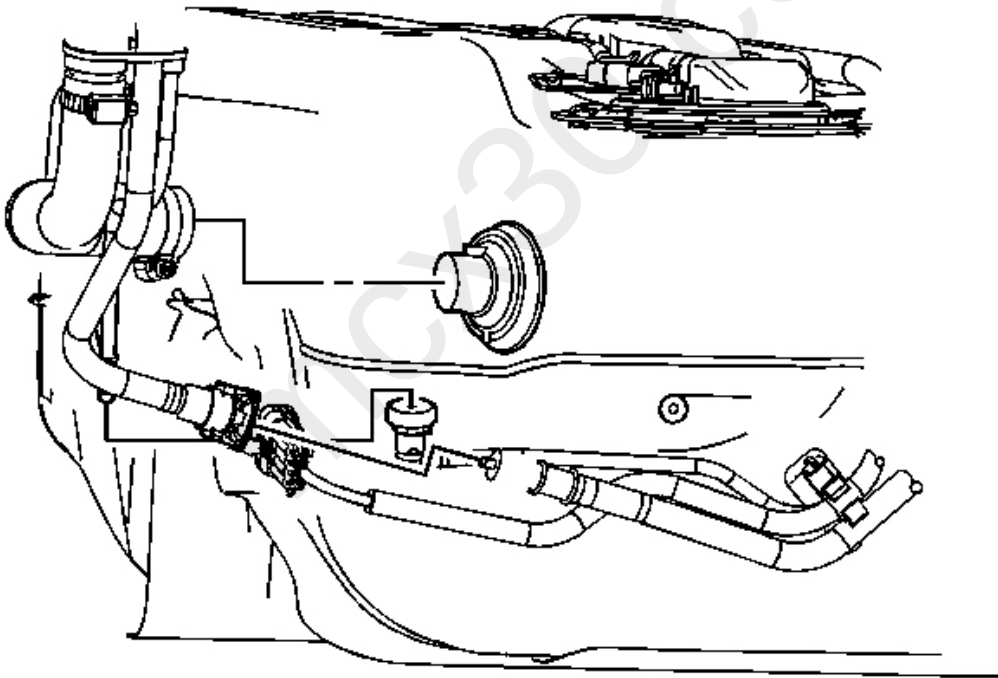


Fig. 38: View Of Fuel Filler Pipe, EVAP Vent & Fresh Air Hoses At Fuel Tank
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel filler tube, EVAP vent hose, and fresh air hose from the fuel tank.
11. Disconnect the fuel tank electrical connector and remove the electrical connector retainer from the rear

frame.

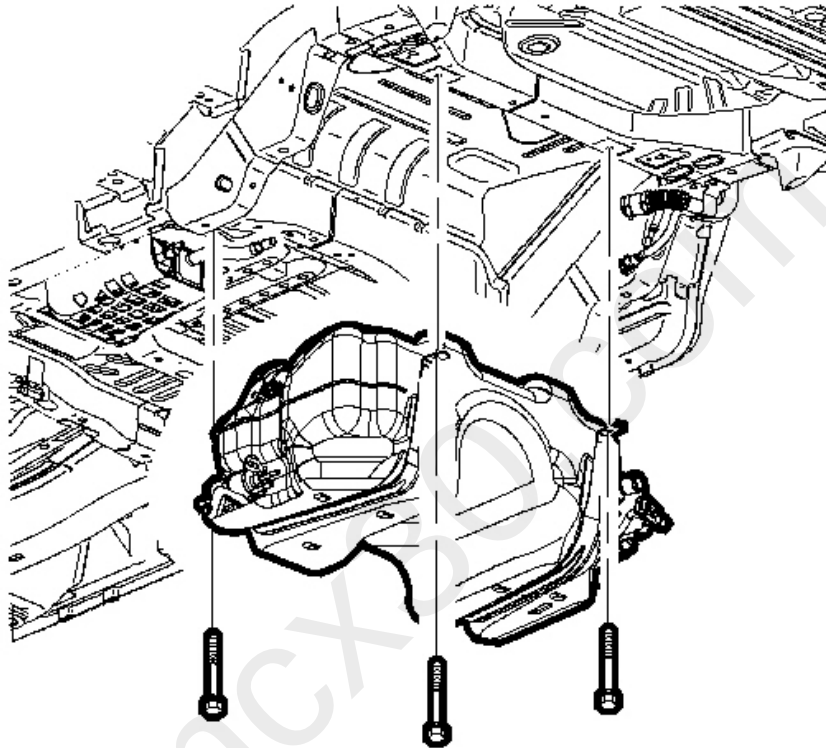


Fig. 39: View Of Fuel Tank Heat Shield & Fuel Tank Assembly
Courtesy of GENERAL MOTORS CORP.

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

12. Support the fuel tank.
13. Remove the fuel tank strap bolts and fuel tank straps.
14. Lower the front of the fuel tank (with shield), and pull the tank forward to clear the rear drive module.
15. If replacing the fuel tank, remove the fuel tank module assemblies. Refer to **Fuel Tank Fuel Pump**

Module Replacement and Fuel Tank Fuel Pump Module Replacement - Secondary .

16. If replacing the fuel tank, remove the heat shield from the tank.

Installation Procedure

1. If previously removed, install the fuel tank module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement** and **Fuel Tank Fuel Pump Module Replacement - Secondary** .
2. If previously removed, install the heat shield to the fuel tank.

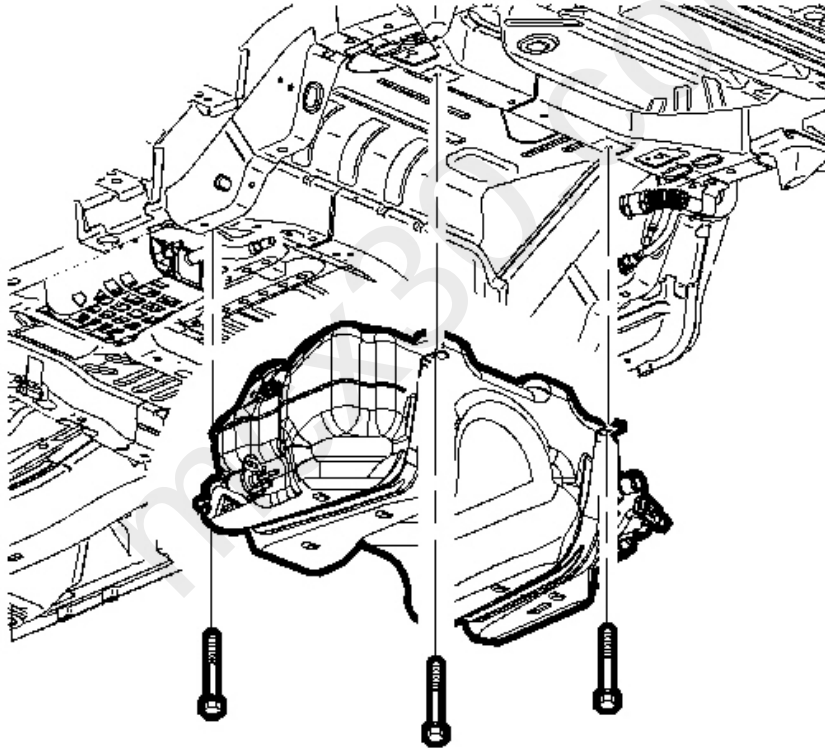


Fig. 40: View Of Fuel Tank Heat Shield & Fuel Tank Assembly
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel tank heat shield and fuel tank assembly to the vehicle.

CAUTION: Refer to Fastener Caution .

4. Install the fuel tank straps and the fuel tank strap-to-body bolts.

Tighten: Tighten the bolts to 25 N.m (18 lb ft).

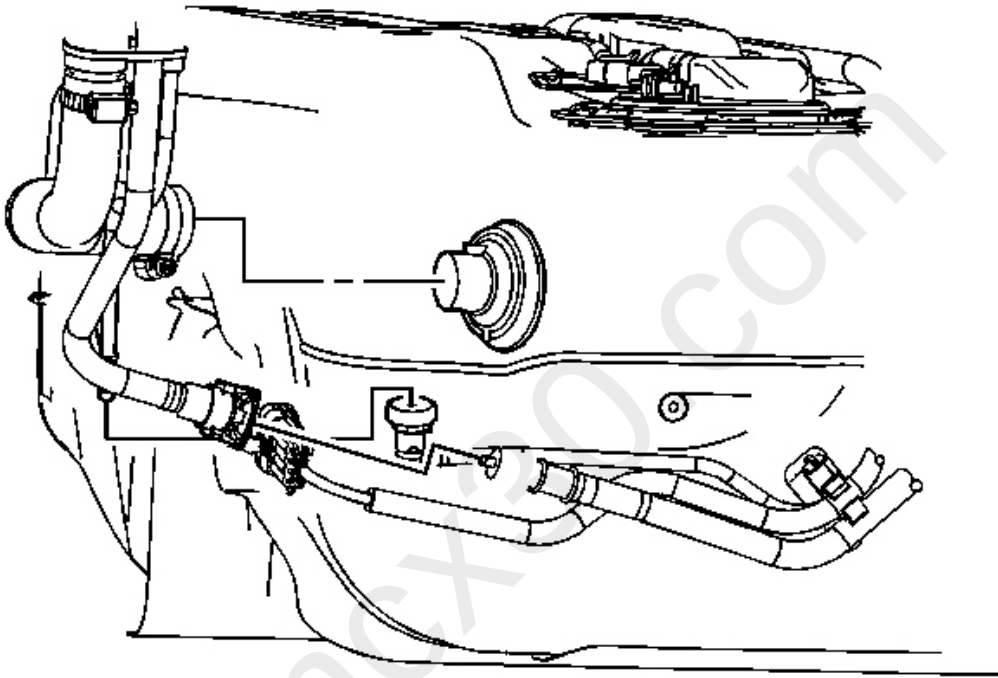


Fig. 41: View Of Fuel Filler Pipe, EVAP Vent & Fresh Air Hoses At Fuel Tank
Courtesy of GENERAL MOTORS CORP.

5. Connect the fuel tank electrical connector and install the electrical connector retainer to the rear frame.
6. Connect the EVAP vent, and fresh air hoses to the fuel tank.
7. Connect the fuel filler tube to the fuel tank.

Tighten: Tighten the fuel filler tube clamp to 5 N.m (44 lb in).

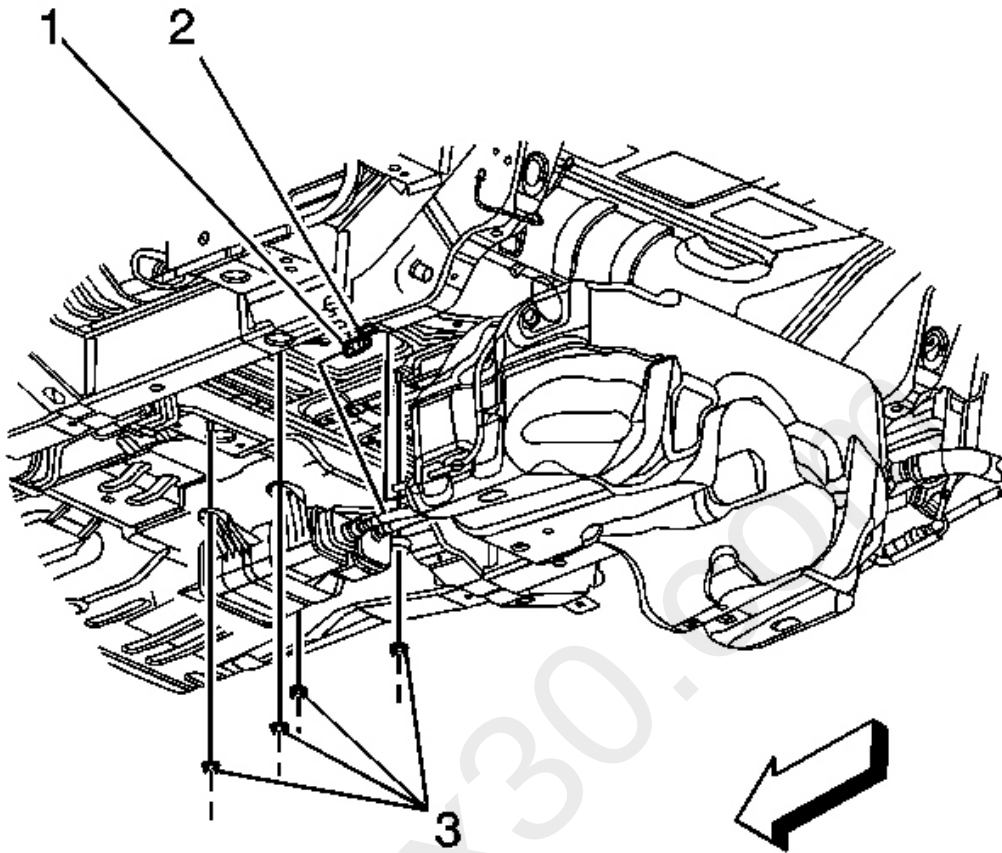


Fig. 42: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

8. Connect the chassis fuel supply line (2) to the fuel tank.
9. Install the evaporative emission canister. Refer to **Evaporative Emission Canister Replacement** .
10. Install the propeller shaft. Refer to **Propeller Shaft Replacement** .
11. Install the exhaust system. Refer to **Exhaust Muffler Replacement** .
12. Lower the vehicle.
13. Fill the fuel tank with gasoline.
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
15. Prime the fuel system:
 1. Cycle the ignition ON for 5 seconds and then OFF for 10 seconds.
 2. Repeat the previous step twice.

3. Crank the engine until it starts. The maximum starter motor cranking time is 20 seconds.
4. If the engine does not start, repeat steps 13.1-13.3.

FUEL TANK REPLACEMENT (FWD)

Removal Procedure

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

1. Ensure that the fuel level in the tank is less than 1/4 full. If necessary, drain the fuel tank to at least this level. Refer to **Fuel Tank Draining**.

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

2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
3. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the exhaust system. Refer to **Exhaust Muffler Replacement** .

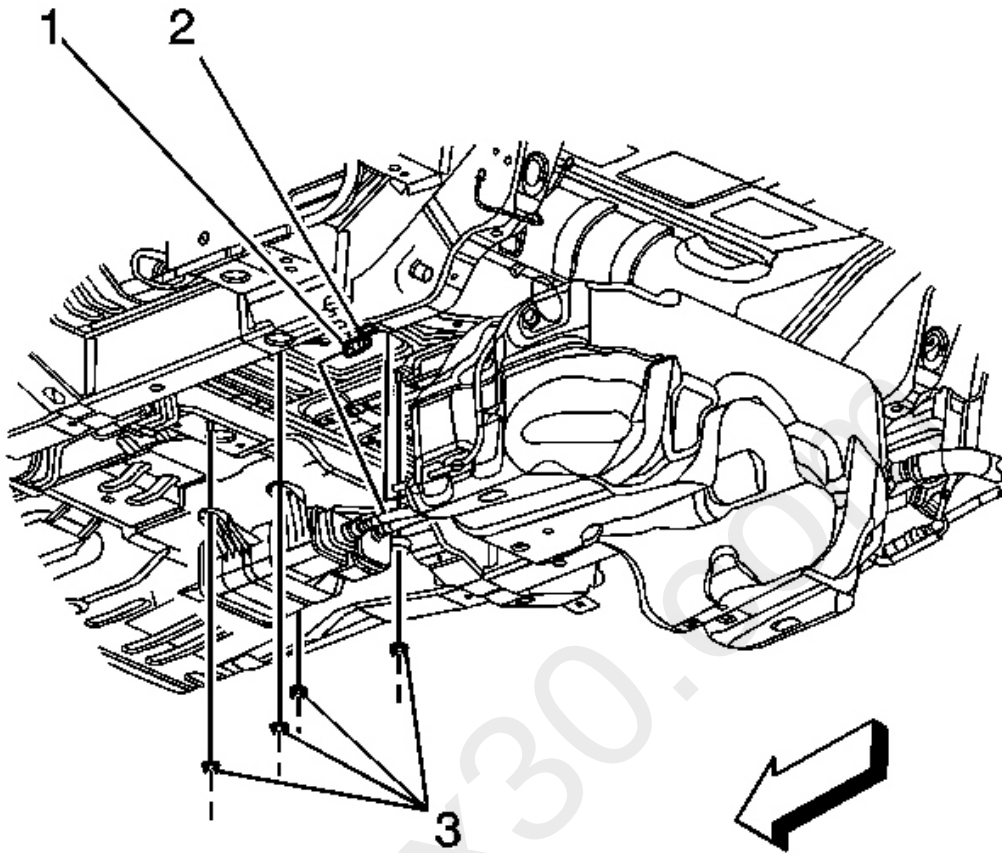


Fig. 43: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

6. Disconnect the canister vent valve electrical connectors.
7. Disconnect the vent hose from the canister filter.
8. Disconnect the fuel tank vent pipe from the evaporative emission canister.

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

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

9. Disconnect the chassis fuel supply line (2) from the fuel tank.

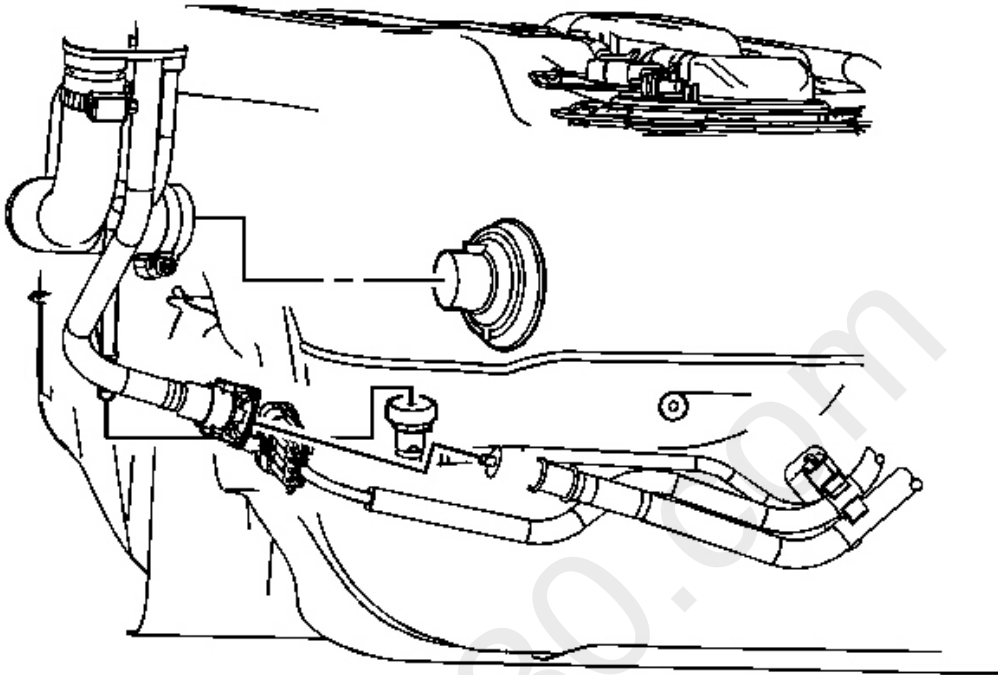


Fig. 44: View Of Fuel Filler Pipe, EVAP Vent & Fresh Air Hoses At Fuel Tank
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel filler tube, EVAP vent hose, and fresh air hose from the fuel tank.
11. Disconnect the fuel tank electrical connector and remove the electrical connector retainer from the rear frame.

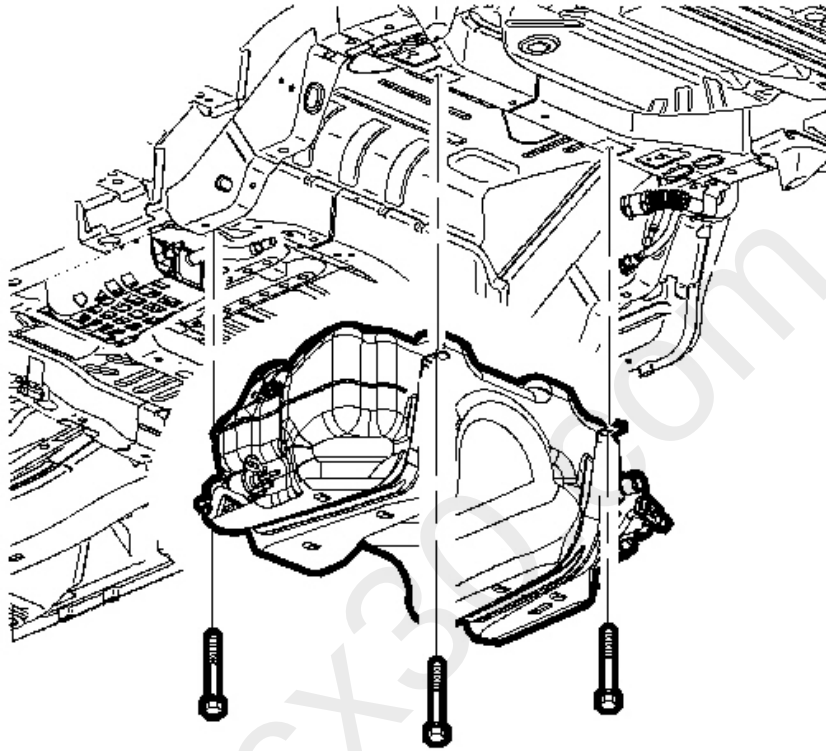


Fig. 45: View Of Fuel Tank Heat Shield & Fuel Tank Assembly
Courtesy of GENERAL MOTORS CORP.

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

NOTE: Do not lower the rear frame. It is not necessary to lower the rear frame for fuel tank removal.

12. Support the fuel tank.
13. Remove the fuel tank strap bolts and fuel tank straps.
14. Lower the fuel tank from the underbody of the vehicle.

15. If replacing the fuel tank, remove the fuel tank module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement** and **Fuel Tank Fuel Pump Module Replacement - Secondary** .

Installation Procedure

1. If previously removed, install the fuel tank module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement** and **Fuel Tank Fuel Pump Module Replacement - Secondary** .

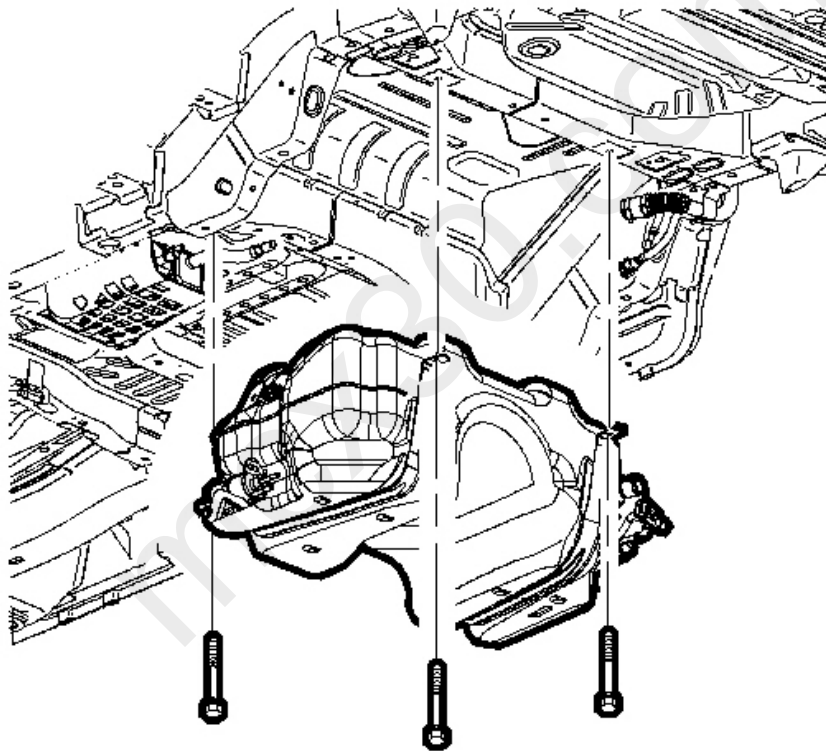


Fig. 46: View Of Fuel Tank Heat Shield & Fuel Tank Assembly
Courtesy of GENERAL MOTORS CORP.

2. Install the fuel tank heat shield and fuel tank assembly to the vehicle.

CAUTION: Refer to Fastener Caution .

3. Install the fuel tank straps and the fuel tank strap-to-body bolts and tighten to 25 N.m (18 lb ft).

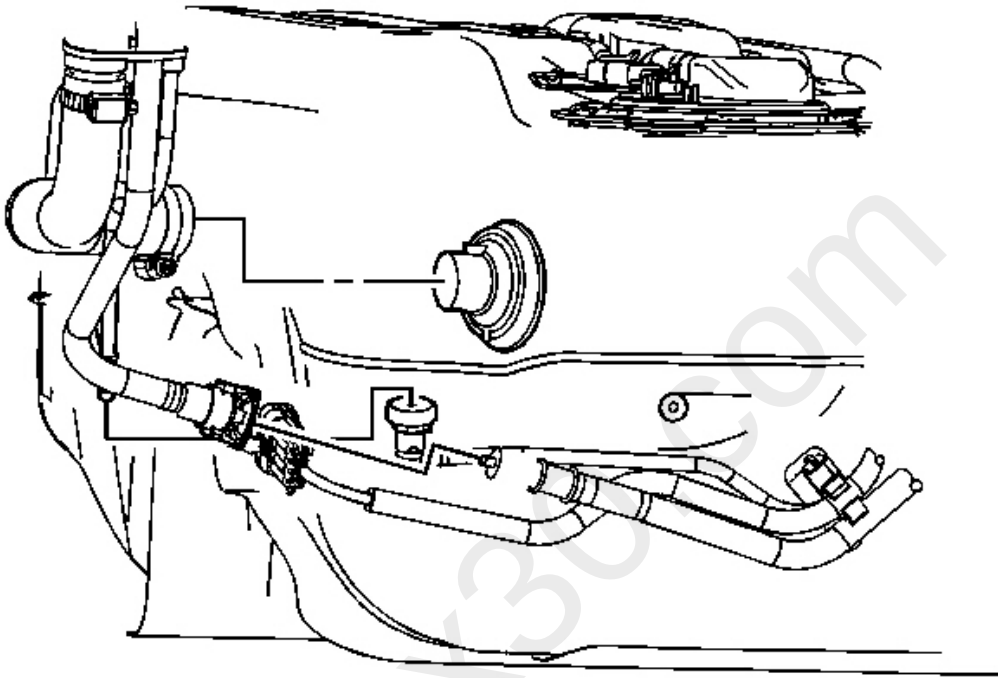


Fig. 47: View Of Fuel Filler Pipe, EVAP Vent & Fresh Air Hoses At Fuel Tank
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel tank electrical connector and install the electrical connector retainer to the rear frame.
5. Connect the EVAP vent, and fresh air hoses to the fuel tank.
6. Connect the fuel filler tube to the fuel tank. Tighten the fuel filler tube clamp to 5 N.m (44 lb in).

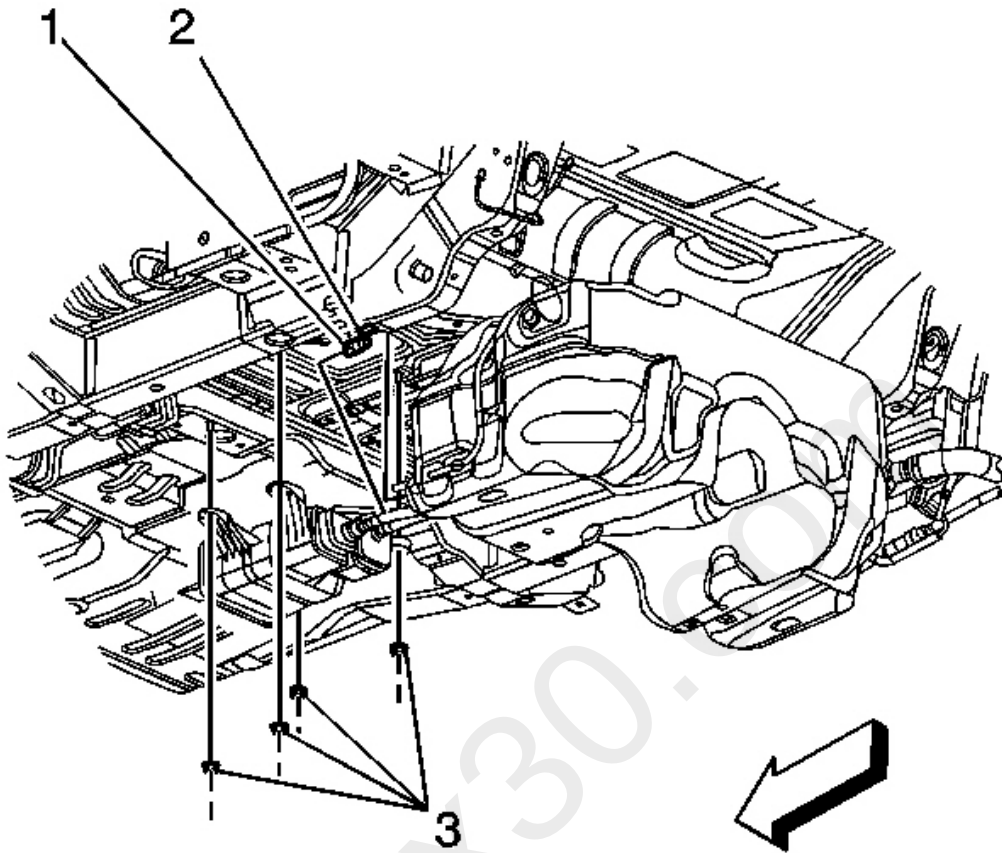


Fig. 48: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

7. Connect the chassis fuel supply line (2) to the fuel tank.
8. Connect the fuel tank vent pipe to the evaporative emission canister.
9. Connect the vent hose to the canister filter.
10. Connect the canister vent valve electrical connector.
11. Install the exhaust system. Refer to **Exhaust Muffler Replacement** .
12. Lower the vehicle.
13. Fill the fuel tank with gasoline.
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
15. Prime the fuel system:
 1. Cycle the ignition ON for 5 seconds and then OFF for 10 seconds.

2. Repeat the previous step twice.
3. Crank the engine until it starts. The maximum starter motor cranking time is 20 seconds.
4. If the engine does not start, repeat steps 15.1-15.3.

FUEL TANK FUEL PUMP MODULE REPLACEMENT

Special Tools

J-45722: Fuel Tank Sender Wrench

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Disconnect the crossover tube from the secondary fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement - Secondary .

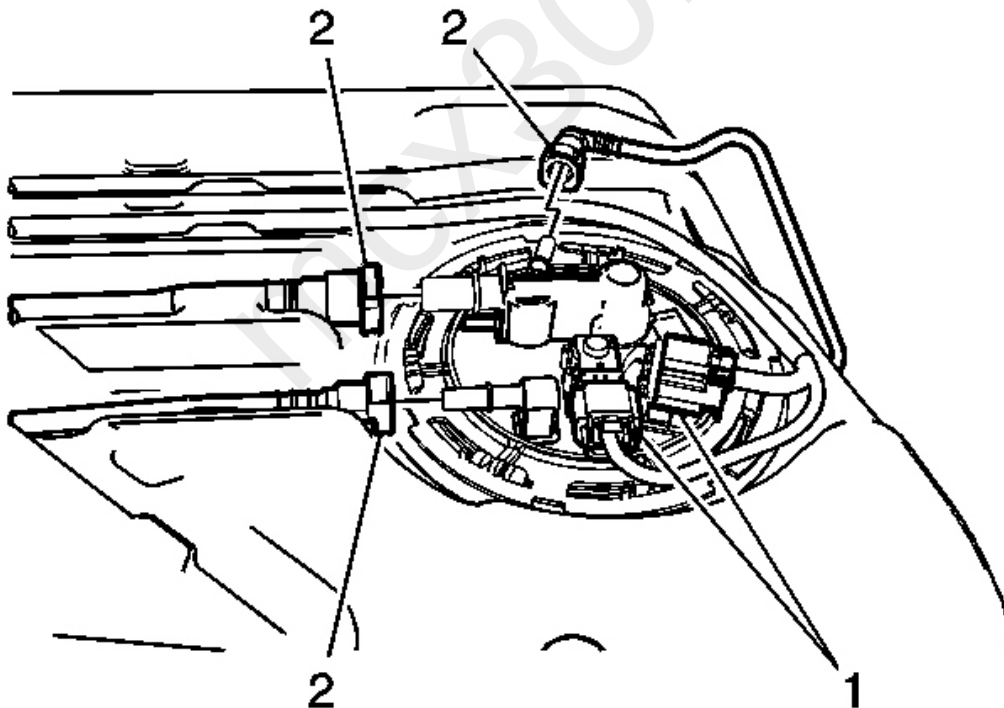


Fig. 49: Fuel & Evaporative Emission Lines, & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the electrical connectors (1).
3. Disconnect the fuel and evaporative emission lines (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

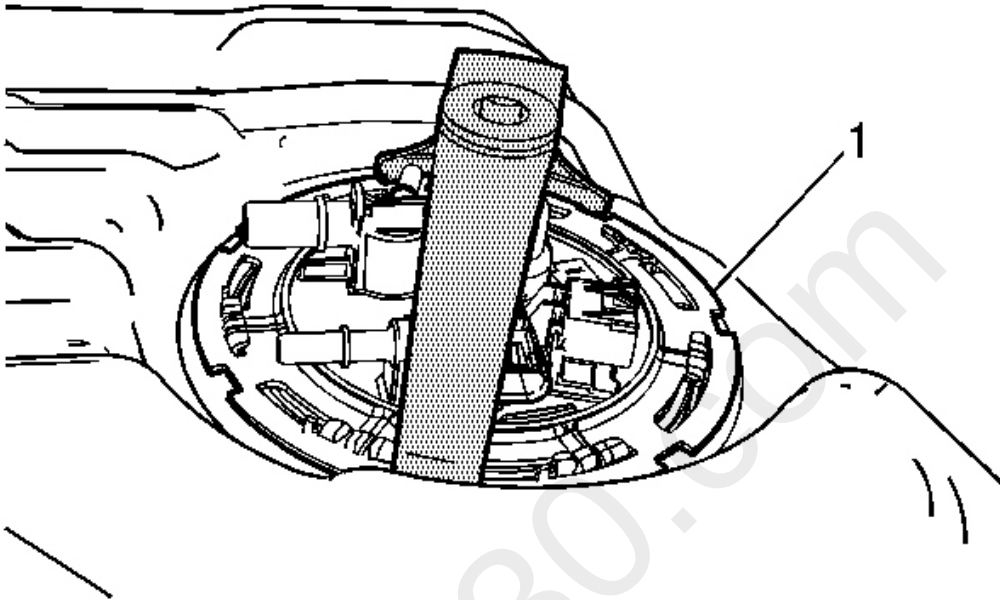


Fig. 50: Removing/Installing Cam Lock Ring
Courtesy of GENERAL MOTORS CORP.

4. Using the J-45722: wrench, remove the cam lock ring (1) by turning counterclockwise.

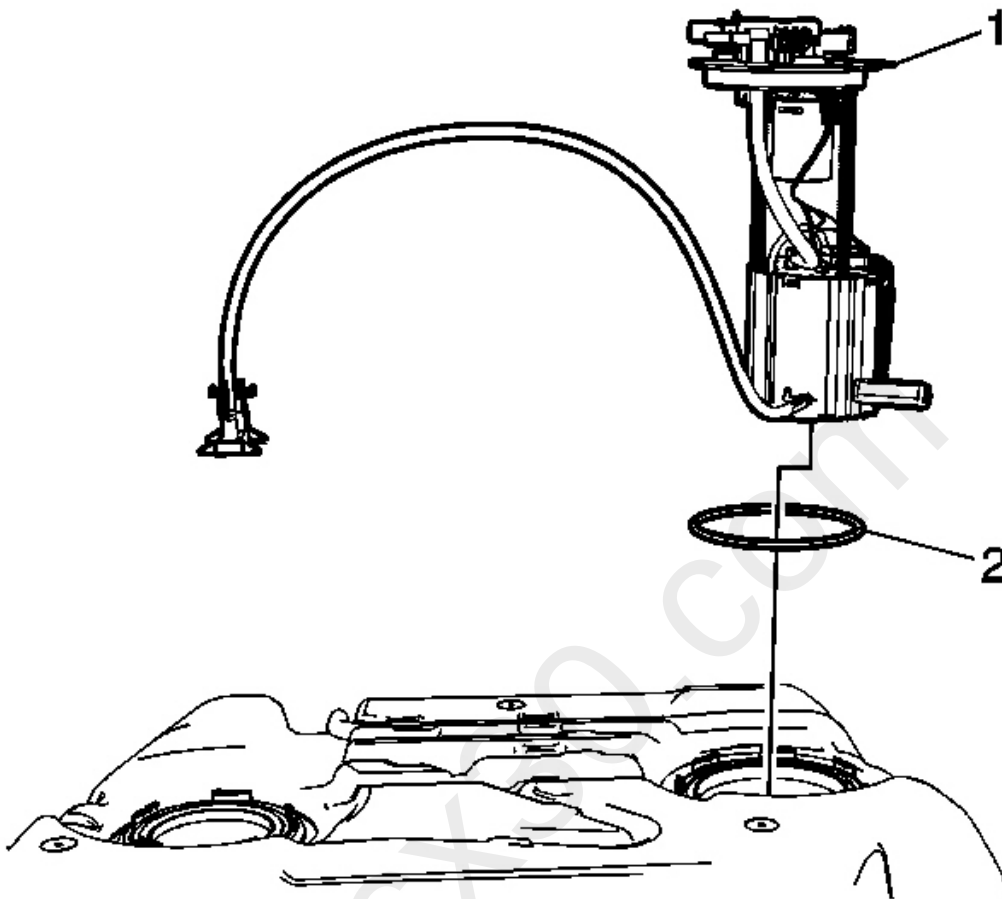


Fig. 51: Primary Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS CORP.

5. Remove the primary fuel tank module (1) and the O-ring (2).
6. If replacing the fuel pump module only, remove the primary fuel level sensor. Refer to **Primary Fuel Level Sensor Replacement** .

Installation Procedure

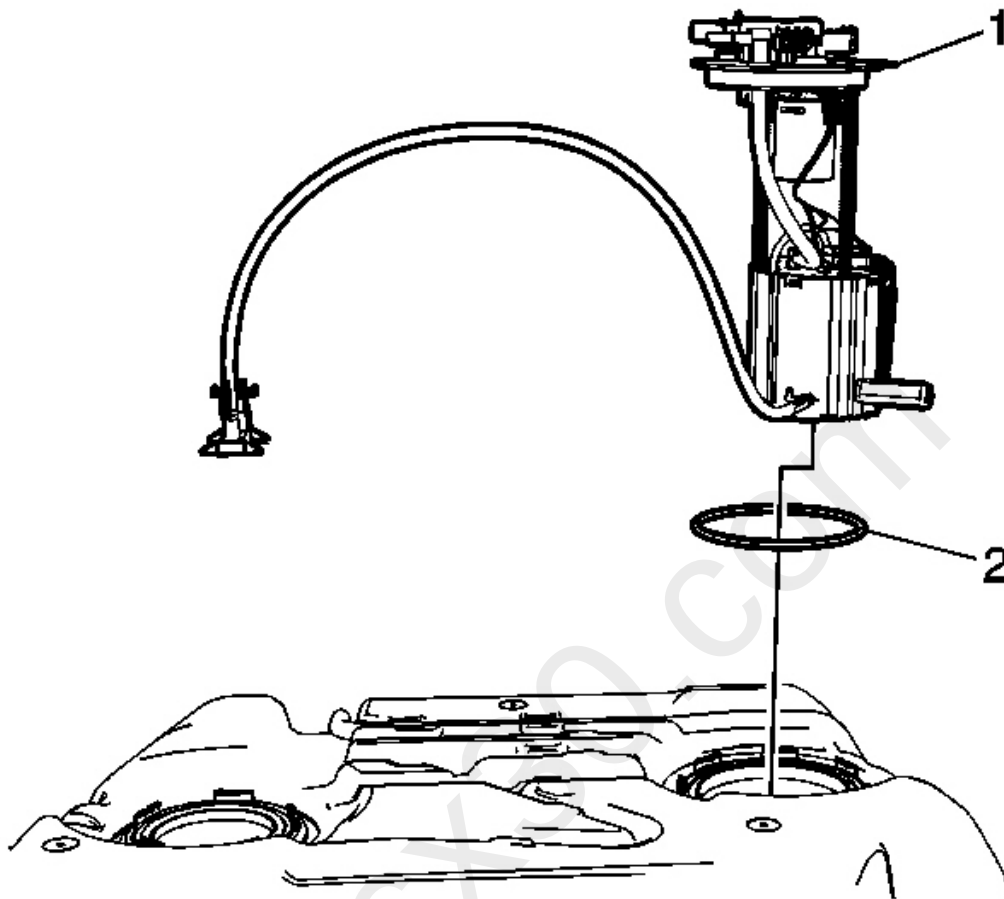


Fig. 52: Primary Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS CORP.

1. If replacing the fuel pump module only, install the primary fuel level sensor. Refer to **Primary Fuel Level Sensor Replacement** .
2. Install a NEW O-ring (2) and the primary fuel tank module (1).

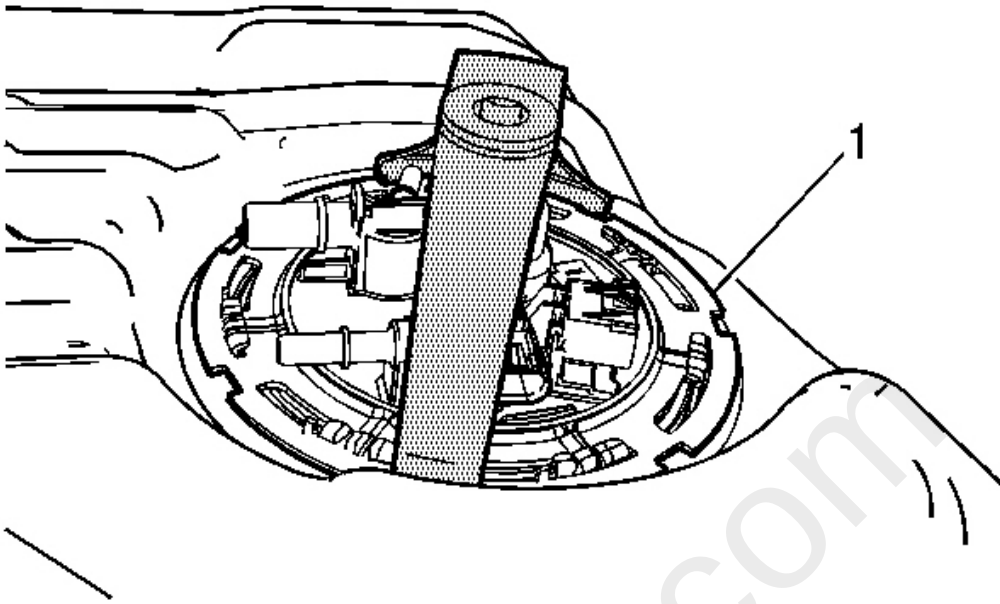


Fig. 53: Removing/Installing Cam Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Using the J-45722: wrench, install the cam lock ring (1) by turning clockwise.

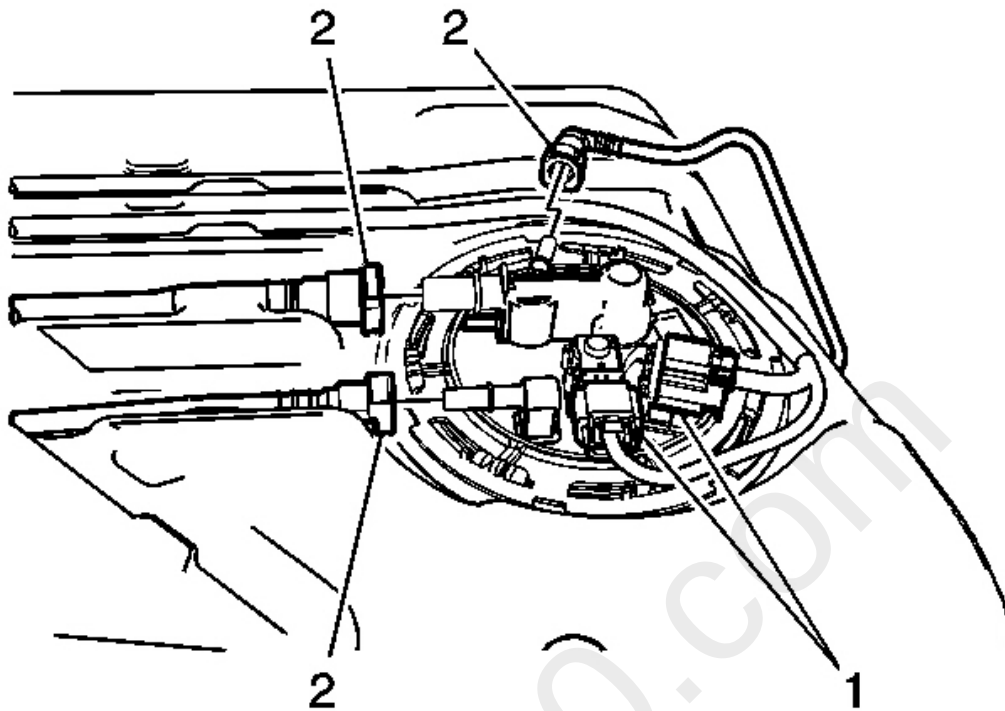


Fig. 54: Fuel & Evaporative Emission Lines, & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Connect the electrical connectors (1).
5. Connect the fuel and evaporative emission lines (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Connect the crossover tube to the secondary fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Secondary**.
7. Install the fuel tank. Refer to **Fuel Tank Replacement (AWD)** or **Fuel Tank Replacement (FWD)**.

FUEL TANK FUEL PUMP MODULE REPLACEMENT - SECONDARY

Special Tools

CH-48482: Fuel Tank Sender Wrench

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning.

1. Remove the fuel tank. Refer to **Fuel Tank Replacement (AWD)** or **Fuel Tank Replacement (FWD)** .

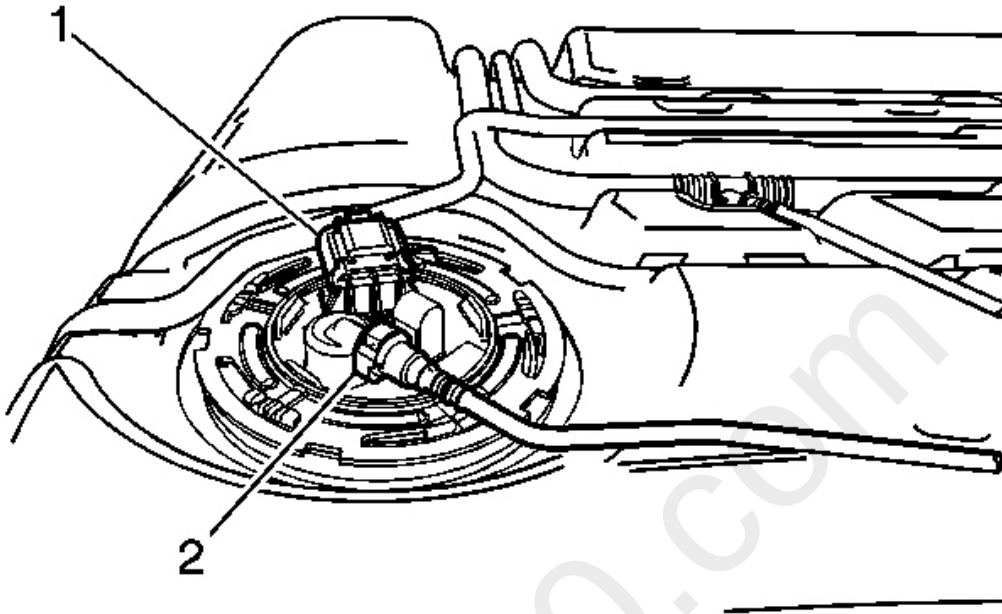


Fig. 55: Electrical Connector & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the electrical connector (1).
3. Disconnect the evaporative emission line (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

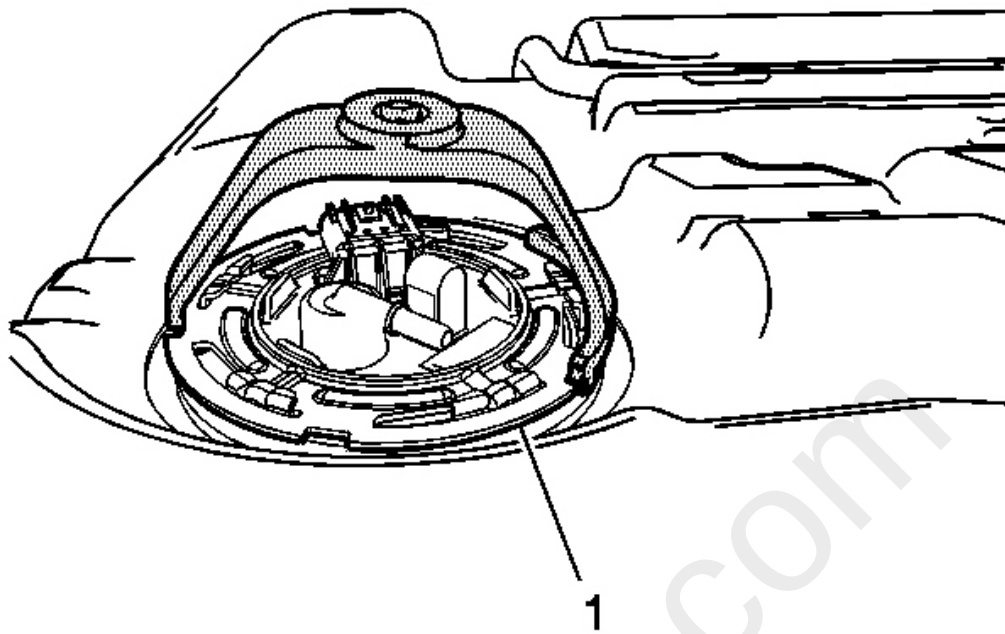


Fig. 56: Removing/Installing Cam Lock Ring
Courtesy of GENERAL MOTORS CORP.

4. Using the **CH-48482:** wrench, remove the cam lock ring (1) by turning counterclockwise.

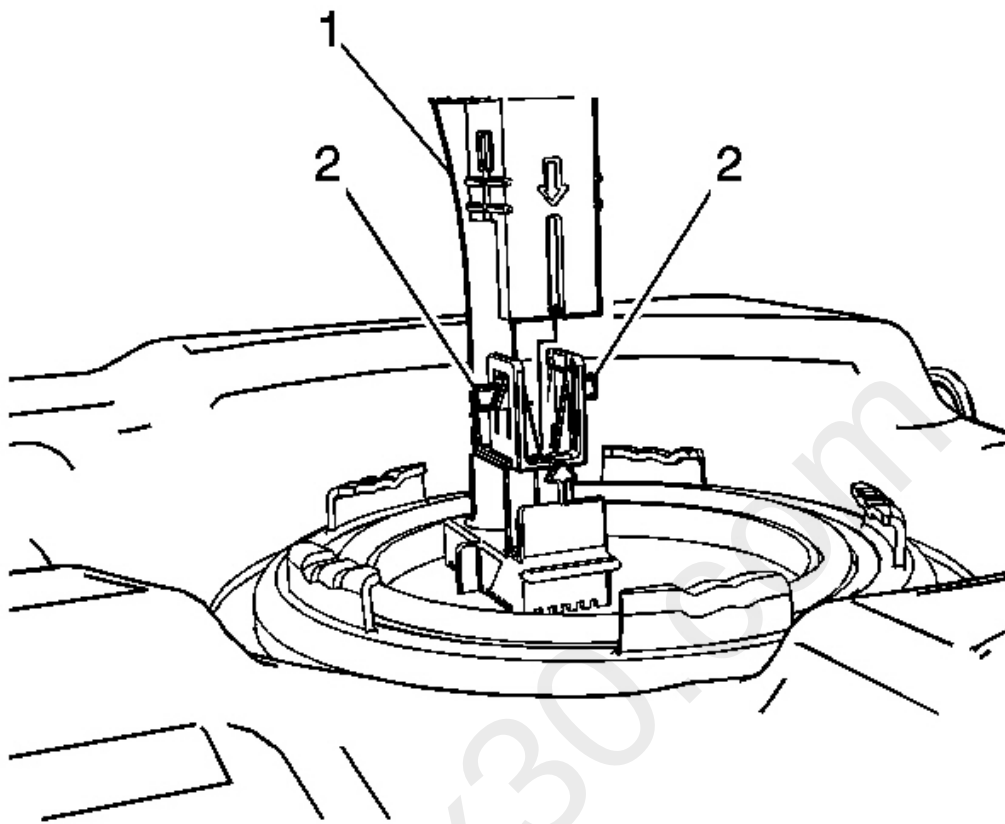


Fig. 57: Crossover Tube & Plastic Retaining Tabs
Courtesy of GENERAL MOTORS CORP.

5. Partially raise the secondary fuel pump module and disconnect the crossover tube (1) by squeezing the plastic retaining tabs (2).

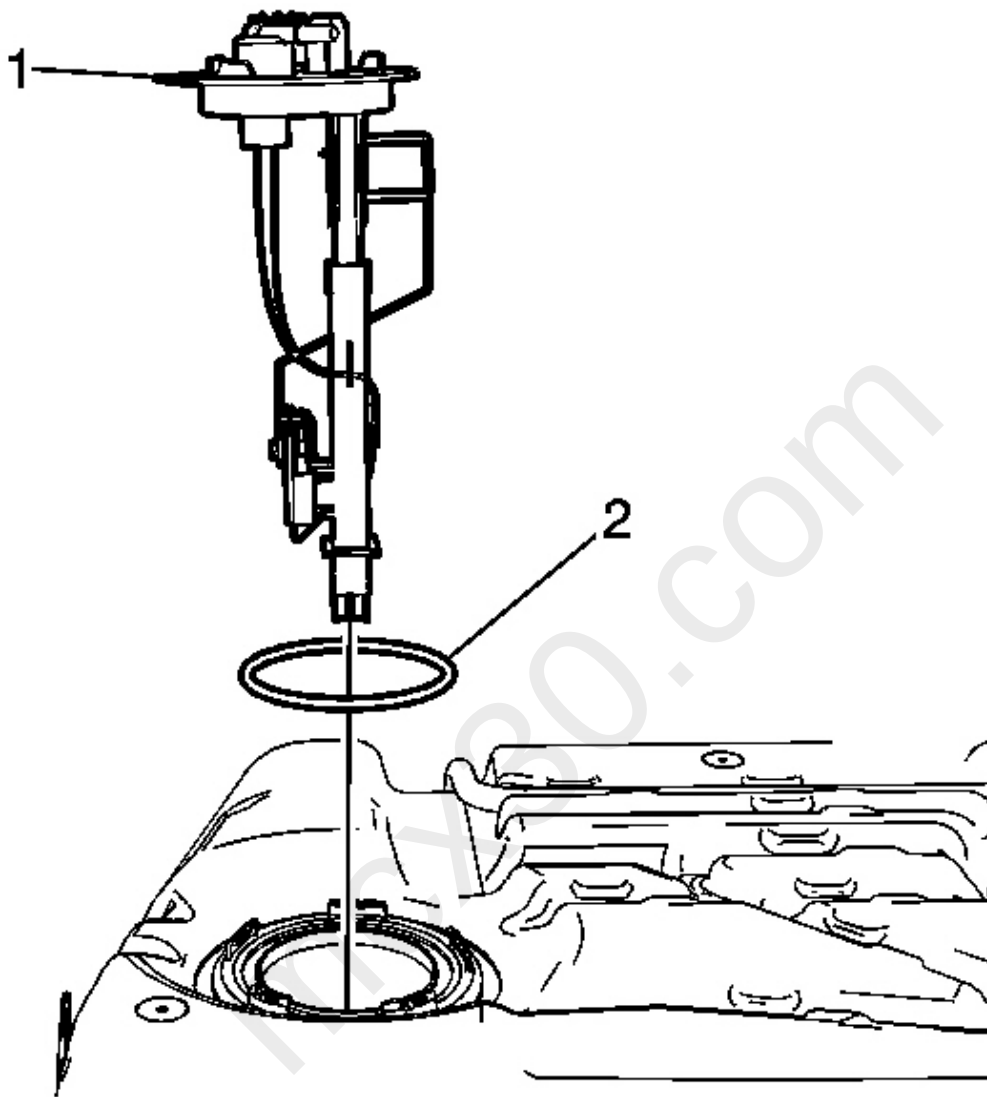


Fig. 58: Secondary Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

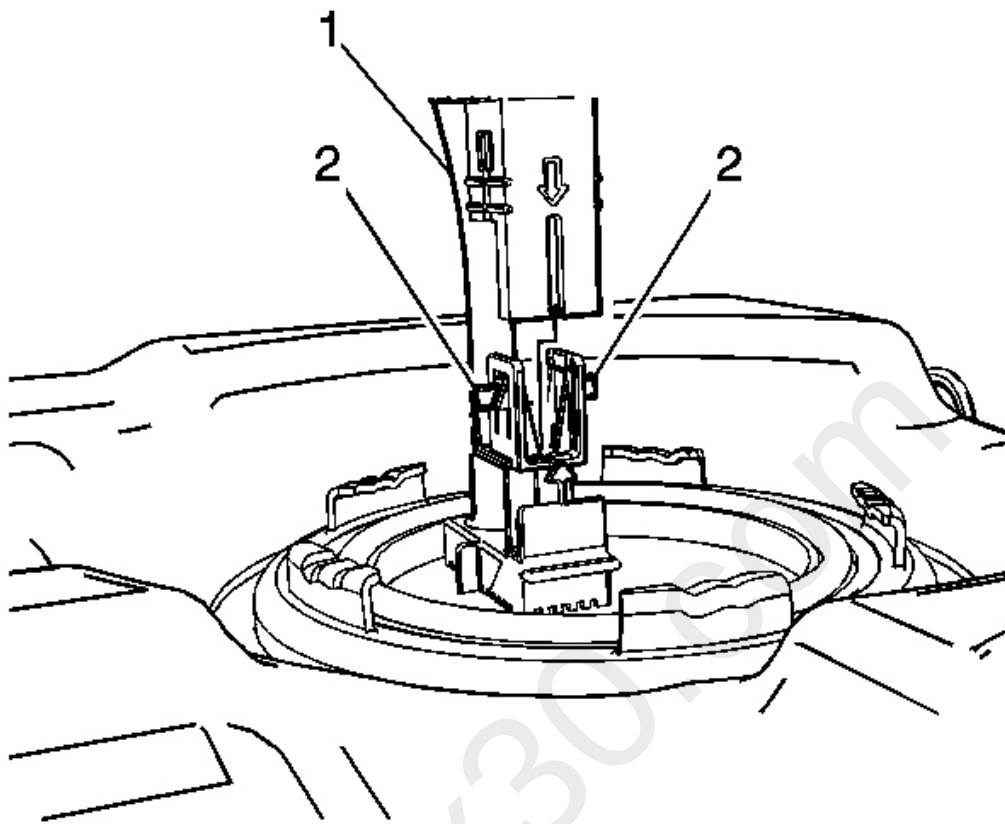


Fig. 59: Crossover Tube & Plastic Retaining Tabs
Courtesy of GENERAL MOTORS CORP.

1. Partially install the secondary fuel pump module and connect the crossover tube (1) by sliding into position.

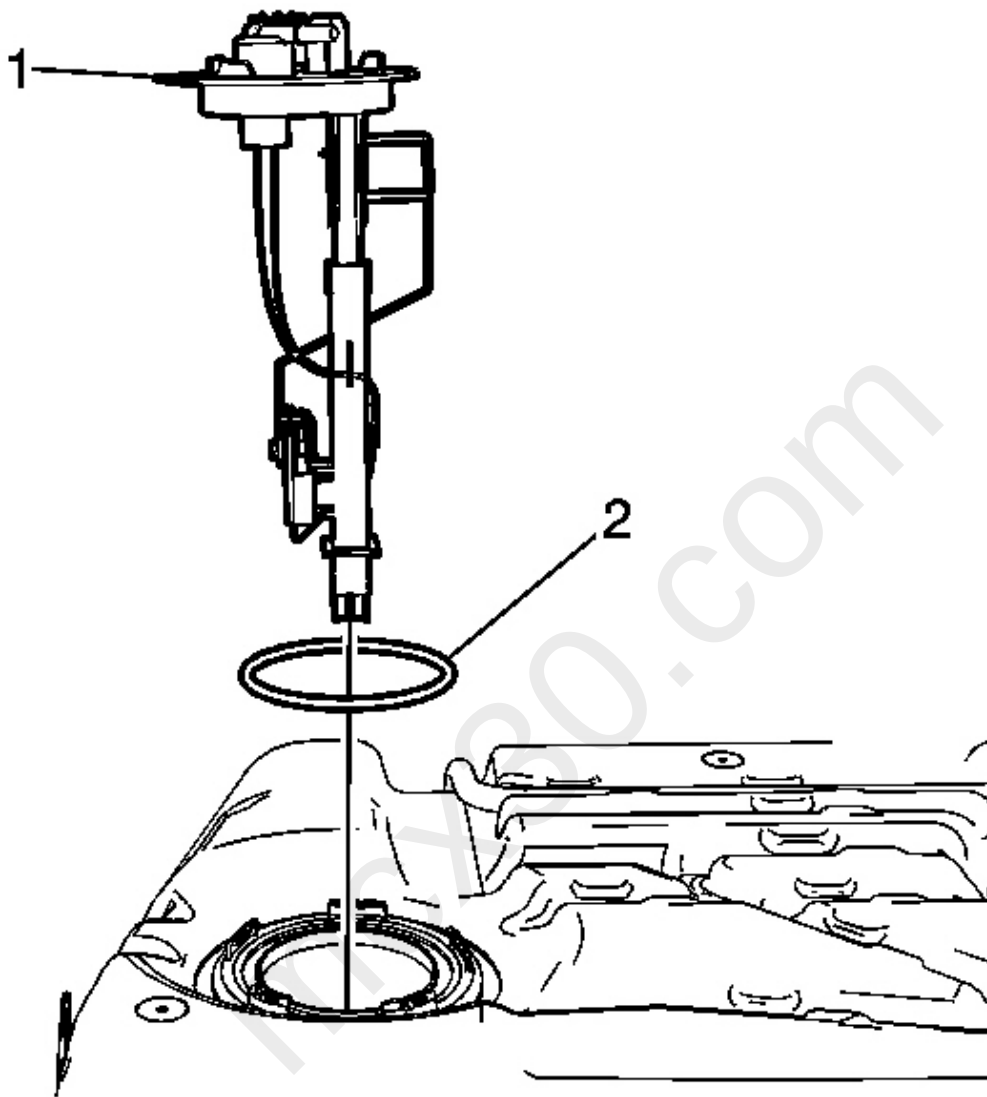


Fig. 60: Secondary Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW O-ring (2) and the secondary fuel tank module (1).

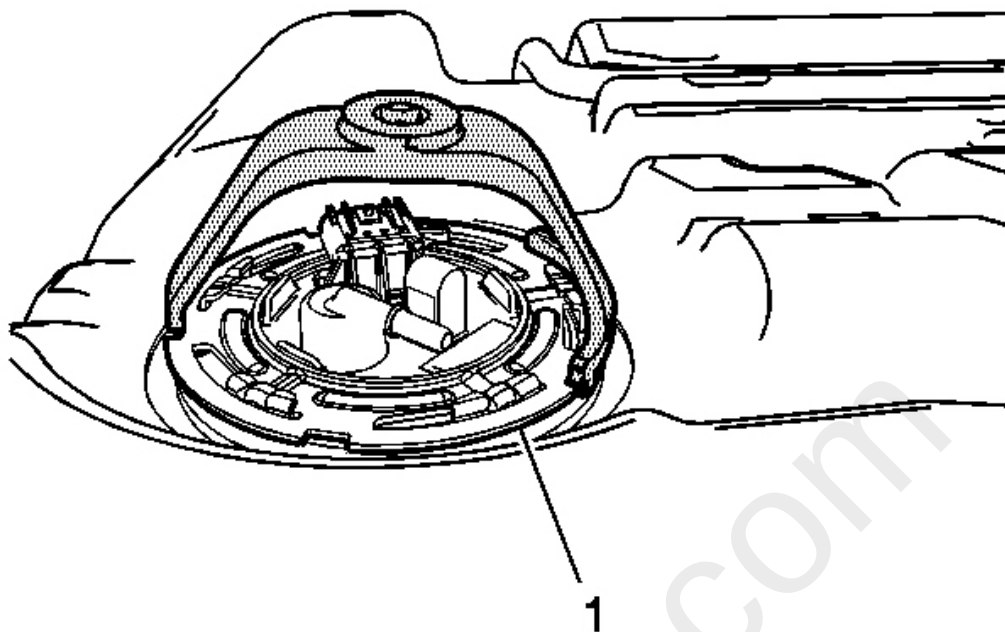


Fig. 61: Removing/Installing Cam Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Using the **CH-48482:** wrench, install the cam lock ring (1) by turning clockwise.

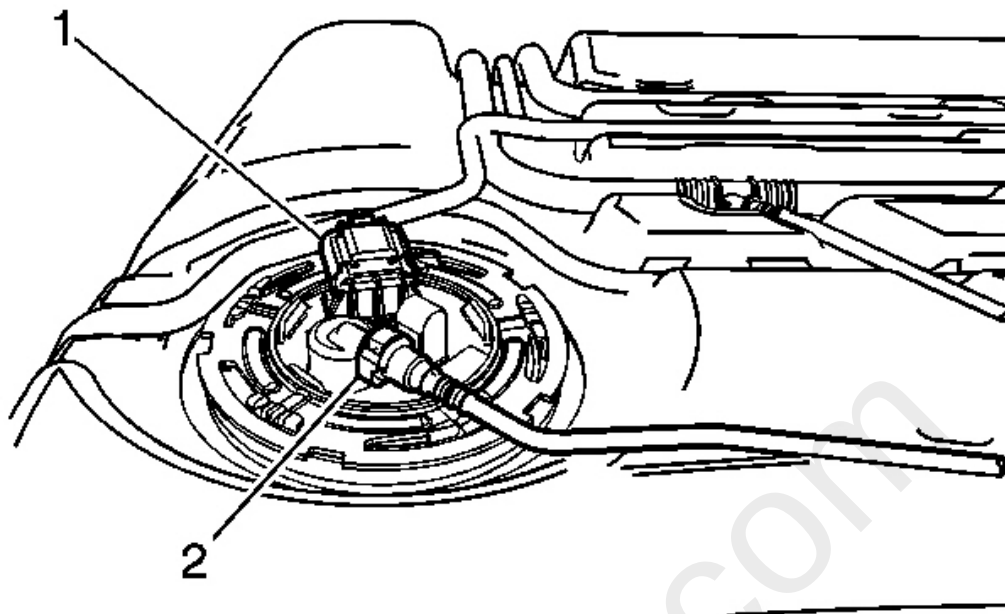


Fig. 62: Electrical Connector & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

4. Connect the electrical connector (1).
5. Connect the evaporative emission line (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Install the fuel tank. Refer to **Fuel Tank Replacement (AWD)** or **Fuel Tank Replacement (FWD)**.

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

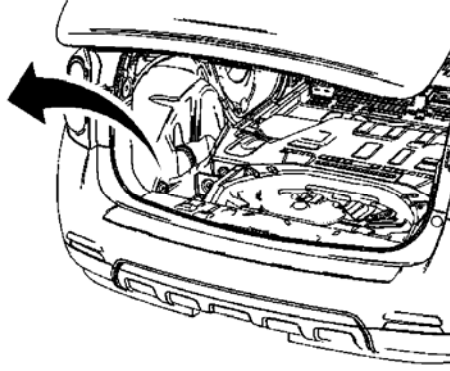
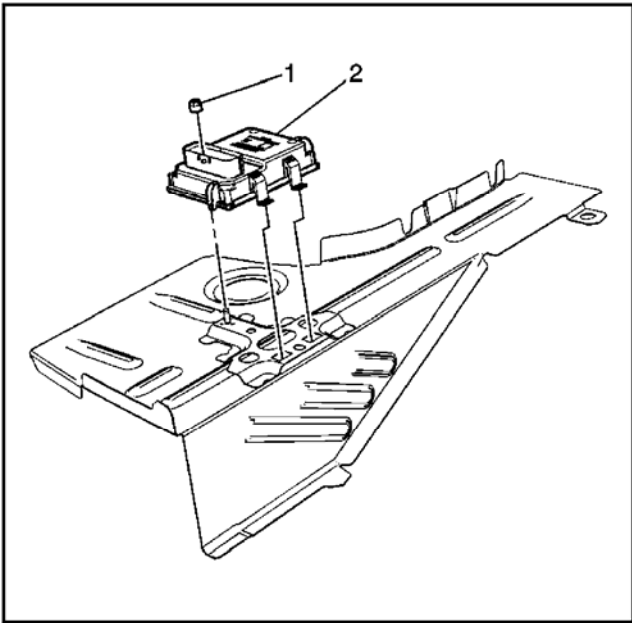


Fig. 63: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Fuel Pump Flow Control Module Fastener CAUTION: Refer to <u>Fastener Caution</u> Tighten: 8 N.m(71 lb in)
2	Fuel Pump Flow Control Module Procedure 1. Open the spare tire compartment lid. 2. Disconnect the electrical connector. 3. If replacing, reprogram the module. Refer to <u>Control Module References</u>

FUEL TANK PRESSURE SENSOR REPLACEMENT

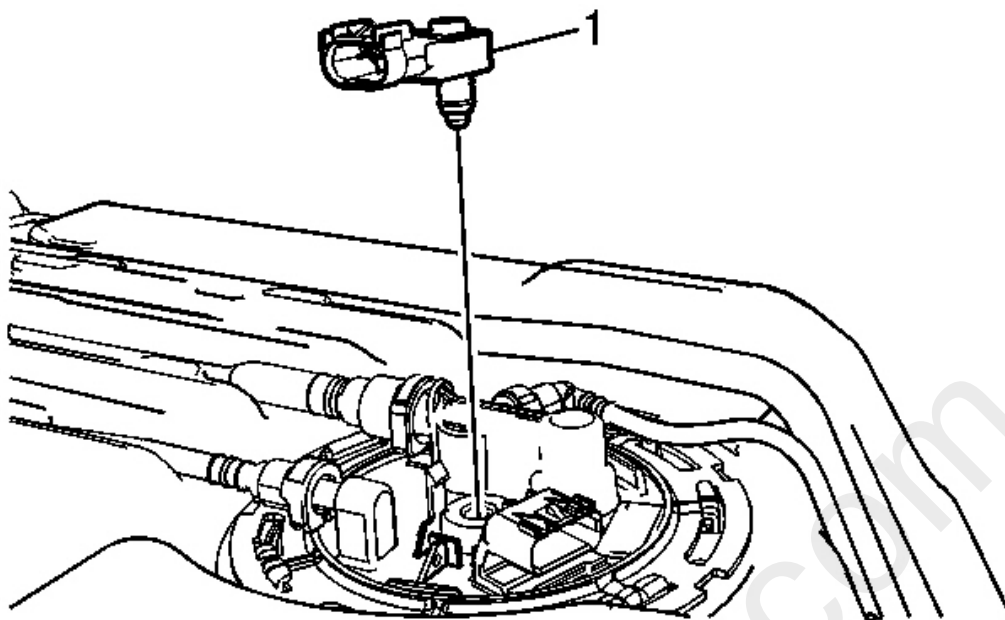


Fig. 64: Fuel Tank Pressure Sensor
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Lower the fuel tank. Refer to <u>Fuel Tank Replacement (AWD)</u> or <u>Fuel Tank Replacement (FWD)</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Fuel Tank Pressure Sensor Procedure 1. Use a flat bladed tool to remove the sensor. 2. Disconnect the electrical connector.

FUEL TANK FILLER PIPE REPLACEMENT

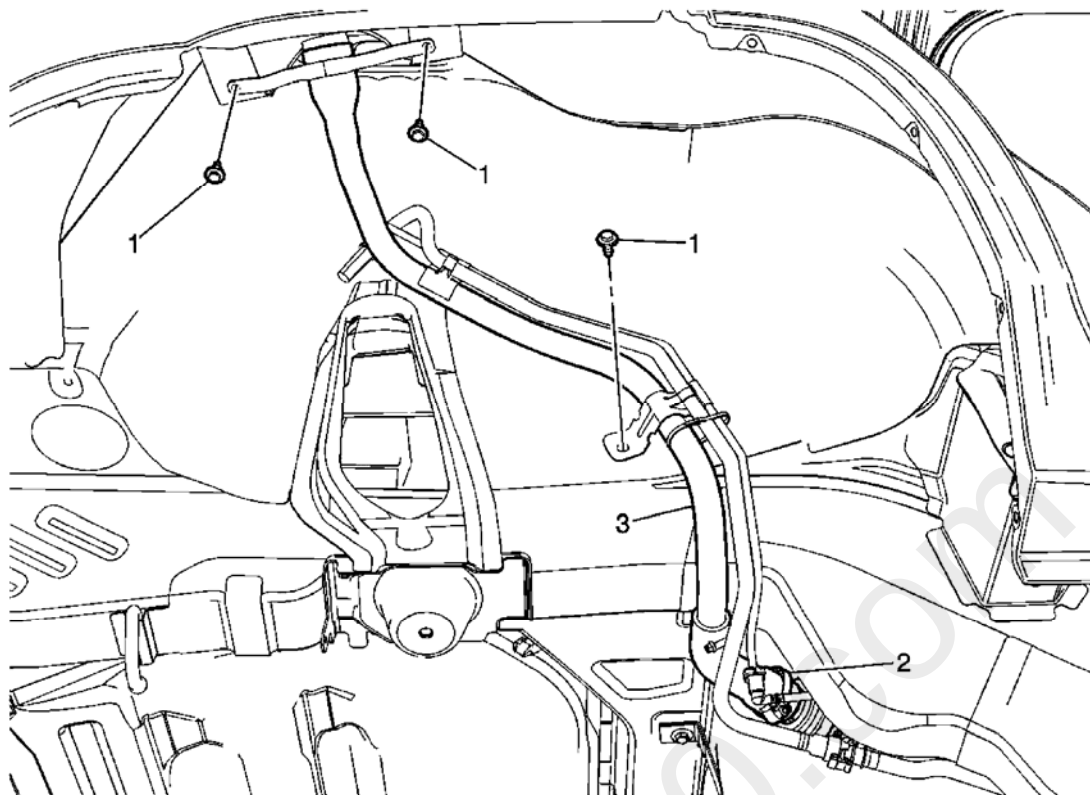


Fig. 65: Fuel Tank Filler Pipe

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the rear wheel house liner. Refer to <u>Rear Wheelhouse Panel Liner Replacement (Equinox)</u> or <u>Rear Wheelhouse Panel Liner Replacement (Terrain)</u> . 2. Disconnect the evaporative emission lines. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Filler Pipe Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Fuel Tank Filler Pipe Clamp Tighten: 4 N.m (35 lb in)
3	Fuel Tank Filler Pipe

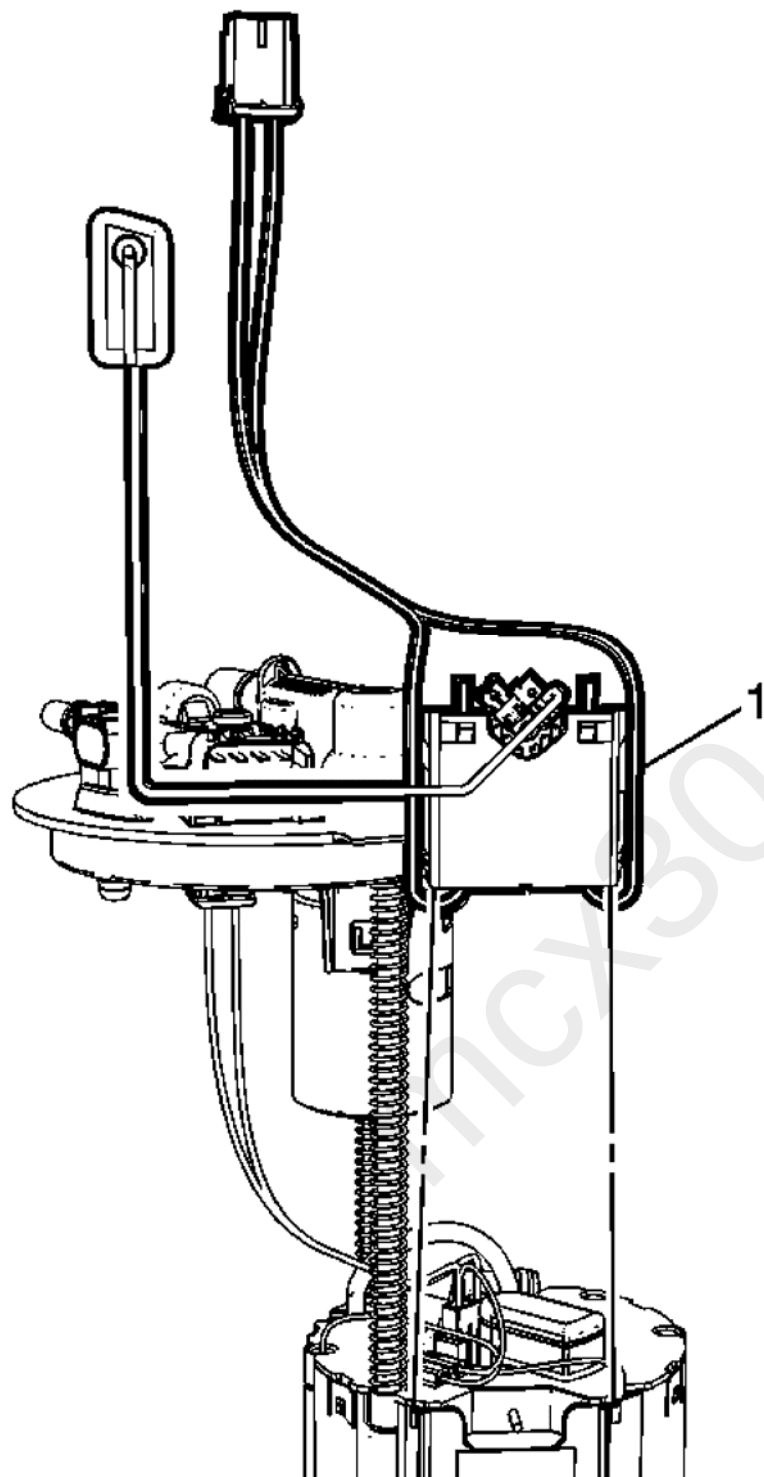


Fig. 66: Primary Fuel Level Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedure:

Remove the fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement** .

1	Fuel Level Sensor
	Procedure
	1. Release the retaining tabs. 2. Disconnect the electrical connector.

FUEL LINE REPLACEMENT - CHASSIS

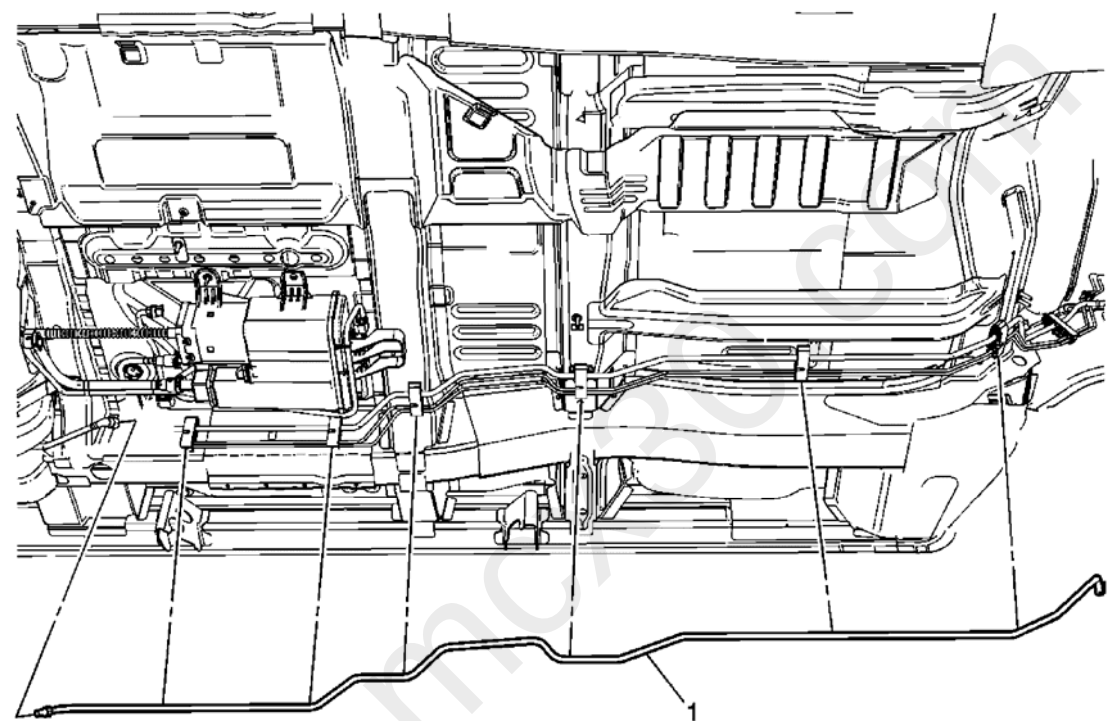


Fig. 67: Fuel Line - Chassis

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief . 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement . 3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 4. Disconnect the quick connectors. Refer to Metal Collar Quick Connect Fitting Service and Plastic Collar Quick Connect Fitting Service.	
	Fuel Feed Line

1

Procedure:

Disengage the line from the plastic retainers.

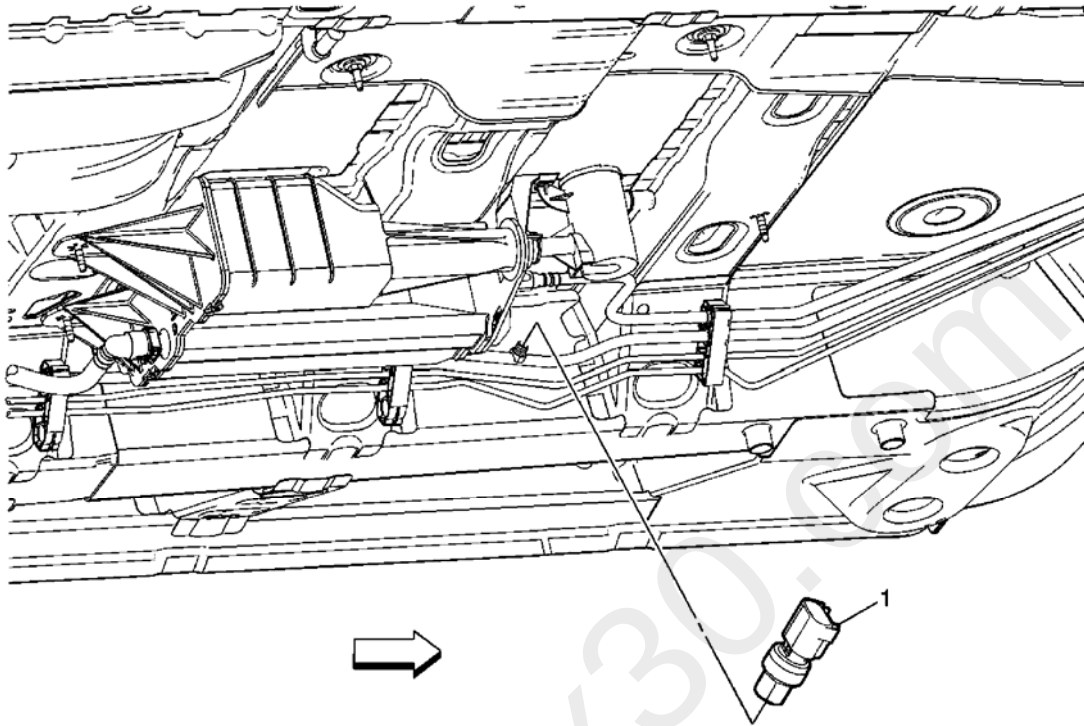
FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

Fig. 68: Fuel Pressure Sensor - Fuel Feed Pipe
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system 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 Pressure Sensor CAUTION: Refer to <u>Fastener Caution</u> . Procedure: Disconnect the electrical connector. Tighten: 9 N.m (80 lb in)

FUEL FEED PIPE REPLACEMENT (LF1)

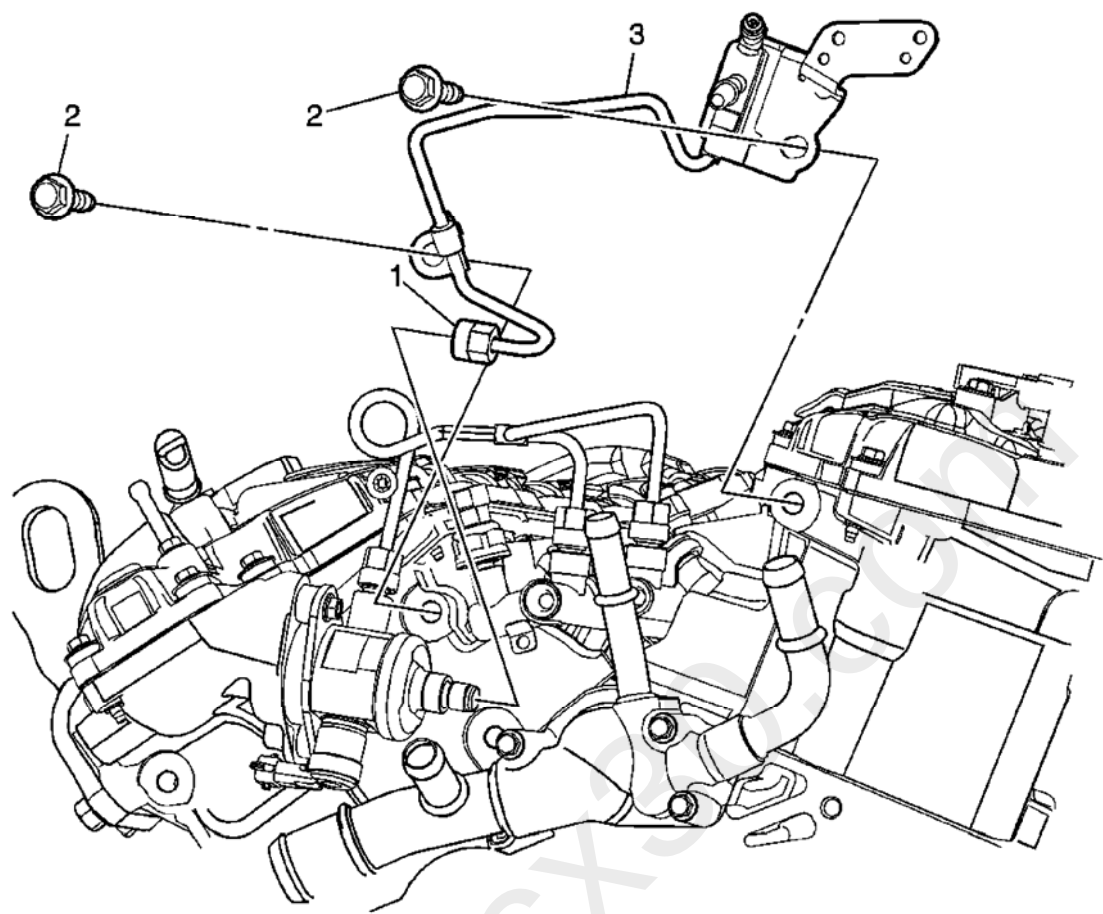


Fig. 69: Fuel Feed Pipe (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .	
2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .	
3. Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement (LF1) .	
1	Fitting (Qty: 1) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 28 N.m(20 lb ft)
	Bolt (Qty: 2)

2	Tighten: 50 N.m(28 lb ft)
3	Fuel Feed Pipe Procedure 1. DISCARD the pipe when removed, and install a NEW pipe. 2. Ensure that the high pressure fuel pipe, and fuel pump fittings are clean and dry prior to assembly. 3. Pressure up the fuel system and check for leaks.

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 modules. Refer to **Fuel Tank Fuel Pump Module Replacement** , and **Fuel Tank Fuel Pump Module Replacement - Secondary** .
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 (LF1)

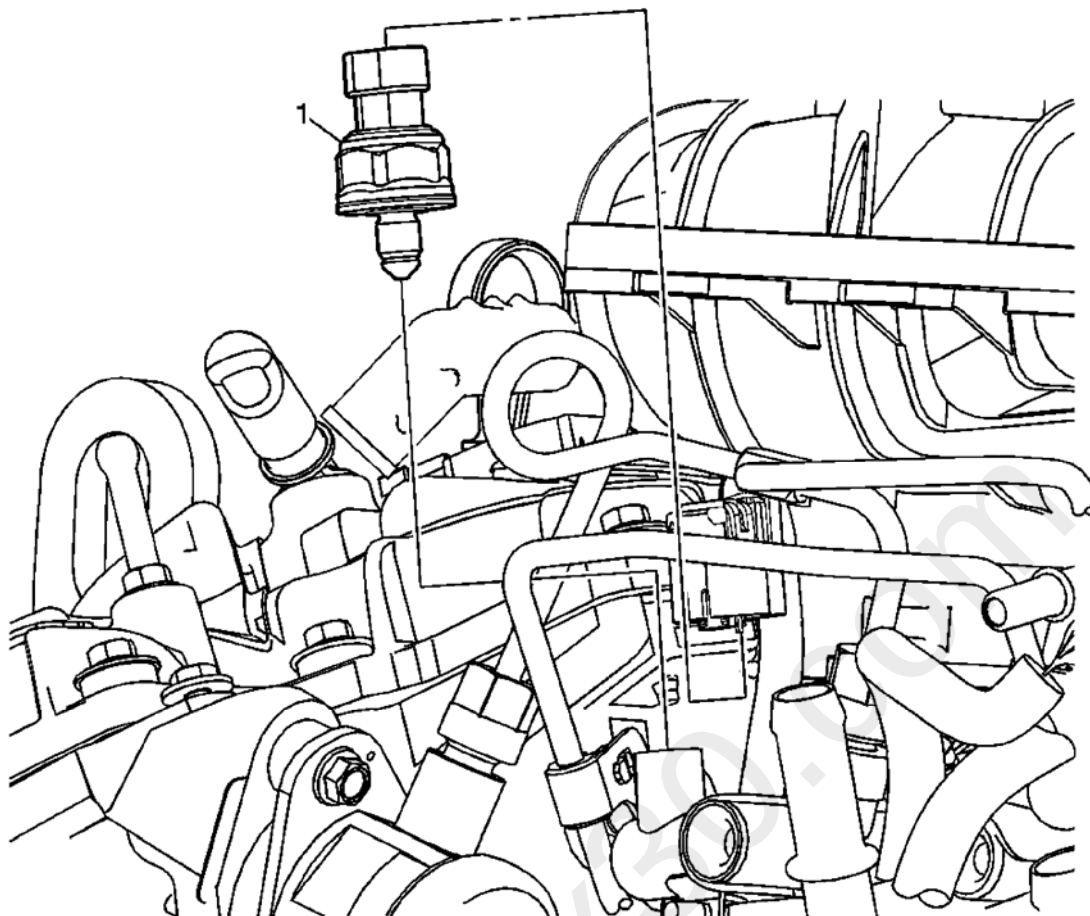


Fig. 70: Fuel Pressure Sensor - Fuel Injection Fuel Rail (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement (LF1)</u> .	
1	Fuel Injection Fuel Rail Fuel Pressure Sensor CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 33 N.m (25 lb ft)

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1 (LF1)

Special Tools

EN-49248: Injector Rail Assembly Remover

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

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 (LF1)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
5. Remove the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** .
6. Remove the foam insulator from the fuel rails.

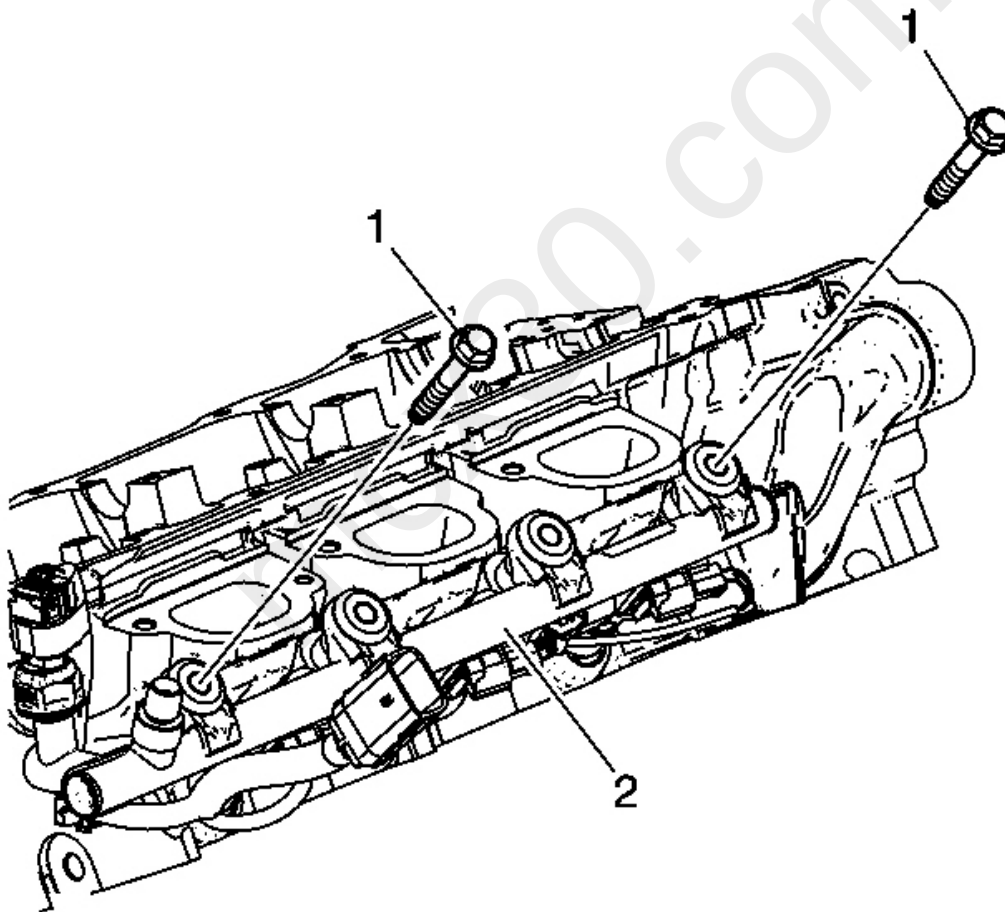


Fig. 71: Fuel Rail Bolts

Courtesy of GENERAL MOTORS CORP.

7. Disconnect the fuel pressure sensor electrical connector and cut the wire harness tie straps.
8. Remove the fuel rail bolts (1).

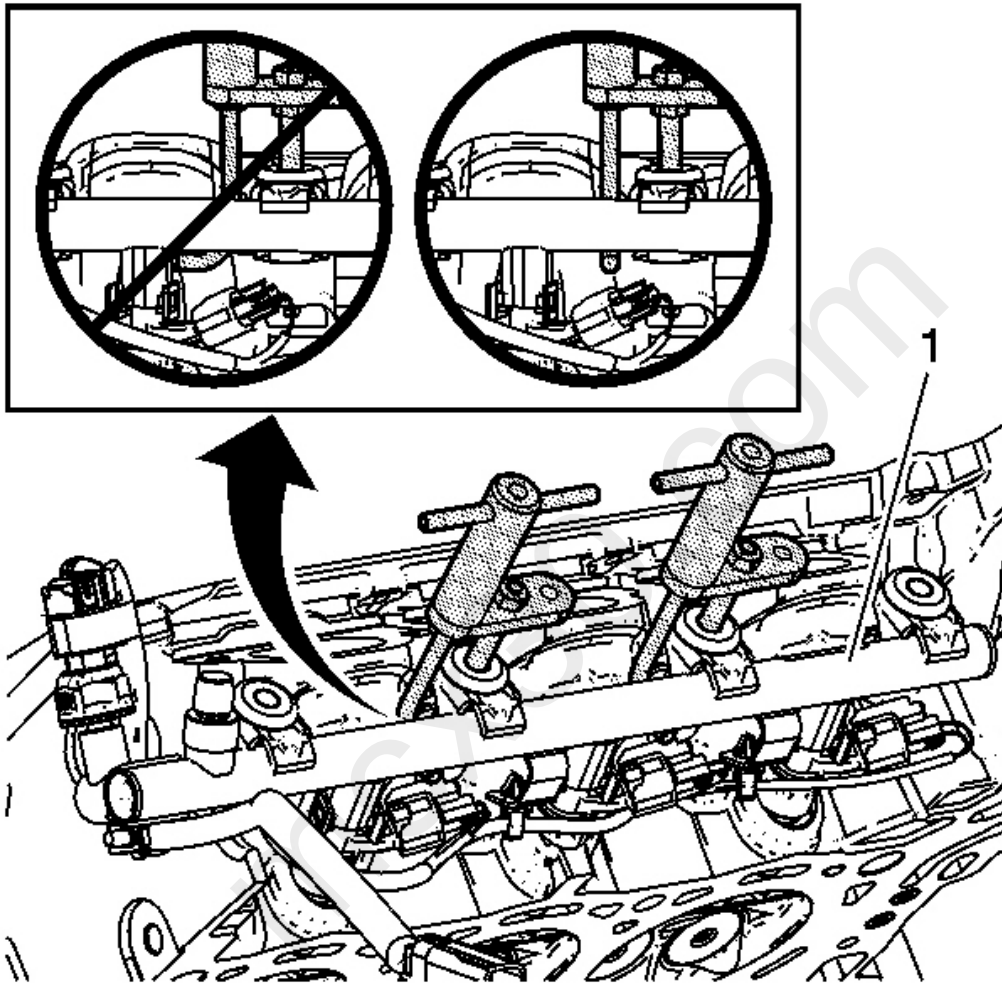


Fig. 72: Removing Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

9. Remove the fuel rail and injectors (1) as an assembly using the **EN-49248**: remover.
10. Remove the fuel pressure sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**.
11. Remove and discard the direct fuel injector hold down clamps.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been

released from the fuel rail or cylinder head.

12. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)** .

Installation Procedure

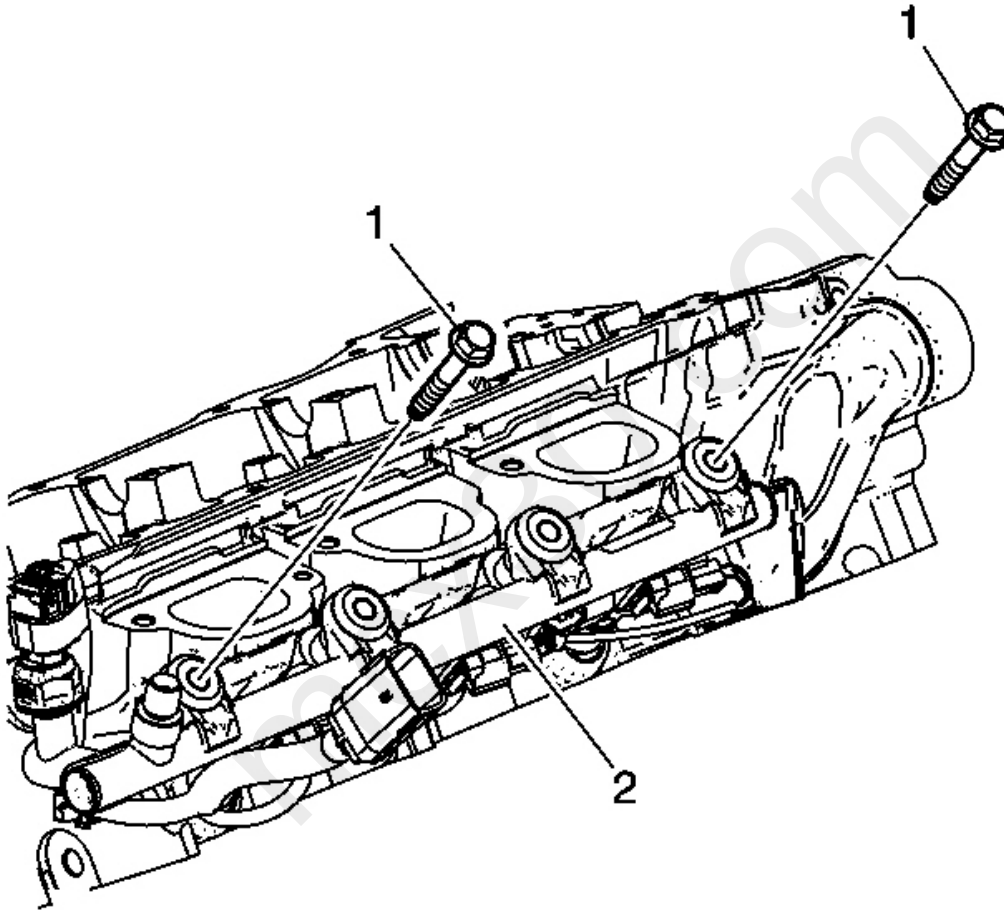


Fig. 73: Fuel Rail Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel rail with injectors (2) into the cylinder head evenly.
2. Install NEW direct injector hold down clamps to the injector.
3. Hand tighten the two outer fuel rail bolts to seat the injector in the injector bores.
4. Start and hand tighten the remaining fuel rail bolts and tighten the fuel rail bolts (1).

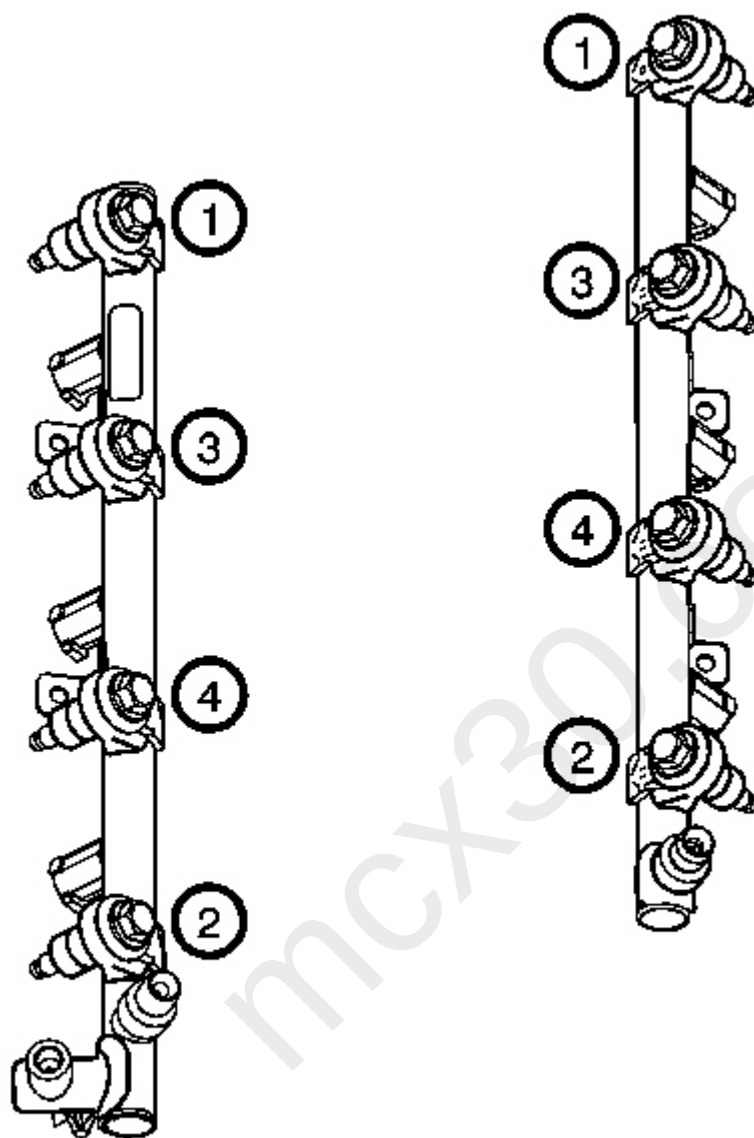


Fig. 74: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

5. Tighten the fuel rail bolts in the sequence shown:

1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
2. Tighten the Bank 1 fuel rail bolts final pass to 23 N.m (17 lb ft).
6. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
7. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**.
8. Connect the fuel injector wiring harness electrical connector to the fuel injectors, fuel rail and fuel pressure sensor.
9. 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.

NOTE: Before installing the foam insulator, remove any remaining fuel from the injector well.

10. Install the foam insulator to the fuel rails.
11. Install the intake manifold. Refer to **Intake Manifold Replacement** .
12. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
13. Install the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** .
14. Install the low side fuel pressure service port cap.
15. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2 (LF1)

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 (LF1)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
5. Remove the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** .

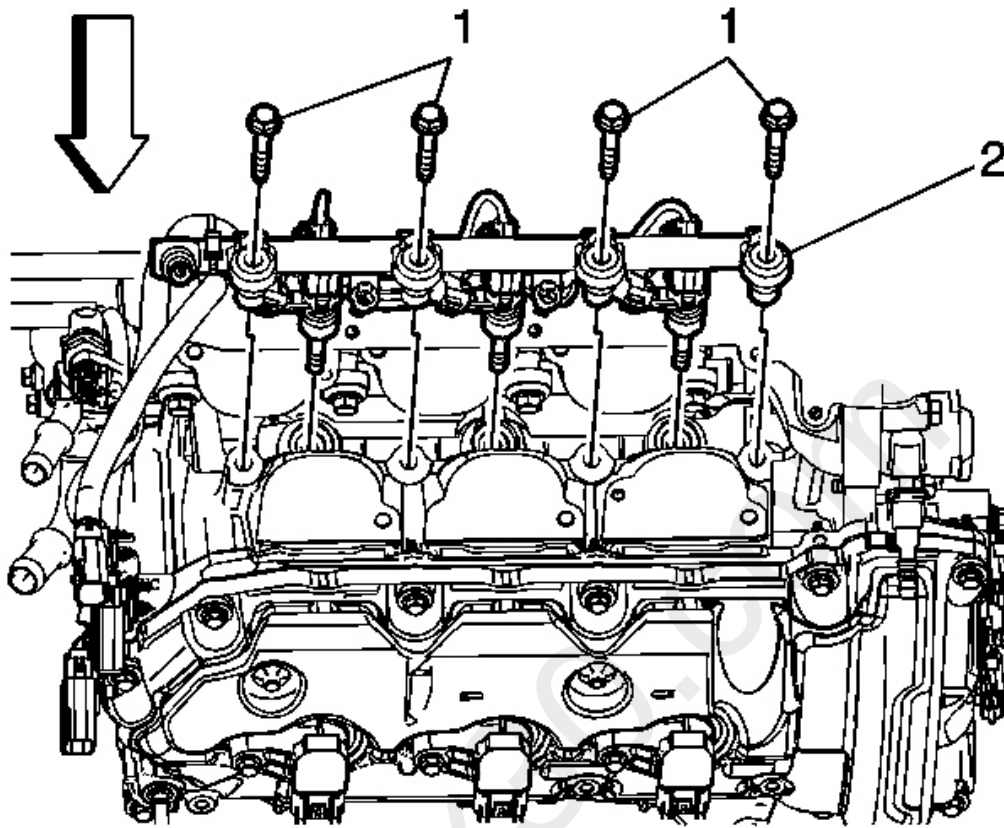


Fig. 75: Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the fuel rail bolts (1).

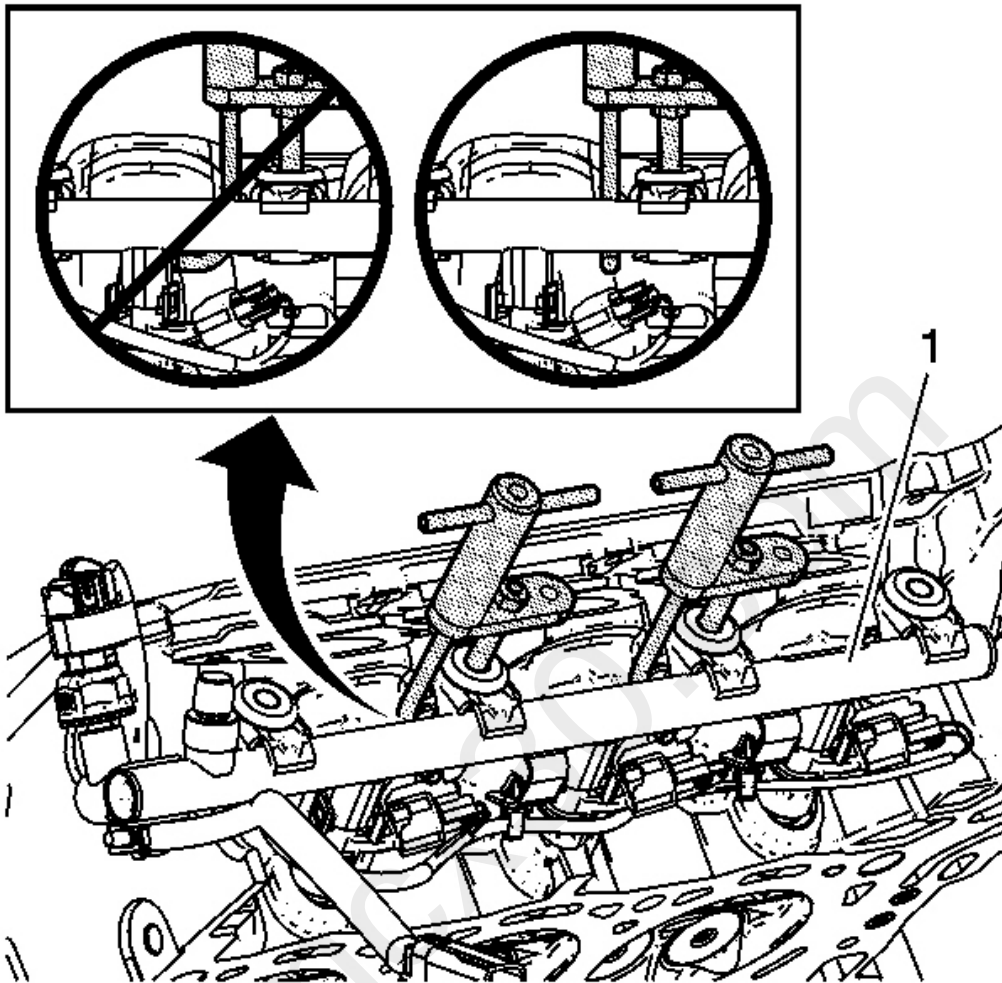


Fig. 76: Removing Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

7. Remove the fuel rail and injectors (1) as an assembly using the **EN-49248**: remover.
8. Remove and discard the direct fuel injector hold down clamps.

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

9. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)**.

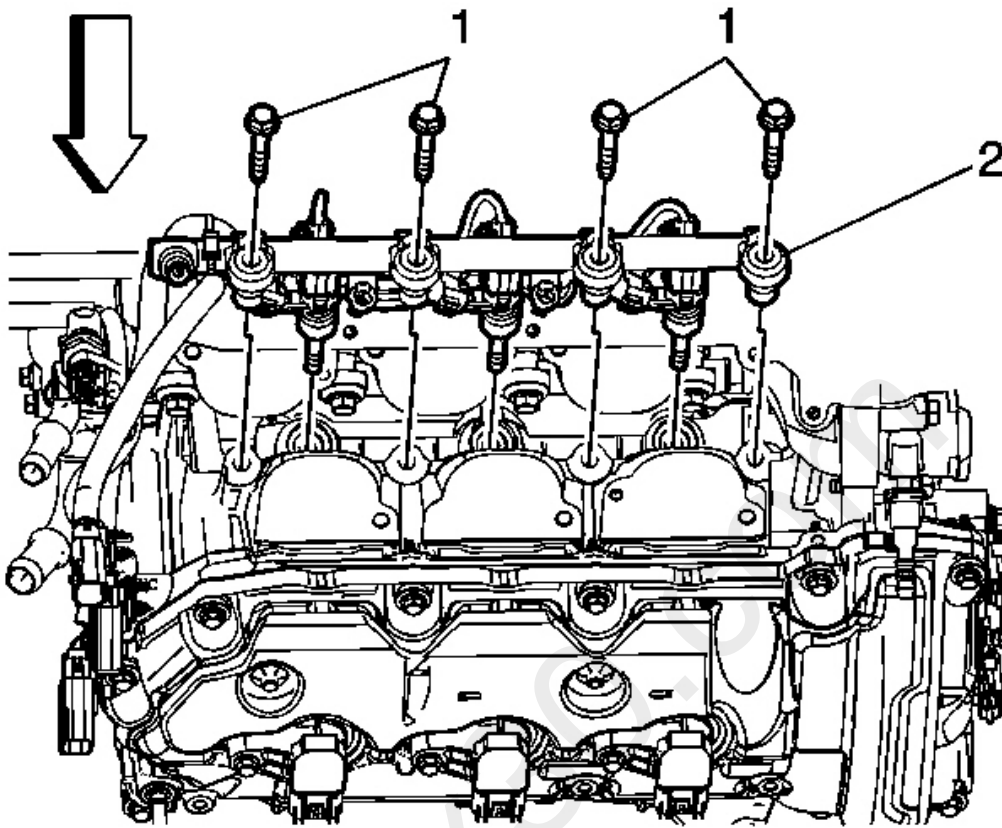


Fig. 77: Fuel Rail & Bolts

Courtesy of GENERAL MOTORS CORP.

1. Install the fuel rail with injectors (2) into the cylinder head evenly.
2. Hand tighten the two outer fuel rail bolts to seat the injector in the injector bores.
3. Start and hand tighten the remaining fuel rail bolts (1).

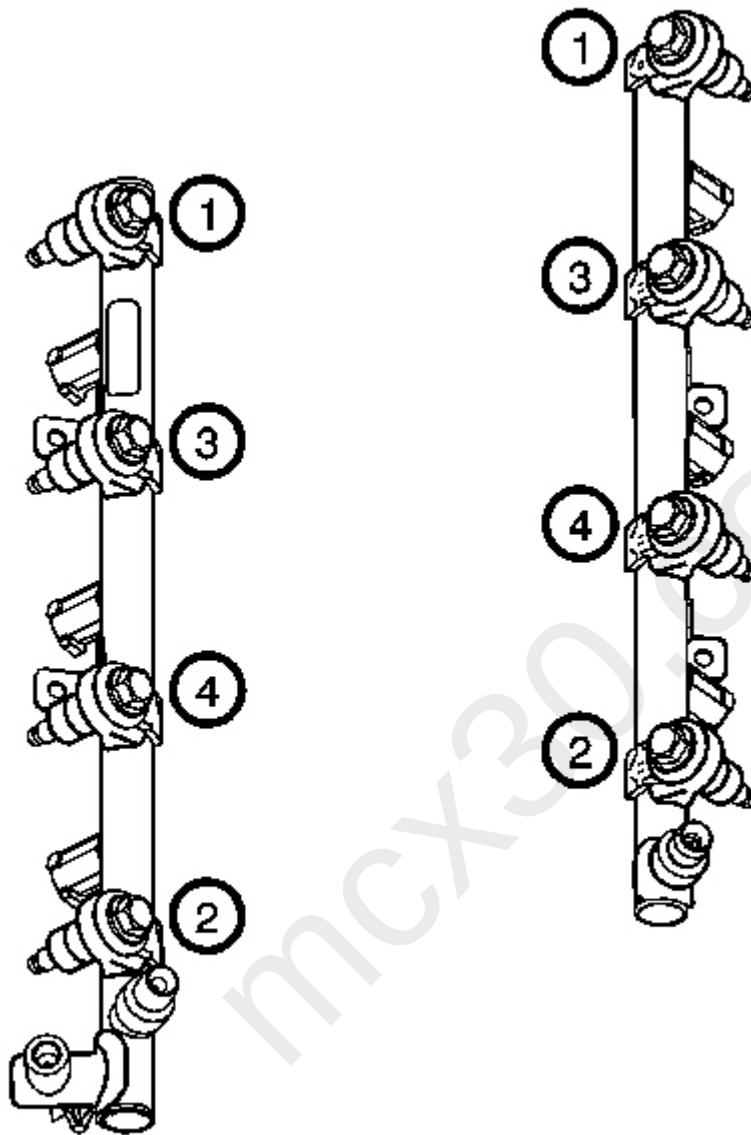


Fig. 78: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Tighten the fuel rail bolts in the sequence shown:

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 (LF1)**.
6. Connect the fuel injector wiring harness electrical connector from the fuel injectors, fuel rail and fuel pressure sensor.
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.

NOTE: **Before installing the foam insulator, remove any remaining fuel from the injector well.**

8. Install the foam insulator to the fuel rails.
9. Install the intake manifold. Refer to **Intake Manifold Replacement** .
10. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
11. Install the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** .
12. Install the low side fuel pressure service port cap.
13. Install the fuel tank cap.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT (LF1)

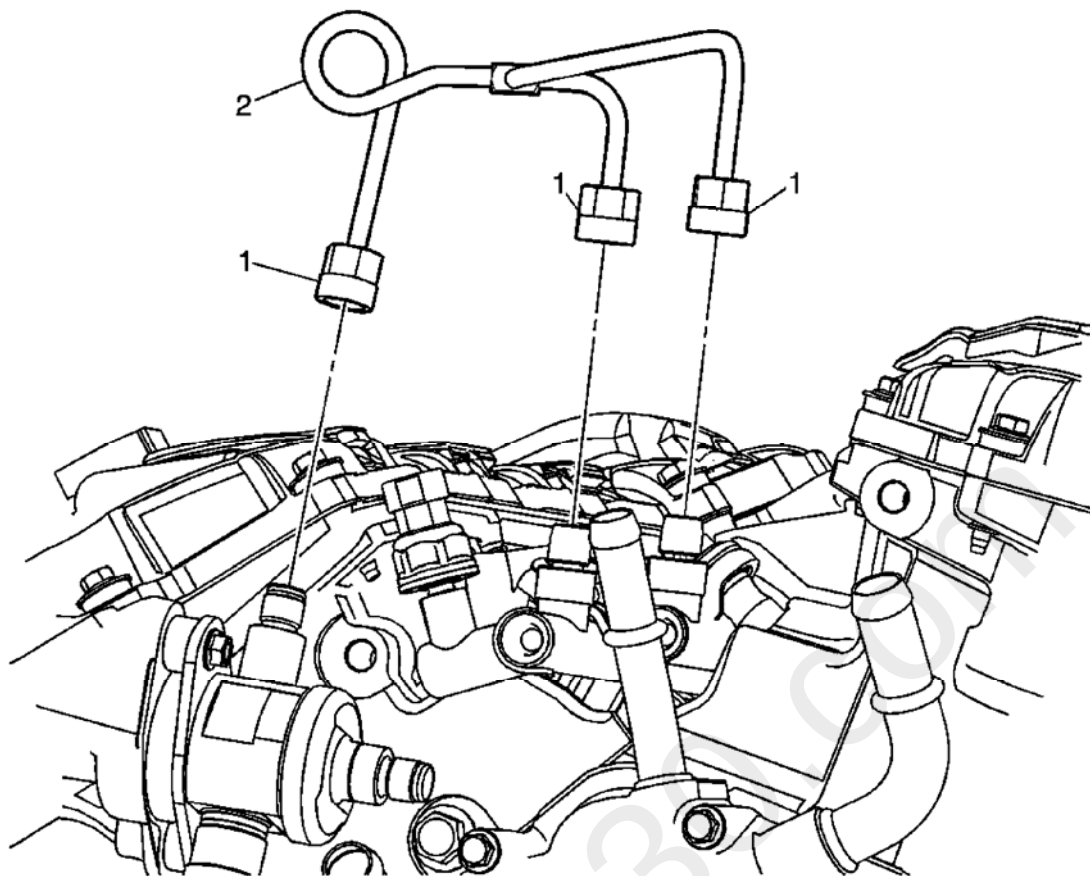


Fig. 79: Fuel Feed Intermediate Pipe (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u> . 2. Remove the Intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 3. Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement (LF1)</u>.	
1	Fitting (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 1. First Pass 15 N.m(11 lb ft) 2. Second Pass 30 N.m(22 lb ft)
	Fuel Feed Intermediate Pipe

Procedure

2

1. Discard the pipe when removed and install a new pipe.
2. Lubricate the pipes with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Pressure up the fuel system and check for leaks.

FUEL PIPE SHIELD REPLACEMENT (LF1)

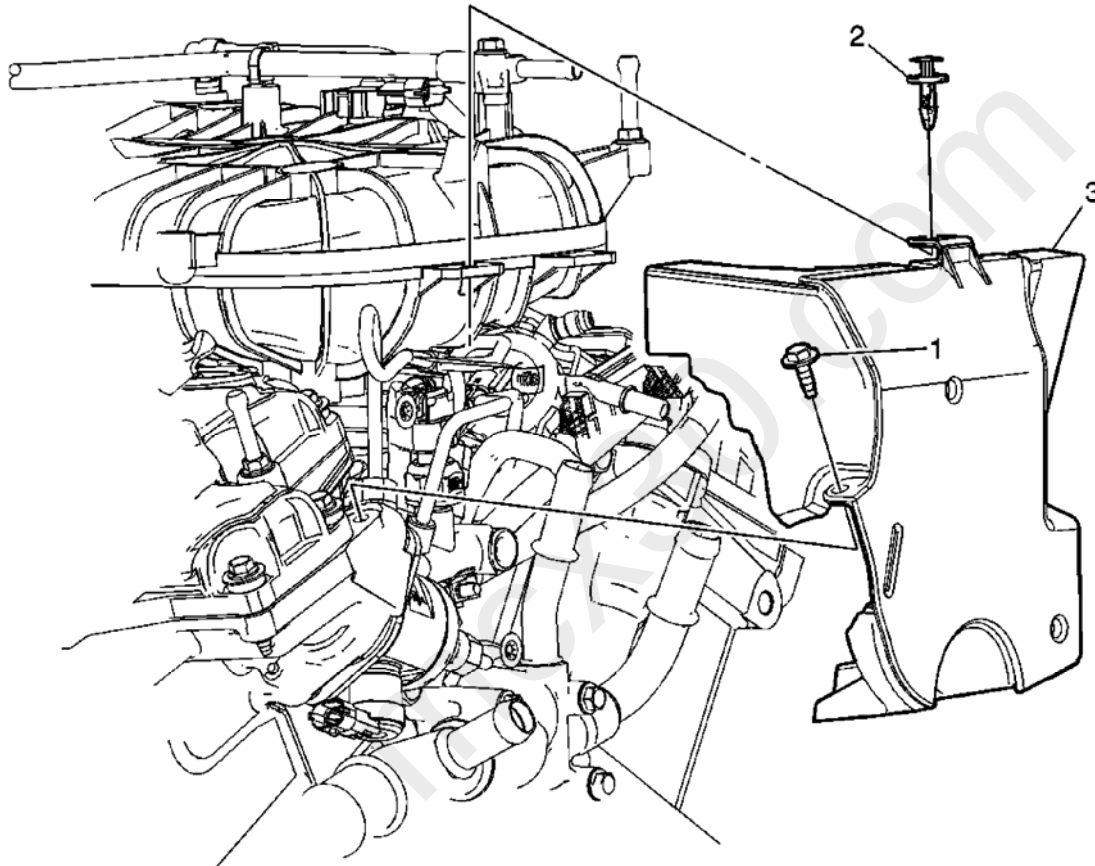


Fig. 80: Fuel Pipe Shield (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Bolt CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten: 10 N.m (89 lb in)
2	Retainer
3	Fuel Pipe Shield

FUEL PUMP REPLACEMENT

Special Tools

EN-48896: High Pressure Fuel Pump Installation Alignment Gauge

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Remove the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.

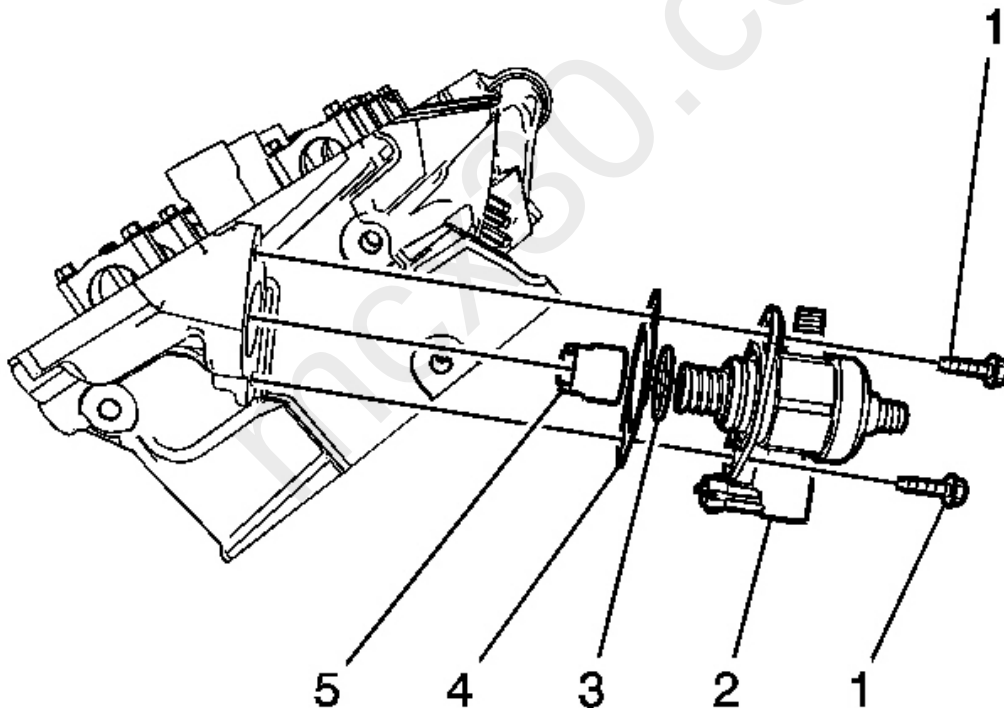


Fig. 81: High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.

4. Remove the low pressure feed pipe. Refer to **Fuel Feed Pipe Replacement (LF1)**.
5. Remove the high pressure pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
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

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 to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head.
2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

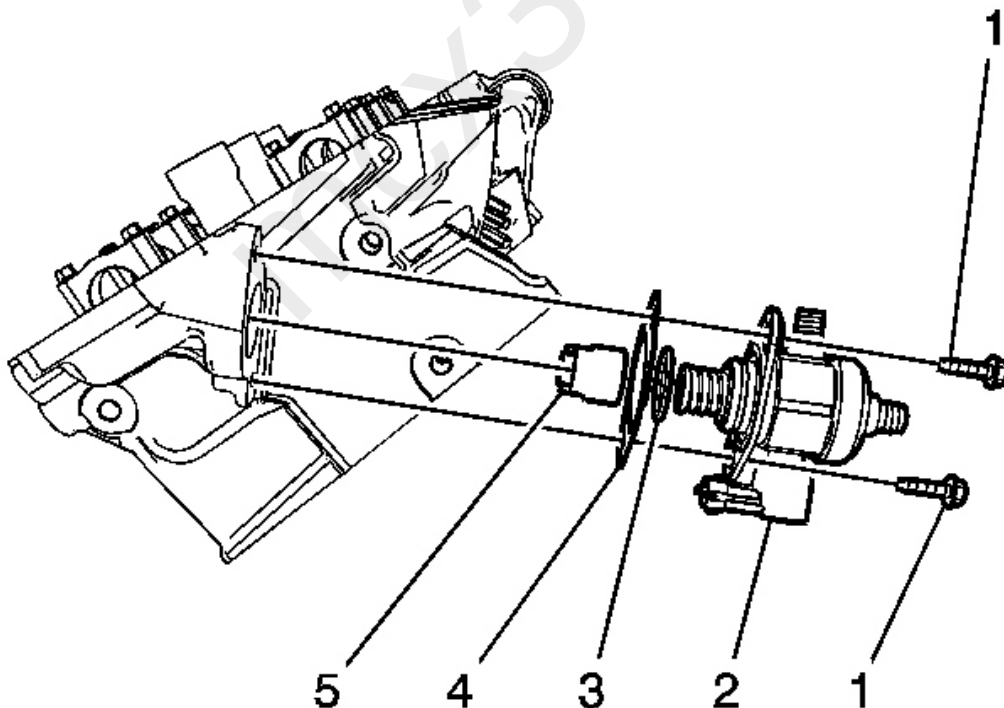


Fig. 82: High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS CORP.

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

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

CAUTION: Refer to Fastener Caution .

8. Tighten the high pressure fuel pump retaining bolts to 15 N.m (11 lb ft).
9. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
10. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
11. Install the fuel feed pipe to the high pressure fuel pump. Refer to **Fuel Feed Pipe Replacement (LF1)**.
12. Connect the high pressure fuel pump wiring harness.
13. Install the fuel tank cap.

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

14. 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.
15. Install the pressure relief cap to the fuel feed pipe.
16. Install the intake manifold. Refer to **Intake Manifold Replacement** .
17. Install the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.

FUEL INJECTOR AND FUEL RAIL REPLACEMENT

Special Tools

EN-47909: Fuel Injector Bore and Sleeve Cleaning Kit

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

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 (LF1)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
5. Remove the foam insulator from the fuel rails.
6. Remove the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** or **Cylinder Head Replacement - Right Side (LF1)**

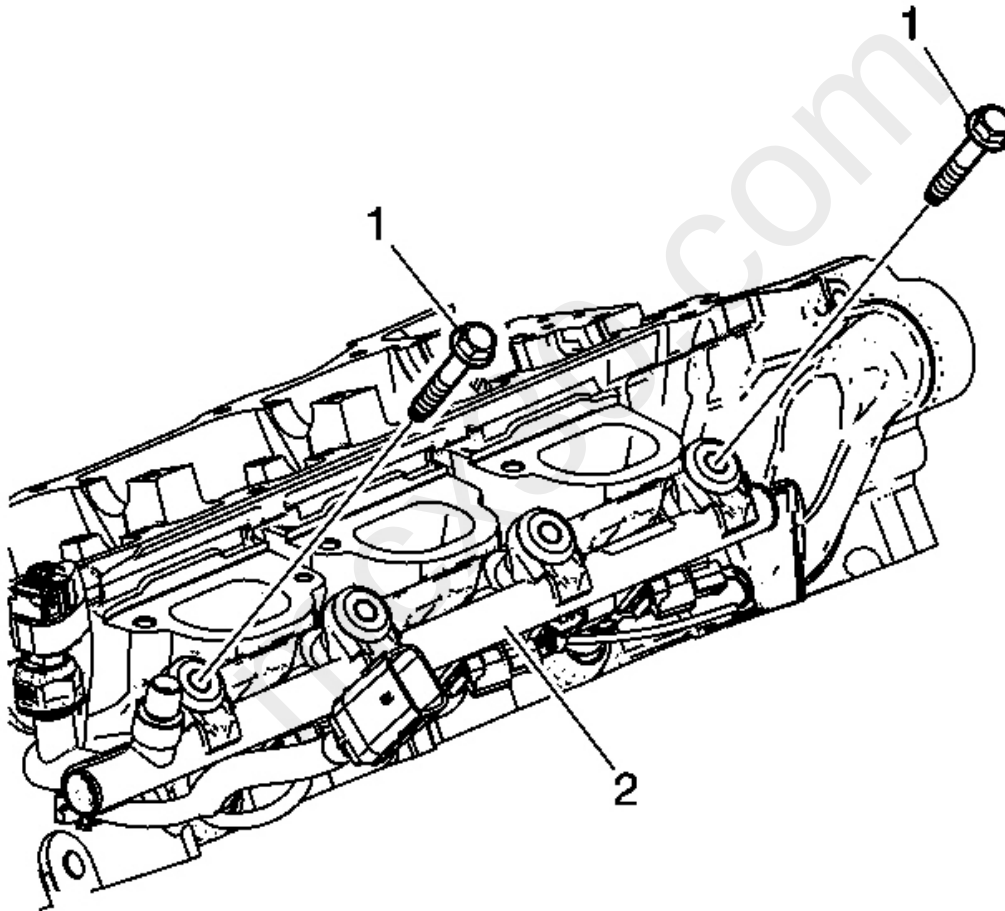


Fig. 83: Fuel Rail Bolts

Courtesy of GENERAL MOTORS CORP.

7. Remove the bolts (1) from the bank 2 fuel rail.
8. Remove the bank 1 fuel rail and injectors (1) as an assembly. Refer to **Cylinder Head Disassemble (LF1)**

or LFW).

9. Disconnect the bank 1 fuel injector electrical connections.

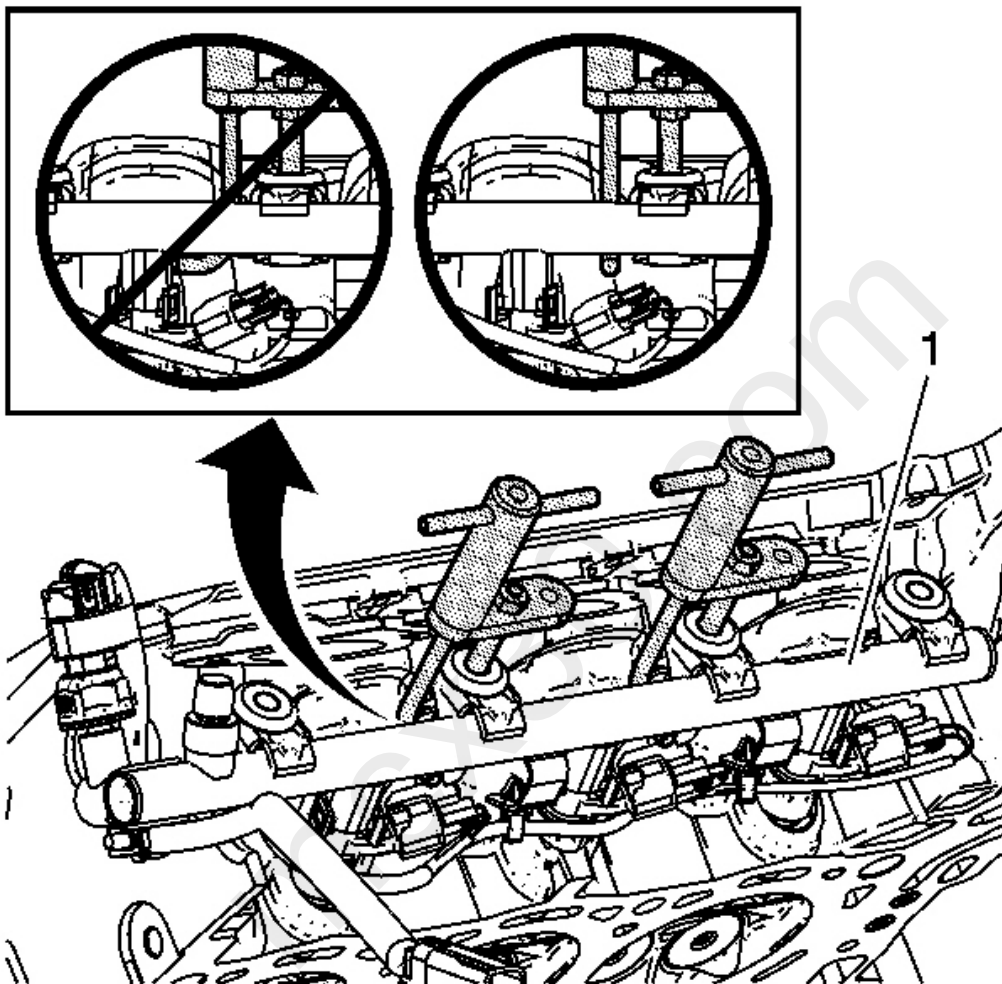


Fig. 84: Removing Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

10. If the bank 2 fuel rail or injectors are being serviced, remove them. Refer to **Cylinder Head Disassemble (LF1 or LFW)**.
11. Disconnect the bank 2 fuel injector and fuel pressure sensor electrical connections.

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

12. It is necessary to rebuild the fuel injectors. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)** .

Installation Procedure

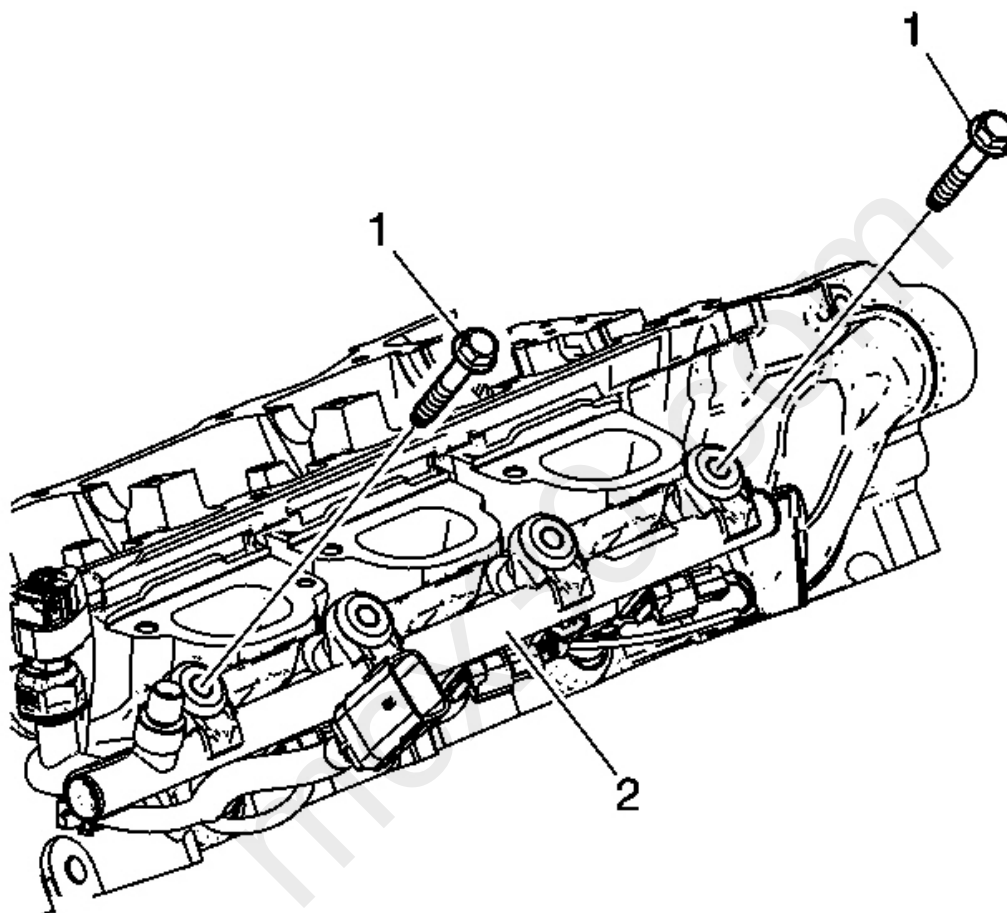


Fig. 85: Fuel Rail Bolts

Courtesy of GENERAL MOTORS CORP.

1. Clean the fuel injector bores using **EN-47909**: kit.
2. Ensure that the fuel injectors have been properly rebuilt and lubricated. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)** .
3. Connect the bank 2 fuel injector and fuel pressure sensor electrical connections.
4. Position the bank 2 fuel rail and evenly hand tighten the 2 outer fuel rail bolts to seat the injectors into the injector bores. Remove the bolts.

5. Connect the bank 1 fuel injector electrical connections.
6. Position the bank 1 fuel rail and evenly hand tighten the 2 outer fuel rail bolts to seat the injectors into the injector bores.
7. Start and hand tighten the remaining fuel rail bolts.

CAUTION: Refer to Fastener Caution .

8. Tighten the bank 1 and bank 2 fuel rail bolts.
 - Tighten the inner fuel rail bolts to 10 N.m (89 lb in).
 - Tighten the outer fuel rail bolts to 10 N.m (89 lb in).
9. Replace any wire harness tie straps cut from the fuel rails.
10. Install the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** or **Cylinder Head Replacement - Right Side (LF1)**
11. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
12. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.

NOTE: Before installing the foam insulator, remove any remaining fuel from the injector well.

13. Install the foam insulator to the fuel rails.
14. Install the intake manifold. Refer to **Intake Manifold Replacement** .
15. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
16. Install the low side fuel pressure service port cap.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT (LF1)

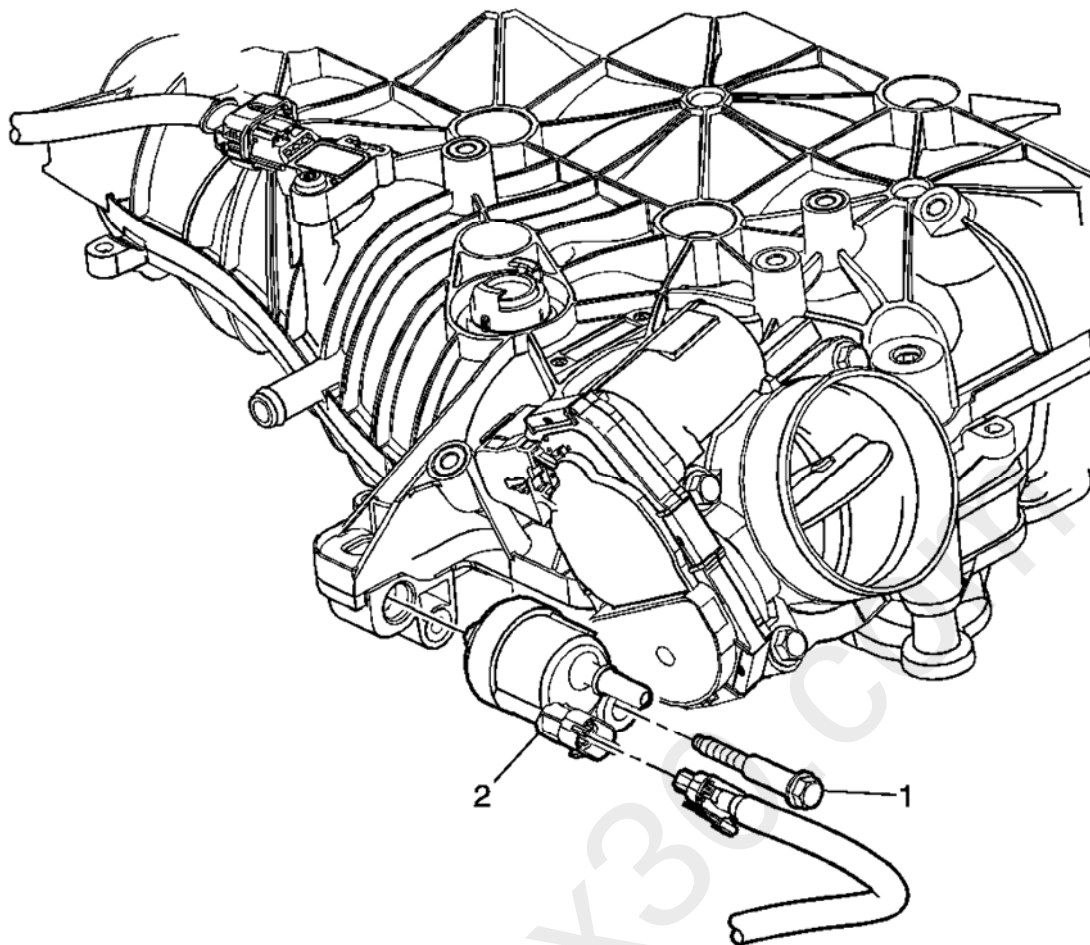


Fig. 86: Evaporative Emission Canister Purge Solenoid Valve (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Evaporative Emission Canister Purge Solenoid Valve Procedure 1. Disconnect the EVAP canister purge solenoid harness connector. 2. Install a NEW O-ring.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

Removal Procedure

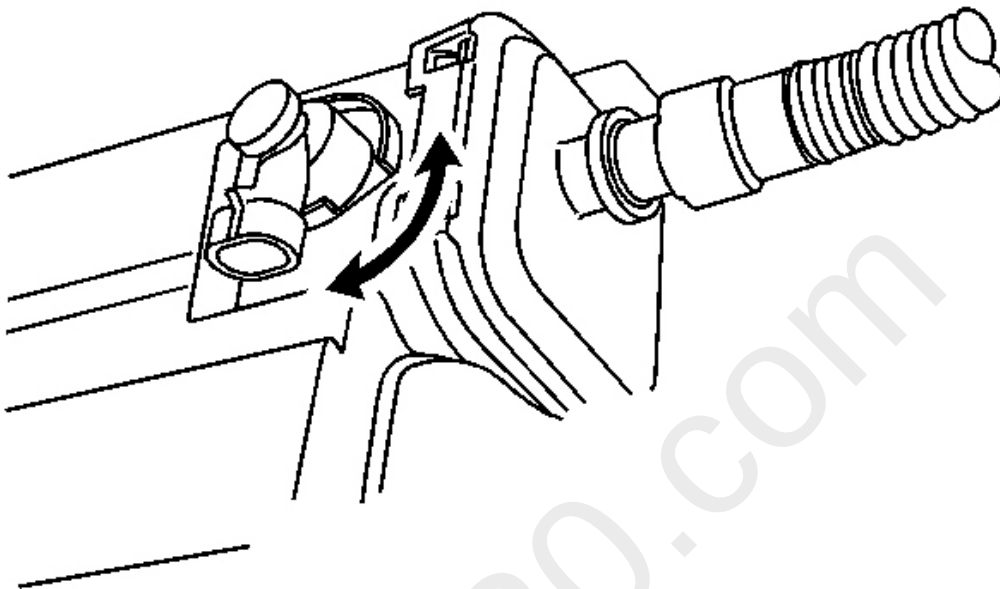


Fig. 87: Rotating EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

1. Remove the evaporative emission (EVAP) canister. Refer to **Evaporative Emission Canister Replacement** .
2. Rotate the EVAP canister vent valve counterclockwise to release from the locked position.

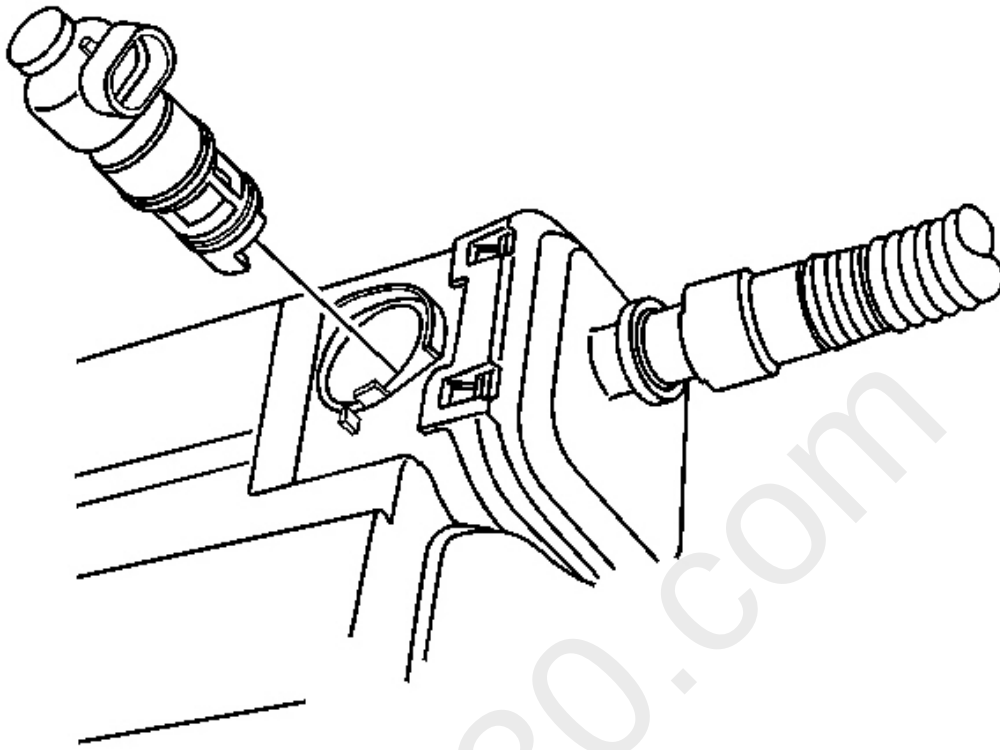


Fig. 88: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

3. Remove the vent valve from the EVAP canister.

Installation Procedure

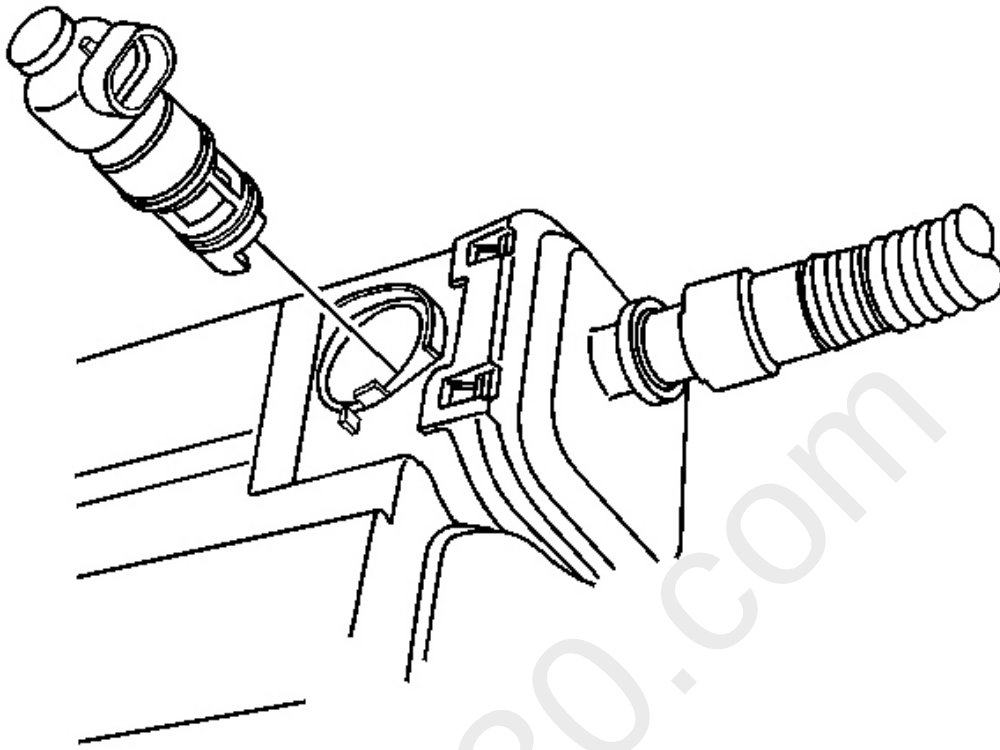


Fig. 89: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

1. Insert the EVAP canister vent solenoid valve into the EVAP canister, with the valve aligned to the released position.

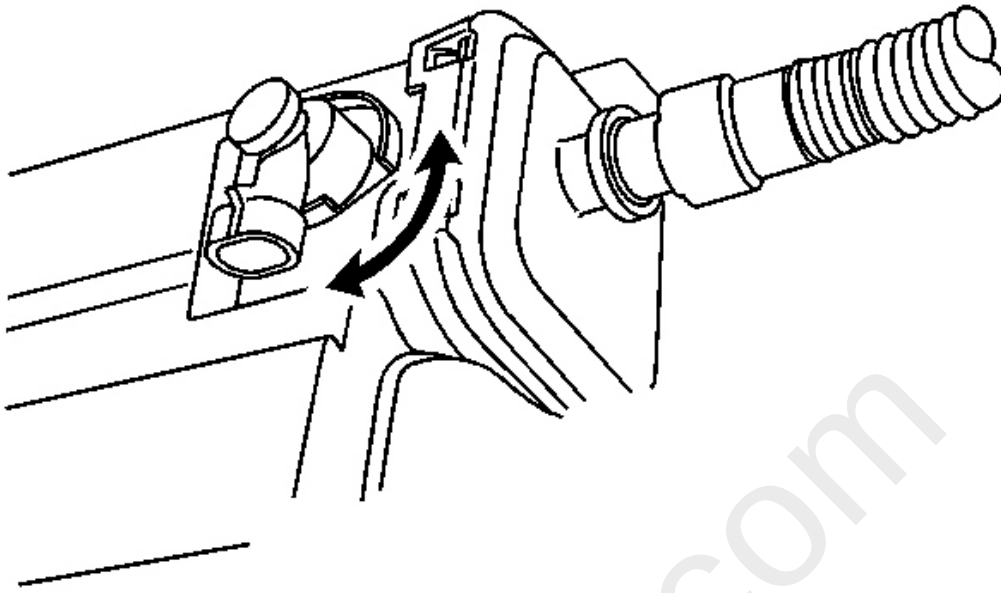


Fig. 90: Rotating EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

2. Rotate vent valve clockwise to secure into the locked position.
3. Install the EVAP canister. Refer to **Evaporative Emission Canister Replacement** .

EVAPORATIVE EMISSION LINE REPLACEMENT - CHASSIS TO CANISTER

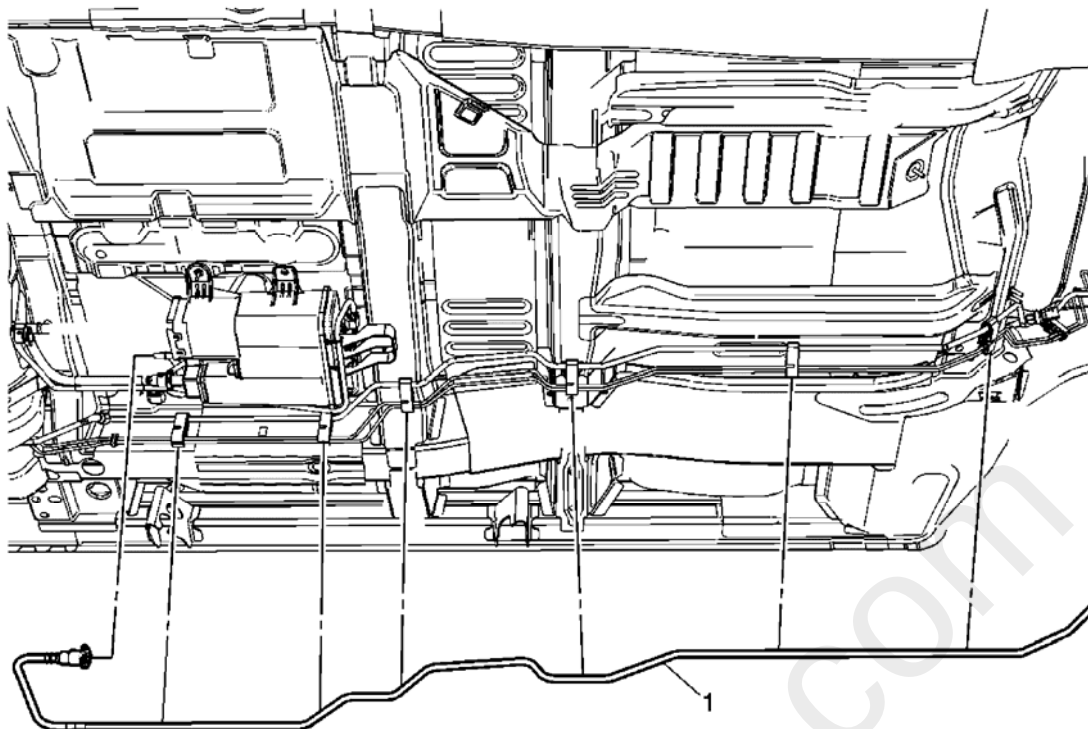


Fig. 91: Evaporative Emission Line - Chassis to Canister
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Disconnect the quick connectors. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Evaporative Emission Line Procedure: Disengage the line from the plastic retainers.

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

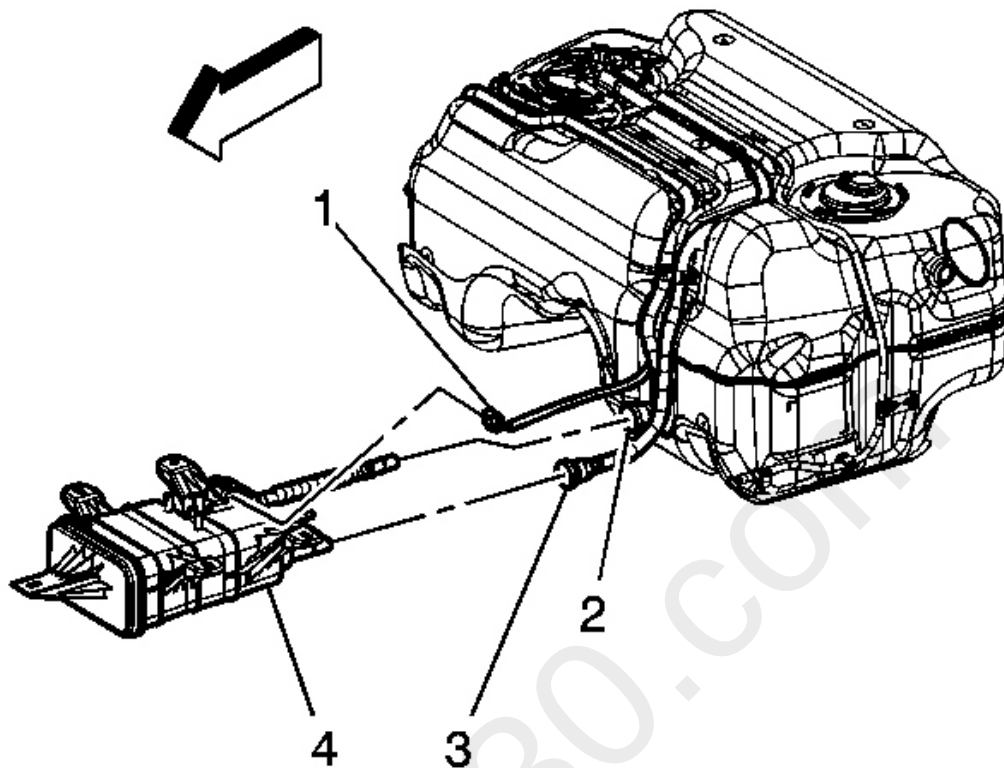


Fig. 92: View Of EVAP Canister, Hose/Pipes & EVAP Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: The EVAP emissions canister is located under the center of the vehicle. It has 3 EVAP line connections:

- The EVAP fresh air
- The EVAP vent
- The EVAP purge

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

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

2. Disconnect the EVAP canister fresh air hose/pipe from the fuel tank fresh air hose/pipe (2). Refer to Plastic Collar Quick Connect Fitting Service.

3. Disconnect the EVAP canister vent hose/pipe from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

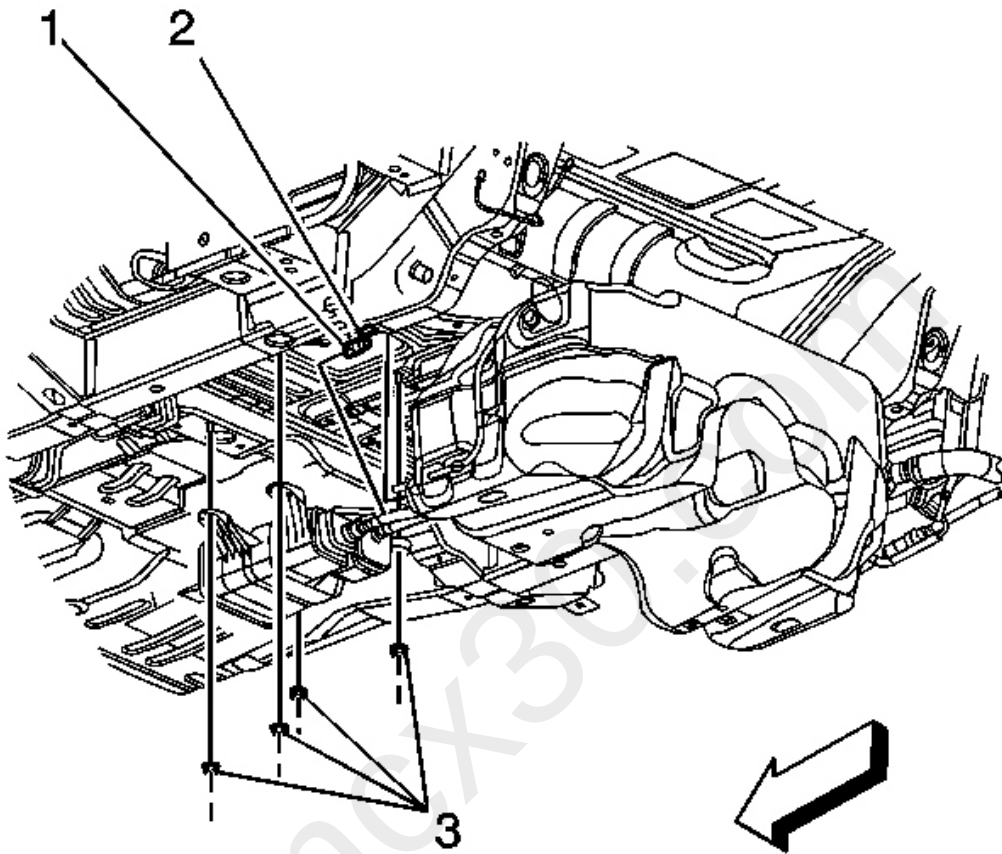


Fig. 93: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

4. Disconnect the EVAP canister purge hose/pipe (1) from the EVAP canister.
5. Remove the EVAP canister-to-underbody nuts (3).
6. Lower the EVAP canister.

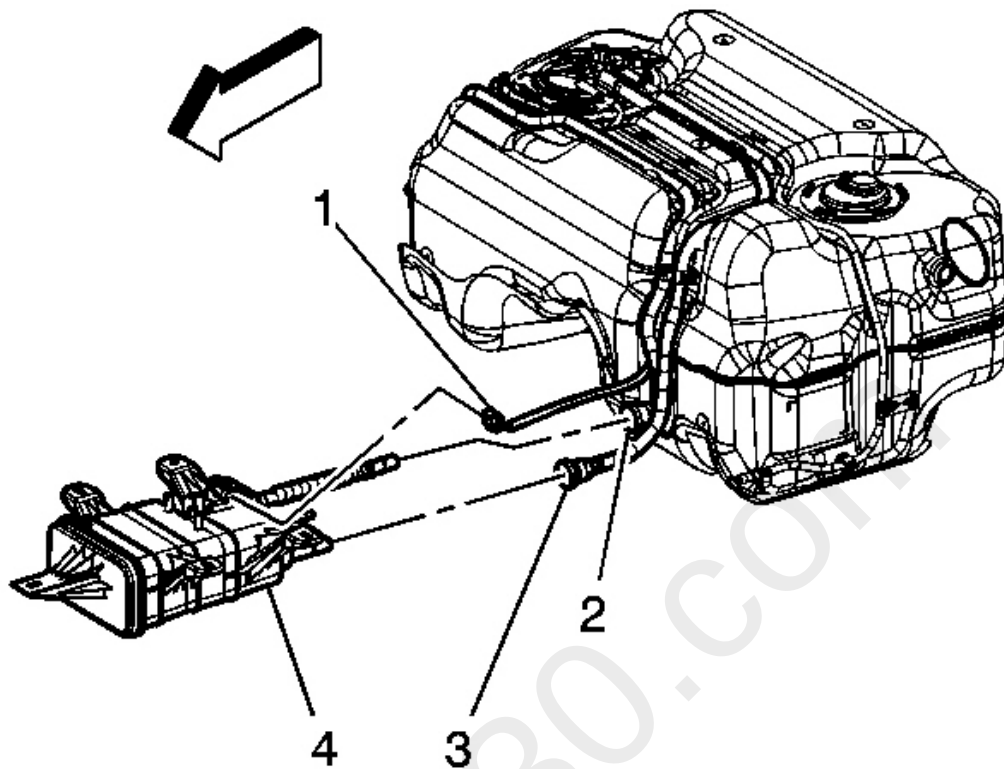


Fig. 94: View Of EVAP Canister, Hose/Pipes & EVAP Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the EVAP vent solenoid electrical connector (1).
8. Remove the EVAP canister (4) from the vehicle.

Installation Procedure

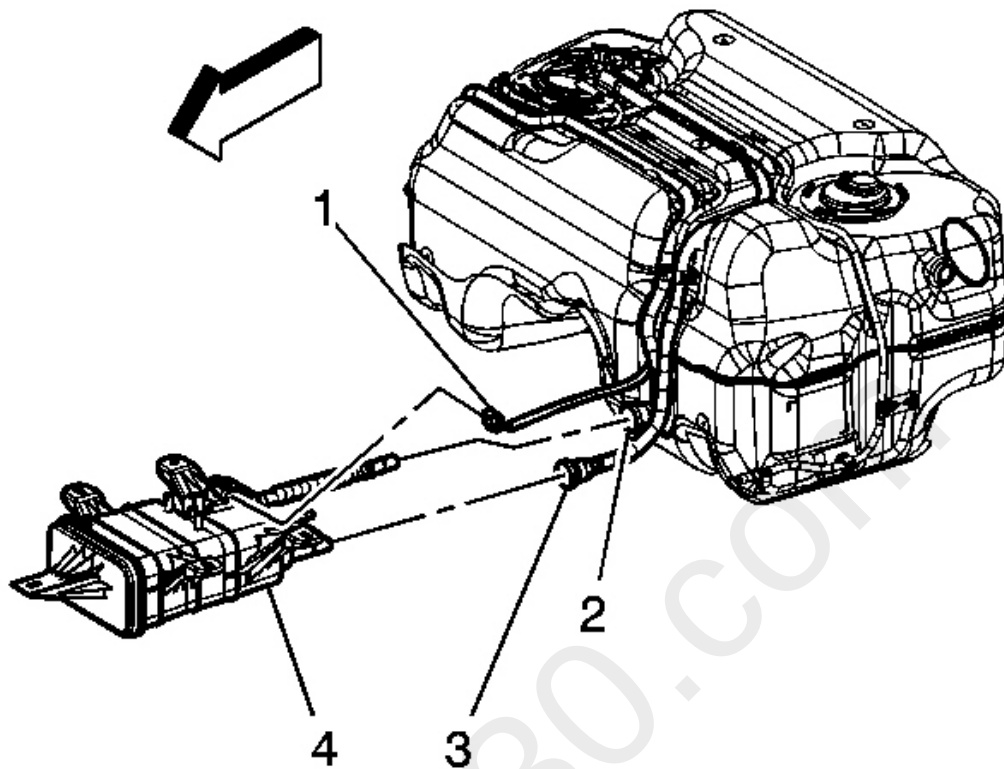


Fig. 95: View Of EVAP Canister, Hose/Pipes & EVAP Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Connect the EVAP vent solenoid electrical connector (1).
2. Install the EVAP canister (4) to the underbody of the vehicle.

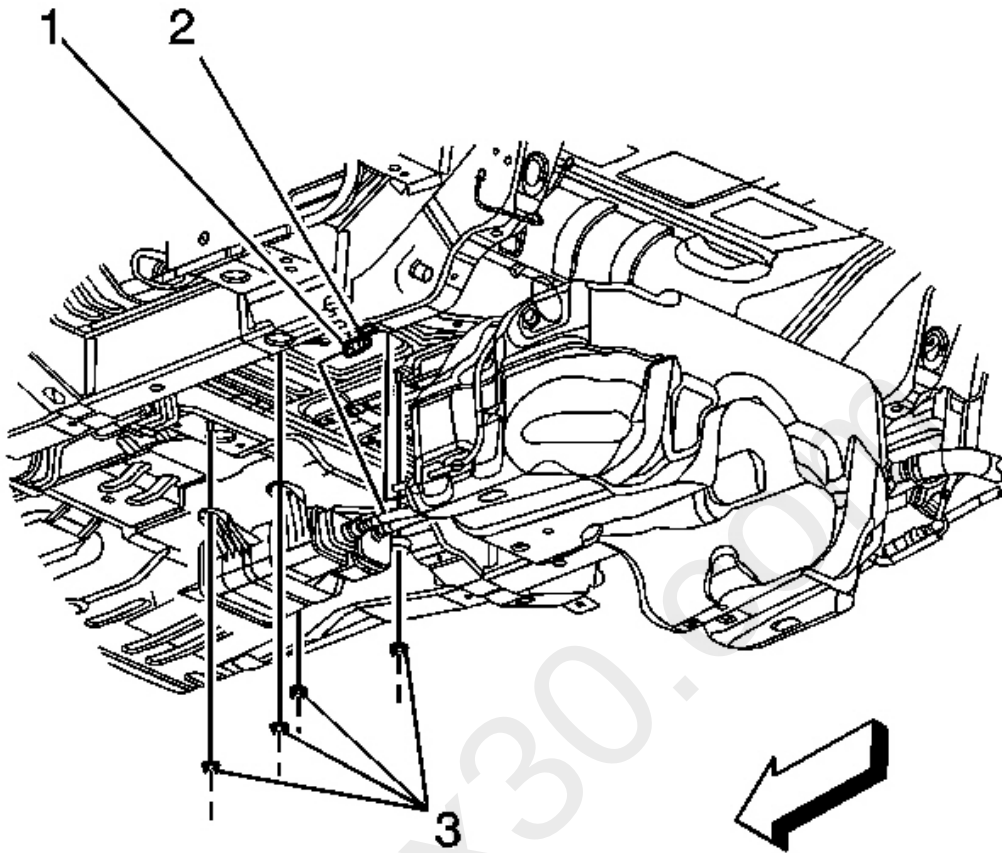


Fig. 96: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the EVAP canister-to-underbody nuts (3).

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

4. Connect the EVAP canister purge hose/pipe (1) to the EVAP canister.

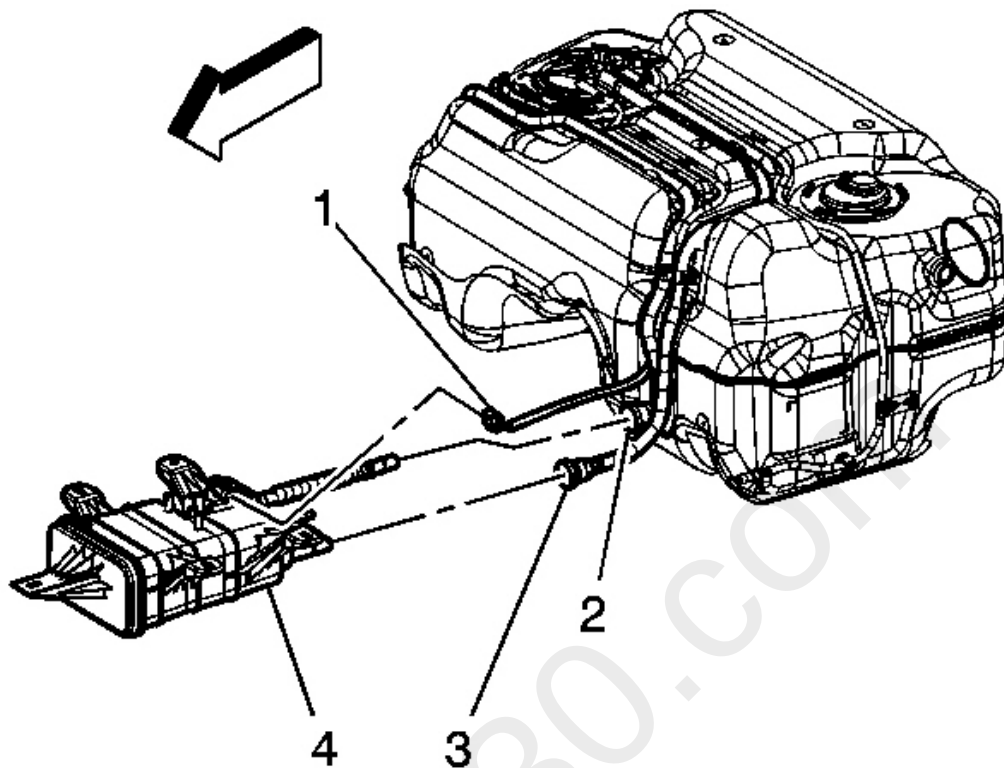


Fig. 97: View Of EVAP Canister, Hose/Pipes & EVAP Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Connect the EVAP canister vent hose/pipe (3) to the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Connect the EVAP canister fresh air hose/pipe to the fuel tank fresh air hose/pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Lower the vehicle.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

J 41413-200 Evaporative Emission System Tested

Inspection Procedure

CAUTION: Use the EVAP Pressure/Purge Diagnostic Station J 41413 in order to

provide a clean, dry, low pressure gas source. Do not substitute any other pressurized gas source. Damage may result to the EVAP system.

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 (LF1)**.
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
 - If no carbon particles were detected, but a blockage was detected during a diagnostic procedure, install the original EVAP canister purge valve. Continue with the cleaning procedure.
 - If carbon particles are found during the inspection procedure, continue with the cleaning procedure.
 - If a diagnostic procedure directed you to replace the EVAP canister purge valve and no carbon particles were detected, replace the EVAP canister purge valve. Return to the published service procedure.

Cleaning Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the EVAP canister. Refer to **Evaporative Emission Canister Replacement** .
3. Turn OFF the main valve on the **J 41413-200** .
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 (LF1)**.
13. Return to the diagnostic table that sent you here.

IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

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

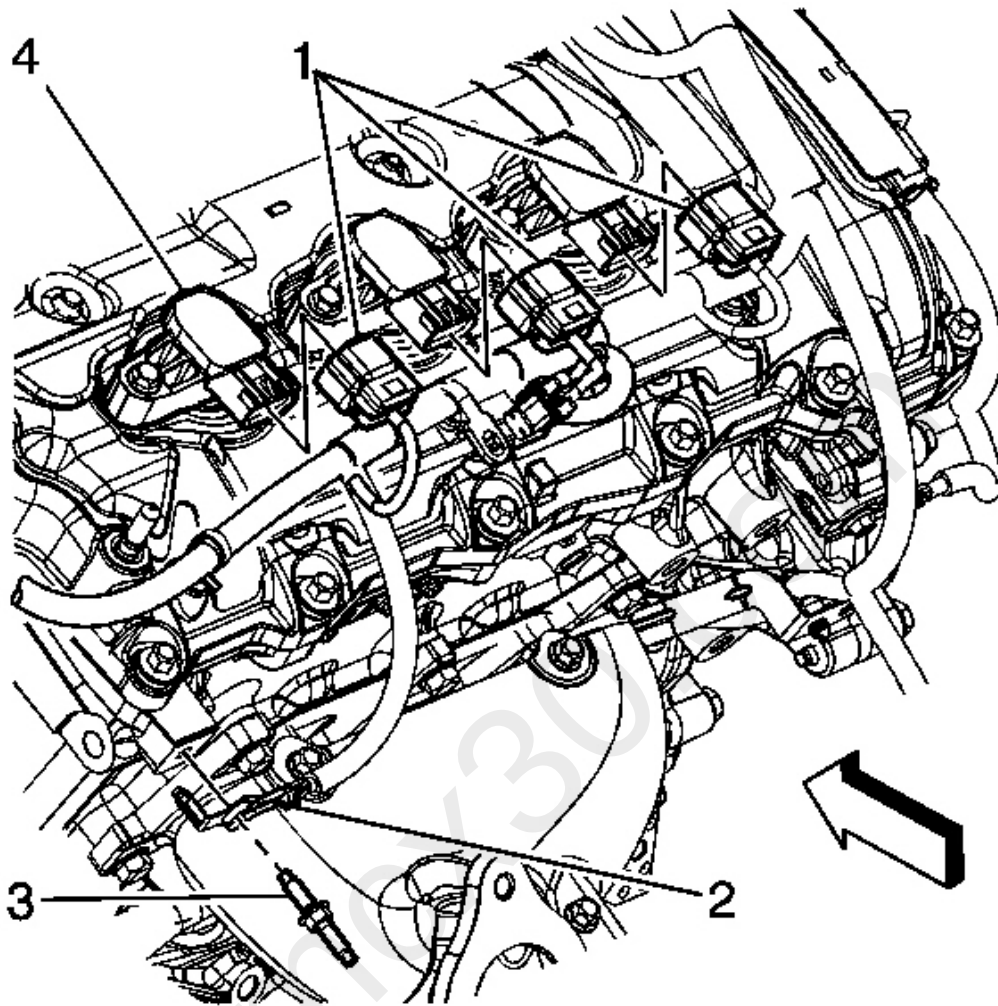


Fig. 98: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS CORP.

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

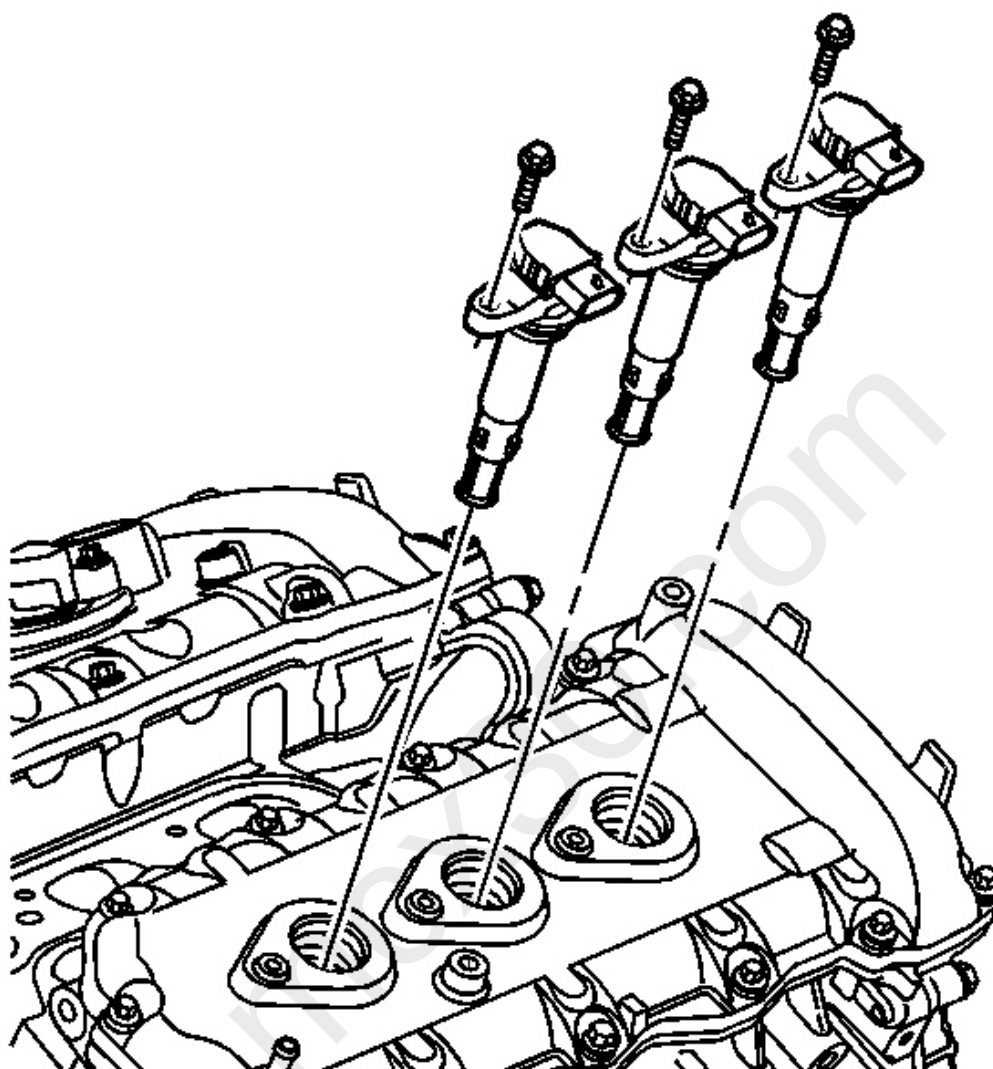


Fig. 99: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

3. Remove the ignition coil bolt(s).
4. Remove the ignition coil(s).

Installation Procedure

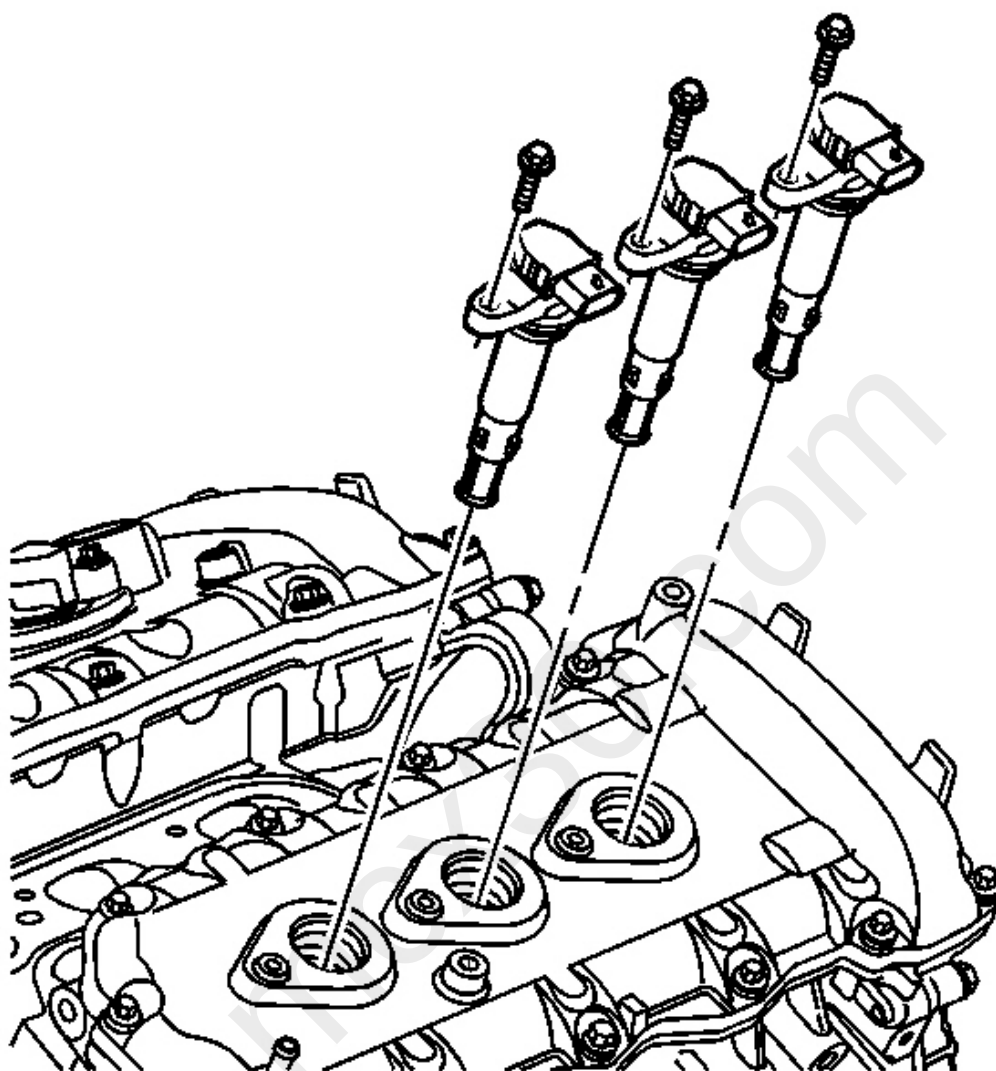


Fig. 100: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s).

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

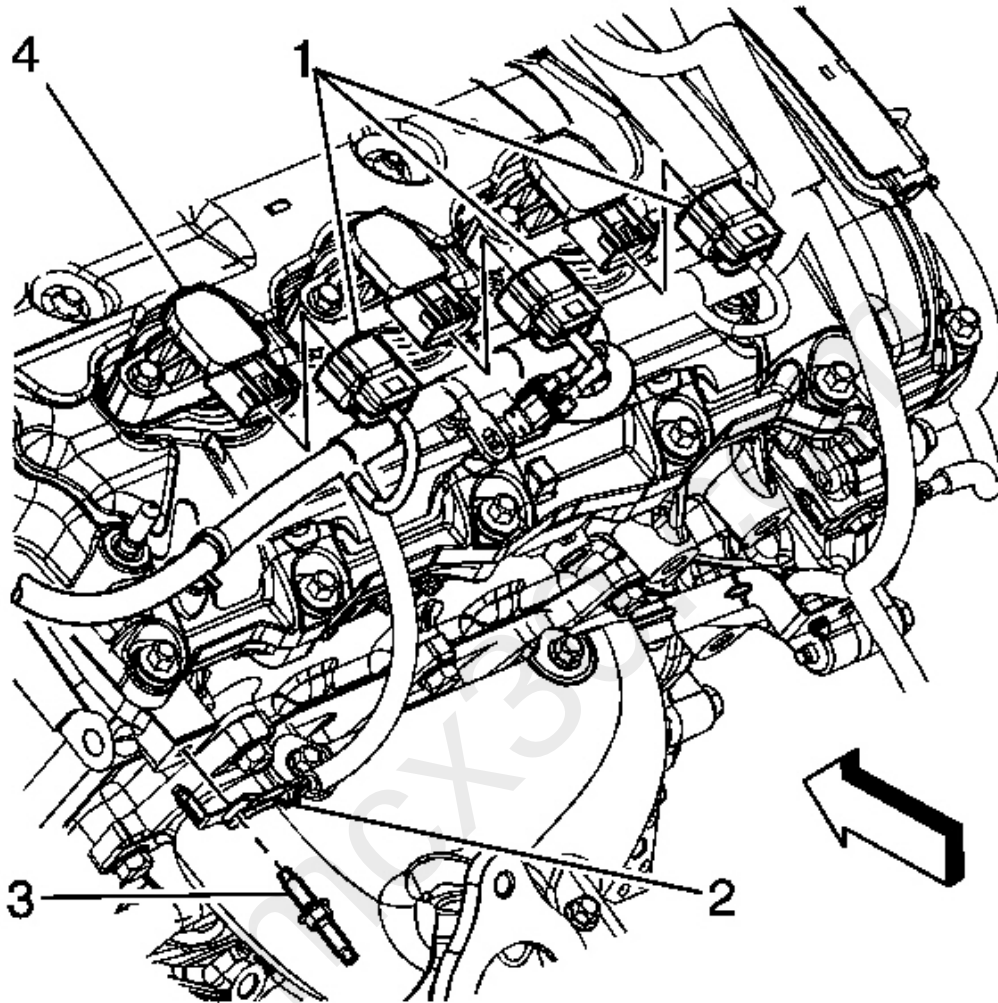


Fig. 101: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s) (4).
4. Install the intake manifold. Refer to **Intake Manifold Replacement** .

IGNITION COIL REPLACEMENT - BANK 2

Removal Procedure

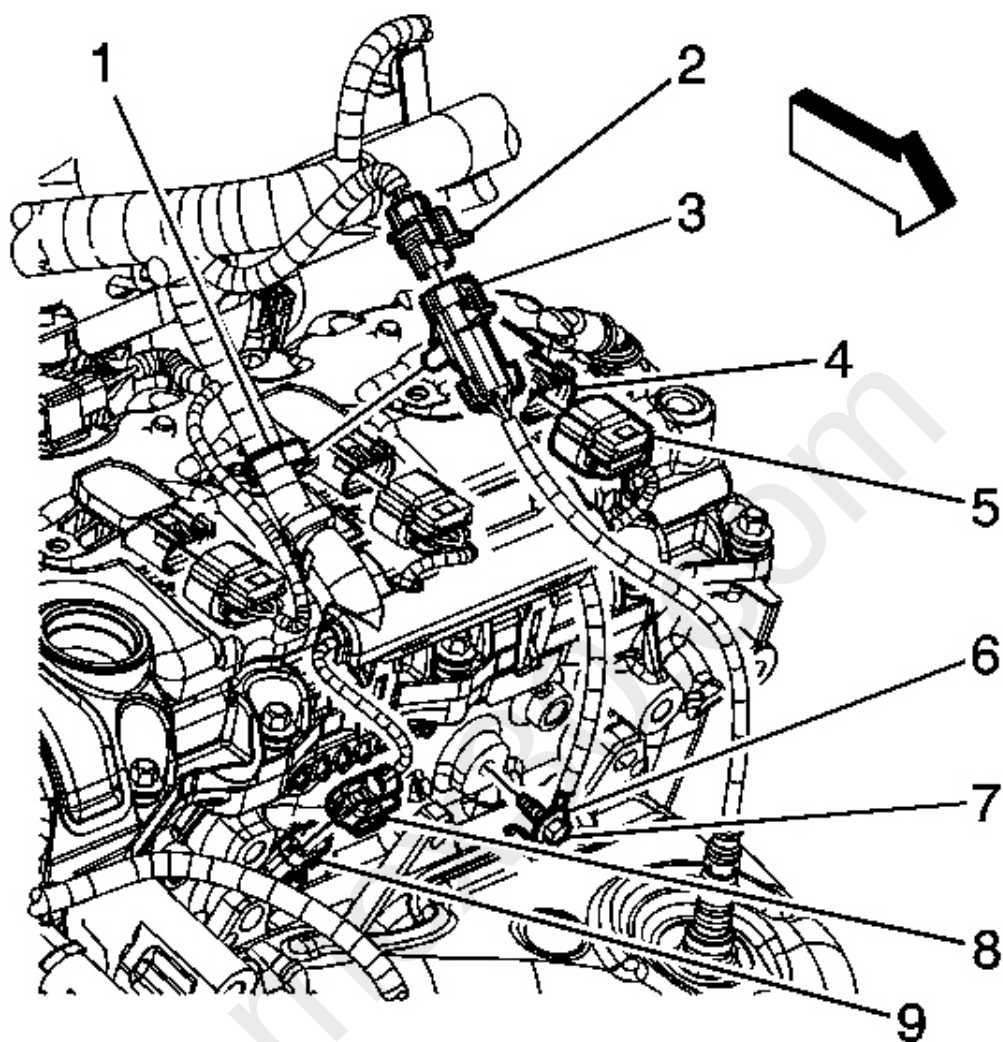


Fig. 102: Identifying Engine Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Disconnect the engine wiring harness electrical connector(s) (5) from the ignition coil(s) (4).

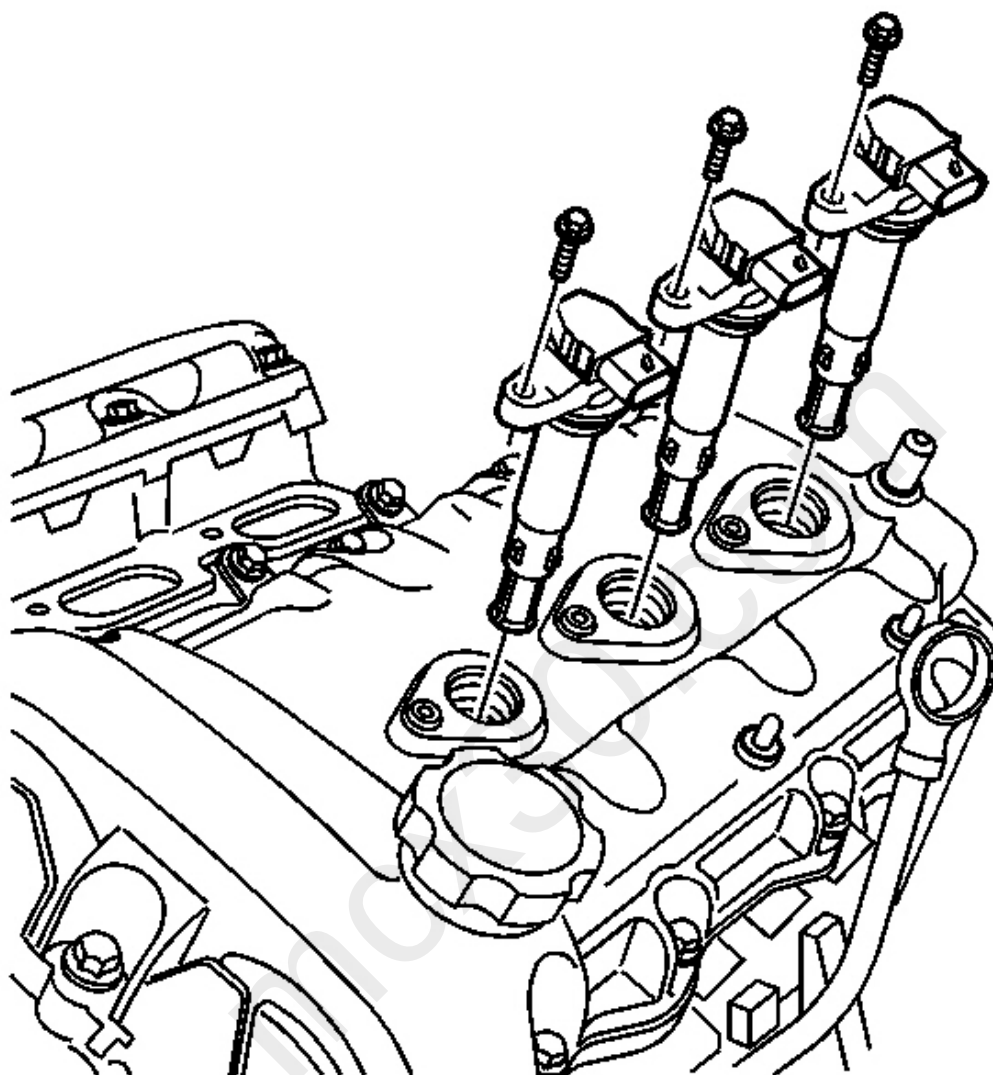


Fig. 103: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

3. Remove the ignition coil bolt(s).
4. Remove the ignition coil(s).

Installation Procedure

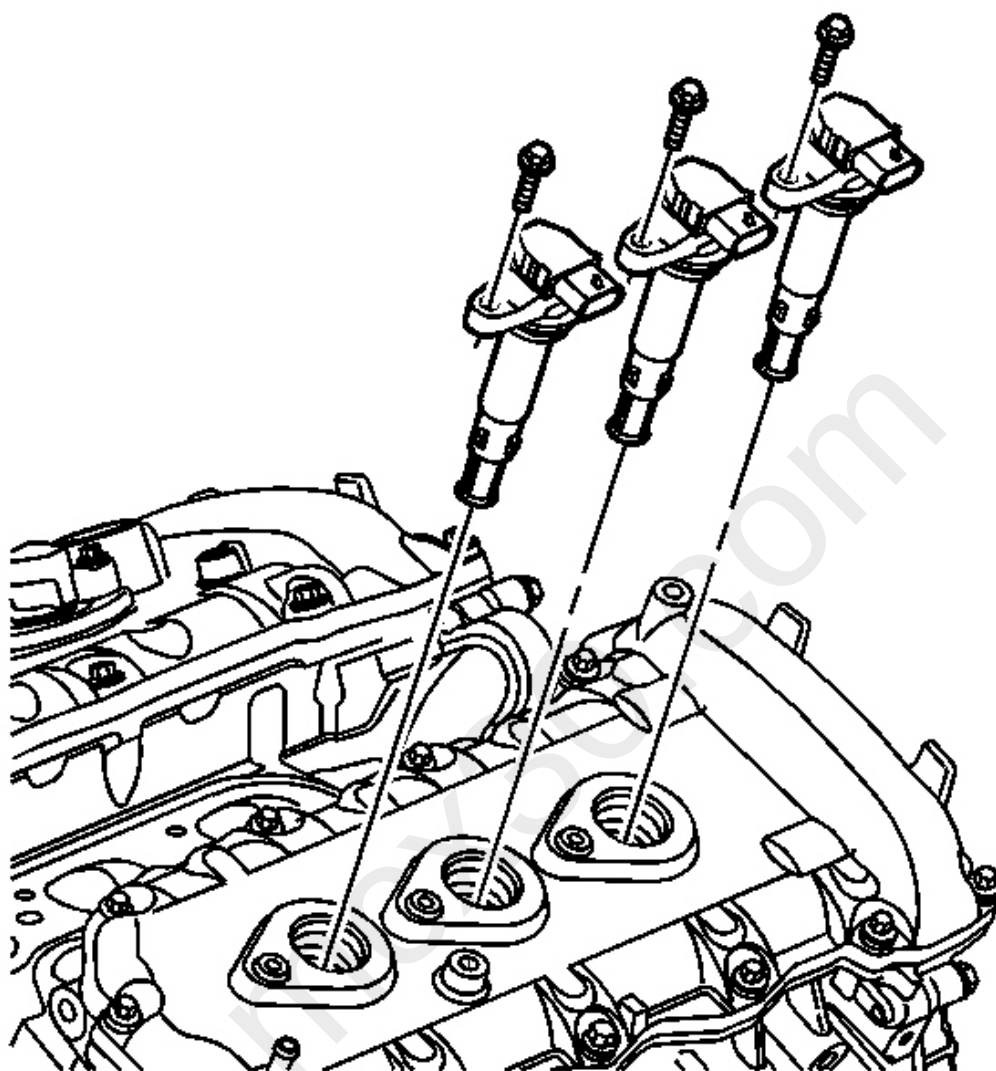


Fig. 104: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s).

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

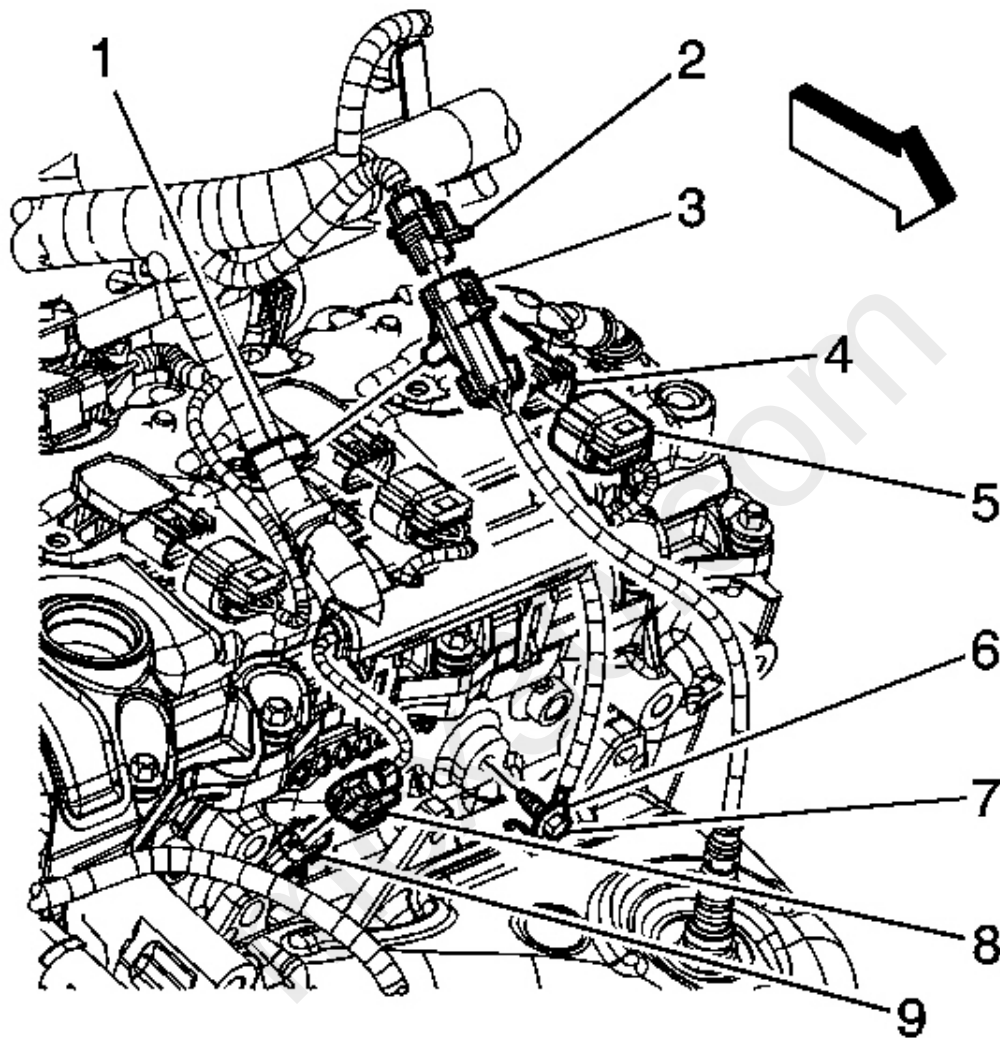


Fig. 105: Identifying Engine Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Connect the engine wiring harness electrical connector(s) (5) to the ignition coil(s) (4).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

SPARK PLUG INSPECTION

Spark Plug Usage

- Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to **Ignition System Specifications** for the correct spark plug.
- Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - Spark plug fouling-Colder plug
 - Pre-ignition causing spark plug and/or engine damage-Hotter plug

Spark Plug Inspection

mcx30.com

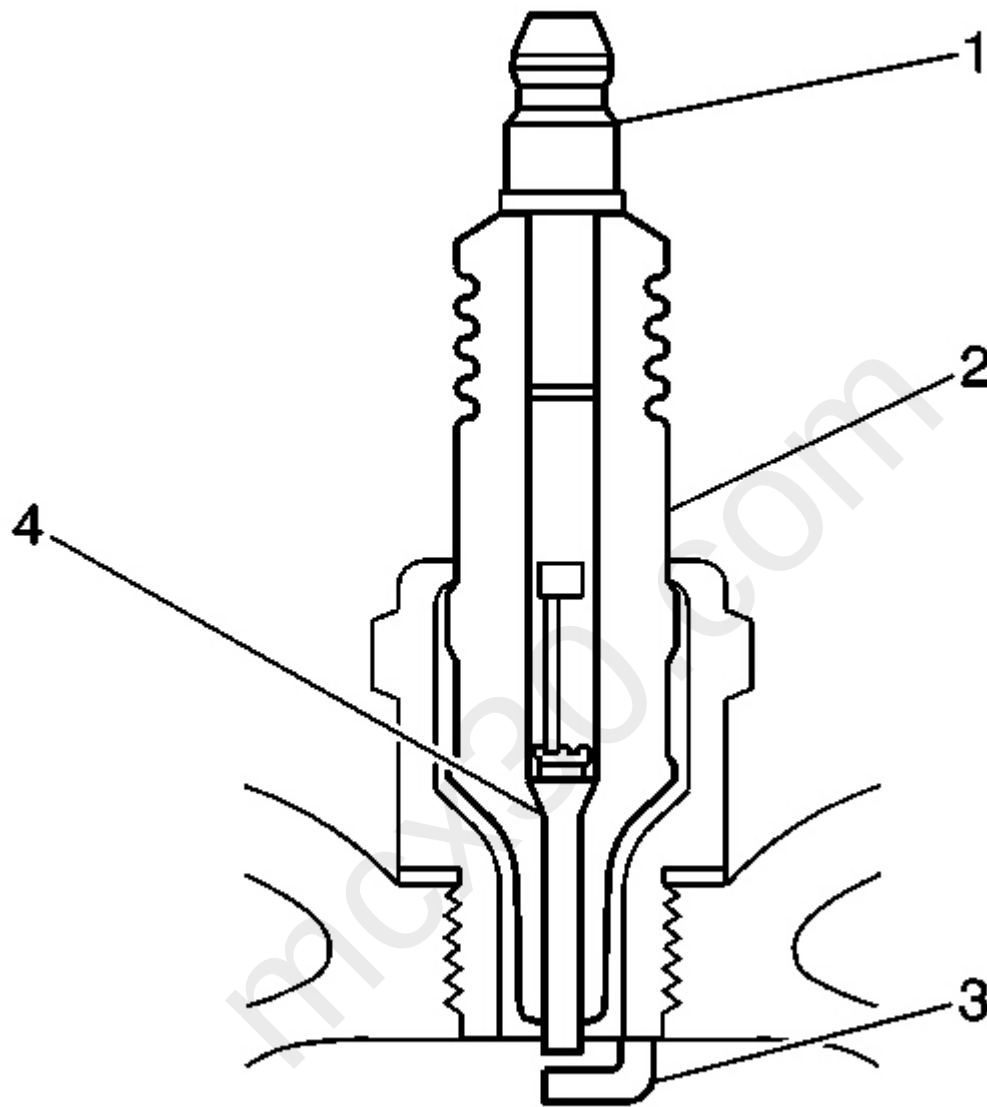


Fig. 106: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS CORP.

- 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.

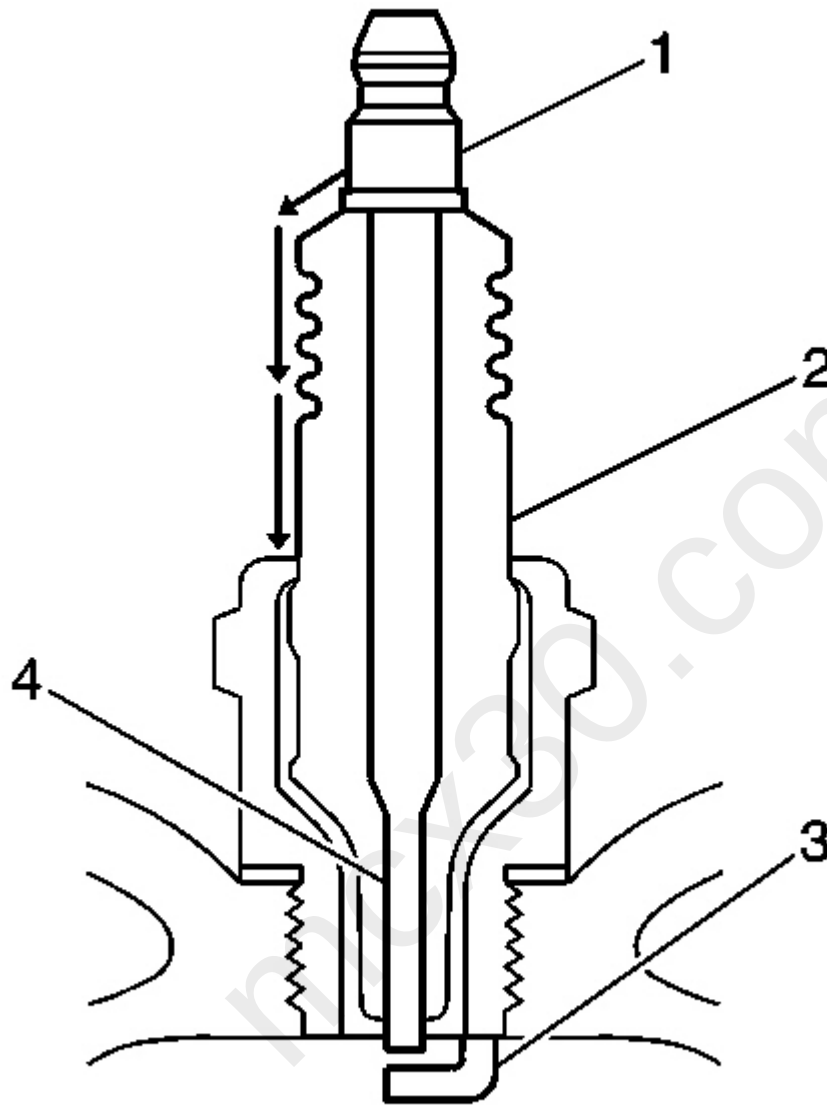


Fig. 107: Identifying Spark Plug Inspection Points
Courtesy of GENERAL MOTORS CORP.

- Inspect the insulator (2) for flashover or carbon tracking, soot. 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.

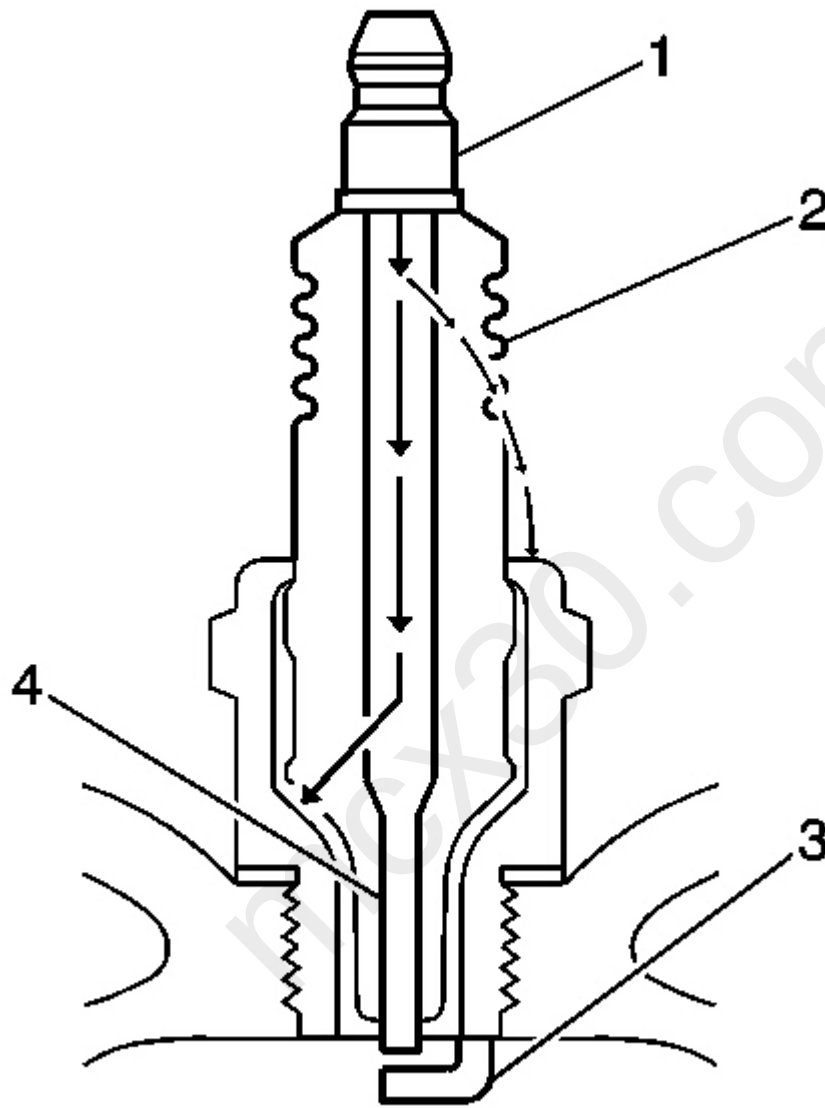


Fig. 108: Inspecting Spark Plug Insulator
Courtesy of GENERAL MOTORS CORP.

- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).

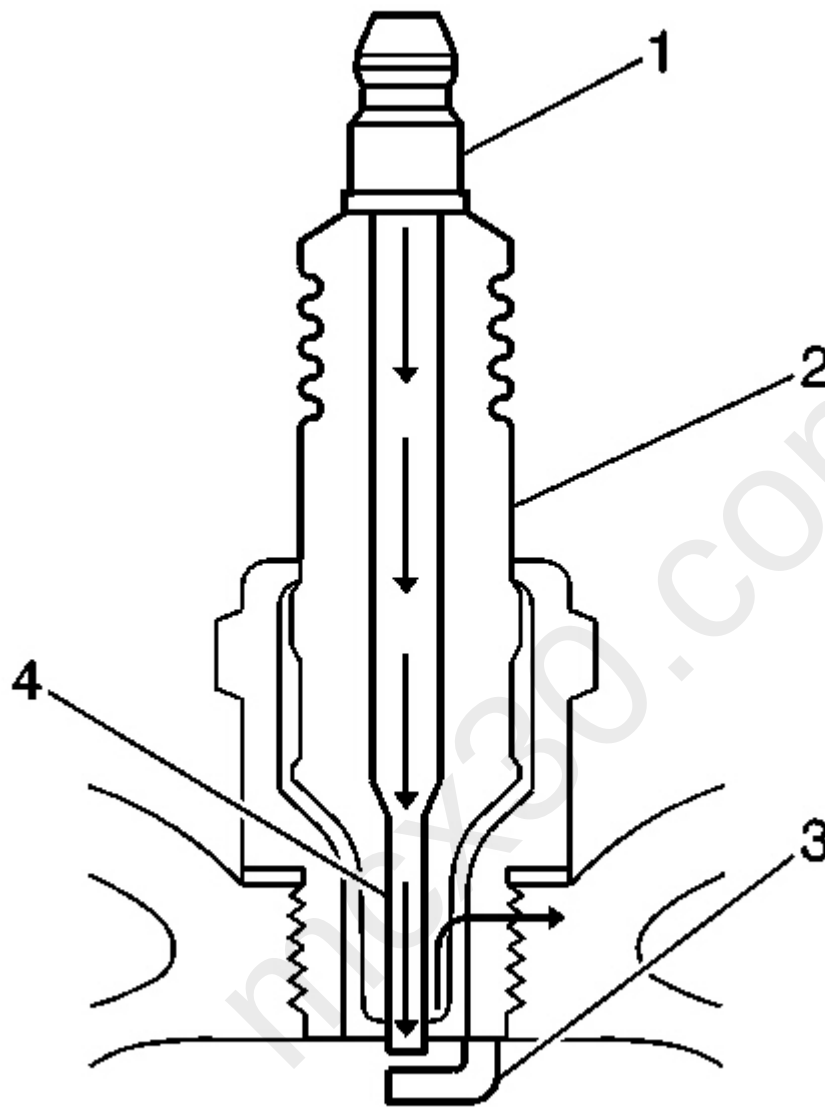


Fig. 109: Cutaway View Of Spark Plug
Courtesy of GENERAL MOTORS CORP.

- Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. 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.
- 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

Removal Procedure

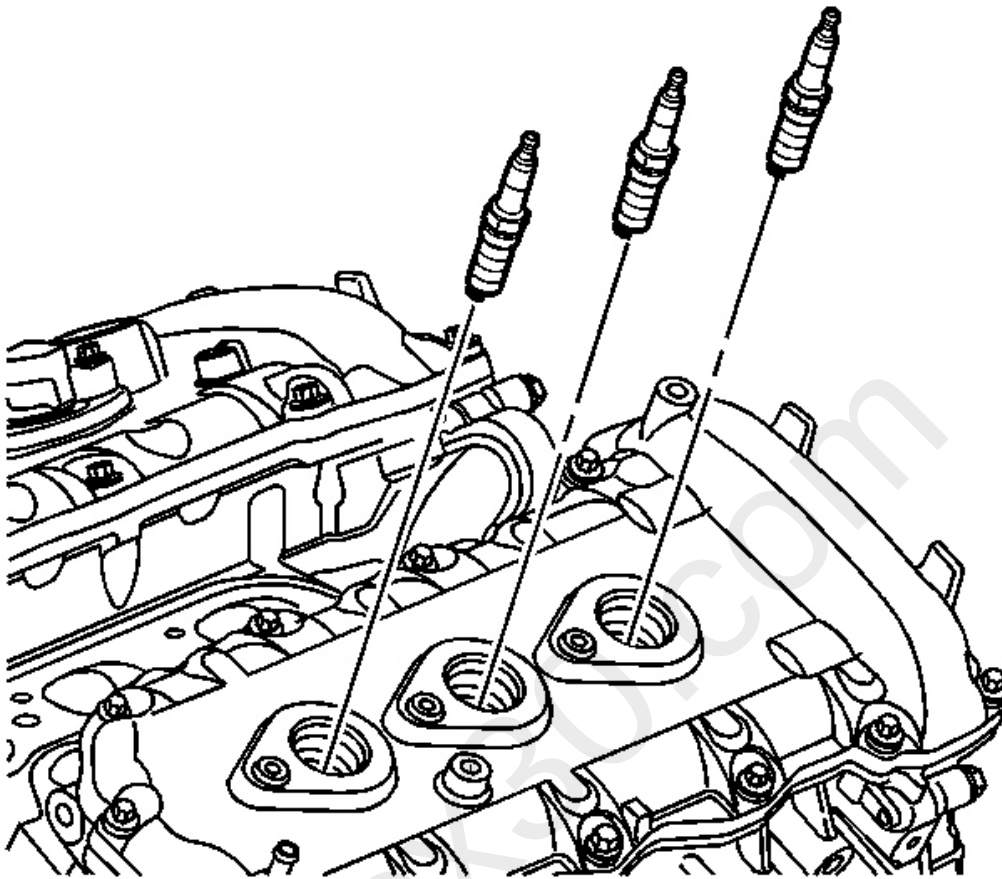


Fig. 110: View Of Spark Plugs

Courtesy of GENERAL MOTORS CORP.

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

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.

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

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.

Installation Procedure

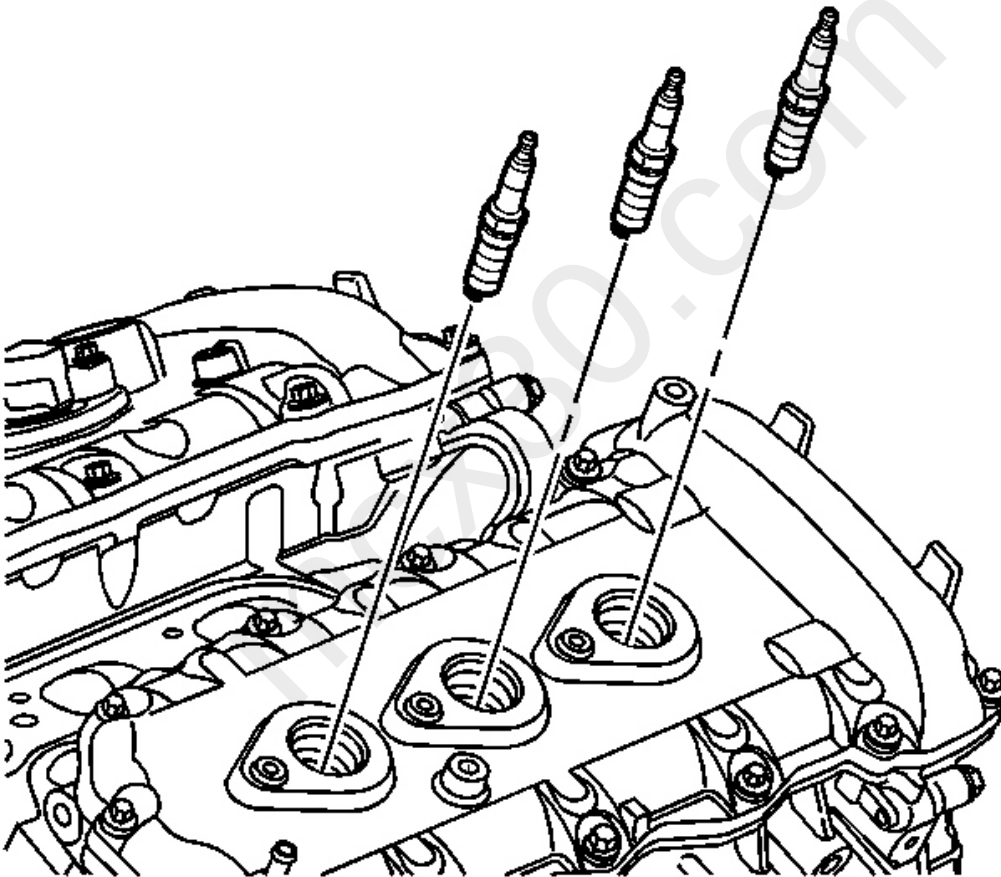


Fig. 111: View Of Spark Plugs

Courtesy of GENERAL MOTORS CORP.

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 **Fastener Caution**.

2. Install the spark plug.

Tighten: Tighten the spark plug to 20 N.m (15 lb ft).

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

CRANKSHAFT POSITION SENSOR REPLACEMENT

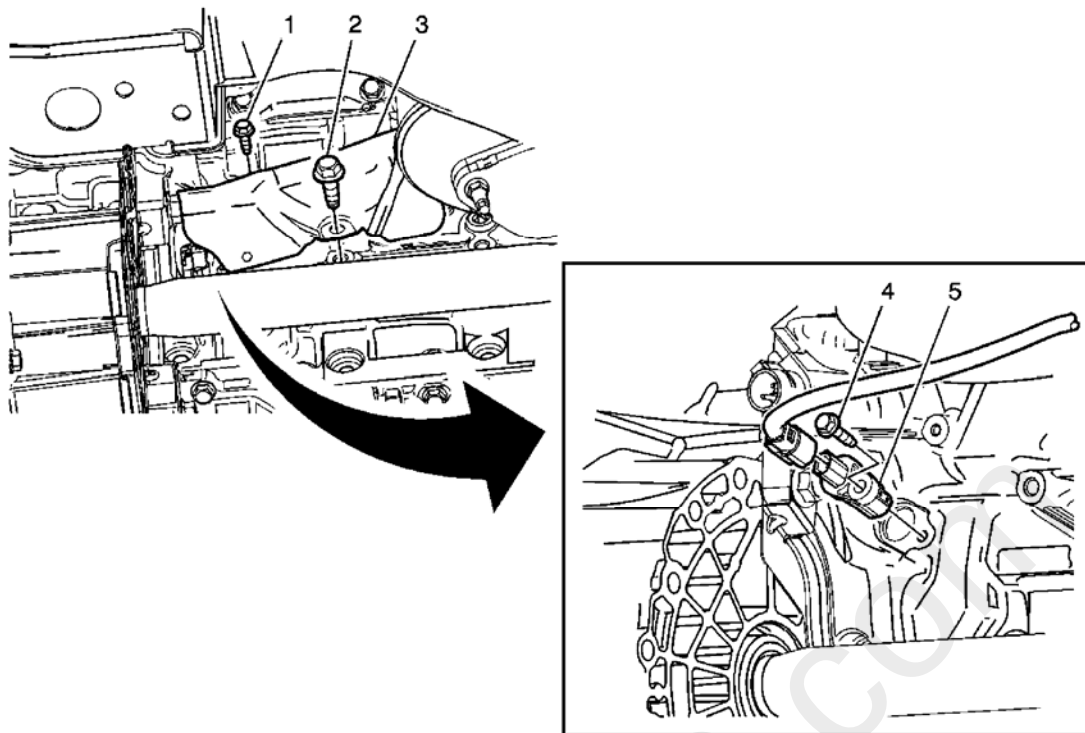


Fig. 112: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. If equipped with AWD, remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side (LF1)</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 9 N.m (80 lb in)
2	Bolt Tighten: 58 N.m (42 lb ft)
3	Exhaust Manifold Lower Heat Shield
4	Bolt Tighten: 10 N.m (89 lb in)
	Crankshaft Position Sensor

Procedure	
5	1. Disconnect the crankshaft position sensor harness connector. 2. If LF1, perform the crankshaft position system variation learn procedure. Refer to <u>Crankshaft Position System Variation Learn</u>

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

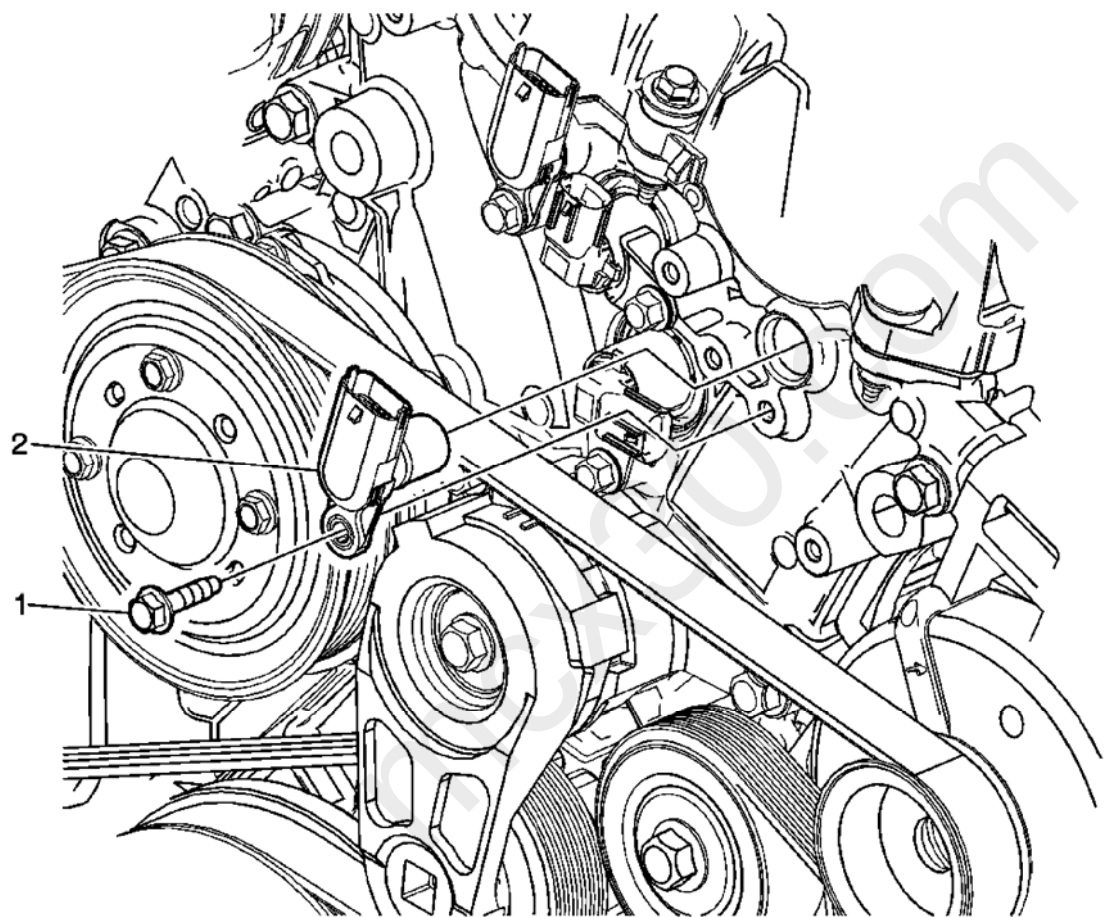


Fig. 113: Camshaft Position Sensor - Bank 2 (Left Side) Exhaust
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten: 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure: Disconnect the electrical connector.

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

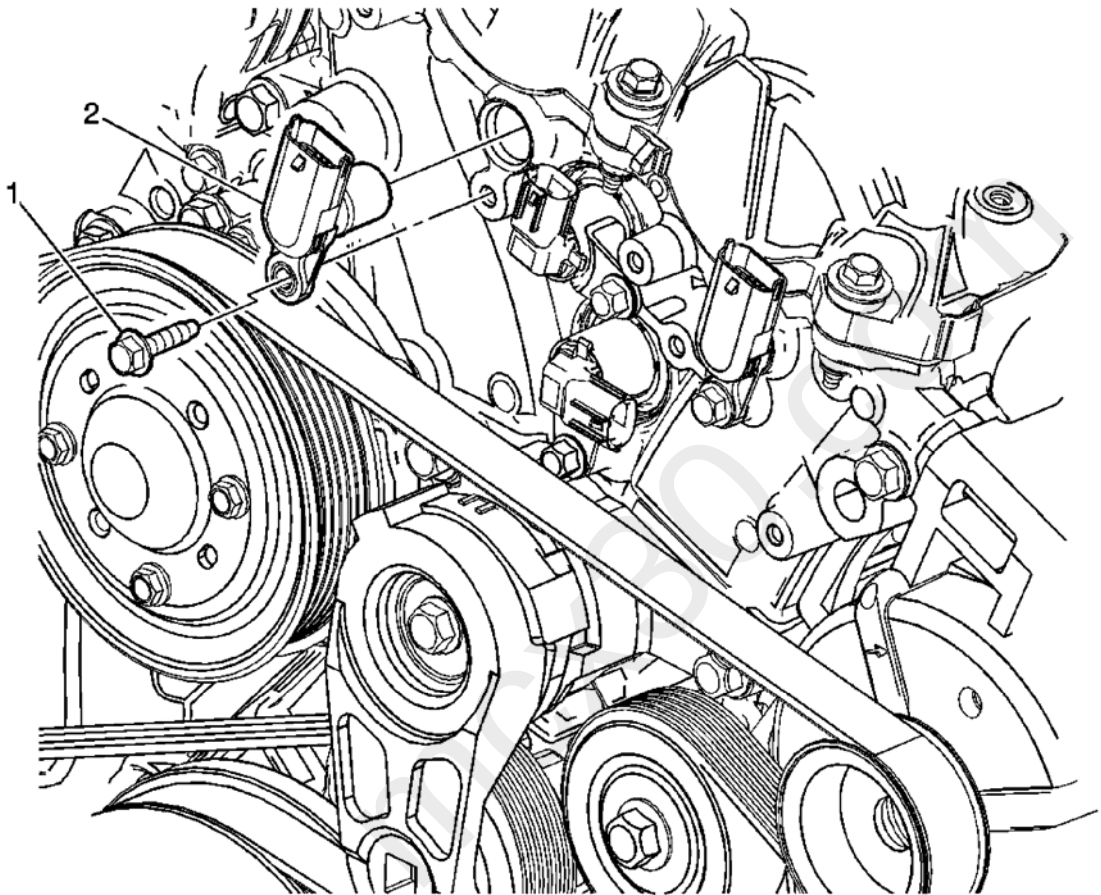


Fig. 114: Camshaft Position Sensor - Bank 2 (Left Side) Intake
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten: 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure: Disconnect the electrical connector.

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

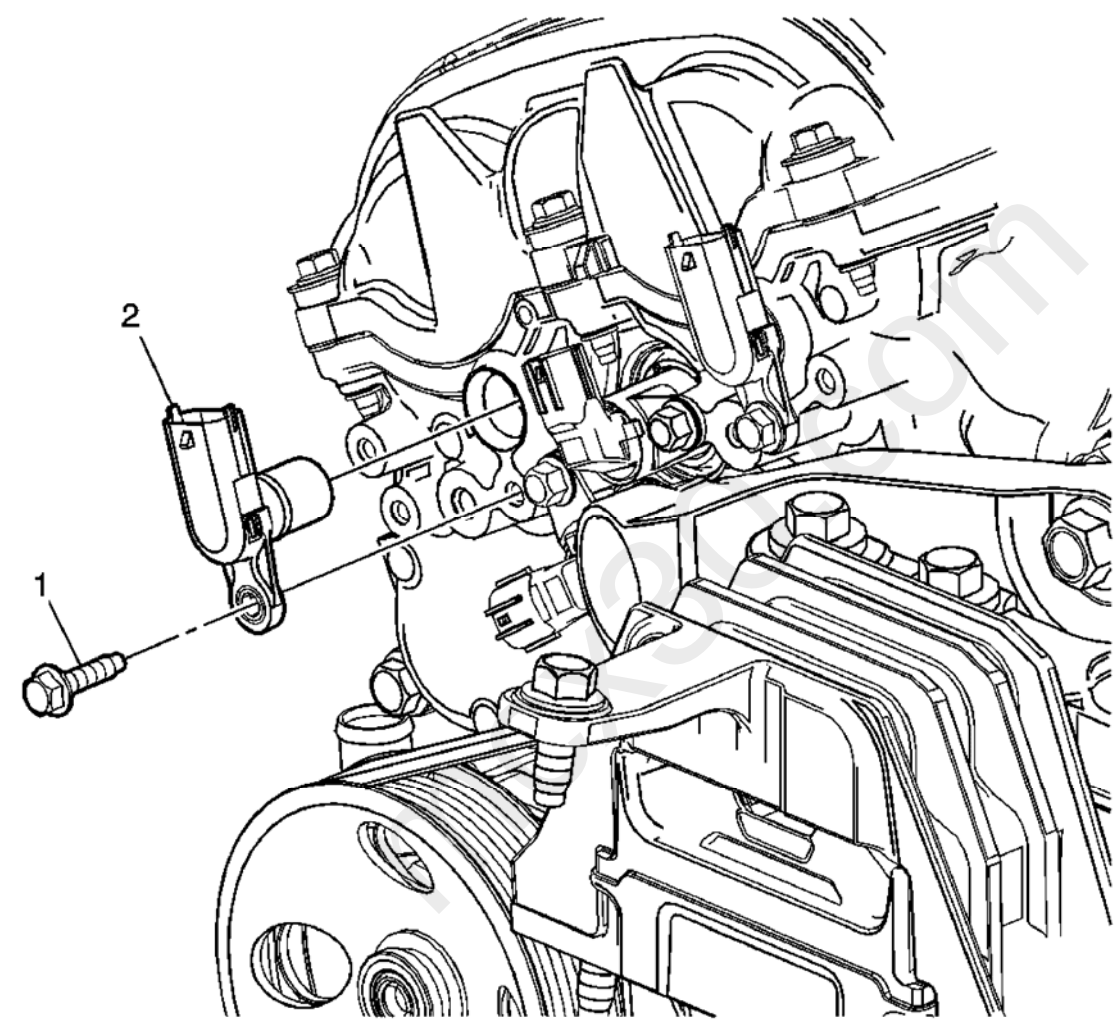


Fig. 115: Camshaft Position Sensor - Bank 1 (Right Side) Exhaust
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
	Camshaft Position Sensor Fastener
	CAUTION:

1	Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure: Disconnect the electrical connector.

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

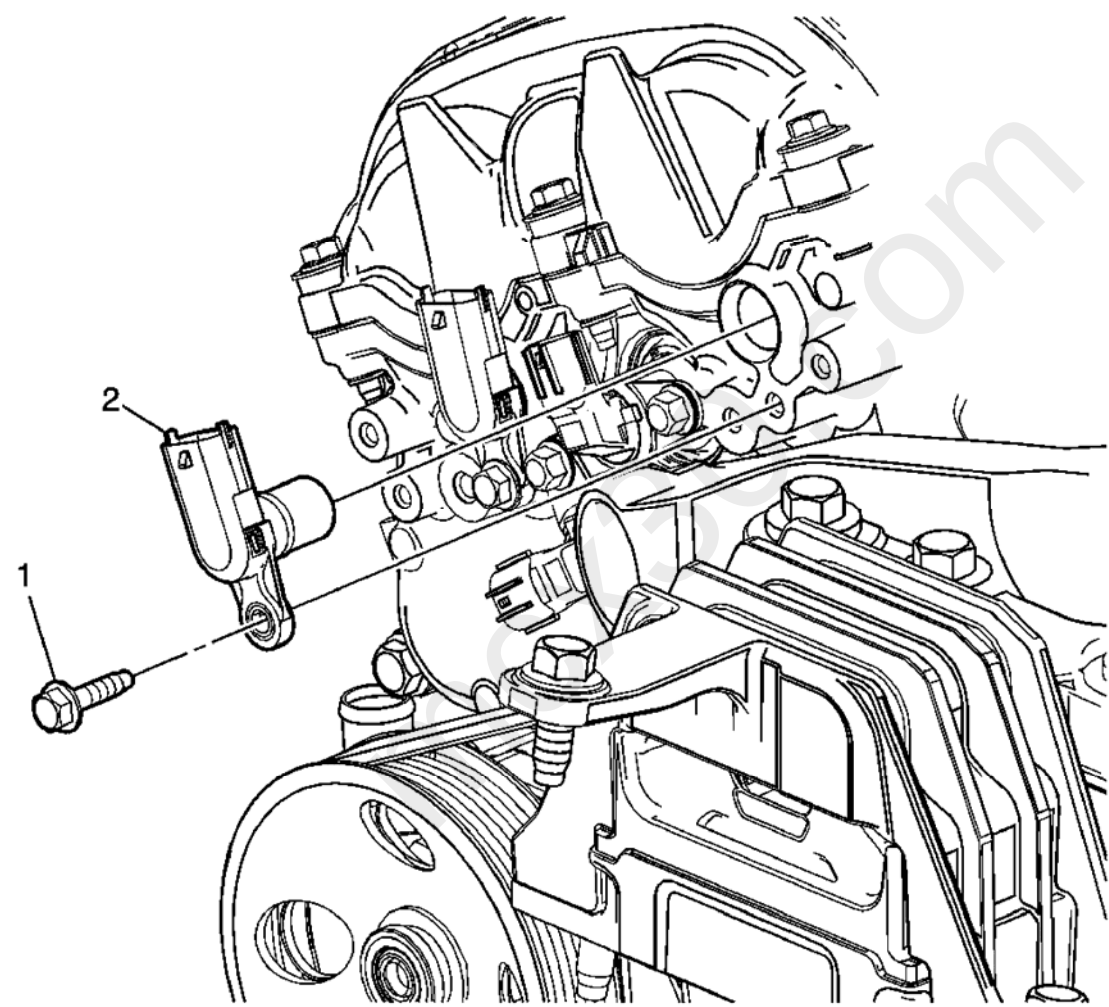


Fig. 116: Camshaft Position Sensor - Bank 1 (Right Side) Intake
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
	Camshaft Position Sensor Fastener

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure: Disconnect the electrical connector.

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

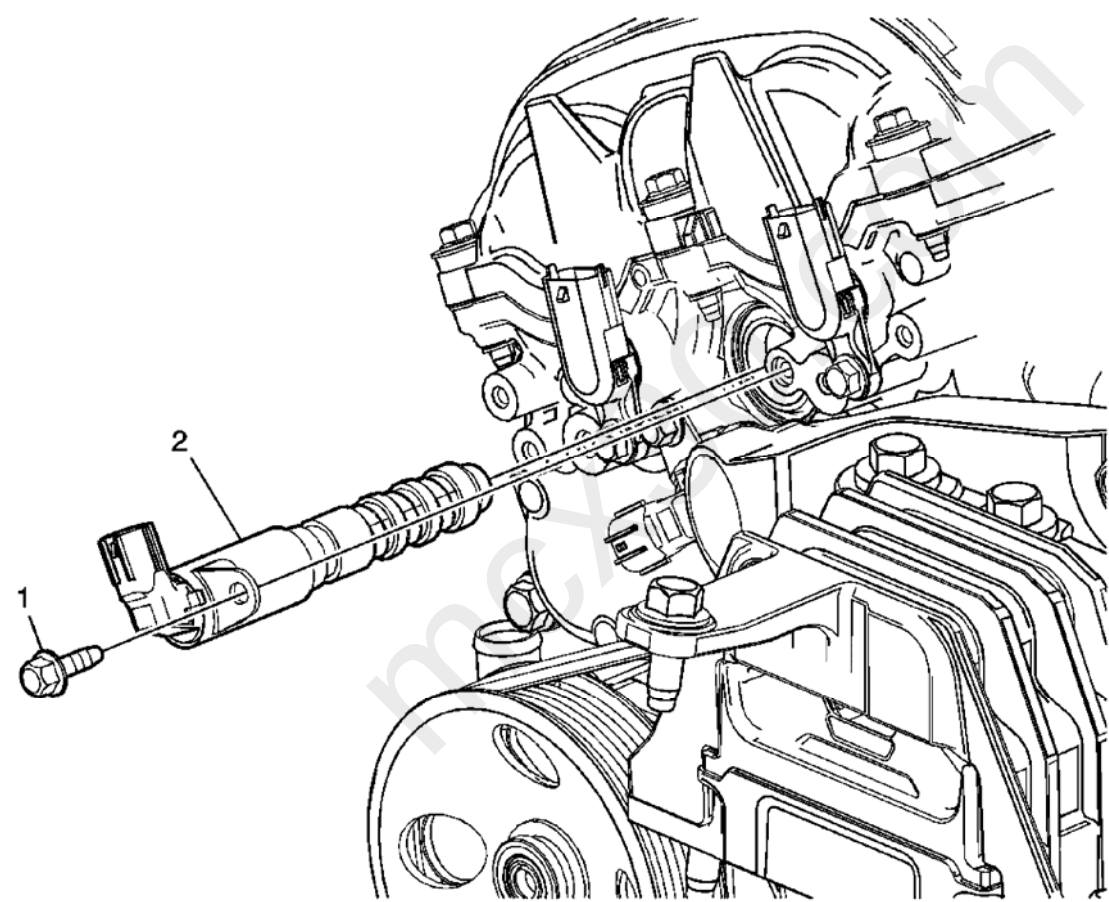


Fig. 117: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Intake
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
	Camshaft Position Actuator Solenoid Valve Fastener

	CAUTION: Refer to <u>Fastener Caution</u> .
1	Procedure: Disconnect the electrical connector. Tighten: 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

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

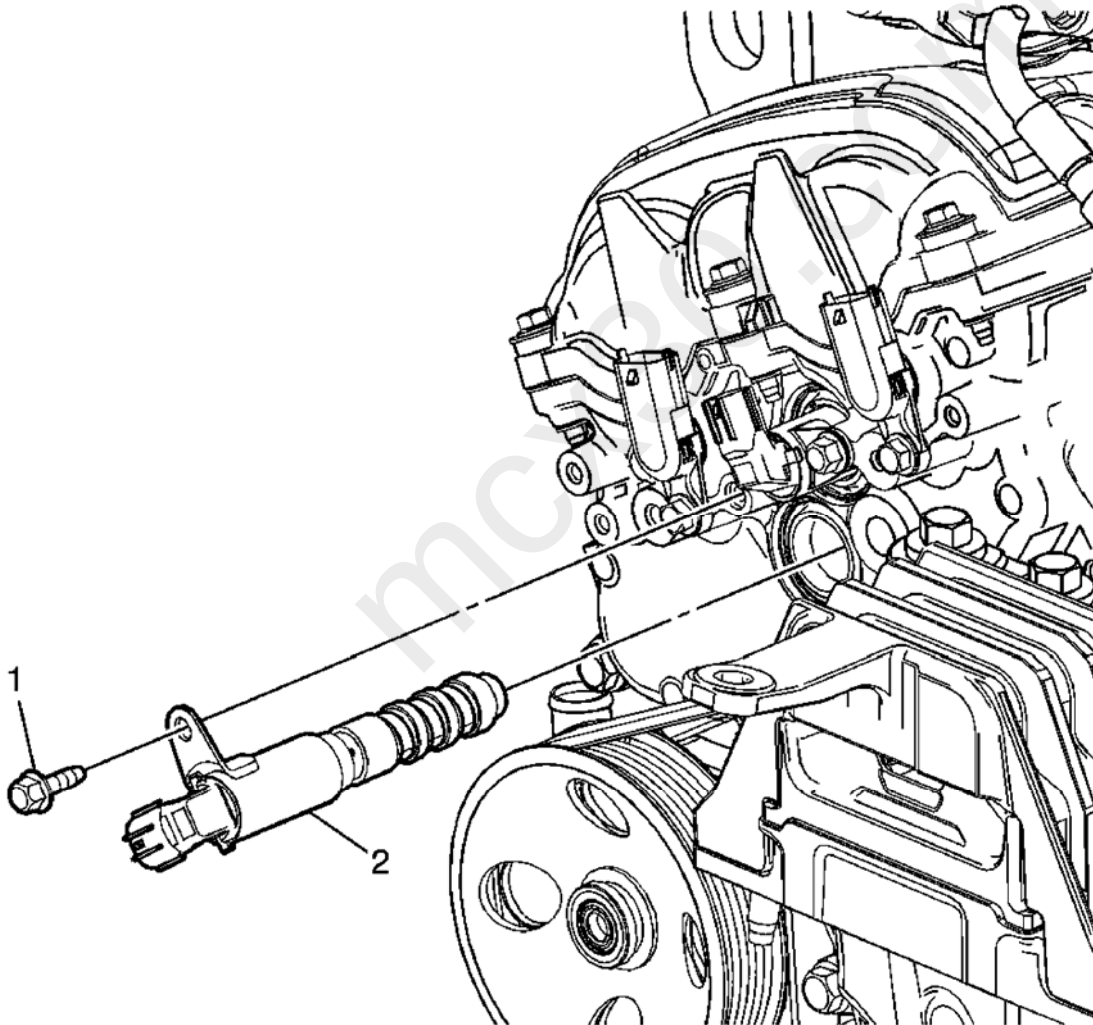


Fig. 118: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Exhaust
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement.</u>	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution .</u> Procedure: Disconnect the electrical connector. Tighten: 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

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

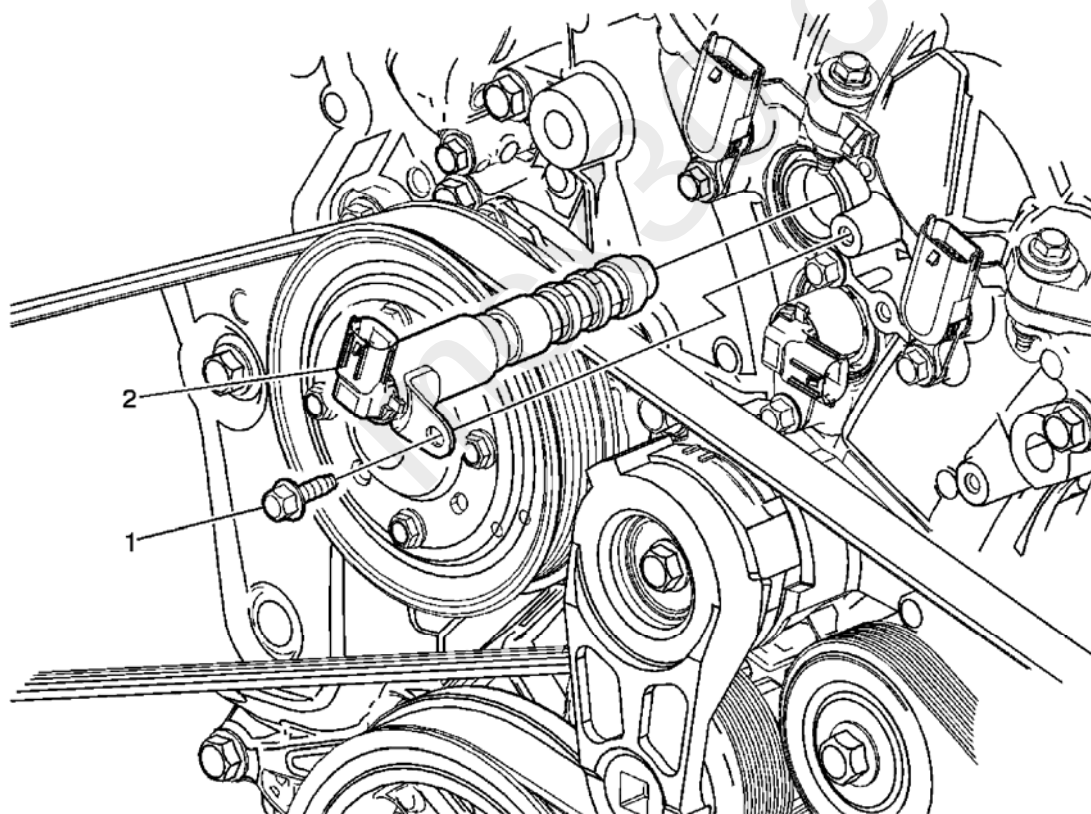


Fig. 119: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Intake
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure: Disconnect the electrical connector. Tighten: 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

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

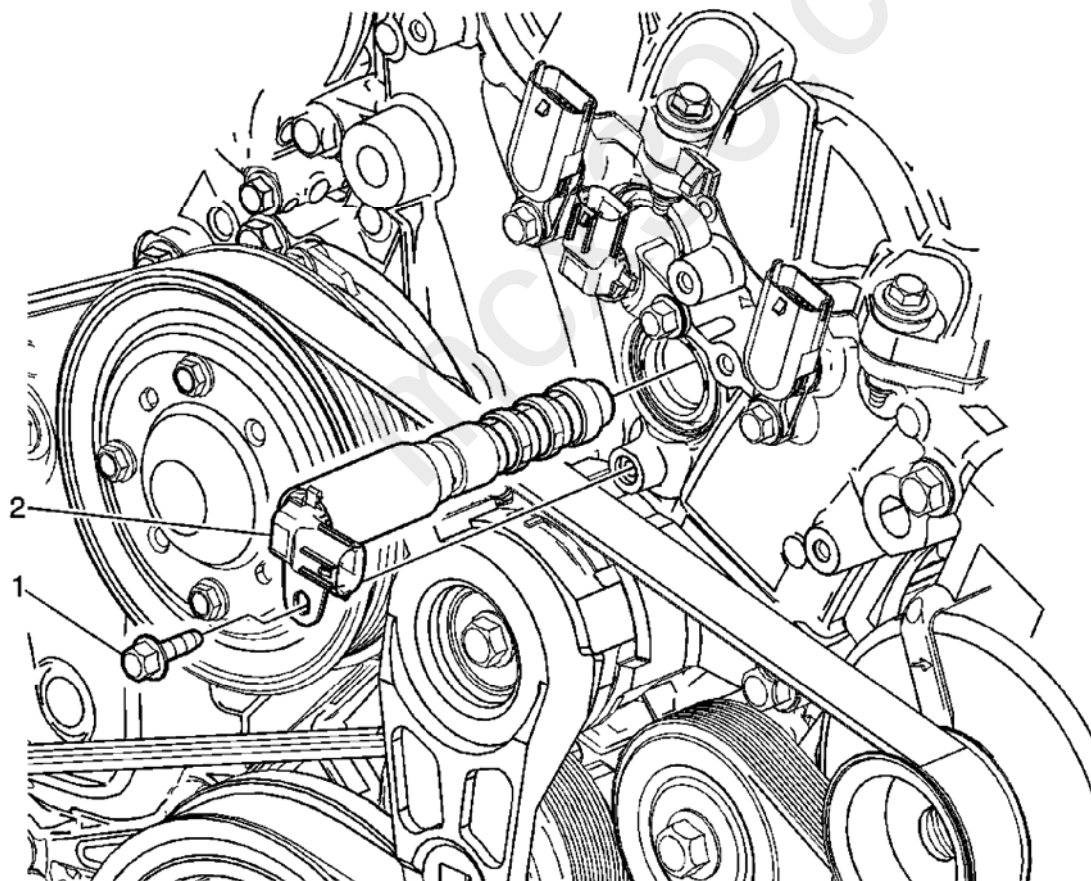


Fig. 120: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Exhaust
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve Procedure: Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 1

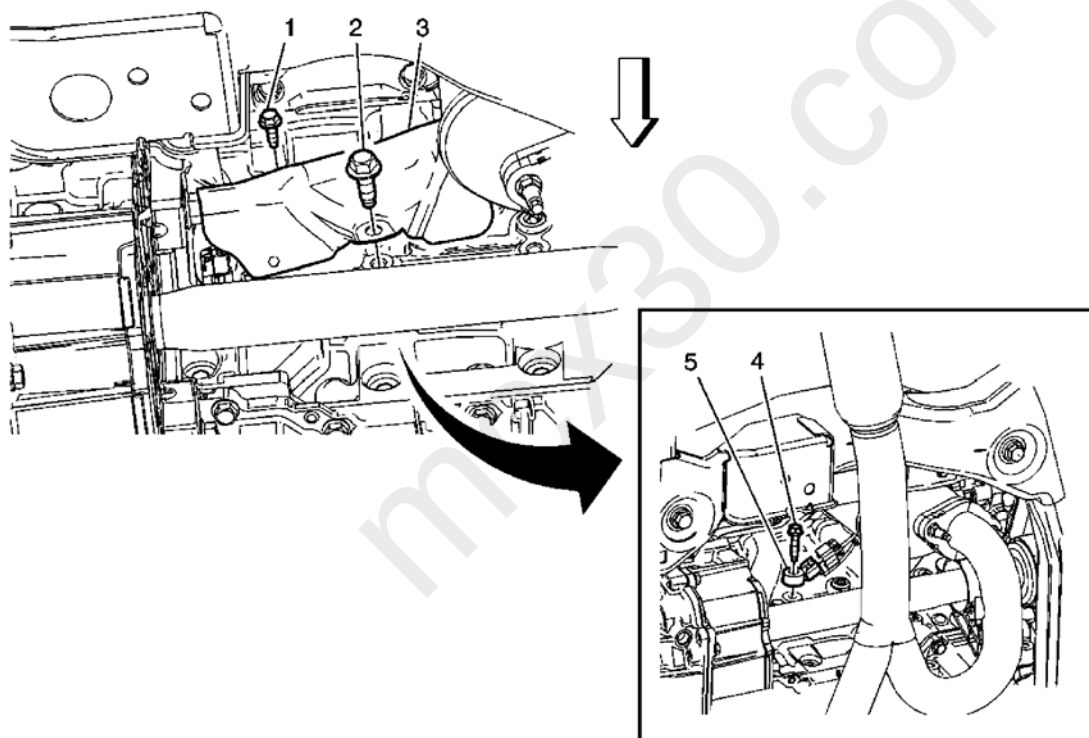


Fig. 121: Knock Sensor - Bank 1
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	If equipped with AWD, remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side (LF1)</u> .

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

1	Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 25 N.m (18 lb ft)
2	Bolt Tighten: 58 N.m (42 lb ft)
3	Exhaust Manifold Lower Heat Shield
4	Bolt Tighten: 25 N.m (18 lb ft)
5	Knock Sensor Procedure: Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 2

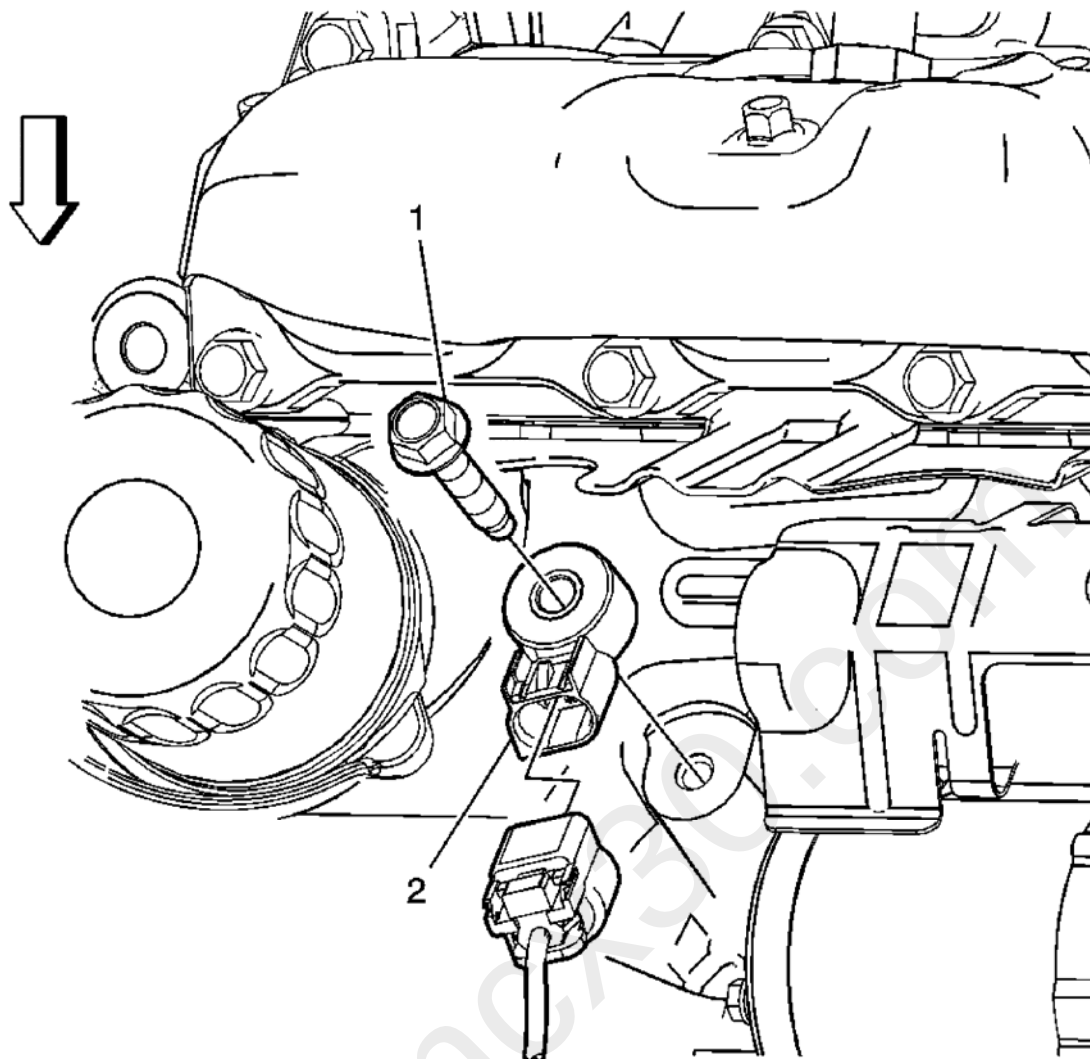


Fig. 122: Knock Sensor - Bank 2
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Knock Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 9 N.m (80 lb in)
2	Knock Sensor Procedure: Disconnect the electrical connector.

AIR CLEANER ELEMENT REPLACEMENT (LE5)

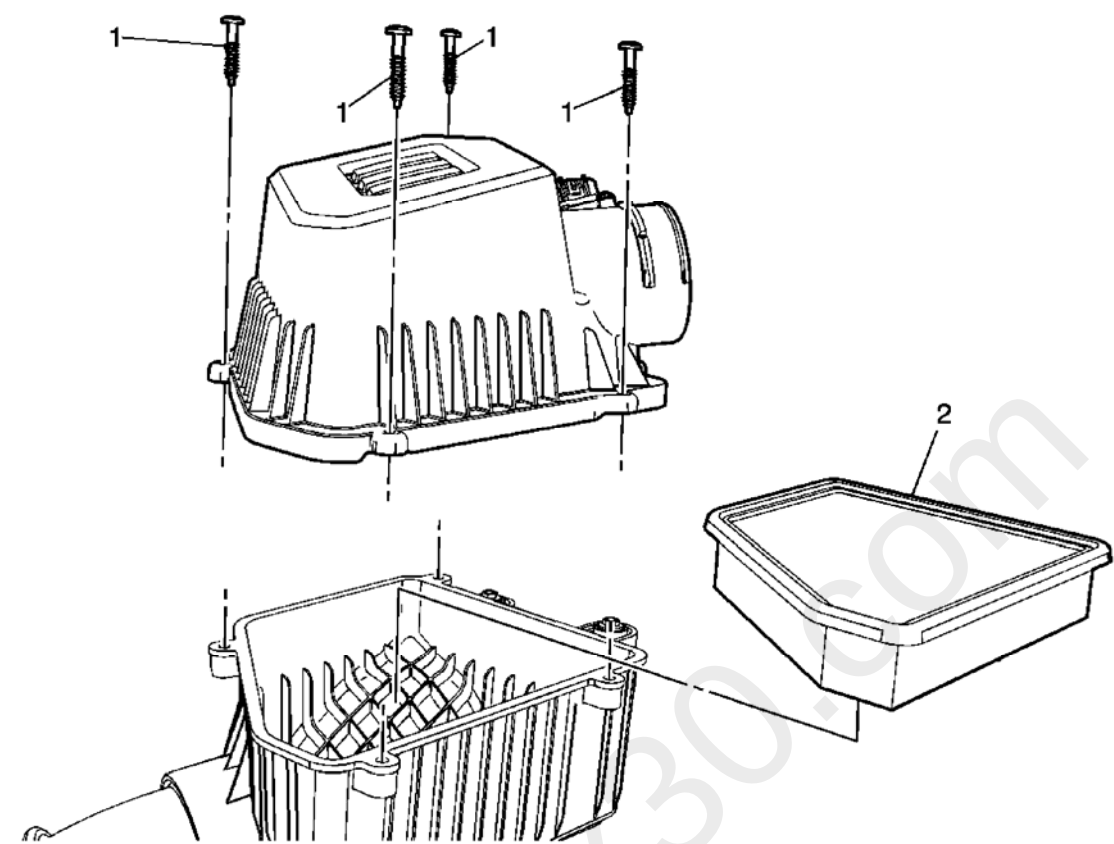


Fig. 123: Air Cleaner Element (LE5)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Disconnect the air cleaner outlet duct from the air cleaner. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
1	Air Cleaner Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 5 N.m (44 lb in)
2	Air Cleaner Element Procedure 1. Disconnect the mass airflow with intake air temperature sensor. 2. Disconnect the throttle inlet absolute pressure sensor.

AIR CLEANER ASSEMBLY REPLACEMENT

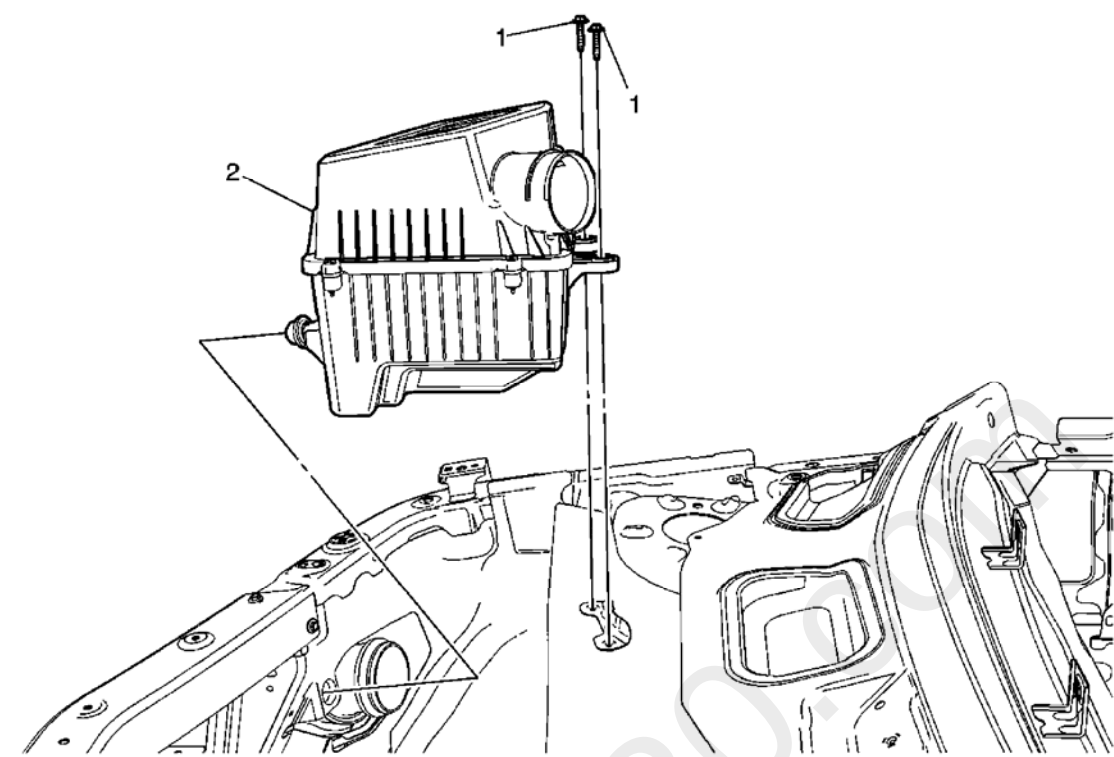


Fig. 124: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Disconnect the air cleaner outlet duct from the air cleaner assembly. Refer to <u>Air Cleaner Outlet Resonator Replacement</u> . 2. If required, remove the throttle inlet absolute pressure sensor. Refer to <u>Throttle Inlet Absolute Pressure Sensor Replacement</u>. 3. If required, remove the mass airflow sensor. Refer to <u>Mass Airflow Sensor with Intake Air Temperature Sensor Replacement</u>.	
1	Air Cleaner Assembly Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> Tighten: 10 N.m (89 lb in)
2	Air Cleaner Assembly

AIR CLEANER OUTLET DUCT REPLACEMENT

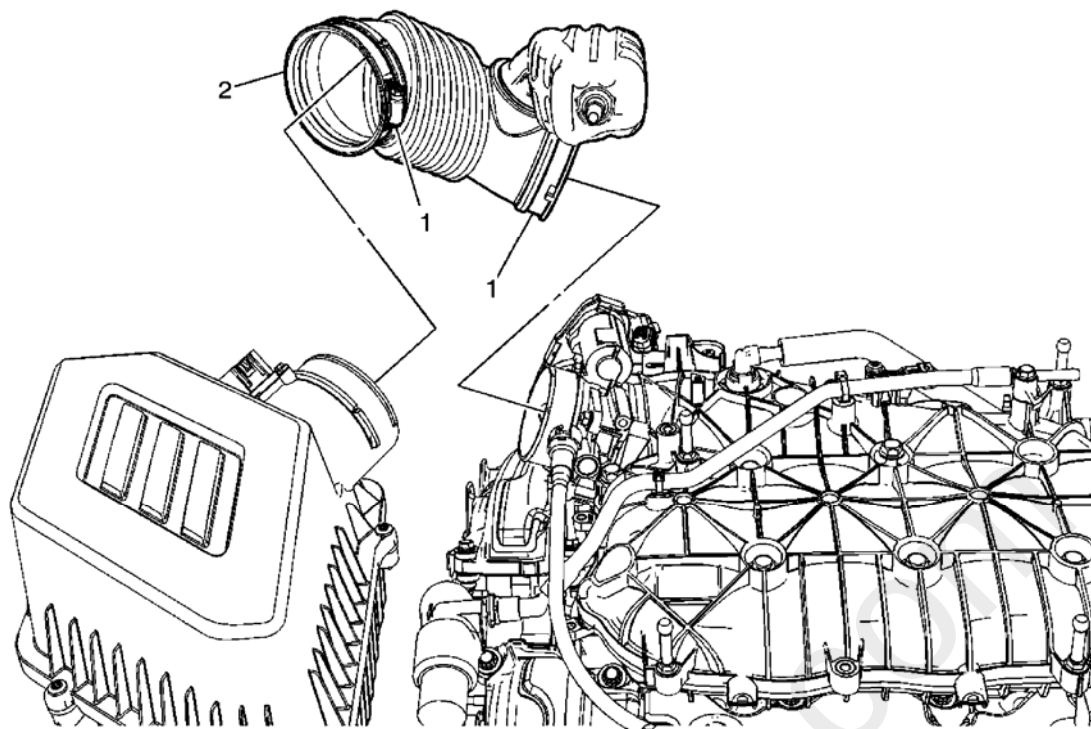


Fig. 125: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Disconnect the front positive crankcase ventilation tube. Refer to <u>Positive Crankcase Ventilation Tube Replacement - Front</u> .	
1	Air Cleaner Clamp (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 4 N.m (35 lb in)
2	Air Cleaner Outlet Duct