

2011 ENGINE**Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - CTS****REPAIR INSTRUCTIONS****CRANKSHAFT POSITION SYSTEM VARIATION LEARN (LF1, LFW)**

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
- A engine control module (ECM) replacement
- A crankshaft balancer replacement
- A crankshaft replacement
- A crankshaft position sensor replacement
- Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.

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. The scan tool only displays the condition that inhibits the procedure. The scan tool displays the signals of the following components:

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

1. 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 Learn Status: Learned this Ignition. If the scan tool indicates that DTC P0315 ran and passed, the crankshaft position variation learn procedure is complete. If the scan tool indicates DTC P0315 failed or did not run, or another DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.
5. 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

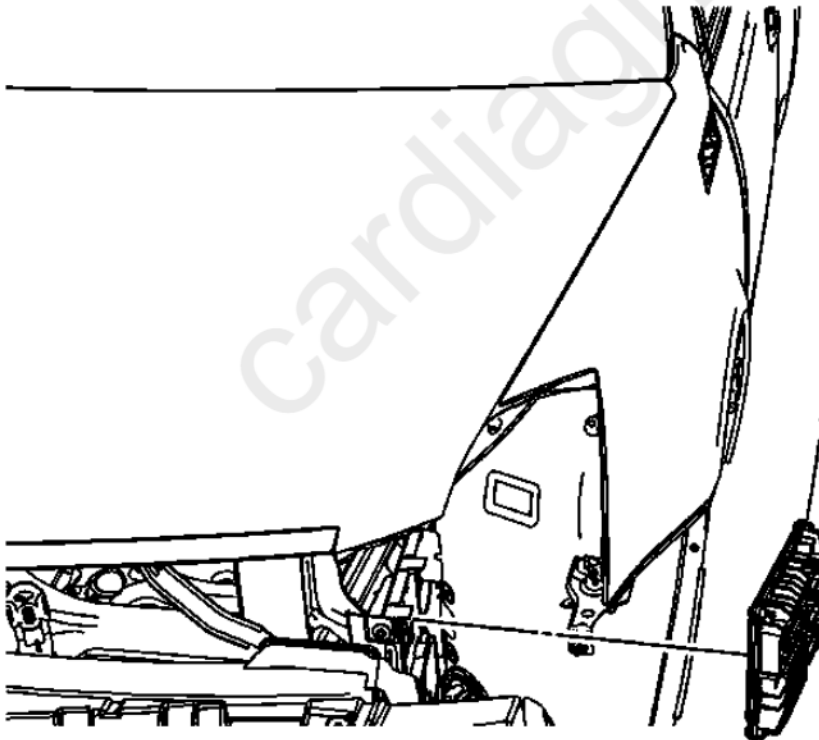


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
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Preliminary Procedure:

Remove the left side head lamp. Refer to Headlamp Assembly or Headlamp Bulb and/or Cornering, Sidemarker, Park, Turn Signal Bulb Replacement (TT6) or Headlamp Assembly or Headlamp Bulb and/or Cornering, Sidemarker, Park, Turn Signal Bulb Replacement (TT7) or Headlamp Assembly or Headlamp Bulb and/or Cornering, Sidemarker, Park, Turn Signal Bulb Replacement (TT8) or Headlamp Assembly or Headlamp Bulb and/or Cornering, Sidemarker, Park, Turn Signal Bulb Replacement (Without TT6/TT7/TT8/T84/T85) .

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 not touch the connector pins or the soldered components on the circuit board.
- Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.
- The replacement control module must be programmed.

Procedure

1. Record the current Engine Oil Life percentage, and use a scan tool to update the NEW ECM, if replacing.
2. Release the retaining tabs.
3. Disconnect the electrical connectors.
4. If replacing ECM, reprogram the ECM. Refer to Control Module References
5. If equipped with a manual transmission, perform the clutch pedal position sensor learn procedure. Refer to Clutch Pedal Position Sensor Learn .

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

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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.

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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.

THROTTLE/IDLE LEARN (WITHOUT LF1, LFW)

Description

The engine control module (ECM) learns the idle position of the throttle body to ensure the correct idle operation. Anytime the ECM or the throttle body is replaced, the ECM must learn the idle position. The engine idle may be unstable or a DTC may set if the idle position is not learned.

Conditions for Running the Idle Learn Procedure

- DTCs P0121, P0122, P0123, P0221, P0222, P0223, P0638, P2100, P2101, P2105, and P2119 are not set.
- The engine speed is less than 40 RPM.
- The vehicle speed is 0 km/h (0 mph).
- The accelerator pedal position is less than 14.9 percent.
- The ignition 1 voltage is more than 10 volts.
- The engine coolant temperature is between 5-85°C (41-185°F).
- The intake air temperature is between 5-60°C (41-140°F).

Idle Learn Procedure

- NOTE:**
- Ensure the above conditions are met before performing with this procedure.
 - Do not perform this procedure if a throttle position sensor or other throttle actuator control (TAC) system DTCs are set other than P2176. The ECM will not perform the idle learn procedure with a DTC set.

1. Turn OFF the ignition for 30 seconds.
2. Turn ON the ignition, with the engine OFF for 60 seconds.
3. Turn OFF the ignition.
4. Turn ON the ignition, with the engine OFF.
5. Clear the DTCs with a scan tool.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT (LF1)

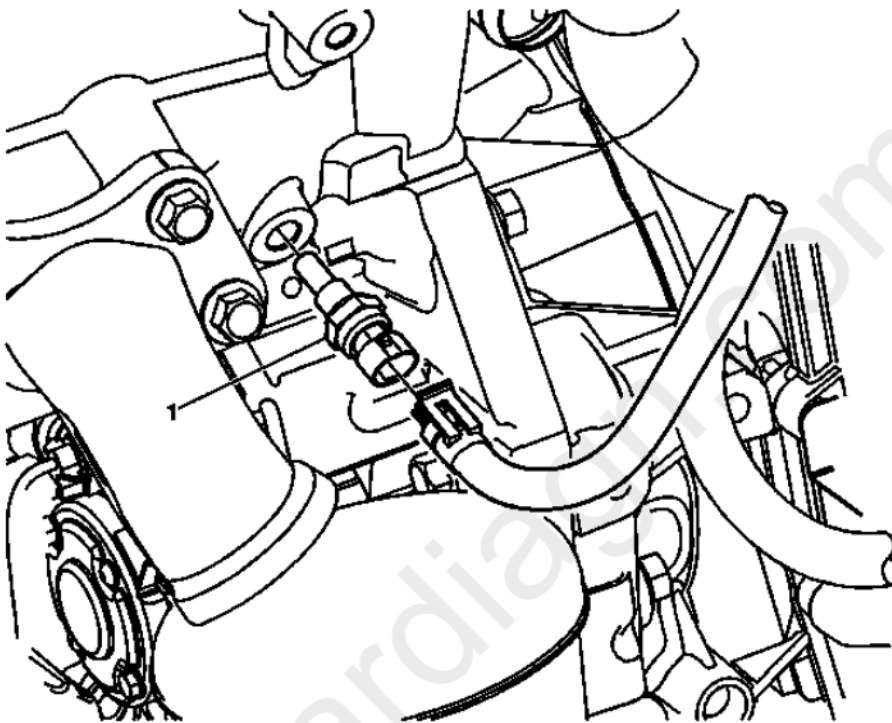


Fig. 2: Identifying Engine Coolant Temperature Sensor (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Partially drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LF1, LLT)</u> or <u>Cooling System Draining and Filling (Static Fill LSA)</u> or <u>Cooling System Draining and Filling (GE 47716 LF1, LLT)</u> or <u>Cooling System Draining and Filling (GE 47716 LSA)</u> .	
1	Engine Coolant Temperature Sensor CAUTION: Refer to. Procedure 1. Reposition the sensor heat shield.

2. Disconnect the ECT sensor harness connector.

Tighten: 20 N.m (35 lb in)

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT (LLT)

Removal Procedure

WARNING: Allow sufficient time for the engine to cool before removing the ECT sensor. A hot engine may cause an excessive coolant loss or a personal injury.

1. Turn the ignition OFF.
2. Remove the engine oil dipstick indicator.

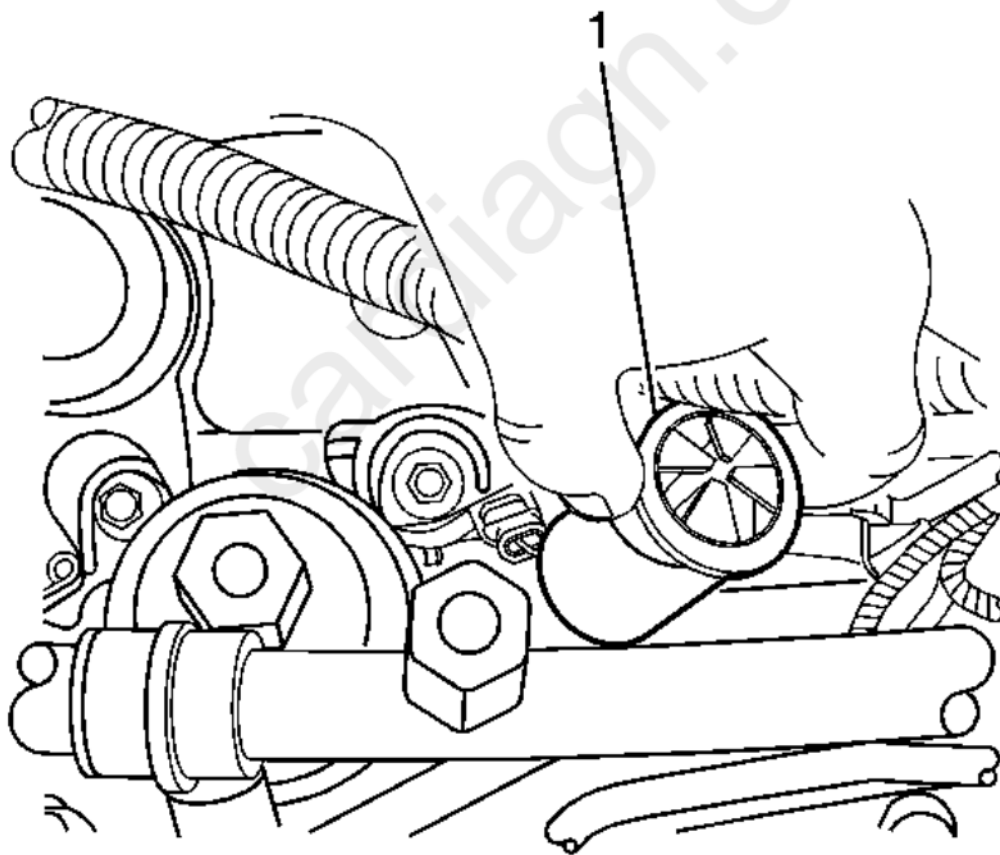


Fig. 3: View Of Electrical Connector Heat Protector
Courtesy of GENERAL MOTORS CORP.

3. Slide the electrical connector heat protector (1) off the electrical connector.

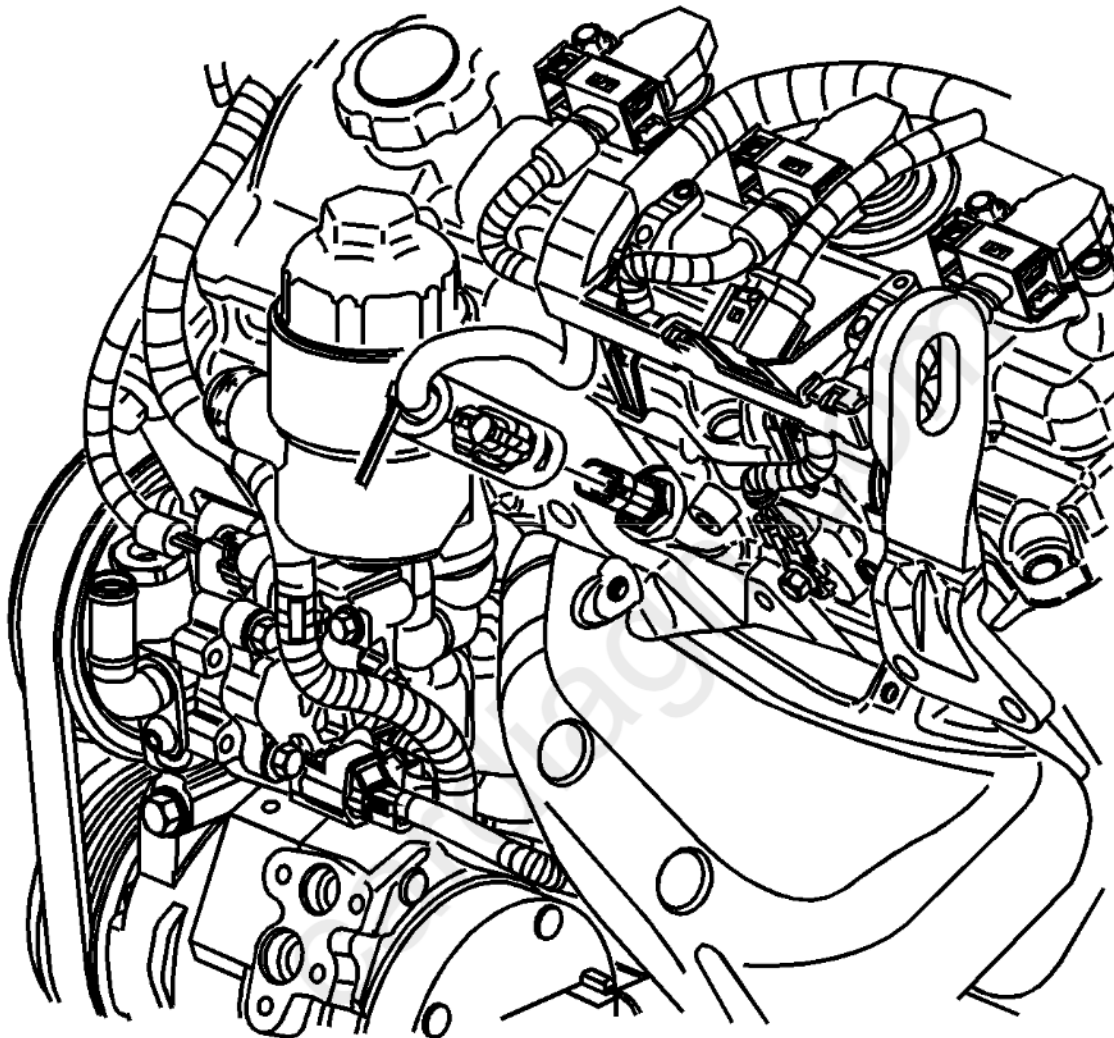


Fig. 4: View Of Coolant Temperature Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the coolant temperature sensor electrical connector.

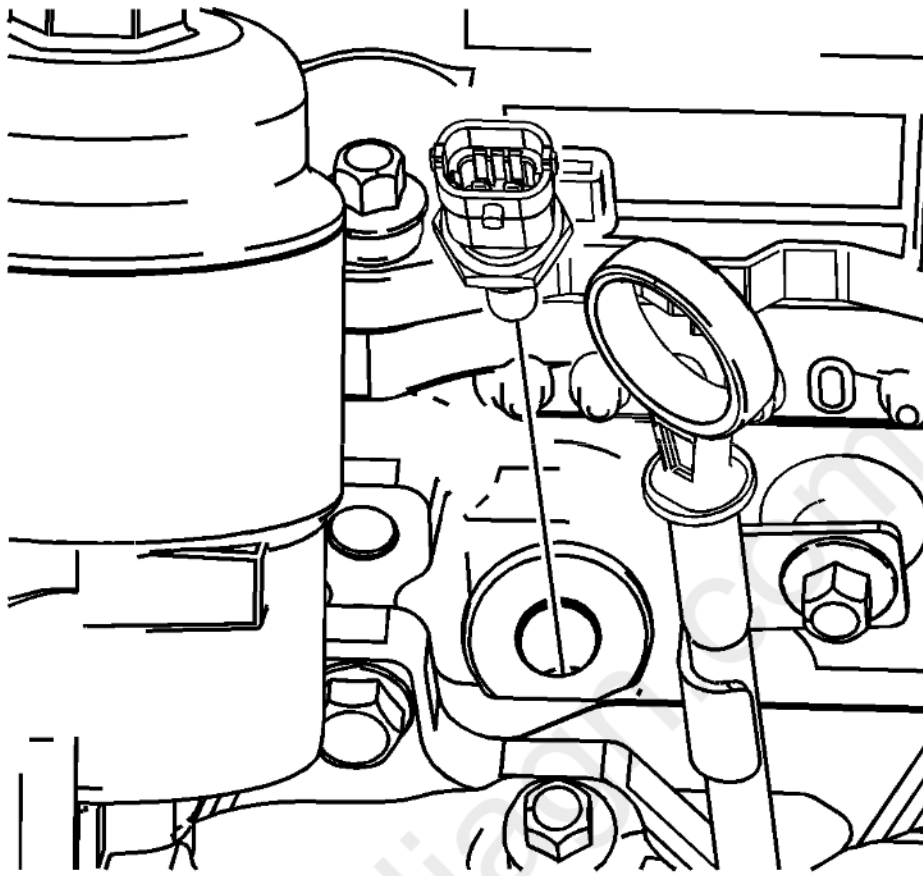


Fig. 5: View Of ECT Sensor
Courtesy of GENERAL MOTORS CORP.

5. Remove the coolant temperature sensor.

Installation Procedure

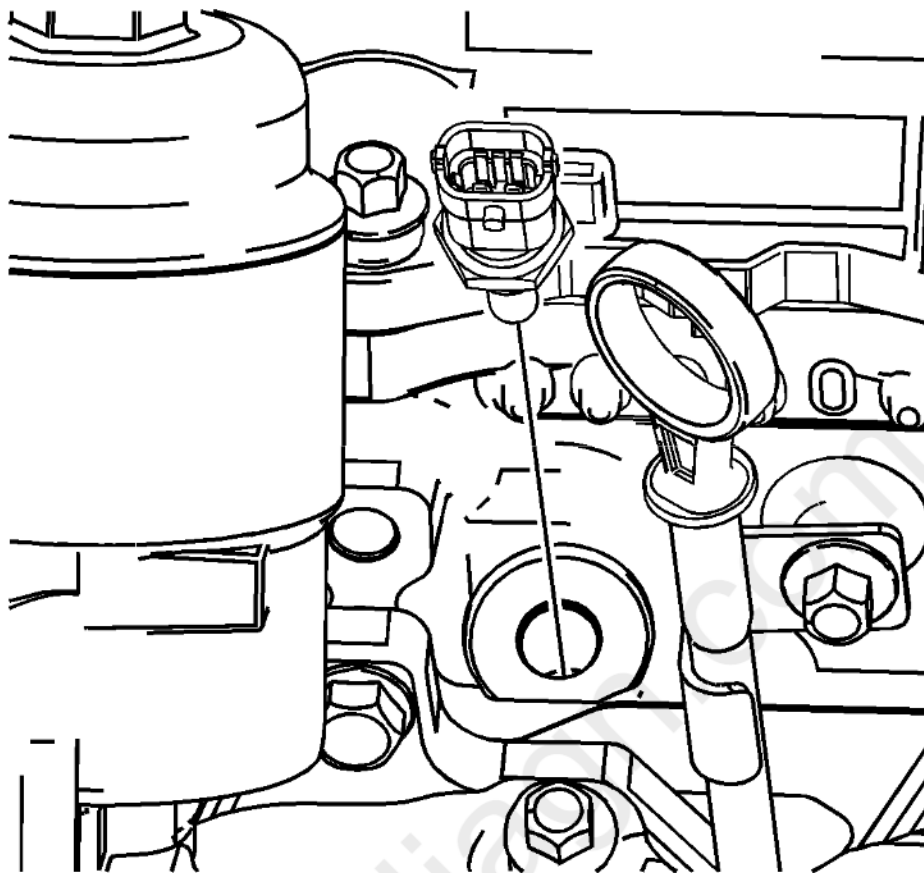


Fig. 6: View Of ECT Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

1. Install the coolant temperature sensor and tighten to 22 N.m (16 lb ft).
2. Install the coolant temperature sensor electrical connector.

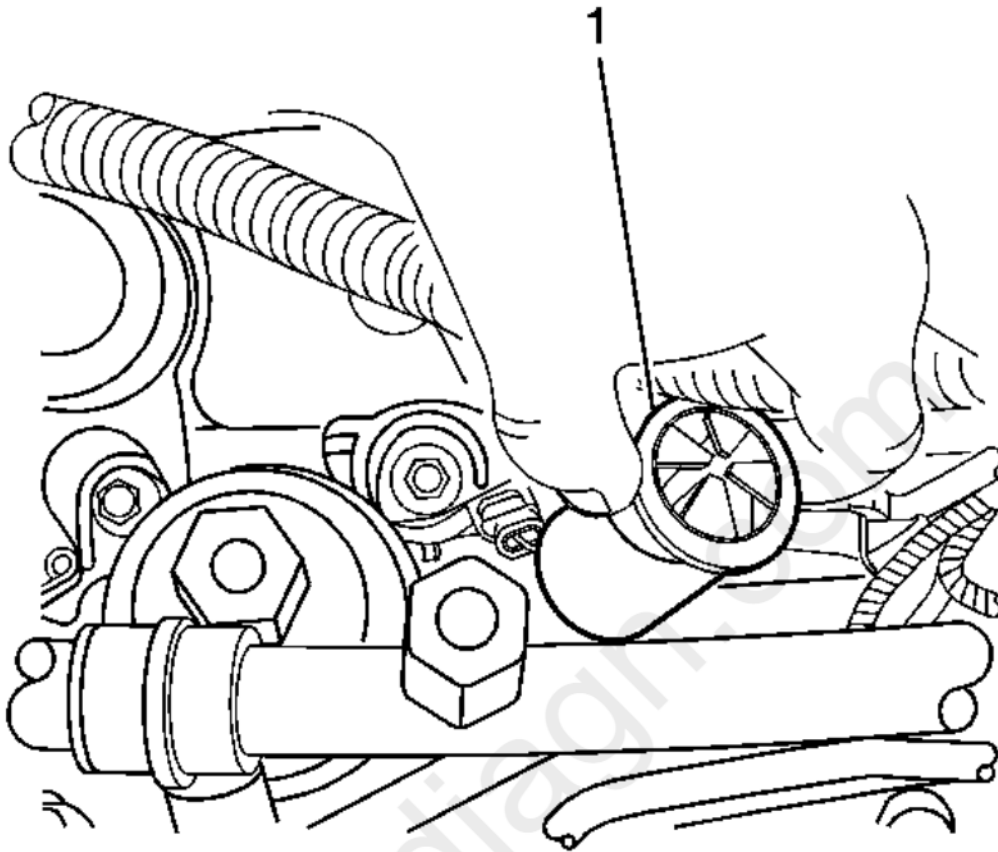


Fig. 7: View Of Electrical Connector Heat Protector
Courtesy of GENERAL MOTORS CORP.

3. Slide the electrical connector heat protector (1) onto the electrical connector.
4. Inspect and fill the cooling system as necessary. Refer to **Cooling System Draining and Filling (Static Fill LF1, LLT)** or **Cooling System Draining and Filling (Static Fill LSA)** or **Cooling System Draining and Filling (GE 47716 LF1, LLT)** or **Cooling System Draining and Filling (GE 47716 LSA)**.

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT (LF1)

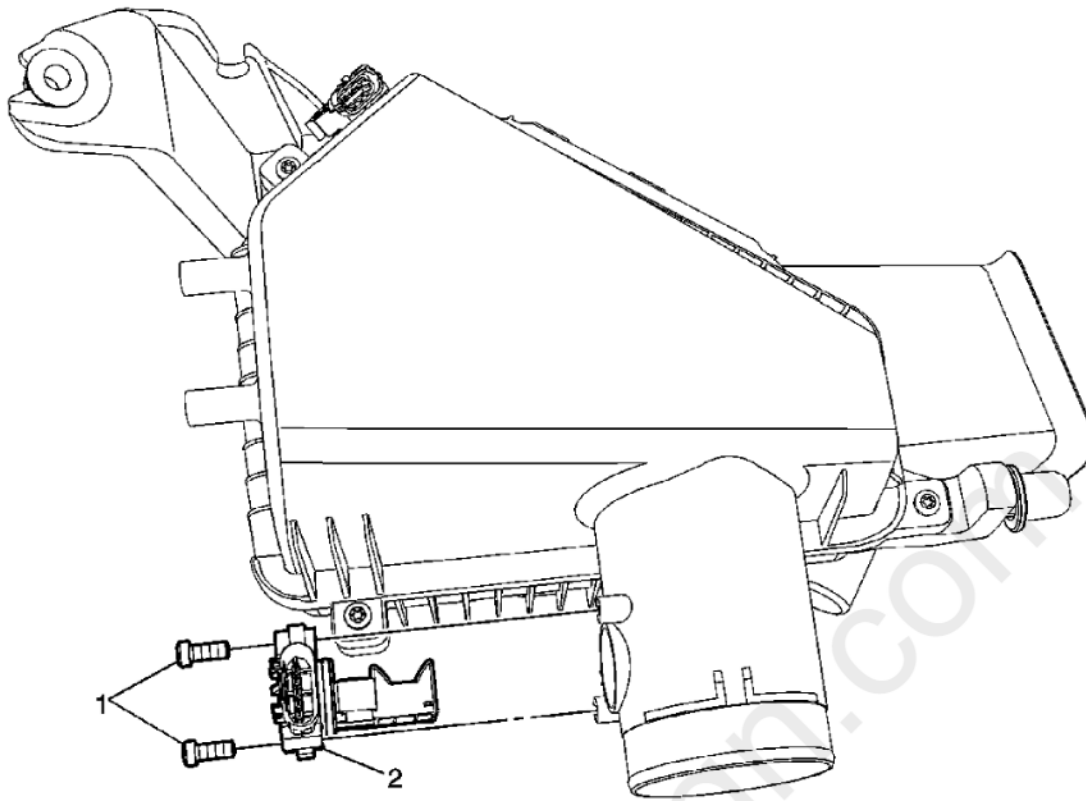


Fig. 8: Mass Airflow Sensor With Intake Air Temperature Sensor (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Mass Airflow Sensor Fastener (Qty: 2) CAUTION: Refer to. Tighten: 3 N.m (27 lb in)
2	Mass Airflow Sensor Procedure: Disconnect the electrical connector.

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT (LLT)

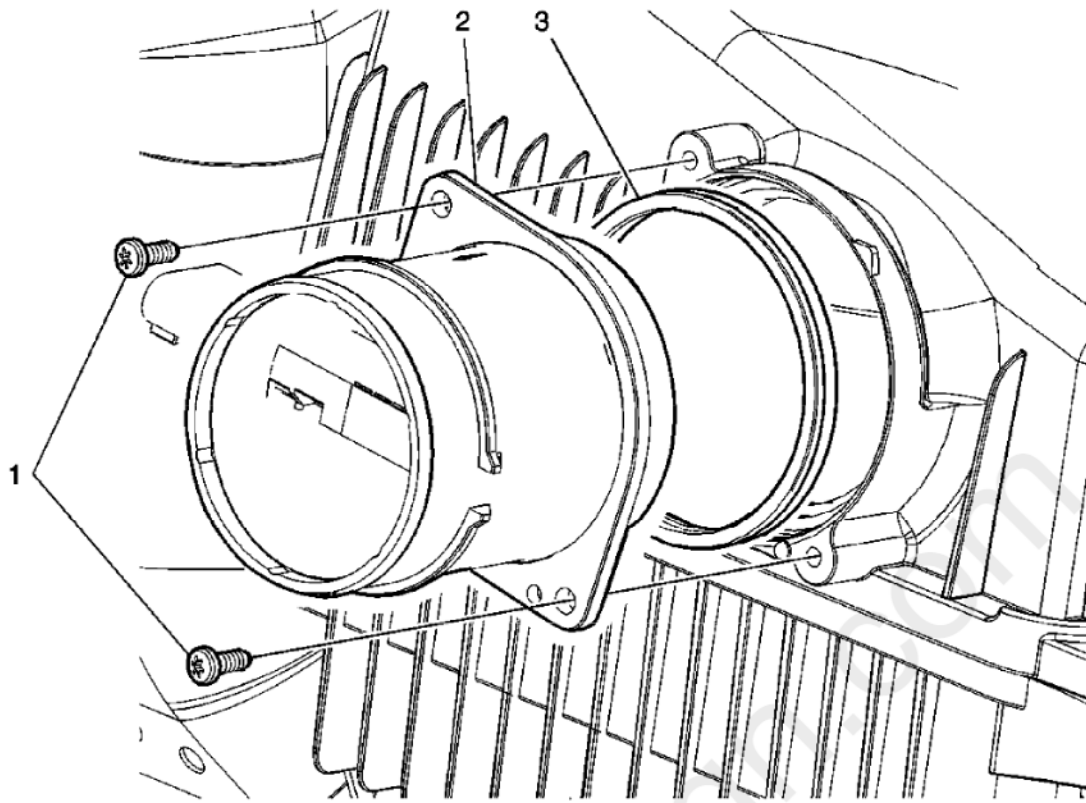


Fig. 9: Mass Airflow Sensor/Intake Air Temperature Sensor Replacement
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Turn OFF the ignition. 2. Remove the air cleaner duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF1)</u> or <u>Air Cleaner Outlet Duct Replacement (LLT)</u> .	
1	Screw (Qty: 2) CAUTION: Refer to. Tighten: 3.25 N.m (29 lb in)
2	Mass Airflow Sensor/Intake Temperature Sensor Procedure: Disconnect the sensor wiring harness.
3	Seal

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT (LSA)

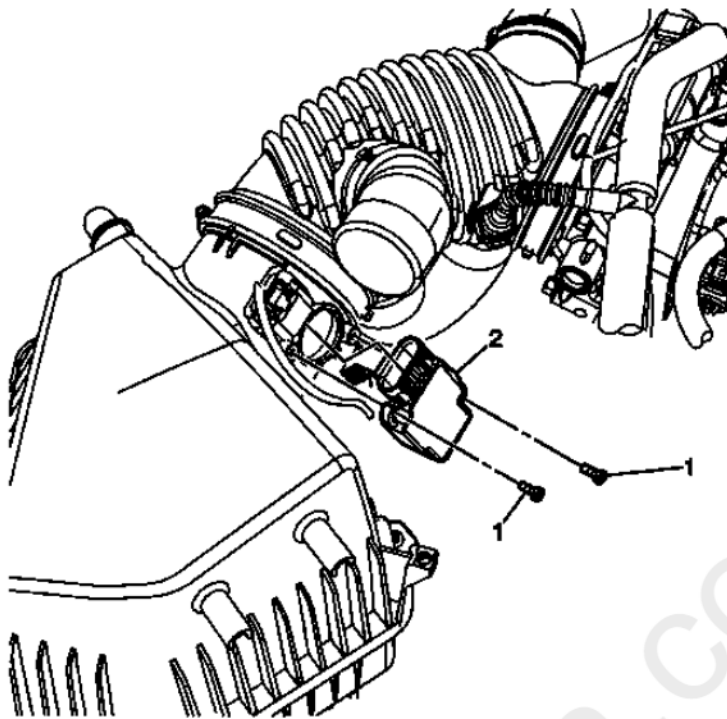


Fig. 10: Identifying Mass Airflow Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Mass Airflow Sensor Fastener (Qty: 2) CAUTION: Refer to. Tighten: 1.5 N.m (13 lb in)
2	Mass Airflow Sensor Procedure: Disconnect the mass airflow harness connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

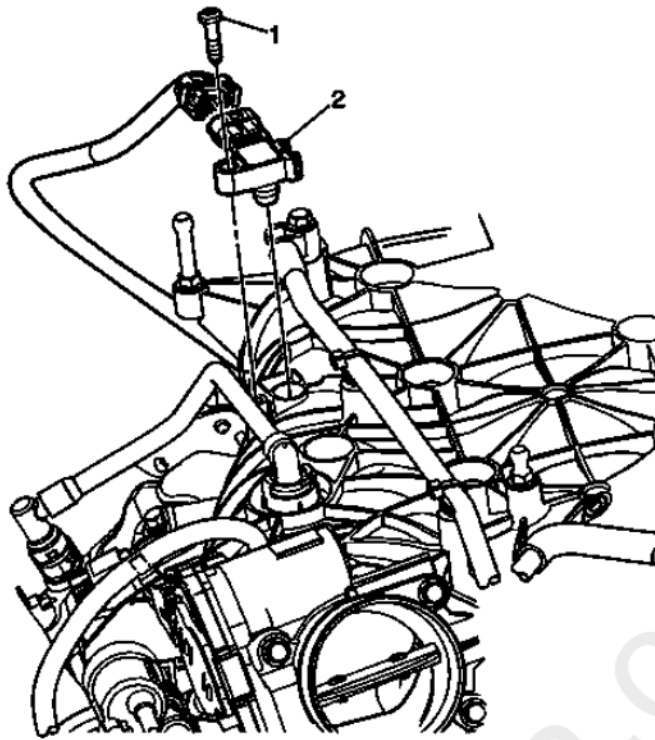


Fig. 11: Manifold Absolute Pressure Sensor (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT) .	
1	Bolt CAUTION: Refer to. Tighten: 4 N.m (35 lb in)
2	Manifold Absolute Pressure Sensor Procedure 1. Disconnect the MAP sensor harness connector. 2. Install a NEW O-ring.

BAROMETRIC PRESSURE SENSOR REPLACEMENT (LF1)

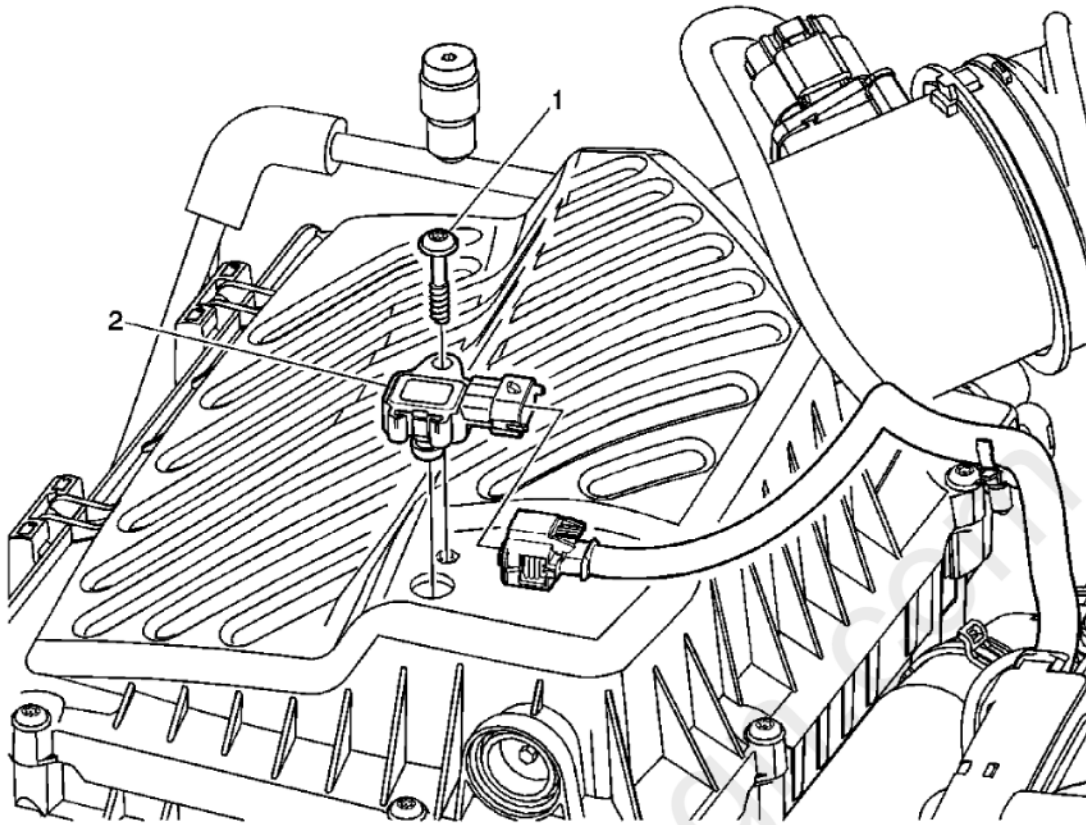


Fig. 12: Barometric Pressure Sensor (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt CAUTION: Refer to. Tighten: 4 N.m (35 lb in)
2	Barometric Pressure Sensor Procedure 1. Disconnect the MAP sensor harness connector. 2. Install a NEW O-ring.

THROTTLE INLET ABSOLUTE PRESSURE SENSOR REPLACEMENT

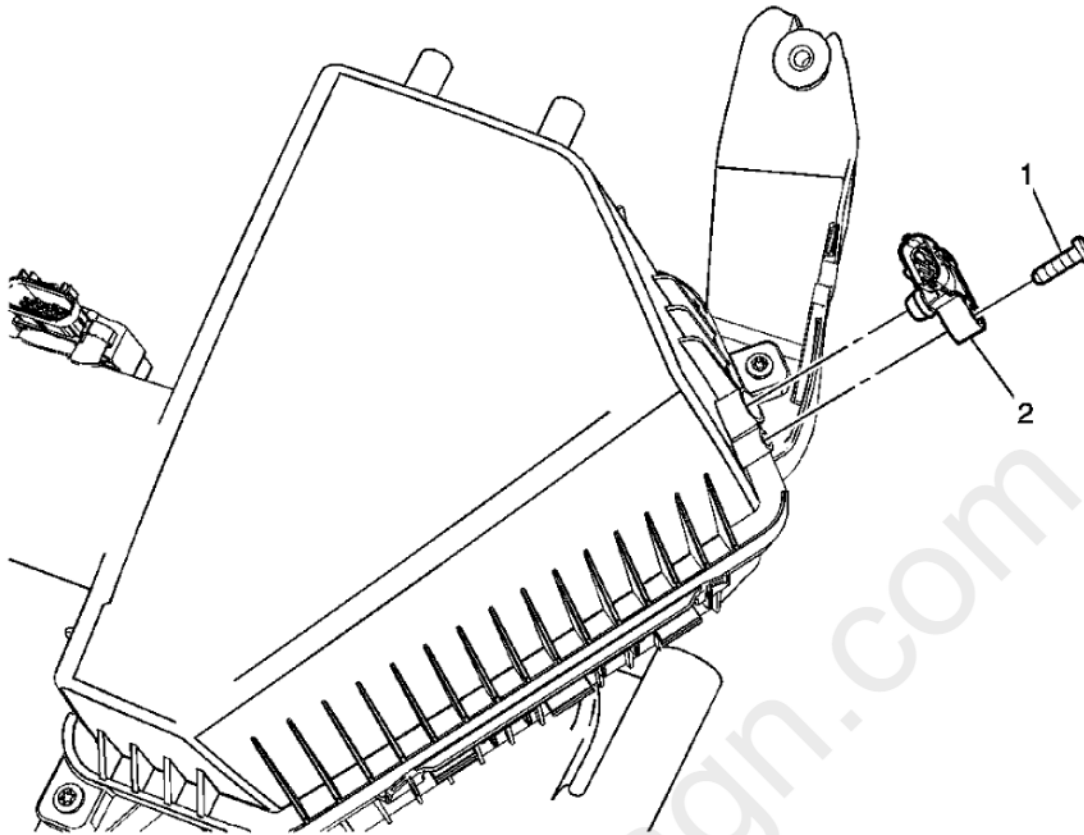


Fig. 13: Throttle Inlet Absolute Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Throttle Inlet Absolute Pressure Sensor Fastener CAUTION: Refer to. Tighten: 3 N.m (27 lb in)
2	Throttle Inlet Absolute Pressure Sensor Procedure: Disconnect the electrical connector.

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

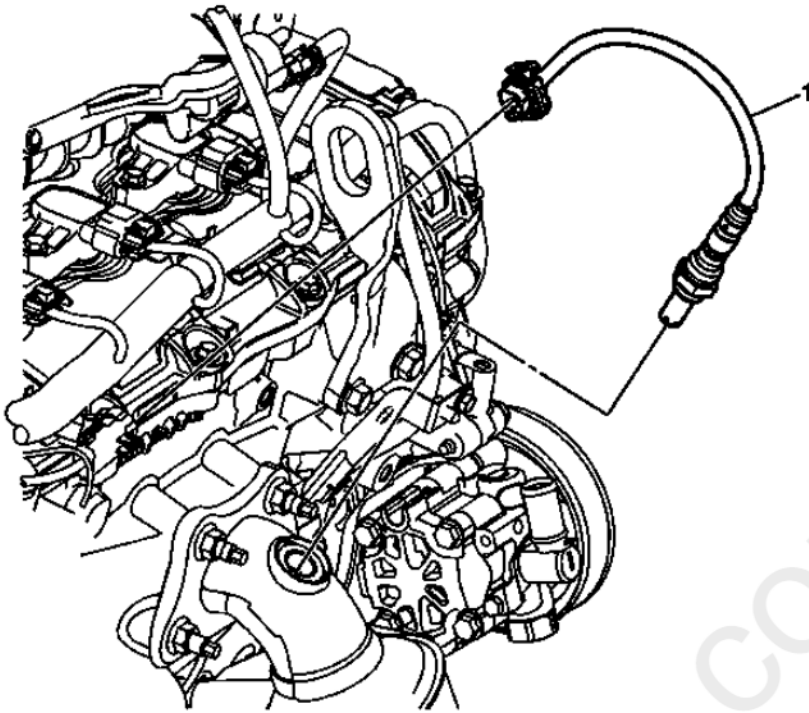


Fig. 14: Identifying Heated Oxygen Sensor - Bank 1 Sensor 1 (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT) .	
1	Heated Oxygen Sensor CAUTION: Refer to. CAUTION: Refer to. Procedure 1. Disconnect the heated oxygen sensor harness connector. 2. 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 1 SENSOR 1 (LLT)

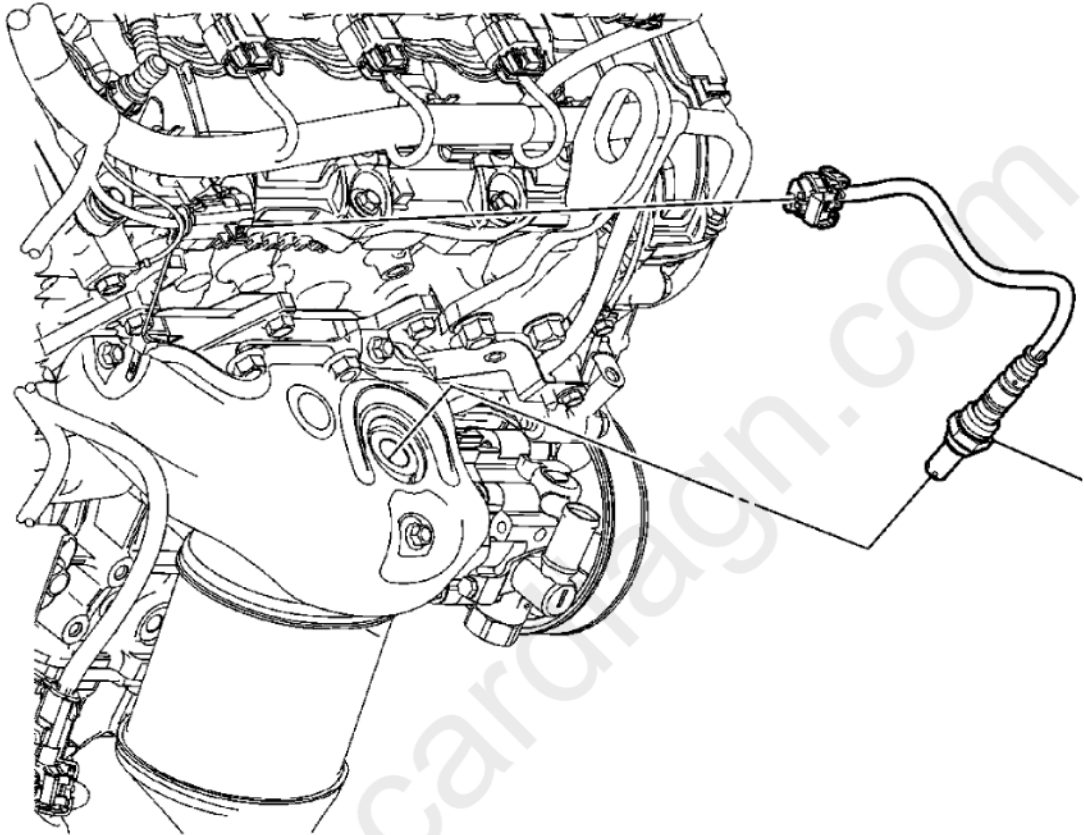


Fig. 15: Heated Oxygen Sensor - Bank 1 Sensor 1 (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT) .	
	Heated Oxygen Sensor
	CAUTION: Refer to.
	Procedure

1. Disconnect the heated oxygen sensor harness connector.
2. 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)

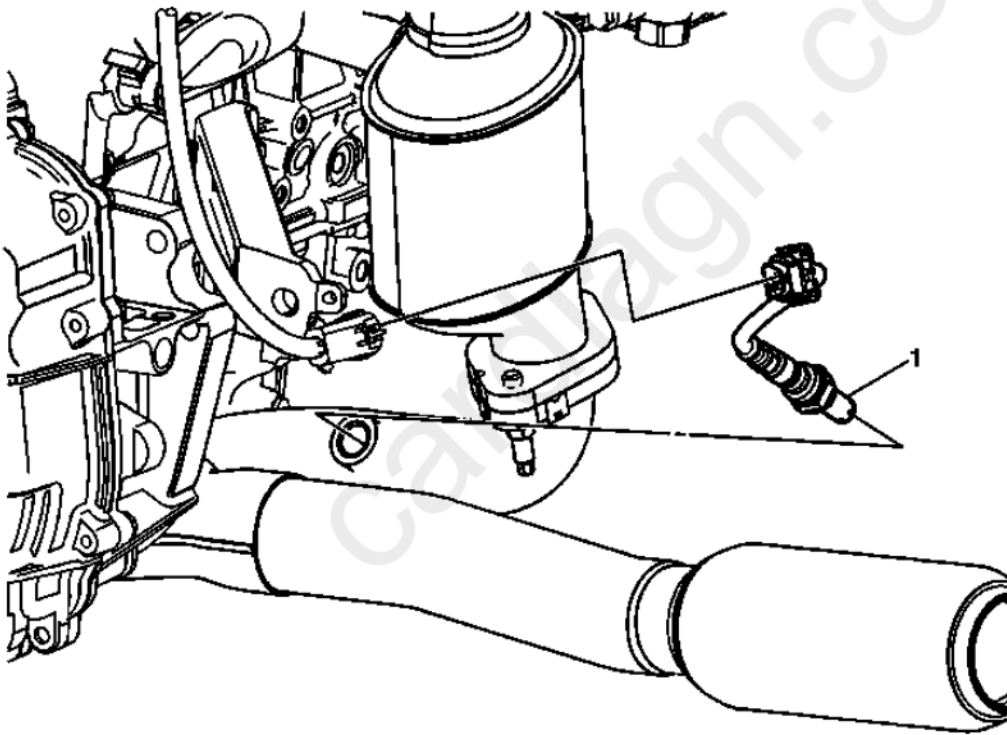


Fig. 16: Heated Oxygen Sensor - Bank 1 Sensor 2 (LF1)

Courtesy of GENERAL MOTORS CORP.

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

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CAUTION:

Refer to.

CAUTION:

Refer to.

Procedure

1

1. Disconnect the heated oxygen sensor harness connector.
2. 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 1 SENSOR 2 (LLT)

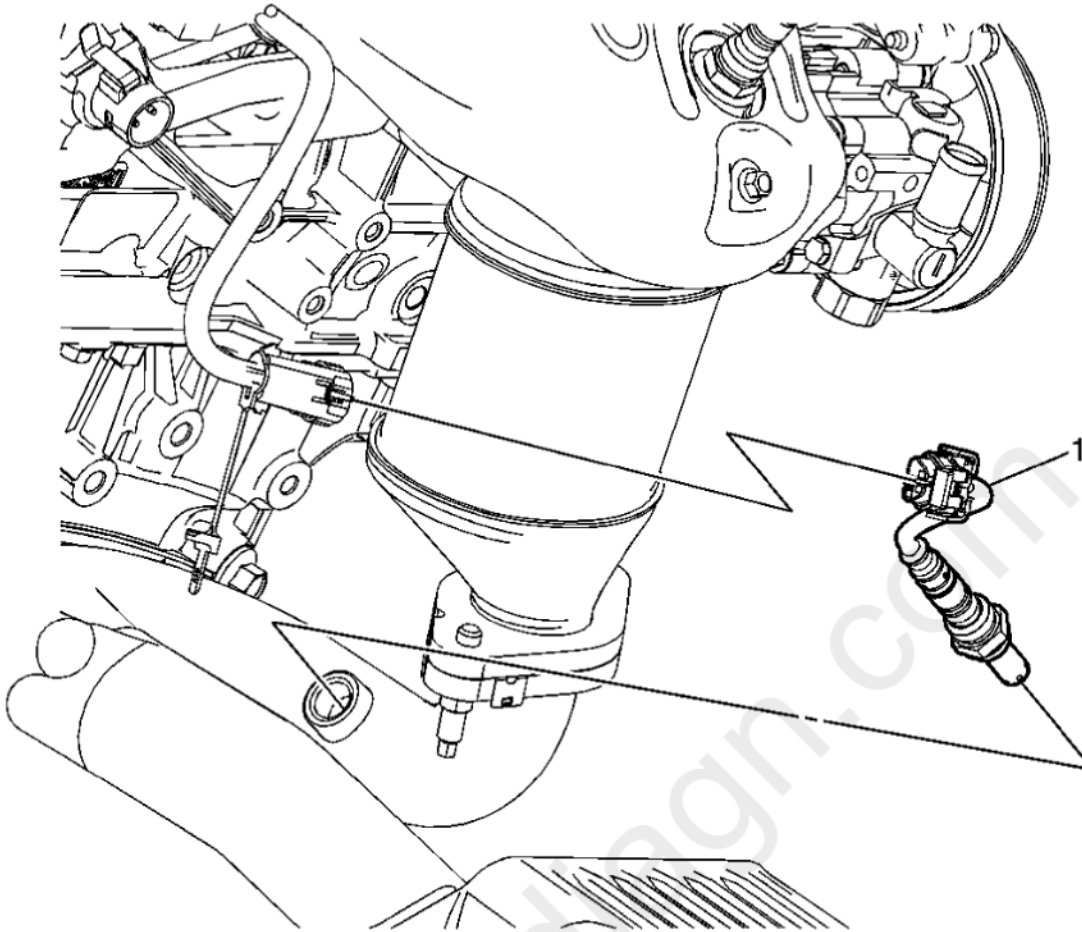


Fig. 17: Heated Oxygen Sensor - Bank 1 Sensor 2 (LLT)

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	Heated Oxygen Sensor CAUTION: Refer to. CAUTION: Refer to. 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 .

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)

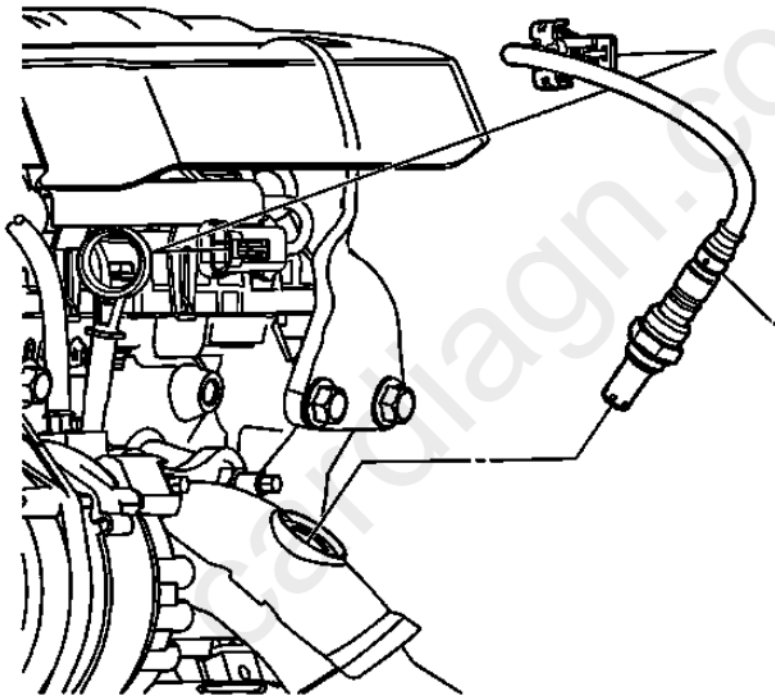
HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1 (LF1)

Fig. 18: Identifying Heated Oxygen Sensor - Bank 2 Sensor 1 (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
	Heated Oxygen Sensor
	CAUTION: Refer to.
	CAUTION: Refer to.

Procedure

1. Disconnect the heated oxygen sensor harness connector.
2. 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)

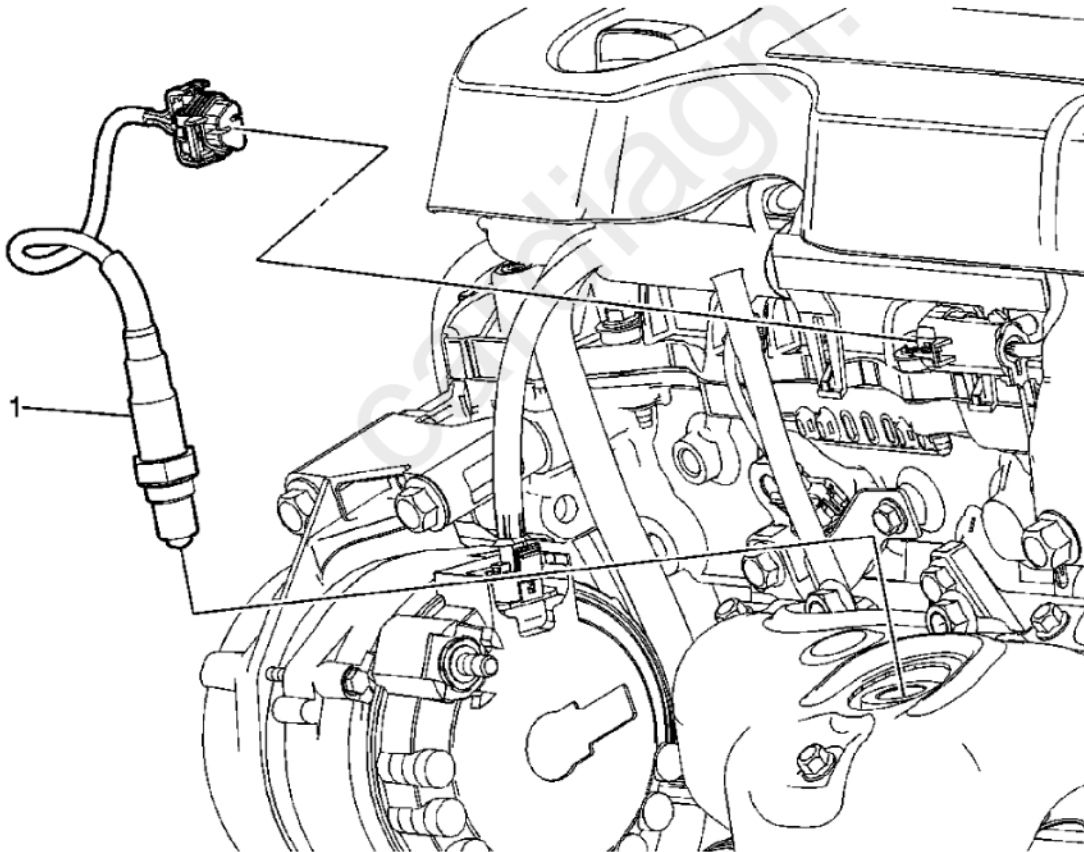
HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1 (LLT)

Fig. 19: Heated Oxygen Sensor - Bank 2 Sensor 1 (LLT)
Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
1	Heated Oxygen Sensor CAUTION: Refer to. CAUTION: Refer to. 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 (LF1)

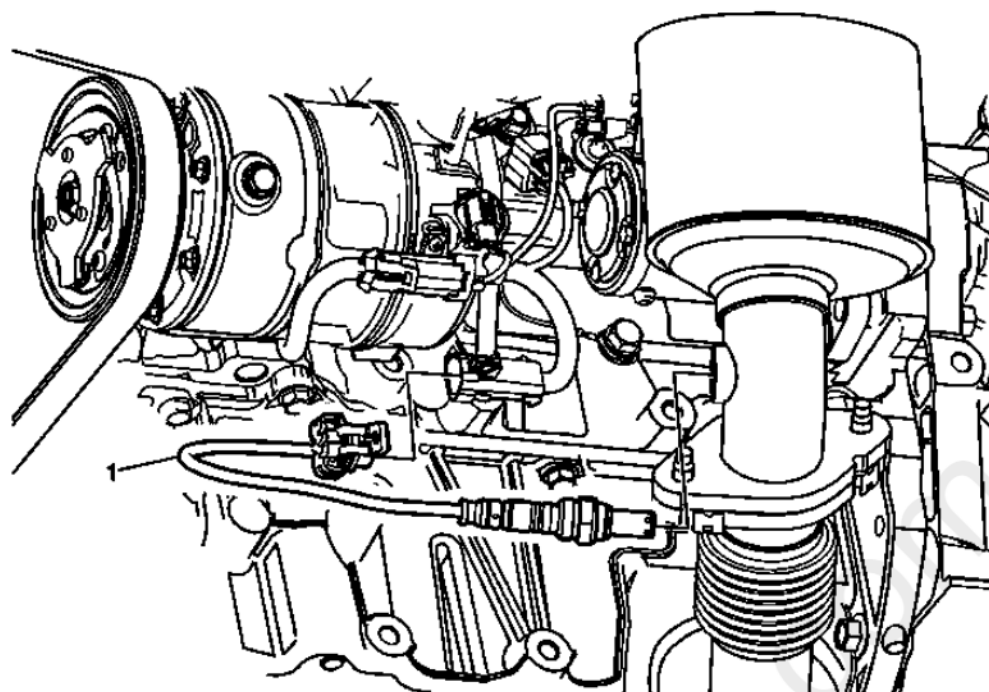


Fig. 20: Locating Heated Oxygen Sensor - Bank 2 Sensor 2 (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Heated Oxygen Sensor CAUTION: Refer to. CAUTION: Refer to. Procedure 1. Disconnect the heated oxygen sensor harness connector. 2. 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

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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 (LLT)

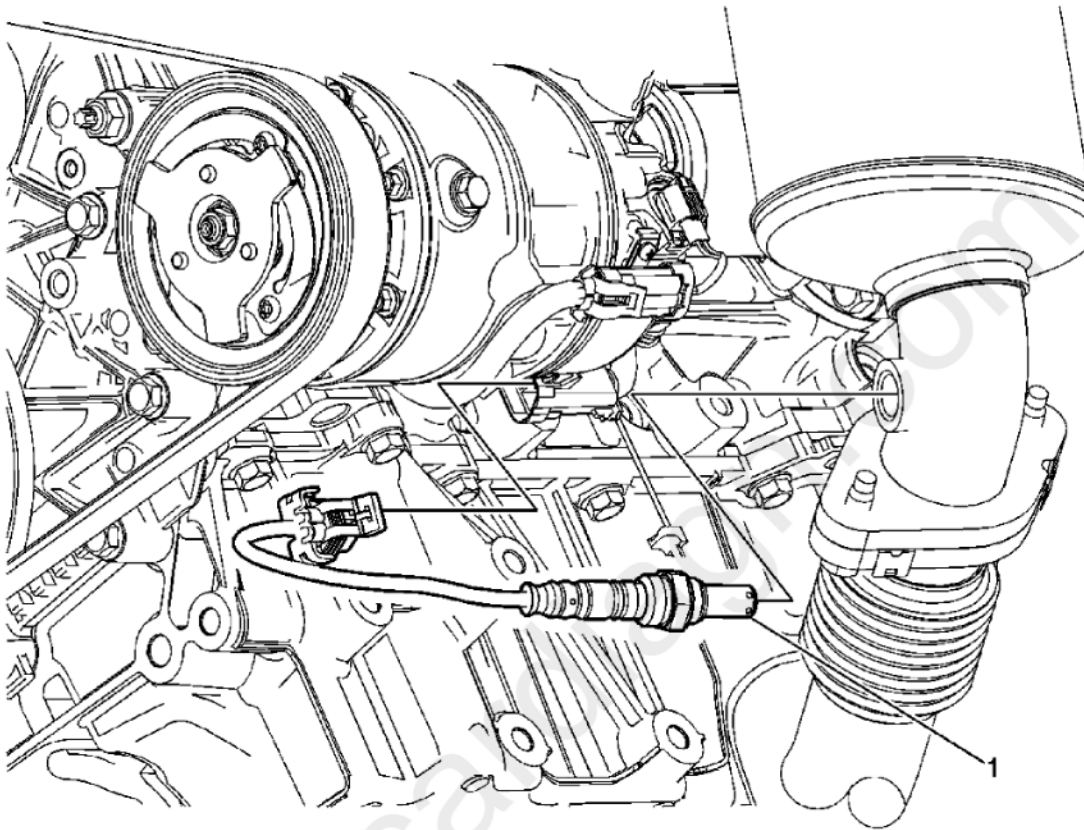


Fig. 21: Heated Oxygen Sensor - Bank 2 Sensor 2 (LLT)
Courtesy of GENERAL MOTORS CORP.

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. CAUTION: Refer to.

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-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**Removal Procedure**

1. Remove the closeout/insulator panel from under the dashboard on the drivers side. Refer to **Instrument Panel Insulator Replacement - Left Side (Left Hand Drive)** or **Instrument Panel Insulator Replacement - Left Side (Right Hand Drive)** or **Instrument Panel Insulator Replacement - Right Side (Left Hand Drive)** or **Instrument Panel Insulator Replacement - Right Side (Right Hand Drive)** .

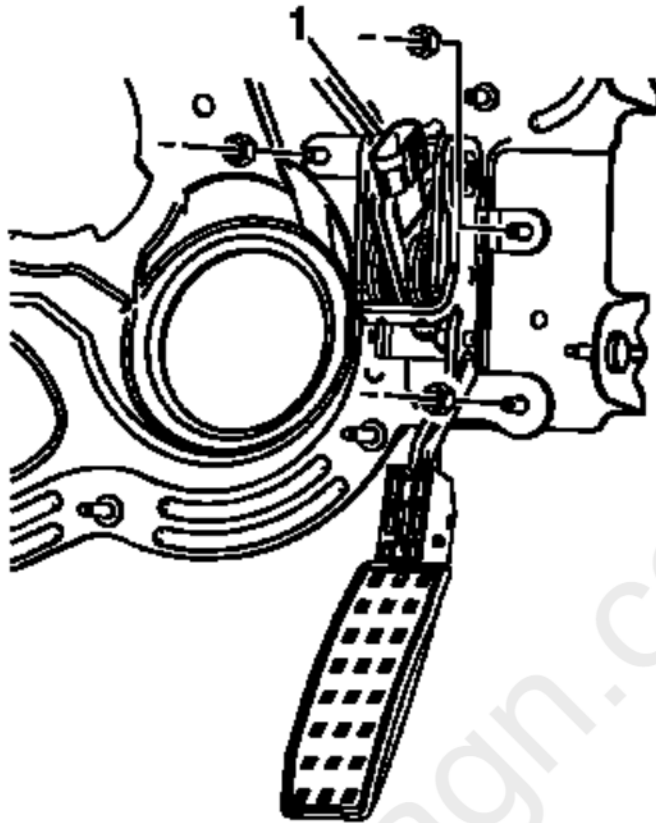


Fig. 22: APP Sensor

Courtesy of GENERAL MOTORS CORP.

CAUTION: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

2. Disconnect the accelerator pedal position (APP) sensor electrical connector from the accelerator pedal module.
3. Remove the nuts from the APP sensor mounting plate and remove the APP sensor (1) from the front of dash.

Installation Procedure

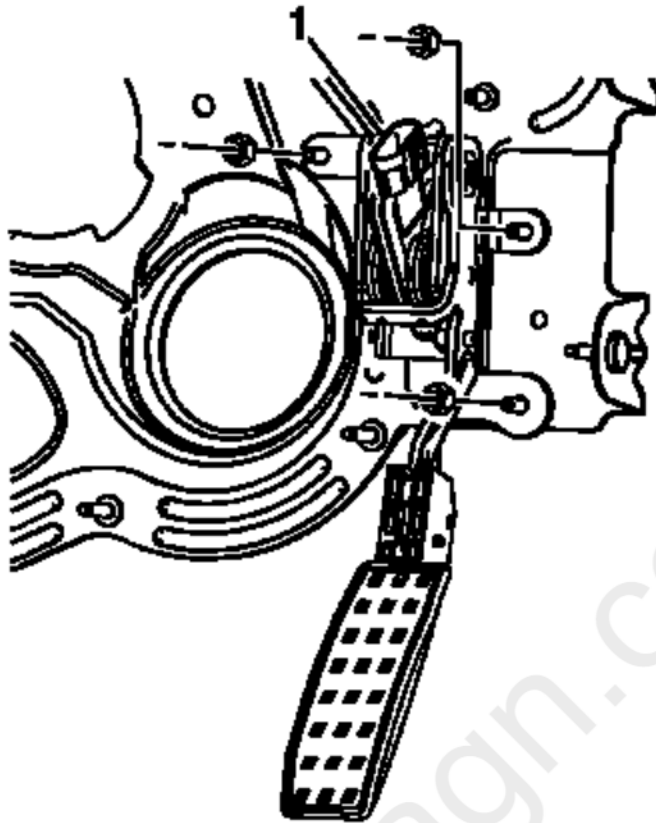


Fig. 23: APP Sensor

Courtesy of GENERAL MOTORS CORP.

1. Install the APP sensor (1) to the front of dash.

CAUTION: Refer to **FASTENER CAUTION** .

2. Install the APP sensor mounting nuts and tighten to 9 N.m (80 lb in).
3. Connect the APP sensor electrical connector.
4. Operate the accelerator pedal and observe the APP angles using a scan tool. The accelerator pedal should operate freely, without binding between closed throttle and wide open throttle.
5. Install the closeout/insulator panel. Refer to **Instrument Panel Insulator Replacement - Left Side (Left Hand Drive)** or **Instrument Panel Insulator Replacement - Left Side (Right Hand Drive)** or **Instrument Panel Insulator Replacement - Right Side (Left Hand Drive)** or **Instrument Panel Insulator Replacement - Right Side (Right Hand Drive)** .

THROTTLE BODY ASSEMBLY REPLACEMENT (LF1)

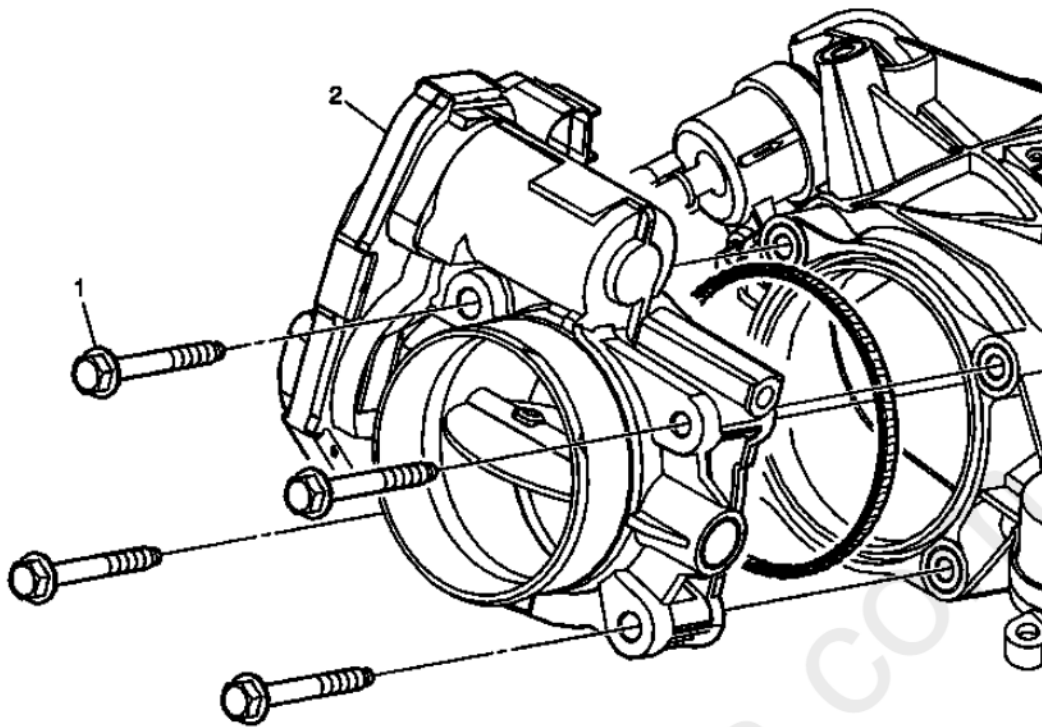


Fig. 24: View Of Throttle Body Assembly & Bolts (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT) .	
1	Bolt (Qty: 4) CAUTION: Refer to. Tighten: 10 N.m (89 lb in)
2	Throttle Body Procedure 1. Disconnect the throttle body harness connector. 2. Install a NEW throttle body seal. 3. Perform the throttle learn procedure. Refer to Throttle/Idle Learn (LF1, LFW) or Throttle/Idle Learn (Without LF1, LFW).

THROTTLE BODY ASSEMBLY REPLACEMENT (LLT)

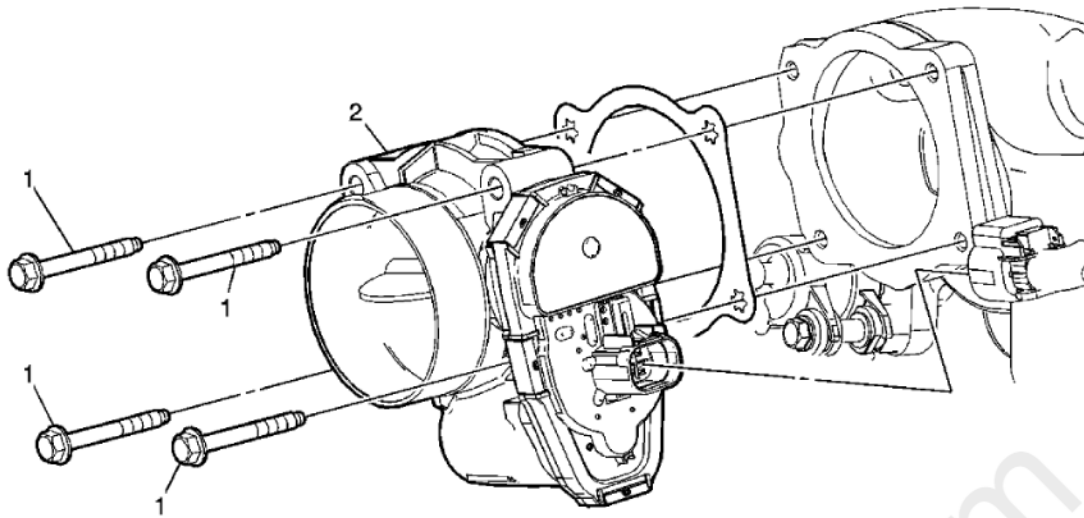


Fig. 25: Throttle Body Assembly (LLT)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to <u>Fuel Injector Sight Shield Replacement (LP1, LY7)</u> or <u>Fuel Injector Sight Shield Replacement (LLT)</u> .	
1	Bolt (Qty: 4) CAUTION: Refer to. Tighten: 10 N.m (89 lb in)
2	Throttle Body Procedure 1. Disconnect the throttle body harness connector. 2. Disconnect the vacuum hose. 3. Discard and install a NEW throttle body gasket. 4. Perform the throttle learn procedure. Refer to <u>Throttle/Idle Learn (LF1, LFW)</u> or <u>Throttle/Idle Learn (Without LF1, LFW)</u>.

THROTTLE BODY INSPECTION AND CLEANING

1. Remove the air cleaner intake duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)**.
2. Fully open the throttle valve in order to Inspect the throttle body bore and the throttle valve plate for any deposits.

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

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

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

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

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

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

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

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

4. Install the air cleaner duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)**.
5. Perform the throttle learn procedure. Refer to **Throttle/Idle Learn (LF1, LFW)** or **Throttle/Idle Learn (Without 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: Digital Pressure Gauge

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

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.

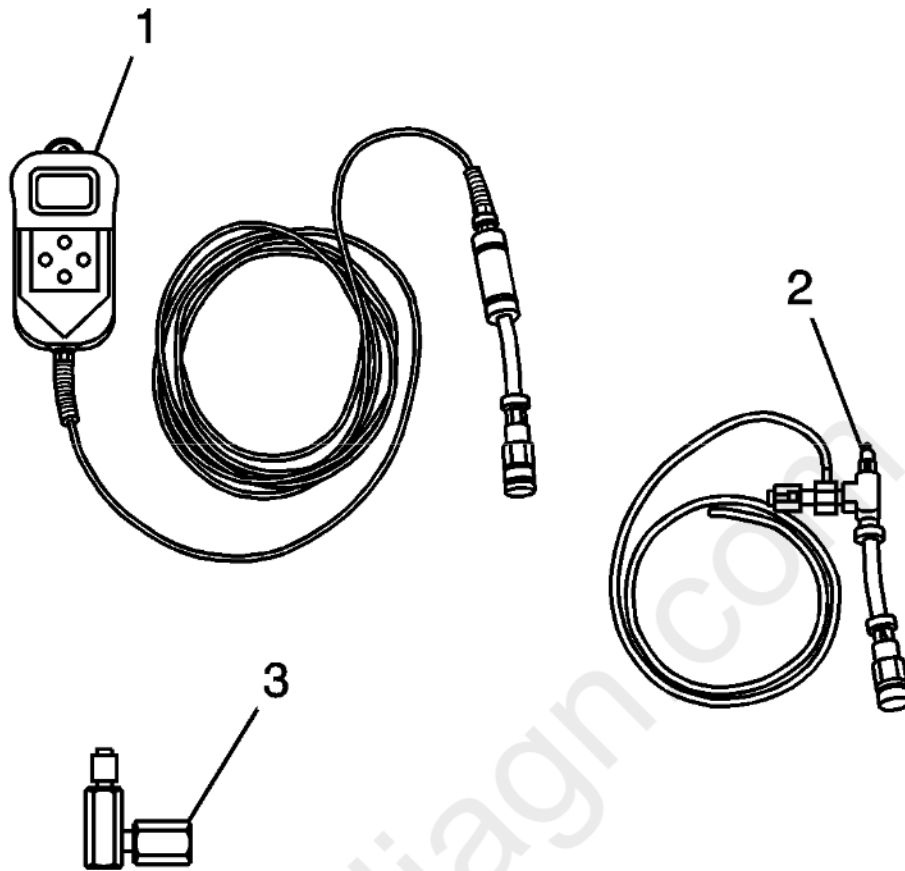


Fig. 26: Identifying CH-48027-100 Components
 Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Connect the **CH 48027**: gauge (1) to the **CH 48027**: adapter (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**: gauge (1), refer to the manufacture's directions.

Removal Procedure

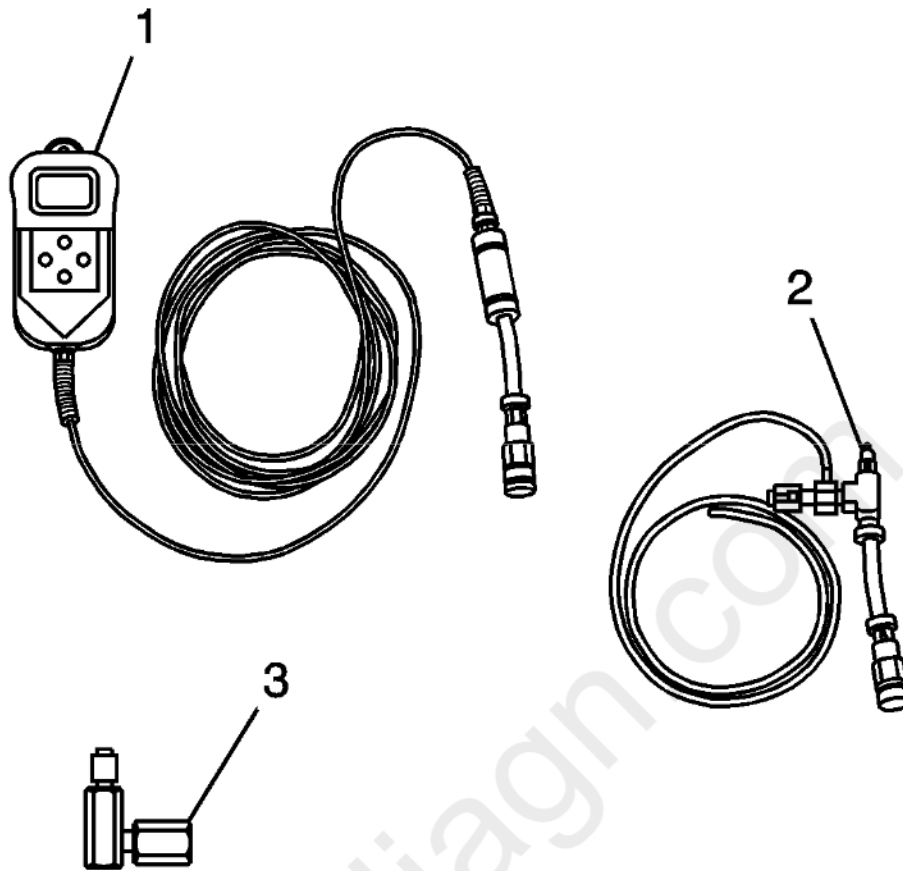


Fig. 27: Identifying CH-48027-100 Components
Courtesy of GENERAL MOTORS CORP.

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

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

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

2. Disconnect the **CH 48027:** gauge (1) from the **CH 48027:** gauge (2).
3. Disconnect the **CH 48027:** adapter (2) from the **CH 48027:** adapter (3).
4. Disconnect the **CH 48027:** adapter (3) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Install the engine cover, if required.
7. Tighten the fuel fill cap.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **J 37088-A** Fuel Line Disconnect Tool Set
- **J 44581** Fuel Line Disconnect Tool. See **Special Tools** .

Removal Procedure

WARNING: Refer to **GASOLINE/GASOLINE VAPORS WARNING** .

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

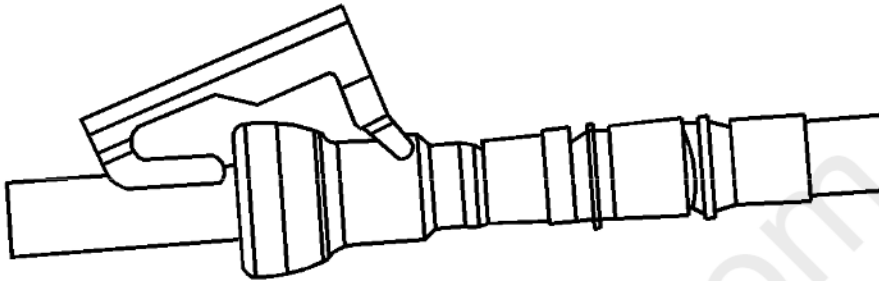


Fig. 28: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS CORP.

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

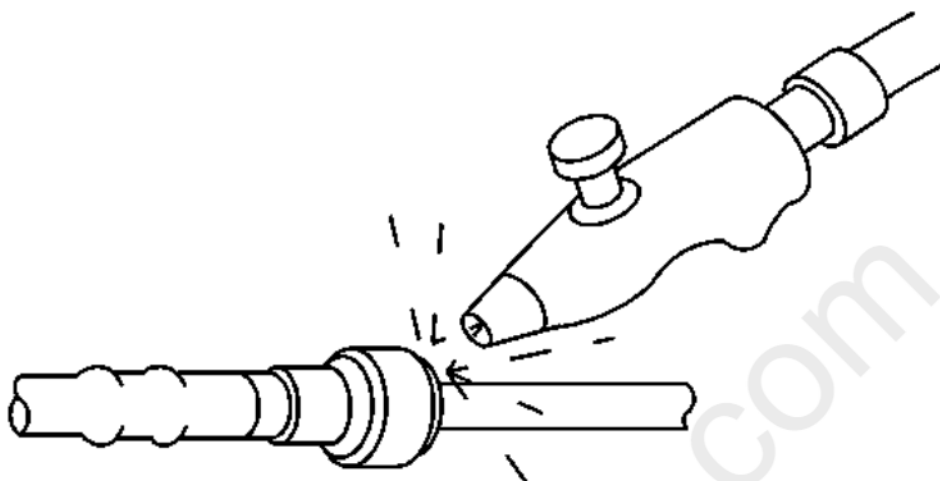


Fig. 29: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

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.

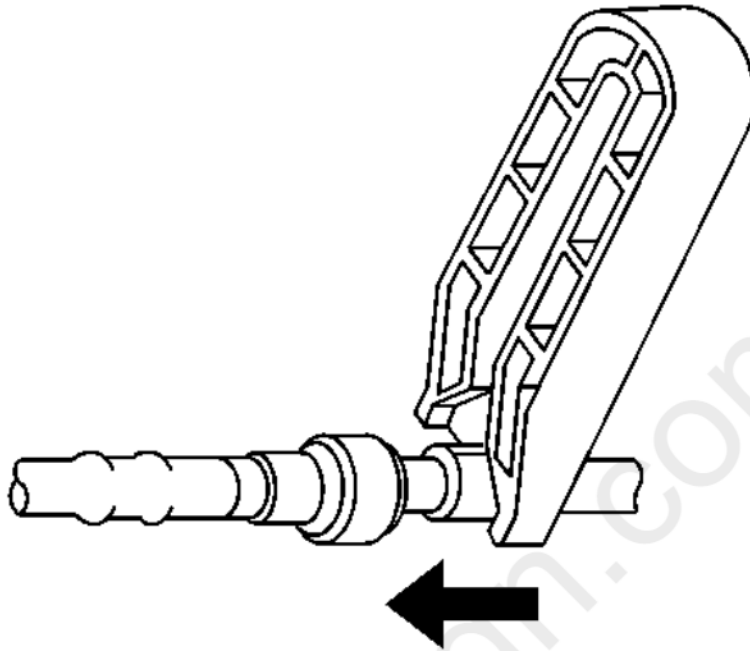


Fig. 30: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **J 37088-A** or **J 44581** . Insert the **J 37088-A** or **J 44581** into the female connector, then push inward to release the locking tabs. See **Special Tools** .

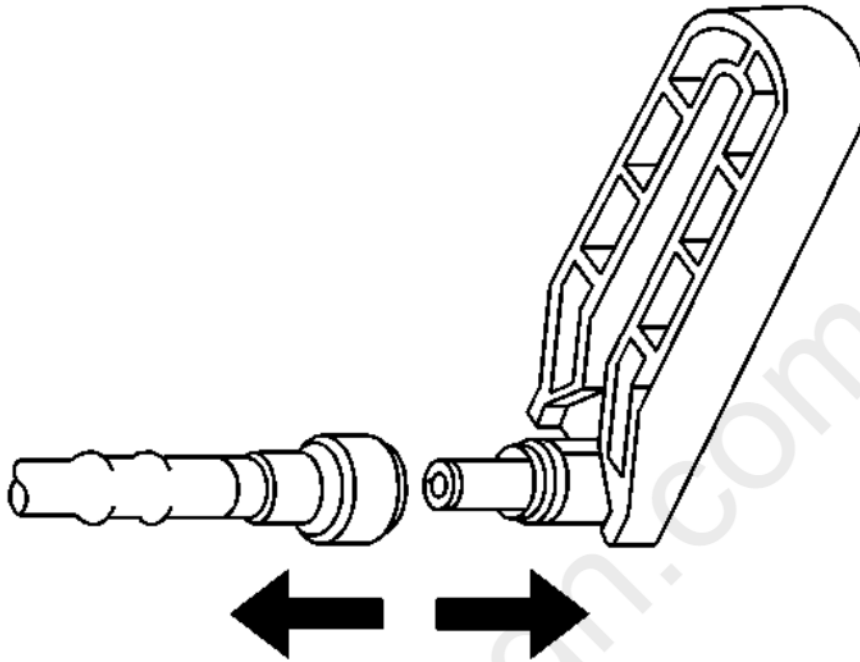


Fig. 31: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

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

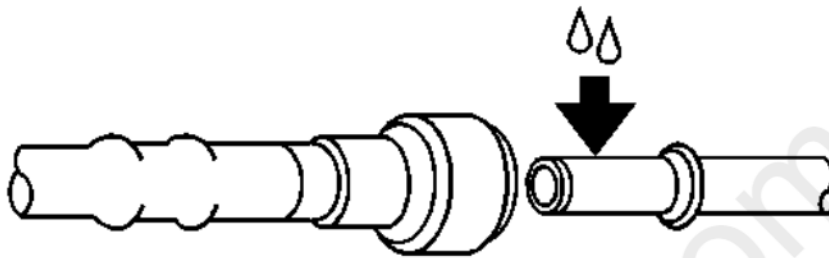


Fig. 32: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

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.

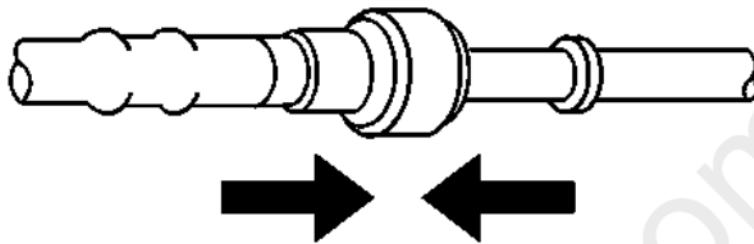


Fig. 33: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

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

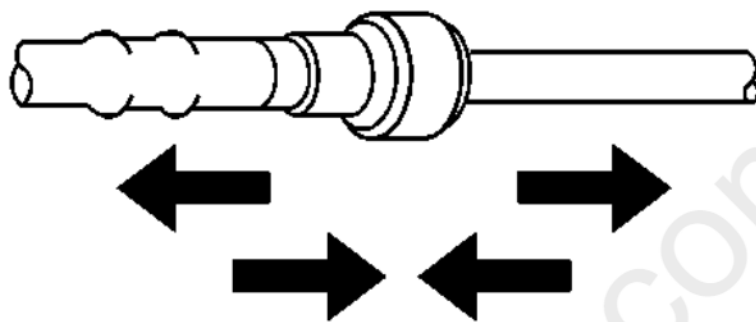


Fig. 34: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS CORP.

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

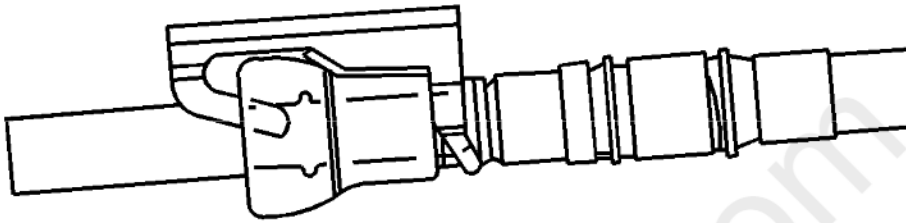


Fig. 35: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS CORP.

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

Disconnect Procedure

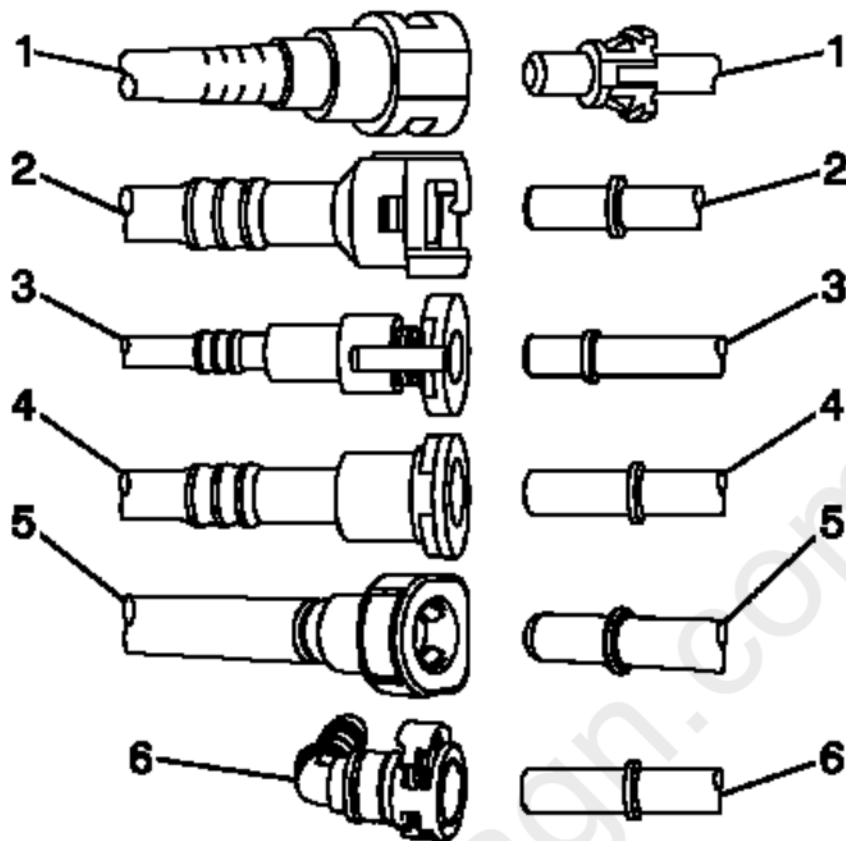


Fig. 36: Identifying Plastic Collar Fuel & Evaporative Emission Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

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)
- Push Down TI (5)

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

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

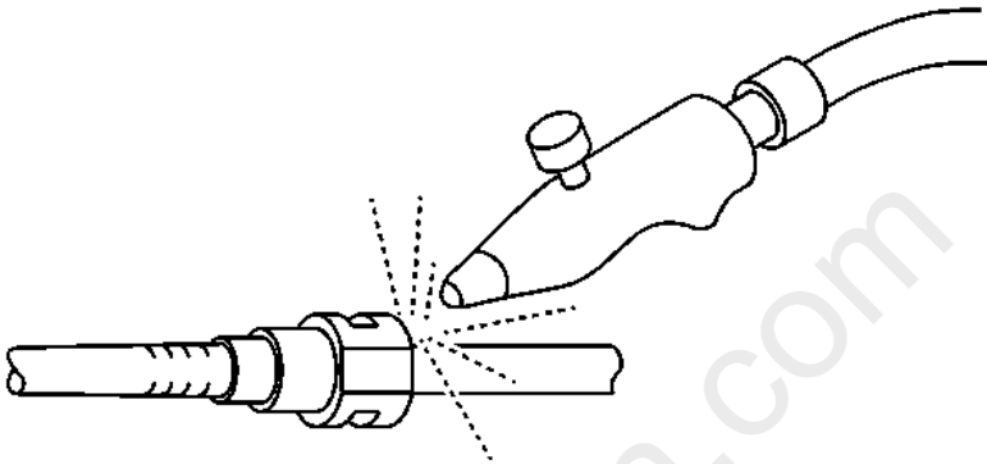


Fig. 37: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to SAFETY GLASSES WARNING .

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

2. Using compressed air, blow any dirt or debris from around the connection.

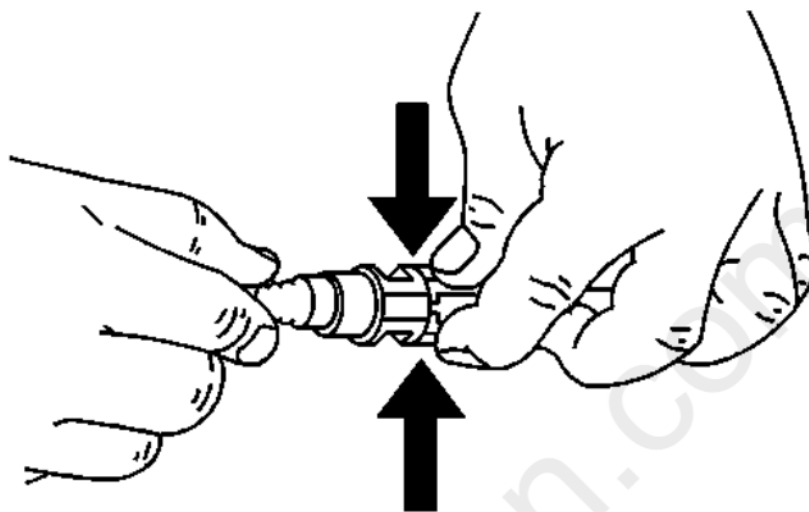


Fig. 38: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

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

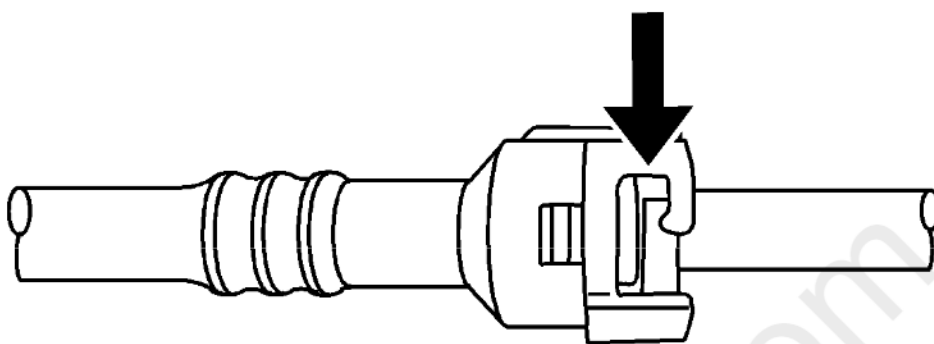


Fig. 39: Q Release Style Connectors (Plastic Collar)

Courtesy of GENERAL MOTORS CORP.

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

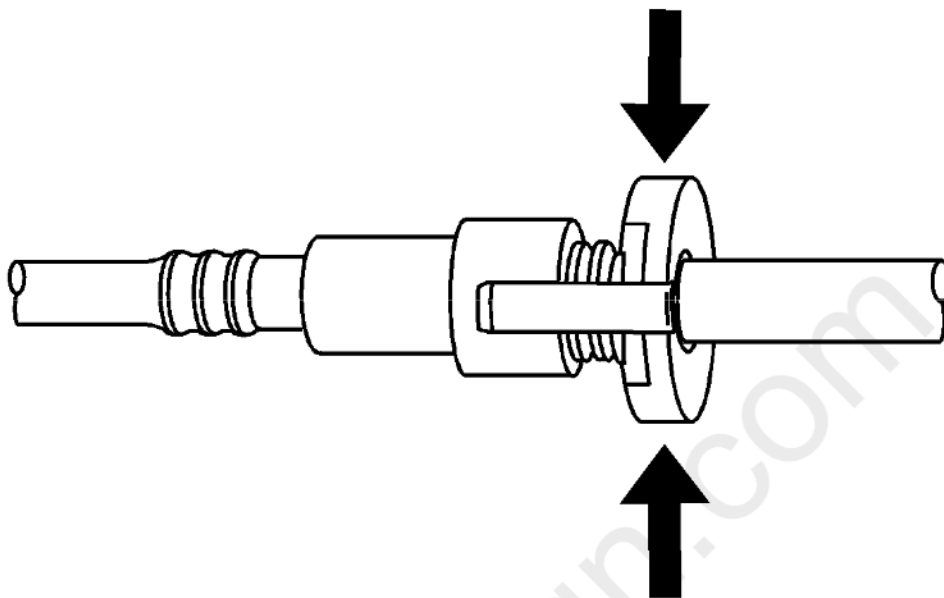


Fig. 40: Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

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

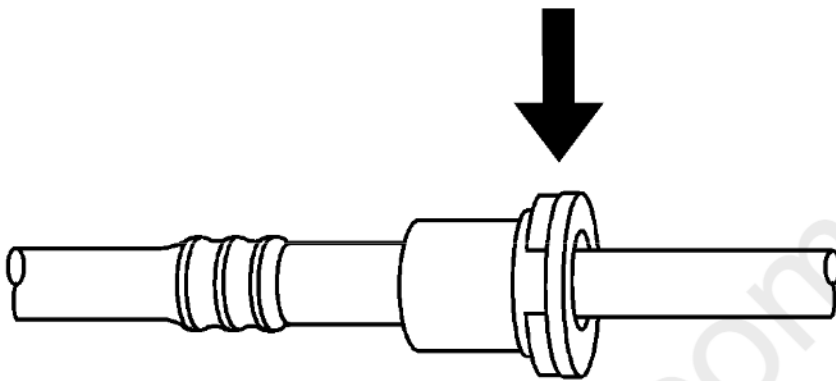


Fig. 41: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS CORP.

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

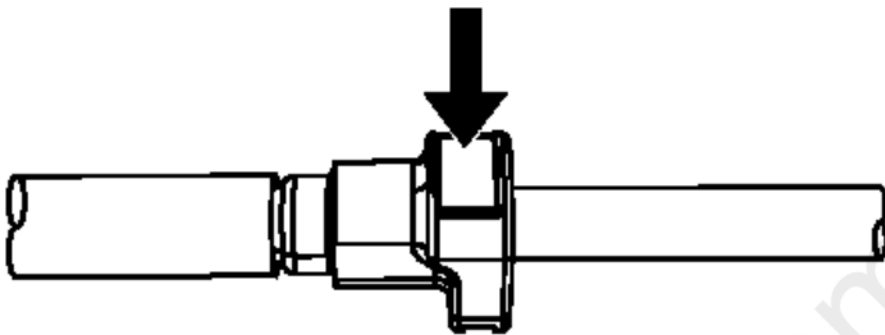


Fig. 42: View Of Push Down TI Style Connector
Courtesy of GENERAL MOTORS CORP.

7. This step applies to the Push Down TI style connector ONLY. Release the fitting by pressing on the tab indicated by the arrow.

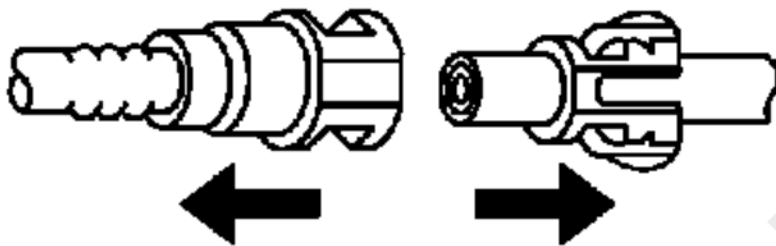


Fig. 43: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to RELIEVING FUEL PRESSURE WARNING .

8. Pull the connection apart.

Connect Procedure

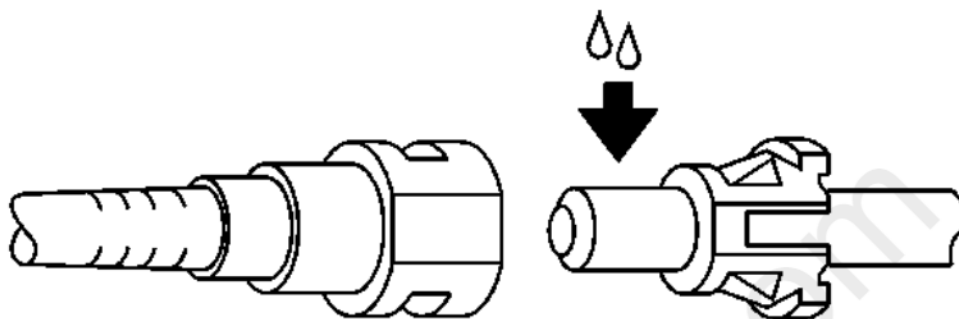


Fig. 44: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Pipe Fitting Warning .

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

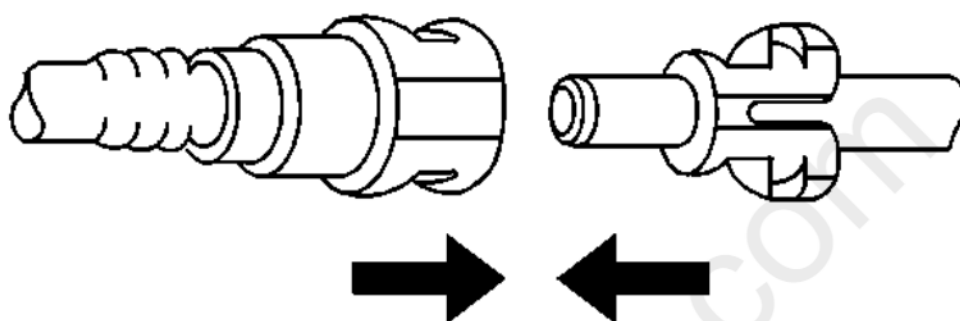


Fig. 45: Quick-Connect Fittings

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.

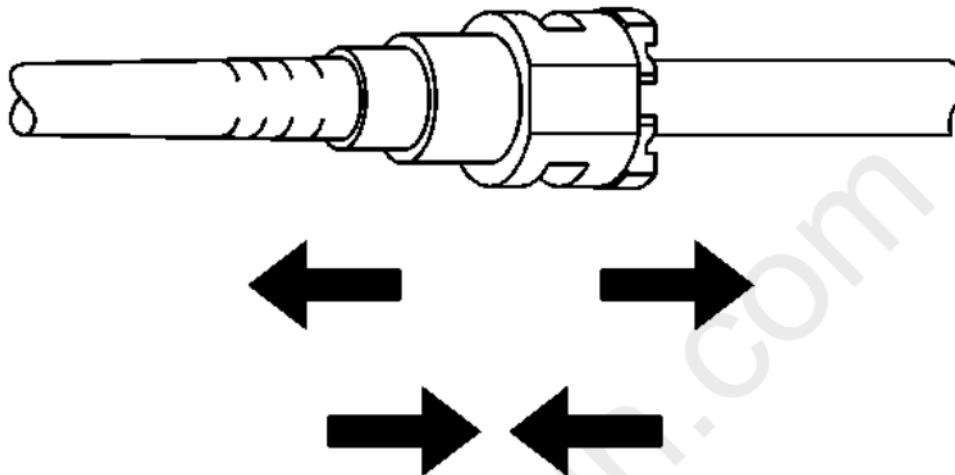


Fig. 46: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS CORP.

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

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.

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

Removal Procedure

WARNING: Refer to **GASOLINE/GASOLINE VAPORS WARNING** .

1. Drain the fuel tank. Refer to **Fuel Tank Draining**.
2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
3. Remove the exhaust system. Refer to **Exhaust System Replacement (LF1-Single)** or **Exhaust System Replacement (LSA-Coupe)** or **Exhaust System Replacement (LF1-Sedan/Wagon)** or **Exhaust System Replacement (LLT-Coupe)** or **Exhaust System Replacement (LLT-Sedan/Wagon)** or **Exhaust System Replacement (LSA-Sedan/Wagon)** .
4. Remove the rear propeller shaft. Refer to **Rear Propeller Shaft Replacement (RPO LLT, LF1 with MXO)** or **Rear Propeller Shaft Replacement (RPO LLT/LF1with MX7 or MN6)** or **Rear Propeller Shaft Replacement (RPO LSA)** .

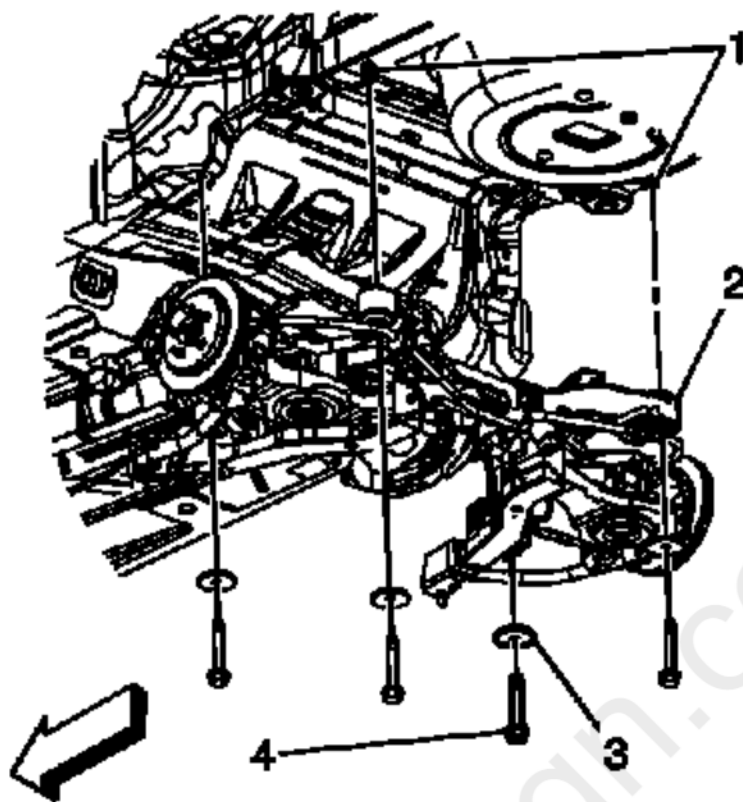


Fig. 47: Frame-To-Body Mounting Bolts & Washers
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not remove any components from the rear frame assembly once the rear frame assembly is removed from the vehicle.

5. Remove the rear frame assembly (2). Refer to Rear Frame Replacement .

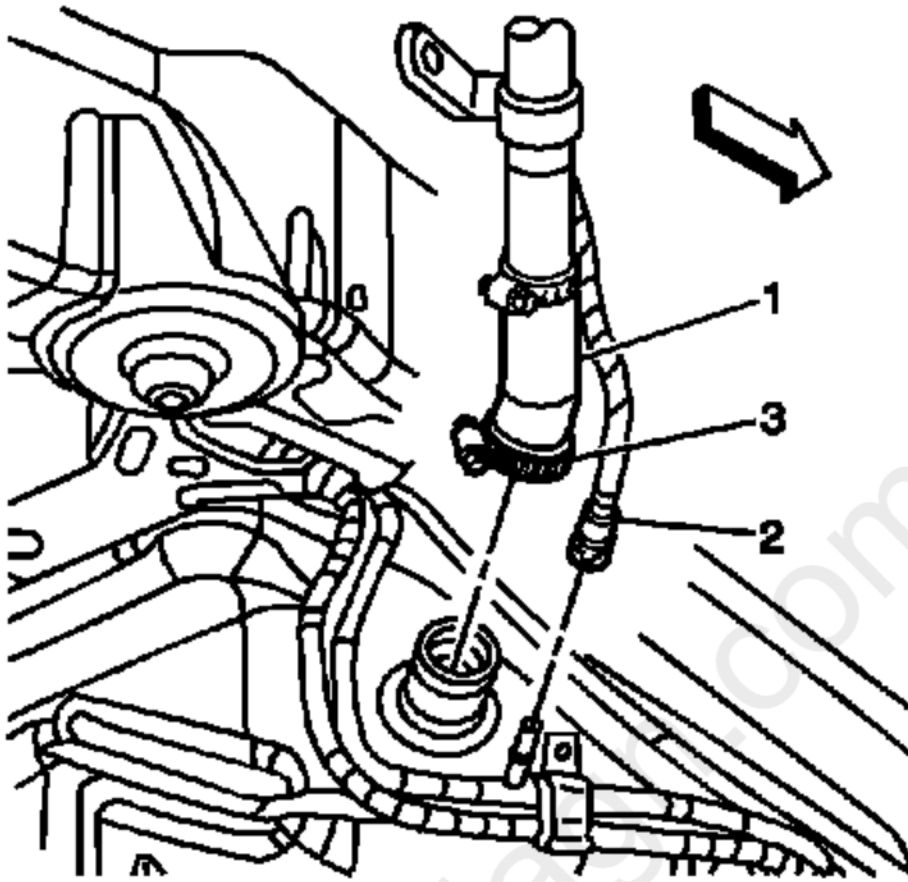


Fig. 48: Identifying Fuel Filler Hose To Fuel tank
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the filler hose (1) from the fuel tank.
7. Disconnect the filler vent tube (2) from the evaporative emission (EVAP) hose. Refer to **Plastic Collar Quick Connect Fitting Service**.

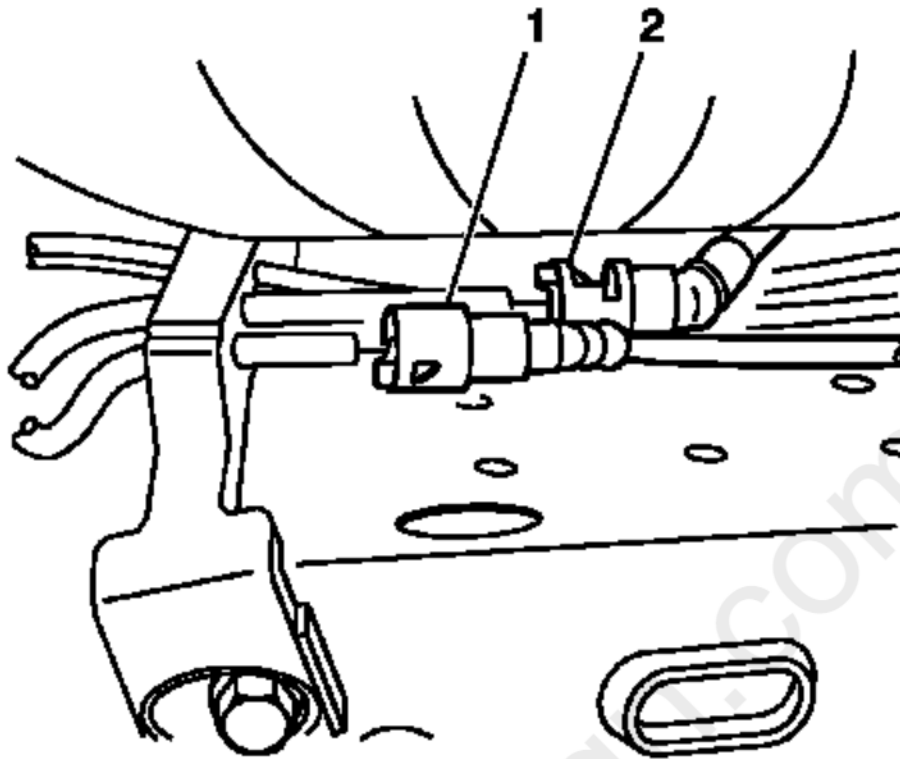


Fig. 49: Identifying Fuel Feed Pipe And Evap Hose
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the fuel feed pipe (1) from the chassis bundle. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Disconnect the fuel EVAP hose (2) from the chassis bundle. Refer to **Plastic Collar Quick Connect Fitting Service**.

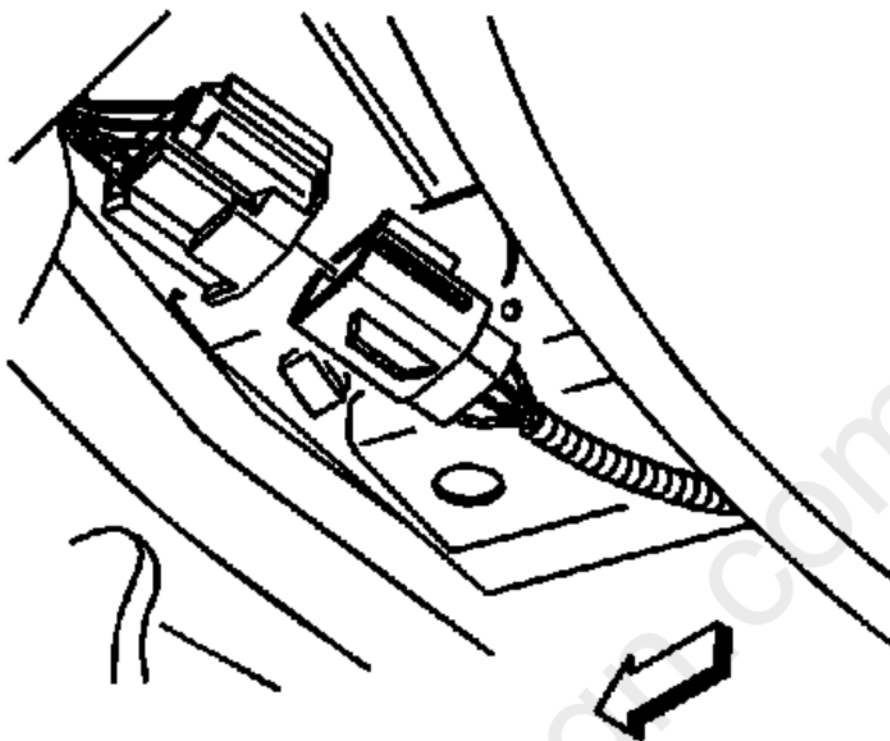


Fig. 50: View Of Fuel Tank Electrical Connector
Courtesy of GENERAL MOTORS CORP.

10. Release the electrical connector interlock and disconnect the fuel tank electrical connector.
11. Remove the fuel tank electrical connector retainer from the chassis.
12. Remove the fuel tank electrical harness from the chassis mounted retainer.

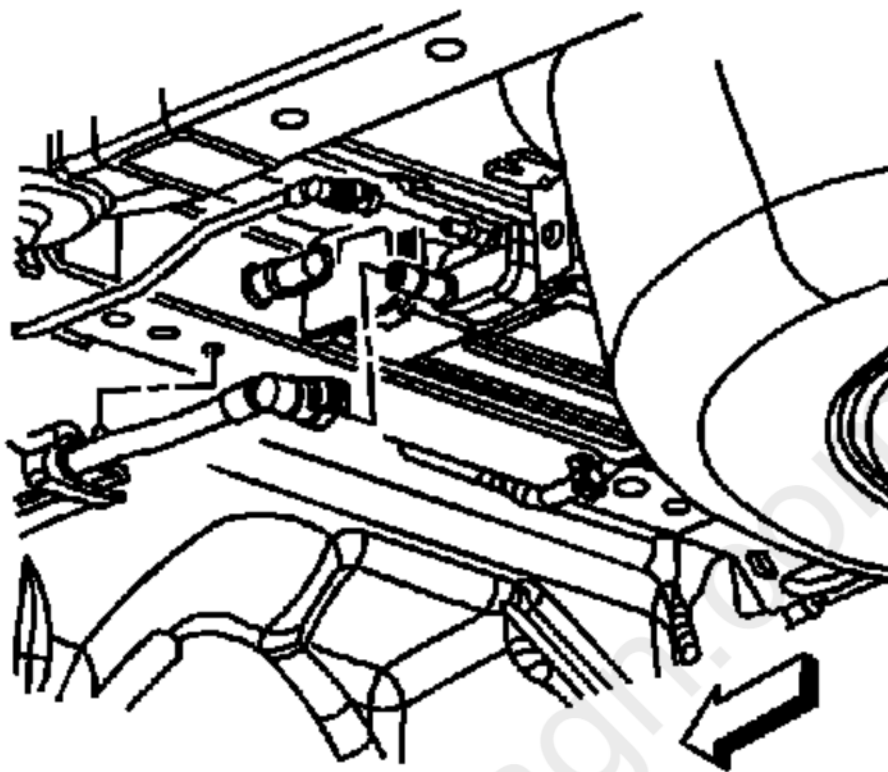


Fig. 51: Identifying EVAP Hoses At EVAP Canister
Courtesy of GENERAL MOTORS CORP.

13. Disconnect the EVAP hoses from the EVAP canister.
14. Pull outward on the retainer tab in order to disengage the retainer from the chassis.

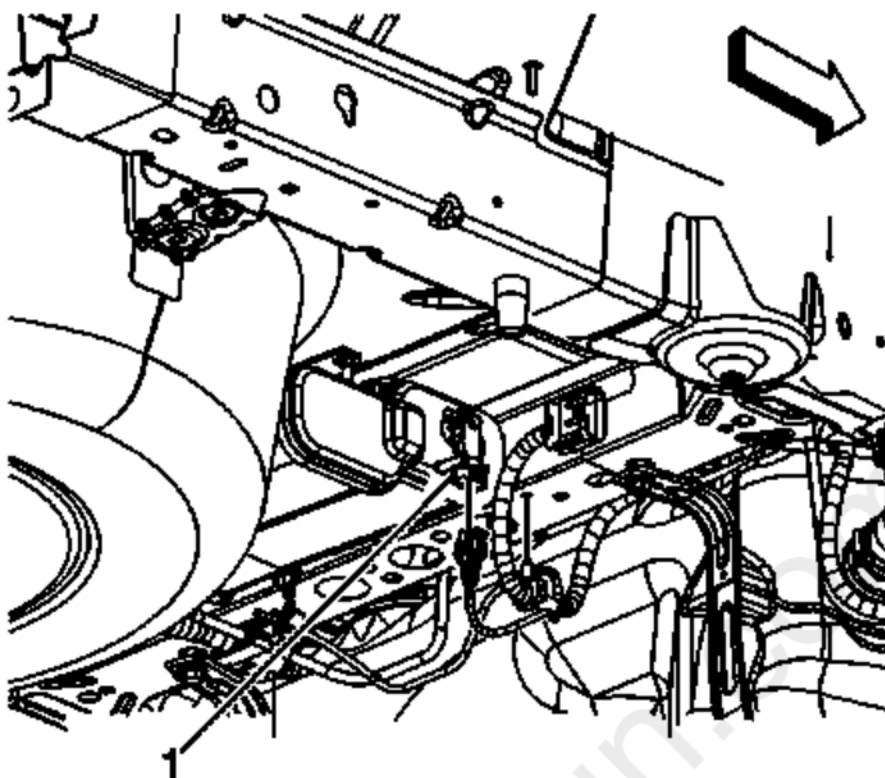


Fig. 52: View Of Fuel Tank Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the electrical connector from the fuel tank pressure sensor (1).
16. Disconnect the electrical connector from the EVAP canister vent valve.

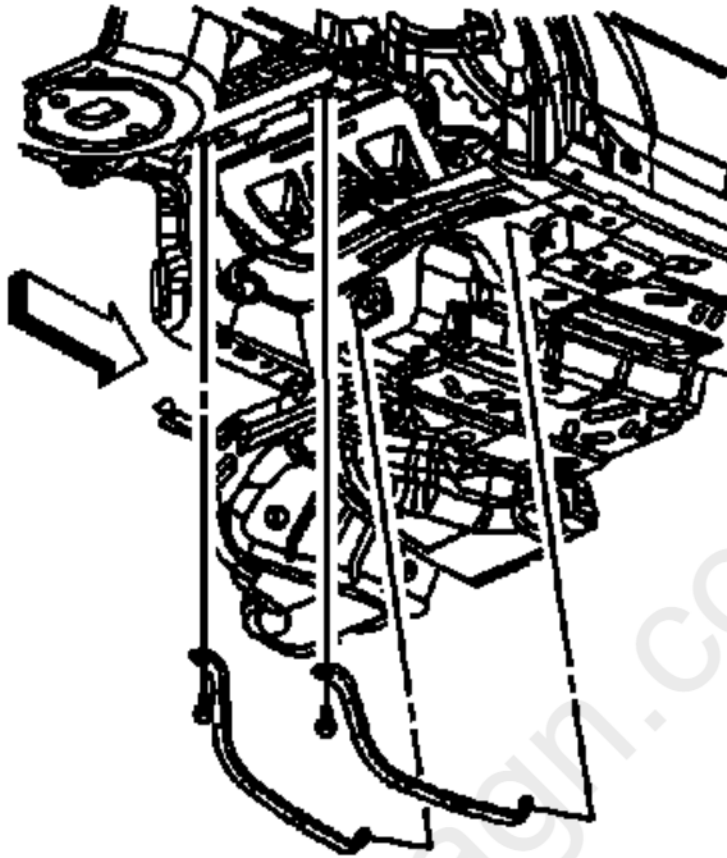


Fig. 53: View Of Fuel Tank Straps
Courtesy of GENERAL MOTORS CORP.

17. Support the fuel tank with a suitable jack.
18. Remove the fuel tank strap bolts.
19. Remove the fuel tank straps.

NOTE: Ensure the following are free from the surrounding components while lowering the fuel tank:

- The fuel tank wiring harness
- The EVAP wiring harness
- The EVAP hoses at the EVAP
- The fuel/EVAP hoses at the chassis pipes

20. With the aid of an assistant, carefully lower the fuel tank from the vehicle.
21. Remove the following components if replacing just the fuel tank:
 - The right fuel tank pump module-Refer to Fuel Tank Fuel Pump Module Replacement - Right Side.

- The left fuel level sensor assembly-Refer to Fuel Level Sensor Replacement - Left Side.

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
 - The right fuel tank pump module-Refer to Fuel Tank Fuel Pump Module Replacement - Right Side.
 - The left fuel level sensor assembly-Refer to Fuel Level Sensor Replacement - Left Side.

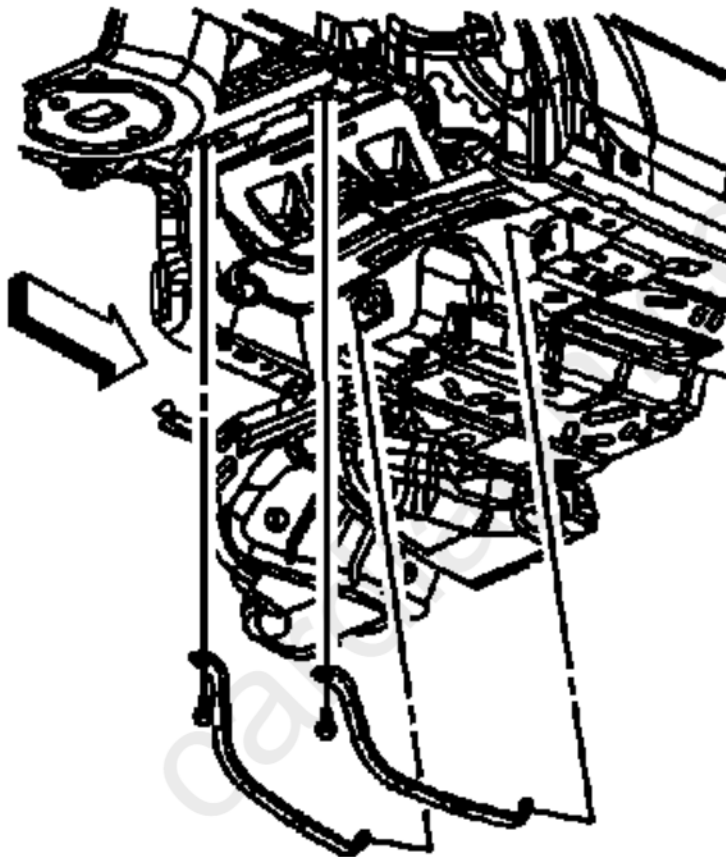


Fig. 54: View Of Fuel Tank Straps
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the following are properly routed while raising the fuel tank:

- The fuel tank wiring harness
- The EVAP wiring harness
- The EVAP hoses at the EVAP
- The fuel/EVAP hoses at the chassis pipes

2. With the aid of an assistant, carefully raise the fuel tank to the vehicle.

3. Install the fuel tank straps to the vehicle.

CAUTION: Refer to FASTENER CAUTION .

4. Install the fuel tank strap bolts and tighten to 50 N.m (37 lb ft).

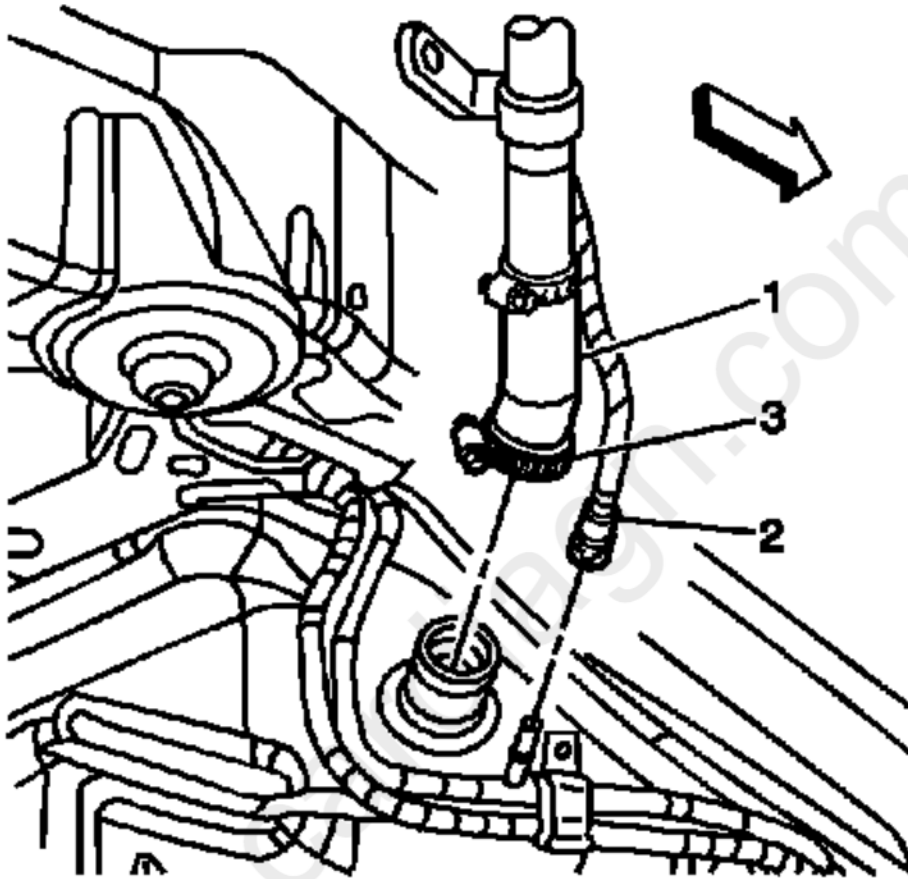


Fig. 55: Identifying Fuel Filler Hose To Fuel tank
Courtesy of GENERAL MOTORS CORP.

5. Connect the filler hose (1) to the fuel tank and tighten to 3.5 N.m (31 lb in).
6. Connect the filler vent tube (2) to the EVAP hose. Refer to Plastic Collar Quick Connect Fitting Service.

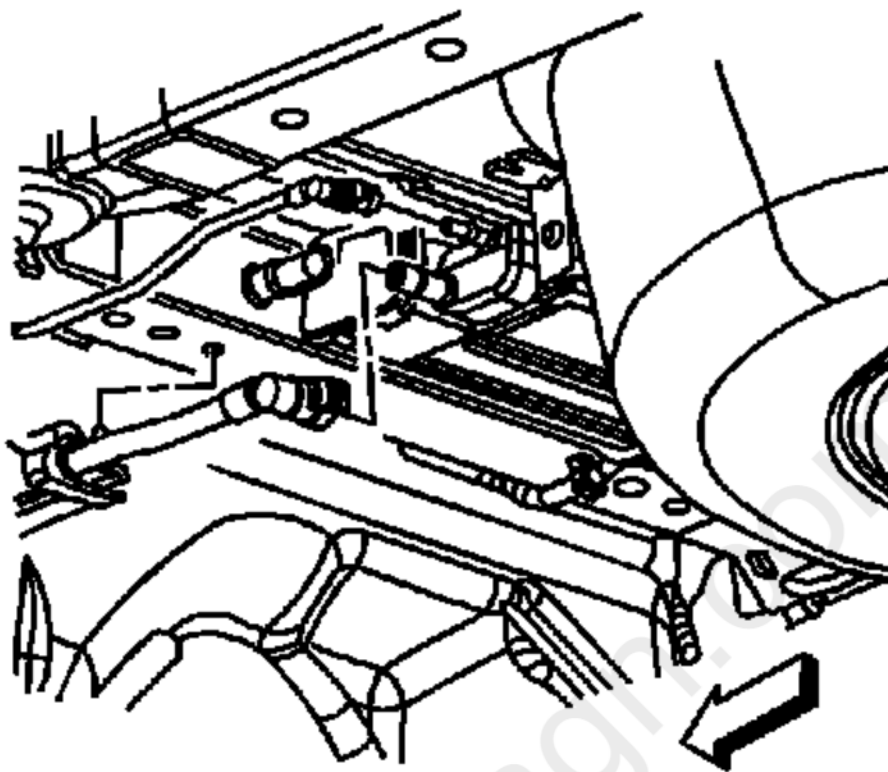


Fig. 56: Identifying EVAP Hoses At EVAP Canister
Courtesy of GENERAL MOTORS CORP.

7. Connect the EVAP hoses to the EVAP canister.
8. Connect the EVAP purge valve and fuel tank pressure sensor electrical connectors.

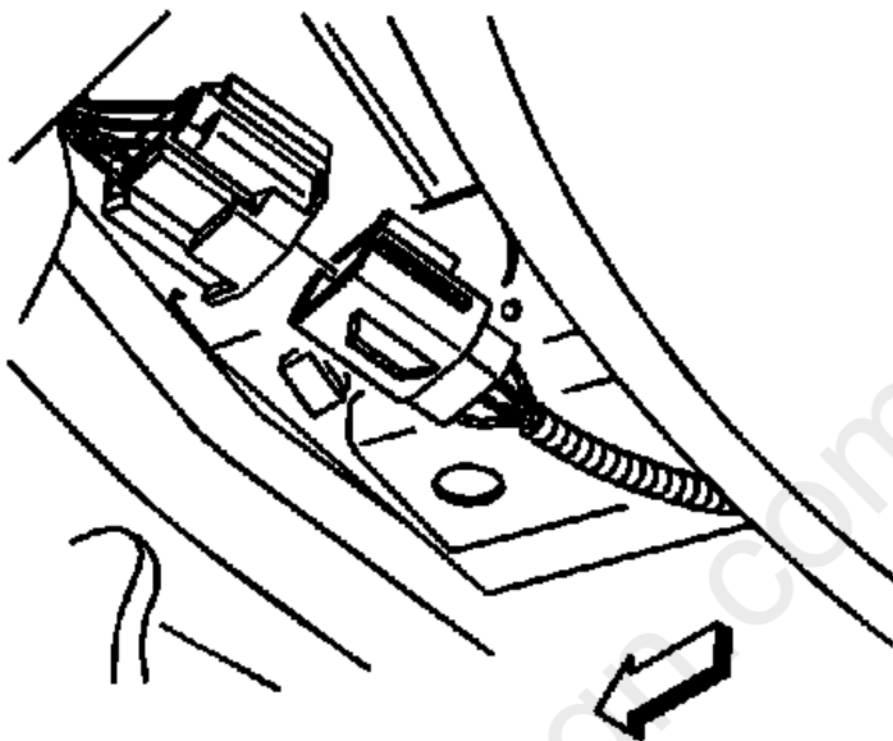


Fig. 57: View Of Fuel Tank Electrical Connector
Courtesy of GENERAL MOTORS CORP.

9. Install the fuel tank wire harness and wire harness connector to the retainers on the chassis.
10. Connect the fuel tank electrical connector, and engage the connector interlock.

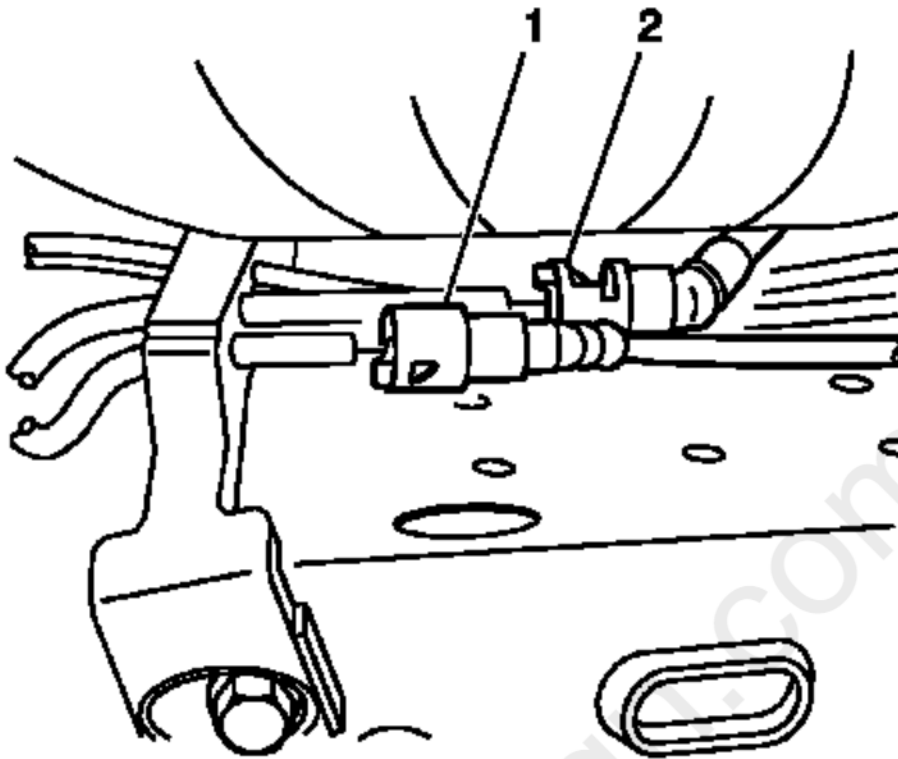


Fig. 58: Identifying Fuel Feed Pipe And Evap Hose
Courtesy of GENERAL MOTORS CORP.

11. Connect the fuel EVAP hose (2) to the chassis bundle. Refer to **Plastic Collar Quick Connect Fitting Service**.
12. Connect the fuel feed pipe (1) to the chassis bundle. Refer to **Plastic Collar Quick Connect Fitting Service**.

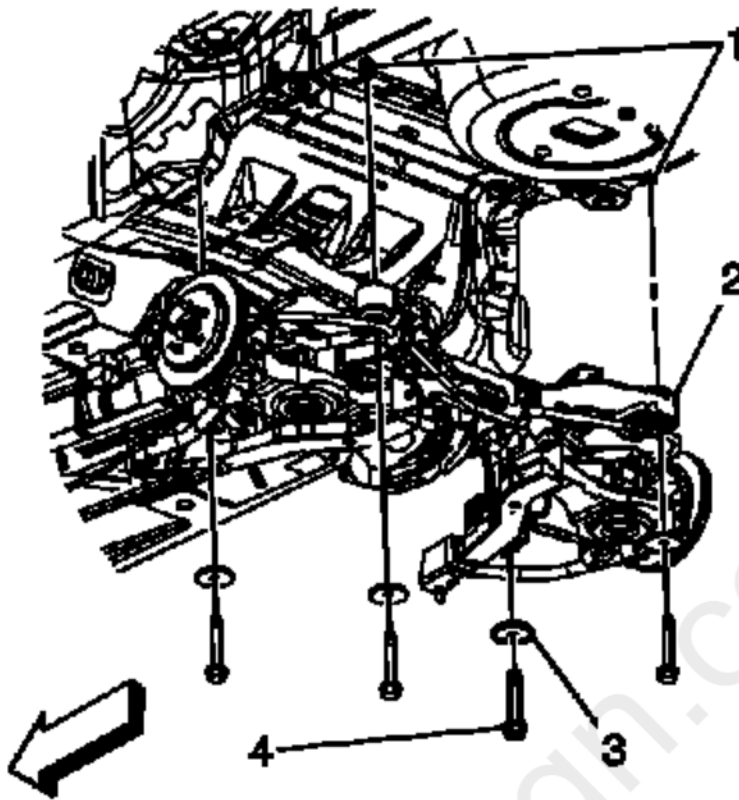


Fig. 59: Frame-To-Body Mounting Bolts & Washers
 Courtesy of GENERAL MOTORS CORP.

13. Install the rear frame assembly (2). Refer to **Rear Frame Replacement** .
14. Install the propeller shaft. Refer to **Rear Propeller Shaft Replacement (RPO LLT, LF1 with MXO)** or **Rear Propeller Shaft Replacement (RPO LLT/LF1with MX7 or MN6)** or **Rear Propeller Shaft Replacement (RPO LSA)** .
15. Install the exhaust system. Refer to **Exhaust System Replacement (LF1-Single)** or **Exhaust System Replacement (LSA-Coupe)** or **Exhaust System Replacement (LF1-Sedan/Wagon)** or **Exhaust System Replacement (LLT-Coupe)** or **Exhaust System Replacement (LLT-Sedan/Wagon)** or **Exhaust System Replacement (LSA-Sedan/Wagon)** .
16. Refill the fuel tank.
17. Inspect for fuel leaks.

FUEL TANK FUEL PUMP MODULE REPLACEMENT - RIGHT SIDE

Special Tools

J 45722 Fuel Sender Lock Ring Wrench. See **Special Tools** .

Removal Procedure

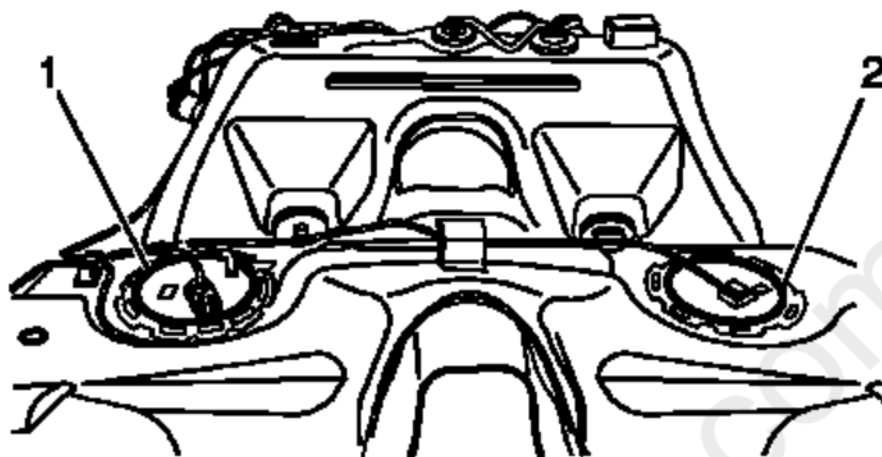


Fig. 60: Fuel Tank Module And Fuel Feed Hose
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to GASOLINE/GASOLINE VAPORS WARNING

1. Remove the fuel tank in order to gain access to the primary fuel tank module (1). Refer to **Fuel Tank Replacement**.

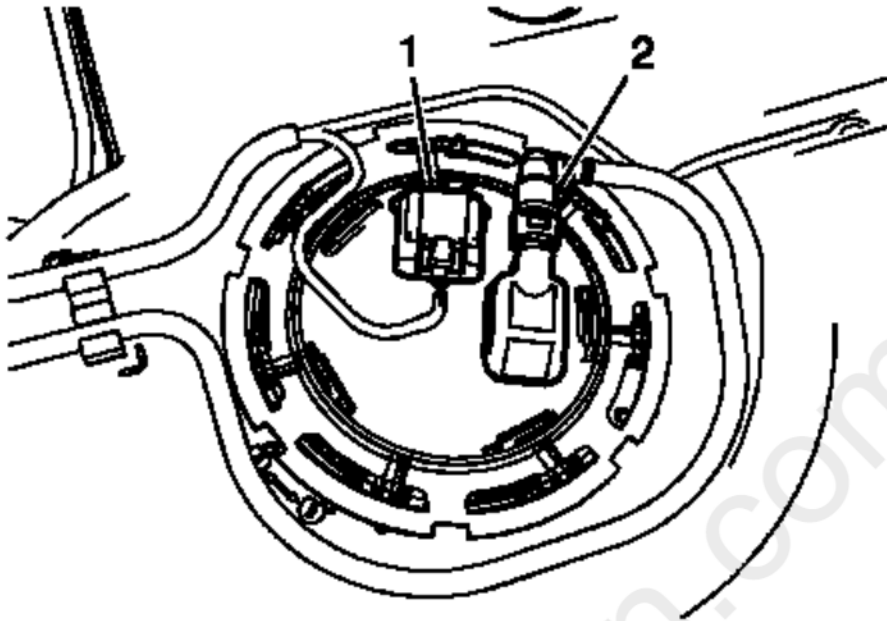


Fig. 61: Identifying Electrical Connector And Fuel Feed Line
 Courtesy of GENERAL MOTORS CORP.

2. Disconnect the electrical connector (1) and the fuel feed line (2) from the primary fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Remove the fuel feed line (2) from the retainer on the fuel tank and position the hose aside.
4. Release the interlock and disconnect the electrical connector from the primary fuel tank module.
5. Remove the wire harness from the retainer on the fuel tank and position the harness aside.

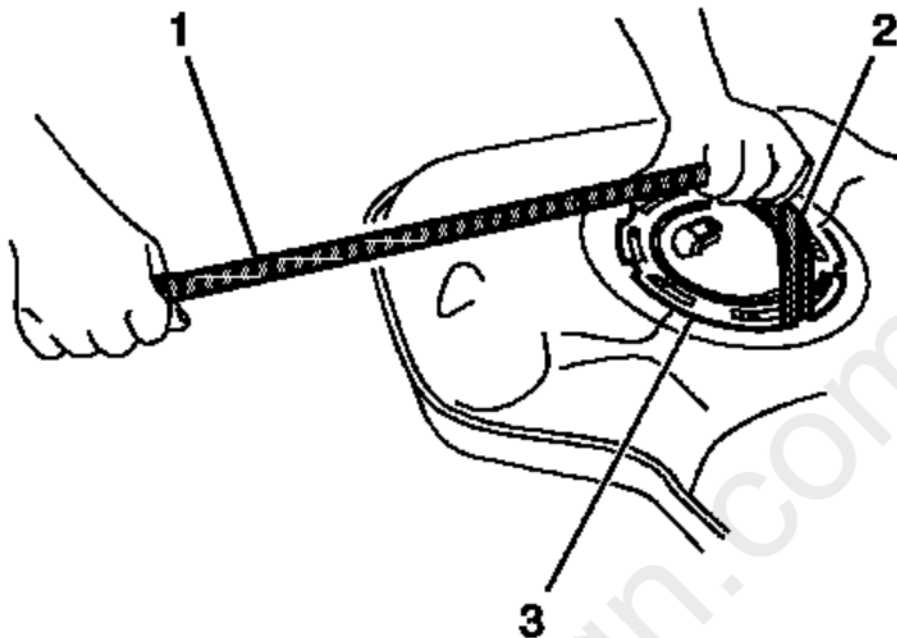


Fig. 62: Identifying J 45722, Breaker-Bar And Fuel Tank Module Lock Ring
Courtesy of GENERAL MOTORS CORP.

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

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

NOTE:

- **DO NOT** use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.
- Do not allow the tool to come in contact with the fuel pipe while unlocking the cam lock ring.

6. Use the **J 45722** (2) and a long breaker-bar (1) in order to unlock the fuel tank module lock ring (3), by turning counterclockwise. See **Special Tools**.
7. Remove the cam lock ring.

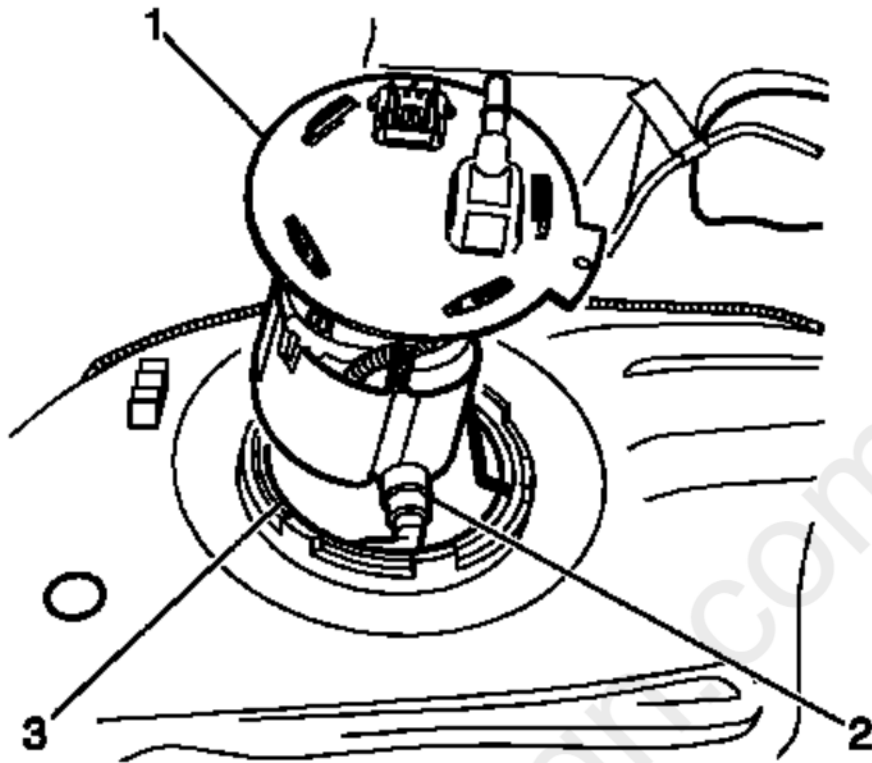


Fig. 63: Identifying Primary Fuel Tank Module, Fuel Transfer Hose Quick Connect Fitting And Fuel Tank Module Seal

Courtesy of GENERAL MOTORS CORP.

8. Partially remove the primary fuel tank module and disconnect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Remove the primary fuel tank module from the fuel tank.
10. Discard the fuel tank module seal (3).

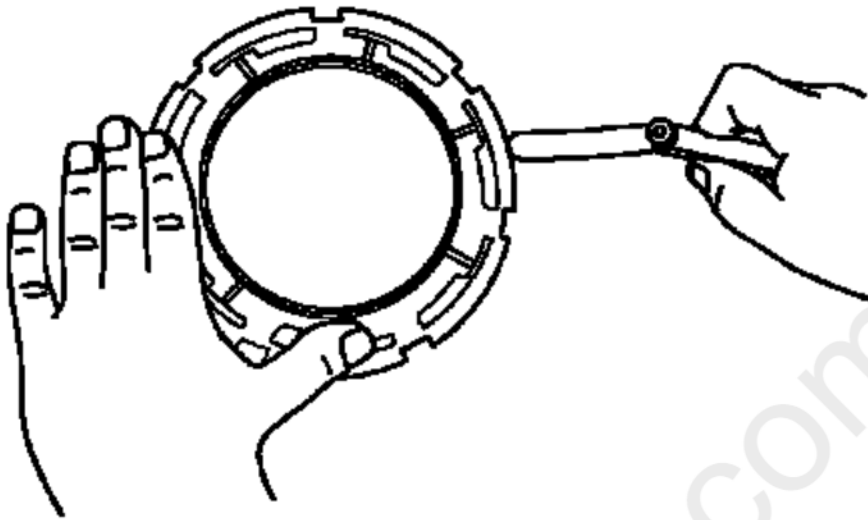


Fig. 64: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS CORP.

NOTE:

- Some lock rings were manufactured with "DO NOT REUSE" stamped into them. These lock rings may be reused if the lock rings are not damaged or warped.
- Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.
- Check the lock ring for flatness.

11. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gauge at 7 points.
12. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
13. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

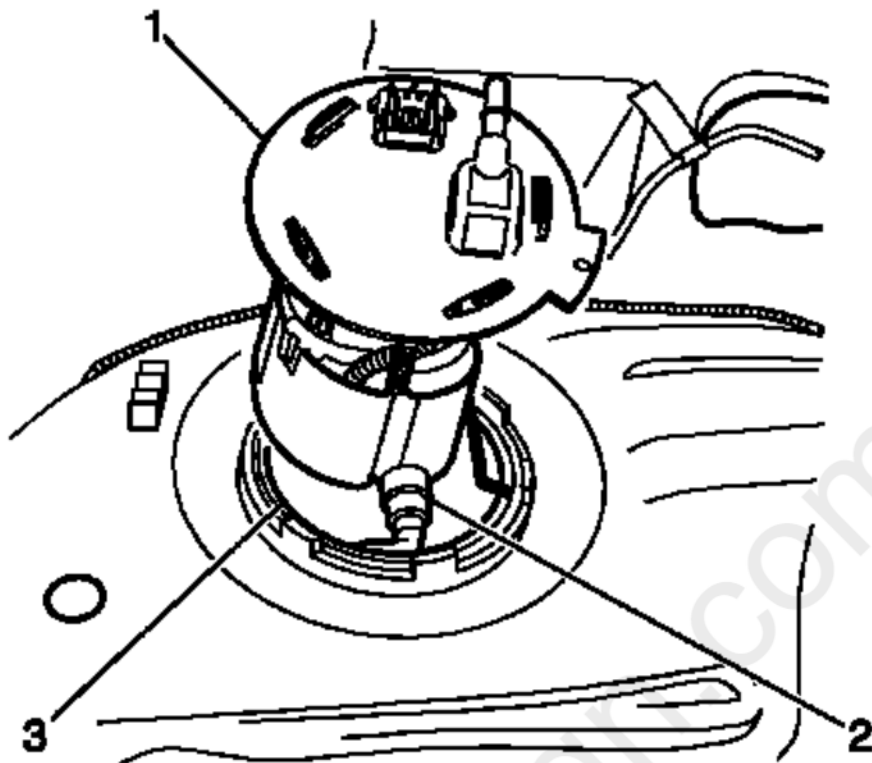


Fig. 65: Identifying Primary Fuel Tank Module, Fuel Transfer Hose Quick Connect Fitting And Fuel Tank Module Seal

Courtesy of GENERAL MOTORS CORP.

NOTE: Always replace the fuel tank module seal when installing the fuel tank module assembly. Replace the lock ring if necessary. DO NOT apply any type of lubrication in the seal groove.

1. Install a NEW fuel tank module seal (3).
2. Grasp the fuel transfer hose from inside the fuel tank.
3. Partially install the primary fuel tank module and connect the fuel transfer hose (2).

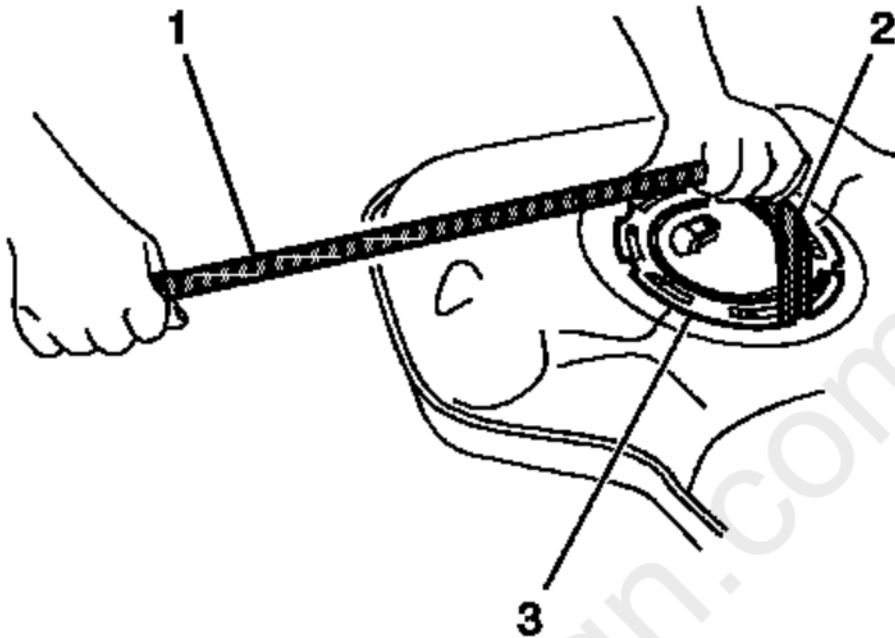


Fig. 66: Identifying J 45722, Breaker-Bar And Fuel Tank Module Lock Ring
Courtesy of GENERAL MOTORS CORP.

4. Press the primary fuel tank module downward, aligning the module to the encapsulated ring.

NOTE: Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

5. Position the cam lock ring (3) to the fuel tank.

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

6. Use the J 45722 (2) and a long breaker-bar (1) to install the fuel tank module lock ring (3), by turning clockwise, until fully seated. See **Special Tools**.

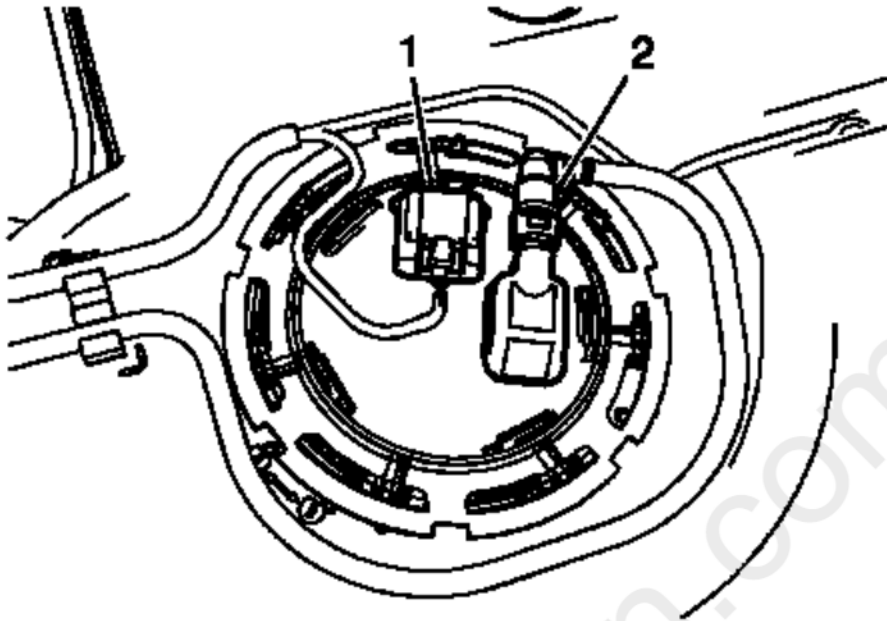


Fig. 67: Identifying Electrical Connector And Fuel Feed Line
 Courtesy of GENERAL MOTORS CORP.

7. Connect the electrical connector (1) and the fuel feed line (2).
8. Install the wire harness to the retainer on the fuel tank.
9. Connect the fuel feed line quick connect fitting to the primary fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
10. Install the fuel feed line to the retainer on the fuel tank.
11. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT (COUPE)

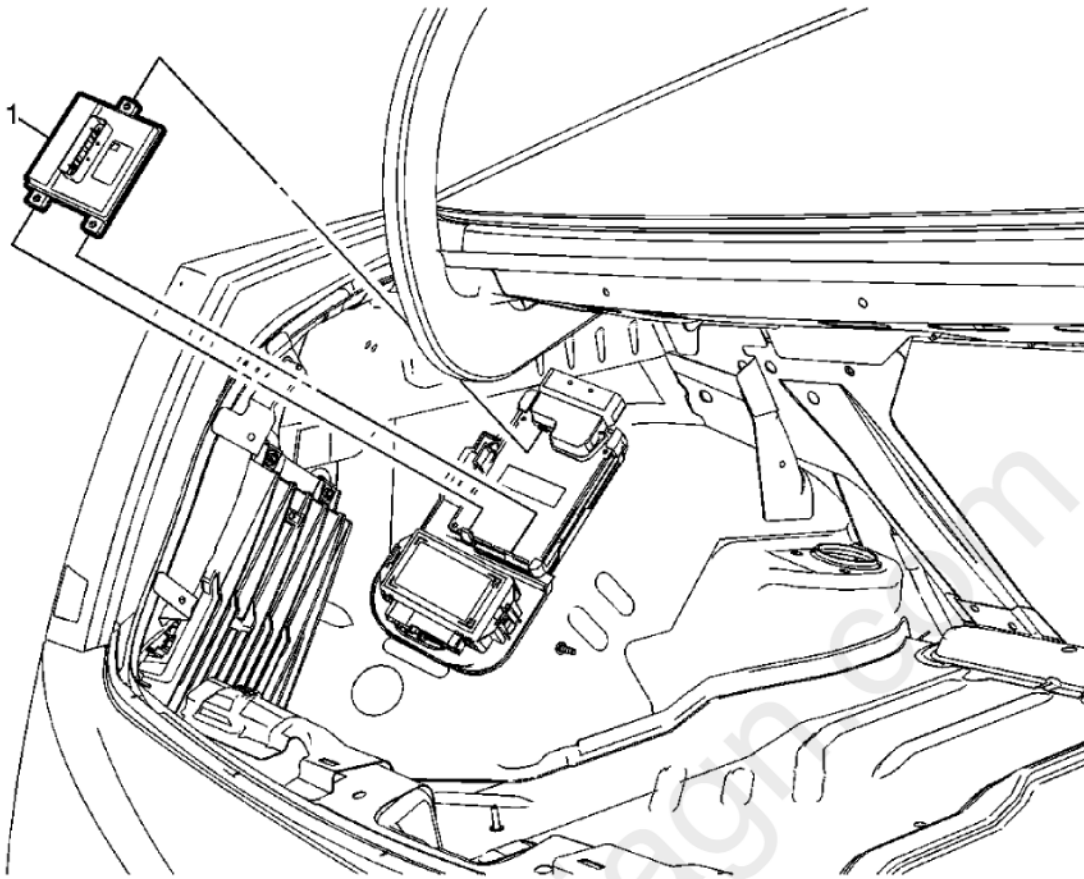


Fig. 68: Fuel Pump Flow Control Module (Coupe)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Partially remove the left side rear compartment trim panel. Refer to <u>Rear Compartment Side Trim Panel Replacement (Sedan)</u> or <u>Rear Compartment Side Trim Panel Replacement (Coupe)</u> .	
1	Fuel Pump Flow Control Module Procedure 1. Disconnect the electrical connector. 2. Release the two integral retainer tabs and remove the module. 3. If replacing the fuel pump flow control module, program the control module. Refer to <u>Control Module References</u> .

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT (WAGON)

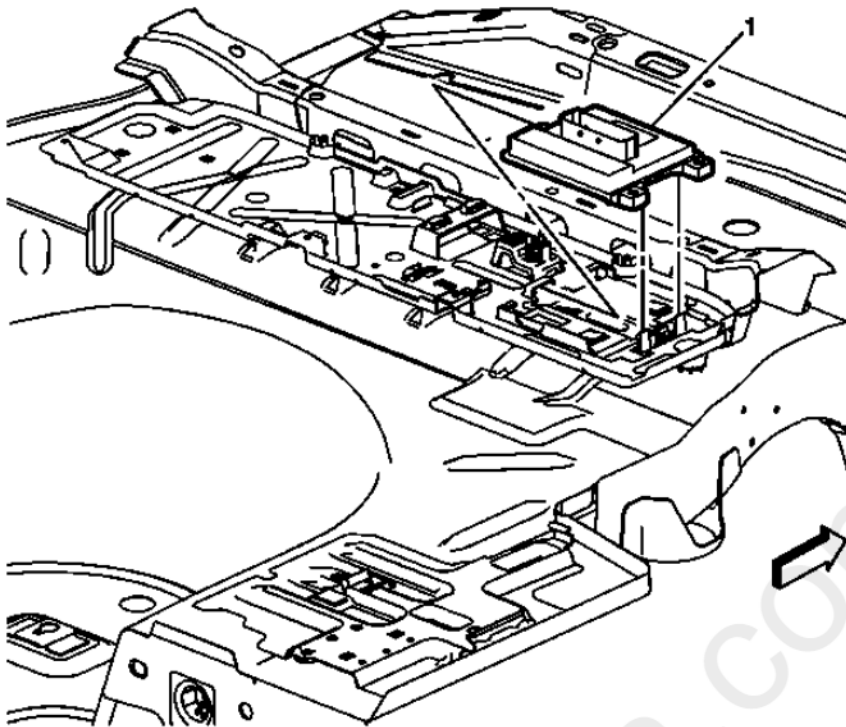


Fig. 69: Fuel Pump Flow Control Module (Wagon)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the rear compartment stowage cover. Refer to <u>Rear Compartment Floor Stowage Compartment Cover Replacement (Wagon)</u> .	
1	Fuel Pump Flow Control Module Fastener CAUTION: Refer to. Tighten: 9 N.m(80 lb in)
2	Fuel Pump Flow Control Module Procedure 1. Disconnect the electrical connector. 2. If replacing, reprogram the control module. Refer to.

FUEL TANK PRESSURE SENSOR REPLACEMENT

Removal Procedure

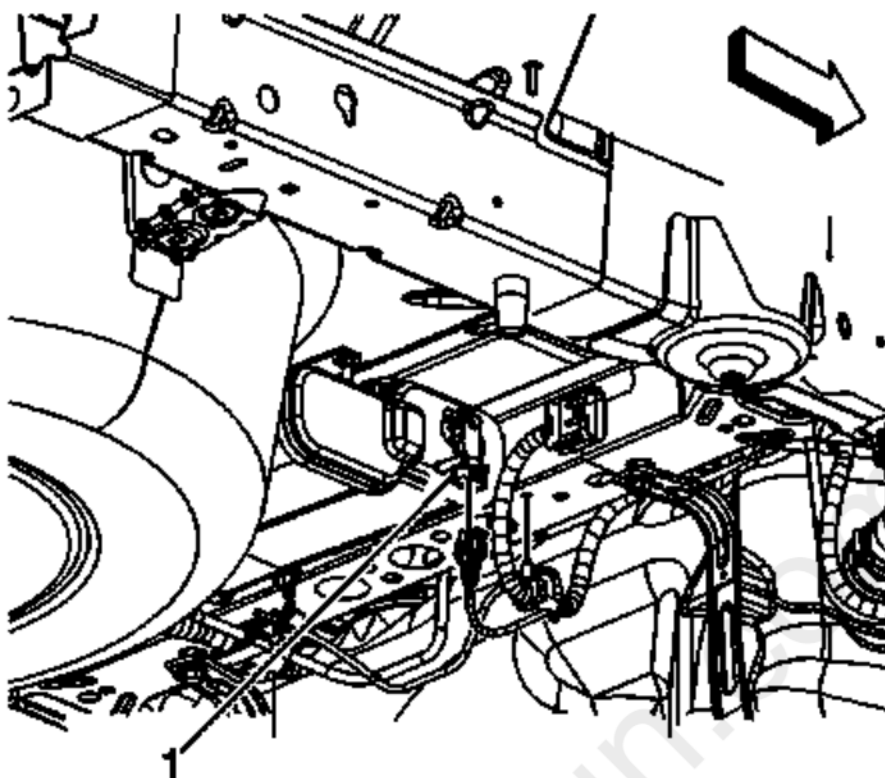


Fig. 70: View Of Fuel Tank Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Disconnect the fuel tank pressure sensor electrical connector (1).

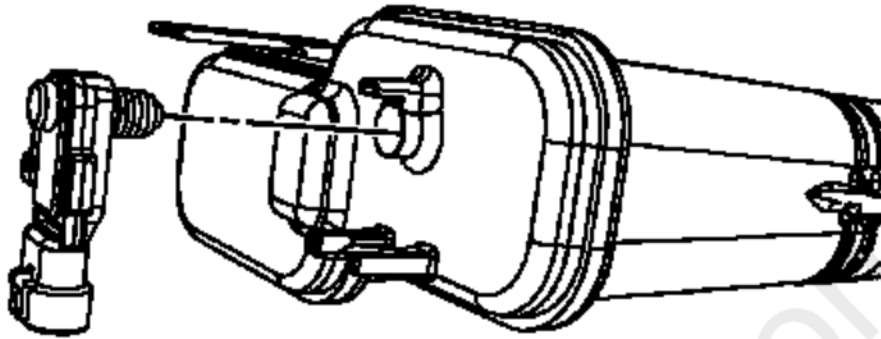


Fig. 71: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: There are alignment features on the canister, however, there are no locking tabs on the sensor/canister. The sensor is held into the canister by the tight fit of the multi-lip seal.

3. Remove the fuel tank pressure sensor from the evaporative emission (EVAP) canister.

Installation Procedure

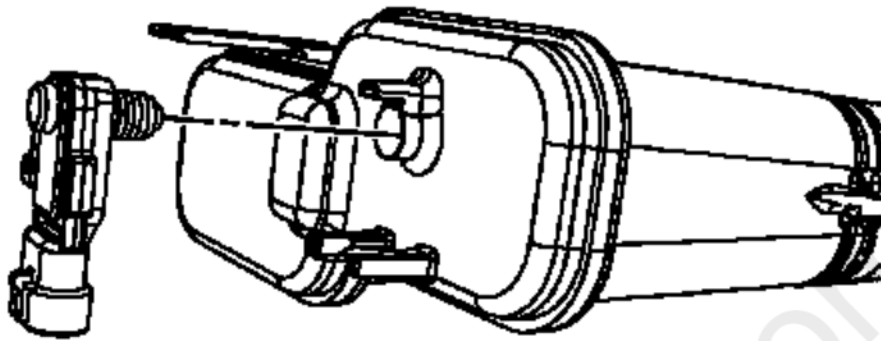


Fig. 72: Fuel Tank Pressure Sensor

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: There are alignment features on the canister, however, there are no locking tabs on the sensor/canister. The sensor is held into the canister by the tight fit of the multi-lip seal.

1. Install the fuel tank pressure sensor to the EVAP canister until fully seated.

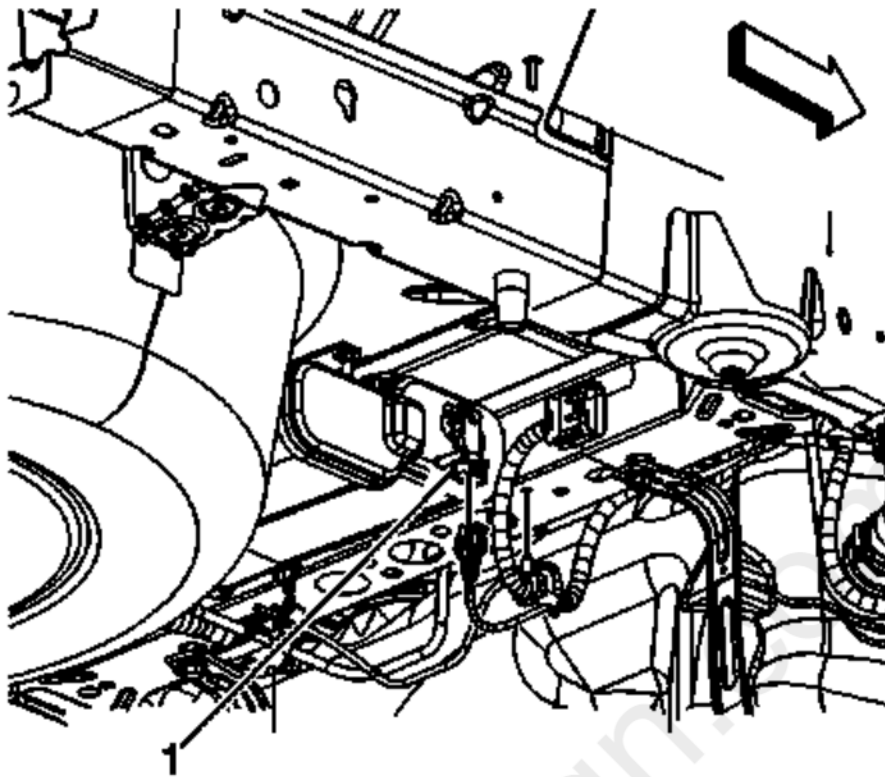


Fig. 73: View Of Fuel Tank Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Connect the fuel tank pressure sensor electrical connector (1).
3. Lower the vehicle.

FILLER TUBE REPLACEMENT

Removal Procedure

1. Remove the fuel filler cap.
2. Drain the fuel tank below the level of the fuel filler hose. Refer to **Fuel Tank Draining**.

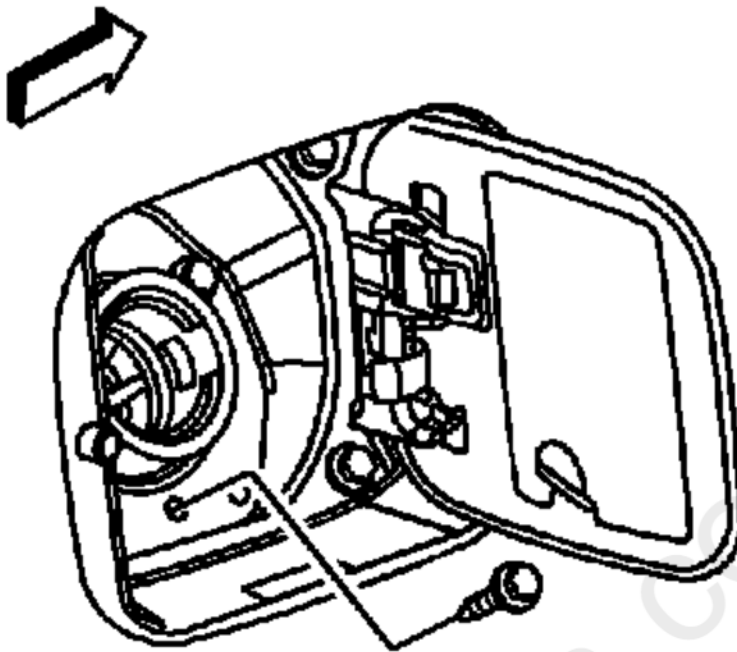


Fig. 74: Fuel Filler Tube Bolts

Courtesy of GENERAL MOTORS CORP.

3. Remove the bolts securing the fuel filler tube to the body.
4. Remove the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the right rear wheelhouse liner. Refer to **Rear Wheelhouse Panel Liner Replacement (Coupe)** or **Rear Wheelhouse Panel Liner Replacement (Sedan and Wagon)** .

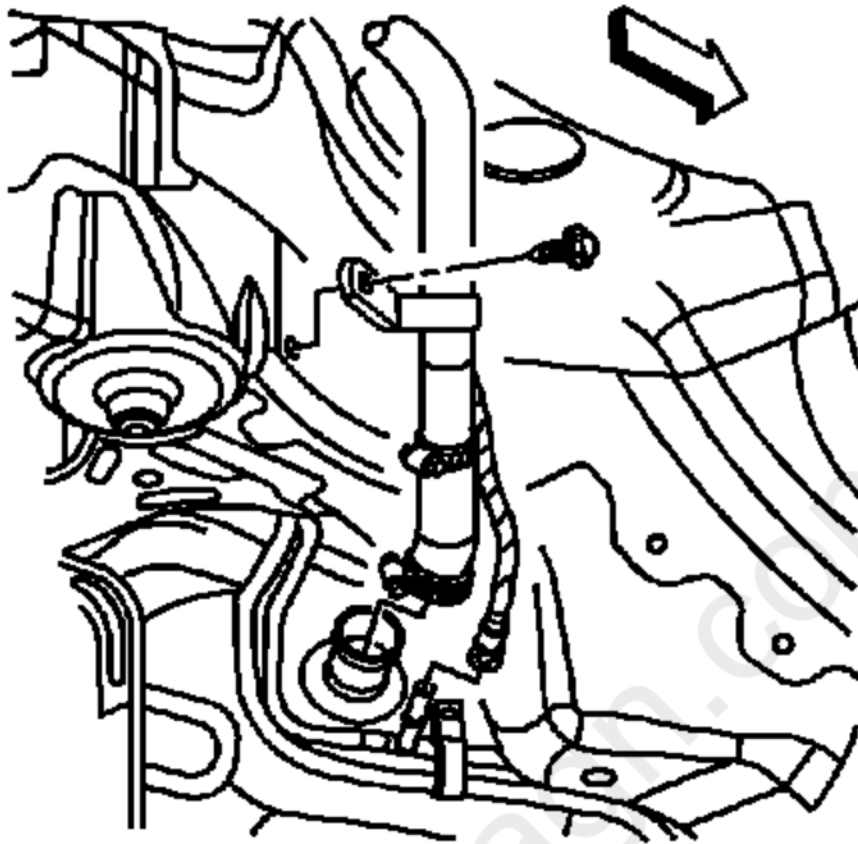


Fig. 75: View Of Fuel Filler Tube Brace Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the fuel filler tube brace bolt.

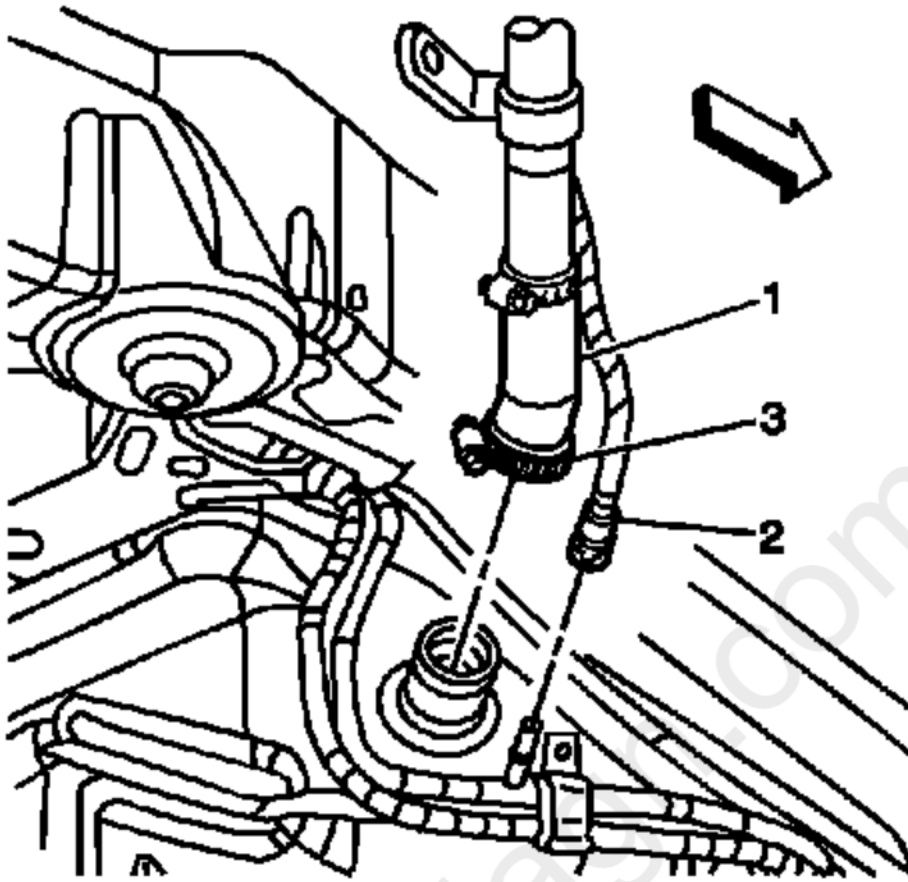


Fig. 76: Identifying Fuel Filler Hose To Fuel tank
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the fuel filler hose (1) from the fuel tank.
8. Disconnect the filler vent tube (2) from the evaporative emission (EVAP) hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Remove the fuel filler tube from the vehicle.

Installation Procedure

1. Position the fuel filler tube to the vehicle.

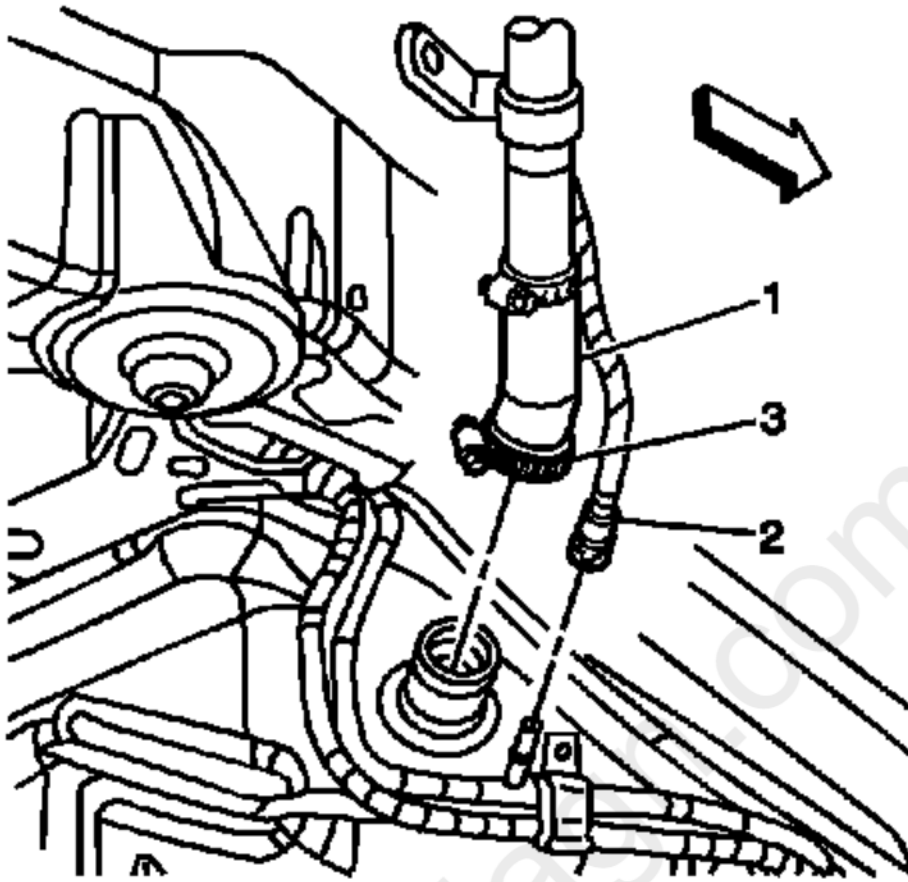


Fig. 77: Identifying Fuel Filler Hose To Fuel tank
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to COMPONENT FASTENER TIGHTENING CAUTION .

2. Connect the filler hose (1) to the fuel tank and tighten to 3.5 N.m (31 lb in).
3. Connect the filler vent tube (2) to the EVAP hose. Refer to Plastic Collar Quick Connect Fitting Service.

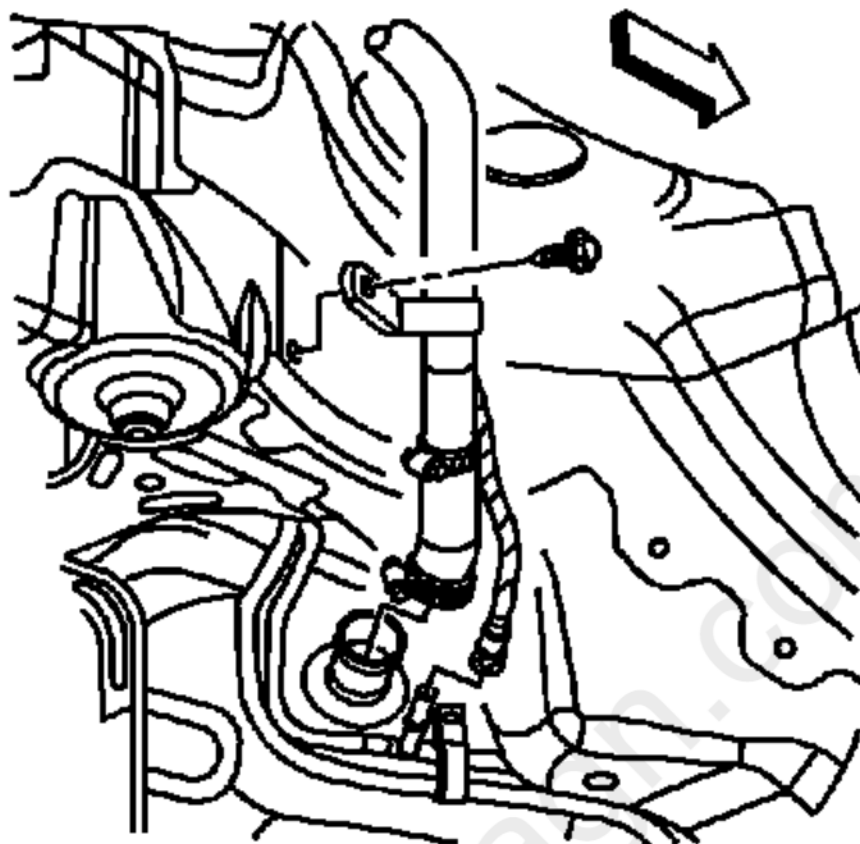


Fig. 78: View Of Fuel Filler Tube Brace Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

4. Install the fuel filler tube brace bolt and tighten to 9 N.m (80 lb in).

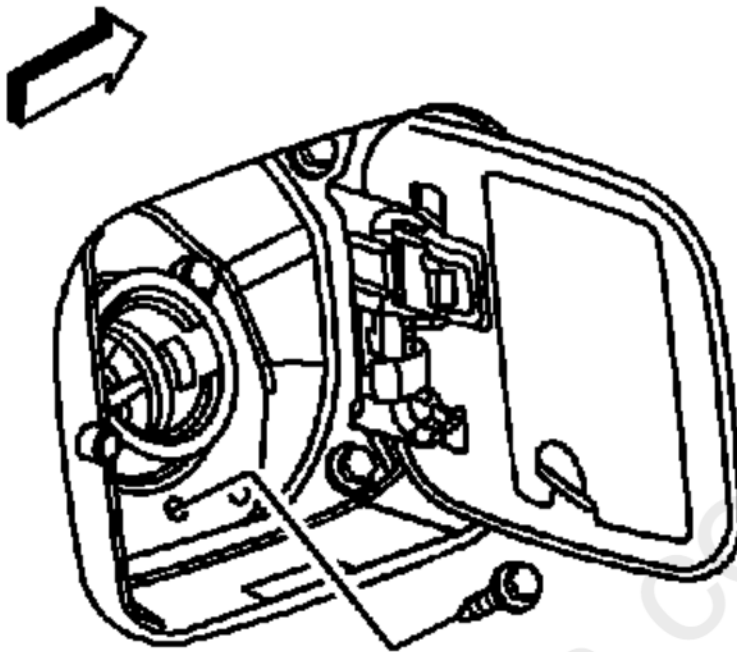


Fig. 79: Fuel Filler Tube Bolts

Courtesy of GENERAL MOTORS CORP.

5. Install the bolts securing the fuel filler tube to the body and tighten to 3.5 N.m (31 lb in).
6. Install the right rear wheelhouse liner. Refer to **Rear Wheelhouse Panel Liner Replacement (Coupe)** or **Rear Wheelhouse Panel Liner Replacement (Sedan and Wagon)** .
7. Install the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .
8. Add fuel to the fuel tank.
9. Inspect for fuel leaks.
10. Install the fuel filler cap.

FUEL LEVEL SENSOR REPLACEMENT - LEFT SIDE

Special Tools

J 45722 Fuel Sender Lock Ring Wrench. See **Special Tools** .

Removal Procedure

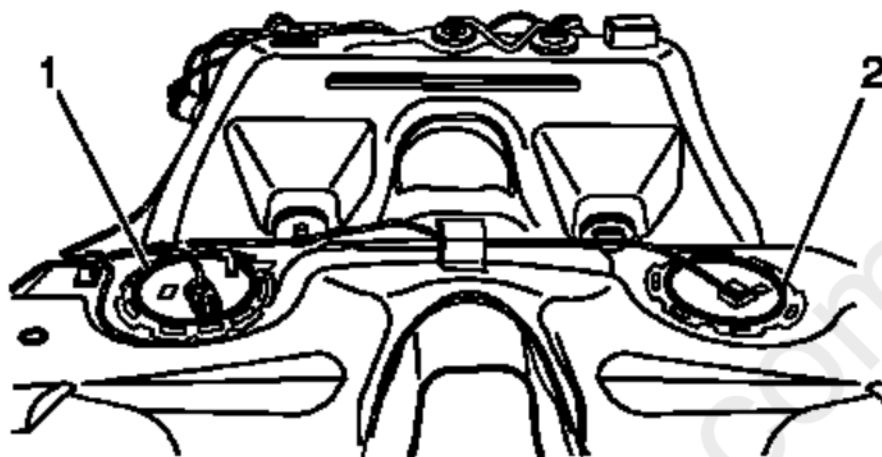


Fig. 80: Fuel Tank Module And Fuel Feed Hose
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to GASOLINE/GASOLINE VAPORS WARNING .

1. Remove the fuel tank in order to gain access to the secondary fuel tank module (2). Refer to **Fuel Tank Replacement**.

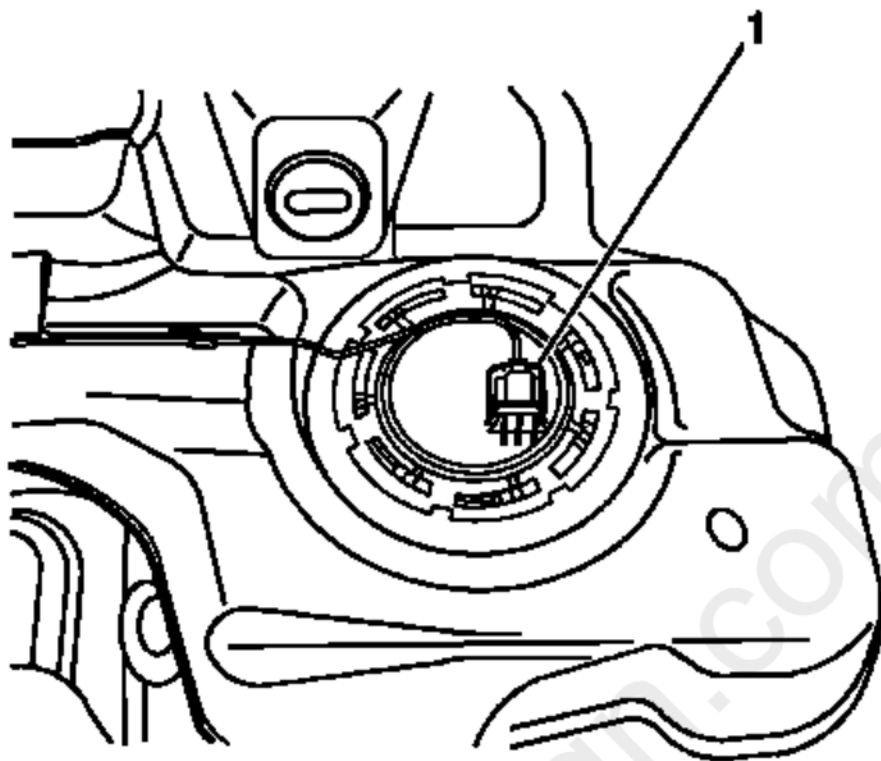


Fig. 81: View Of Electrical Connector Fuel Tank Module
Courtesy of GENERAL MOTORS CORP.

2. Release the interlock and disconnect the electrical connector (1) from the secondary fuel tank module. Position the connector and wire harness aside.

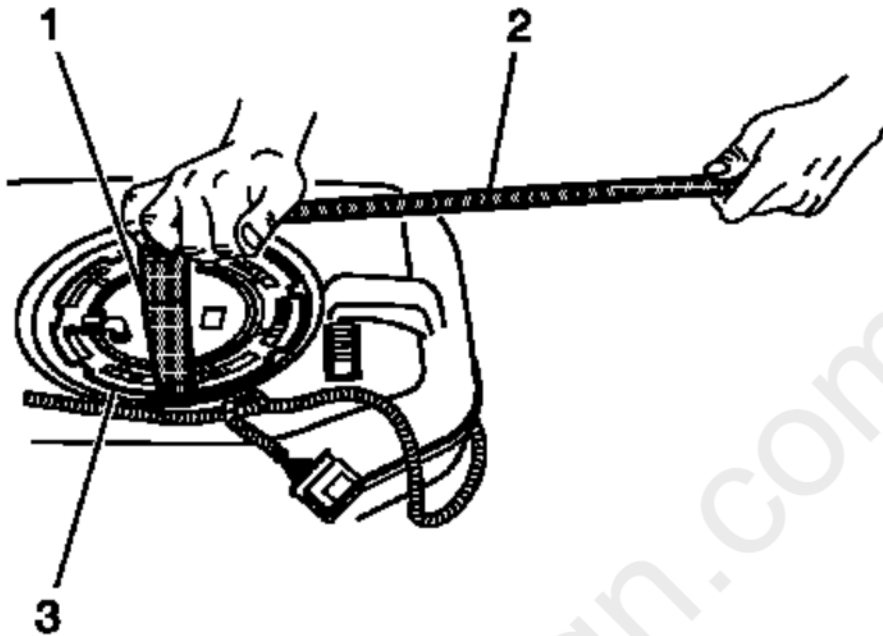


Fig. 82: Identifying J-45722, Long Breaker-Bar And Lock Ring
Courtesy of GENERAL MOTORS CORP.

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

NOTE:

- DO NOT use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.
- Do not allow the tool to come in contact with the fuel pipe while unlocking the cam lock ring.

3. Use the **J 45722** (1) and a long breaker-bar (2) in order to unlock the fuel tank module lock ring (3), by turning counterclockwise. See **Special Tools**.
4. Remove the cam lock ring.

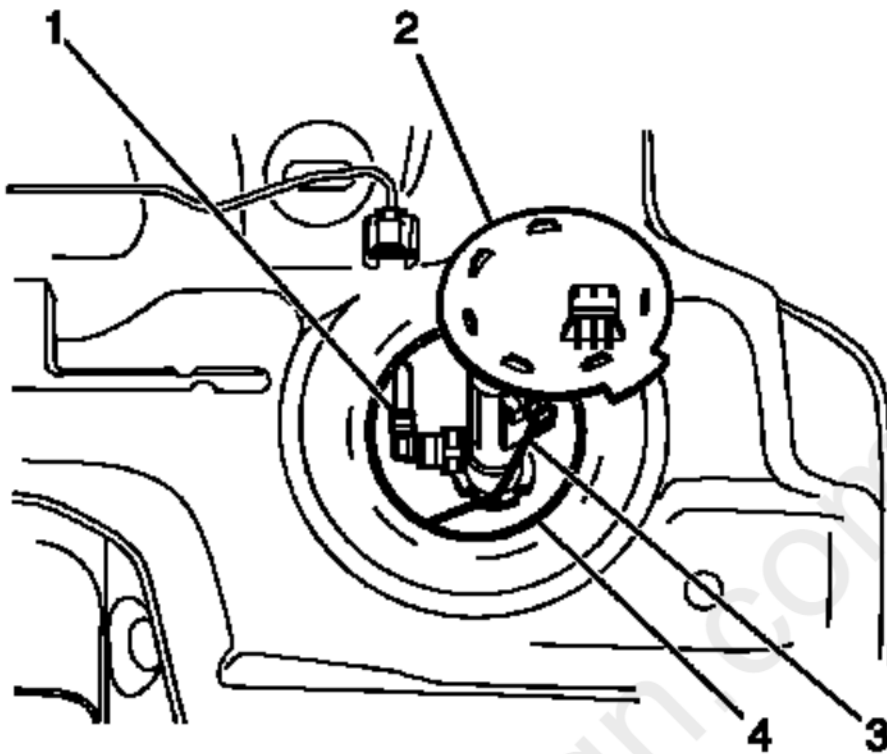


Fig. 83: Secondary Fuel Tank Module, Hose Quick Connect Fitting And Fuel Tank Module Seal
 Courtesy of GENERAL MOTORS CORP.

5. Partially remove the secondary fuel tank module (2) in order to gain access to the fuel transfer hose quick connect fitting (1). Use care not to damage the float arm (3).
6. Disconnect the fuel transfer hose quick connect fitting (1).
7. Remove the secondary fuel tank module from the fuel tank.
8. Discard the fuel tank module seal (4).

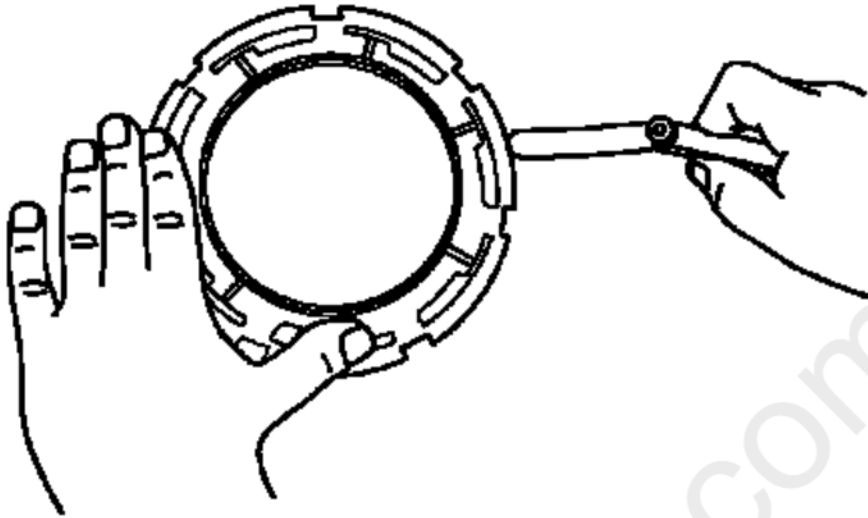


Fig. 84: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS CORP.

NOTE:

- Some lock rings were manufactured with "DO NOT REUSE" stamped into them. These lock rings may be reused if the lock rings are not damaged or warped.
- Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.
- Check the lock ring for flatness.

9. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gauge at 7 points.
10. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
11. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

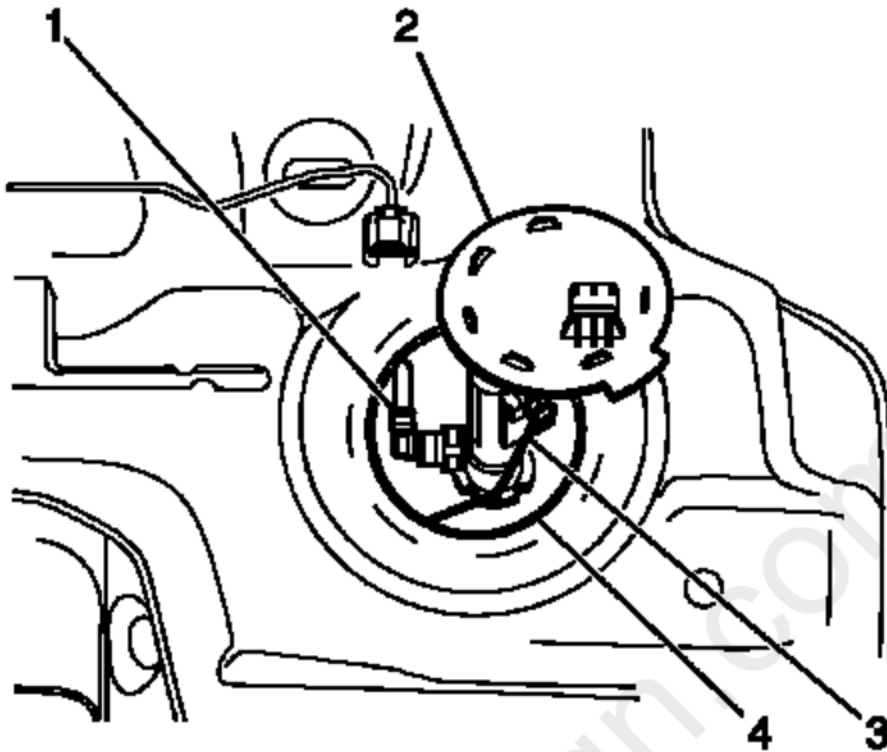


Fig. 85: Secondary Fuel Tank Module, Hose Quick Connect Fitting And Fuel Tank Module Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: Always replace the fuel tank module seal when installing the fuel tank module assembly. Replace the lock ring if necessary. DO NOT apply any type of lubrication in the seal groove.

1. Install a NEW fuel tank module seal (4).
2. Grasp the fuel transfer hose from inside the fuel tank.
3. Partially install the secondary fuel tank module (2) to the fuel tank.
4. Connect the fuel transfer hose quick connect fitting (1) to the port on the fuel tank module.

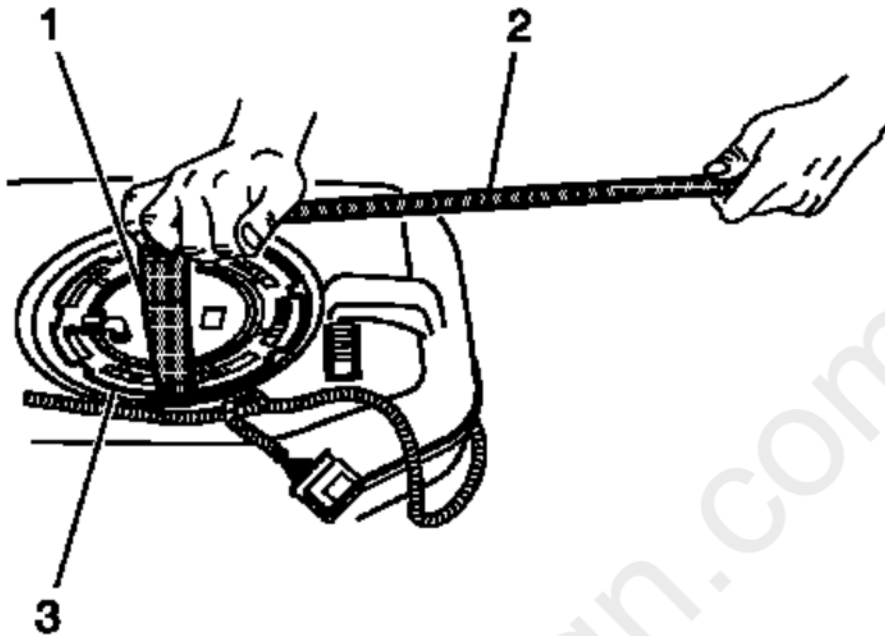


Fig. 86: Identifying J-45722, Long Breaker-Bar And Lock Ring
Courtesy of GENERAL MOTORS CORP.

5. Press the secondary fuel tank module downward, aligning the module to the encapsulated ring.

NOTE: Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

6. Position the cam lock ring (3) to the fuel tank.

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

7. Use the J 45722 (1) and a long breaker-bar (2) to install the fuel tank module lock ring (3), by turning clockwise, until fully seated. See **Special Tools** .

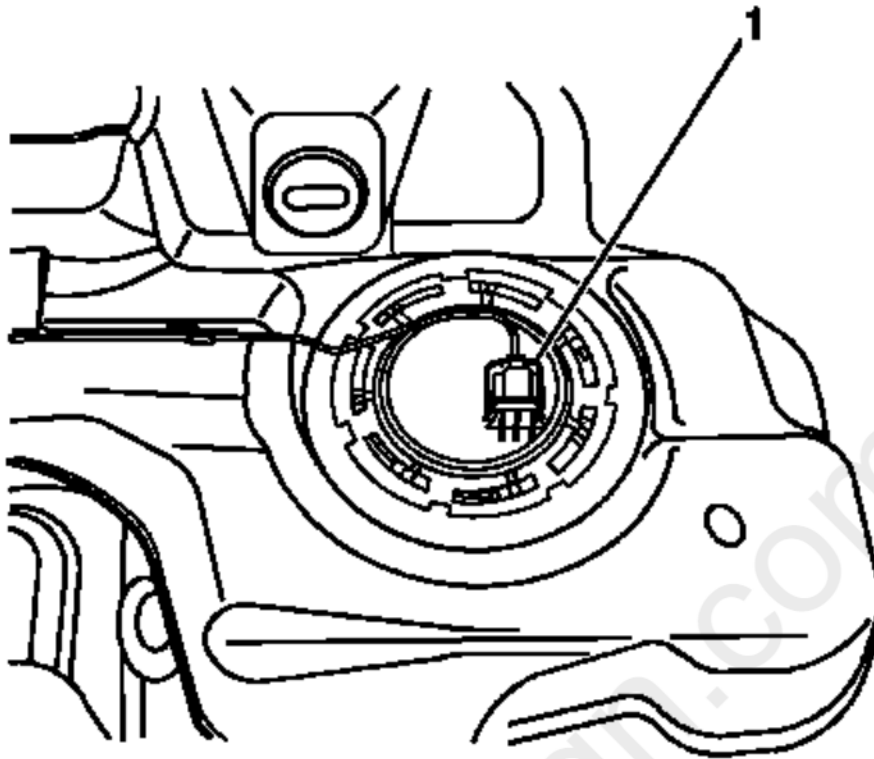


Fig. 87: View Of Electrical Connector Fuel Tank Module
Courtesy of GENERAL MOTORS CORP.

8. Connect the electrical connector (1) to the secondary fuel tank module and engage the connector interlock.
9. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL LEVEL SENSOR REPLACEMENT - RIGHT SIDE

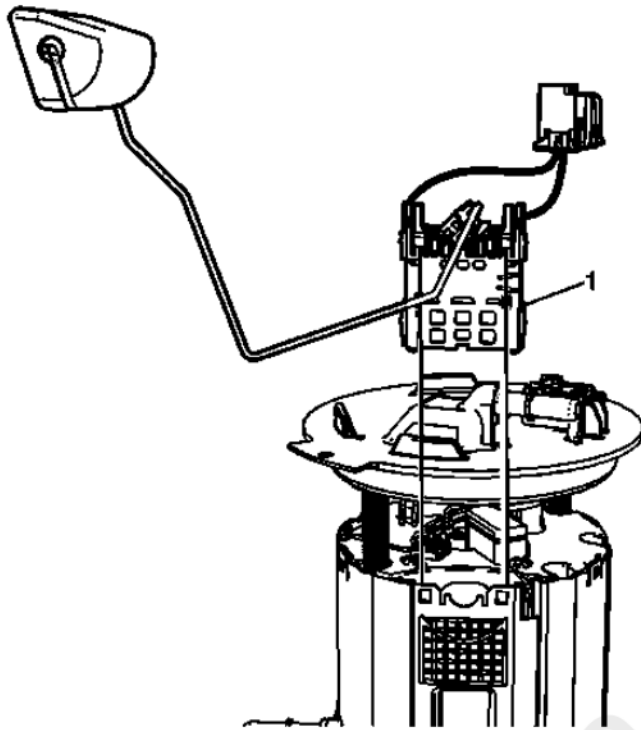
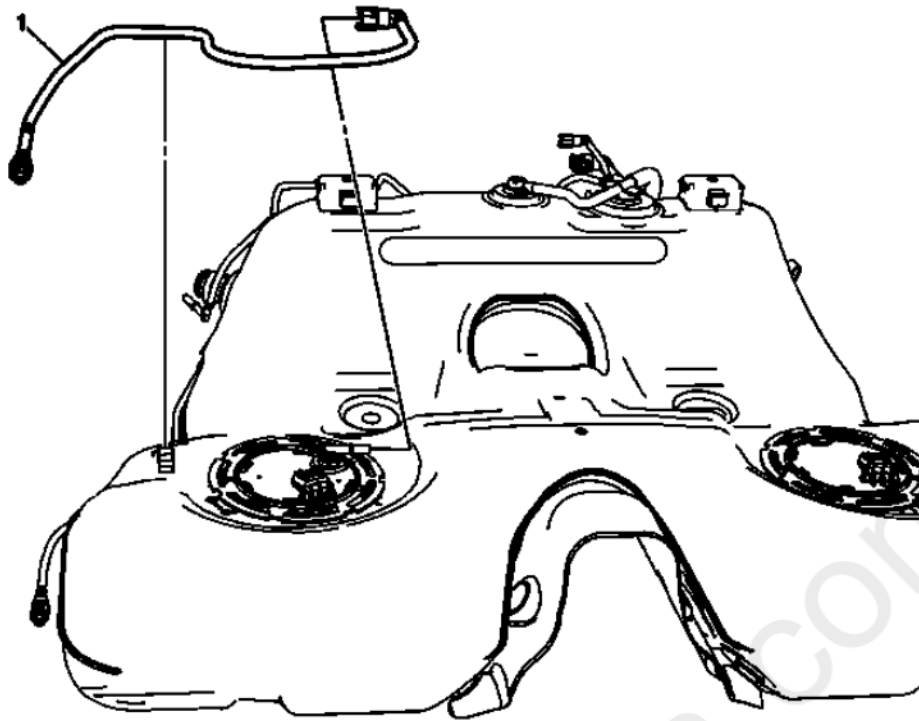


Fig. 88: Fuel Level Sensor - Right Side
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the right fuel tank fuel pump module. Refer to <u>Fuel Tank Fuel Pump Module Replacement - Right Side.</u>	
1	Fuel Level Sensor Procedure 1. Release the retaining tabs. 2. Ensure proper routing of wires. 3. Disconnect the electrical connector.

FUEL FEED REAR PIPE REPLACEMENT

**Fig. 89: Fuel Feed Rear Pipe**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1. Remove the fuel tank. Refer to <u>Fuel Tank Replacement</u> .	
2. Disconnect the quick connect connector. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Fuel Feed Rear Pipe

FUEL LINE REPLACEMENT - CHASSIS (LF1/LLT)**Removal Procedure**

The fuel system hose/pipes are serviceable individually or as a complete fuel/brake bundle assembly, the following procedure is servicing the fuel hose/pipes individually.

WARNING: Refer to **RELIEVING FUEL PRESSURE WARNING** .

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

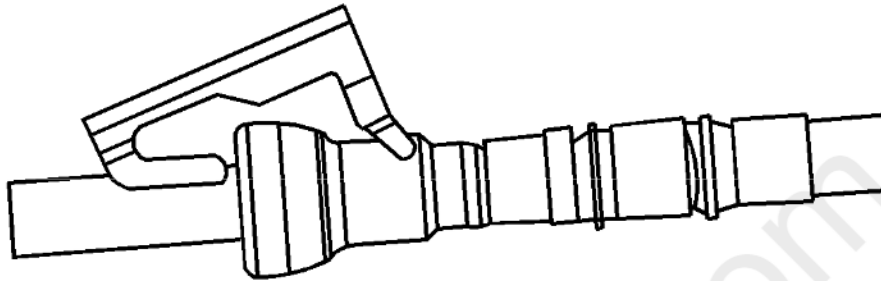


Fig. 90: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS CORP.

2. Remove the fuel pipe retaining clip from the fuel pipe. Refer to **Metal Collar Quick Connect Fitting Service**.

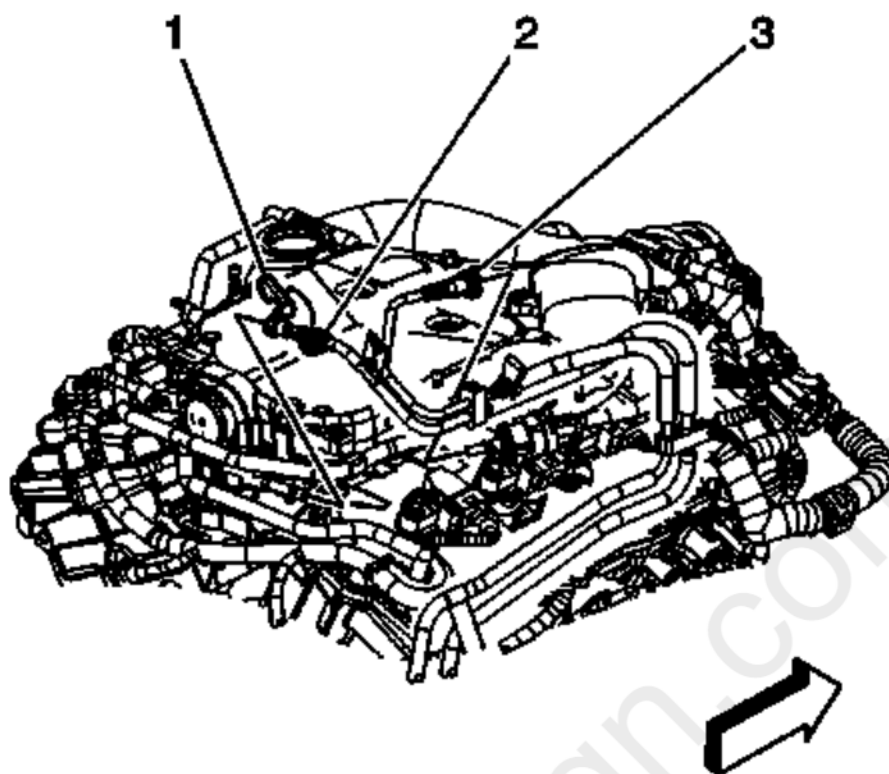


Fig. 91: Top Of Engine View

Courtesy of GENERAL MOTORS CORP.

3. Disconnect the fuel pipe (2) from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
4. Disconnect the evaporative emission (EVAP) purge line (3) from the purge solenoid.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

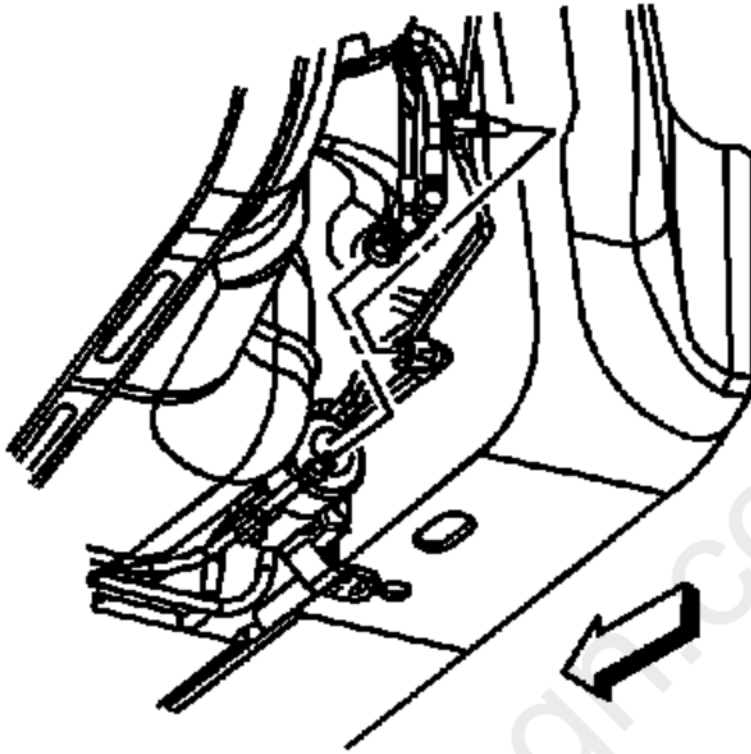


Fig. 92: Identifying Quick-Connect Fitting At The Fuel Filter Inlet
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the fuel pipes from the fuel filter and the fuel tank bundle.

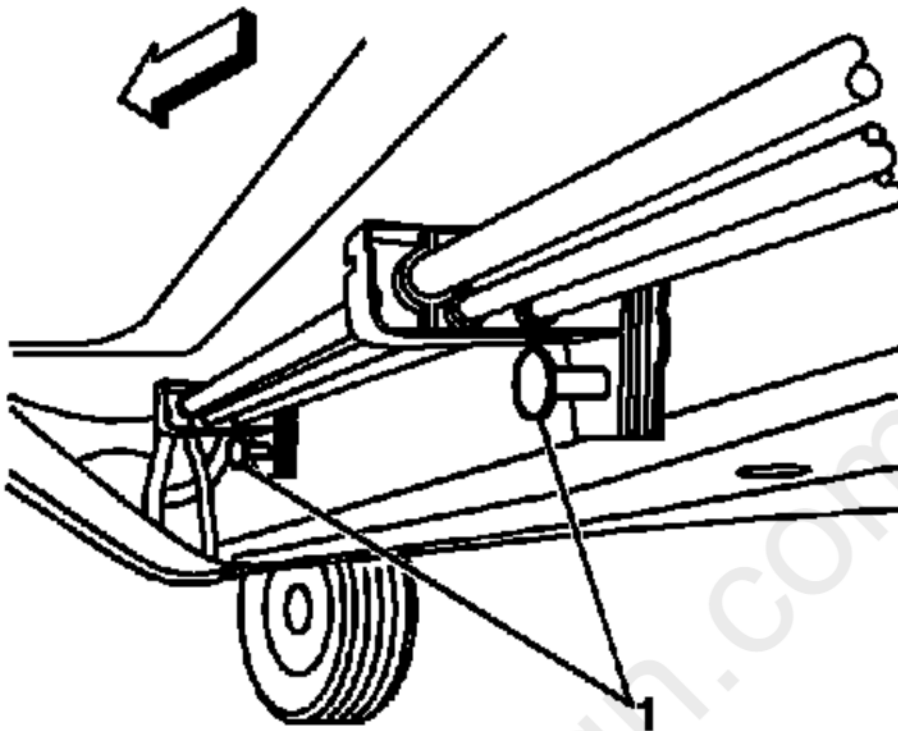


Fig. 93: Locating Fuel/Brake Bundle Chassis Pipe Retainers Locking Mechanisms
Courtesy of GENERAL MOTORS CORP.

7. Pull the locking mechanism (1) outward in order to disengage the fuel/brake bundle chassis pipe retainers from the rail.

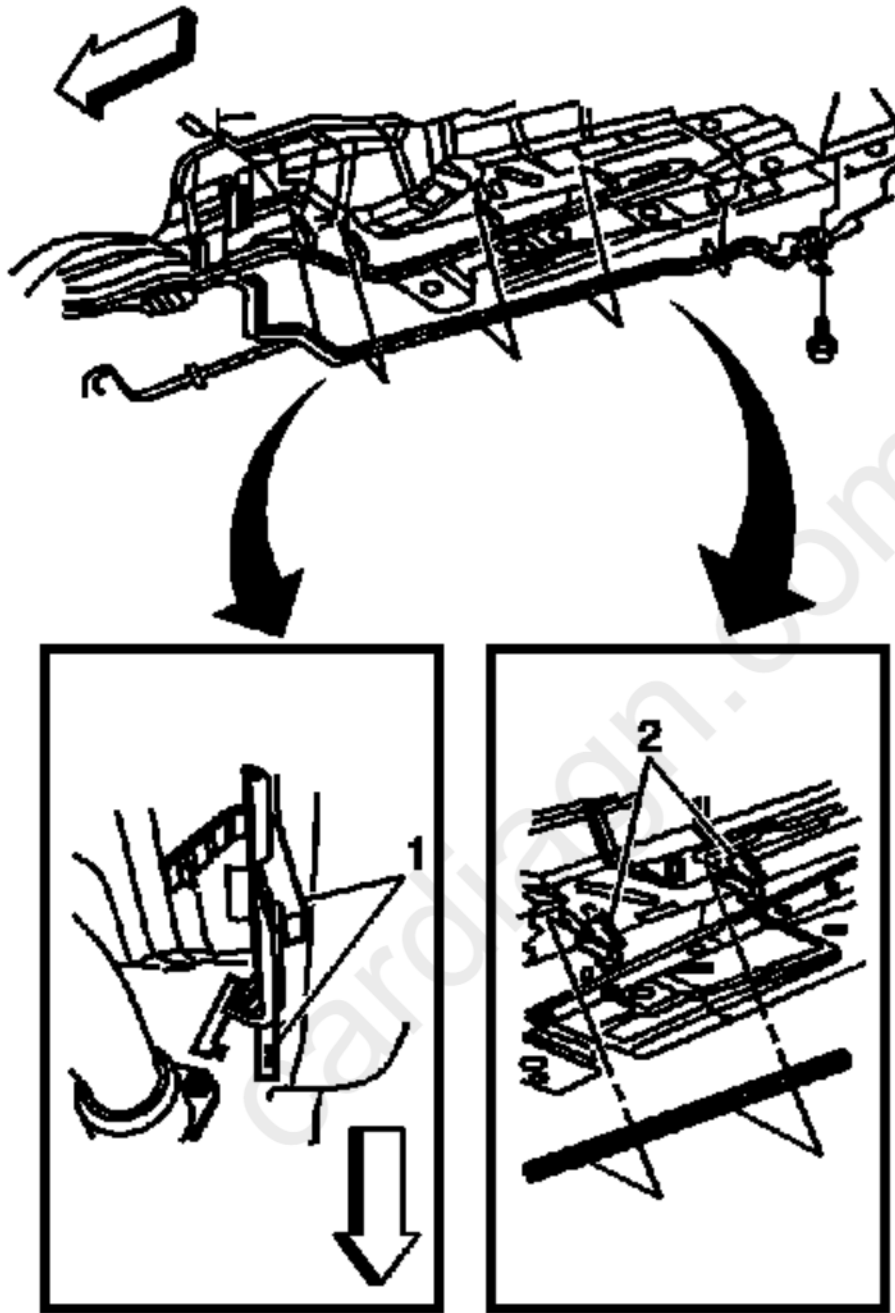


Fig. 94: Locating Fuel/Brake Pipe Retainers
Courtesy of GENERAL MOTORS CORP.

8. Open the retainers (1) located at the forward portion of the rail in order to remove the chassis hose/pipes.
9. Complete the following in order to remove the chassis hose/pipes from the retainers (2) located at the rearward portion of the rail.
 1. Pull the retainers (2) free from the rail.
 2. Open the retainers (2) at the top.

3. Remove the chassis hose/pipes from the retainers (2).

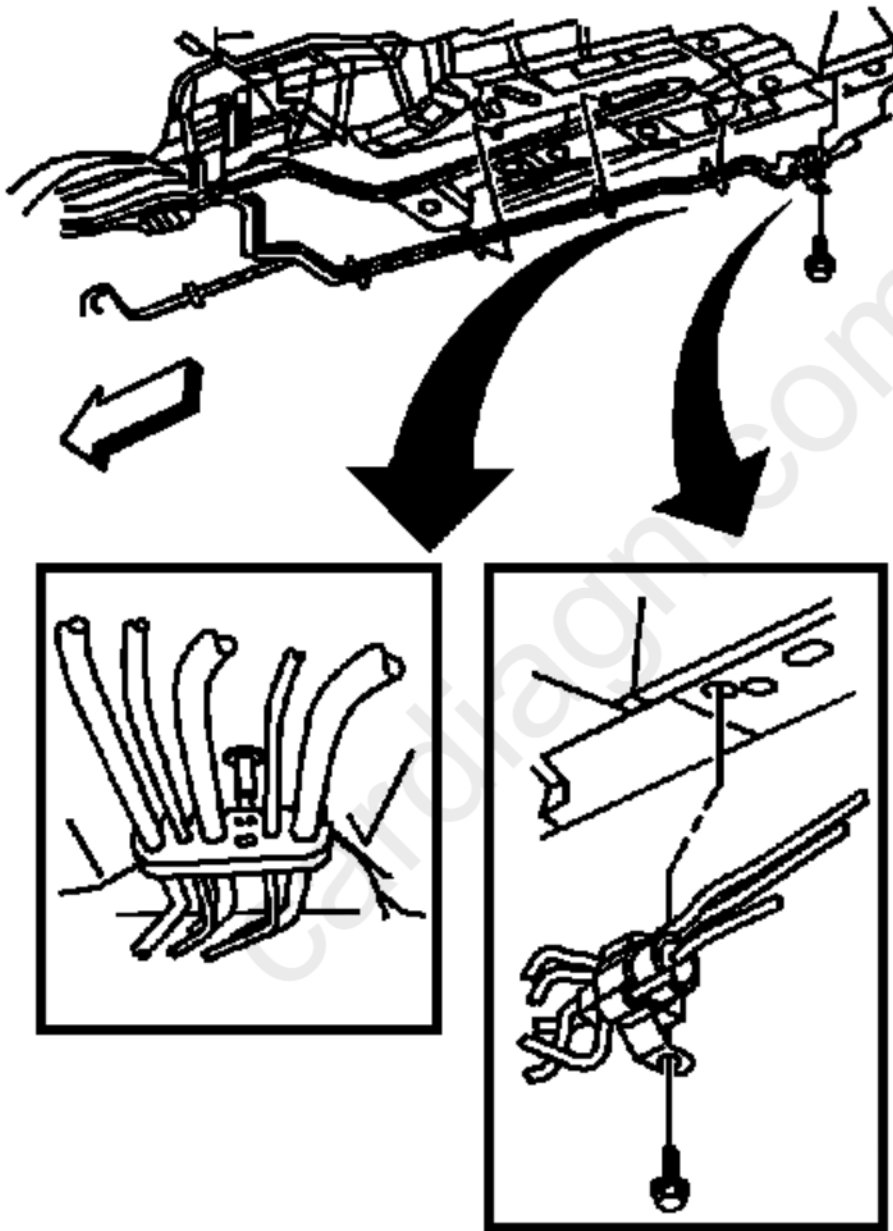


Fig. 95: View Of Fuel Filter Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Pull downward in order to disconnect the fuel/brake bundle chassis pipe retainer from the underbody.
11. Remove the bolt securing the fuel filter bracket to the body.
12. Remove the EVAP hose from the fuel filter bracket.

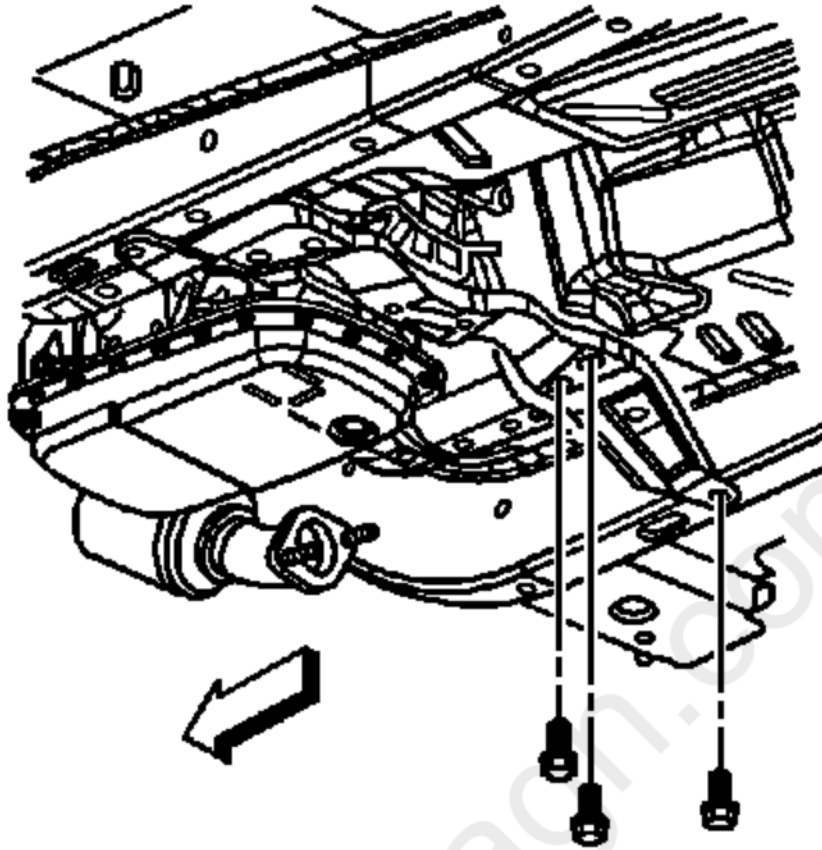


Fig. 96: View Of Transmission Support Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the bolts securing the transmission support to the underbody, from the right side only.

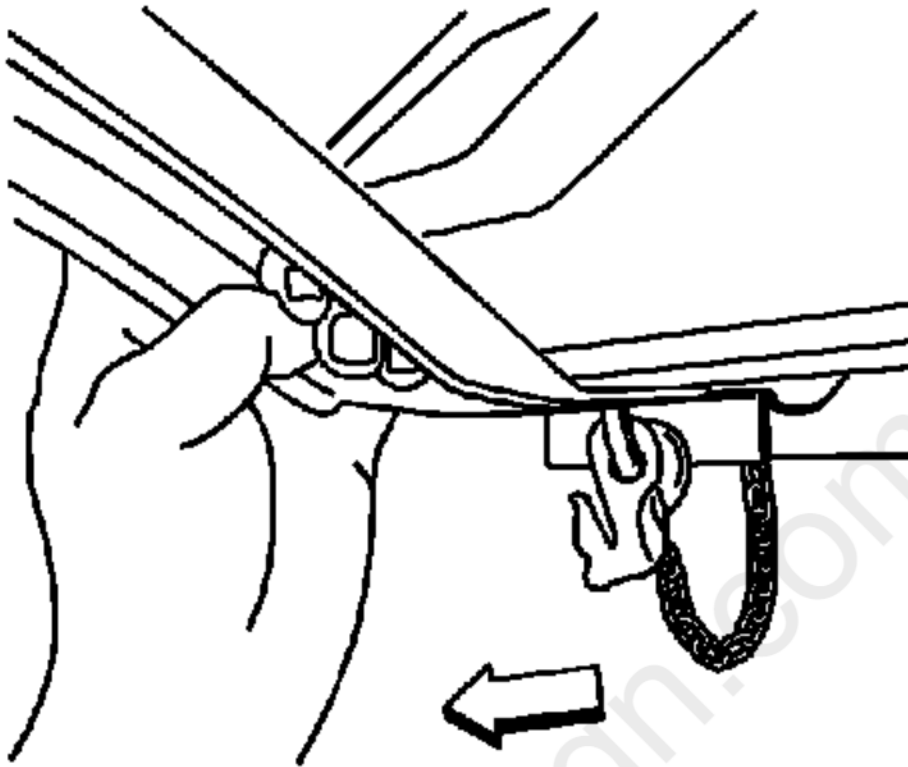


Fig. 97: Pulling Right Side Transmission Support Down
Courtesy of GENERAL MOTORS CORP.

14. Pull the right side transmission support down only enough to allow removal of the chassis fuel hose/pipes.
15. Partially lower the hoist only enough to simultaneously gain access to both the front and rear portions of the chassis fuel hose/pipes.
16. With the aid of an assistant, carefully guide the chassis fuel hose/pipes down through the engine compartment, removing from the bottom.

Installation Procedure

1. Clean any of the contamination from the male line ends and apply a few drops of clean engine oil.
2. With the aid of an assistant, carefully guide the chassis fuel hose/pipes up through the engine compartment into position.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

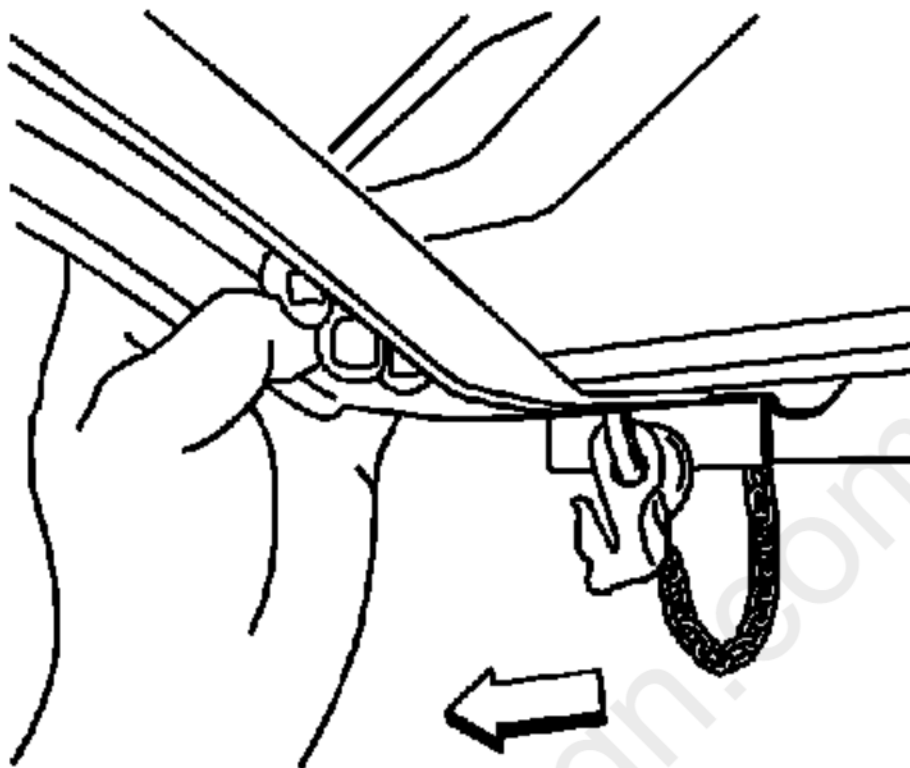


Fig. 98: Pulling Right Side Transmission Support Down
Courtesy of GENERAL MOTORS CORP.

4. Pull the right side transmission support down only enough to allow installation of the chassis fuel hose/pipes.

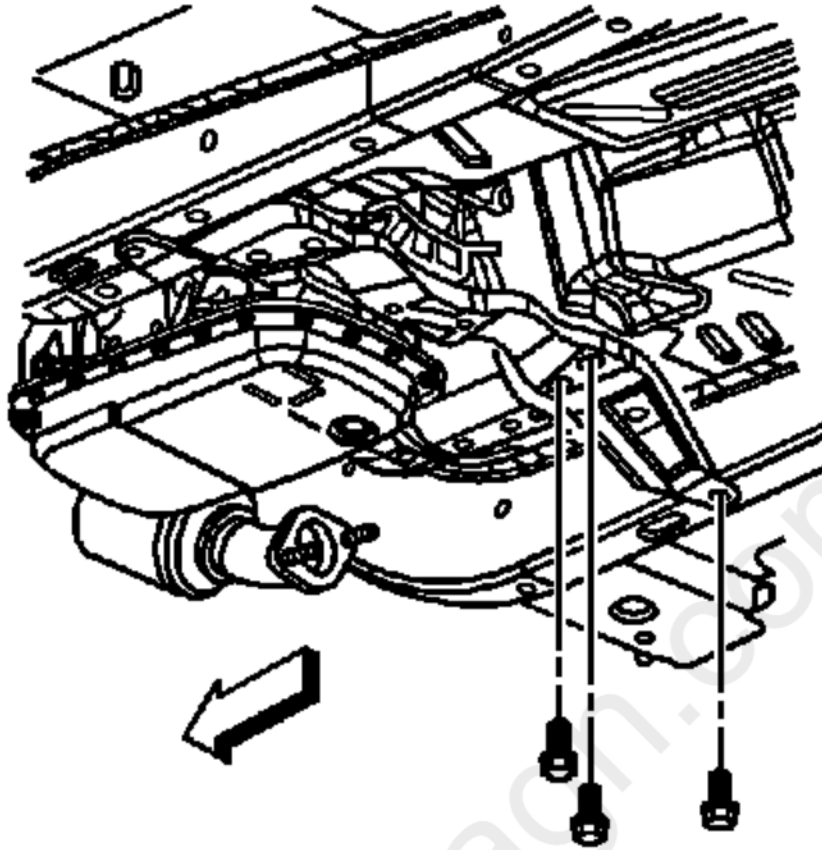


Fig. 99: View Of Transmission Support Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the transmission support right side bolts. Refer to **Transmission Support Replacement (Automatic AWD)** or **Transmission Support Replacement (Automatic CTS-V)** or **Transmission Support Replacement (Automatic RWD except CTS-V)** or **Transmission Support Replacement (Manual CTS-V)** or **Transmission Support Replacement (Manual except CTS-V)** .

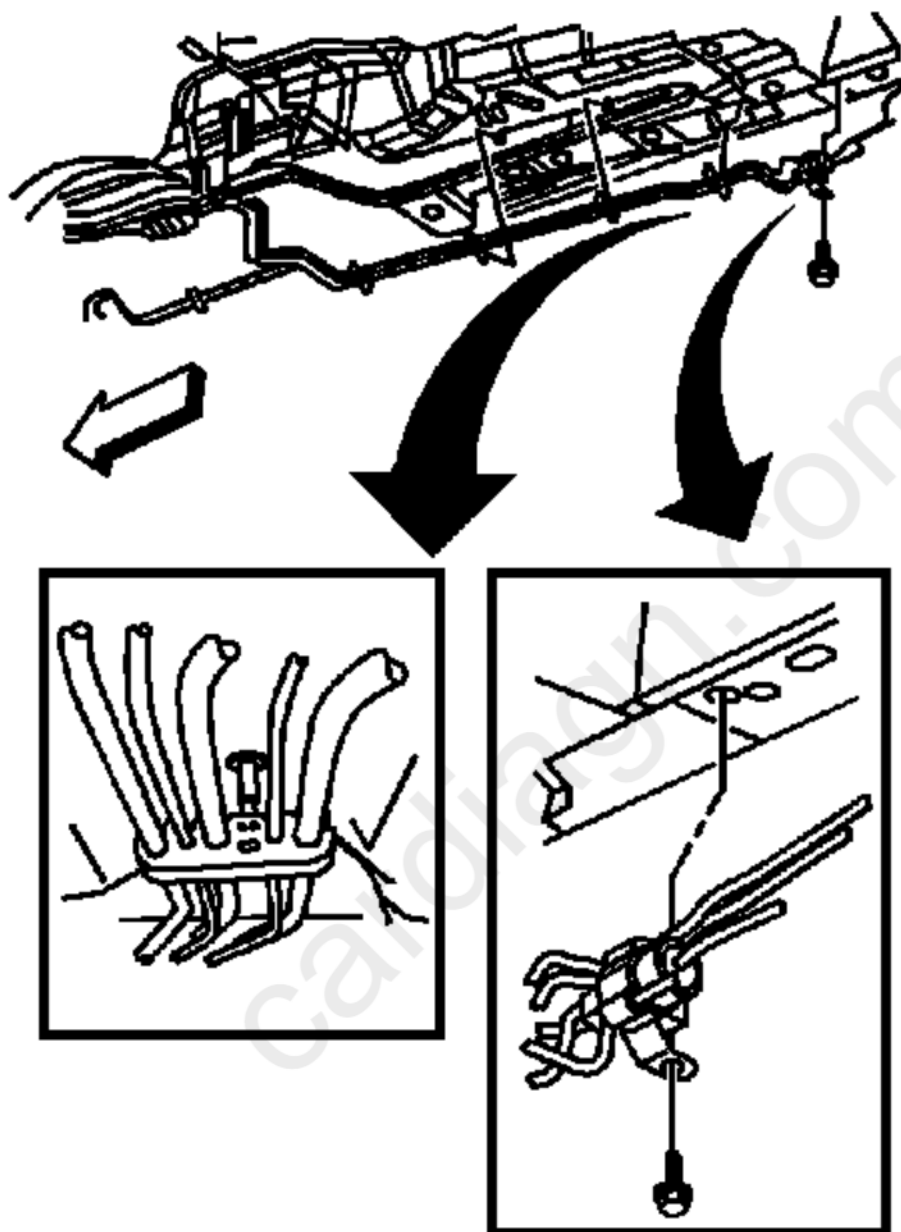


Fig. 100: View Of Fuel Filter Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Install the EVAP hose to the fuel filter bracket:

CAUTION: Refer to FASTENER CAUTION .

7. Install the fuel filter bracket bolt and tighten to 9 N.m (80 lb in).
8. Install the fuel/brake bundle to the underbody.

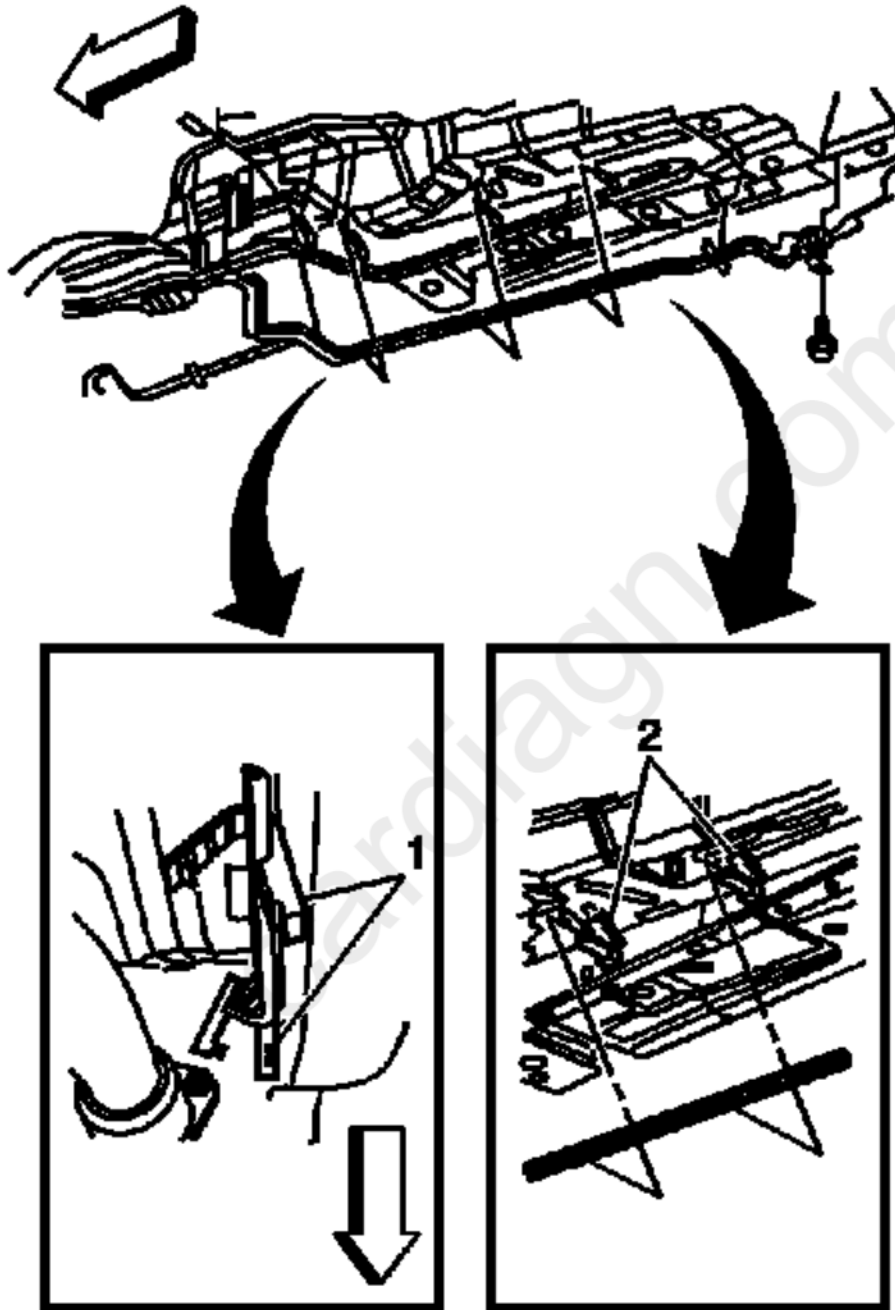


Fig. 101: Locating Fuel/Brake Pipe Retainers
Courtesy of GENERAL MOTORS CORP.

9. Complete the following in order to install the chassis hose/pipes to the retainers (2) located at the rearward portion of the rail:

1. Install the chassis hose/pipes into the retainers (2).
 2. Close the retainers (2) at the top.
 3. Insert the retainers (2) into the rail.
10. Install the chassis hose/pipes into the retainers (1) located at the forward portion of the rail.
 11. Close the retainers.

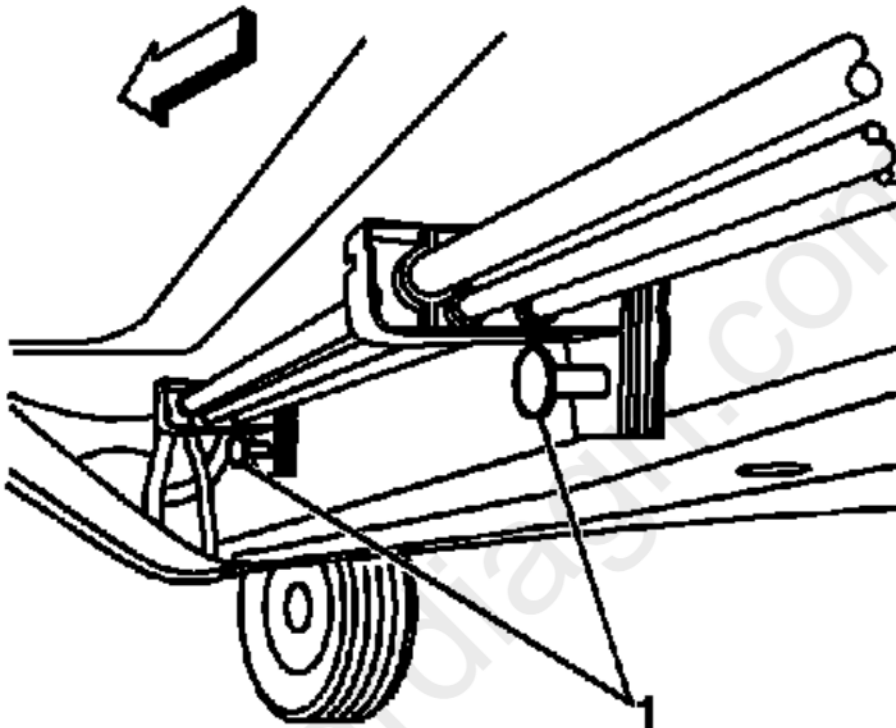


Fig. 102: Locating Fuel/Brake Bundle Chassis Pipe Retainers Locking Mechanisms
Courtesy of GENERAL MOTORS CORP.

12. Push the locking mechanism (1) inward in order to engage the fuel/brake bundle chassis pipe retainers to the rail.

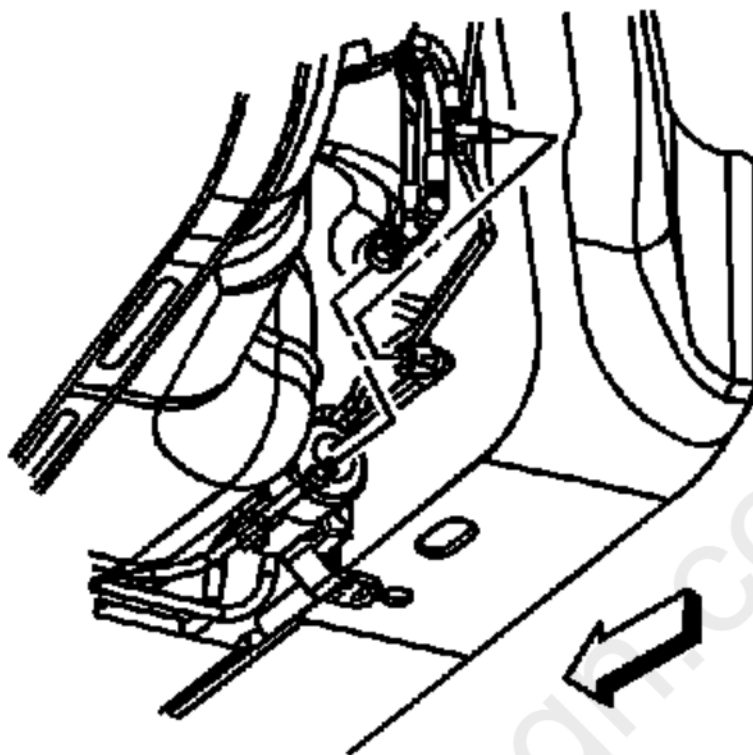


Fig. 103: Identifying Quick-Connect Fitting At The Fuel Filter Inlet
Courtesy of GENERAL MOTORS CORP.

13. Connect the fuel feed pipe and the EVAP hose to the fuel bundle.
14. Lower the vehicle.

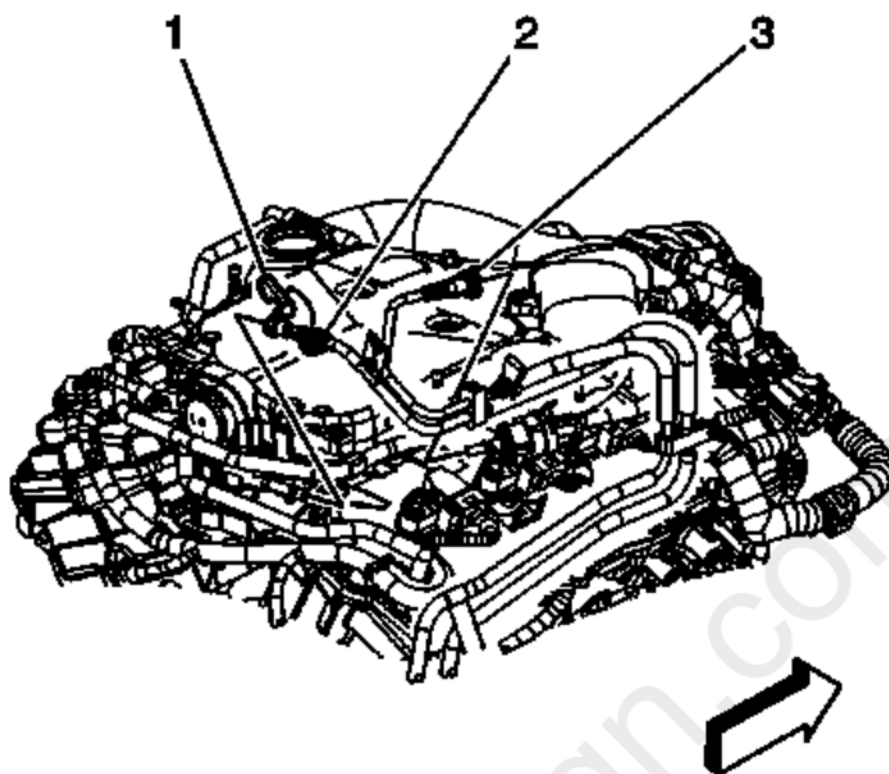


Fig. 104: Top Of Engine View

Courtesy of GENERAL MOTORS CORP.

15. Connect the evaporative emission (EVAP) purge line (3) to the purge solenoid.
16. Connect the fuel feed pipe (1) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.

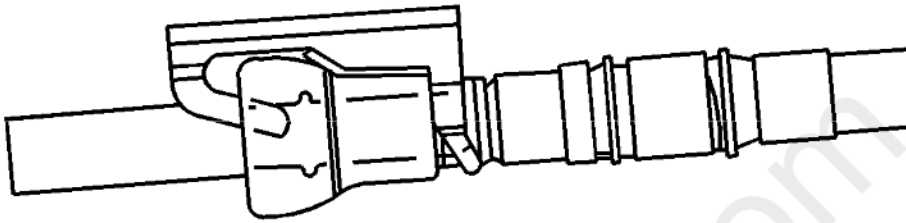
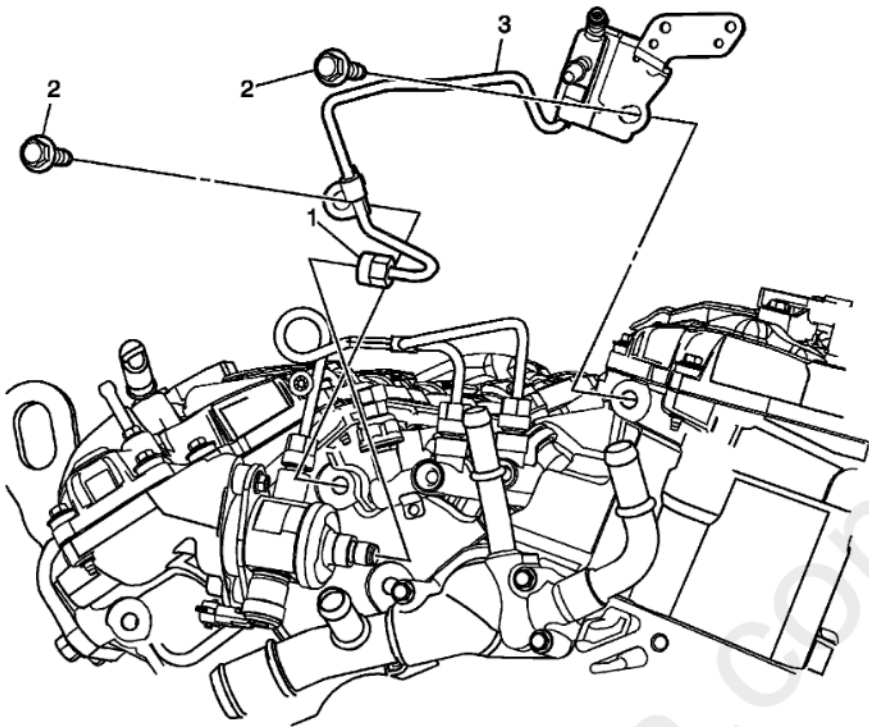


Fig. 105: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS CORP.

17. Install the fuel pipe retaining clip.

FUEL FEED PIPE REPLACEMENT (LF1)

**Fig. 106: View Of Fuel Feed Pipe Components**

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 fuel injector sight shield. Refer to <u>Fuel Injector Sight Shield Replacement (LP1, LY7)</u> or <u>Fuel Injector Sight Shield Replacement (LLT)</u>. 3. Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement (LF1)</u> or <u>Fuel Pipe Shield Replacement (LLT)</u>.	
1	Fitting (Qty: 1) CAUTION: Refer to. Tighten: 28 N.m(20 lb ft)
2	Bolt (Qty: 2) Tighten: 50 N.m(28 lb ft)
3	Fuel Feed Pipe Procedure

1. Ensure that the high pressure fuel pipe, and fuel pump fittings are clean and dry prior to assembly.
2. Pressure up the fuel system and check for leaks.

FUEL FEED PIPE REPLACEMENT (LLT)

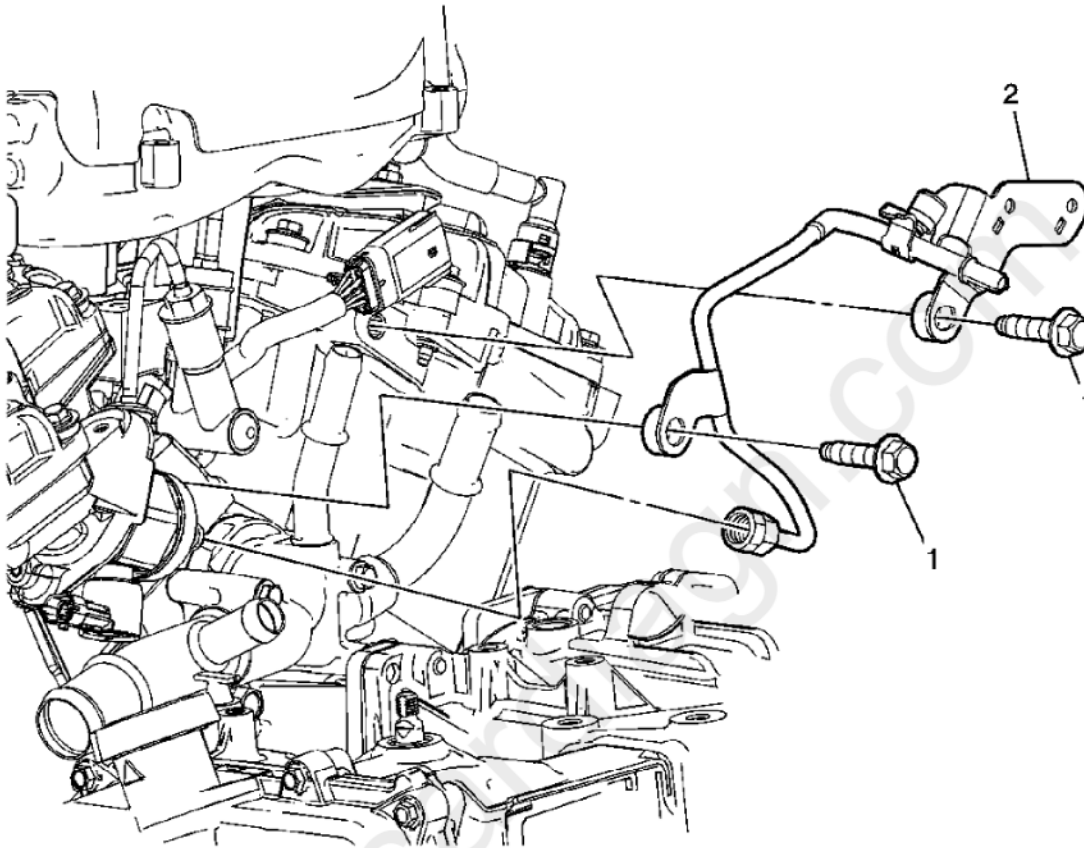


Fig. 107: Fuel Feed Pipe (LLT)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief. 2. Disconnect the fuel feed pipe. Refer to Plastic Collar Quick Connect Fitting Service.	
1	Fuel Feed Pipe Fastener (Qt: 2) CAUTION: Refer to. Tighten: 50 N.m (28 lb ft)

- | | |
|---|--|
| 2 | Fuel Feed Pipe
Procedure:
Discard the pipe when removed, and install a NEW pipe.

Tighten: 28 N.m (21 lb ft) |
|---|--|

FUEL SYSTEM CLEANING

WARNING: Refer to **GASOLINE/GASOLINE VAPORS WARNING** .

The following procedure covers the disassembly and the inspection of the complete fuel supply system. If the fuel system is contaminated, the fuel system can be cleaned. You can usually determine the extent of the fuel system contamination during the disassembly.

1. Remove the right fuel tank pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.
2. Remove the left fuel level sensor assembly. Refer to **Fuel Level Sensor Replacement - Left Side**
3. Locate the tank in a suitable work area away from any heat, any flame, or any other source of ignition.
4. Perform the following procedures:
 - Inspect the fuel tank pump module strainer. Replace the primary fuel tank module if the strainer is contaminated.
 - Inspect the left fuel level sensor assembly for debris. Clean the left fuel level sensor assembly if debris is found.

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

- Use compressed air in order to apply air pressure to the transfer tube.

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

5. Flush the fuel tank with running hot water for at least five minutes. Pour the water out of the fuel sender assembly opening. Rock the tank in order to ensure that the removal of the water from the tank is complete.
6. Refer to **Metal Collar Quick Connect Fitting Service** in order to disconnect the following quick connect fittings from the fuel rail:
 - The feed hose/pipe
 - The return hose/pipe
7. Use compressed air in order to apply air pressure to the fuel lines in the opposite direction from the normal fuel flow.

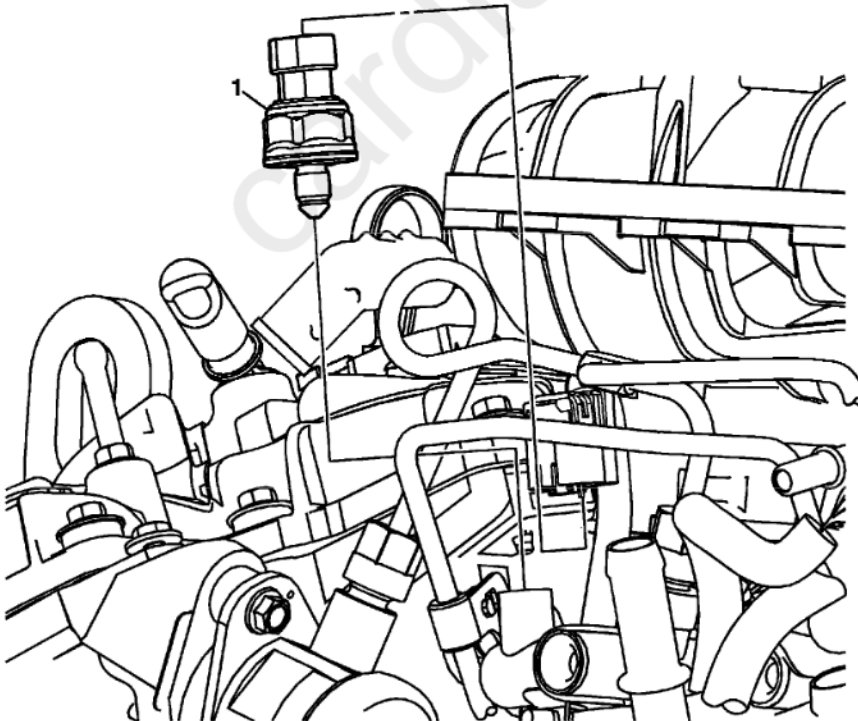
8. Remove the fuel injectors and fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1, LFW)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LLT)** and **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1, LFW)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)**.
9. Clean and inspect the fuel injectors and fuel rail.

Installation Procedure

Assemble the fuel system as follows:

1. Install the fuel injectors and fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1, LFW)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LLT)** and **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1, LFW)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)**.
2. Install the right fuel tank pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.
3. Install the left fuel level sensor assembly. Refer to **Fuel Level Sensor Replacement - Left Side**.
4. Refer to **Metal Collar Quick Connect Fitting Service** in order to connect the following quick connect fittings to the fuel rail:
 - The feed hose/pipe
 - The return hose/pipe

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL (LF1)



2011 Cadillac CTS

2011 ENGINE Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - CTS

Fig. 108: Identifying Fuel Pressure Sensor - Fuel Injection Fuel Rail (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to <u>Fuel Injector Sight Shield Replacement (LP1, LY7)</u> or <u>Fuel Injector Sight Shield Replacement (LLT)</u> .	
1	Fuel Injection Fuel Rail Fuel Pressure Sensor CAUTION: Refer to. Tighten: 33 N.m (25 lb ft)

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

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
3. Remove the foam insulator from the fuel rails.

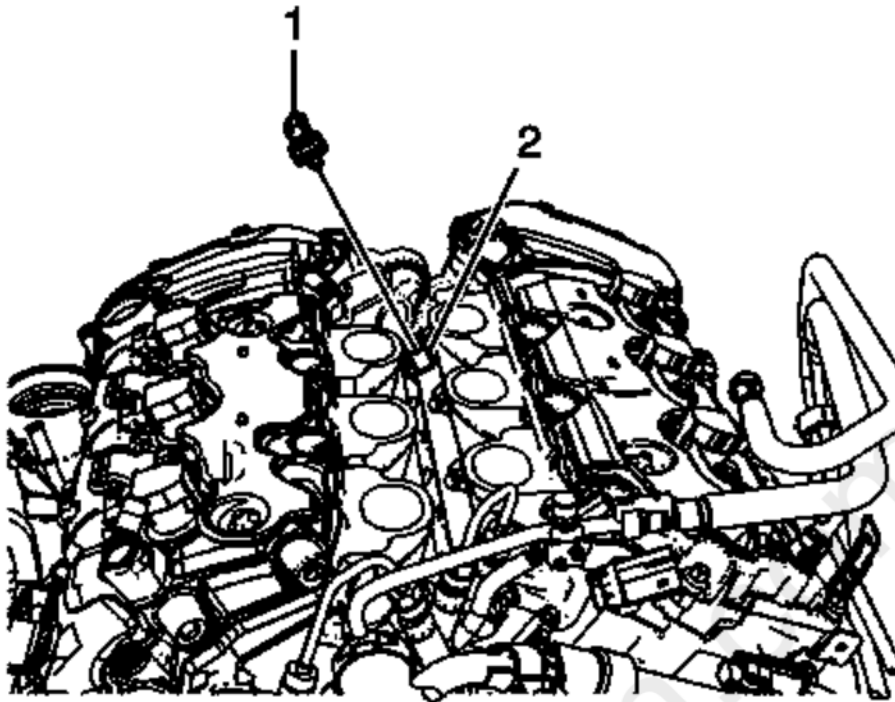


Fig. 109: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

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

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

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

Installation Procedure

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

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

1. Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers .
2. Lubricate the threads and sealing cone on the NEW fuel injection fuel rail fuel pressure sensor with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.

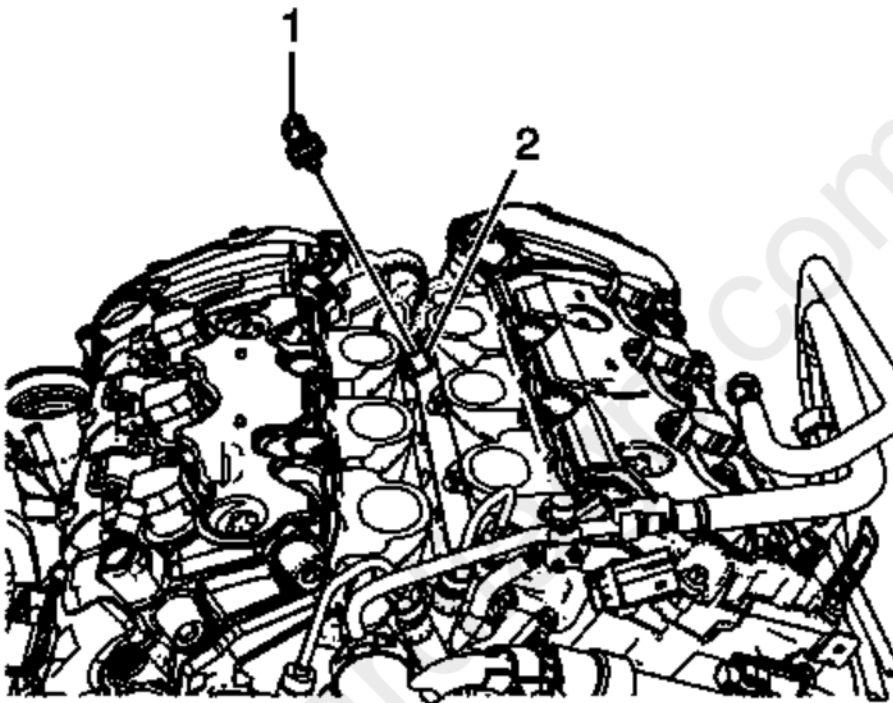


Fig. 110: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) hand tight.
4. Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.

CAUTION: Refer to FASTENER CAUTION .

5. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) and tighten to 33 N.m (25 lb ft).
6. Install the foam insulator from the fuel rails.
7. Install the intake manifold. Refer to Intake Manifold Replacement .

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

8. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.

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

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)** or **Fuel Pipe Shield Replacement (LLT)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
5. Remove the foam insulator from the fuel rails.

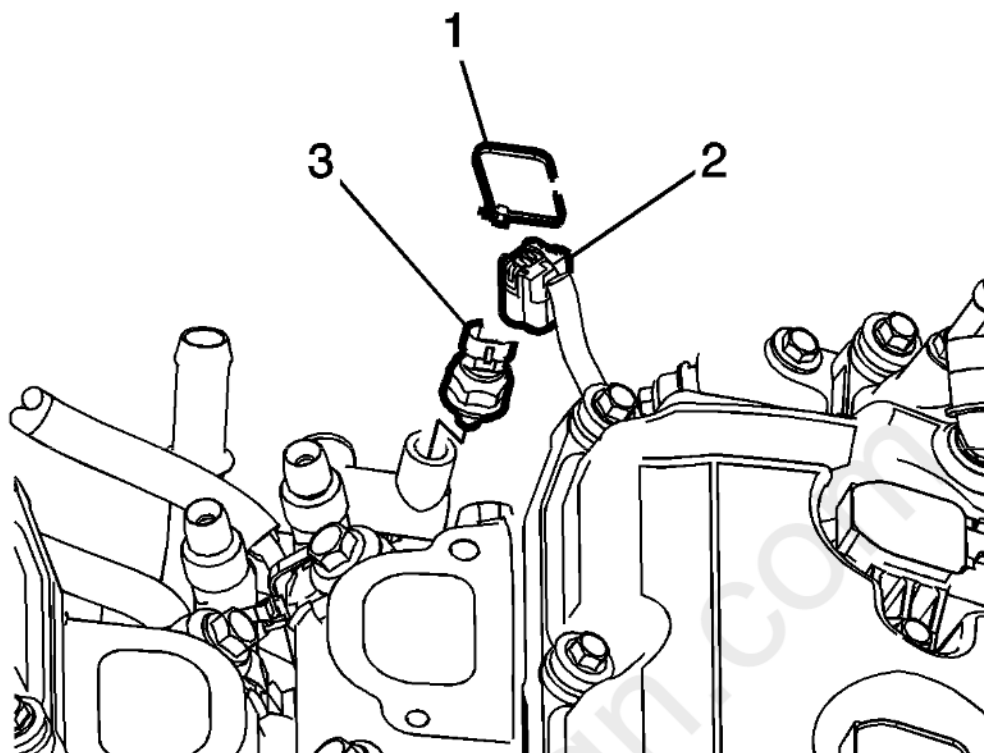


Fig. 111: Fuel Pressure Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

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

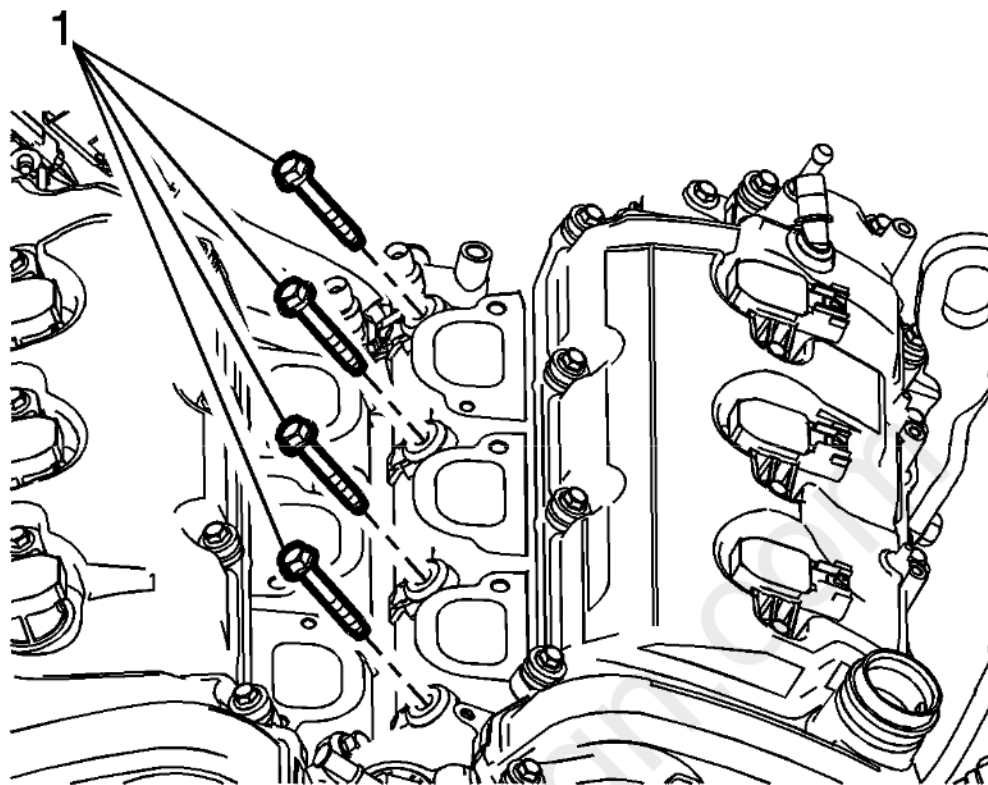


Fig. 112: Left Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS CORP.

9. Remove the left side fuel rail fasteners (1).

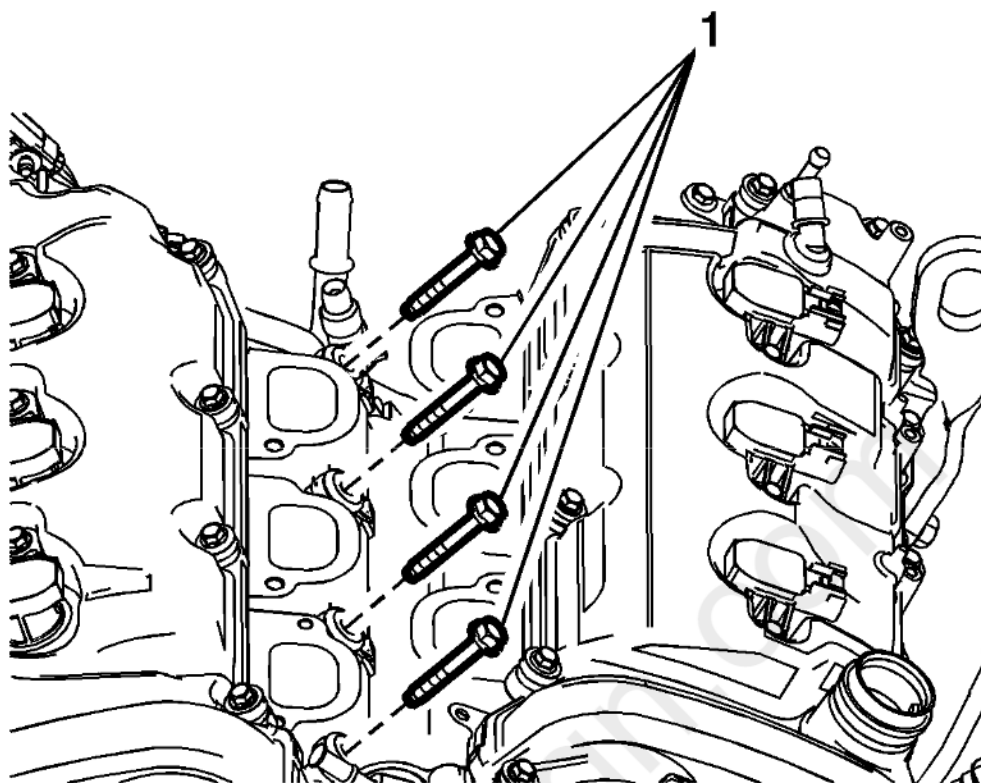


Fig. 113: Right Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS CORP.

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

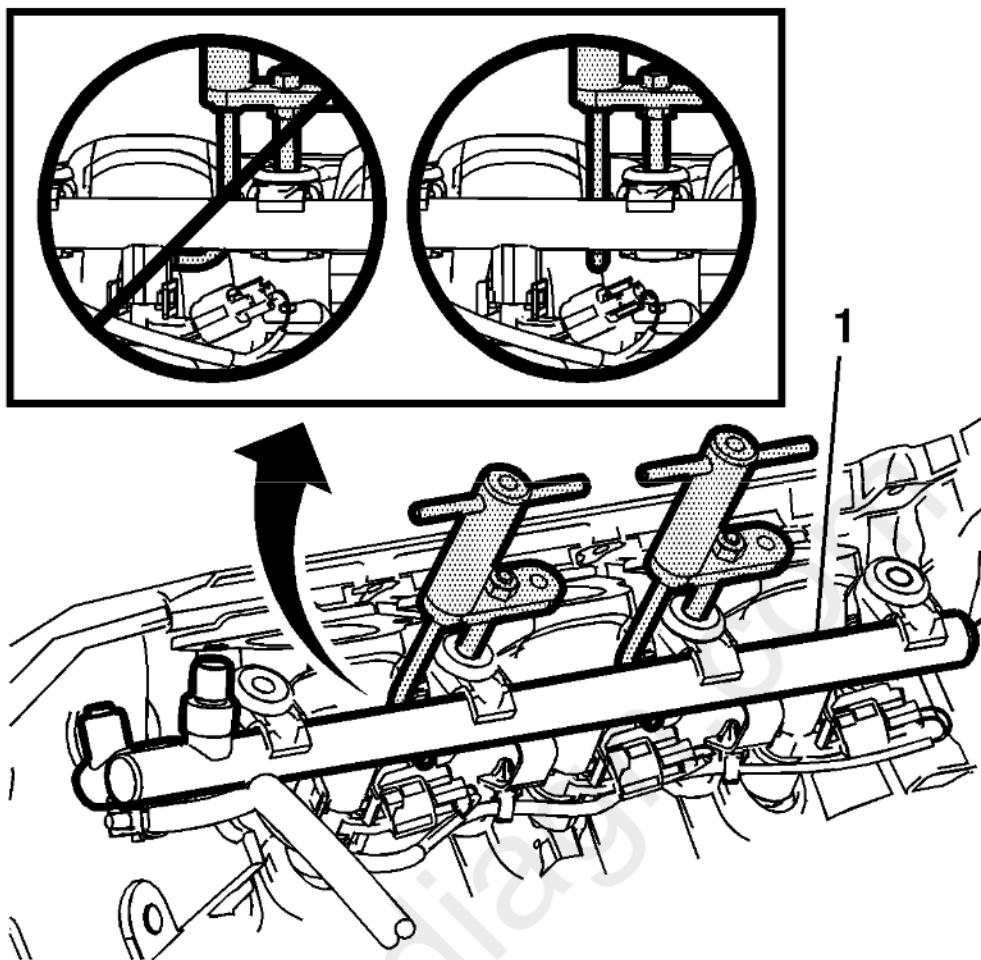


Fig. 114: Raising The Fuel Rail With Special Tool
Courtesy of GENERAL MOTORS CORP.

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

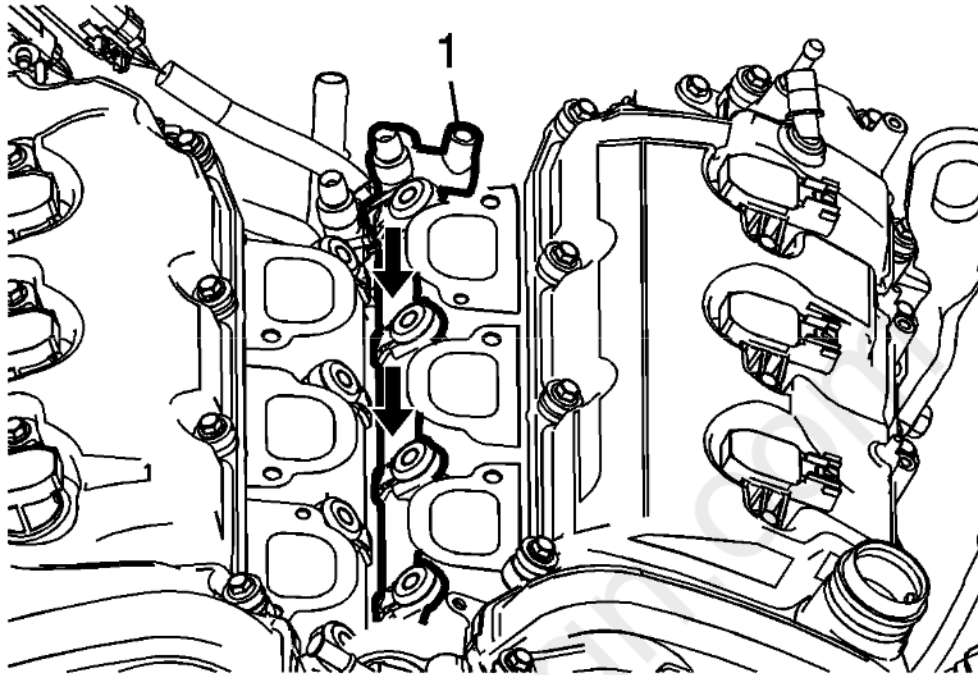


Fig. 115: Sliding Fuel Rail Toward The Front Of Engine
 Courtesy of GENERAL MOTORS CORP.

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

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

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

Installation Procedure

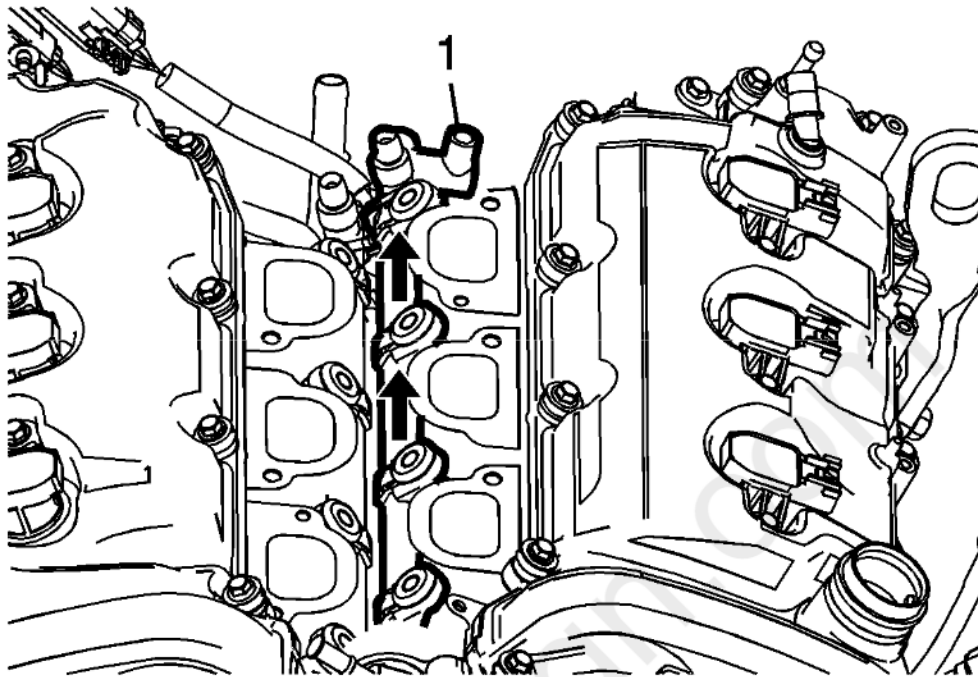


Fig. 116: Sliding Fuel Rail Toward The Rear Of Engine
Courtesy of GENERAL MOTORS CORP.

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

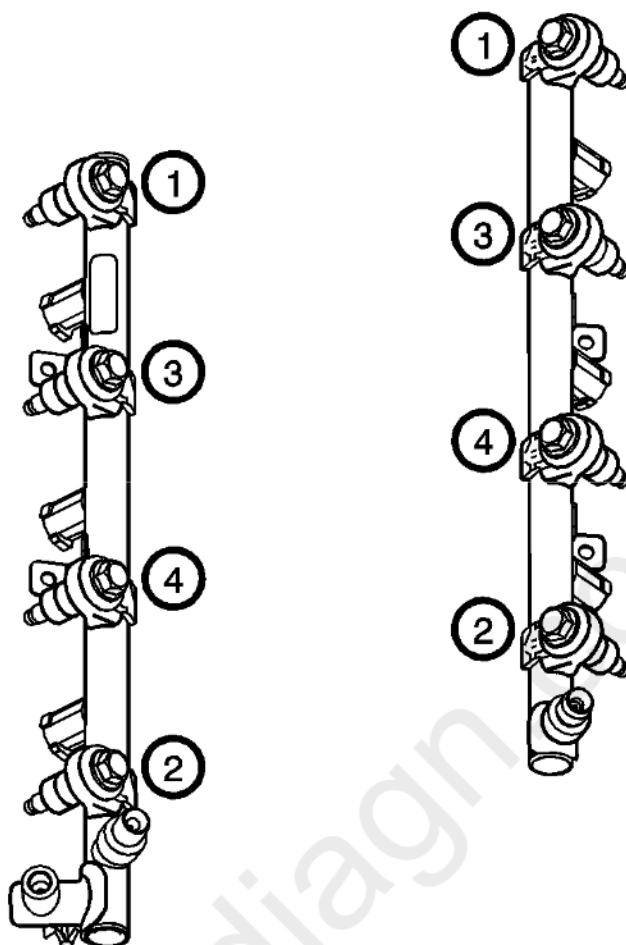


Fig. 117: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

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

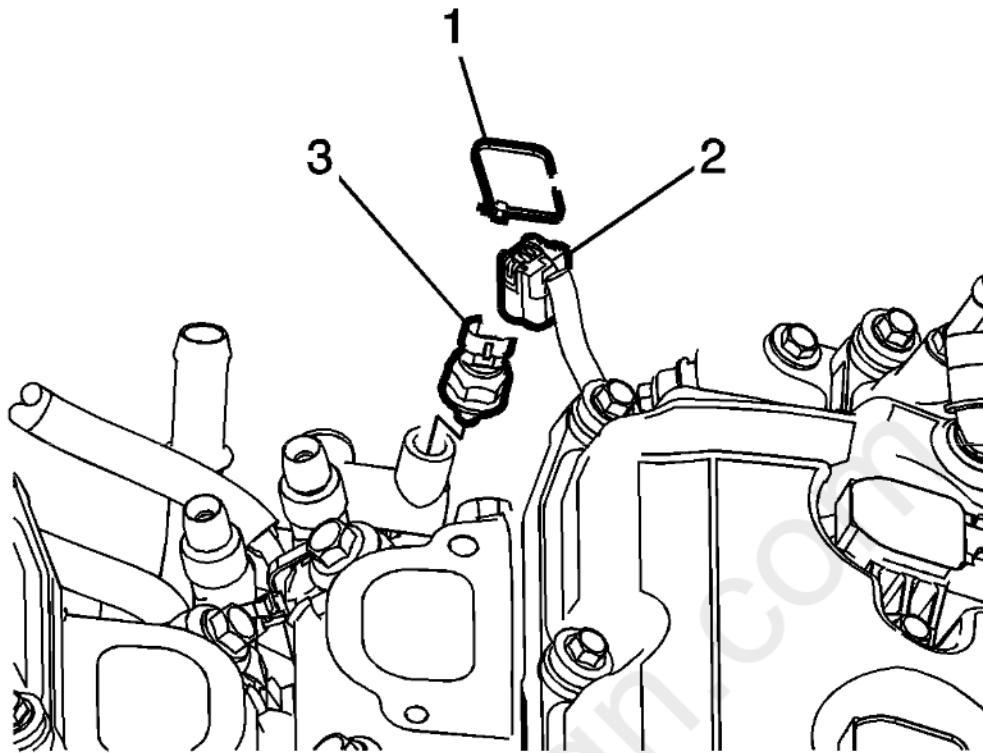


Fig. 118: Fuel Pressure Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Tighten the fuel pressure sensor (3) to 33 N.m (25 lb ft).
6. Connect the fuel pressure sensor electrical connector (2) and secure it with a new plastic zip tie.
7. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
8. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.
9. Install the foam insulator to the fuel rails.
10. Install the intake manifold. Refer to **Intake Manifold Replacement**.
11. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.
12. Install the low side fuel pressure service port cap.

13. Install the fuel tank cap.

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

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) or Fuel Pipe Shield Replacement (LLT).
3. Remove the intake manifold. Refer to Intake Manifold Replacement.
4. Remove the crossover tube. Refer to Fuel Injection Fuel Rail Crossover Tube Replacement (LLT).
5. Remove the foam insulator from the fuel rails.
6. Remove the bank 2 fuel injection rail. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1, LFW) or Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT).

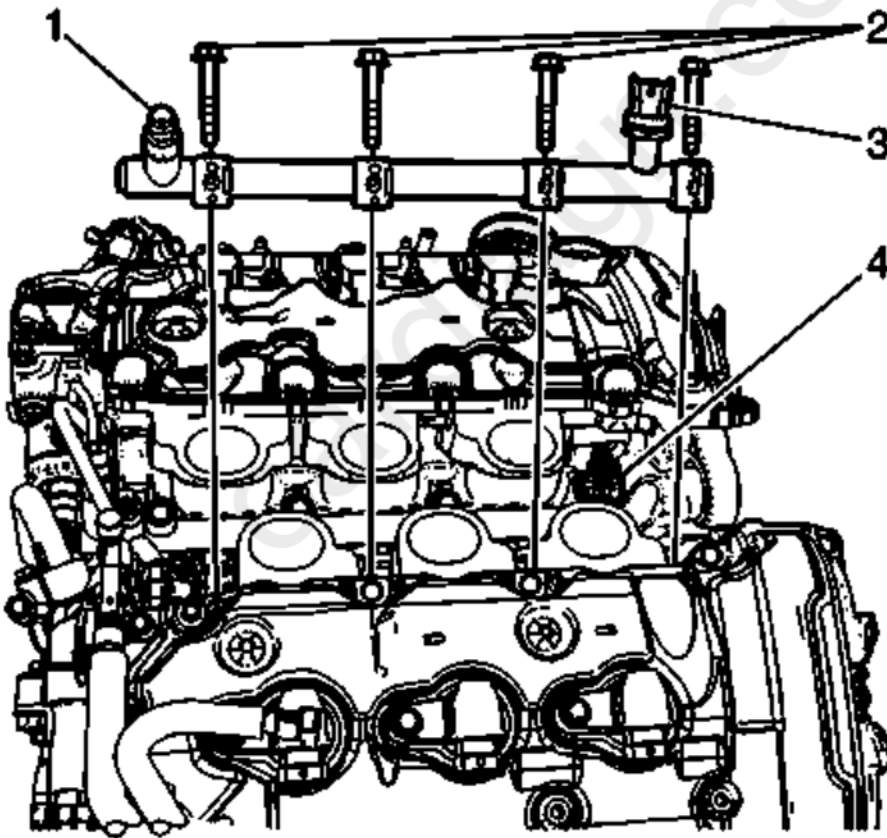


Fig. 119: Fuel Rail & Bolts

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 (1) bolts (2).

9. Remove the fuel pressure sensor. Refer to Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1) or Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LLT).
10. 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.

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

Installation Procedure

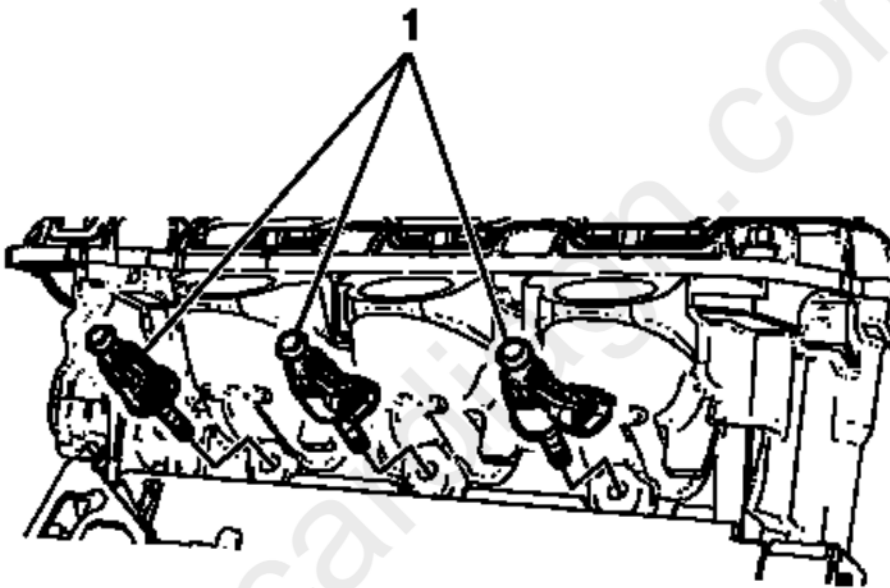


Fig. 120: Direct Fuel Injectors

Courtesy of GENERAL MOTORS CORP.

1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to Fuel Rail and Injectors Cleaning and Inspection (LLT) or Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW).
2. Install NEW direct injector hold down clamps to the injector.

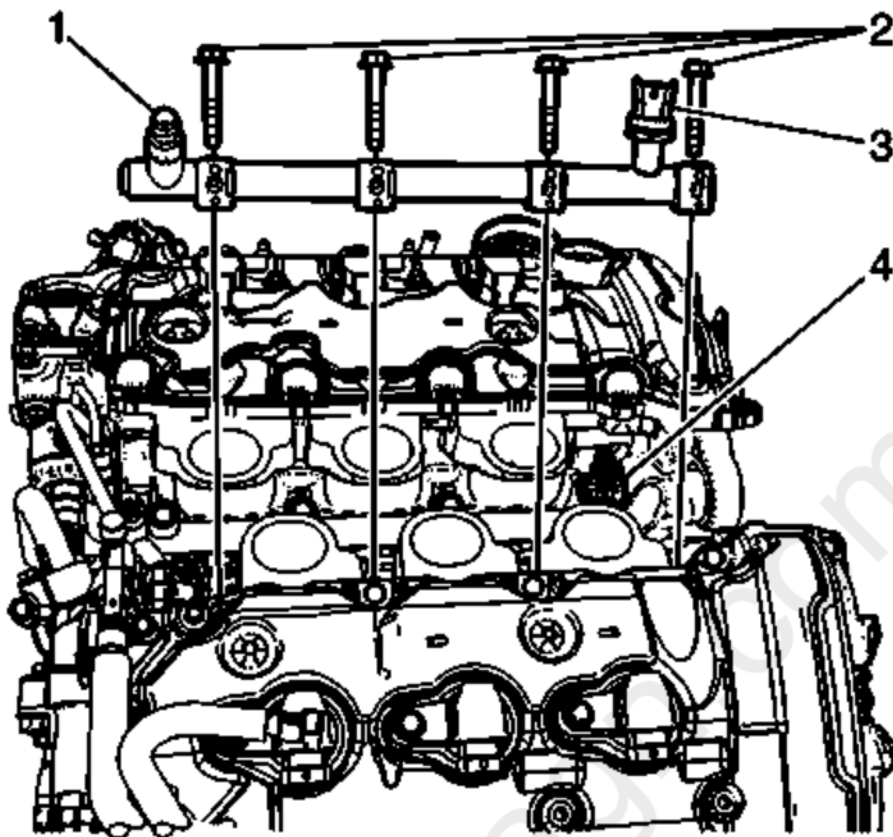


Fig. 121: Fuel Rail & Bolts

Courtesy of GENERAL MOTORS CORP.

3. On a new fuel rail, lubricate the fuel injector cups with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
4. Carefully place the fuel rail (1) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts, and hand tighten.
6. Install the bank 2 fuel injection rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1, LFW)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)**.

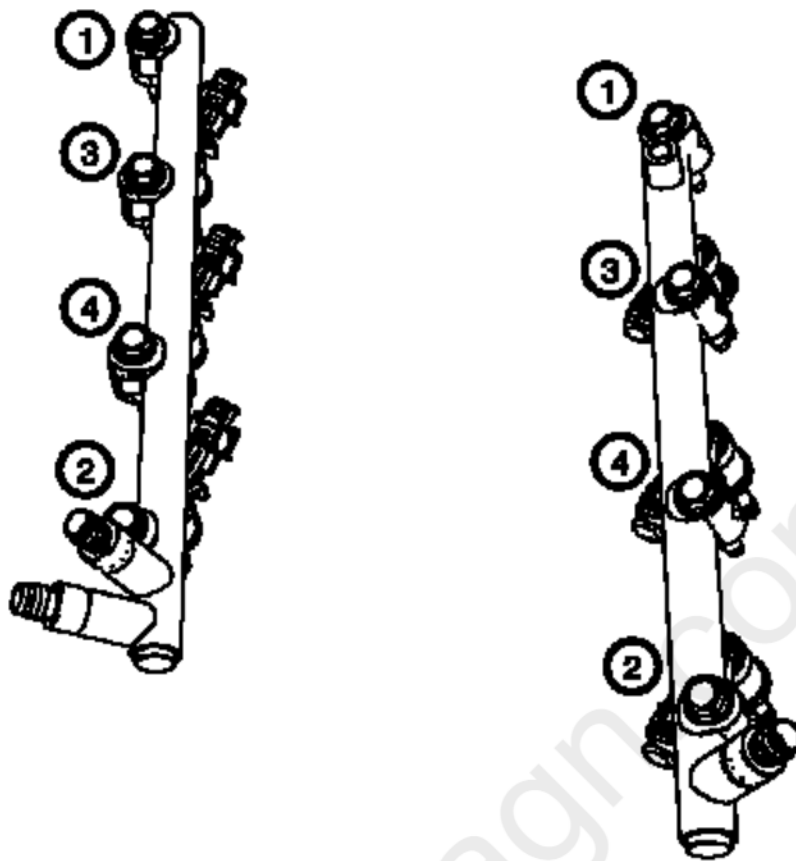


Fig. 122: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to **FASTENER CAUTION** .

7. Tighten the fuel rail bolts in the sequence shown above:
 1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
 2. Tighten the Bank 1 fuel rail bolts final pass to 23 N.m (17 lb ft).
8. Install a NEW crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)**.
9. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)** or **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LLT)**.
10. Connect the fuel injector wiring harness electrical connector to the fuel injectors, fuel rail and fuel pressure sensor.
11. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.

4. Inspect for fuel leaks.
12. Install the foam insulator from the fuel rails.
13. Install the intake manifold. Refer to **Intake Manifold Replacement** .
14. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.
15. Install the low side fuel pressure service port cap.
16. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2 (LF1, LFW)**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)** or **Fuel Pipe Shield Replacement (LLT)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
5. Remove the foam insulator from the fuel rails.

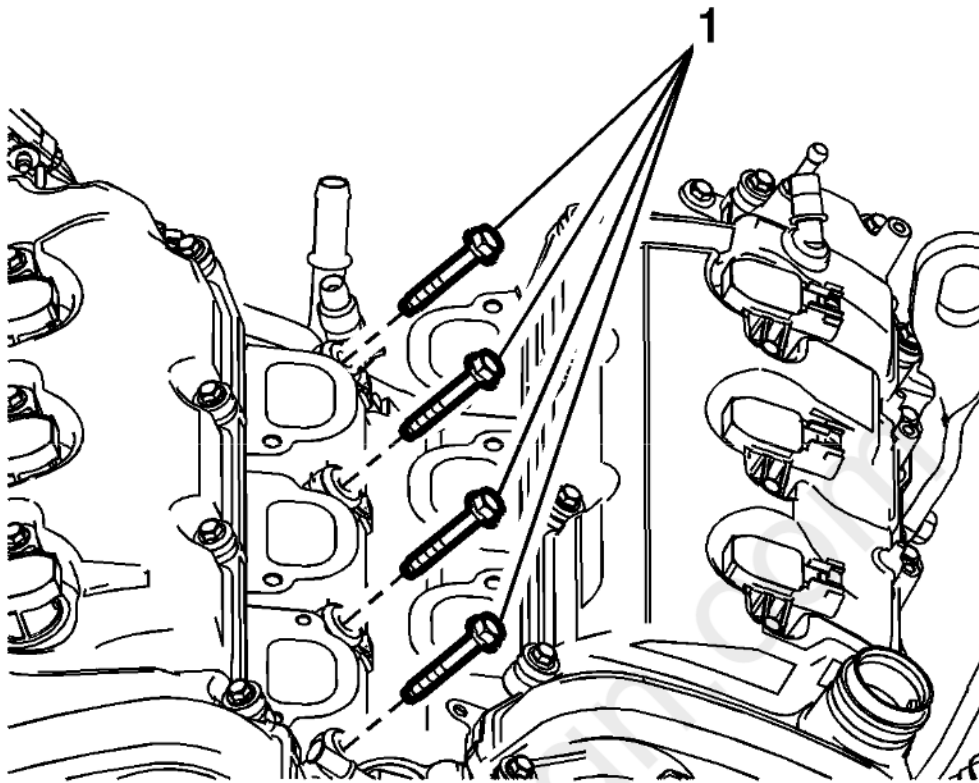


Fig. 123: Right Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS CORP.

6. Remove the right side fuel rail fasteners (1).

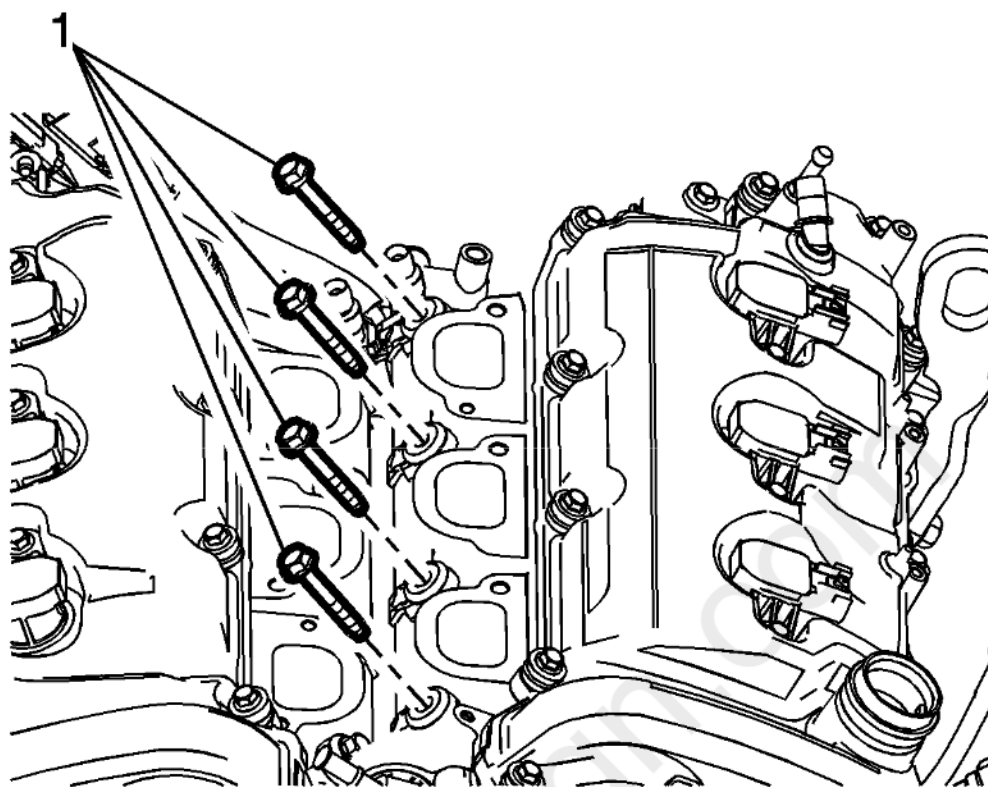


Fig. 124: Left Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS CORP.

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

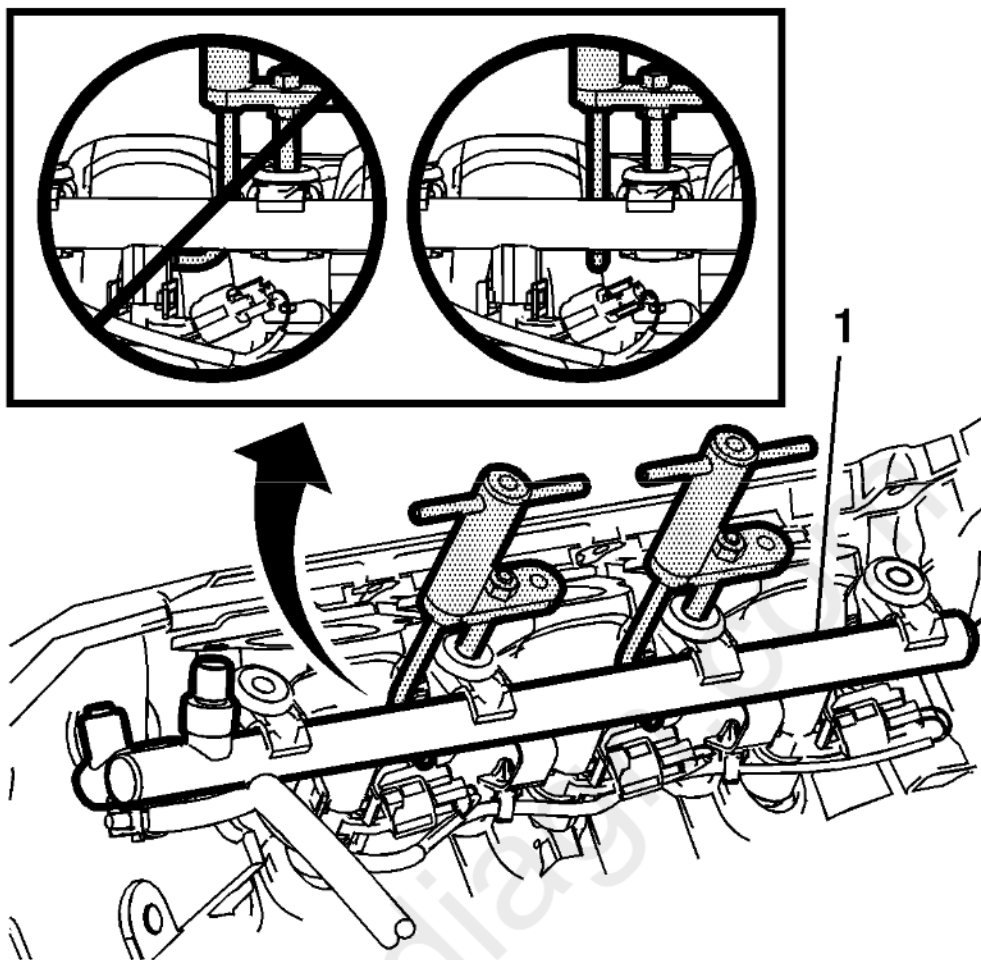


Fig. 125: Raising Fuel Rail With Special Tool
 Courtesy of GENERAL MOTORS CORP.

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

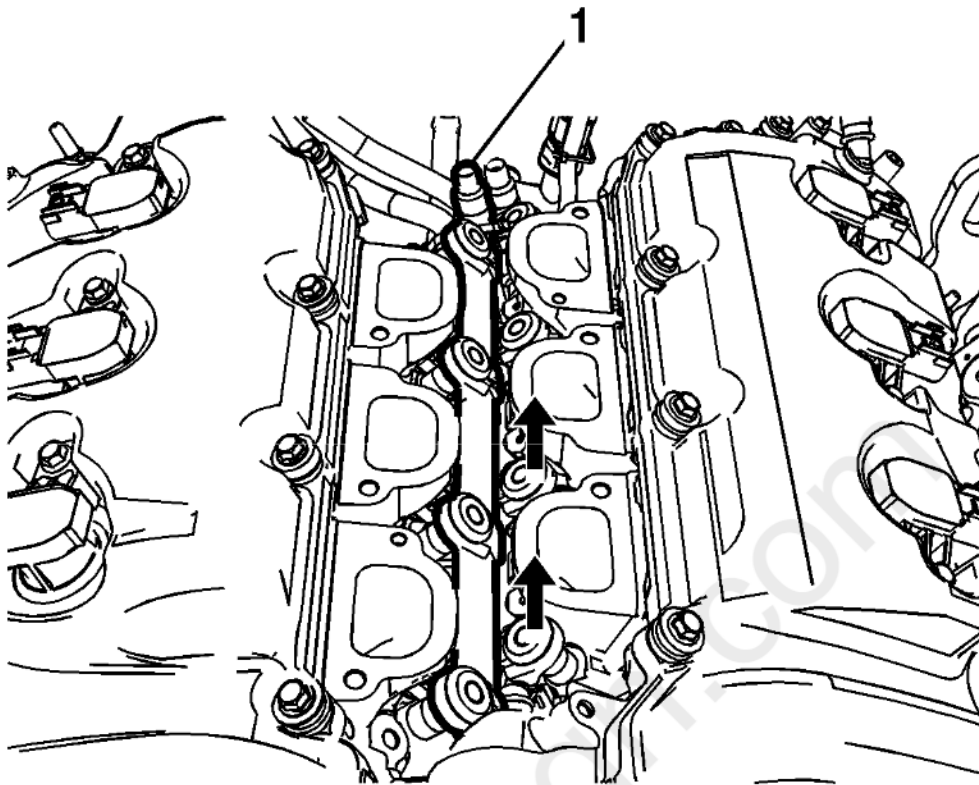


Fig. 126: Sliding Fuel Rail Toward Rear Of Engine
Courtesy of GENERAL MOTORS CORP.

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

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

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

Installation Procedure

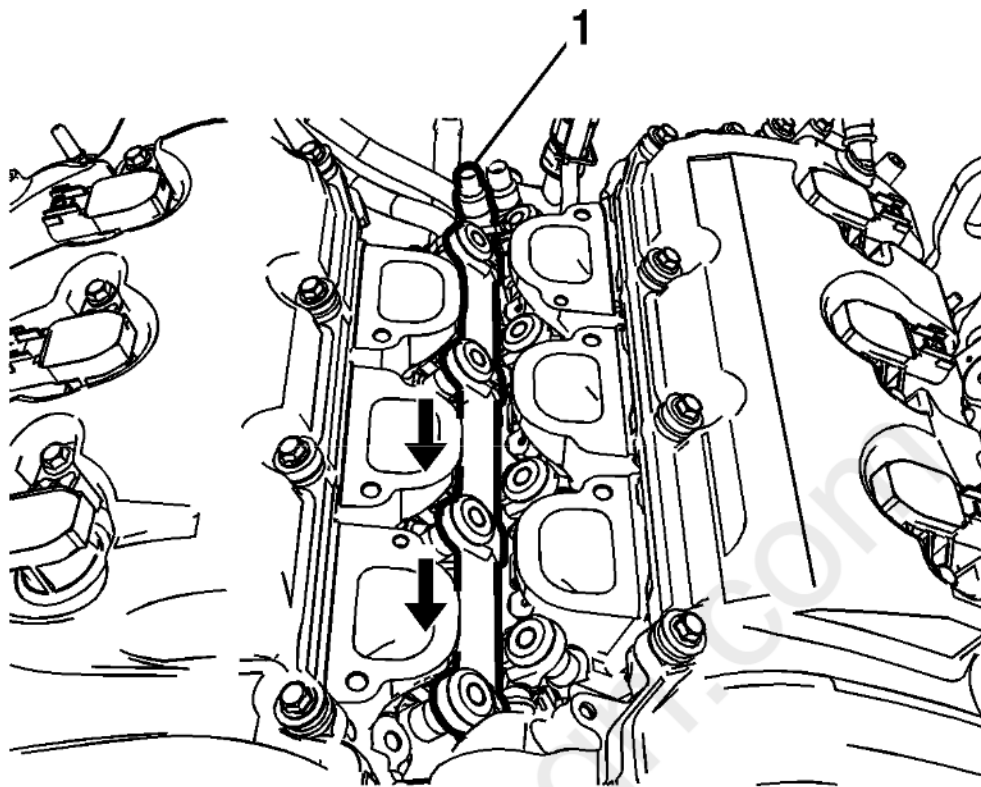


Fig. 127: Sliding Fuel Rail Toward Front Of Engine
Courtesy of GENERAL MOTORS CORP.

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

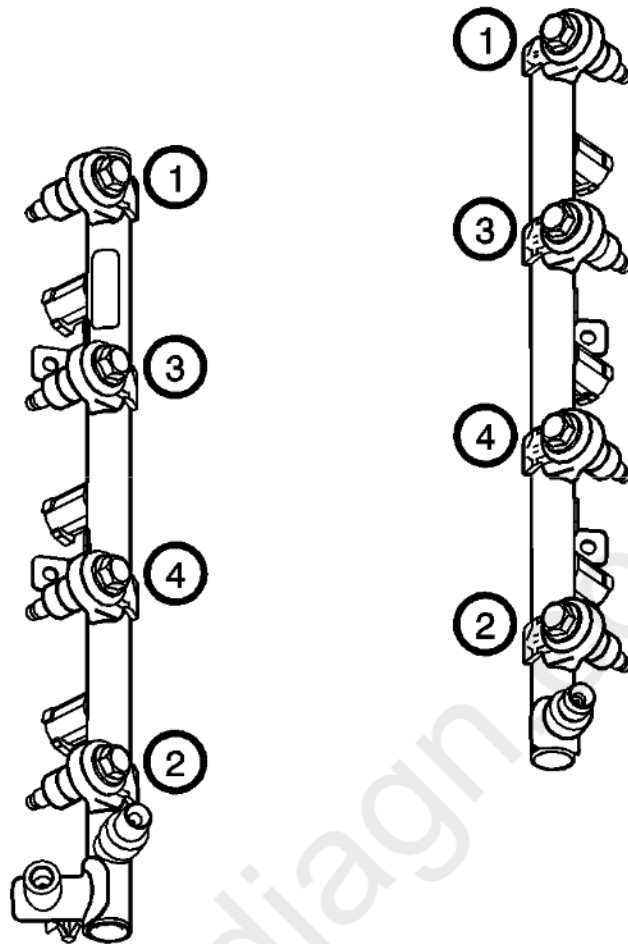


Fig. 128: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
 1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
 2. Tighten the Bank 1 fuel rail bolts a final pass to 23 N.m (17 lb ft).
5. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
6. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.

4. Inspect for fuel leaks.
7. Install the foam insulator to the fuel rails.
8. Install the intake manifold. Refer to **Intake Manifold Replacement** .
9. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.
10. Install the low side fuel pressure service port cap.
11. Install the fuel tank cap.

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

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)** or **Fuel Pipe Shield Replacement (LLT)**.
3. Remove the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)** or **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LLT)**.
4. Remove the crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)**. Discard this pipe.

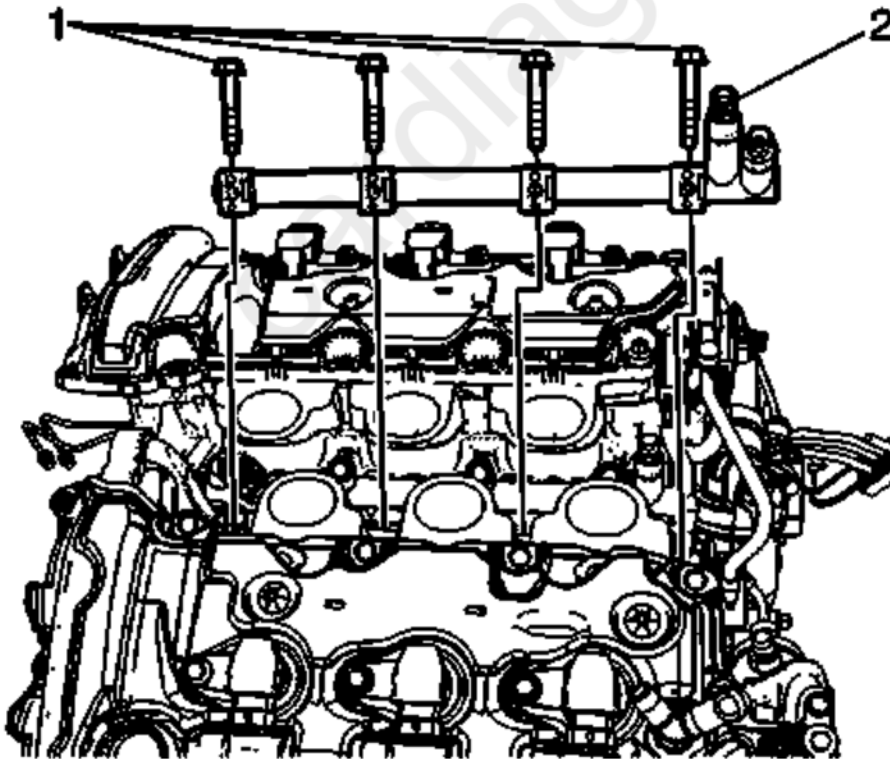


Fig. 129: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel rail bolts (1).
6. Carefully remove the Bank 2 fuel rail (2) from the engine. Lift the rear of the rail to ease removal.
7. 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.

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

Installation Procedure

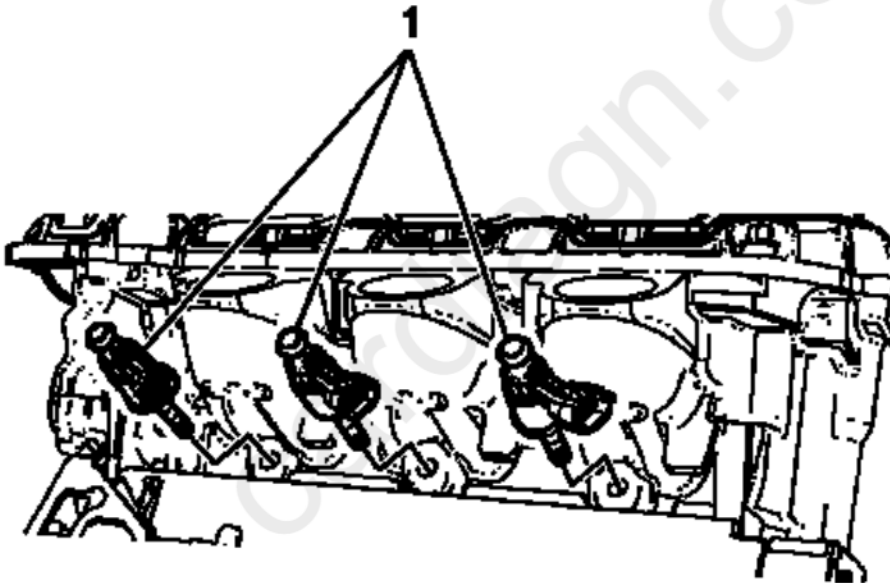


Fig. 130: Direct Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LLT)** or **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)**.

2. Install new direct injector hold down clamps to the injectors.

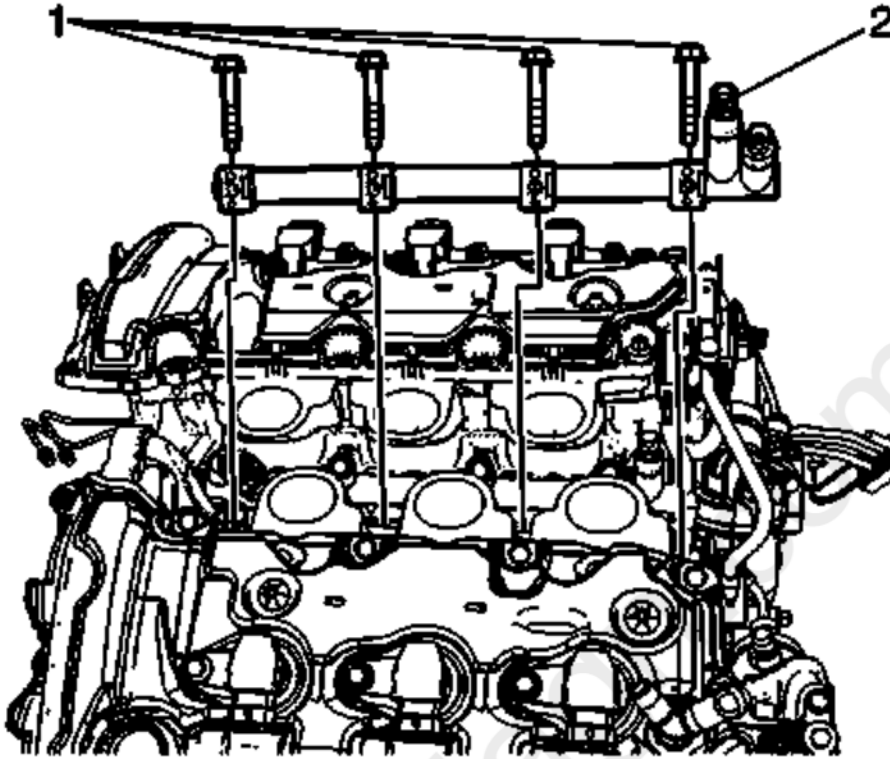


Fig. 131: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

3. On the new fuel rail, lubricate the fuel injector cups with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers**
4. Carefully place the fuel rail (2) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts and hand tighten.

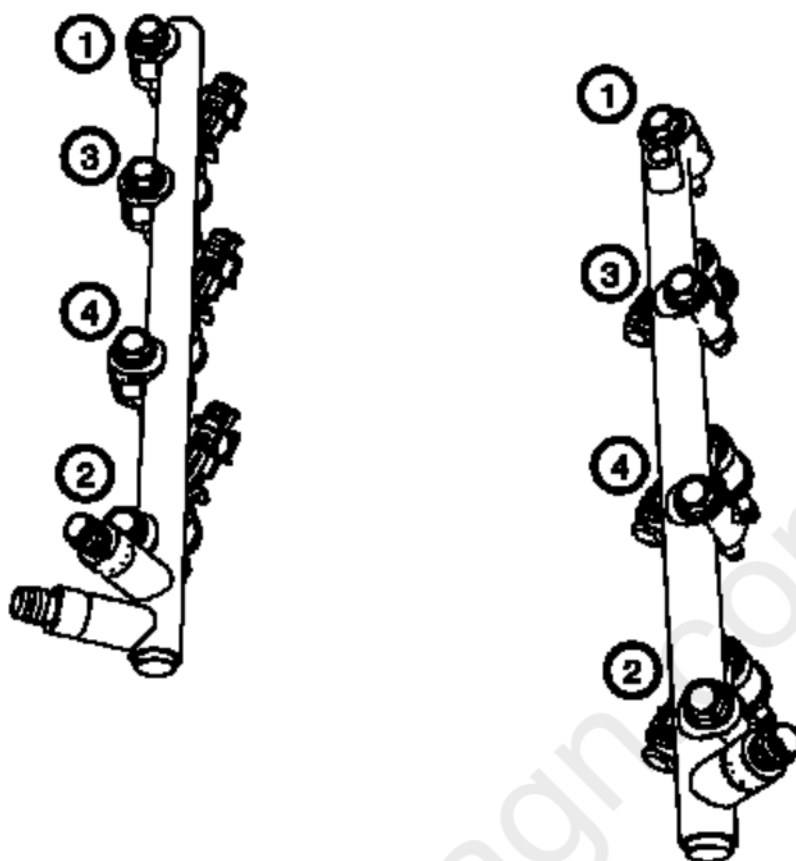


Fig. 132: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to **FASTENER CAUTION** .

6. Tighten the fuel rail bolts in the sequence shown above:
 1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
 2. Tighten the Bank 1 fuel rail bolts a final pass to 23 N.m (17 lb ft).
7. Install a NEW fuel rail crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)**.

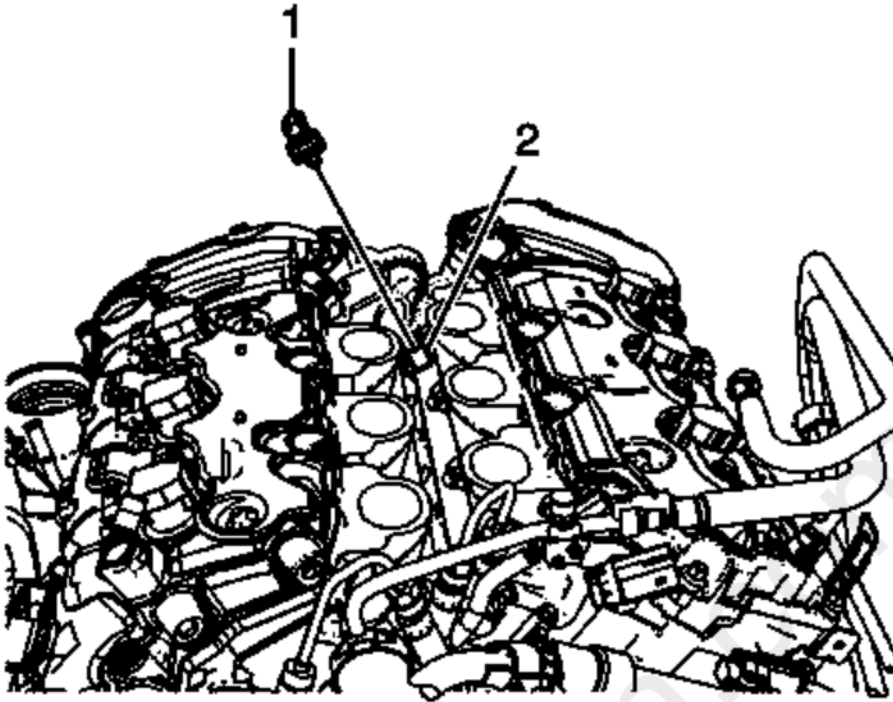


Fig. 133: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

8. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)** or **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LLT)**.
9. Connect the fuel injector wiring harness electrical connector (1) from the fuel injectors, fuel rail and fuel pressure sensor.
10. 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.
11. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.
12. Install the low side fuel pressure service port cap.
13. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL CROSSOVER TUBE REPLACEMENT (LLT)

Removal Procedure

1. Remove the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT).
2. Remove the high pressure pump shield. Refer to Fuel Pipe Shield Replacement (LF1) or Fuel Pipe Shield Replacement (LLT).
3. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.
4. Remove the intake manifold. Refer to Intake Manifold Replacement.

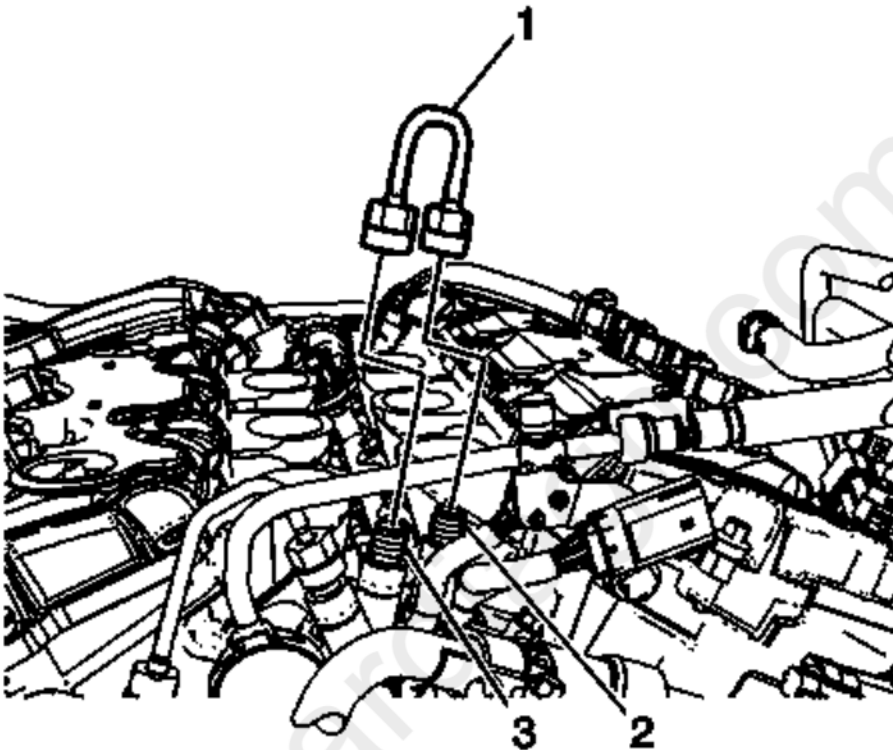


Fig. 134: Identifying Fuel Rail Crossover Pipe & Right Fuel Rail
 Courtesy of GENERAL MOTORS CORP.

5. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (2).
6. Loosen the fuel rail crossover pipe (1) fitting to the left fuel rail (3).
7. Remove the fuel rail crossover pipe (1) from the vehicle. Discard the pipe.

Installation Procedure

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

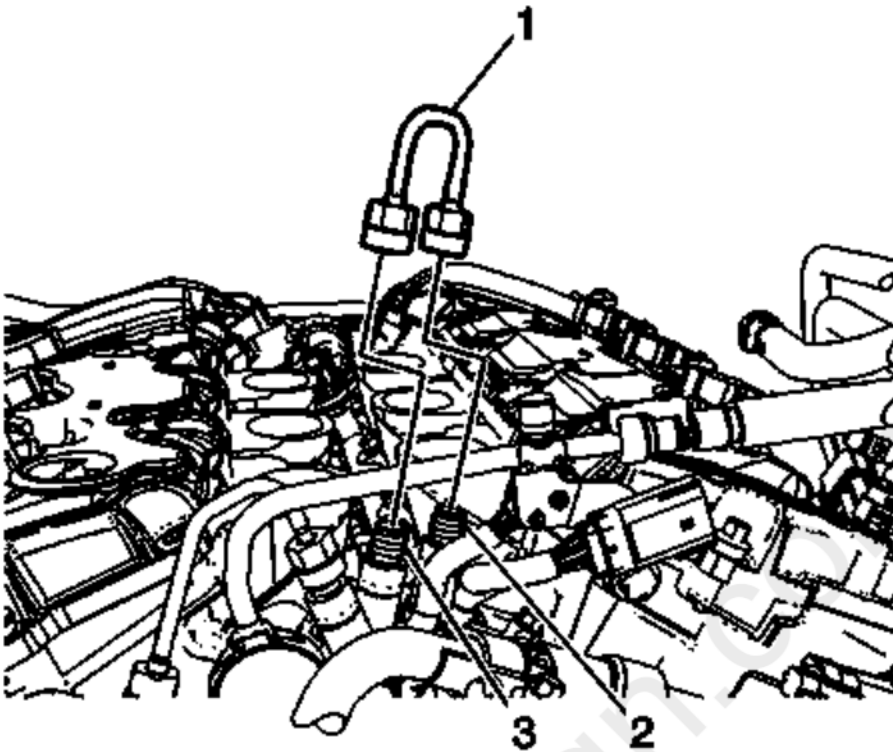


Fig. 135: Identifying Fuel Rail Crossover Pipe & Right Fuel Rail
Courtesy of GENERAL MOTORS CORP.

3. Position the fuel rail crossover pipe (1) to the right fuel rails fitting (2) and left fuel rail fitting (3).

CAUTION: Refer to FASTENER CAUTION .

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

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

5. 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.
6. Install the low side fuel pressure service port cap.
7. Install the fuel tank cap.
8. Install the intake manifold. Refer to **Intake Manifold Replacement**.
9. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.
10. Install the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT (LLT)

Removal Procedure

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
2. Remove the pressure pump shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.
3. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

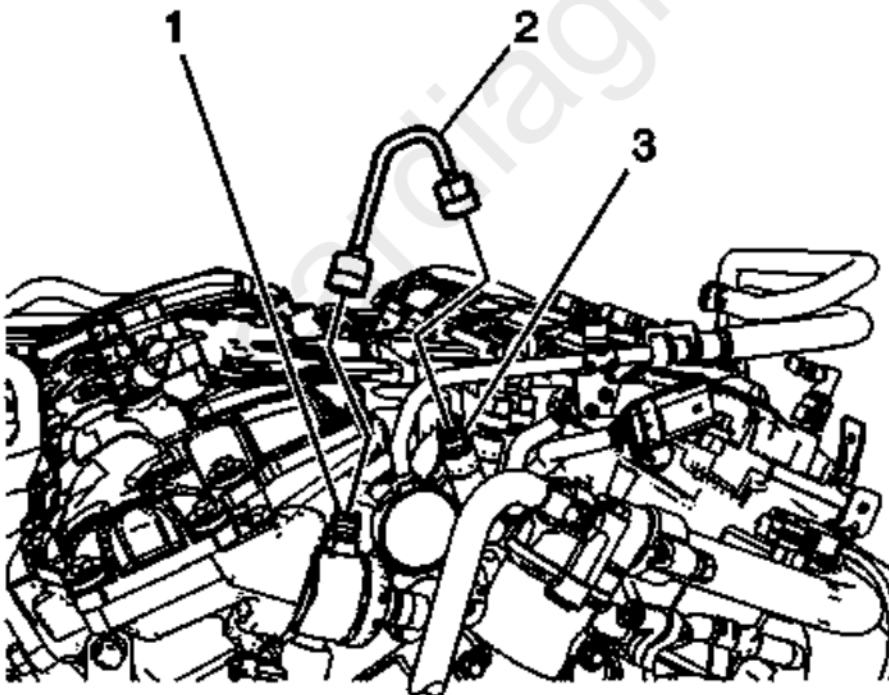


Fig. 136: Identifying High Pressure Pipe Fitting, Left Fuel Rail & High Pressure Fuel Pipe

Courtesy of GENERAL MOTORS CORP.

4. Remove the foam insulator from the pipes.
5. Loosen the high pressure pipe fitting to the high pressure fuel pump (1).
6. Loosen the high pressure pipe fitting to the left fuel rail (3).
7. Remove the high pressure fuel pipe (2) from the vehicle. Discard the pipe.

Installation Procedure

1. Lubricate the pipes with silicon free engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers .

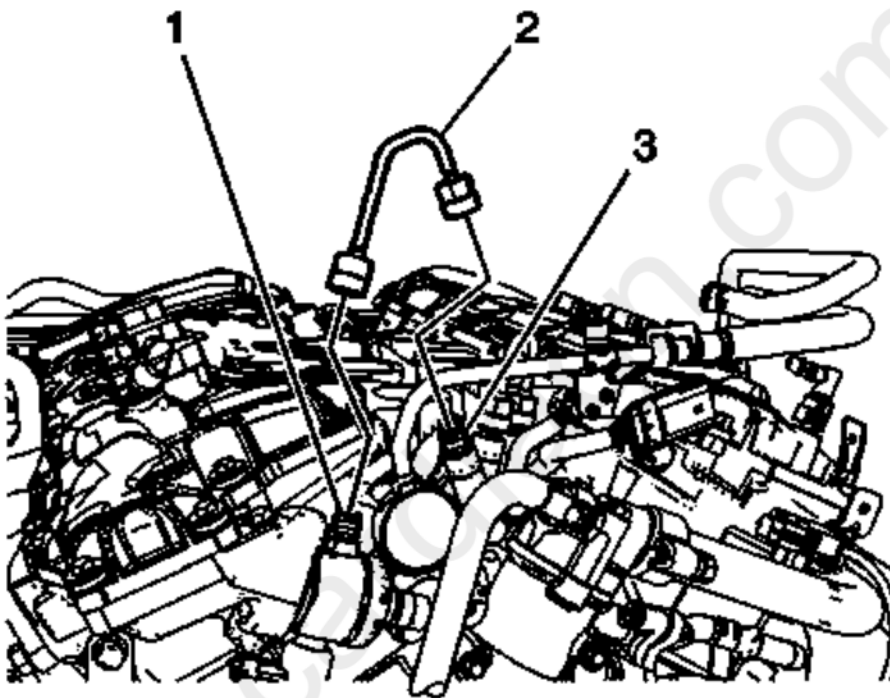


Fig. 137: Identifying High Pressure Pipe Fitting, Left Fuel Rail & High Pressure Fuel Pipe
Courtesy of GENERAL MOTORS CORP.

2. Position the NEW high pressure fuel pipe (2) to the high pressure fuel pump fitting (1) and left fuel rail (3). hand tighten the fitting.

CAUTION: Refer to FASTENER CAUTION .

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

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

4. 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.
5. Install the low side fuel pressure service port cap.
6. Install the fuel tank cap.
7. Install the high pressure pump shield. Refer to Fuel Pipe Shield Replacement (LF1) or Fuel Pipe Shield Replacement (LLT).
8. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT).

FUEL PIPE SHIELD REPLACEMENT (LF1)

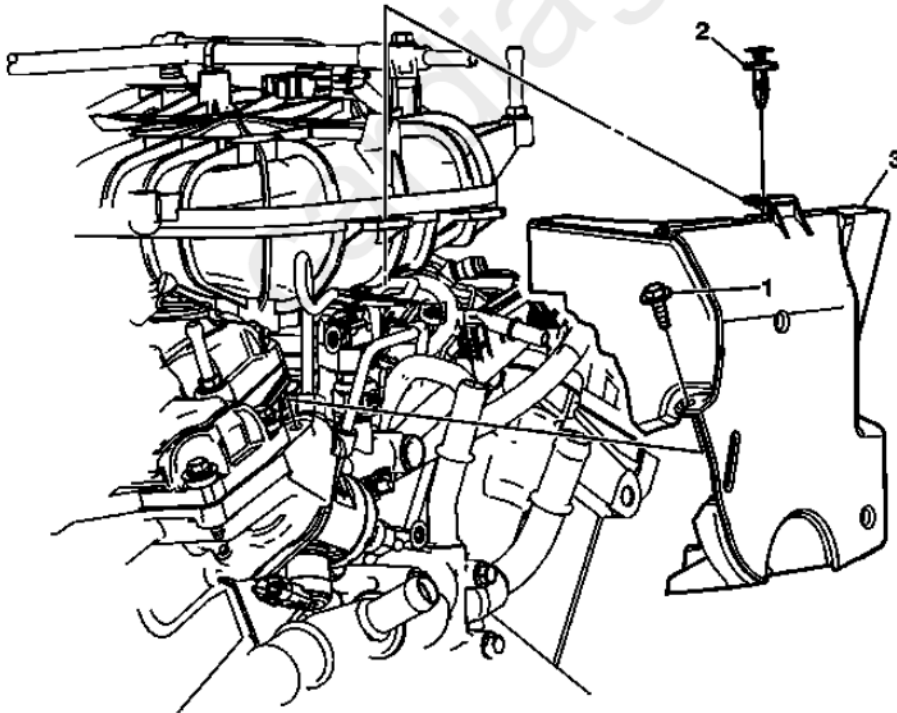


Fig. 138: Fuel Pipe Shield (LF1)

Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to <u>Fuel Injector Sight Shield Replacement (LP1, LY7)</u> or <u>Fuel Injector Sight Shield Replacement (LLT)</u> .	
1	Bolt CAUTION: Refer to. Tighten: 10 N.m (89 lb in)
2	Retainer
3	Fuel Pipe Shield

FUEL PIPE SHIELD REPLACEMENT (LLT)

Removal Procedure

1. Remove the cross vehicle brace. Refer to Cross Vehicle Brace Replacement .
2. Remove the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT)
3. Remove the intake manifold insulator.
4. Remove the wiper transmission. Refer to Windshield Wiper Transmission Replacement .

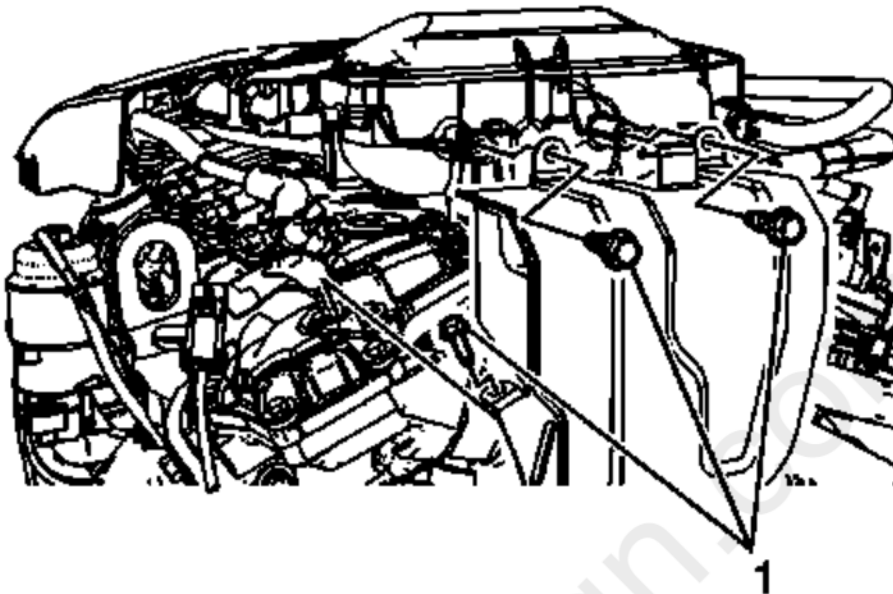


Fig. 139: Intake Manifold & Cylinder Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel pipe shield to intake manifold bolts (1).
6. Remove the fuel pipe shield to cylinder bolt (1).
7. Carefully remove the fuel pipe shield from the vehicle. Take care not to damage the insulation behind the shield.

Installation Procedure

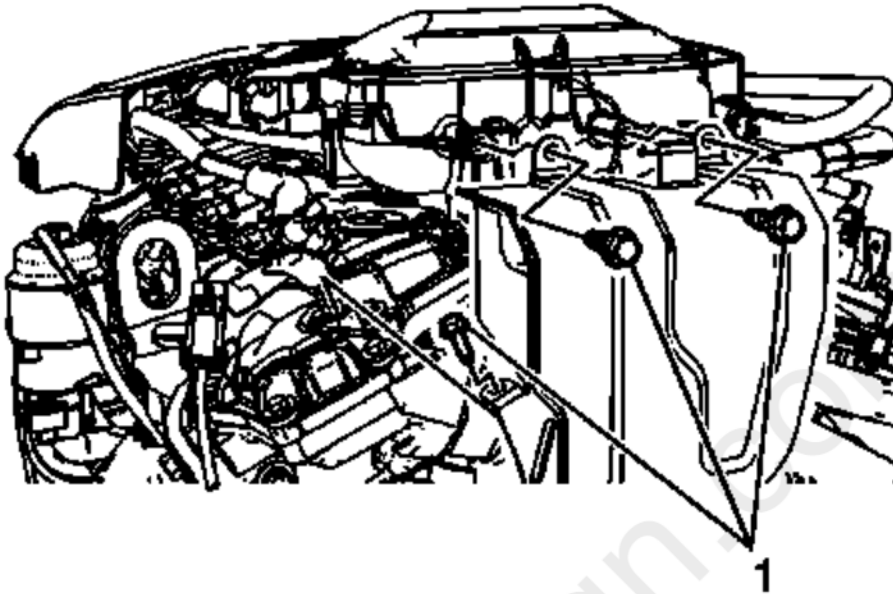


Fig. 140: Intake Manifold & Cylinder Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the fuel pipe shield behind the high pressure fuel pump. Take care not to damage the insulation behind the shield.
2. Install the fuel pipe shield to cylinder bolt (1). Hand tighten at this time.

CAUTION: Refer to **FASTENER CAUTION** .

3. Install the fuel pipe shield to intake manifold bolts (1).
 1. Tighten the fuel pipe shield to manifold bolts to 23 N.m (17 lb ft).
 2. Tighten the fuel pipe shield to head bolt to 10 N.m (89 lb in).
4. Instal the wiper transmission. Refer to **Windshield Wiper Transmission Replacement** .
5. Install the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**
6. Install the cross vehicle brace. Refer to **Cross Vehicle Brace Replacement** .

FUEL PUMP REPLACEMENT

Special Tools

EN-48896: High Pressure Fuel Pump Installation Alignment Gauge

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

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)** or **Fuel Pipe Shield Replacement (LLT)**.

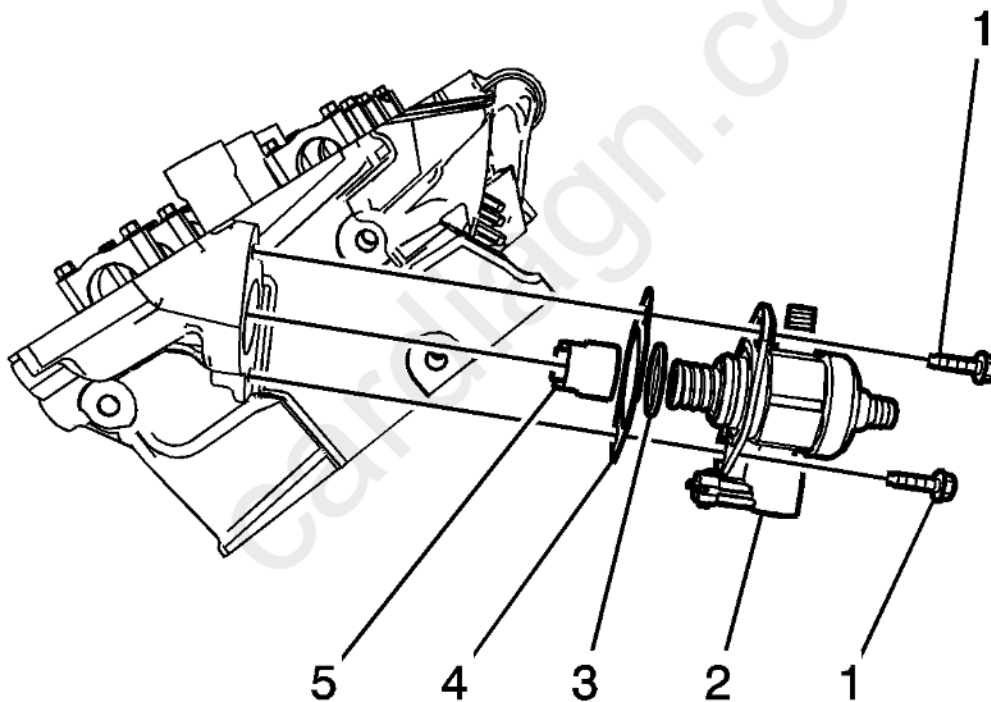


Fig. 141: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS CORP.

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)** or **Fuel Feed Pipe Replacement (LLT)**.

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5. Remove the high pressure pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.
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** .

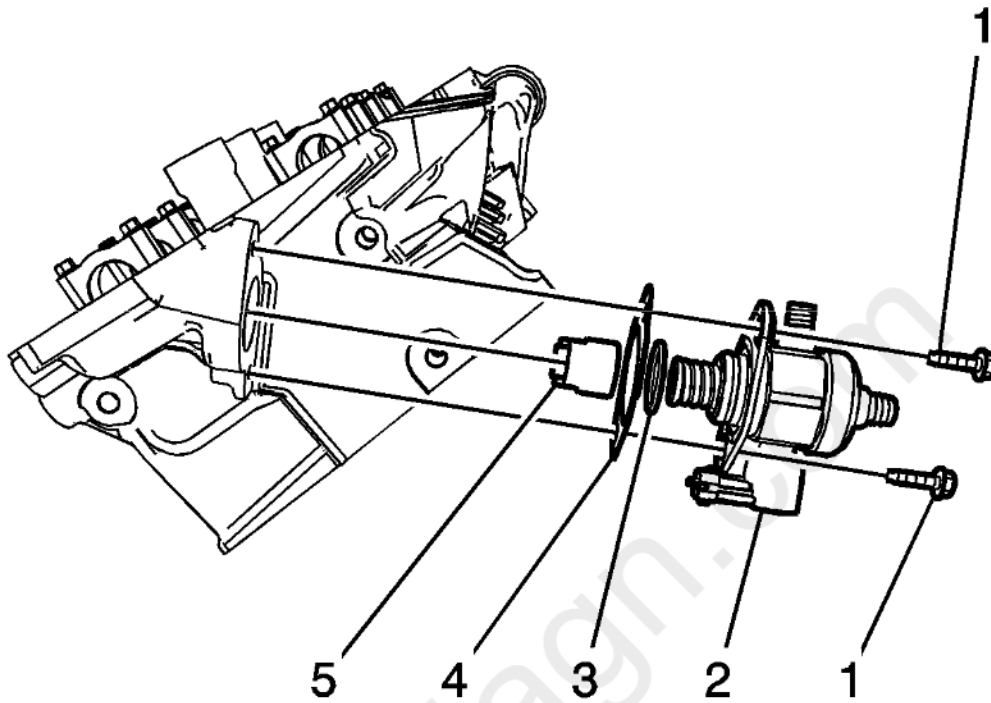


Fig. 142: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS CORP.

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

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

CAUTION: Refer to **FASTENER CAUTION** .

7. Tighten the high pressure fuel pump retaining bolts to 15 N.m (11 lb ft).
8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
9. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LLT)**.

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10. Install the fuel feed pipe to the high pressure fuel pump. Refer to **Fuel Feed Pipe Replacement (LF1)** or **Fuel Feed Pipe Replacement (LLT)**.
11. Connect the high pressure fuel pump wiring harness.
12. Install the fuel tank cap.

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

13. Inspect for leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.
14. Install the pressure relief cap to the fuel feed pipe.
15. Install the intake manifold. Refer to **Intake Manifold Replacement**.
16. Install the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.

FUEL INJECTOR REPLACEMENT

Special Tools

- **EN-47909:** Injector Bore and Sleeve Cleaning Kit
- **EN-48266:** Injector Seal Installer and Sizer
- **GE-6125-1B:** Slide Hammer
- **EN 3721-A:** Injector Remover
- **EN 39313:** Spark Plug Port Adapter

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

Removal Procedure

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

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

2. Remove the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1, LFW)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LLT)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1, LFW)** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)**.

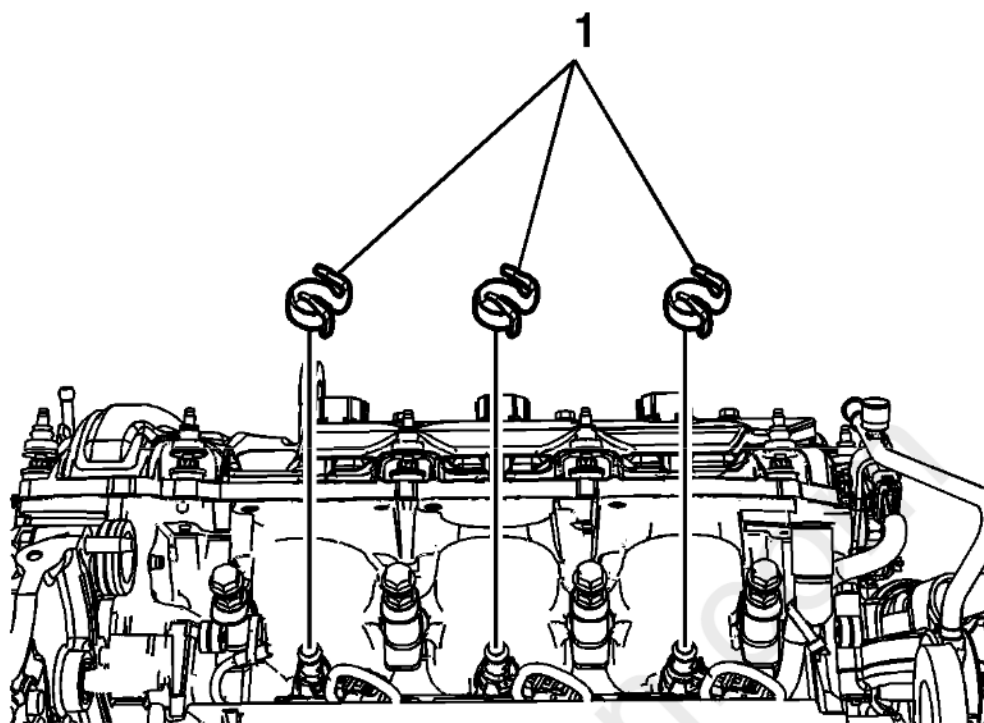


Fig. 143: Identifying Fuel Injector Retaining Rings
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the three fuel injector retaining rings (1).

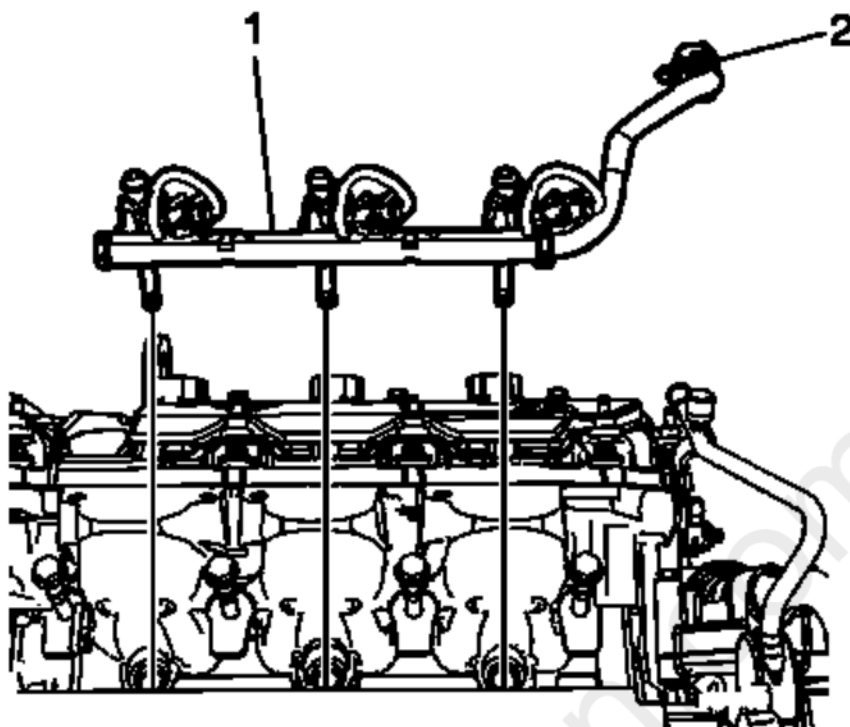


Fig. 144: Identifying Direct Fuel Injector & Harness Assembly
Courtesy of GENERAL MOTORS CORP.

4. Remove the direct fuel injectors and harness (1) as an assembly, and disconnect the electrical connector (2). If necessary, use the **GE-6125-1B:** slide hammer with the **EN 3721-A:** injector remover in order to remove the direct fuel injectors evenly.

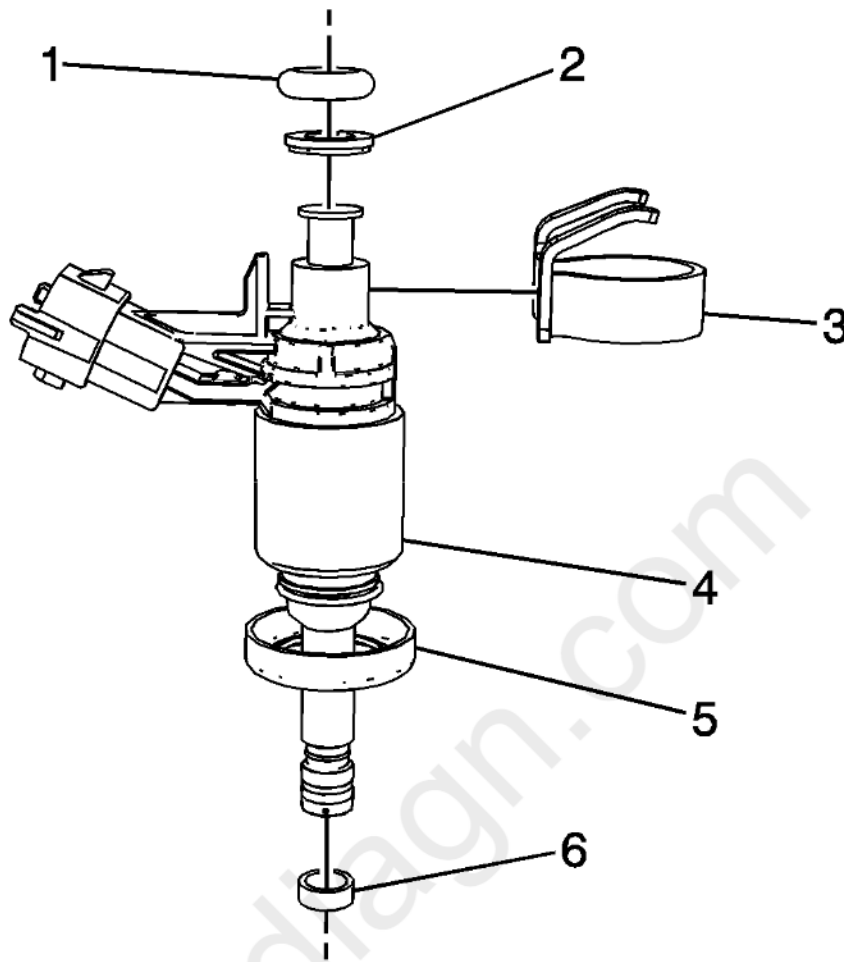


Fig. 145: Identifying Fuel Injector Components
 Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the following components from the fuel injectors (4).
 - Upper O-ring Seal (1)
 - Plastic Spacer (2)
 - Retaining Ring (3)
 - Isolator Cup (5)
 - Teflon Seal (6)
6. Inspect the fuel rail injector bores and clean with the **EN 39313:** adapter, and **EN-47909:** cleaning kit, if required.

Installation Procedure

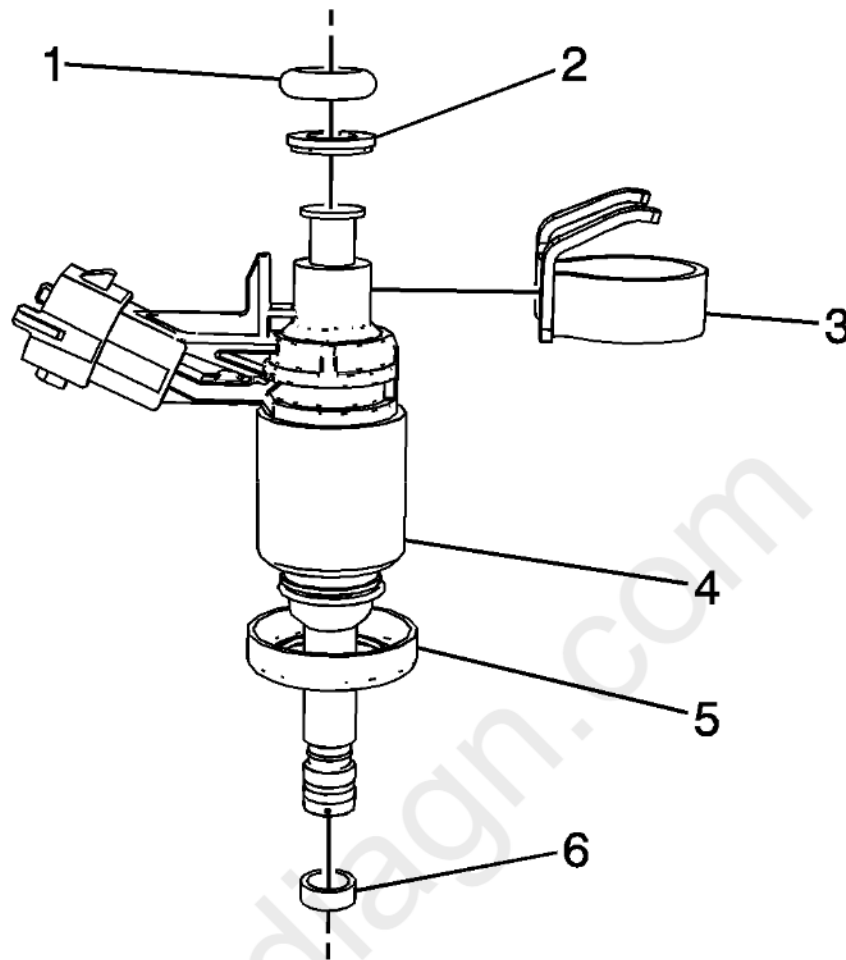


Fig. 146: Identifying Fuel Injector Components
Courtesy of GENERAL MOTORS CORP.

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

1. Install the following NEW components to the fuel injectors. Use steps 2 through 8 to install these components.
 - Upper O-ring Seal (1)
 - Plastic Spacer (2)
 - Retaining Ring (3)
 - Isolator Cup (5)
 - Teflon Seal (6)

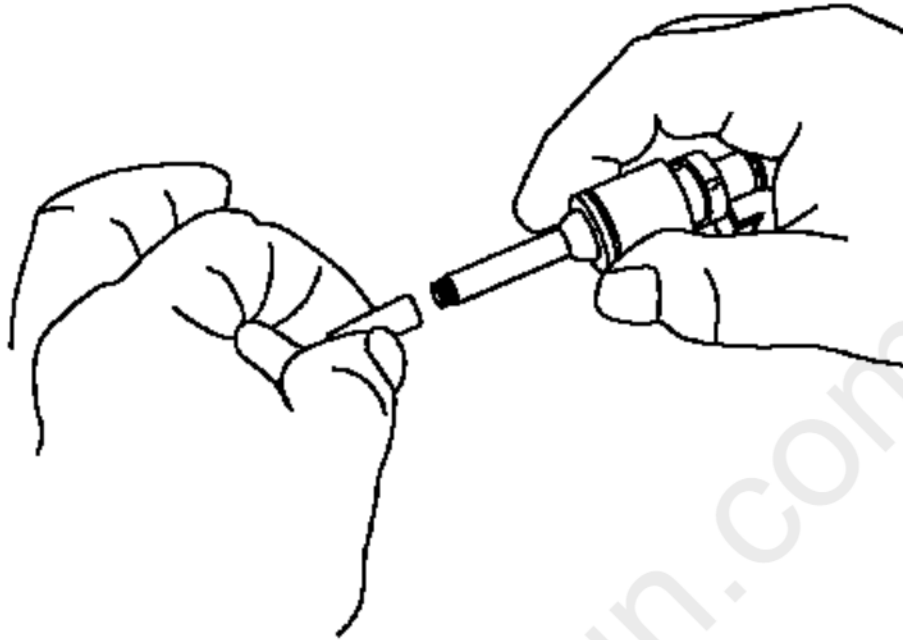


Fig. 147: View Of Injector Tip & Special Tool EN 48266
Courtesy of GENERAL MOTORS CORP.

2. From the **EN-48266**: installer, position the EN 48266-1 to the injector tip.

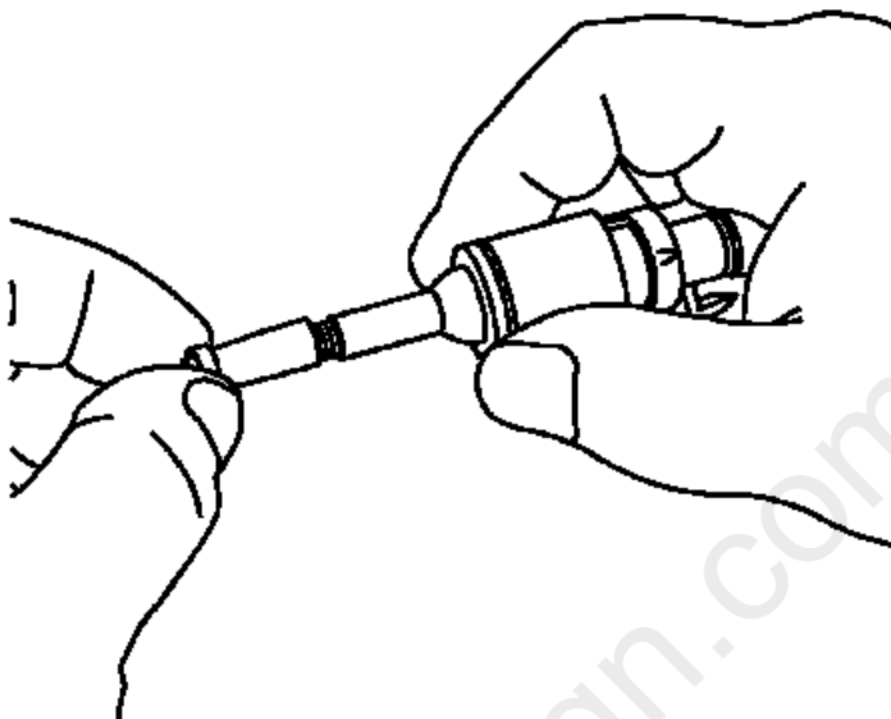


Fig. 148: Using Special Tool EN 48266-1
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT lubricate the NEW teflon seal.

3. Install a NEW teflon seal onto the EN 48266-1.

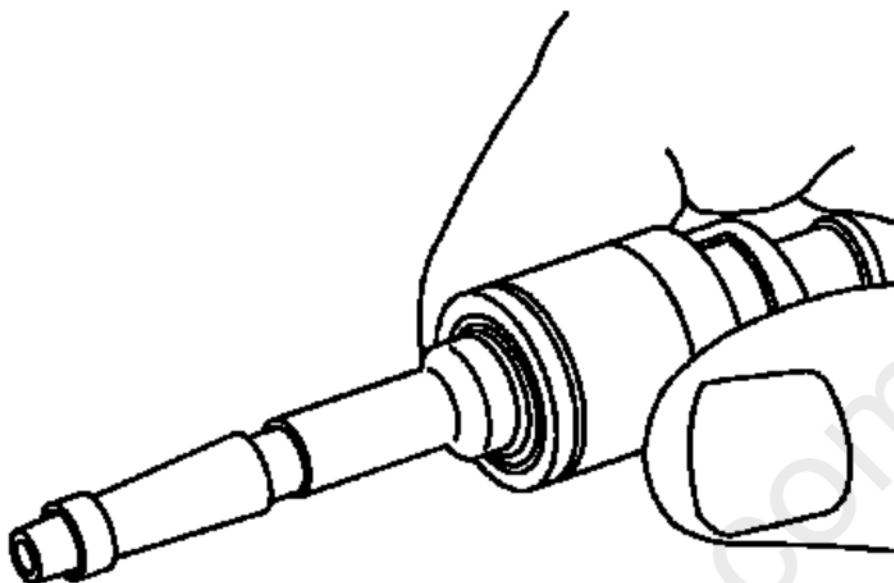


Fig. 149: View Of Special Tool EN 48266-1
Courtesy of GENERAL MOTORS CORP.

4. Pull the NEW teflon seal by hand over the EN 48266-1 and into the groove in the injector.
5. Remove the EN 48266-1 from the injector tip.

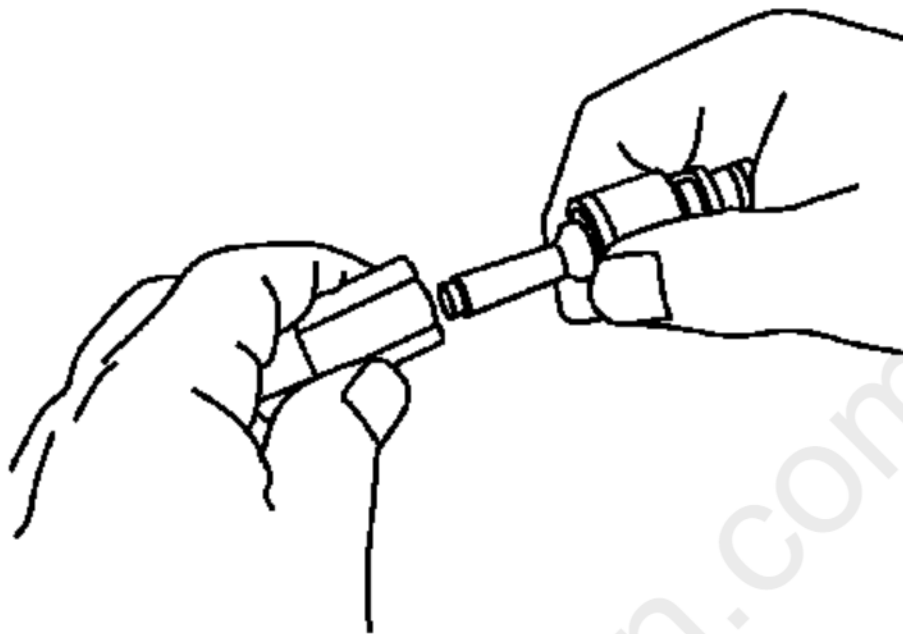


Fig. 150: Injector Tip & EN 48266-2
Courtesy of GENERAL MOTORS CORP.

6. From the **EN-48266**: installer, install the EN 48266-2 to the injector tip.

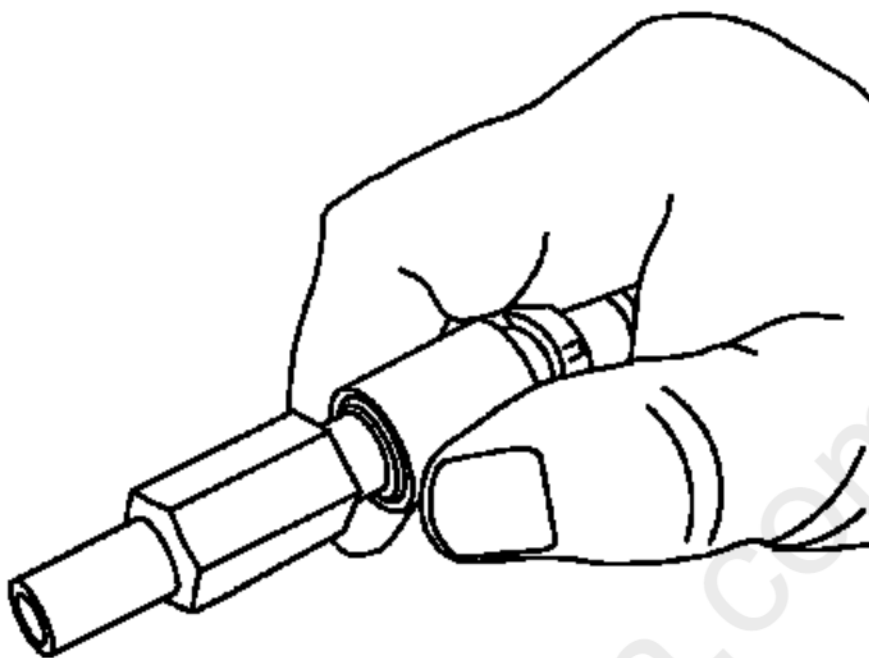


Fig. 151: View Of Special Tool EN 48266-2
Courtesy of GENERAL MOTORS CORP.

7. Using the EN 48266-2, resize the teflon seal. Install the EN 48266-2, until it bottoms out against the injector body, and rotate the EN 48266-2 while applying only moderate force 180 degrees in one direction and then 180 degrees back in the other direction.
8. Remove the EN 48266-2.

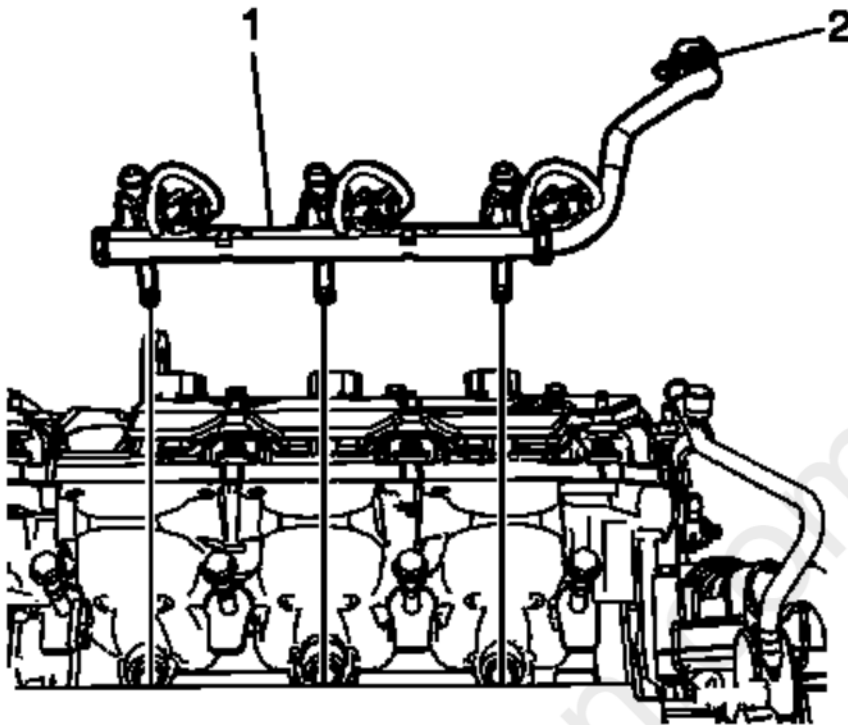


Fig. 152: Identifying Direct Fuel Injector & Harness Assembly
 Courtesy of GENERAL MOTORS CORP.

9. Install the direct fuel injectors and harness (1) as an assembly and connect the electrical connector (2).

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

10. Install the fuel injection fuel rail assembly. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1, LFW) or Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LLT) or Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1, LFW) or Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT).

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT (LF1)

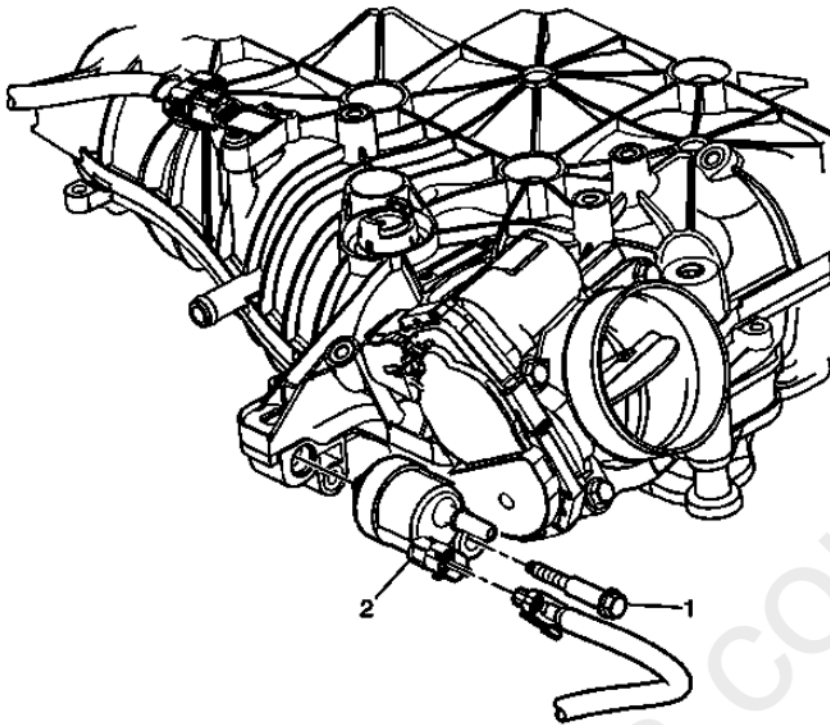


Fig. 153: View Of Evaporative Emission Canister Purge Solenoid Valve (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT) .	
1	Bolt CAUTION: Refer to. 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 PURGE SOLENOID VALVE REPLACEMENT (LLT)

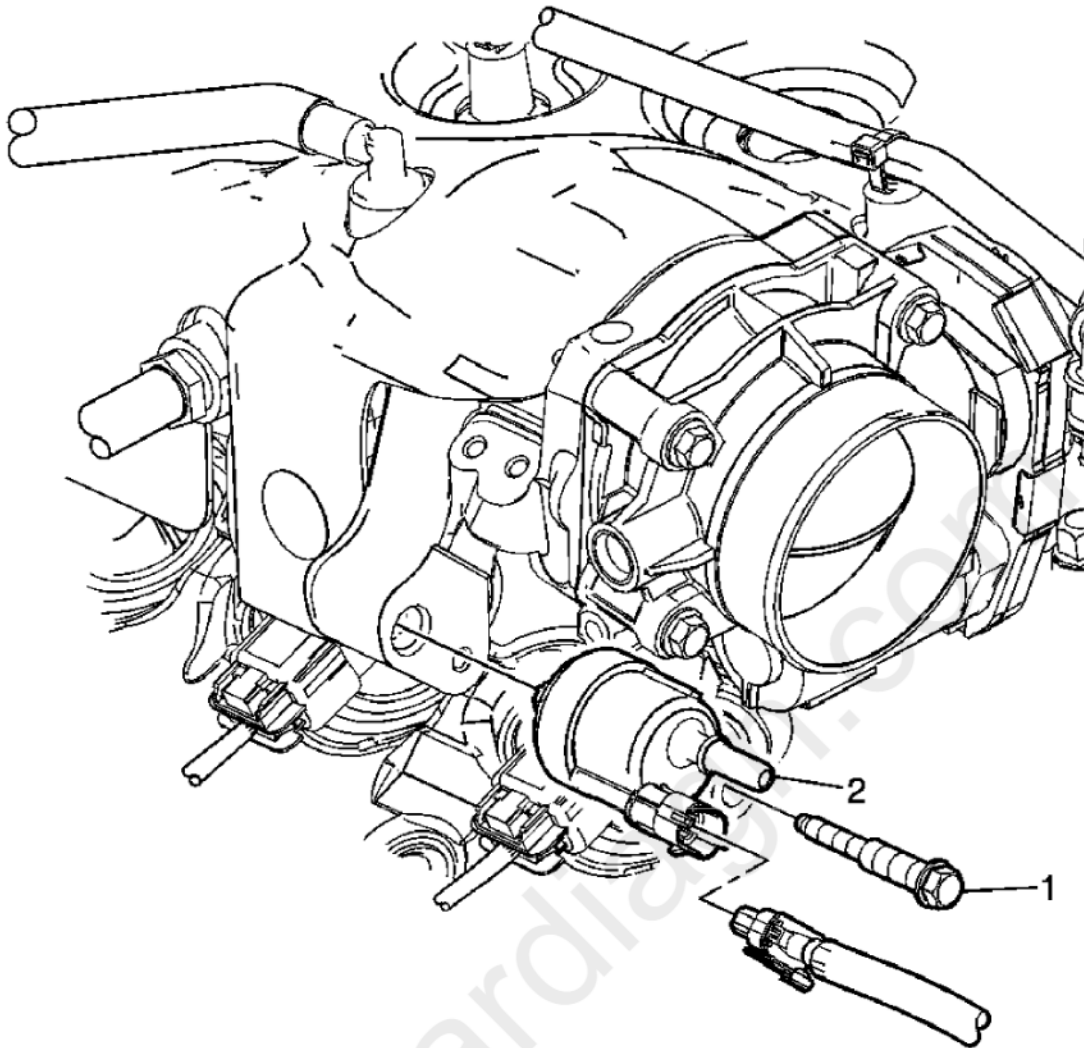


Fig. 154: Evaporative Emission Canister Purge Solenoid Valve (LLT)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT) .	
1	Bolt CAUTION: Refer to. Tighten: 10 N.m (89 lb in)
	Evaporative Emission Canister Purge Solenoid Valve

2011 Cadillac CTS

2011 ENGINE Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - CTS

Procedure

2

1. Disconnect the EVAP canister purge solenoid harness connector.
2. Install a NEW O-ring.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Remove the exhaust system. Refer to **EXHAUST SYSTEM REPLACEMENT (LF1-SINGLE)** or **EXHAUST SYSTEM REPLACEMENT (LF1-SEDAN/WAGON)** or **EXHAUST SYSTEM REPLACEMENT (LLT-COUPE)** or **EXHAUST SYSTEM REPLACEMENT (LLT-SEDAN/WAGON)**
2. Steps 3-5 apply to Sedan/Wagon only. Proceed to step 6 for Coupe
3. Place a jack stand under the rear differential assembly

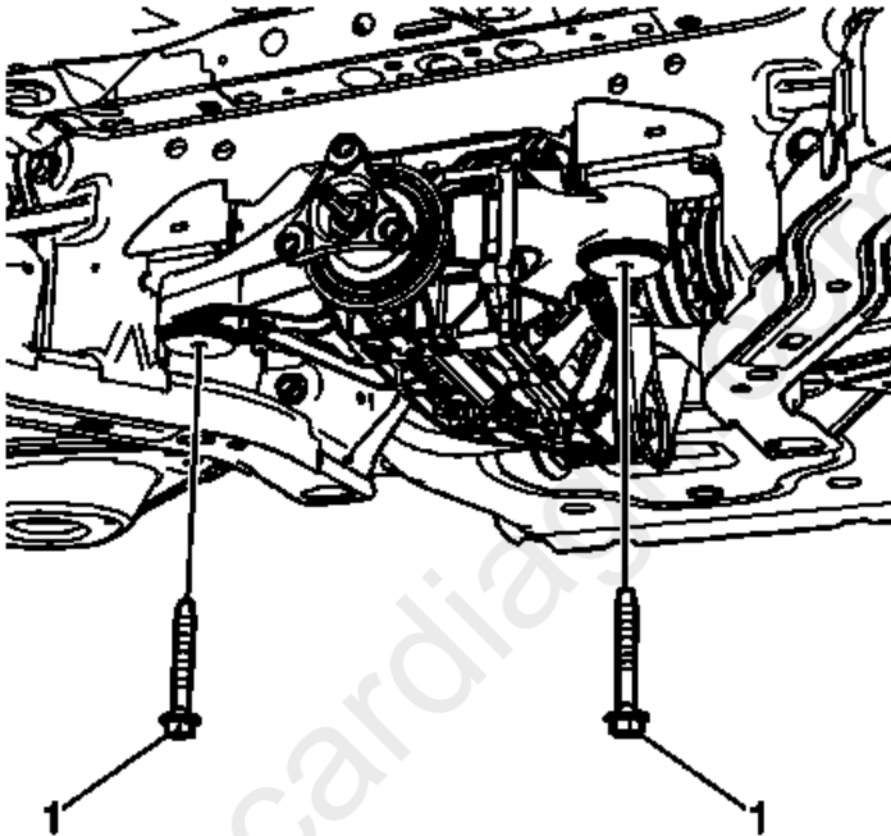


Fig. 155: View of Front Differential Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the two front differential mounting bolts.
5. Lower the differential slightly to provide additional clearance to the Evap canister
6. Remove the two EVAP canister retaining nuts and lower the rear of the canister enough to clear the weld studs
7. Slide the canister rearward from the body brace to gain access to the canister vent valve

8. Clean away any debris that may be present around the EVAP canister vent valve
9. Disconnect the electrical connector from the EVAP canister vent valve

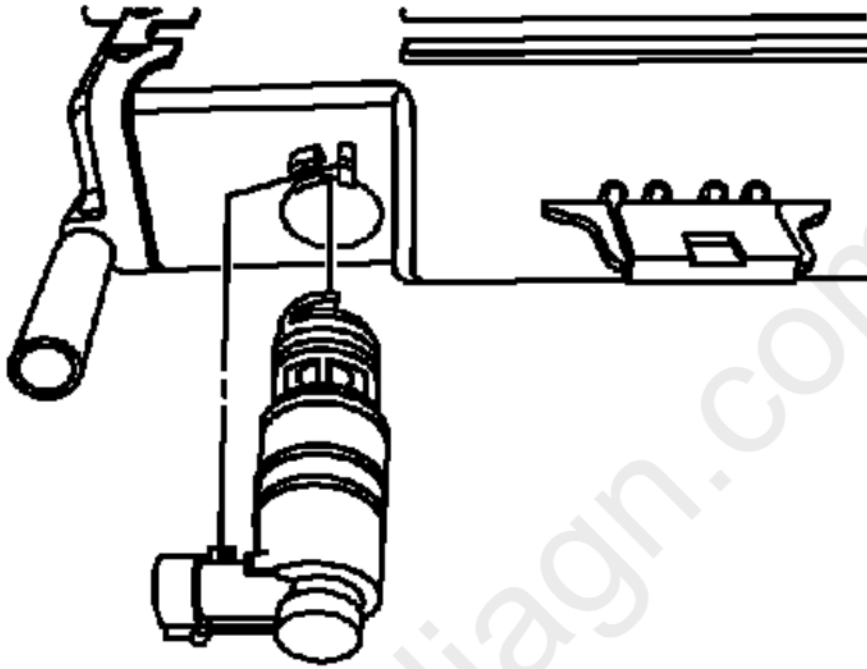


Fig. 156: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS COMPANY

10. Twist the EVAP canister vent valve counterclockwise
11. Pull the EVAP canister vent valve from the EVAP canister

Installation Procedure

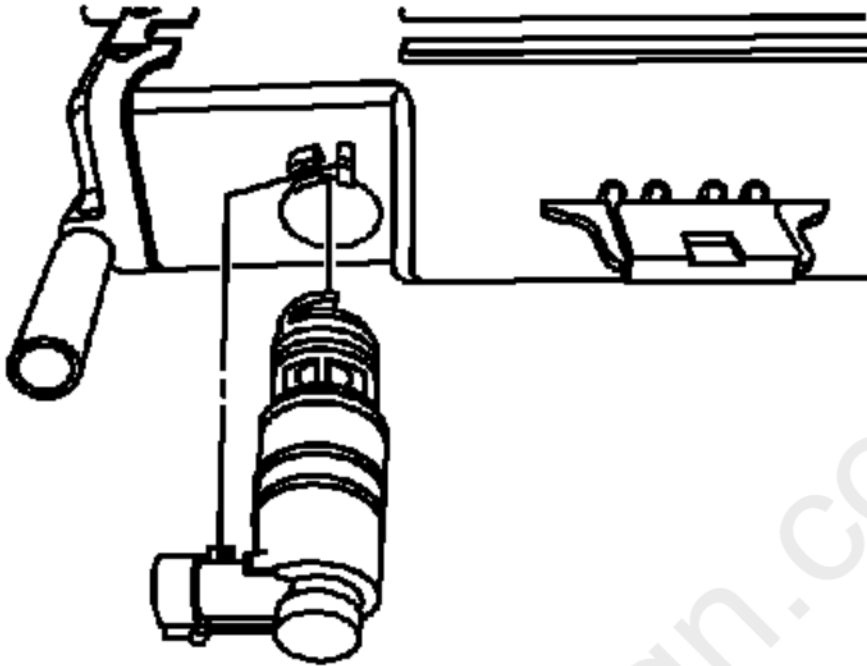


Fig. 157: View Of EVAP Canister Vent Valve
 Courtesy of GENERAL MOTORS COMPANY

1. Insert the EVAP canister vent valve into the EVAP canister
2. Twist the EVAP canister vent valve clockwise into the locked position
3. Connect the electrical connector to the EVAP canister vent valve
4. Attach the EVAP canister to the body by inserting the fresh air tube and tab on the canister forward into the body brace.
5. Rotate the rear of the canister up over the 2 weld studs on the floor pan
6. Install the EVAP canister to the body and install the bolts and tighten to 6 N.m (53 lb in).

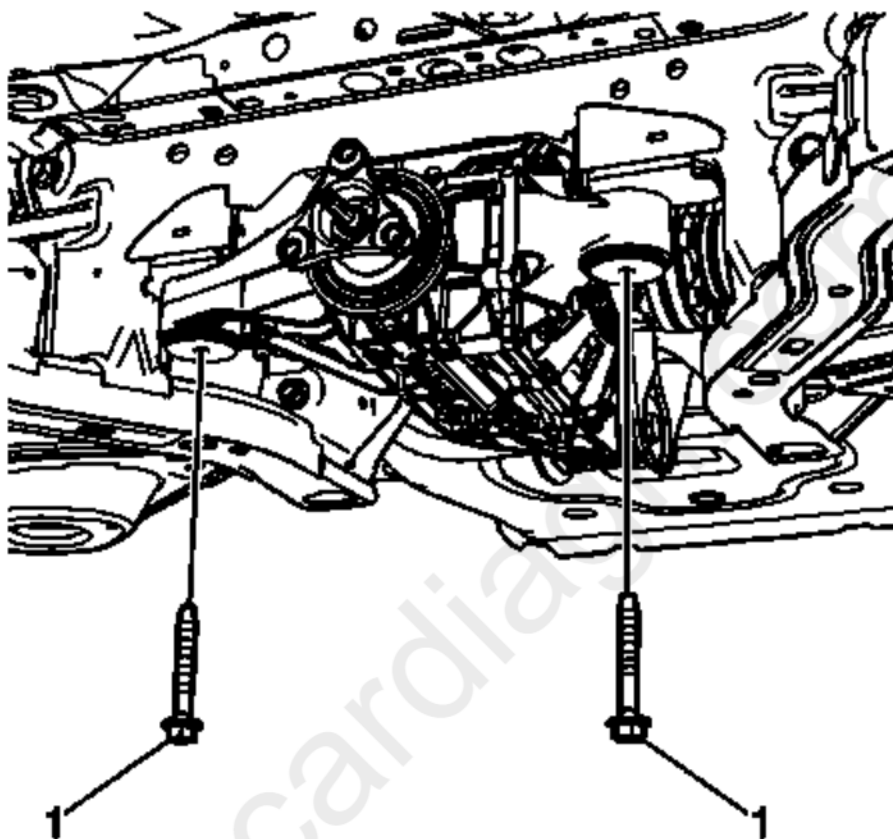


Fig. 158: View of Front Differential Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Sedan/Wagon only: Raise the rear differential into position and install the front mounting bolts (1) and tighten to 175 N.m (129 lb ft).
8. Install the exhaust system. Refer to the exhaust system. Refer to **EXHAUST SYSTEM REPLACEMENT (LF1-SINGLE)** or **EXHAUST SYSTEM REPLACEMENT (LF1-SEDAN/WAGON)** or **EXHAUST SYSTEM REPLACEMENT (LLT-COUPE)** or **EXHAUST**

SYSTEM REPLACEMENT (LLT-SEDAN/WAGON)**EVAPORATIVE EMISSION LINE REPLACEMENT - CHASSIS TO CANISTER****Removal Procedure****CAUTION:**

- Do not attempt to straighten kinked nylon pipes. Replace any kinked nylon pipes in order to prevent damage to the vehicle.
- Do not attempt to repair sections of nylon pipes. Replace damaged nylon pipes.
- Replace the vapor hoses/pipes with original equipment or parts that meet GM specifications.

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

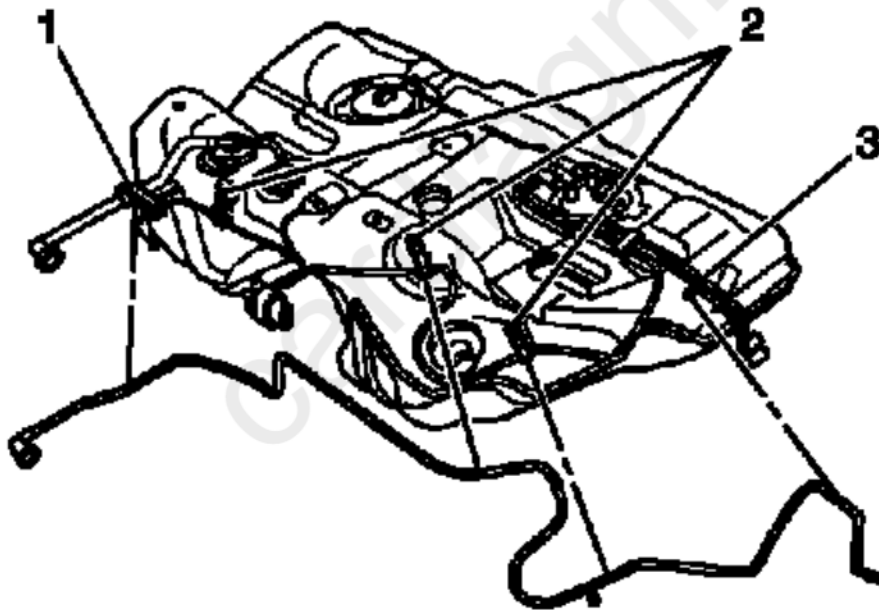


Fig. 159: View Of EVAP Hose Retainers
Courtesy of GENERAL MOTORS CORP.

2. Remove the chassis to canister evaporative emission (EVAP) hose from the following:
 - The body retainer (1)

- The 3 retaining features (2) on the fuel tank
 - The retainer clip (3)
3. Remove the EVAP hose from the fuel tank.

Installation Procedure

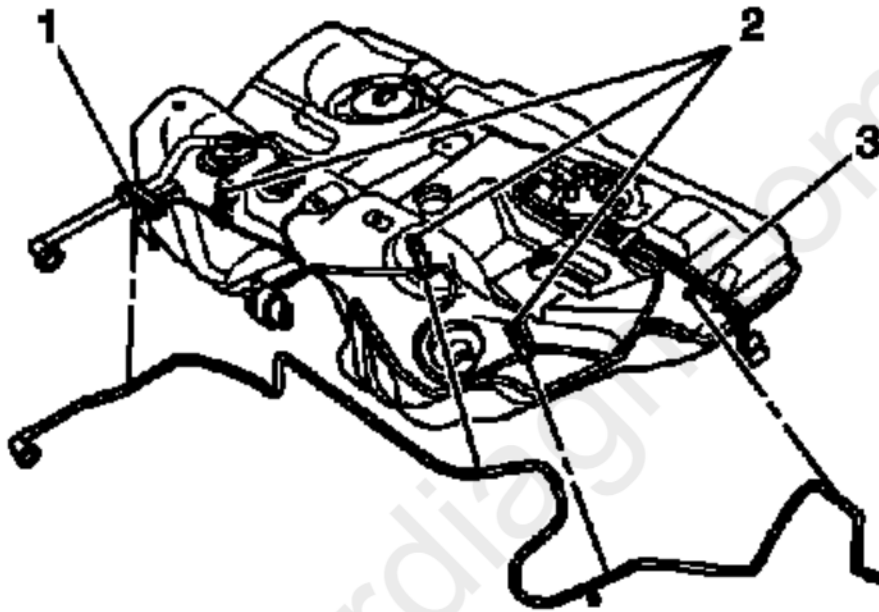


Fig. 160: View Of EVAP Hose Retainers
Courtesy of GENERAL MOTORS CORP.

1. Position the EVAP hose to the fuel tank.
2. Install the chassis to canister EVAP hose to the following:
 - The body retainer (1)
 - The 3 retaining features (2) on the fuel tank
 - The retainer clip (3)
3. Install the fuel tank. Refer to **Fuel Tank Replacement**.

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

1. Remove the rear frame. Refer to [Rear Frame Replacement](#) .

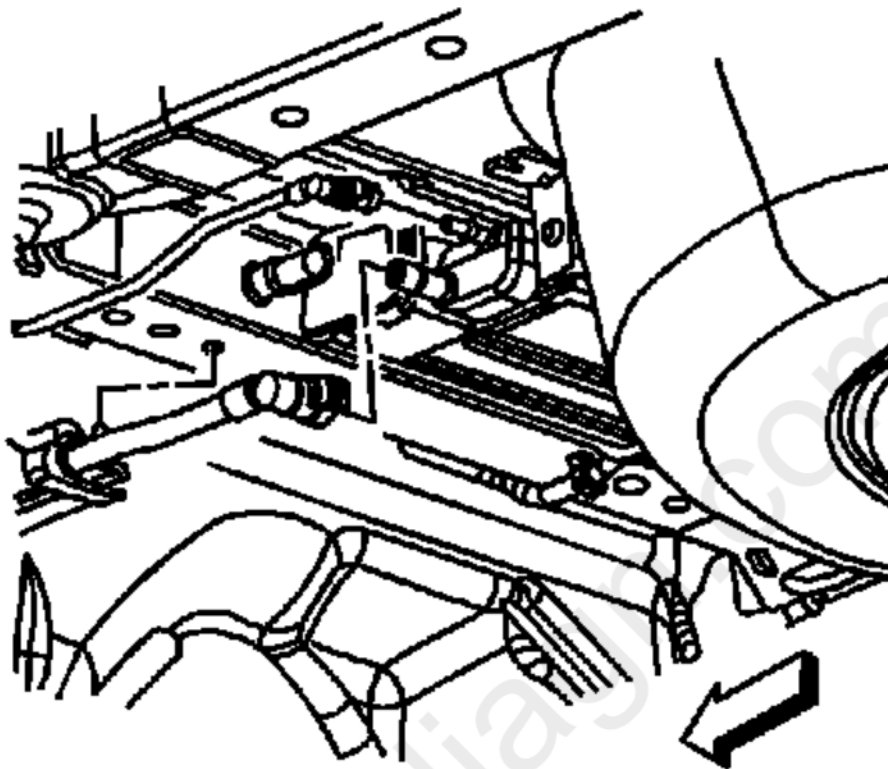


Fig. 161: Identifying EVAP Hoses At EVAP Canister
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the evaporative emission (EVAP) hoses from the EVAP canister.
3. Disconnect the electrical connector from the EVAP canister.

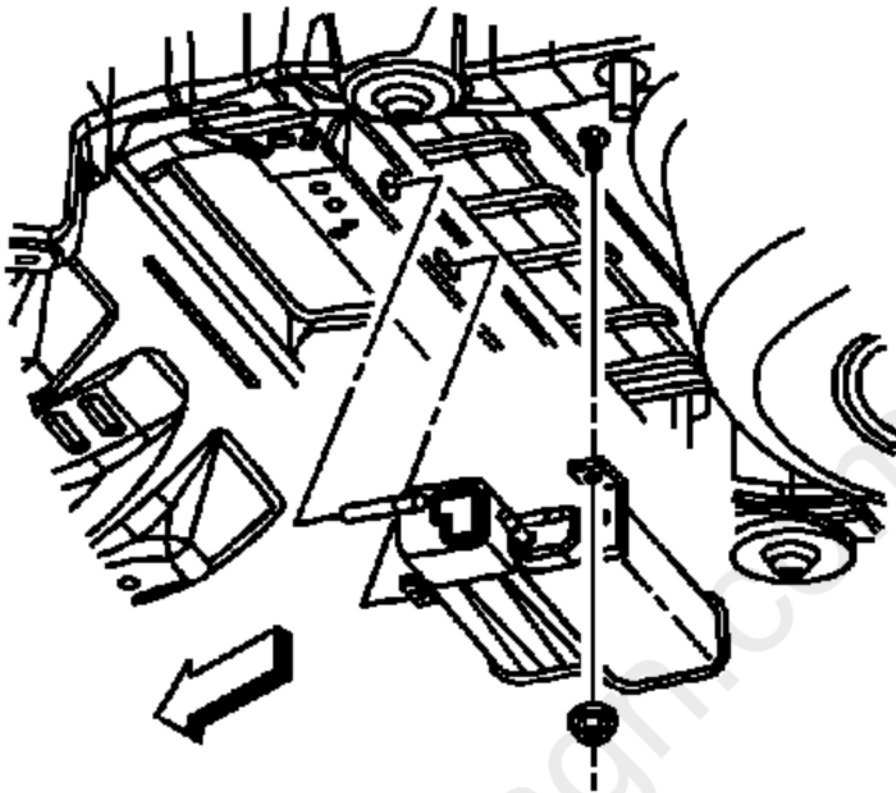


Fig. 162: View Of EVAP Canister Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

4. Remove the EVAP canister retaining nuts.
5. Complete the following in order to remove the EVAP canister:
 1. Lower the rear of the canister enough to clear the 2 weld studs.
 2. Slide the canister rearward from the body brace.

Installation Procedure

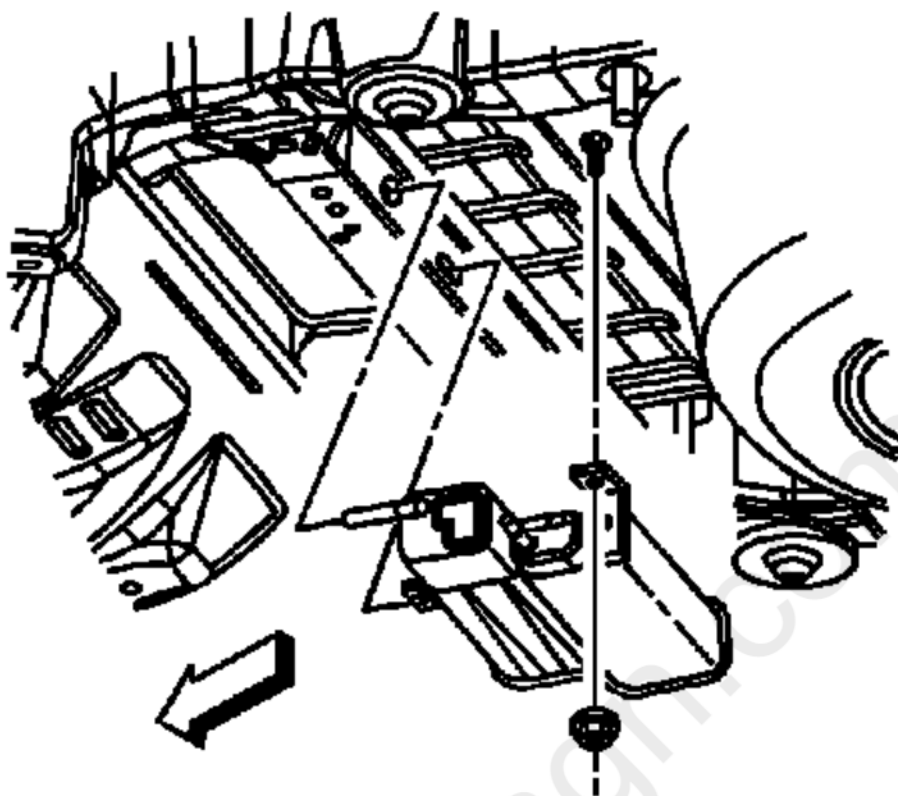


Fig. 163: View Of EVAP Canister Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

1. Complete the following in order to install the EVAP canister:
 1. Insert the fresh air tube and tab on the canister forward into the body brace.
 2. Rotate the rear of the canister up over the 2 weld studs on the floor pan.

CAUTION: Refer to FASTENER CAUTION .

2. Install the EVAP canister retaining nuts and tighten to 6 N.m (53 lb in).

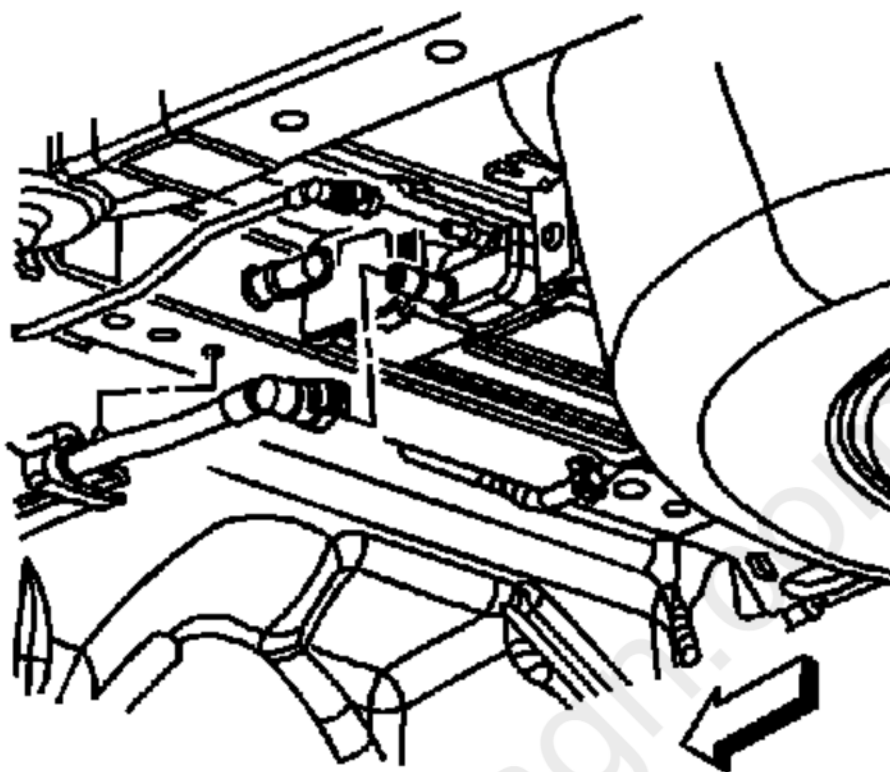


Fig. 164: Identifying EVAP Hoses At EVAP Canister
Courtesy of GENERAL MOTORS CORP.

3. Connect the EVAP hoses to the EVAP canister.
4. Connect the electrical connector to the EVAP canister.
5. Install the rear frame. Refer to **Rear Frame Replacement**.

EVAPORATIVE EMISSION CANISTER FILTER REPLACEMENT

Removal Procedure

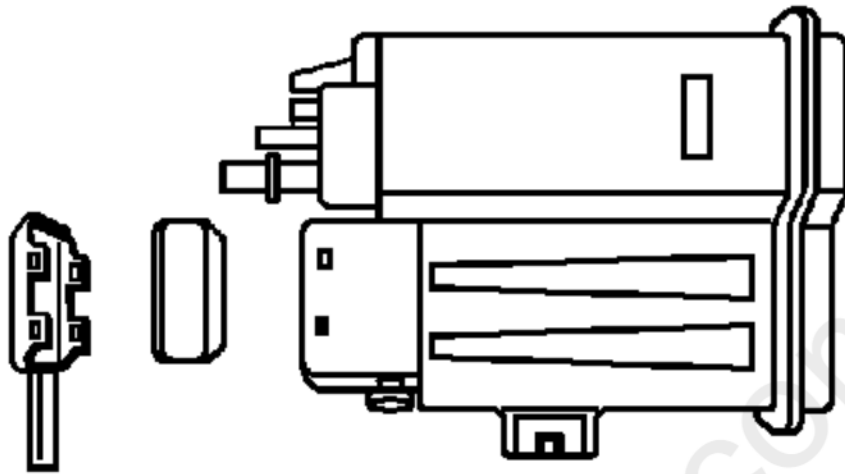


Fig. 165: View Of EVAP Canister Filter
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Using a 90 degree pick, disengage the lower filter cover clips.
3. Insert a flat-bladed tool between the filter cover and canister, and push up to disengage the upper clips.
4. Remove and discard the evaporative emission (EVAP) canister filter cover.
5. Remove and discard the EVAP canister filter.
6. Clean the inside of the EVAP canister filter housing with a clean shop towel.

Installation Procedure

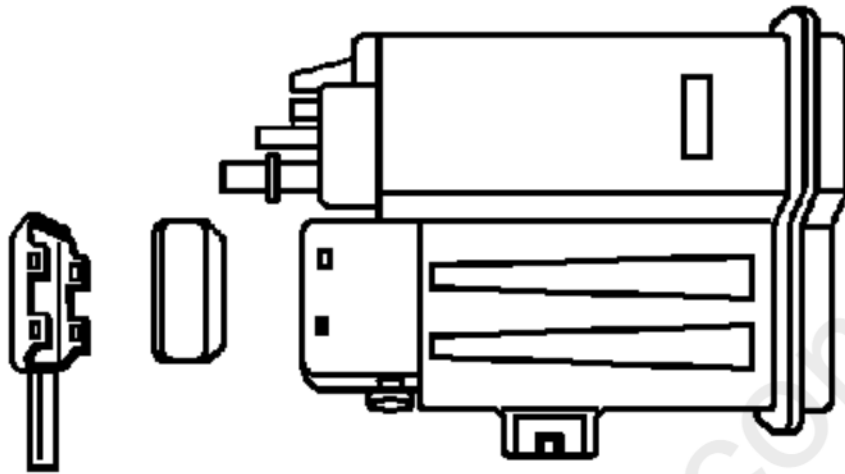


Fig. 166: View Of EVAP Canister Filter
Courtesy of GENERAL MOTORS CORP.

1. Insert a NEW EVAP canister filter into the EVAP canister.

IMPORTANT: Ensure the NEW seal is properly seated into the NEW cover.

2. Install a NEW EVAP canister filter cover seal to a EVAP NEW canister cover.
3. Snap the EVAP canister filter cover onto the EVAP canister.
4. Lower the vehicle.

IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

1. Remove the intake manifold. Refer to [Intake Manifold Replacement](#) .

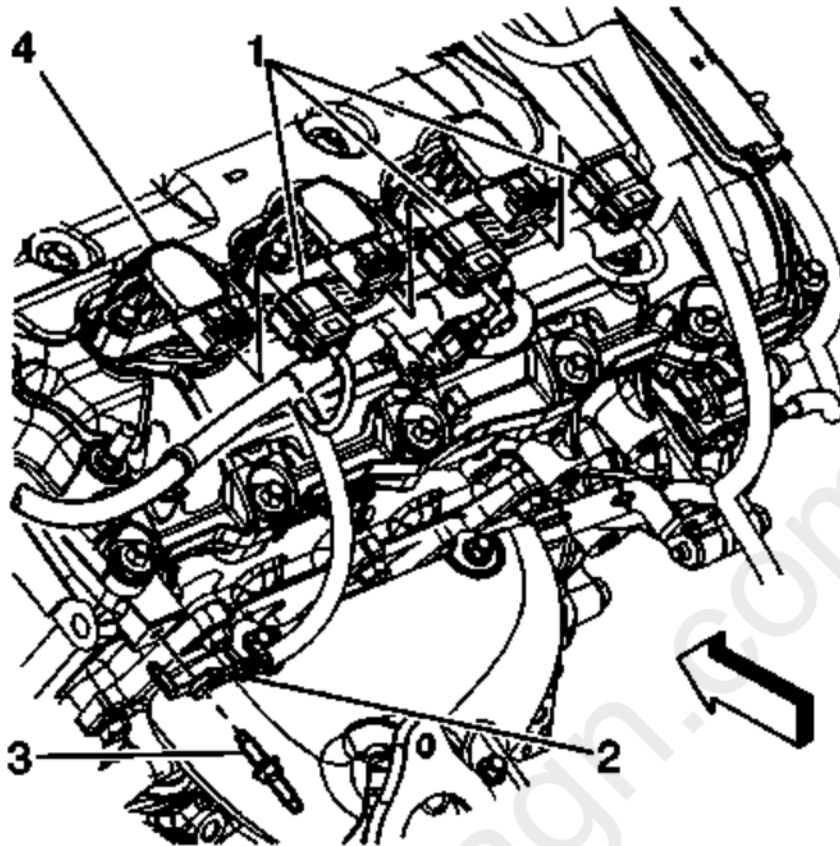


Fig. 167: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS CORP.

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

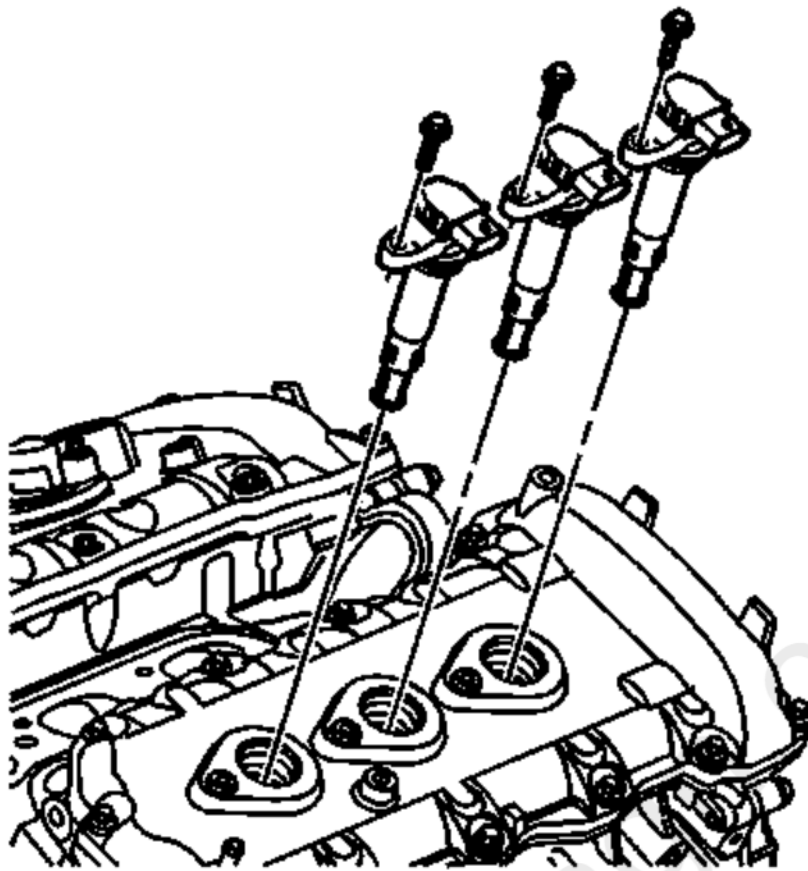


Fig. 168: Ignition Coil View

Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

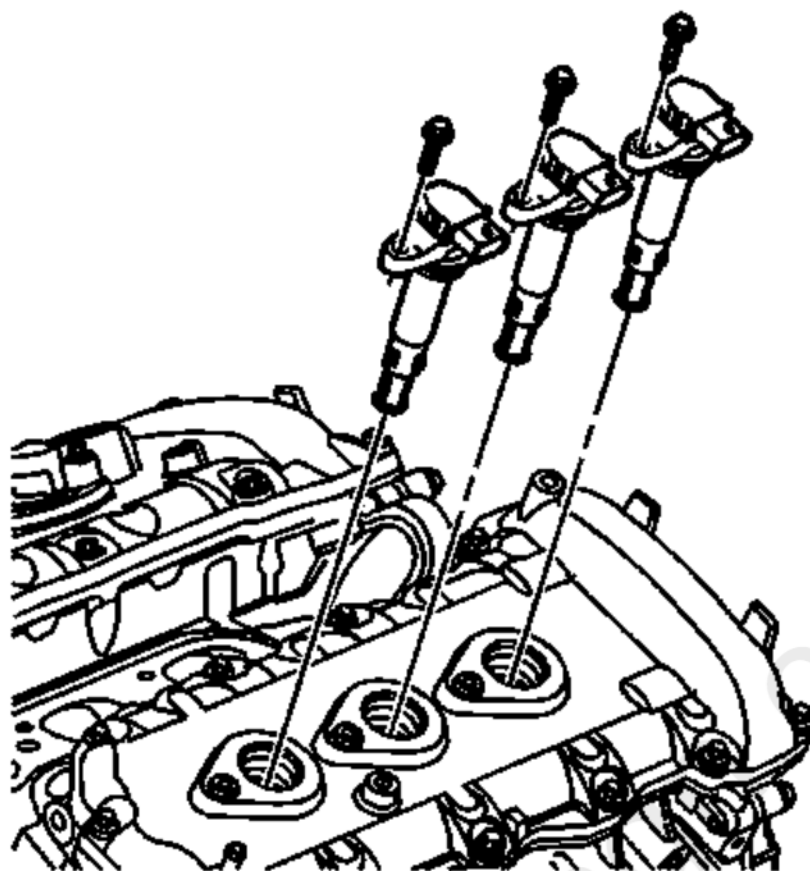


Fig. 169: Ignition Coil View

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).

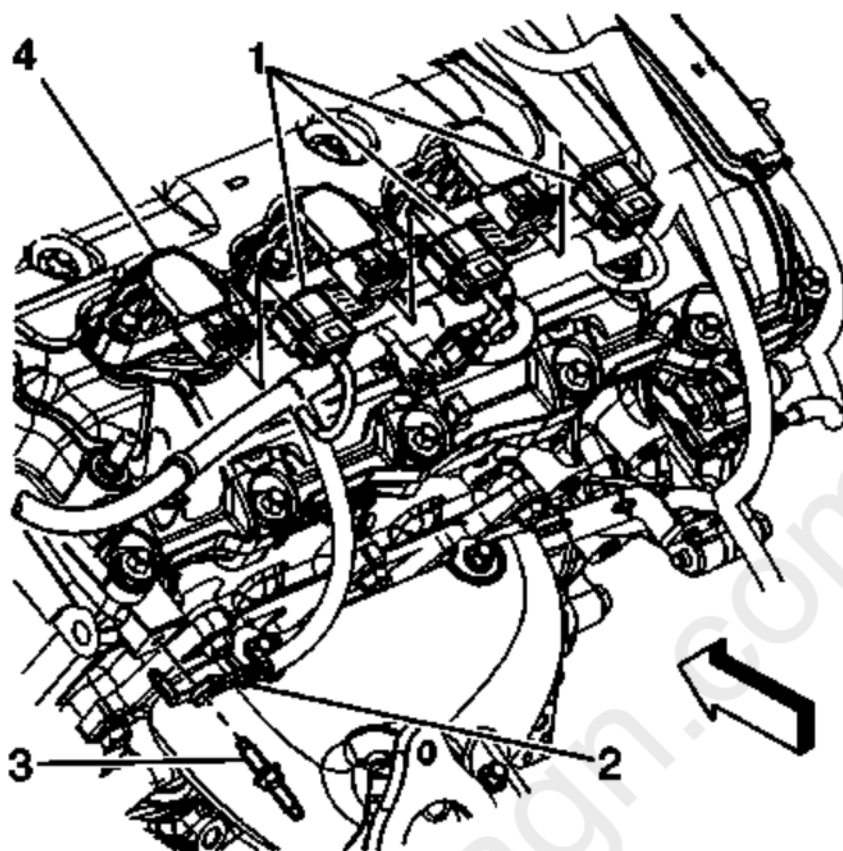


Fig. 170: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS CORP.

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

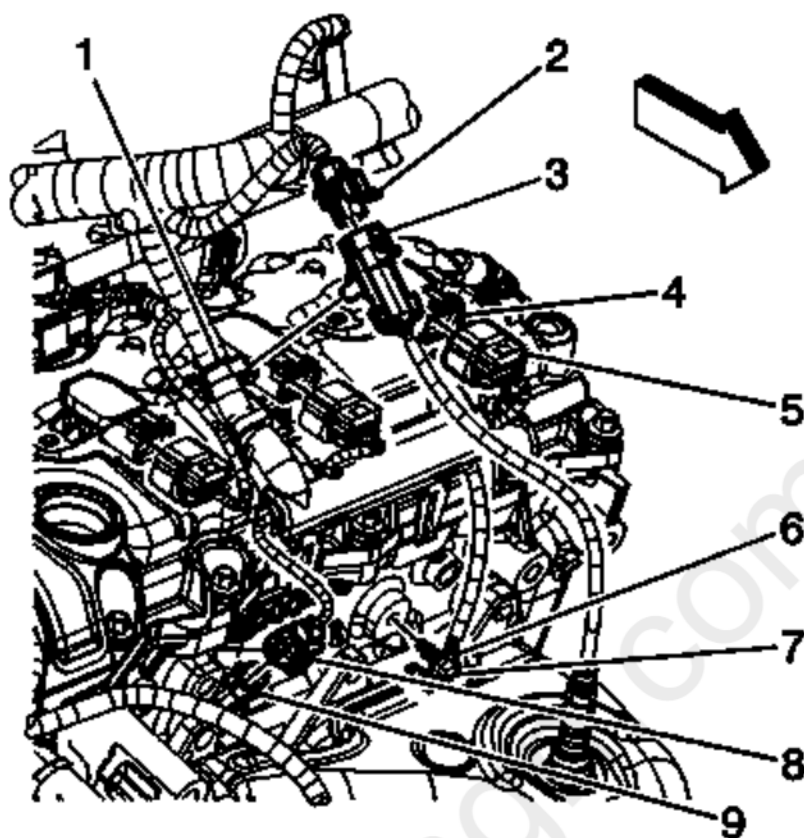


Fig. 171: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
2. Disconnect the engine wiring harness electrical connector(s) (5) from the ignition coil(s) (4).

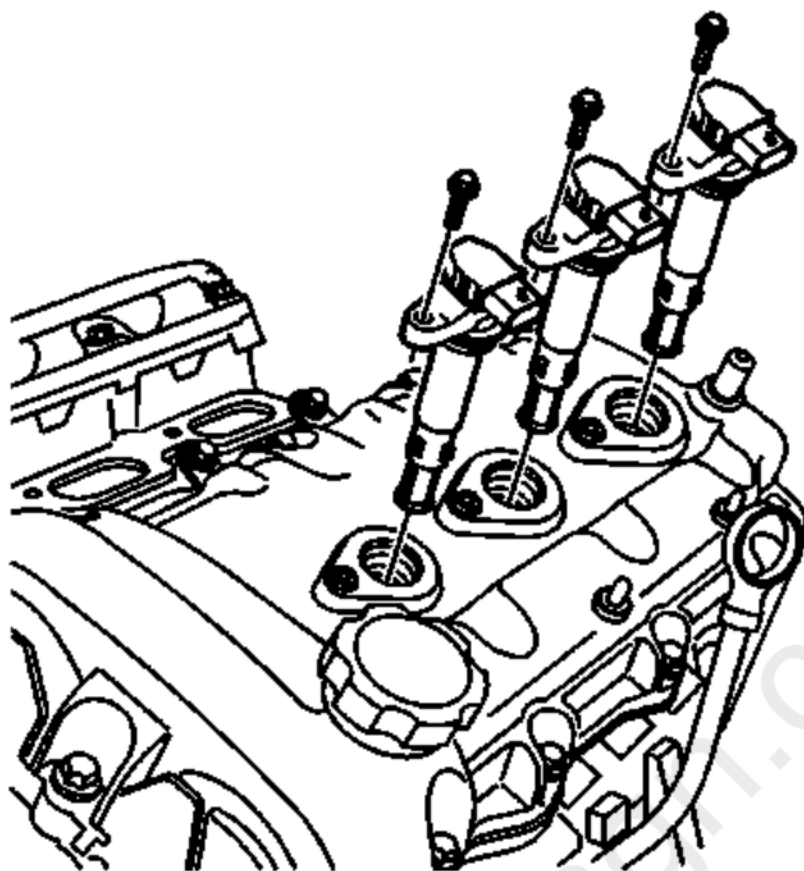


Fig. 172: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

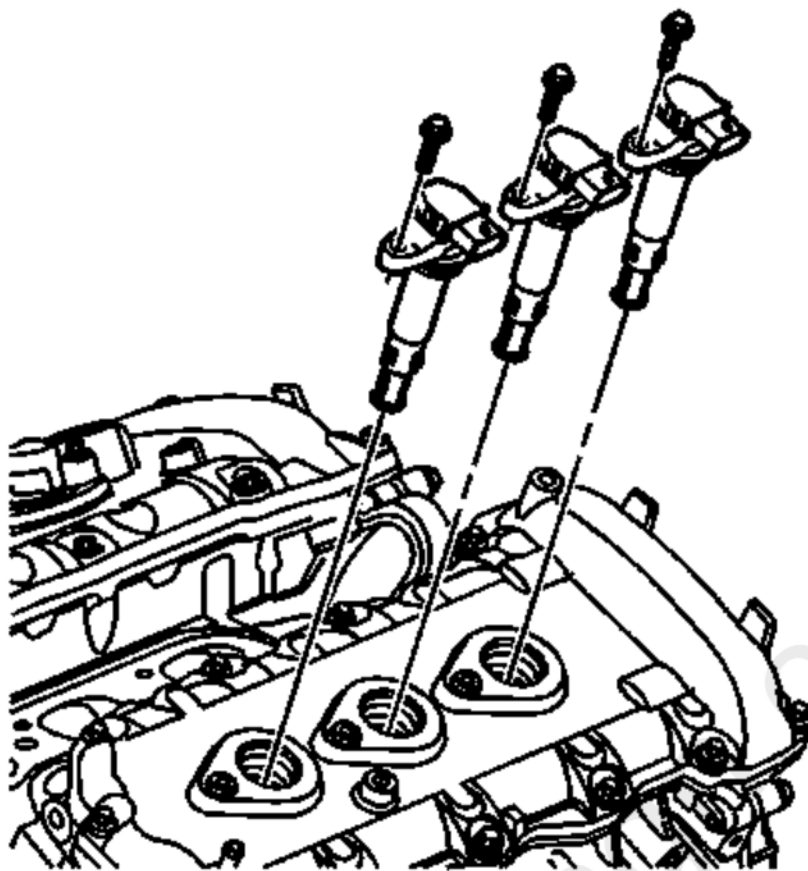


Fig. 173: Ignition Coil View

Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to FASTENER CAUTION .

2. Install the ignition coil bolt(s) and tighten to 10 N.m (89 lb in).

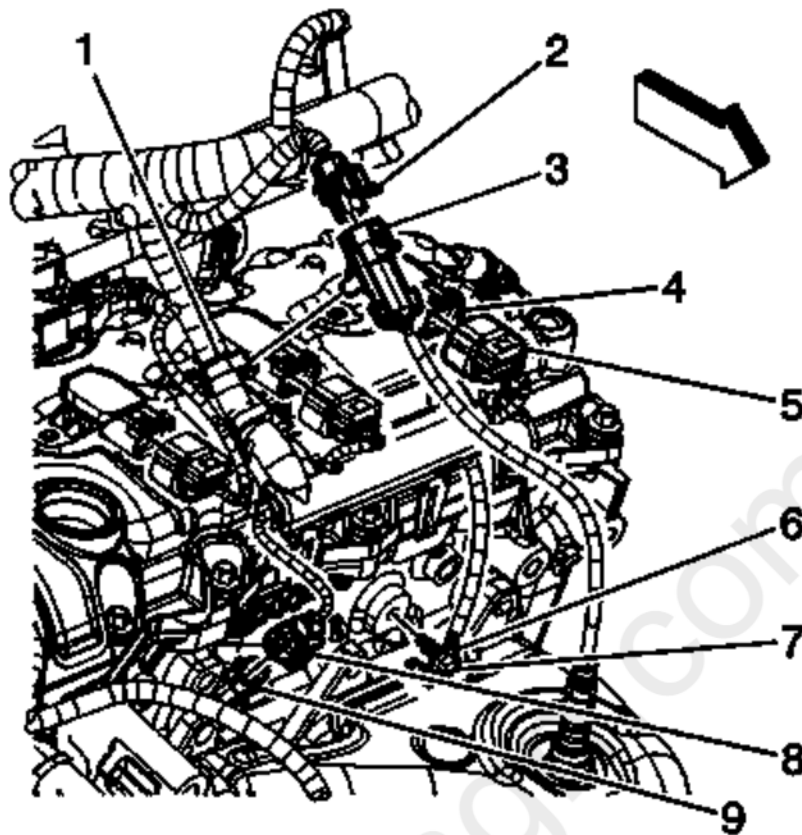


Fig. 174: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the engine wiring harness electrical connector(s) (5) to the ignition coil(s) (4).
4. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)** .

SPARK PLUG INSPECTION

Spark Plug Operation

Worn or dirty spark plugs may operate well at idle speeds, but frequently fail at higher load. Bad spark plugs are often responsible for the following conditions:

- Power loss
- Poor fuel economy
- Loss of speed
- Hard starting
- Poor engine performance

Normal spark plug operation results in brown to grayish tan deposits on the area of the spark plug that enters the

cylinder. A small amount of reddish brown, yellow, and white powdery residue may also be present on the insulator tip around the center electrode. These deposits are normal combustion by-products of fuels and lubricating oils which contain additives.

Misfiring is a general term that applies to a poor running engine. With misfiring, the ignition spark is not igniting the air/fuel mixture at the proper time. While other possible causes must be investigated, the spark plugs should be inspected first. Spark voltage should not reach ground before jumping across the gap at the tip of the spark plug. This leaves the air/fuel mixture unburned, causing misfiring. Pre-ignition misfiring occurs when the spark plug tip overheats, igniting the mixture before the spark jumps.

Carbon fouling of the spark plug is indicated by dry carbon deposits on the portion of the spark plug inside of the cylinder. Excess idling and driving at slower speeds under light engine loads can keep the spark plug temperatures so low that these deposits are not burned off. Rich fuels or poor ignition system output may also cause carbon fouling.

Oil fouling of the spark plug appears as wet oily deposits on the portion of the spark plug inside of the cylinder. This may be caused by the following conditions:

- Oil getting past worn piston rings
- Breaking in a new or recently overhauled engine

Deposit fouling of the spark plug occurs when the normal reddish brown, yellow, or white deposits of combustion by-products become sufficient enough to cause misfiring. In some cases, these deposits melt and form a shiny glaze on the insulator around the center electrode. If the fouling is found only in one or two of the cylinders, valve stem clearances or the intake valve seals may be allowing excess lubricating oil to enter the cylinder, particularly if the deposits are heavier on the intake valve side of the spark plug.

Excess gap means that the air space between the center and side electrodes at the bottom of the spark plug is too wide for consistent firing. This may be due to improper gap adjustment or to excess wear of the electrodes during use. A gap that is too small may cause idling instability. Excess gap wear might indicate vehicle operation at continual high speeds or with high engine loads. This causes the spark plugs to run too hot. Excessively lean fuel may also cause the wear.

Improper torque or seating can cause a spark plug to run hot, eventually leading to excess gap wear. In extreme cases, an overtightened or under-tightened spark plug can cause exhaust blow-by. The cylinder head seats must make good contact for sufficient heat transfer and spark plug cooling. Dirty or damaged threads in the head or on the spark plug can keep the spark plug from seating even though the proper torque is applied. Once the spark plugs are properly seated, tighten the spark plugs properly.

Cracked or broken insulators and insulator tips may be the result of improper installation or heat shock. Heat shock is a rapid increase in the insulator tip temperature which causes the insulator material to crack. The upper insulators can be broken when a poorly-fitting tool is used during servicing, or when the spark plug is hit from the outside. Cracks in the upper insulator may be inside the shell or invisible. The breakage may not cause problems until oil or water penetrates the crack later. Heat shock breakage in the lower insulator tip generally occurs during severe engine operating conditions such as higher RPM or heavy loading. Over advanced timing or low grade fuels may also cause heat shock breakage. Always replace spark plugs with broken or cracked insulators.

Damage during gapping can occur when the tool is pushed against the center electrode or the surrounding insulator, causing the insulator to crack. When gapping a spark plug, bend only the outside electrode. Keep tools free of any other parts.

Spark plugs with less than the recommended amount of service can sometimes be cleaned and re-gapped, then returned to service. If there is any doubt about the serviceability of a spark plug, replace the spark plug.

SPARK PLUG REPLACEMENT

Removal Procedure

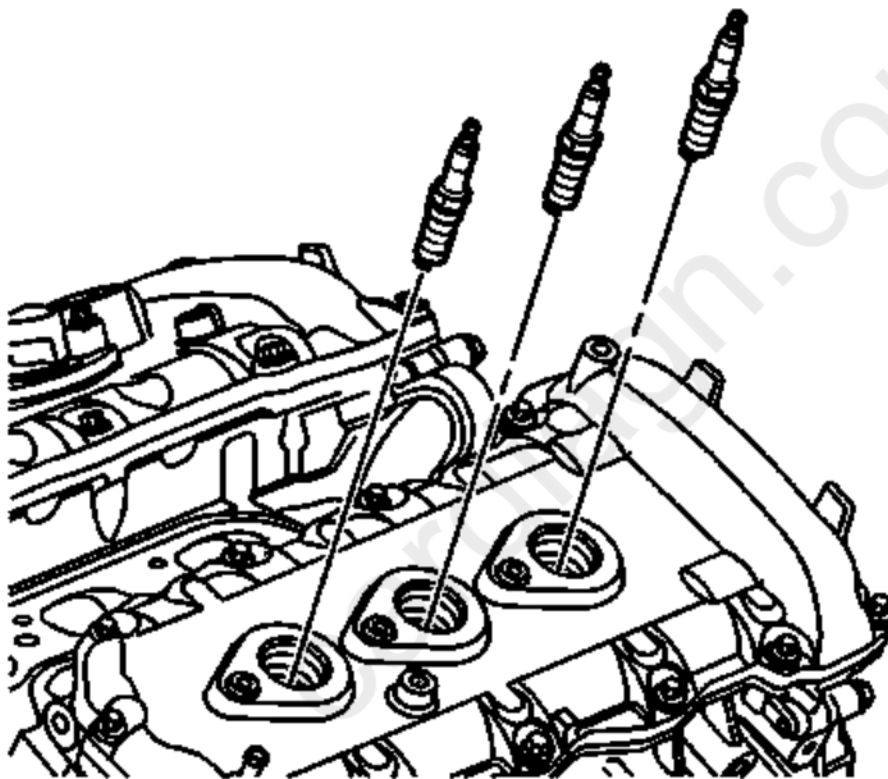


Fig. 175: View Of Spark Plugs

Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the ignition coil. 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.

3. 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.

4. Remove the spark plug.

Installation Procedure

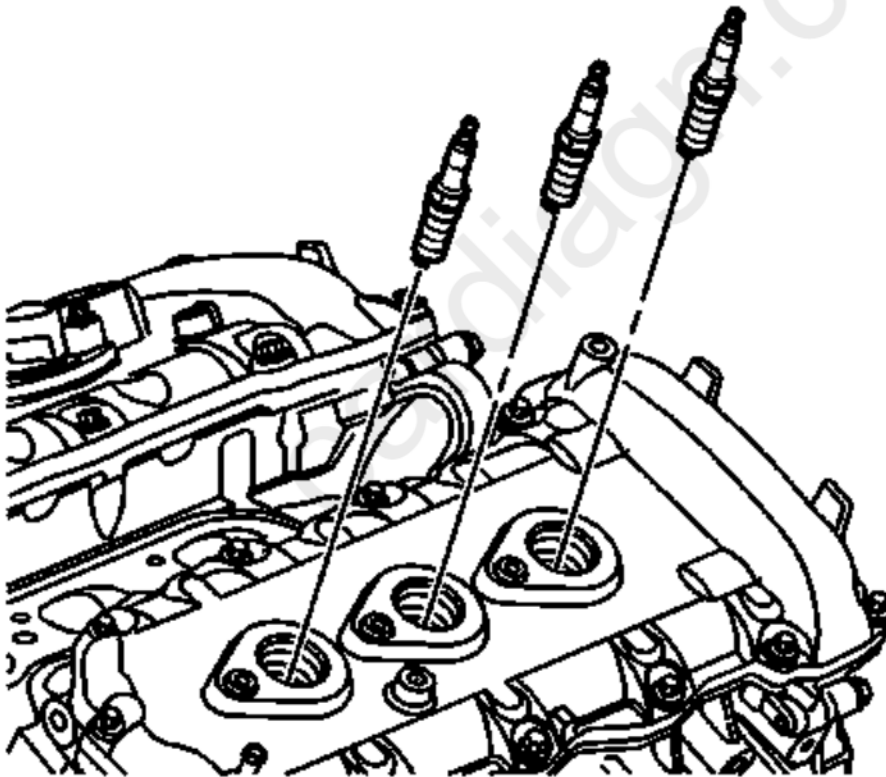


Fig. 176: View Of Spark Plugs

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.

2. Install the spark plug and tighten to 20 N.m (15 lb ft).
3. Install the ignition coil. Refer to **Ignition Coil Replacement - Bank 1** and/or **Ignition Coil Replacement - Bank 2**.

CRANKSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

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

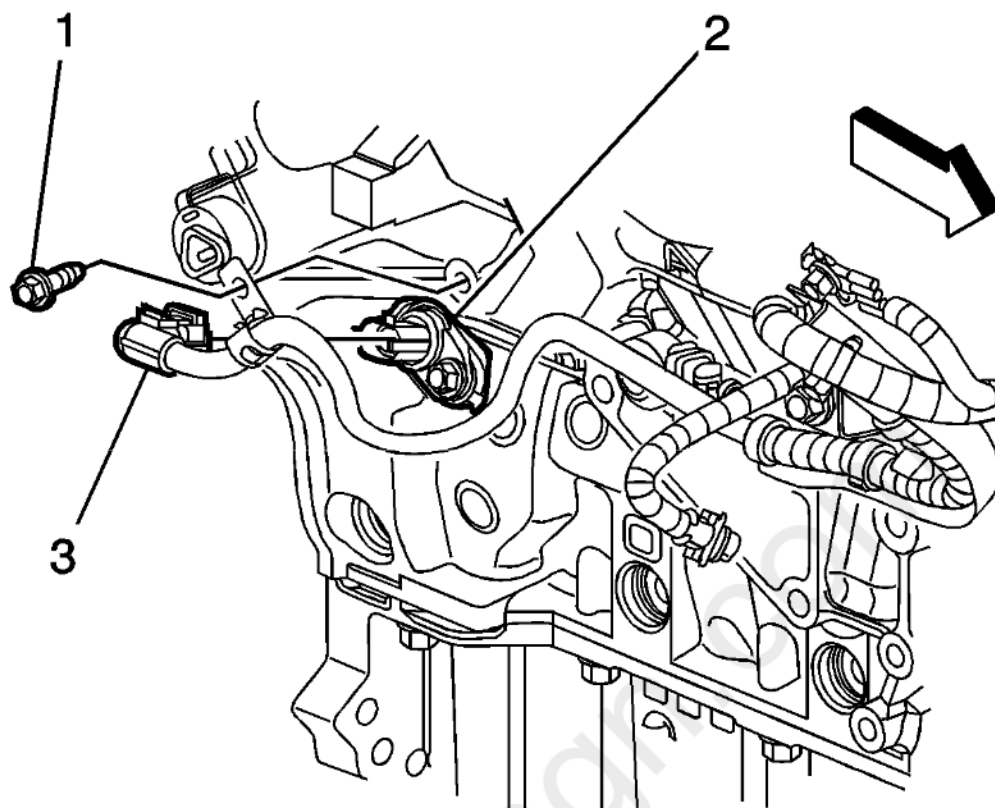


Fig. 177: Locating CKP Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the crankshaft position (CKP) electrical connector (3).

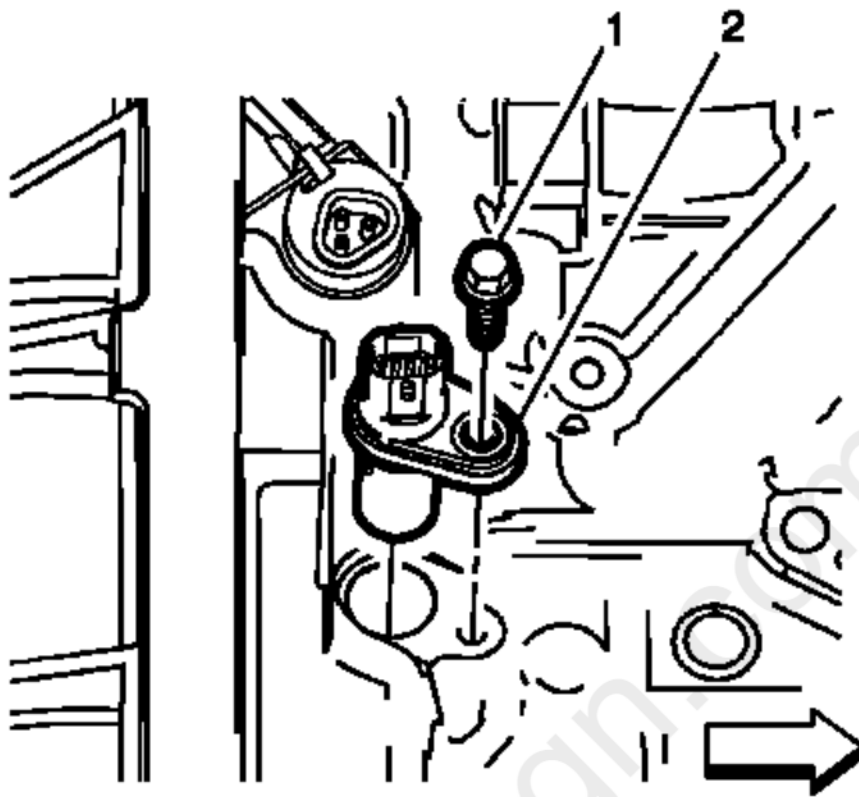


Fig. 178: Identifying Crankshaft Position (CKP) Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft sensor bolt.
4. Remove the crankshaft sensor.

Installation Procedure

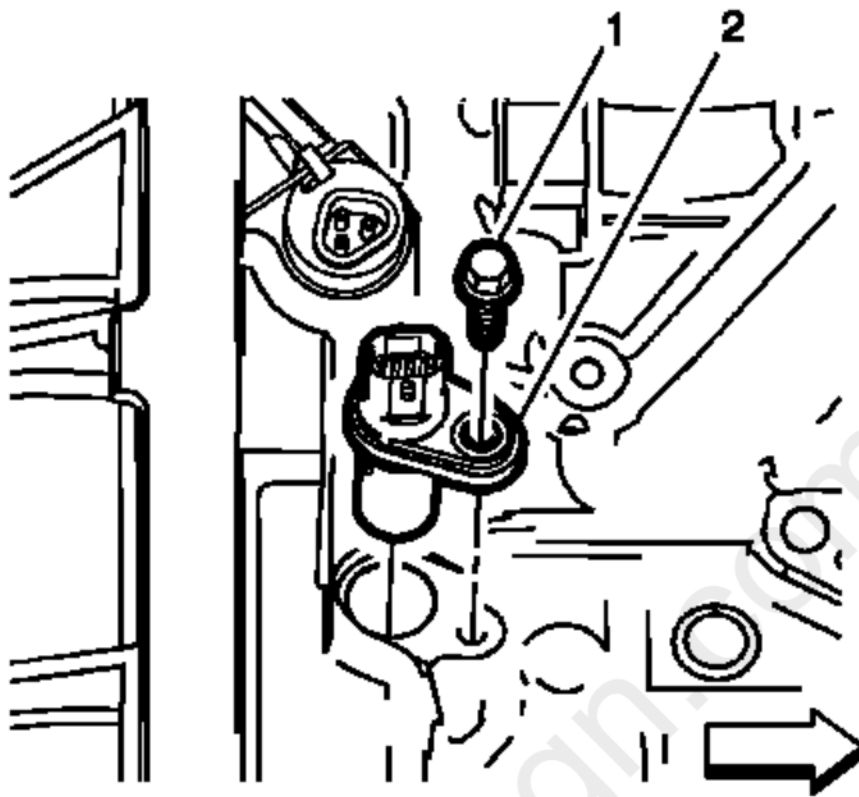


Fig. 179: Identifying Crankshaft Position (CKP) Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft position sensor.

CAUTION: Refer to FASTENER CAUTION .

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

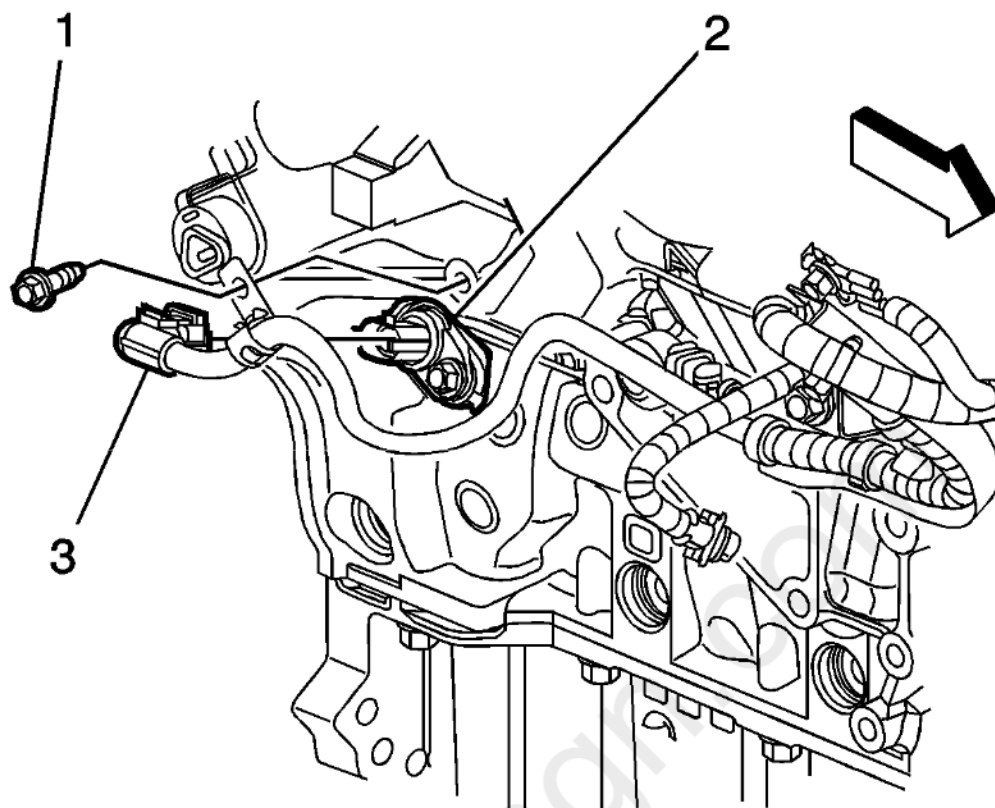


Fig. 180: Locating CKP Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the CKP electrical connector (3).
4. Lower the vehicle.

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

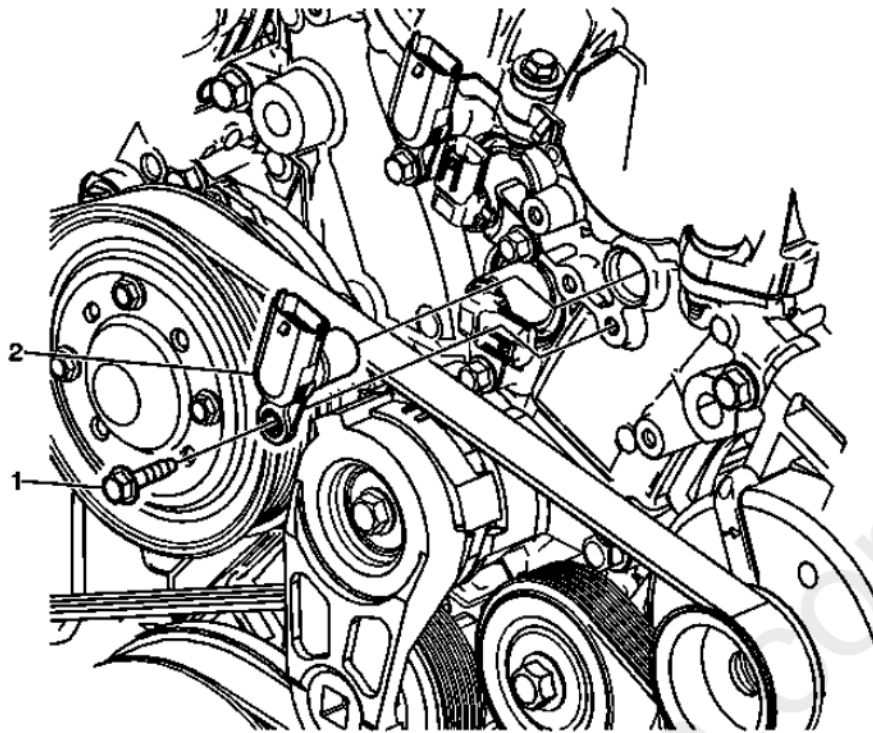


Fig. 181: Identifying Camshaft Position Sensor - Bank 2 (Left Side) Exhaust
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the left engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Left Side (AWD)</u> or <u>Engine Mount Bracket Replacement - Left Side (RWD)</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to. 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

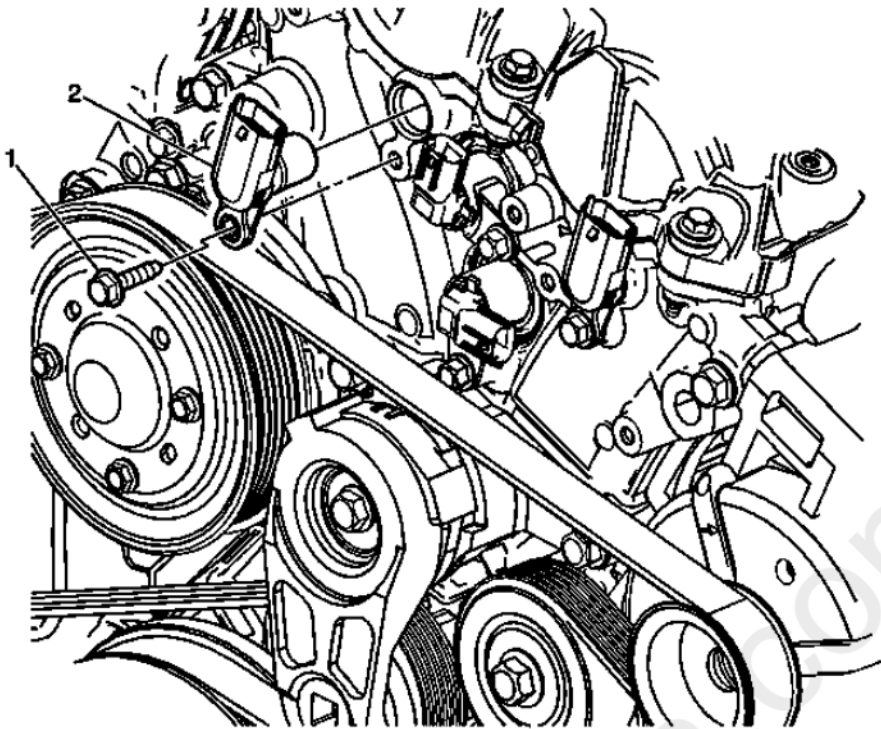


Fig. 182: Identifying Camshaft Position Sensor - Bank 2 (Left Side) Intake
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the left engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Left Side (AWD)</u> or <u>Engine Mount Bracket Replacement - Left Side (RWD)</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to. 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

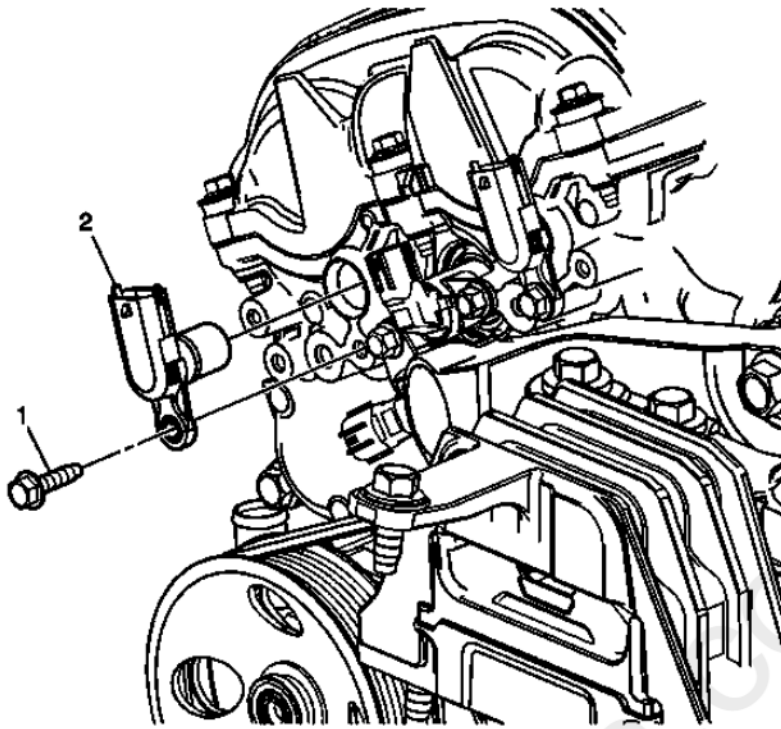


Fig. 183: Identifying Camshaft Position Sensor - Bank 1 (Right Side) Exhaust
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LF1)</u> or <u>Air Cleaner Assembly Replacement (LLT)</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to. 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

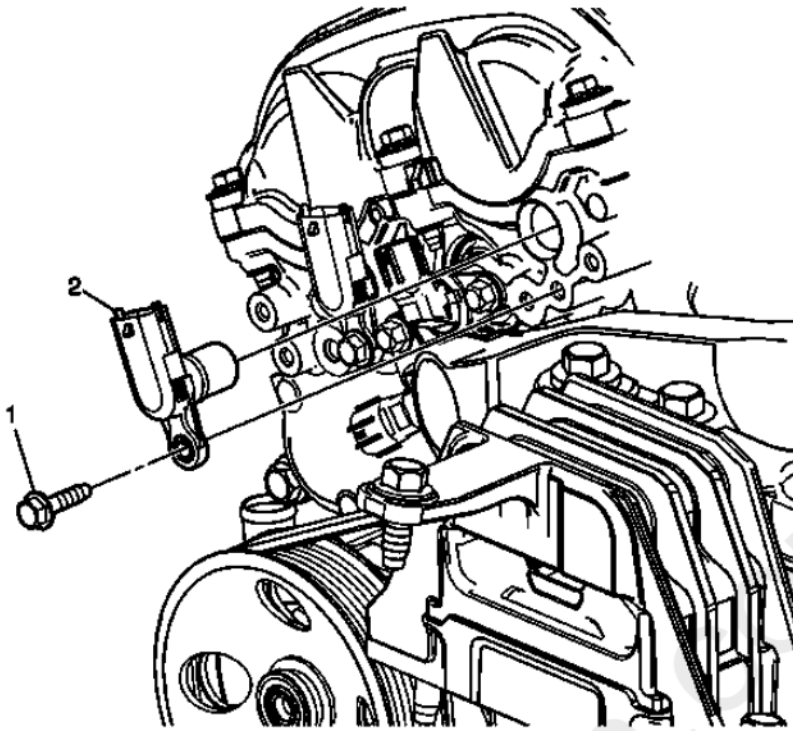


Fig. 184: Identifying Camshaft Position Sensor - Bank 1 (Right Side) Intake
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LF1)</u> or <u>Air Cleaner Assembly Replacement (LLT)</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to. 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

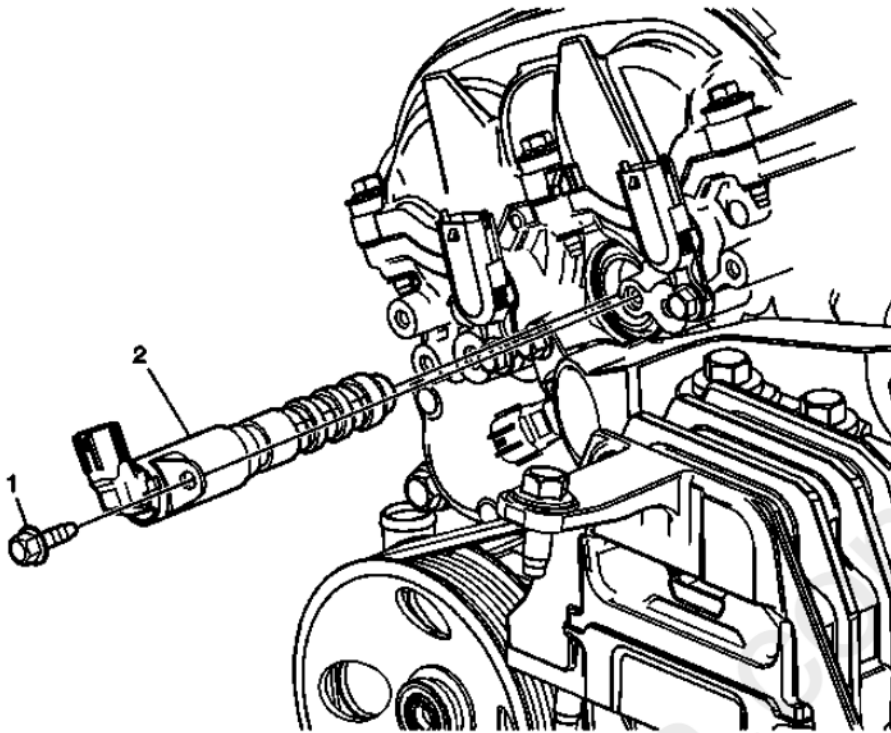


Fig. 185: Locating Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Intake
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LF1)</u> or <u>Air Cleaner Assembly Replacement (LLT)</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to. 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

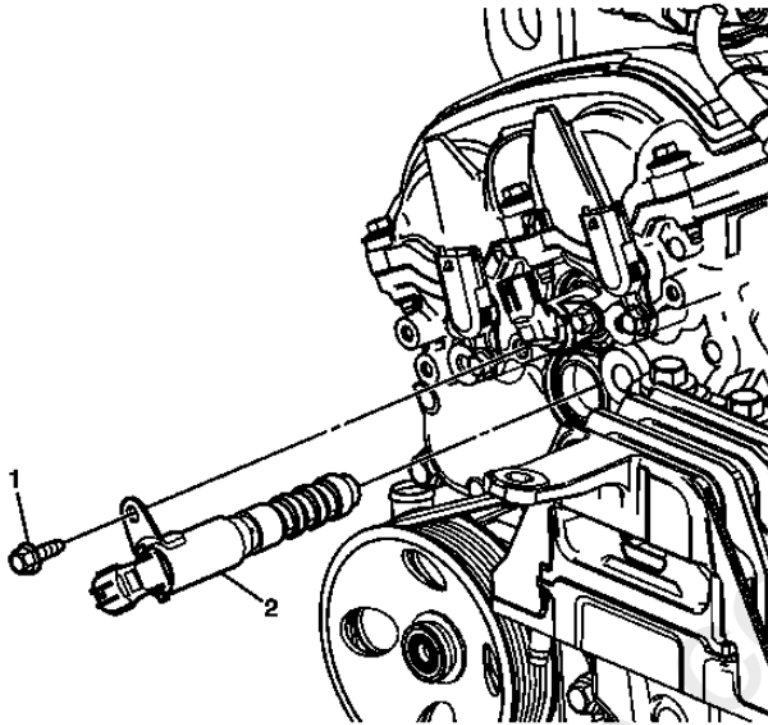


Fig. 186: Locating Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Exhaust
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LF1)</u> or <u>Air Cleaner Assembly Replacement (LLT)</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to. 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

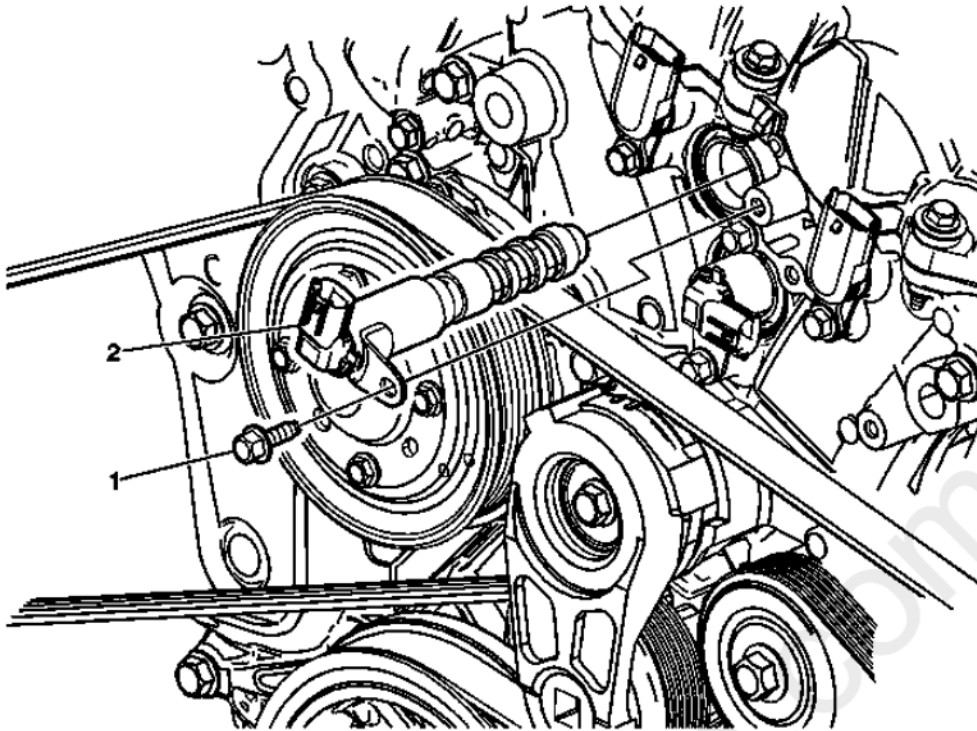


Fig. 187: Identifying Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Intake
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the left engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Left Side (AWD)</u> or <u>Engine Mount Bracket Replacement - Left Side (RWD)</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to. 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

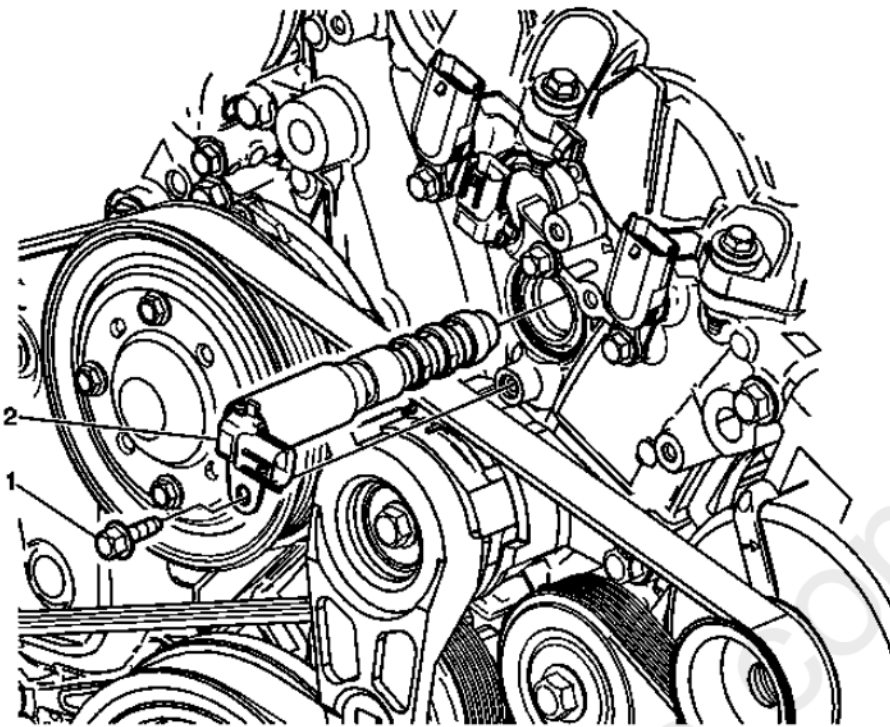


Fig. 188: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Exhaust
 Courtesy of GENERAL MOTORS CORP.

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

KNOCK SENSOR REPLACEMENT - BANK 1

Removal Procedure

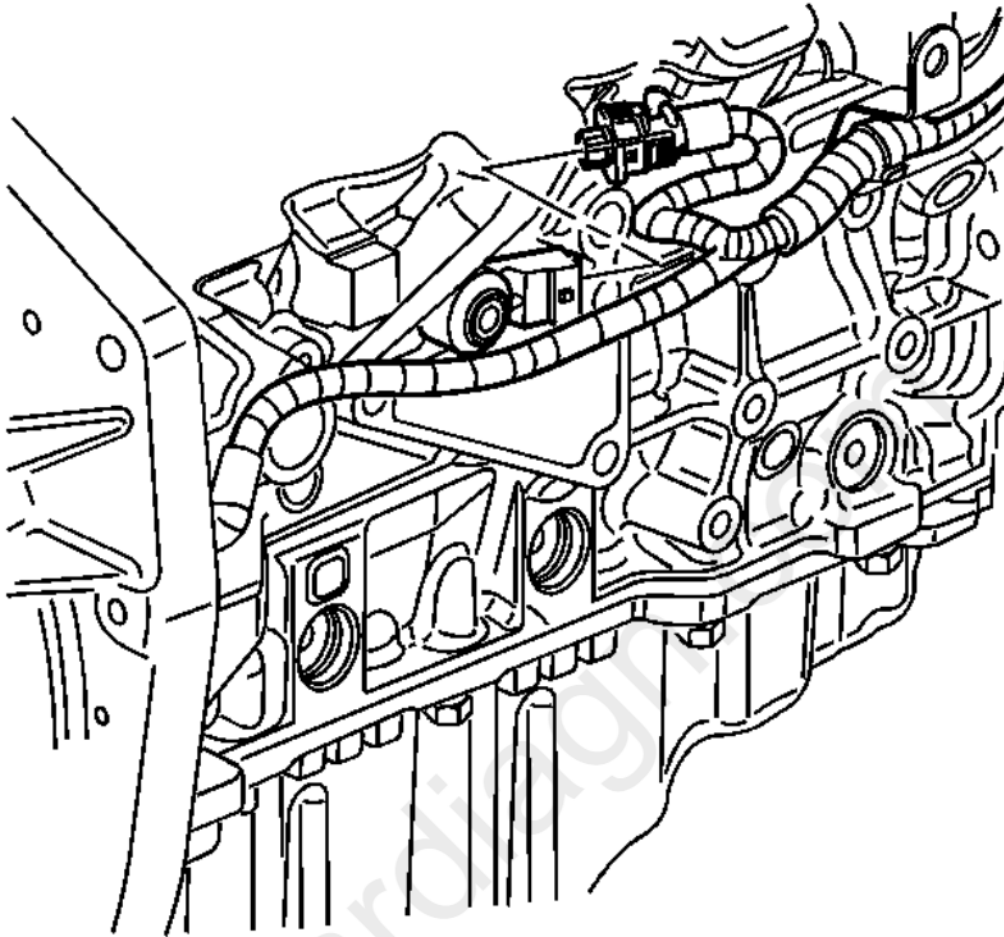


Fig. 189: View Of Right Knock Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Reposition the wiring harness heat shield to obtain access.
4. Remove the knock sensor (KS) electrical connector.

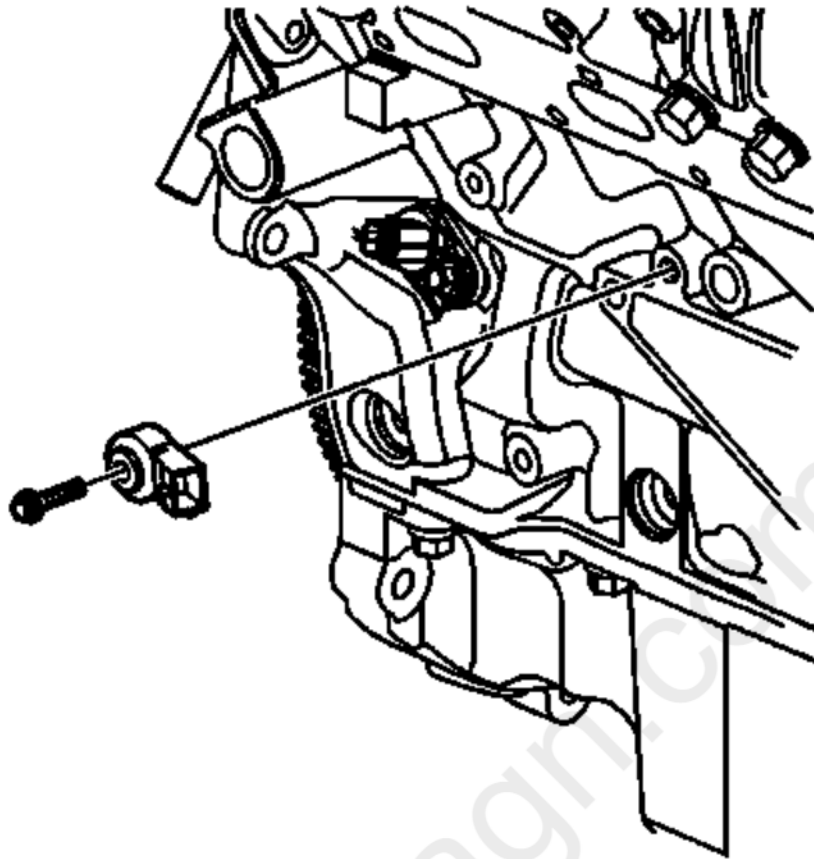


Fig. 190: View Of Right Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the KS bolt.
6. Remove the KS.

Installation Procedure

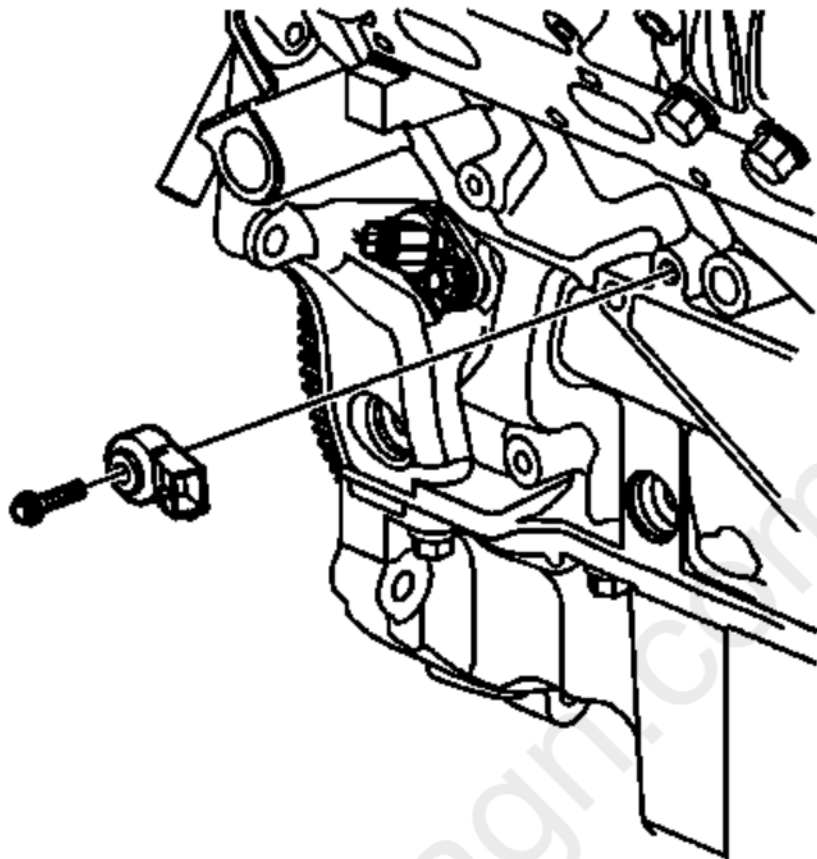


Fig. 191: View Of Right Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the KS.

CAUTION: Refer to FASTENER CAUTION .

2. Install the KS bolt and tighten to 23 N.m (17 lb ft).

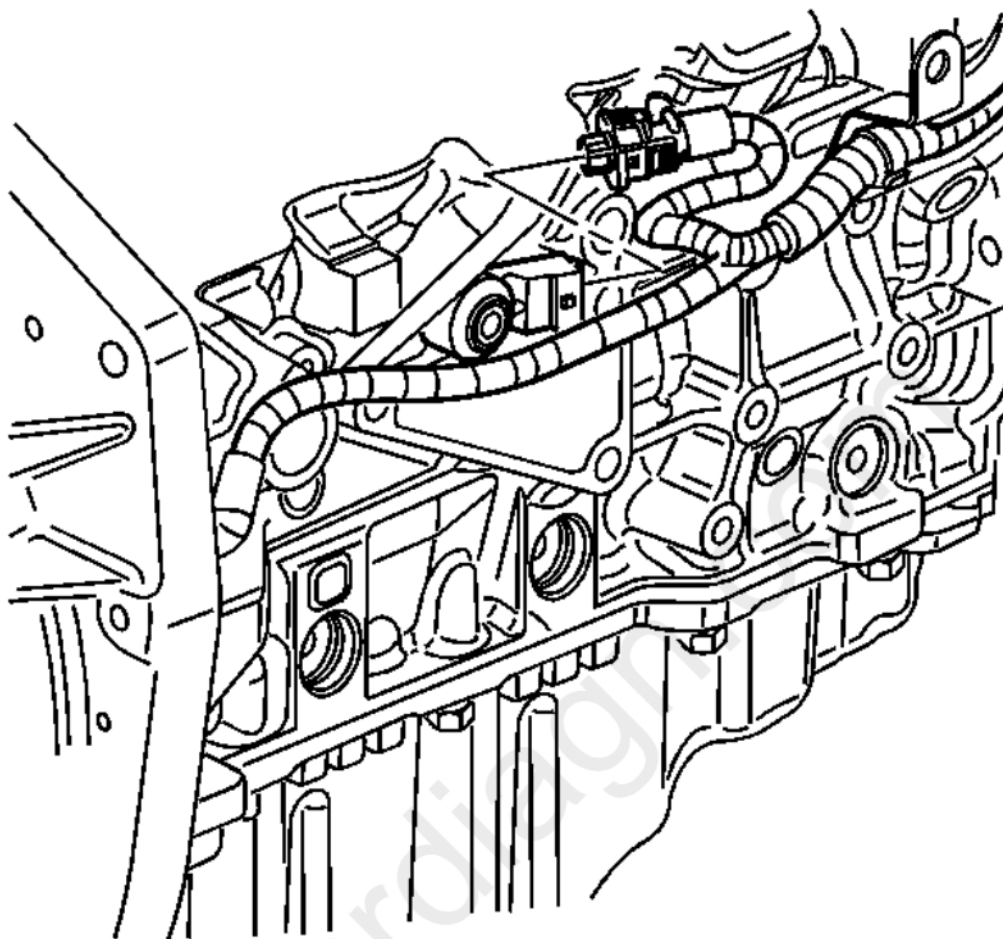


Fig. 192: View Of Right Knock Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Install the KS electrical connector.
4. Install the wiring harness heat shield to the original position.
5. Lower the vehicle.

KNOCK SENSOR REPLACEMENT - BANK 2

Removal Procedure

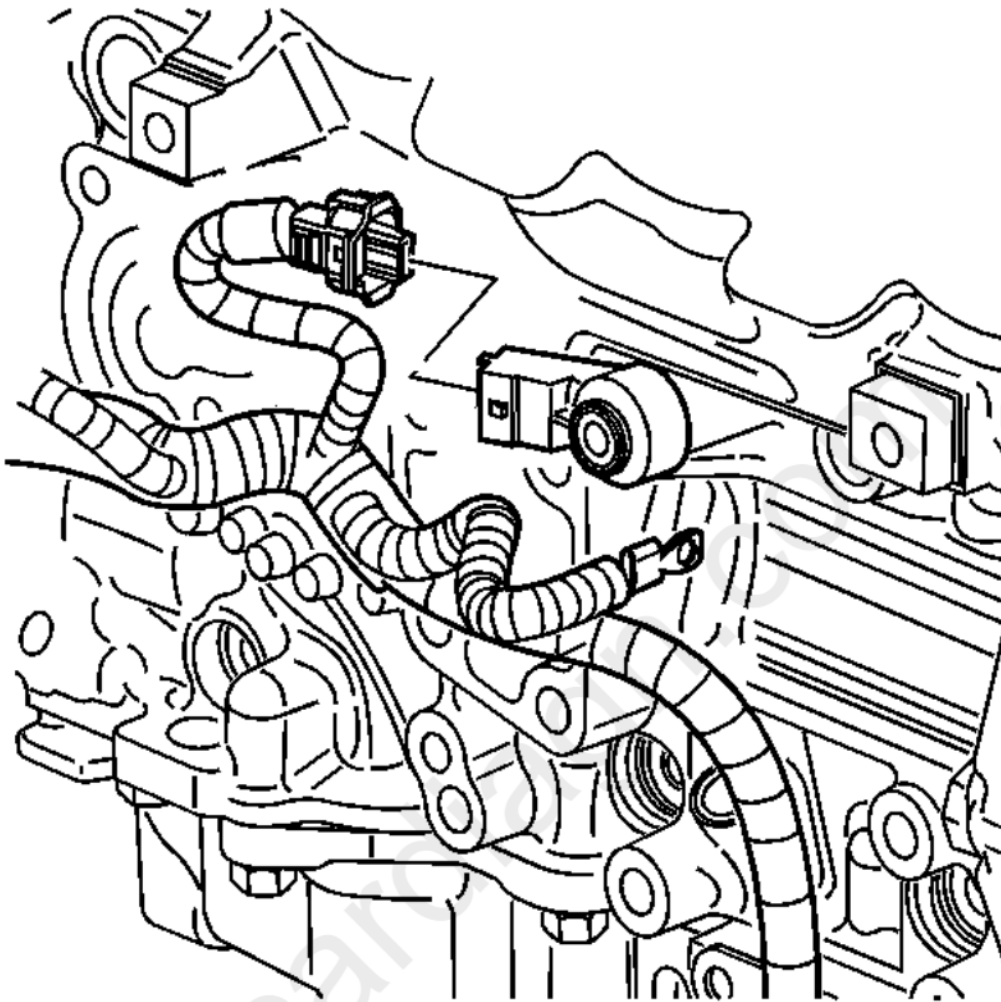


Fig. 193: View Of Left Knock Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the wiring harness heat shield from the oil level indicator tube to gain access.
4. Remove the knock sensor (KS) electrical connector.

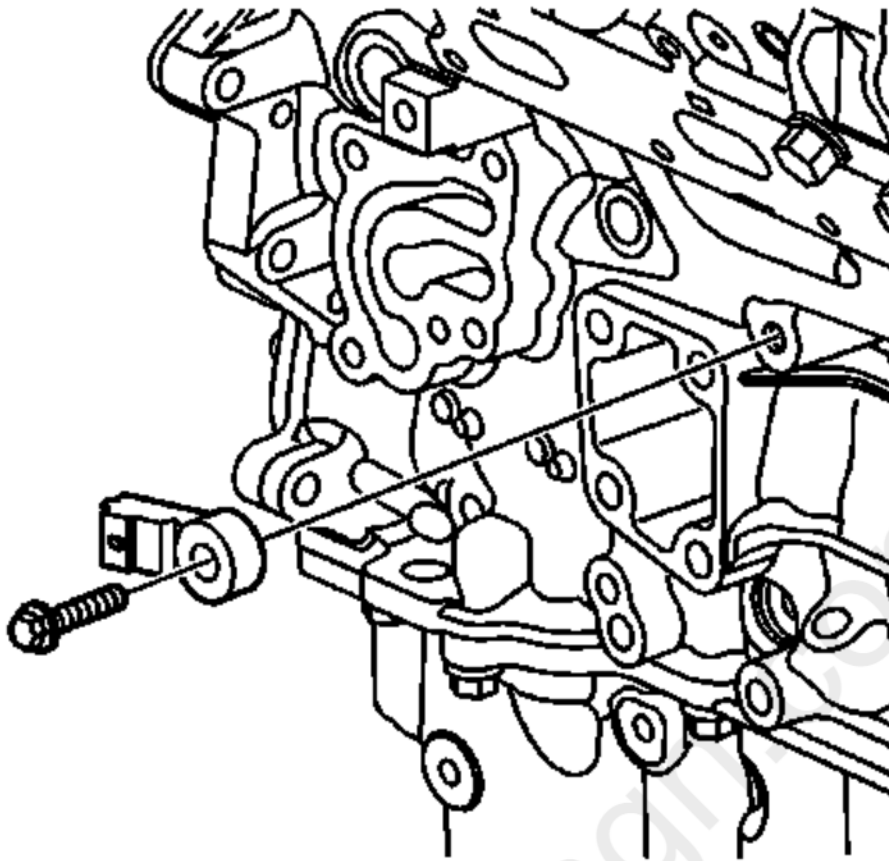


Fig. 194: View Of Left Knock Sensor
Courtesy of GENERAL MOTORS CORP.

5. Remove the KS bolt.
6. Remove the KS.

Installation Procedure

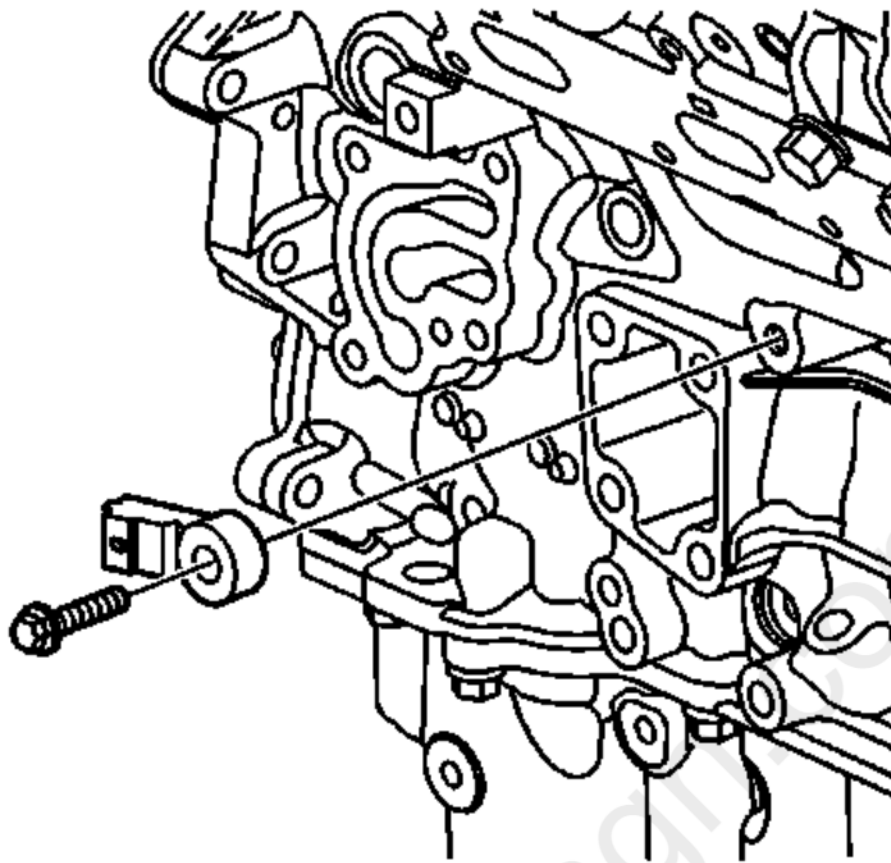


Fig. 195: View Of Left Knock Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the KS.

CAUTION: Refer to **FASTENER CAUTION** .

2. Install the KS bolt and tighten to 23 N.m (17 lb ft).

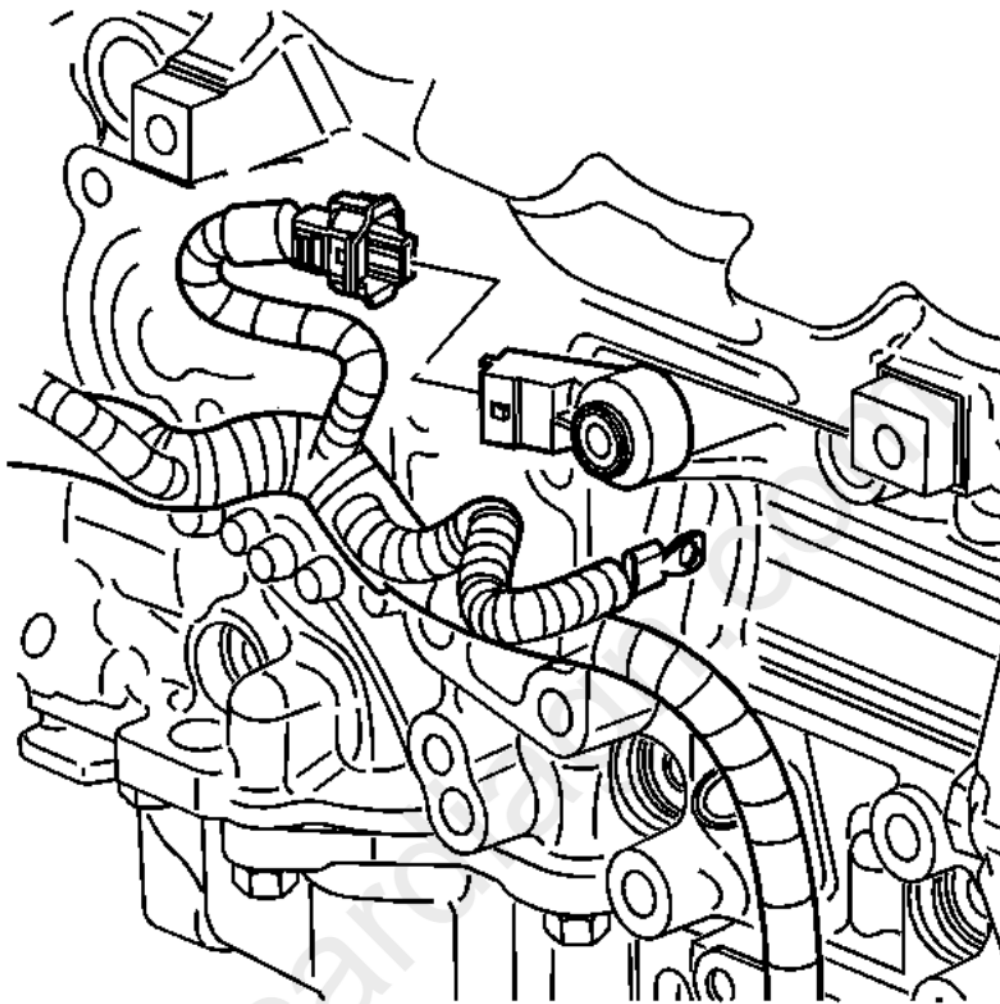


Fig. 196: View Of Left Knock Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Install the KS electrical connector.
4. Install the wiring harness heat shield to the oil level indicator tube.
5. Lower the vehicle.

AIR CLEANER ELEMENT REPLACEMENT (LF1)

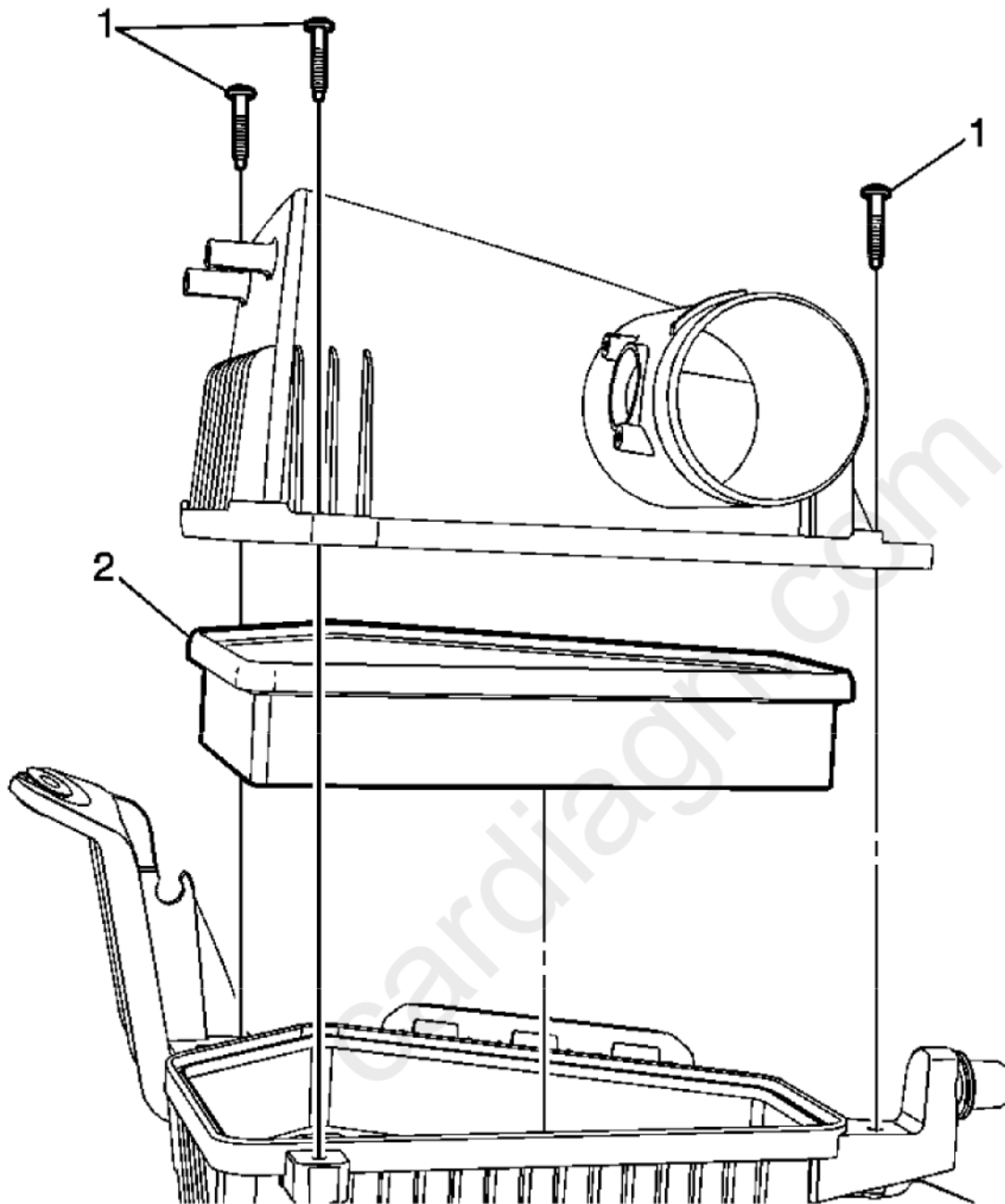


Fig. 197: Air Cleaner Element (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1. Remove the sight shield. Refer to <u>Front Compartment Side Sight Shield Replacement</u> .	
2. Disconnect the air cleaner duct from the air cleaner assembly. Refer to <u>Air Cleaner Resonator</u>	

Outlet Duct Replacement .

1	Screw (Qty: 3) CAUTION: Refer to. Tighten: 4 N.m (35 lb in)
2	Air Cleaner Element Procedure 1. Reposition the surge tank bypass hose as necessary. 2. Disconnect the MAF and Throttle Inlet Absolute Pressure sensor harness connectors.

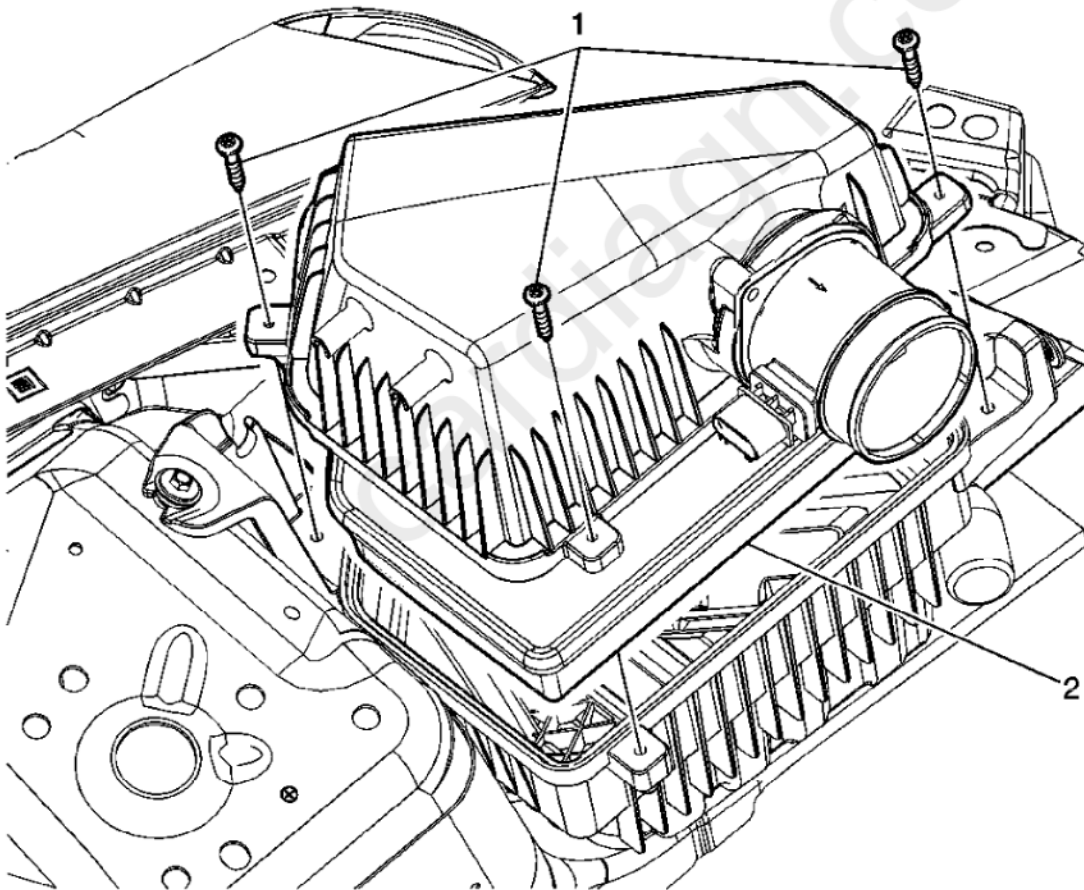
AIR CLEANER ELEMENT REPLACEMENT (LLT)

Fig. 198: Air Cleaner Element Replacement
Courtesy of GENERAL MOTORS CORP.

2011 Cadillac CTS

2011 ENGINE Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - CTS

Callout	Component Name
Preliminary Procedures 1. Turn OFF the ignition. 2. Remove the air cleaner duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF1)</u> or <u>Air Cleaner Outlet Duct Replacement (LLT)</u>. 3. Disconnect the MAF/IAT sensor harness connector.	
1	Screws (Qty: 3) CAUTION: Refer to. Tighten: 4 N.m (35 lb in)
2	Air Cleaner Element Procedure 1. Disconnect the sensor wiring harness. 2. Lift the air cleaner cover in order to remove the air cleaner element.

AIR CLEANER ASSEMBLY REPLACEMENT (LF1)

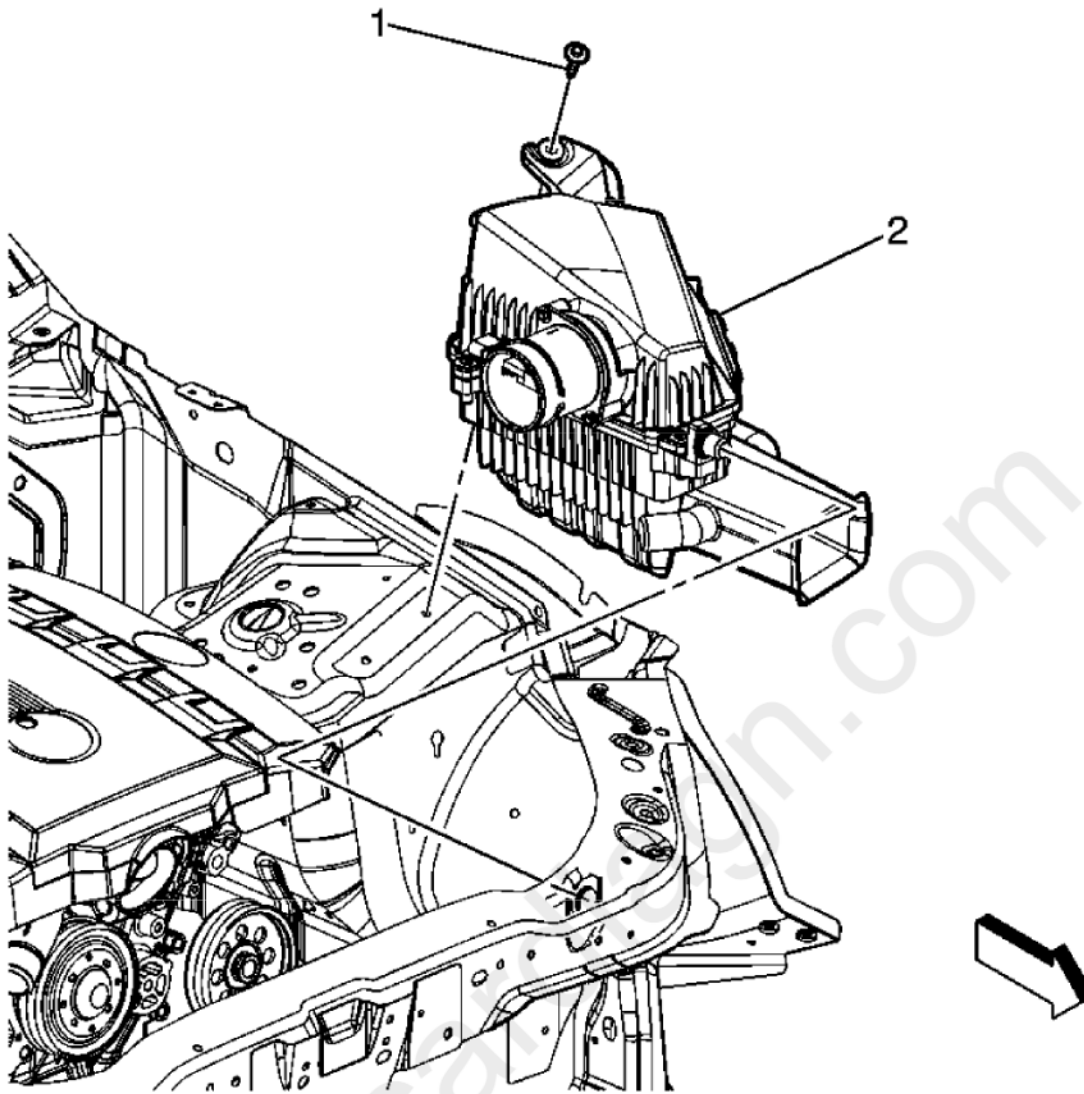


Fig. 199: Air Cleaner Assembly Replacement
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Remove the sight shield. Refer to <u>Front Compartment Side Sight Shield Replacement</u> . 2. Remove the air cleaner duct. Refer to <u>Air Cleaner Resonator Outlet Duct Replacement</u> . 3. Disconnect the MAF/IAT sensor electrical connector.	
1	Air Cleaner Assembly Fastener CAUTION: Refer to.

Tighten: 9 N.m (80 lb in)

Air Cleaner Assembly

Procedure

2

1. Reposition the surge tank bypass hose as necessary.
2. Disconnect the electrical connectors.
3. Tilt the assembly rearward while disengaging the air cleaner isolator.

AIR CLEANER ASSEMBLY REPLACEMENT (LLT)

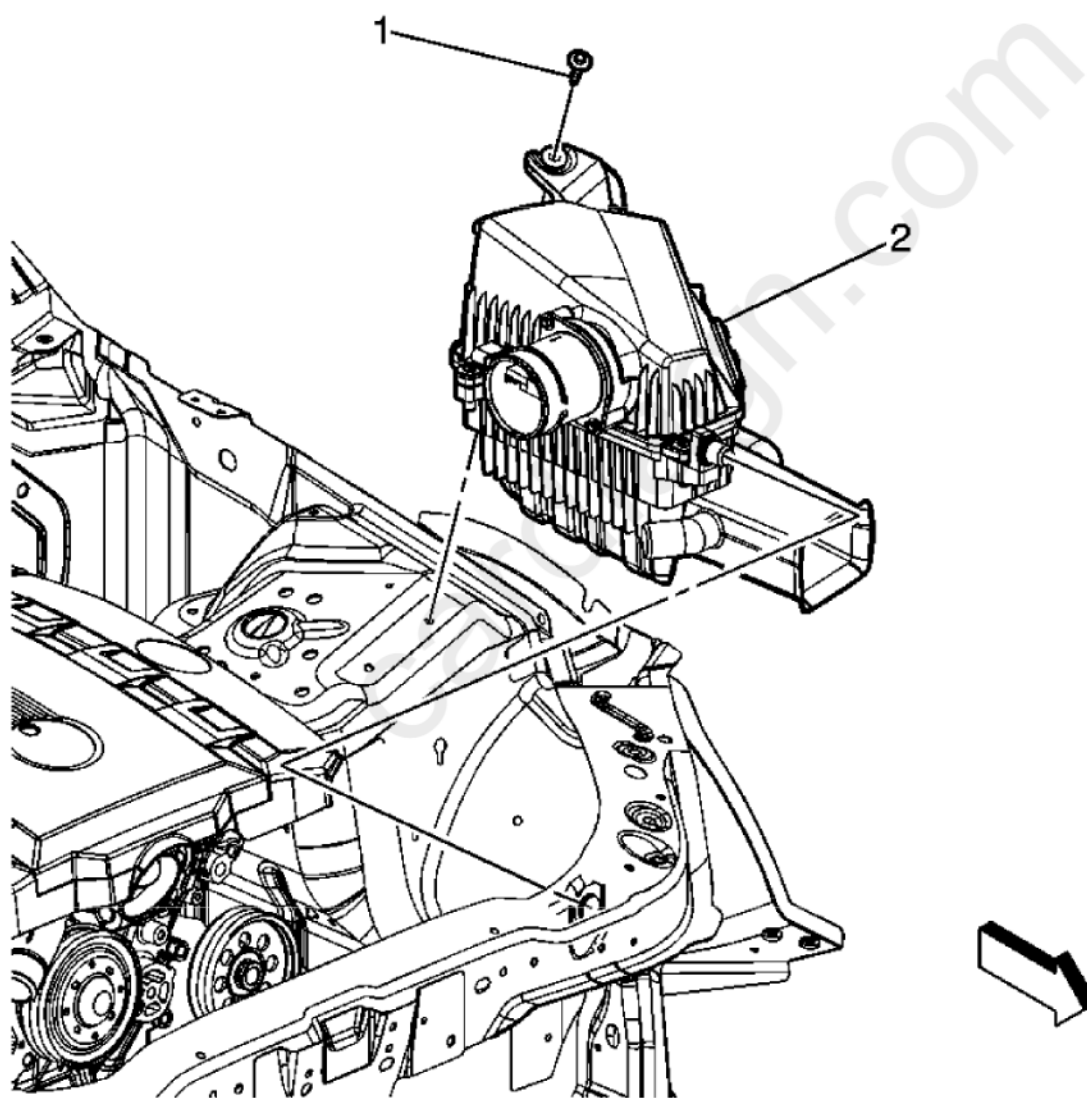


Fig. 200: Air Cleaner Assembly Replacement
Courtesy of GENERAL MOTORS CORP.

2011 Cadillac CTS

2011 ENGINE Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - CTS

Callout	Component Name
Preliminary Procedures 1. Remove the sight shield. Refer to <u>Front Compartment Side Sight Shield Replacement</u> . 2. Remove the air cleaner duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF1)</u> or <u>Air Cleaner Outlet Duct Replacement (LLT)</u>. 3. Disconnect the MAF/IAT sensor electrical connector.	
1	Bolt CAUTION: Refer to. Tighten: 9 N.m (80 lb in)
2	Air Cleaner Assembly Procedure 1. Disconnect the electrical connector. 2. Tilt the assembly rear upward while disengaging the air cleaner isolator.

AIR CLEANER OUTLET DUCT REPLACEMENT (LF1)

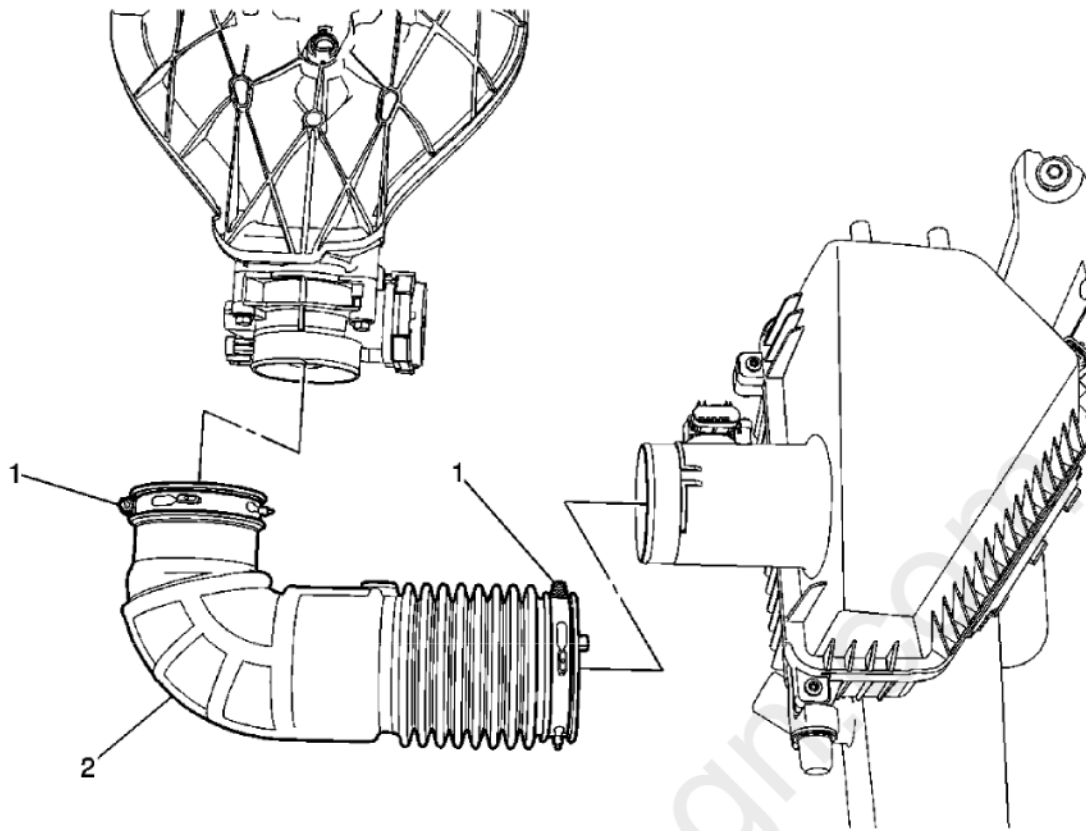


Fig. 201: Air Cleaner Outlet Duct (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Fuel Injector Sight Shield Replacement (LP1, LY7)</u> or <u>Fuel Injector Sight Shield Replacement (LLT)</u> . 2. Disconnect the PCV pipe from the outlet duct. Refer to <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LP1, LY7)</u> or <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LLT)</u>	
1	Air Cleaner Outlet Duct Hose Clamp (Qty: 2) CAUTION: Refer to Tighten: 4 N.m(35 lb in)
2	Air Cleaner Outlet Duct

AIR CLEANER OUTLET DUCT REPLACEMENT (LLT)

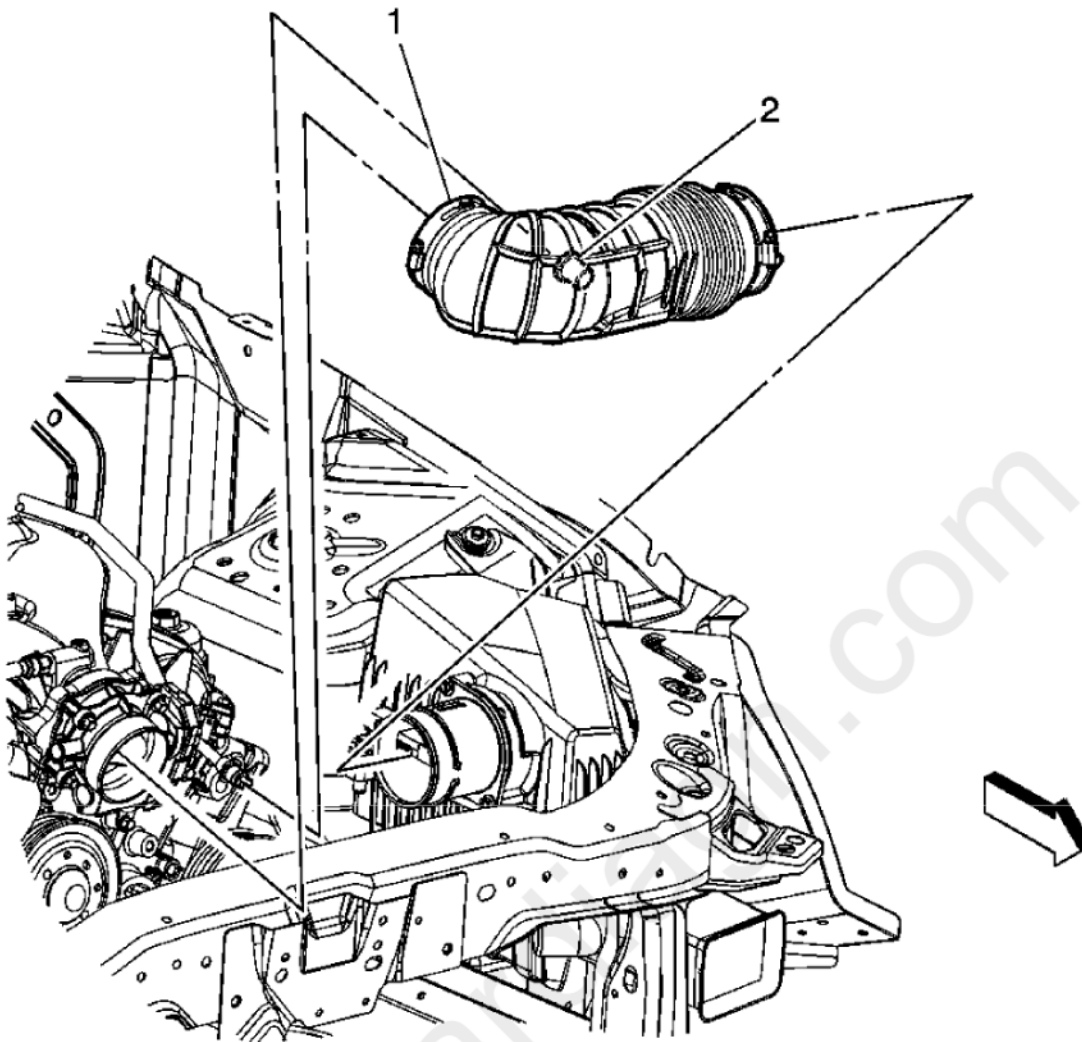


Fig. 202: Air Cleaner Outlet Duct Replacement (LLT)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT) .	
1	Clamp (Qty: 2) CAUTION: Refer to. Tighten: 4 N.m (35 lb in)
2	Air Cleaner Duct Procedure:

2011 Cadillac CTS

2011 ENGINE Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - CTS

Align the air cleaner duct with the PCV vent tube during installation.

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