

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 1.4L (LE2) - Repair Instructions - Encore

REPAIR INSTRUCTIONS

WIRE TO WIRE REPAIR - ENGINE CONTROLS AND FUEL

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool (non GMNA)
- **J-38125-5A** Ultra Torch Special Tool
- **J-38125-8** Splice Sleeve Crimping Tool (GMNA)

For equivalent regional tools, refer to [Special Tools](#).

WARNING: In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector, or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables, or terminals. Performing this procedure on high voltage circuits may result in serious injury or death.

NOTE: If the wiring harness internal to the transmission is damaged, the wiring harness must be replaced. The use of splice sleeves in an attempt to repair the internal transmission wires, connectors, or terminals could result in performance issues.

NOTE: Do not splice wires in Door Harness Grommets.

NOTE: The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides the necessary low resistance contact integrity for these sensitive, low energy circuits.

Use only DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except high voltage and specialty cables. Use DuraSeal splice sleeves where there are special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

Splice Sleeve Selection

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm ² / (AWG)
	3 Crimp Nests	4 Crimp Nests	
Salmon (Yellow-Pink) 19300089	Red (1) or Red/Green (1)	Red (2)	0.22-0.8/(18-26)
Blue 19168447	Blue (2)	Blue (3)	1.0-2.0/(14-16)
Yellow 19168448	Yellow (3)	Yellow (4)	3.0-5.0/(10-12)

NOTE:

You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.

1. Open the harness by removing any tape:

- Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
- Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
- Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.

2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

3. Strip the insulation:

- When adding a length of wire to the existing harness, use the same size wire as the original wire.
- Perform one of the following items in order to find the correct wire size:
 - Find the wire on the schematic and convert to regional wiring gauge size.
 - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
- Strip approximately 5.0 mm (0.20 in) of insulation from each wire to be spliced.
- Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
- If the wire is damaged, repeat this procedure after removing the damaged section.

4. For high temperature wiring, slide a section of high temperature SCT1 shrink tubing down the length of wire to be spliced. Ensure that the shrink tubing will not interfere with the splice procedure.

5. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.

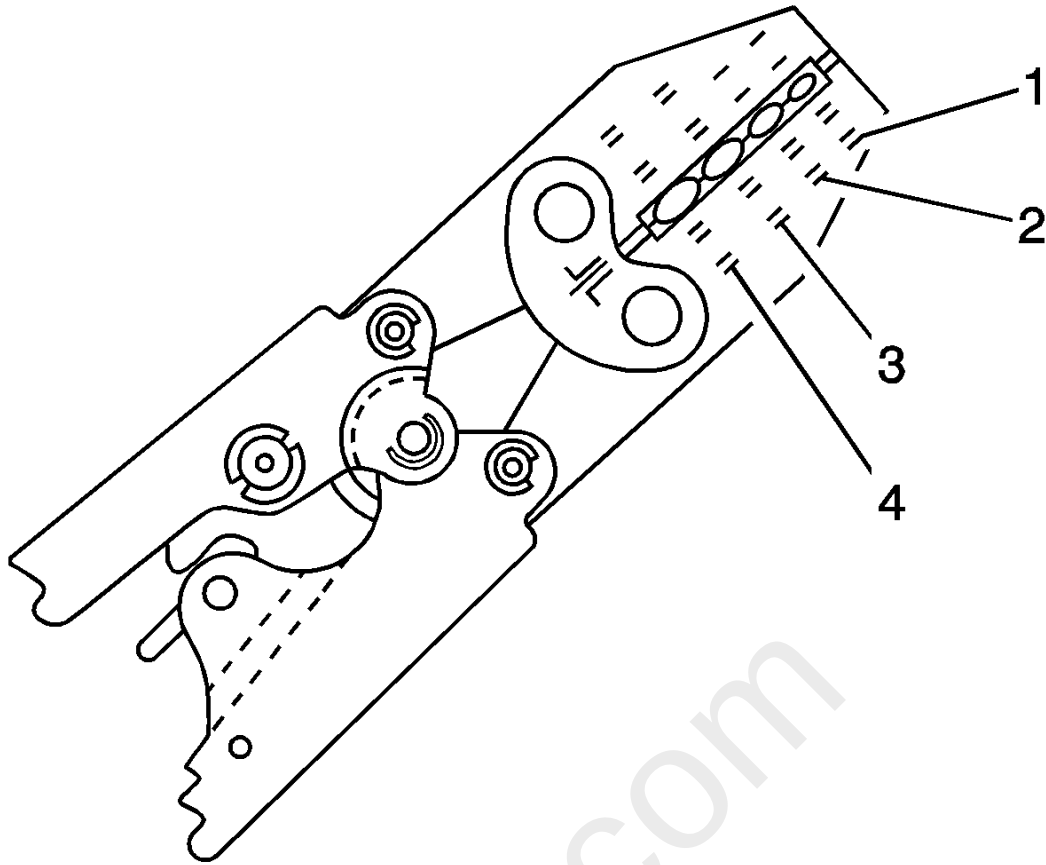


Fig. 1: Splice Sleeve Crimping Tool With 4 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

6. The **EL-38125-10** splice sleeve crimping tool has four crimp nests. The largest crimp nest (4) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (3) is used for crimping 14 and 16 gauge wires. The third largest crimp nest (2) is used for crimping 18 and 20 gauge wires. The smallest crimp nest (1) is used for crimping 22 to 26 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.

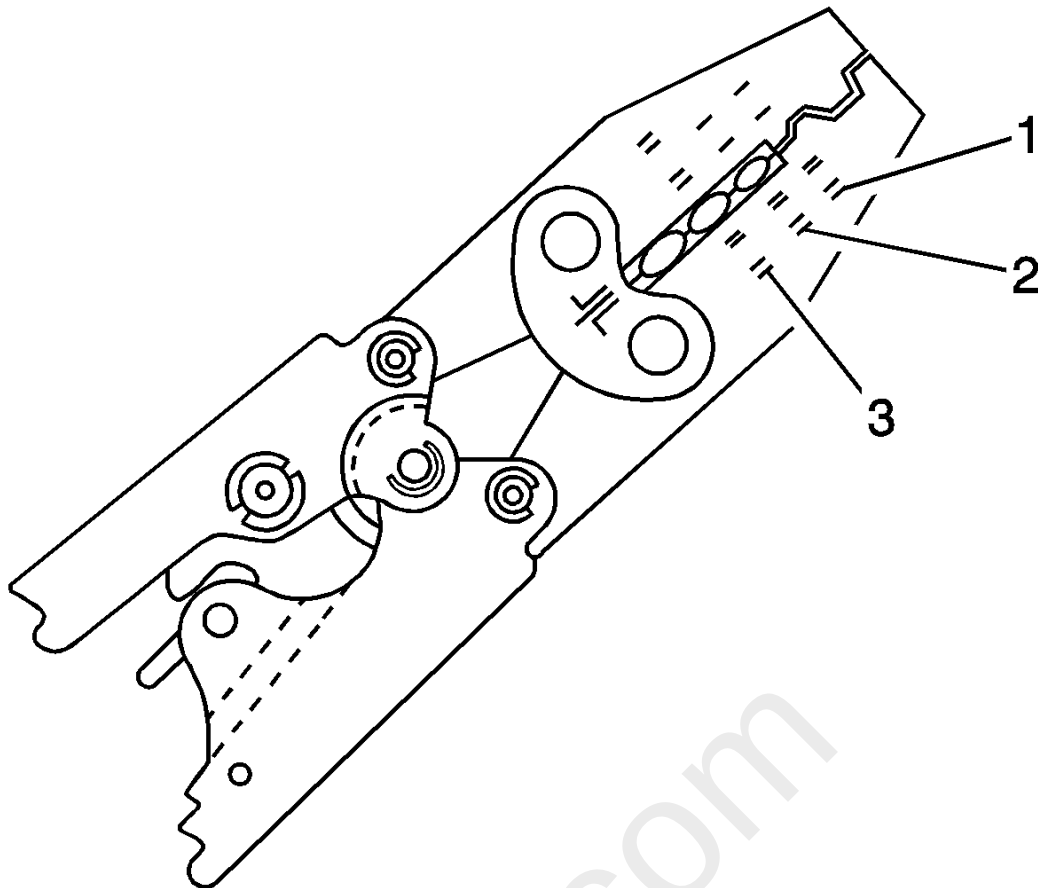


Fig. 2: Splice Sleeve Crimping Tool With 3 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

7. The **J-38125-8** splice sleeve crimping tool has three crimp nests. The largest crimp nest (3) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (2) is used for crimping 14 and 16 gauge wires. The smallest crimp nest (1) is used for crimping 18 to 20 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.
8. Use the splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. For the four crimp nest tool, use the three largest crimp nests to crimp the splice sleeves. For the three crimp nest tool, use all three crimp nests to crimp the splice sleeves. Use the four and three crimp tool diagrams (above) and the table (farther above) to match the splice sleeve with the correct crimp nest. The crimp tool diagram callout numbers match the numbers in the table (under crimp tool nest color).

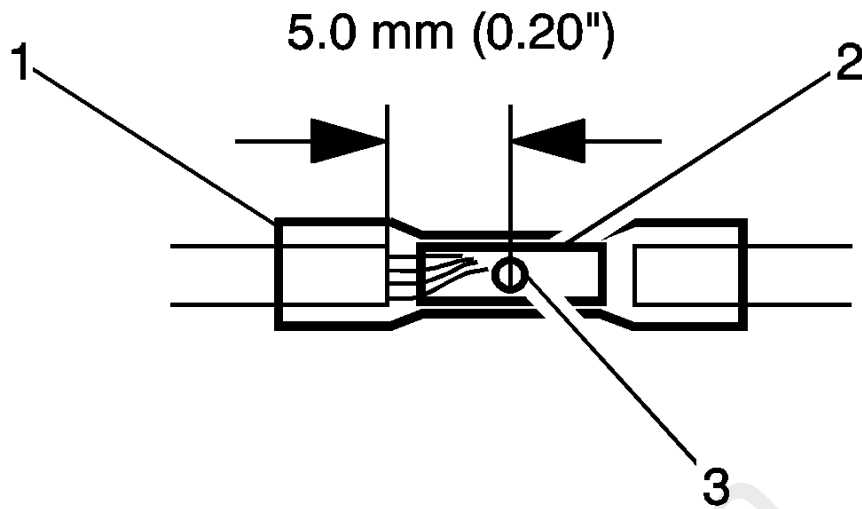


Fig. 3: Identifying DuraSeal Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

9. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.



Fig. 4: Crimped DuraSeal Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

10. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.
11. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 6 for the opposite end of the splice.



Fig. 5: Heated Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

12. Using the heat torch, apply heat to the crimped area of the barrel.
13. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Weatherpack™ Wiring Repair

NOTE: Some replacement pigtail connectors may be delivered without the terminated leads installed into the connector. For Weatherpack™ connectors, all terminated leads included in the package should to be installed into the connector. If the connector end view shows that a terminal is not occupied, the extra terminated lead(s) need to be installed and the end(s) sealed using a DuraSeal splice sleeve and taped back into the harness.

1. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.

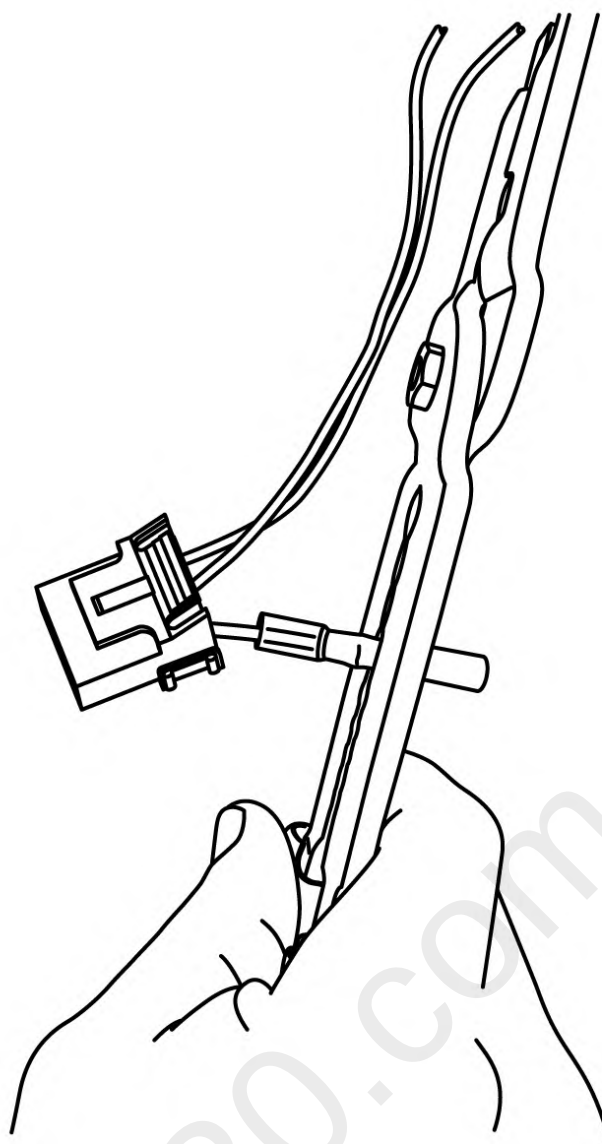


Fig. 6: Tightly Close Handles Of Crimp Tool

Courtesy of GENERAL MOTORS COMPANY

2. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Holding the DuraSeal with one hand gently tug on the wire to ensure it is crimped in the DuraSeal.

3. Using the heat torch, apply heat to the crimped area of the barrel.

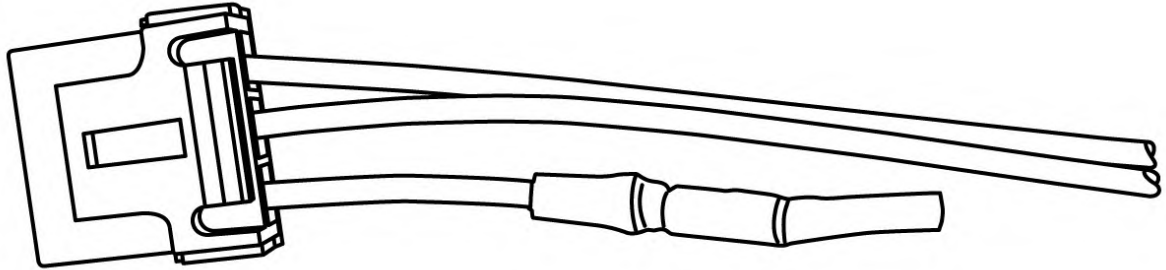


Fig. 7: Heat To Crimped Area Of Barrel

Courtesy of GENERAL MOTORS COMPANY

4. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

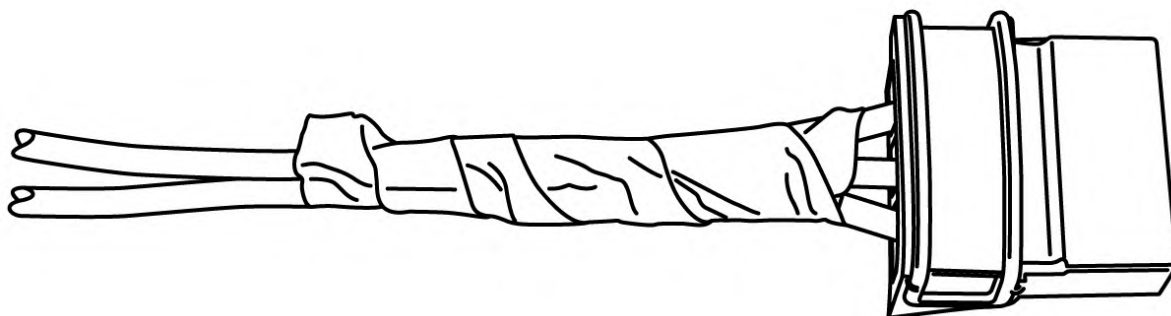


Fig. 8: Taping Extra Terminated Leads Back Into Harness
Courtesy of GENERAL MOTORS COMPANY

5. Tape the extra terminated lead(s) back into the harness.

High Temperature Wiring Repairs

Use the following procedures to perform high temperature wiring repairs:

1. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
2. Using the heat torch, apply heat to the high temperature heat shrink tubing.
3. Gradually move the heat from the center to the open end of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.
4. Replace any reflective tape and clips that may have been removed during the repair.

CONNECTOR RECONNECTION - ENGINE CONTROLS AND FUEL

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to [Special Tools](#) .

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Loose, corroded, or painted terminal stud/fastener
- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- A terminal not seated all the way into the connector body
- Poor terminal to wire connection - Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to [**Inducing Intermittent Fault Conditions**](#) in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to [**Testing for Electrical Intermittents**](#) for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to [**Scan Tool Snapshot Procedure**](#) for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Terminal Fretting

Some intermittent conditions can be caused by wire terminal fretting corrosion. Fretting corrosion is a build-up of insulating, oxidized wear debris that can form when there is a small motion between electrical contacts. The oxidized wear debris can pile up enough at the electrical contact spots that the electrical resistance across the connection increases. Movement between the contacting surfaces as small as 10 to 100 microns can cause fretting. To put this in perspective, a sheet of paper is about 100 microns thick, so fretting motion is small and hard to see. Vibration and thermal expansion/contraction are the main sources that create fretting motion. Since vehicles vibrate and can experience large temperature swings, they are a good source for fretting motion. Tin, copper, nickel, and iron surfaces are all susceptible to fretting corrosion. Fretting corrosion can be difficult to see but it looks like small, dark smudges on the terminals contact surface.

To correct a fretting condition disconnect the suspect connector and add dielectric grease/lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to both sides of the connector terminals. Then reconnect the connector and wipe away any excess lubricant. This will correct the additional terminal contact resistance due to the terminal fretting corrosion.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the **EL-35616** kit when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center. Use the **EL-35616** kit to test for proper terminal contact. Failure to use the **EL-35616** kit can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal/terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire Connectors

There are no serviceable parts for flat wire connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter into the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to [Circuit Testing](#) , and [Power Distribution Schematics \(Buick\)](#) .
- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point (screw or stud). Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to [Circuit Testing](#) , and [Ground Distribution Schematics \(Buick\)](#) .

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
 - High ambient temperatures
 - Underhood/engine generated heat
 - Circuit generated heat due to a poor connection, or high electrical load

- Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
 - Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
 - The condition only occurs on a cold start.
 - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to [Inducing Intermittent Fault Conditions](#) in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:

- A mis-routed harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. - These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch - These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. - These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to [Checking Aftermarket Accessories](#).
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
 - A new service control module is installed.
 - A control module from another vehicle is installed.
 - Revised software/calibration files have been released for this vehicle.

NOTE: **DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module. This is not an effective repair for any type of concern.**

- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to [Control Module References](#) for replacement, setup, and programming.

BRAKE PEDAL POSITION SENSOR LEARN

Calibration Criteria

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

Brake pedal position sensor calibration must be performed after the brake pedal position sensor, body control module (BCM), or engine control module (ECM) have been serviced. The calibration procedure will set the brake pedal position sensor home value. This value is used by the BCM and ECM to

determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via serial data.

Calibration Procedure

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

ACCELERATOR PEDAL WITH POSITION SENSOR ASSEMBLY REPLACEMENT

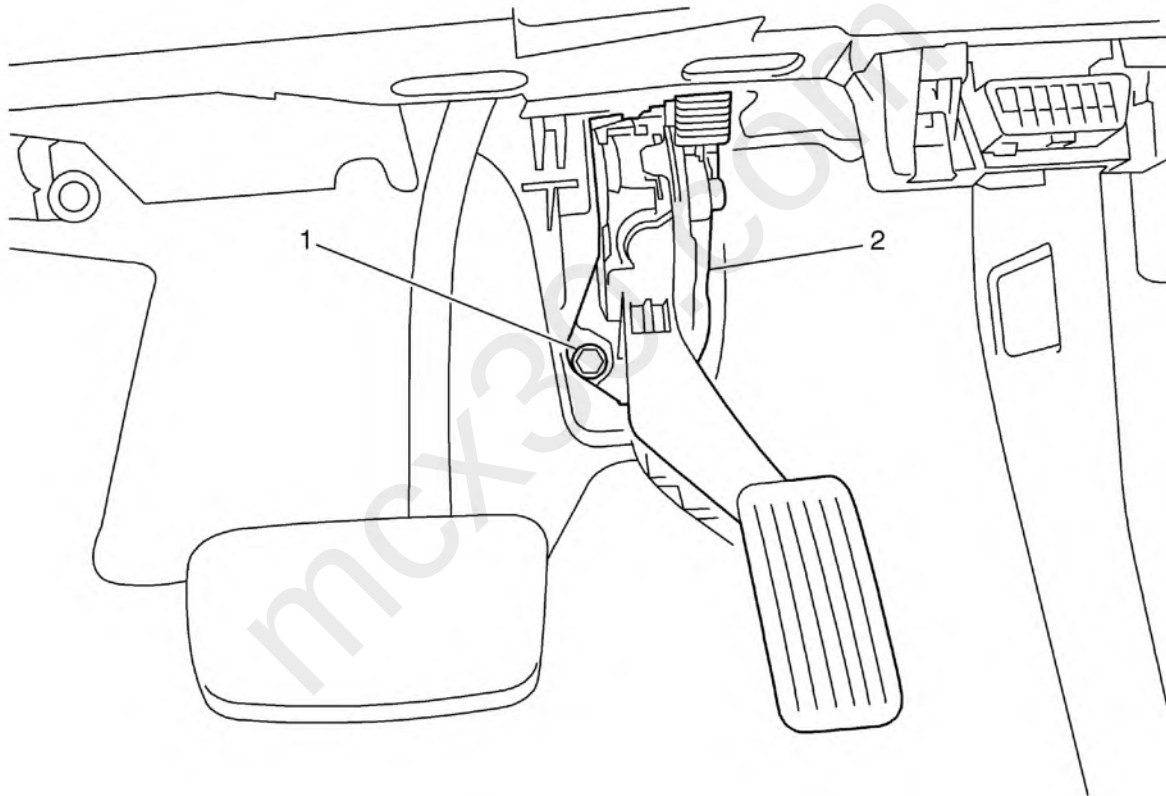


Fig. 9: Accelerator Pedal Position Sensor & Fastener
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Accelerator Pedal Position Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 6 N.m (53 lb in)
2	Accelerator Pedal Position Sensor Procedure Disconnect electrical connector.

THROTTLE OR IDLE LEARN

Description

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

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

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

Conditions for Running the Throttle Learn Procedure

Scan tool Idle Learn or Idle Learn Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, or P2322 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 MPH).

Service Bay/On Road Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, or P2322 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.

Diagnostic Aids

A un-metered air leak in the induction system or a small vacuum leak may not set a DTC. If the condition goes undetected, the ECM may learn an incorrect Throttle Body Idle Airflow Compensation value over time. The incorrectly learned value may cause various symptoms to occur such as rough or unstable idle speeds, and/or engine stall. If this condition is detected and repaired it will be necessary perform the Idle Learn procedure to ensure any symptoms are corrected.

Throttle Learn

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

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

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

NOTE: Do NOT perform this procedure if any DTCs are set.

1. Engine idling for 3 min.
2. The ECM will start to learn the new idle cells and the scan tool Desired Idle Speed should start to decrease.
3. Ignition OFF for 60 s.
4. Start and idle the engine for 3 min.
5. Verify the engine is idling normally.
 - If the engine idle is not correct

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.

1. Operate the vehicle at speeds above 70 km/h (44 mph) with several decelerations and extended idles.
2. Verify the engine is idling normally.
 - If the engine idle is not correct.
Ignition OFF for 60 s, repeat step 5.1.
 - If the engine idle is correct.
3. Clear any DTCs and return to the diagnostic that referred you here.
 - If the engine idle is correct
6. Clear any DTCs and return to the diagnostic that referred you here.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

Special Tools

J 37088-A Fuel Line Disconnect Tool Set

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the [Fuel Pressure Relief](#) .

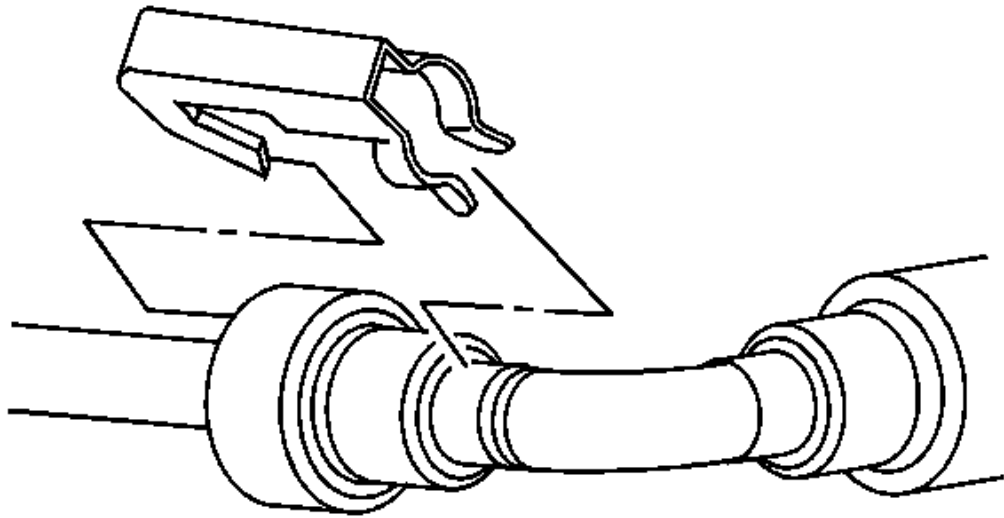


Fig. 10: Quick-Connect Fitting Retainer (Metal Collar).
Courtesy of GENERAL MOTORS COMPANY

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

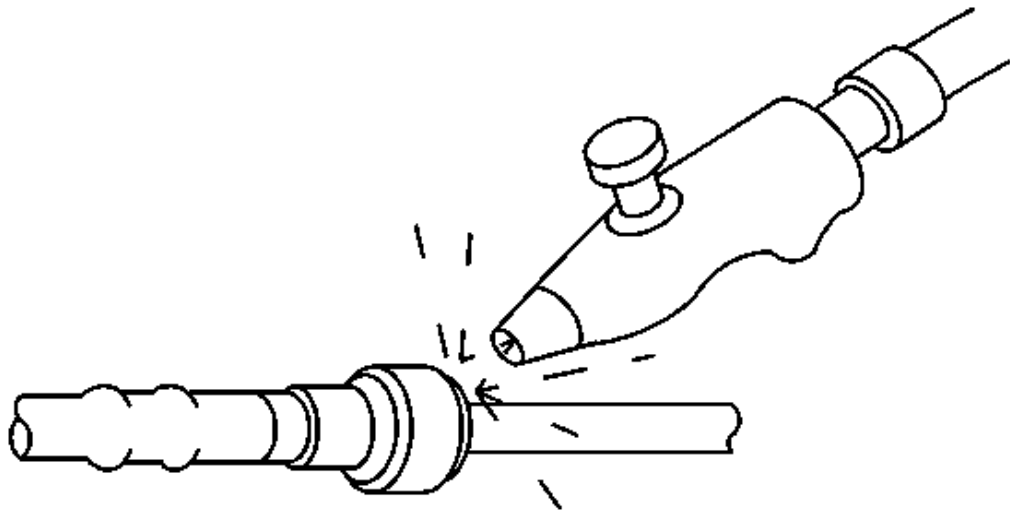


Fig. 11: Blowing Dirt Out Of Fitting.(Metal Collar)

Courtesy of GENERAL MOTORS COMPANY

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

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

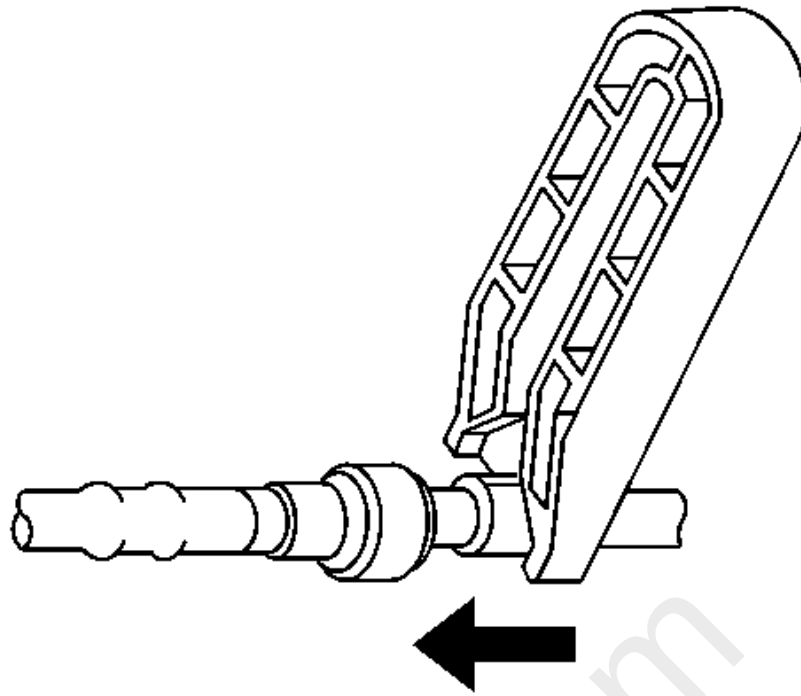


Fig. 12: Releasing Quick Connect Locking Tabs (Metal Collar).
Courtesy of GENERAL MOTORS COMPANY

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

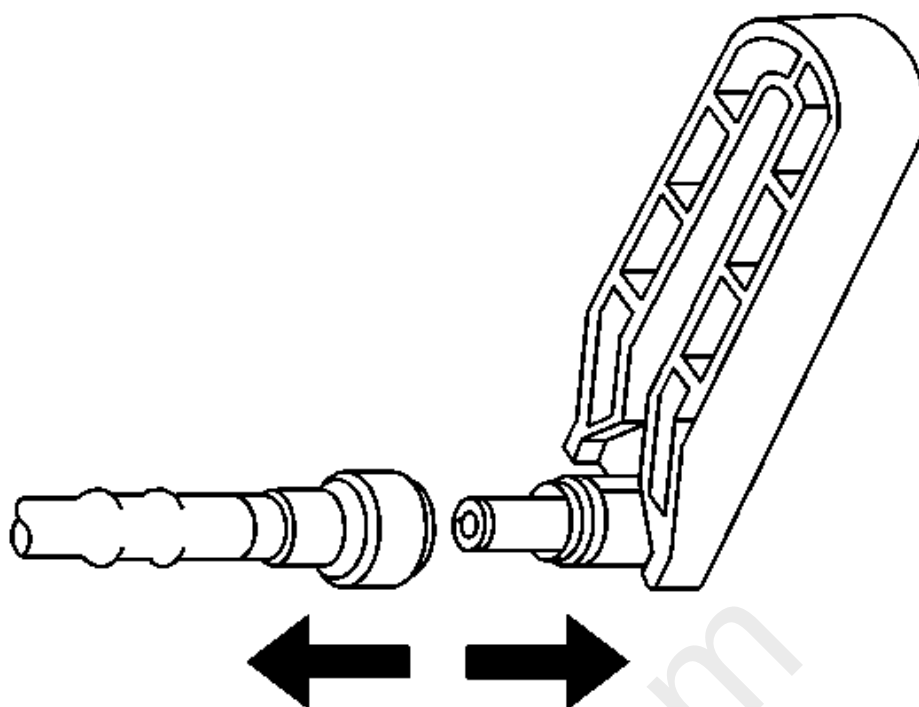


Fig. 13: Pulling Connection Apart (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the connection apart.

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

6. Using a clean shop towel, wipe off the male pipe end.

7. Inspect both ends of the fitting for dirt and burrs.

Clean or replace the components as required.

Installation Procedure

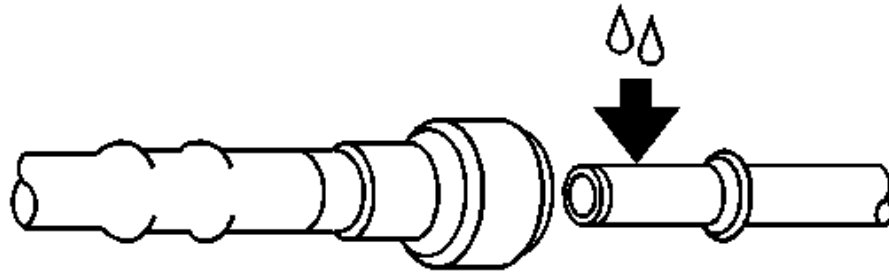


Fig. 14: Oiling Male Pipe Ends (Metal Collar).
Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

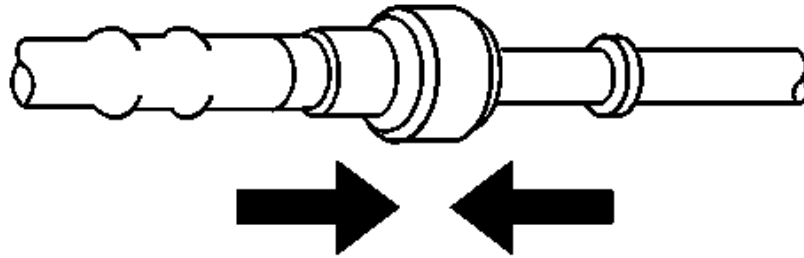


Fig. 15: Pushing Connectors Together (Metal Collar).
Courtesy of GENERAL MOTORS COMPANY

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

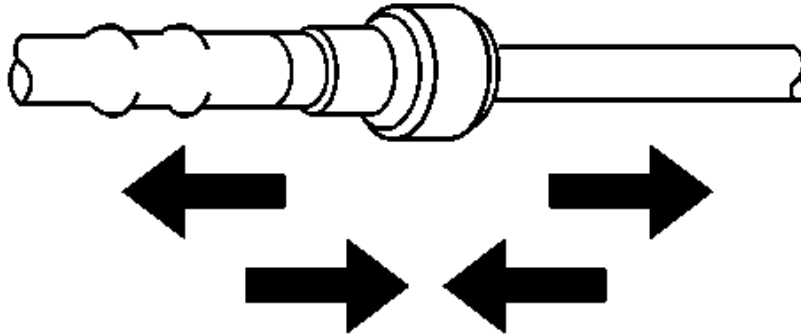


Fig. 16: Ensuring Connection Is Secure (Metal Collar).
Courtesy of GENERAL MOTORS COMPANY

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

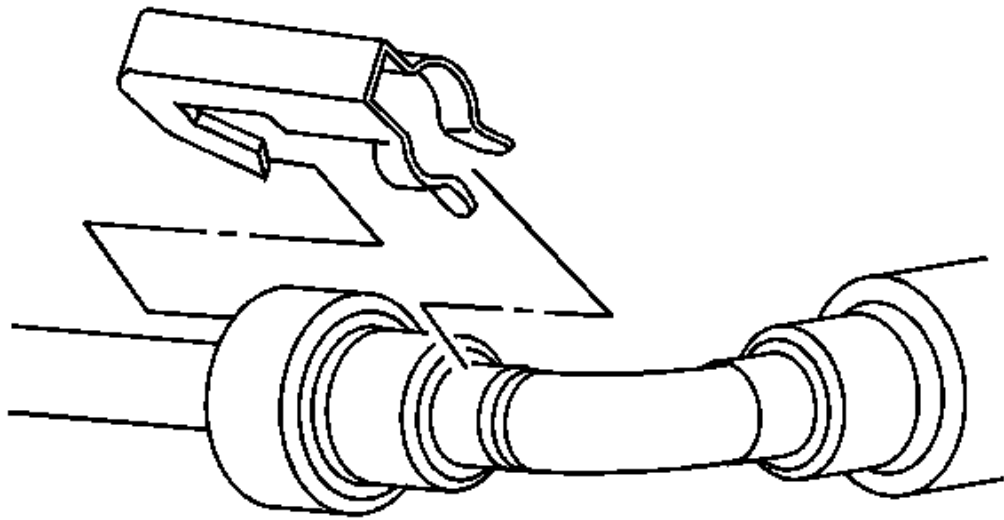


Fig. 17: Quick-Connect Fitting Retainer (Metal Collar).
Courtesy of GENERAL MOTORS COMPANY

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

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

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

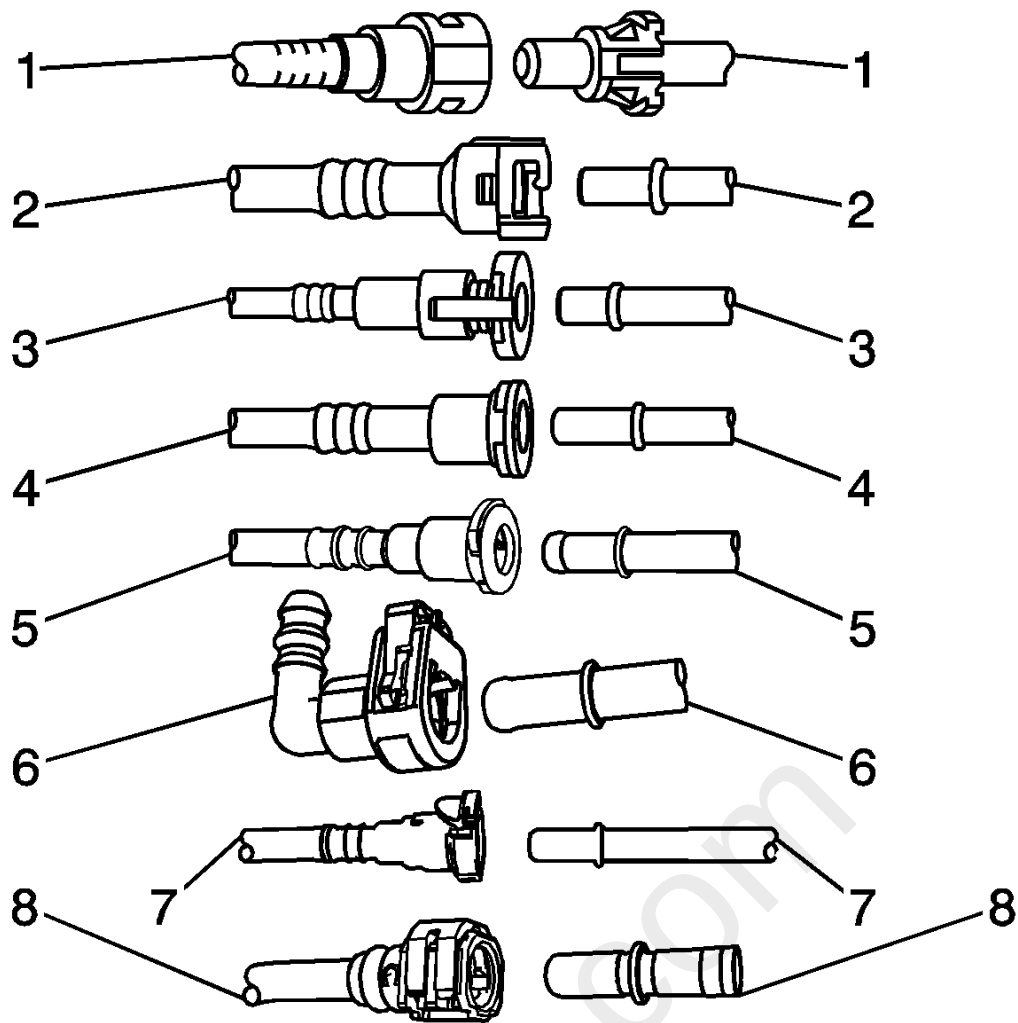


Fig. 18: Identifying Plastic Collar Quick Connect Fitting Types

Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

- Bartholomew (1)
- Q Release (2)
- Squeeze to Release (3)
- Sliding Retainer (4)
- Global Connect (5)
- TI Loc (6)
- Safe Lock (7)
- Plastic Connector (8)

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

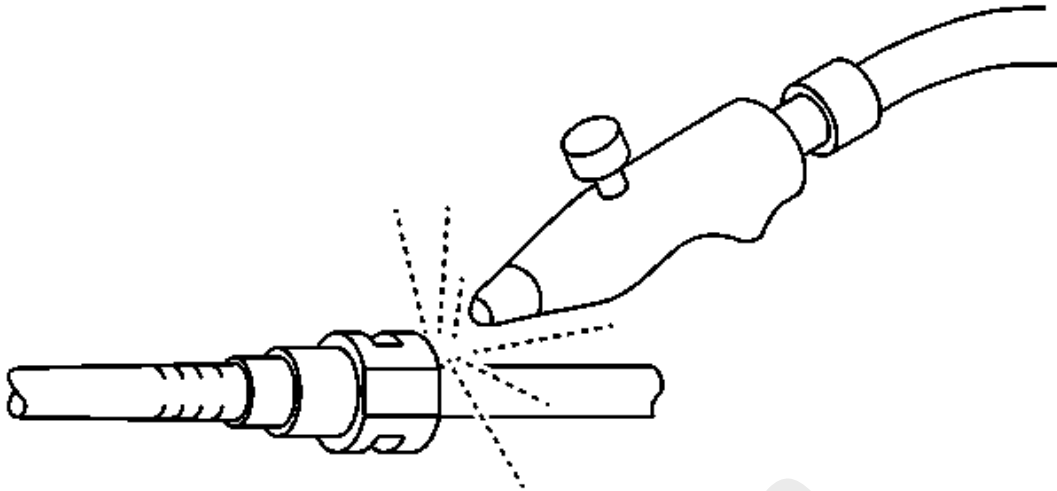


Fig. 19: Blowing Dirt Out Of Fitting (Plastic Collar)

Courtesy of GENERAL MOTORS COMPANY

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

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

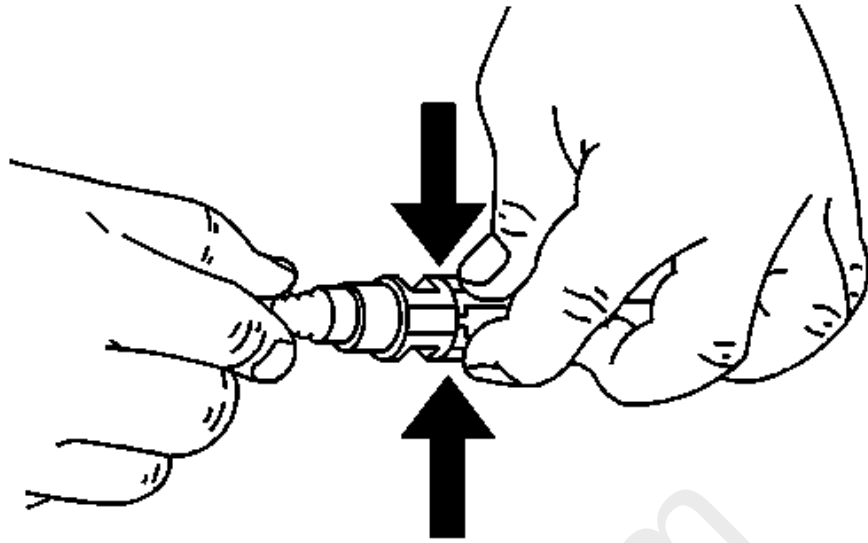


Fig. 20: Quick Connect Fitting Release Tabs (Plastic Collar).

Courtesy of GENERAL MOTORS COMPANY

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

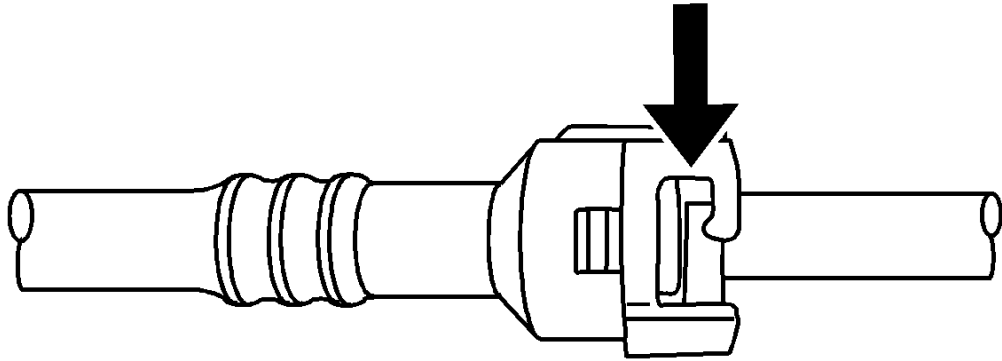


Fig. 21: Q Release Style Connectors (Plastic Collar)

Courtesy of GENERAL MOTORS COMPANY

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

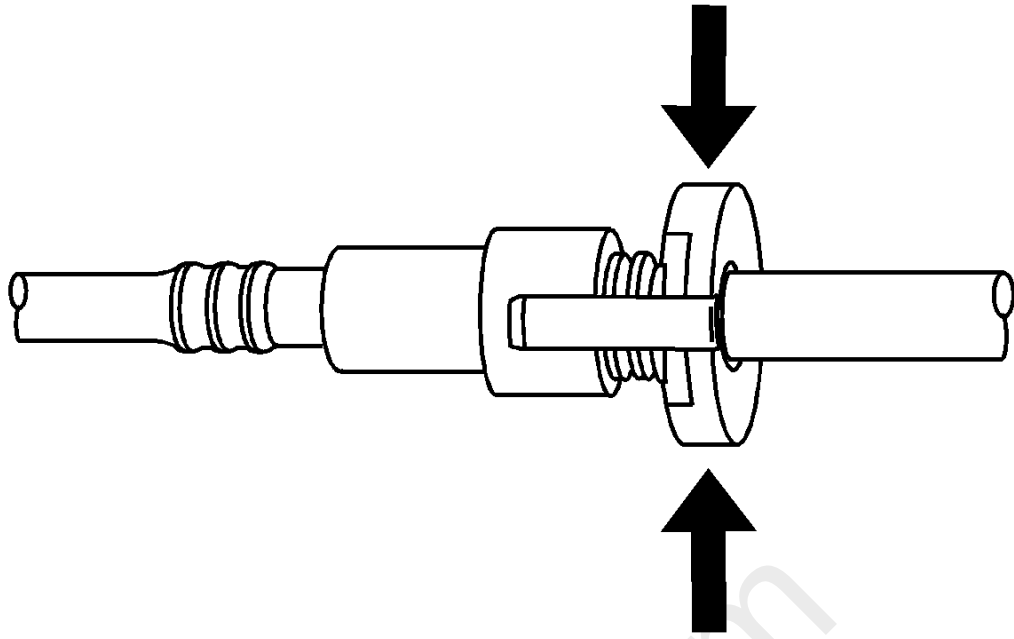


Fig. 22: Squeeze To Release Quick Connect Fitting (Plastic Collar).

Courtesy of GENERAL MOTORS COMPANY

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

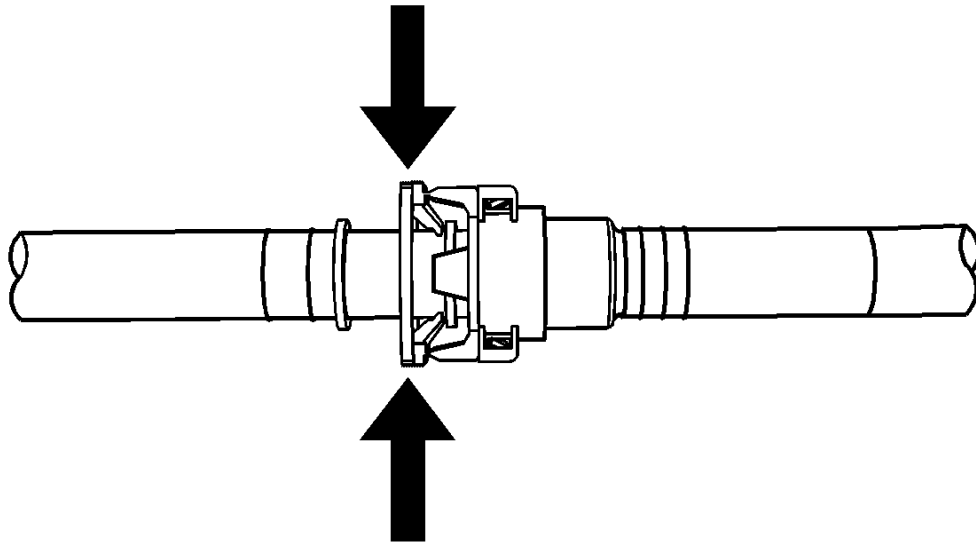


Fig. 23: Pushing In Male Side Of Connector - Squeeze To Release
 Courtesy of GENERAL MOTORS COMPANY

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



Fig. 24: Variants Of Sliding Retainer Style Connectors
 Courtesy of GENERAL MOTORS COMPANY

NOTE: There are two variants of sliding retainer style connectors shown above, both have the same release and installation procedure.

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

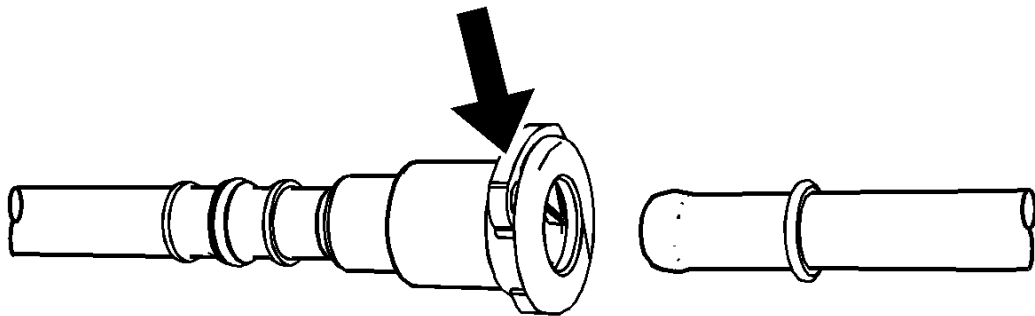


Fig. 25: Global Connector Style
Courtesy of GENERAL MOTORS COMPANY

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

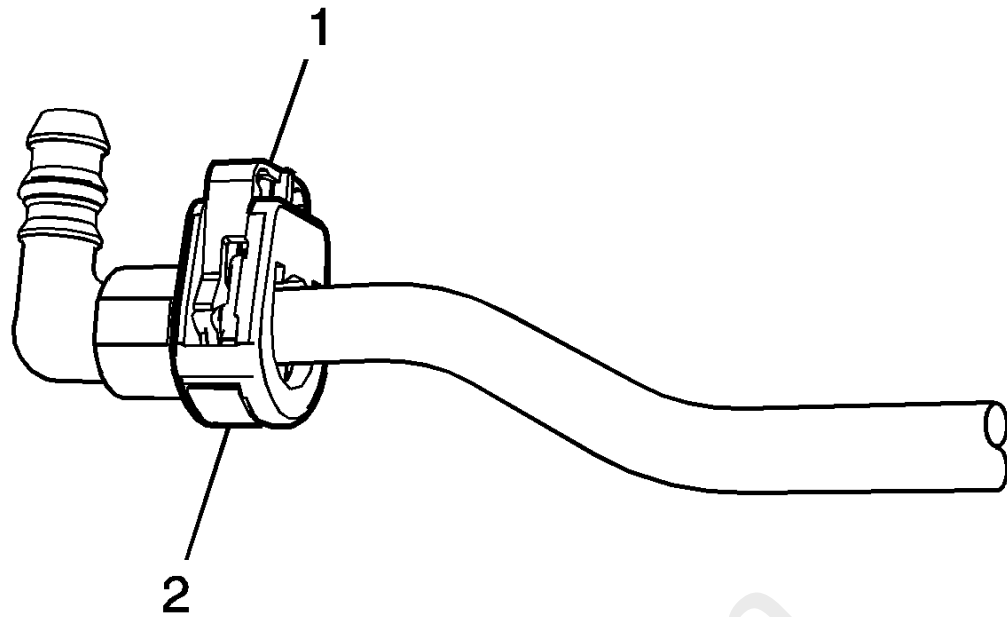


Fig. 26: Redundant Latch And Release Mechanism - TI Loc Style
Courtesy of GENERAL MOTORS COMPANY

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

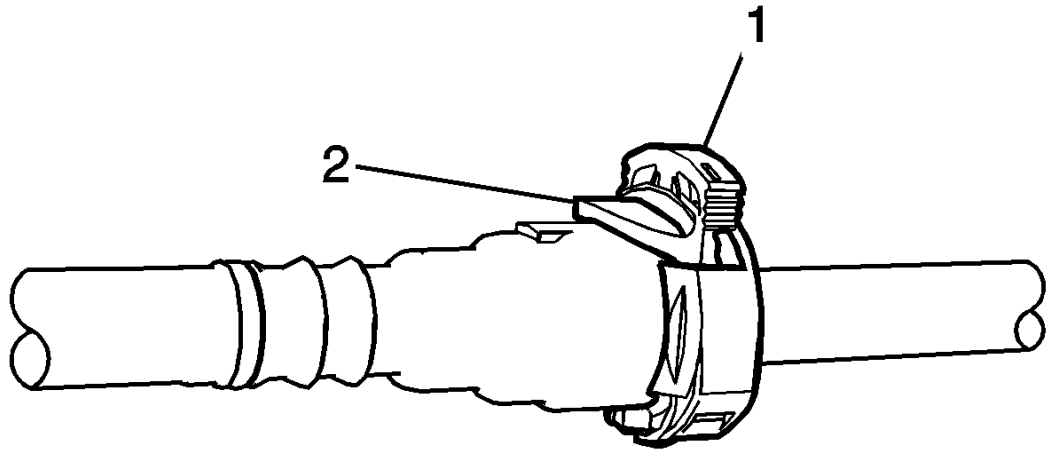


Fig. 27: Second Latch And Release Mechanism - Safe Lock Style
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to [Relieving Fuel Pressure Warning](#) .

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

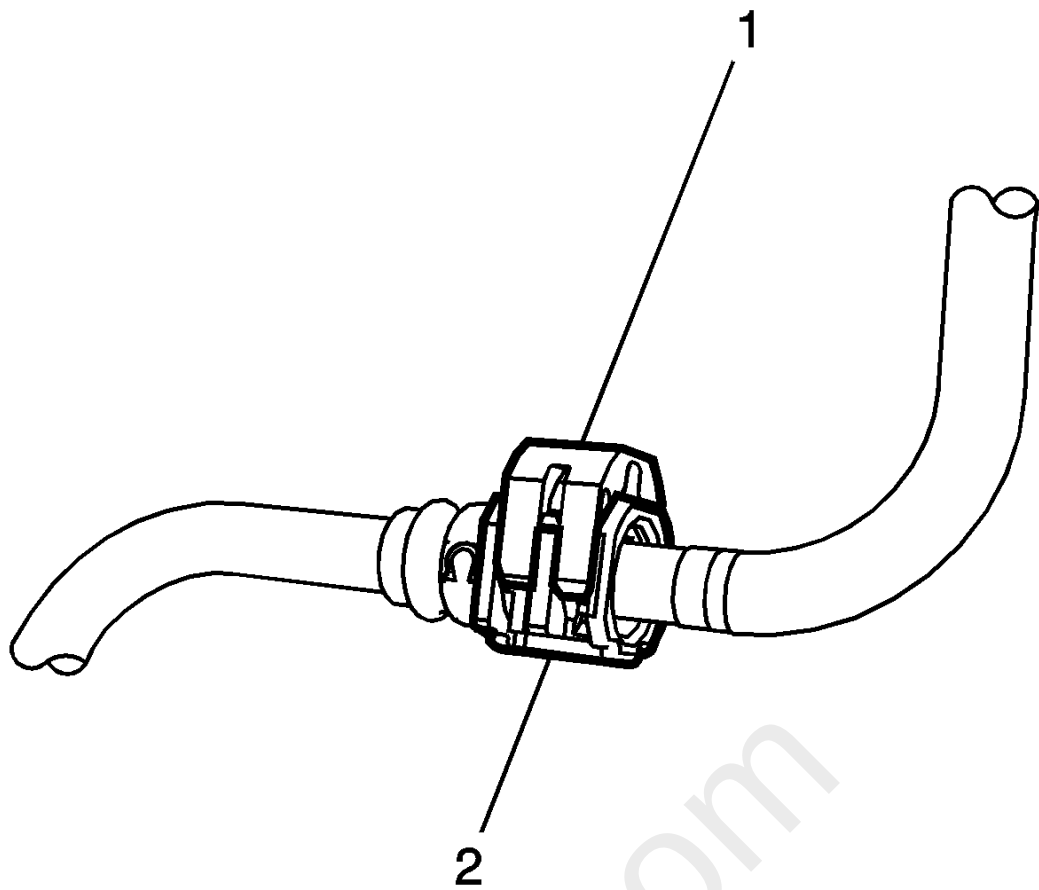


Fig. 28: Latch And Connector - Plastic Connector Style 8

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

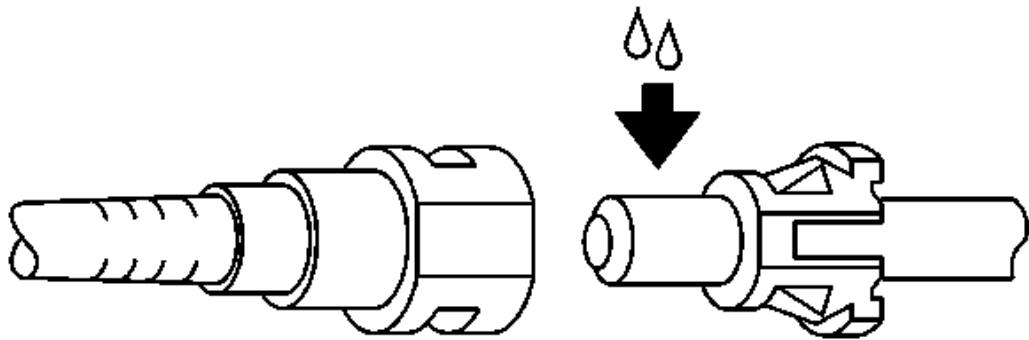


Fig. 29: Oiling Male Pipe End (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

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

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

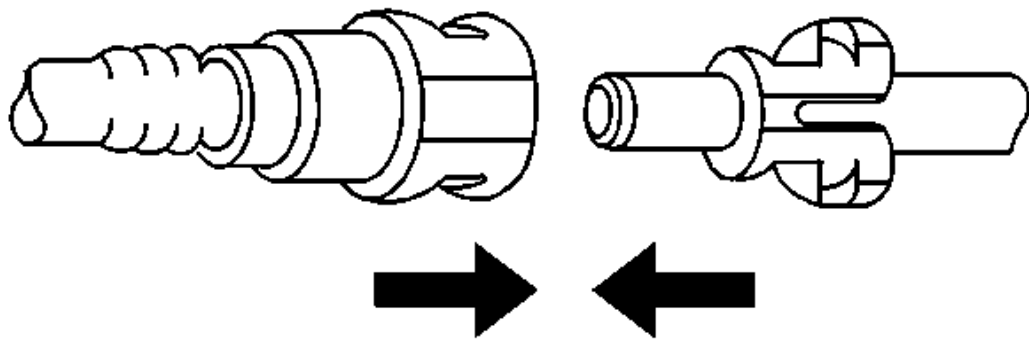


Fig. 30: Connecting Quick-Connect Fittings (Plastic Collar).

Courtesy of GENERAL MOTORS COMPANY

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

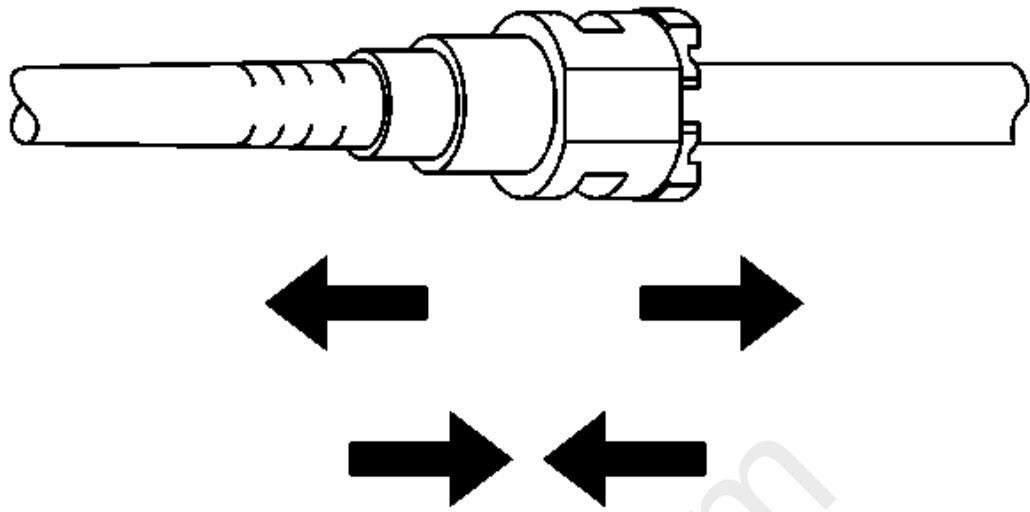


Fig. 31: Ensuring Secure Connection (Plastic Collar).
Courtesy of GENERAL MOTORS COMPANY

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

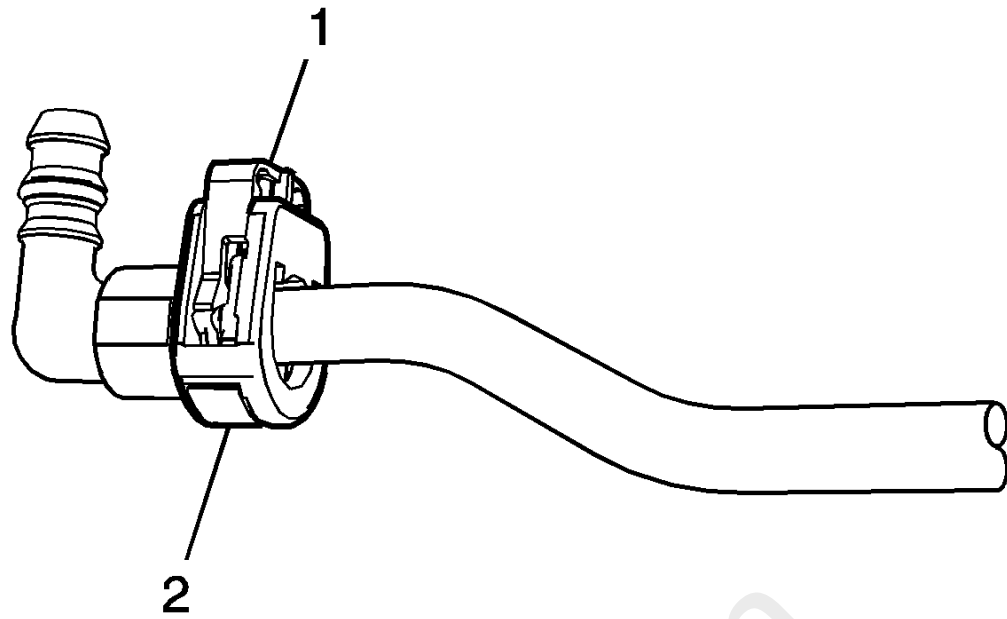


Fig. 32: Redundant Latch And Release Mechanism - TI Loc Style
Courtesy of GENERAL MOTORS COMPANY

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

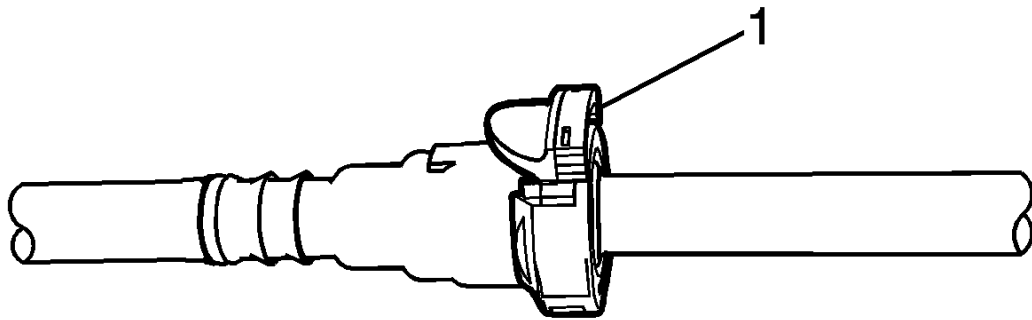


Fig. 33: Second Latch - Safe Lock Style

Courtesy of GENERAL MOTORS COMPANY

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

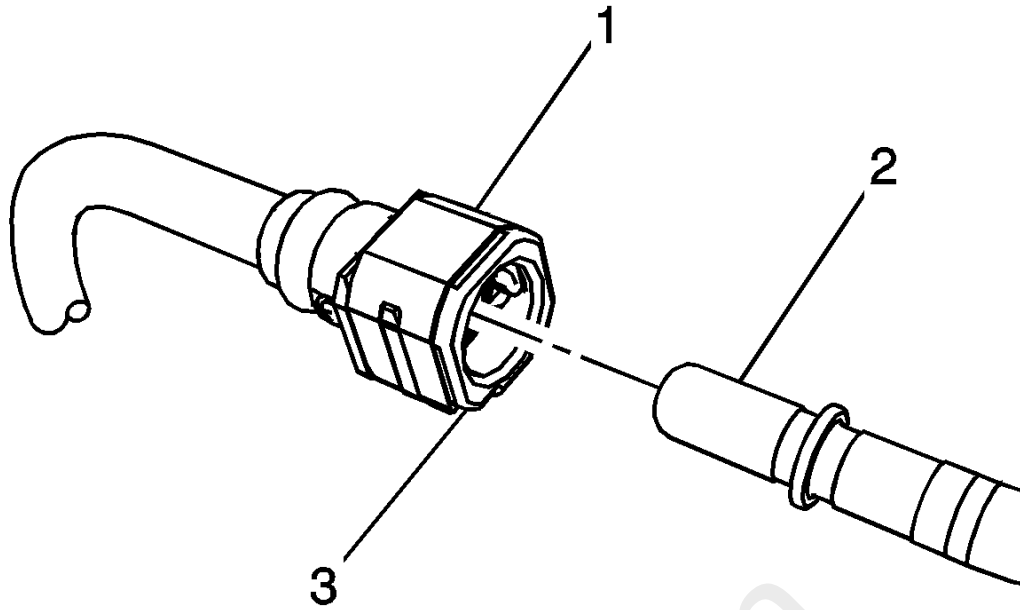


Fig. 34: Latch And Connector - Plastic Connector Type 8

Courtesy of GENERAL MOTORS COMPANY

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

ENGINE CONTROL MODULE REPLACEMENT

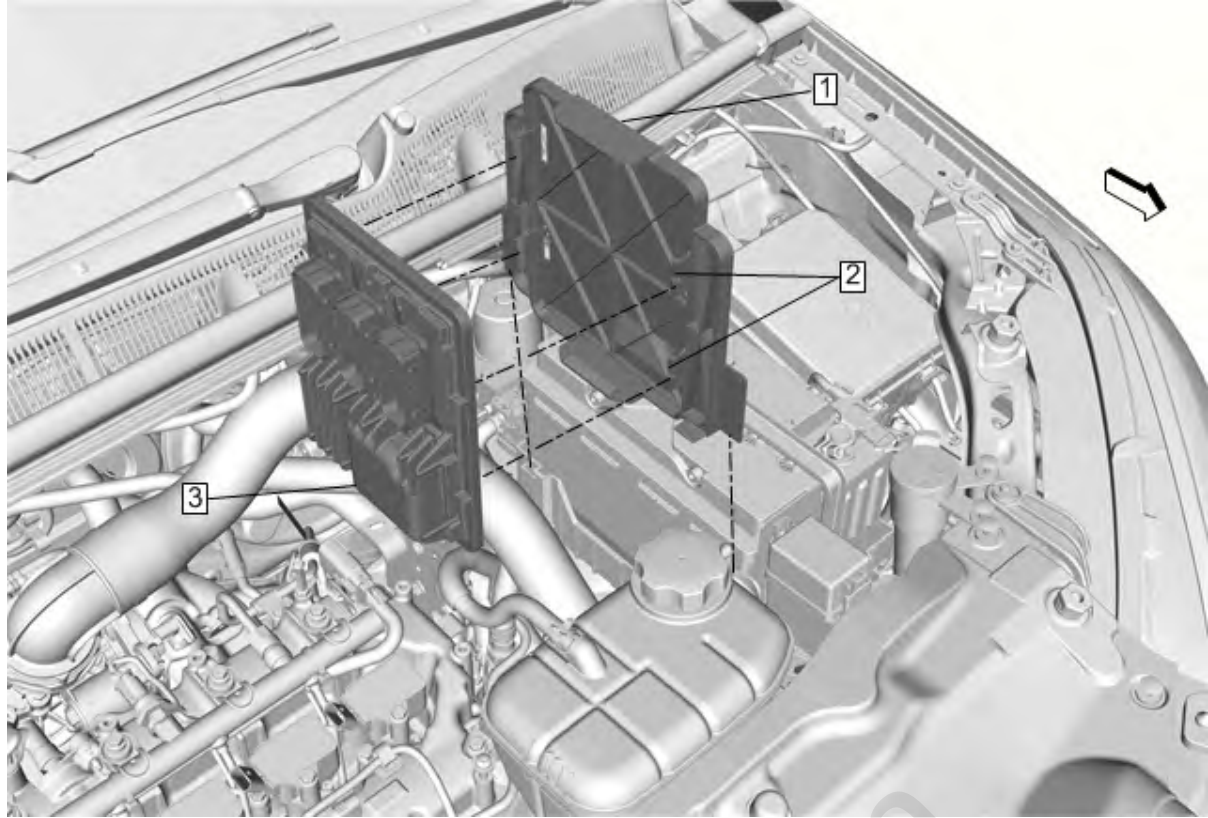


Fig. 35: Engine Control Module

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (without KL9), Battery Negative Cable Disconnection and Connection (with KL9). 2. Disconnect the charge air cooler outlet air hose from the throttle body. 3. Remove Charge Air Cooler Outlet Air Hose Bracket Nut (Qty: 2) @ Engine Wiring Harness Bracket. Refer to Charge Air Cooler Outlet Air Hose Replacement 4. Disconnect the electrical connectors from the engine control module.	
1	Engine Control Module Bracket Procedure Unclip the engine control module bracket from the battery tray.
2	Engine Control Module Retainer (Qty: 2)

Callout	Component Name
3	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. NOTE: Before removing the engine control module (ECM), use the scan tool to capture the ECM data. This captured data will then need to be restored into the NEW ECM. Refer to Control Module References

CRANKSHAFT POSITION VARIATION LEARN

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)

Description

The crankshaft position sensor variation or reluctor ring learn is used to calculate reference period errors caused by slight tolerance variations in the crankshaft and the crankshaft position sensor. The calculated error allows the ECM to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load. The compensation values are stored in ECM memory after a learn procedure has been performed.

When to Perform the Procedure

NOTE: Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.

Perform this procedure when the following component has been serviced:

- B26 Crankshaft Position Sensor
- Any repair which disturbs the alignment between the components: B26 Crankshaft Position Sensor & Crankshaft
- Crankshaft

- Crankshaft Balancer
- Engine Assembly

Conditions for Running the Procedure

- DTC P0117, P0118, P0335, P0336 = Not set
- ECT = Greater than 60°C (140°F)
- Ignition Voltage = Greater than 11 V

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition On/Vehicle In Service Mode
2. Verify there are no other DTCs set, except for DTC P0300-P0308, P0315.
 - **If any other DTCs are set**

Refer to: [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **If no other DTCs are set**
3. Select: Module Diagnostics
 4. Select: Engine Control Module
 5. Select: Configuration/Reset Functions
 6. Select: Learn Functions
 7. Select: Crankshaft Position Variation Learn
 8. Follow the instructions on the scan tool.

Verify the scan tool procedure was successful.

- **If the procedure was not successful and first time here**

1. Ignition/Vehicle Off
2. Verify the following conditions do not exist:
 - B26 Crankshaft Position Sensor & Reluctor Ring - Foreign material passing between the components/Incorrect air gap
 - Battery Voltage - Low
 - Crankshaft Bearing - Worn
 - Crankshaft - Excessive runout/Visual Damage
 - Reluctor Ring - Misaligned/Visual Damage
 - Signal circuit @ B26 Crankshaft Position Sensor - Electromagnetic Interference
 - If a condition exists, repair or replace as necessary
 - If no condition exists, repeat step 1
- **If the procedure was not successful and performed 4 times or less**

Repeat step 6

- **If the procedure was not successful and performed 5 times**

Replace the component: K20 Engine Control Module

- **If the procedure was successful**

9. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)

For control module replacement, programming, and setup refer to: [Control Module References](#)

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

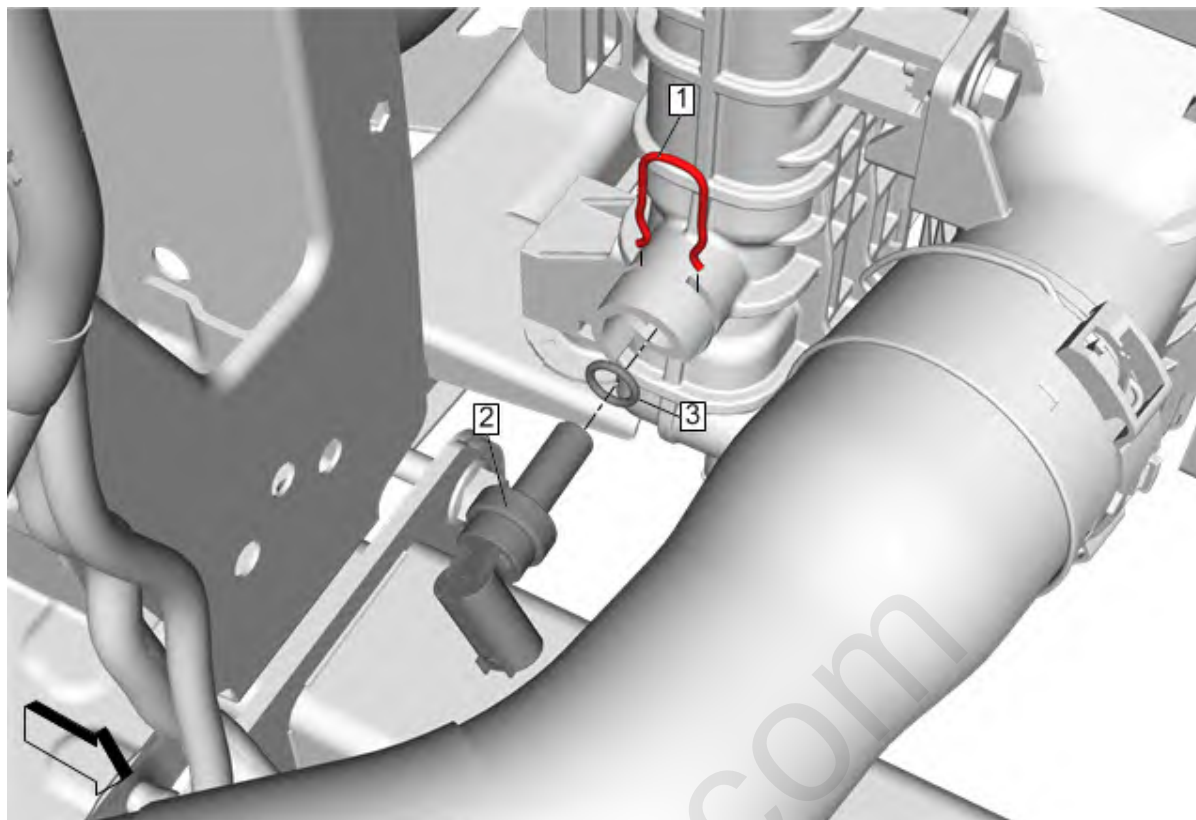


Fig. 36: Engine Coolant Temperature Sensor

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Drain engine cooling system. Refer to Cooling System Draining and Filling	
1	Retaining Clamp
2	Engine Coolant Temperature Sensor Procedure Disconnect the electrical connector.
3	Engine Coolant Temperature Sensor Seal Procedure Install a NEW O-ring seal.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT - WATER OUTLET

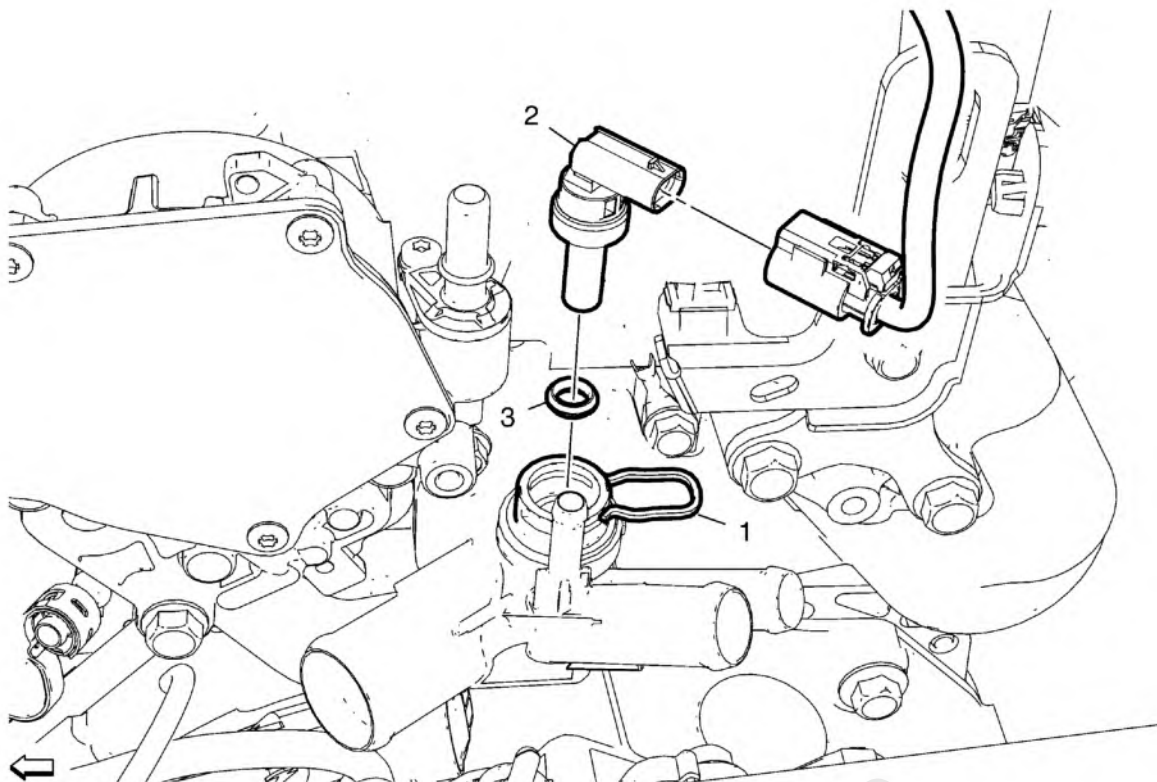


Fig. 37: Engine Coolant Temperature Sensor - Water Outlet

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove Engine Lift Rear Bracket. Refer to Engine Lift Rear Bracket Replacement	
1	Retaining Clamp
2	Engine Coolant Temperature Sensor Procedure Disconnect the electrical connector.
3	Engine Coolant Temperature Sensor Seal Procedure Install a NEW O-ring seal.

KNOCK SENSOR REPLACEMENT

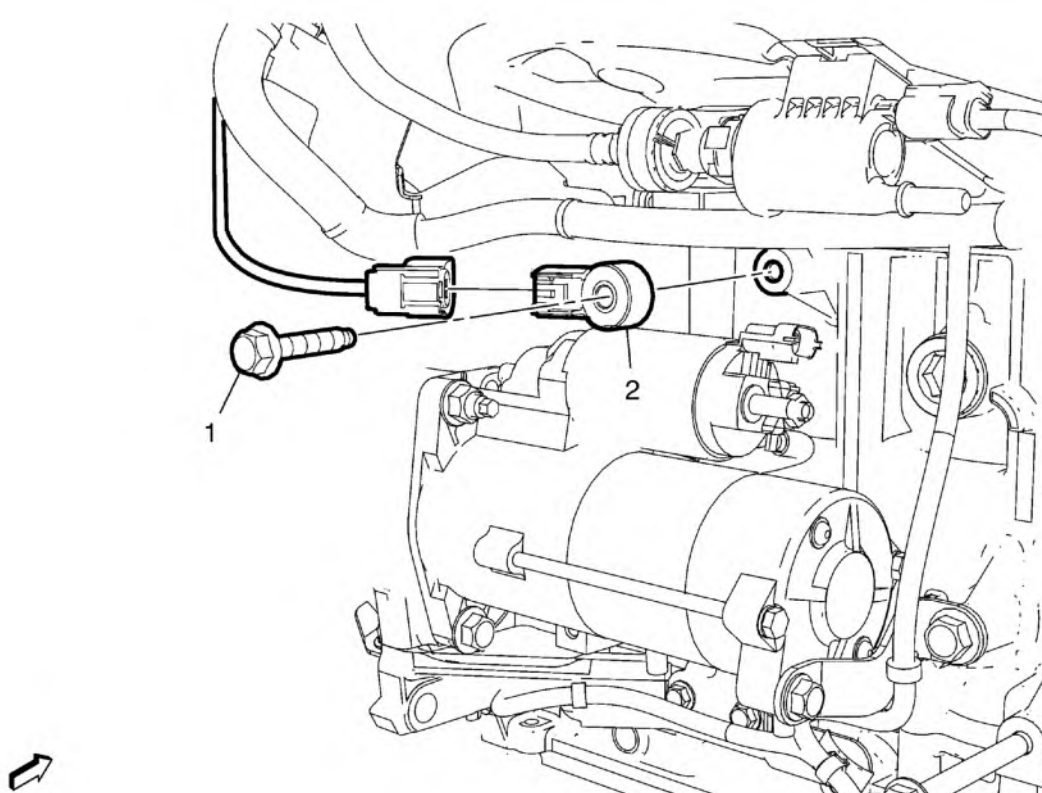


Fig. 38: Knock Sensor

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (without KL9), Battery Negative Cable Disconnection and Connection (with KL9). 2. Remove Starter Motor. Refer to Starter Replacement (LE2-FWD), Starter Replacement (LE2-AWD).	
1	Knock Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 25 N.m (18 lb ft)
2	Knock Sensor Procedure Disconnect the electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT

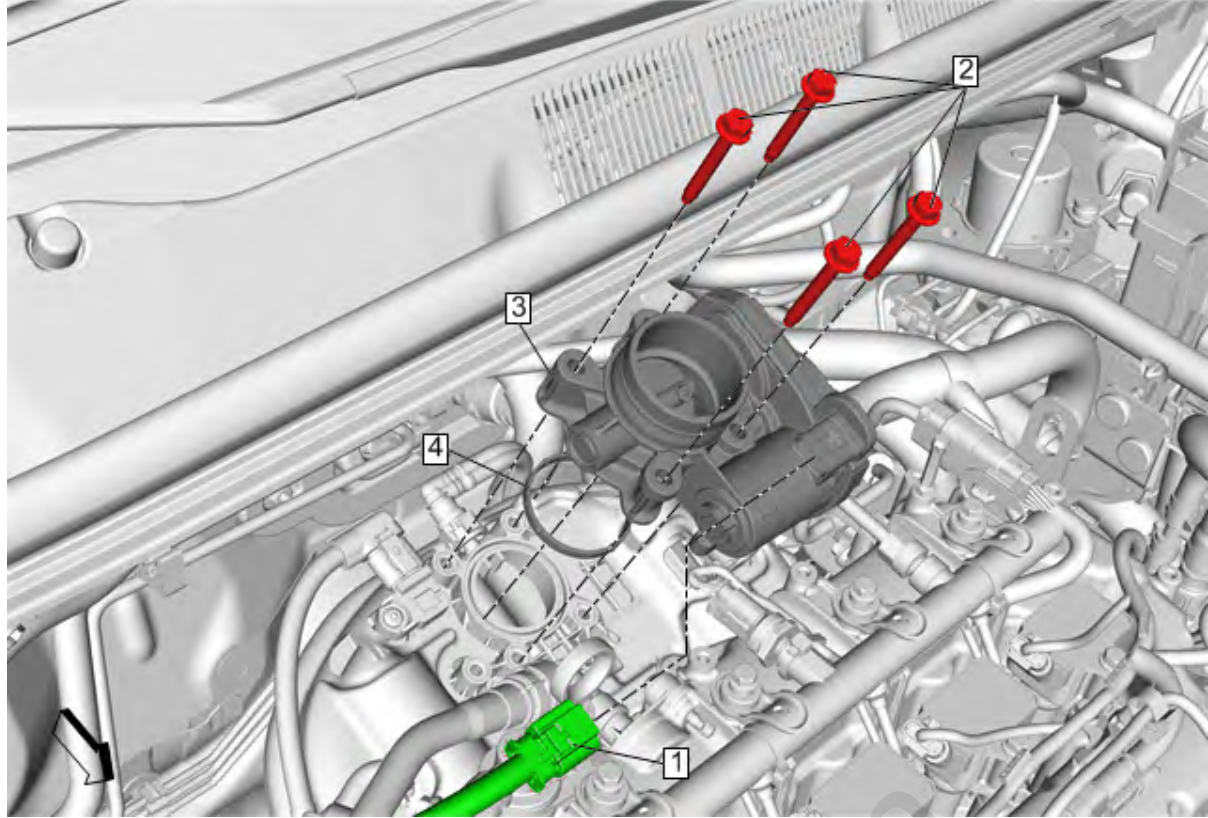


Fig. 39: Throttle Body Assembly

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Charge Air Cooler Outlet Air Hose. Refer to Charge Air Cooler Outlet Air Hose Replacement	
1	Electrical Connector
2	Throttle Body Assembly Bolt CAUTION: Refer to Fastener Caution . Tighten to 10 N.m (89 lb in)
3	Throttle Body Assembly
4	Throttle Body Assembly Seal Procedure Install a NEW throttle body assembly seal.

THROTTLE BODY INSPECTION AND CLEANING

1. Remove Throttle Body Assembly. Refer to [Throttle Body Assembly Replacement](#)

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

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

NOTE: Open the throttle valve in order to inspect all surfaces.

2. Inspect the throttle body bore and the throttle valve plate for deposits.

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK).

This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with an appropriate cleaner.
4. Install Throttle Body Assembly. Refer to [Throttle Body Assembly Replacement](#).
5. Perform Throttle or Idle Learn. Refer to [Throttle or Idle Learn](#)

FUEL PRESSURE RELIEF

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

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

FUEL TANK DRAINING

Special Tool

CH 45004 Fuel Tank Drain Hose

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

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

1. Remove the fuel fill cap.

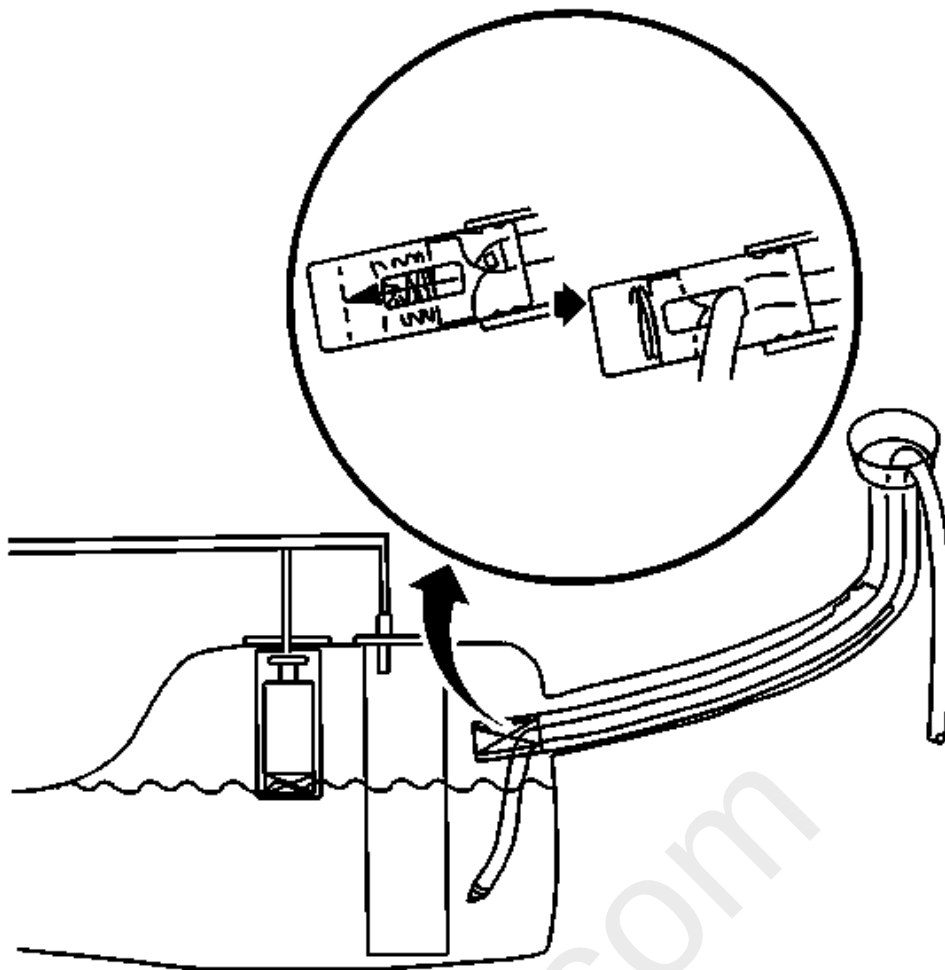


Fig. 40: View Of Fuel Tank Draining Procedure
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate the fuel drain hose with Transjel Lubricant or equivalent to aid in hose insertion.

2. Insert the **CH 45004** hose into the fuel tank until the bottom is reached.
3. Use a hand or air operated pump device in order to drain as much fuel through the fuel fill pipe as possible.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

1. Remove the fuel cap.
2. Drain the fuel tank. Refer to [Fuel Tank Draining](#)
3. Remove the right rear tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
4. Remove the right rear wheelhouse panel liner. Refer to [Rear Wheelhouse Liner Replacement](#).

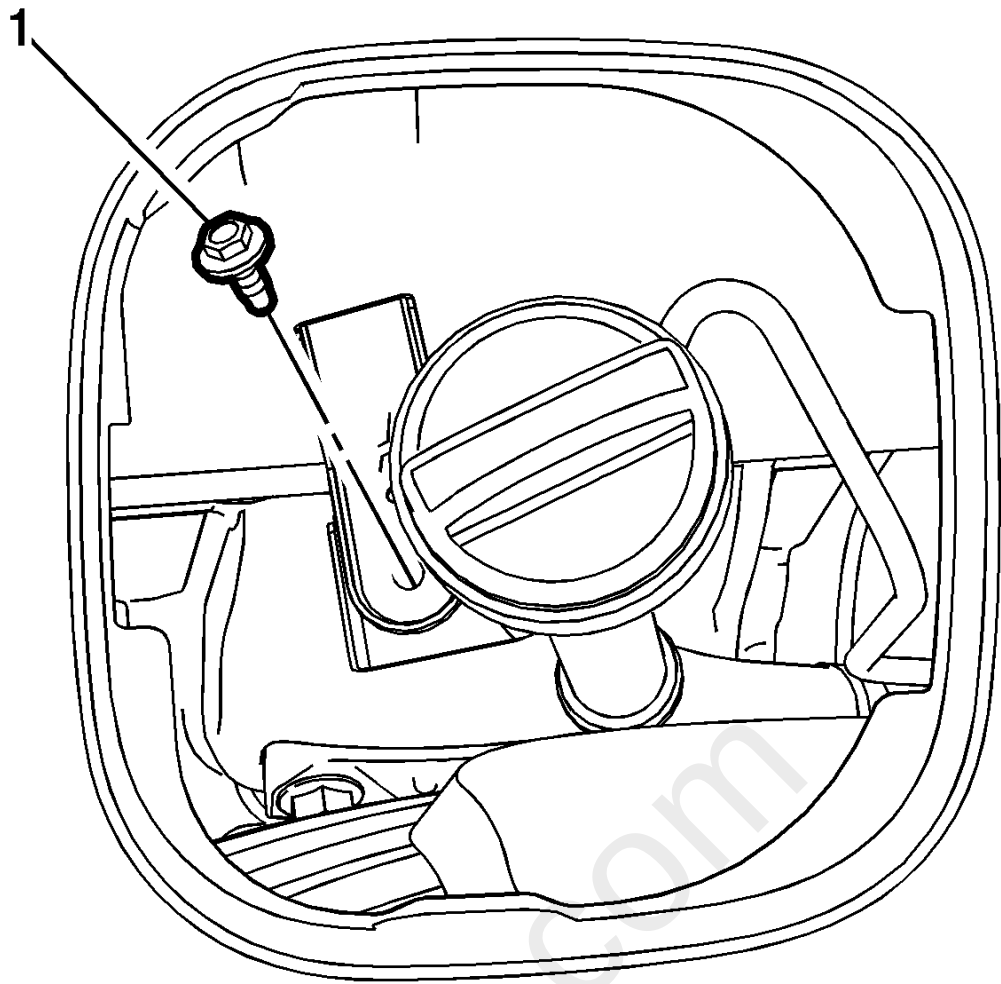


Fig. 41: Fuel Tank Filler Pipe Fastener

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel tank filler pipe fastener (1).
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

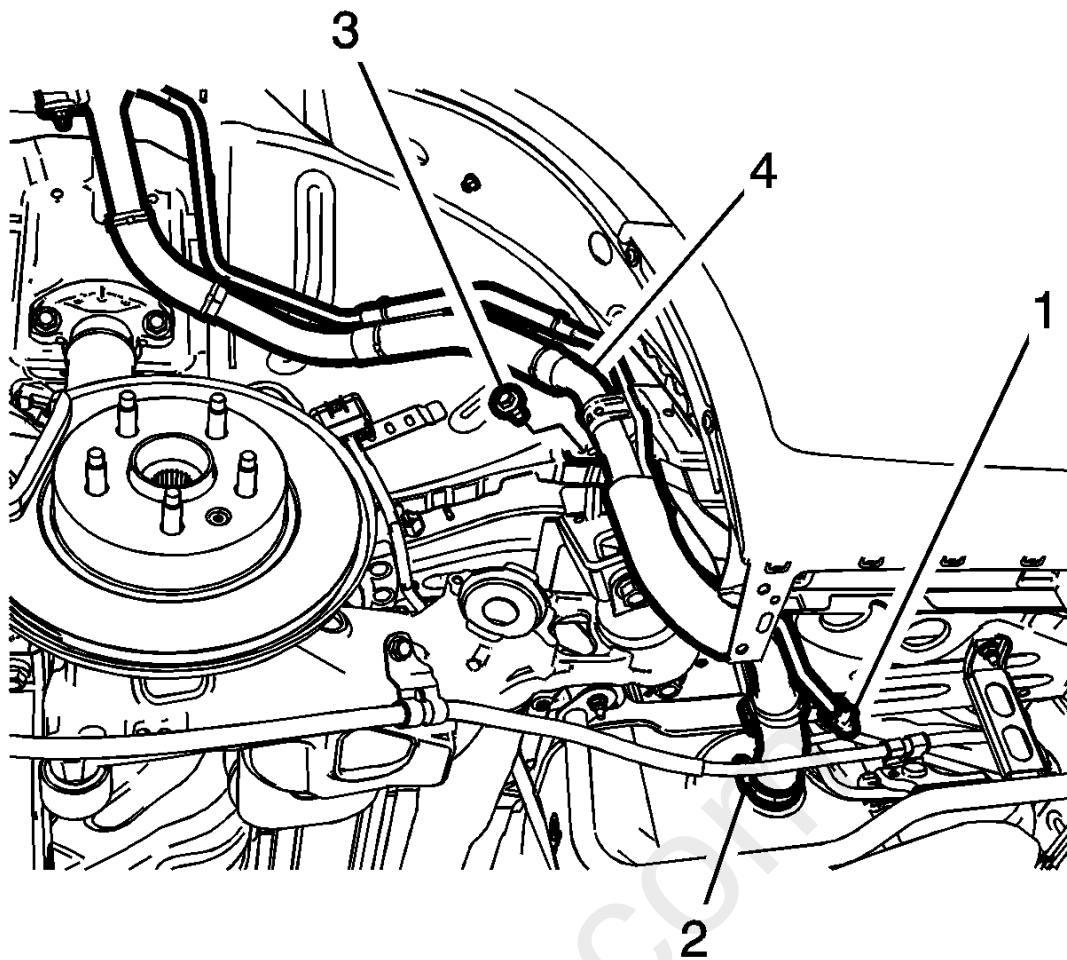


Fig. 42: Fuel Tank Filler Pipe, Clamp, Fastener And Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Remove the fuel tank filler pipe clamp (2).
8. Disconnect the fuel tank filler pipe quick connect fitting (1). Refer to [Plastic Collar Quick Connect Fitting Service](#) .
9. Remove the fuel tank filler pipe fastener (3).
10. Remove the fuel tank filler pipe (4) from the vehicle.

Installation Procedure

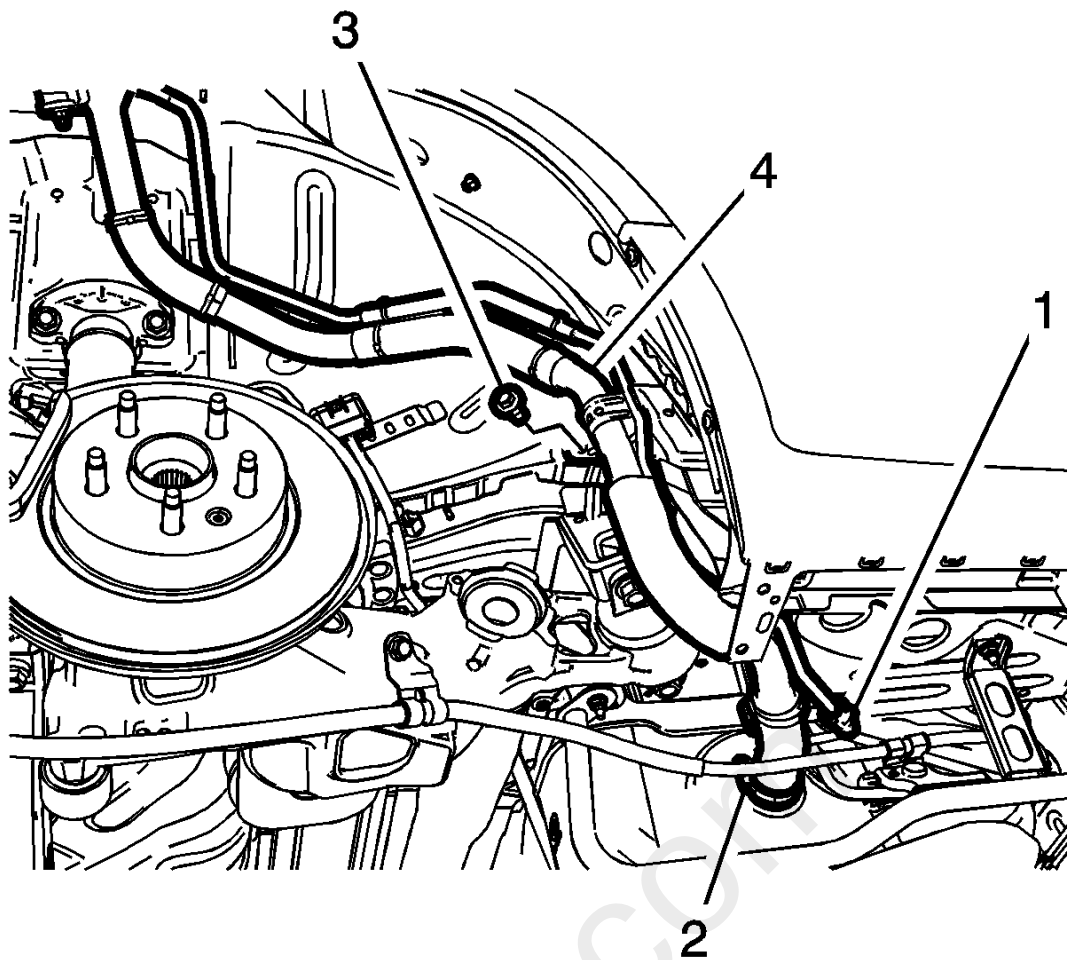


Fig. 43: Fuel Tank Filler Pipe, Clamp, Fastener And Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank filler pipe (4) to the vehicle.

CAUTION: Refer to [Fastener Caution](#) .

2. Install the fuel tank filler pipe fastener (3) and tighten to 9 N.m (80 lb in).
3. Connect the fuel tank filler pipe quick connect fitting (1). Refer to [Plastic Collar Quick Connect Fitting Service](#) .
4. Install the fuel tank filler pipe clamp (2).
5. Lower the vehicle.

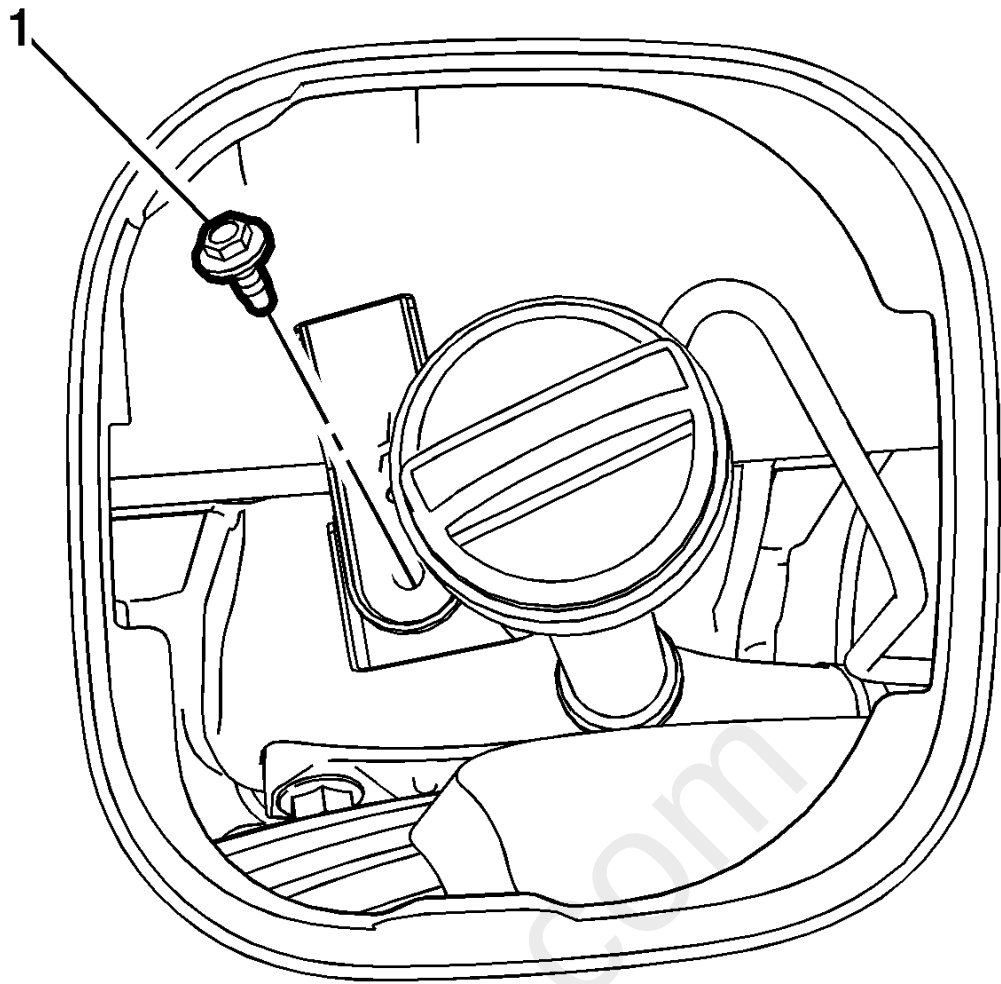


Fig. 44: Fuel Tank Filler Pipe Fastener

Courtesy of GENERAL MOTORS COMPANY

6. Install the fuel tank filler pipe fastener (1) and tighten to 9 N.m (80 lb in).
7. Install the right rear wheelhouse panel liner. Refer to [Rear Wheelhouse Liner Replacement](#).
8. Install the right rear tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
9. Fill the fuel tank.
10. Install the fuel cap.

FUEL FEED PIPE REPLACEMENT (UNDERBODY)

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#).

WARNING: Refer to [Safety Goggles and Fuel Warning](#).

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

1. Remove Intake Manifold Cover. Refer to [Intake Manifold Cover Replacement](#)
2. Disconnect Fuel Feed Front Pipe. Refer to [Fuel Feed Front Pipe Replacement](#), and [Metal Collar Quick Connect Fitting Service](#)

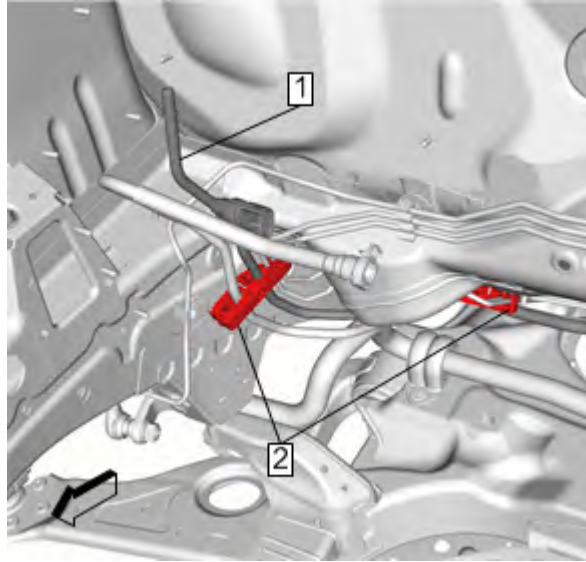


Fig. 45: Fuel Feed Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

3. Remove Fuel Feed Pipe (1) @ Retainers (2) (Qty: 2)
4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)

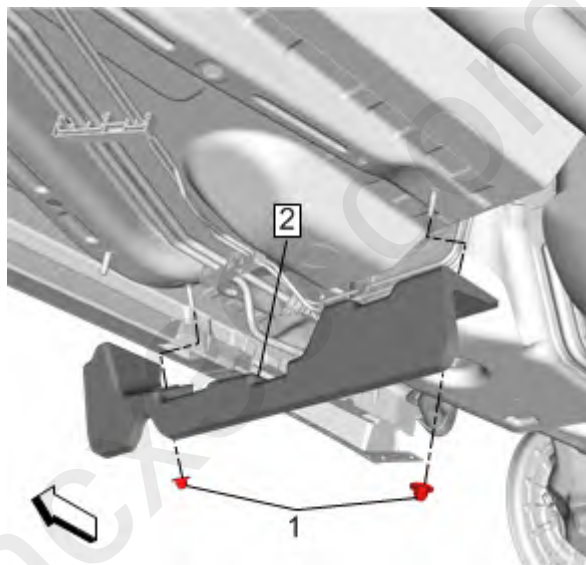


Fig. 46: Underbody Cross Sill Shield And Nuts

Courtesy of GENERAL MOTORS COMPANY

5. Remove Underbody Cross Sill Shield Nuts (1) (Qty: 2)
6. Remove Underbody Cross Sill Shield (2)

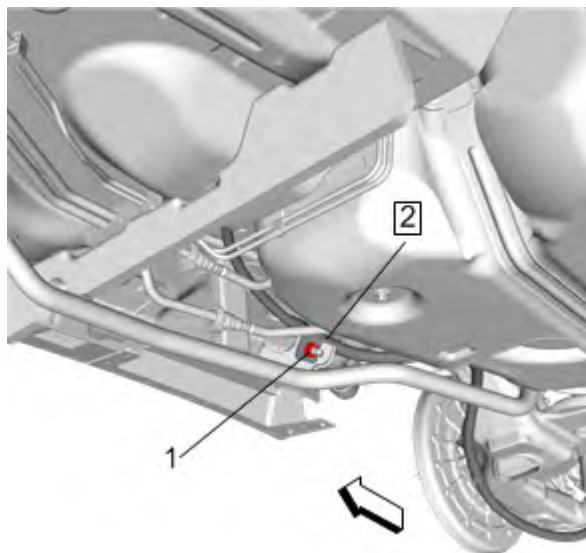


Fig. 47: Parking Brake Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

7. Remove Parking Brake Cable Nut (1)
8. Remove Parking Brake Cable (2)

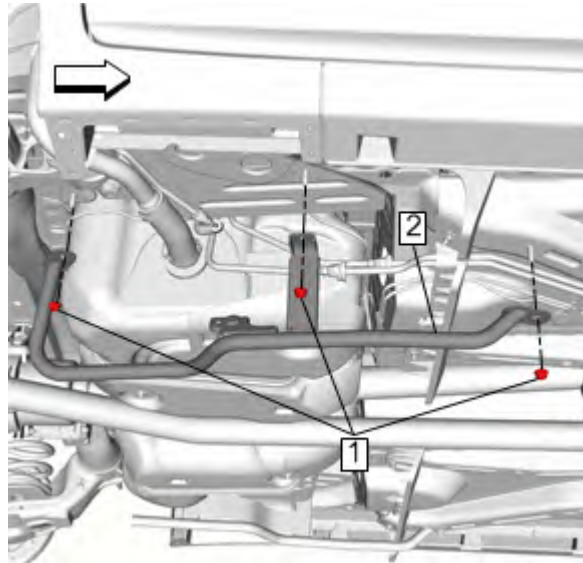


Fig. 48: Fuel Tank Protector And Nuts
Courtesy of GENERAL MOTORS COMPANY

9. Remove Fuel Tank Protector Nuts (1) (Qty: 3)
10. Remove Fuel Tank Protector (2)

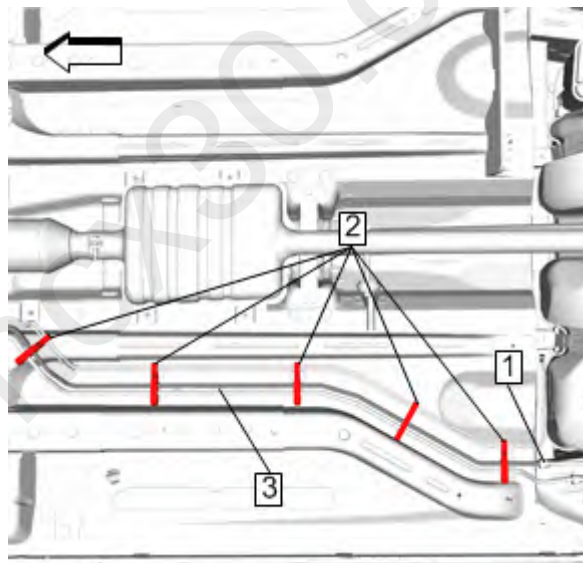


Fig. 49: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect Fuel Feed Pipe (1) @ Fuel Feed Pipe (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).
12. Remove Fuel Feed Pipe (1) @ Retainers (2) (Qty: 5)

Installation Procedure

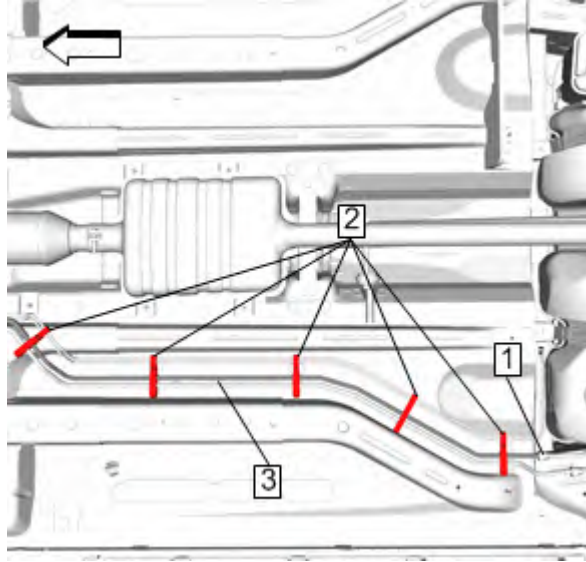


Fig. 50: Fuel Feed Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Feed Pipe (1) @ Retainers (2) (Qty: 5)
2. Connect Fuel Feed Pipe (1) @ Fuel Feed Pipe (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).

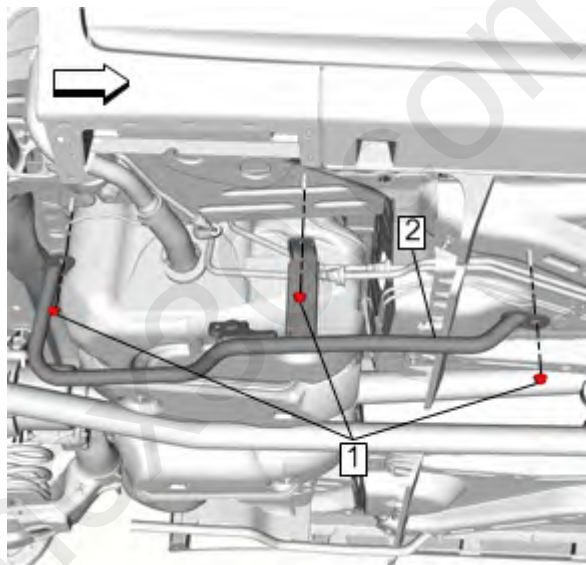


Fig. 51: Fuel Tank Protector And Nuts

Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Tank Protector (2)

CAUTION: Refer to [Fastener Caution](#) .

4. Install and tighten Fuel Tank Protector Nuts (1) (Qty: 3) to 22 N.m (16 lb ft)

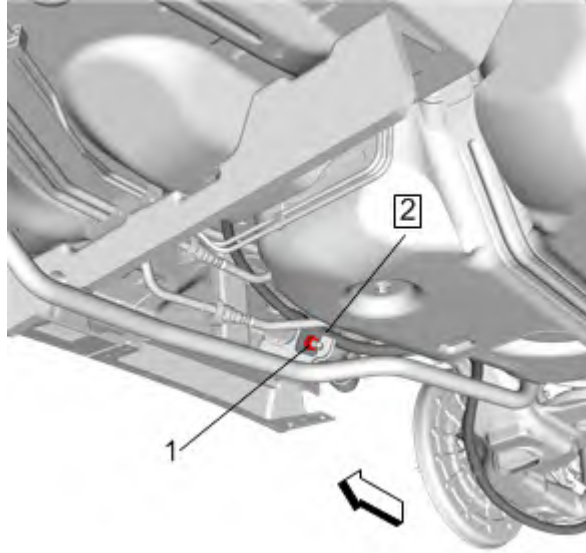


Fig. 52: Parking Brake Cable And Nut
 Courtesy of GENERAL MOTORS COMPANY

5. Install Parking Brake Cable (2)
6. Install and tighten Parking Brake Cable Nut (1) to 22 N.m (16 lb ft)

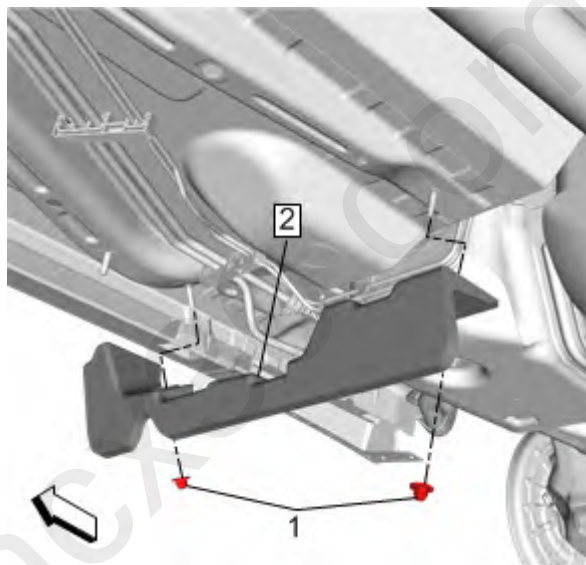


Fig. 53: Underbody Cross Sill Shield And Nuts
 Courtesy of GENERAL MOTORS COMPANY

7. Install Underbody Cross Sill Shield (2)
8. Install and tighten Underbody Cross Sill Shield Nuts (1) (Qty: 2) to 3.5 N.m (31 lb in)
9. Lower the vehicle.

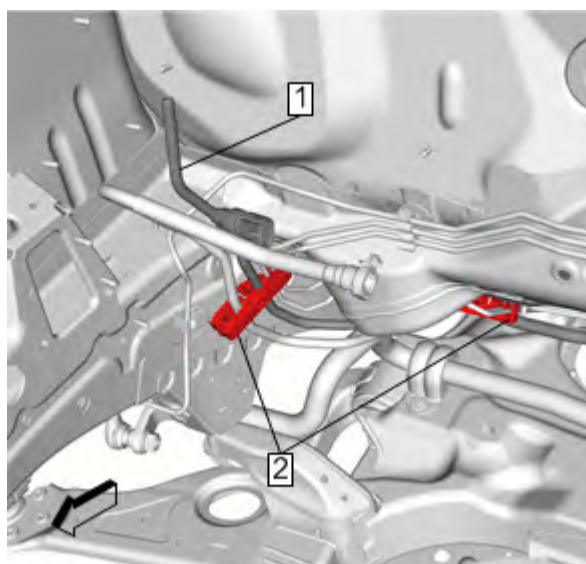


Fig. 54: Fuel Feed Pipe And Retainers
 Courtesy of GENERAL MOTORS COMPANY

10. Install Fuel Feed Pipe (1) @ Retainers (2) (Qty: 2)
11. Connect Fuel Feed Front Pipe. Refer to [Fuel Feed Front Pipe Replacement](#), and [Metal Collar Quick Connect Fitting Service](#)
12. Install Intake Manifold Cover. Refer to [Intake Manifold Cover Replacement](#)

FUEL FEED PIPE REPLACEMENT (AT TANK AWD)

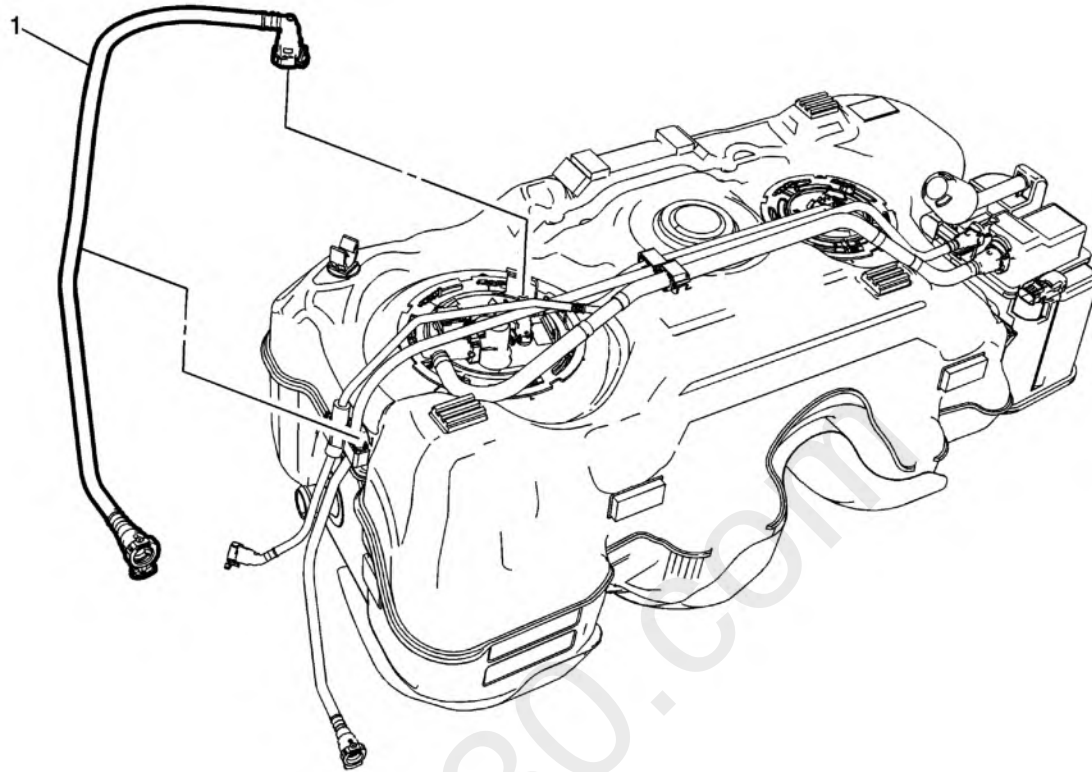


Fig. 55: Fuel Feed Pipe (At Tank - AWD)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby. Preliminary Procedures 1. Release fuel pressure. Refer to Fuel Pressure Relief 2. Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)Fuel Tank Replacement (AWD).	
1	Fuel Feed Pipe Procedure Disconnect the quick connect fittings. Refer to Plastic Collar Quick Connect Fitting Service

FUEL FEED PIPE REPLACEMENT (AT TANK FWD)

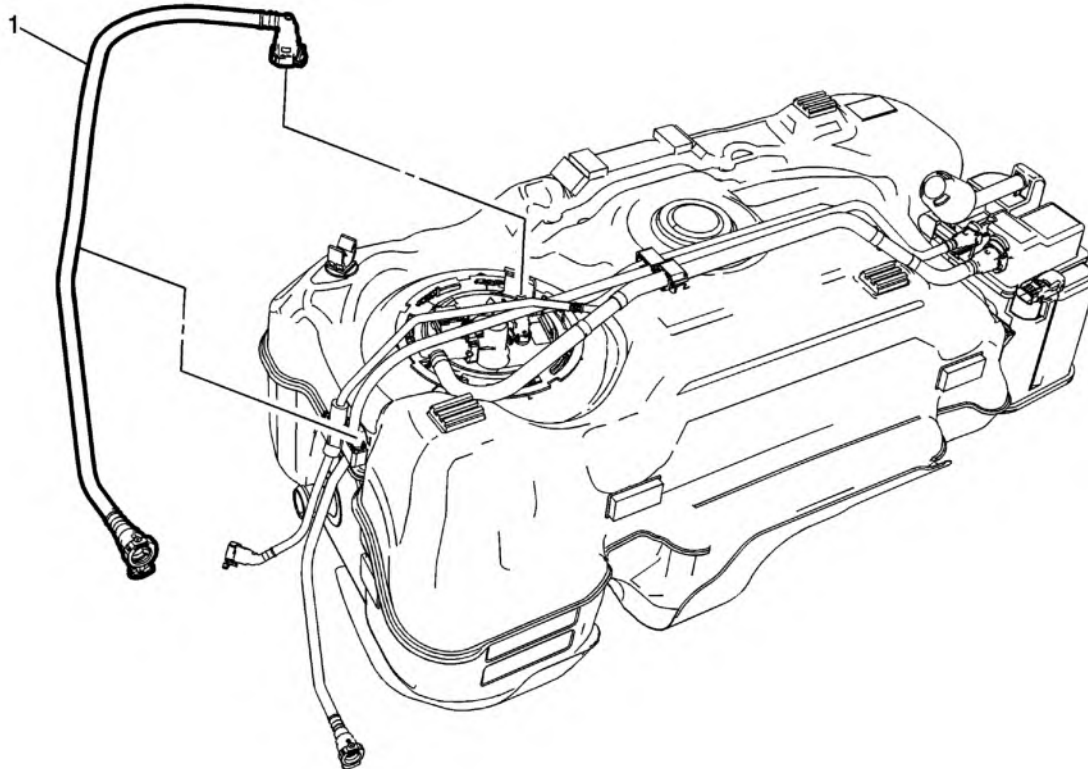


Fig. 56: Fuel Feed Pipe (At Tank - FWD)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby. Preliminary Procedures 1. Release fuel pressure. Refer to Fuel Pressure Relief 2. Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD) Fuel Tank Replacement (AWD) .	
1	Fuel Feed Pipe Procedure Disconnect the quick connect fittings. Refer to Plastic Collar Quick Connect Fitting Service

FUEL TANK FUEL PUMP MODULE REPLACEMENT (FWD)

Special Tools

CH-45722 Fuel Pump Locking Ring Wrench

For equivalent regional tools: [Special Tools \(Mechanical Tools\)](#).

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

WARNING: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

WARNING: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done

on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

1. Remove the fuel tank. Refer to [Fuel Tank Replacement \(FWD\)](#).
2. Disconnect the electrical connector.
3. Disconnect the fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Disconnect the evaporative emission hoses. Refer to [Plastic Collar Quick Connect Fitting Service](#).

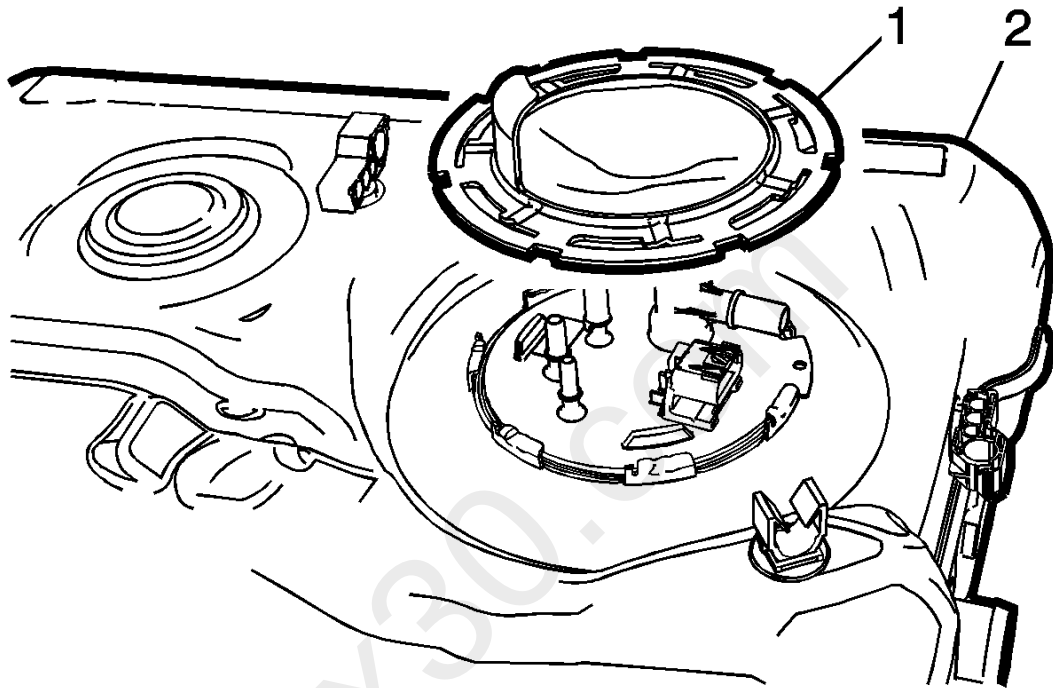


Fig. 57: Fuel Sender Lock Ring

Courtesy of GENERAL MOTORS COMPANY

5. Install the **CH-45722** Tool-Fuel Sender Lock Ring to the fuel pump module lock ring (1).
6. Using the **CH-45722** Tool-Fuel Sender Lock Ring and a long breaker-bar, rotate the fuel pump module lock ring (1) in a counterclockwise direction in order to unlock the lock ring from the fuel tank (2).

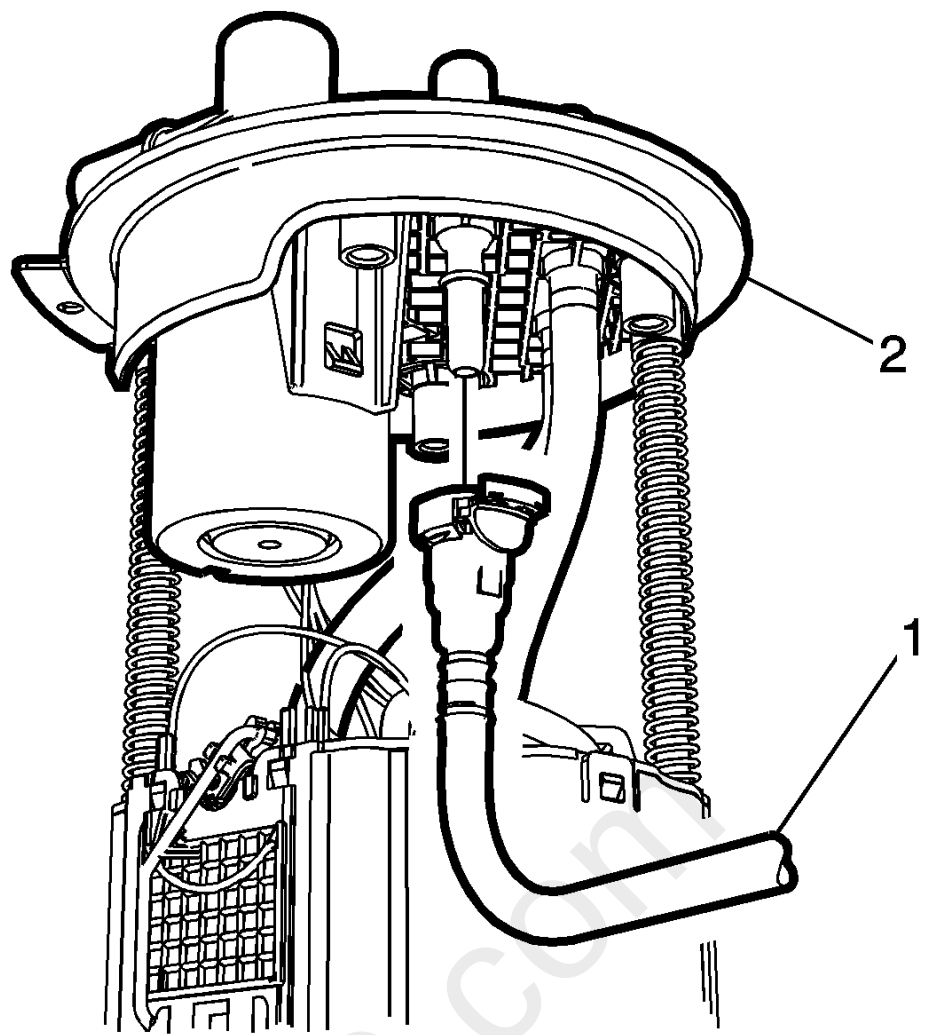


Fig. 58: Fuel Tank Vent Pipe And Fuel Pump Module

Courtesy of GENERAL MOTORS COMPANY

7. Raise the fuel pump module (2) enough to gain access to the fuel tank vent pipe (1) and disconnect the pipe from the fuel pump module. Refer to [Plastic Collar Quick Connect Fitting Service](#)

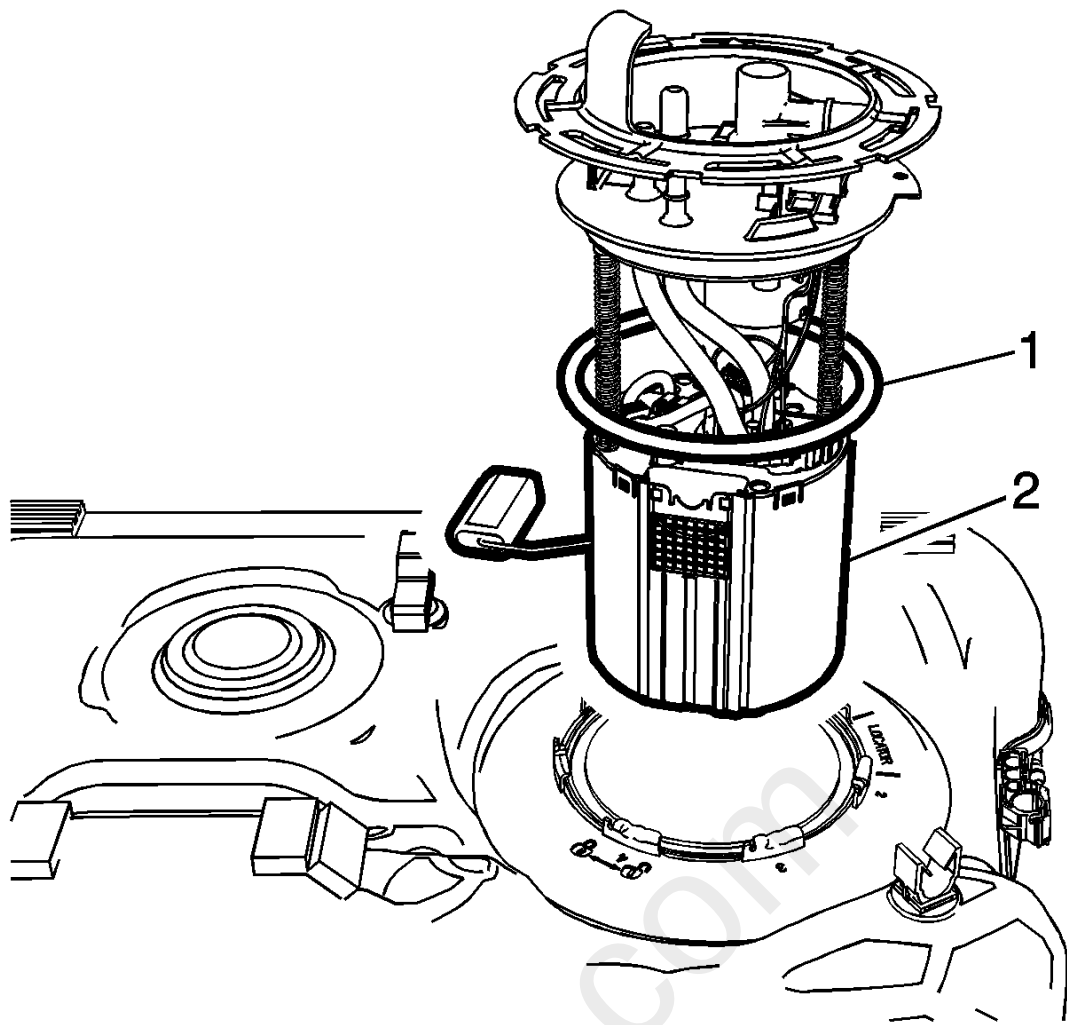


Fig. 59: Fuel Tank Fuel Pump Module And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

8. Remove the fuel tank fuel pump module (2).
9. Remove and discard the fuel tank fuel pump module O-ring gasket (1).

Installation Procedure

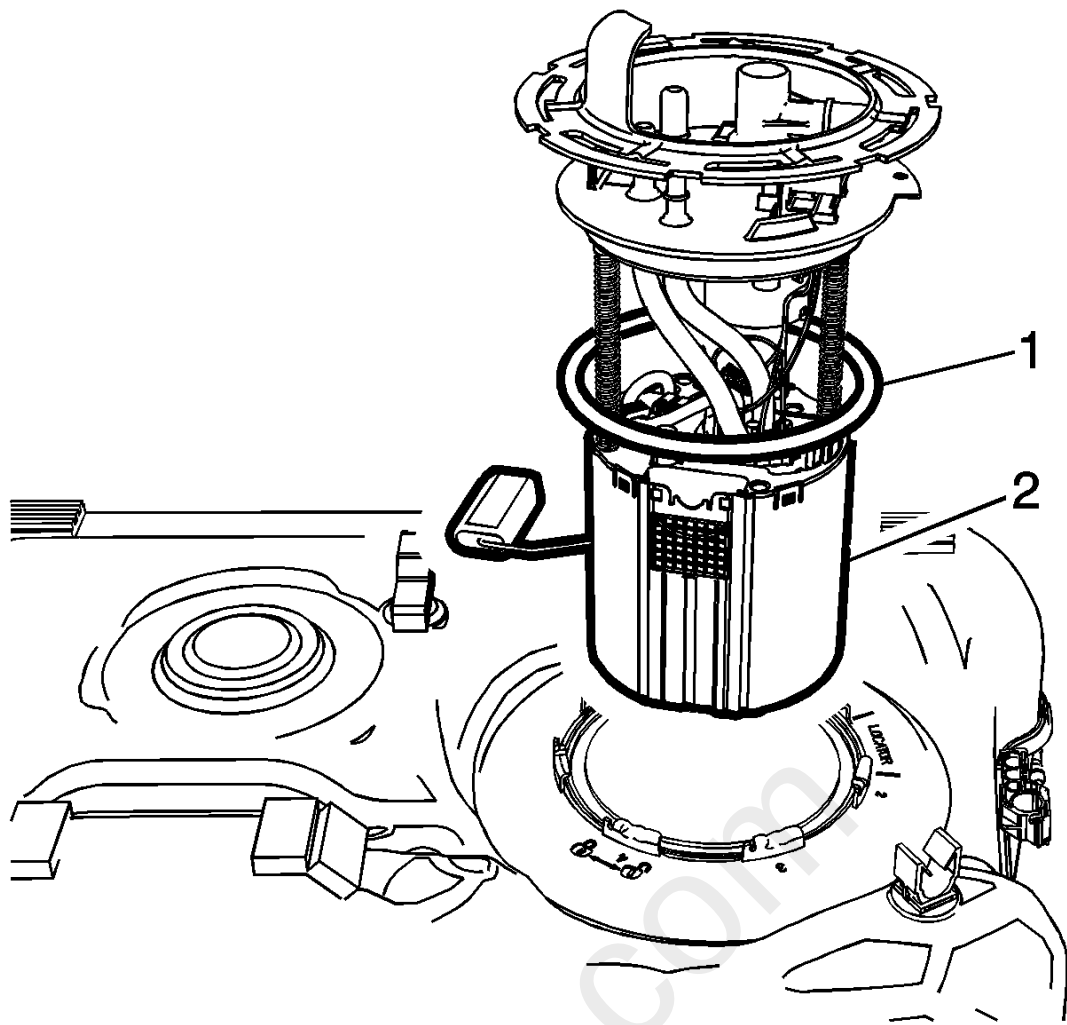


Fig. 60: Fuel Tank Fuel Pump Module And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW fuel tank fuel pump module O-ring gasket (1).
2. Install the fuel tank fuel pump module (2).

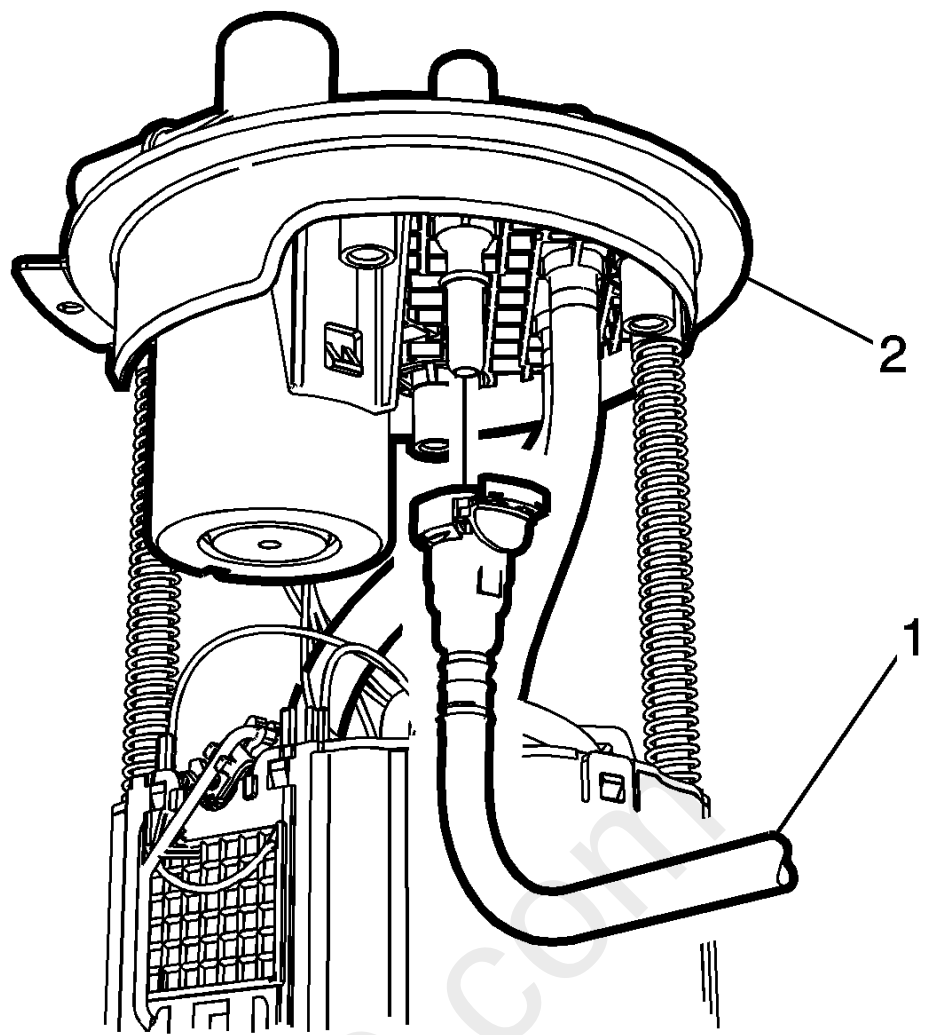


Fig. 61: Fuel Tank Vent Pipe And Fuel Pump Module

Courtesy of GENERAL MOTORS COMPANY

3. Lower the fuel pump module (2) into the fuel tank while connecting the fuel tank vent pipe (1) to the fuel pump module. Refer to [Plastic Collar Quick Connect Fitting Service](#)

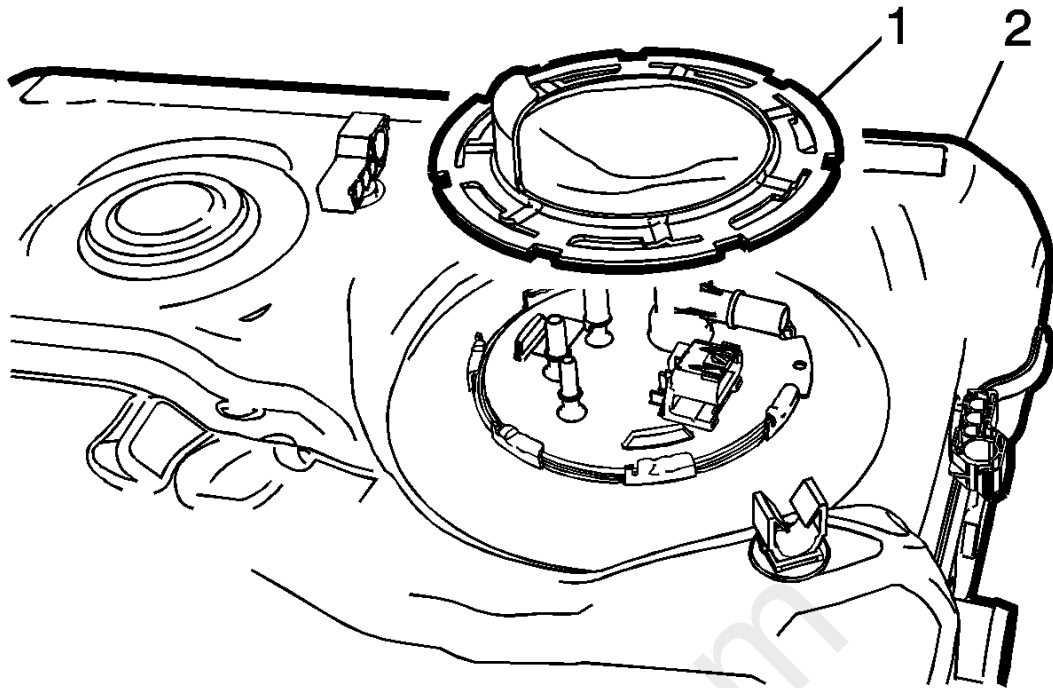


Fig. 62: Fuel Sender Lock Ring

Courtesy of GENERAL MOTORS COMPANY

4. Install the fuel tank fuel pump module lock ring (1) to the fuel tank (2).
5. Using the **CH-45722** Tool-Fuel Sender Lock Ring and a long breaker-bar, rotate the fuel pump module lock ring (1) in a clockwise direction in order to lock the lock ring.
6. Connect the evaporative emission hoses. Refer to [Plastic Collar Quick Connect Fitting Service](#)
7. Connect the fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#)
8. Connect the electrical connector.
9. Install the fuel tank. Refer to [Fuel Tank Replacement \(FWD\)](#)

FUEL TANK FUEL PUMP MODULE REPLACEMENT (AWD)

Special Tools

CH-45722 Fuel Pump Locking Ring Wrench

For equivalent regional tools: [Special Tools \(Mechanical Tools\)](#)

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

WARNING: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

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

1. Remove the fuel tank. Refer to [Fuel Tank Replacement \(AWD\)](#).
2. Remove the fuel sender assembly. Refer to [Fuel Sender Assembly Replacement \(AWD\)](#).
3. Disconnect the electrical connector.
4. Remove the fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#)
5. Remove the EVAP system hoses. Refer to [Plastic Collar Quick Connect Fitting Service](#)

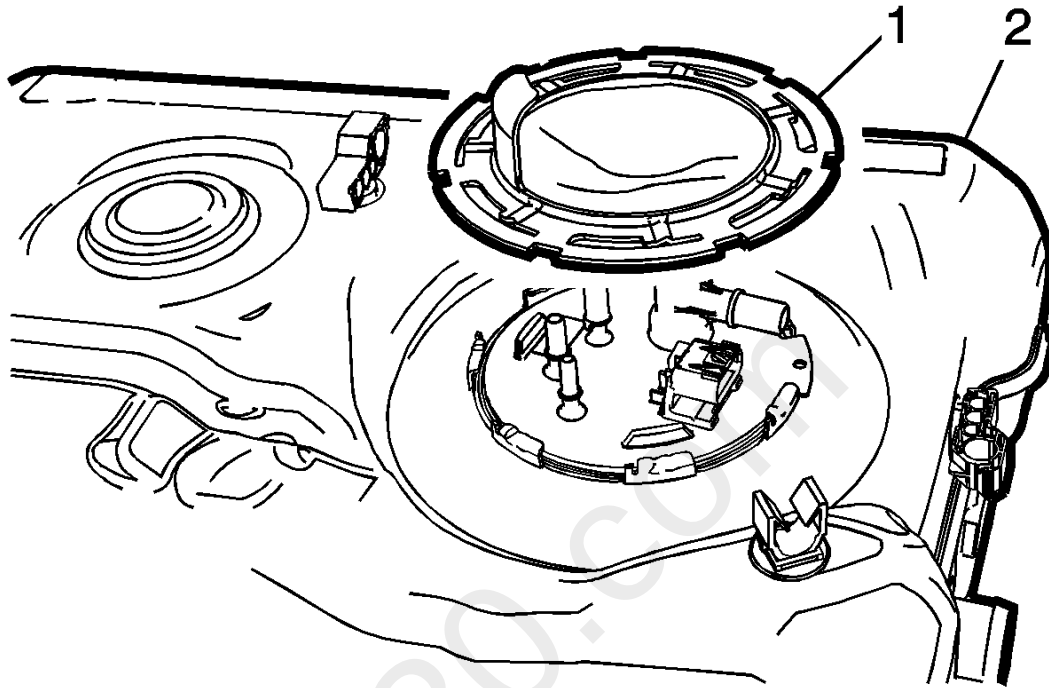


Fig. 63: Fuel Sender Lock Ring

Courtesy of GENERAL MOTORS COMPANY

6. Install the **CH-45722** Fuel Pump Locking Ring Wrench to the fuel pump module lock ring (1).
7. Using the **CH-45722** Fuel Pump Locking Ring Wrench and a long breaker-bar, rotate the fuel pump module lock ring (1) in a counterclockwise direction in order to unlock the lock ring from the fuel tank (2).

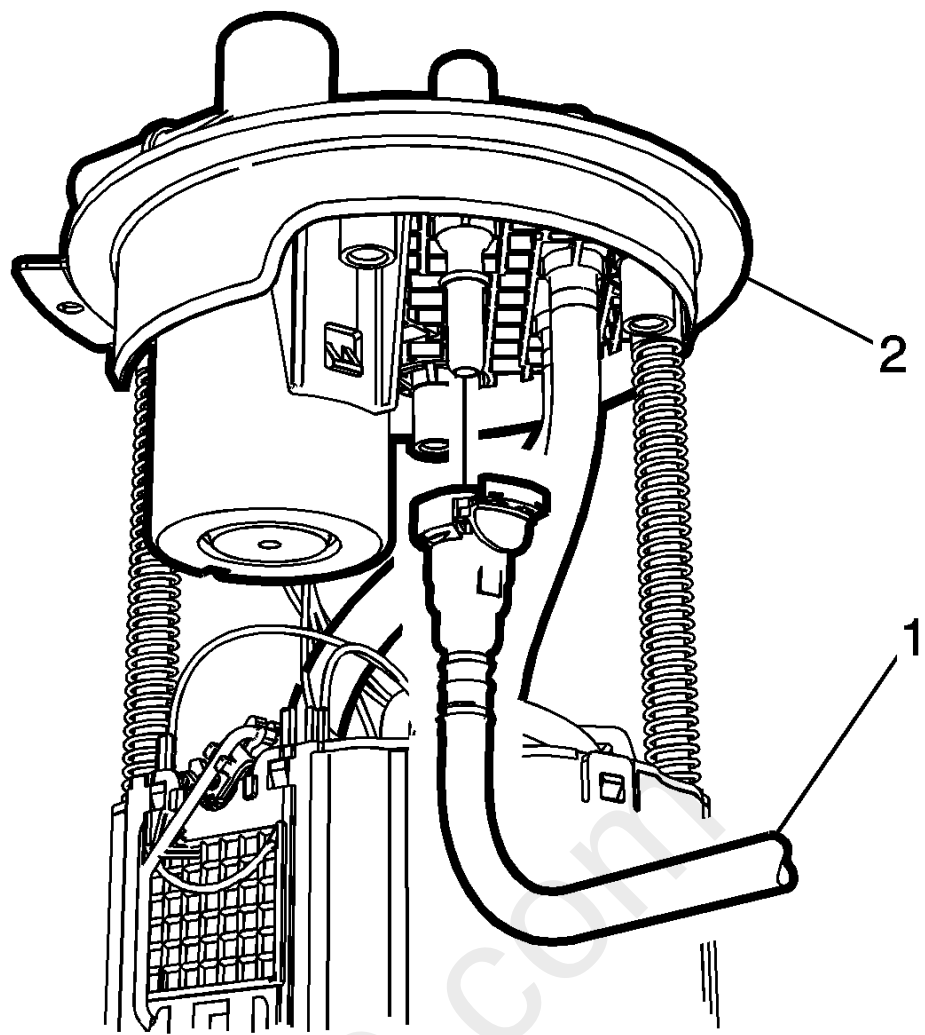


Fig. 64: Fuel Tank Vent Pipe And Fuel Pump Module

Courtesy of GENERAL MOTORS COMPANY

8. Raise the fuel pump module (2) enough to gain access to the fuel tank vent pipe (1) and disconnect the pipe from the fuel pump module. Refer to [**Plastic Collar Quick Connect Fitting Service**](#)

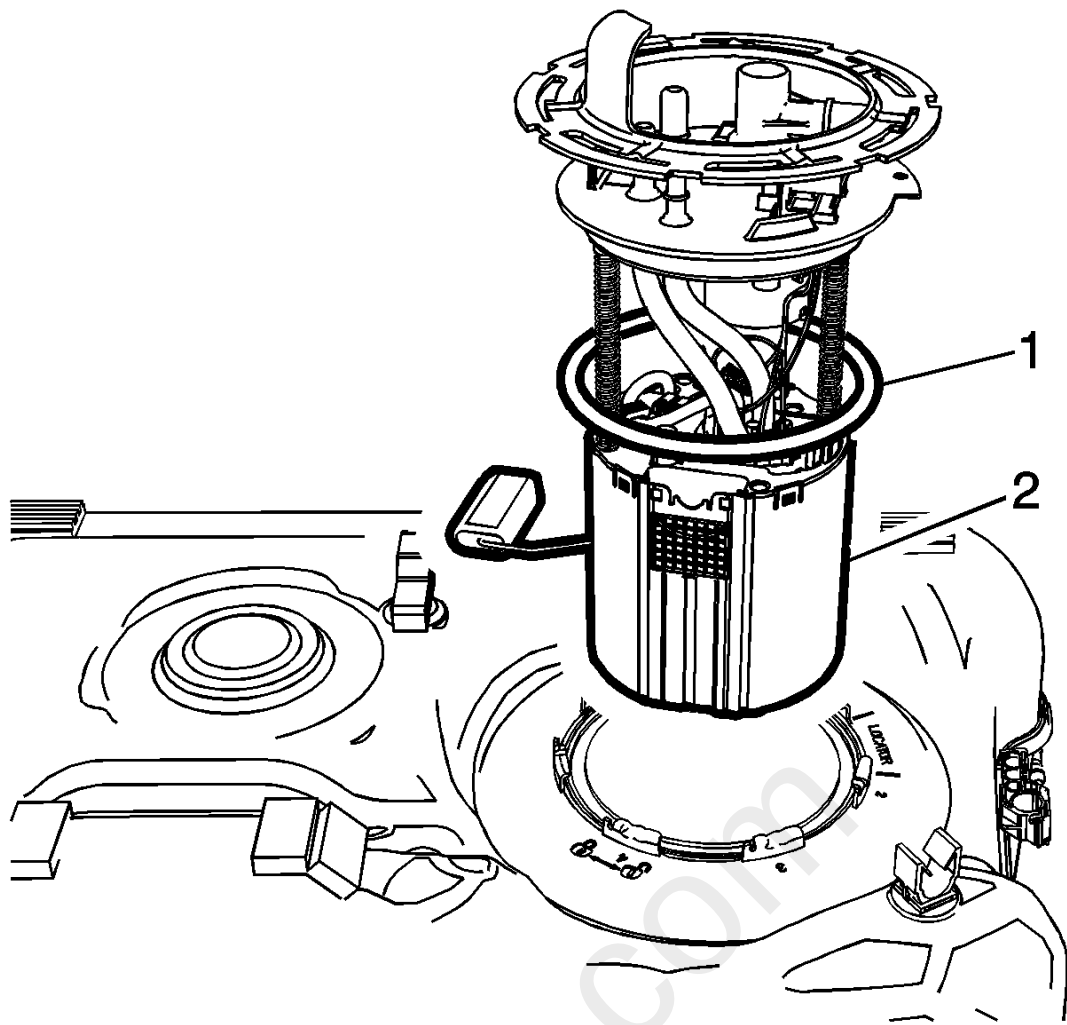


Fig. 65: Fuel Tank Fuel Pump Module And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

9. Remove the fuel tank fuel pump module (2).
10. Remove and discard the fuel tank fuel pump module O-ring gasket (1).

Installation Procedure

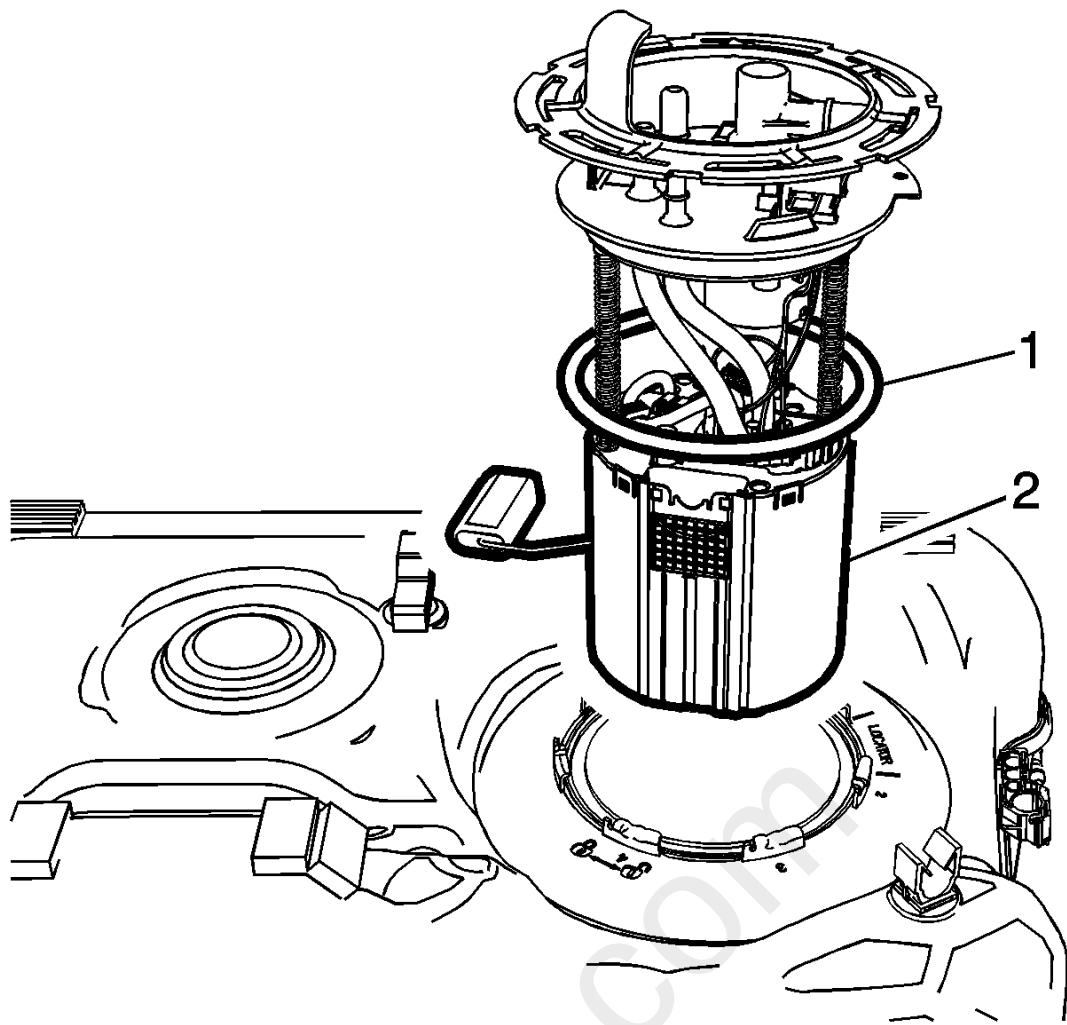


Fig. 66: Fuel Tank Fuel Pump Module And O-Ring Seal

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW fuel tank fuel pump module O-ring gasket (1) to the fuel tank fuel pump module (2).

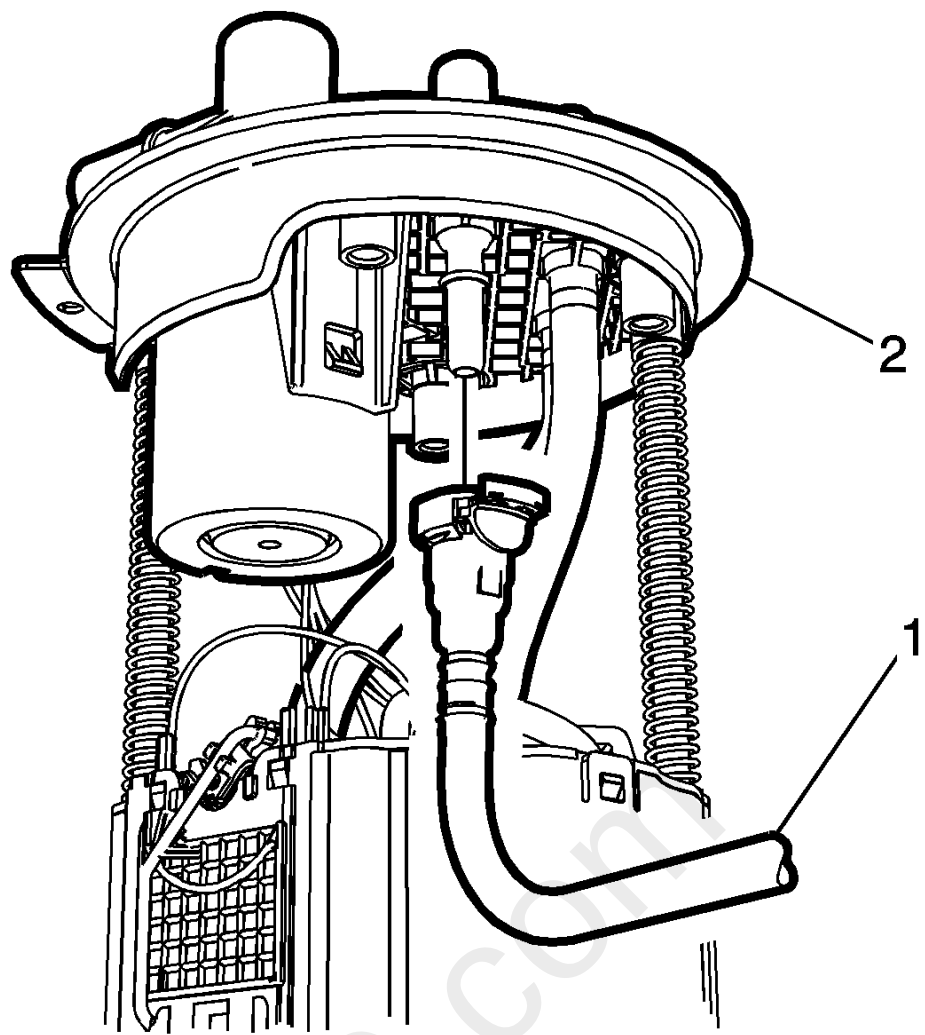


Fig. 67: Fuel Tank Vent Pipe And Fuel Pump Module

Courtesy of GENERAL MOTORS COMPANY

2. Lower the fuel pump module (2) into the fuel tank while connecting the fuel tank vent pipe (1) to the fuel pump module. Refer to [Plastic Collar Quick Connect Fitting Service](#)

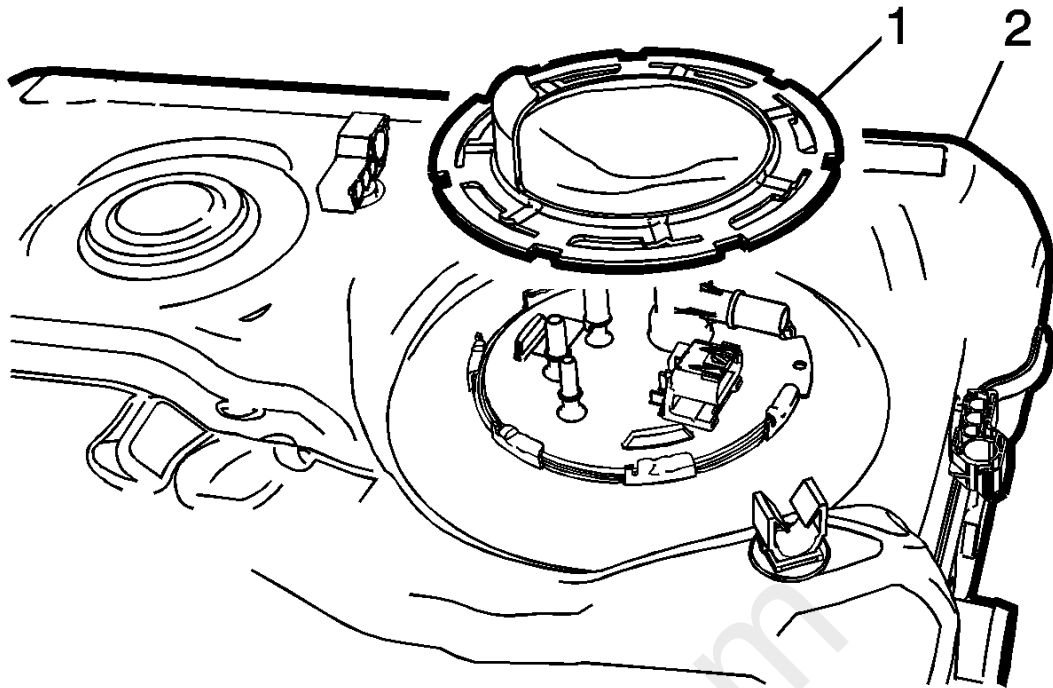


Fig. 68: Fuel Sender Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel tank fuel pump module lock ring (1) to the fuel tank (2).
4. Using the **CH-45722** Fuel Pump Locking Ring Wrench and a long breaker-bar, rotate the fuel pump module lock ring (1) in a clockwise direction in order to lock the lock ring.
5. Install the EVAP system hoses. Refer to [Plastic Collar Quick Connect Fitting Service](#)
6. Install the fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#)
7. Connect the electrical connector.
8. Install the fuel sender assembly. Refer to [Fuel Sender Assembly Replacement \(AWD\)](#)
9. Install the fuel tank. Refer to [Fuel Tank Replacement \(AWD\)](#)

FUEL TANK PROTECTOR REPLACEMENT (RIGHT SIDE FWD)

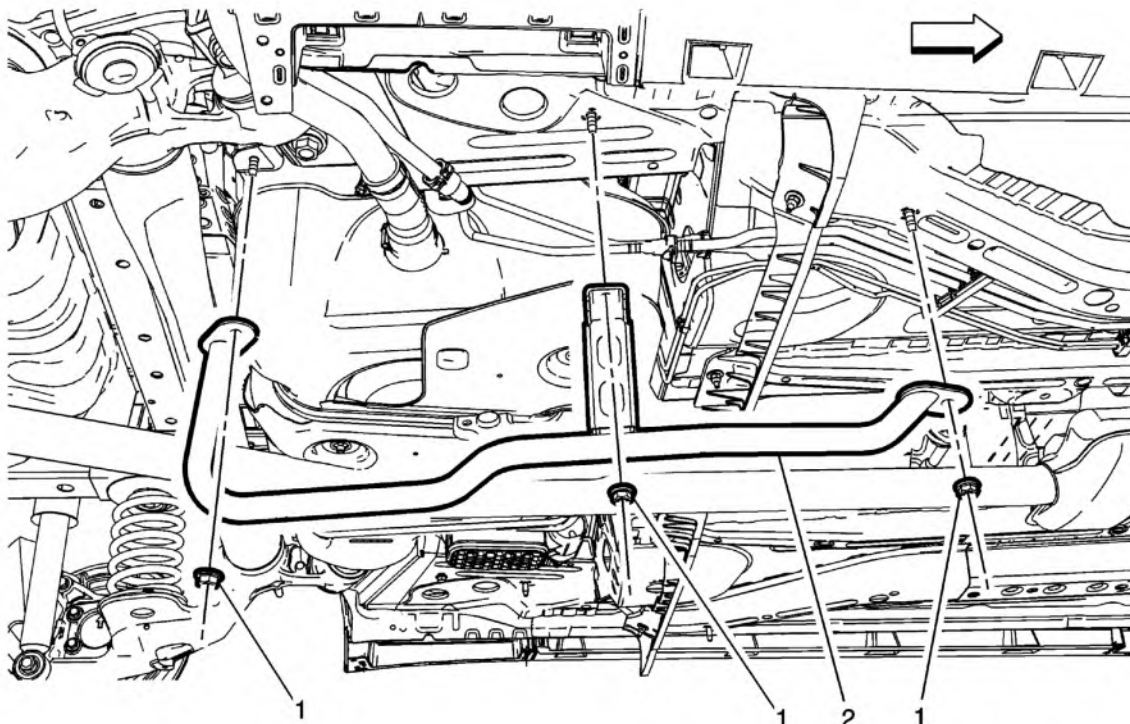


Fig. 69: Fuel Tank Protector (Right Side FWD).
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle	
1	Fuel Tank Protector Fasteners (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft)
2	Fuel Tank Protector Procedure Remove the front right parking brake cable bracket nut and position the parking brake rear cable aside. Refer to Parking Brake Rear Cable Replacement (Disc Brake) , Parking Brake Rear Cable Replacement (Drum Brake) .

FUEL TANK PROTECTOR REPLACEMENT (RIGHT SIDE AWD)

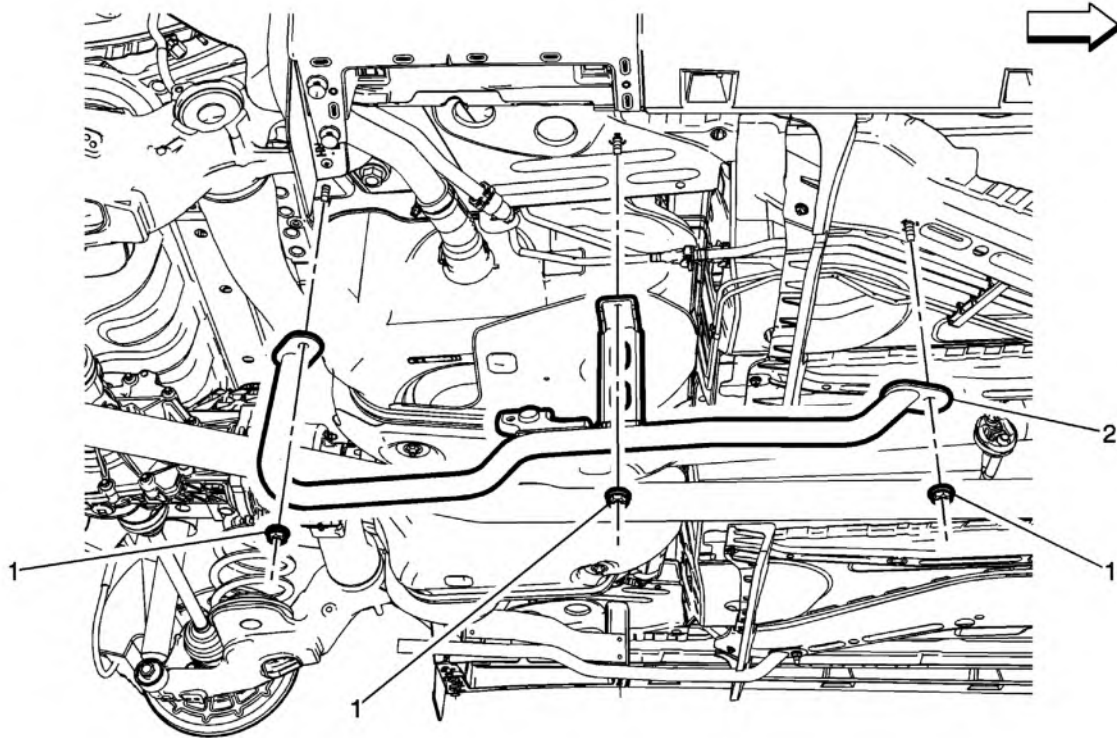


Fig. 70: Fuel Tank Protector (Right Side AWD).
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle	
1	Fuel Tank Protector Fasteners (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft)
2	Fuel Tank Protector Procedure Remove the front right parking brake cable bracket nut and position the parking brake rear cable aside. Refer to Parking Brake Rear Cable Replacement (Disc Brake) , Parking Brake Rear Cable Replacement (Drum Brake) .

FUEL TANK PROTECTOR REPLACEMENT (LEFT SIDE AWD)

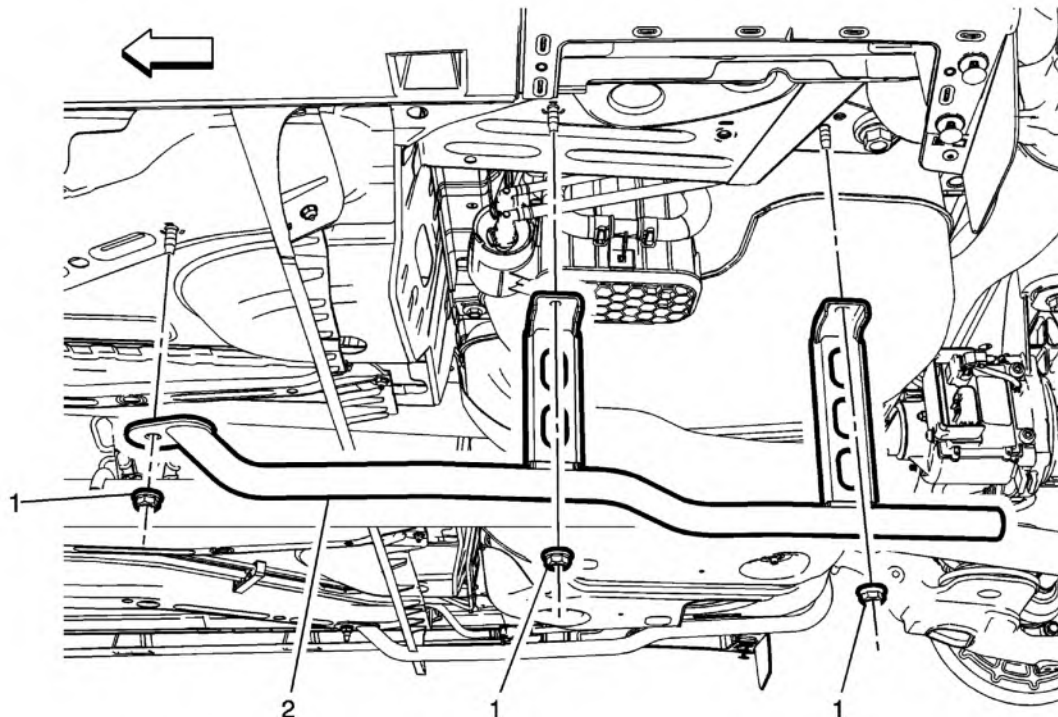


Fig. 71: Fuel Tank Protector (Left Side AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle	
1	Fuel Tank Protector Nut (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft)
2	Fuel Tank Protector

FUEL TANK REPLACEMENT (FWD)

Removal Procedure

WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

WARNING: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#)
2. Drain the fuel tank. Refer to [Fuel Tank Draining](#)
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)
4. Remove the exhaust. Refer to [Exhaust Muffler Replacement \(LE2\)](#) .
5. Remove the right rear wheelhouse panel liner. Refer to [Rear Wheelhouse Liner Replacement](#)

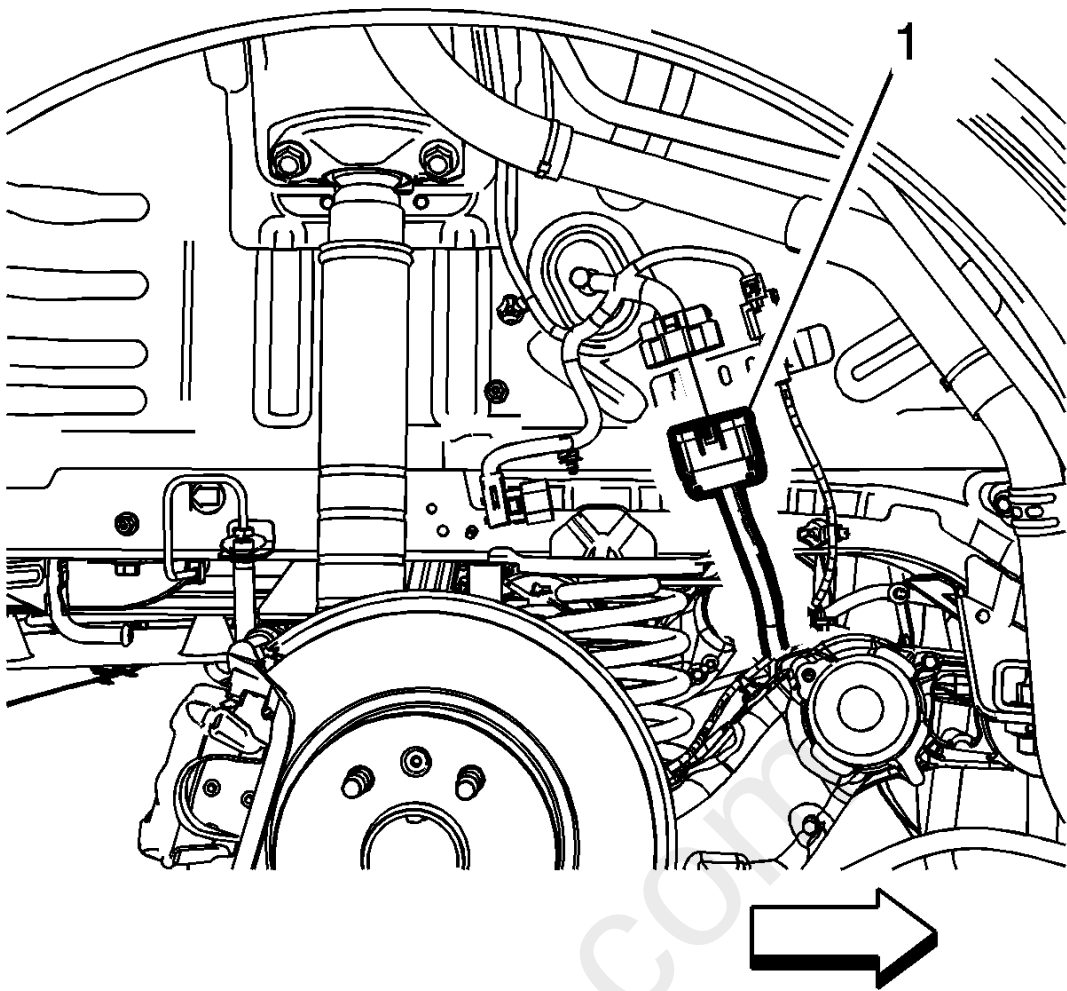


Fig. 72: Fuel Tank Fuel Pump Module Wiring Harness

Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the fuel tank fuel pump module wiring harness (1) and unclip the fuel tank module wiring harness from the chassis.
7. Disconnect the fuel tank filler pipe. Refer to [**Fuel Tank Filler Pipe Replacement**](#)
8. Disconnect the fuel feed pipe. Refer to [**Plastic Collar Quick Connect Fitting Service**](#)
9. Disconnect the EVAP system hoses. Refer to [**Plastic Collar Quick Connect Fitting Service**](#)
10. Position a suitable hydraulic lift below the fuel tank.

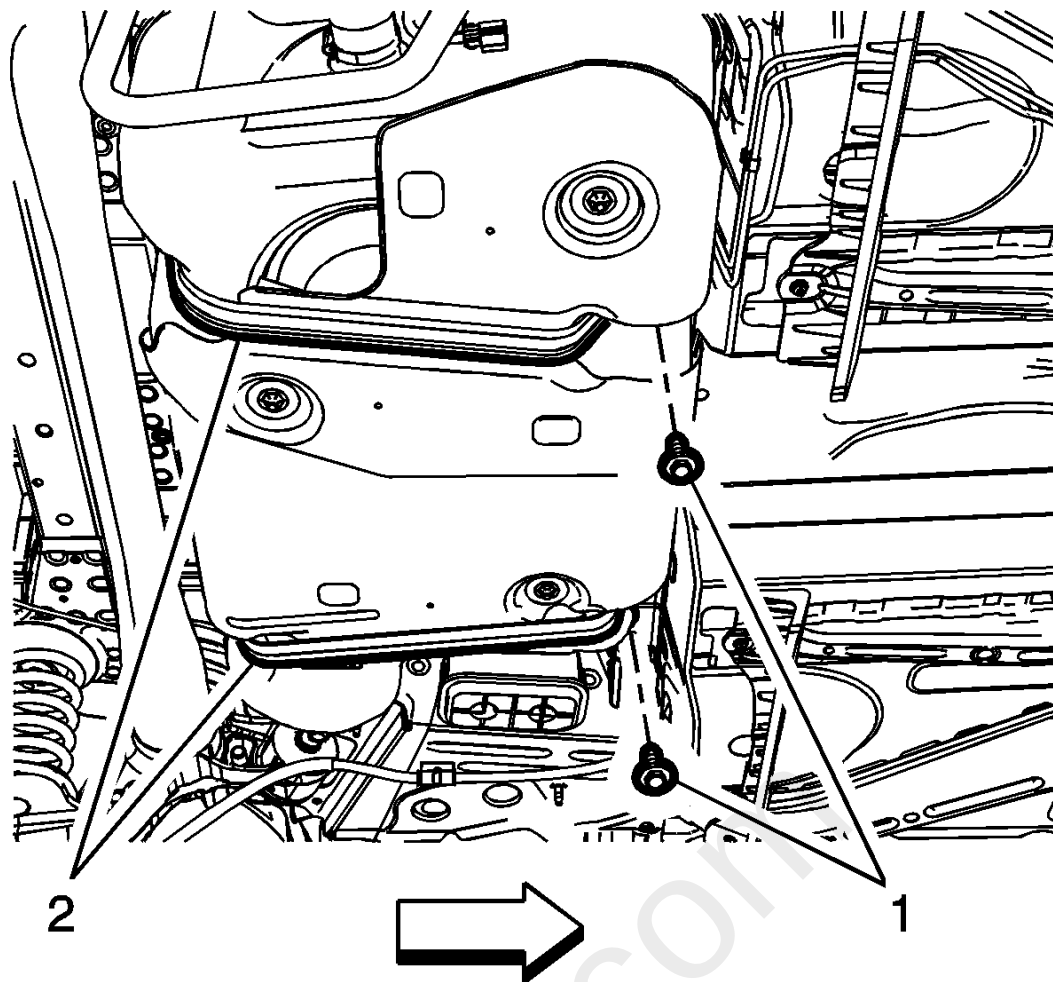


Fig. 73: Fuel Tank Straps And Fasteners

Courtesy of GENERAL MOTORS COMPANY

11. Remove both fuel tank strap fasteners (1).
12. Remove both fuel tank straps from the fuel tank (2).

WARNING: To help avoid personal injury, always use jack stands when you are working on or under any vehicle that is supported only by a jack.

CAUTION: When you are jacking or lifting a vehicle at the frame side rails or other prescribed lift points, be certain that the lift pads do not contact the catalytic converter, the brake pipes or the fuel lines. If such contact occurs, vehicle damage or unsatisfactory vehicle performance may result.

13. With the aid of an assistant, lower the hydraulic lift to remove the fuel tank from the vehicle.
14. Remove the fuel tank from the hydraulic lift.
15. Remove the fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(FWD\)](#).
16. Remove the evaporative emission canister. Refer to [Evaporative Emission Canister Replacement \(FWD\)](#).

Installation Procedure

1. Transfer the evaporative emission canister. Refer to [Evaporative Emission Canister Replacement \(FWD\)](#).
2. Transfer the fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(FWD\)](#).
3. Install the fuel tank to the hydraulic lift.

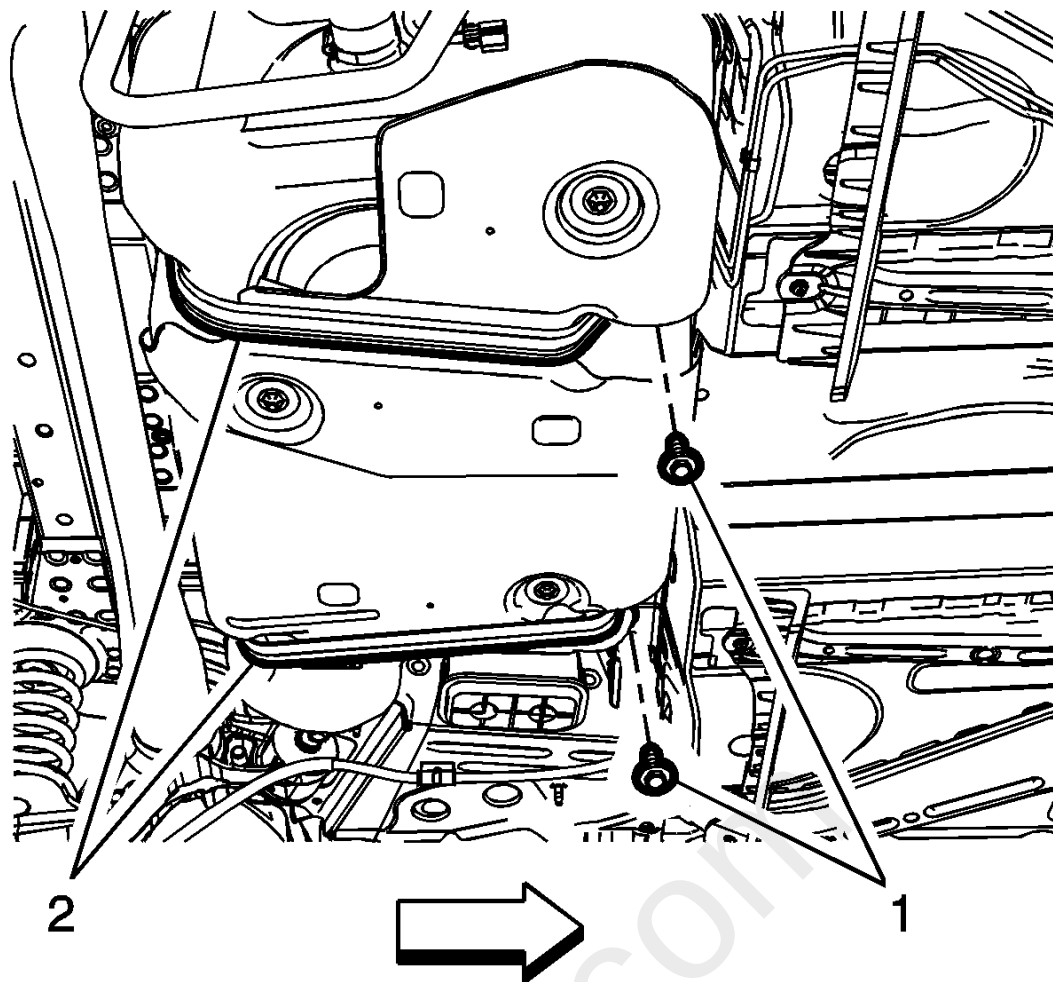


Fig. 74: Fuel Tank Straps And Fasteners

Courtesy of GENERAL MOTORS COMPANY

4. With the aid of an assistant, position the fuel tank to the vehicle.

CAUTION: Refer to [Fastener Caution](#) .

5. Install both fuel tank straps to the fuel tank (2) and tighten the fasteners to 22 N.m (16 lb ft).
6. Remove the hydraulic lift from the fuel tank.
7. Connect the EVAP system hoses. Refer to [Plastic Collar Quick Connect Fitting Service](#)
8. Connect the fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#)
9. Connect the fuel tank filler pipe. Refer to [Fuel Tank Filler Pipe Replacement](#)

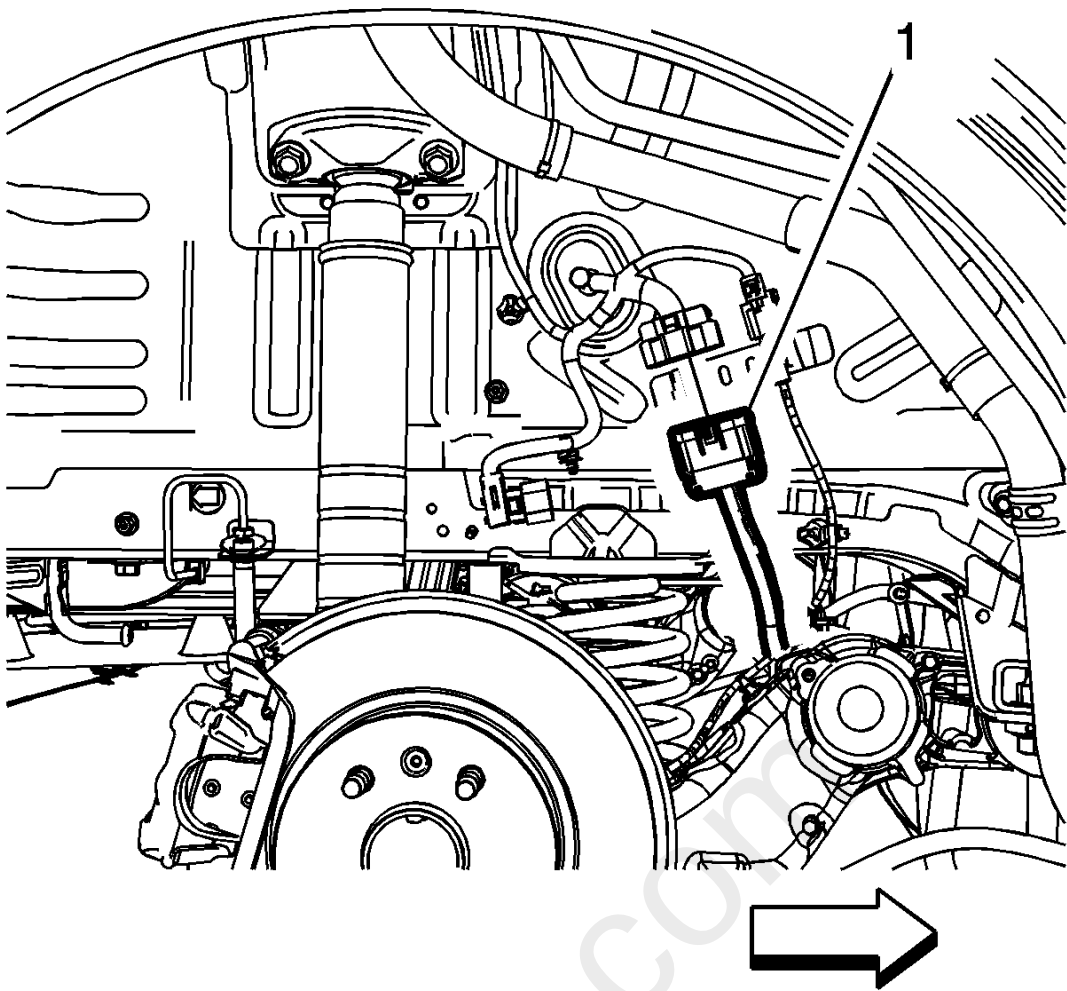


Fig. 75: Fuel Tank Fuel Pump Module Wiring Harness

Courtesy of GENERAL MOTORS COMPANY

10. Connect the fuel tank fuel pump module wiring harness (1) and clip the fuel tank module wiring harness to the chassis.
11. Install the exhaust. Refer to [Exhaust Muffler Replacement \(LE2\)](#)
12. Install the right rear wheelhouse panel liner. Refer to [Rear Wheelhouse Liner Replacement](#)
13. Lower the vehicle.
14. Return fuel to the tank.

FUEL TANK REPLACEMENT (AWD)

Removal Procedure

WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

WARNING: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#)
2. Drain the fuel tank. Refer to [Fuel Tank Draining](#)
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)
4. Remove the exhaust. Refer to [Exhaust Muffler Replacement \(LE2\)](#)
5. Remove the propeller shaft. Refer to [Two-Piece Propeller Shaft Replacement](#)
6. Remove the right rear wheelhouse panel liner. Refer to [Rear Wheelhouse Liner Replacement](#)

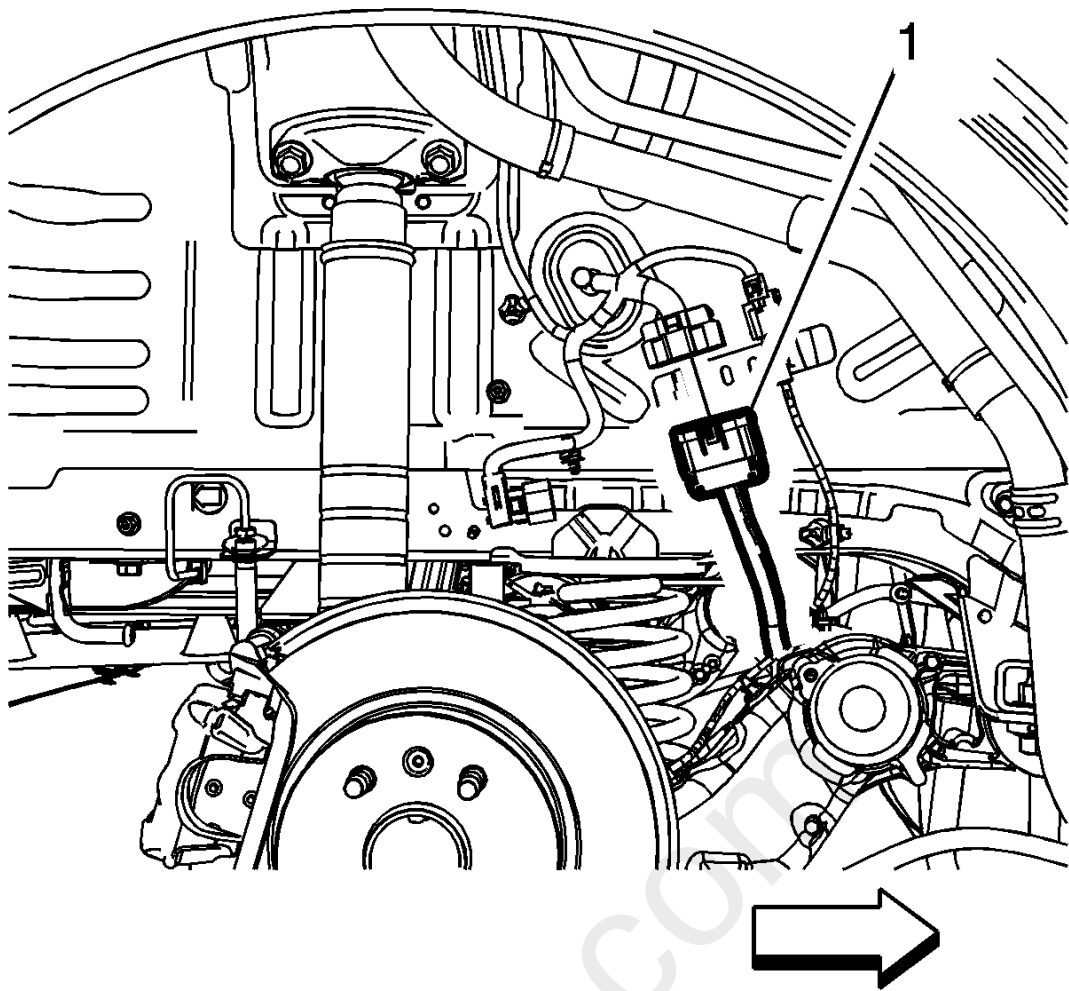


Fig. 76: Fuel Tank Fuel Pump Module Wiring Harness

Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the fuel tank fuel pump module wiring harness (1) and unclip the fuel tank module wiring harness from the chassis.
8. Disconnect the fuel tank filler pipe. Refer to [**Fuel Tank Filler Pipe Replacement**](#)
9. Disconnect the fuel feed pipe. Refer to [**Plastic Collar Quick Connect Fitting Service**](#)
10. Disconnect the EVAP system hoses. Refer to [**Plastic Collar Quick Connect Fitting Service**](#)
11. Position a suitable hydraulic lift below the fuel tank.

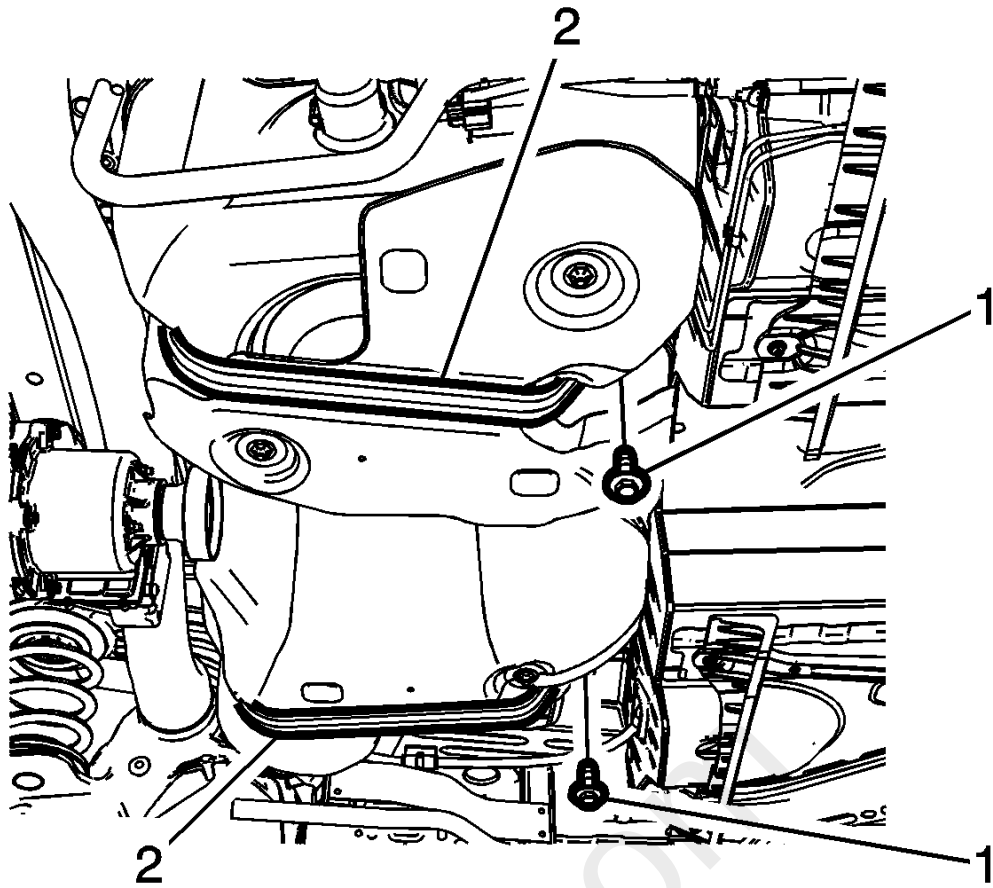


Fig. 77: Fuel Tank Straps And Fasteners
Courtesy of GENERAL MOTORS COMPANY

12. Remove both fuel tank strap fasteners (1).
13. Remove both fuel tank straps from the fuel tank (2).

WARNING: To help avoid personal injury, always use jack stands when you are working on or under any vehicle that is supported only by a jack.

CAUTION: When you are jacking or lifting a vehicle at the frame side rails or other prescribed lift points, be certain that the lift pads do not contact the catalytic converter, the brake pipes or the fuel lines. If such contact occurs, vehicle damage or unsatisfactory vehicle performance may result.

14. With the aid of an assistant, lower the hydraulic lift to remove the fuel tank from the vehicle.
15. Remove the fuel tank from the hydraulic lift.
16. Remove the fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(AWD\)](#).
17. Remove the fuel sender assembly. Refer to [Fuel Sender Assembly Replacement \(AWD\)](#).
18. Remove the evaporative emission canister. Refer to [Evaporative Emission Canister Replacement \(AWD\)](#).

Installation Procedure

1. Transfer the evaporative emission canister. Refer to [Evaporative Emission Canister Replacement \(AWD\)](#).
2. Transfer the fuel sender assembly. Refer to [Fuel Sender Assembly Replacement \(AWD\)](#).

3. Transfer the fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(FWD\)](#).
4. Install the fuel tank to the hydraulic lift.

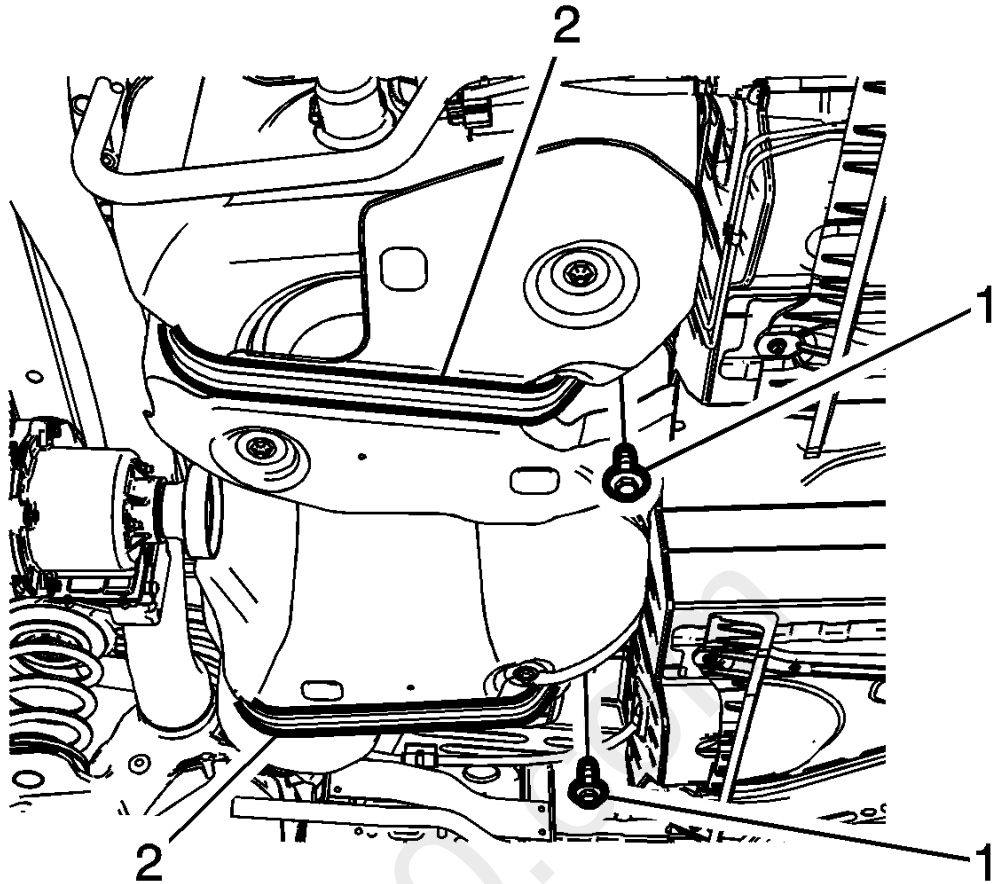


Fig. 78: Fuel Tank Straps And Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. With the aid of an assistant, position the fuel tank to the vehicle.

CAUTION: Refer to [Fastener Caution](#) .

6. Install both fuel tank straps to the fuel tank (2) and tighten the fasteners to 22 N.m (16 lb ft).
7. Remove the hydraulic lift from the fuel tank.
8. Connect the EVAP system hoses. Refer to [Plastic Collar Quick Connect Fitting Service](#)
9. Connect the fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#)
10. Connect the fuel tank filler pipe. Refer to [Fuel Tank Filler Pipe Replacement](#)

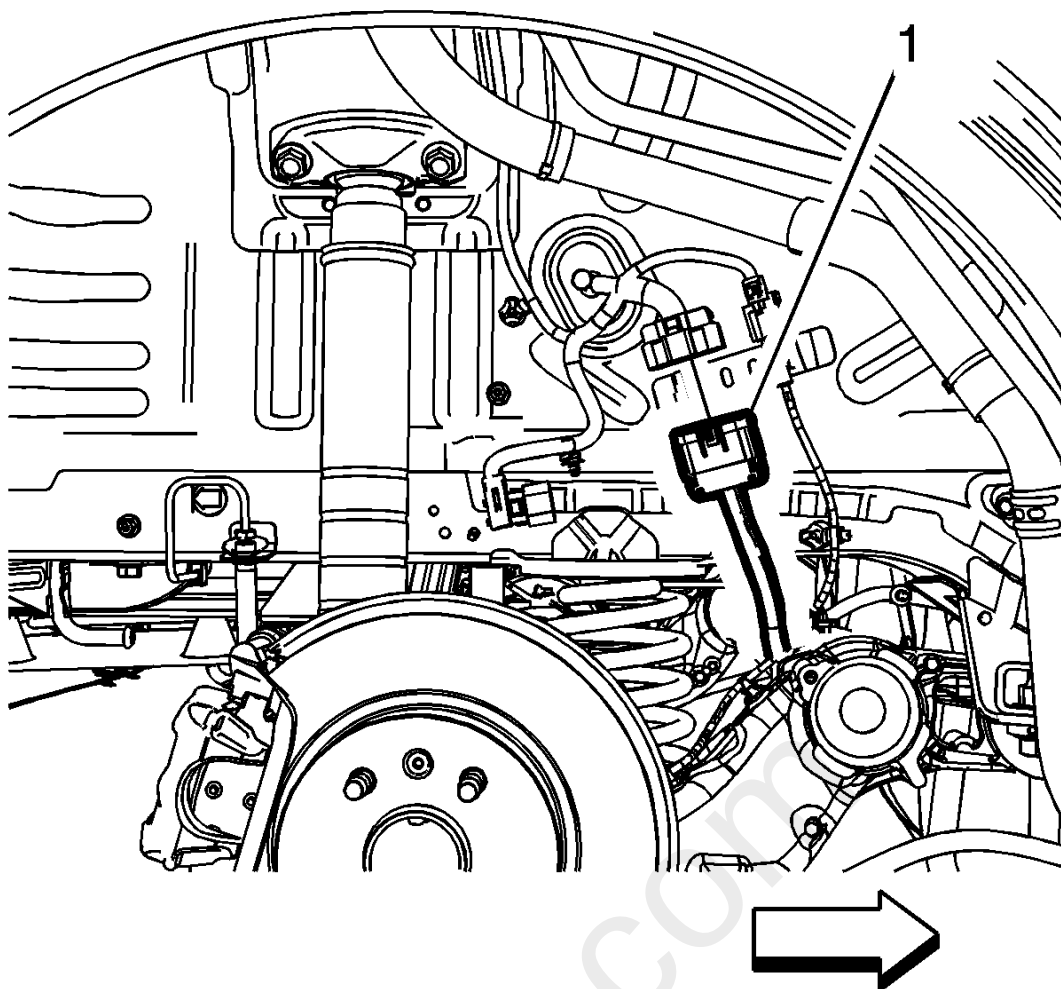


Fig. 79: Fuel Tank Fuel Pump Module Wiring Harness

Courtesy of GENERAL MOTORS COMPANY

11. Connect the fuel tank fuel pump module wiring harness (1) and clip the fuel tank module wiring harness to the chassis.
12. Install the propeller shaft. Refer to [Two-Piece Propeller Shaft Replacement](#)
13. Install the exhaust. Refer to [Exhaust Muffler Replacement \(LE2\)](#)
14. Install the right rear wheelhouse panel liner. Refer to [Rear Wheelhouse Liner Replacement](#)
15. Lower the vehicle.

FUEL TANK PRESSURE SENSOR REPLACEMENT

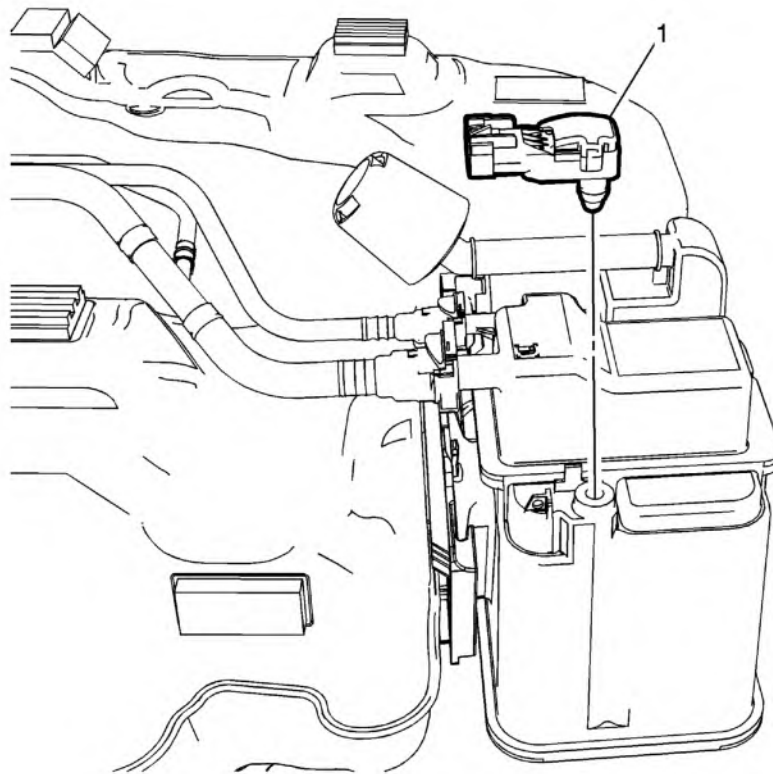


Fig. 80: Fuel Tank Pressure Sensor

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.	
Preliminary Procedures Remove the fuel tank. Refer to Fuel Tank Replacement (AWD) .	
1	Fuel Tank Pressure Sensor Procedure Disconnect the electrical connector.

FUEL SENDER ASSEMBLY REPLACEMENT (AWD)

Special Tools

EN-48482 Fuel Sender Lock Ring Wrench

For equivalent regional tools: [Special Tools \(Mechanical Tools\)](#).

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

WARNING: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

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

1. Remove the fuel tank. Refer to [Fuel Tank Replacement \(AWD\)](#).
2. Disconnect the fuel tank wiring harness from the fuel sender.

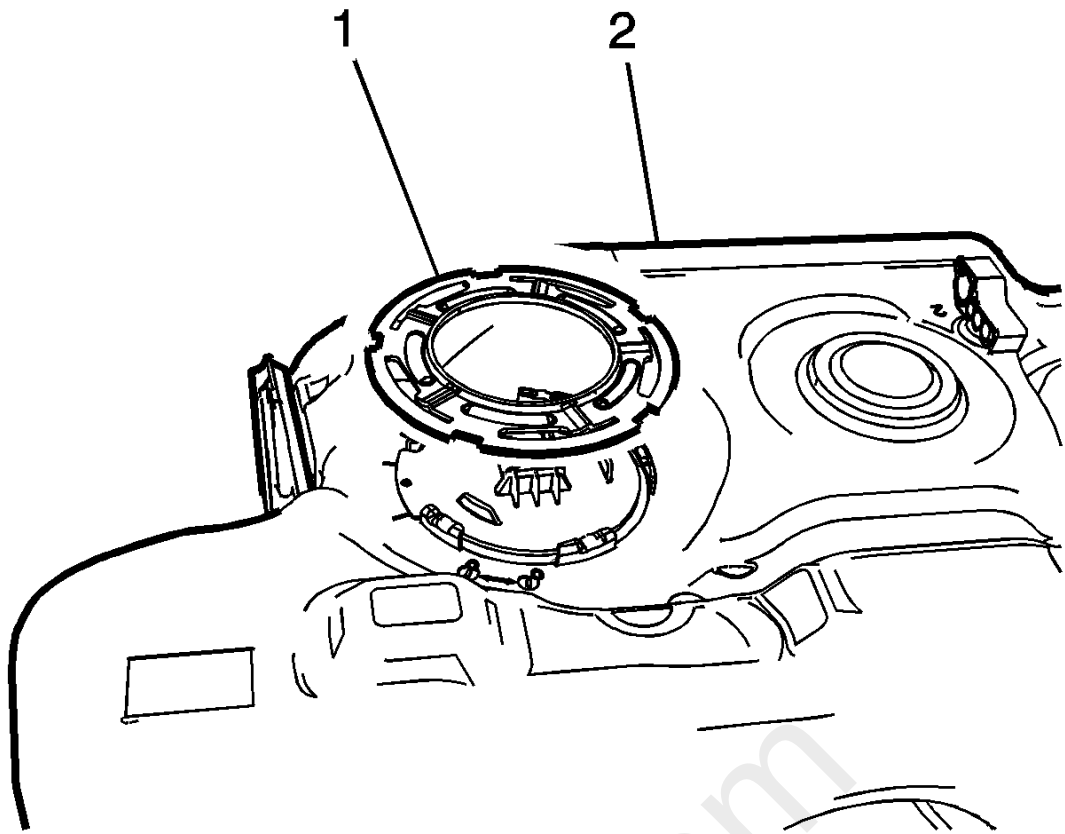


Fig. 81: Fuel Sender Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-48482** Fuel Sender Lock Ring Wrench to the fuel sender lock ring (1).
4. Using the **EN-48482** Fuel Sender Lock Ring Wrench and a long breaker-bar, rotate the fuel sender lock ring (1) in a counterclockwise direction in order to unlock the lock ring from the fuel tank (2).

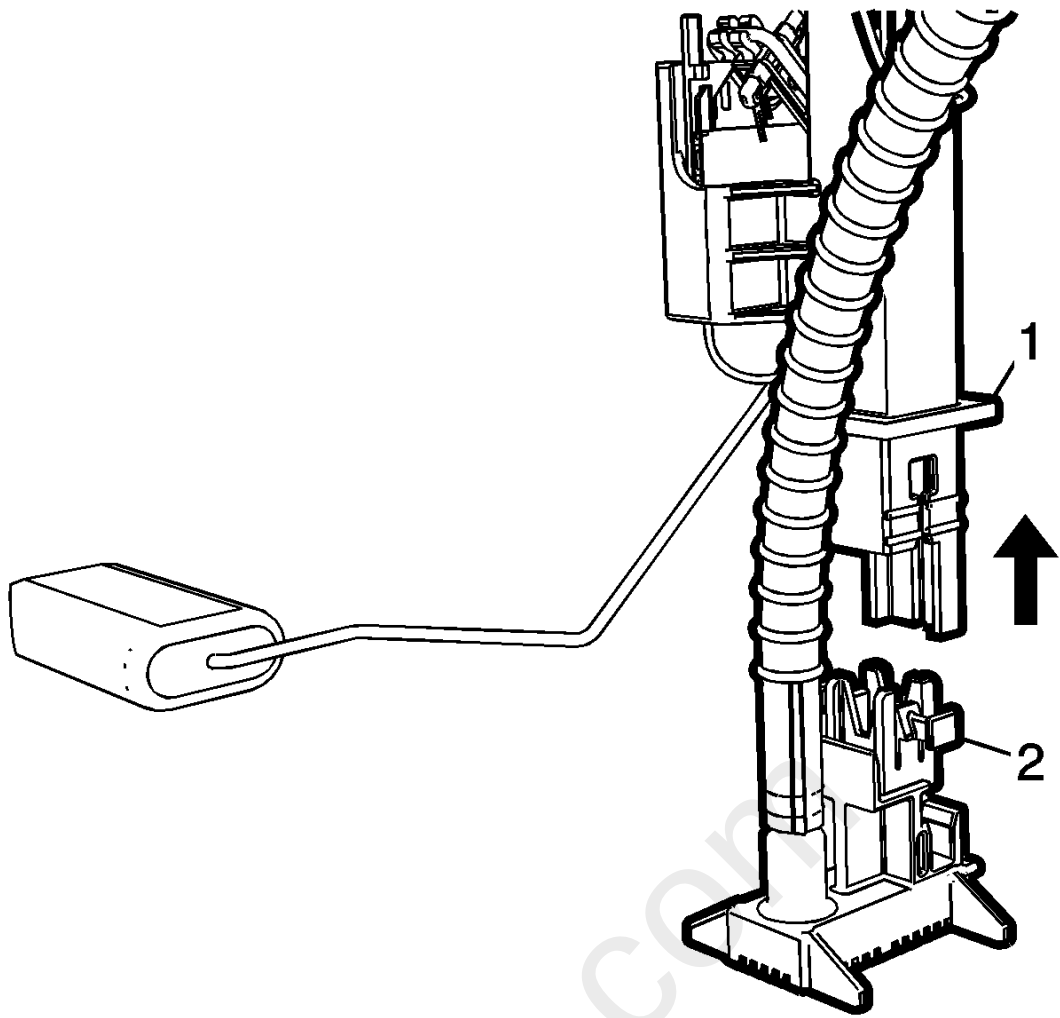


Fig. 82: Fuel Sender And Pump Module Fuel Pickup
Courtesy of GENERAL MOTORS COMPANY

5. Raise the fuel sender (1) enough to gain access to the fuel tank fuel pump module fuel pickup (2) and disconnect the fuel sender from the fuel pickup.

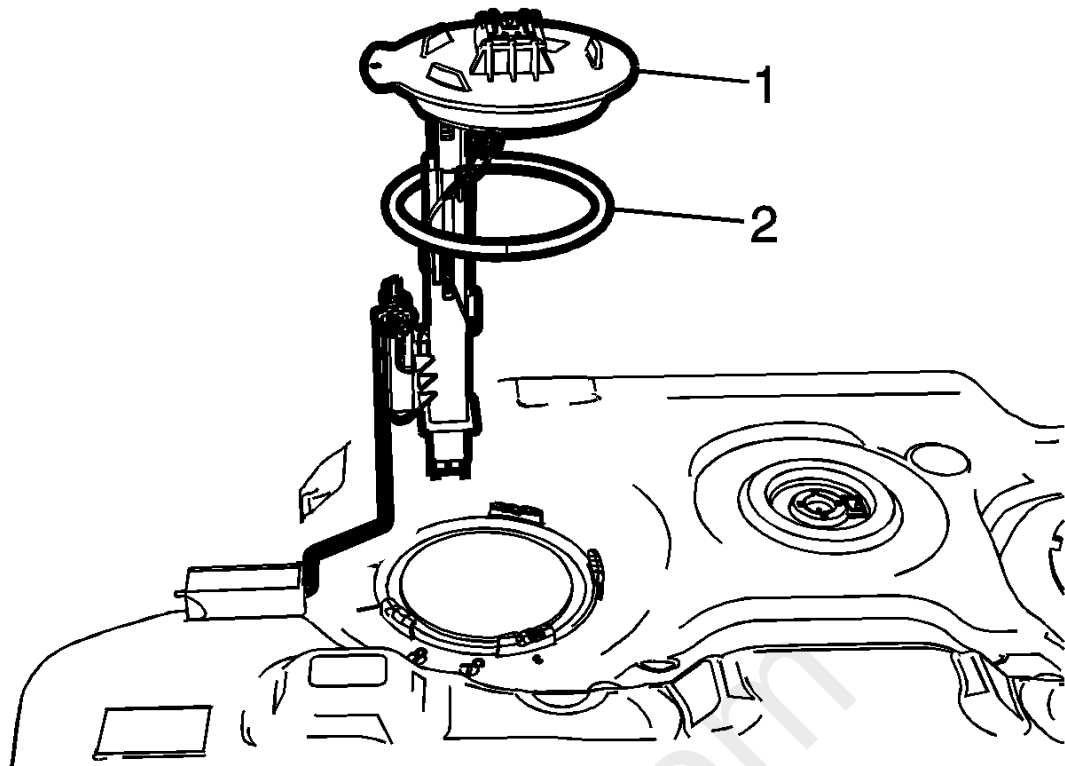


Fig. 83: Fuel Sender And O-Ring Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel sender (1).
7. Remove and discard the fuel sender O-ring gasket (2).

Installation Procedure

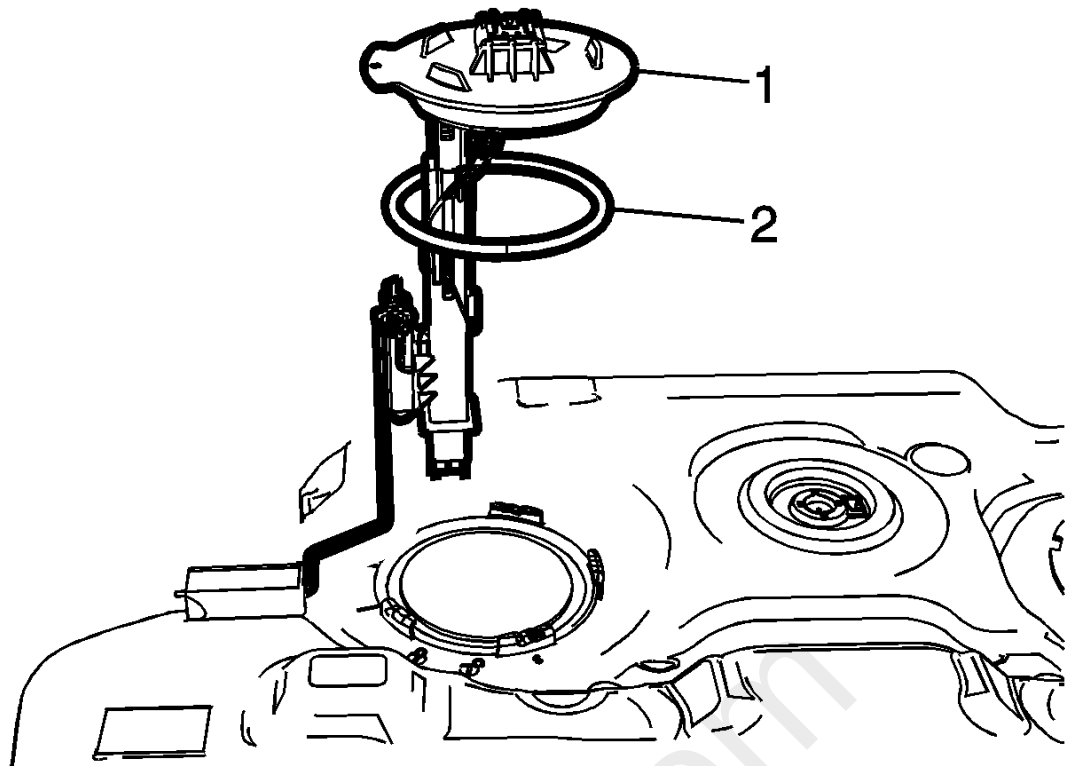


Fig. 84: Fuel Sender And O-Ring Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW fuel sender O-ring gasket (2) to the fuel sender (1).

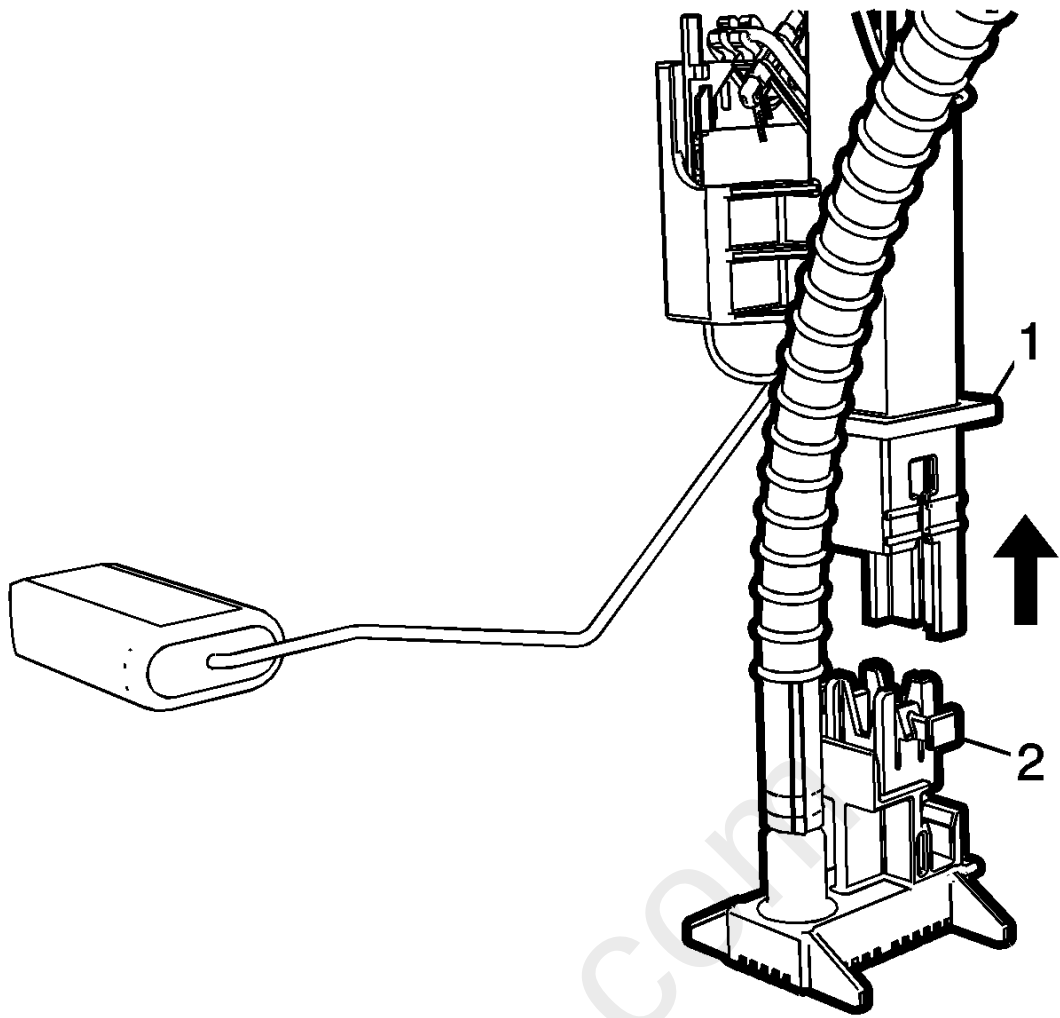


Fig. 85: Fuel Sender And Pump Module Fuel Pickup
Courtesy of GENERAL MOTORS COMPANY

2. Lower the fuel sender (1) into the fuel tank while connecting the fuel tank fuel pump module fuel pickup (2) to the fuel sender (1).

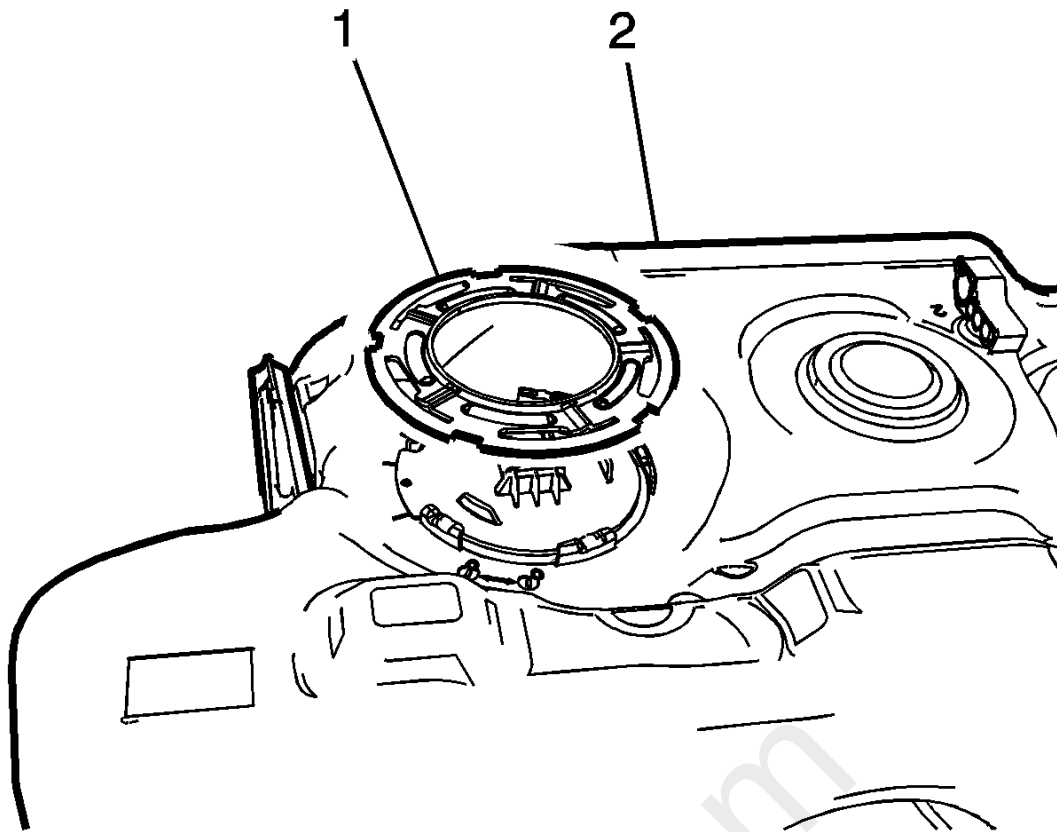


Fig. 86: Fuel Sender Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel sender lock ring (1) to the fuel tank (2).
4. Install the **EN-48482** Fuel Sender Lock Ring Wrench to the fuel sender lock ring (1).
5. Using the **EN-48482** Fuel Sender Lock Ring Wrench and a long breaker-bar, rotate the fuel sender lock ring (1) in a clockwise direction in order to lock the lock ring.
6. Connect the fuel tank sender wiring harness electrical connector.
7. Install the fuel tank. Refer to **Fuel Tank Replacement (AWD)**.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT

Special Tools

EN-51146 Fuel Injector Removal/Installation Kit

EN-51146-100 Adapter Plate

EN-51146-150 Injector Remover/Installer Adapters

Equivalent regional tools: **Special Tools (Mechanical Tools)**

Removal Procedure

WARNING: The noise cancelling foam component **MUST** be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

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

WARNING: Refer to [Safety Goggles and Fuel Warning](#) .

CAUTION: When working on the fuel rail and fuel injectors, always maintain a clean work surface. Failure to maintain a clean work surface can result in contaminant on the injector seals and cause leaks.

1. Remove Ignition Coil. Refer to [Ignition Coil Replacement](#)
2. Remove Fuel Feed Intermediate Pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#)

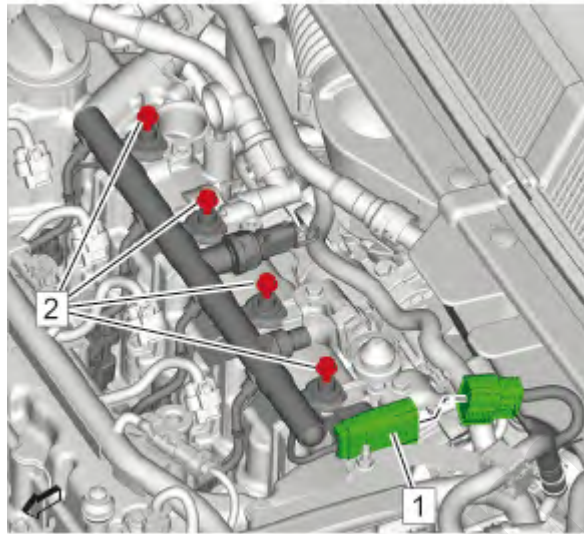


Fig. 87: Fuel Injection Fuel Rail Wiring Harness And Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Fuel Injection Fuel Rail Wiring Harness (1)

NOTE: The fuel rail bolts remain in the fuel rail assembly.

4. Loosen the 4 fuel rail bolts (2) from the cylinder head completely, but do not remove the bolts.

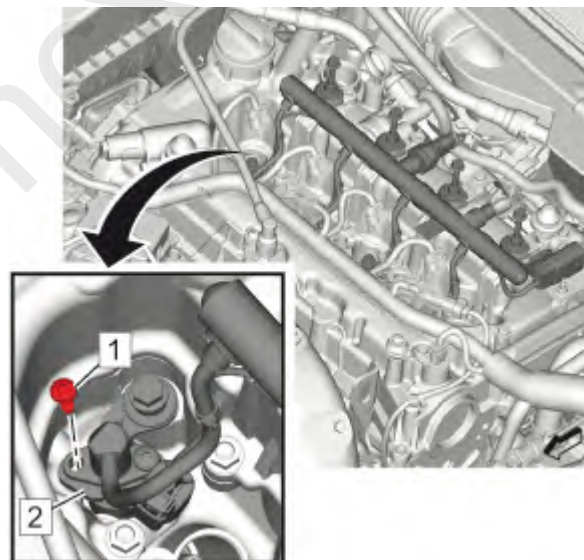


Fig. 88: Cylinder 1 Fuel Injector And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Never loosen both bolts at the same time. Failure to follow this could cause leaks or malfunction after installation.

NOTE: Ensure that the bolt does not fall into the cylinder head slot.

5. Remove the fuel injector bolt (1) from the fuel injector cylinder 1 (2) at the rail side.

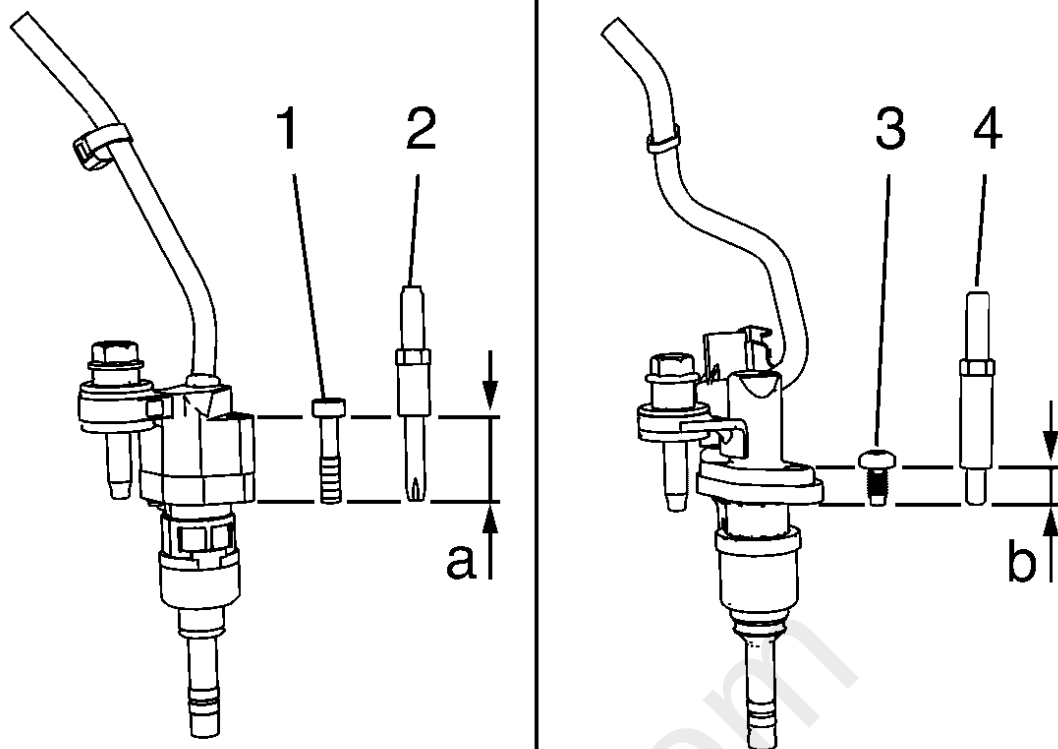


Fig. 89: Demounting Screw

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Make sure that the correct special tool EN-51146-1-6 demounting screws (long) are used for the continental MGE fuel rail and the EN-51146-150 demounting screws (short) are used for the Delphi fuel rail.

The use of the wrong demounting screws can lead to a damage of the cylinder head.

6. Match the length of the fuel injector bolts (1, 3) with EN-51146-150 demounting screw (4) and EN-51146-1-6 demounting screw (2).

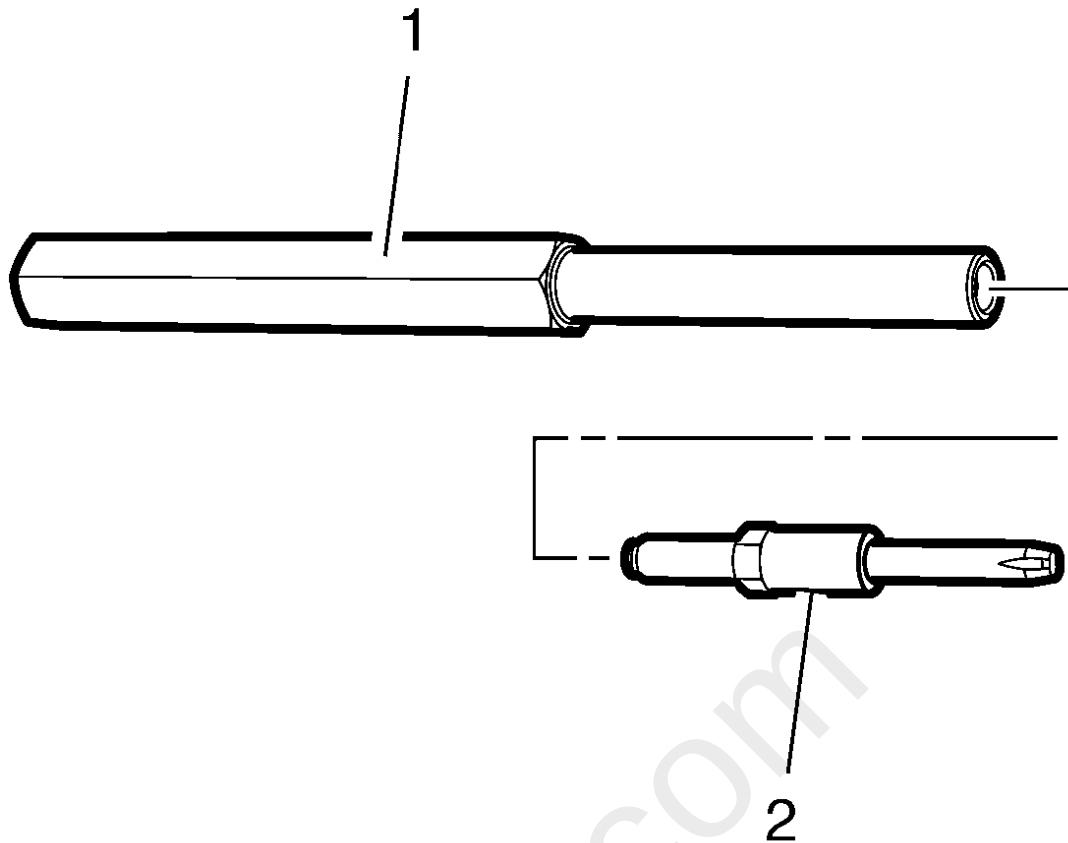


Fig. 90: Continental MGE Demounting Screw
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

7. If the length matches with **EN-51146-1-6** demounting screw install the **EN-51146-1-6** demounting screw (2) to the **EN-51146-1-1** support (1) and tighten to 7 N.m (62 lb in).

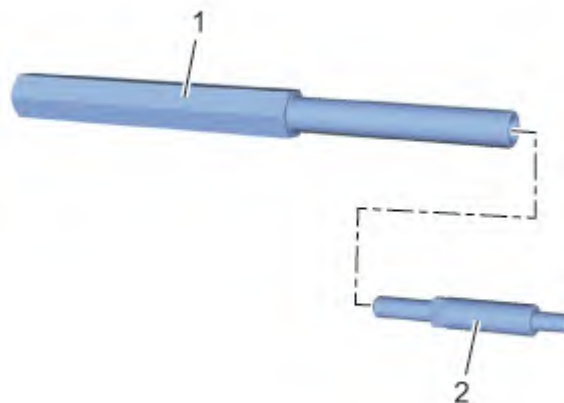


Fig. 91: Demounting Screw And Support
 Courtesy of GENERAL MOTORS COMPANY

8. If the length matches with the **EN-51146-1-150** demounting screw install the **EN-51146-150** demounting screw (2) to the **EN-51146-1-1** support (1) and tighten to 7 N.m (62 lb in).

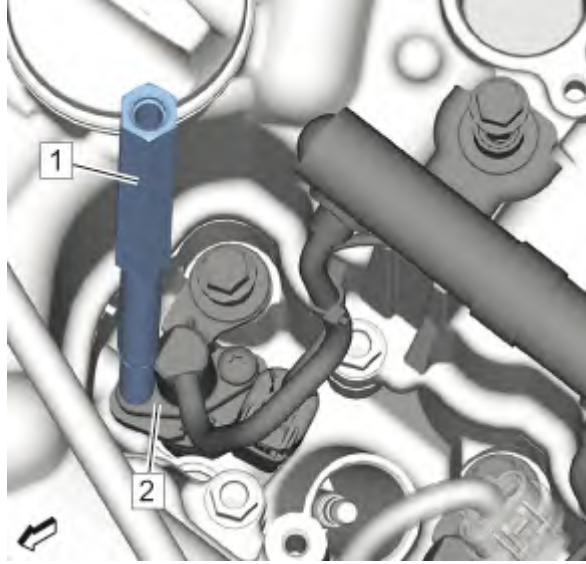


Fig. 92: Support And Cylinder 1 Fuel Injector
 Courtesy of GENERAL MOTORS COMPANY

9. Install the **EN-51146-1-1** support (1) to the fuel injector cylinder 1 (2) and tighten to 5 N.m (44 lb in).

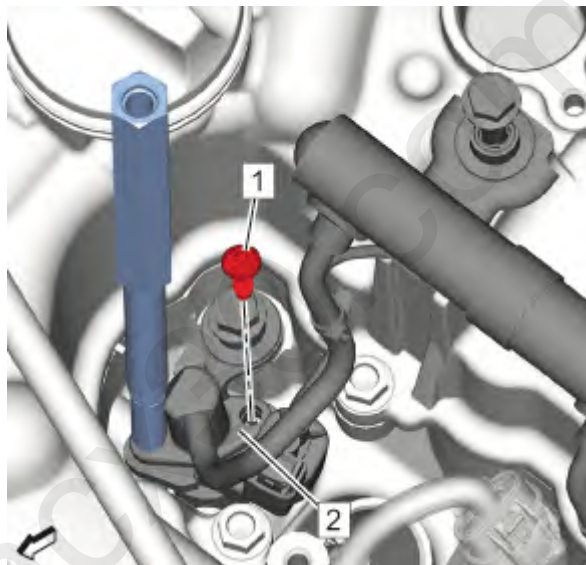


Fig. 93: Cylinder 1 Fuel Injector And Bolt
 Courtesy of GENERAL MOTORS COMPANY

10. Remove the fuel injector bolt (1) from the fuel injector cylinder 1 (2).
11. Install the **EN-51146-1-6** demounting screw or **EN-51146-150** demounting screw to the **EN-51146-1-1** support and tighten to 7 N.m (62 lb in).

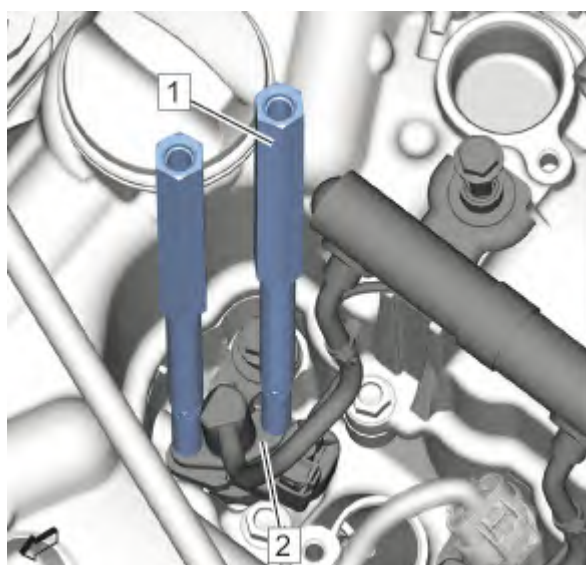


Fig. 94: Support And Cylinder 1 Fuel Injector
Courtesy of GENERAL MOTORS COMPANY

12. Install the **EN-51146-1-1** support (1) to the fuel injector cylinder 1 (2) and tighten to 5 N.m (44 lb in).
13. Repeat the steps 6 - 10 for the other 3 injectors.

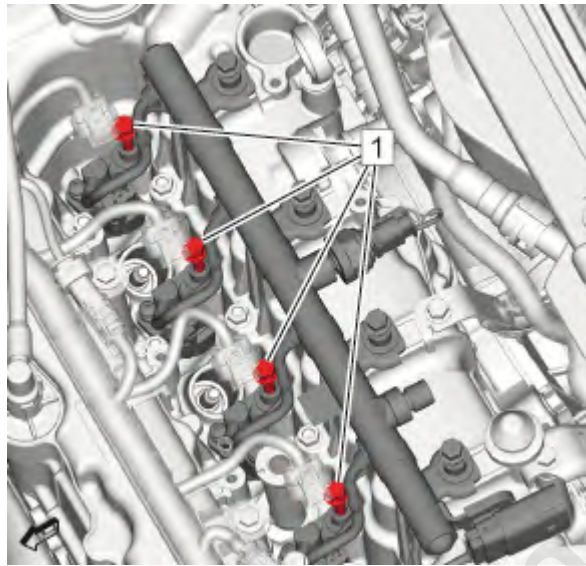


Fig. 95: Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: The fuel rail bolts remain in the fuel rail assembly.

14. Loosen the 4 fuel rail bolts (1) completely from the cylinder head, but do not remove the bolts.

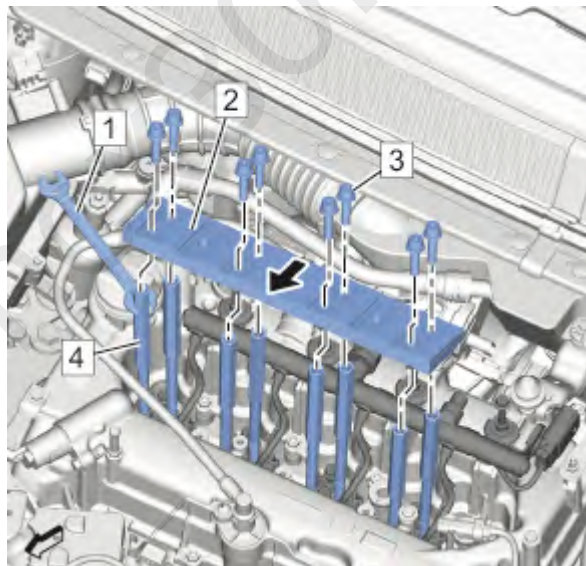


Fig. 96: Plates, Supports And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: The arrow on the **EN-51146-100** plate must point towards the front of the vehicle.

15. Install the **EN-51146-100** plate (2) to the 8 **EN-51146-1-1** supports (4).
16. Install the 8 plate bolts (3).
17. Tighten the 8 plate bolts (3) and counterhold with a wrench (1) at the **EN-51146-1-1** supports (4).

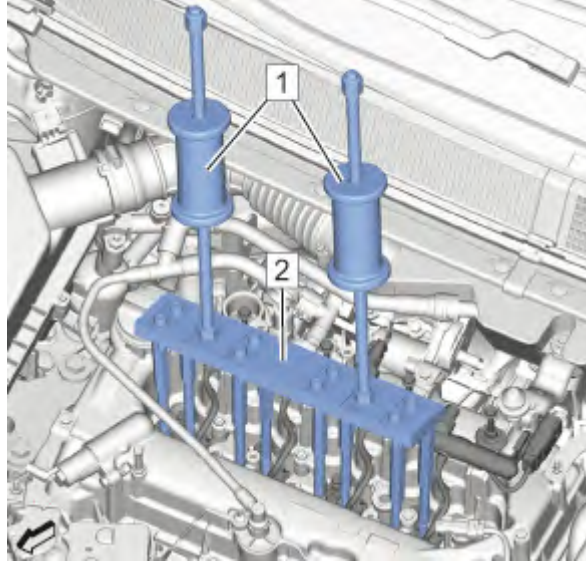


Fig. 97: Slide Hammers And Plate

Courtesy of GENERAL MOTORS COMPANY

18. Install the 2 EN-51146-1-3 sliding hammers (1) to the EN-51146-1-2 plate (2).

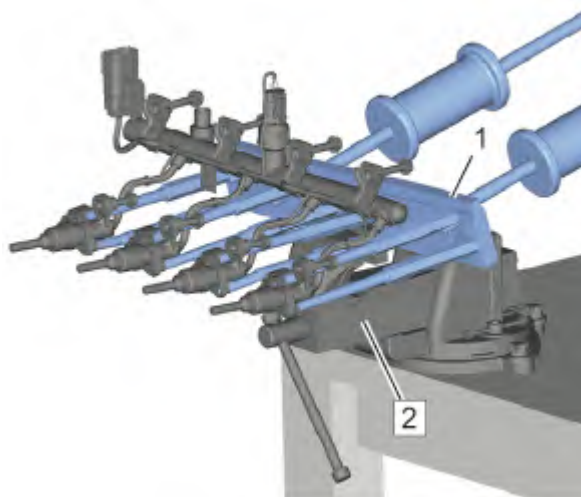


Fig. 98: Removing Fuel Injector Rail Assembly

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the fuel injectors are removed from the bore evenly.

19. Using the EN-51146-1-3 sliding hammers carefully loosen the fuel injector rail assembly.
20. Remove the fuel injector rail assembly.



CAUTION: After removing the fuel rail and injector assembly, do not allow the weight of the assembly to rest on the fuel injectors. Always position the assembly on a clean work surface with the fuel injectors on top. Failure to follow this caution could cause leaks or malfunction after installation.

21. Install the **EN-51146-1-2** plate (1) with the fuel injector assembly to a bench vise (2).

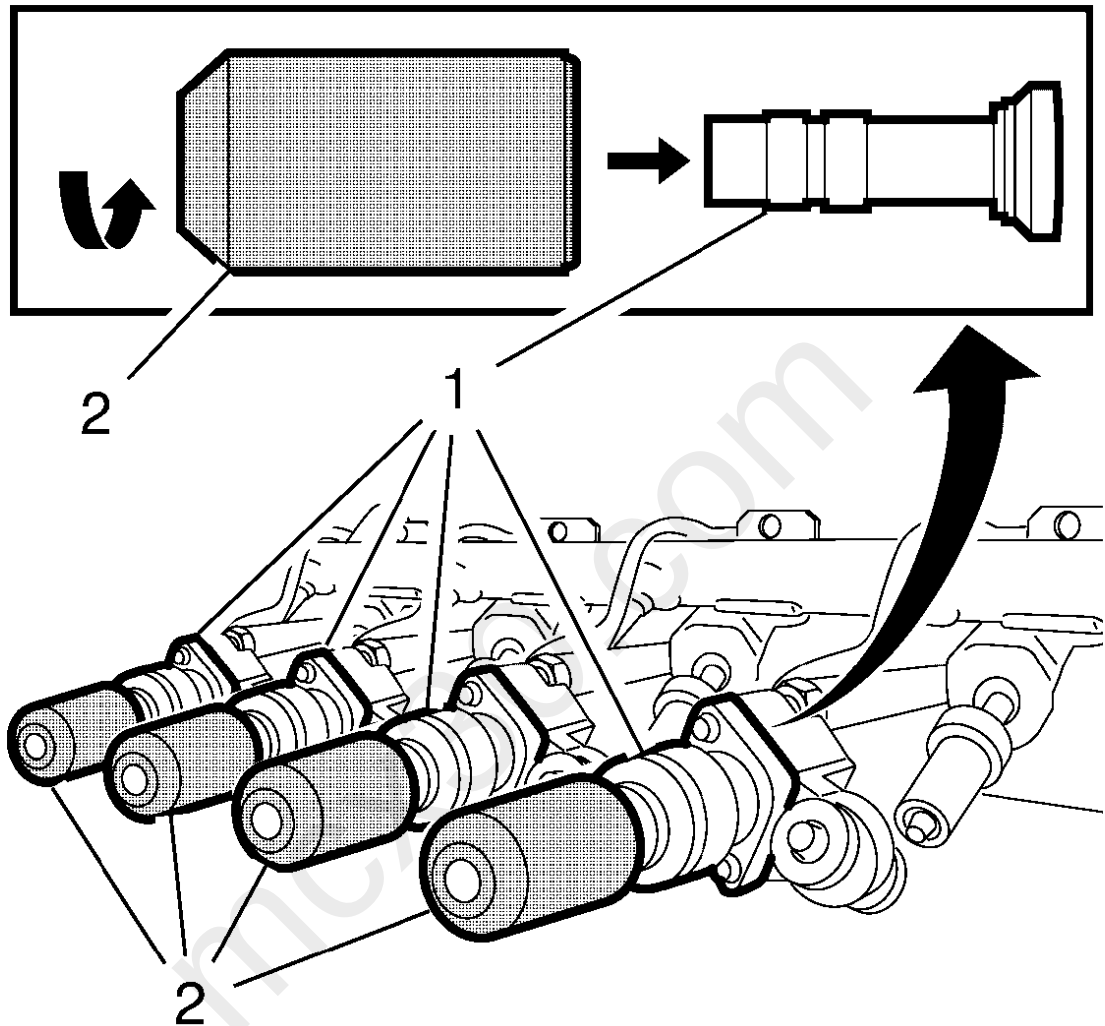


Fig. 100: Calibration Tools
Courtesy of GENERAL MOTORS COMPANY

NOTE: The **EN-51146-2-5** calibration tools are also used to protect the fuel injectors.

22. Install the 4 **EN-51146-2-5** calibration tools (2) to the fuel injectors (1), as shown in the graphic.
23. Cover the fuel injector bores at the cylinder head, to prevent dirt contamination.
24. Remove the 2 **EN-51146-1-3** sliding hammers.
25. Remove the 4 **EN-51146-2-5** calibration tools.
26. Inspect all fuel injectors for damage.

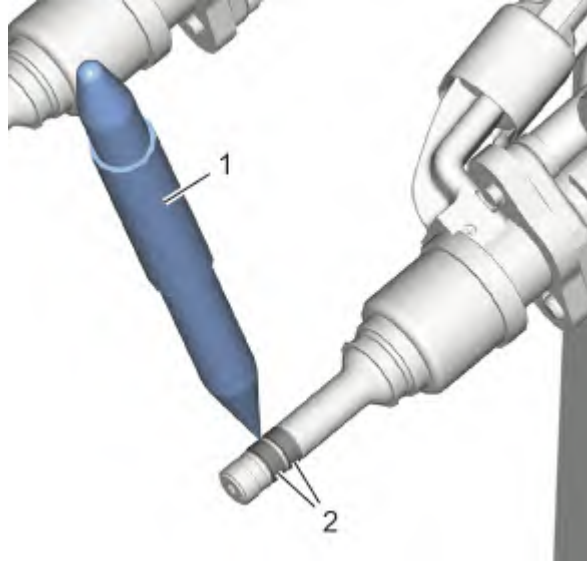


Fig. 101: Combustion Seals And Stylus

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Always use the stylus from the EN-51146 fuel injector kit. Never use a metal tool in place of the stylus. Use of another tool can damage the fuel injector and may cause a leak.

27. Remove the 2 combustion seals (2) each fuel injector, use EN-51146-2-1 stylus (1).
28. Inspect all fuel injectors for damage.

Installation Procedure

1. Clean and inspect the fuel injectors and the fuel injector rail. Do not remove the fuel injector from the fuel rail. Refer to **Fuel Injector and Fuel Injector Bore Cleaning and Inspection** .

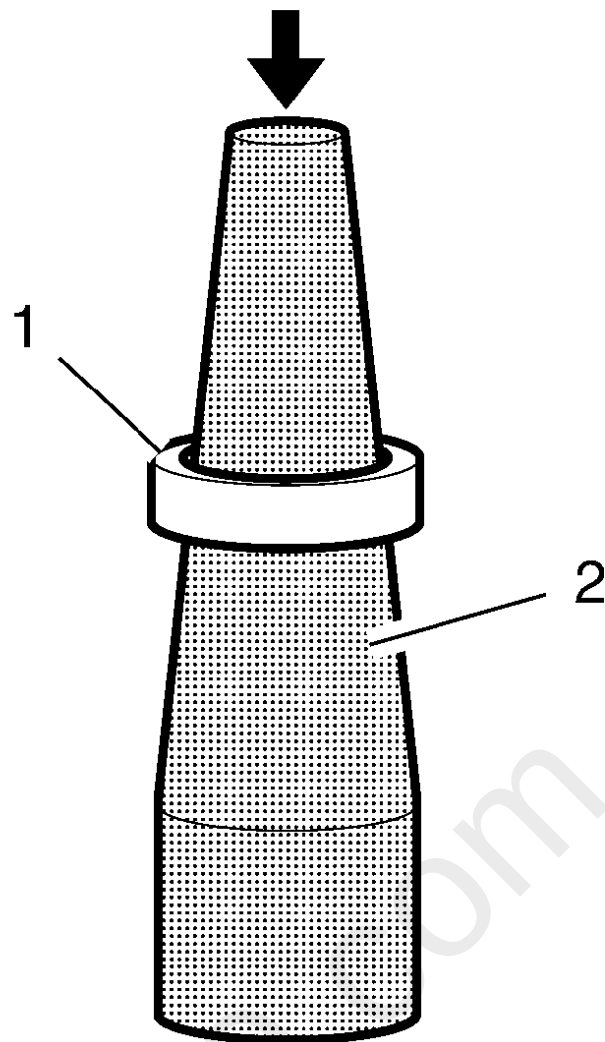


Fig. 102: Combustion Seals

Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW combustion fuel injector seal (1) to the **EN-51146-2-2** mounting sleeve-long (2).

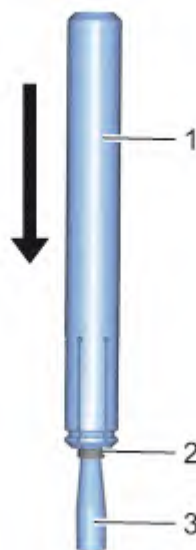


Fig. 103: Installing Combustion Seals

Courtesy of GENERAL MOTORS COMPANY

3. Use the **EN-51146-2-6-1** slider outside (1) to push down the combustion fuel injector seal (2) on the **EN-51146-2-2** mounting sleeve-long (3).

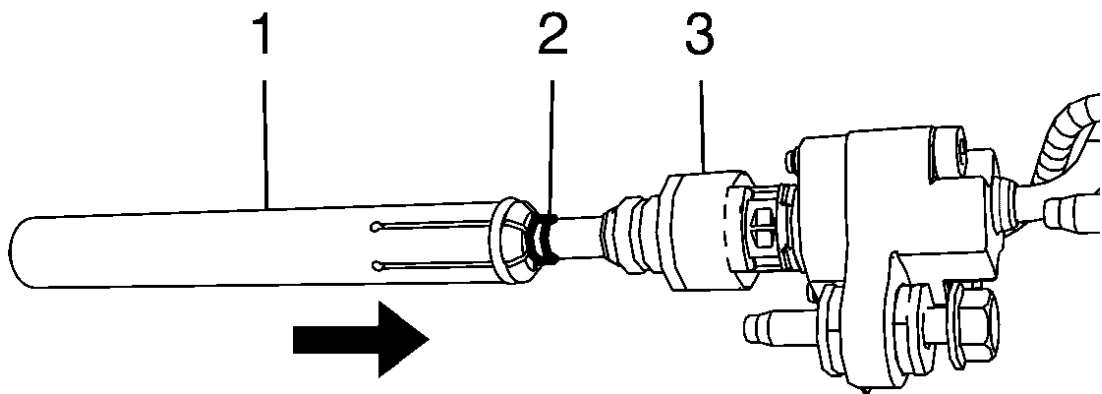


Fig. 104: Installing Combustion Seals

Courtesy of GENERAL MOTORS COMPANY

4. Push the combustion fuel injector seal (2) over the **EN-51146-2-2** mounting sleeve-long, use the **EN-51146-2-6-1** slider outside (1) to the fuel injector (3).
5. Remove the **EN-51146-2-2** mounting sleeve-long with the **EN-51146-2-1** stylus from the **EN-51146-2-6-1** slider outside.
6. Install a NEW combustion fuel injector seal to the **EN-51146-2-3** mounting sleeve-short.
7. Use the **EN-51146-2-6-1** slider outside to push down the combustion fuel injector seal on the **EN-51146-2-2** mounting sleeve-short.
8. Push the combustion fuel injector seal over the **EN-51146-2-3** mounting sleeve-short, use the **EN-51146-2-6-1** slider outside to the fuel injector.
9. Remove the **EN-51146-2-3** mounting sleeve-short with the **EN-51146-2-1** stylus from the **EN-51146-2-6-1** slider outside.

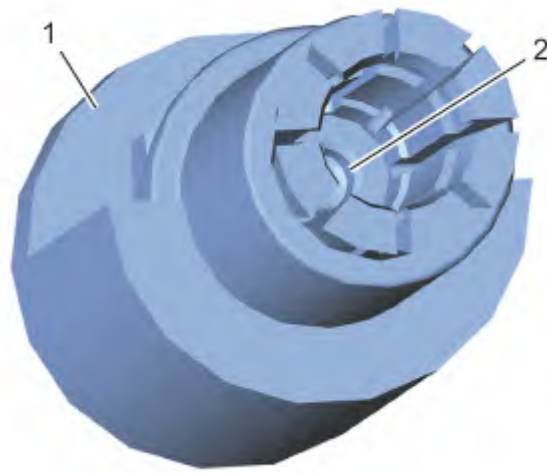


Fig. 105: Fuel Injector Limiter

Courtesy of GENERAL MOTORS COMPANY

10. Before using the EN-51146-2-4 pre-sizing tool (1), check if the fuel injector limiter (2) is in the right position.

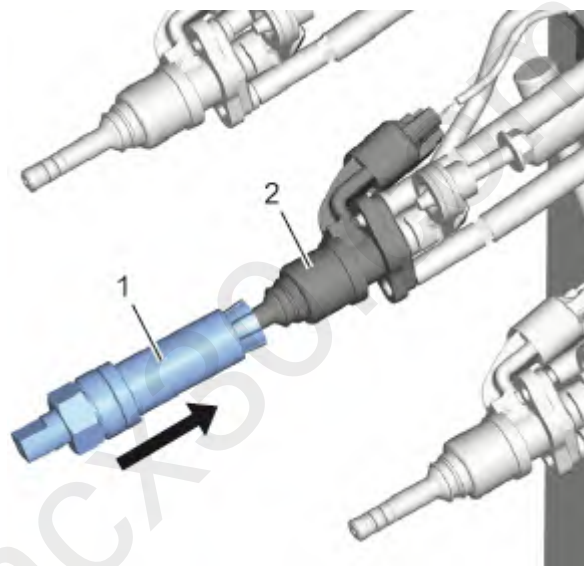


Fig. 106: Pre-Sizing Tool And Fuel Injector

Courtesy of GENERAL MOTORS COMPANY

NOTE: First form the combustion fuel injector seals a bit with finger and thumb.

11. Push the EN-51146-2-4 pre-sizing tool (1) over the fuel injector (2).

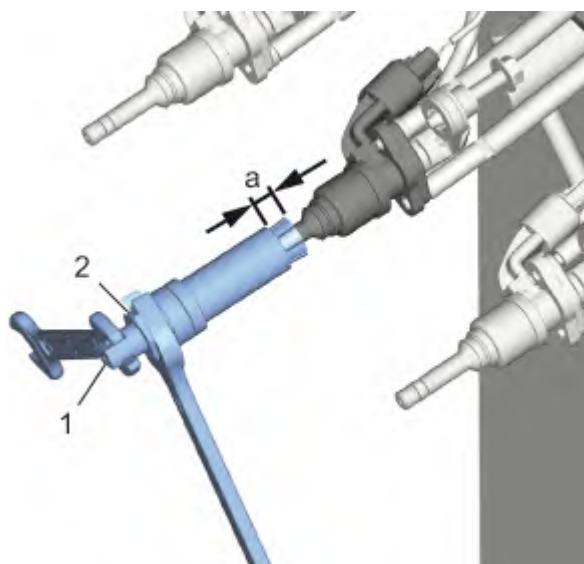


Fig. 107: Pre-Sizing Tool

Courtesy of GENERAL MOTORS COMPANY

12. Tighten the nut (2) and counterhold at the spanner flat of the **EN-51146-2-4** pre-sizing tool thread (1) until the measure (a) of 4.5 mm (0.177 in) is reached.
13. Loosen the nut (2) of the **EN-51146-2-4** pre-sizing tool.

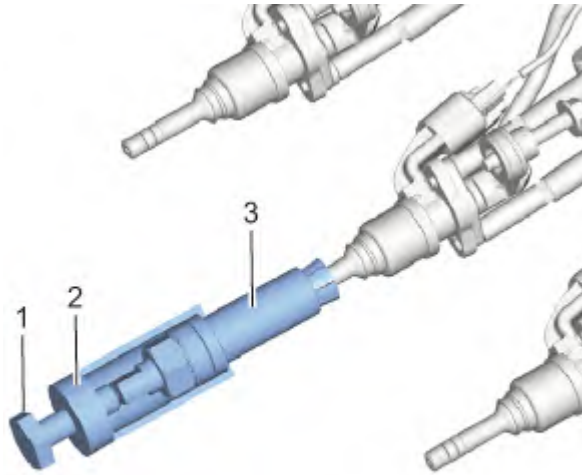


Fig. 108: Take Off Chassis And Pre-Sizing Tool

Courtesy of GENERAL MOTORS COMPANY

14. Install the **EN-51146-2-4-7** take off chassis (2) to the **EN-51146-2-4** pre-sizing tool (3).
15. Install the **EN-51146-2-4-6** screw M10 (1) to the **EN-51146-2-4-7** take off chassis (2), and tighten until the **EN-51146-2-4** pre-sizing tool (3) is loosened.

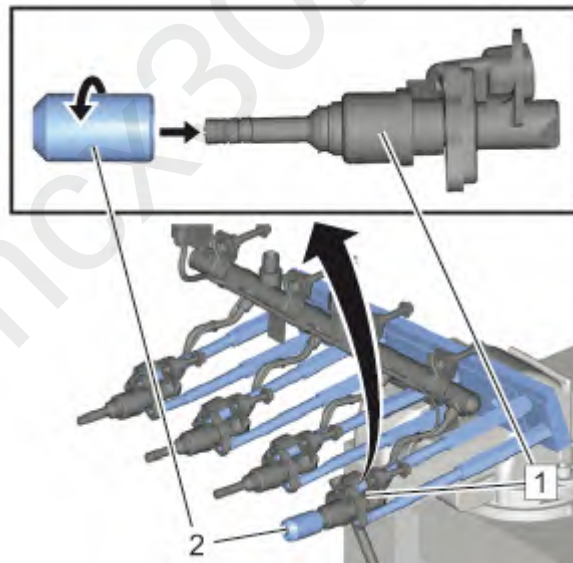


Fig. 109: Calibration Tool And Fuel Injector

Courtesy of GENERAL MOTORS COMPANY

16. Install the **EN-51146-2-5** calibration tool (2) to the fuel injector (1), as shown in the graphic.
17. Remove the **EN-51146-2-5** calibration tool from the fuel injector.

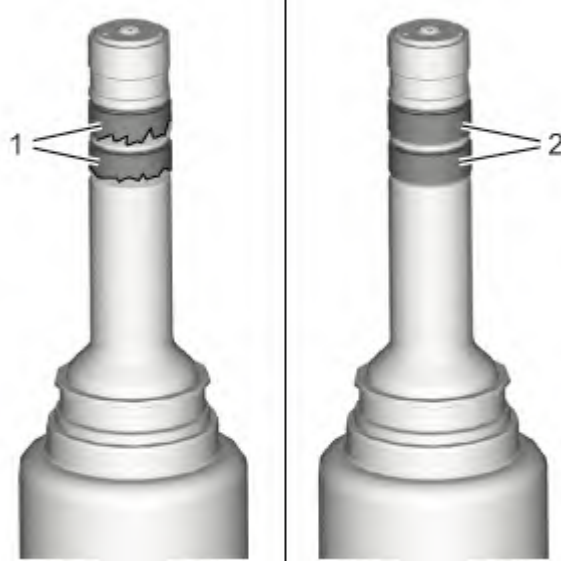


Fig. 110: Ensure Seals Are Installed Correctly.
Courtesy of GENERAL MOTORS COMPANY

WARNING: The fuel injector seals must fit properly in the relative groove. Overlapping of the fuel injector seals with the external surface of the injector must be avoided. If the seals are installed incorrectly, it could cause leaks and risk of injury.

18. Check the combustion fuel injector seals (2 seals each fuel injector) for correct seat:
 - The seal must not be too large, buckled or corrugated (1).
 - The seal must be fixed tight and accurate (2).
19. If the seals are installed incorrectly, repeat the steps 27 - 29 of the removal procedure and the steps 1 - 19 of the installation procedure.

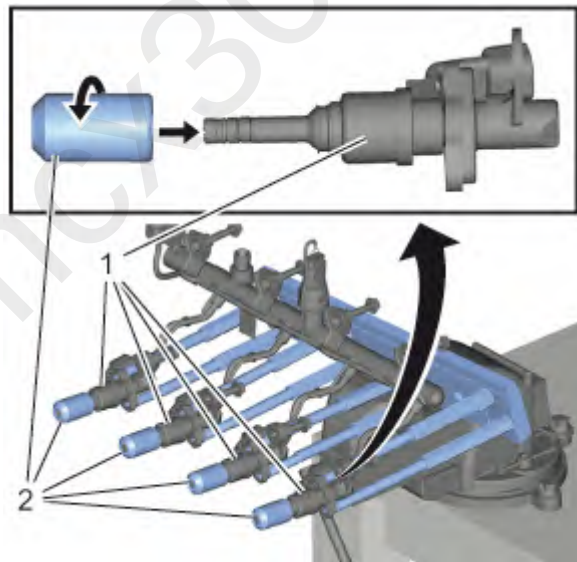


Fig. 111: Calibration Tools And Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

20. Install the 4 **EN-51146-2-5** calibration tools (2) to the fuel injectors (1).
21. Remove the fuel injector assembly with the **EN-51146-100** plate from the bench vise.

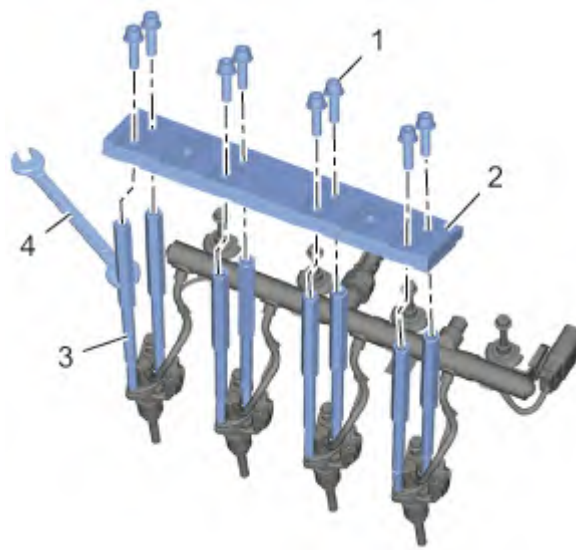


Fig. 112: Plate, Bolts And Supports

Courtesy of GENERAL MOTORS COMPANY

22. Remove the 8 plate bolts (1) and remove EN-51146-100 plate (2), counterhold with a wrench (4) at the EN-51146-1-1 supports (3).

NOTE: Never loosen both EN-51146-1-1 supports at the same time. Failure to follow this caution could cause leaks or malfunction after installation. It is only possible, when the fuel injector will be replaced.

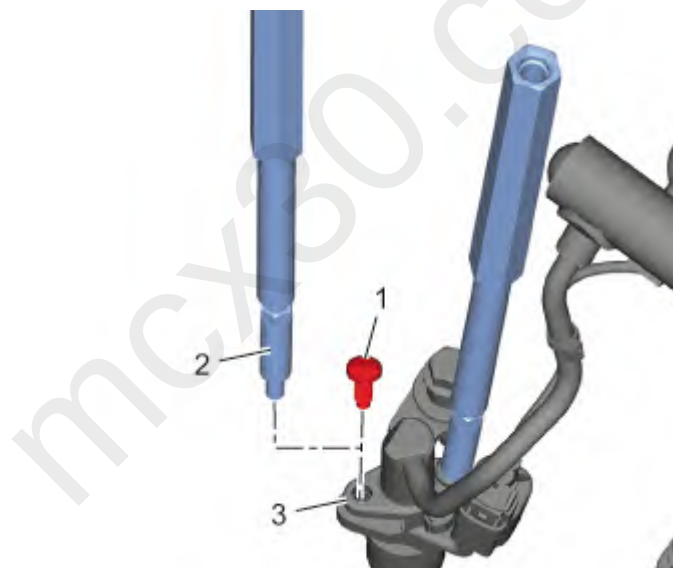


Fig. 113: Support, Fuel Injector And Bolt

Courtesy of GENERAL MOTORS COMPANY

23. Remove one EN-51146-1-1 support (2) from the fuel injector (3).

NOTE: DO NOT reuse the old fuel injector bolt.

24. Apply thread lock agent to the NEW fuel injector bolt (1).
25. Install NEW fuel injector bolt to the fuel injector and tighten to 5 N.m (44 lb in).

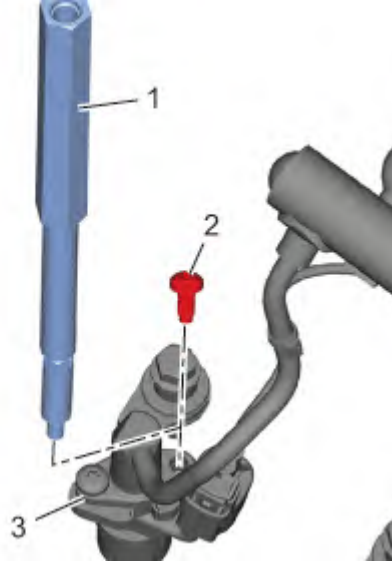


Fig. 114: Support, Fuel Injector And Bolt
 Courtesy of GENERAL MOTORS COMPANY

26. Remove the EN-51146-1-1 support (1) from the fuel injector (3).

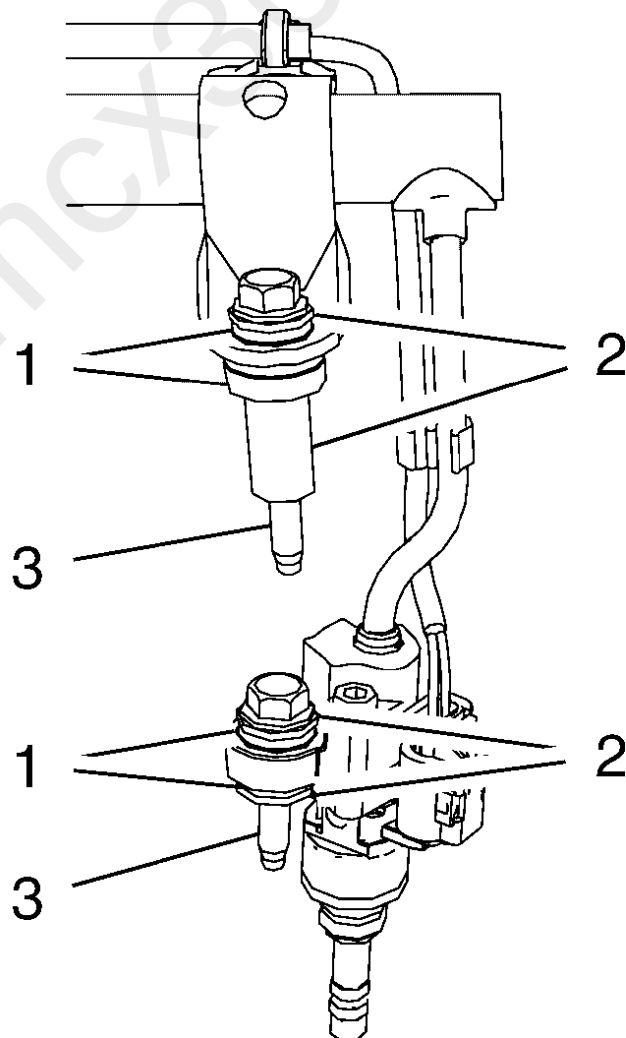
NOTE: **DO NOT reuse the old fuel injector bolt.**

27. Apply thread lock agent to the NEW fuel injector bolt (2).

28. Install a NEW fuel injector bolt to the fuel injector and tighten to 5 N.m (44 lb in).

29. Repeat the steps 22 - 27 for the other 3 injectors.

30. Clean the fuel injector bores at the cylinder head. Refer to [Fuel Injector and Fuel Injector Bore Cleaning and Inspection](#) .



31. Inspect the fuel injector rail assembly:
 - Check the 4 fuel injector for damage.
 - Check the 8 fuel injector seals for correct seat.
 - Check if all bolts (3) with decoupling elements (1) and retainer (2) are complete.
32. Remove the 4 **EN-51146-2-5** calibration tools from the fuel injector.

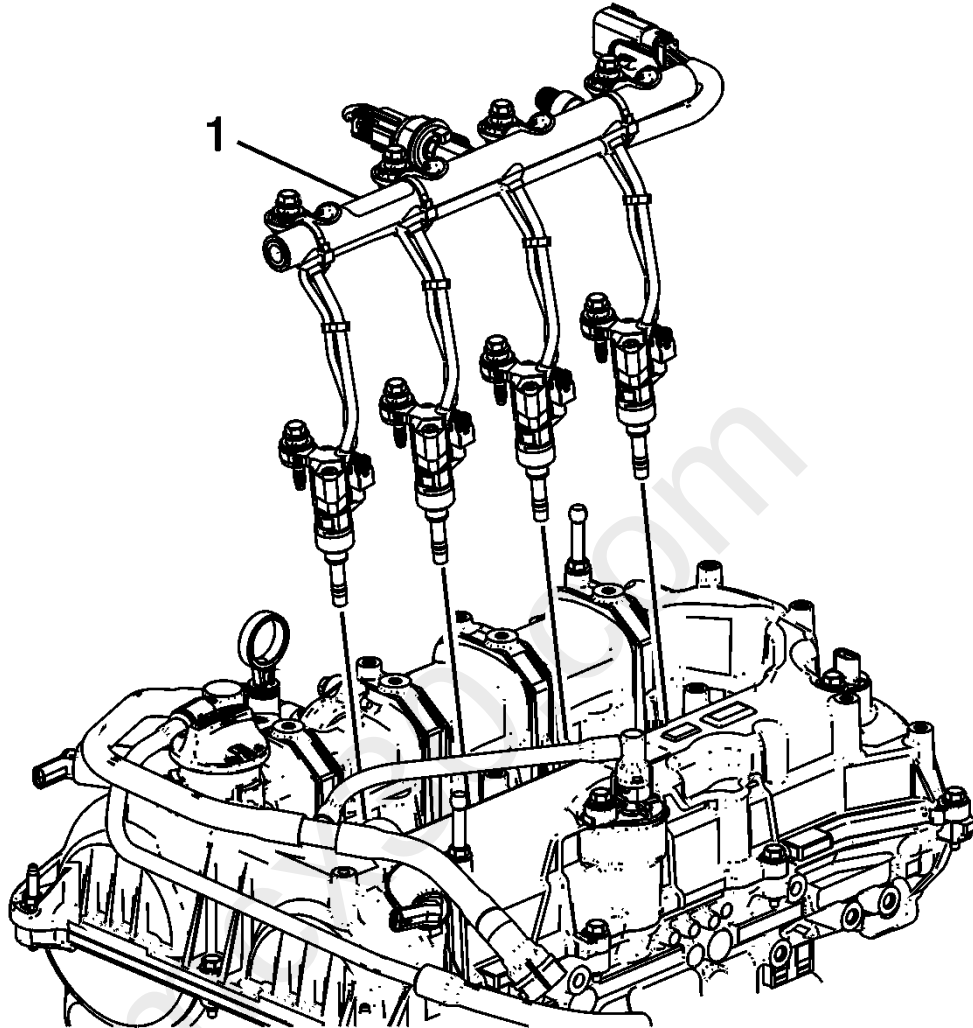


Fig. 116: Fuel Rail Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: During the installation of the fuel rail and injector assembly, ensure that the fuel injectors are positioned straight into the injector opening. Failure to follow this caution can tilt or bend the injectors and could cause leaks or malfunction after installation.

33. Install the fuel rail assembly (1).
34. Push the fuel injectors slightly in their seats.

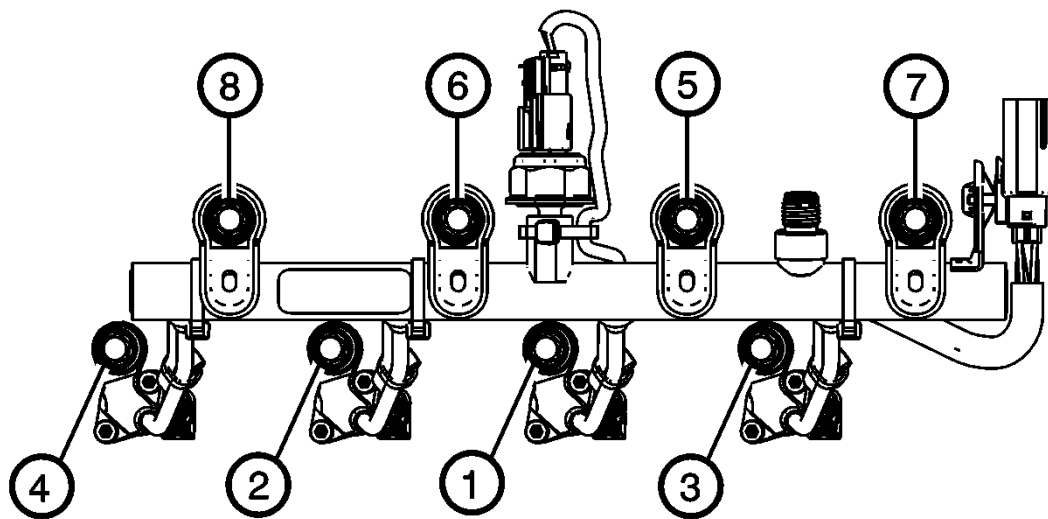


Fig. 117: Fuel Rail Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

35. Tighten the 8 fuel rail bolts in the sequence as shown to 10 N.m (89 lb in).

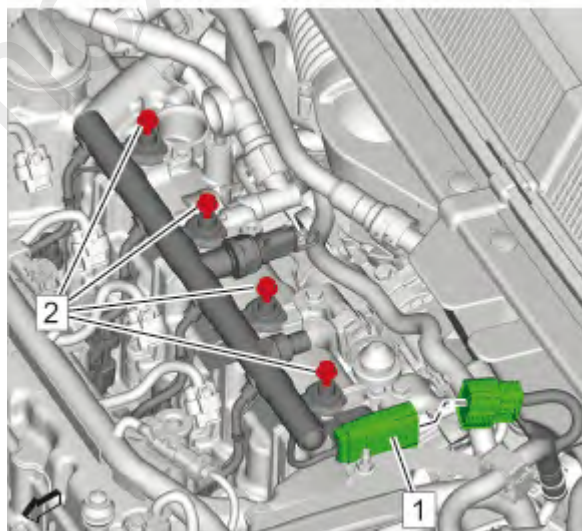


Fig. 118: Fuel Injection Fuel Rail Wiring Harness And Fuel Rail Bolts
 Courtesy of GENERAL MOTORS COMPANY

36. Connect Fuel Injection Fuel Rail Wiring Harness (1)
 37. Install Fuel Feed Intermediate Pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#)
 38. Install Ignition Coil. Refer to [Ignition Coil Replacement](#)

WARNING: Fuel escapes - observe safety measures and national legislation. Failure to comply could result in personal injury.

NOTE: Ensure that all work at the engine is finished.

39. Perform a fuel rail assembly leak test.

1. Start the engine.
2. Check the fuel system for leaks.

FUEL INJECTOR REPLACEMENT

Special Tools

EN-51146 Fuel Injector Removal/Installation Kit

Equivalent regional tools: [Special Tools \(Mechanical Tools\)](#)

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

WARNING: Refer to [Safety Goggles and Fuel Warning](#) .

CAUTION: When working on the fuel rail and fuel injectors, always maintain a clean work surface. Failure to maintain a clean work surface can result in contaminant on the injector seals and cause leaks.

1. Remove Fuel Injection Fuel Rail Assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#)

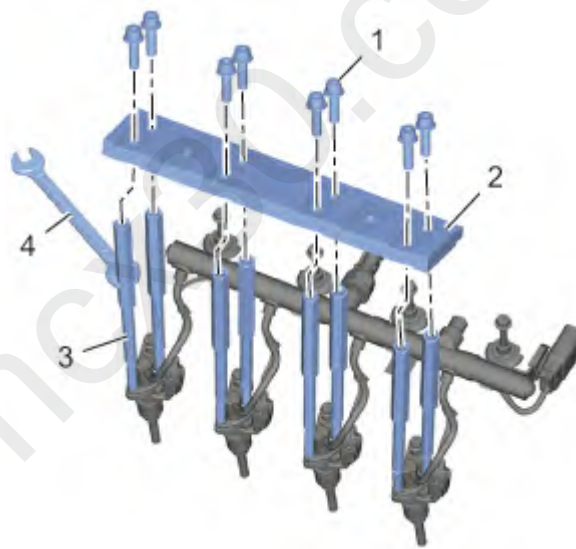


Fig. 119: Plate, Bolts And Supports

Courtesy of GENERAL MOTORS COMPANY

NOTE: The EN-51146-2-5 calibrations tools must be installed.

2. Remove the 8 plate bolts (1) and remove the EN-51146-1-2 plate (2), counterhold with a wrench (4) at the EN-51146-1-1 supports (3).

NOTE: Remove only the EN-51146-1-1 supports (3) of the fuel injector or fuel injectors, which will be replaced. The EN-51146-1-1 supports must remain at the injectors, which will be re-used.

3. Remove the EN-51146-1-1 supports (3).

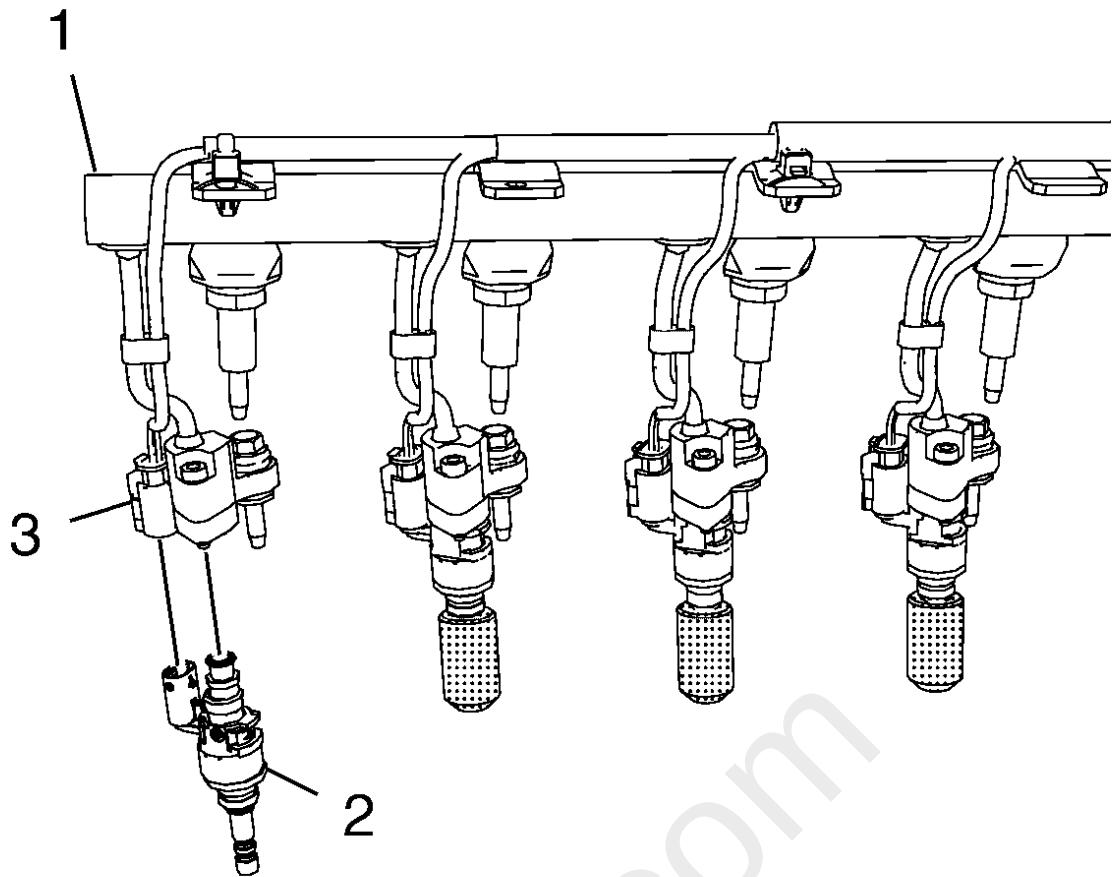


Fig. 120: Fuel Injection Fuel Rail, Fuel Injector And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel injector electrical connector (3).
5. Remove Fuel Injector (2) @ Fuel Injection Fuel Rail (1)

Cleaning Procedure

1. Clean the fuel injector bores and clean the fuel injectors, if the fuel injectors will be re-installed.
Refer to **Fuel Injector and Fuel Injector Bore Cleaning and Inspection**

Installation Procedure

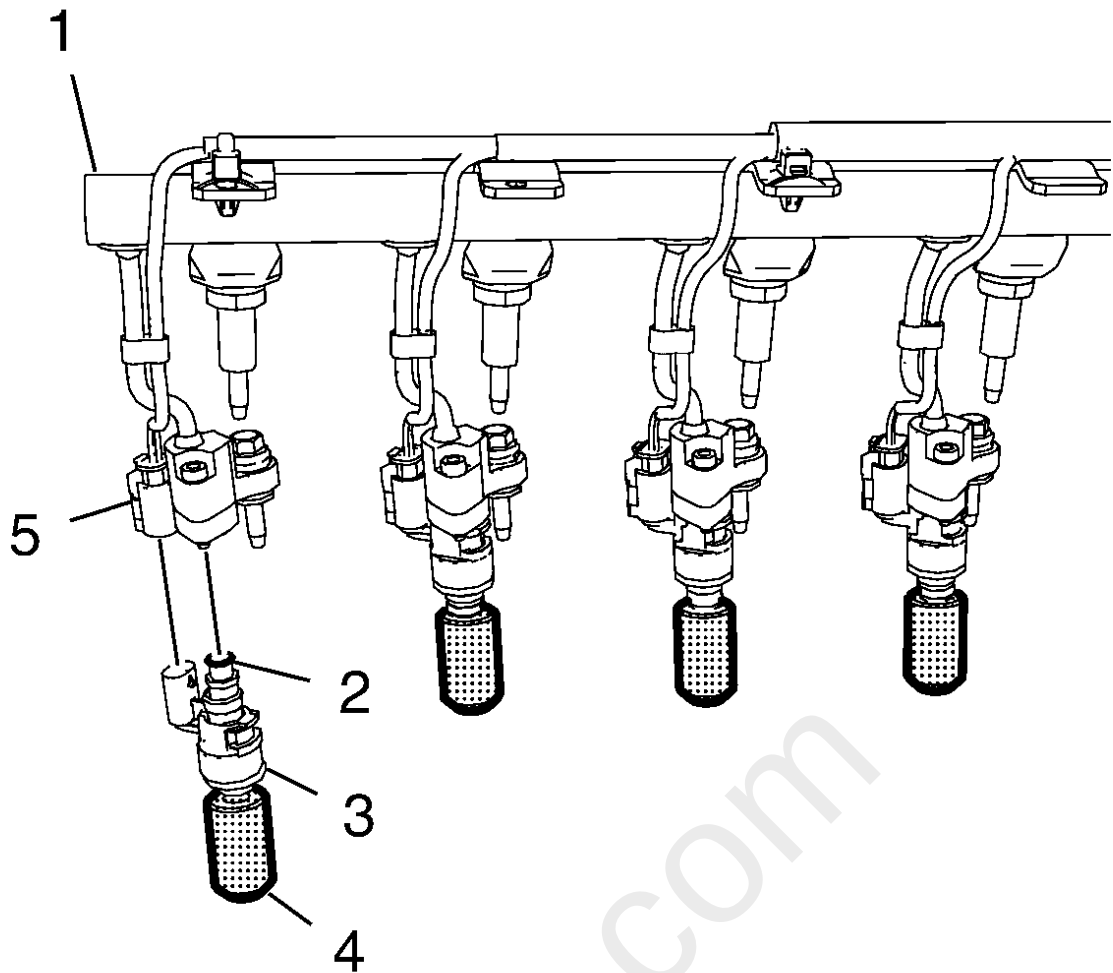


Fig. 121: Fuel Injection Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-51146-2-5** calibrations tools (4) to the fuel injectors (3).
2. Lightly coat the fuel injector seal (2) with clean engine oil.
3. Install Fuel Injector (3) @ Fuel Injection Fuel Rail (1)
4. Apply thread lock agent to the NEW fuel injector bolts.

CAUTION: Refer to **Fastener Caution** .

5. Install the NEW fuel injector bolts to the fuel injectors (3) and tighten to 5 N.m (44 lb in).
6. Connect the 4 fuel injector electrical connectors (5).
7. Install Fuel Injection Fuel Rail Assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement**

FUEL INJECTOR WIRING HARNESS REPLACEMENT

Removal Procedure

1. Remove Fuel Injection Fuel Rail Assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement**

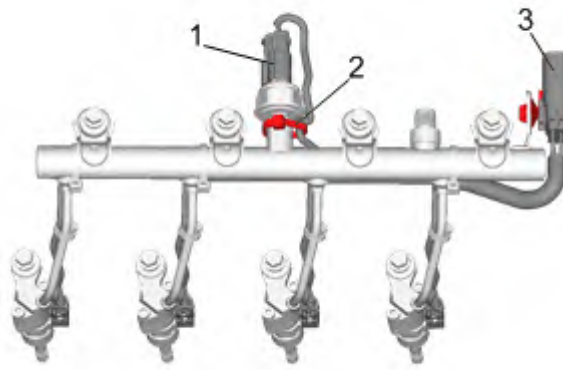


Fig. 122: Fuel Injector Wiring Harness, Connector And Tie Strap
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the fuel injector wiring harness connector (1) from the fuel injection fuel rail fuel pressure sensor.
3. Cut the fuel injector wiring harness tie strap (2) and DISCARD.
4. Unclip the fuel injector wiring harness (3) from the fuel injection fuel rail.

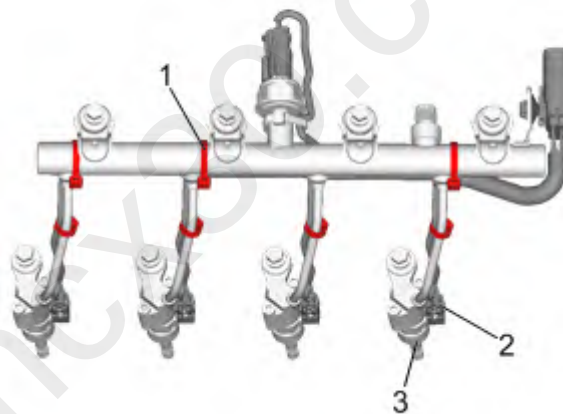


Fig. 123: Fuel Injectors, Wiring Harness And Tie Straps
Courtesy of GENERAL MOTORS COMPANY

5. Cut the remaining fuel injector wiring harness tie straps (1) and DISCARD.
6. Disconnect the fuel injector wiring harness connectors (2) from the fuel injectors (3).

Installation Procedure

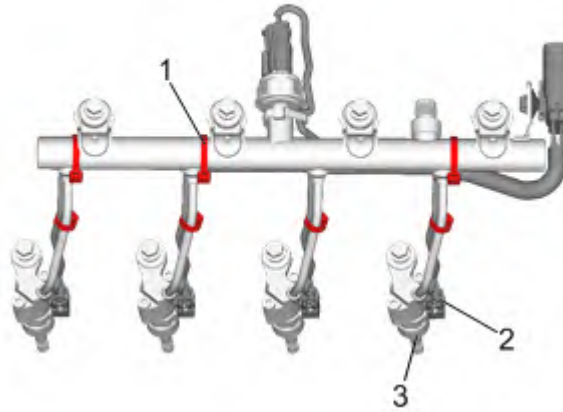


Fig. 124: Fuel Injectors, Wiring Harness And Tie Straps
 Courtesy of GENERAL MOTORS COMPANY

1. Connect the fuel injector wiring harness connectors (2) to the fuel injectors (3).
2. Position the fuel injector wiring harness to the fuel injection fuel rail and install NEW wiring harness tie straps (1).

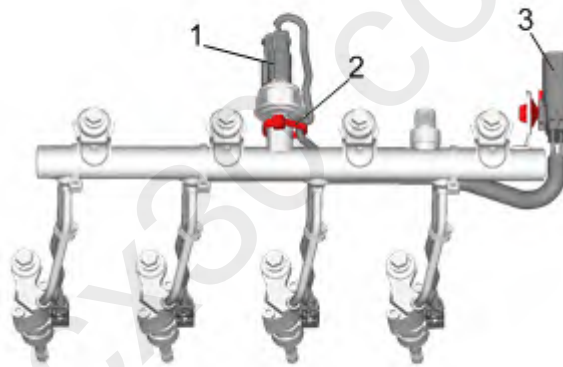


Fig. 125: Fuel Injector Wiring Harness, Connector And Tie Strap
 Courtesy of GENERAL MOTORS COMPANY

3. Connect the fuel injector wiring harness connector (1) to the fuel injection fuel rail fuel pressure sensor.
4. Install a NEW wiring harness tie strap (1).
5. Clip the fuel injector wiring harness (3) to the fuel injection fuel rail.
6. Install Fuel Injection Fuel Rail Assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).

FUEL INJECTION FUEL RAIL FUEL PRESSURE SENSOR REPLACEMENT

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

WARNING: Refer to [Safety Goggles and Fuel Warning](#) .

CAUTION: Refer to [Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution](#) .

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#)
2. Disconnect Negative Battery Cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#). [Battery Negative Cable Disconnection and Connection \(with KL9\)](#). »Disconnect

NOTE: Replace the noise cancelling foam component if it is exposed to and has absorbed automotive fluids.

3. Remove Intake Manifold Cover. Refer to [Intake Manifold Cover Replacement](#)

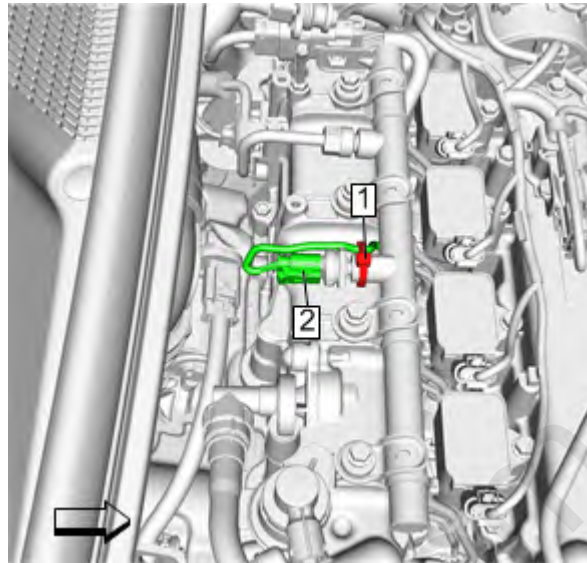


Fig. 126: Fuel Injector Wiring Harness Connector And Cable Tie
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD Cable Tie (1)
5. Disconnect the electrical connector (2).

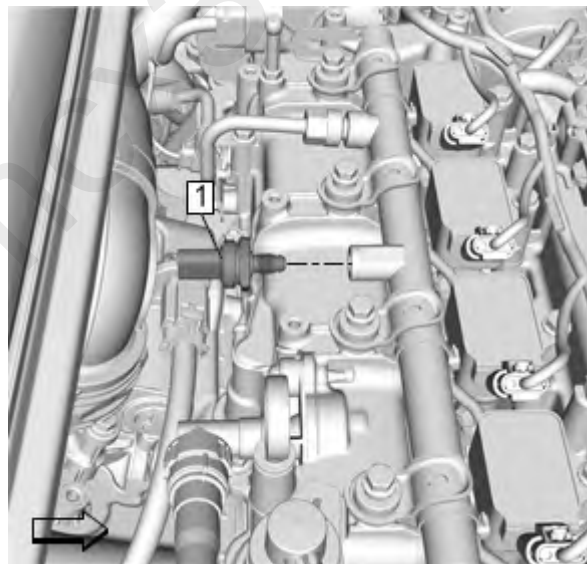


Fig. 127: Fuel Injection Fuel Rail Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

6. Remove and DISCARD Fuel Injection Fuel Rail Fuel Pressure Sensor (1)

Installation Procedure

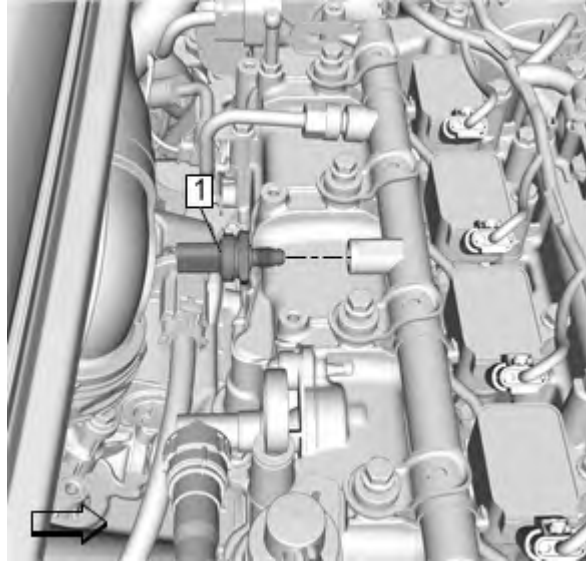


Fig. 128: Fuel Injection Fuel Rail Fuel Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Applying force to the plastic housing of the sensor may damage the sensor. To tighten or loosen, apply force only 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 sealing surface of the NEW fuel rail pressure sensor with one drop of clean engine oil.
2. Install the NEW fuel rail pressure sensor (1) and hand tighten.
3. Remove Fuel Injection Fuel Rail Fuel Pressure Sensor (1)
4. Re-lubricate with one drop of clean engine oil.

CAUTION: Refer to [Component Fastener Tightening Caution](#) .

5. Install and tighten Fuel Injection Fuel Rail Fuel Pressure Sensor (1) to 32 N.m (24 lb ft).

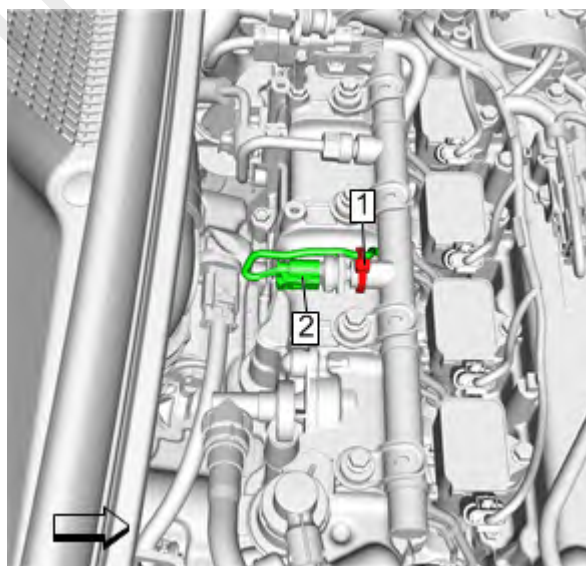


Fig. 129: Fuel Injector Wiring Harness Connector And Cable Tie
 Courtesy of GENERAL MOTORS COMPANY

6. Connect the electrical connector (2).
7. Install a NEW cable tie (1)
8. Inspect for fuel leaks using the following procedure:

1. Turn the ignition ON, with the engine OFF for 2 seconds
2. Turn OFF the ignition. for 10 seconds.
3. Ignition On, engine Off.
4. Inspect for fuel leaks, using tissue paper or hydrocarbon sniffer.
5. Start vehicle and re-inspect for fuel leaks with engine at idle.
6. Re-inspect for fuel leaks with engine at 3,000 rpm no load.
9. Install Intake Manifold Cover. Refer to [Intake Manifold Cover Replacement](#) .»Install
10. Connect Battery Negative Cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#). [Battery Negative Cable Disconnection and Connection \(with KL9\)](#)
11. After replacement of the fuel injection fuel rail pressure sensor, use a scan tool to program and reset functions. Refer to [Control Module References](#) .

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

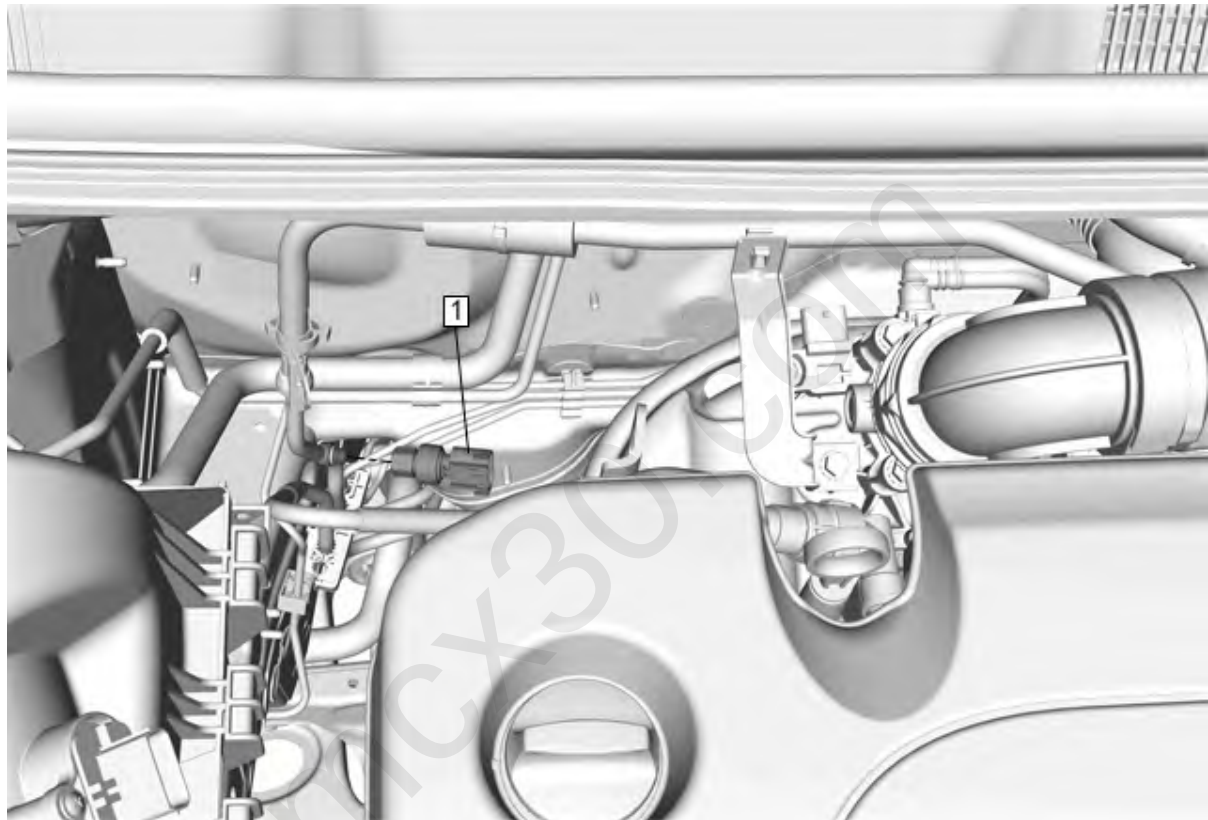


Fig. 130: Fuel Pressure Sensor - Fuel Feed Pipe
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
<b style="background-color: red; color: white;">WARNING: Refer to Gasoline/Gasoline Vapors Warning .	
<b style="background-color: red; color: white;">WARNING: Refer to Safety Glasses Warning .	
Preliminary Procedure Relieve the fuel system pressure. Refer to Fuel Pressure Relief	
1	Fuel Pressure Sensor Procedure Disconnect the electrical connector.

FUEL INJECTION PUMP REPLACEMENT

Special Tools

EN-51365 High Pressure Fuel Pump Installation Alignment Gauge

Equivalent regional tools: [Special Tools \(Mechanical Tools\)](#)

Removal Procedure

WARNING: The noise cancelling foam component **MUST** be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

WARNING: Refer to [Safety Goggles and Fuel Warning](#) .

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#)
2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#). [Battery Negative Cable Disconnection and Connection \(with KL9\)](#)

NOTE: It is **NOT** necessary to remove the evaporative emission canister purge solenoid valve or the throttle body from the intake manifold.

3. Remove Intake Manifold. Refer to [Intake Manifold Replacement](#)

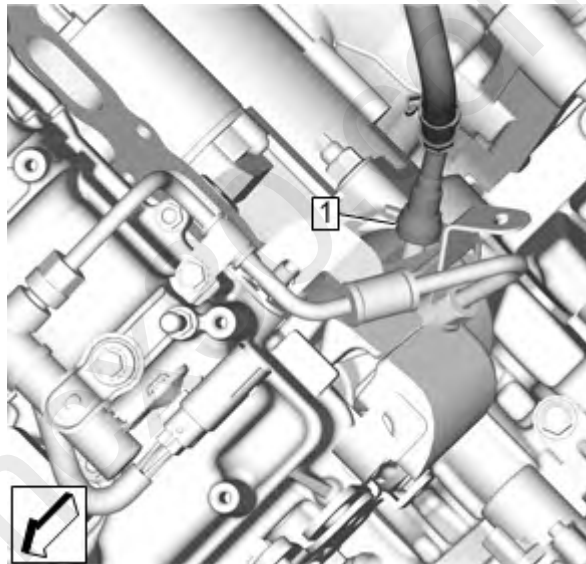


Fig. 131: Fuel Feed Front Pipe

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel feed front pipe (1) from the fuel pump. Refer to [Fuel Feed Front Pipe Replacement](#)

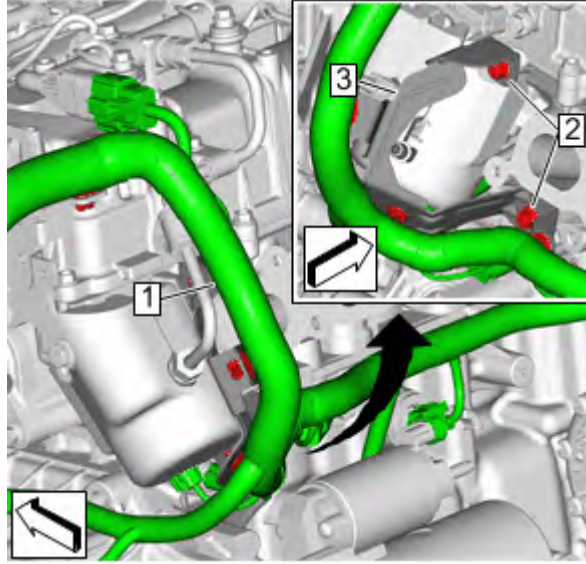


Fig. 132: Engine Wiring Harness Bracket, Bolts And Electrical Connectors
 Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the engine wiring harness electrical connectors (1) as necessary, including the electrical connector at the fuel pump.
6. Remove the engine wiring harness bracket bolts (2) and reposition the engine wiring harness bracket (3).

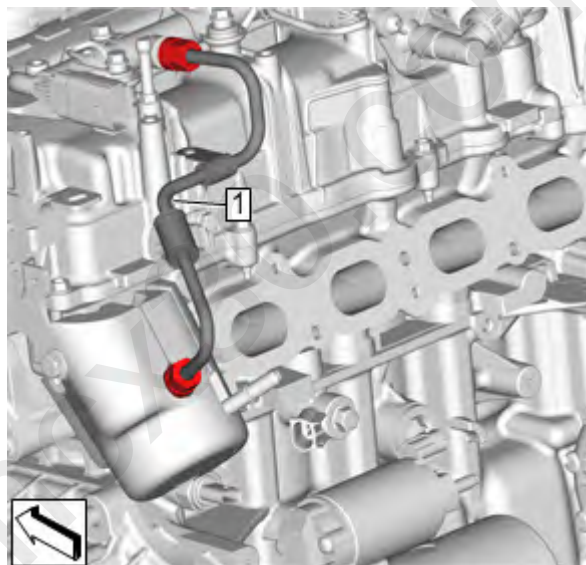


Fig. 133: Fuel Feed Intermediate Pipe
 Courtesy of GENERAL MOTORS COMPANY

NOTE: High pressure fuel feed pipes are one time use only. **ALWAYS** install a **NEW** high pressure fuel feed pipe if the pipe is removed **OR** the fittings are loosened.

7. Remove and DISCARD the fuel feed intermediate pipe (1). Refer to [Fuel Feed Intermediate Pipe Replacement](#)

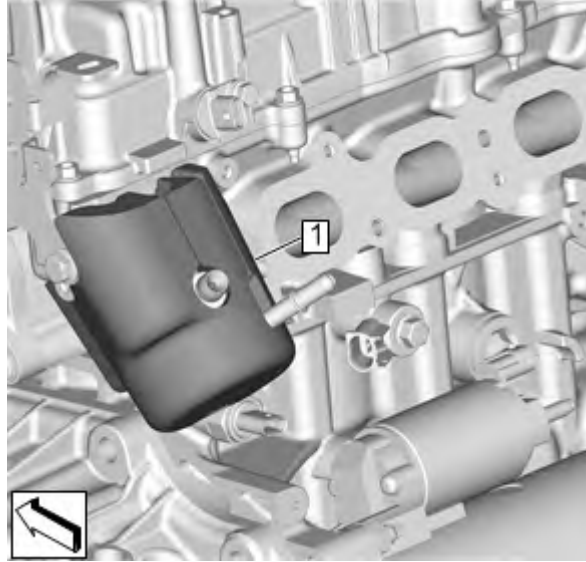


Fig. 134: Fuel Pump Insulator

Courtesy of GENERAL MOTORS COMPANY

8. Remove the fuel pump insulator (1).

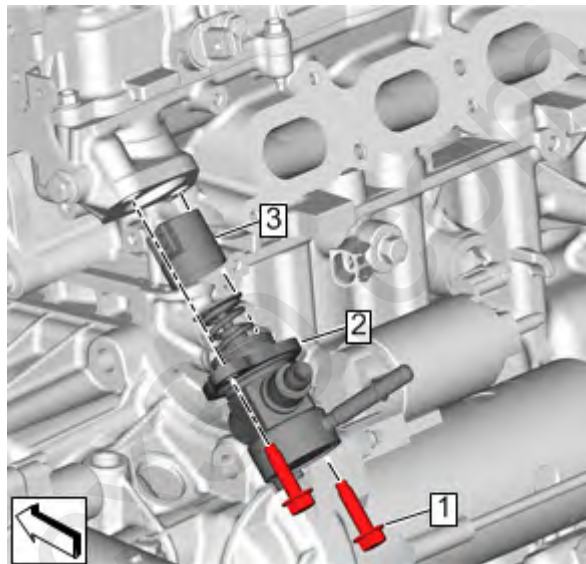


Fig. 135: Fuel Pump, Bolts And Valve Lifter Follower

Courtesy of GENERAL MOTORS COMPANY

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

9. Remove and DISCARD the fuel pump bolts (1).

NOTE: Ensure that during removal of the fuel pump that the valve lifter follower does NOT fall apart.

10. Remove the fuel pump (2).

NOTE:

- The valve lifter follower MAY remain in the cylinder head bore after removing the fuel pump.
- If the valve lifter follower does NOT pull out of the cylinder head bore with the fuel pump, then remove it afterwards.

11. Remove the valve lifter follower (3).

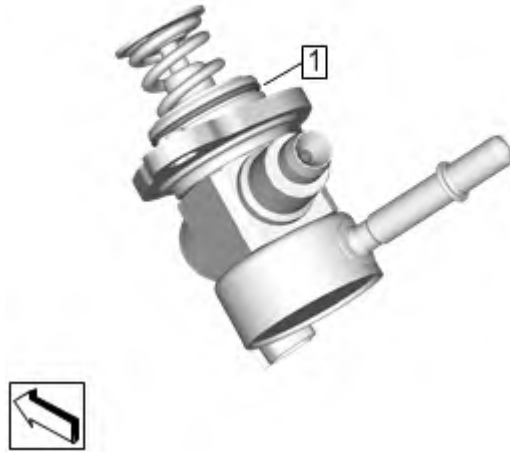


Fig. 136: Fuel Pump Housing Seal
Courtesy of GENERAL MOTORS COMPANY

12. Remove and DISCARD the fuel pump housing seal (1).

Installation Procedure

1. Before continuing, lubricate the cylinder head bore with clean engine oil.

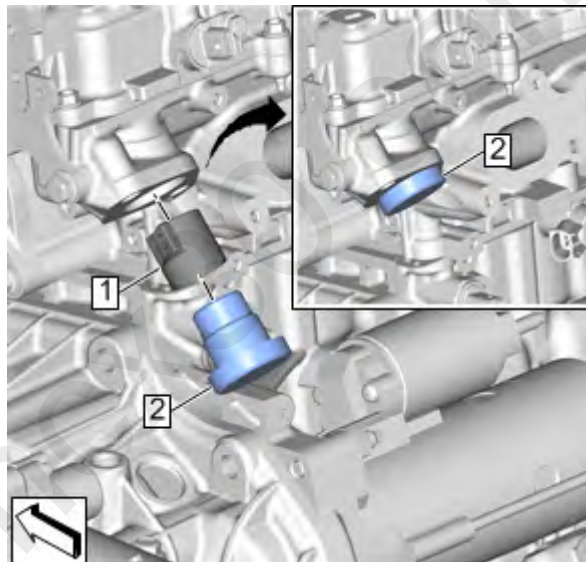


Fig. 137: Valve Lifter Follower And Alignment Gauge
Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the valve lifter follower (1) with clean engine oil and install it into the cylinder head bore.

NOTE:

- The camshaft **MUST** be at the base circle position before the fuel pump is installed.
- At the base circle position, the EN-51365 alignment gauge will sit flush with the cylinder head.

3. Install the **EN-51365** alignment gauge (2) and turn the crankshaft until the camshaft lobe is at the base circle position.
4. Remove the **EN-51365** alignment gauge (2) and valve lifter follower (1).

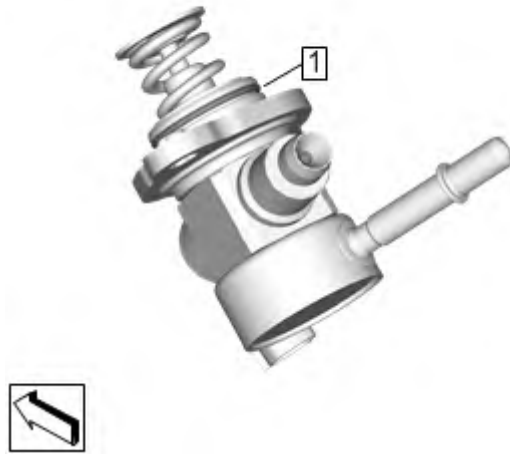


Fig. 138: Fuel Pump Housing Seal

Courtesy of GENERAL MOTORS COMPANY

5. Lubricate the NEW fuel pump housing seal (1) with clean engine oil and install it on the fuel pump.

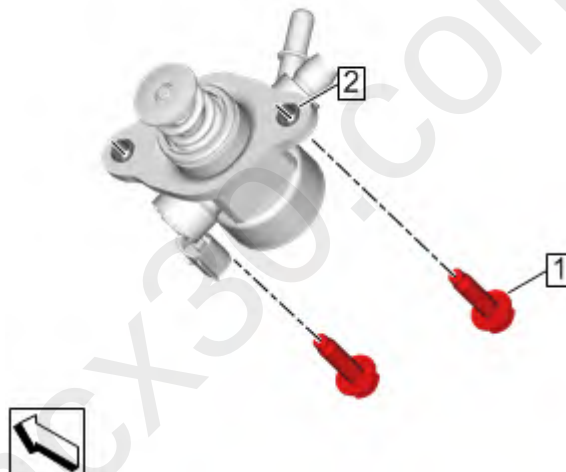


Fig. 139: Fuel Pump Bolts And Retainers

Courtesy of GENERAL MOTORS COMPANY

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

NOTE:

- ALWAYS make sure the fuel pump bolt retainers are present before installing the fuel pump bolts.
- If ANY fuel pump bolt retainers are missing or NOT suitable for reuse, replace the retainers as necessary.

6. Install the NEW fuel pump bolts (1) through the fuel pump bolt retainers (2).

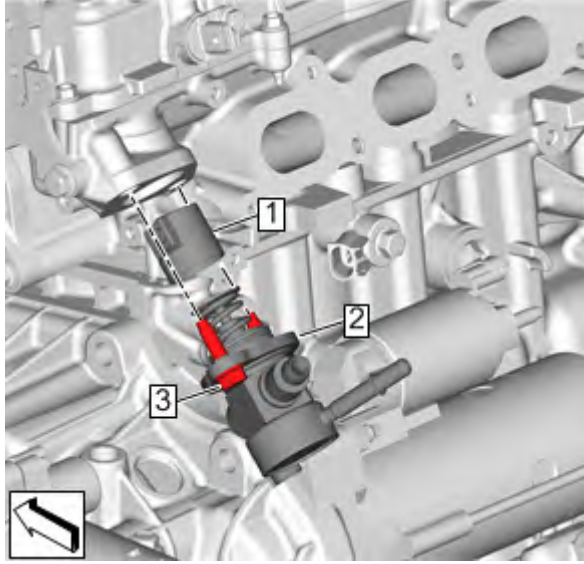


Fig. 140: Valve Lifter Follower, Fuel Pump Assembly And Bolts
 Courtesy of GENERAL MOTORS COMPANY

7. Lubricate the valve lifter follower (1) again with clean engine oil, if necessary, and install it into the cylinder head bore.
8. Install the fuel pump assembly (2) into the cylinder head and start the NEW fuel pump bolts (3) by hand.

CAUTION: Refer to **Fastener Caution** .

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

9. Tighten the NEW fuel pump bolts (3) to 25 N.m (18 lb ft).

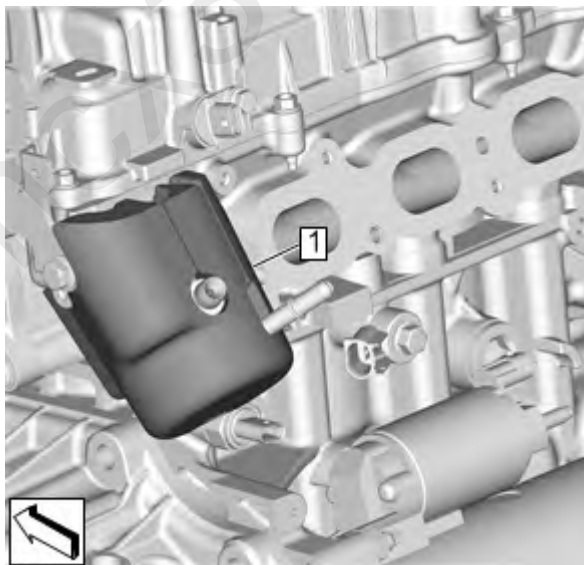


Fig. 141: Fuel Pump Insulator
 Courtesy of GENERAL MOTORS COMPANY

10. Install the fuel pump insulator (1).

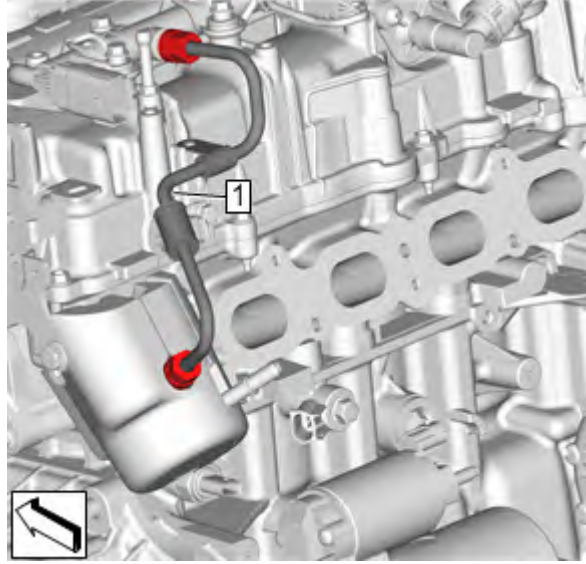


Fig. 142: Fuel Feed Intermediate Pipe
 Courtesy of GENERAL MOTORS COMPANY

NOTE: High pressure fuel feed pipes are one time use only. **ALWAYS** install a **NEW** high pressure fuel feed pipe if the pipe is removed **OR** the fittings are loosened.

11. Install the NEW fuel feed intermediate pipe (1). Refer to [Fuel Feed Intermediate Pipe Replacement](#)

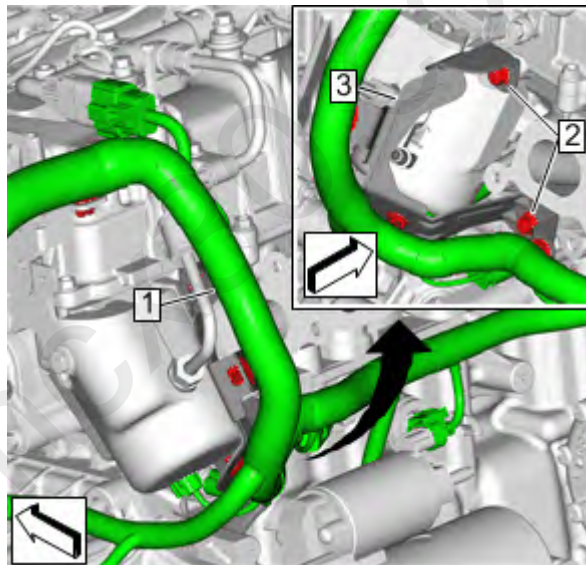


Fig. 143: Engine Wiring Harness Bracket, Bolts And Electrical Connectors
 Courtesy of GENERAL MOTORS COMPANY

12. Position the engine wiring harness bracket (3).
13. Install the engine wiring harness bracket bolts (2) and tighten to 9 N.m (80 lb in).
14. Connect the engine wiring harness electrical connectors (1).

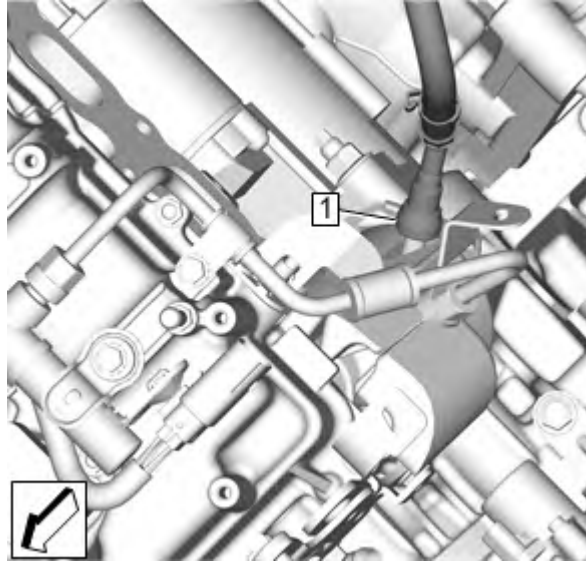


Fig. 144: Fuel Feed Front Pipe

Courtesy of GENERAL MOTORS COMPANY

15. Connect the fuel feed front pipe (1) to the fuel pump. Refer to [Fuel Feed Front Pipe Replacement](#)
16. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#), [Battery Negative Cable Disconnection and Connection \(with KL9\)](#)
17. 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.
18. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#), [Battery Negative Cable Disconnection and Connection \(with KL9\)](#)
19. Install Intake Manifold. Refer to [Intake Manifold Replacement](#)
20. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#), [Battery Negative Cable Disconnection and Connection \(with KL9\)](#)

FUEL SYSTEM CLEANING

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

1. Drain the fuel tank. Refer to [Fuel Tank Draining](#)
2. Remove the fuel pump module assembly. Refer to [Fuel Tank Fuel Pump Module Replacement \(FWD\)](#), [Fuel Tank Fuel Pump Module Replacement \(AWD\)](#)
3. Inspect the fuel pump module strainer. Replace the pump module assembly if the fuel strainer is contaminated.

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.

4. Flush the fuel tank with hot water.
5. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to be sure that the removal of the water from the fuel tank is complete.
6. Allow the tank to dry completely before reassembly.
7. Disconnect the fuel feed pipe at the engine fuel rail. Refer to [Plastic Collar Quick Connect Fitting Service](#)

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

8. Clean the fuel pipes by applying air pressure in the opposite direction of the fuel flow.
9. Connect the fuel feed pipe to the engine fuel rail. Refer to [Plastic Collar Quick Connect Fitting Service](#)
10. Install the fuel pump module assembly. Refer to [Fuel Tank Fuel Pump Module Replacement \(FWD\)](#)[Fuel Tank Fuel Pump Module Replacement \(AWD\)](#).

FUEL FEED FRONT PIPE REPLACEMENT

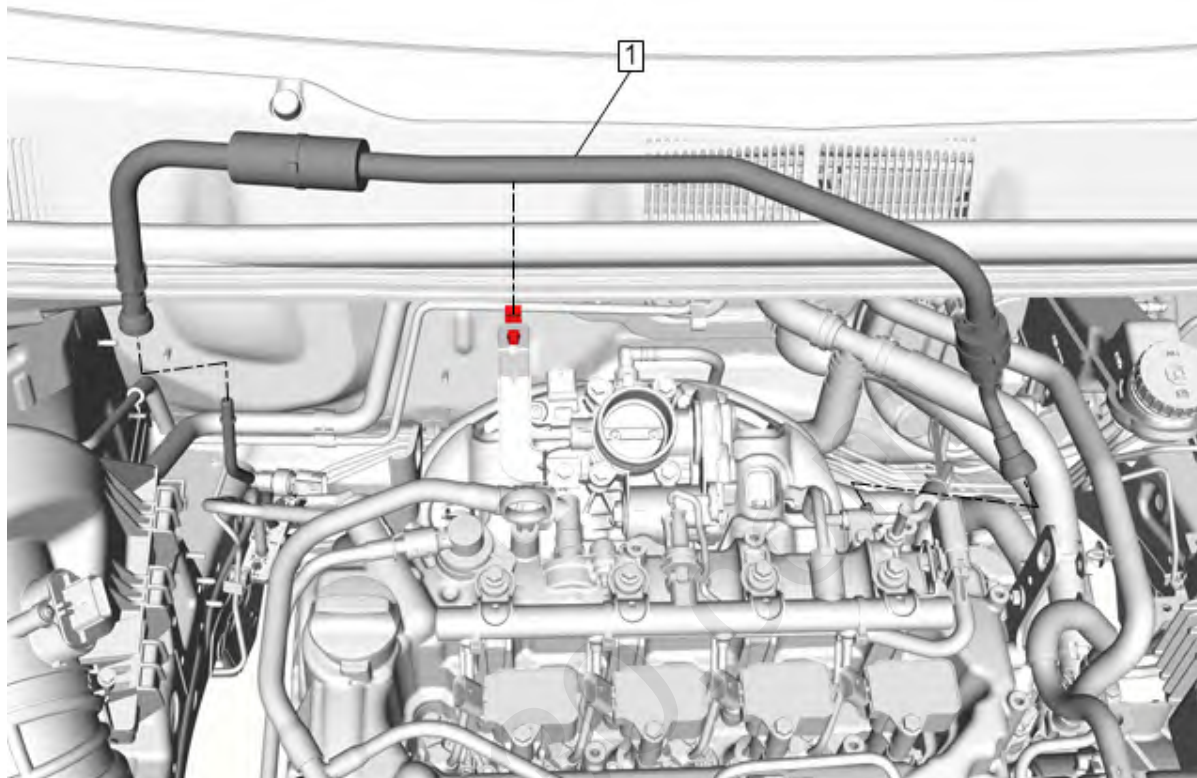


Fig. 145: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Gasoline/Gasoline Vapors Warning .	
WARNING: Refer to Safety Glasses Warning .	
Preliminary Procedures 1. Relieve fuel system pressure. Refer to Fuel Pressure Relief 2. Remove Intake Manifold. Refer to Intake Manifold Replacement 3. Remove wiring harness bracket.	
1	Fuel Feed Front Pipe Procedure Disconnect the quick connects and remove from retainer. Refer to Metal Collar Quick Connect Fitting Service

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

Removal Procedure

WARNING: Fuel escapes - observe safety measures and national legislation. Failure

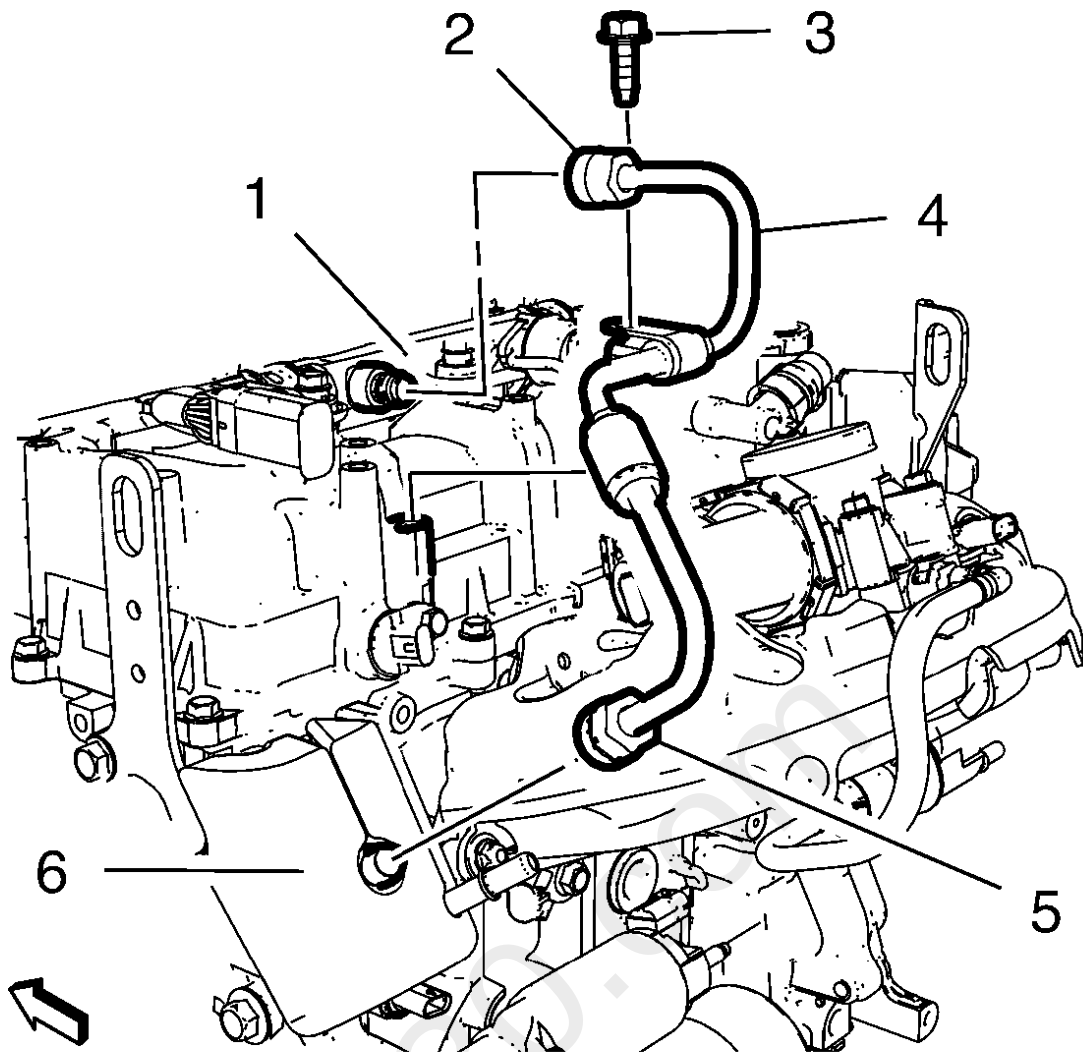


Fig. 147: Fuel Feed Intermediate Pipe, Fittings And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW fuel feed intermediate pipe (4).

CAUTION: Refer to Component Fastener Tightening Caution .

2. Hand tighten Fuel Feed Intermediate Pipe Fittings (2, 5)
3. Tighten Fuel Feed Intermediate Pipe Fittings (2, 5) to 30 N.m (22 lb ft)

CAUTION: Refer to Fastener Caution .

4. Install and tighten Fuel Injection Fuel Feed Pipe Clip Bolt (3) to 10 N.m (89 lb in)
5. Connect Charge Air Cooler Outlet Air Hose @ Throttle Body. Refer to Charge Air Cooler Outlet Air Hose Replacement
6. Connect Battery Negative Cable. Refer to Battery Negative Cable Disconnection and Connection (without KL9). Battery Negative Cable Disconnection and Connection (with KL9)
7. Pressurize the fuel system and inspect for leaks.
8. Install Intake Manifold Cover. Refer to Intake Manifold Cover Replacement » Install

EVAPORATIVE EMISSION CANISTER REPLACEMENT (FWD)

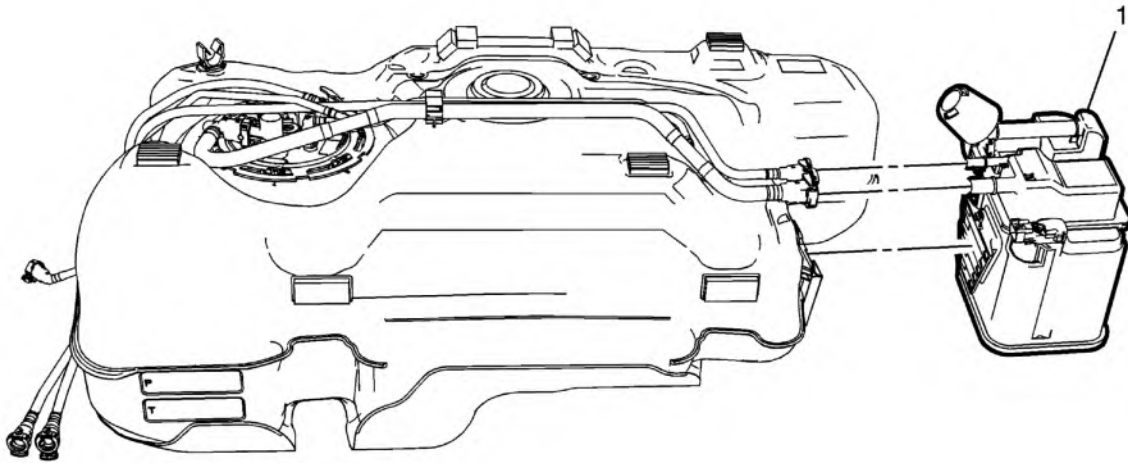


Fig.148: Evaporative Emission Canister (FWD).

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.	
Preliminary Procedures 1. Remove the fuel tank. Refer to Fuel Tank Replacement (FWD). 2. Remove the evaporative emission pipes. Refer to Plastic Collar Quick Connect Fitting Service	
1	Evaporative Emission Canister

EVAPORATIVE EMISSION CANISTER REPLACEMENT (AWD)

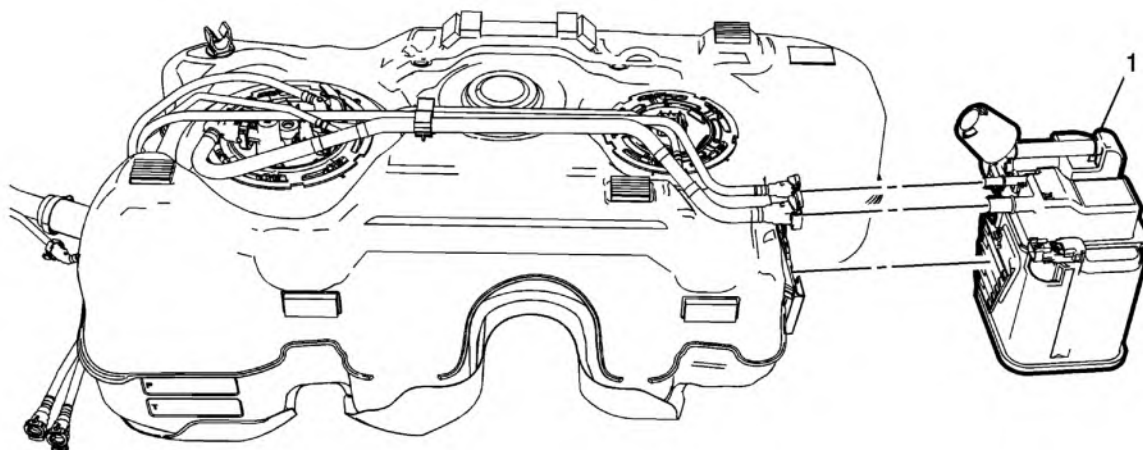


Fig. 149: Evaporative Emission Canister (AWD).

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.	
Preliminary Procedures 1. Remove the fuel tank. Refer to Fuel Tank Replacement (AWD). 2. Remove the evaporative emission pipes. Refer to Plastic Collar Quick Connect Fitting Service	
1	Evaporative Emission Canister

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

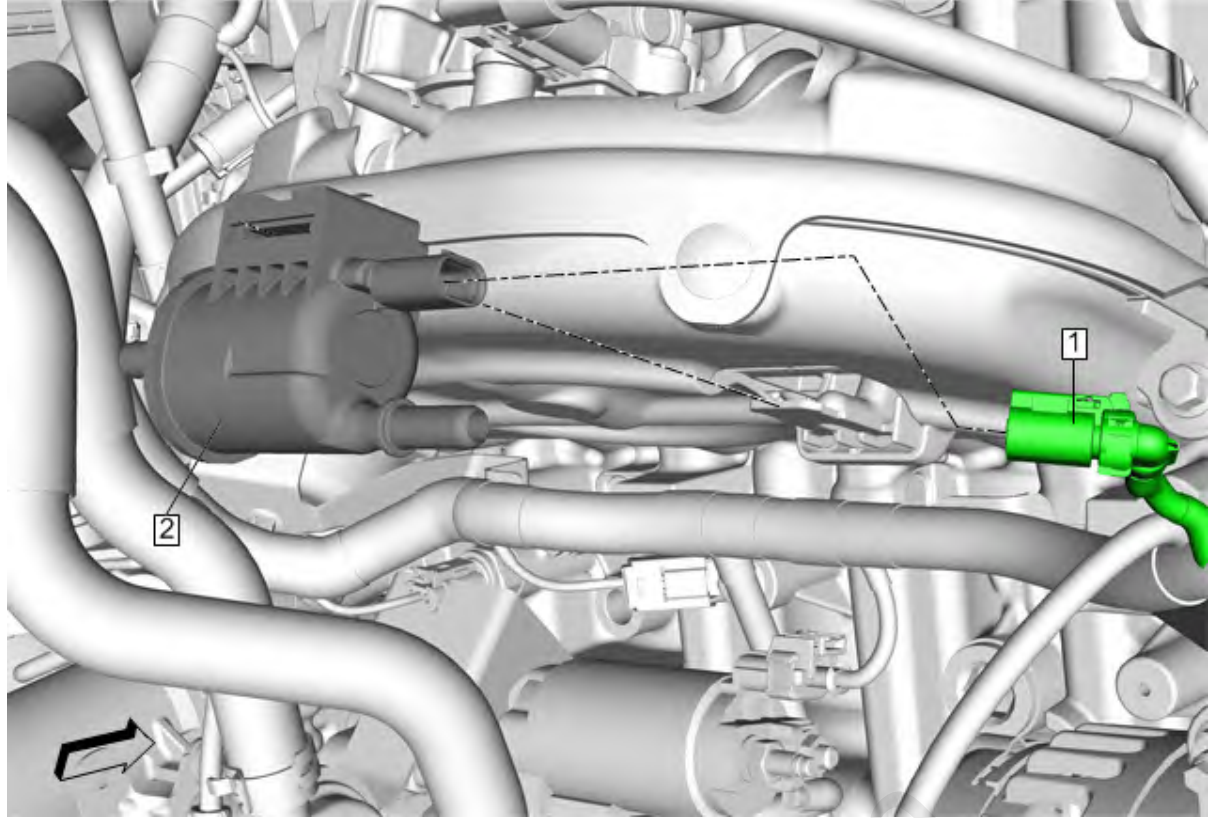


Fig. 150: Evaporative Emission Canister Purge Solenoid Valve

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect Evaporative Emission Canister Purge Tube (Qty: 2) @ Evaporative Emission Canister Purge Solenoid Valve Refer to Evaporative Emission Canister Purge Tube Replacement	
1	Electrical Connector
2	Evaporative Emission Canister Purge Solenoid Valve

EVAPORATIVE EMISSION CANISTER PURGE TUBE REPLACEMENT

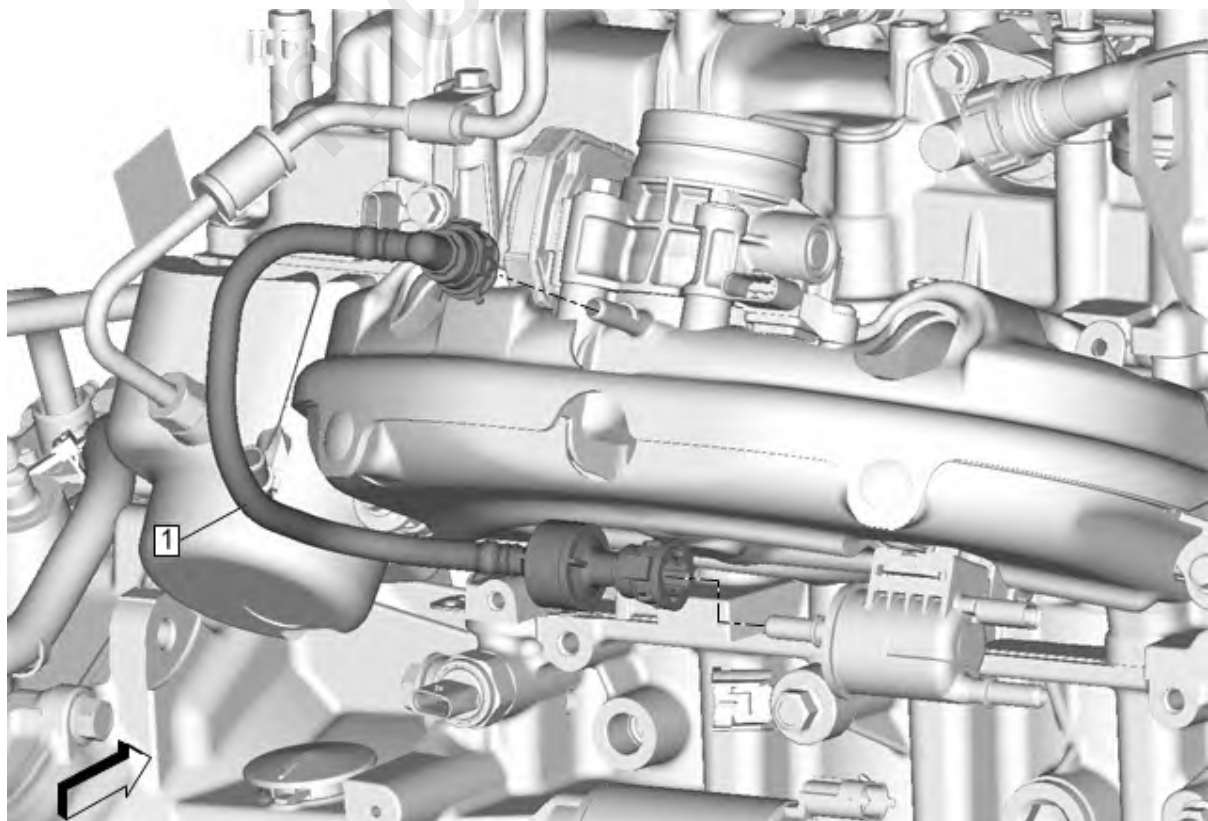


Fig. 151: Evaporative Emission Canister Purge Tube
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Evaporative Emission Canister Purge Tube Procedure Disconnect the evaporative emission canister purge tube from the intake manifold and the evaporative emission canister purge valve. Refer to Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

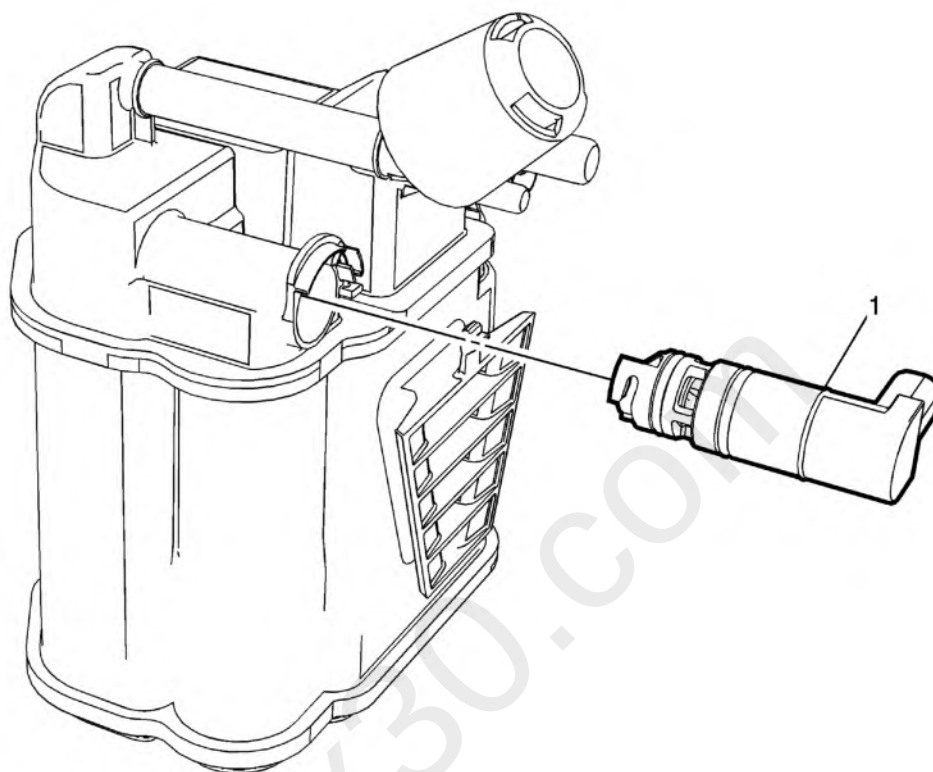


Fig. 152: Evaporative Emission Canister Vent Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the evaporative emission canister. Refer to Evaporative Emission Canister Replacement (FWD) Evaporative Emission Canister Replacement (AWD) .	
1	Evaporative Emission Canister Vent Solenoid Valve Procedure 1. Disconnect the electrical connector. 2. Rotate the solenoid counterclockwise to remove.

EVAPORATIVE EMISSION PIPE REPLACEMENT (ENGINE TO TANK)

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

WARNING: Refer to [Safety Goggles and Fuel Warning](#) .

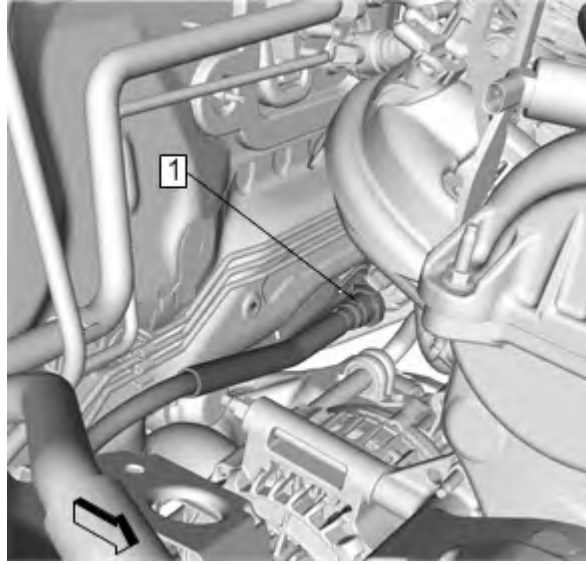


Fig. 153: Evaporative Emission Pipe
 Courtesy of GENERAL MOTORS COMPANY

1. Disconnect Evaporative Emission Pipe (1) @ Evaporative Emission Canister Purge Solenoid Valve. Refer to [Plastic Collar Quick Connect Fitting Service](#)

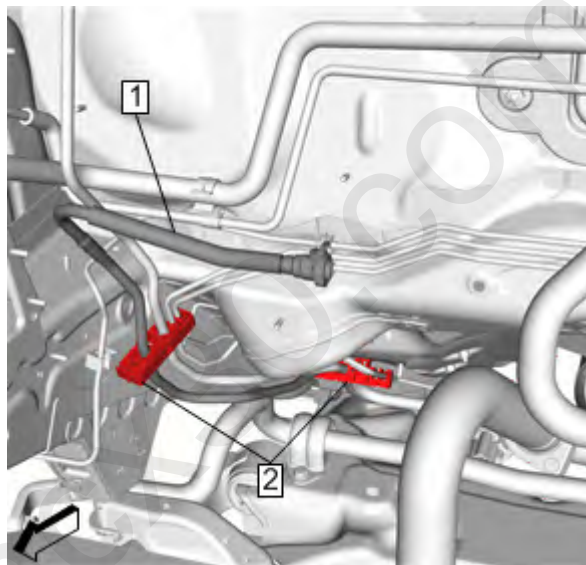


Fig. 154: Evaporative Emission Pipe And Retainers
 Courtesy of GENERAL MOTORS COMPANY

2. Remove Evaporative Emission Pipe (1) @ Retainers (2) (Qty: 2)
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)

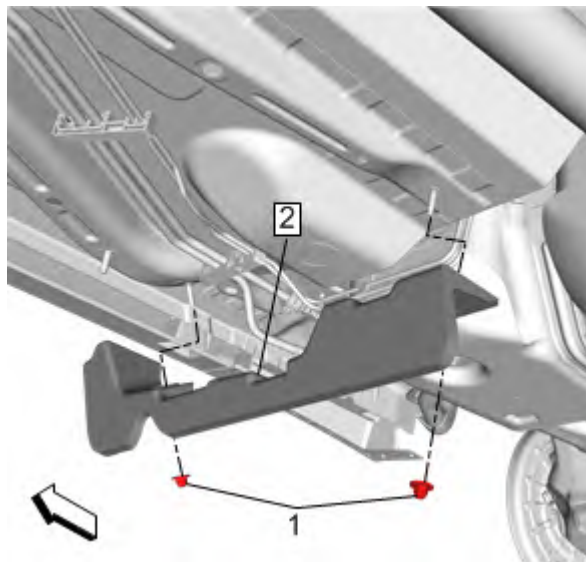


Fig. 155: Underbody Cross Sill Shield And Nuts
Courtesy of GENERAL MOTORS COMPANY

4. Remove Underbody Cross Sill Shield Nuts (1) (Qty: 2)
5. Remove Underbody Cross Sill Shield (2)

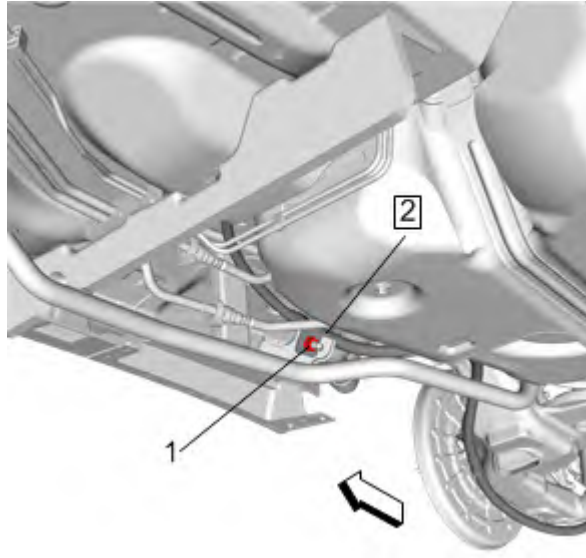


Fig. 156: Parking Brake Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

6. Remove Parking Brake Cable Nut (1)
7. Remove Parking Brake Cable (2)

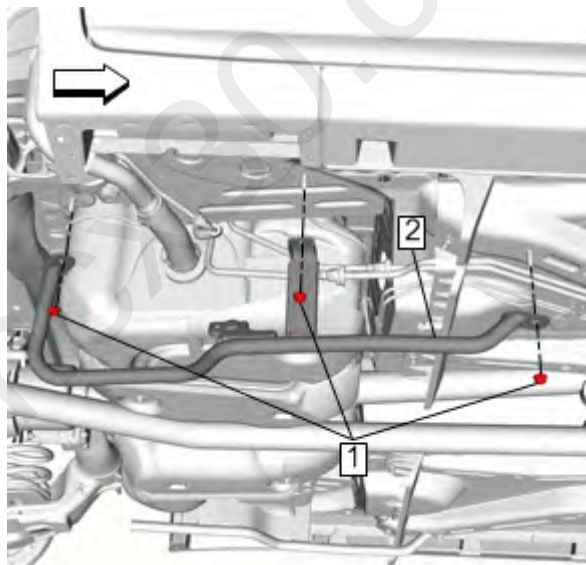


Fig. 157: Fuel Tank Protector And Nuts
Courtesy of GENERAL MOTORS COMPANY

8. Remove Fuel Tank Protector Nuts (1) (Qty: 3)
9. Remove Fuel Tank Protector (2)

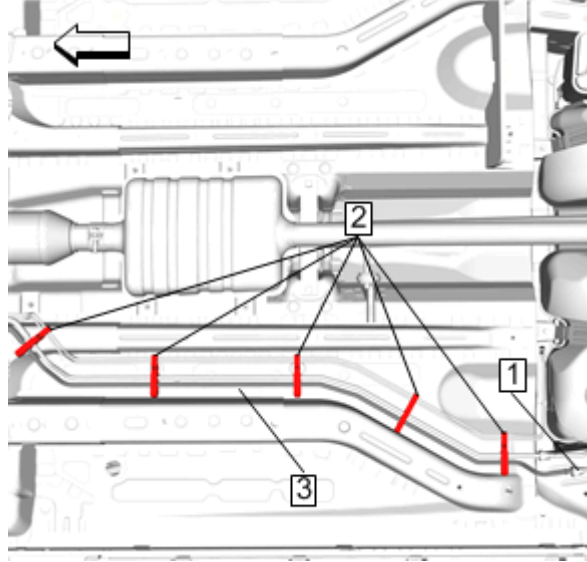


Fig. 158: Evaporative Emission Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

10. Disconnect Evaporative Emission Pipe (1) @ Evaporative Emission Pipe (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).
11. Remove Evaporative Emission Pipe (1) @ Retainers (2) (Qty: 5)

Installation Procedure

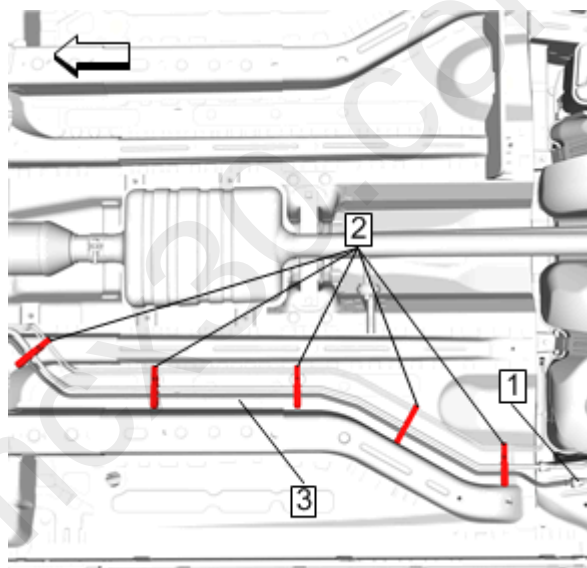


Fig. 159: Evaporative Emission Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

1. Install Evaporative Emission Pipe (1) @ Retainers (2) (Qty: 5)
2. Connect Evaporative Emission Pipe (1) @ Evaporative Emission Pipe (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).

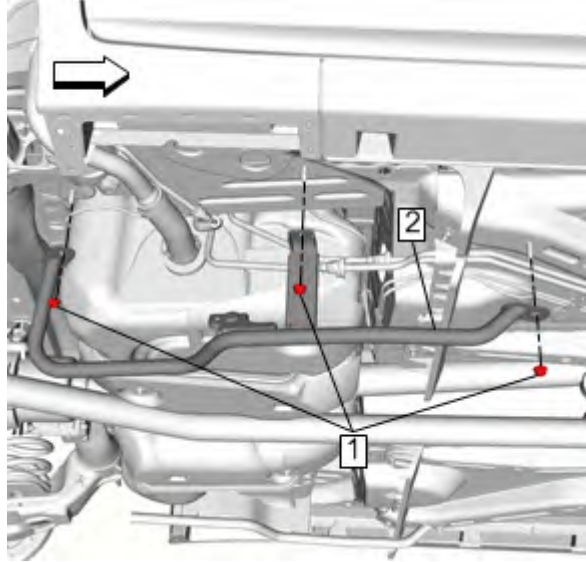


Fig. 160: Fuel Tank Protector And Nuts

Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Tank Protector (2)

CAUTION: Refer to **Fastener Caution** .

4. Install and tighten Fuel Tank Protector Nuts (1) (Qty: 3) to 22 N.m (16 lb ft)

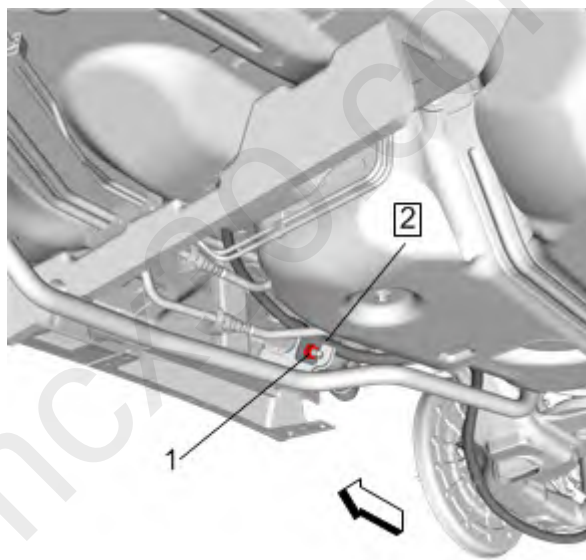


Fig. 161: Parking Brake Cable And Nut

Courtesy of GENERAL MOTORS COMPANY

5. Install Parking Brake Cable (2)
6. Install and tighten Parking Brake Cable Nut (1) to 22 N.m (16 lb ft)

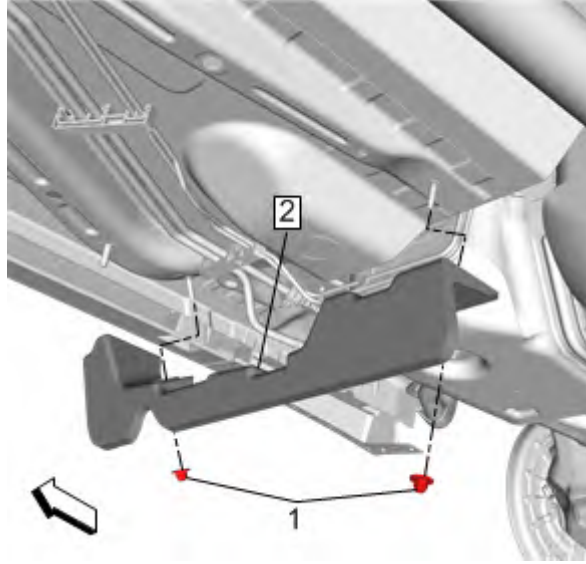


Fig. 162: Underbody Cross Sill Shield And Nuts
 Courtesy of GENERAL MOTORS COMPANY

7. Install Underbody Cross Sill Shield (2)
8. Install and tighten Underbody Cross Sill Shield Nuts (1) (Qty: 2) to 3.5 N.m (31 lb in)
9. Lower the vehicle.

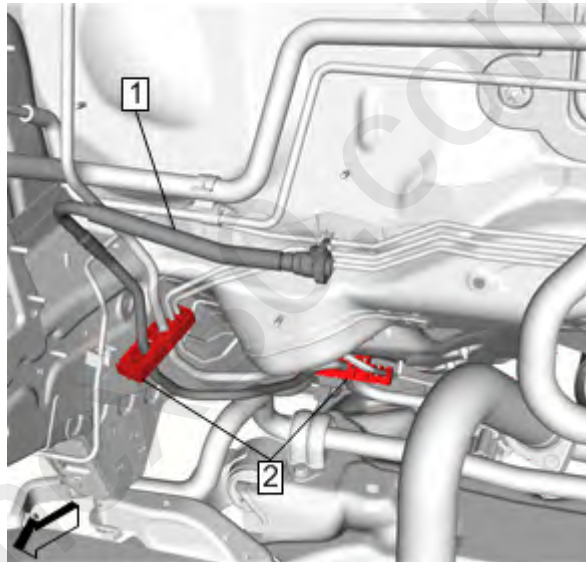


Fig. 163: Evaporative Emission Pipe And Retainers
 Courtesy of GENERAL MOTORS COMPANY

10. Install Evaporative Emission Pipe (1) @ Retainers (2) (Qty: 2)

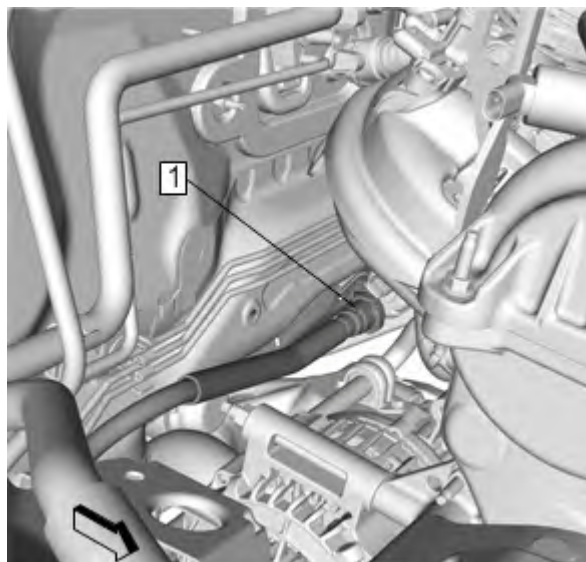


Fig. 164: Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

11. Connect Evaporative Emission Pipe (1) @ Evaporative Emission Canister Purge Solenoid Valve.
Refer to [Plastic Collar Quick Connect Fitting Service](#)

EVAPORATIVE EMISSION PIPE REPLACEMENT (CANISTER TO PIPE AWD)

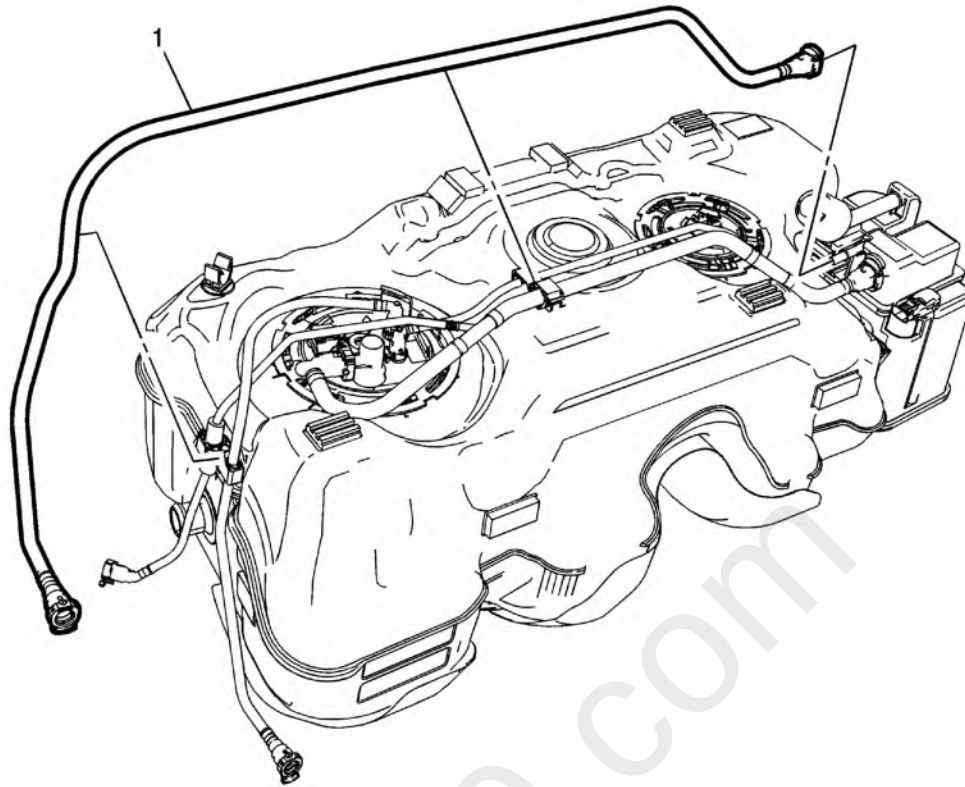


Fig. 165: Evaporative Emission System Hose/Pipe (Canister To Pipe - AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.	
Preliminary Procedure Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD) .	
1	Evaporative Emission Pipe Procedure Disconnect the quick connect fittings. Refer to Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION PIPE REPLACEMENT (CANISTER TO PIPE FWD)

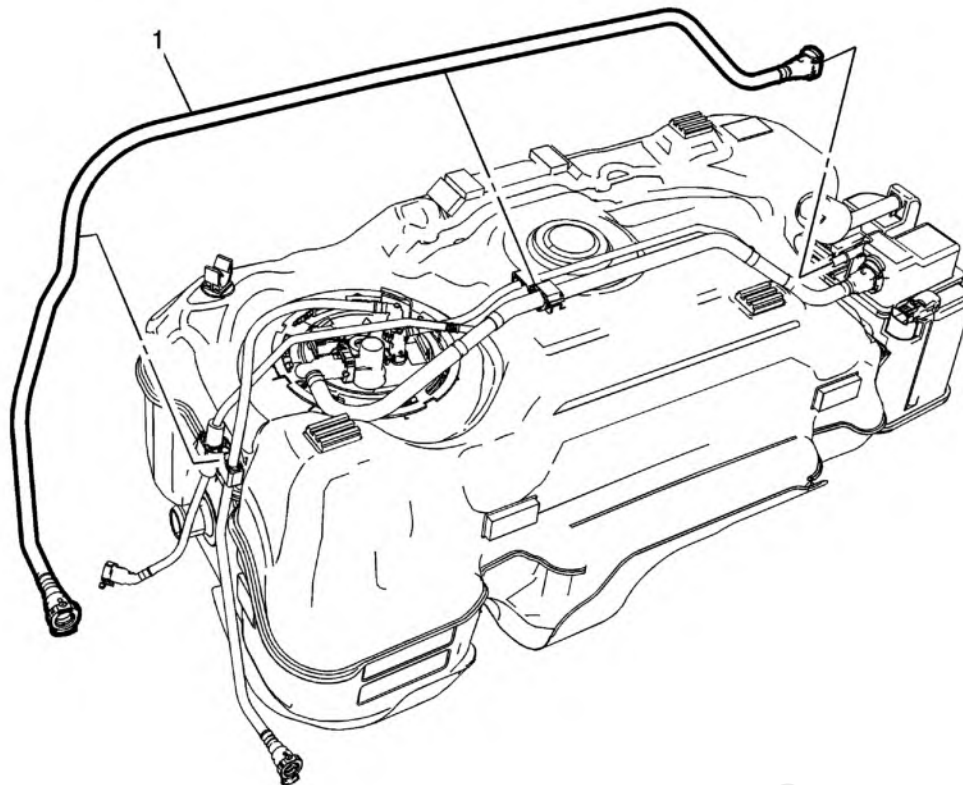


Fig. 166: Evaporative Emission System Hose/Pipe (Canister To Pipe - FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.	
Preliminary Procedure Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD) .	
1	Evaporative Emission Pipe Procedure Disconnect the quick connect fittings. Refer to Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION PIPE REPLACEMENT (FUEL PUMP MODULE TO CANISTER AWD)

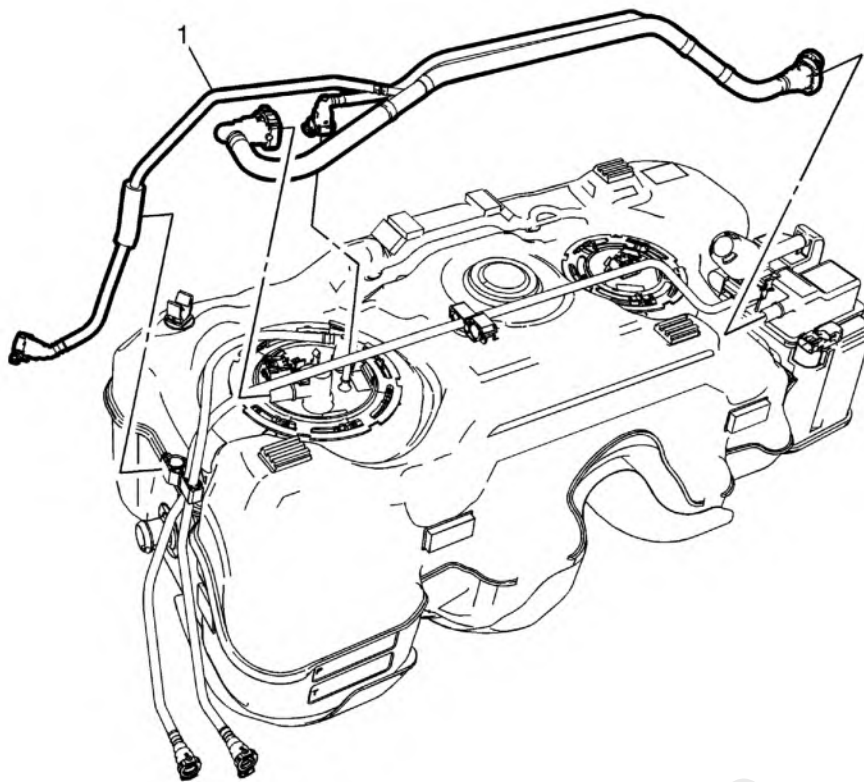


Fig. 167: Evaporative Emission System Hose/Pipe (Fuel Pump Module To Canister - AWD)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.	
Preliminary Procedure Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD) .	
1	Evaporative Emission Pipe Procedure Disconnect the quick connect fittings. Refer to Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION PIPE REPLACEMENT (FUEL PUMP MODULE TO CANISTER FWD)

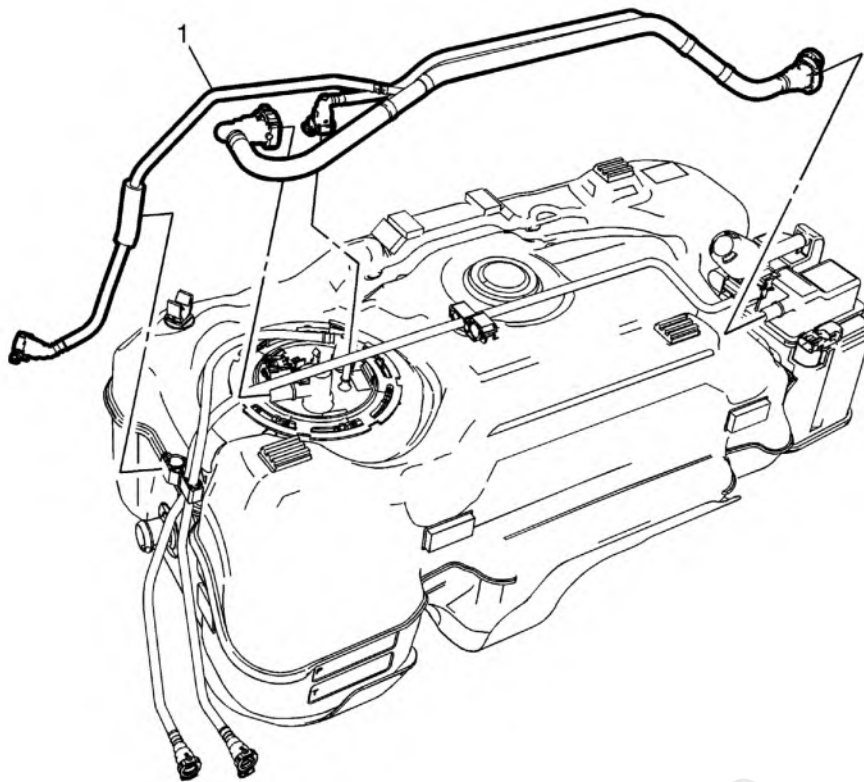


Fig. 168: Evaporative Emission System Hose/Pipe (Fuel Pump Module To Canister - FWD)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.	
Preliminary Procedure Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD) .	
1	Evaporative Emission Pipe Procedure Disconnect the quick connect fittings. Refer to Plastic Collar Quick Connect Fitting Service

IGNITION COIL REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover. Refer to [Intake Manifold Cover Replacement](#)
2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#). [Battery Negative Cable Disconnection and Connection \(with KL9\)](#)

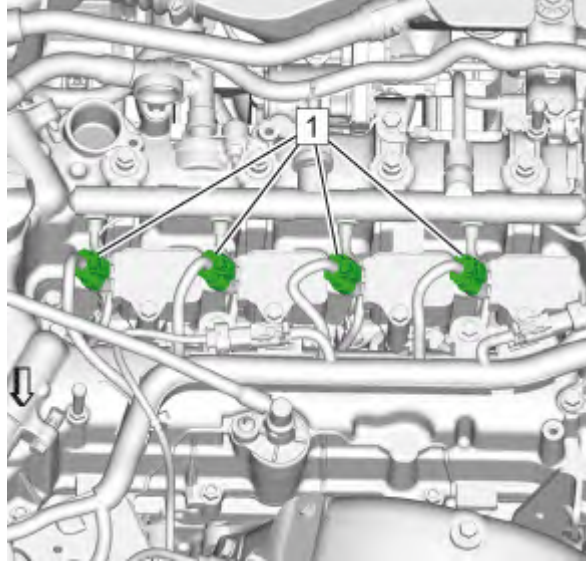


Fig. 169: Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connectors (1).

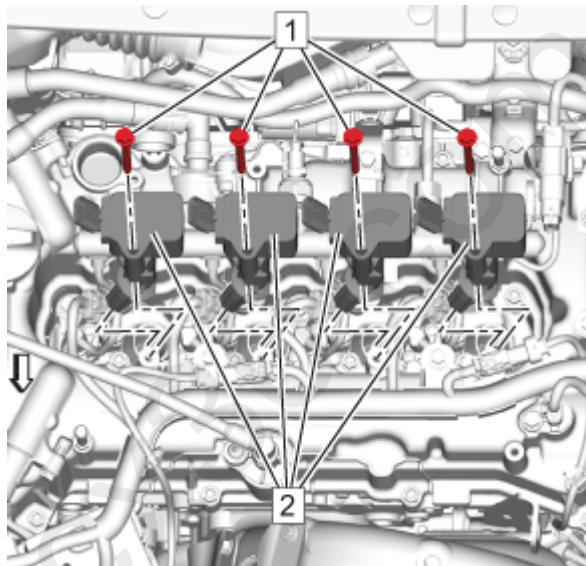


Fig. 170: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coil bolts (1).
5. Remove the ignition coils (2).

Installation Procedure

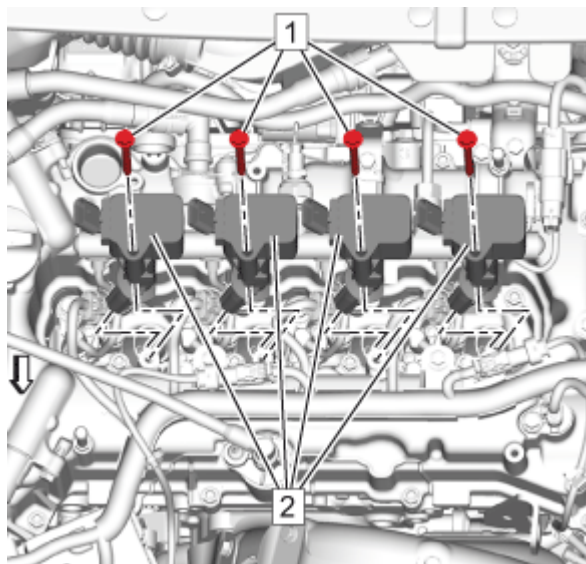


Fig. 171: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coils (2).

CAUTION: Refer to [Fastener Caution](#) .

2. Install the ignition coil bolts (1) and tighten to 10 N.m (89 lb in).

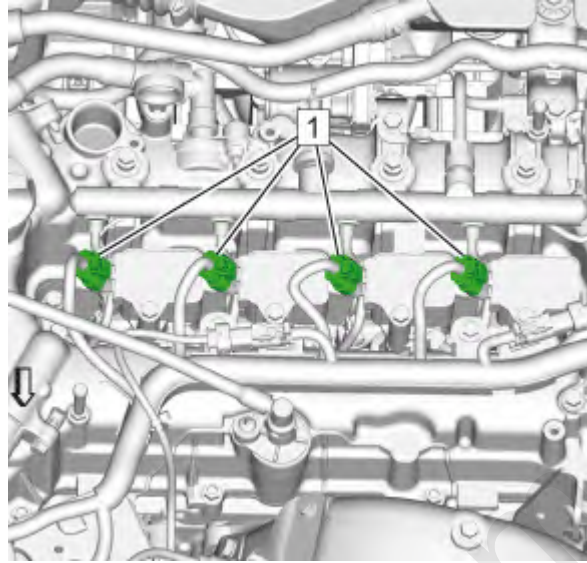


Fig. 172: Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

NOTE: The ignition coil wiring harness cylinders 1 and 3 are marked white.

3. Connect the electrical connectors (1).
4. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#), [Battery Negative Cable Disconnection and Connection \(with KL9\)](#).
5. Install Intake Manifold Cover. Refer to [Intake Manifold Cover Replacement](#)

SPARK PLUG INSPECTION

Spark Plug Usage

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

Spark Plug Inspection

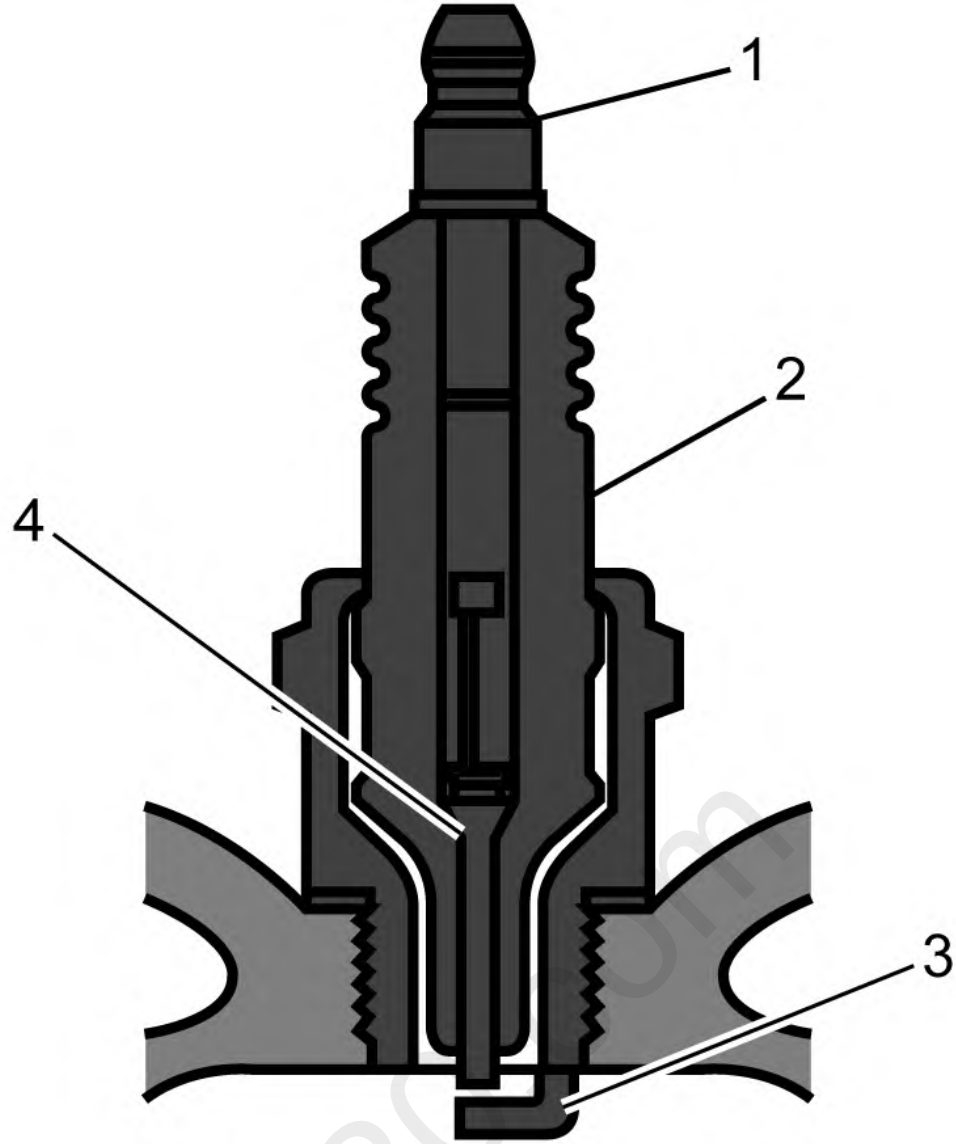


Fig. 173: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

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

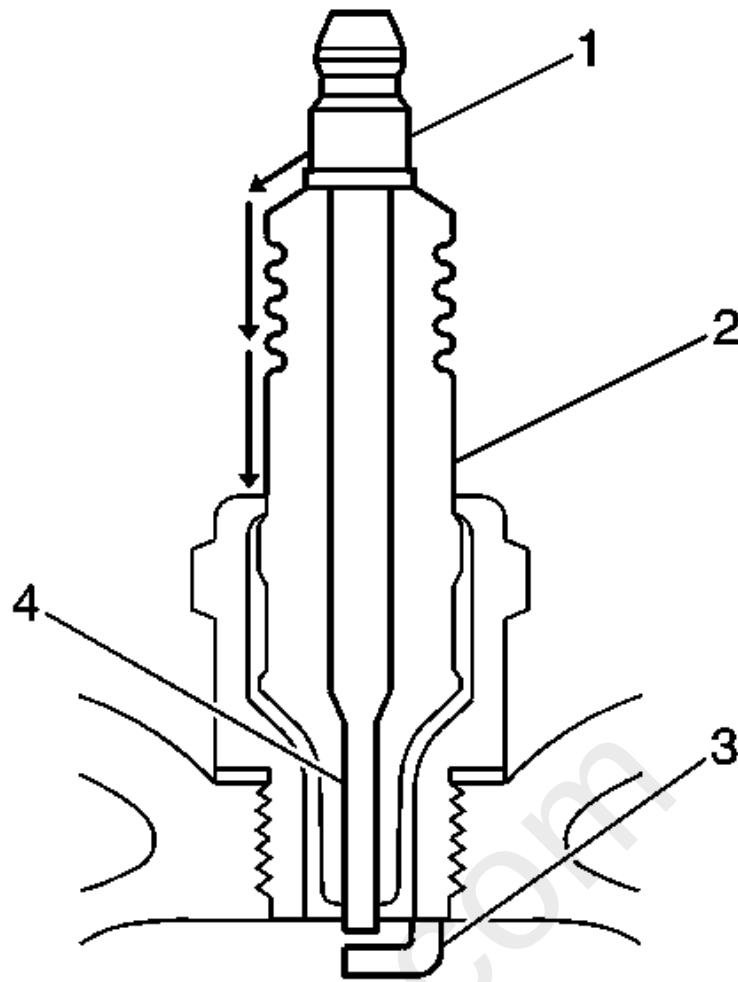


Fig. 174: Inspecting Spark Plug For Flashover Or Carbon Tracking Soot
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
 - Inspect the spark plug boot for damage.
 - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.

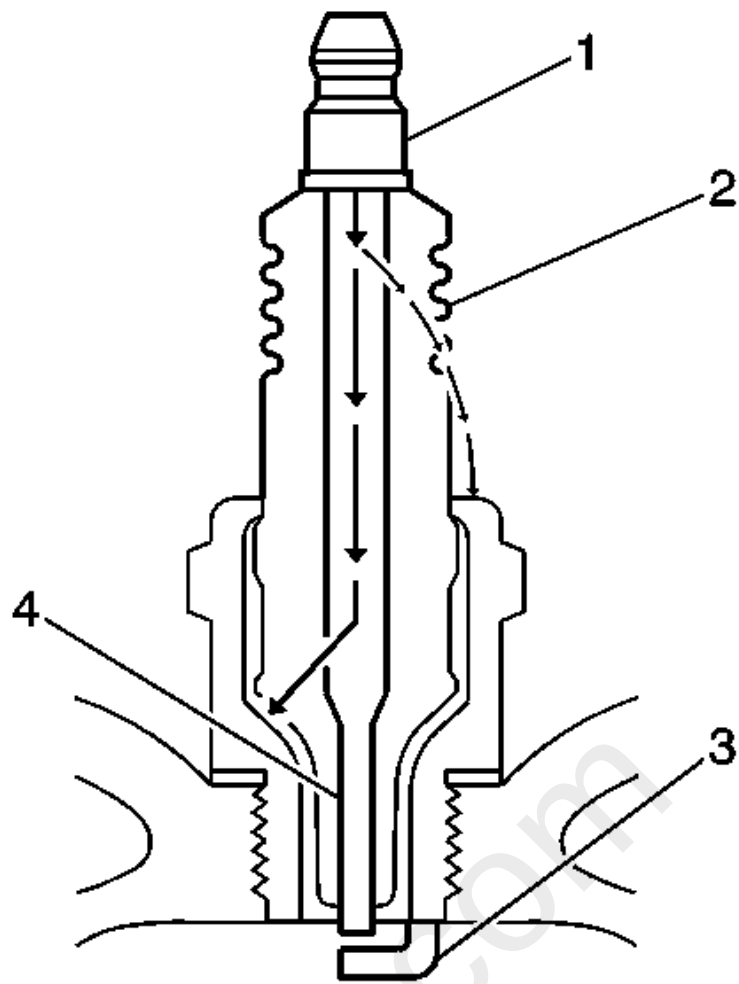


Fig. 175: Inspecting Spark Plug Insulator
Courtesy of GENERAL MOTORS COMPANY

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

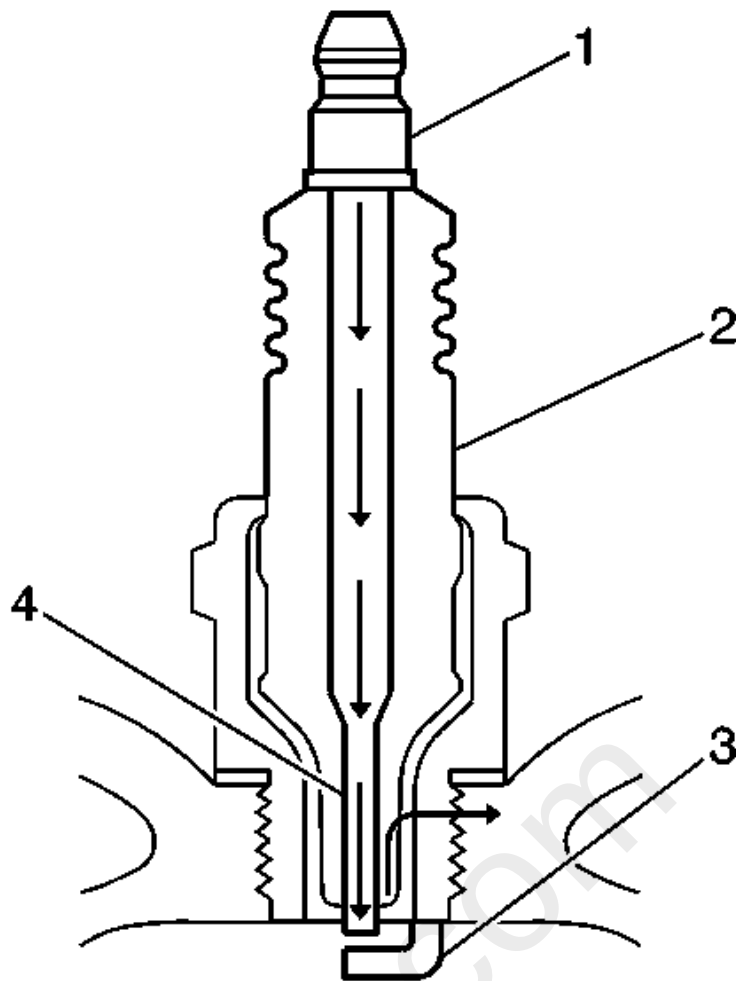


Fig. 176: Cutaway/Description View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

4. Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. Refer to **Ignition System Specifications** . An excessively wide electrode gap can prevent correct spark plug operation.
 - Inspect for the correct spark plug torque. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
 - Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
 - Inspect for a broken or worn side electrode (3).
 - Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
5. A rattling sound indicates internal damage.
6. A loose center electrode (4) reduces the spark intensity.
 - Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
 - Inspect for worn or missing platinum pads on the electrodes (3, 4) If equipped.
 - Inspect for excessive fouling.
 - Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

1. Normal operation - Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
2. Carbon Fouled - Dry, fluffy black carbon, or soot caused by the following conditions:

- Rich fuel mixtures
- Leaking fuel injectors
- Excessive fuel pressure
- Restricted air filter element
- Incorrect combustion
- Reduced ignition system voltage output
- Weak coils
- Worn ignition wires
- Incorrect spark plug gap
- Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling - Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

SPARK PLUG REPLACEMENT

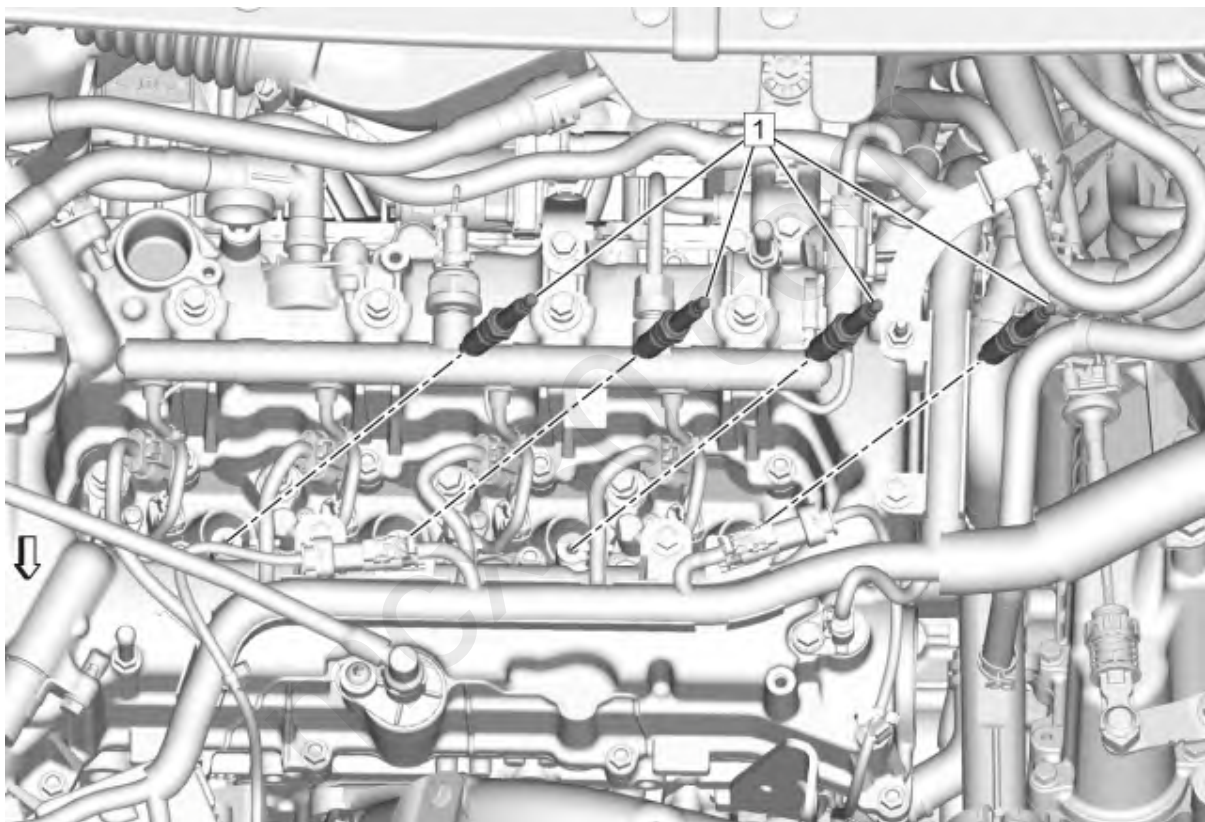


Fig. 177: Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove Ignition Coil. Refer to Ignition Coil Replacement	
1	Spark Plug (Qty: 4) CAUTION: Refer to: Component Fastener Tightening Caution Tighten 17 N.m (13 lb ft)

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT - INTAKE

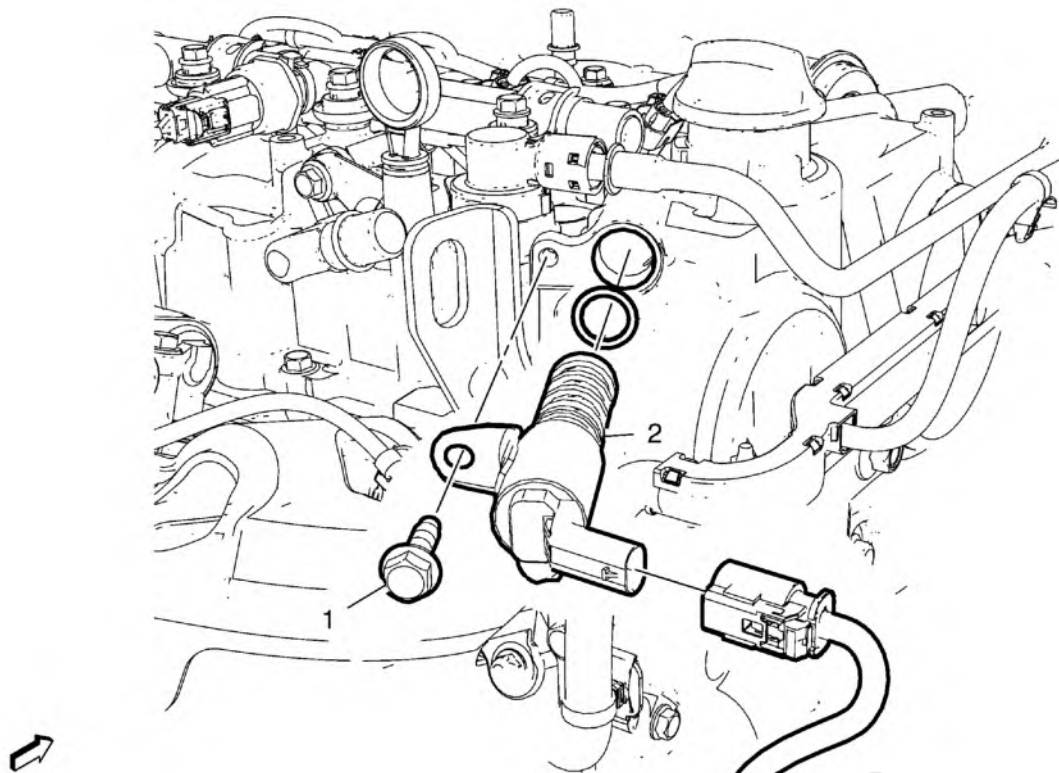


Fig. 178: Camshaft Position Actuator Solenoid Valve - Intake
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement	
1	Camshaft Position Actuator Solenoid Valve Solenoid Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve Procedure 1. Disconnect the electrical connector. 2. Install a NEW O-ring seal.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT - EXHAUST

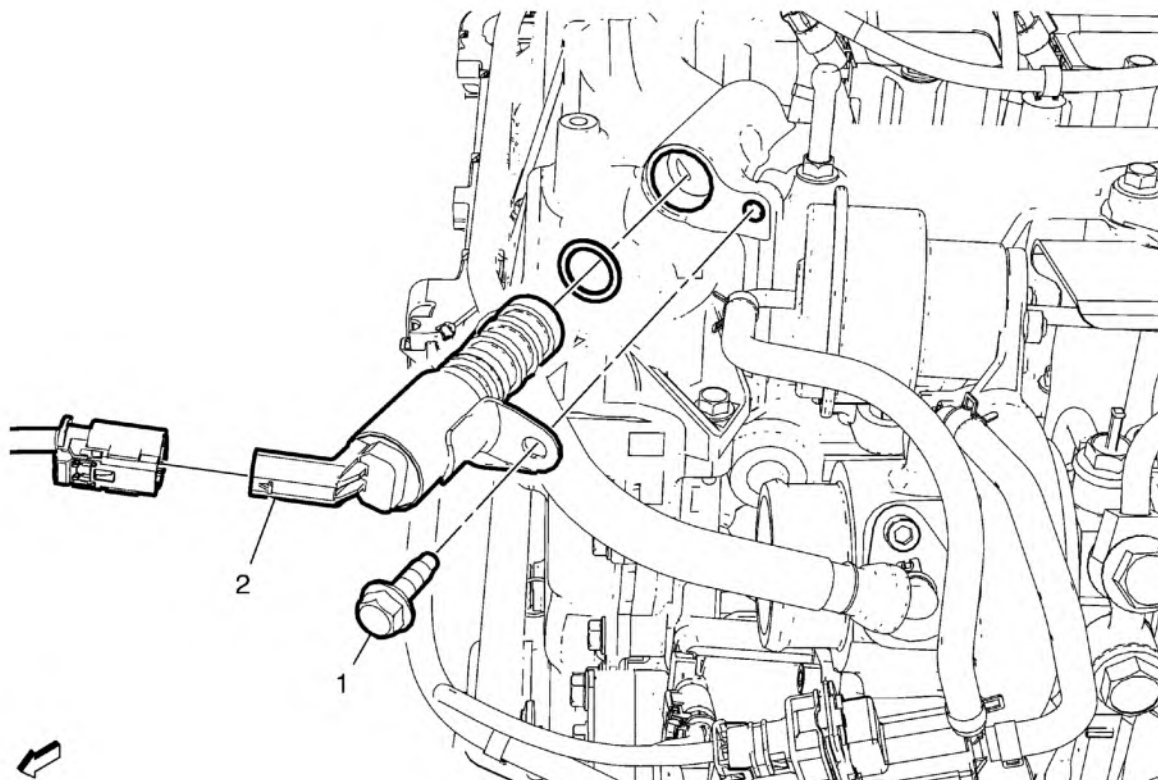


Fig. 179: Camshaft Position Actuator Solenoid Valve - Exhaust
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement	
1	Camshaft Position Actuator Solenoid Valve Solenoid Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve Procedure 1. Disconnect the electrical connector. 2. Install a NEW O-ring seal.

CRANKSHAFT POSITION SENSOR REPLACEMENT (AWD)

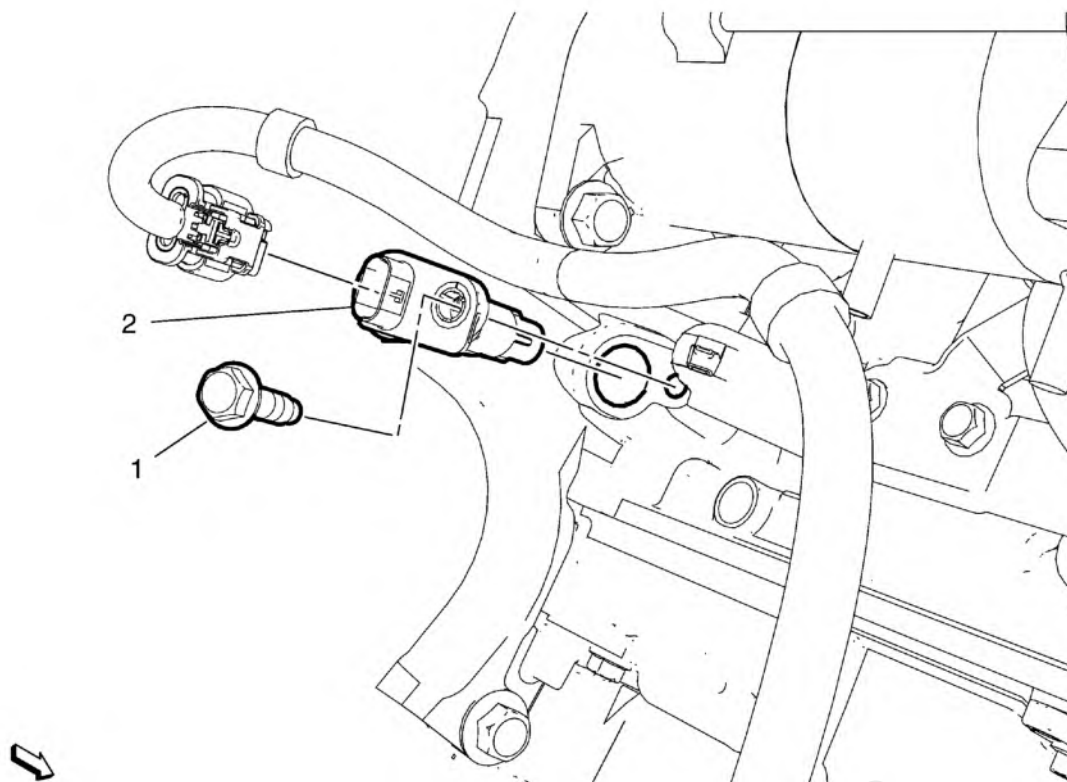


Fig. 180: Crankshaft Position Sensor (AWD)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle 2. Remove Transfer Case. Refer to Transfer Case Replacement	
1	Crankshaft Position Sensor Bolt CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Crankshaft Position Sensor Procedure Disconnect the electrical connector.

CRANKSHAFT POSITION SENSOR REPLACEMENT (FWD)

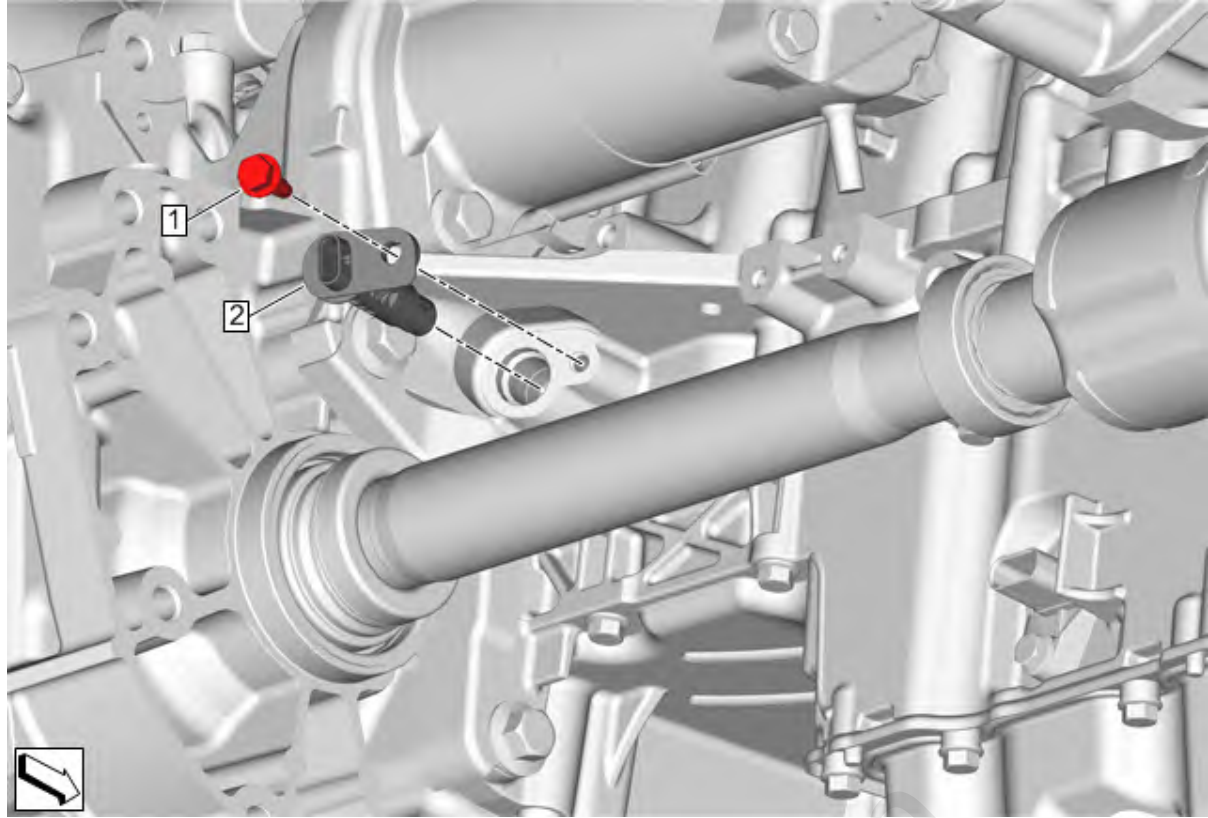


Fig. 181: Crankshaft Position Sensor (FWD)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle 2. Disconnect the electrical connector.	
1	Crankshaft Position Sensor Bolt CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Crankshaft Position Sensor Procedure Perform the crankshaft position sensor variation learn. Refer to Crankshaft Position Variation Learn

CAMSHAFT POSITION SENSOR REPLACEMENT - INTAKE

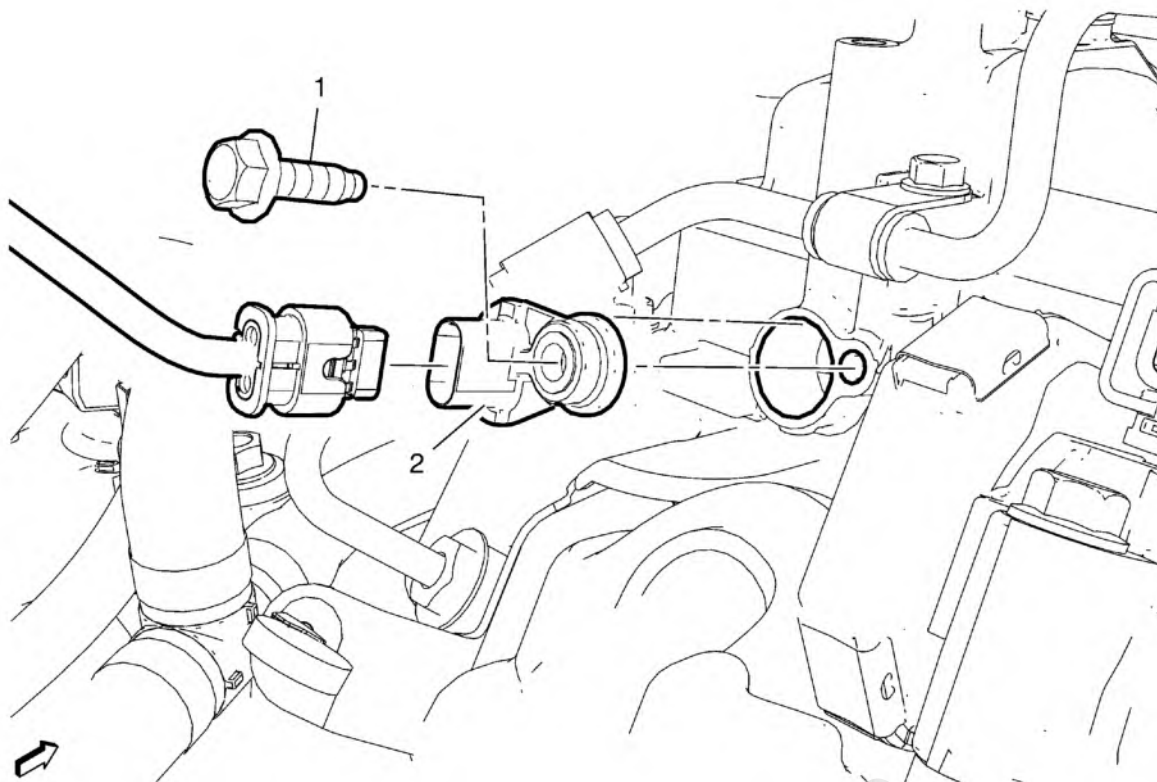


Fig. 182: Camshaft Position Sensor - Intake
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement	
1	Camshaft Position Sensor Bolt CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure 1. Disconnect the electrical connector. 2. Install a NEW O-ring seal.

CAMSHAFT POSITION SENSOR REPLACEMENT - EXHAUST

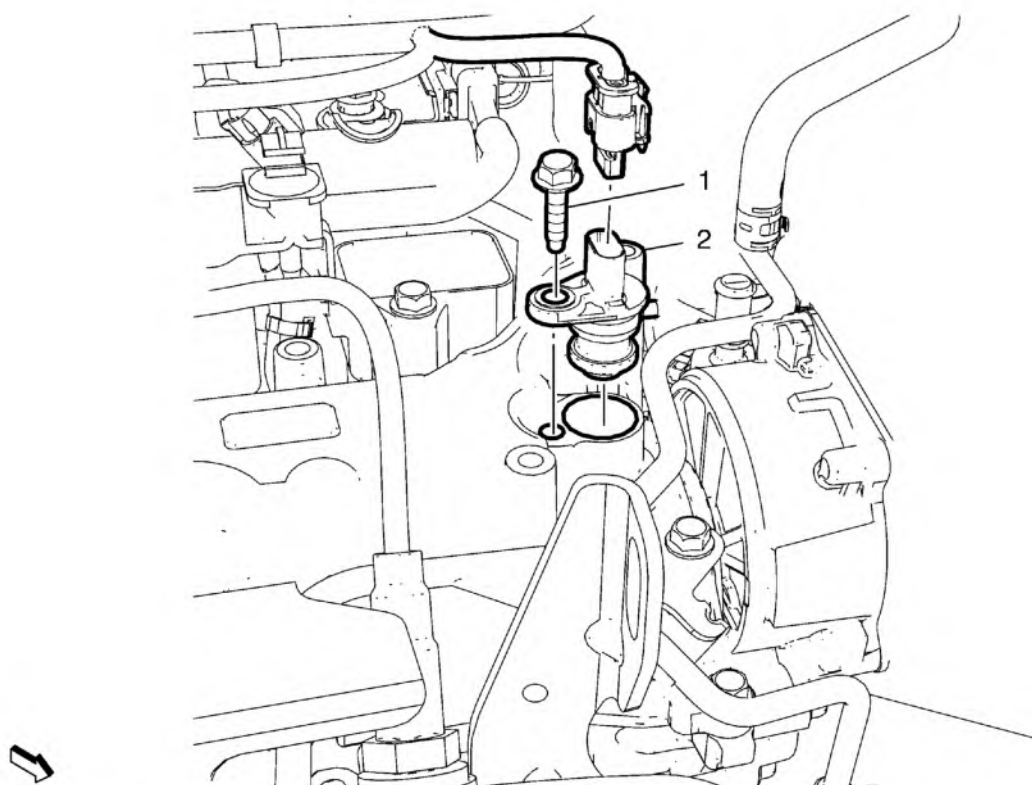


Fig. 183: Camshaft Position Sensor - Exhaust
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement	
1	Camshaft Position Sensor Bolt CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure 1. Disconnect the electrical connector. 2. Install a NEW O-ring seal.

VACUUM PUMP ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove Charge Air Cooler Outlet Hose. Refer to [Charge Air Cooler Outlet Air Hose Replacement](#)
2. Disconnect Power Brake Booster Vacuum Hose. Refer to [Power Brake Booster Vacuum Hose Replacement \(LE2\)](#)
3. Reposition away Radiator Surge Tank. Refer to [Radiator Surge Tank Replacement \(LE2\)](#)

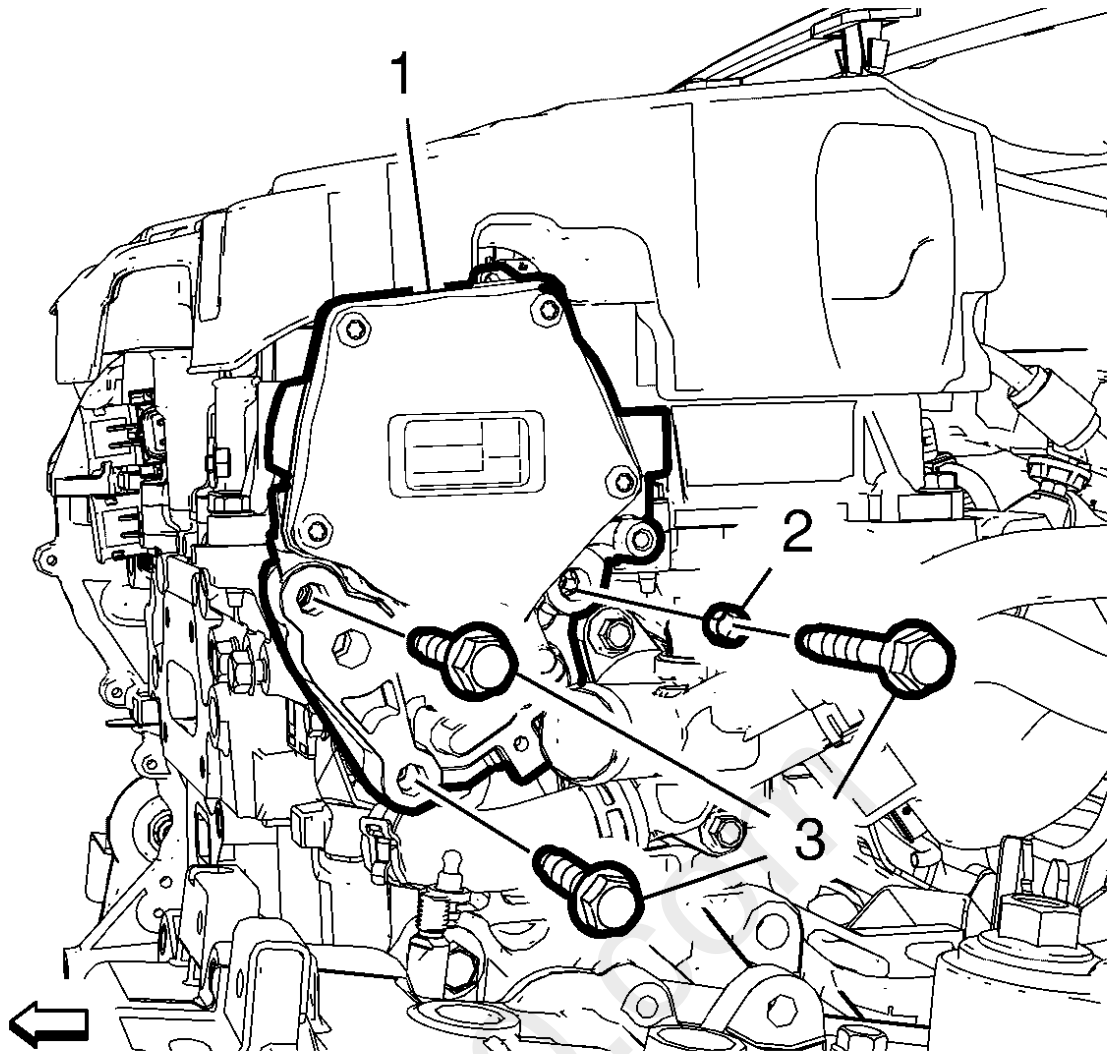


Fig. 184: Vacuum Pump, Bolts And Retainer

Courtesy of GENERAL MOTORS COMPANY

4. Remove the vacuum pump bolts (3).
5. Remove the vacuum pump bolt retainer (2).

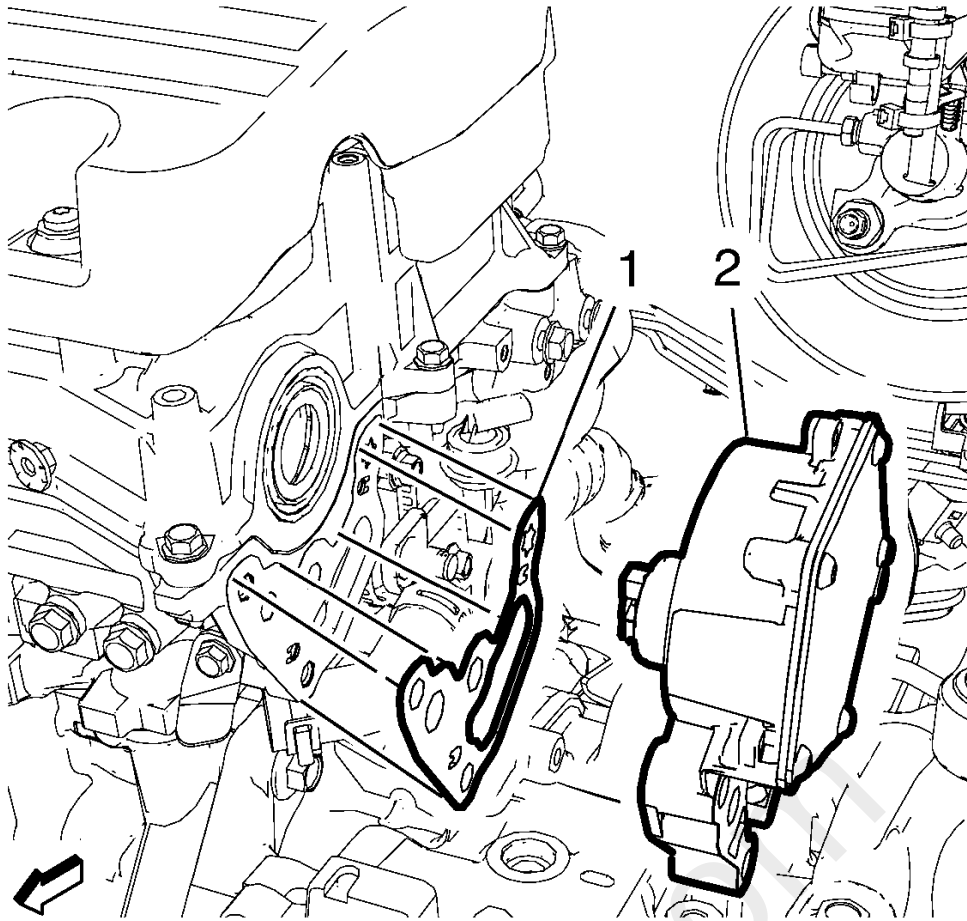


Fig.185: Vacuum Pump And Gasket

Courtesy of GENERAL MOTORS COMPANY

6. Remove the vacuum pump (2).
7. Remove and DISCARD the vacuum pump gasket (1).

Installation Procedure

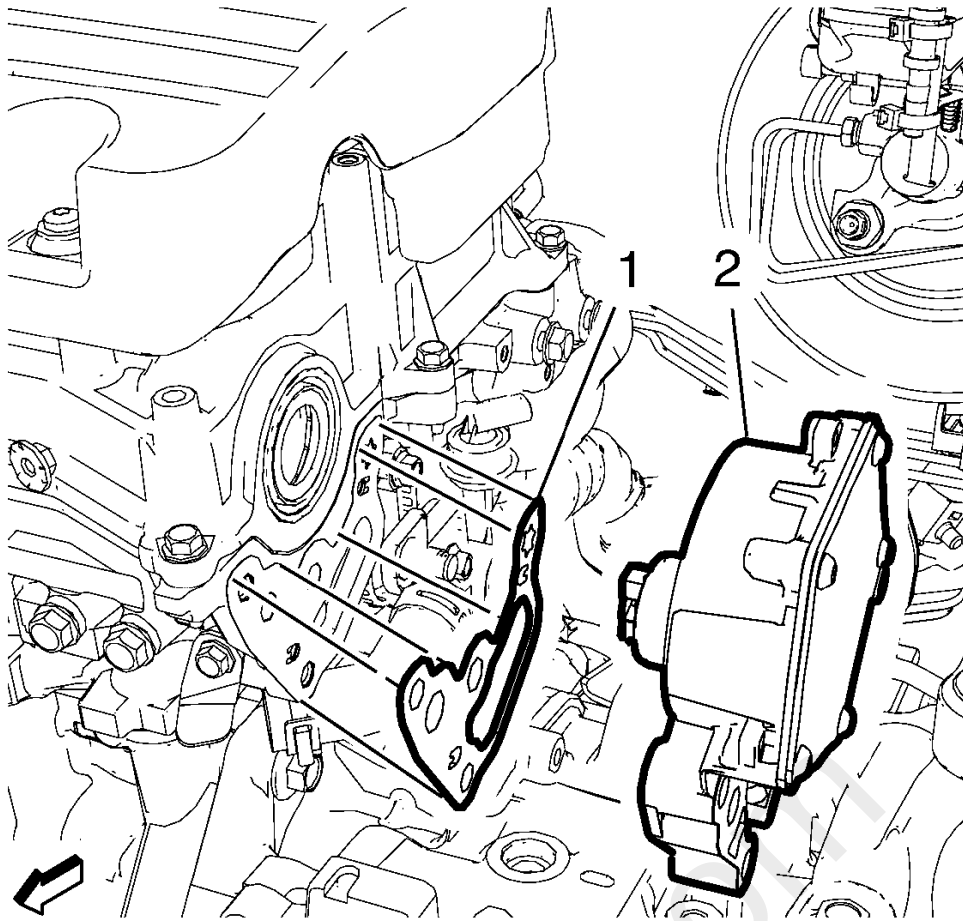


Fig.186: Vacuum Pump And Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW vacuum pump gasket (1).

NOTE: Ensure all passages of the vacuum pump are clean and free of all debris prior to installation.

2. Install the vacuum pump (2).

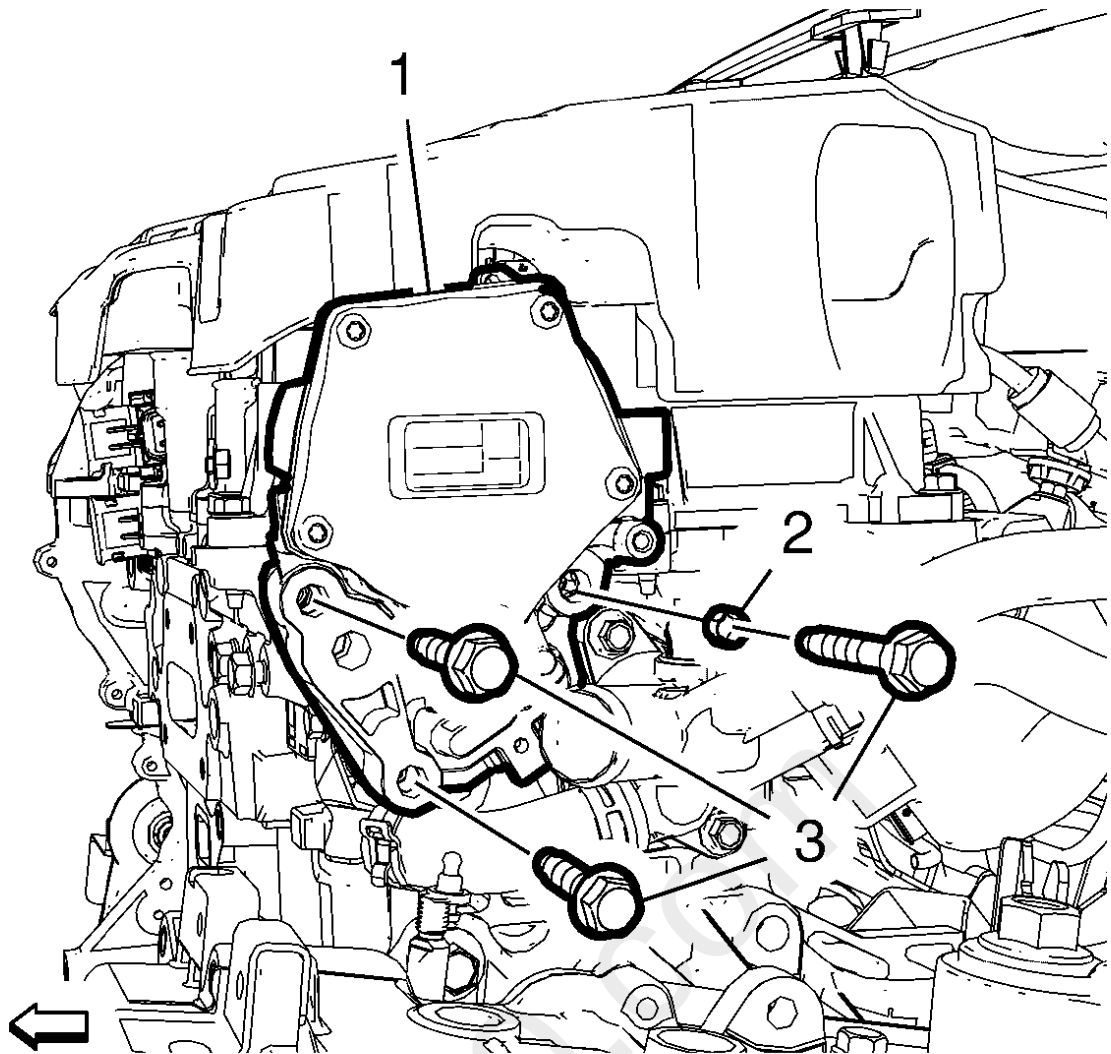


Fig. 187: Vacuum Pump, Bolts And Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Install the vacuum pump bolt retainer (2).

CAUTION: Refer to Fastener Caution .

4. Install the vacuum pump bolts (3) and tighten. Refer to Vacuum Pump Installation
5. Install Radiator Surge Tank. Refer to Radiator Surge Tank Replacement (LE2)
6. Connect Power Brake Booster Vacuum Hose. Refer to Power Brake Booster Vacuum Hose Replacement (LE2)
7. Install Charge Air Cooler Outlet Hose. Refer to Charge Air Cooler Outlet Air Hose Replacement

VACUUM PUMP SEAL REPLACEMENT

Special Tools

DT-45866 Seal Installer.

Equivalent regional tools: Special Tools (Mechanical Tools)

Removal Procedure

1. Remove Vacuum Pump Assembly. Refer to Vacuum Pump Assembly Replacement
2. Remove Engine Control Module. Refer to Engine Control Module Replacement

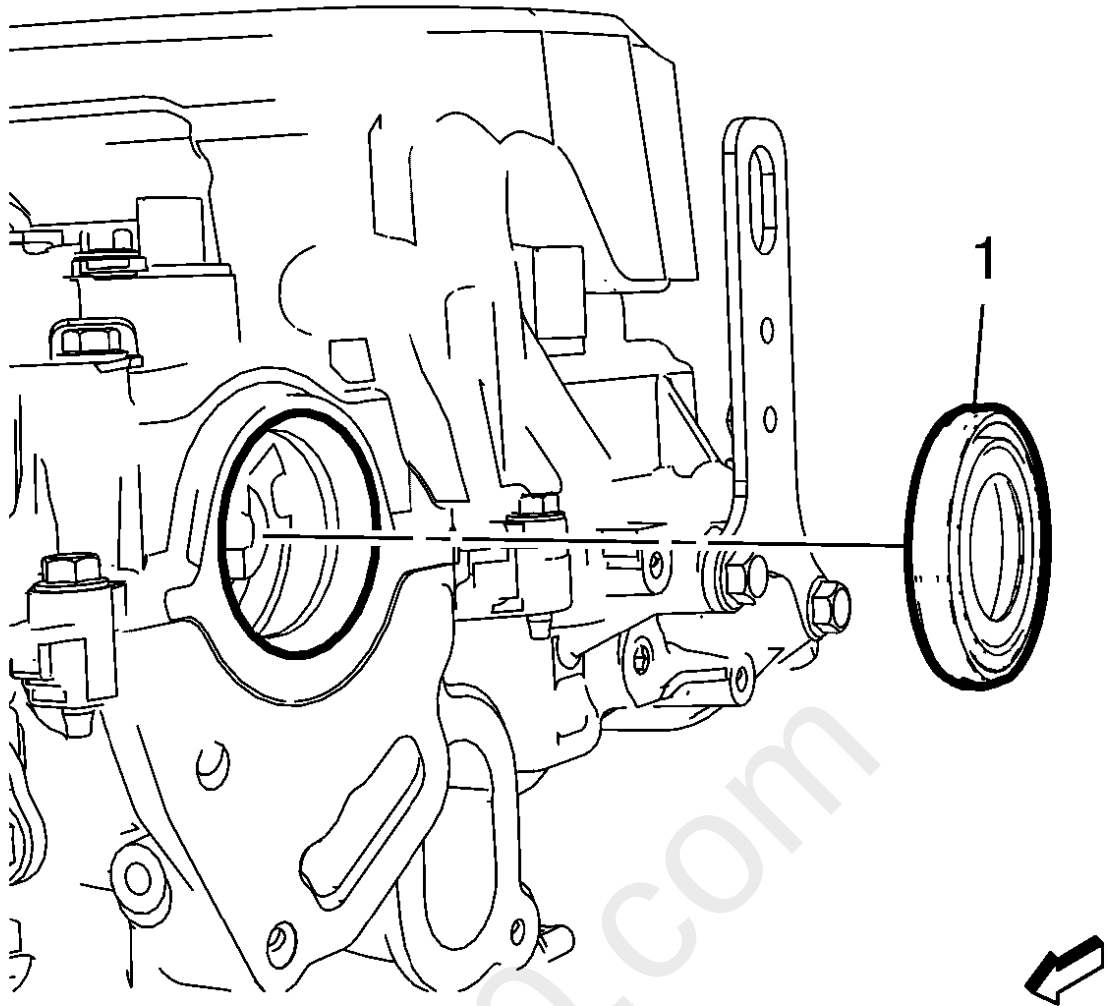


Fig. 188: Vacuum Pump Seal

Courtesy of GENERAL MOTORS COMPANY

3. Remove and DISCARD the vacuum pump seal (1), using a suitable tool.

Installation Procedure

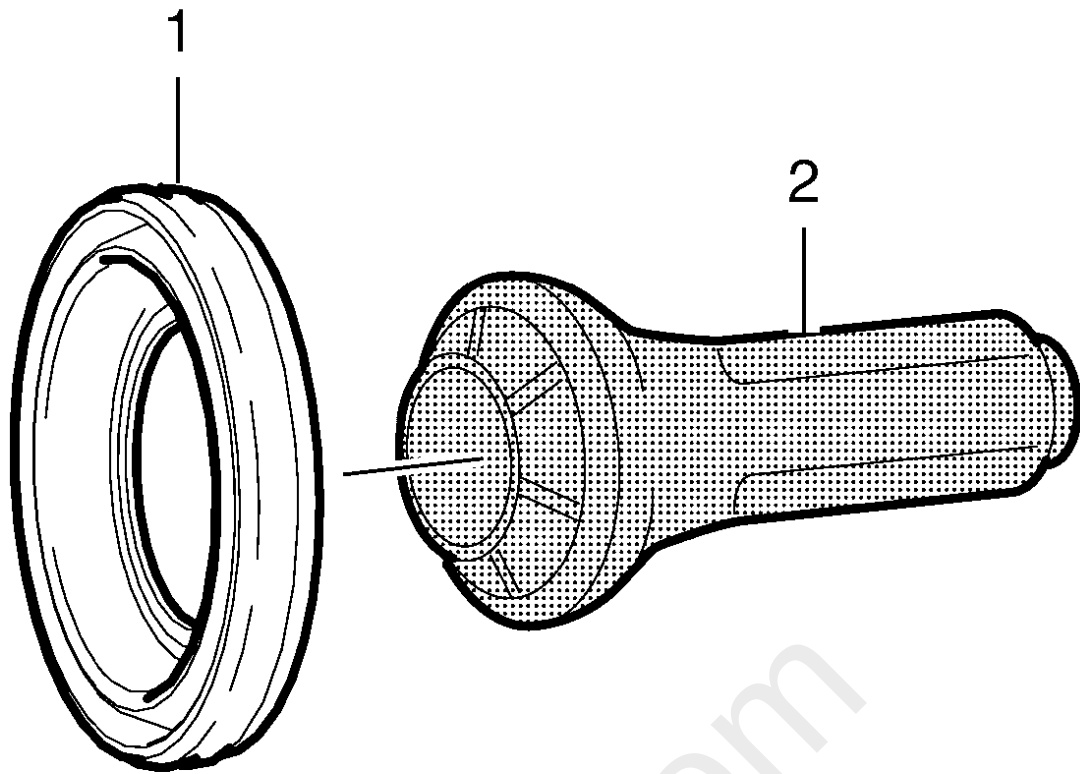


Fig. 189: Vacuum Pump Seal

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the vacuum pump seal does not deform during the installation procedure.

1. Install the NEW vacuum pump seal (1) to the **DT-45866** Seal Installer (2).

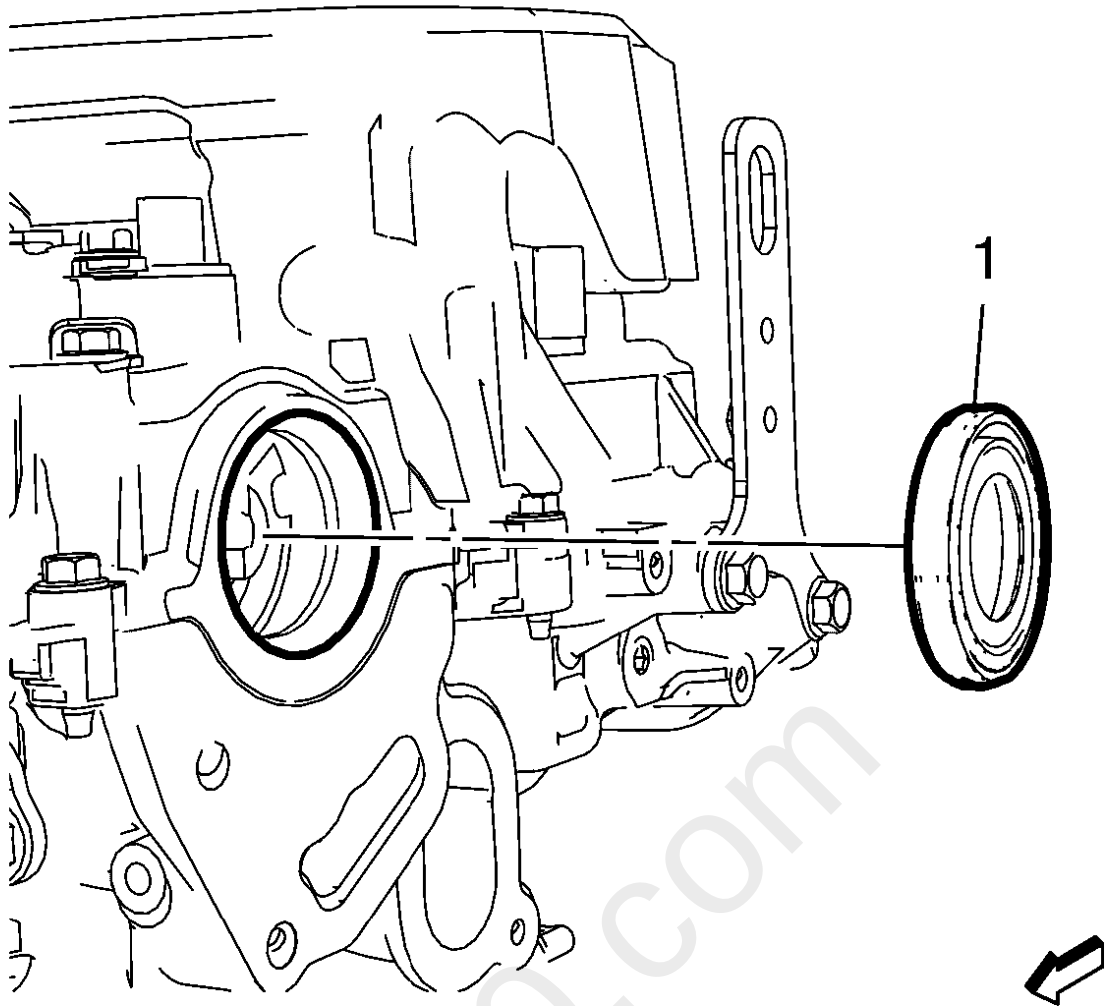


Fig. 190: Vacuum Pump Seal

Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW vacuum pump seal using the **DT-45866** Seal Installer.
3. Install Engine Control Module. Refer to [**Engine Control Module Replacement**](#)
4. Install Vacuum Pump Assembly. Refer to [**Vacuum Pump Assembly Replacement**](#)

AIR CLEANER ASSEMBLY REPLACEMENT

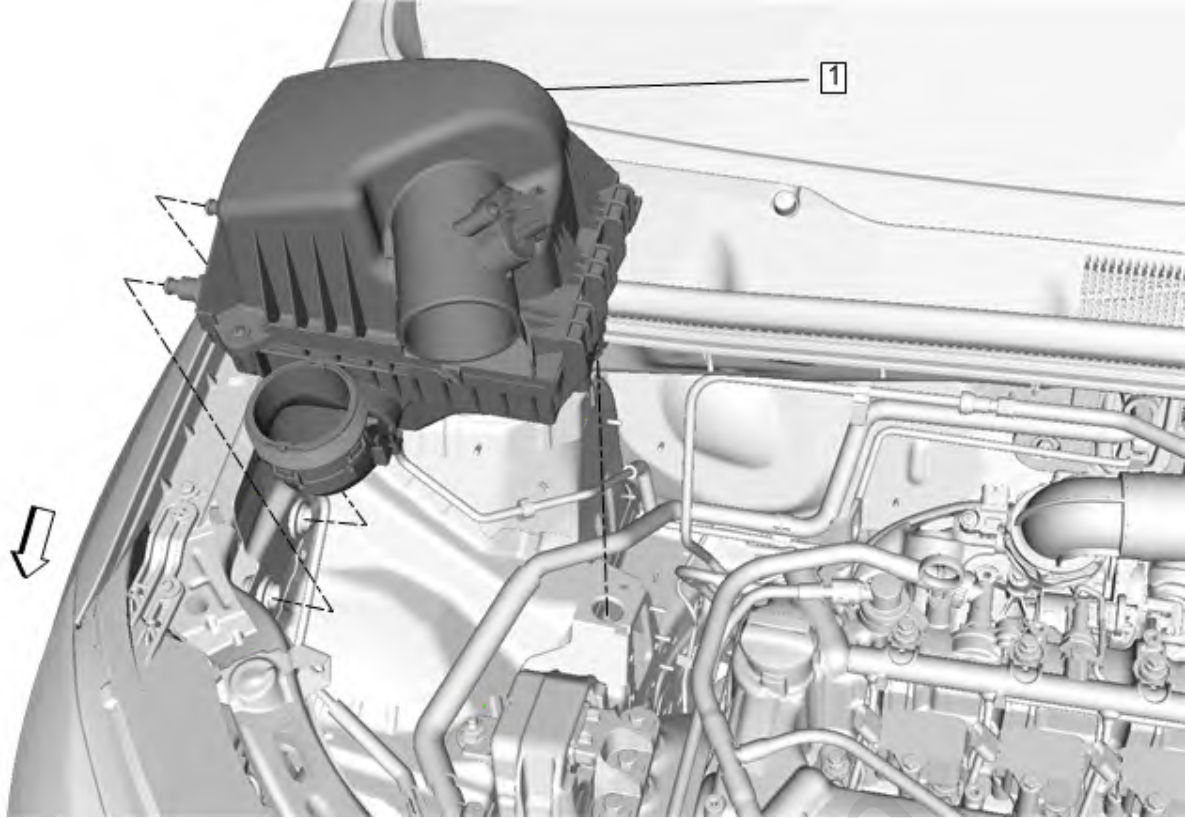


Fig. 191: Air Cleaner Assembly.

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove Air Cleaner Inlet Duct. Refer to Air Cleaner Inlet Duct Replacement 2. Remove Air Cleaner Outlet Duct. Refer to Air Cleaner Outlet Duct Replacement 3. Disconnect the electrical connector.	
1	Air Cleaner Assembly Procedure 1. Remove the air cleaner housing from the retainers. 2. Transfer parts as necessary.

AIR CLEANER ELEMENT REPLACEMENT

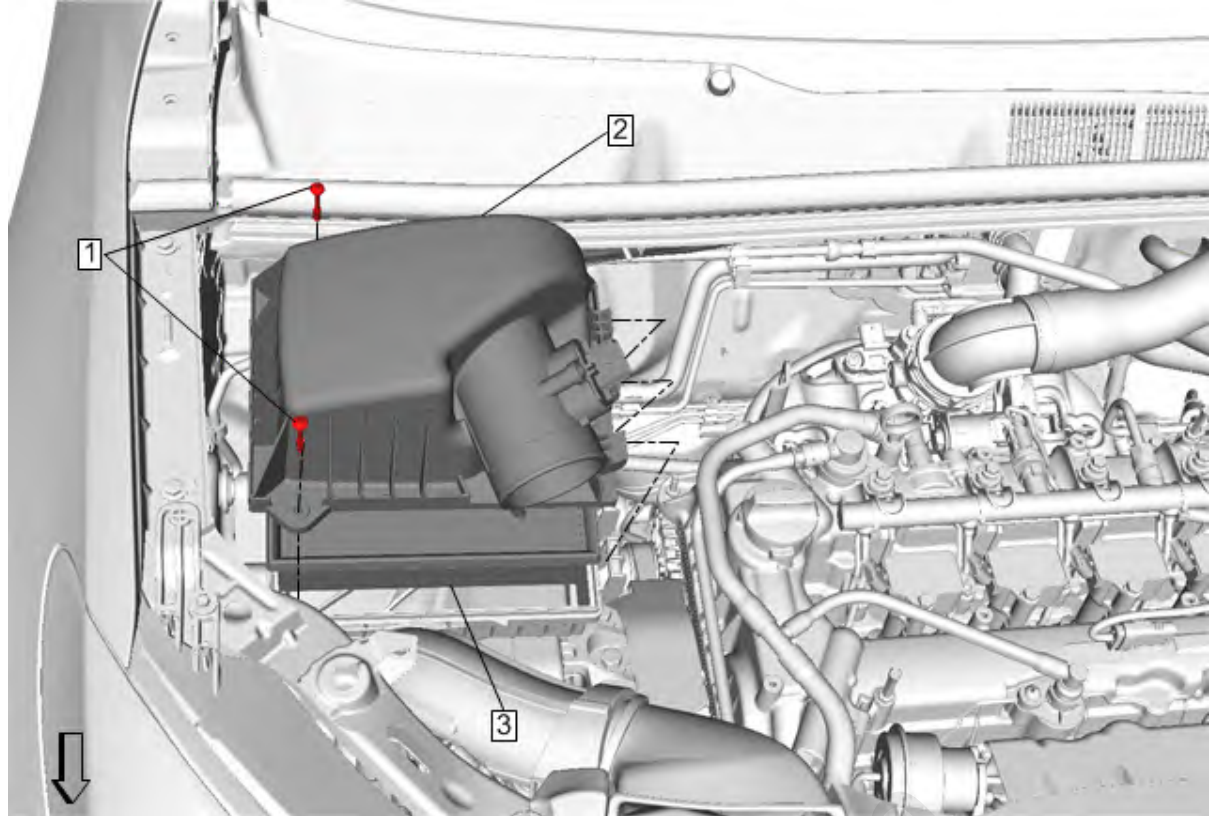


Fig.192: Air Cleaner Element

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove Air Cleaner Outlet Duct. Refer to Air Cleaner Outlet Duct Replacement 2. Disconnect the electrical connector.	
1	Air Cleaner Upper Housing Bolt (Qty: 2) CAUTION: Refer to Fastener Caution .
2	Air Cleaner Upper Housing
3	Air Cleaner Element

AIR CLEANER INLET DUCT REPLACEMENT

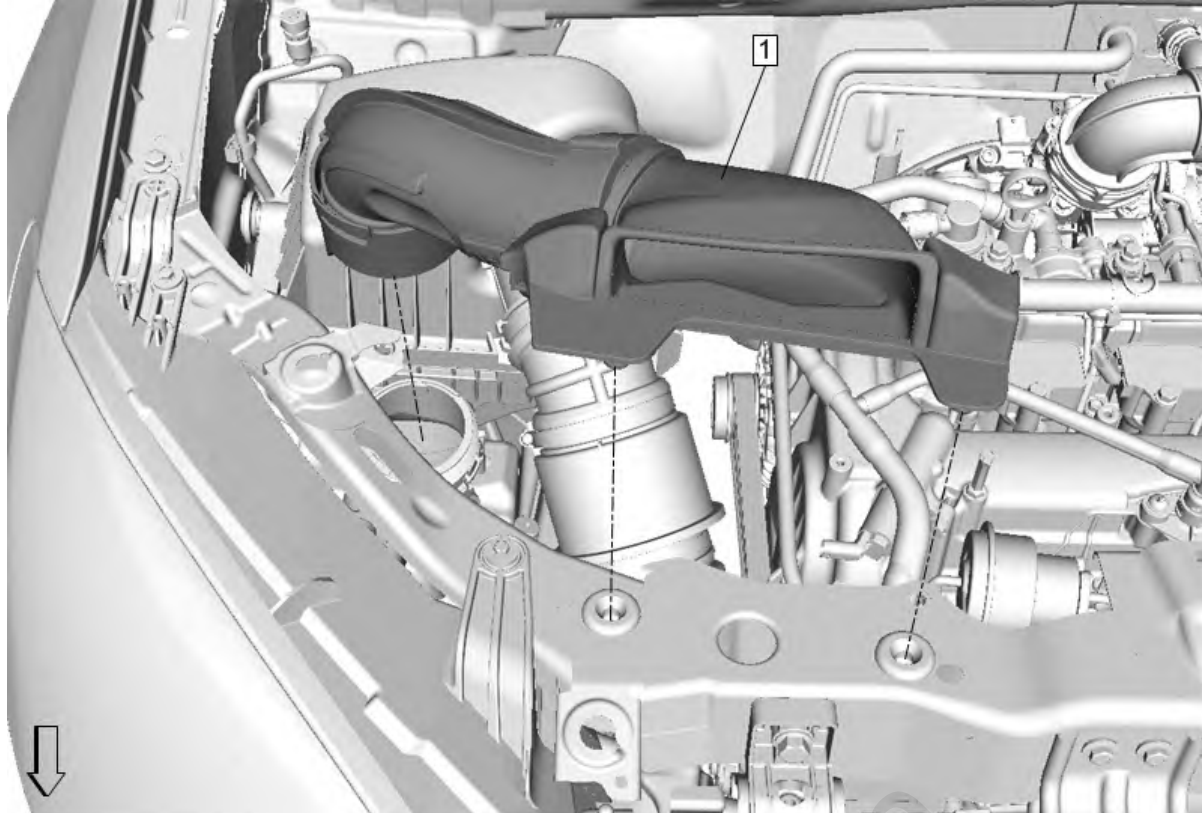


Fig.193: Air Cleaner Inlet Duct

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Air Cleaner Inlet Duct Procedure Remove the air cleaner inlet duct by pulling upward to release the inlet duct from the rubber grommets and rotate to remove from cleaner assembly.

AIR CLEANER OUTLET DUCT REPLACEMENT

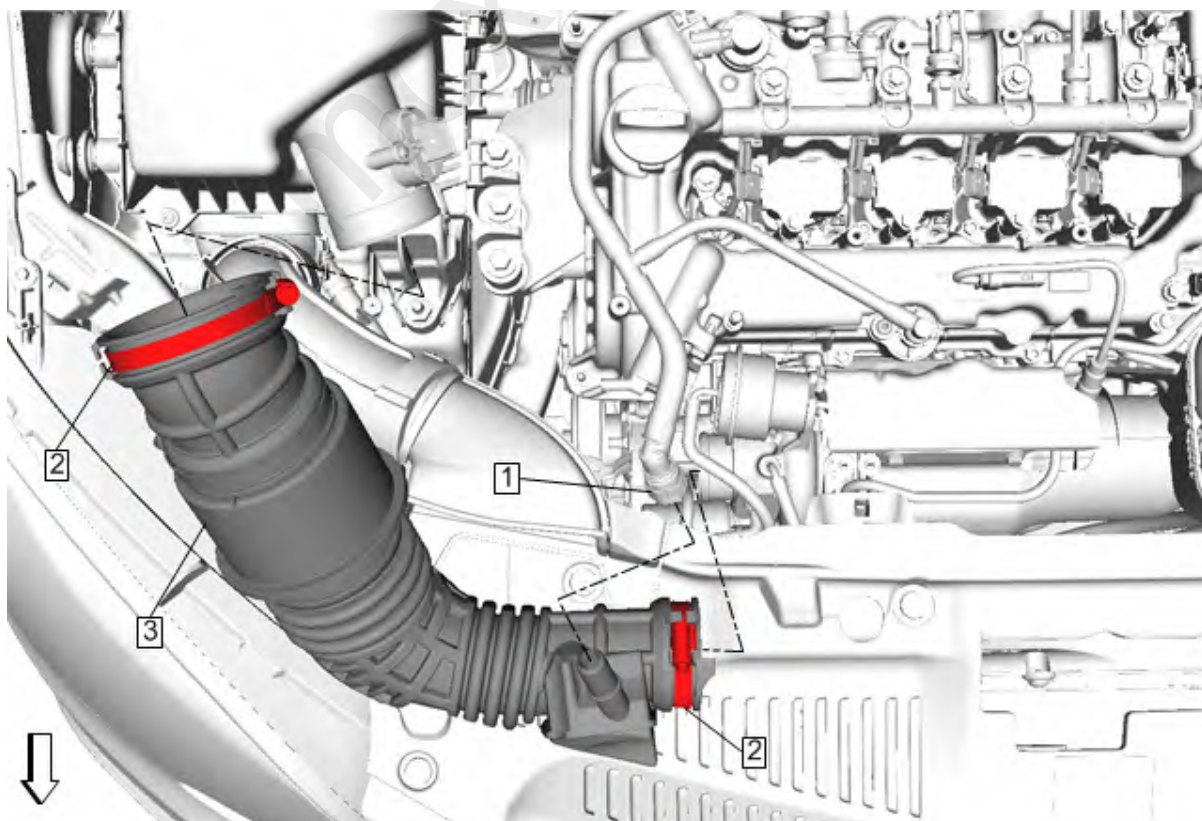


Fig.194: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Tube Procedure Disconnect PCV Tube @ Air Cleaner Outlet Duct. Refer to Plastic Collar Quick Connect Fitting Service
2	Air Cleaner Outlet Duct Clamp (Qty: 2) CAUTION: Refer to Fastener Caution . NOTE: Ensure the outlet duct is fully seated to the mating surfaces before clamping. Verify that the cuff is not rolled under. Tighten 3 N.m (27 lb in)
3	Air Cleaner Outlet Duct

CHARGE AIR COOLER INLET AIR HOSE REPLACEMENT

Removal Procedure

1. Remove Air Cleaner Outlet Duct. Refer to [Air Cleaner Outlet Duct Replacement](#)
2. Remove Front Bumper Fascia. Refer to [Front Bumper Fascia Replacement \(Buick\)](#)

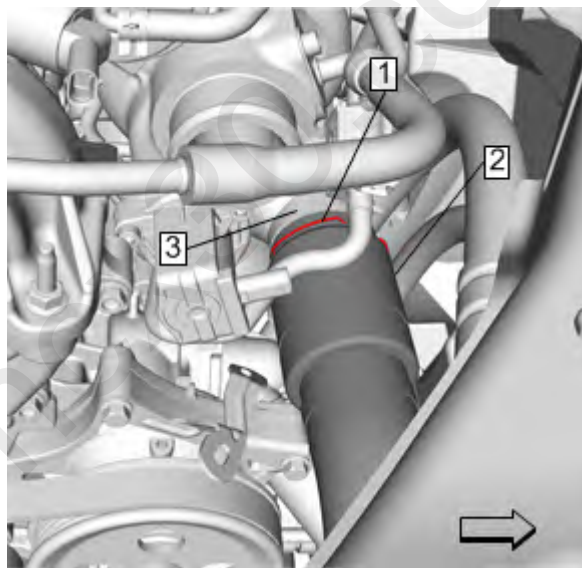


Fig. 195: Charge Air Cooler Inlet Air Hose, Retainer Spring And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

3. Unclip Charge Air Cooler Inlet Air Hose Retainer Spring (1)
4. Remove Charge Air Cooler Inlet Air Hose (2) @ Turbocharger (3)

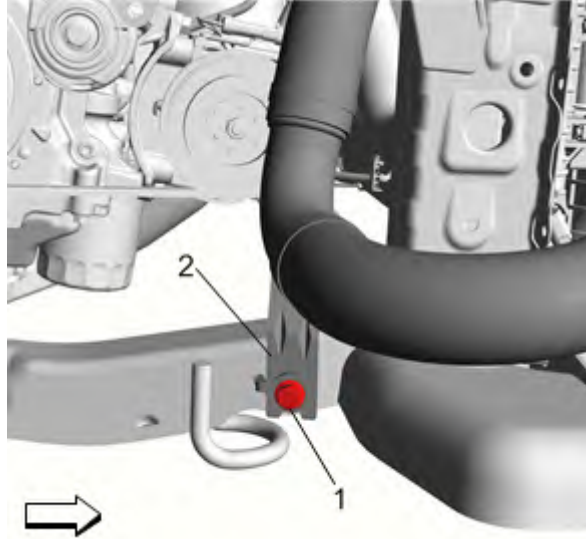


Fig. 196: Charge Air Cooler Inlet Air Hose Bracket And Bolt
 Courtesy of GENERAL MOTORS COMPANY

5. Remove Charge Air Cooler Inlet Air Hose Bracket Bolt (1) @ Charge Air Cooler Inlet Air Hose Bracket (2)

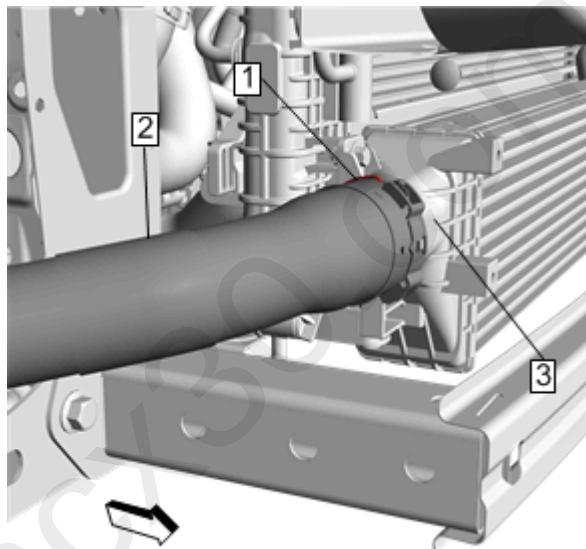


Fig. 197: Charge Air Cooler, Inlet Air Hose And Retainer Spring
 Courtesy of GENERAL MOTORS COMPANY

6. Unclip Charge Air Cooler Inlet Air Hose Retainer Spring (1)
7. Remove Charge Air Cooler Inlet Air Hose (2) @ Charge Air Cooler (3)

Installation Procedure

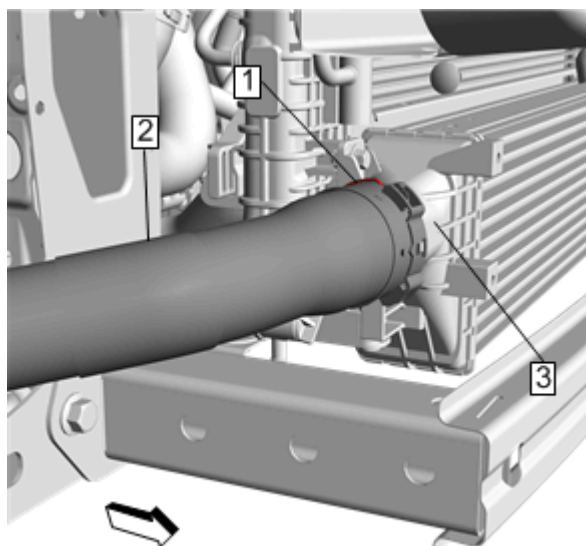


Fig. 198: Charge Air Cooler, Inlet Air Hose And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

1. Install Charge Air Cooler Inlet Air Hose (2) @ Charge Air Cooler (3)
2. Clip Charge Air Cooler Inlet Air Hose Retainer Spring (1)

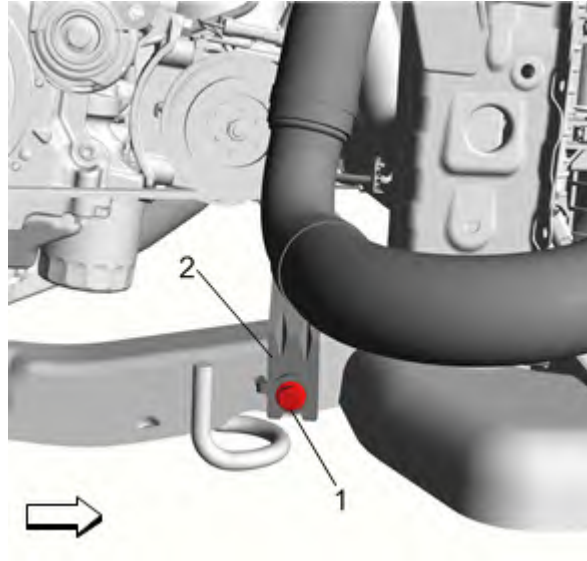


Fig. 199: Charge Air Cooler Inlet Air Hose Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

3. Install and tighten Charge Air Cooler Inlet Air Hose Bracket Bolt (1) @ Charge Air Cooler Inlet Air Hose Bracket (2) to 22 N.m (16 lb ft)

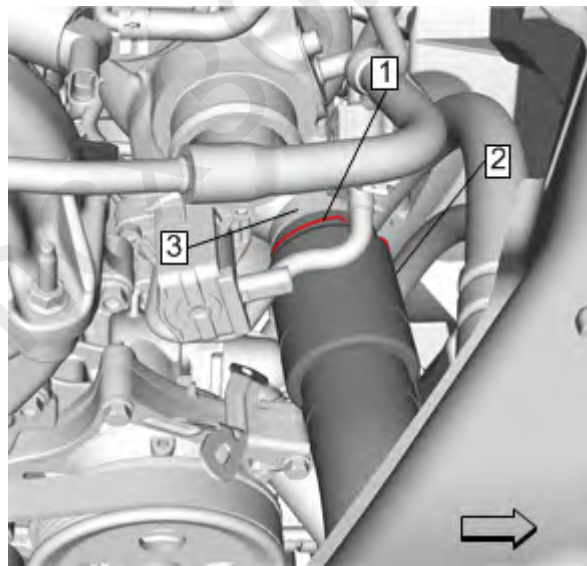


Fig. 200: Charge Air Cooler Inlet Air Hose, Retainer Spring And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

4. Install Charge Air Cooler Inlet Air Hose (2) @ Turbocharger (3)
5. Clip Charge Air Cooler Inlet Air Hose Retainer Spring (1)
6. Install Front Bumper Fascia. Refer to [Front Bumper Fascia Replacement \(Buick\)](#).
7. Install Air Cleaner Outlet Duct. Refer to [Air Cleaner Outlet Duct Replacement](#)

CHARGE AIR COOLER OUTLET AIR HOSE REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover. Refer to [Intake Manifold Cover Replacement](#)
2. Remove Front Bumper Fascia. Refer to [Front Bumper Fascia Replacement \(Buick\)](#).

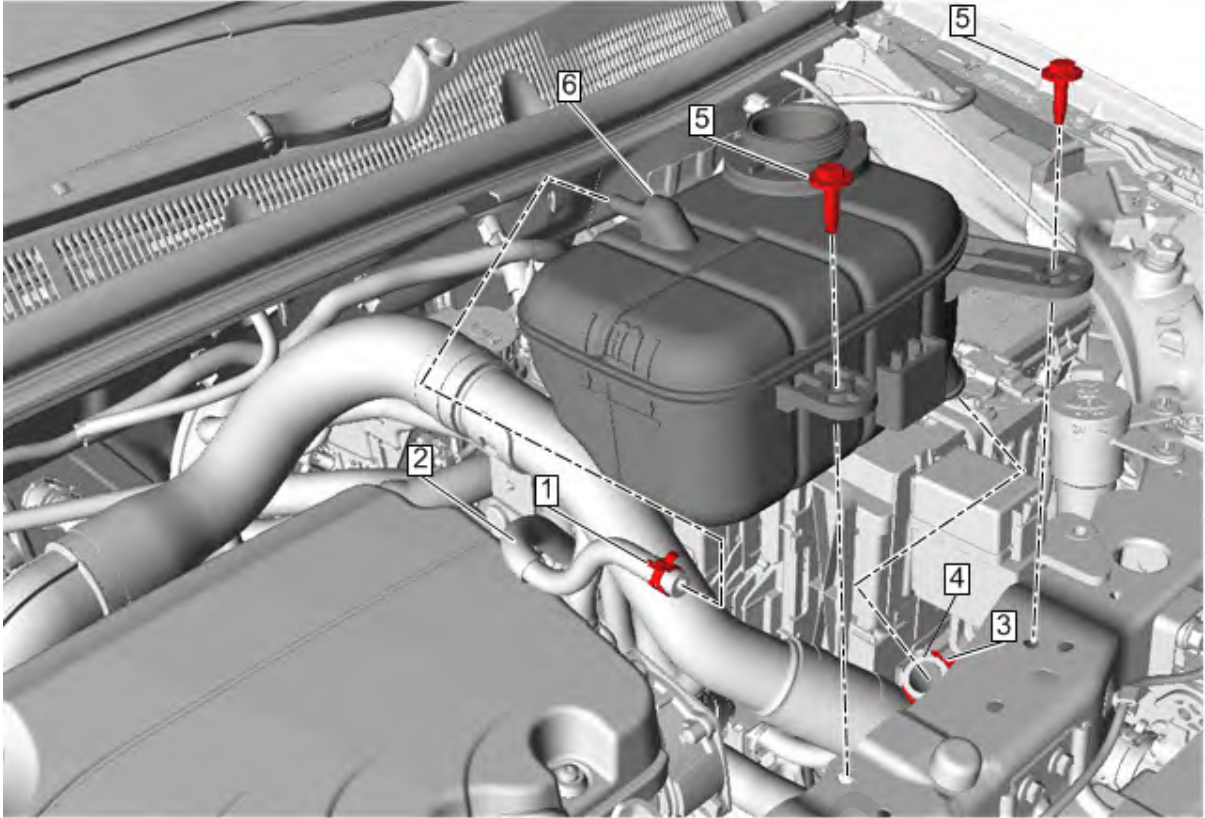


Fig. 201: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

3. Remove Radiator Surge Tank (6). Refer to [Radiator Surge Tank Replacement \(LE2\)](#).
4. Remove the relay center on upper tie bar.
5. Disconnect the control valve body transmission control module electrical connector.
6. Remove Battery Tray. Refer to [Battery Tray Replacement](#)

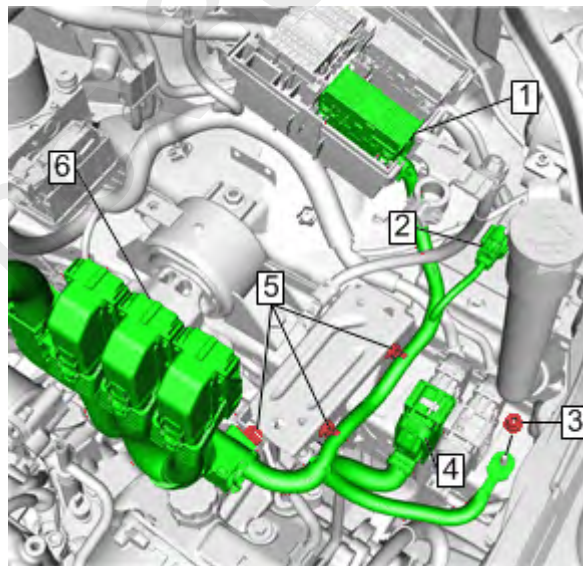


Fig. 202: Electrical Connector And Ground Nut

Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Electrical Connector (4)
8. Remove Ground Nut (3)

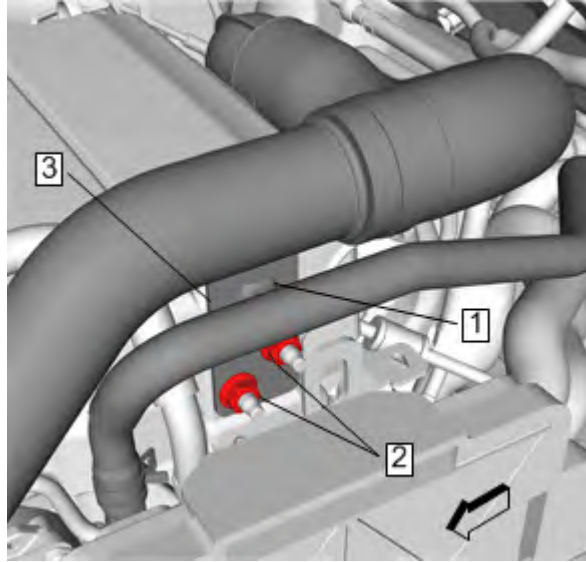


Fig. 203: Charge Air Cooler Outlet Air Hose, Bracket Nuts And Vacuum Hose
 Courtesy of GENERAL MOTORS COMPANY

9. Remove Power Brake Booster Vacuum Hose (1) @ Charge Air Cooler Outlet Air Hose (3)
10. Remove Charge Air Cooler Outlet Air Hose Bracket Nuts (2) (Qty: 2) @ Charge Air Cooler Outlet Air Hose (3)

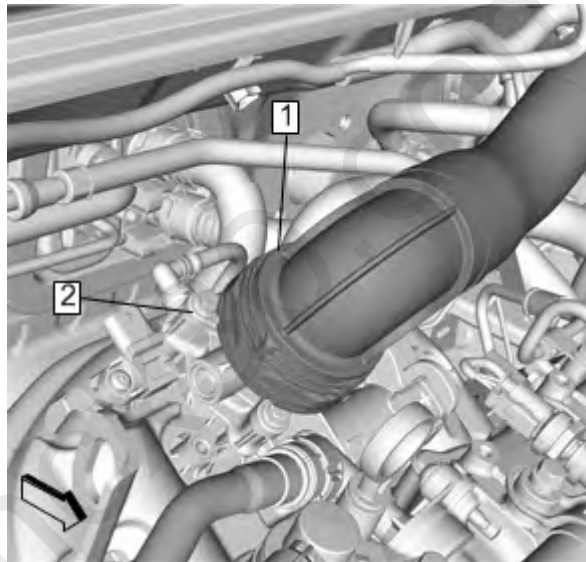
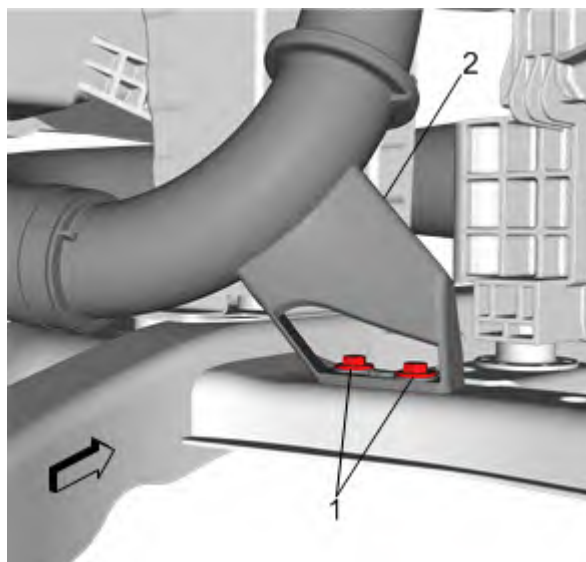


Fig. 204: Charge Air Cooler Outlet Air Hose At Throttle Body
 Courtesy of GENERAL MOTORS COMPANY

11. Remove Charge Air Cooler Outlet Air Hose (1) @ Throttle Body (2)



12. Remove Charge Air Cooler Outlet Air Hose Bracket Bolts (1) (Qty: 2) @ Charge Air Cooler Outlet Air Hose Bracket (2)

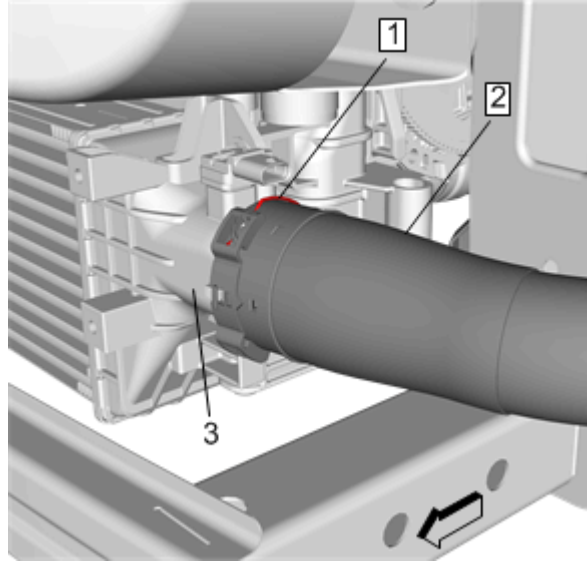


Fig. 206: Charge Air Cooler Outlet Air Hose, Retainer Spring And Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

13. Unclip Charge Air Cooler Outlet Air Hose Retainer Spring (1)
14. Remove Charge Air Cooler Outlet Air Hose (2) @ Charge Air Cooler (3)

Installation Procedure

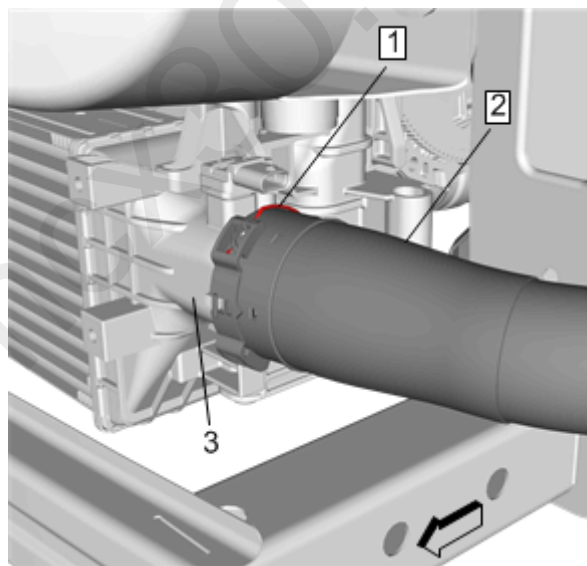


Fig. 207: Charge Air Cooler Outlet Air Hose, Retainer Spring And Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

1. Install Charge Air Cooler Outlet Air Hose (2) @ Charge Air Cooler (3)
2. Clip Charge Air Cooler Outlet Air Hose Retainer Spring (1)

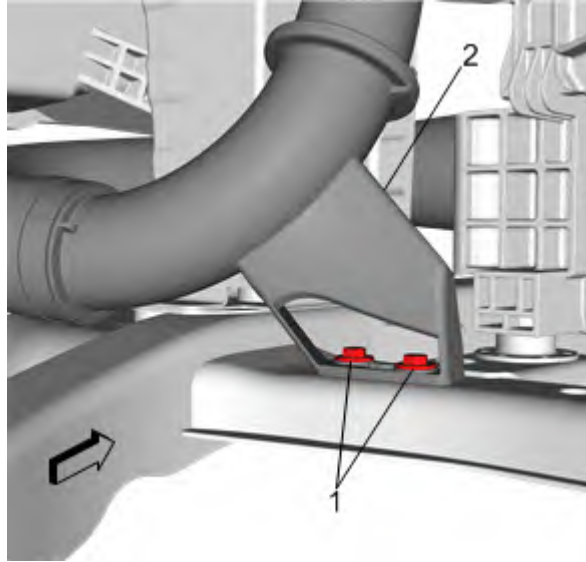


Fig. 208: Charge Air Cooler Outlet Air Hose Bracket And Bolts
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

3. Install and tighten Charge Air Cooler Outlet Air Hose Bracket Bolts (1) (Qty: 2) @ Charge Air Cooler Outlet Air Hose Bracket (2) to 22 N.m (16 lb ft)

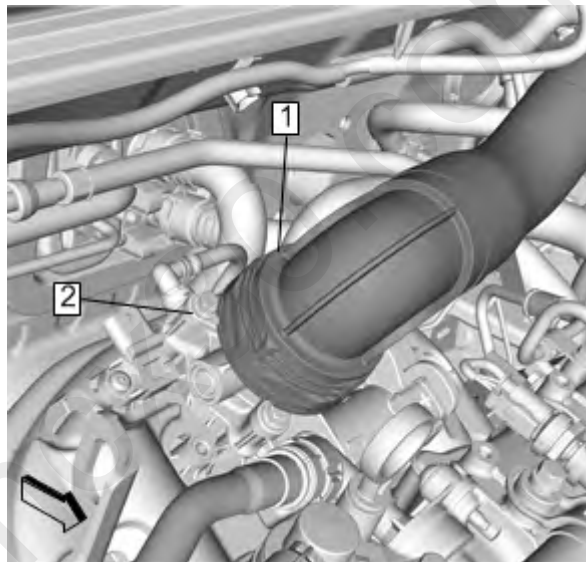


Fig. 209: Charge Air Cooler Outlet Air Hose At Throttle Body
 Courtesy of GENERAL MOTORS COMPANY

4. Install Charge Air Cooler Outlet Air Hose (1) @ Throttle Body (2)

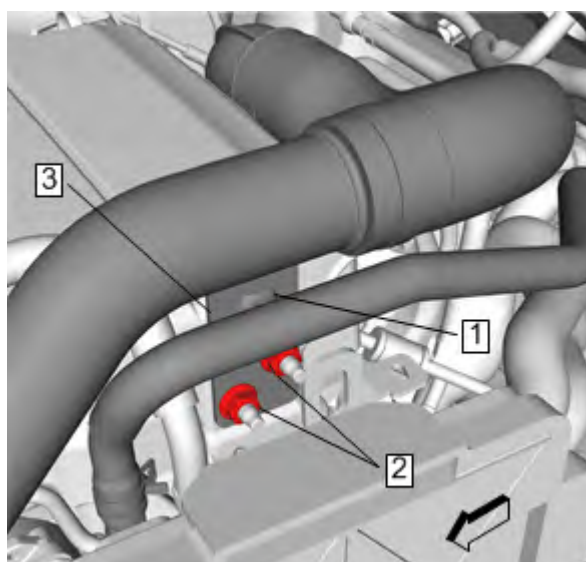


Fig. 210: Charge Air Cooler Outlet Air Hose, Bracket Nuts And Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install and tighten Charge Air Cooler Outlet Air Hose Bracket Nuts (2) (Qty: 2) @ Charge Air Cooler Outlet Air Hose (3) to 22 N.m (16 lb ft)
6. Install Power Brake Booster Vacuum Hose (1) @ Charge Air Cooler Outlet Air Hose (3)

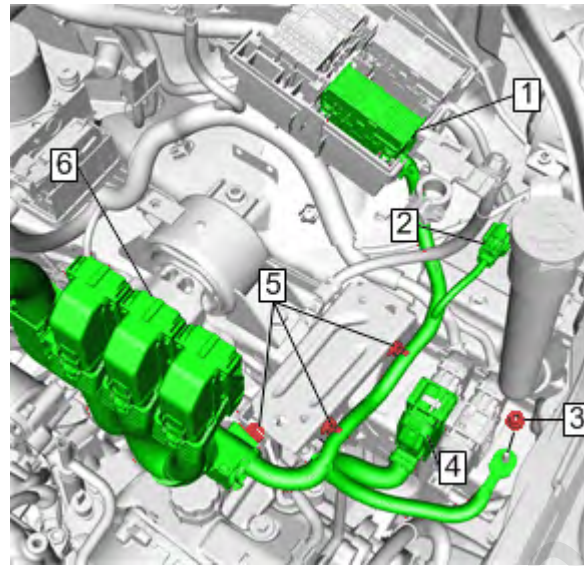


Fig. 211: Electrical Connector And Ground Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install and tighten Ground Nut (3) to 10 N.m (89 lb in)
8. Connect Electrical Connector (4)
9. Install Battery Tray. Refer to [Battery Tray Replacement](#)
10. Connect the control valve body transmission control module electrical connector.
11. Install the relay center to upper tie bar.

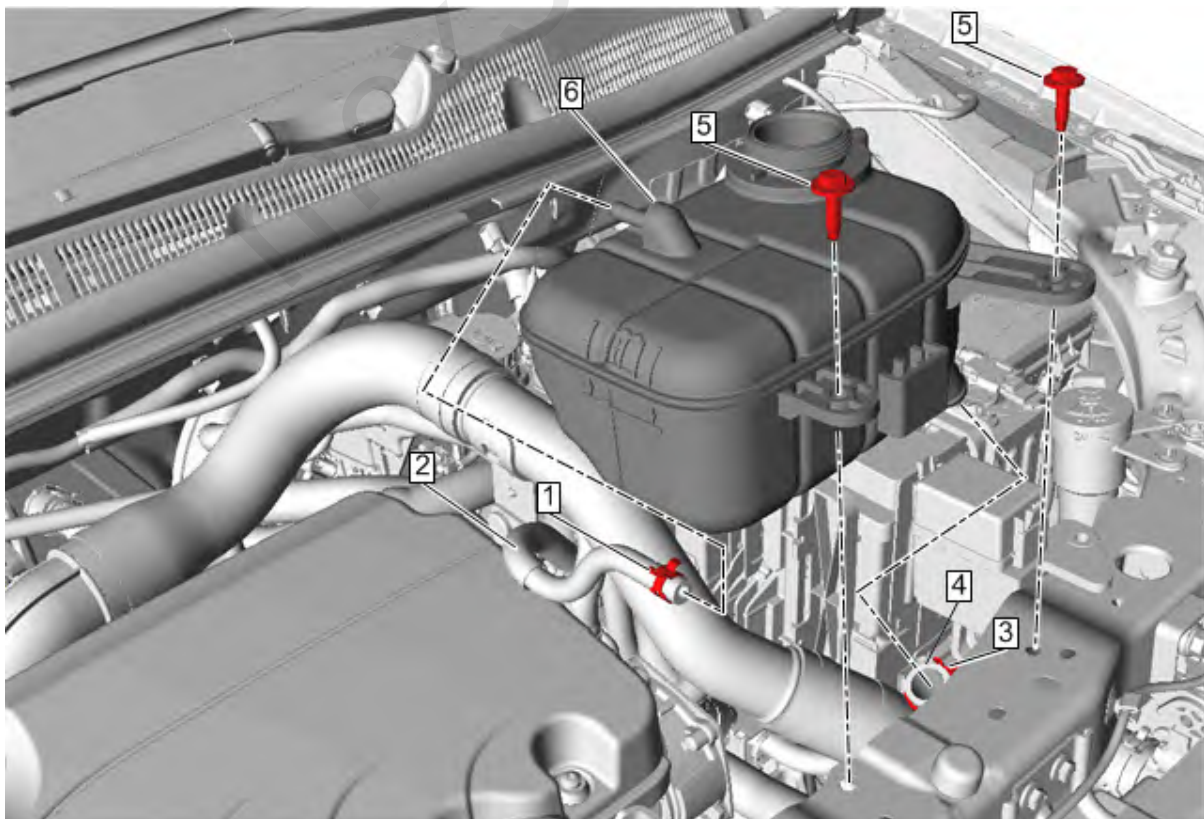


Fig. 212: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

12. Install Radiator Surge Tank (6). Refer to [Radiator Surge Tank Replacement \(LE2\)](#)
13. Install Front Bumper Fascia. Refer to [Front Bumper Fascia Replacement \(Buick\)](#)

14. Install Intake Manifold Cover. Refer to [Intake Manifold Cover Replacement](#)

CHARGE AIR COOLER REPLACEMENT

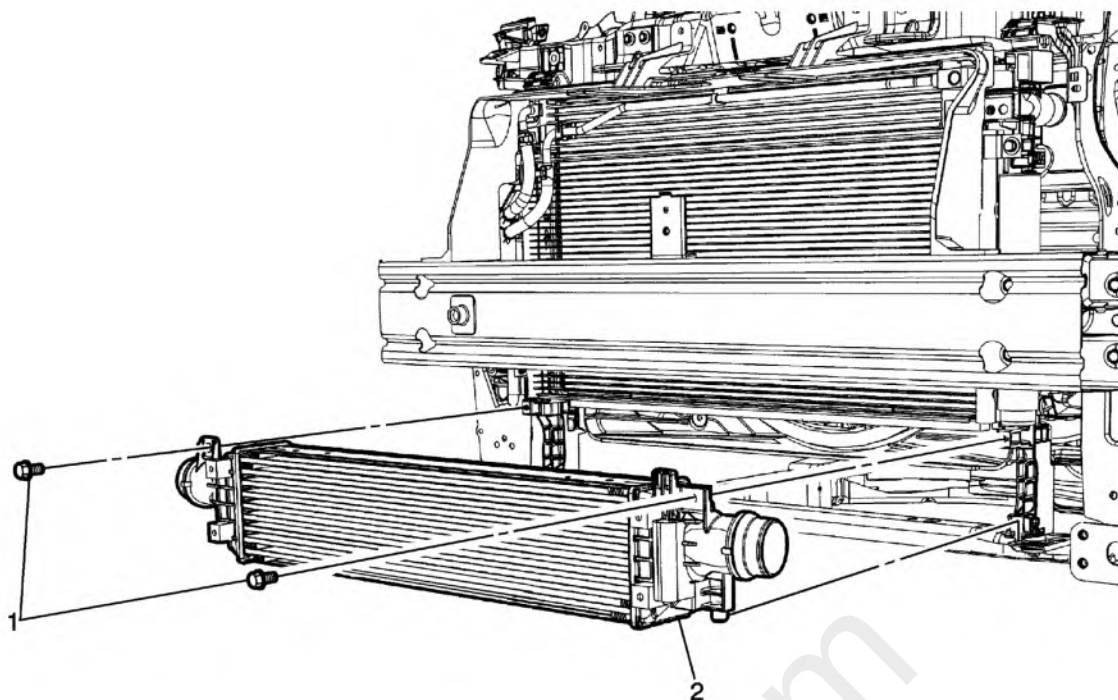


Fig. 213: Charge Air Cooler

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures	
1. Remove Front Bumper Fascia. Refer to Front Bumper Fascia Replacement (Buick)	
2. Remove Charge Air Cooler Inlet Air Hose. Refer to Charge Air Cooler Inlet Air Hose Replacement	
3. Remove Charge Air Cooler Outlet Air Hose. Refer to Charge Air Cooler Outlet Air Hose Replacement	
4. Remove Radiator Air Lower Baffle and Deflector. Refer to Radiator Air Lower Baffle and Deflector Replacement (LE2)	
1	Charge Air Cooler Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Charge Air Cooler Procedure Disconnect turbocharger air pressure sensor electrical connector.

FUEL LEVEL SENSOR REPLACEMENT

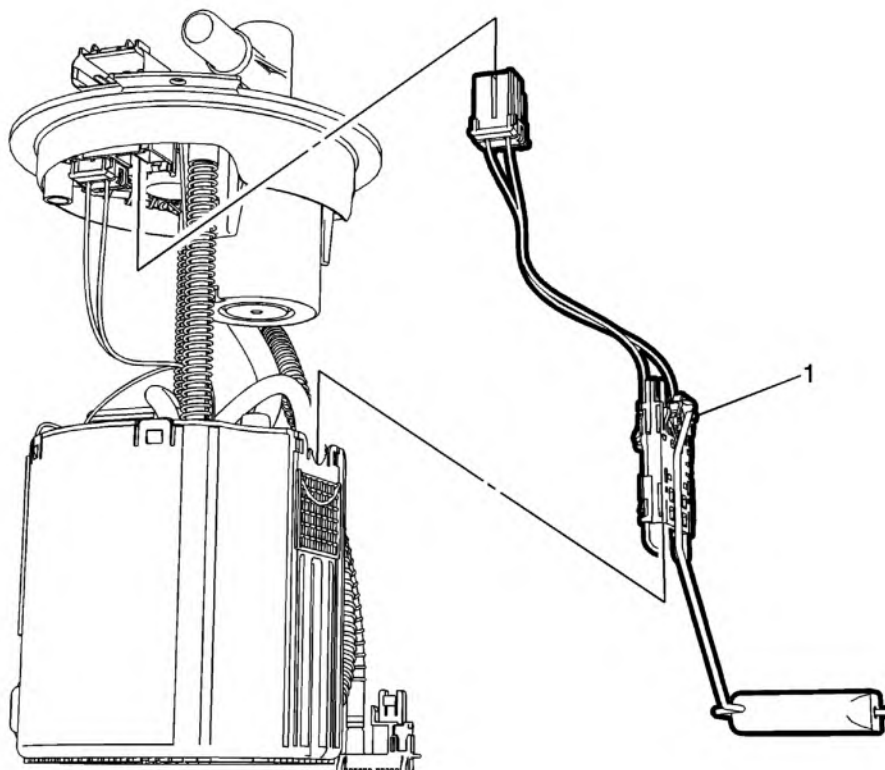


Fig. 214: Fuel Level Sensor

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.	
Preliminary Procedures 1. Remove the fuel tank fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement (FWD)Fuel Tank Fuel Pump Module Replacement (AWD). 2. Disconnect the electrical connector.	
1	Fuel Level Sensor Procedure Release tabs and slide fuel level sensor up to remove.

CHASSIS CONTROL MODULE REPLACEMENT

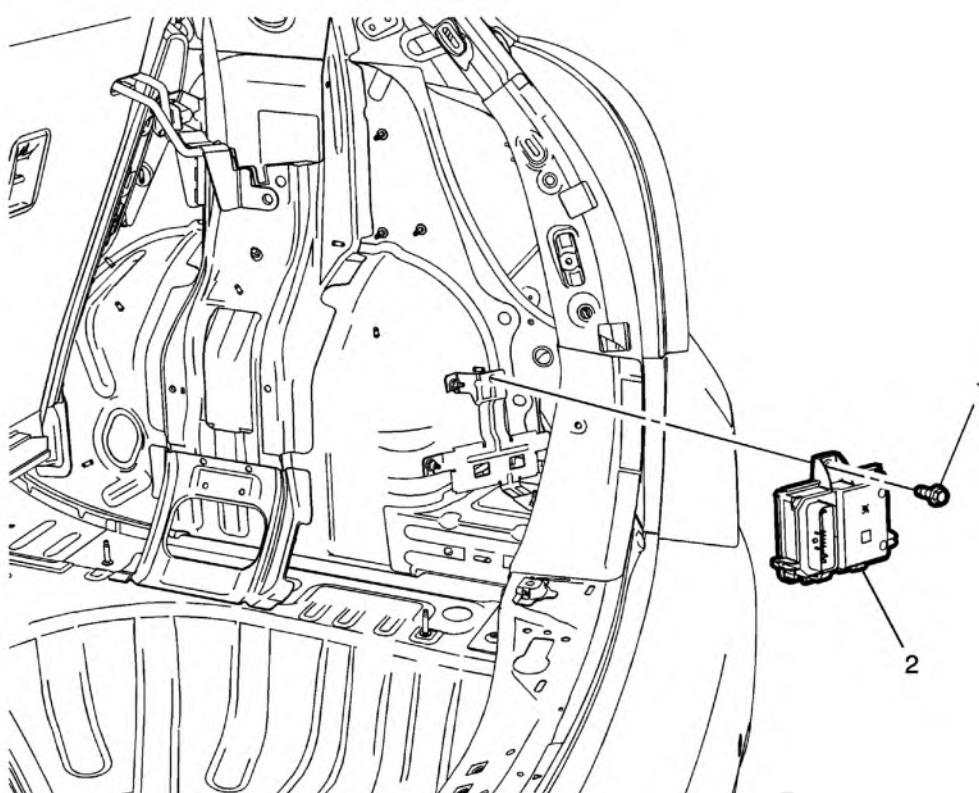


Fig. 215: Fuel Pump Flow Control Module
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Quarter Lower Rear Trim Panel. Refer to Quarter Lower Rear Trim Panel Replacement	
1	Chassis Control Module Bolt CAUTION: Refer to Fastener Caution Tighten 9 N.m (80 lb in)
2	Chassis Control Module Procedure 1. Disconnect the electrical connector. 2. Program the fuel pump flow control module. Refer to Control Module References

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 1

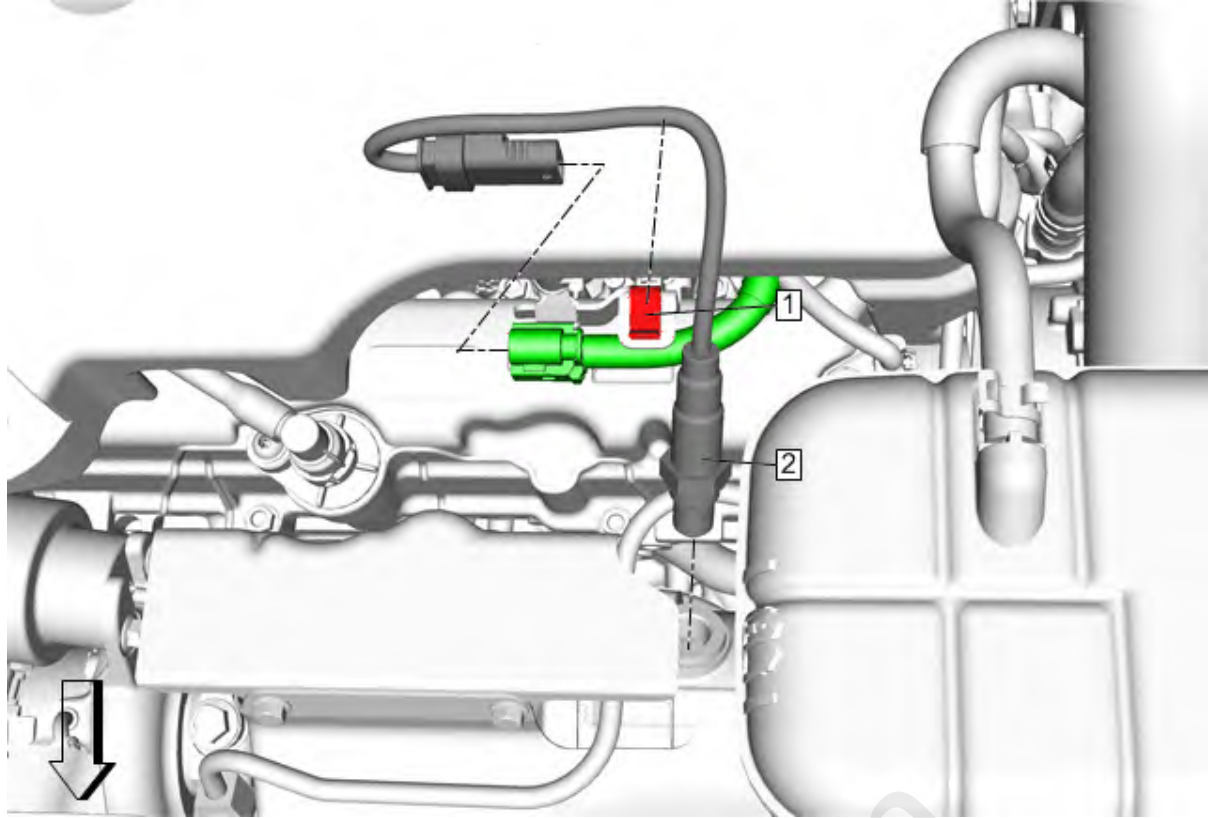


Fig. 216: Heated Oxygen Sensor - Sensor 1
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Exhaust Service Warning .	
Preliminary Procedures 1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection (without KL9), Battery Negative Cable Disconnection and Connection (with KL9). 2. Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement	
1	Wiring Harness Clip

Callout	Component Name
	Heated Oxygen Sensor CAUTION: Refer to Component Fastener Tightening Caution . CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution . Procedure 1. Disconnect the electrical connector. 2. If reinstalling the OLD sensor, coat the threads with anti-seize compound. NOTE: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation. Tighten 42 N.m (31 lb ft) Special Tools EN-6179 Heated Oxygen Sensor Remover/Installer Equivalent regional tools: Special Tools (Mechanical Tools).

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 2

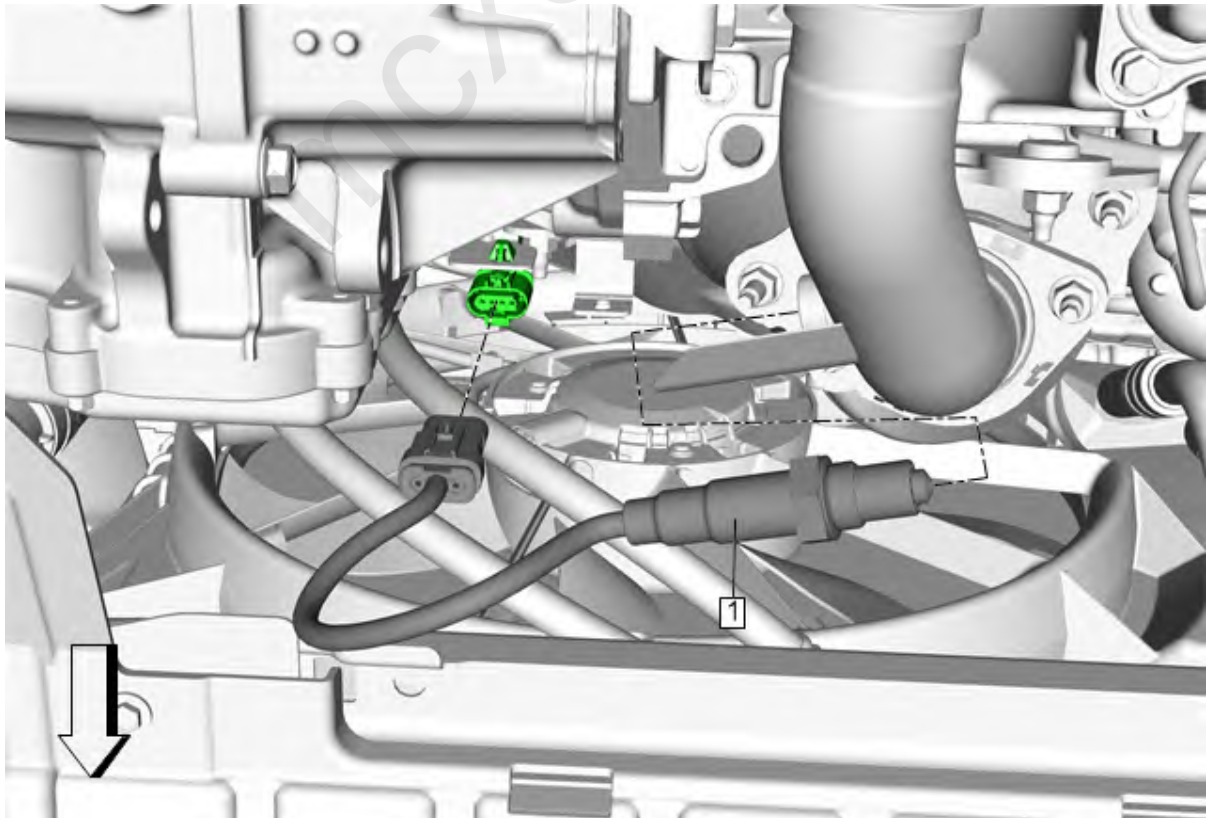


Fig. 217: Heated Oxygen Sensor - Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
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Callout	Component Name
	WARNING: Refer to Exhaust Service Warning . Preliminary Procedures 1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection (without KL9) Battery Negative Cable Disconnection and Connection (with KL9). 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle
1	Heated Oxygen Sensor CAUTION: Refer to Component Fastener Tightening Caution . CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution . Procedure 1. Disconnect the electrical connector. 2. If reinstalling the OLD sensor, coat the threads with anti-seize compound. NOTE: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation. Tighten 42 N.m (31 lb ft) Special Tools EN-6179 Heated Oxygen Sensor Remover/Installer Equivalent regional tools: Special Tools (Mechanical Tools)

INTAKE AIR PRESSURE AND TEMPERATURE SENSOR REPLACEMENT

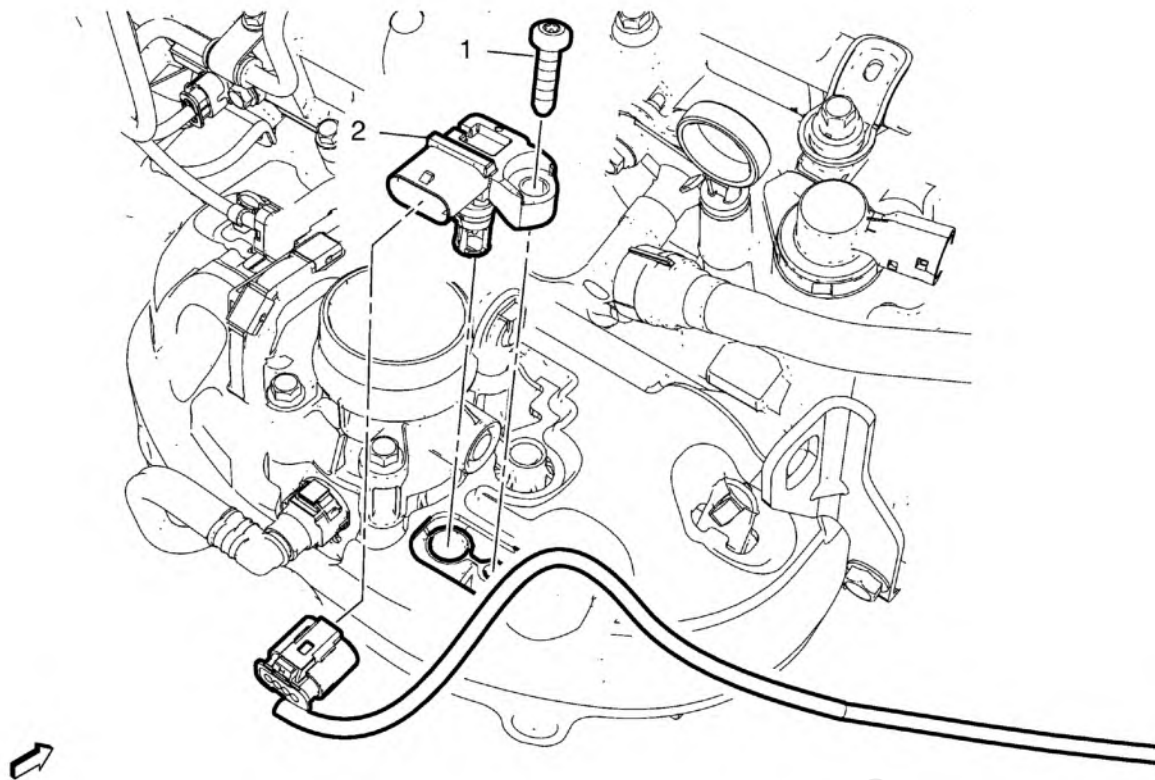


Fig. 218: Intake Air Pressure and Temperature Sensor
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Air Pressure and Temperature Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 5 N.m (44 lb in).
2	Intake Air Pressure and Temperature Sensor Procedure Disconnect the electrical connector.

MASS AIRFLOW SENSOR REPLACEMENT

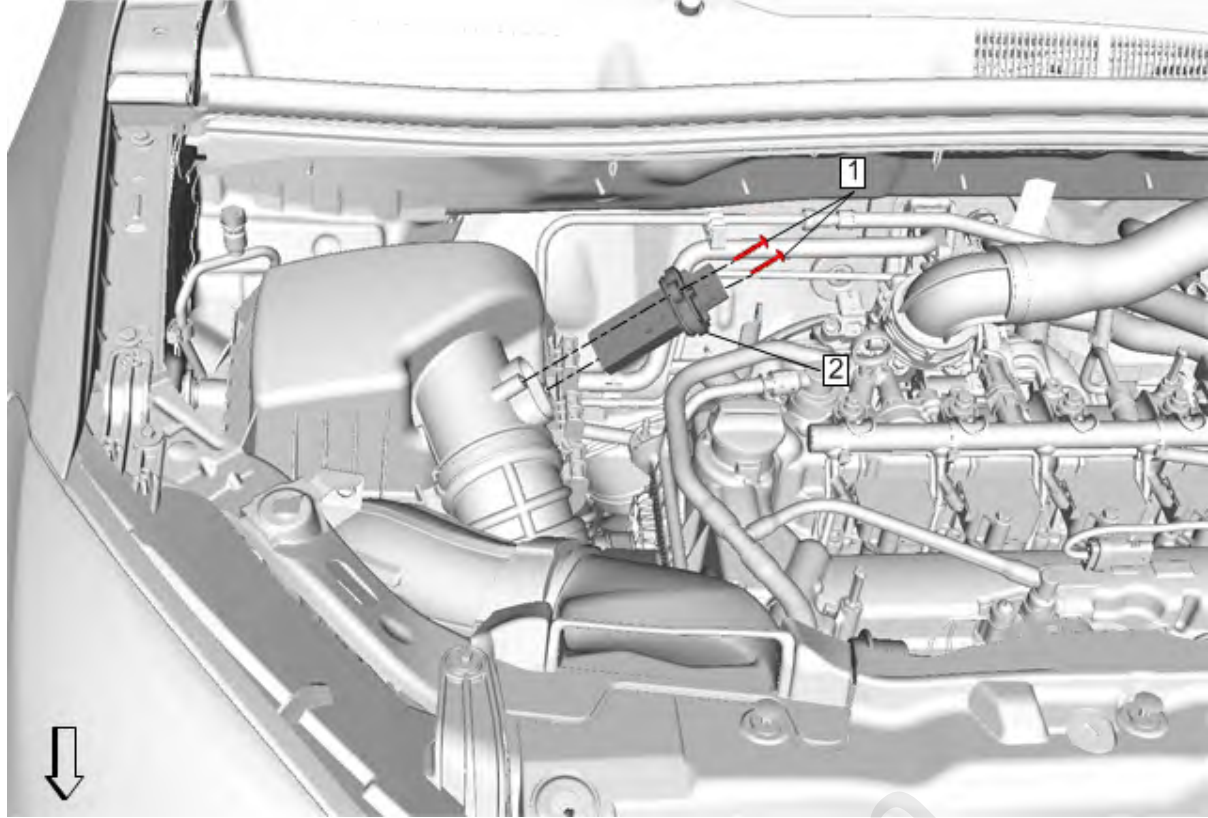


Fig. 219: Mass Airflow Sensor

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mass Airflow Sensor Bolt (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 5 N.m (44 lb in)
2	Mass Airflow Sensor Procedure Disconnect the electrical connector.

ENGINE OIL PRESSURE SENSOR REPLACEMENT

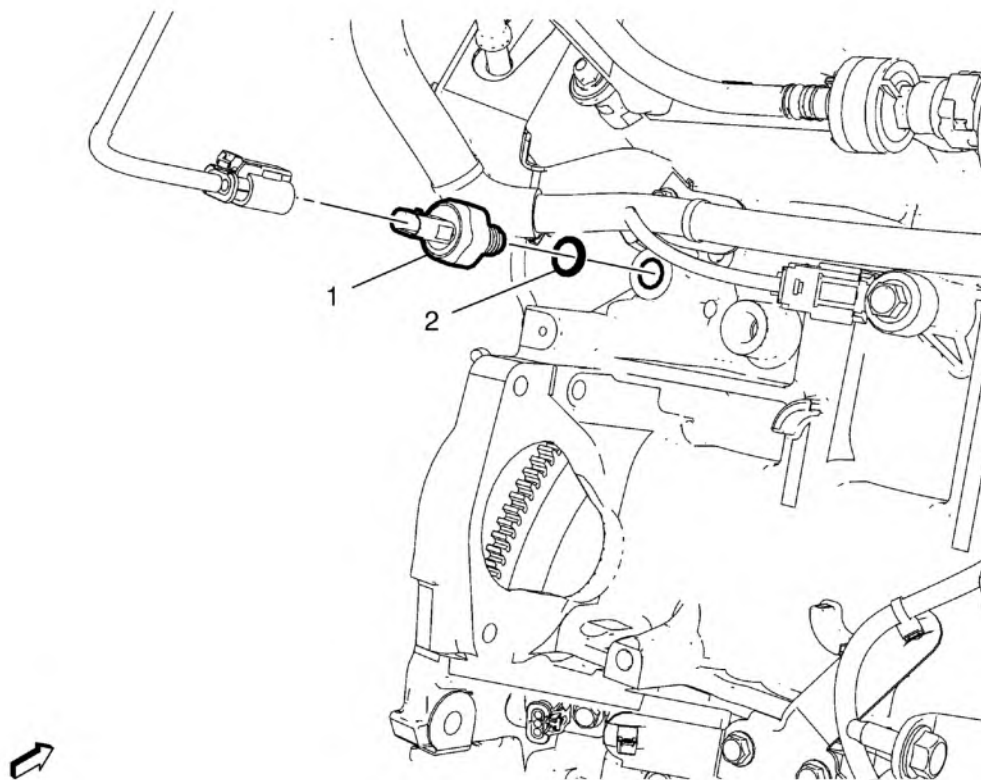


Fig. 220: Engine Oil Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Starter Motor. Refer to Starter Replacement (LE2-FWD) , Starter Replacement (LE2-AWD) .	
1	Engine Oil Pressure Sensor CAUTION: Refer to Component Fastener Tightening Caution . Procedure Disconnect the electrical connector. Tighten 35 N.m (26 lb ft)
2	Engine Oil Pressure Sensor Seal

TURBOCHARGER AIR PRESSURE SENSOR REPLACEMENT

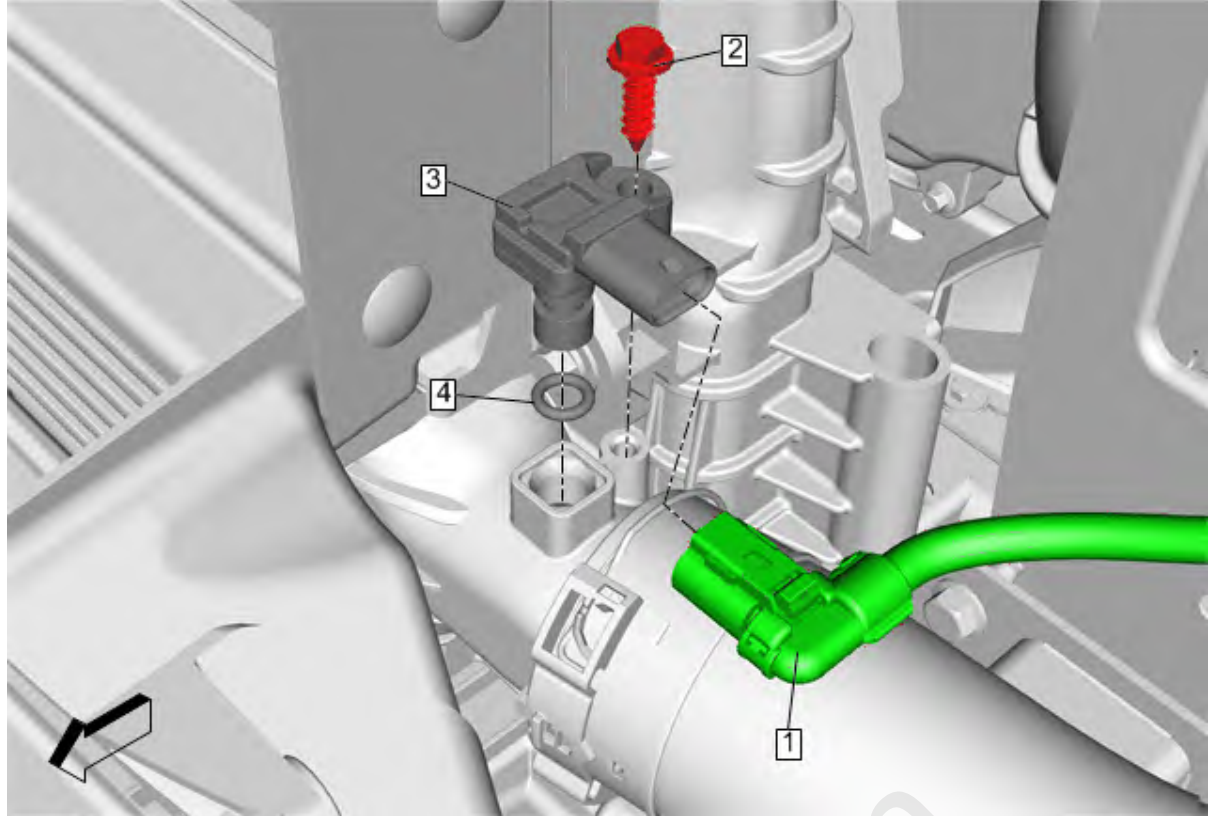


Fig. 221: Turbocharger Air Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Front Bumper Fascia. Refer to Front Bumper Fascia Replacement (Buick) .	
1	Electrical Connector
2	Turbocharger Air Pressure Sensor Bolt CAUTION: Refer to Fastener Caution . Tighten 3.8 N.m (34 lb in)
3	Turbocharger Air Pressure Sensor
4	Turbocharger Air Pressure Sensor Seal Procedure DISCARD the seal.

TURBOCHARGER BYPASS VALVE SOLENOID REPLACEMENT

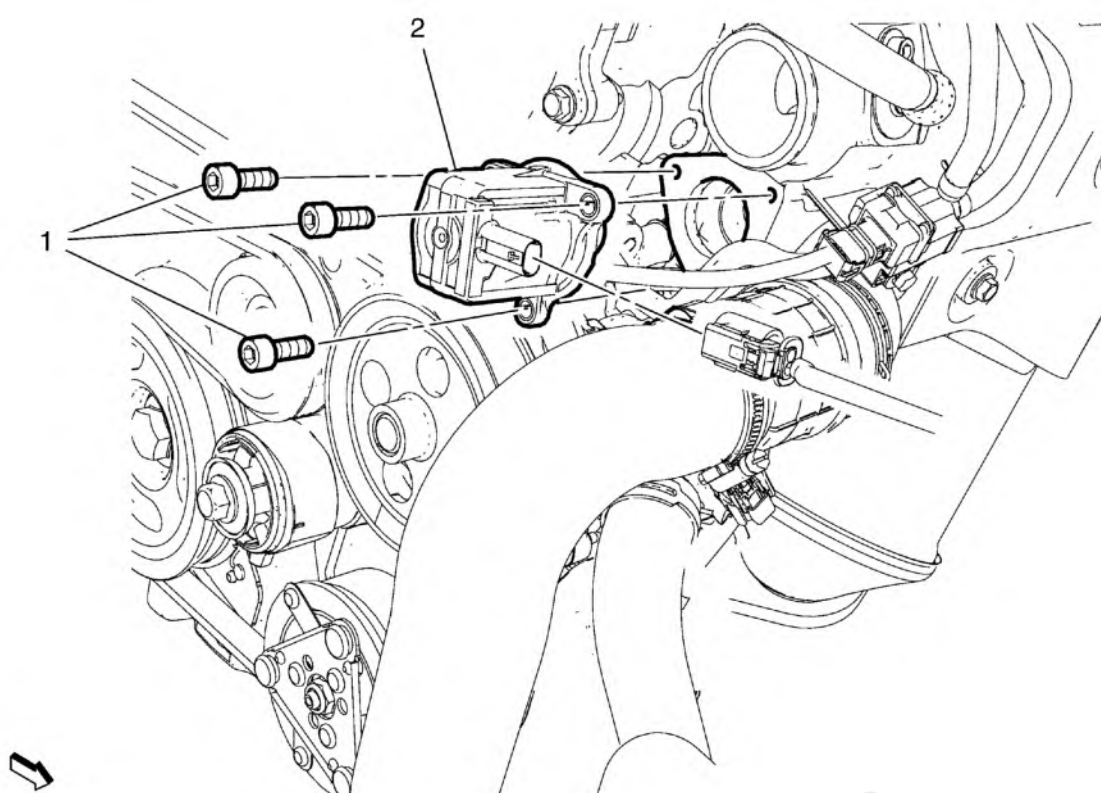


Fig. 222: Turbocharger Bypass Valve Solenoid
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Air Cleaner Outlet Duct. Refer to Air Cleaner Outlet Duct Replacement	
1	Turbocharger Bypass Valve Solenoid Bolt (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Turbocharger Bypass Valve Solenoid Procedure Disconnect the electrical connector.

TURBOCHARGER WASTEGATE ACTUATOR REPLACEMENT

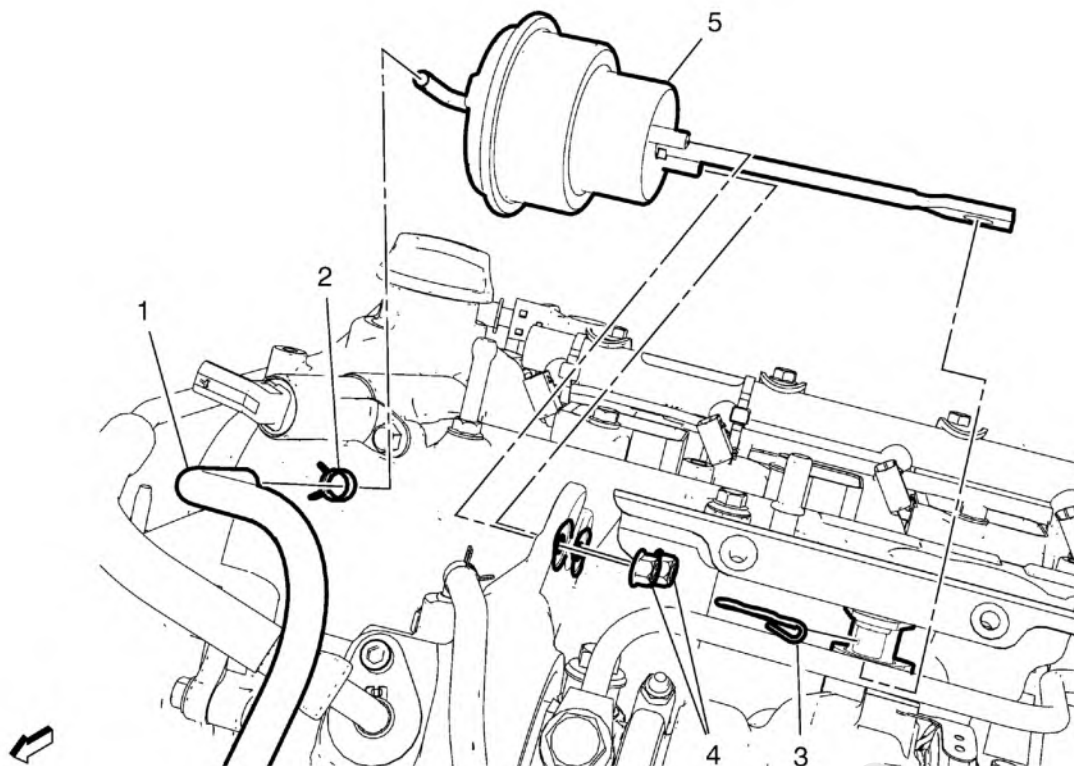


Fig. 223: Turbocharger Wastegate Actuator
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove Turbocharger Heat Shield. Refer to Turbocharger Heat Shield Replacement	
1	Turbocharger Wastegate Regulator Solenoid Valve Hose
2	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp
3	Turbocharger Wastegate Actuator Arm Retainer
4	Turbocharger Wastegate Actuator Nut CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
5	Turbocharger Wastegate Actuator

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Disconnect Battery Negative Cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#). [Battery Negative Cable Disconnection and Connection \(with KL9\)](#).
2. Remove Air Cleaner Outlet Duct. Refer to [Air Cleaner Outlet Duct Replacement](#)

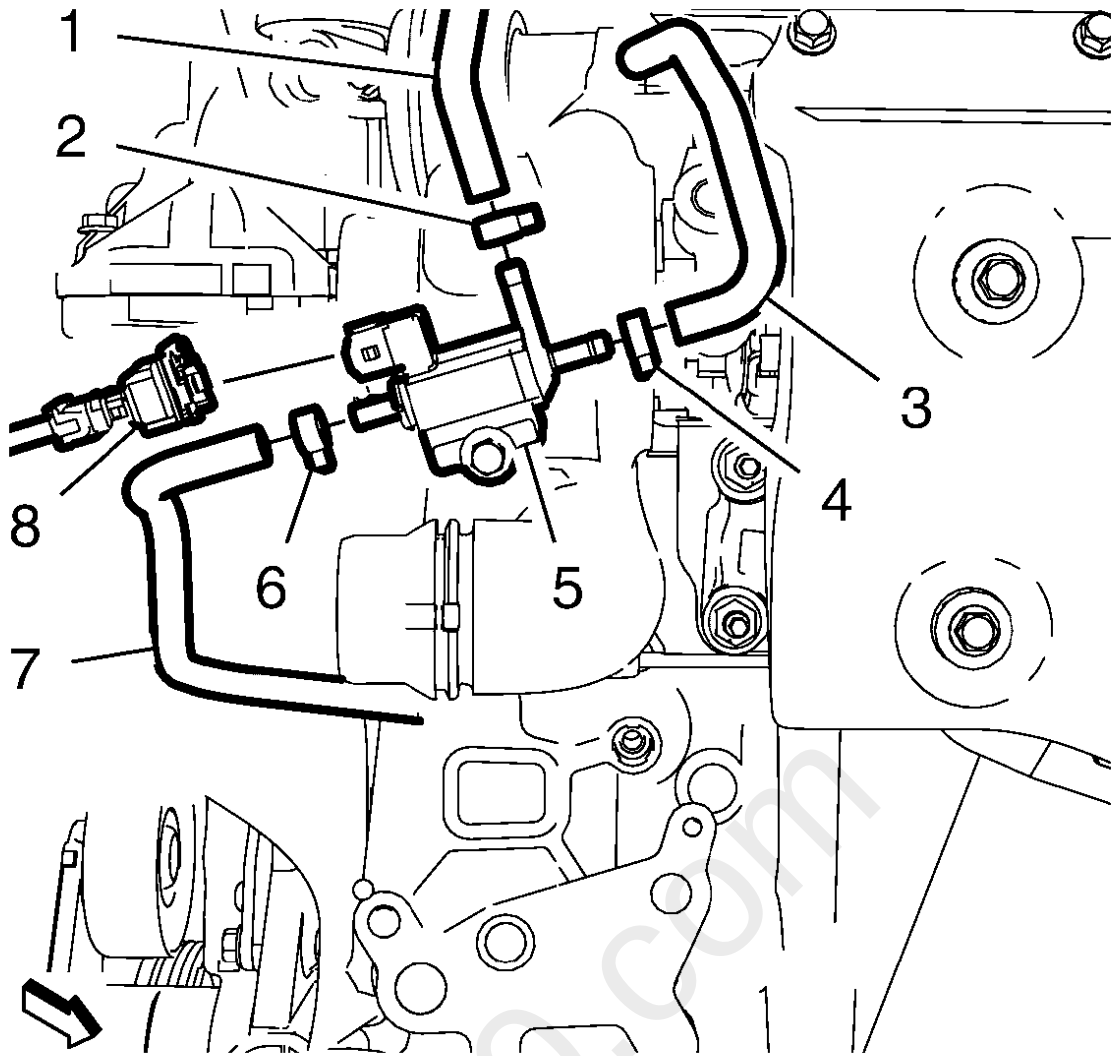


Fig. 224: Turbocharger Wastegate Regulator Solenoid Valve Components

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the turbocharger wastegate regulator solenoid valve electrical connector (8) from the turbocharger wastegate regulator solenoid valve (5).
4. Remove the 3 turbocharger wastegate regulator solenoid valve hose clamps (2, 4, 6). Refer to [Hose Clamp Replacement Guidelines - Spring Type](#)
5. Remove the 3 turbocharger wastegate regulator solenoid valve hoses (1, 3, 7) from the turbocharger wastegate regulator solenoid valve (5).

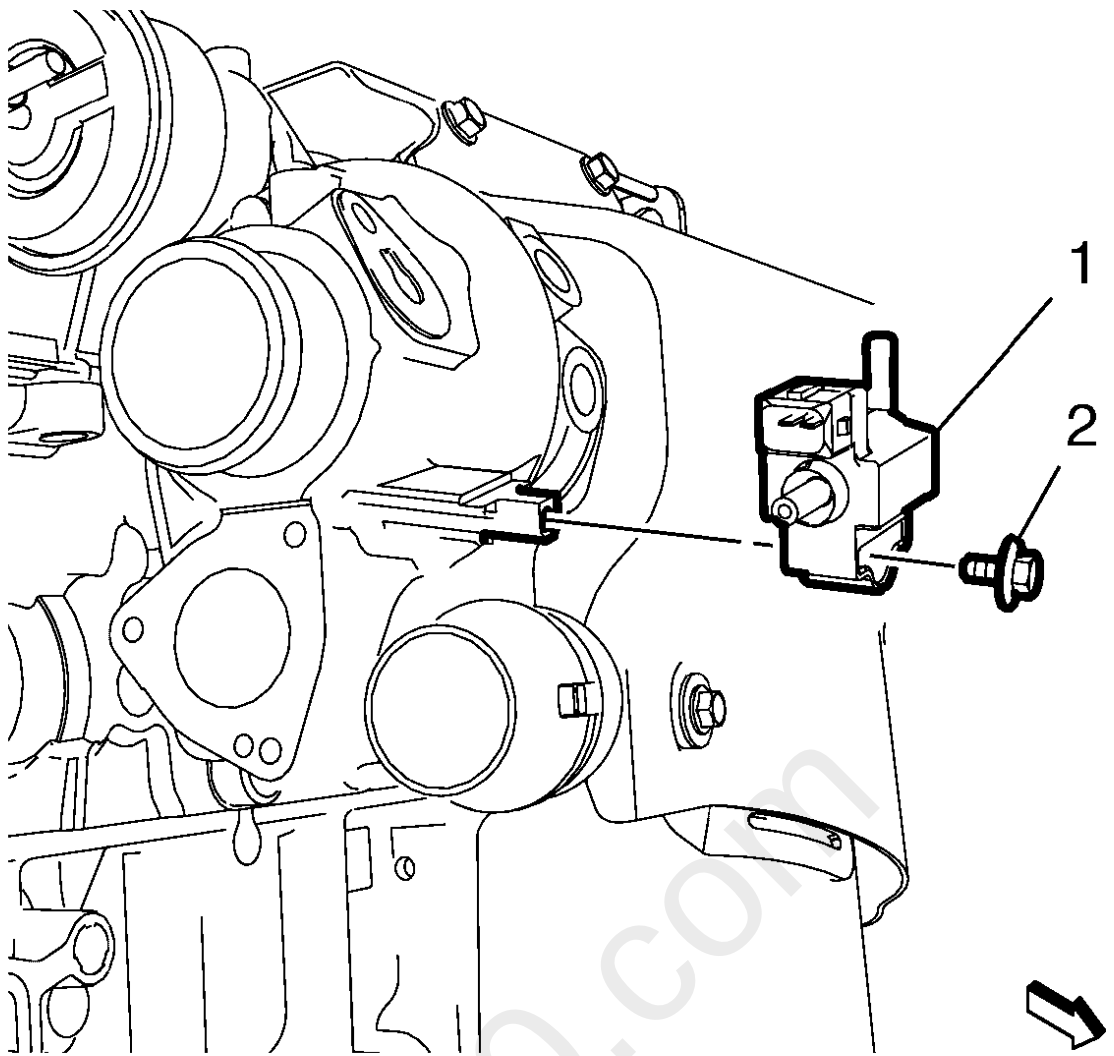


Fig. 225: Turbocharger Wastegate Regulator Solenoid Valve And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the turbocharger wastegate regulator solenoid valve bolt (2).
7. Remove the turbocharger wastegate regulator solenoid valve (1).

Installation Procedure

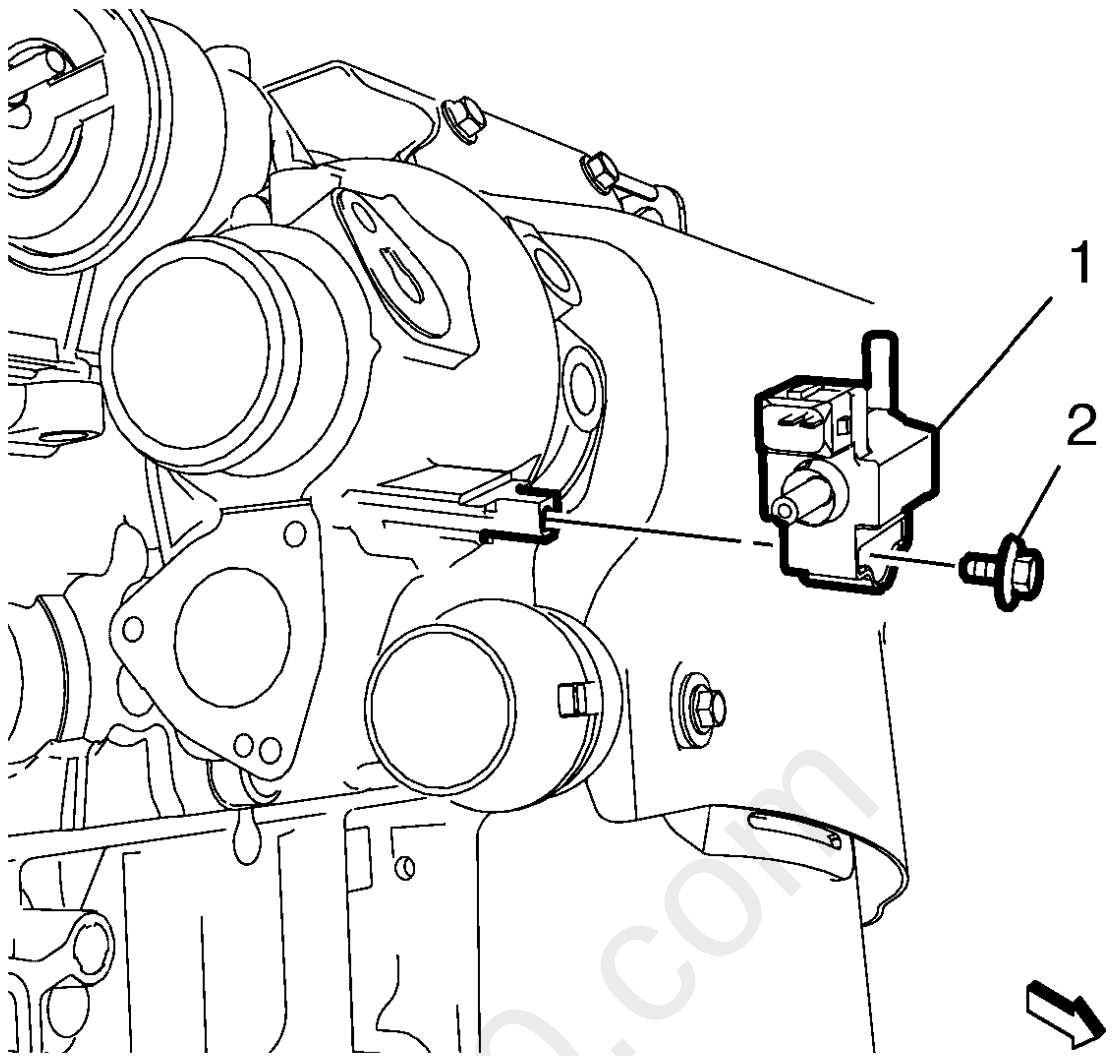


Fig. 226: Turbocharger Wastegate Regulator Solenoid Valve And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the turbocharger wastegate regulator solenoid valve (1).

CAUTION: Refer to **Fastener Caution** .

2. Install the turbocharger wastegate regulator solenoid valve bolt (2) and tighten to 8 N.m (71 lb in).

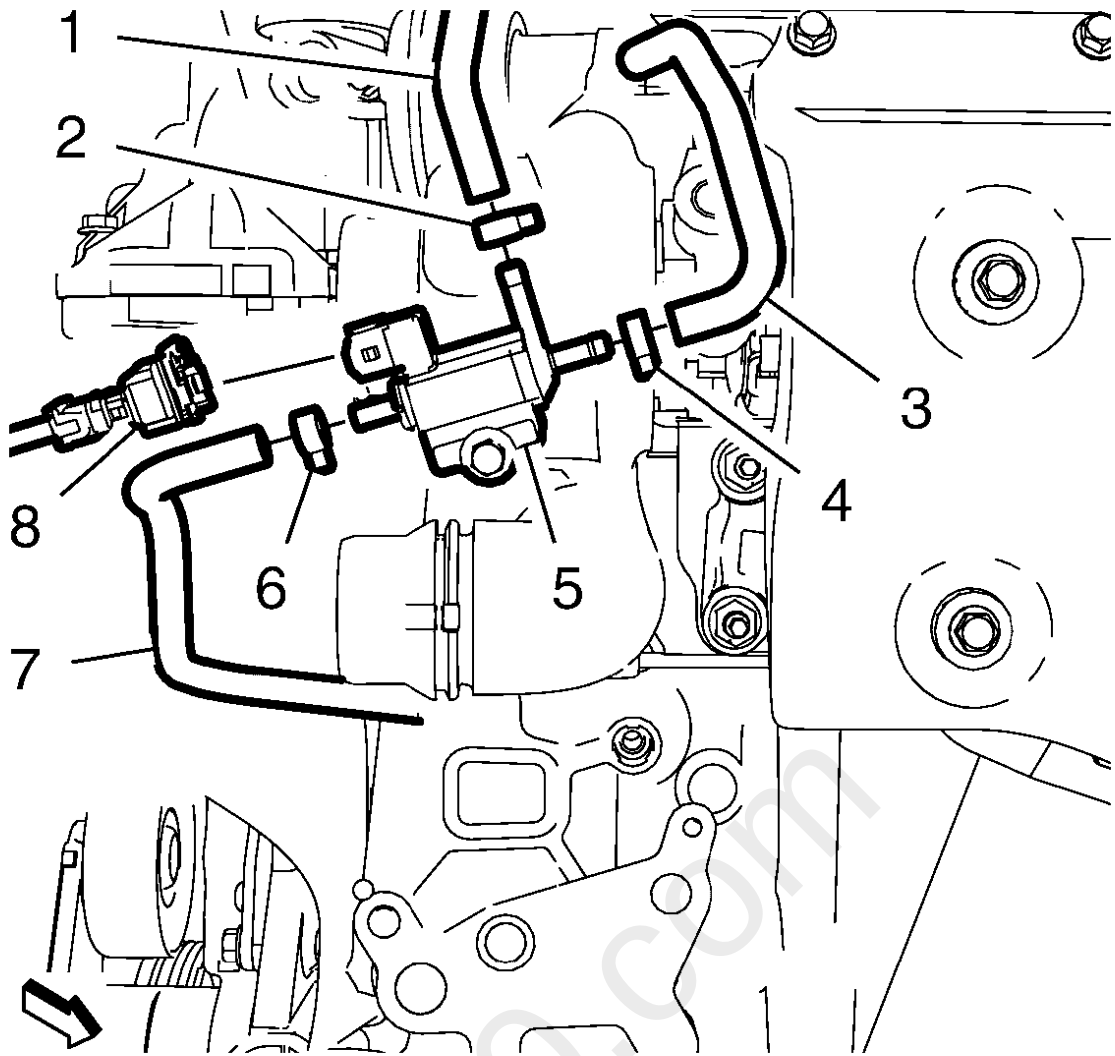


Fig. 227: Turbocharger Wastegate Regulator Solenoid Valve Components

Courtesy of GENERAL MOTORS COMPANY

3. Install the 3 turbocharger wastegate regulator solenoid valve hoses (1, 3, 7) to the turbocharger wastegate regulator solenoid valve (5).
4. Install the 3 turbocharger wastegate regulator solenoid valve hose clamps (2, 4, 6). Refer to [Hose Clamp Replacement Guidelines - Spring Type](#)
5. Connect the turbocharger wastegate regulator solenoid valve wiring harness plug (8) to the turbocharger wastegate regulator solenoid valve (5).
6. Install Air Cleaner Outlet Duct. Refer to [Air Cleaner Outlet Duct Replacement](#)
7. Connect Battery Negative Cable. Refer to [Battery Negative Cable Disconnection and Connection \(without KL9\)](#). [Battery Negative Cable Disconnection and Connection \(with KL9\)](#)

**TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE HOSE REPLACEMENT
(COMPRESSOR OUTLET TO SOLENOID)**

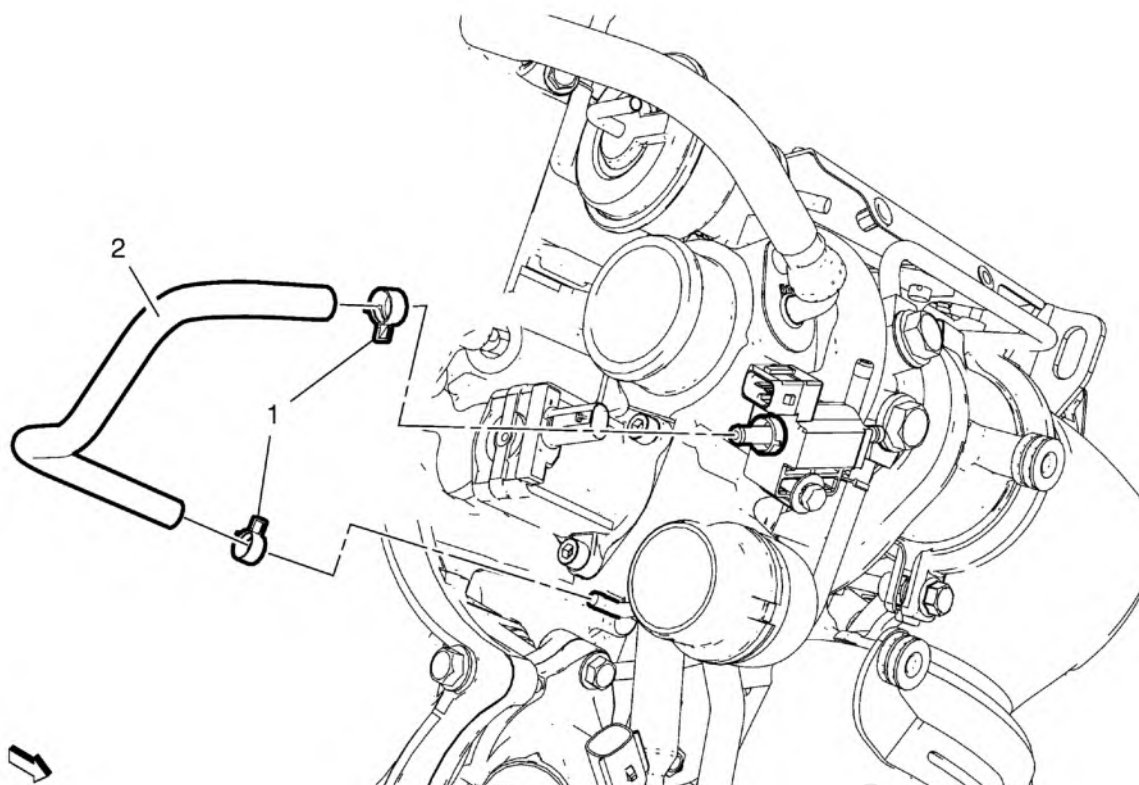


Fig. 228: Turbocharger Wastegate Regulator Solenoid Valve Hose (Compressor Outlet to Solenoid).

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp (Qty: 2)
2	Turbocharger Wastegate Regulator Solenoid Valve Hose CAUTION: Refer to Solenoid Valve Caution .

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE HOSE REPLACEMENT (WASTEGATE SOLENOID TO ACTUATOR)

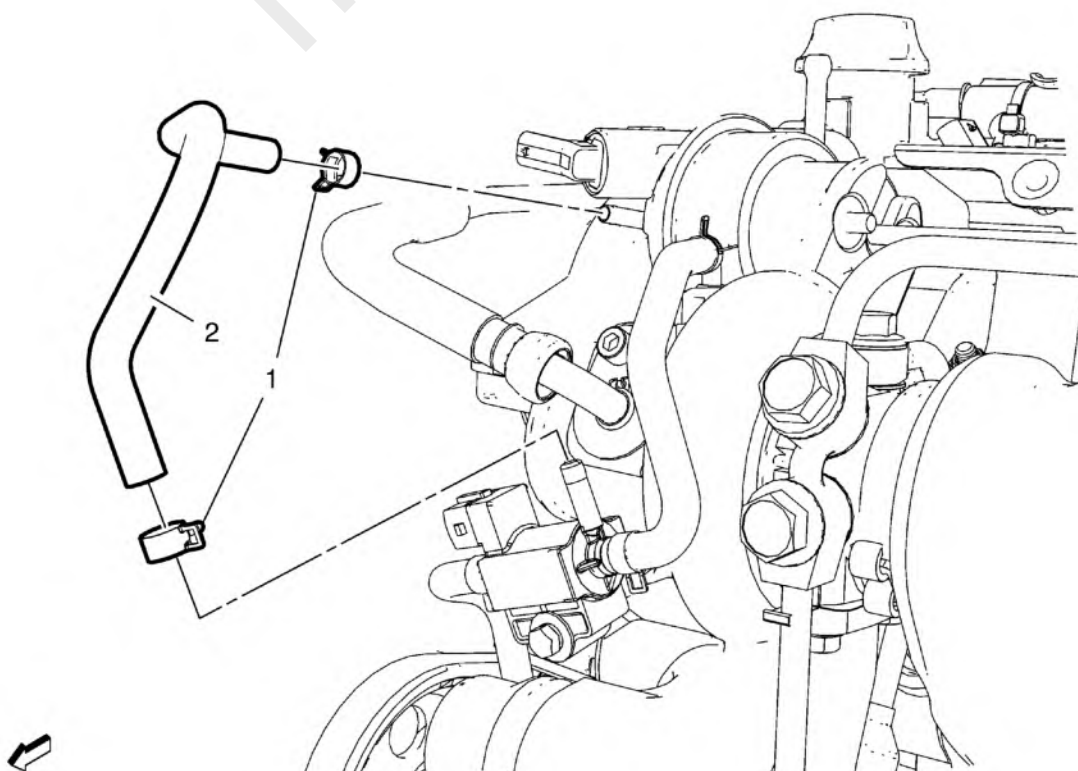


Fig. 229: Turbocharger Wastegate Regulator Solenoid Valve Hose (Wastegate Solenoid to Actuator).

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp (Qty: 2)
2	Turbocharger Wastegate Regulator Solenoid Valve Hose CAUTION: Refer to Solenoid Valve Caution .

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE HOSE REPLACEMENT (COMPRESSOR INLET TO SOLENOID)

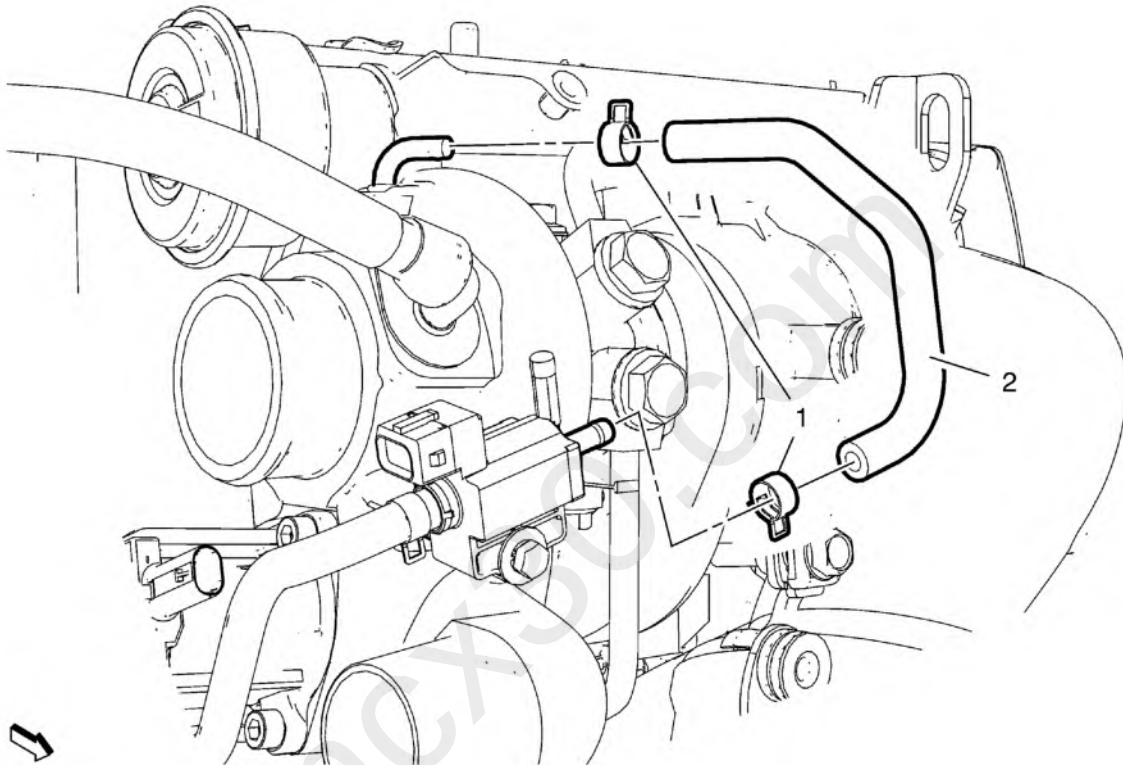


Fig. 230: Turbocharger Wastegate Regulator Solenoid Valve Hose (Compressor Inlet to Solenoid).

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp (Qty: 2)
2	Turbocharger Wastegate Regulator Solenoid Valve Hose CAUTION: Refer to Solenoid Valve Caution .