

## ENGINE

### Exhaust - Canyon, Colorado

## SPECIFICATIONS

### FASTENER SPECIFICATIONS

| Application                                                            | Specification |           |
|------------------------------------------------------------------------|---------------|-----------|
|                                                                        | Metric        | English   |
| Catalytic Converter Bracket to Engine Fastener (LCV)                   | 58 N.m        | 43 lb ft  |
| Catalytic Converter Bracket Fastener (LCV, LWN)                        | 22 N.m        | 16 lb ft  |
| Catalytic Converter Heat Shield Bolt (LWN)                             | 10 N.m        | 89 lb in  |
| Catalytic Converter to Engine (LFX)                                    | 50 N.m        | 37 lb ft  |
| Catalytic Converter to Exhaust Manifold Nut (LCV)                      | 58 N.m        | 43 lb ft  |
| Catalytic Converter to Muffler (LFX)                                   | 45 N.m        | 33 lb ft  |
| Catalytic Converter to Nitrogen Oxide Catalytic Converter (LWN)        | 50 N.m        | 37 lb ft  |
| Catalytic Converter to Three-Way Catalytic Converter (LFX)             | 50 N.m        | 37 lb ft  |
| Catalytic Converter to Turbocharger (LWN)                              | 28 N.m        | 21 lb ft  |
| Exhaust Manifold Fastener (LCV)                                        | 20 N.m        | 15 lb ft  |
| Exhaust Manifold Fastener (LWN)                                        | 32 N.m        | 24 lb ft  |
| Exhaust Manifold Heat Shield (LCV)                                     | 14 N.m        | 124 lb in |
| Exhaust Manifold Heat Shield (LWN)                                     | 10 N.m        | 89 lb in  |
| Exhaust Muffler Heat Shield                                            | 1.5 N.m       | 13 lb in  |
| Exhaust Pipe Fastener (LCV)                                            | 28 N.m        | 21 lb ft  |
| Nitrogen Oxide Catalytic Converter to Exhaust Particulate Filter (LWN) | 50 N.m        | 37 lb ft  |
| Turbocharger Brace Bolt (LWN)                                          | 32 N.m        | 24 lb ft  |

## DIAGNOSTIC INFORMATION AND PROCEDURES

### SYMPTOMS - ENGINE EXHAUST

- Review the exhaust system description in order to familiarize yourself with the exhaust system components and the intended function of the components.
- All diagnostics on a vehicle should follow a logical process. Strategy Based Diagnostics is a uniform approach for repairing all systems. The diagnostic flow is the place to start when repairs are necessary and may always be used in order to resolve a system problem. For a detailed explanation, refer to [Strategy Based Diagnosis](#).

#### Visual/Physical Inspection

- Inspect for aftermarket or non-OEM devices such as, but not limited to; tailpipe extensions, headers, and exhaust cutouts. Any aftermarket exhaust system devices could affect the operation and proper performance of the exhaust system.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, engine temperature, engine load, and frequency of concern.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause any symptom.

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating as designed.

### Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Loss of power

Refer to [Restricted Exhaust](#)

- Poor acceleration

Refer to [Restricted Exhaust](#)

- Poor fuel economy

Refer to [Restricted Exhaust](#)

- Excessive smoke diesel

Refer to [Restricted Exhaust](#)

- Exhaust hissing noise

Refer to [Exhaust Leakage](#)

- Exhaust popping noise

Refer to [Exhaust Leakage](#)

- Exhaust rattle noise

Refer to [Exhaust Noise](#)

- Loud exhaust noise

Refer to [Exhaust Noise](#)

- Exhaust buzz, groan, hum noise

Refer to [Exhaust Noise](#)

### RESTRICTED EXHAUST

#### Diagnostic Aids

**WARNING:** In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

For dual exhaust systems a quick check of exhaust flow will help determine which side of the exhaust system is restricted. The side that has less exhaust flow is the side that will be suspect, and diagnosis should begin there.

**NOTE:** This will not apply if the dual exhaust is equipped with an "H" pipe or similar configuration in which the exhaust flow would be equalized.

| Step | 1 | Action | Value(s) | Yes | No |
|------|---|--------|----------|-----|----|
|------|---|--------|----------|-----|----|

The numbers below refer to the step numbers on the diagnostic table.

4

The exhaust system has very low back pressure under normal conditions. If the exhaust system is restricted, a significant increase in the exhaust pressure is noticed on the **J-35314-A** Exhaust Back Pressure Gauge.

Removing the AIR check valve or HO2S sensor may set a DTC. When finishing this diagnostic table, be sure to clear all codes.

5

This step will isolate the catalytic converter from the remainder of the exhaust system.

8

Confirming that the condition has been fixed is essential. If the symptom still exists and the vehicle has a dual exhaust system, proceed to Step 2 and repeat diagnostic procedure on the opposite exhaust pipe.

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Value(s)       | Yes                   | No                                     |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------------------|----------------------------------------|
| 1    | Did you verify the customers complaint?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | -              | Go to <b>Step 2</b>   | -                                      |
| 2    | Did you review the exhaust symptoms diagnostic information and perform the necessary inspections?                                                                                                                                                                                                                                                                                                                                                                                                                                                           | -              | Go to <b>Step 3</b>   | Go to <b>Symptoms - Engine Exhaust</b> |
| 3    | Is the system equipped with dual exhaust?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | -              | Go to Diagnostic Aids | Go to <b>Step 4</b>                    |
| 4    | <ol style="list-style-type: none"> <li>1. Remove the secondary air injection (AIR) check valve or the heated oxygen sensor (HO2S) that is in front of and closest to the catalytic converter. Refer to the affected component's service procedure.</li> <li>2. Install the <b>J-35314-A</b> Exhaust Back Pressure Gauge in place of the AIR check valve or HO2S sensor.</li> <li>3. Start the engine.</li> <li>4. Increase and monitor the engine speed at 2,000 RPM.</li> <li>5. Observe the exhaust system back pressure reading on the gauge.</li> </ol> | 14 kPa (2 psi) |                       |                                        |
|      | Does the reading exceed the specified value?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                | Go to <b>Step 5</b>   | Go to <b>Step 8</b>                    |

| Step | Problem                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Action | Value(s)       | Yes                 | No                  |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------------|---------------------|---------------------|
| 5    | <ol style="list-style-type: none"> <li>1. Turn the engine off and place the ignition in the lock position.</li> <li>2. Remove the <b>J-35314-A</b> Exhaust Back Pressure Gauge.</li> <li>3. Re-install the AIR check valve/HO2S sensor. Refer to the affected component's service procedure.</li> <li>4. Remove the post-catalyst HO2S sensor. Refer to the affected component's service procedure.</li> <li>5. Install the <b>J-35314-A</b> Exhaust Back Pressure Gauge in place of the post HO2S sensor.</li> <li>6. Start the engine.</li> <li>7. Increase and monitor the engine speed at 2,000 RPM.</li> <li>8. Observe the exhaust system back pressure reading on the gauge.</li> </ol> |        | 14 kPa (2 psi) |                     |                     |
|      | Does the reading exceed the specified value?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |                | Go to <b>Step 6</b> | Go to <b>Step 7</b> |
| 6    | Inspect the exhaust system for the following conditions: <ul style="list-style-type: none"> <li>• Damage in the exhaust pipe</li> <li>• Debris in the exhaust pipe</li> <li>• Muffler or resonator internal failure</li> <li>• Two-layer exhaust pipe separation</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                    |        | -              |                     | -                   |
|      | Did you find and correct the condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |                | Go to <b>Step 8</b> |                     |
| 7    | Replace the catalytic converter. Refer to the affected component's service procedure.           Did you find and correct the condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        | -              | Go to <b>Step 8</b> | -                   |
| 8    | <ol style="list-style-type: none"> <li>1. Remove the <b>J-35314-A</b> Exhaust Back Pressure Gauge.</li> <li>2. Reinstall the AIR check valve or the post-catalyst HO2S sensor. Refer to the affected component's service procedure</li> <li>3. Clear any codes.</li> <li>4. Road test the vehicle in order to verify the repair.</li> </ol>                                                                                                                                                                                                                                                                                                                                                    |        | -              |                     |                     |
|      | Did you correct the condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |                | System OK           | Go to <b>Step 2</b> |

## EXHAUST LEAKAGE

| Problem | Action |
|---------|--------|
|---------|--------|

| Problem                                                                                                                                                                                                                                                                                                  | Condition | Action                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARNING:</b><br><b>While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.</b>                                                                                                                                               |           |                                                                                                                                                                                                                                                           |
| <b>DEFINITION:</b> An exhaust leak may show stains at the area of the leak. The leak may be felt by holding a hand close to the suspected areas or using a smoke pencil. The leak may make a popping or hissing noise. Refer to <a href="#">Symptoms - Engine Exhaust</a> prior to beginning this table. |           |                                                                                                                                                                                                                                                           |
| Misaligned or improperly installed exhaust system components                                                                                                                                                                                                                                             |           | <ul style="list-style-type: none"> <li>Align and tighten the exhaust system components to the specifications. Refer to <a href="#">Fastener Specifications</a>.</li> <li>Ensure the exhaust hangers are in the proper locations and not loose.</li> </ul> |
| Exhaust leaks at the following connections: <ul style="list-style-type: none"> <li>Exhaust manifold to pipe</li> <li>Flanges</li> <li>Pipe clamps</li> </ul>                                                                                                                                             |           | Tighten the components to the specifications. Refer to <a href="#">Fastener Specifications</a> .                                                                                                                                                          |
| Seals or gaskets leaking <ul style="list-style-type: none"> <li>Exhaust manifold to cylinder head</li> <li>Exhaust pipes to exhaust manifold</li> <li>Catalytic converter connection</li> <li>EGR connections</li> <li>AIR connections to the exhaust manifold or cylinder head</li> </ul>               |           | Replace the leaking seal or gasket. Refer to the affected components procedure for service.                                                                                                                                                               |
| Irregularities at the mating surfaces on the flange connections                                                                                                                                                                                                                                          |           | Repair as required or replace the affected component. Refer to the affected components procedure for service.                                                                                                                                             |
| Exhaust manifold cracked or broken                                                                                                                                                                                                                                                                       |           | Replace the exhaust manifold. Refer to the affected component's procedure for service.                                                                                                                                                                    |
| Exhaust system component connection welds leaking                                                                                                                                                                                                                                                        |           | Replace the leaking component. Refer to the affected component's procedure for service.                                                                                                                                                                   |
| Muffler or resonator (if equipped) damaged or leaking at the seams                                                                                                                                                                                                                                       |           | Replace the affected muffler or resonator. Refer to the affected component's procedure for service.                                                                                                                                                       |

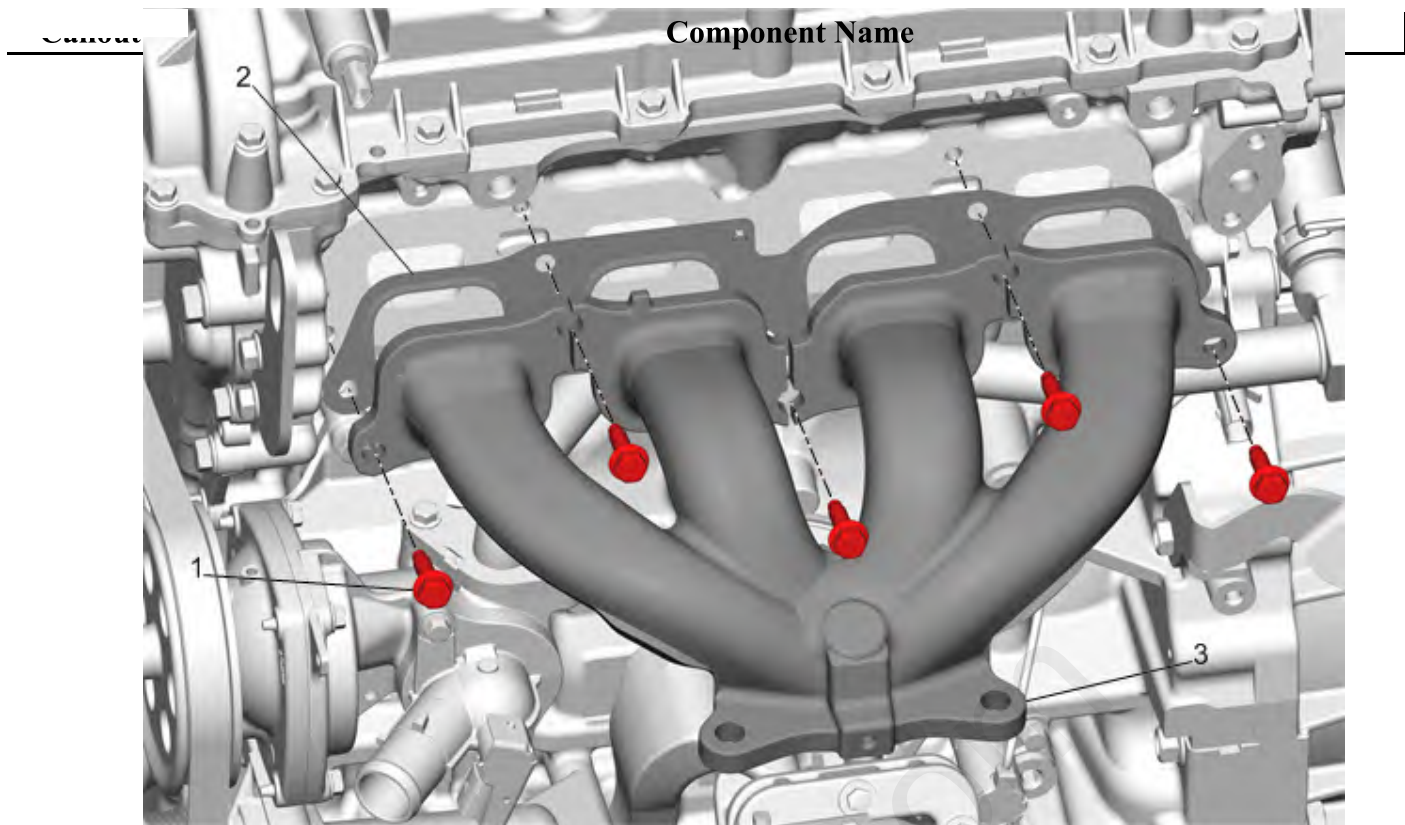
## EXHAUST NOISE

| Condition | Action |
|-----------|--------|
|           |        |

| Condition                                                                                                                                                                                                                                                                                       | Action                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARNING:</b><br><b>While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.</b>                                                                                                                                      |                                                                                                                                                                                                                                                                                                      |
| <b>DEFINITION:</b> An audible or physical noise due to a faulty component or damaged components causing a loose or misaligned exhaust system resulting in a rattle or vibration noise, i.e. buzz, groan, hum. Refer to <a href="#">Symptoms - Engine Exhaust</a> prior to beginning this table. |                                                                                                                                                                                                                                                                                                      |
| Popping or hissing noise                                                                                                                                                                                                                                                                        | Exhaust leak. Refer to <a href="#">Exhaust Leakage</a> .                                                                                                                                                                                                                                             |
| Loud exhaust                                                                                                                                                                                                                                                                                    | <ol style="list-style-type: none"> <li>1. Compare to a known good vehicle.</li> <li>2. Inspect for a damaged or failed muffler.</li> <li>3. Repair or replace the affected component. Refer to the affected component's service procedure.</li> </ol>                                                |
| External rattle or vibration noise                                                                                                                                                                                                                                                              | <ol style="list-style-type: none"> <li>1. Inspect for a bent or loose hanger, loose heat shield, or loose clamp.</li> <li>2. Inspect for an exhaust pipe causing interference.</li> <li>3. Repair or replace the affected component. Refer to the affected component's service procedure.</li> </ol> |
| Internal rattle                                                                                                                                                                                                                                                                                 | <ol style="list-style-type: none"> <li>1. Test the components by tapping with a rubber mallet to confirm a rattle.</li> <li>2. Repair or replace the affected component. Refer to the affected component's service procedure.</li> </ol>                                                             |

## REPAIR INSTRUCTIONS

### EXHAUST MANIFOLD REPLACEMENT (LCV)



**Fig. 1: Exhaust Manifold (LCV)**  
 Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                                                                                                                                                                 | Component Name                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARNING:</b><br>Refer to <a href="#">Exhaust Service Warning</a> .                                                                                                                                                   |                                                                                                                                    |
| <b>Preliminary Procedure</b> <ol style="list-style-type: none"> <li><a href="#">Exhaust Manifold Heat Shield Replacement (LCV)</a></li> <li>Disconnect <a href="#">Catalytic Converter Replacement (LCV)</a></li> </ol> |                                                                                                                                    |
| 1                                                                                                                                                                                                                       | Fastener (Qty: 5)<br><br><b>CAUTION:</b><br>Refer to <a href="#">Fastener Caution</a> .<br><br><b>Tighten</b><br>20 N.m (15 lb ft) |
| 2                                                                                                                                                                                                                       | Exhaust Manifold Gasket<br><b>Procedure</b><br>Install a NEW gasket.                                                               |
| 3                                                                                                                                                                                                                       | Exhaust Manifold                                                                                                                   |

**EXHAUST MANIFOLD REPLACEMENT (LWN)**

**Removal Procedure**

In order to avoid being burned, do not service the exhaust system while it is still

in order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

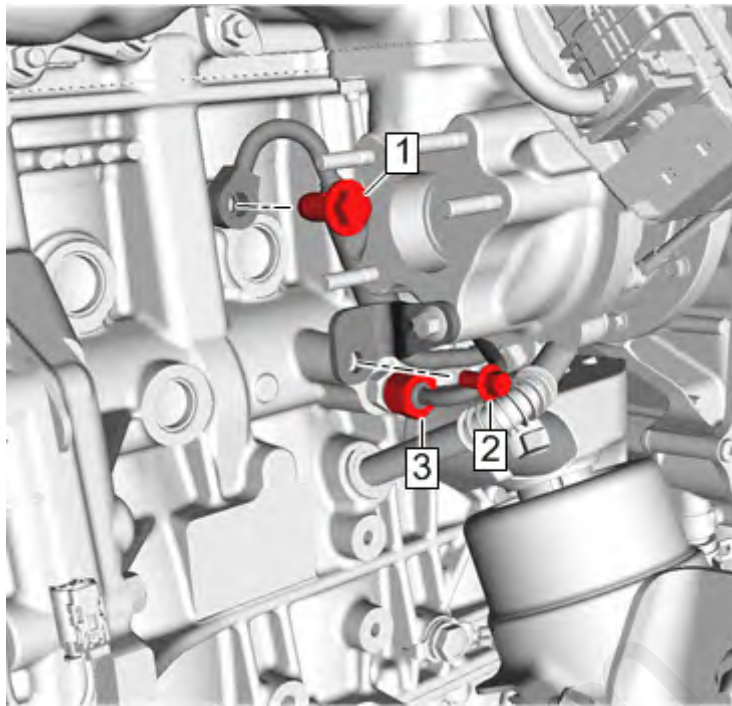
**WARNING:** Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.

1. Remove Charge Air Cooler Inlet Duct. [Charge Air Cooler Inlet Duct Replacement](#)
2. Remove Charge Air Cooler Outlet Duct. [Charge Air Cooler Outlet Duct Replacement](#)



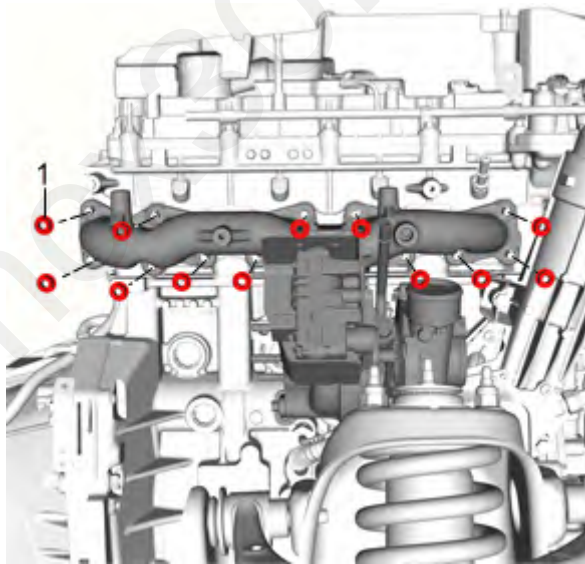
**Fig. 2: Radiator Surge Tank Outlet Hose**  
Courtesy of GENERAL MOTORS COMPANY

3. Reposition Radiator Surge Tank Outlet Hose Clamp (1)
4. Disconnect Radiator Surge Tank Outlet Hose (2) @Turbocharger Coolant Return Pipe.
5. Remove Catalytic Converter [Catalytic Converter Replacement \(LWN\)](#)
6. Remove Turbocharger Oil Feed Pipe [Turbocharger Oil Feed Pipe Replacement](#)
7. Remove Turbocharger Oil Return Pipe [Turbocharger Oil Return Pipe Replacement](#)



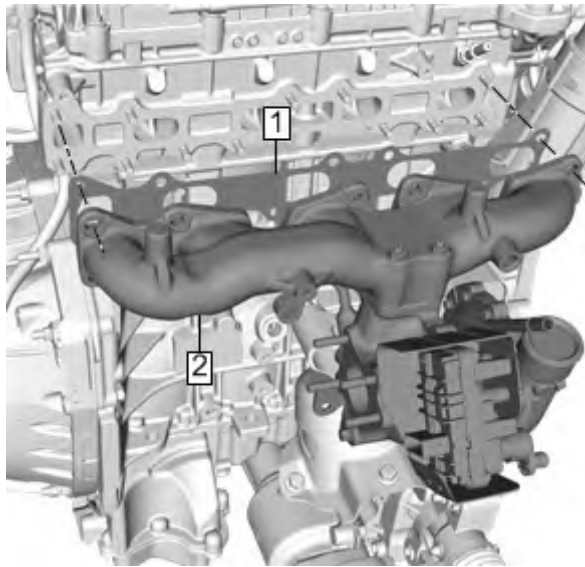
**Fig. 3: Turbocharger Coolant Feed Pipe Hollow Screw**  
Courtesy of GENERAL MOTORS COMPANY

8. Remove Turbocharger Coolant Feed Pipe Hollow Screw (1)
9. Remove Turbocharger Brace Bolt (2)



**Fig. 4: Exhaust Manifold Nut**  
Courtesy of GENERAL MOTORS COMPANY

10. Remove Exhaust Manifold Nut (1)



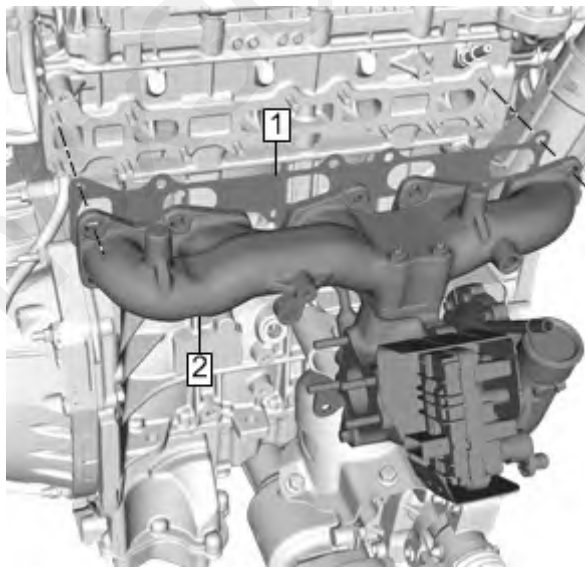
**Fig. 5: Exhaust Manifold Gasket**

Courtesy of GENERAL MOTORS COMPANY

11. Remove Exhaust Manifold and Turbocharger Assembly (2)
12. Remove Exhaust Manifold Gasket (1) and DISCARD
13. Remove Turbocharger. [Turbocharger Replacement](#)

#### **Installation Procedure**

1. Install Turbocharger [Turbocharger Replacement](#)

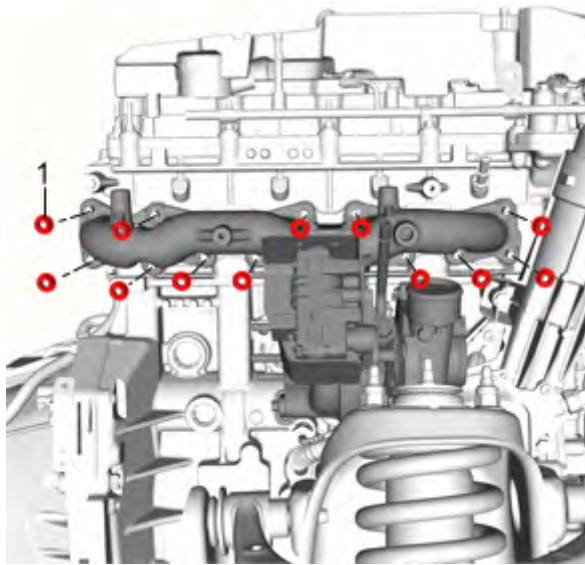


**Fig. 6: Exhaust Manifold Gasket**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Install a NEW exhaust manifold gasket.

2. Install Exhaust Manifold Gasket (1)
3. Install Exhaust Manifold and Turbocharger Assembly (2)

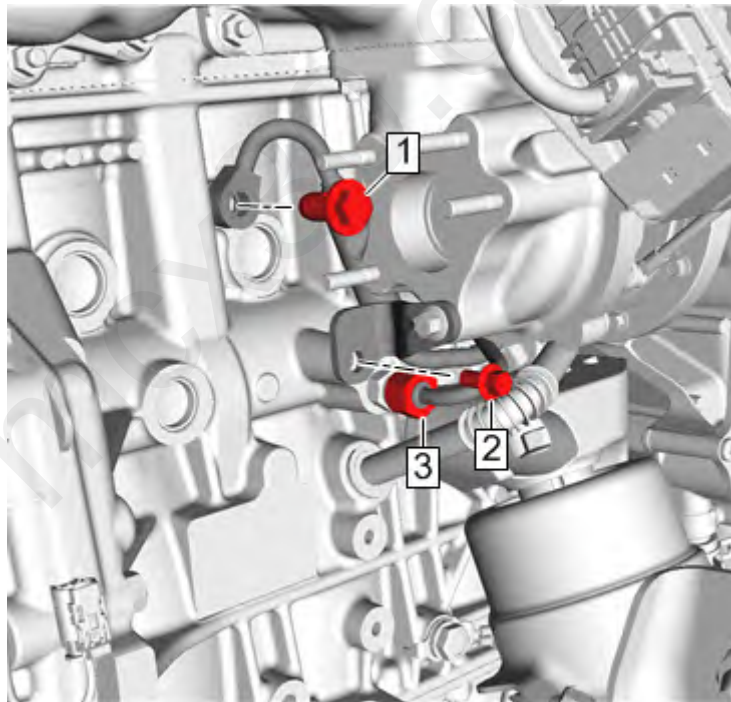


**Fig. 7: Exhaust Manifold Nut**

Courtesy of GENERAL MOTORS COMPANY

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

4. Install Exhaust Manifold Nut (1) and tighten 32 N.m (24 lb ft)



**Fig. 8: Turbocharger Coolant Feed Pipe Hollow Screw**

Courtesy of GENERAL MOTORS COMPANY

5. Install Turbocharger Brace Bolt (2) and tighten 32 N.m (24 lb ft)
6. Install Turbocharger Coolant Feed Pipe Hollow Screw (1) and tighten 35 N.m (26 lb ft)
7. Install Turbocharger Oil Return Pipe. [Turbocharger Oil Return Pipe Replacement](#)
8. Install Turbocharger Oil Feed Pipe. [Turbocharger Oil Feed Pipe Replacement](#)
9. Install Catalytic Converter. [Catalytic Converter Replacement \(LWN\)](#)



**Fig. 9: Radiator Surge Tank Outlet Hose**

Courtesy of GENERAL MOTORS COMPANY

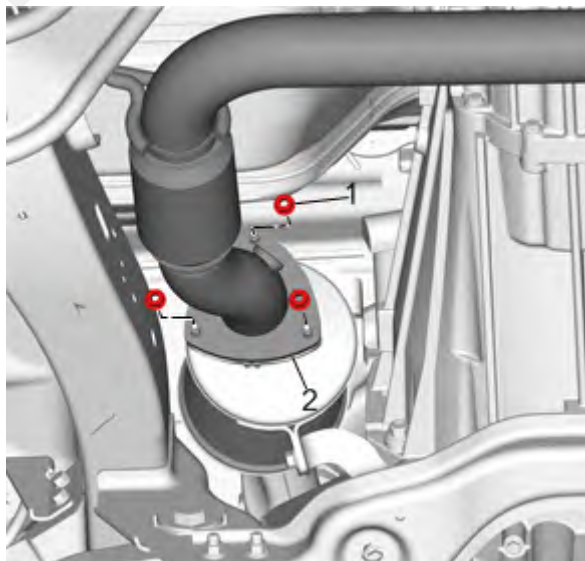
10. Connect Radiator Surge Tank Outlet Hose (2) @Turbocharger Coolant Return Pipe
11. Install Radiator Surge Tank Outlet Hose Clamp (1)
12. Install Charge Air Cooler Outlet Duct. [Charge Air Cooler Outlet Duct Replacement](#)
13. Install Charge Air Cooler Inlet Duct. [Charge Air Cooler Inlet Duct Replacement](#)

## **EXHAUST PIPE REPLACEMENT (LCV)**

### **Removal Procedure**

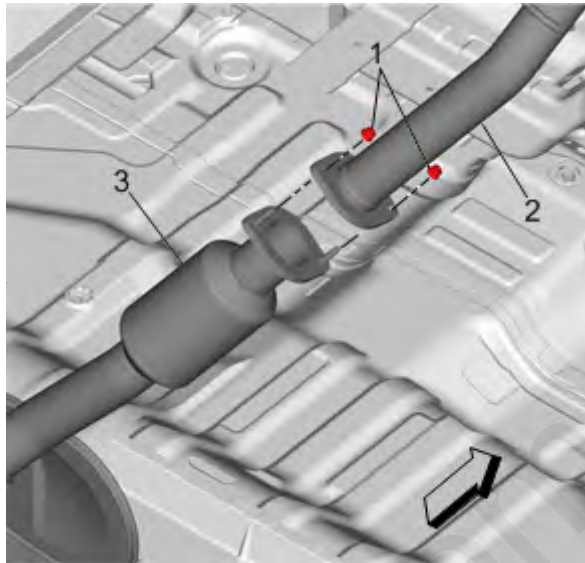
**WARNING:** Refer to [Exhaust Service Warning](#) .

1. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)
2. Disconnect Heated Oxygen Sensor - Sensor 2 [Heated Oxygen Sensor Replacement - Sensor 2](#)
3. Disconnect Exhaust System Insulator, Hanger, Bracket [Exhaust System Insulator, Hanger, Bracket Replacement \(LCV\)](#)



**Exhaust Pipe Fasteners**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove Exhaust Pipe Fasteners (1)
5. Remove Exhaust Pipe (2)

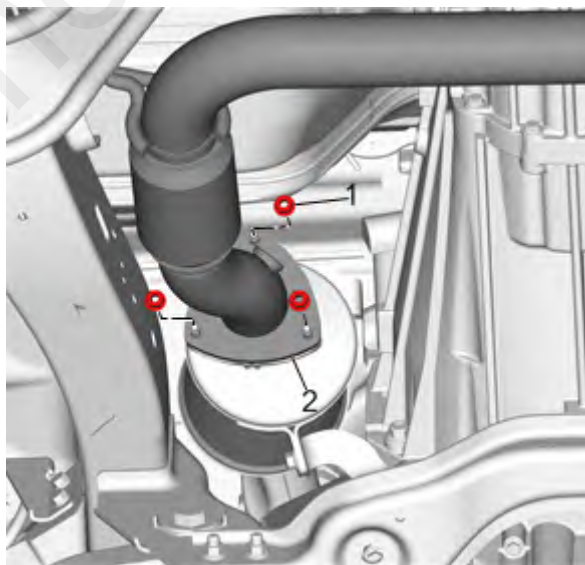


**Fig. 11: Exhaust Pipe Fasteners**  
Courtesy of GENERAL MOTORS COMPANY

6. Remove Exhaust Pipe Fasteners (1)
7. Disconnect Exhaust Front Pipe (2) @Exhaust Muffler (3)
8. Remove Exhaust Pipe

**Installation Procedure**

1. Install a NEW gasket.



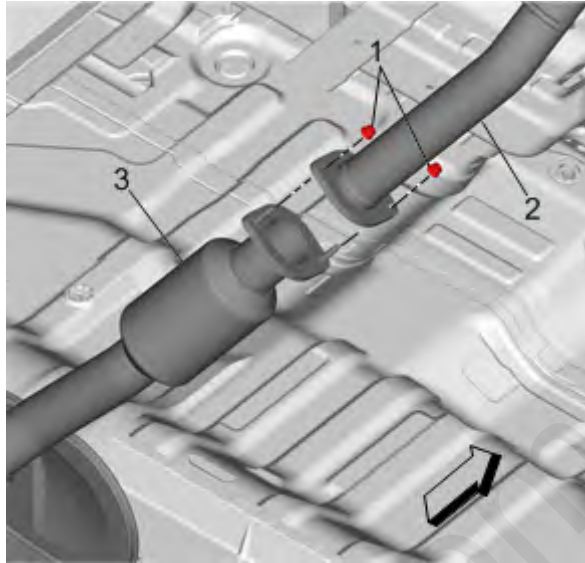
**Fig. 12: Exhaust Pipe Fasteners**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Clean and lubricate the exhaust isolators for ease of installation.

Exhaust Pipe (2)

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

3. Exhaust Pipe Fasteners (1) Tighten 28 N.m (21 lb ft)



**Fig. 13: Exhaust Pipe Fasteners**

Courtesy of GENERAL MOTORS COMPANY

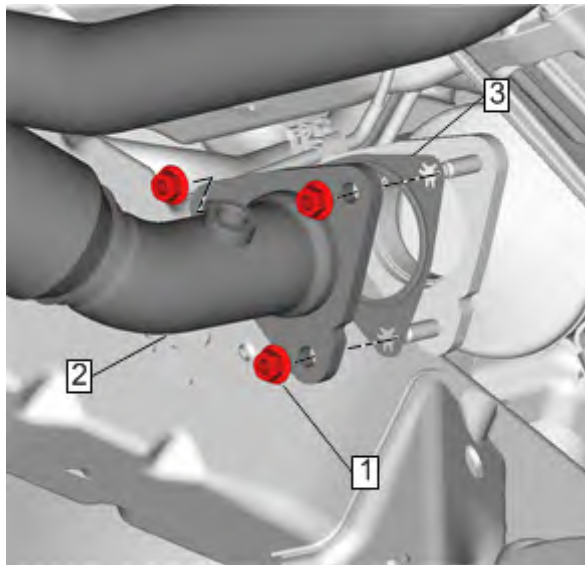
4. Install a NEW gasket.
5. Connect Exhaust Front Pipe (2) @Exhaust Muffler (3)
6. Exhaust Pipe Fastener (1) Tighten 28 N.m (21 lb ft)
7. Connect [Exhaust System Insulator, Hanger, Bracket Replacement \(LCV\)](#)
8. Connect [Heated Oxygen Sensor Replacement - Sensor 2](#)
9. Lower the vehicle.

## **EXHAUST PIPE REPLACEMENT**

### **Removal Procedure**

**WARNING:** Refer to [Exhaust Service Warning](#) .

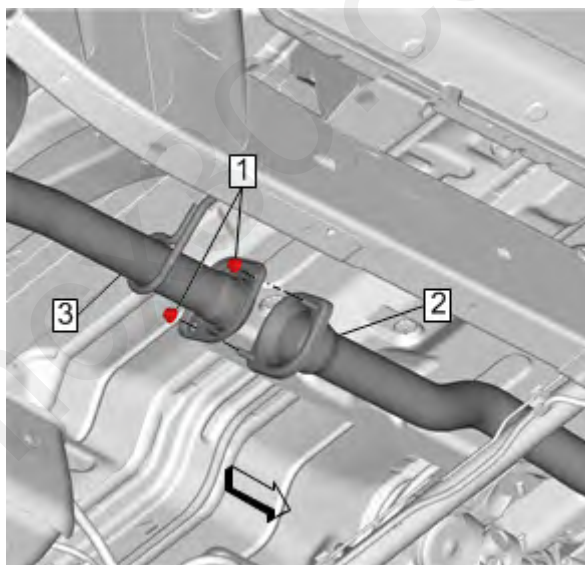
1. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)
2. Disconnect Heated Oxygen Sensor - Sensor 2 [Heated Oxygen Sensor Replacement - Sensor 2](#)
3. Disconnect Exhaust System Insulator, Hanger, Bracket [Exhaust System Insulator, Hanger, Bracket Replacement \(LCV\)](#)[Exhaust System Insulator, Hanger, Bracket Replacement \(LFX\)](#)



**Fig. 14: Exhaust Pipe Fasteners**

Courtesy of GENERAL MOTORS COMPANY

4. Remove Exhaust Pipe Fasteners (1)
5. Remove Exhaust Pipe (2)
6. Remove Exhaust Gasket (3) and DISCARD

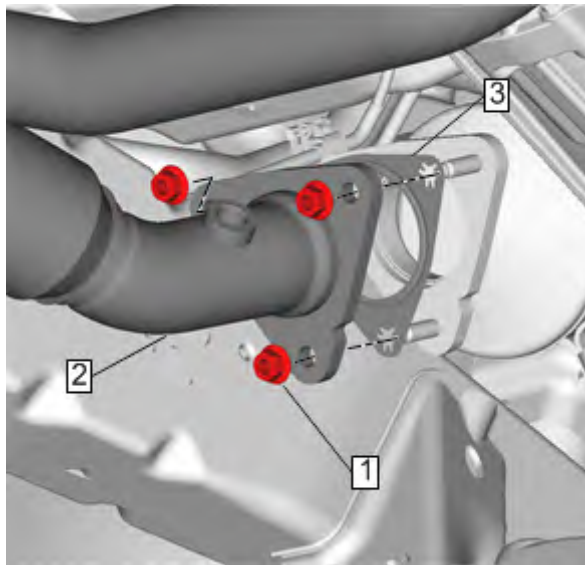


**Fig. 15: Exhaust Pipe Fasteners**

Courtesy of GENERAL MOTORS COMPANY

7. Remove Exhaust Pipe Fasteners (1)
8. Disconnect Exhaust Front Pipe (2) @Exhaust Muffler (3)
9. Remove Exhaust Front Pipe (2)

### Installation Procedure



**Fig. 16: Exhaust Pipe Fasteners**

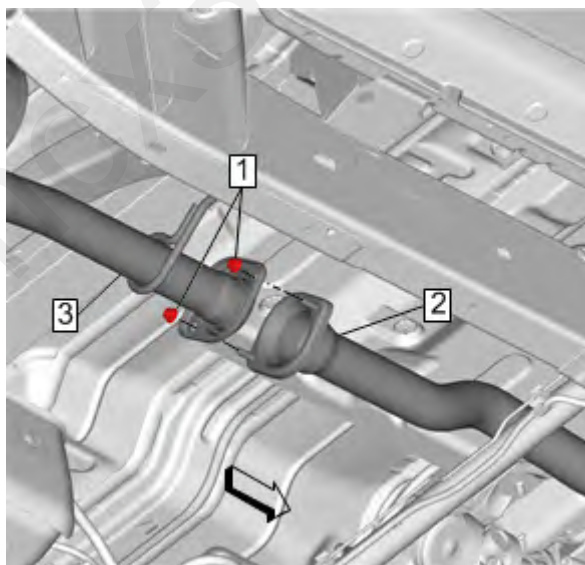
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Clean and lubricate the exhaust isolators for ease of installation.

1. Install a NEW gasket (3)
2. Install Exhaust Pipe (2)

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

3. Exhaust Pipe Fasteners (1) Tighten 50 N.m (37 lb ft)



**Fig. 17: Exhaust Pipe Fasteners**

Courtesy of GENERAL MOTORS COMPANY

4. Connect Exhaust Front Pipe (2) @Exhaust Muffler (3)
5. Exhaust Pipe Fastener (1) Tighten 45 N.m (33 lb ft)
6. Connect Exhaust System Insulator, Hanger, Bracket [Exhaust System Insulator, Hanger, Bracket Replacement \(LCV\)](#)[Exhaust System Insulator, Hanger, Bracket Replacement \(LFX\)](#)
7. Connect Heated Oxygen Sensor - Sensor 2 [Heated Oxygen Sensor Replacement - Sensor 2](#)

CATALYTIC CONVERTER REPLACEMENT (LCV)

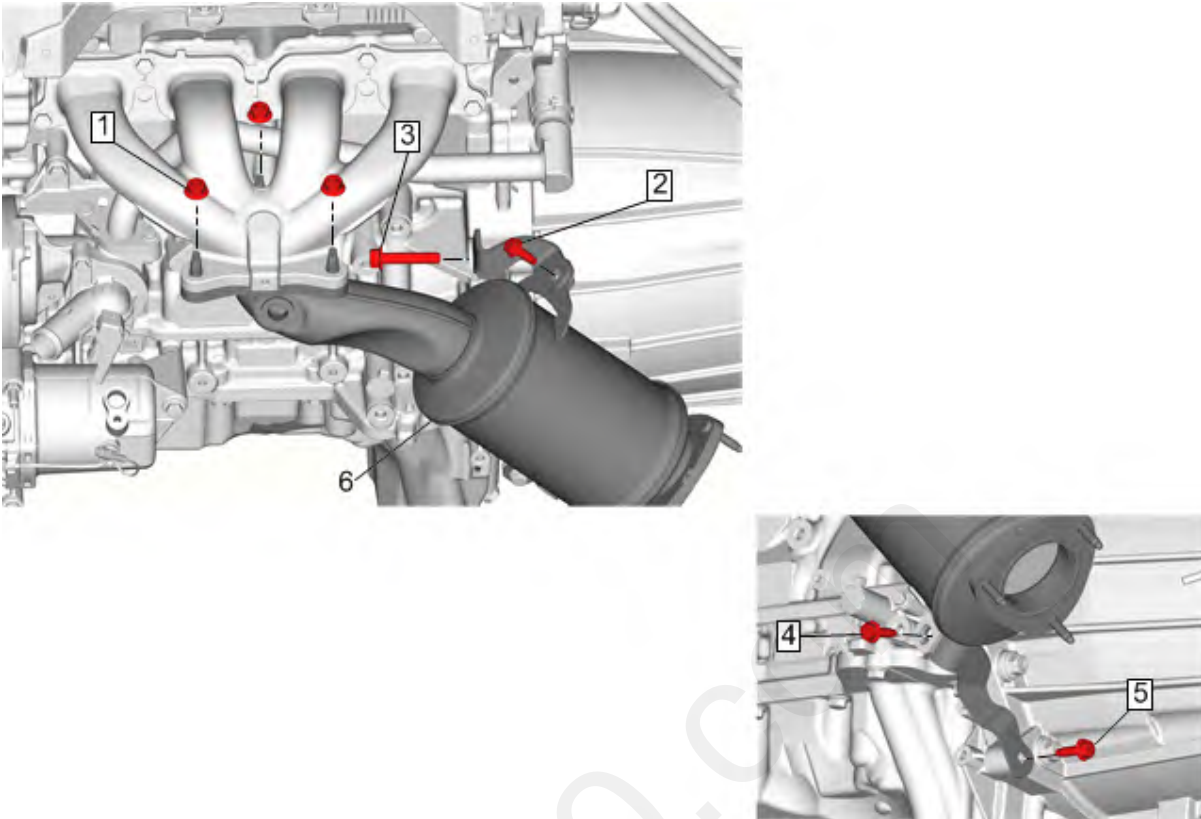


Fig. 18: Catalytic Converter Replacement (LCV)  
Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Component Name                                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>WARNING:</b><br/>Refer to <a href="#">Exhaust Service Warning</a> .</p> <p><b>IMPORTANT:</b><br/>Torque all fasteners in the order listed.</p> <p><b>Preliminary Procedure</b></p> <ol style="list-style-type: none"> <li><a href="#">Heated Oxygen Sensor Replacement - Sensor 1</a></li> <li><a href="#">Exhaust Manifold Replacement (LCV)</a></li> <li>Disconnect Exhaust Pipe @Catalytic Converter <a href="#">Exhaust Pipe Replacement (LCV)</a></li> </ol> |                                                                                                                                             |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>Fastener (Qty: 3)</p> <p><b>CAUTION:</b><br/>Refer to <a href="#">Fastener Caution</a> .</p> <p><b>Tighten</b><br/>58 N.m (43 lb ft)</p> |

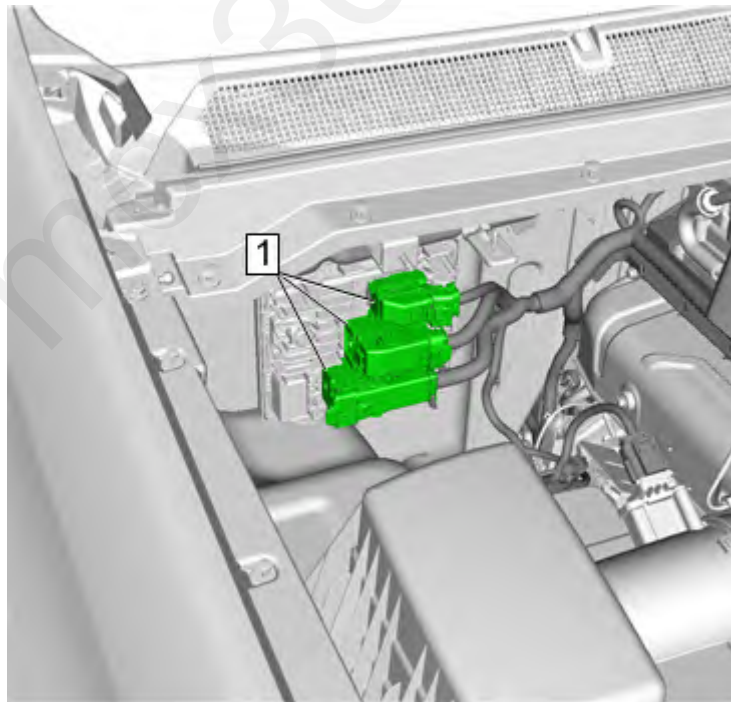
| Count | Component Name                                                   |
|-------|------------------------------------------------------------------|
| 2     | Fastener (Qty: 3)<br><b>Tighten</b><br>22 N.m (16 lb ft)         |
| 3     | Fastener (Qty: 3)<br><b>Tighten</b><br>58 N.m (43 lb ft)         |
| 4     | Fastener (Qty: 3)<br><b>Tighten</b><br>22 N.m (16 lb ft)         |
| 5     | Fastener (Qty: 3)<br><b>Tighten</b><br>22 N.m (16 lb ft)         |
| 6     | Catalytic Converter<br><b>Procedure</b><br>Install a NEW gasket. |

## CATALYTIC CONVERTER REPLACEMENT (LWN)

### Removal Procedure

**WARNING:** In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

**WARNING:** Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.

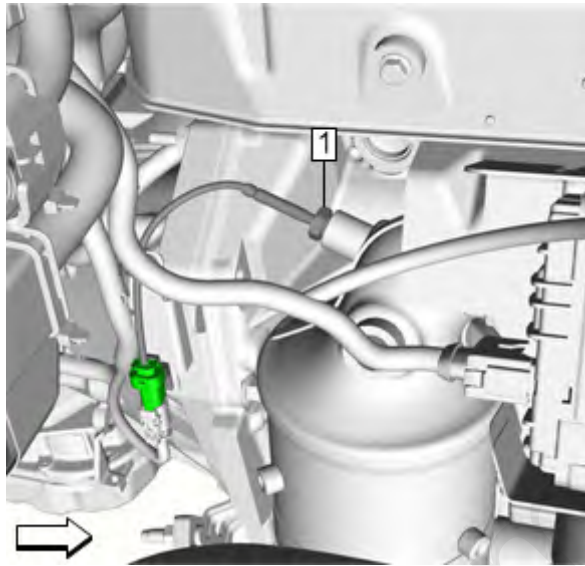


**Fig. 19: Engine Wiring Harness Electrical Connectors**

Courtesy of GENERAL MOTORS COMPANY

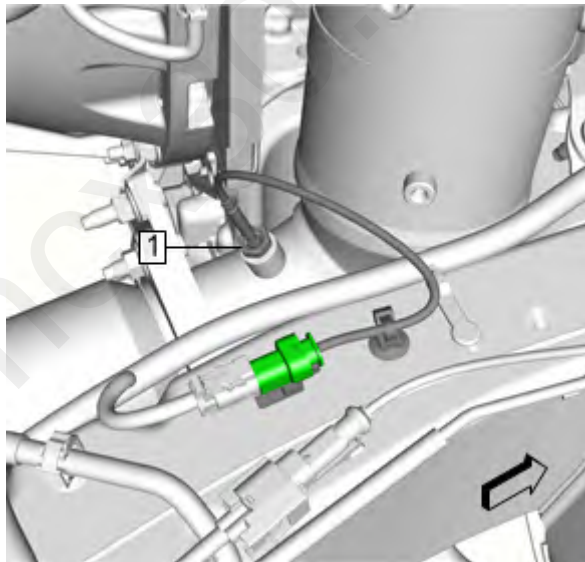
1. Disconnect the engine wiring harness electrical connectors (1) from the powertrain control module and position aside. **Engine Control Module Replacement**

- : Catalytic Converter Heat Shield [Catalytic Converter Heat Shield Replacement \(LWN\)](#)
- 3. Remove Exhaust Manifold Heat Shield [Exhaust Manifold Heat Shield Replacement \(LWN\)](#)
- 4. Remove Nitrogen Oxides Catalytic Converter [Nitrogen Oxides Catalytic Converter Replacement \(LWN\)](#)



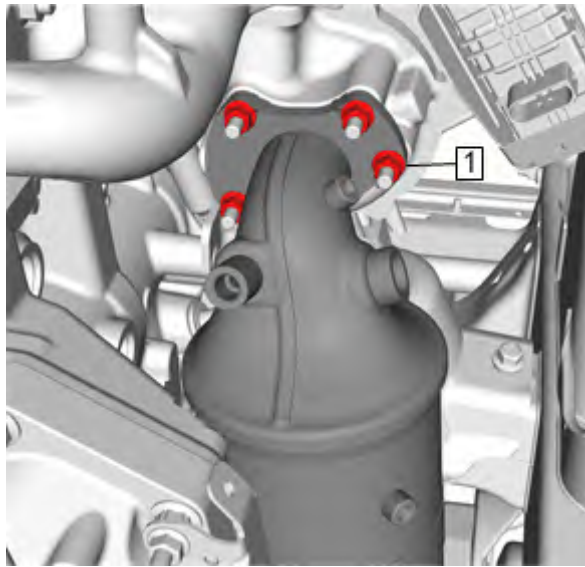
**Fig. 20: Exhaust Temperature Sensor**  
Courtesy of GENERAL MOTORS COMPANY

- 5. Disconnect Exhaust Temperature Sensor (1) [Exhaust Temperature Sensor Replacement - Position 1](#)



**Fig. 21: Exhaust Temperature Sensor**  
Courtesy of GENERAL MOTORS COMPANY

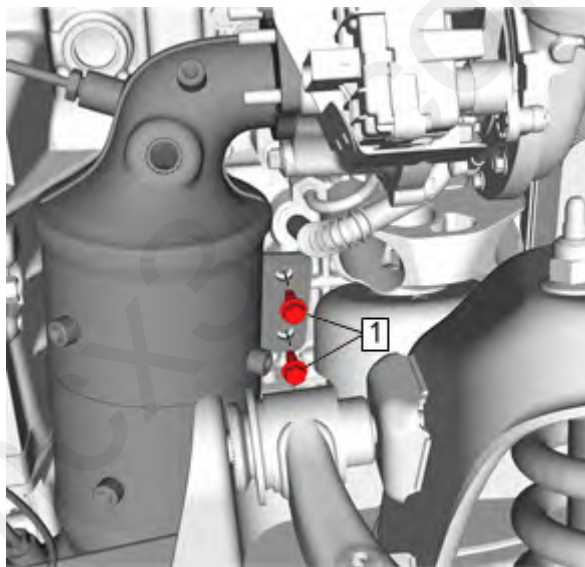
- 6. Disconnect Exhaust Temperature Sensor (1) [Exhaust Temperature Sensor Replacement - Position 2](#)



**Fig. 22: Catalytic Converter Nut**

Courtesy of GENERAL MOTORS COMPANY

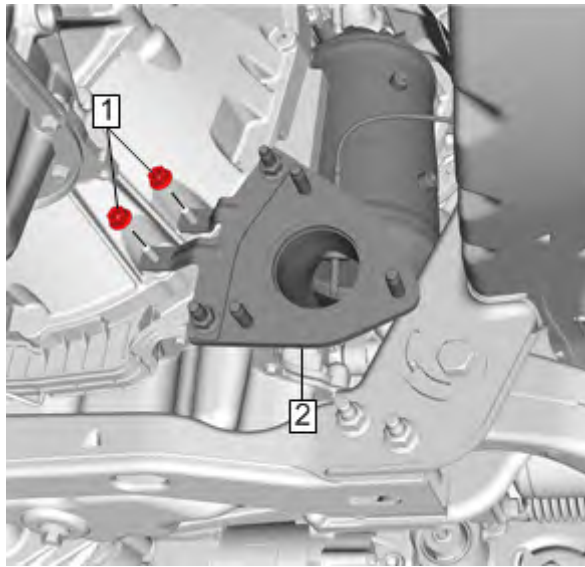
7. Remove Catalytic Converter Nut (1)



**Fig. 23: Converter Brace Bracket Bolt**

Courtesy of GENERAL MOTORS COMPANY

8. Remove Catalytic Converter Brace Bracket Bolt (1)



**Fig. 24: Converter Brace Bracket Nut**

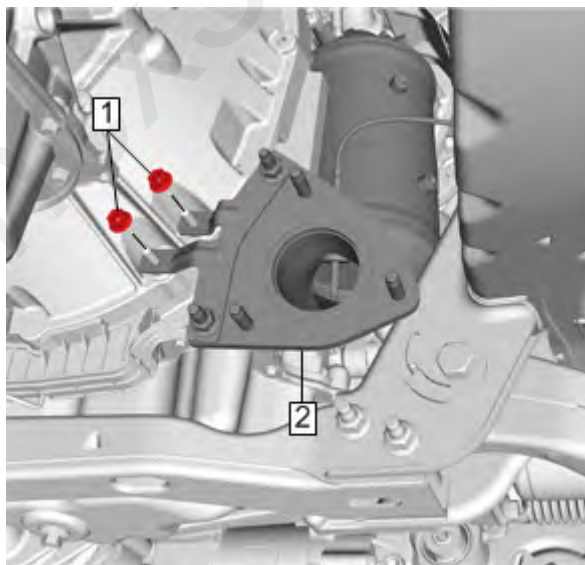
Courtesy of GENERAL MOTORS COMPANY

9. Remove Catalytic Converter Brace Bracket Nut (1)

**NOTE:** Lower the vehicle to remove the catalytic converter through the top of the engine compartment.

10. Remove Catalytic Converter (2)
11. If replacing the catalytic converter, transfer parts as necessary.

#### Installation Procedure

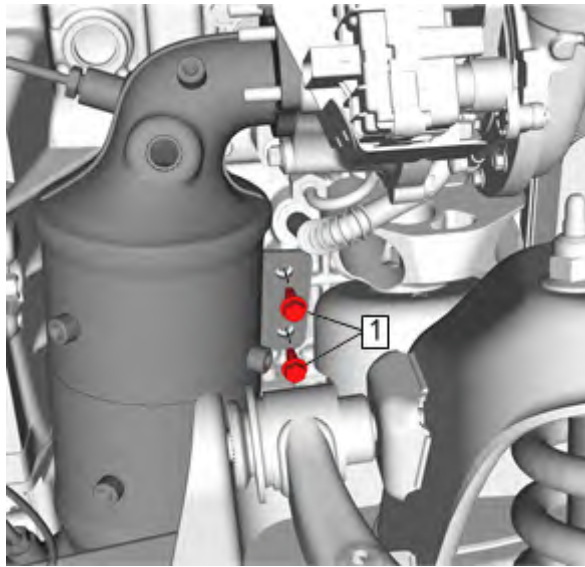


**Fig. 25: Converter Brace Bracket Nut**

Courtesy of GENERAL MOTORS COMPANY

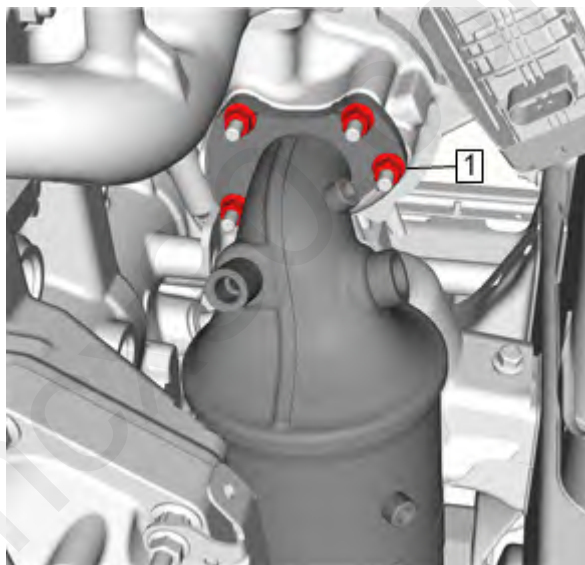
**NOTE:** Replace the exhaust gaskets with NEW gaskets.

1. Install Catalytic Converter (2)
2. Catalytic Converter Brace Bracket Nut (1) Hand tighten



**Fig. 26: Converter Brace Bracket Bolt**  
Courtesy of GENERAL MOTORS COMPANY

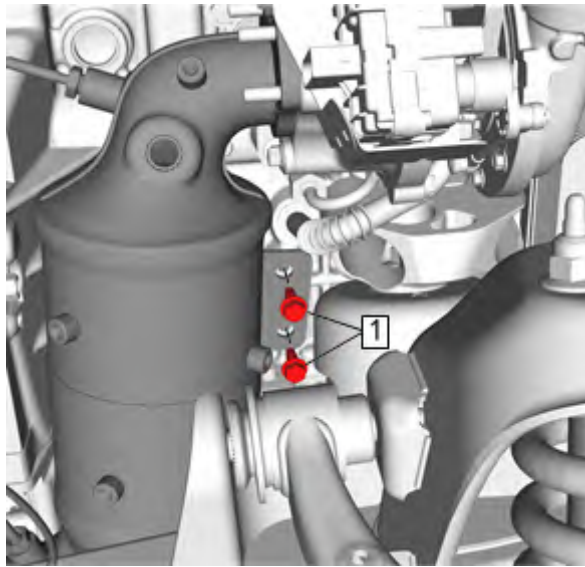
3. Catalytic Converter Brace Bracket Bolt (1) Hand tighten



**Fig. 27: Catalytic Converter Nut**  
Courtesy of GENERAL MOTORS COMPANY

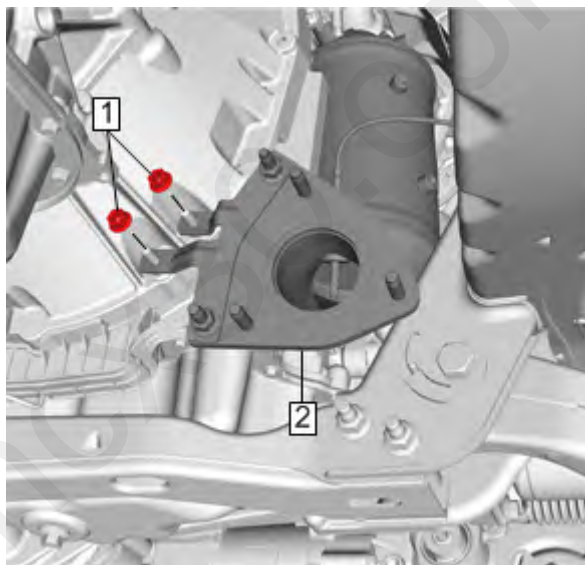
**CAUTION:** Refer to **Fastener Caution** .

4. Install Catalytic Converter Nut (1) and tighten 28 N.m (21 lb ft)



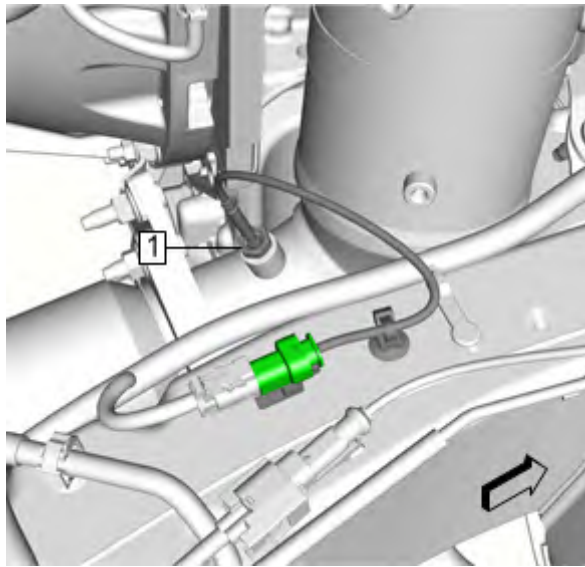
**Fig. 28: Converter Brace Bracket Bolt**  
Courtesy of GENERAL MOTORS COMPANY

5. Catalytic Converter Brace Bracket Bolt (1) Tighten 22 N.m (16 lb ft)



**Fig. 29: Converter Brace Bracket Nut**  
Courtesy of GENERAL MOTORS COMPANY

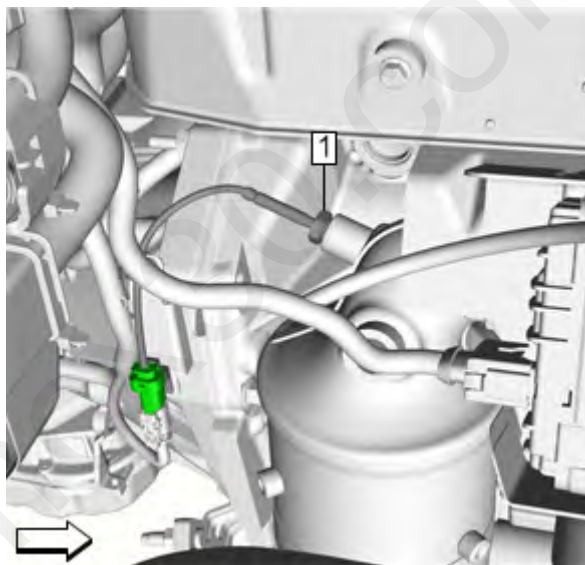
6. Catalytic Converter Brace Bracket Nut (1) Tighten 22 N.m (16 lb ft)



**Fig. 30: Exhaust Temperature Sensor**

Courtesy of GENERAL MOTORS COMPANY

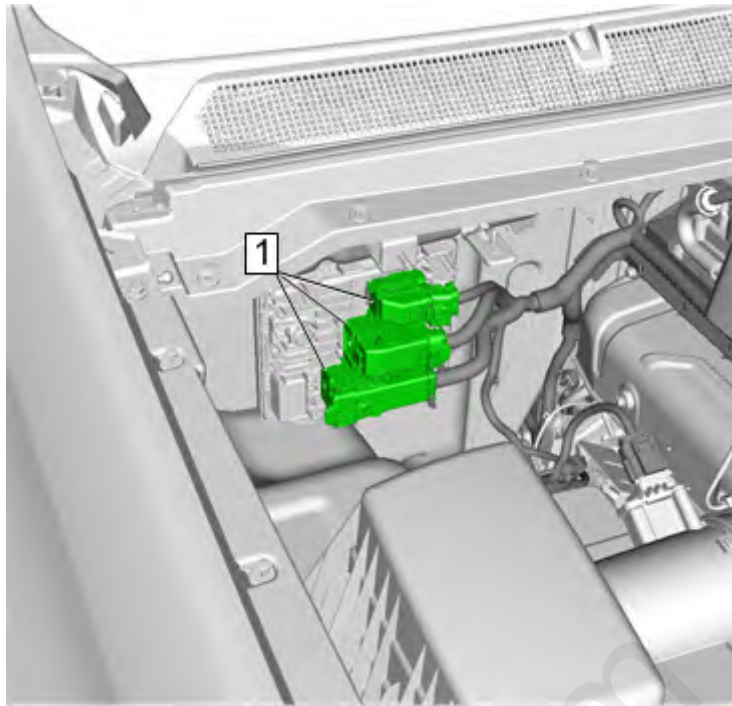
7. Connect Exhaust Temperature Sensor (1) [Exhaust Temperature Sensor Replacement - Position 2](#)



**Fig. 31: Exhaust Temperature Sensor**

Courtesy of GENERAL MOTORS COMPANY

8. Connect Exhaust Temperature Sensor (1) [Exhaust Temperature Sensor Replacement - Position 1](#)  
 9. Install Nitrogen Oxides Catalytic Converter [Nitrogen Oxides Catalytic Converter Replacement \(LWN\)](#)  
 10. Install Exhaust Manifold Heat Shield [Exhaust Manifold Heat Shield Replacement \(LWN\)](#)  
 11. Install Catalytic Converter Heat Shield [Catalytic Converter Heat Shield Replacement \(LWN\)](#)



**Fig. 32: Engine Wiring Harness Electrical Connectors**  
Courtesy of GENERAL MOTORS COMPANY

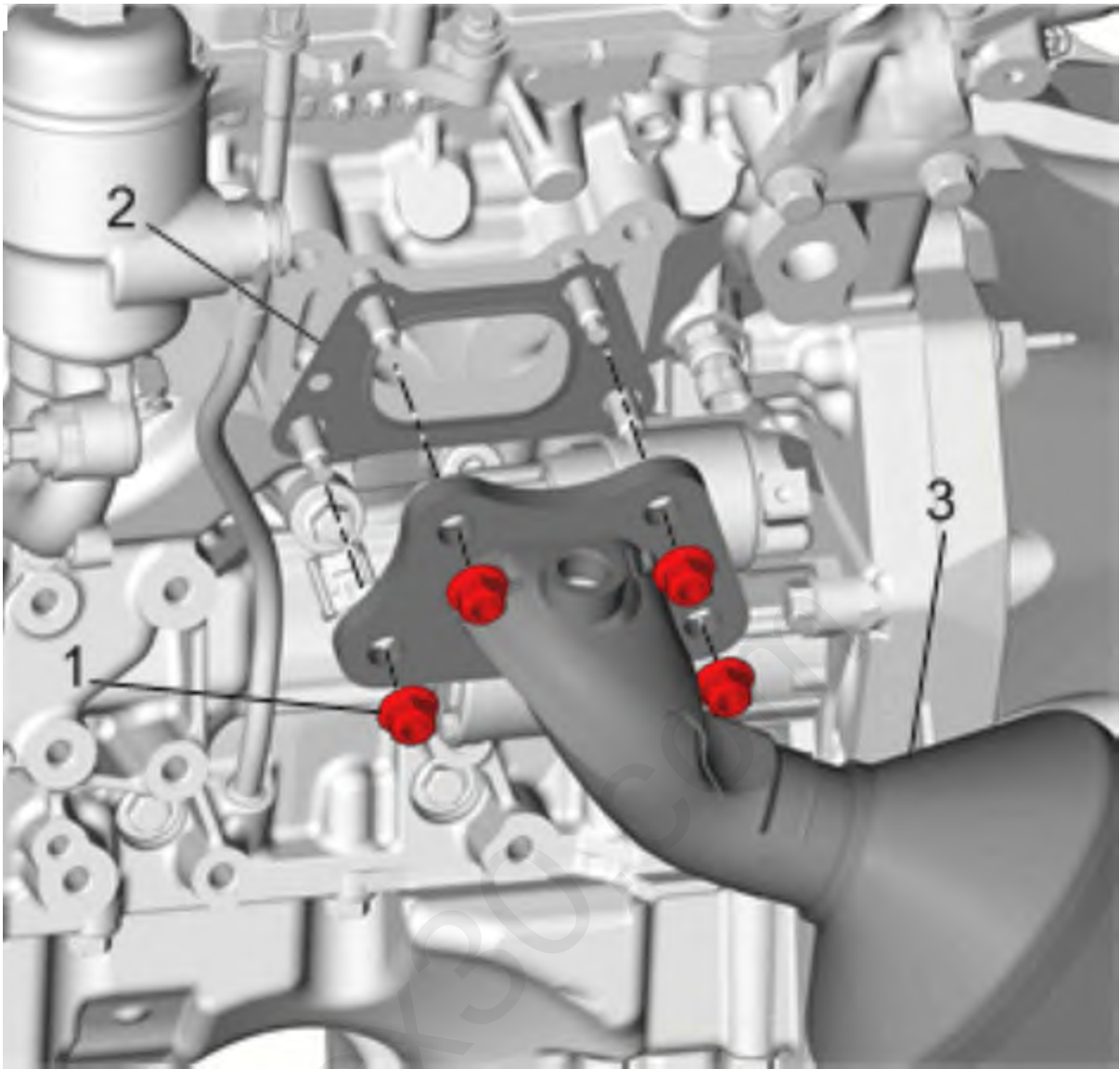
12. Connect the engine wiring harness electrical connectors (1) to the powertrain control module. [Engine Control Module Replacement](#)

### **CATALYTIC CONVERTER REPLACEMENT - LEFT SIDE (LFX)**

#### **Removal Procedure**

**WARNING:** Refer to [Exhaust Service Warning](#) .

1. Remove Air Cleaner Outlet Duct [Air Cleaner Outlet Duct Replacement](#)
2. Disconnect Heated Oxygen Sensor - Bank 2 Sensor 1 [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
3. Disconnect Heated Oxygen Sensor - Bank 2 Sensor 2 [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2](#)
4. Remove Three-Way Catalytic Converter [Three-Way Catalytic Converter Replacement \(LFX\)](#)
5. Remove Front Axle Propeller Shaft [Front Axle Propeller Shaft Replacement](#)

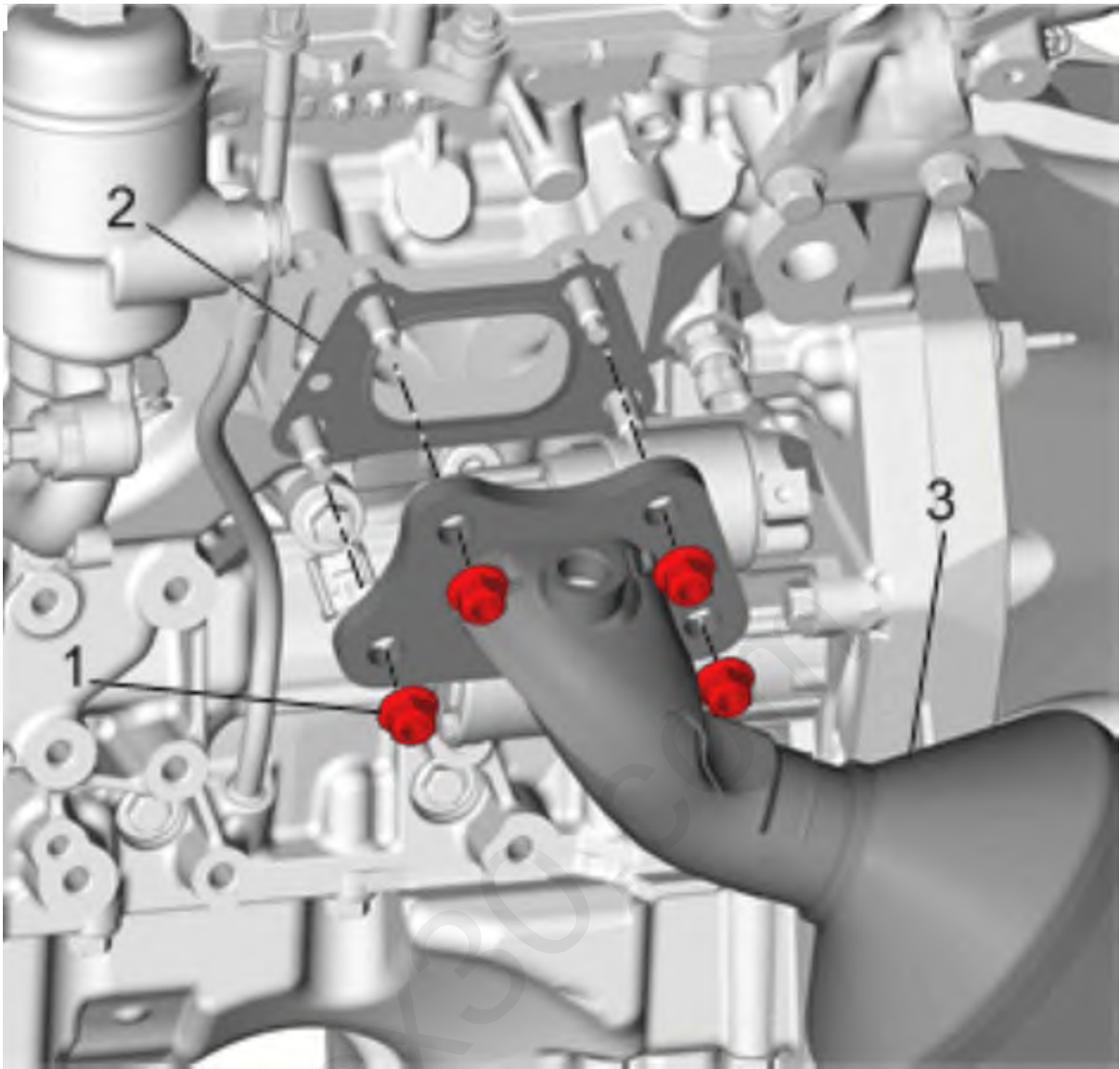


**Fig. 33: Fastener And Gasket**

Courtesy of GENERAL MOTORS COMPANY

6. Remove Fastener (1)
7. DISCARD Gasket (2)
8. Remove Catalytic Converter (3)

#### **Installation Procedure**



**Fig. 34: Fastener And Gasket**

Courtesy of GENERAL MOTORS COMPANY

1. Install Catalytic Converter (3)
2. Install a NEW gasket (2)

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

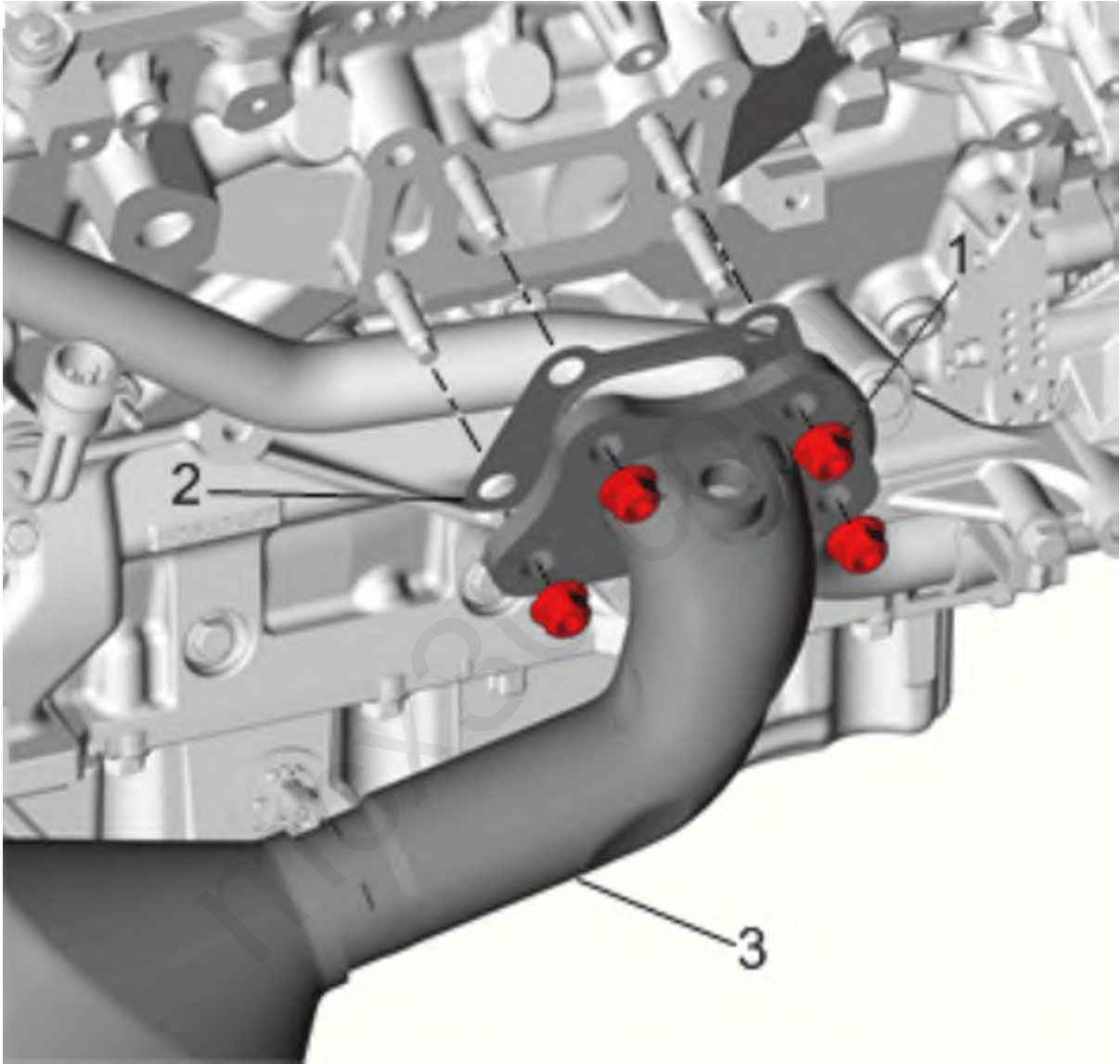
3. Fastener (1) Tighten 50 N.m (37 lb ft)
4. Install Front Axle Propeller Shaft [Front Axle Propeller Shaft Replacement](#)
5. Install Three-Way Catalytic Converter [Three-Way Catalytic Converter Replacement \(LFX\)](#)
6. Connect Heated Oxygen Sensor - Bank 2 Sensor 1 [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
7. Connect Heated Oxygen Sensor - Bank 2 Sensor 2 [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2](#)
8. Install Air Cleaner Outlet Duct [Air Cleaner Outlet Duct Replacement](#)

## **CATALYTIC CONVERTER REPLACEMENT - RIGHT SIDE (LFX)**

### **Removal Procedure**

Refer to [Exhaust Service Warning](#) .

1. Disconnect Heated Oxygen Sensor - Bank 1 Sensor 1 [Heated Oxygen Sensor Replacement - Bank 1 Sensor 1](#)
2. Disconnect Heated Oxygen Sensor - Bank 1 Sensor 2 [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2](#)
3. Remove Three-Way Catalytic Converter [Three-Way Catalytic Converter Replacement \(LFX\)](#)

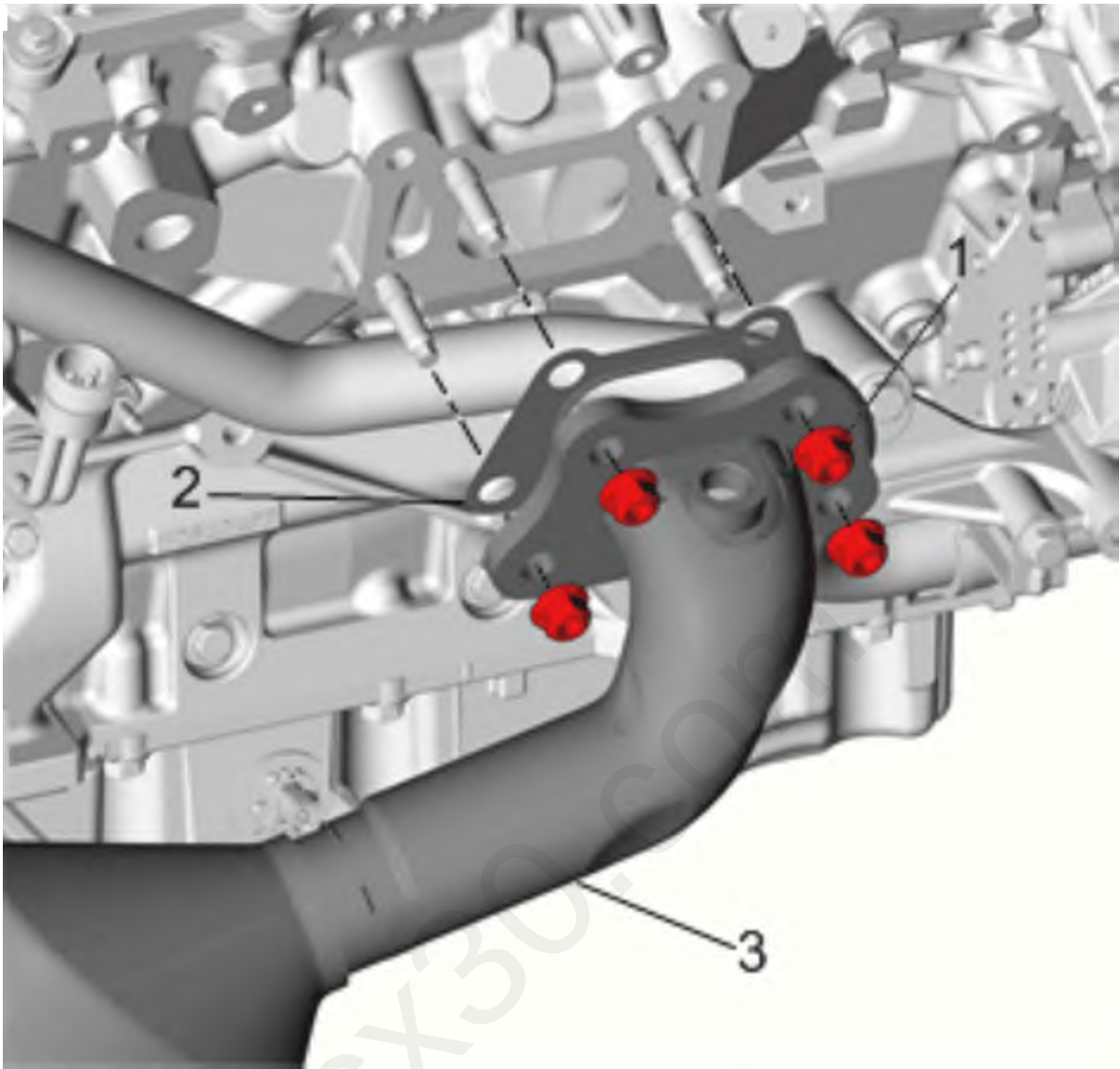


**Fig. 35: Fastener And Gasket**

Courtesy of GENERAL MOTORS COMPANY

4. Remove Fastener (1)
5. DISCARD Gasket (2)
6. Remove Catalytic Converter (3)

#### **Installation Procedure**



**Fig. 36: Fastener And Gasket**

Courtesy of GENERAL MOTORS COMPANY

1. Install Catalytic Converter (3)
2. Install a NEW gasket (2)

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

3. Fastener (1) Tighten 50 N.m (37 lb ft)
4. Install Three-Way Catalytic Converter [Three-Way Catalytic Converter Replacement \(LFX\)](#)
5. Connect Heated Oxygen Sensor - Bank 1 Sensor 2 [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2](#)
6. Connect Heated Oxygen Sensor - Bank 1 Sensor 1 [Heated Oxygen Sensor Replacement - Bank 1 Sensor 1](#)
7. Install Air Cleaner Outlet Duct [Air Cleaner Outlet Duct Replacement](#)

## **NITROGEN OXIDES CATALYTIC CONVERTER REPLACEMENT (LWN)**

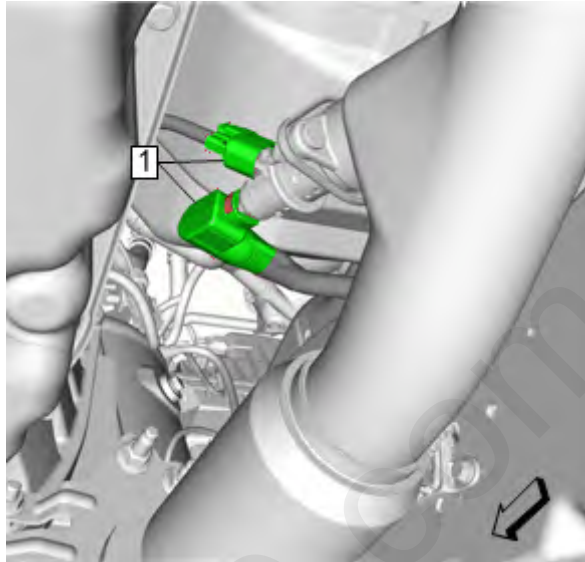
### **Removal Procedure**

**In order to avoid being burned, do not service the exhaust system while it is still**

in order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

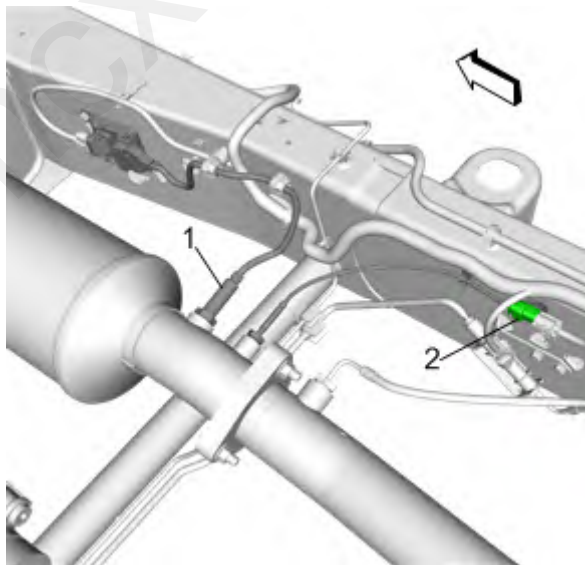
**WARNING:** Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.

1. Remove Transmission Support Crossmember [Transmission Support Crossmember Replacement \(4WD\)](#)  
[Transmission Support Crossmember Replacement \(2WD\)](#)



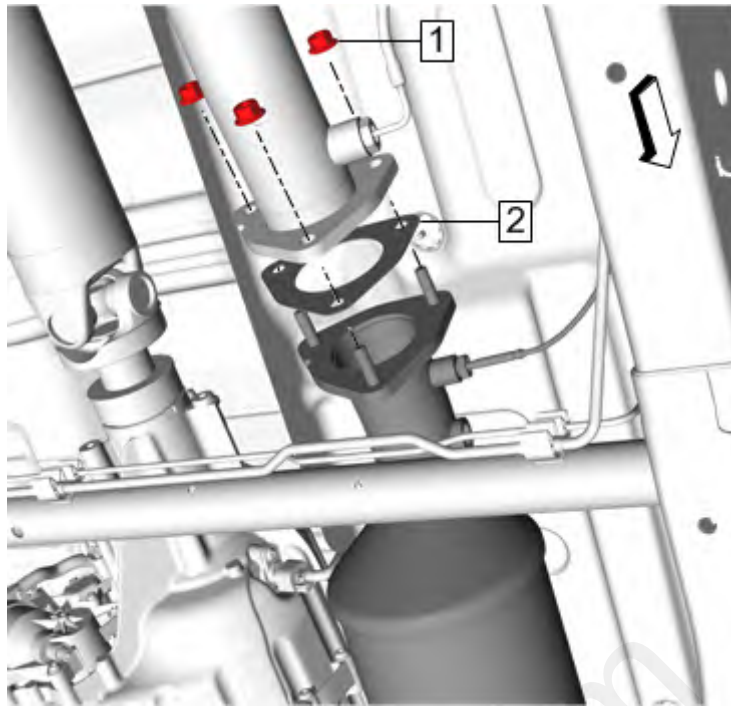
**Fig. 37: Emission Reduction Fluid Injector**  
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Emission Reduction Fluid Injector (1) [Emission Reduction Fluid Injector Replacement](#)



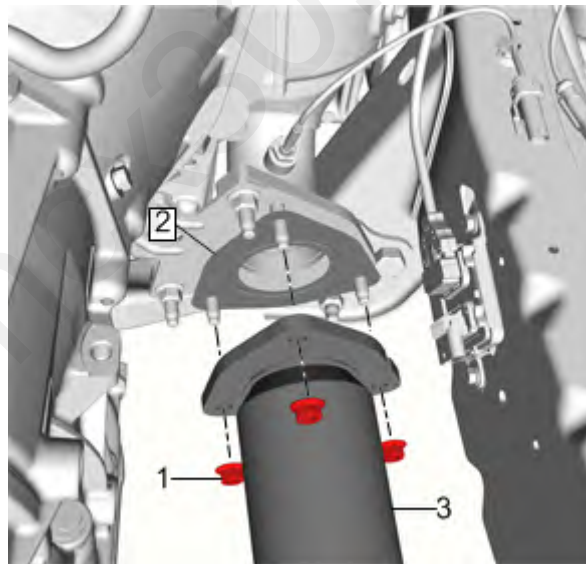
**Fig. 38: Nitrogen Oxides Sensor**  
Courtesy of GENERAL MOTORS COMPANY

3. Remove Nitrogen Oxides Sensor (1) [Nitrogen Oxides Sensor Replacement - Position 2](#)
4. Disconnect Exhaust Temperature Sensor (2) [Exhaust Temperature Sensor Replacement - Position 3](#)



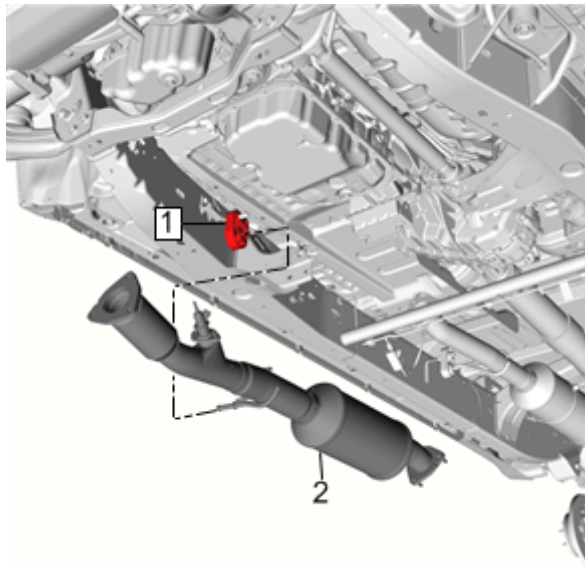
**Fig. 39: Nitrogen Oxides Catalytic Converter Nut**  
**Courtesy of GENERAL MOTORS COMPANY**

5. Remove Nitrogen Oxides Catalytic Converter Nut (1)
6. Remove and DISCARD the gasket (2)



**Fig. 40: Catalytic Converter Nut**  
**Courtesy of GENERAL MOTORS COMPANY**

7. Remove Catalytic Converter Nut (1)
8. Remove and DISCARD the gasket (2)

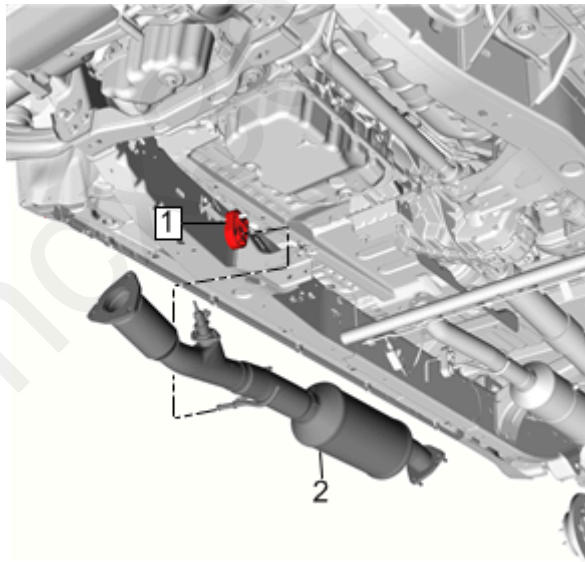


**Fig. 41: Exhaust Isolator**

Courtesy of GENERAL MOTORS COMPANY

9. Remove Exhaust Isolator (1)
10. Nitrogen Oxides Catalytic Converter (2)
11. If replacing the catalytic converter, transfer parts as necessary.

#### **Installation Procedure**

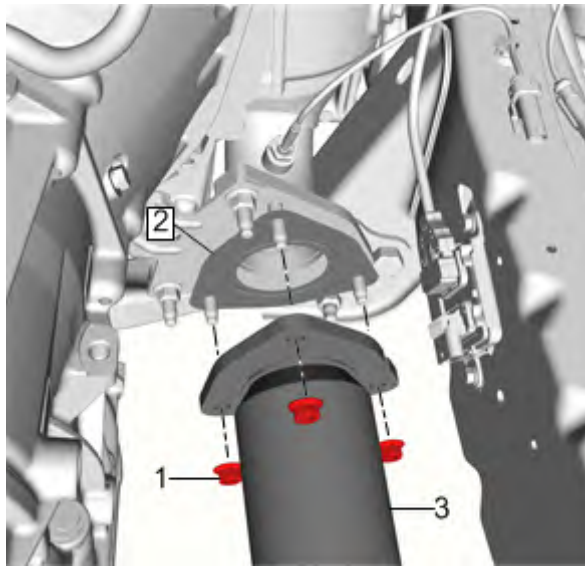


**Fig. 42: Exhaust Isolator**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Clean and lubricate the exhaust isolators for ease of installation.

1. Install Exhaust Isolator (1)
2. Install Nitrogen Oxides Catalytic Converter (2)



**Fig. 43: Catalytic Converter Nut**

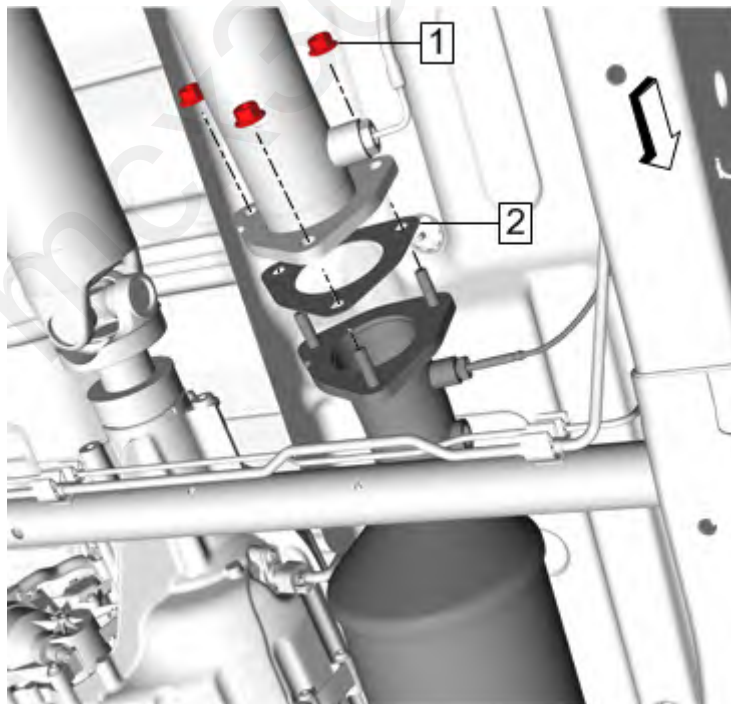
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Replace the exhaust gaskets with **NEW** gaskets.

3. Install Catalytic Converter Gasket (2)

**CAUTION:** Refer to **Fastener Caution** .

4. Install Catalytic Converter Nut (1) and tighten 50 N.m (37 lb ft)



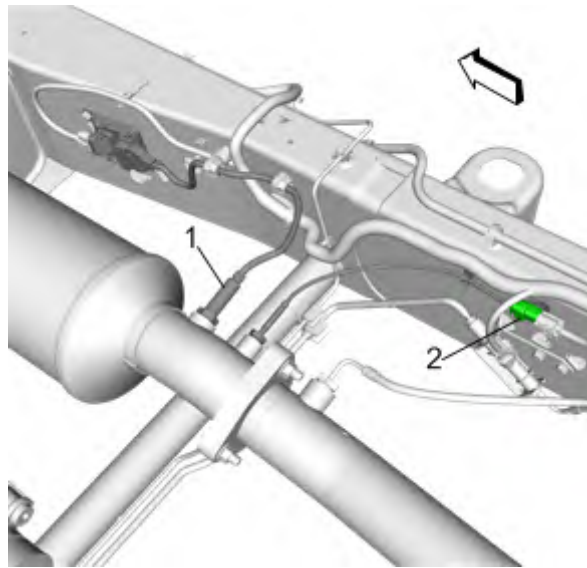
**Fig. 44: Nitrogen Oxides Catalytic Converter Nut**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Replace the exhaust gaskets with **NEW** gaskets.

5. Install Catalytic Converter Gasket (2)

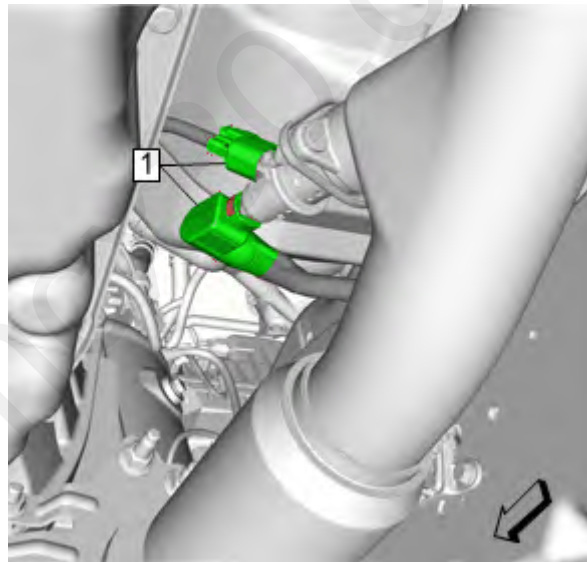
- 1 Oxides Catalytic Converter Nut (1) and tighten 50 N.m (37 lb ft)



**Fig. 45: Nitrogen Oxides Sensor**

Courtesy of GENERAL MOTORS COMPANY

7. Install Nitrogen Oxides Sensor (1) [Nitrogen Oxides Sensor Replacement - Position 2](#)
8. Connect Exhaust Temperature Sensor (2) [Exhaust Temperature Sensor Replacement - Position 3](#)



**Fig. 46: Emission Reduction Fluid Injector**

Courtesy of GENERAL MOTORS COMPANY

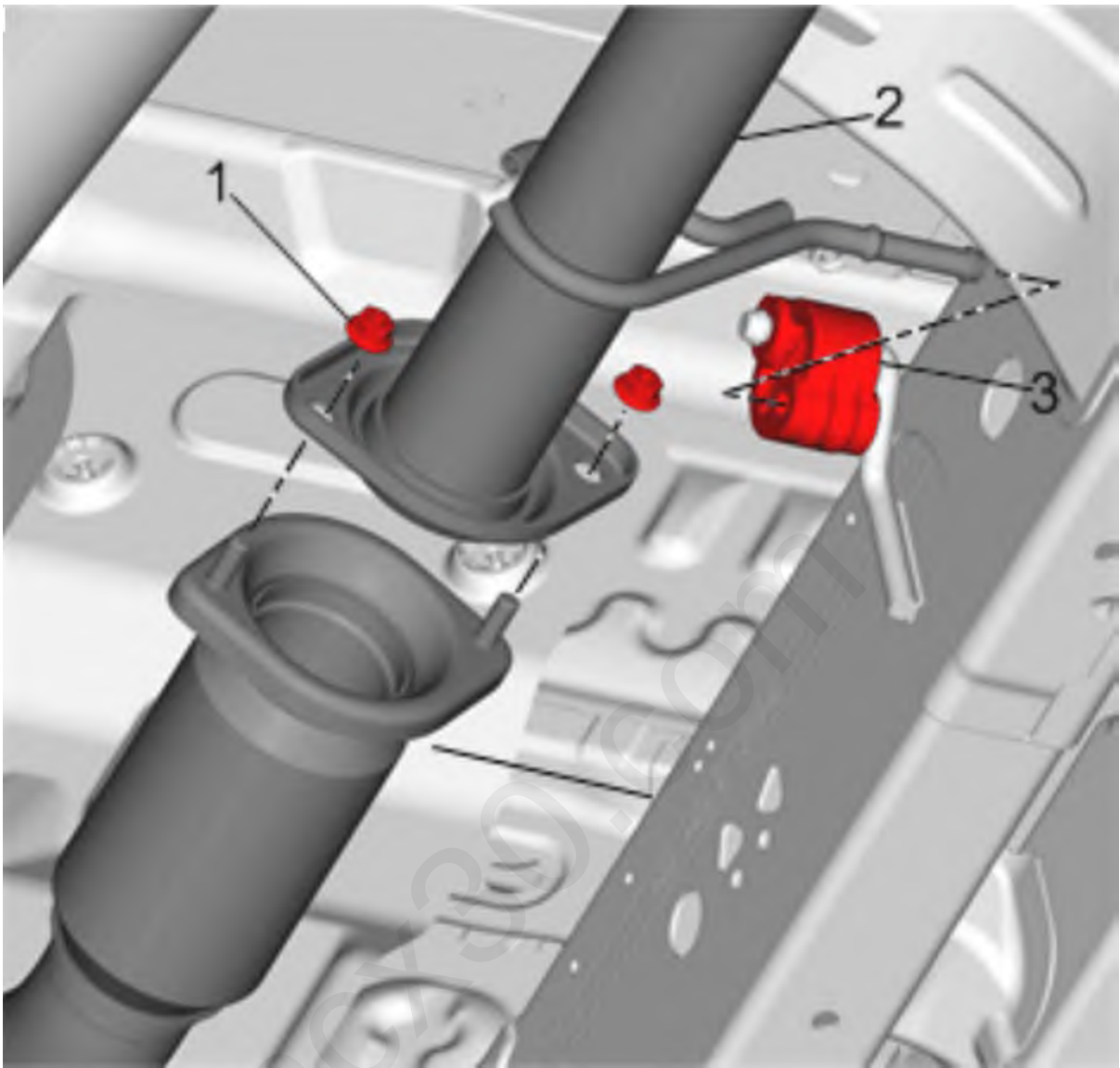
9. Connect Emission Reduction Fluid Injector (1) [Emission Reduction Fluid Injector Replacement](#)
10. Install Transmission Support Crossmember [Transmission Support Crossmember Replacement \(4WD\)](#)  
[Transmission Support Crossmember Replacement \(2WD\)](#)

## **THREE-WAY CATALYTIC CONVERTER REPLACEMENT (LFX)**

### **Removal Procedure**

**WARNING:** Refer to [Exhaust Service Warning](#) .

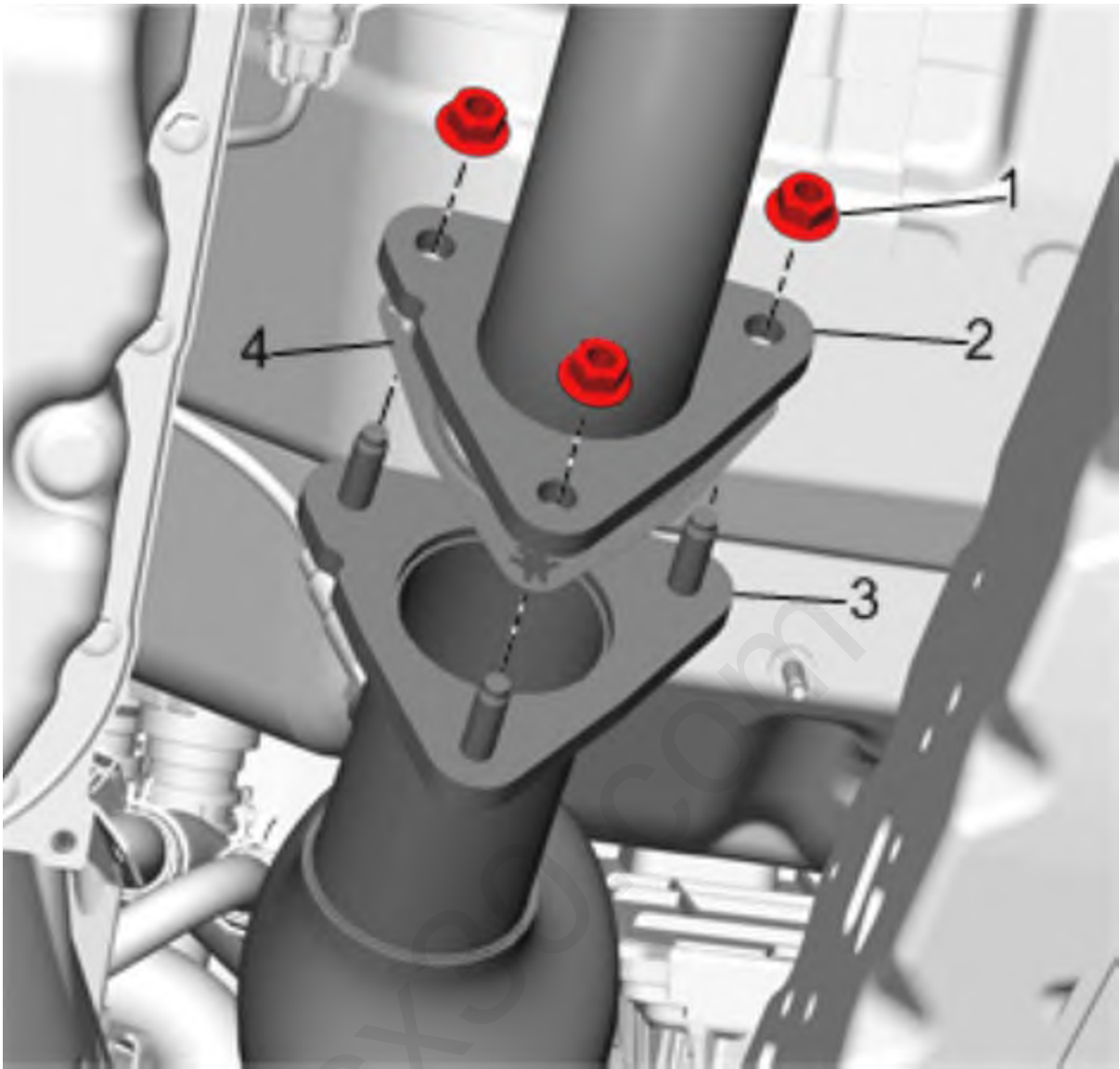
id support the vehicle. [Lifting and Jacking the Vehicle](#)



**Fig. 47: Fastener And Converter**

**Courtesy of GENERAL MOTORS COMPANY**

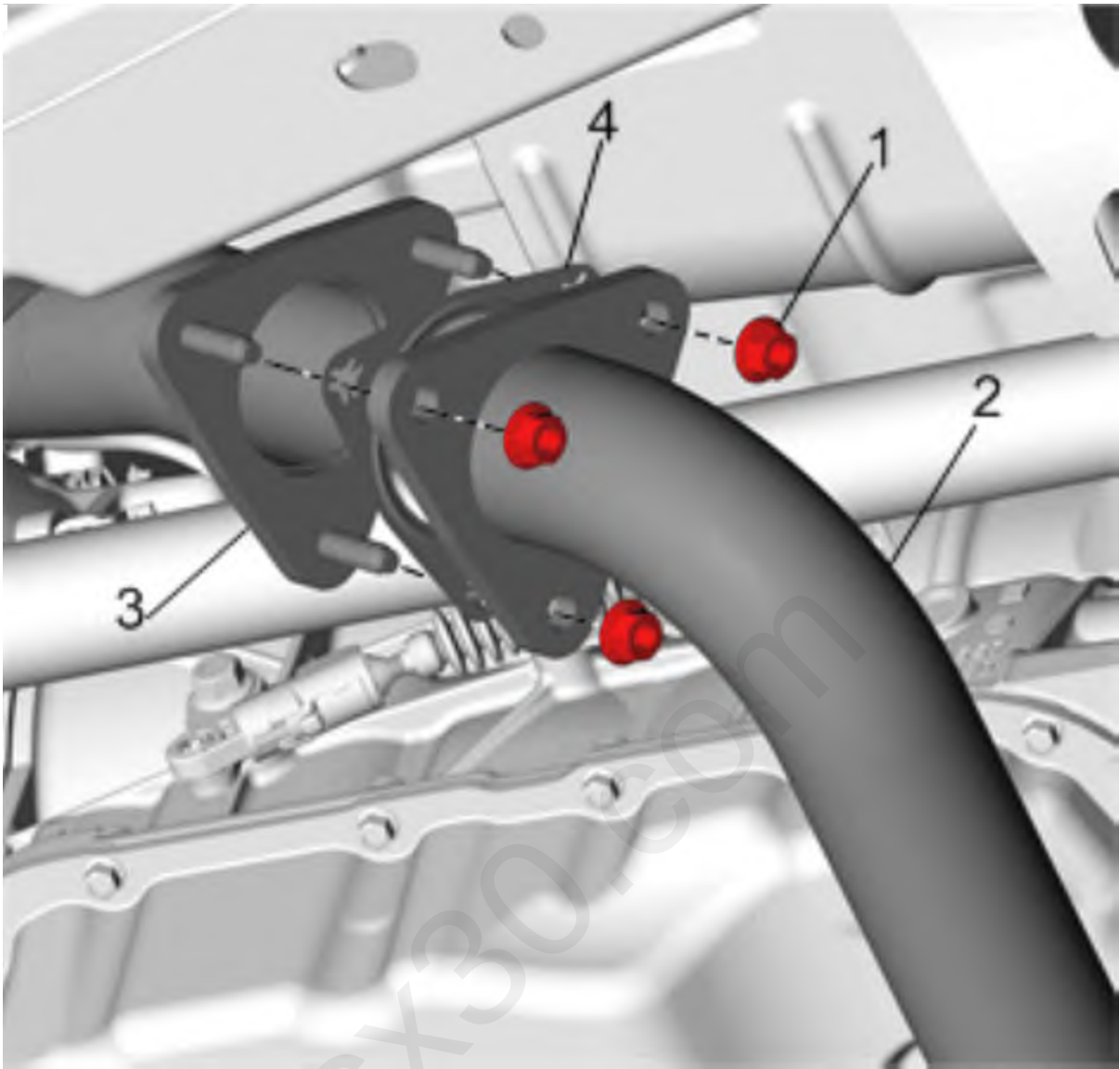
2. Remove Fastener (1)
3. Disconnect Three-way catalytic converter (2)
4. Exhaust Isolator (3) Inspect for excessive wear or damage.



**Fig. 48: Fastener**

Courtesy of GENERAL MOTORS COMPANY

5. Remove Fastener (1)
6. Disconnect Three-way catalytic converter (2) @Catalytic Converter (3)
7. DISCARD Gasket (4)

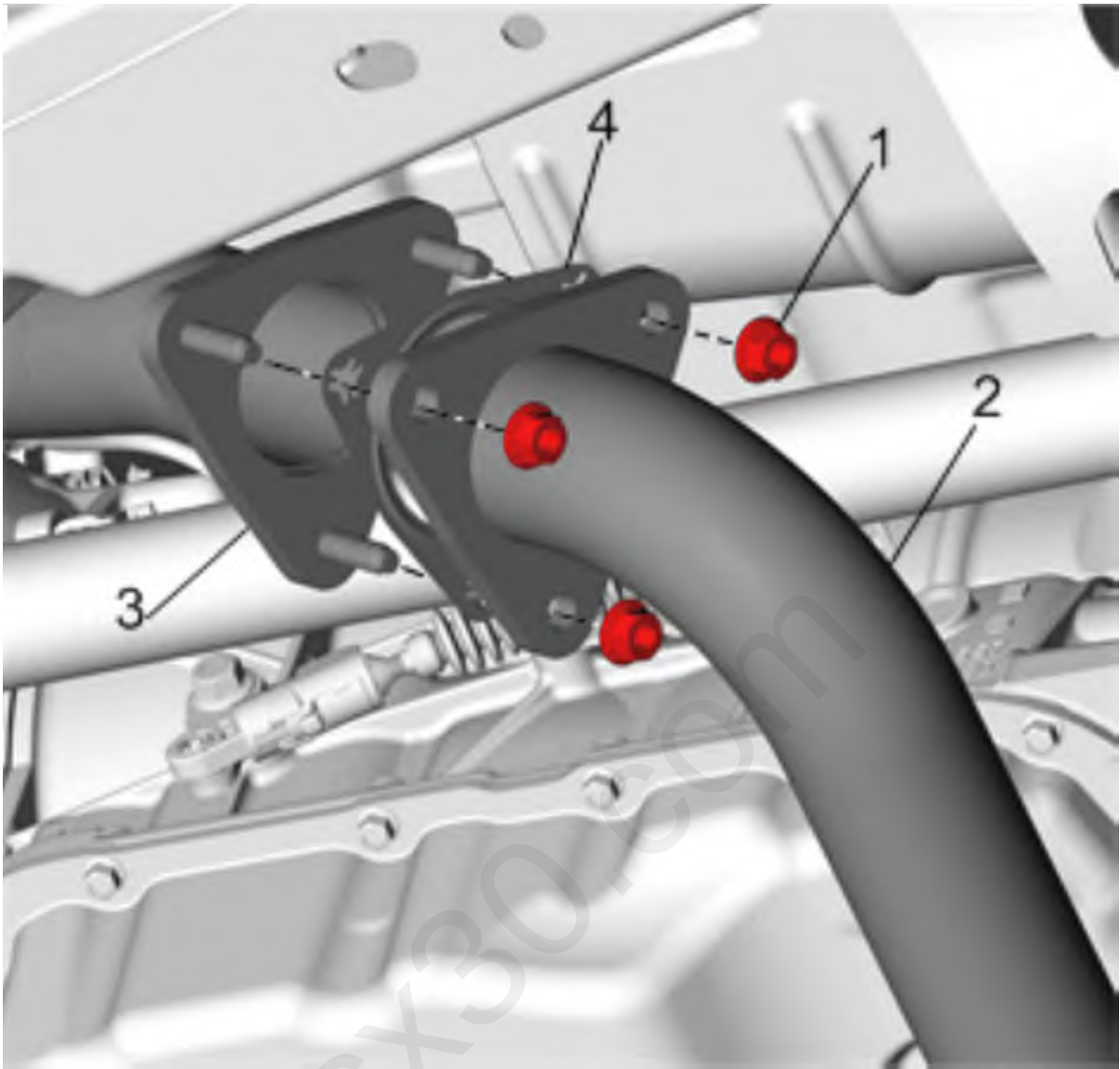


**Fig. 49: Fastener And Gasket**

**Courtesy of GENERAL MOTORS COMPANY**

8. Remove Fastener (1)
9. Disconnect Three-way catalytic converter (2) @Catalytic Converter (3)
10. DISCARD Gasket (4)
11. Remove the three-way catalytic converter.

#### **Installation Procedure**



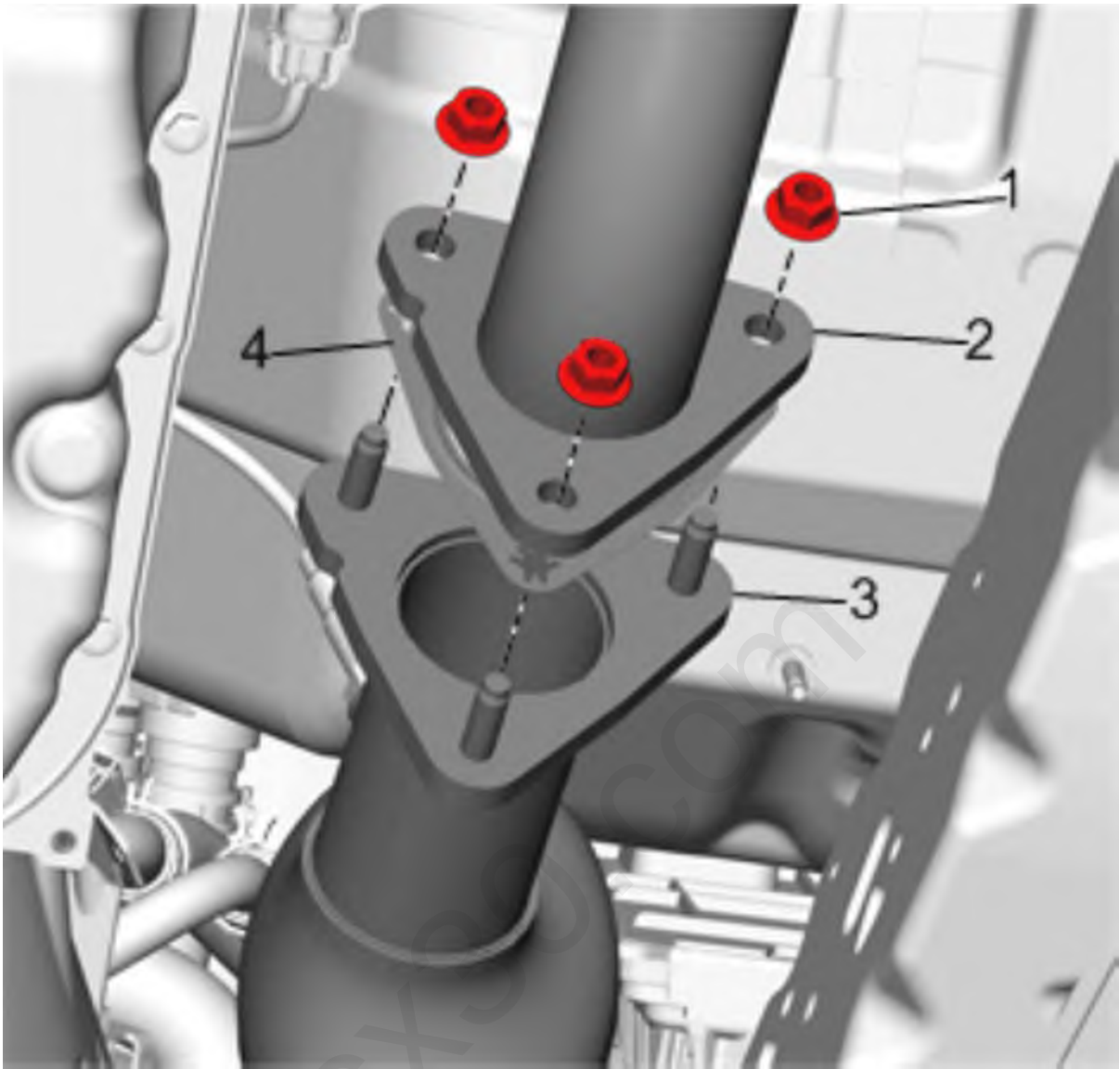
**Fig. 50: Fastener And Gasket**

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket (4)
2. Connect Three-way catalytic converter (2) @Catalytic Converter (3)

**CAUTION:** Refer to **Fastener Caution** .

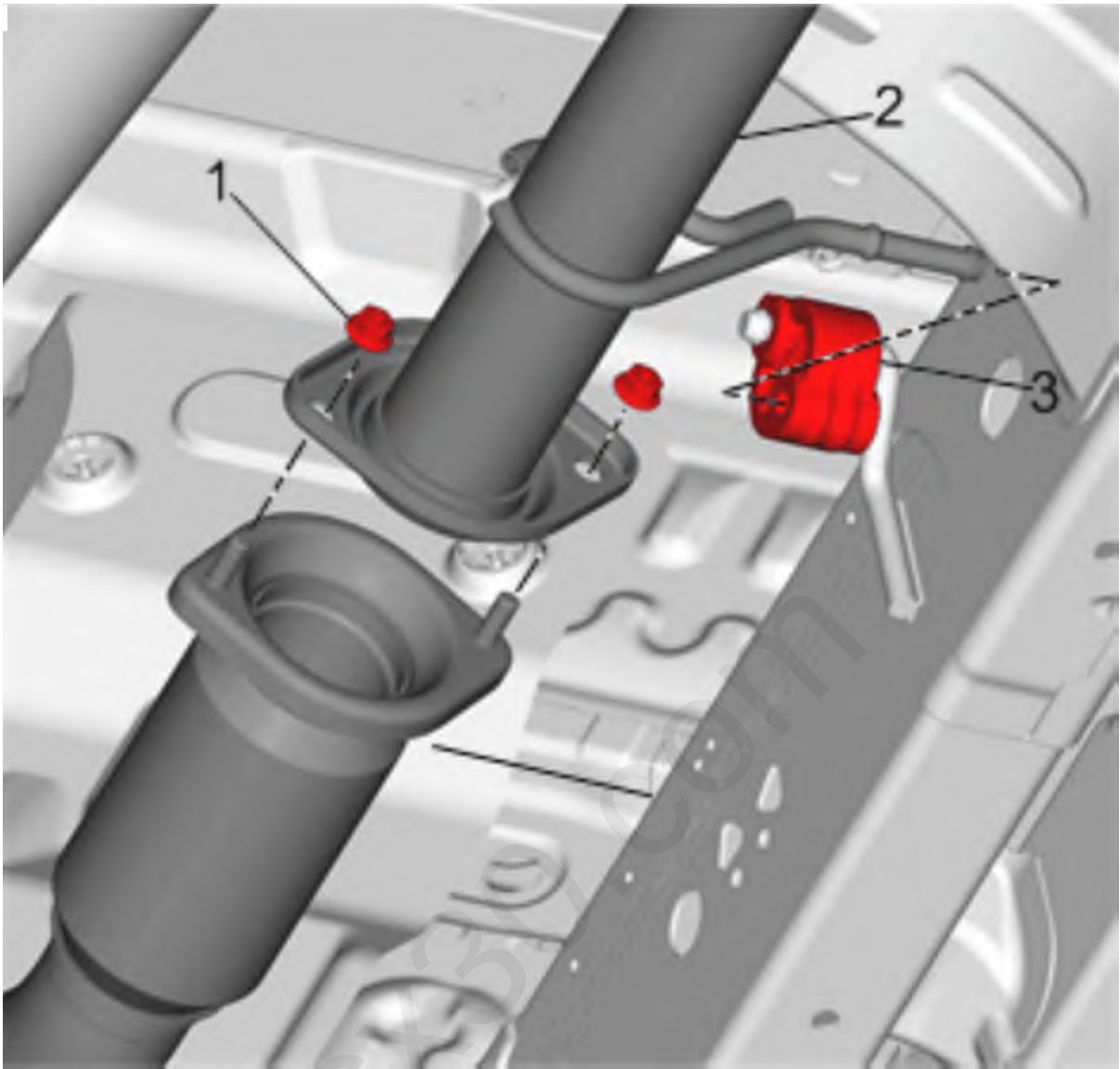
3. Fastener (1) Tighten 50 N.m (37 lb ft)



**Fig. 51: Fastener**

**Courtesy of GENERAL MOTORS COMPANY**

4. Install a NEW gasket (4)
5. Connect Three-way catalytic converter (2) @Catalytic Converter (3)
6. Fastener (1) Tighten 50 N.m (37 lb ft)



**Fig. 52: Fastener And Converter**  
Courtesy of GENERAL MOTORS COMPANY

7. Exhaust Isolator (3) Clean and lubricate the exhaust isolators for ease of installation.
8. Connect Three-way catalytic converter (2)
9. Fastener (1) Tighten 45 N.m (33 lb ft)
10. Lower the vehicle.

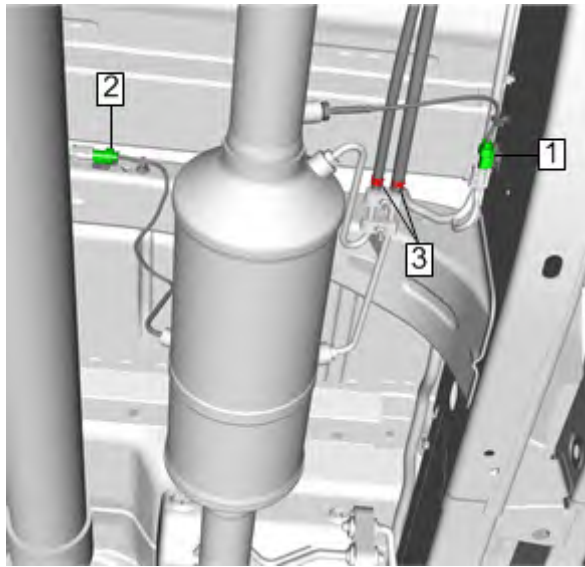
## **EXHAUST PARTICULATE FILTER REPLACEMENT (LWN)**

### **Removal Procedure**

**WARNING:** In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

**WARNING:** Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.

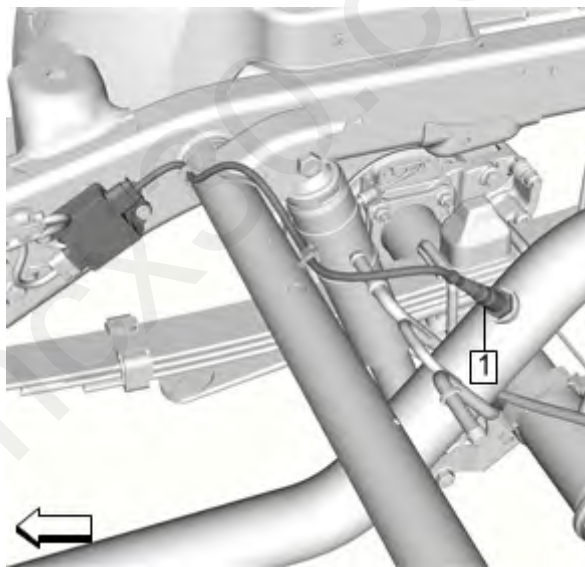
1. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)



**Fig. 53: Exhaust Temperature Sensor**

Courtesy of GENERAL MOTORS COMPANY

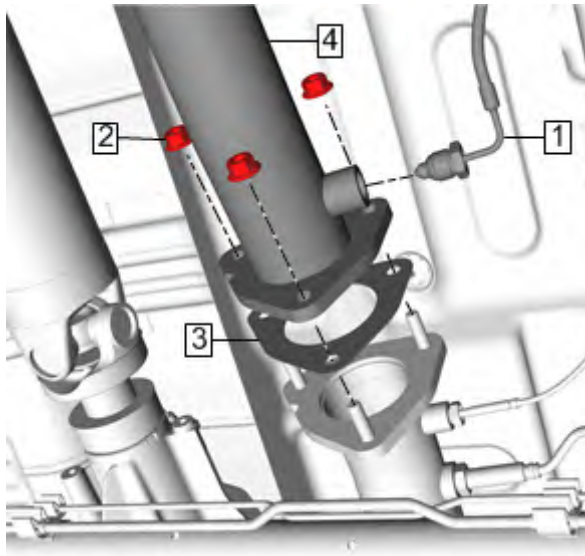
2. Disconnect Exhaust Temperature Sensor (1) [Exhaust Temperature Sensor Replacement - Position 5](#)
3. Disconnect Exhaust Temperature Sensor (2) [Exhaust Temperature Sensor Replacement - Position 4](#)
4. Disconnect Exhaust Pressure Sensor Hose



**Fig. 54: Exhaust Particulate Sensor**

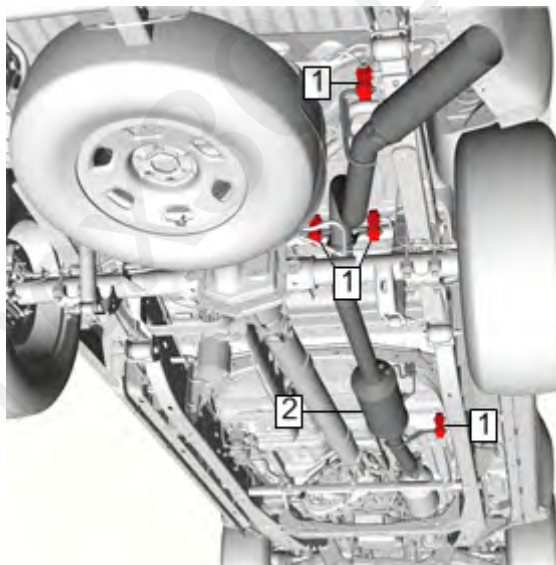
Courtesy of GENERAL MOTORS COMPANY

5. Remove Exhaust Particulate Sensor (1) [Exhaust Particulate Sensor Replacement](#)



**Fig. 55: Low Pressure Diesel Hydrocarbon Injector**  
 Courtesy of GENERAL MOTORS COMPANY

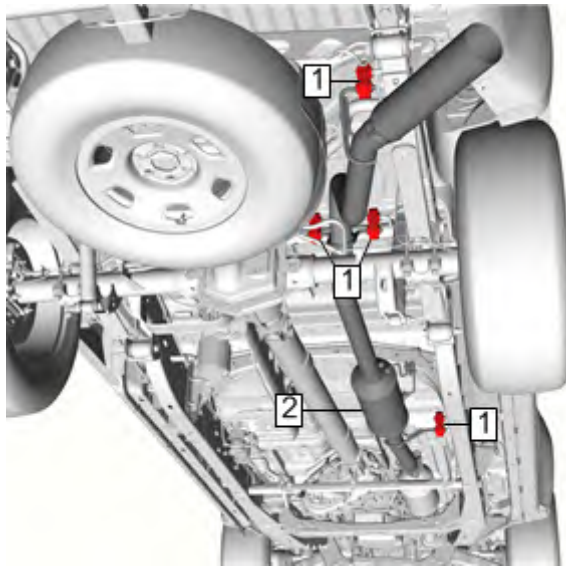
6. Remove Low Pressure Diesel Hydrocarbon Injector (1) **Low Pressure Diesel Hydrocarbon Injector Replacement**
7. Remove Nitrogen Oxides Catalytic Converter Nut (2)
8. Remove and DISCARD the gasket (3)



**Fig. 56: Exhaust Isolator**  
 Courtesy of GENERAL MOTORS COMPANY

9. Remove Exhaust Isolator (1)
10. Remove Exhaust Particulate Filter (2)
11. Transfer components as necessary.

#### **Installation Procedure**

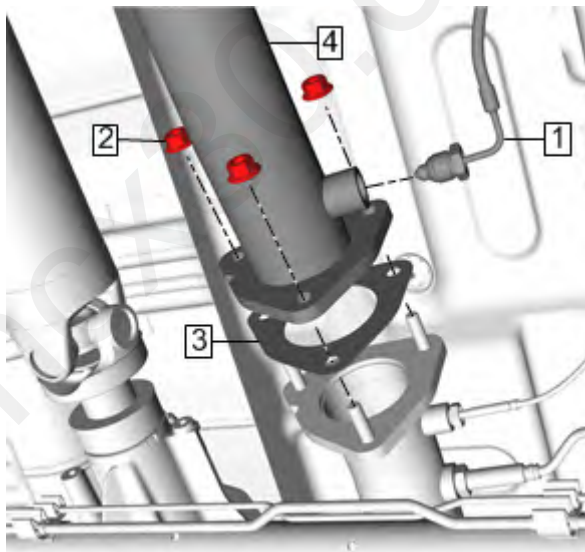


**Fig. 57: Exhaust Isolator**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Clean and lubricate the exhaust isolators for ease of installation.

1. Install Exhaust Isolator (1)
2. Install Exhaust Particulate Filter (2)



**Fig. 58: Low Pressure Diesel Hydrocarbon Injector**

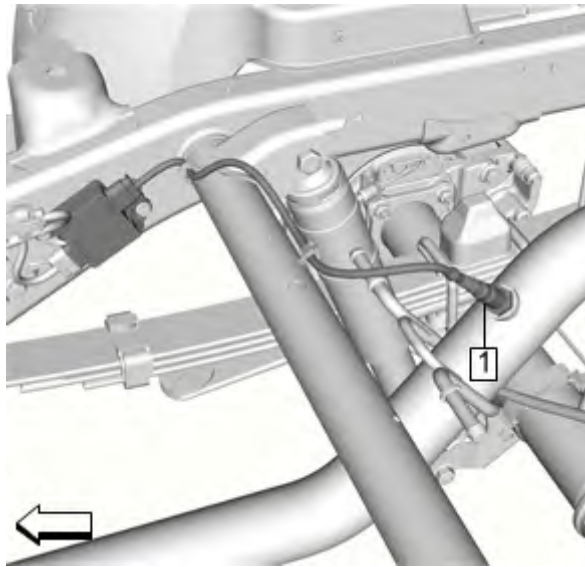
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Replace the exhaust gaskets with **NEW** gaskets.

3. Install Catalytic Converter Gasket (3)

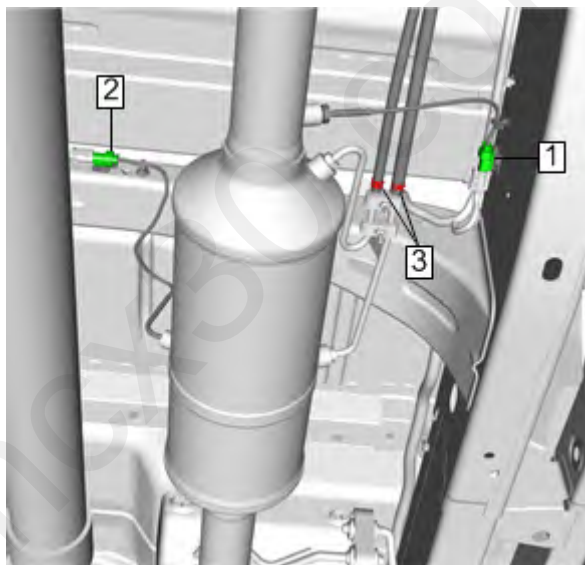
**CAUTION:** Refer to **Fastener Caution** .

4. Install Nitrogen Oxides Catalytic Converter Nut (2) and tighten 50 N.m (37 lb ft)
5. Install Low Pressure Diesel Hydrocarbon Injector (1) **Low Pressure Diesel Hydrocarbon Injector Replacement**



**Fig. 59: Exhaust Particulate Sensor**  
**Courtesy of GENERAL MOTORS COMPANY**

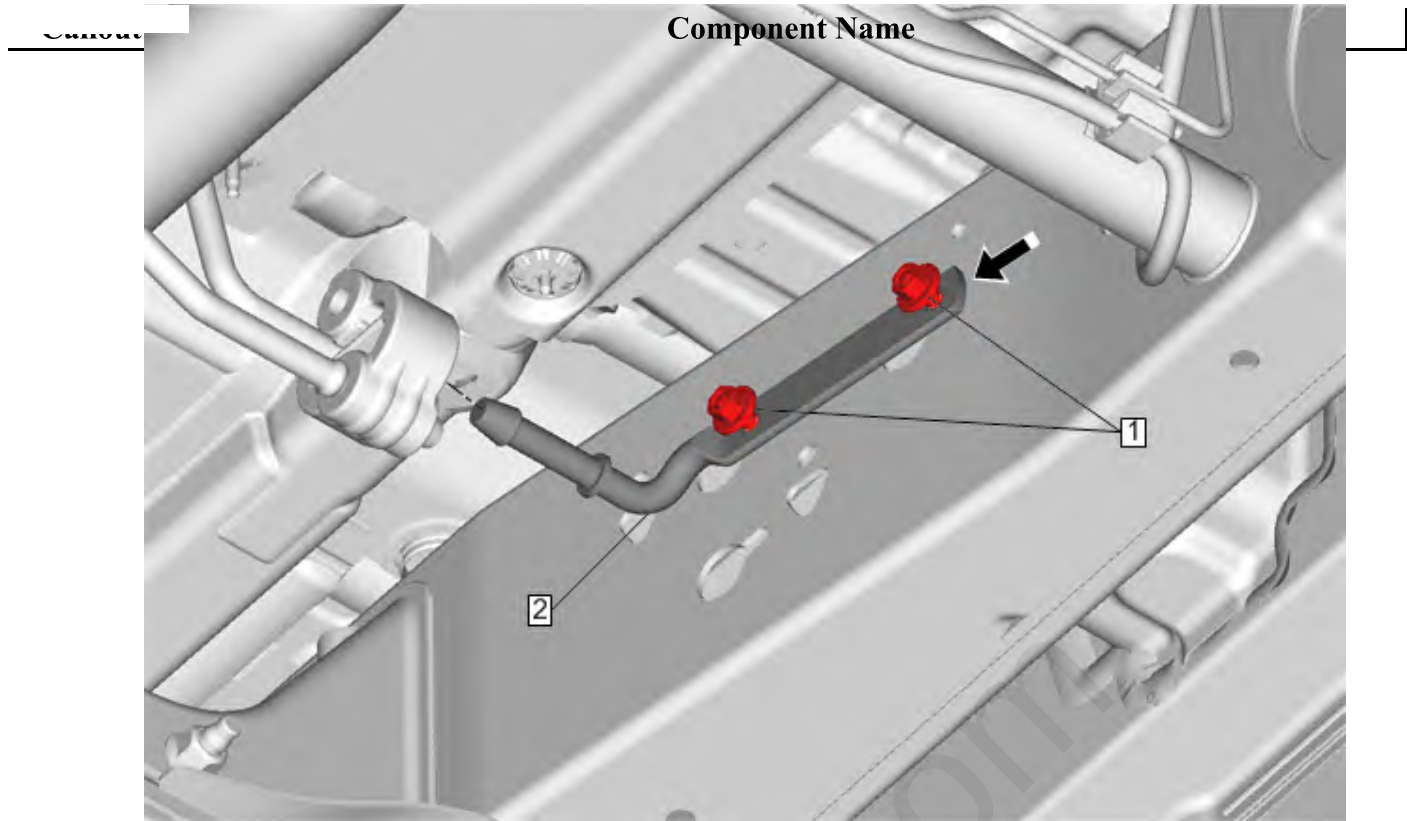
6. Install Exhaust Particulate Sensor (1) **Exhaust Particulate Sensor Replacement**



**Fig. 60: Exhaust Temperature Sensor**  
**Courtesy of GENERAL MOTORS COMPANY**

7. Connect Exhaust Temperature Sensor (1) **Exhaust Temperature Sensor Replacement - Position 5**  
 8. Connect Exhaust Temperature Sensor (2) **Exhaust Temperature Sensor Replacement - Position 4**  
 9. Connect Exhaust Pressure Sensor Hose

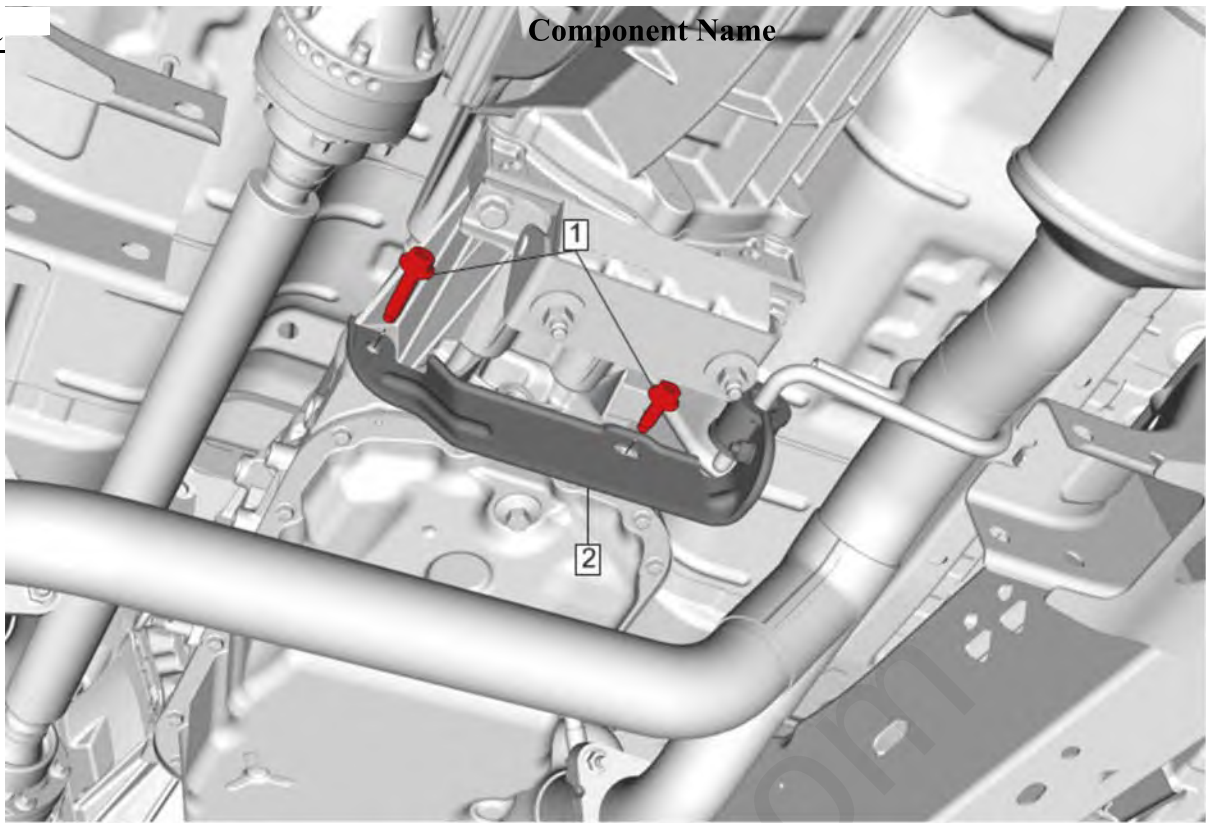
## **EXHAUST SYSTEM INSULATOR, HANGER, BRACKET REPLACEMENT (LCV)**



**Fig. 61: Exhaust System Insulator, Hanger, Bracket (LCV)**  
 Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                       | Component Name                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br><b><u>Lifting and Jacking the Vehicle</u></b> |                                                                                                                                                                                                                                                               |
| 1                                                                             | Exhaust Hanger Nuts (Qty: 2)<br><br><b>CAUTION:</b><br>Refer to <b><u>Fastener Caution</u></b> .<br><br><b>Procedure</b><br>Counter hold the exhaust hanger bolts then loosen the exhaust hanger nuts (1).<br><b>Tighten</b><br>22 N.m (16 lb ft)             |
| 2                                                                             | Exhaust Hanger<br><b>Procedure</b><br><br><b>NOTE:</b><br><b>Clean and lubricate the exhaust isolators for ease of installation.</b><br><br>With nuts loose, move the exhaust hanger in the direction of the arrow to disengage and remove if from the frame. |

**EXHAUST SYSTEM INSULATOR, HANGER, BRACKET REPLACEMENT (LFX)**

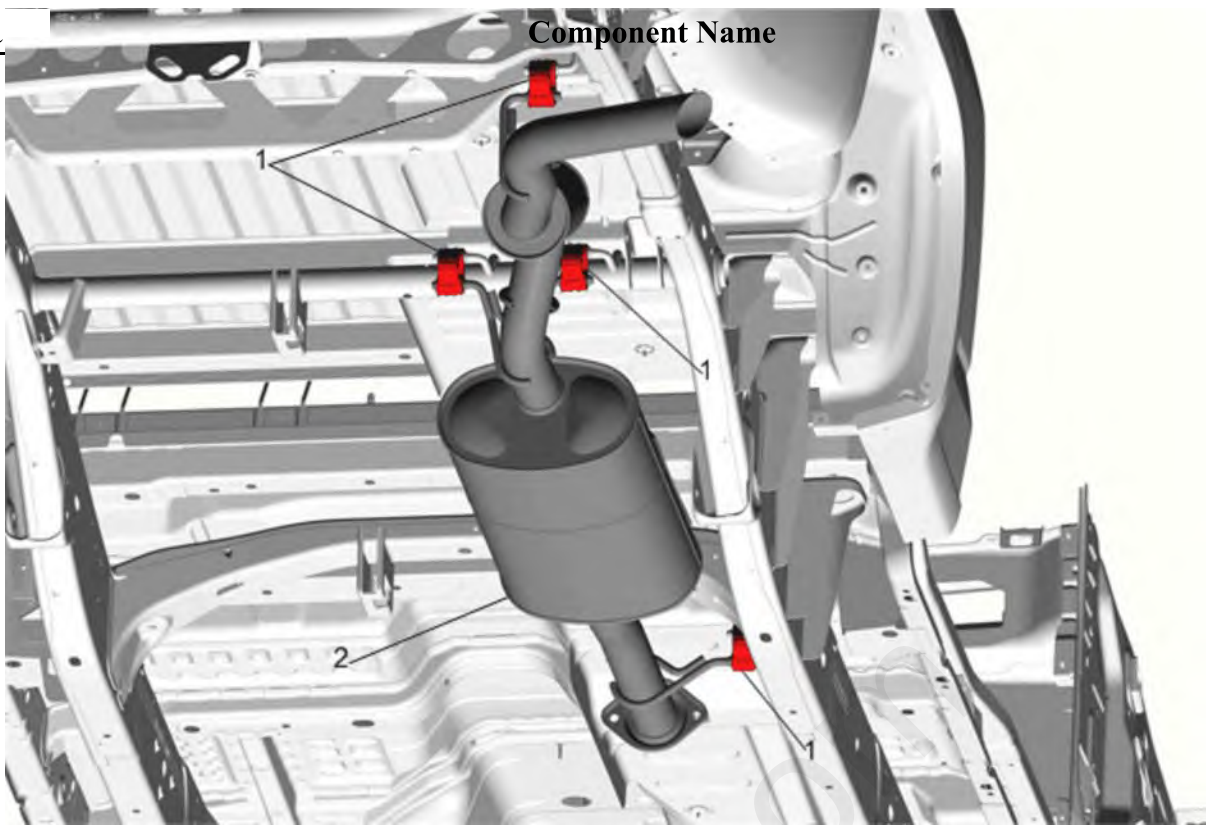


**Fig. 62: Exhaust System Insulator, Hanger, Bracket (LFX)**

Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                                                                                                                                                                                                                          | Component Name                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARNING:</b><br>In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.<br><br><b>WARNING:</b><br>Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury. |                                                                                                                                                                |
| Preliminary Procedure <b><u>Lifting and Jacking the Vehicle</u></b>                                                                                                                                                                                                              |                                                                                                                                                                |
| 1                                                                                                                                                                                                                                                                                | Exhaust Front Pipe Hanger Bracket Bolt (Qty: 2)<br><br><b>CAUTION:</b><br>Refer to <b><u>Fastener Caution</u></b> .<br><br><b>Tighten</b><br>35 N.m (26 lb ft) |
| 2                                                                                                                                                                                                                                                                                | Exhaust Front Pipe Hanger Bracket<br><b>Procedure</b><br>Clean and lubricate the exhaust isolators for ease of installation.                                   |

## **EXHAUST MUFFLER REPLACEMENT (LFX)**

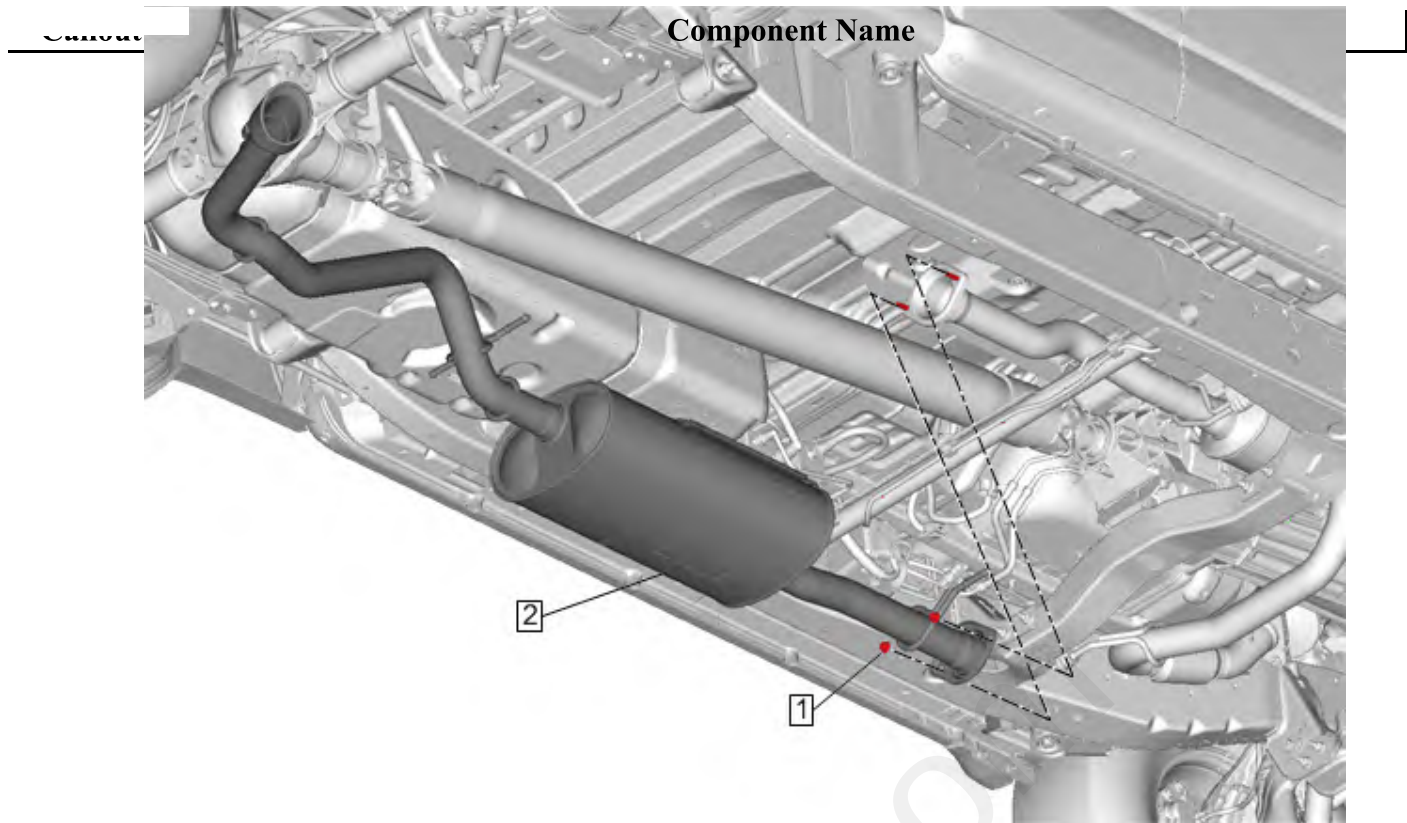


**Fig. 63: Exhaust Muffler (LFX)**

Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                                                  | Component Name                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Disconnect <b><u>Three-Way Catalytic Converter Replacement (LFX)</u></b> |                                                                                                                                                                                                                                                    |
| 1                                                                                                        | Exhaust Isolator (Qty: 4)<br><br><b>NOTE:</b><br><b>Clean and lubricate the exhaust muffler isolator rods for ease of installation.</b><br><br><b>Procedure</b><br>Using a suitable tool, pry the muffler support rods from the exhaust isolators. |
| 2                                                                                                        | Exhaust Muffler                                                                                                                                                                                                                                    |

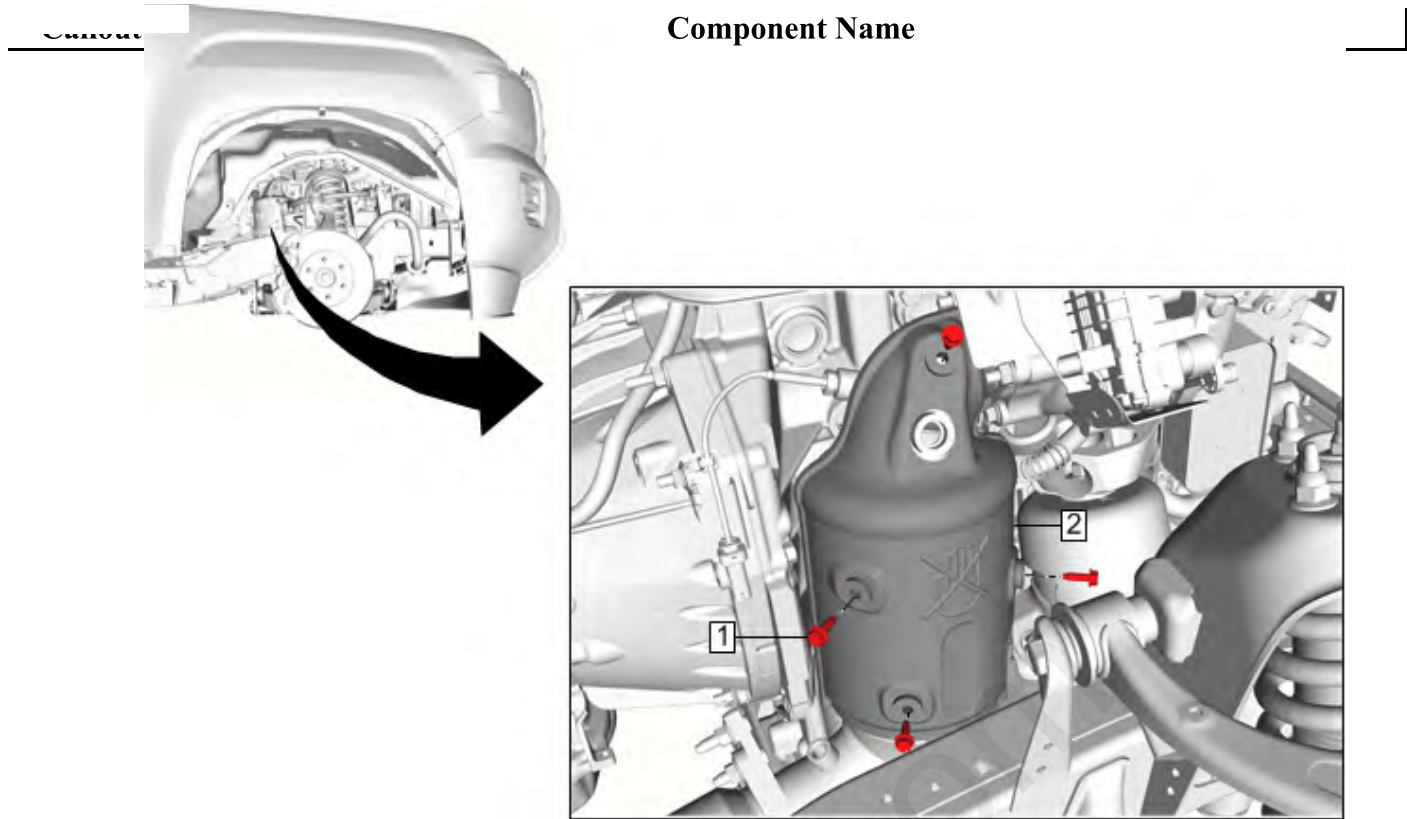
## **EXHAUST MUFFLER REPLACEMENT (LCV)**



**Fig. 64: Exhaust Muffler (LCV)**  
 Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                | Component Name                                                                                                                                                                                              |
|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br><u>Lifting and Jacking the Vehicle</u> |                                                                                                                                                                                                             |
| 1                                                                      | Exhaust Front Pipe Nut (Qty: 2)<br><br><b>WARNING:</b><br>Refer to <u>Exhaust Service Warning</u> .<br><br><b>CAUTION:</b><br>Refer to <u>Fastener Caution</u> .<br><br><b>Tighten</b><br>45 N.m (33 lb ft) |
| 2                                                                      | Exhaust Muffler<br><br><b>NOTE:</b><br>Clean and lubricate the exhaust muffler isolator rods for ease of installation.                                                                                      |

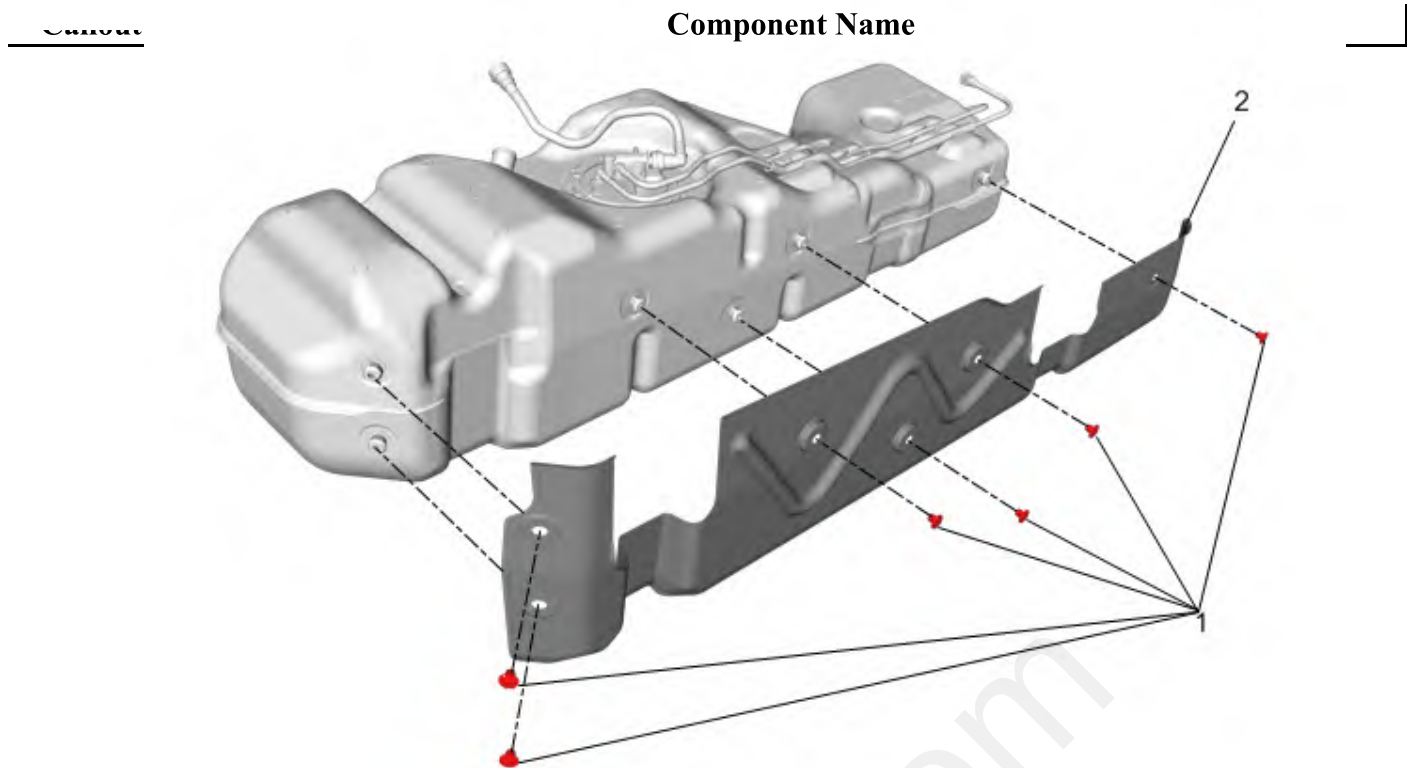
**CATALYTIC CONVERTER HEAT SHIELD REPLACEMENT (LWN)**



**Fig. 65: Catalytic Converter Heat Shield (LWN)**  
 Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Component Name                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>WARNING:</b><br/>           In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.</p> <p><b>WARNING:</b><br/>           Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.</p> <p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"> <li><u>Front Wheelhouse Liner Replacement</u></li> <li><u>Nitrogen Oxides Sensor Replacement - Position 1</u></li> </ol> |                                                                                                                                                       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Catalytic Converter Heat Shield Bolt (Qty: 4)<br><br><b>CAUTION:</b><br>Refer to <u>Fastener Caution</u> .<br><br><b>Tighten</b><br>10 N.m (89 lb in) |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Catalytic Converter Heat Shield                                                                                                                       |

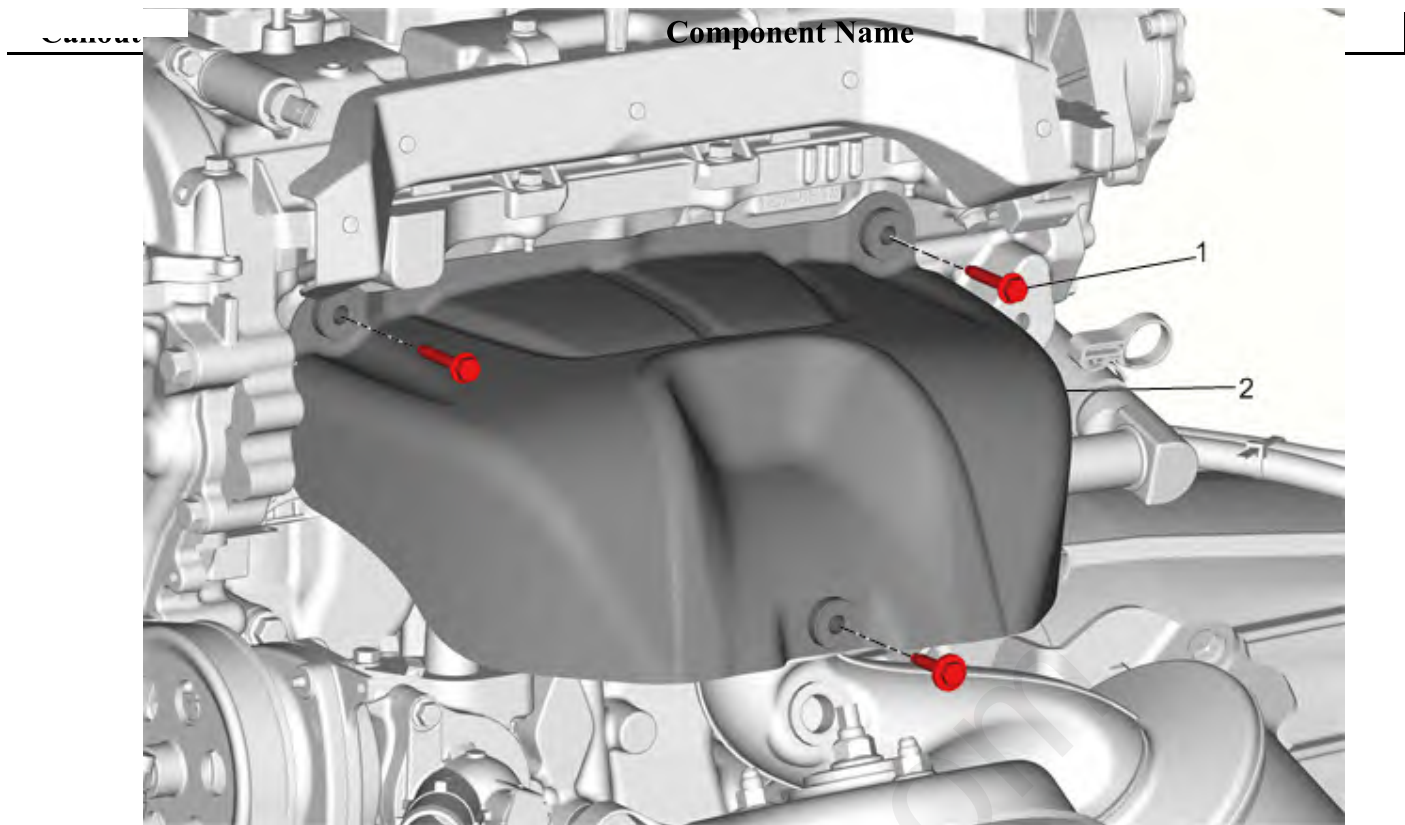
**FUEL TANK HEAT SHIELD REPLACEMENT (LWN)**



**Fig. 66: Fuel Tank Heat Shield (LWN)**  
Courtesy of GENERAL MOTORS COMPANY

| Callout                                                      | Component Name                                                                                     |
|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br><b>Fuel Tank Replacement</b> |                                                                                                    |
| 1                                                            | Fuel Tank Heat Shield Retainer (Qty: 6)<br><br><b>CAUTION:</b><br>Refer to <b>Fastener Caution</b> |
| 2                                                            | Fuel Tank Heat Shield                                                                              |

**EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT (LCV)**



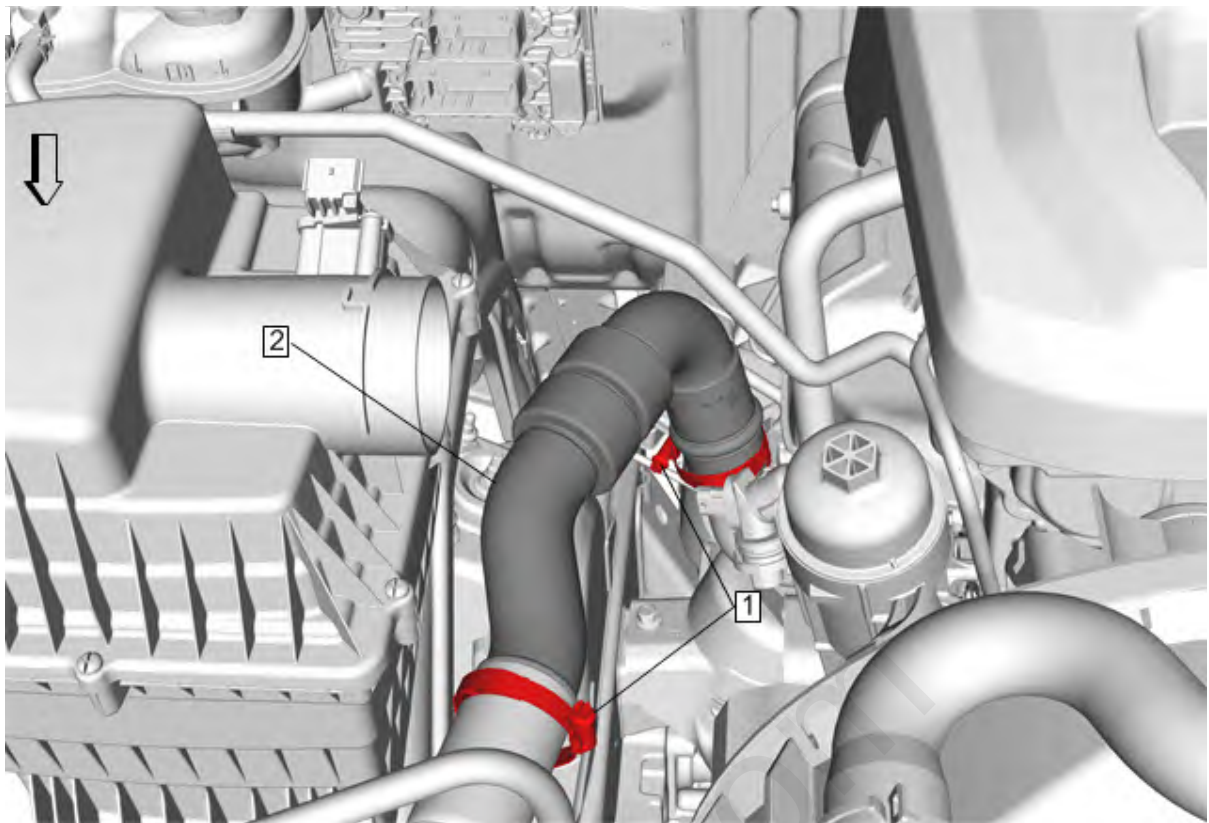
**Fig. 67: Exhaust Manifold Heat Shield (LCV)**  
 Courtesy of GENERAL MOTORS COMPANY

| Callout                                                               | Component Name                                                                                                                     |
|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARNING:</b><br>Refer to <a href="#">Exhaust Service Warning</a> . |                                                                                                                                    |
| 1                                                                     | Fastener (Qty: 3)<br><br><b>CAUTION:</b><br>Refer to <a href="#">Fastener Caution</a> .<br><br><b>Tighten</b><br>14 N.m (10 lb ft) |
| 2                                                                     | Exhaust Manifold Heat Shield                                                                                                       |

**EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT (LWN)**

**Removal Procedure**

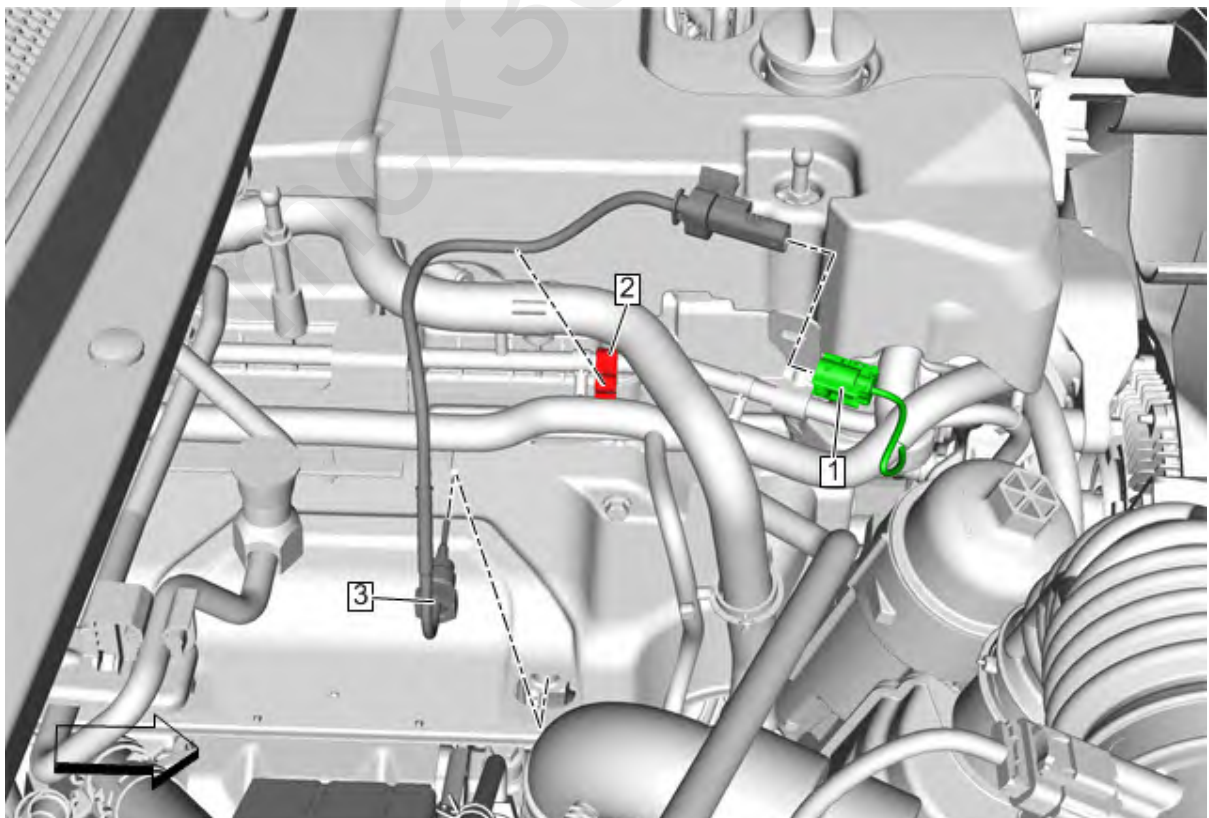
- WARNING:** In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.
- WARNING:** Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.



**Fig. 68: Charge Air Cooler Inlet Duct**

Courtesy of GENERAL MOTORS COMPANY

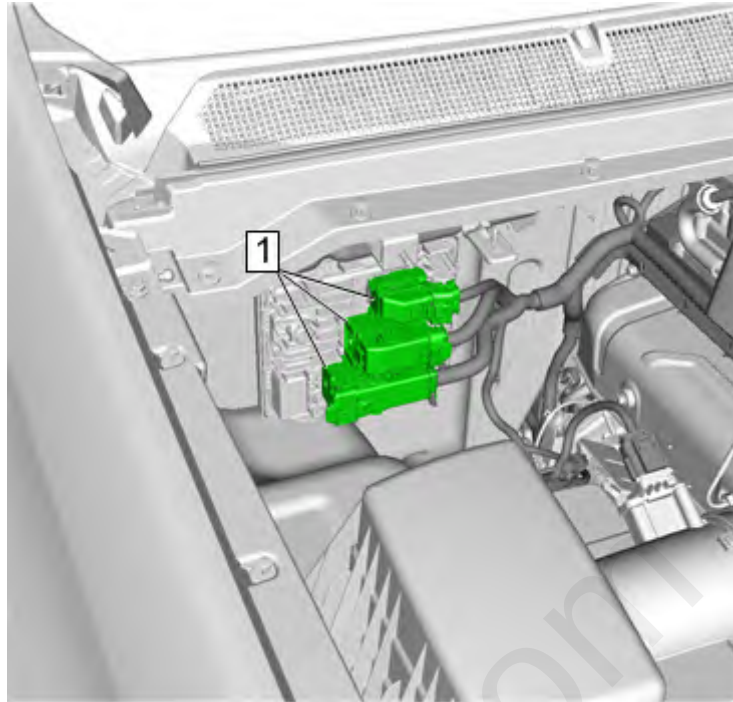
1. Remove Charge Air Cooler Inlet Duct (2) [Charge Air Cooler Inlet Duct Replacement](#)



**Fig. 69: Exhaust Gas Recirculation Valve Temperature Sensor**

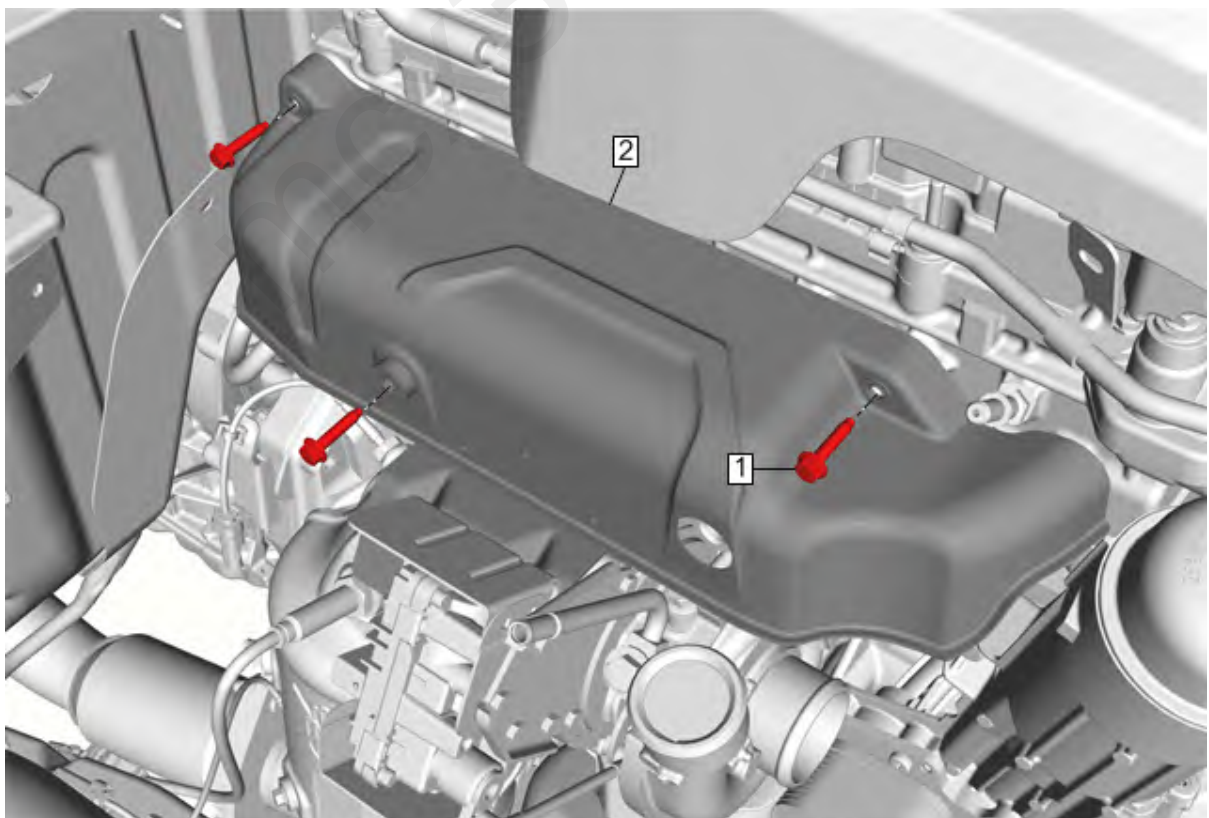
Courtesy of GENERAL MOTORS COMPANY

Exhaust Gas Recirculation Valve Temperature Sensor (3) Exhaust Gas Recirculation Valve Temperature Sensor Replacement - Position 1



**Fig. 70: Engine Wiring Harness Electrical Connectors**  
Courtesy of GENERAL MOTORS COMPANY

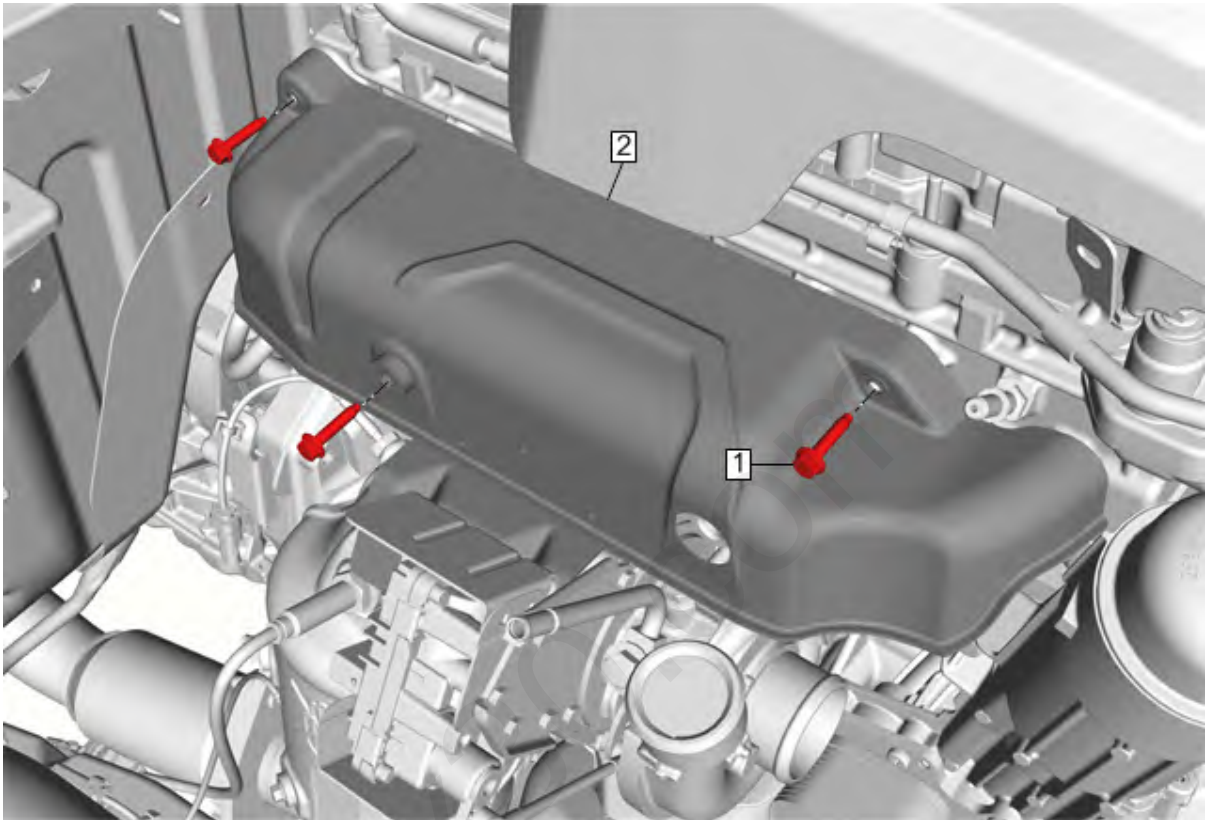
3. Disconnect the engine wiring harness electrical connectors (1) from the powertrain control module and position aside. Engine Control Module Replacement



**Exhaust Manifold Heat Shield Bolt**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove Exhaust Manifold Heat Shield Bolt (1)
5. Remove Exhaust Manifold Heat Shield (2)

**Installation Procedure**

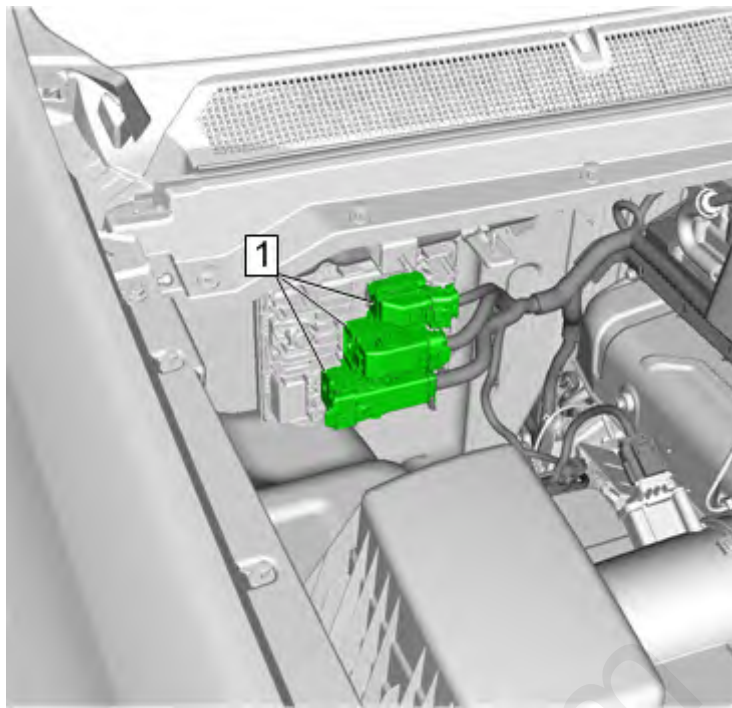


**Fig. 72: Exhaust Manifold Heat Shield Bolt**  
Courtesy of GENERAL MOTORS COMPANY

1. Install Exhaust Manifold Heat Shield (2)

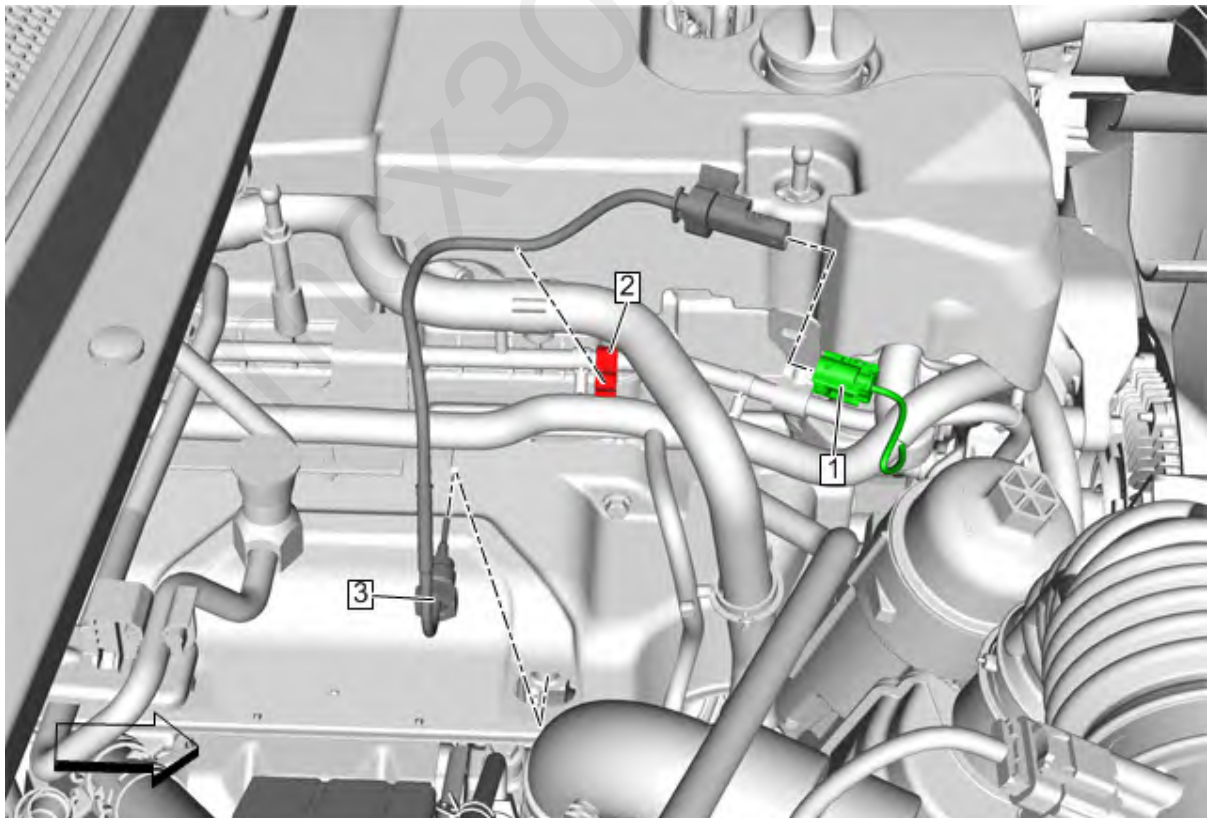
**CAUTION:** Refer to **Fastener Caution** .

2. Install Exhaust Manifold Heat Shield Bolt (1) and tighten 10 N.m (7 lb ft)



**Fig. 73: Engine Wiring Harness Electrical Connectors**  
 Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connectors (1) to the powertrain control module. **Engine Control Module Replacement**



**Fig. 74: Exhaust Gas Recirculation Valve Temperature Sensor**  
 Courtesy of GENERAL MOTORS COMPANY

Exhaust Gas Recirculation Valve Temperature Sensor (3) Exhaust Gas Recirculation Valve Temperature Sensor Replacement - Position 1

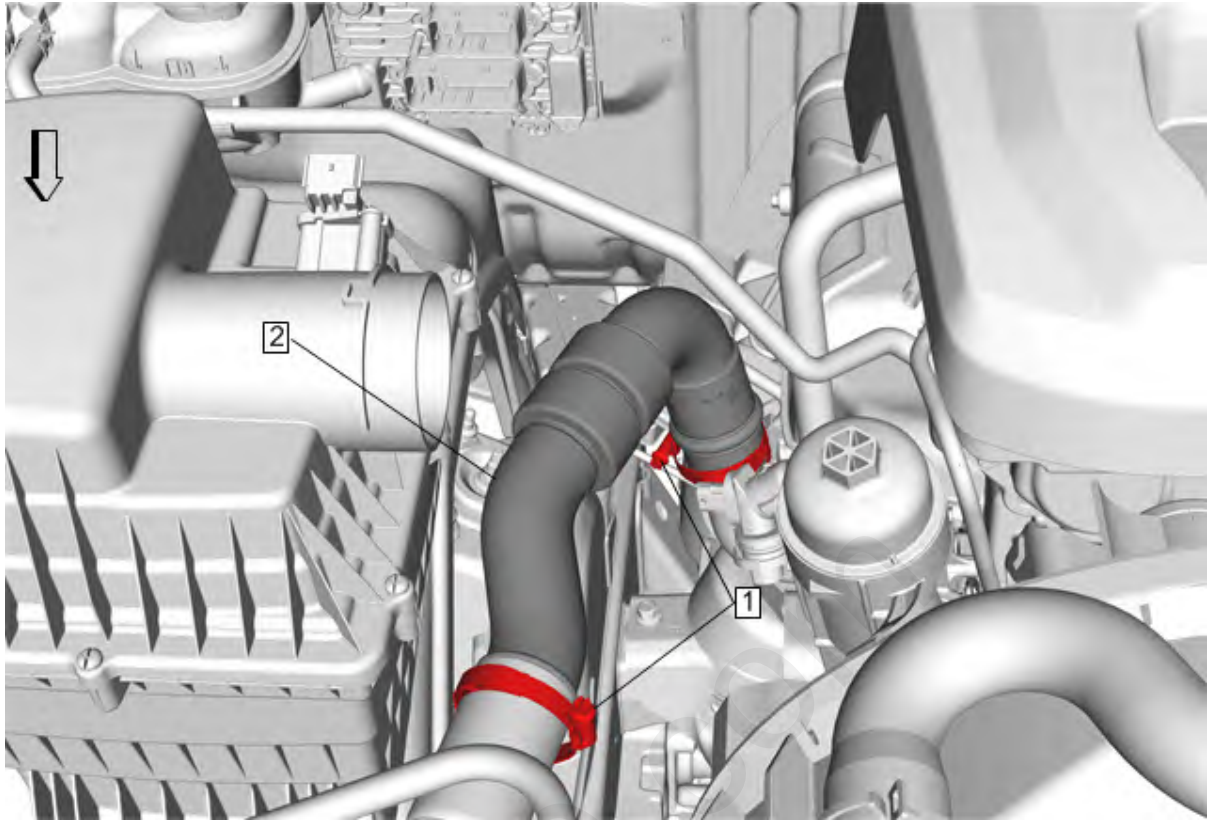
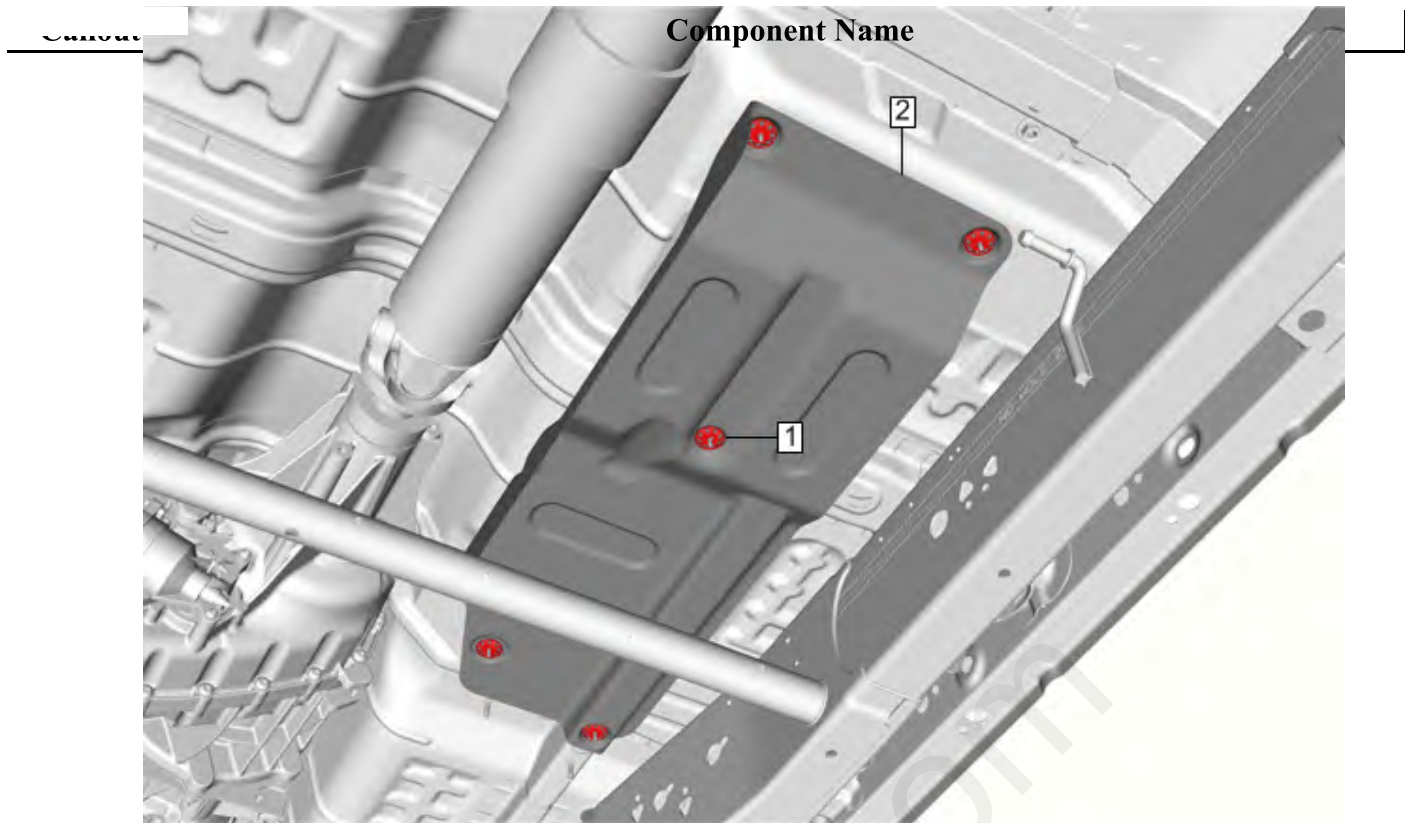


Fig. 75: Charge Air Cooler Inlet Duct  
Courtesy of GENERAL MOTORS COMPANY

5. Install Charge Air Cooler Inlet Duct (2) Charge Air Cooler Inlet Duct Replacement

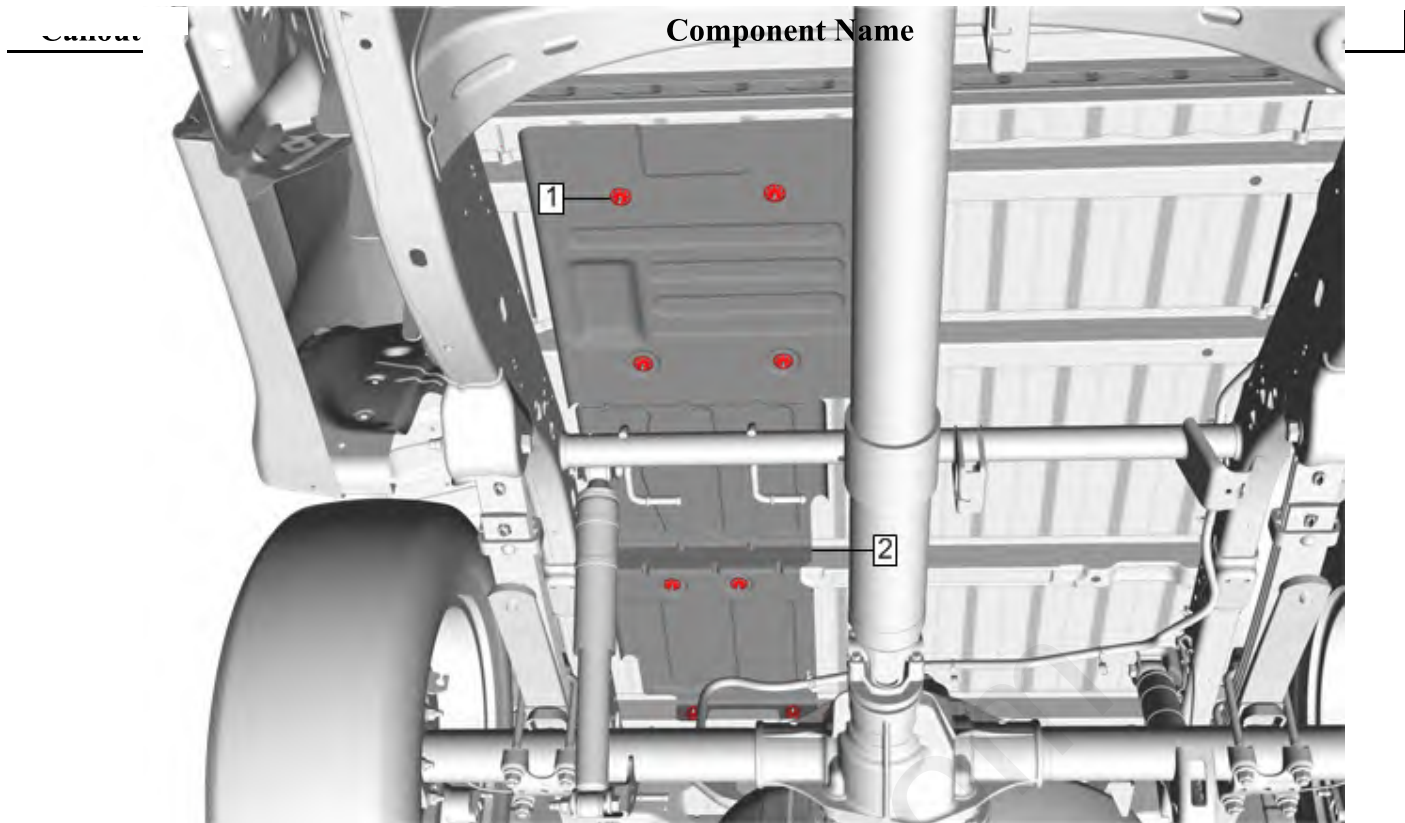
**EXHAUST MUFFLER HEAT SHIELD REPLACEMENT (FRONT)**



**Fig. 76: Exhaust Muffler Heat Shield (Front)**  
 Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                                                                                         | Component Name                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARNING:</b><br>In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool. |                                                                                                                                                         |
| <b>WARNING:</b><br>Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.                       |                                                                                                                                                         |
| <b>Preliminary Procedure</b> <a href="#">Lifting and Jacking the Vehicle</a>                                                                    |                                                                                                                                                         |
| 1                                                                                                                                               | Exhaust Heat Shield Retainer (Qty: 5)<br><br><b>CAUTION:</b><br>Refer to <a href="#">Fastener Caution</a> .<br><br><b>Tighten</b><br>1.5 N.m (13 lb in) |
| 2                                                                                                                                               | Exhaust Heat Shield                                                                                                                                     |

**EXHAUST MUFFLER HEAT SHIELD REPLACEMENT (REAR)**



**Fig. 77: Exhaust Muffler Heat Shield (Rear)**  
 Courtesy of GENERAL MOTORS COMPANY

| Callout                                                                                                                                         | Component Name                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARNING:</b><br>In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool. |                                                                                                                                                         |
| <b>WARNING:</b><br>Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.                       |                                                                                                                                                         |
| Preliminary Procedure <a href="#">Lifting and Jacking the Vehicle</a>                                                                           |                                                                                                                                                         |
| 1                                                                                                                                               | Exhaust Heat Shield Retainer (Qty: 8)<br><br><b>CAUTION:</b><br>Refer to <a href="#">Fastener Caution</a> .<br><br><b>Tighten</b><br>1.5 N.m (13 lb in) |
| 2                                                                                                                                               | Exhaust Heat Shield                                                                                                                                     |

## DESCRIPTION AND OPERATION

### EXHAUST SYSTEM DESCRIPTION

IMPORTANT: Use of non-OEM parts may cause driveability concerns.

ystem carries exhaust gases, treated by the catalytic converter, through a resonator, if applicable and into the exhaust muffler where exhaust noise is lessened.

In order to secure the exhaust pipe to the exhaust manifold, a flange and seal-joint coupling is utilized. The exhaust system may utilize a slip-joint coupling design with a clamp and a U-bolt or a flange connection with a gasket.

Exhaust hangers and rubber insulators help to support the weight of the exhaust pipe along with insulating any exhaust system vibration, rattle, or noise.

Exhaust hangers also space the exhaust system away from the underbody of the vehicle and allows the exhaust system to expand as the exhaust system warms up.

Exhaust heat shields are used to protect the body and other components from damage due to the heat from the exhaust system.

The exhaust system may be comprised of the following components:

- Exhaust manifold
- Exhaust pipes
- Catalytic converters
- Exhaust muffler
- Exhaust resonator, if equipped
- Exhaust tail pipe, if equipped
- Exhaust hangers
- Exhaust heat shields

### **Resonator**

Some exhaust systems are equipped with a resonator. The resonator, located either before or after the muffler, allows the use of mufflers with less back pressure. Resonators are used when vehicle characteristics require specific exhaust tuning.

### **Catalytic Converter**

The catalytic converter is an emission control device added to the engine exhaust system in order to reduce hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) pollutants from the exhaust gas.

The catalytic converter is comprised of a ceramic monolith substrate, supported in insulation and housed within a sheet metal shell. The substrate may be washcoated with 3 noble metals:

- Platinum (Pt)
- Palladium (Pd)
- Rhodium (Rh)

The catalyst in the converter is not serviceable.

### **Diesel Particulate Filter (DPF)**

#### **Exhaust Particulate Filter**

The exhaust particulate filter (EPF) captures diesel exhaust gas particulates, preventing their release into the atmosphere. This is accomplished by forcing particulate-laden exhaust (1) through a filter substrate of porous cells, which removes the particulates from the exhaust gas. The exhaust gas enters the filter, but because every other cell

capped at the opposite end, the exhaust particulates cannot exit the cell. Instead, the exhaust gas passes through the porous walls of the cell leaving the particulates trapped on the cell wall. The cleaned exhaust gas exits the filter through the adjacent cell. The EPF is capable of reducing more than 90 percent of particulate matter (PM).

### **Diesel Oxidation Catalyst**

The diesel oxidation catalyst (DOC) (7) has two functions. One function is to reduce emissions of non methane hydro-carbons (NMHC) and carbon monoxide (CO), from the exhaust gases. The other function is to help start a regeneration event by converting the fuel-rich exhaust gases to heat. The engine control module (ECM) monitors the functionality of the DOC by determining if the exhaust gas temperature (EGT) sensor 1 (1) reaches a predetermined temperature during a regeneration event. The Diesel Particulate Filter (DPF) System Description DOC and the exhaust particulate filter (EPF) (6) are downstream of the turbocharger, and are two separate components under the vehicle.

### **Differential Pressure Sensor (DPS) and Pressure Lines**

The difference between the inlet and outlet of the exhaust particulate filter (EPF). When pressure difference has increased above a calibrated threshold, a high particulate loading condition is indicated. The ECM will command a regeneration event in order to restore the filter. If the pressure differential continues to increase across the exhaust filter without a regeneration event, the ECM will illuminate an EPF lamp or send a message to the driver information center (DIC) referring the customer to clean the exhaust filter. To clean the exhaust filter the vehicle must be driven under the conditions necessary for a regeneration to take place. If these lamps and messages are ignored, the ECM will eventually illuminate the malfunction indicator lamp (MIL) and revert to Reduced Engine Power which will require the vehicle to be serviced. The DPS sensor provides a voltage signal to the ECM on a signal circuit relative to the pressure differential changes in the EPF. The ECM converts the signal voltage input to a pressure value. The DPS pressure lines (2) are connected before and after the EPF. To provide the pressure sensor with accurate back pressure measurements, the DPS pressure lines should have a continuous downward gradient without any sharp bends.

### **Exhaust Gas Temperature Sensors**

The ECM uses two exhaust gas temperature (EGT) sensors to measure the temperature of the exhaust gases at the inlet and outlet of the exhaust particulate filter (EPF). The EGT sensors are variable resistors, when the EGT sensors are cold, the sensor resistance is low, and as the temperature increases, the sensor resistance increases. When sensor resistance is high, the ECM detects a high voltage on the signal circuit. When sensor resistance is low, the ECM detects a lower voltage on the signal circuit. Proper EGTs at the inlet and outlet of the EPF are crucial for proper operation and for initiating the regeneration process. A temperature that is too high in the EPF will cause the EPF substrate to melt or crack. The ECM monitors the temperatures at the EPF inlet and outlet to regulate EPF temperatures.

### **Normal Regeneration**

Regeneration is the process of removing the captured particulates through incineration within the exhaust particulate filter (EPF). Elevated temperatures are created in the diesel oxidation catalyst (DOC) through a calibrated strategy in the engine control system. Regeneration occurs when the ECM calculates that the particulate level in the filter has reached a calibrated threshold using a number of different factors, including engine run time, distance traveled, fuel used since the last regeneration, and the exhaust differential pressure. In general, the vehicle will need to be operating continuously at speeds above 48 km/h (30 mph) for approximately 20-30 minutes for a full and effective regeneration to complete. During regeneration the exhaust gases reach temperatures above 550°C (1,022°F). The ECM monitors the EGT sensors during regeneration. If the sensors indicate that regeneration temperatures are exceeding a calibrated threshold, regeneration will be temporally suspended until the sensors return to a normal temperature. If EGT temperatures fall below a normal calibrated threshold, regeneration will be terminated and a corresponding DTC should set. If a regeneration event is interrupted for any reason, it will

iding the next key cycle, when the conditions are met for regeneration enablement. Normal regeneration is transparent to the customer.

## Service Regeneration

A scan tool is an essential tool that is required for service regeneration. Commanding a service regeneration is accomplished using the output control function. The vehicle will need to be parked outside the facility and away from nearby objects, such as other vehicles and buildings, due to the elevated exhaust gas temperature at the tail pipe during regeneration. The service regeneration can be terminated by applying the brake pedal, commanding service regeneration OFF using the scan tool, or disconnecting the scan tool from the vehicle.

## Regeneration Process

A number of engine components are required to function together for the regeneration process to be performed. These components are the fuel injectors, turbocharger, IA valve, fuel pressure control, and the intake air heater (IAH). The regeneration process consists of several stages: Warming up the diesel oxidation catalyst (DOC) to 350Å°C (662Å°F) by performing the following:

- Reducing air flow with the intake air valve
- Increasing or decreasing boost pressure with the turbocharger, depending on engine load
- Elevating the engine speed
- Reduce fuel rail pressure
- Retard fuel injection timing
- Add late fuel injection pulses. The added fuel is not combusted but is oxidized by the DOC and exhaust particulate filter (EPF) to create heat.

## Ash Loading

Ash is a non-combustible by product from normal oil consumption. Low Ash content engine oil (CJ-4 API) is required for vehicles with the exhaust particulate filter (EPF) system. Ash accumulation in the EPF will eventually cause a restriction in particulate filter. Regeneration will not burn off the ash, only particulate matter is burned off. An ash loaded EPF will need to be removed from the vehicle and cleaned or replaced.

## Muffler

### Muffler

The exhaust muffler reduces the noise levels of the engine exhaust by the use of tuning tubes. The tuning tubes create channels inside the exhaust muffler that lower the sound levels created by the combustion of the engine.

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