

## 2010 BRAKES

### Hydraulic Brakes - Equinox & Terrain

## SPECIFICATIONS

### FASTENER TIGHTENING SPECIFICATIONS

| Application                                               | Specification |          |
|-----------------------------------------------------------|---------------|----------|
|                                                           | Metric        | English  |
| Brake Hose Fitting Bolt - Front                           | 40 N.m        | 30 lb ft |
| Brake Hose Fitting Bolt - Rear                            | 52 N.m        | 38 lb ft |
| Brake Hose Bracket Bolt - Front                           | 10 N.m        | 89 lb in |
| Brake Hose Bracket Bolt - Rear                            | 16 N.m        | 12 lb ft |
| Brake Hose Bracket Nut                                    | 10 N.m        | 89 lb in |
| Brake Pedal Bracket Bolt                                  | 25 N.m        | 18 lb ft |
| Power Brake Booster Auxiliary Pump Bracket M8 Bolt - LAF  | 22 N.m        | 16 lb ft |
| Power Brake Booster Auxiliary Pump Bracket M10 Bolt - LAF | 58 N.m        | 43 lb ft |
| Power Brake Booster Auxiliary Pump Bracket M10 Bolt - LF1 | 50 N.m        | 37 lb ft |
| Power Brake Booster Auxiliary Pump Nut                    | 9 N.m         | 80 lb in |
| Power Vacuum Brake Booster Nut                            | 25 N.m        | 18 lb ft |
| Power Vacuum Brake Booster Pushrod Retainer Nut           | 25 N.m        | 18 lb ft |

### BRAKE COMPONENT SPECIFICATIONS

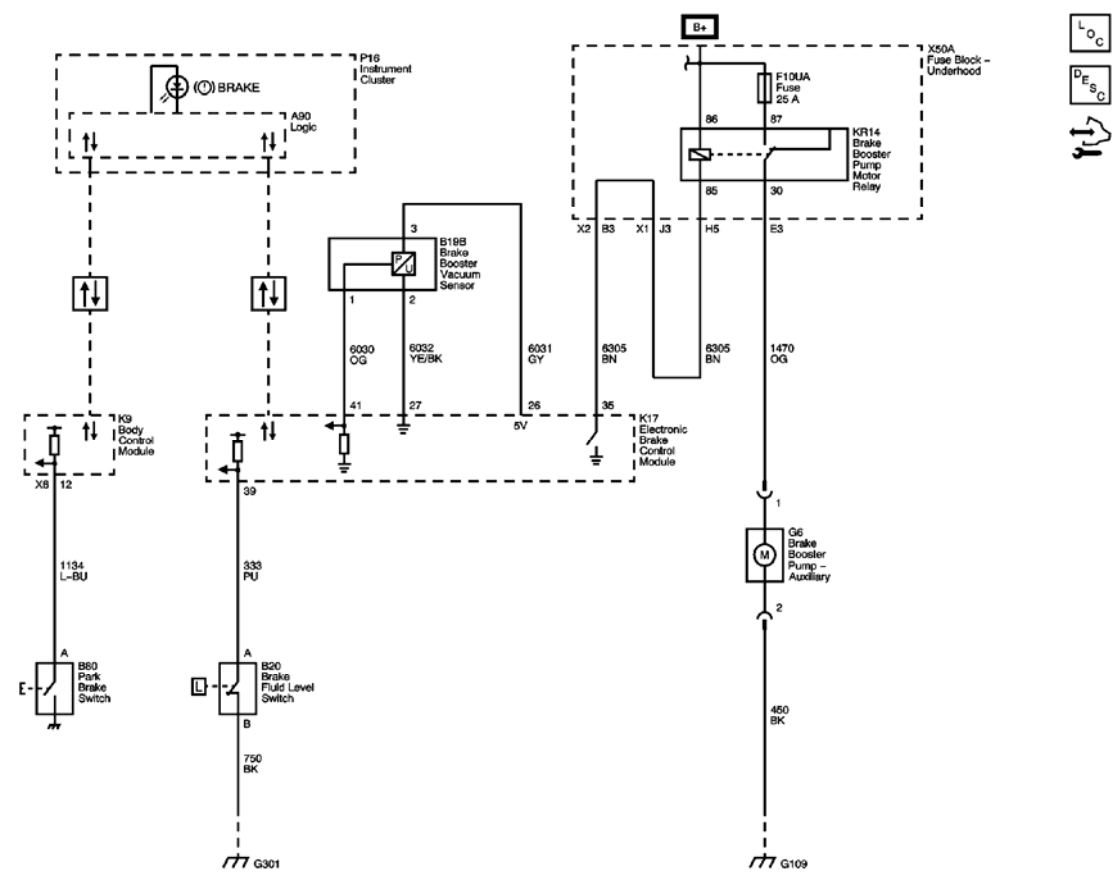
| Application                         | Specification |          |
|-------------------------------------|---------------|----------|
|                                     | Metric        | English  |
| Brake Caliper Bleeder Valve - Front | 10 N.m        | 89 lb in |
| Brake Caliper Bleeder Valve - Rear  | 10 N.m        | 89 lb in |

### BRAKE SYSTEM SPECIFICATIONS

| Application                                                                                                                                                                                                     | Specification |         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------|
|                                                                                                                                                                                                                 | Metric        | English |
| Brake Pedal Travel <ul style="list-style-type: none"><li>Maximum specification with 445 N (100 lbs) of force applied to the brake pedal with the ignition OFF and the booster power reserve depleted.</li></ul> | 57 mm         | 2.25 in |

# SCHEMATIC AND ROUTING DIAGRAMS

## HYDRAULIC BRAKE SCHEMATICS



**Fig. 1: Hydraulic Brake**  
Courtesy of GENERAL MOTORS CORP.

## DIAGNOSTIC INFORMATION AND PROCEDURES

### DIAGNOSTIC CODE INDEX

### DIAGNOSTIC CODE INDEX

| DTC              | Description                                                                                                                                                                                                                |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DTC C0267</b> | C0267 00: Low Brake Fluid Indicated                                                                                                                                                                                        |
| <b>DTC C027B</b> | C027B 00: Brake Booster Electric Vacuum Pump Malfunction                                                                                                                                                                   |
| <b>DTC C0299</b> | C0299 5A: Brake Booster Large Vacuum Leak Detected Not Plausible                                                                                                                                                           |
| <b>DTC C1100</b> | C1100 00: Brake Pressure Sensor 2 Malfunction<br>C1100 01: Brake Pressure Sensor 2 Short to Battery<br>C1100 02: Brake Pressure Sensor 2 Short to Ground<br>C1100 08: Brake Pressure Sensor 2 Performance - Signal Invalid |

DTC C0267

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0267 00

Low Brake Fluid Indicated

Diagnostic Fault Information

| Circuit                   | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|---------------------------|-----------------|----------------------|------------------|--------------------|
| Signal                    | C0267 00        | 1                    | -                | -                  |
| Ground                    | -               | 1                    | -                | -                  |
| 1. Open Circuit Condition |                 |                      |                  |                    |

Circuit/System Description

The brake fluid level switch monitors the level of brake fluid in the brake fluid reservoir.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

- A short to ground detected on the brake fluid level signal circuit for 60 seconds.
- Low brake fluid level is detected for 60 seconds.

Action Taken When the DTC Sets

One or more of the following actions may occur:

- The vehicle stability enhancement system (VSES) and traction control system (TCS) is disabled.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

## **Reference Information**

### **Schematic Reference**

#### **Hydraulic Brake Schematics**

### **Connector End View Reference**

#### **Component Connector End Views**

### **Description and Operation**

#### **Brake Warning System Description and Operation**

### **Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

### **Scan Tool Reference**

#### **Control Module References** for scan tool information

### **Circuit/System Verification**

1. Inspect for proper brake fluid level. The fluid level should be above the minimum level.
  - If low, refer to **Brake Fluid Loss**.
2. Ignition ON, observe the scan tool Brake Fluid Level Sensor parameter. The reading should be OK.

### **Circuit/System Testing**

1. Ignition OFF, disconnect the harness connector at the B20 brake fluid level switch.
2. Test for less than 5 ohms between the ground circuit terminal A and ground.
  - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Brake Fluid Level Sensor parameter is OK.
  - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K17 electronic brake control module (EBCM).
4. Install a 3 A fused jumper wire between the signal circuit terminal A and ground.
5. Verify the scan tool Brake Fluid Level Sensor parameter is Low. The parameter may take up to 60 seconds to go from OK to Low.

- If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K17 EBCM.
- 6. If all circuits test normal, test or replace the B20 brake fluid level switch.

### Component Testing

1. Ignition OFF, disconnect the harness connector at the B20 brake fluid level switch.
2. Test for infinite resistance between the ground circuit terminal B and the signal circuit terminal A with the switch in the open position.
  - If less than the specified value, replace the B20 brake fluid level switch.
3. Test for less than 5 ohms between the signal terminal A and ground terminal B with the switch in the closed position.
  - If greater than the specified range, replace the brake fluid level switch.

### Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Master Cylinder Reservoir Replacement**
- **Control Module References** for EBCM replacement, setup and programming

### DTC C027B

#### Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

#### DTC Descriptor

#### DTC C027B 00

Brake Booster Electric Vacuum Pump Malfunction

#### Diagnostic Fault Information

| Circuit                                   | Short to Ground    | Open/High Resistance | Short to Voltage   | Signal Performance |
|-------------------------------------------|--------------------|----------------------|--------------------|--------------------|
| Vacuum Pump Relay Coil Ignition           | C027B 00           | C027B 00             | -                  | -                  |
| Vacuum Pump Relay Switch Ignition         | C027B 00           | C027B 00             | -                  | -                  |
| Brake Booster Vacuum Sensor 5 V Reference | C1100 00, C1100 02 | C1100 00, C1100 08   | C1100 00, C1100 01 | -                  |
| Brake Booster Vacuum Sensor               | C1100 00,          |                      | C1100 00,          | C1100 08, C1100    |

| Signal                                    | C1100 02 | C1100 00 | C1100 01 | 09, C1100 5A |
|-------------------------------------------|----------|----------|----------|--------------|
| Vacuum Pump Relay Control                 | 1        | C027B 00 | C027B 00 | -            |
| Brake Booster Pump Motor Control          | C027B 00 | C027B 00 | 1        | -            |
| Brake Booster Vacuum Sensor Low Reference | -        | C1100 00 | -        | -            |
| Brake Booster Pump Motor Ground           | -        | C027B 00 | -        | -            |
| 1. Brake Booster Pump Motor Always ON     |          |          |          |              |

### Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module (EBCM) supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the EBCM. When the vacuum within the system drops, the EBCM turns ON the vacuum pump by providing ground to the vacuum pump relay. The relay activates and supplies voltage to the brake booster pump motor.

### Conditions for Running the DTC

Ignition ON

### Conditions for Setting the DTC

The EBCM detects a vacuum leak.

### Action Taken When the DTC Sets

The brake warning indicator turns ON.

### Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The EBCM will turn OFF the indicator in the next ignition cycle.

### Reference Information

### Schematic Reference

### Hydraulic Brake Schematics

### Connector End View Reference

### Component Connector End Views

### Description and Operation

### Brake Assist System Description and Operation

## Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

## Scan Tool Reference

**Control Module References** for scan tool information

## Circuit/System Verification

1. Ignition OFF, apply and release the brake pedal several times to ventilate the brake booster.
2. Engine running, the M9 Brake Booster Pump Motor should turn ON for a short time.

## Circuit/System Testing

1. Inspect the brake booster vacuum system for damage, leakage and correct installation. Refer to **Brake Assist System Diagnosis**.
2. If the brake booster vacuum systems diagnoses normal, disconnect the harness connector at the M9 Brake Booster Pump Motor.
3. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 2 and ground.
  - If greater than the specified value, test the ground circuit for an open/high resistance.
4. Disconnect the KR28 Vacuum Pump Relay.
5. Ignition ON, verify that a test lamp illuminates between the circuit terminals listed below and ground.
  - Relay coil ignition terminal 86
  - Relay switch ignition terminal 87
  - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
6. Verify that a test lamp does not illuminate between the relay controlled output circuit terminal 30 and ground.
  - If the test lamp illuminates, test the controlled output circuit for a short to voltage.
7. Verify that a test lamp does not illuminate between the relay control circuit terminal 85 and ground.
  - If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the K17 Electronic Brake Control Module (EBCM).
8. Ignition OFF, connect the harness connector at the M9 Brake Booster Pump Motor.
9. Momentarily connect a 20 A fused jumper wire between the vacuum pump relay controlled output circuit terminal 30 and B+. Verify the M9 Brake Booster Pump Motor activates.
  - If the M9 Brake Booster Pump Motor does not activate and the vacuum pump motor fuse is open, test the controlled output circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the M9 Brake Booster Pump Motor.

10. Disconnect the harness connector at the K17 Electronic Brake Control Module (EBCM).
11. Test for infinite resistance between the vacuum pump relay control circuit terminal 85 and ground.
  - If less than the specified value, test the control circuit for a short to ground.
12. Connect the KR28 Vacuum Pump Relay.
13. Engine running, momentarily connect a fused jumper wire between the control circuit terminal 35 and ground. Verify the M9 Brake Booster Pump Motor activates.
  - If the M9 Brake Booster Pump Motor does not activate, test the vacuum pump relay control circuit for an open/high resistance. If the circuit tests normal, test or replace the KR28 Vacuum Pump Relay.
14. If all circuits test normal, replace the K17 Electronic Brake Control Module (EBCM).

## Component Testing

### Vacuum Pump Motor Test

1. Ignition OFF, disconnect the harness connector at the M9 Brake Booster Pump Motor.
2. Connect a 20 A fused jumper wire between the control circuit terminal 1 and B+.
3. Connect a jumper wire between the ground circuit terminal 2 and ground, verify the M9 Brake Booster Pump Motor activates.
  - If the M9 Brake Booster Pump Motor does not activate, replace the M9 Brake Booster Pump Motor.

### Relay Test

1. Ignition OFF, disconnect the KR28 Vacuum Pump Relay.
2. Test for 60-100 ohms between terminals 85 and 86 of the relay.
  - If not within the specified range, replace the KR28 Vacuum Pump Relay.
3. Test for infinite resistance between the following terminals:
  - 30 and 85
  - 30 and 86
  - 30 and 87
  - If less than the specified value, replace the KR28 Vacuum Pump Relay.
4. Install a fused jumper wire between relay terminal 86 and B+. Install a jumper wire between relay terminal 85 and ground.
5. Test for less than 5 ohms between terminals 30 and 87.
  - If greater than the specified value, replace the KR28 Vacuum Pump Relay.

## Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Power Brake Booster Vacuum Sensor Replacement (2.4L)** or **Power Brake Booster Vacuum Sensor**

**Replacement (3.0L)**

- **Power Vacuum Brake Booster Replacement**

**Control Module References** for EBCM replacement, setup and programming

**DTC C0299**

**Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**DTC Descriptor**

**DTC C0299 5A**

Brake Booster Large Vacuum Leak Detected Not Plausible

**Diagnostic Fault Information**

| Circuit                                   | Short to Ground    | Open/High Resistance | Short to Voltage   | Signal Performance           |
|-------------------------------------------|--------------------|----------------------|--------------------|------------------------------|
| Brake Booster Vacuum Sensor 5 V Reference | C1100 00, C1100 02 | C1100 00, C1100 08   | C1100 00, C1100 01 | -                            |
| Brake Booster Vacuum Sensor Signal        | C1100 00, C1100 02 | C1100 00             | C1100 00, C1100 01 | C1100 08, C1100 09, C1100 5A |
| Brake Booster Vacuum Sensor Low Reference | -                  | C1100 00             | -                  | -                            |

**Circuit/System Description**

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module (EBCM) supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the EBCM.

**Conditions for Running the DTC**

Ignition ON.

**Conditions for Setting the DTC**

The EBCM detected a too low vacuum in the brake booster assembly for 120 seconds.

**Action Taken When the DTC Sets**

The brake warning indicator turns ON.

### Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The EBCM will turn OFF the indicator in the next ignition cycle.

### Reference Information

### Schematic Reference

### Hydraulic Brake Schematics

### Connector End View Reference

### Component Connector End Views

### Description and Operation

### Brake Assist System Description and Operation

### Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

### Scan Tool Reference

### Control Module References

### Circuit/System Testing

1. Ignition ON, verify that DTC C1100 is not present.
  - If DTC C1100 is present, refer to **DTC C1100**.
2. Inspect the brake booster vacuum system for damage, leakage and correct installation. Refer to **Brake Assist System Diagnosis**.
3. If the brake booster vacuum systems diagnoses normal, replace the B19B Brake Booster Vacuum Sensor and verify the DTC does not reset. If the DTC resets, replace the K17 Electronic Brake Control Module (EBCM).

### Repair Procedures

Perform the **Diagnostic Repair Verification**

- Power Brake Booster Vacuum Sensor Replacement (2.4L) or Power Brake Booster Vacuum Sensor Replacement (3.0L)
- Control Module References

DTC C1100

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC C1100 00

Brake Pressure Sensor 2 Malfunction

DTC C1100 01

Brake Pressure Sensor 2 Short to Battery

DTC C1100 02

Brake Pressure Sensor 2 Short to Ground

DTC C1100 08

Brake Pressure Sensor 2 Performance - Signal Invalid

DTC C1100 09

Brake Pressure Sensor 2 Too Fast Transitions

DTC C1100 5A

Brake Pressure Sensor 2 Not Plausible

Diagnostic Fault Information

| Circuit       | Short to Ground    | Open/High Resistance | Short to Voltage   | Signal Performance           |
|---------------|--------------------|----------------------|--------------------|------------------------------|
| 5 V Reference | C1100 00, C1100 02 | C1100 00, C1100 08   | C1100 00, C1100 01 | -                            |
| Signal        | C1100 00, C1100 02 | C1100 00             | C1100 00, C1100 01 | C1100 08, C1100 09, C1100 5A |

|               |   |          |   |   |
|---------------|---|----------|---|---|
| Low Reference | - | C1100 00 | - | - |
|---------------|---|----------|---|---|

**Circuit/System Description**

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module (EBCM) supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the EBCM.

**Conditions for Running the DTC**

Ignition ON.

**Conditions for Setting the DTC**

**C1100 00**

The vacuum sensor signal is out of the specified range.

**C1100 01**

The EBCM detected a short to voltage on the vacuum sensor 5 V reference circuit.

**C1100 02**

The EBCM detected a short to ground on the vacuum sensor 5 V reference circuit.

**C1100 08, C1100 09, and C1100 5A**

The vacuum sensor signal is not plausible.

**Action Taken When the DTC Sets**

The brake warning indicator turns ON.

**Conditions for Clearing the DTC**

- A current DTC clears when the diagnostic runs and passes.
- The EBCM will turn OFF the indicator in the next ignition cycle.

**Reference Information**

**Schematic Reference**

**Hydraulic Brake Schematics**

**Connector End View Reference**

## **Component Connector End Views**

### **Description and Operation**

## **Brake Assist System Description and Operation**

### **Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

### **Scan Tool Reference**

**Control Module References** for scan tool information

### **Circuit/System Testing**

1. Inspect the brake booster vacuum system for damage, leakage and correct installation.
  - If damage, leakage or incorrect installation is diagnosed, repair or replace the component.
2. Ignition OFF, disconnect the harness connector at the B19B Brake Booster Vacuum Sensor.
3. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
  - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K17 Electronic Brake Control Module (EBCM).
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
  - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K17 Electronic Brake Control Module (EBCM).
  - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K17 Electronic Brake Control Module (EBCM).
5. Verify the scan tool Brake Booster Vacuum Sensor Parameter is greater than 100 kPa (14.5 PSI).
  - If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K17 Electronic Brake Control Module (EBCM).
6. Install a fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
7. Verify the scan tool Brake Booster Vacuum Sensor Parameter is less than 30 kPa (4 PSI).
  - If greater than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K17 Electronic Brake Control Module (EBCM).
8. If all circuits test normal, replace the B19B Brake Booster Vacuum Sensor.

### **Repair Procedures**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Power Brake Booster Vacuum Sensor Replacement (2.4L) or Power Brake Booster Vacuum Sensor Replacement (3.0L)**
- **Control Module References** for EBCM replacement, setup and programming

## **SYMPTOMS - HYDRAULIC BRAKES**

**NOTE:**        **The following steps must be completed before using the symptom tables.**

1. Perform the **Brake System Vehicle Road Test** before using the hydraulic brake symptom tables in order to duplicate the customer's concern.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
  - **Brake Warning System Description and Operation**
  - **Hydraulic Brake System Description and Operation**
  - **Brake Booster Vacuum Assist Description and Operation**
  - **Brake Assist System Description and Operation**
  - **ABS Description and Operation**
  - **Park Brake System Description and Operation**

### **Visual/Physical Inspection**

- Inspect for aftermarket devices which could affect the operation of the hydraulic brake system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components, for obvious damage or conditions, which could cause the symptom.

### **Intermittent**

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

### **Symptom List**

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

- **Brake Warning Indicator Malfunction**
- **Brake Booster Pump Motor Malfunction**
- **Brake Pulsation**
- **Brake System Noise**
- **Braking Action Uneven - Pulls to One Side**
- **Braking Action Uneven - Front to Rear**
- **Brake Pedal Excessive Travel**
- **Brake Pedal Excessive Effort**

- **Brakes Drag**
- **Brake System Slow Release**
- **Brake Fluid Loss**

## **BRAKE BOOSTER PUMP MOTOR MALFUNCTION**

### **Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

### **Circuit/System Description**

The electronic brake control module (EBCM) monitors the control circuit of the brake booster pump relay. The EBCM supplies ground through the pump relay control circuit which then supplies B+ voltage to actuate the brake booster pump. B+ voltage is supplied at all times to the coil side of the pump relay.

### **Reference Information**

#### **Schematic Reference**

#### **Hydraulic Brake Schematics**

#### **Connector End View Reference**

#### **Component Connector End Views**

### **Description and Operation**

#### **Brake Booster Vacuum Assist Description and Operation**

### **Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

### **Circuit/System Verification**

1. Verify that a vacuum leak is not present, refer to **Brake System Vacuum Source Test**.
2. Ignition ON, command the relay ON and OFF with a scan tool. Observe to verify that the vacuum relay and motor turns ON and OFF with each command.

## Circuit/System Testing

1. Ignition OFF, disconnect the vacuum pump relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 30 and ground.
  - If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the B+ circuit terminals listed below and ground.
  - Terminal 86
  - Terminal 87
  - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test or replace the relay.
4. Verify that a test lamp does not illuminate between the control circuit terminal 85 and ground.
  - If the test lamp illuminates, test the control circuit for a short to voltage.
5. Disconnect the harness connector at the vacuum pump.
6. Test for less than 2 ohms between the vacuum pump ground circuit terminal 2 and ground.
  - If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the vacuum pump.
8. Connect a 20 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30. Verify the vacuum pump is activated.
  - If the vacuum pump does not activate, test the control circuit for a short ground or an open/high resistance. If the circuit tests normal, test or replace the vacuum pump.
9. Disconnect the X1 harness connector at the EBCM.
10. Ignition OFF, test for infinite resistance between the control circuit terminal 85 and ground.
  - If less than the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the EBCM.
11. Test for less than 2 ohms between the control circuit terminal 85 at the relay cavity and terminal 35 at the EBCM harness connector.
  - If greater than the specified range, test the control circuit for an open/high resistance.
12. If all circuits test normal, replace the brake booster pump relay.

## Component Testing

1. Ignition OFF, disconnect the vacuum pump relay.
2. Test for 60-180 ohms between terminals 85 and 86.
  - If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
  - 30 and 85
  - 30 and 87
  - 30 and 86
  - 86 and 87

- If not the specified value, replace the relay.
- 4. Install a 30 A fused jumper wire between relay terminal 86 and B+. Install a jumper wire between relay terminal 85 and ground.
- 5. Test for less than 2 ohms between terminals 30 and 87.
  - If greater than the specified range, replace the relay.

**Repair Procedures**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for EBCM replacement, setup, and programming

**BRAKE WARNING INDICATOR MALFUNCTION**

**Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**Diagnostic Fault Information**

| Circuit                                | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|----------------------------------------|-----------------|----------------------|------------------|--------------------|
| Brake Fluid Level Signal               | C0267 00        | 1                    | -                | -                  |
| Park Brake Signal                      | 1               | 1                    | -                | -                  |
| Ground                                 | -               | 1                    | -                | -                  |
| 1. Brake Warning Indicator Malfunction |                 |                      |                  |                    |

**Circuit/System Description**

The brake fluid level switch monitors the level of brake fluid in the master cylinder. When the electronic brake control module (EBCM) sees the brake fluid level switch input grounded, it sends a serial data message to the instrument panel cluster to turn ON the Red Brake Warning indicator.

The BCM sees the park brake switch input grounded and sends a serial data message to the instrument panel cluster requesting illumination of the Red Brake Warning indicator.

**Reference Information**

**Schematic Reference**

**Hydraulic Brake Schematics**

## Connector End View Reference

### Component Connector End Views

## Description and Operation

### Brake Warning System Description and Operation

## Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

## Scan Tool Reference

### Control Module References for scan tool information

## Circuit/System Verification

1. Verify the park brake is released and the brake fluid is at or above the minimum level.
  - If low, refer to **Brake Fluid Loss**.
2. Command the instrument panel cluster lamp test with a scan tool, the warning indicator should turn ON.
  - If the red brake warning indicator does not illuminate, replace the instrument panel cluster.
3. Ignition ON, observe the scan tool BCM Park Brake Switch parameter while applying and releasing the park brake. The parameter should cycle between Applied and Released.
  - If the parameter does not cycle between the specified values, refer to Park Brake Switch Malfunction.
4. Observe the scan tool EBCM Brake Fluid Level parameter. The reading should be OK.
  - If not the specified value, refer to Brake Fluid Level Switch Malfunction.

## Circuit/System Testing

### **Park Brake Switch Malfunction**

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Ignition ON, verify the scan tool BCM Park Brake Switch parameter is Released.
  - If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
3. Install a 3 A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool BCM Park Brake Switch parameter is Applied.
  - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance.
4. If all circuits test normal, test or replace the park brake switch.

## Brake Fluid Level Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 1 ohms between the ground circuit terminal A and ground.
  - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool EBCM Brake Fluid Level parameter is OK.
  - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the EBCM.
4. Install a 3 A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool EBCM Brake Fluid Level parameter is Low.
  - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the EBCM.
5. If all circuits test normal, test or replace the brake fluid level switch.

## Component Testing

### Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Test for infinite resistance between the signal terminal A and ground with the park brake released.
  - If less than the specified value, replace the park brake switch.
3. Test for less than 1 ohms between the signal terminal A and ground with the park brake applied.
  - If greater than the specified range, replace the park brake switch.

## Brake Fluid Level Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for infinite resistance between the ground terminal B and the signal terminal A with the switch in the open position.
  - If less than the specified value, replace the brake fluid level switch.
3. Test for less than 5 ohms between the signal terminal A and ground terminal B with the switch in the closed position.
  - If greater than the specified range, replace the brake fluid level switch.

## Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Master Cylinder Reservoir Replacement**
- **Parking Brake Indicator Switch Replacement**
- **Control Module References** for BCM, instrument panel cluster, and EBCM replacement, setup, and programming

BRAKE PULSATION

| Step                                                                                                                                        | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Yes          | No                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------------|
| DEFINITION: Fluctuation or pulsation is felt through the brake pedal, steering wheel, seat, floor, and/or in the vehicle ONLY when braking. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |                                                         |
| 1                                                                                                                                           | Were you sent here from the Hydraulic Brake Symptom table?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Go to Step 2 | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 2                                                                                                                                           | <div>1. Inspect the disc brake system for the following conditions.<ul style="list-style-type: none"><li>Excessive thickness variation of rotor friction surfaces</li><li>Excessive assembled lateral runout (LRO) of rotor friction surfaces</li><li>Hard spots, heat checks, bluing discoloration of rotor friction surfaces; possibly due to brake drag</li><li>Excessive corrosion of rotor friction surfaces; including red, gray or black oxidation</li><li>Loose, damaged or missing caliper or lining hardware</li><li>Bent or damaged caliper or mounting component</li><li>Excessive LRO of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings</li></ul></div> <div>2. Adjust, repair or replace components as necessary. Refer to <b><u>Disc Brake System Diagnosis</u></b>.</div> <div>Did you find and correct a condition?</div> | Go to Step 3 | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 3                                                                                                                                           | <div>1. Install or connect components that were removed or disconnected during diagnosis.</div> <div>2. Road test the vehicle in order to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b>.</div> <div>Is the condition still present?</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Go to Step 2 | System OK                                               |

BRAKE SYSTEM NOISE

| Step | Action | Yes | No |
|------|--------|-----|----|
|      |        |     |    |

DEFINITION: Vehicle exhibits abnormal noise when braking; vehicle may exhibit abnormal noise during motion just after brake pedal release.

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |                                                         |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| 1 | Were you sent here from the Hydraulic Brake Symptom table?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Go to <b>Step 2</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 2 | <p>1. Inspect the disc brake system for the following conditions.</p> <ul style="list-style-type: none"><li>• Lining wear indicator contact with rotor</li><li>• Debris trapped between rotor and splash shield or backing plate; and/or debris trapped between rotor and linings</li><li>• Contaminated linings</li><li>• Aftermarket linings</li><li>• Glazed linings</li><li>• Distorted, cracked or damaged linings</li><li>• Excessively worn linings</li><li>• Damaged or excessively worn caliper hardware and/or lining hardware</li><li>• Incorrectly installed, loose or missing caliper hardware and/or lining hardware</li><li>• Lack of lubrication or excessive corrosion on metal to metal contact surfaces</li><li>• Bent or damaged splash shield or backing plate</li><li>• Hard spots, heat checks, blueing discoloration of rotor friction surfaces</li><li>• Glazed rotor friction surfaces</li><li>• Bent or damaged caliper or mounting component</li></ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Disc Brake System Diagnosis</u></b>.</p> <p>Did you find and correct a condition?</p> | Go to <b>Step 9</b> | Go to <b>Step 3</b>                                     |
|   | <p>1. Inspect the brake assist system for the following conditions.</p> <ul style="list-style-type: none"><li>• Lack of lubrication or excessively worn pushrod or pedal pivots or pivot bushings</li><li>• Bent or damaged pedal pushrod, pedal, or pedal bracket</li><li>• Damaged or improperly operating vacuum booster and/or check valve, if equipped</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                     |                                                         |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                     |                     |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|
| 3 | <ul style="list-style-type: none"> <li>• Low power steering fluid level, if equipped with hydraulic boost</li> <li>• Improperly tensioned, excessively worn or damaged power steering belt, if equipped with hydraulic boost</li> <li>• Restricted return hose from hydraulic booster, if equipped</li> <li>• Improperly operating hydraulic booster, if equipped</li> <li>• Improperly functioning power steering system, if equipped with a hydraulic booster assembly</li> <li>• Contaminated power steering fluid, if equipped with hydraulic boost</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Brake Assist System Diagnosis</u></b>.</p> <p>Did you find and correct a condition?</p> | Go to <b>Step 9</b> | Go to <b>Step 4</b> |
| 4 | <p>1. Inspect the hydraulic brake system for the following conditions.</p> <ul style="list-style-type: none"> <li>• Improper operation of caliper pistons</li> <li>• Contaminated brake fluid</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Hydraulic Brake System Diagnosis</u></b>.</p> <p>Did you find and correct a condition?</p>                                                                                                                                                                                                                                                                                                                                                        | Go to <b>Step 9</b> | Go to <b>Step 5</b> |
| 5 | Is the vehicle equipped with a drum-in-rotor type of park brake system?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Go to <b>Step 6</b> | Go to <b>Step 9</b> |
| 6 | <p>Ensure the park brake shoes are not adjusted too tightly, possibly causing a noise under certain conditions.</p> <p>Are the park brake shoes adjusted too tightly?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Go to <b>Step 7</b> | Go to <b>Step 9</b> |
| 7 | <p>1. Clean and inspect the park brake shoes for excessive wear and/or damage.</p> <p>2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration, heat spots, and excessive radial runout.</p> <p>3. If any of these conditions are present, replace the affected components.</p> <p>4. Adjust the park brake system.</p> <p>Did you find and correct a condition?</p>                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 9</b> | Go to <b>Step 8</b> |

|   |                                                                                                                                                                                                                                                       |                     |                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| 8 | Inspect the park brake system for proper operation.<br>Refer to <b><u>Park Brake System Diagnosis</u></b> .<br>Did you find and correct a condition?                                                                                                  | Go to <b>Step 9</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 9 | 1. Install or connect components that were removed or disconnected during diagnosis.<br>2. Road test the vehicle in order to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b> .<br><br>Is the condition still present? | Go to <b>Step 2</b> | System OK                                               |

## BRAKING ACTION UNEVEN - PULLS TO ONE SIDE

### Test Description

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

**4:** Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

**5:** Steering components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

| Step                                                     | Action                                                                                                                                                                                                                                                                                                                                                                                                                                   | Yes                 | No                                                      |
|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| DEFINITION: Vehicle pulls to one side only when braking. |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |                                                         |
| 1                                                        | Were you sent here from the Hydraulic Brake Symptom table?                                                                                                                                                                                                                                                                                                                                                                               | Go to <b>Step 2</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 2                                                        | 1. Inspect the hydraulic brake system for the following conditions. <ul style="list-style-type: none"> <li>• Kinked, pinched or damaged brake pipe or flexible brake hose</li> <li>• Sticking or improperly operating caliper piston</li> <li>• Brake fluid leak</li> </ul> 2. Adjust, repair or replace components as necessary. Refer to <b><u>Hydraulic Brake System Diagnosis</u></b> .<br><br>Did you find and correct a condition? | Go to <b>Step 6</b> | Go to <b>Step 3</b>                                     |
|                                                          | 1. Inspect the disc brake system for the following conditions. <ul style="list-style-type: none"> <li>• Contaminated linings</li> <li>• Glazed linings</li> </ul>                                                                                                                                                                                                                                                                        |                     |                                                         |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |                                                         |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| 3 | <ul style="list-style-type: none"> <li>• Distorted, cracked or damaged linings on one side</li> <li>• Loose, damaged or missing caliper hardware and/or lining hardware</li> <li>• Incorrect linings on one side</li> <li>• Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag</li> <li>• Glazed rotor friction surfaces</li> <li>• Bent or damaged caliper or mounting component</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Disc Brake System Diagnosis</u></b>.</p> <p>Did you find and correct a condition?</p> | Go to <b>Step 6</b> | Go to <b>Step 4</b>                                     |
| 4 | <p>1. Inspect the suspension system for the following conditions.</p> <ul style="list-style-type: none"> <li>• Incorrect tire pressures</li> <li>• Loose suspension component connections</li> <li>• Excessively worn or damaged suspension components</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Diagnostic Starting Point - Vehicle</u></b>.</p> <p>Did you find and correct a condition?</p>                                                                                                                                                                       | Go to <b>Step 6</b> | Go to <b>Step 5</b>                                     |
| 5 | <p>1. Inspect the steering system for the following conditions.</p> <ul style="list-style-type: none"> <li>• Loose steering component connections</li> <li>• Excessively worn or damaged steering components</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Diagnostic Starting Point - Vehicle</u></b>.</p> <p>Did you find and correct a condition?</p>                                                                                                                                                                                                                 | Go to <b>Step 6</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 6 | <p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b>.</p>                                                                                                                                                                                                                                                                                                                                                                                      |                     |                                                         |

|                                 |                     |           |
|---------------------------------|---------------------|-----------|
| Is the condition still present? | Go to <b>Step 2</b> | System OK |
|---------------------------------|---------------------|-----------|

### BRAKING ACTION UNEVEN - FRONT TO REAR

#### Test Descriptions

The number below refers to the step number on the diagnostic table.

**4:** Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

| Step                                                                                                                                                                                                                   | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Yes                 | No                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| DEFINITION: Braking action or stopping force sensitive or grabbing and/or more pronounced at the front or at the rear axle. Sensitive or grabbing brakes: Excessive brake jump-in force relative to brake pedal input. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |                                                         |
| 1                                                                                                                                                                                                                      | Were you sent here from the Hydraulic Brake Symptom table?                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Go to <b>Step 2</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 2                                                                                                                                                                                                                      | 1. Inspect the hydraulic brake system for the following conditions: <ul style="list-style-type: none"> <li>• Improper operation of caliper pistons</li> <li>• Kinked, pinched or damaged brake pipe or flexible brake hose</li> <li>• Brake fluid leak</li> <li>• Improperly functioning proportion valve, if equipped</li> <li>• Improper operation of dynamic rear proportion (DRP) system, if equipped</li> </ul> 2. Adjust, repair or replace components as necessary. Refer to <b><u>Hydraulic Brake System Diagnosis</u></b> . |                     |                                                         |
|                                                                                                                                                                                                                        | Did you find and correct a condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Go to <b>Step 6</b> | Go to <b>Step 3</b>                                     |
| 3                                                                                                                                                                                                                      | 1. Inspect the disc brake system for the following conditions: <ul style="list-style-type: none"> <li>• Contaminated linings</li> <li>• Glazed linings</li> <li>• Distorted, cracked or damaged linings</li> <li>• Excessively worn linings</li> <li>• Aftermarket linings</li> <li>• Damaged or excessively worn caliper hardware and/or lining hardware</li> </ul>                                                                                                                                                                 |                     |                                                         |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                     |                                                         |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
|   | <ul style="list-style-type: none"> <li>• Hard spots, heat checks, blueing discoloration of rotor friction surfaces</li> <li>• Glazed rotor friction surfaces</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Disc Brake System Diagnosis</u></b>.</p> <p>Did you find and correct a condition?</p>                                                                                                                                                                        | Go to <b>Step 6</b> | Go to <b>Step 4</b>                                     |
| 4 | <p>1. Inspect the suspension system for the following conditions:</p> <ul style="list-style-type: none"> <li>• Loose suspension component connections</li> <li>• Excessively worn or damaged suspension components</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Diagnostic Starting Point - Vehicle</u></b>.</p> <p>Did you find and correct a condition?</p>                                                                                                          | Go to <b>Step 6</b> | Go to <b>Step 5</b>                                     |
| 5 | <p>1. Inspect the brake assist system for the following conditions:</p> <ul style="list-style-type: none"> <li>• Binding, bent or damaged pedal pushrod, pedal, or pedal bracket</li> <li>• Damaged or improperly operating vacuum booster, if equipped</li> <li>• Damaged or improperly operating hydraulic booster, if equipped</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Brake Assist System Diagnosis</u></b>.</p> <p>Did you find and correct a condition?</p> | Go to <b>Step 6</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 6 | <p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b>.</p> <p>Is the condition still present?</p>                                                                                                                                                                                                                                              | Go to <b>Step 2</b> | System OK                                               |

## BRAKE PEDAL EXCESSIVE TRAVEL

| Step                                                                                                   | Action | Yes | No |
|--------------------------------------------------------------------------------------------------------|--------|-----|----|
| DEFINITION: Brake pedal travels further than expected to obtain firm pedal and/or firm pedal cannot be |        |     |    |

obtained, pedal fades away, or pedal is spongy.

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                     |                                                         |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| 1 | Were you sent here from the Hydraulic Brake Symptom table?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Go to <b>Step 2</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 2 | <p>Inspect the travel and feel of brake pedal applies. Perform the following:</p> <ol style="list-style-type: none"><li>1. Apply the brake pedal several times to fully deplete the power reserve.</li><li>2. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel.</li><li>3. Apply the brake pedal with light, steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply.</li><li>4. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply.</li></ol> <p>Did you complete the brake pedal travel and feel inspections?</p>                                                                                                                                               | Go to <b>Step 3</b> | -                                                       |
| 3 | <ol style="list-style-type: none"><li>1. Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections:<ul style="list-style-type: none"><li>• Pedal feel was spongy<ul style="list-style-type: none"><li>○ Air in hydraulic system</li><li>○ External brake fluid leaks</li><li>○ Soft, weak or damaged hydraulic hoses; expanding under pressure</li></ul></li><li>• Pedal fell away and/or traveled to or almost to floor<ul style="list-style-type: none"><li>○ External brake fluid leaks</li><li>○ Poor brake fluid quality; low boiling point</li><li>○ Internal brake fluid leaks; improperly functioning master cylinder</li></ul></li><li>• Pedal was somewhat firm then dropped slightly, or pedal rose with successive applies, or pedal travel was different between slow and quick applies</li></ul></li></ol> |                     |                                                         |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |                     |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|
|   | <ul style="list-style-type: none"> <li>○ Internal brake fluid leaks; improperly functioning master cylinder</li> <li>○ Poor brake fluid quality; low boiling point</li> <li>● Pedal returned to rest slowly after any of the applies <ul style="list-style-type: none"> <li>○ Internally damaged flexible brake hoses; hindering fluid return</li> <li>○ Binding caliper pistons</li> <li>○ Internal brake fluid leaks; improperly functioning master cylinder</li> </ul> </li> </ul> <p>2. Repair or replace components as necessary. Refer to <b><u>Hydraulic Brake System Diagnosis</u></b>.</p> <p>3. Re-inspect brake pedal apply travel and feel.</p>                                                    |                     |                     |
|   | Did you find and correct a condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Go to <b>Step 8</b> | Go to <b>Step 4</b> |
| 4 | <p>1. Inspect the disc brake system for the following conditions:</p> <ul style="list-style-type: none"> <li>● Cracked, excessively worn or damaged linings</li> <li>● Cracked, excessively worn or damaged rotors</li> <li>● Improperly operating, binding or damaged caliper hardware and/or lining hardware</li> <li>● Loose or missing caliper hardware and/or lining hardware</li> <li>● Excessive assembled lateral runout (LRO) of rotor friction surfaces</li> <li>● Bent or damaged caliper or mounting component</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Disc Brake System Diagnosis</u></b>.</p> <p>3. Re-inspect brake pedal apply travel and feel.</p> |                     |                     |
|   | Did you find and correct a condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Go to <b>Step 8</b> | Go to <b>Step 5</b> |
| 5 | <p>Inspect for proper brake pedal travel. Refer to <b><u>Brake Pedal Travel Measurement and Inspection</u></b>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 7</b> | Go to <b>Step 6</b> |
|   | <p>1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |                     |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |                                                         |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| 6 | <ul style="list-style-type: none"> <li>For the brake pedal pushrod component inspection, refer to <b><u>Brake Pedal Pushrod Inspection</u></b> .</li> <li>Inspect the brake pedal bushings for binding, excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition.</li> </ul> <p>2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged.</p> <p>Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?</p> | Go to <b>Step 8</b> | Go to <b>Step 7</b>                                     |
| 7 | <p>1. Inspect the brake assist system for the following conditions:</p> <ul style="list-style-type: none"> <li>Vacuum leaks and/or improperly operating check valve, if equipped with vacuum assist</li> <li>Power steering fluid leaks, if equipped with hydraulic power assist</li> <li>Damaged or improperly operating brake booster assembly</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Brake Assist System Diagnosis</u></b>.</p> <p>Did you find and correct a condition?</p>                          | Go to <b>Step 8</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 8 | <p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b>.</p> <p>Is the condition still present?</p>                                                                                                                                                                                                                                                                                      | Go to <b>Step 2</b> | System OK                                               |

## BRAKE PEDAL EXCESSIVE EFFORT

| Step                                                                                                                                               | Action                                                     | Yes                 | No                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|---------------------|---------------------------------------------------------|
| DEFINITION: Brake pedal requires an increased amount of input from the driver to obtain good braking action and/or stopping distance is increased. |                                                            |                     |                                                         |
| 1                                                                                                                                                  | Were you sent here from the Hydraulic Brake Symptom table? | Go to <b>Step 2</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
|                                                                                                                                                    | 1. Inspect the brake assist system for the following       |                     |                                                         |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |                     |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|
| 2 | <p>conditions:</p> <ul style="list-style-type: none"> <li>• Vacuum leaks, if equipped with vacuum power assist</li> <li>• Power steering fluid leaks, if equipped with hydraulic power assist</li> <li>• Lack of lubrication, binding or excessively worn pushrod or pedal pivots or pivot bushings</li> <li>• Bent or damaged pedal pushrod, pedal, or pedal bracket</li> <li>• Damaged or improperly operating brake booster assembly</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Brake Assist System Diagnosis</u></b>.</p>                         |                     |                     |
|   | Did you find and correct a condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Go to <b>Step 5</b> | Go to <b>Step 3</b> |
| 3 | <p>1. Inspect the hydraulic brake system for the following conditions:</p> <ul style="list-style-type: none"> <li>• Binding caliper pistons</li> <li>• Internally damaged flexible brake hoses; hindering fluid flow</li> <li>• External brake fluid leaks</li> <li>• Kinked or damaged flexible brake hoses and/or pipes</li> <li>• Internal brake fluid leaks; improperly operating master cylinder</li> <li>• Poor brake fluid quality; low boiling point</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Hydraulic Brake System Diagnosis</u></b>.</p> |                     |                     |
|   | Did you find and correct a condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Go to <b>Step 5</b> | Go to <b>Step 4</b> |
|   | <p>1. Inspect the disc brake system for the following conditions:</p> <ul style="list-style-type: none"> <li>• Excessively worn linings</li> <li>• Glazed linings</li> <li>• Cracked, distorted or damaged linings</li> <li>• Contaminated linings</li> <li>• Binding, damaged or excessively worn caliper hardware and/or lining hardware</li> <li>• Lack of lubrication or excessive corrosion</li> </ul>                                                                                                                                                                                   |                     |                     |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| 4 | <p>on metal to metal contact surfaces</p> <ul style="list-style-type: none"> <li>Excessively worn or corroded rotor friction surfaces</li> <li>Glazed rotor friction surfaces</li> <li>Hard spots, heat checks, blueing discoloration of rotor friction surfaces</li> </ul> <p>2. Adjust, repair or replace components as necessary. Refer to <b><u>Disc Brake System Diagnosis</u></b>.</p> <p>Did you find and correct a condition?</p> | Go to <b>Step 5</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 5 | <p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b>.</p> <p>Is the condition still present?</p>                                                                                                                                                                           | Go to <b>Step 2</b> | System OK                                               |

## BRAKES DRAG

| Step                                                                                                                                            | Action                                                                                                                                                                                                                                                                                                  | Yes                  | No                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------------------------------|
| DEFINITION: Brake system does not fully release or has delayed release; vehicle motion may be hindered by brake system without applying brakes. |                                                                                                                                                                                                                                                                                                         |                      |                                                         |
| 1                                                                                                                                               | Were you sent here from the Hydraulic Brake Symptom table?                                                                                                                                                                                                                                              | Go to <b>Step 2</b>  | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 2                                                                                                                                               | Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?                                                                                                                                                                                         | Go to <b>Step 3</b>  | Go to <b>Step 4</b>                                     |
| 3                                                                                                                                               | <p>1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing.</p> <p>2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing.</p> <p>Did you find and correct a condition?</p> | Go to <b>Step 14</b> | Go to <b>Step 4</b>                                     |
| 4                                                                                                                                               | Is the vehicle equipped with a drum-in-rotor type of park brake system?                                                                                                                                                                                                                                 | Go to <b>Step 5</b>  | Go to <b>Step 7</b>                                     |
| 5                                                                                                                                               | Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions. Are the park brake shoes adjusted too tightly?                                                                                                                                                | Go to <b>Step 6</b>  | Go to <b>Step 7</b>                                     |
|                                                                                                                                                 |                                                                                                                                                                                                                                                                                                         |                      |                                                         |

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|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|
| 6  | <ol style="list-style-type: none"> <li>1. Clean and inspect the park brake shoes for excessive wear and/or damage.</li> <li>2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration and heat spots.</li> <li>3. If any of these conditions are present, replace the affected components.</li> <li>4. Adjust the park brake system.</li> </ol> <p>Did you find and correct a condition?</p>                                                                                                                                                                                                                                                                                                                                                                  | Go to <b>Step 14</b> | Go to <b>Step 7</b>  |
| 7  | <p>Inspect the park brake system for proper operation. Refer to <b><u>Park Brake System Diagnosis</u></b> .</p> <p>Did you find and correct a condition?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Go to <b>Step 14</b> | Go to <b>Step 8</b>  |
| 8  | <ol style="list-style-type: none"> <li>1. Inspect the disc brake system for the following conditions: <ul style="list-style-type: none"> <li>• Binding, incorrectly installed or missing caliper hardware and/or lining hardware- Ensure free movement of linings and of caliper, if equipped with sliding type caliper</li> <li>• Lack of lubrication or excessive corrosion on metal to metal contact surfaces</li> <li>• Distorted or damaged linings</li> <li>• Damaged or excessively worn caliper hardware and/or lining hardware</li> <li>• Bent or damaged caliper or mounting component</li> </ul> </li> <li>2. Adjust, repair or replace components as necessary. Refer to <b><u>Disc Brake System Diagnosis</u></b>.</li> </ol> <p>Did you find and correct a condition?</p> | Go to <b>Step 14</b> | Go to <b>Step 9</b>  |
| 9  | <ol style="list-style-type: none"> <li>1. Separate the brake booster pushrod from the brake pedal.</li> <li>2. Inspect the brake corners to determine if the brake drag condition is still present.</li> </ol> <p>Do the brake corners still exhibit the brake drag condition?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Go to <b>Step 11</b> | Go to <b>Step 10</b> |
| 10 | <ol style="list-style-type: none"> <li>1. Inspect the pushrod for improper positioning and/or damage. Correctly position or replace the pushrod if necessary.</li> <li>2. Inspect the brake pedal assembly for damage and</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                      | -                    |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                                                         |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------------------------------|
|    | replace if necessary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                      |                                                         |
|    | Did you complete the repair or replacement?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Go to <b>Step 14</b> |                                                         |
| 11 | <ol style="list-style-type: none"> <li>1. For vacuum boost systems, disconnect the vacuum check valve from the booster to relieve vacuum reserve.</li> <li>2. Separate the master cylinder from the brake booster. Do not disconnect any brake pipes.</li> <li>3. Inspect the brake corners to determine if the brake drag condition is still present.</li> </ol> <p>Do the brake corners still exhibit the brake drag condition?</p>                                                                                                                            | Go to <b>Step 13</b> | Go to <b>Step 12</b>                                    |
| 12 | <p>Replace the brake booster assembly.</p> <p>Did you complete the replacement?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Go to <b>Step 14</b> | -                                                       |
| 13 | <ol style="list-style-type: none"> <li>1. Inspect the hydraulic brake system for the following conditions. <ul style="list-style-type: none"> <li>• Improper operation of caliper pistons</li> <li>• Contaminated brake fluid</li> <li>• Internally damaged flexible brake hoses; hindering brake release</li> <li>• Damaged or improperly operating master cylinder</li> </ul> </li> <li>2. Adjust, repair or replace components as necessary. Refer to <b><u>Hydraulic Brake System Diagnosis</u></b>.</li> </ol> <p>Did you find and correct a condition?</p> | Go to <b>Step 14</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 14 | <ol style="list-style-type: none"> <li>1. Install or connect components that were removed or disconnected during diagnosis.</li> <li>2. Road test the vehicle in order to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b>.</li> </ol> <p>Is the condition still present?</p>                                                                                                                                                                                                                                                     | Go to <b>Step 2</b>  | System OK                                               |

## BRAKE SYSTEM SLOW RELEASE

| Step                                                                                                                                           | Action                                                     | Yes | No                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----|-------------------------------------------------|
| DEFINITION: Brake system releases and returns to rest slowly; vehicle motion is hindered by brake system briefly after release of brake pedal. |                                                            |     |                                                 |
| 1                                                                                                                                              | Were you sent here from the Hydraulic Brake Symptom table? |     | Go to <b><u>Diagnostic Starting Point -</u></b> |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Go to <b>Step 2</b> | <b>Vehicle</b>                                  |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------|
| 2 | <ol style="list-style-type: none"> <li>1. Inspect the hydraulic brake system for the following conditions: <ul style="list-style-type: none"> <li>• Improper operation of caliper pistons</li> <li>• Internally damaged flexible brake hoses; hindering brake release</li> <li>• Contaminated brake fluid</li> <li>• Damaged or improperly operating master cylinder</li> </ul> </li> <li>2. Adjust, repair or replace components as necessary. Refer to <b><u>Hydraulic Brake System Diagnosis</u></b>.</li> </ol> <p>Did you find and correct a condition?</p>                                                                 | Go to <b>Step 5</b> | Go to <b>Step 3</b>                             |
| 3 | <ol style="list-style-type: none"> <li>1. Inspect the brake assist system for the following conditions: <ul style="list-style-type: none"> <li>• Binding, bent or damaged pedal pushrod, pedal, or pedal bracket</li> <li>• Damaged or improperly operating vacuum booster, if equipped</li> <li>• Restricted return hose from hydraulic booster, if equipped</li> <li>• Damaged or improperly operating hydraulic booster, if equipped</li> </ul> </li> <li>2. Adjust, repair or replace components as necessary. Refer to <b><u>Brake Assist System Diagnosis</u></b>.</li> </ol> <p>Did you find and correct a condition?</p> | Go to <b>Step 5</b> | Go to <b>Step 4</b>                             |
| 4 | <ol style="list-style-type: none"> <li>1. Inspect the disc brake system for the following conditions: <ul style="list-style-type: none"> <li>• Damaged or excessively worn caliper hardware and/or lining hardware</li> <li>• Distorted or damaged linings</li> <li>• Lack of lubrication or excessive corrosion on metal to metal contact surfaces</li> <li>• Bent or damaged caliper or mounting component</li> </ul> </li> <li>2. Adjust, repair or replace components as necessary. Refer to <b><u>Disc Brake System Diagnosis</u></b>.</li> </ol>                                                                           |                     | Go to <b><u>Diagnostic Starting Point</u></b> - |

|   |                                                                                                                                                                                                                                                                       |                     |                       |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------|
|   | Did you find and correct a condition?                                                                                                                                                                                                                                 | Go to <b>Step 5</b> | <b><u>Vehicle</u></b> |
| 5 | <ol style="list-style-type: none"> <li>1. Install or connect components that were removed or disconnected during diagnosis.</li> <li>2. Road test the vehicle in order to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b>.</li> </ol> |                     |                       |
|   | Is the condition still present?                                                                                                                                                                                                                                       | Go to <b>Step 2</b> | System OK             |

## BRAKE FLUID LOSS

| Step                                                             | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Yes                 | No                                                      |
|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
| DEFINITION: Brake fluid level is low not related to lining wear. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                     |                                                         |
| 1                                                                | Were you sent here from the Hydraulic Brake Symptom table?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Go to <b>Step 2</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 2                                                                | <ol style="list-style-type: none"> <li>1. Inspect the following hydraulic brake system components for brake fluid leaks: <ul style="list-style-type: none"> <li>• Flexible brake hose connections; threaded and bolted</li> <li>• Flexible brake hose crimp joints</li> <li>• Brake pipe fittings</li> <li>• Caliper piston seals</li> <li>• Wheel cylinder piston seals, if equipped</li> <li>• Master cylinder reservoir</li> <li>• Master cylinder reservoir low pressure hose, if equipped</li> <li>• Brake pressure modulator valve (BPMV) assembly, if equipped</li> </ul> </li> <li>2. Repair or replace components as necessary. Refer to <b><u>Hydraulic Brake System Diagnosis</u></b>.</li> </ol> |                     |                                                         |
|                                                                  | Did you find and correct a condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Go to <b>Step 8</b> | Go to <b>Step 3</b>                                     |
| 3                                                                | Is the vehicle equipped with a vacuum brake booster?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Go to <b>Step 4</b> | Go to <b>Step 6</b>                                     |
| 4                                                                | <ol style="list-style-type: none"> <li>1. Disconnect the vacuum check valve from the booster to relieve vacuum reserve.</li> <li>2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes.</li> <li>3. Inspect the rear of the master cylinder for a brake fluid leak.</li> <li>4. Inspect for brake fluid in the vacuum brake booster.</li> </ol>                                                                                                                                                                                                                                                                                                                   |                     | Go to <b><u>Diagnostic</u></b>                          |

|   |                                                                                                                                                                                                                                                                                                                                                                                                   |                     |                                                         |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
|   | Did you find a brake fluid leak?                                                                                                                                                                                                                                                                                                                                                                  | Go to <b>Step 5</b> | <b><u>Starting Point - Vehicle</u></b>                  |
| 5 | Replace the brake master cylinder and the vacuum brake booster.<br>Did you complete the replacement?                                                                                                                                                                                                                                                                                              | Go to <b>Step 8</b> | -                                                       |
| 6 | <ol style="list-style-type: none"> <li>1. Wipe clean the external surface of the master cylinder to hydraulic brake booster area, if equipped.</li> <li>2. Separate the master cylinder from the hydraulic brake booster, if equipped. Do not disconnect any brake pipes.</li> <li>3. Inspect the rear of the master cylinder for a brake fluid leak.</li> </ol> Did you find a brake fluid leak? | Go to <b>Step 7</b> | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 7 | Replace the brake master cylinder.<br>Did you complete the replacement?                                                                                                                                                                                                                                                                                                                           | Go to <b>Step 8</b> | -                                                       |
| 8 | <ol style="list-style-type: none"> <li>1. Install or connect components that were removed or disconnected during diagnosis.</li> <li>2. Road test the vehicle to confirm proper operation. Refer to <b><u>Brake System Vehicle Road Test</u></b>.</li> </ol> Is the condition still present?                                                                                                      | Go to <b>Step 2</b> | System OK                                               |

## DISC BRAKE SYSTEM DIAGNOSIS

### Test Description

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

**9:** Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

**10:** Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

**12:** Disc brake rotor shields/backing plates that come in contact with disc brake rotors may cause brake system noise.

**15:** Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

**19:** Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

**22:** Disc brake rotor assembled lateral runout (LRO) that exceeds the maximum acceptable level can lead to thickness variation.

| Step                                                                                                                                                                                                                                                                                             | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Yes                  | No                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------------------------------|
| DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                      |                                                         |
| 1                                                                                                                                                                                                                                                                                                | Were you sent here from a Brake Symptom table?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Go to <b>Step 2</b>  | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b> |
| 2                                                                                                                                                                                                                                                                                                | <p>Visually inspect the disc brake pads for the following conditions:<br/>Refer to <b><u>Front Disc Brake Pads Replacement</u></b> .</p> <ul style="list-style-type: none"> <li>• Lining thickness below specifications</li> <li>• Uneven and/or abnormal wear- edge-to-edge and/or side-to-side</li> <li>• Looseness or damage-including pad hardware</li> <li>• Evidence of contamination from an external substance</li> </ul> <p>Did you find any conditions to indicate a concern with any of the front and/or rear disc brake pads?</p> | Go to <b>Step 3</b>  | Go to <b>Step 12</b>                                    |
| 3                                                                                                                                                                                                                                                                                                | Are any of the front and/or rear disc brake pads contaminated?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Go to <b>Step 8</b>  | Go to <b>Step 4</b>                                     |
| 4                                                                                                                                                                                                                                                                                                | Are any of the front and/or rear disc brake pads worn unevenly?                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Go to <b>Step 7</b>  | Go to <b>Step 5</b>                                     |
| 5                                                                                                                                                                                                                                                                                                | Are any of the front and/or rear disc brake pads and/or pad hardware loose or damaged?                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Go to <b>Step 7</b>  | Go to <b>Step 6</b>                                     |
| 6                                                                                                                                                                                                                                                                                                | <p>1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage.</p> <p>2. Replace the worn disc brake pads as a complete axle set. Refer to <b><u>Front Disc Brake Pads Replacement</u></b> and/or <b><u>Rear Disc Brake Pads Replacement</u></b> .</p> <p>Did you complete the inspection and replacement?</p>                                                                                                                                                                                               | Go to <b>Step 12</b> | -                                                       |
|                                                                                                                                                                                                                                                                                                  | <p><b>CAUTION:</b></p> <p><b>Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.</b></p>                                                                                                                              |                      |                                                         |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |   |
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| 7 | <p><b>NOTE:</b><br/>Do NOT disconnect the hydraulic brake flex hoses from the calipers.</p> <ol style="list-style-type: none"> <li>1. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets or from the suspension knuckles and support the calipers. Refer to <b><u>Front Brake Caliper Replacement</u></b> and/or <b><u>Rear Brake Caliper Replacement</u></b> .</li> <li>2. Inspect the disc brake caliper mounting bracket or the suspension knuckles and the mounting/sliding hardware for the following conditions:<br/><br/>Refer to <b><u>Front Disc Brake Mounting and Hardware Inspection</u></b> and/or <b><u>Rear Disc Brake Mounting and Hardware Inspection</u></b> . <ul style="list-style-type: none"> <li>• Binding or seized hardware</li> <li>• Worn, damaged or missing hardware components</li> <li>• Loose, bent, cracked, or damaged caliper mounting bracket or suspension knuckle</li> </ul> </li> <li>3. Replace components as required. Refer to the following procedures, as required: <ul style="list-style-type: none"> <li>• <b><u>Front Brake Caliper Bracket Replacement</u></b></li> <li>• <b><u>Rear Brake Caliper Bracket Replacement</u></b></li> <li>• <b><u>Front Brake Caliper Hardware Replacement</u></b></li> <li>• <b><u>Rear Brake Caliper Hardware Replacement</u></b></li> </ul> </li> <li>4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to <b><u>Front Disc Brake Pads Replacement</u></b> and/or <b><u>Rear Disc Brake Pads Replacement</u></b> .</li> </ol> <p>Did you complete the inspection and replacement?</p> | Go to <b>Step 12</b> | - |
|   | <ol style="list-style-type: none"> <li>1. Inspect the disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak.</li> <li>2. Replace any components found to be leaking</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                      |   |

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|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|
| 8  | <p>brake fluid. Refer to the following procedures as required:</p> <ul style="list-style-type: none"> <li>• <b><u>Front Brake Caliper Replacement</u></b></li> <li>• <b><u>Rear Brake Caliper Replacement</u></b></li> <li>• <b><u>Front Brake Hose Replacement</u></b></li> <li>• <b><u>Rear Brake Hose Replacement</u></b></li> <li>• <b><u>Brake Pipe Replacement</u></b></li> </ul> <p>Did you find and correct the source of the leak causing contamination of the pads?</p>                                                                                                                                       | Go to <b>Step 11</b> | Go to <b>Step 9</b>  |
| 9  | <ol style="list-style-type: none"> <li>1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak.</li> <li>2. Replace any wheel drive shaft seal that is found to be leaking grease which may be the source of the contamination to the pads. Refer to <b><u>Wheel Drive Shaft Outer Joint Inspection</u></b> and/or <b><u>Wheel Drive Shaft Inner Joint Inspection</u></b>.</li> </ol> <p>Did you find and correct the source of the leak causing contamination of the pads?</p>                                                                                                           | Go to <b>Step 11</b> | Go to <b>Step 10</b> |
| 10 | <ol style="list-style-type: none"> <li>1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads.</li> <li>2. Inspect the power steering system hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads.</li> <li>3. Replace any components found to be leaking fluid which may be the source of the contamination to the pads.</li> </ol> <p>Did you find and correct the source of the leak causing contamination of the pads?</p> | Go to <b>Step 11</b> | -                    |
|    | <ol style="list-style-type: none"> <li>1. Clean the remaining disc brake system components to remove any traces of the contaminant.</li> </ol> <p><b>CAUTION:</b><br/>Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible</p>                                                                                                                                                                                                    |                      |                      |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                      |                      |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|
| 11 | <p>brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.</p> <p><b>NOTE:</b><br/><b>Do NOT disconnect the hydraulic brake flex hoses from the calipers.</b></p> <ol style="list-style-type: none"> <li>Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets or the suspension knuckles and support the calipers. Refer to <b><u>Front Brake Caliper Replacement</u></b> and/or <b><u>Rear Brake Caliper Replacement</u></b>.</li> <li>Inspect the disc brake caliper mounting/sliding hardware for the following conditions:</li> </ol> <p>Refer to <b><u>Front Disc Brake Mounting and Hardware Inspection</u></b> and/or <b><u>Rear Disc Brake Mounting and Hardware Inspection</u></b>.</p> <ul style="list-style-type: none"> <li>Binding or seized hardware</li> <li>Distorted, worn, damaged or missing hardware components</li> </ul> <ol style="list-style-type: none"> <li>Replace the caliper mounting/sliding hardware components as required. Refer to <b><u>Front Brake Caliper Hardware Replacement</u></b> and/or <b><u>Rear Brake Caliper Hardware Replacement</u></b>.</li> <li>Replace the contaminated disc brake pads as a complete axle set. Refer to <b><u>Front Disc Brake Pads Replacement</u></b> and/or <b><u>Rear Disc Brake Pads Replacement</u></b>.</li> </ol> <p>Did you complete the cleaning, inspection and replacement?</p> | Go to <b>Step 12</b> | -                    |
| 12 | <p>Visually inspect each of the disc brake rotor shields/backing plates, if equipped, for evidence of contact with the brake rotors.</p> <p>Are any of the brake rotor shields/backing plates contacting the brake rotors?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 13</b> | Go to <b>Step 14</b> |
| 13 | <p>Repair or replace the disc brake rotor shields/backing plates as required. Refer to <b><u>Front Brake Shield Replacement</u></b> and/or <b><u>Rear Brake Shield Replacement</u></b>.</p> <p>Did you complete the repair or replacement?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 14</b> | -                    |
|    | <ol style="list-style-type: none"> <li>Check the thickness of each of the disc brake rotors.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                      |                      |

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| 14 | <p><b>NOTE:</b><br/>Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements.</p> <p>Refer to <b><u>Brake Rotor Thickness Measurement</u></b> .Does the disc brake rotor meet the minimum requirements for REFINISHING?</p>                                                                                                                                                                                                                                                                                                                                                                       | Go to <b>Step 15</b> | Go to <b>Step 18</b> |
| 15 | <p><b>NOTE:</b><br/>Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to <b><u>Brake Rotor Thickness Variation Measurement</u></b> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?</p>                                                                                                                                                                                                                                                                                                                                                               | Go to <b>Step 17</b> | Go to <b>Step 16</b> |
| 16 | <p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <p>Refer to <b><u>Brake Rotor Surface and Wear Inspection</u></b> .</p> <ul style="list-style-type: none"> <li>• Heavy rust and/or pitting</li> <li>• Cracks and/or heat spots</li> <li>• Excessive blueing discoloration</li> <li>• Deep or excessive scoring beyond maximum acceptable level</li> </ul> <p><b>NOTE:</b><br/>Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection.</p> <p>If the brake rotor exhibits any of the conditions listed previously, it requires refinishing.</p> |                      |                      |

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|    | Does the brake rotor require REFINISHING?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 17</b> | Go to <b>Step 22</b> |
| 17 | <ol style="list-style-type: none"> <li>1. Refinish the brake rotor. Refer to <b><u>Brake Rotor Refinishing</u></b> .</li> <li>2. Inspect the brake rotor thickness. Refer to <b><u>Brake Rotor Thickness Measurement</u></b> .</li> </ol> <p>Were you able to REFINISH the brake rotor within the minimum requirements?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Go to <b>Step 22</b> | Go to <b>Step 21</b> |
| 18 | Is the brake rotor at or below the MINIMUM THICKNESS requirements?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Go to <b>Step 21</b> | Go to <b>Step 19</b> |
| 19 | <p><b>NOTE:</b><br/>Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to <b><u>Brake Rotor Thickness Variation Measurement</u></b> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Go to <b>Step 21</b> | Go to <b>Step 20</b> |
| 20 | <ol style="list-style-type: none"> <li>1. Inspect each of the disc brake rotors for the following surface and wear conditions:<br/><br/>Refer to <b><u>Brake Rotor Surface and Wear Inspection</u></b> . <ul style="list-style-type: none"> <li>• Heavy rust and/or pitting</li> <li>• Cracks and/or heat spots</li> <li>• Excessive blueing discoloration</li> <li>• Deep or excessive scoring beyond maximum acceptable level</li> </ul> </li> </ol> <p><b>NOTE:</b><br/><b>Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</b></p> <ol style="list-style-type: none"> <li>2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection.</li> </ol> <p>If the brake rotor exhibits any of the conditions listed previously, it requires replacement.</p> <p>Does the brake rotor require REPLACEMENT?</p> | Go to <b>Step 21</b> | Go to <b>Step 22</b> |
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| 21 | <p><b>NOTE:</b><br/>Whenever a brake rotor is replaced, the assembled lateral runout (LRO) of the rotor must be measured to ensure optimum performance of the disc brakes.</p> <p>Replace the brake rotor. Refer to <b>Front Brake Rotor Replacement</b> or <b>Rear Brake Rotor Replacement</b> .Did you complete the replacement?</p>                                                           | Go to <b>Step 24</b>                            | -                    |
| 22 | <p><b>NOTE:</b><br/>Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>Inspect each of the disc brake rotors for assembled lateral runout (LRO) that exceeds the maximum acceptable level. Refer to <b>Brake Rotor Assembled Lateral Runout Measurement</b> .Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level?</p> | Go to <b>Step 23</b>                            | Go to <b>Step 24</b> |
| 23 | <p>Correct the LRO for each brake rotor that was determined to have LRO exceeding the maximum acceptable level. Refer to <b>Brake Rotor Assembled Lateral Runout Correction</b> .<br/>Did you complete the operation?</p>                                                                                                                                                                        | Go to <b>Step 24</b>                            | -                    |
| 24 | <p>Install or connect components that were removed or disconnected during diagnosis.<br/>Did you complete the operation?</p>                                                                                                                                                                                                                                                                     | Disc Brake System OK<br>Return to Symptom Table | -                    |

## HYDRAULIC BRAKE SYSTEM DIAGNOSIS

| Step                                                                                                                                                                                                                                                                                                       | Action                                                                                                                                                                                                              | Yes                 | No                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------------------------------|
| DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the HYDRAULIC brake system in order to determine if the Hydraulic brake system is operating properly. You will be directed by the appropriate Symptom Table to go to other brake system diagnostic tables as appropriate. |                                                                                                                                                                                                                     |                     |                                                  |
| 1                                                                                                                                                                                                                                                                                                          | Were you sent here from a Brake Symptom Table?                                                                                                                                                                      | Go to <b>Step 2</b> | Go to <b>Diagnostic Starting Point - Vehicle</b> |
| 2                                                                                                                                                                                                                                                                                                          | Inspect and adjust the brake fluid level in the brake master cylinder. Refer to <b>Master Cylinder Reservoir Filling</b> .<br>Was the brake fluid level low?                                                        | Go to <b>Step 3</b> | Go to <b>Step 4</b>                              |
|                                                                                                                                                                                                                                                                                                            | <p>1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:</p> <ul style="list-style-type: none"> <li>Fluid separation, indicating two types of fluid are present</li> </ul> |                     |                                                  |

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| 3 | <ul style="list-style-type: none"> <li>○ Swirled appearance-oil-based substance</li> <li>○ Layered appearance-silicone-based substance</li> <li>● Fluid discoloration <ul style="list-style-type: none"> <li>○ Cloudy appearance-moisture</li> <li>○ Dark appearance/suspended particles in fluid-dirt, rust, corrosion, brake dust</li> </ul> </li> </ul> <p>2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination.</p> <p>Do any of the above conditions exist?</p>                                                                                                                                                                                                                         | Go to <b>Step 5</b> | Go to <b>Step 6</b>  |
| 4 | <p>1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:</p> <ul style="list-style-type: none"> <li>● Fluid separation, indicating two types of fluid are present <ul style="list-style-type: none"> <li>○ Swirled appearance-oil-based substance</li> <li>○ Layered appearance-silicone-based substance</li> </ul> </li> <li>● Fluid discoloration <ul style="list-style-type: none"> <li>○ Cloudy appearance-moisture</li> <li>○ Dark appearance/ suspended particles in fluid-dirt, rust, corrosion, brake dust</li> </ul> </li> </ul> <p>2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination.</p> <p>Do any of the above conditions exist?</p> | Go to <b>Step 5</b> | Go to <b>Step 12</b> |
|   | <p>1. Flush the hydraulic brake system. Refer to <b><u>Hydraulic Brake System Flushing</u></b>.</p> <p>2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following steps. Refer to the procedures indicated.</p> <p>1. Remove ALL of the following components</p>                                                                                                                                                                                                                                                                                                                              |                     |                      |

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| 5 | <p>listed. Each component contains internal rubber seals/linings which have been contaminated.</p> <ol style="list-style-type: none"> <li>2. Clean out the hydraulic brake pipes using denatured alcohol, or equivalent.</li> <li>3. Dry the brake pipes using non-lubricated, filtered air.</li> <li>4. Repair or replace ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. <ul style="list-style-type: none"> <li>• <b><u>Master Cylinder Replacement</u></b></li> <li>• Brake master cylinder reservoir: Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air, or if necessary, replace the brake master cylinder reservoir.</li> <li>• Replace the brake master cylinder reservoir cap diaphragm.</li> <li>• <b><u>Front Brake Hose Replacement</u></b></li> <li>• <b><u>Rear Brake Hose Replacement</u></b></li> <li>• <b><u>Front Brake Caliper Replacement</u></b></li> <li>• <b><u>Rear Brake Caliper Replacement</u></b></li> <li>• <b><u>Brake Pressure Modulator Valve Replacement</u></b></li> </ul> </li> <li>3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system.</li> <li>4. Refill and bleed the hydraulic brake system. Refer to <b><u>Hydraulic Brake System Bleeding (Manual)</u></b> or <b><u>Hydraulic Brake System Bleeding (Pressure)</u></b>.</li> </ol> <p>Did you complete the operation and any required repairs and/or replacements?</p> | -                   |  |
|   | <ol style="list-style-type: none"> <li>1. Inspect the following hydraulic brake system components for external fluid leaks; repair or replace any of the components found to be leaking brake fluid. Refer to the appropriate procedures:</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Go to <b>Step 9</b> |  |

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| 6  | <ul style="list-style-type: none"> <li>• <b><u>Master Cylinder Replacement</u></b></li> <li>• Brake master cylinder reservoir cap diaphragm</li> <li>• <b><u>Front Brake Hose Replacement</u></b></li> <li>• <b><u>Rear Brake Hose Replacement</u></b></li> <li>• <b><u>Brake Pipe Replacement</u></b></li> <li>• <b><u>Front Brake Caliper Replacement</u></b></li> <li>• <b><u>Rear Brake Caliper Replacement</u></b></li> <li>• <b><u>Brake Pressure Modulator Valve Replacement</u></b></li> </ul> <p>2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to <b><u>Hydraulic Brake System Bleeding (Manual)</u></b> or <b><u>Hydraulic Brake System Bleeding (Pressure)</u></b>. While bleeding the hydraulic brake system, observe for the following conditions:</p> <ul style="list-style-type: none"> <li>• The presence of air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced</li> <li>• An unrestricted and even flow of brake fluid per axle during the bleeding procedure</li> </ul> <p>Did you find and correct a condition?</p> |                      |                      |
| 7  | Was there air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Go to <b>Step 7</b>  | Go to <b>Step 12</b> |
| 8  | Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Go to <b>Step 19</b> | Go to <b>Step 8</b>  |
| 9  | <p>Inspect the hydraulic function of the brake calipers for proper operation. Refer to <b><u>Hydraulic Brake Component Operation Visual Inspection</u></b>.</p> <p>Was the hydraulic function of the brake calipers operating properly?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Go to <b>Step 9</b>  | Go to <b>Step 10</b> |
| 10 | Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Go to <b>Step 21</b> | Go to <b>Step 14</b> |
| 11 | Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 13</b> | Go to <b>Step 11</b> |
| 12 | Inspect the hydraulic function of the brake calipers for proper operation. Refer to <b><u>Hydraulic Brake Component Operation Visual Inspection</u></b> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Go to <b>Step 17</b> | -                    |

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|    | Was the hydraulic function of the brake calipers operating properly?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Go to <b>Step 15</b> | Go to <b>Step 13</b> |
| 13 | <p>Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly:</p> <ol style="list-style-type: none"> <li>1. Raise and support the vehicle. Refer to <b><u>Lifting and Jacking the Vehicle</u></b>.</li> <li>2. Remove the tire and wheel assemblies. Refer to <b><u>Tire and Wheel Removal and Installation</u></b>.</li> <li>3. Open the suspected caliper bleeder valve.</li> <li>4. Using a large C-clamp, compress the caliper piston and observe for an unrestricted flow of brake fluid and for free movement of the caliper piston.</li> <li>5. Close the caliper bleeder valve.</li> </ol> <p>Was the flow of brake fluid unrestricted and did the caliper piston move freely?</p> | Go to <b>Step 17</b> | Go to <b>Step 14</b> |
| 14 | <p>Repair or replace any brake caliper that was not operating properly. Refer to the appropriate procedure:</p> <ul style="list-style-type: none"> <li>• <b><u>Front Brake Caliper Replacement</u></b></li> <li>• <b><u>Rear Brake Caliper Replacement</u></b></li> </ul> <p>Did you complete the repair and/or replacement?</p>                                                                                                                                                                                                                                                                                                                                                                                                     | Go to <b>Step 21</b> | -                    |
| 15 | <p>Bleed the hydraulic brake system to observe for the presence of air in the system and to observe for an unrestricted and even flow of brake fluid per axle during the bleeding procedure. Refer to <b><u>Hydraulic Brake System Bleeding (Manual)</u></b> or <b><u>Hydraulic Brake System Bleeding (Pressure)</u></b>.</p> <p>Was there air in the system?</p>                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 19</b> | Go to <b>Step 16</b> |
| 16 | Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Go to <b>Step 21</b> | Go to <b>Step 17</b> |
| 17 | <ol style="list-style-type: none"> <li>1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to <b><u>Brake Pipe and Hose Inspection</u></b>.</li> <li>2. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched or damaged. Refer to the following procedures as necessary: <ul style="list-style-type: none"> <li>• <b><u>Front Brake Hose Replacement</u></b></li> </ul> </li> </ol>                                                                                                                                                                                              |                      |                      |

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|    | <ul style="list-style-type: none"> <li>• <b><u>Rear Brake Hose Replacement</u></b></li> <li>• <b><u>Brake Pipe Replacement</u></b></li> </ul> <p>3. If none of the hydraulic brake pipes or flexible brake hoses were visibly bent, kinked, pinched or damaged, replace the hydraulic brake flex hose at the restricted location.</p> <p>Did you find and correct a condition?</p>                                                                            | Go to <b>Step 21</b>                                 | Go to <b>Step 18</b>    |
| 18 | <p>Replace the brake pressure modulator valve (BPMV), in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to <b><u>Brake Pressure Modulator Valve Replacement</u></b>.</p> <p>Did you complete the replacement?</p>                                                                                                                                                                                                | Go to <b>Step 21</b>                                 | -                       |
| 19 | <p>1. Inspect the hydraulic brake system components for brake fluid seepage at a seal and/or fitting location, which may have drawn air into the system.</p> <p>2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system.</p> <p>3. Repair or replace any of the components found to be installed incorrectly or seeping brake fluid.</p> <p>Did you find and correct a condition?</p> | Go to <b>Step 21</b>                                 | Go to <b>Step 20</b>    |
| 20 | <p>1. Inspect the brake master cylinder for internal fluid leaks. Refer to <b><u>Brake System Internal Leak Test</u></b>.</p> <p>2. Replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to <b><u>Master Cylinder Replacement</u></b>.</p> <p>Did you find and correct a condition?</p>                                                                                                                               | Go to <b>Step 21</b>                                 | Return to Symptom Table |
| 21 | <p>Install or connect components that were removed or disconnected during diagnosis.</p> <p>Did you complete the operation?</p>                                                                                                                                                                                                                                                                                                                               | Hydraulic Brake System OK<br>Return to Symptom Table | -                       |

## BRAKE ASSIST SYSTEM DIAGNOSIS

| Step                                                                                                                                                                                                                                                                                                 | Action                                         | Yes                 | No                  |
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| DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the brake ASSIST system in order to determine if the brake ASSIST system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate. |                                                |                     |                     |
| 1                                                                                                                                                                                                                                                                                                    | Were you sent here from a Brake Symptom table? | Go to <b>Step 3</b> | Go to <b>Step 2</b> |

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| 2 | Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Go to <b>Step 5</b>  | Go to <b><u>Diagnostic Starting Point - Vehicle</u></b>                                                                                   |
| 3 | Inspect for proper brake pedal travel. Refer to <b><u>Brake Pedal Travel Measurement and Inspection</u></b> .<br>Is the brake pedal travel distance within the acceptable limits?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Go to <b>Step 5</b>  | Go to <b>Step 4</b>                                                                                                                       |
| 4 | <ol style="list-style-type: none"> <li>Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. <ul style="list-style-type: none"> <li>For the brake pedal pushrod component inspection, refer to <b><u>Brake Pedal Pushrod Inspection</u></b>.</li> <li>Inspect the brake pedal bushings for excessive wear and/or damage and inspect the brake pedal for a misaligned, bent and/or damaged condition.</li> </ul> </li> <li>Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged.</li> </ol> <p>Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?</p> | Go to <b>Step 5</b>  | Go to <b><u>Hydraulic Brake System Diagnosis</u></b> to check for internal and external fluid leaks and air in the hydraulic brake system |
| 5 | Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to <b><u>Brake System Vacuum Source Test</u></b> .<br>Is the vacuum reading within the acceptable limits?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Go to <b>Step 6</b>  | Go to Engine Controls Diagnostics Information to check for vacuum issues, including vacuum pump operation, if equipped                    |
| 6 | Does the condition occur during cold start-up conditions?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Go to <b>Step 7</b>  | Go to <b>Step 8</b>                                                                                                                       |
| 7 | Check engine vacuum, and vacuum pump operation, if equipped, under the same cold start-up conditions. Refer to Engine Controls Diagnostics.<br>Did you find and correct a condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Go to <b>Step 22</b> | Go to <b>Step 9</b>                                                                                                                       |
| 8 | During the vacuum source test, did the vacuum booster check valve operate properly?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Go to <b>Step 10</b> | Go to <b>Step 9</b>                                                                                                                       |
| 9 | Replace the vacuum booster check valve. Refer to <b><u>Power Brake Booster Vacuum Check Valve and Hose Replacement (2.4L)</u></b> or <b><u>Power Brake Booster Vacuum Check Valve and Hose Replacement (3.0L)</u></b> .<br>Did you complete the replacement?                                                                                                                                                                                                                                                                                                                                                                                                                      | Go to <b>Step 10</b> | -                                                                                                                                         |
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| 10 | <p>If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot, or damage.</p> <p>Does the vacuum sensor grommet exhibit any of the conditions listed?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Go to <b>Step 11</b> | Go to <b>Step 12</b> |
| 11 | <p>Replace the vacuum sensor grommet.</p> <p>Did you complete the replacement?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Go to <b>Step 12</b> | -                    |
| 12 | <ol style="list-style-type: none"> <li>1. If the vehicle is equipped with a vacuum sensor, install a scan tool.</li> <li>2. Using the Data Display function, determine if brake booster vacuum sensor data is available within either the chassis brake controls area or the powertrain engine controls area.</li> </ol> <p>Is vacuum sensor data available through the scan tool?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 13</b> | Go to <b>Step 16</b> |
| 13 | <p>Perform the vacuum booster leak-down test using a scan tool:</p> <ol style="list-style-type: none"> <li>1. Release the brake pedal.</li> <li>2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once.</li> <li>3. Turn the ignition OFF.</li> <li>4. Turn the ignition ON. Do not start the engine.</li> <li>5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds.</li> </ol> <p><b>NOTE:</b><br/> <b>Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level.</b></p> <ol style="list-style-type: none"> <li>6. Determine the rate of vacuum leak.</li> </ol> <p><b>Specification:</b> Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds</p> <p>Was the rate of vacuum leak within the specified allowable range?</p> | Go to <b>Step 18</b> | Go to <b>Step 14</b> |
|    | <ol style="list-style-type: none"> <li>1. Deplete the vacuum reserve by pressing the brake pedal several times, or by removing the vacuum booster check valve.</li> <li>2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |                      |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                      |                      |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|
| 14 | <p>pipes. Refer to <b><u>Master Cylinder Replacement</u></b>.</p> <ol style="list-style-type: none"> <li>If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. Replace the vacuum seal as necessary.</li> <li>Carefully reinstall the master cylinder to the brake booster. Refer to <b><u>Master Cylinder Replacement</u></b>.</li> </ol> <p>Did you complete the operation?</p>                                                                                                                                                                                                                                                                                                                                                                                                             | Go to <b>Step 15</b> | -                    |
| 15 | <p>Perform the vacuum booster leak-down test using a scan tool:</p> <ol style="list-style-type: none"> <li>Release the brake pedal.</li> <li>Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once.</li> <li>Turn the ignition OFF.</li> <li>Turn the ignition ON. Do not start the engine.</li> <li>Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds.</li> </ol> <p><b>NOTE:</b><br/><b>Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level.</b></p> <ol style="list-style-type: none"> <li>Determine the rate of vacuum leak.</li> </ol> <p><b>Specification:</b> Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds</p> <p>Was the rate of vacuum leak within the specified allowable range?</p> | Go to <b>Step 22</b> | Go to <b>Step 21</b> |
| 16 | <ol style="list-style-type: none"> <li>Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by removing the check valve or applying the brake pedal several times. Refer to <b><u>Master Cylinder Replacement</u></b>.</li> <li>If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder.</li> <li>If equipped with a vacuum seal that is part of the</li> </ol>                                                                                                                                                                                                                                                                                                                          |                      |                      |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                      |                      |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|
|    | <p>booster, inspect the seal for damage.</p> <p>Does the vacuum seal exhibit any of the conditions listed?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Go to <b>Step 17</b> | Go to <b>Step 18</b> |
| 17 | <ol style="list-style-type: none"> <li>1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as necessary. Ensure the seal is positioned correctly during installation.</li> <li>2. If equipped with a vacuum seal that requires replacement and which is part of the booster, the booster assembly must be replaced.</li> <li>3. Carefully reinstall the master cylinder to the brake booster. Refer to <b><u>Master Cylinder Replacement</u></b>.</li> </ol> <p>Did you complete the replacement?</p>                                                                                                                                                                                                                         | Go to <b>Step 18</b> | -                    |
| 18 | <p>Perform the vacuum boost functional test:</p> <ol style="list-style-type: none"> <li>1. If still separated, reinstall the master cylinder to the booster. Refer to <b><u>Master Cylinder Replacement</u></b>.</li> <li>2. If the engine was started after reinstalling the master cylinder to the booster, perform the following:<br/><br/>With the engine OFF, depress the brake pedal several times to deplete the vacuum reserve.</li> <li>3. Depress and maintain moderate foot pressure on the brake pedal.</li> <li>4. Start the engine and observe pedal operation.</li> <li>5. Observe for audible vacuum leaks.</li> </ol> <p>The brake pedal should fall slightly, then hold.</p> <p>Is there an audible vacuum leak coming from the brake pedal area?</p> | Go to <b>Step 21</b> | Go to <b>Step 19</b> |
| 19 | <p>Did the brake pedal fall slightly after the engine was started, then hold?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Go to <b>Step 20</b> | Go to <b>Step 21</b> |
|    | <p>Perform the vacuum booster leak-down test:</p> <ol style="list-style-type: none"> <li>1. Release the brake pedal.</li> <li>2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                      |                      |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                   |                      |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------------------|
| 20 | <p>and repeat once.</p> <ol style="list-style-type: none"> <li>Turn the ignition OFF.</li> <li>Wait 60 seconds.</li> <li>Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. <ul style="list-style-type: none"> <li>Both pedal applies should be assisted</li> <li>The amount of assist could diminish slightly with the second apply</li> </ul> </li> </ol> |                                                   |                      |
|    | Were both pedal applies power assisted?                                                                                                                                                                                                                                                                                                                                                                              | Go to <b>Step 22</b>                              | Go to <b>Step 21</b> |
| 21 | <p>Replace the vacuum brake booster. Refer to <b><u>Power Vacuum Brake Booster Replacement</u></b>.</p> <p>Did you complete the replacement?</p>                                                                                                                                                                                                                                                                     | Go to <b>Step 22</b>                              | -                    |
| 22 | <p>Install or connect any components that were removed or disconnected during diagnosis.</p> <p>Did you complete the operation?</p>                                                                                                                                                                                                                                                                                  | Brake Assist System OK<br>Return to Symptom Table | -                    |

## BRAKE SYSTEM VEHICLE ROAD TEST

### Preliminary Inspections

- Visually inspect easily accessible brake system components for obvious damage and/or leaks which may indicate that the vehicle should not be driven until further inspections have been completed.
- Inspect the brake master cylinder reservoir fluid level and adjust only if necessary for brake system road testing. Refer to **Master Cylinder Reservoir Filling**.
- Inspect the tire inflation pressures and adjust as necessary.
- Inspect the tire tread patterns to ensure that they are the same or very similar, especially per axle.
- Ensure that the vehicle is not loaded unevenly prior to brake system road testing.

### Road Testing Procedure

**WARNING:** Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

- Start the engine and allow it to idle.
- Check to see if the brake system warning lamp remains illuminated.
- If the brake system warning lamp remains illuminated, DO NOT proceed to test drive the vehicle until it is diagnosed and repaired. Refer to **Symptoms - Hydraulic Brakes**.
- Select a smooth, dry, clean and level road or large lot that is as free of traffic and obstacles as possible for

brake system low speed road testing.

5. With the transmission in PARK, lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
6. If the brake pedal apply felt spongy, or the pedal travel was excessive, DO NOT drive the vehicle until it is repaired.
7. If the brake pedal apply did not feel spongy and the pedal travel was not excessive, proceed to step 8.
8. Release and apply the brakes.
9. While continuing to apply the brakes, shift the transmission into DRIVE, release the brakes and allow the engine to idle the vehicle away from the stopped position. Observe for a slow release of the brake system.
10. With the aid of an assistant to observe the vehicle's performance from outside of the vehicle, drive the vehicle at a low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to them, while you observe both the pedal effort and the pedal travel.
11. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
12. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 13.
13. Drive the vehicle in the opposite direction, at the same low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to him.
14. Drive the vehicle at a low speed and shift the transmission into NEUTRAL without applying the brakes. Observe for a rapid deceleration in vehicle speed, indicating possible brake drag.
15. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
16. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
17. While continuing to drive the vehicle at a moderate speed, perform several light applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system noise, pulsation and/or brake drag.
18. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
19. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 20.
20. While continuing to drive the vehicle at a moderate speed, perform several moderate applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system pulsation and/or uneven braking action - either side to side, or front to rear.

A small amount of vehicle front end dip is expected during a moderate apply of the brakes.

21. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.

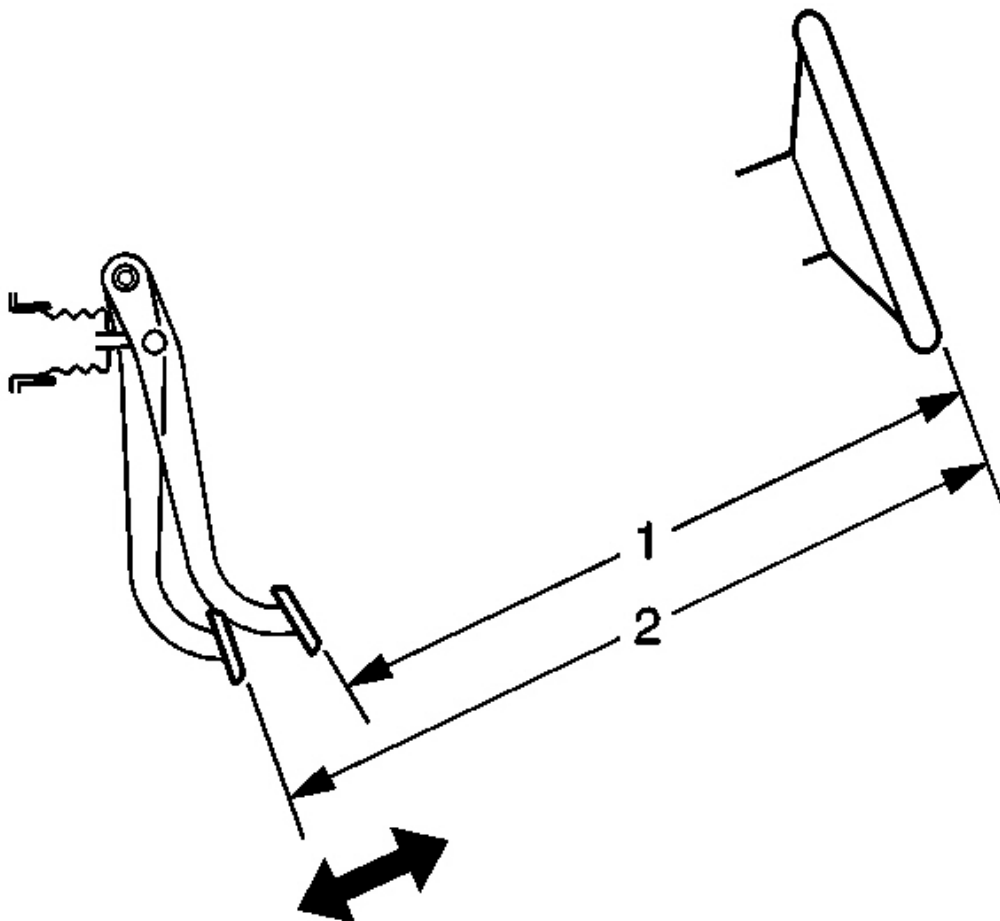
## **BRAKE PEDAL TRAVEL MEASUREMENT AND INSPECTION**

### **Special Tools**

## **J-28662: Brake Pedal Effort Gauge, or equivalent**

### **Inspection**

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal becomes firm, in order to deplete the brake booster power reserve.
2. Install the **J-28662: Brake Pedal Effort Gauge, or equivalent** to the brake pedal.



**Fig. 2: Measuring Brake Pedal Travel**  
**Courtesy of GENERAL MOTORS CORP.**

3. Measure and record the distance (1) from the brake pedal to the rim of the steering wheel; note the points of measurement.
4. Apply and maintain the brakes with 445 N (100 lb) of force to the brake pedal, as indicated on the J-

**28662:** Brake Pedal Effort Gauge, or equivalent.

5. While maintaining 445 N (100 lb) of force to the brake pedal, measure and record the distance (2) from the same point on the brake pedal to the same point on the rim of the steering wheel.
6. Release the brakes and repeat steps 4 and 5 to obtain a second measurement. After obtaining a second measurement, proceed to step 7.
7. Average the first and second measurements recorded during the two applies of the brakes.
8. Subtract the initial measurement, unapplied (1), from the averaged, applied measurement (2) to obtain the brake pedal travel distance.

**Specification:** Maximum brake pedal travel measured with the ignition OFF, power vacuum brake booster vacuum reserve depleted, and the brakes cool: 57 mm (2.24 in).

## **BRAKE SYSTEM VACUUM SOURCE TEST**

**NOTE:**

- **Engine temperature, accessory load, and elevation level will affect engine vacuum.**
- **Vacuum readings will decrease by approximately 2.7 kPa (0.8 in Hg) for every 305 m (1000 ft) of elevation above sea level.**

1. Disconnect the engine vacuum hose from the vacuum brake booster check valve.
2. Install a vacuum gauge to the engine vacuum hose.
3. Start the engine and allow the engine to idle until normal operating temperatures are reached.
4. With the vehicle in PARK, the engine idling, and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is within the specified normal engine vacuum range.

**Specification:** 47-68 kPa (14-20 in Hg)

5. Turn the ignition OFF.
6. If the engine vacuum reading was within the specified normal range, proceed to step 10.
7. If the engine vacuum reading was NOT within the specified normal range, inspect the engine vacuum hose for the following conditions:
  - Loose connection to the engine
  - Collapse, deformation or contamination
  - Cracks, cuts, dry-rot
8. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2-4.
9. If none of these conditions were found with the engine vacuum hose, then there is an engine vacuum source problem, check the engine vacuum system.
10. Remove the vacuum brake booster check valve from the booster.
11. Install the check valve to the engine vacuum hose.
12. Install the vacuum gauge to the check valve.
13. Start the engine and allow the engine to idle in PARK with the A/C system OFF, until normal operating

temperatures are reached.

14. Turn the ignition OFF.
15. Check to see if the engine vacuum reading is maintained within the specified normal engine vacuum range.

**Specification:** 47-68 kPa (14-20 in Hg)

16. If the engine vacuum reading is maintained within the specified normal range, proceed to step 18.
17. If the engine vacuum reading is NOT maintained within the specified normal range, replace the brake booster check valve, then repeat steps 11-15.
18. Inspect the brake booster check valve grommet for the following conditions:
  - Loose connection to the vacuum brake booster
  - Deformation or contamination
  - Cracks, cuts, dry-rot
19. If any of these conditions were found with the check valve grommet, replace the grommet.

## **BRAKE SYSTEM EXTERNAL LEAK INSPECTION**

**WARNING:** Refer to **Brake Fluid Irritant Warning** .

**CAUTION:** Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

1. In order to inspect for external brake fluid leaks, first check the fluid level in the master cylinder.

While a slight brake fluid level drop can be considered a normal condition due to brake lining wear, a very low level may indicate a brake fluid leak in the hydraulic system.

2. If the fluid level is abnormally low, adjust the brake fluid level. Refer to **Master Cylinder Reservoir Filling**.
3. Start the engine and allow it to idle.
4. Apply constant, moderate foot pressure to the brake pedal.

If the brake pedal gradually falls away while under foot pressure, there may be a brake fluid leak.

5. Turn OFF the ignition.
6. Visually inspect the following brake system components for brake fluid leaks, excessive corrosion, and damage. Give particular attention to all brake pipe and flexible hose connections to ensure that there are not any slight brake fluid leaks - even though the brake pedal may feel firm and hold steady:
  - Master cylinder brake pipe fittings
  - All brake pipe connections

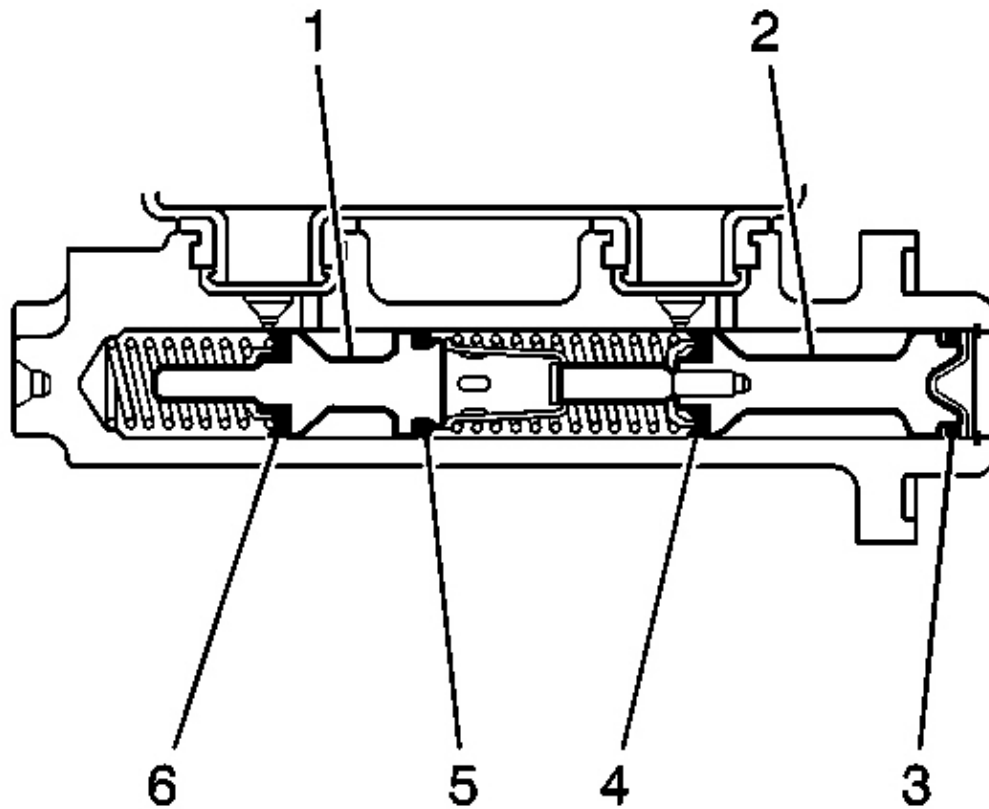
- Brake pipes
  - Brake hoses and connections
  - Brake calipers and/or wheel cylinders, if equipped
7. While slight dampness around the master cylinder reservoir can be considered acceptable, brake fluid leaking from any of the brake system components requires immediate attention. If any of these components exhibit signs of brake fluid leakage, repair or replace those components. After the repair or replacement, reinspect the hydraulic brake system to assure proper function.

## **BRAKE SYSTEM INTERNAL LEAK TEST**

**WARNING:** Refer to Brake Fluid Irritant Warning .

**CAUTION:** Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Start the engine and allow it to idle.
2. Apply light, steady pressure to the brake pedal. Observe both the brake pedal feel and travel.
3. Release the brakes and turn OFF the ignition.
4. If the brake pedal apply felt spongy, but the brake pedal travel was not excessive, perform the following steps:
  1. Inspect the brake system for external leaks. Refer to Brake System External Leak Inspection .
  2. Pressure bleed the brake system in order to purge any air that may be trapped in the system. Refer to Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure) .



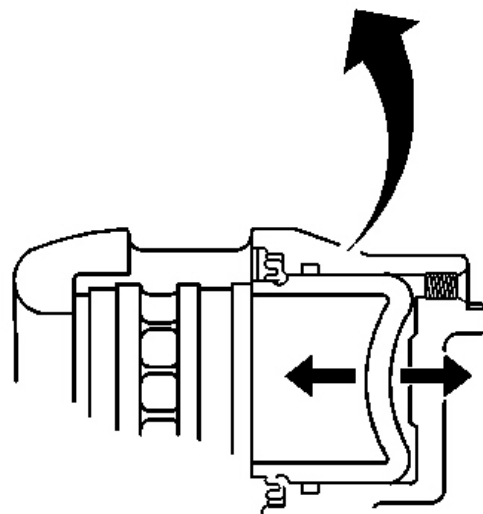
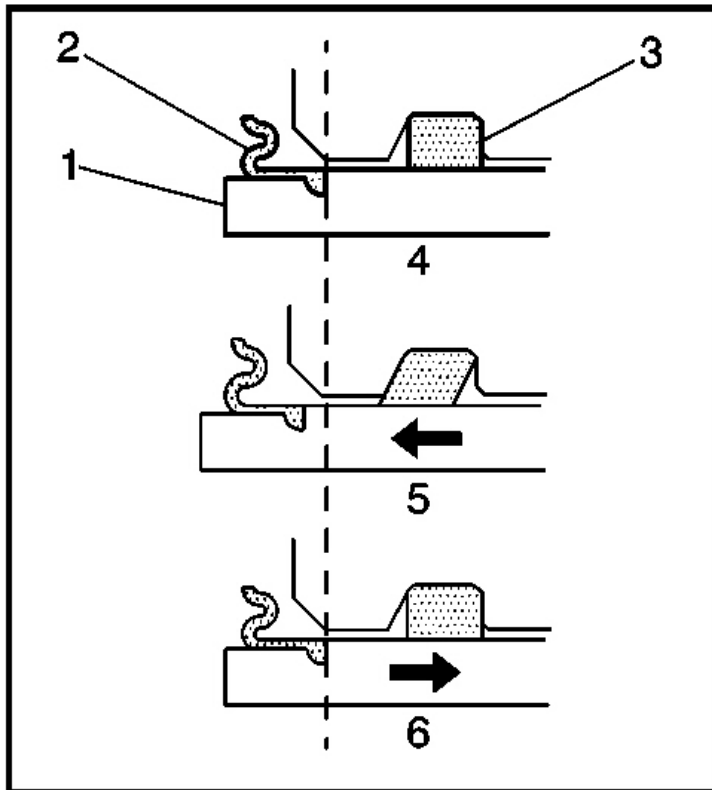
**Fig. 3: Cross Sectional View Of Brake Master Cylinder**  
**Courtesy of GENERAL MOTORS CORP.**

5. If the brake pedal apply did not feel spongy, but the brake pedal travel was excessive, perform the following steps:
  1. Loosen the master cylinder-to-brake power booster mounting nuts.
  2. Carefully pull the master cylinder away from the brake power booster just enough to inspect the mounting surface of the master cylinder.
  3. Inspect the master cylinder mounting surface at the primary piston (2) for brake fluid leaks.
6. If the master cylinder exhibits any leakage around the primary piston (2), then the primary piston primary seal (4) and/or secondary seal (3) is leaking and the master cylinder requires overhaul or replacement.
7. If the master cylinder primary piston (2) does not exhibit any leakage, pressure bleed the brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
8. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, but then gradually fell, then the master cylinder requires overhaul or replacement due to an

internal leak past the secondary piston (1) from the secondary piston primary seal (6) or secondary seal (5).

9. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, then fell slightly, then became steady again, then the brake pressure modulator valve (BPMV) may be leaking internally, and may require replacement.

## **HYDRAULIC BRAKE COMPONENT OPERATION VISUAL INSPECTION**



**Fig. 4: Identifying Brake Caliper/Pad Inspection Areas**  
 Courtesy of GENERAL MOTORS CORP.

**WARNING:** Refer to Brake Fluid Irritant Warning .

**CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

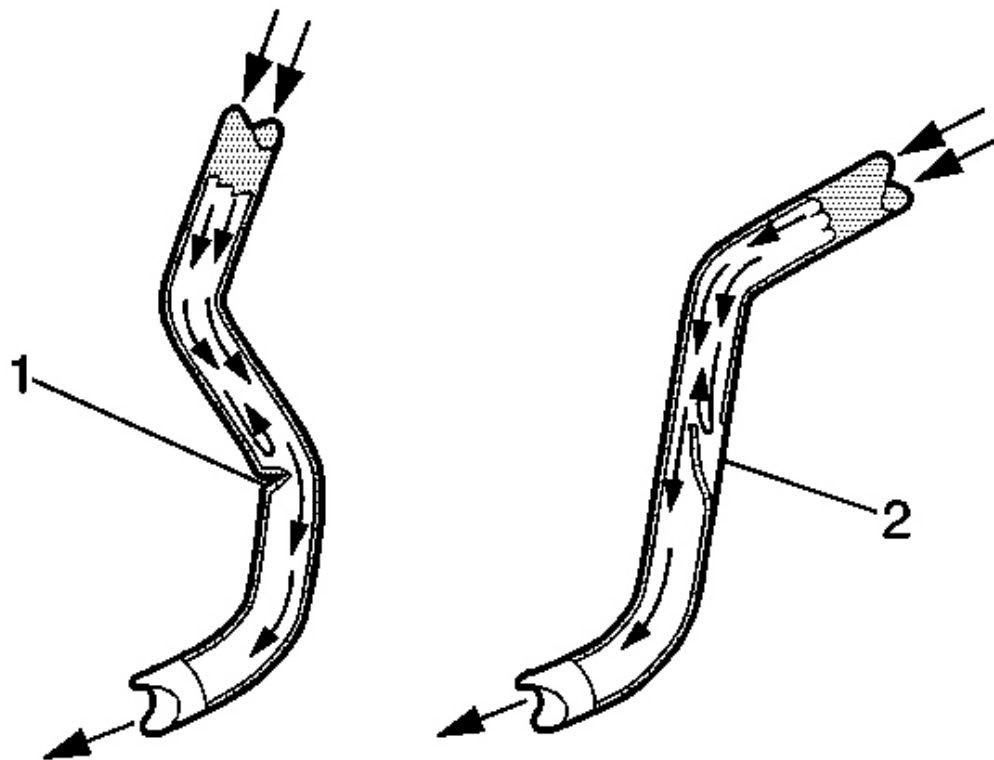
1. With the tire and wheel assemblies removed and the brake rotors retained by wheel lug nuts, visually inspect the caliper piston dust boot (2) sealing area to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the caliper piston (1) in relation to the caliper housing.
4. Have an assistant apply and release the brake pedal several times while you observe the operation of the hydraulic brake caliper.
  1. Observe the caliper piston (1) for unrestricted and even movement during each apply of the brake system (5).
  2. Observe the caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the caliper piston (1) did not exhibit unrestricted and even movement during brake system apply and/or release, the piston square seal (3) may be worn or damaged and the caliper may require overhaul or replacement.

**BRAKE PIPE AND HOSE INSPECTION**

**WARNING: Refer to Brake Fluid Irritant Warning .**

**CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

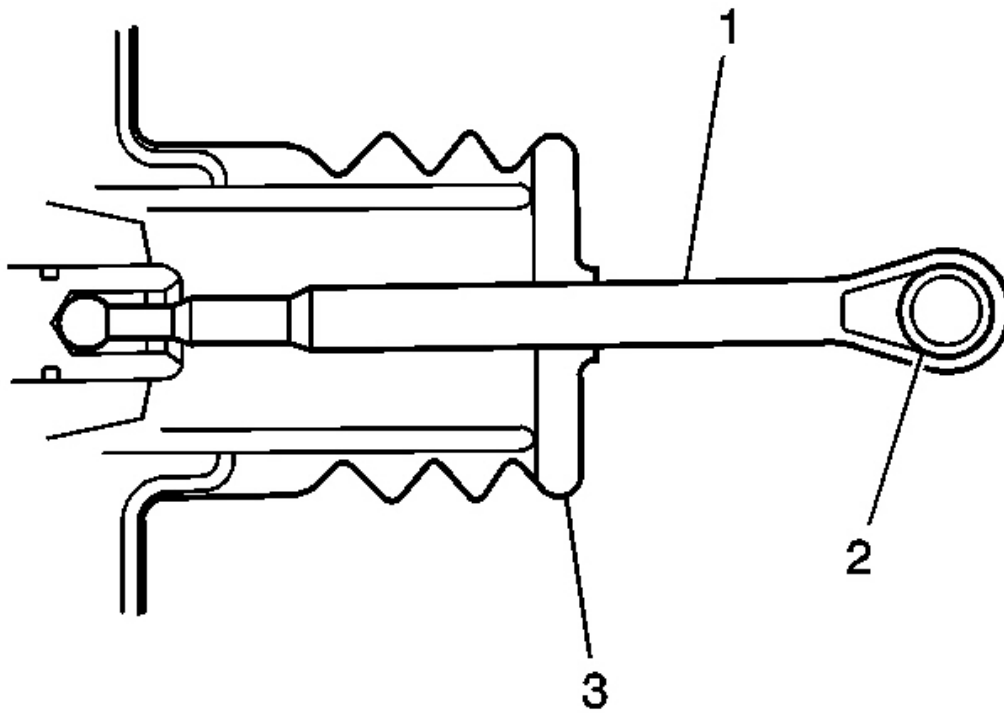
1. Visually inspect all of the brake pipes for the following conditions:
  - Kinks, improper routing, missing or damaged retainers
  - Leaking fittings, excessive corrosion
2. If any of the brake pipes exhibited any of the conditions listed, then the identified pipe, or pipes, require replacement.
3. Ensure that the vehicle axles are properly supported at ride height in order to maintain the proper relationship of the flexible brake hoses to the chassis.



**Fig. 5: Identifying Flexible Brake Hose Failure Conditions**  
Courtesy of GENERAL MOTORS CORP.

4. Visually inspect all of the flexible brake hoses for the following conditions:
  - Kinks (1), improper routing, twists, chafing, missing or damaged retainers
  - Leaking connections, cracking, dry-rot, blisters, bulges
5. If any of the flexible brake hoses exhibited any of the conditions listed, then the identified flexible brake hose, or hoses require replacement.
6. Squeeze the flexible brake hoses with firm finger pressure to check for soft spots (2), indicating an internal restriction. Check the entire length of each flexible brake hose.
7. If any of the flexible brake hoses were found to have soft spots (2), then the identified flexible brake hose, or hoses require replacement.

## **BRAKE PEDAL PUSHROD INSPECTION**



**Fig. 6: View of Brake Pedal Pushrod**  
**Courtesy of GENERAL MOTORS CORP.**

1. Disconnect the brake pedal pushrod (1) from the brake pedal.
2. Inspect the brake pedal pushrod eyelet bushing (2), if equipped, for cracks and/or excessive wear.
3. Reposition the pedal pushrod boot (3) toward the front of the vehicle to expose as much of the pedal pushrod (1) as possible.
4. Inspect the brake pedal pushrod (1) for straightness.
5. If the brake pedal pushrod eyelet bushing (2) exhibited cracks and/or excessive wear, then the bushing requires replacement.
6. If the brake pedal pushrod (1) is not straight, then the pushrod requires replacement.
7. Return the pedal pushrod boot (3) to its original position on the pedal pushrod (1).
8. Connect the brake pedal pushrod (1) to the brake pedal.

## **REPAIR INSTRUCTIONS**

### **MASTER CYLINDER RESERVOIR FILLING**

**WARNING: Refer to Brake Fluid Irritant Warning .**

**CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Visually inspect the brake fluid level through the brake master cylinder reservoir.
2. If the brake fluid level is at or below the half-full point during routine fluid checks, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the half-full point during routine fluid checks, and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped-off up to the maximum-fill level.
4. If brake system service was just completed, the brake fluid may be topped-off up to the maximum-fill level.
5. If the brake fluid level is above the half-full point, adding brake fluid is not recommended under normal conditions.
6. If brake fluid is to be added to the master cylinder reservoir, clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm. Use only GM approved brake fluid from a clean, sealed brake fluid container.

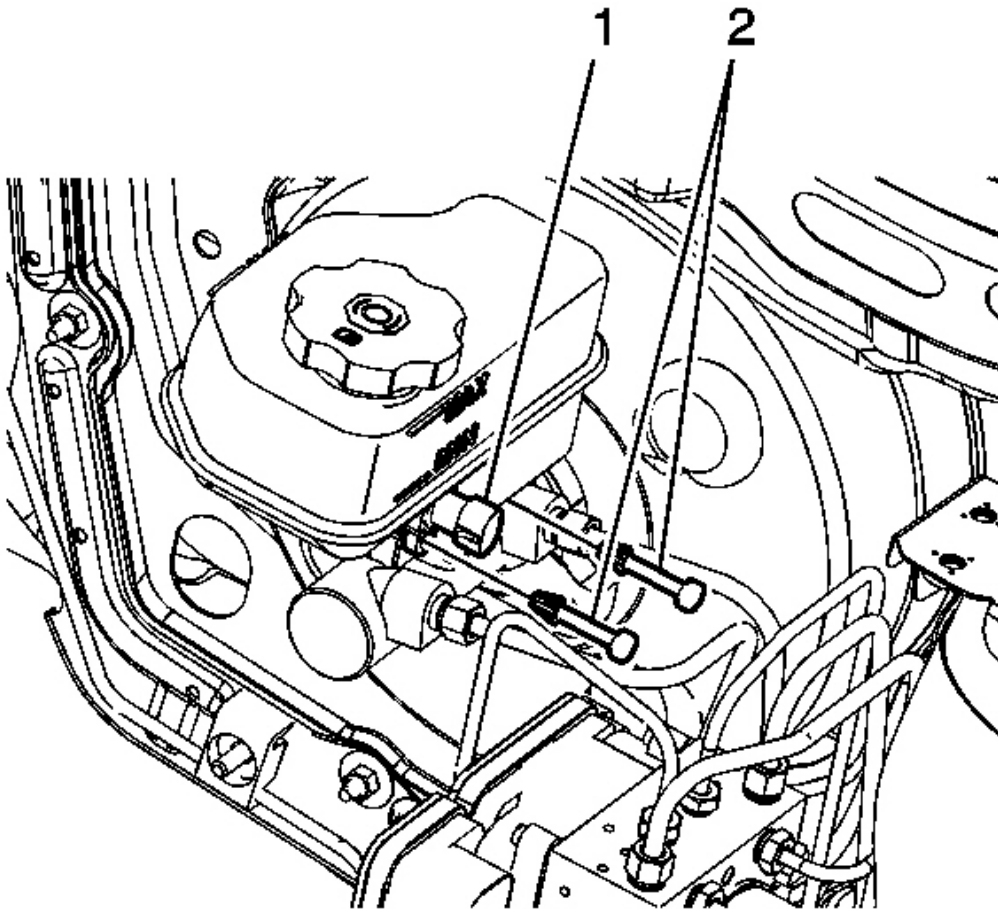
## **MASTER CYLINDER RESERVOIR REPLACEMENT**

### **Removal Procedure**

**WARNING: Refer to Brake Fluid Irritant Warning .**

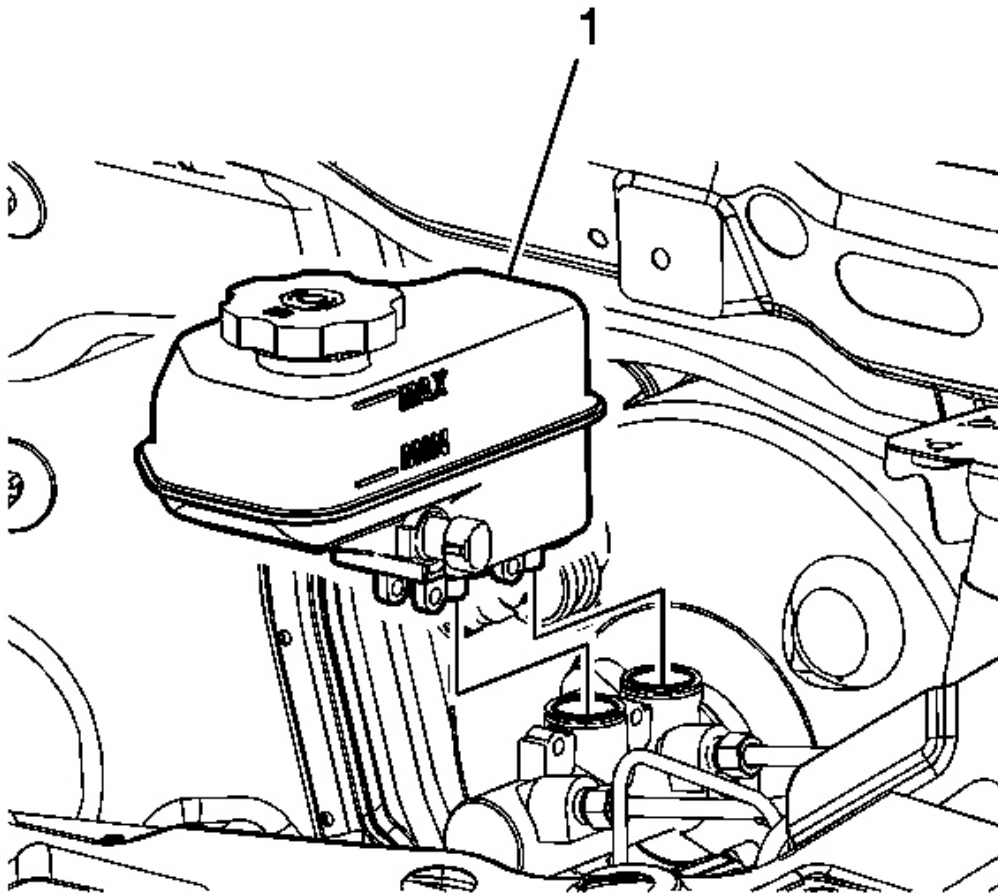
**CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Using a suitable tool, remove the brake fluid from the brake master cylinder reservoir.
2. Discard the brake fluid into an approved container.



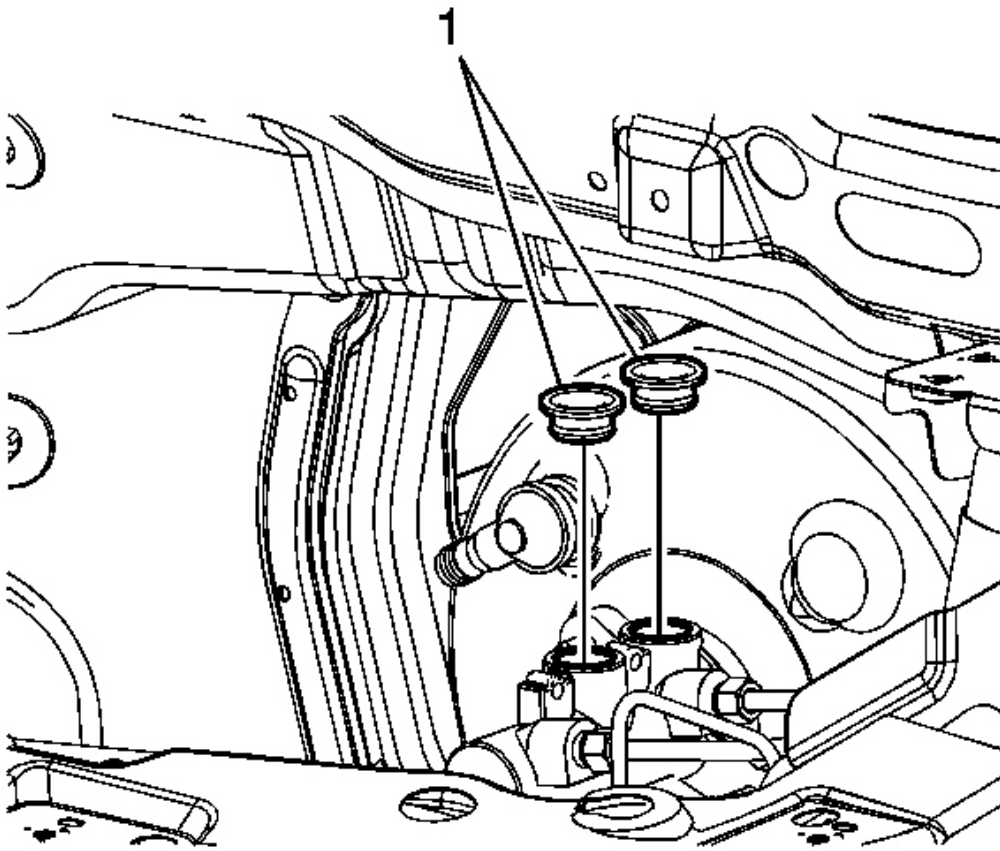
**Fig. 7: Master Cylinder Fluid Level Sensor Electrical Connector**  
**Courtesy of GENERAL MOTORS CORP.**

3. Disconnect the master cylinder fluid level sensor electrical connector (1).
4. Remove and discard the master cylinder reservoir retaining pins (2) by compressing the locking tabs.



**Fig. 8: Master Cylinder Reservoir**  
**Courtesy of GENERAL MOTORS CORP.**

5. Carefully remove the master cylinder reservoir (1) by pulling the reservoir straight up.

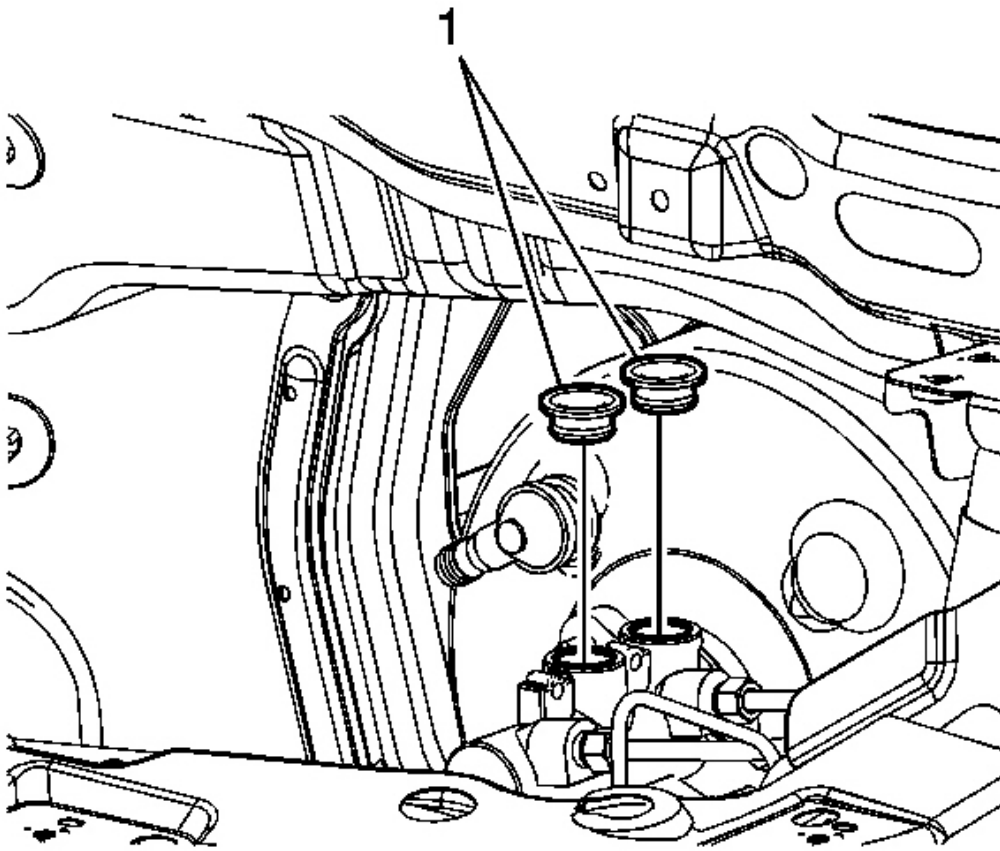


**Fig. 9: Master Cylinder Reservoir Seals**  
**Courtesy of GENERAL MOTORS CORP.**

6. Remove the master cylinder reservoir seals (1).

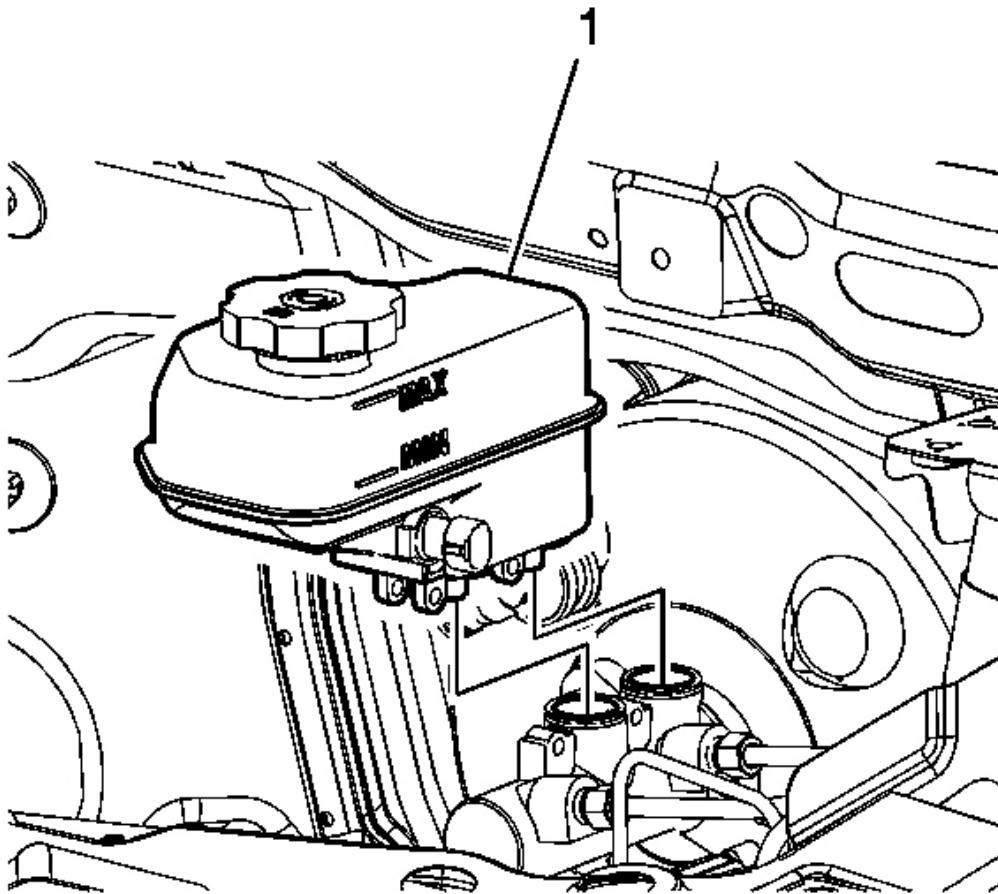
#### **Installation Procedure**

1. Lubricate the master cylinder reservoir seals with GM approved brake fluid from a clean, sealed brake fluid container.



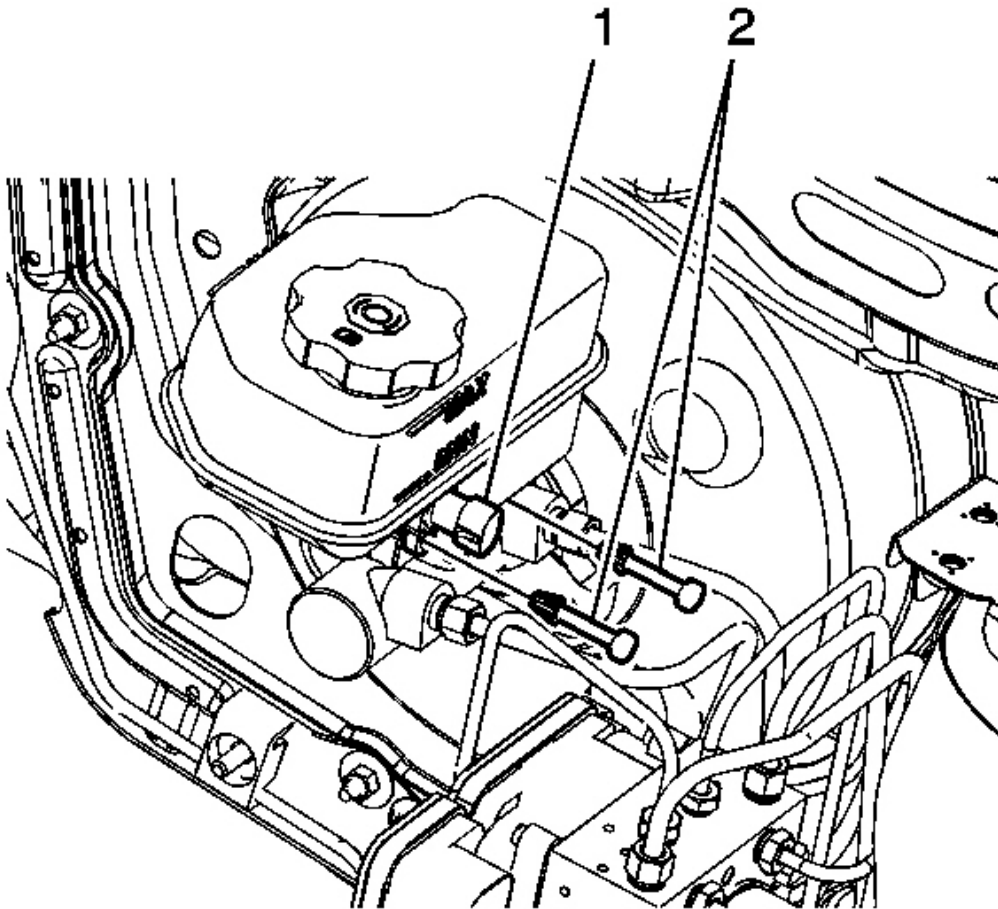
**Fig. 10: Master Cylinder Reservoir Seals**  
**Courtesy of GENERAL MOTORS CORP.**

2. Install the master cylinder reservoir seals (1).



**Fig. 11: Master Cylinder Reservoir**  
**Courtesy of GENERAL MOTORS CORP.**

3. Install the master cylinder reservoir (1) to the master cylinder.
4. Ensure the master cylinder reservoir bayonets are fully seated in the master cylinder.



**Fig. 12: Master Cylinder Fluid Level Sensor Electrical Connector**  
**Courtesy of GENERAL MOTORS CORP.**

5. Connect the master cylinder fluid level sensor electrical connector (1).
6. Install new master cylinder reservoir retaining pins (2).
7. Ensure the retaining pins are fully seated and the locking tabs are fully deployed.
8. Fill the master cylinder reservoir to the proper level. Refer to **Master Cylinder Reservoir Filling**.
9. Observe the brake pedal feel after filling the master cylinder reservoir. If the pedal feels spongy, bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

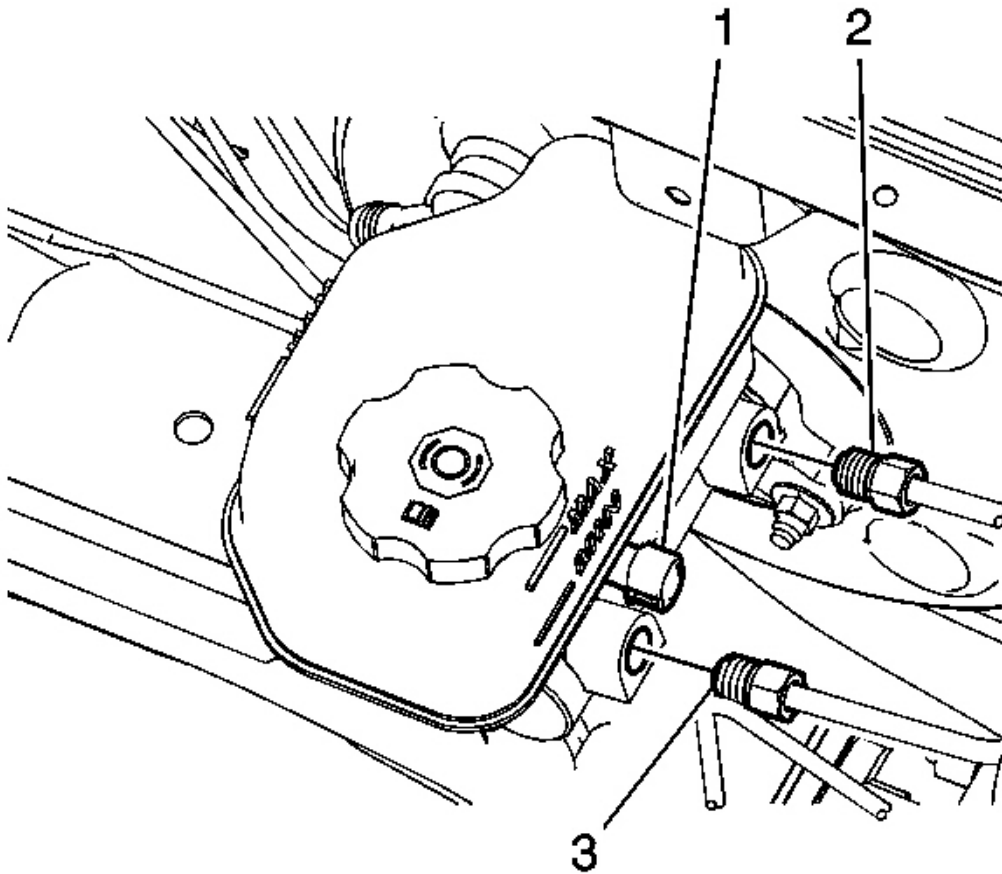
## **MASTER CYLINDER REPLACEMENT**

### **Removal Procedure**

**WARNING: Refer to Brake Fluid Irritant Warning .**

**CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Using a suitable tool, remove the brake fluid from the brake master cylinder reservoir.
2. Discard the brake fluid into an approved container.



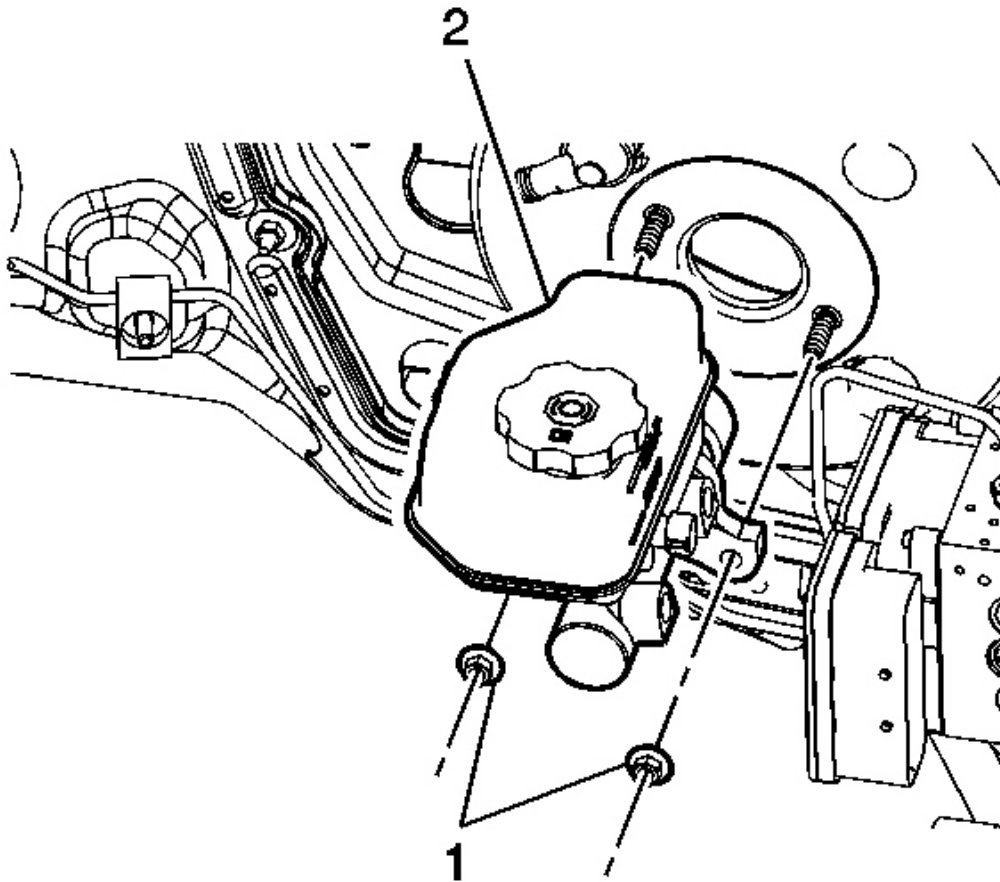
**Fig. 13: Master Cylinder Fluid Level Sensor Electrical Connector & Pipe Fittings**  
**Courtesy of GENERAL MOTORS CORP.**

3. Disconnect the master cylinder fluid level sensor electrical connector (1).
4. Disconnect the master cylinder primary brake pipe fitting (2).

Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

5. Disconnect the master cylinder secondary brake pipe fitting (3).

Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.



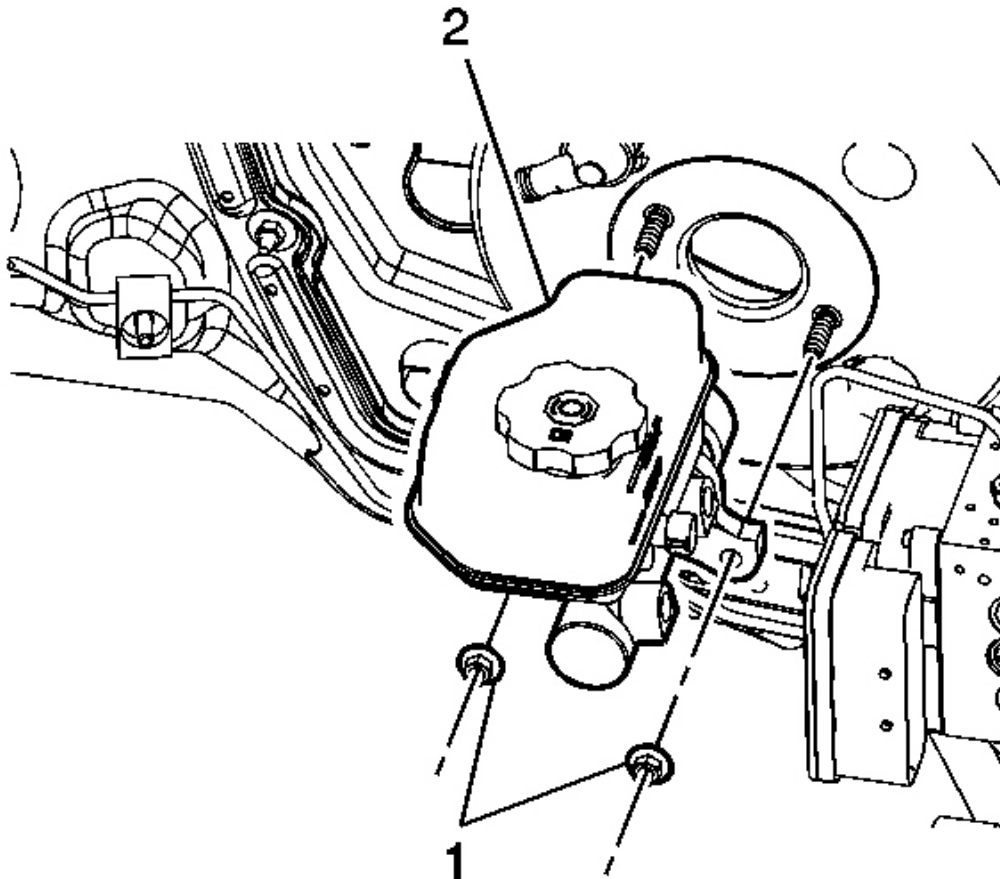
**Fig. 14: Master Cylinder And Nuts**  
**Courtesy of GENERAL MOTORS CORP.**

6. Remove the 2 master cylinder nuts (1).
7. Remove the master cylinder (2).
8. If installing a new master cylinder, remove the master cylinder reservoir and cap. Refer to **Master Cylinder Reservoir Replacement**.

9. If removing the master cylinder reservoir, discard the reservoir retaining pins and seals.

#### **Installation Procedure**

1. If the master cylinder reservoir was removed, install new master cylinder reservoir seals.
2. If installing a new master cylinder, install the master cylinder reservoir and cap using new reservoir retaining pins. Refer to **Master Cylinder Reservoir Replacement**.
3. If installing a new master cylinder, bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.

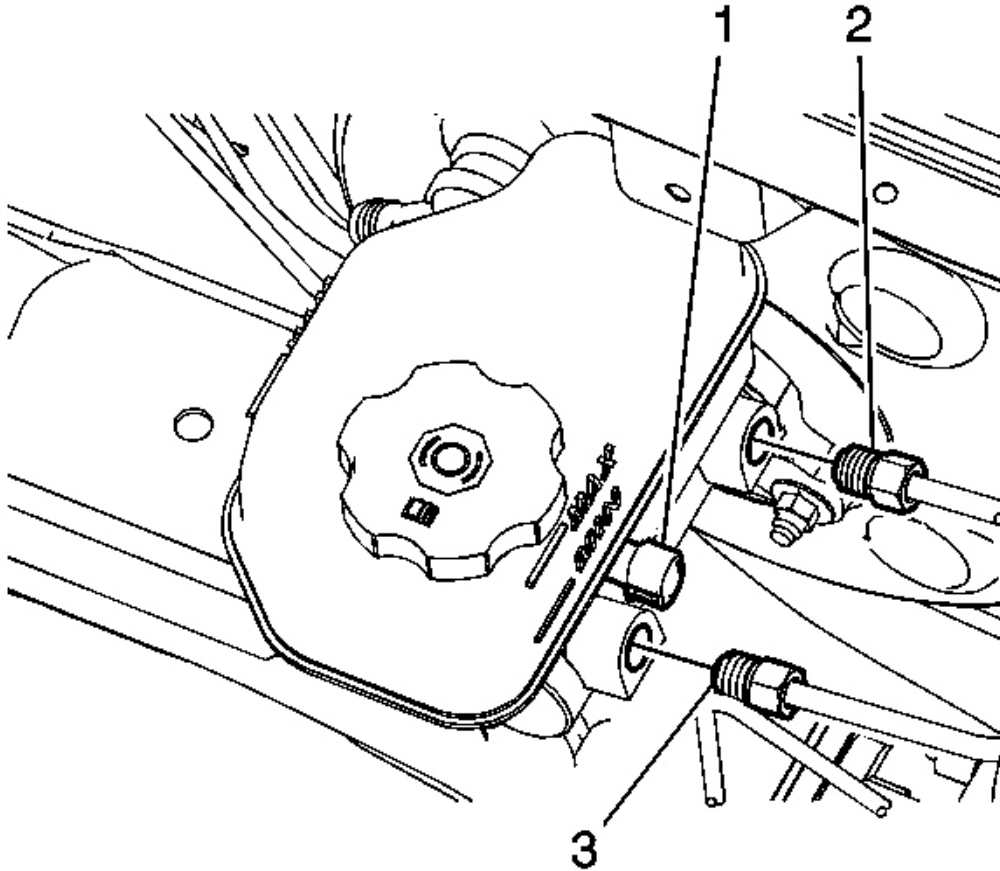


**Fig. 15: Master Cylinder And Nuts**  
Courtesy of GENERAL MOTORS CORP.

4. Install the master cylinder (2).

**CAUTION: Refer to Fastener Caution .**

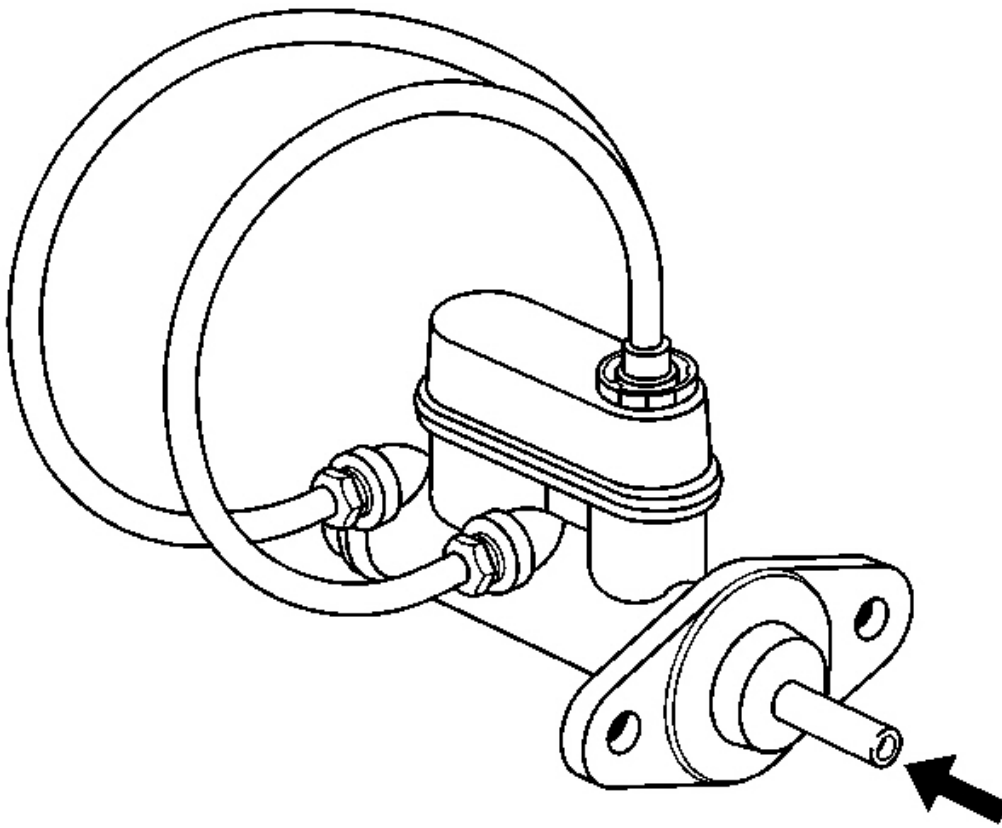
5. Install the 2 master cylinder nuts (1) and tighten to 25 N.m (18 lb ft).



**Fig. 16: Master Cylinder Fluid Level Sensor Electrical Connector & Pipe Fittings**  
**Courtesy of GENERAL MOTORS CORP.**

6. Connect the master cylinder fluid level sensor electrical connector (1).
7. Connect the master cylinder primary brake pipe fitting (2) and tighten to 18 N.m (13 lb ft).
8. Connect the master cylinder secondary brake pipe fitting (3) and tighten to 18 N.m (13 lb ft).
9. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

## **MASTER CYLINDER BENCH BLEEDING**



**Fig. 17: Bleeding Master Cylinder**  
Courtesy of GENERAL MOTORS CORP.

**WARNING: Refer to Brake Fluid Irritant Warning .**

**CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Secure the mounting flange of the brake master cylinder in a bench vise so that the rear of the primary piston is accessible.
2. Remove the master cylinder reservoir cap and diaphragm.
3. Install suitable fittings to the master cylinder ports that match the type of flare seat required and also provide for hose attachment.
4. Install transparent hoses to the fittings installed to the master cylinder ports, then route the hoses into the

master cylinder reservoir.

5. Fill the master cylinder reservoir to at least the half-way point with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Master Cylinder Reservoir Filling**.
6. Ensure that the ends of the transparent hoses running into the master cylinder reservoir are fully submerged in the brake fluid.
7. Using a smooth, round-ended tool, depress and release the primary piston as far as it will travel, a depth of about 25 mm (1 in), several times. Observe the flow of fluid coming from the ports.

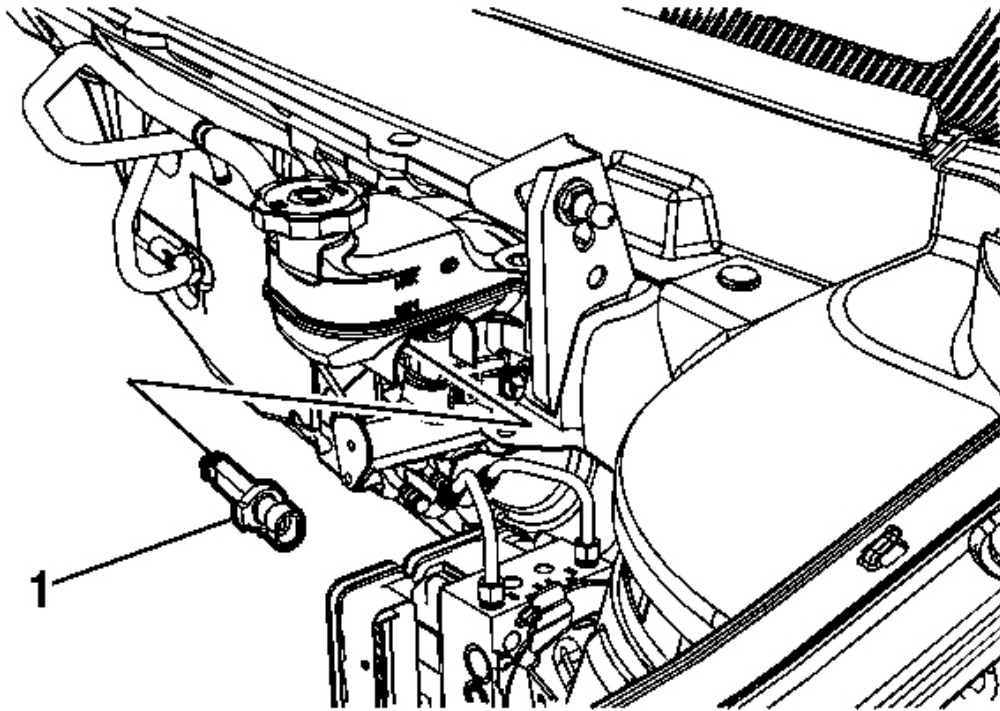
As air is bled from the primary and secondary pistons, the effort required to depress the primary piston will increase and the amount of travel will decrease.

8. Continue to depress and release the primary piston until fluid flows freely from the ports with no evidence of air bubbles.
9. Remove the transparent hoses from the master cylinder reservoir.
10. Install the master cylinder reservoir cap and diaphragm.
11. Remove the fittings with the transparent hoses from the master cylinder ports. Wrap the master cylinder with a clean shop cloth to prevent brake fluid spills.
12. Remove the master cylinder from the vise.

## **BRAKE FLUID LEVEL INDICATOR SWITCH REPLACEMENT**

### **Removal Procedure**

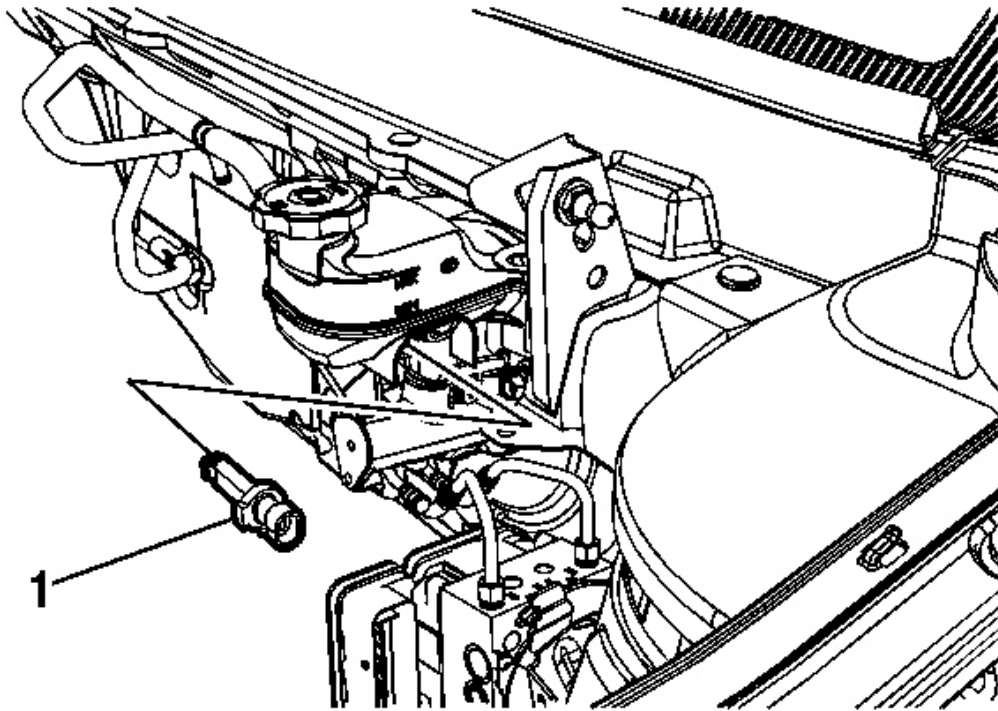
1. Remove the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement**.
2. Disconnect the brake fluid level indicator switch electrical connector.



**Fig. 18: Brake Fluid Level Indicator Switch**  
Courtesy of GENERAL MOTORS CORP.

3. While compressing the retaining tabs on the inboard side of the brake fluid level indicator switch (1), carefully remove the switch from the brake master cylinder reservoir.

#### **Installation Procedure**



**Fig. 19: Brake Fluid Level Indicator Switch**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Ensure the retaining tabs on the brake fluid level indicator switch are fully engaged in the master cylinder reservoir.

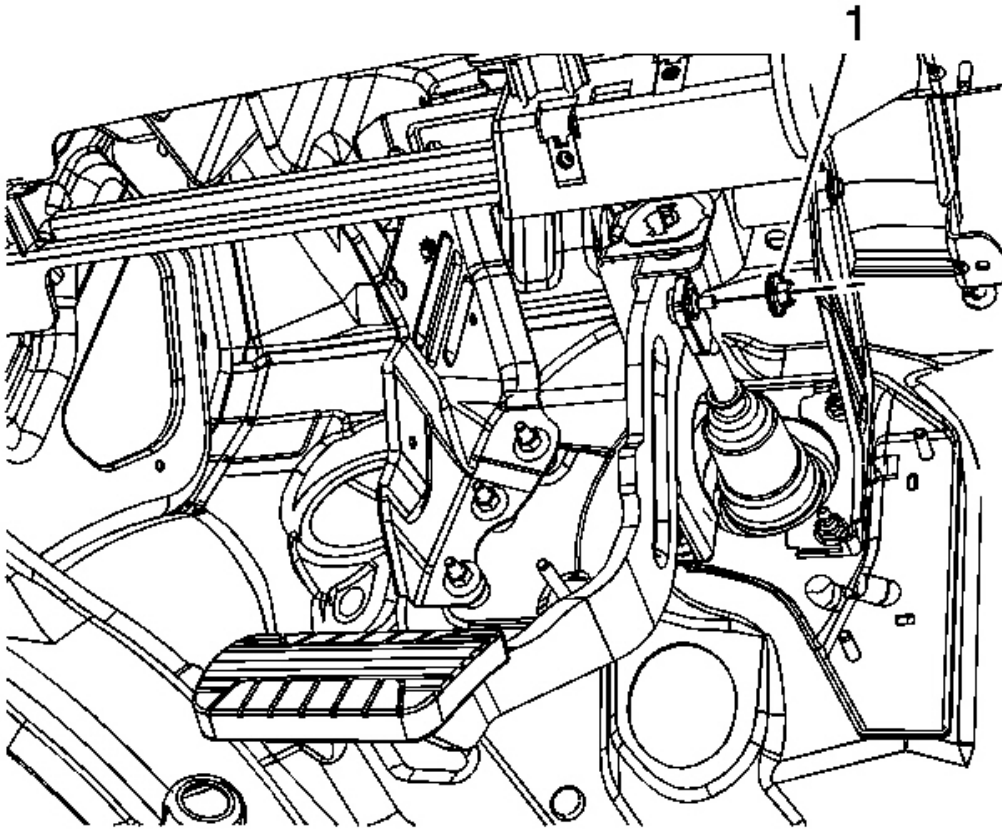
1. Install the brake fluid level indicator switch (1) by carefully inserting the switch into the master cylinder reservoir.
2. Connect the brake fluid level indicator switch electrical connector.
3. Install the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement** .

## **BRAKE PEDAL ASSEMBLY REPLACEMENT**

### **Removal Procedure**

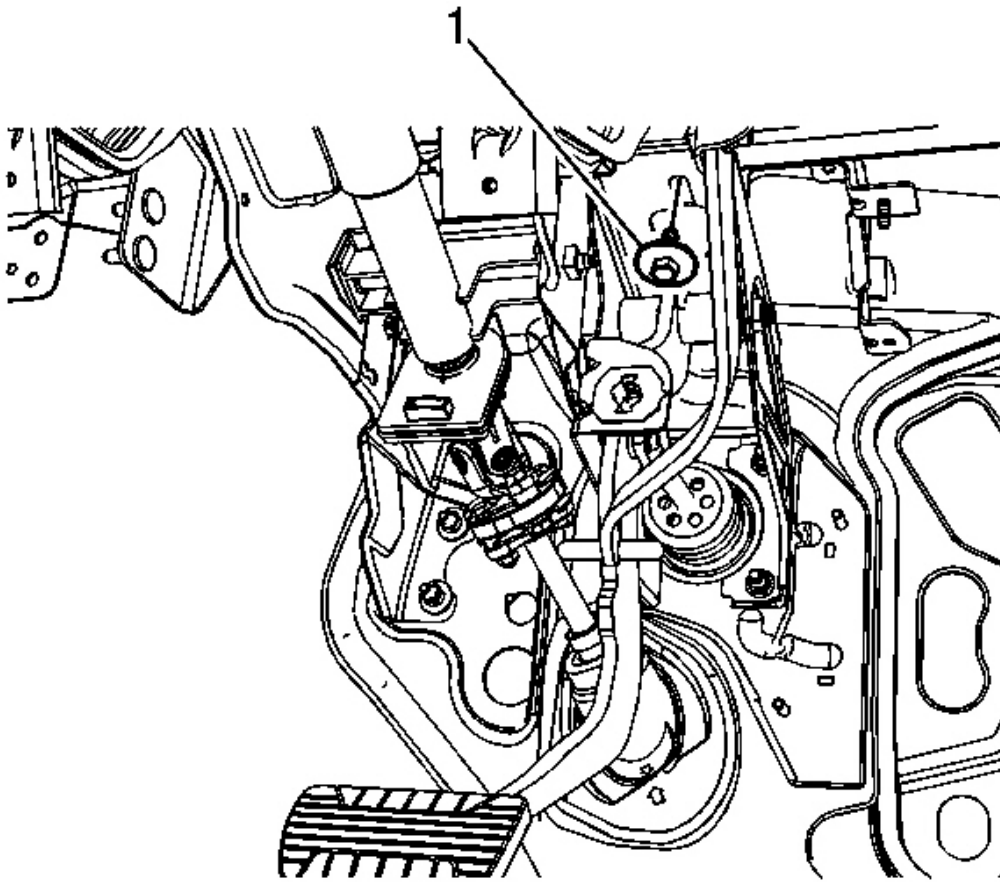
1. Remove the instrument carrier. Refer to **Instrument Carrier Replacement (Equinox)** or **Instrument Carrier Replacement (Terrain)** .
2. Remove the accelerator pedal position sensor. Refer to **Accelerator Pedal with Position Sensor Assembly Replacement** or **Accelerator Pedal Position Sensor Replacement** .

3. Remove the brake pedal position sensor. Refer to [Brake Pedal Position Sensor Replacement](#) .



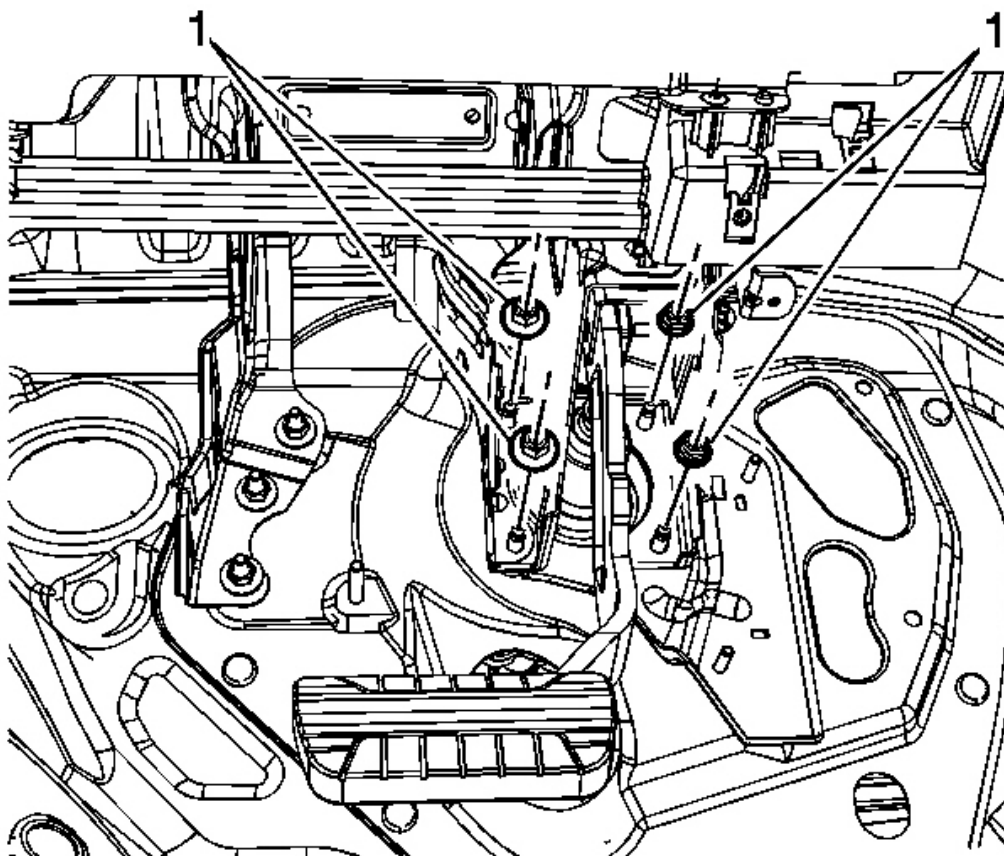
**Fig. 20: Brake Booster Pushrod Nut**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the brake booster pushrod nut (1).
5. Disconnect the brake booster pushrod from the brake pedal pivot pin.



**Fig. 21: Brake Pedal Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

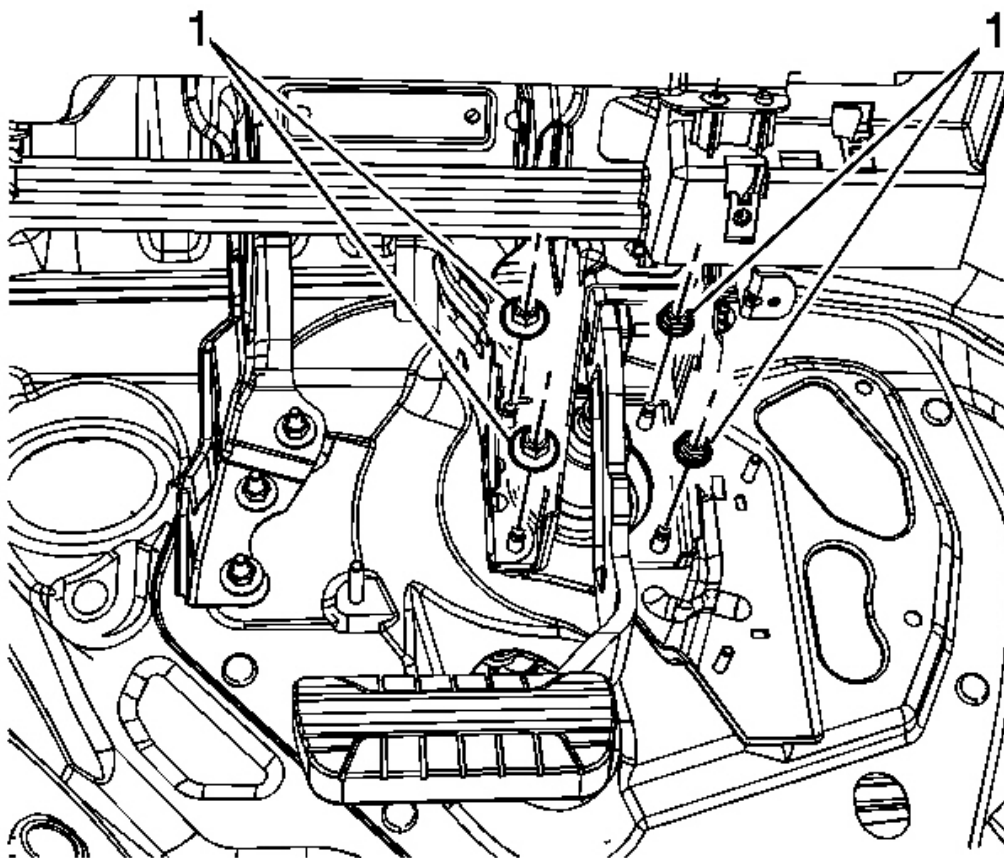
6. Remove the brake pedal bracket bolt (1).
7. Remove the instrument carrier. Refer to **Instrument Carrier Replacement (Equinox)** or **Instrument Carrier Replacement (Terrain)** .



**Fig. 22: Brake Pedal Bracket Nuts**  
**Courtesy of GENERAL MOTORS CORP.**

8. Remove the brake pedal bracket nuts (1) and the brake pedal assembly.

#### **Installation Procedure**

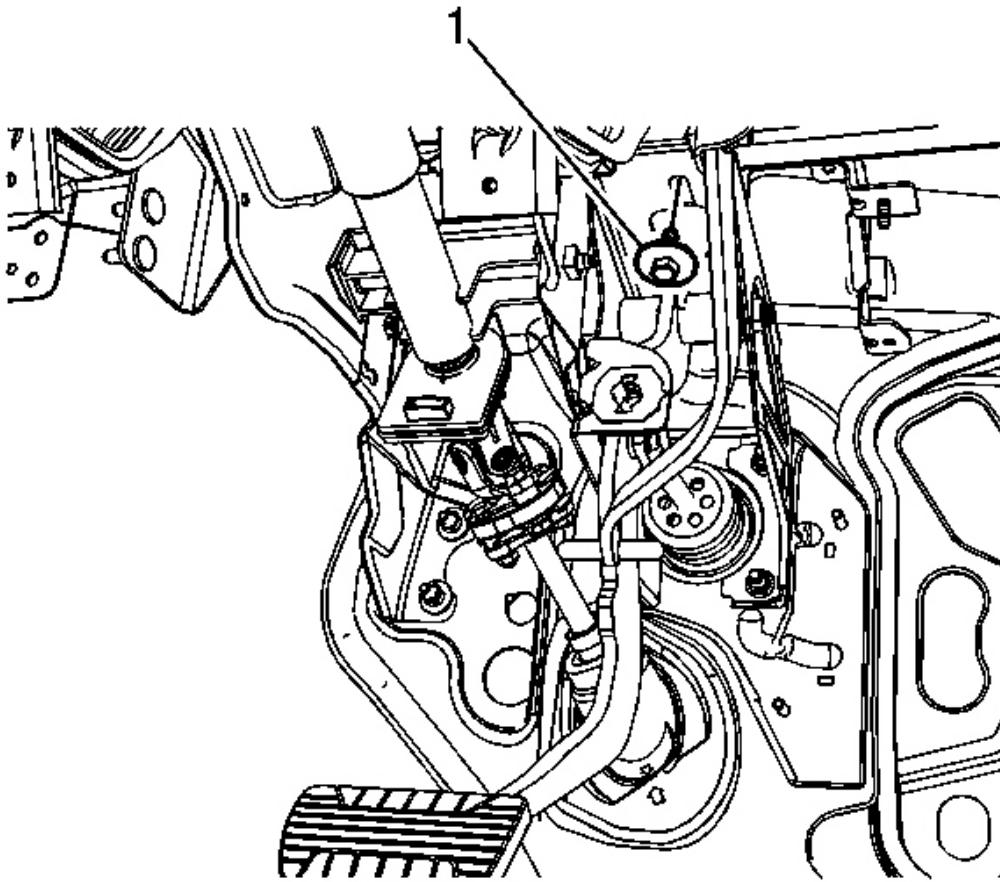


**Fig. 23: Brake Pedal Bracket Nuts**  
**Courtesy of GENERAL MOTORS CORP.**

1. Install the brake pedal assembly to the dash panel reinforcement plate.

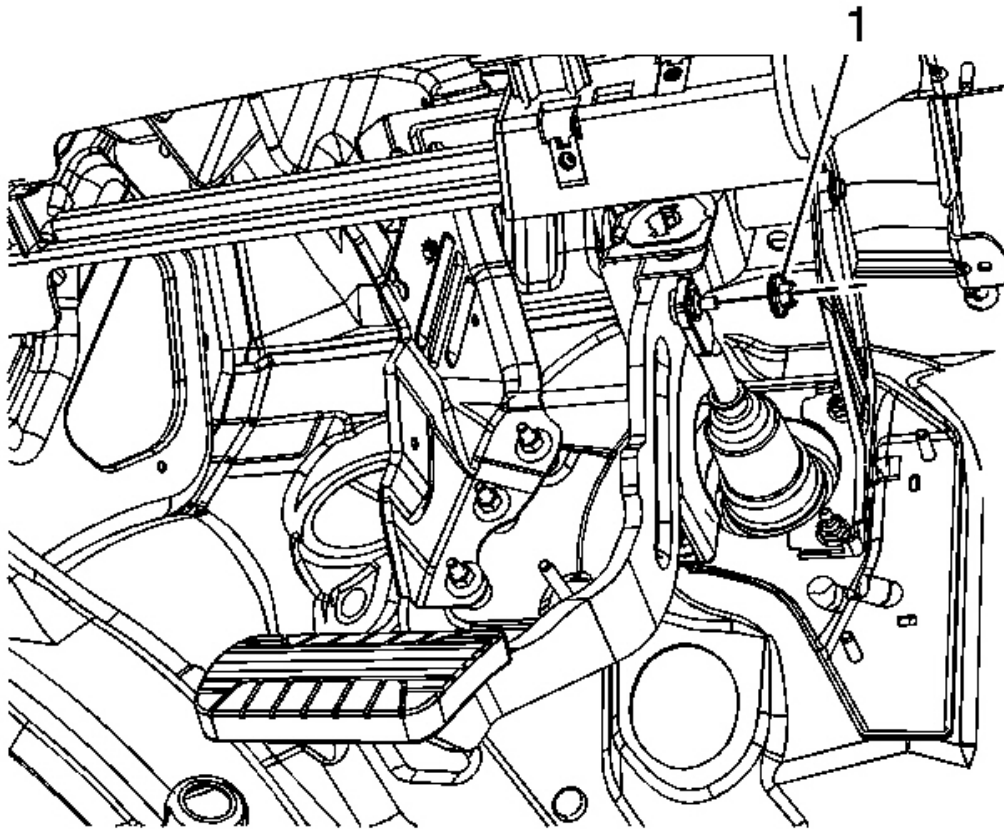
**CAUTION: Refer to Fastener Caution .**

2. Install the brake pedal bracket nuts (1) and tighten to 25 N.m (18 lb ft).



**Fig. 24: Brake Pedal Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

3. Install the brake pedal bracket bolt (1) and tighten to 25 N.m (18 lb ft).



**Fig. 25: Brake Booster Pushrod Nut**  
Courtesy of GENERAL MOTORS CORP.

4. Connect the brake booster pushrod from the brake pedal pivot pin.
5. Install the brake booster pushrod nut (1) and tighten to 25 N.m (18 lb ft).
6. Install the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement** .
7. Install the accelerator pedal position sensor. Refer to **Accelerator Pedal with Position Sensor Assembly Replacement** or **Accelerator Pedal Position Sensor Replacement** .
8. Install the instrument carrier. Refer to **Instrument Carrier Replacement (Equinox)** or **Instrument Carrier Replacement (Terrain)** .

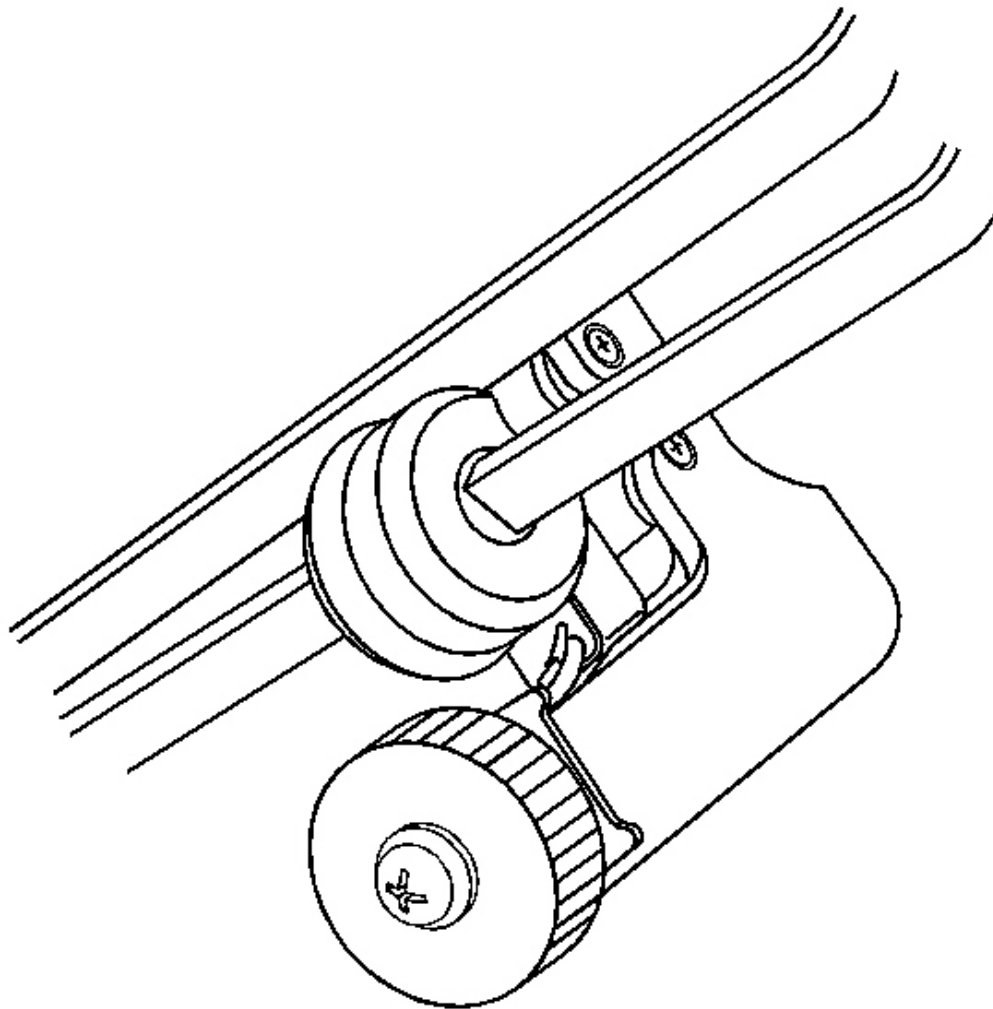
## **BRAKE PIPE REPLACEMENT**

### **Special Tools**

**J-45405:** Pipe Flaring Tool Kit

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

**Replace**



**Fig. 26: Sectioning Brake Pipe Using Pipe Cutter**  
Courtesy of GENERAL MOTORS CORP.

**WARNING:** Refer to **Brake Fluid Irritant Warning** .

**WARNING:** Always use double walled steel brake pipe when replacing brake

pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the correct fasteners and the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and cause brake system failure.

**CAUTION:** Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

**NOTE:** When servicing the brake pipes, note the following:

- If sectioning the brake pipe, use replacement pipe of the same type and outside diameter.
- Use fittings of the appropriate size and type.
- Only create flares of the same type or design as originally equipped on the vehicle.

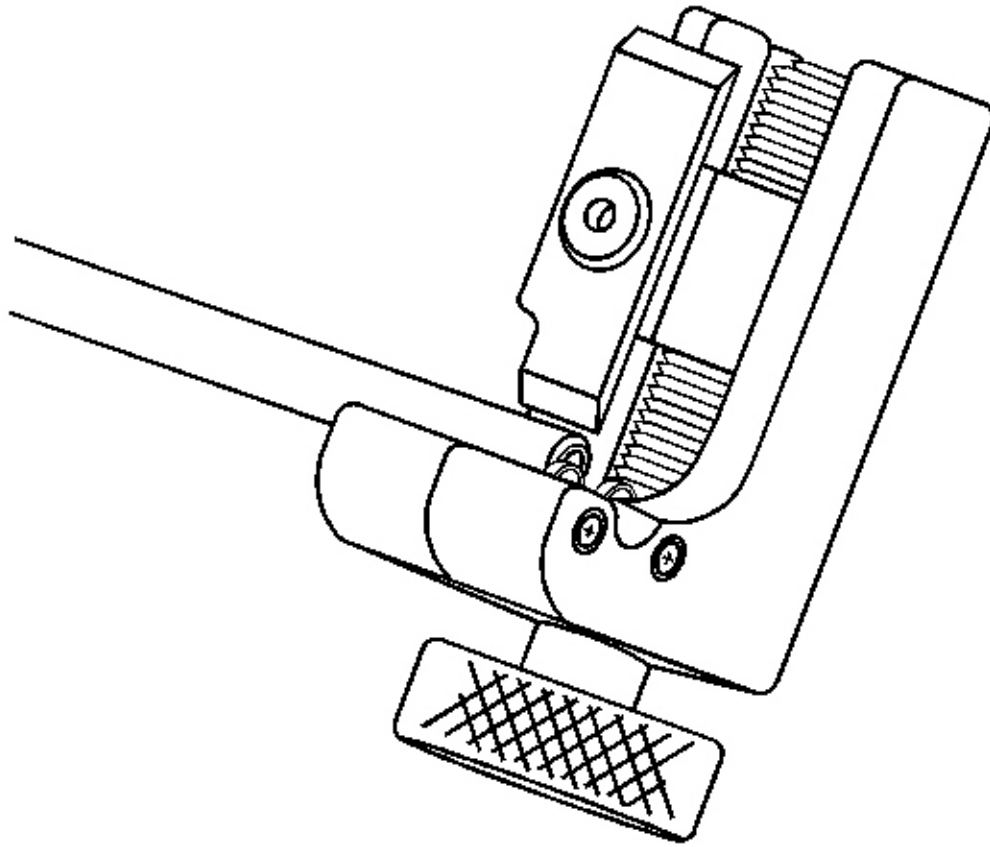
1. Inspect the area of brake pipe to be repaired or replaced.
2. Release the brake pipe to be replaced from the retainers, as required.
3. Select an appropriate location to section the brake pipe, if necessary.
  - Allow adequate clearance in order to maneuver the **J-45405: Pipe Flaring Tool Kit** .
  - Avoid sectioning the brake pipe at bends or mounting points.
4. Using a string or wire, measure the length of the pipe to be replaced including all pipe bends.
5. Add to the measurement taken the appropriate additional length required for each flare to be created.

**Specification:**

- 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe
- 9.50 mm (0.374 in) for 6.35 mm (1/4 in) diameter pipe
- 12.67 mm (0.499 in) for 7.94 mm (5/16 in) diameter pipe

**NOTE:** Ensure that the brake pipe end to be flared is cut at a square, 90 degree angle to the pipe length.

6. Using the pipe cutter included in the **J-45405: Pipe Flaring Tool Kit**, carefully cut the brake pipe squarely to the measured length.
7. Remove the sectioned brake pipe from the vehicle.
8. Select the appropriate size of brake pipe and tube nuts, as necessary. The brake pipe outside diameter determines brake pipe size.



**Fig. 27: Stripping Nylon Coating From Brake Pipe Ends**  
**Courtesy of GENERAL MOTORS CORP.**

9. Strip the nylon coating from the brake pipe end to be flared, if necessary.
  1. Select the appropriate blade on the coating stripping tool included in the **J-45405: Pipe Flaring Tool Kit**, by unthreading the blade block from the stripping tool and installing the block with the desired blade facing the tool rollers.

**Specification:**

- 6.35 mm (0.250 in) blade for 4.76 mm (3/16 in) diameter pipe
  - 9.50 mm (0.374 in) blade for 6.35 mm (1/4 in) and 7.94 mm (5/16 in) diameter pipe
2. Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
  3. While holding the brake pipe firmly against the stripping tool roller ledges, rotate the thumbwheel

of the tool until the blade contacts the brake pipe coated surface.

**NOTE: Do not gouge the metal surface of the brake pipe.**

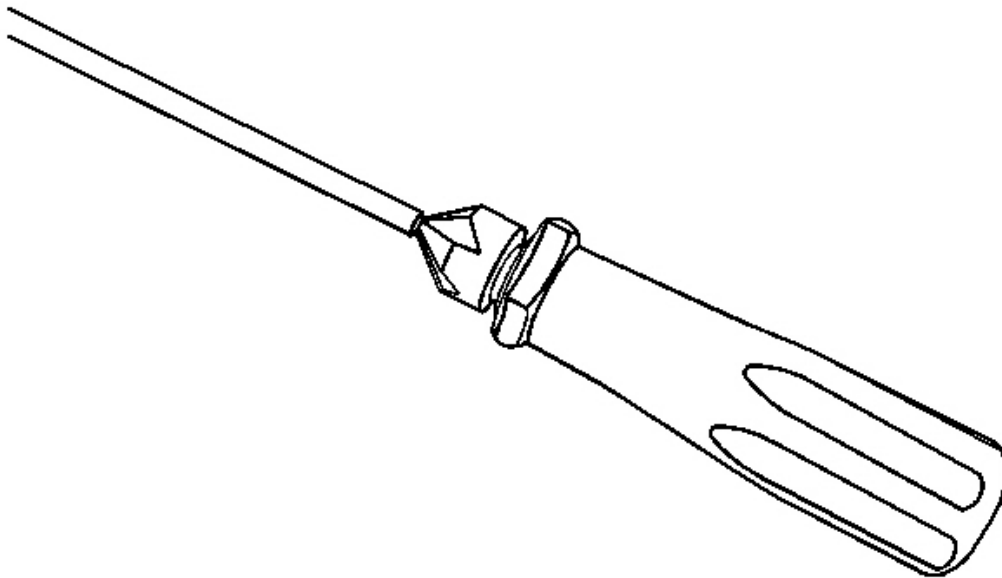
4. Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against the tool roller ledges.
5. After each successive revolution of the stripping tool, carefully rotate the thumbwheel of the tool clockwise, in order to continue stripping the coating from the brake pipe until the metal pipe surface is exposed.
6. Loosen the thumbwheel of the tool and remove the brake pipe.

**NOTE: Ensure that all loose remnants of the nylon coating have been removed from the brake pipe.**

7. Inspect the stripped end of the brake pipe to ensure that the proper amount of coating has been removed.

**Specification:**

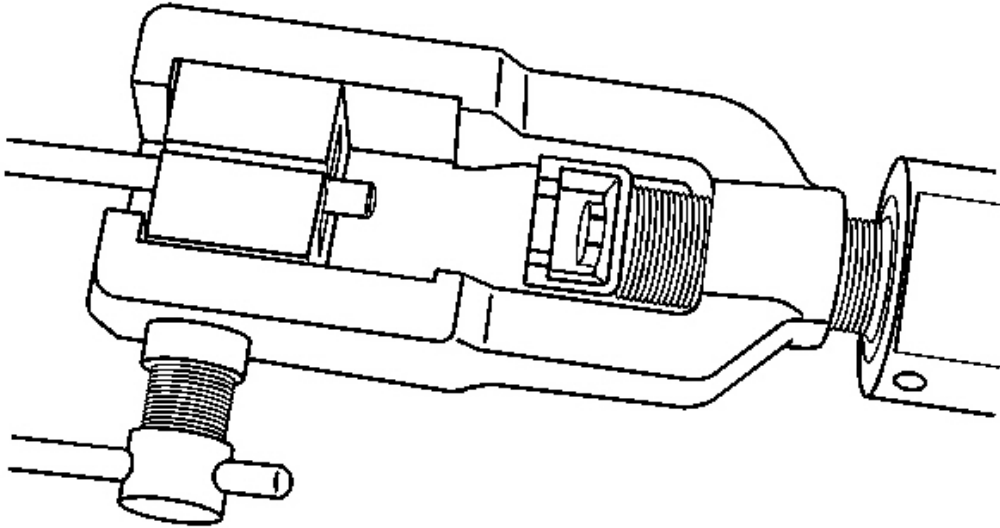
- 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe
- 9.50 mm (0.374 in) for 6.35 mm (1/4 in) and 7.94 mm (5/16 in) diameter pipe



**Fig. 28: Chamfering Pipe Using De-Burring Tool**

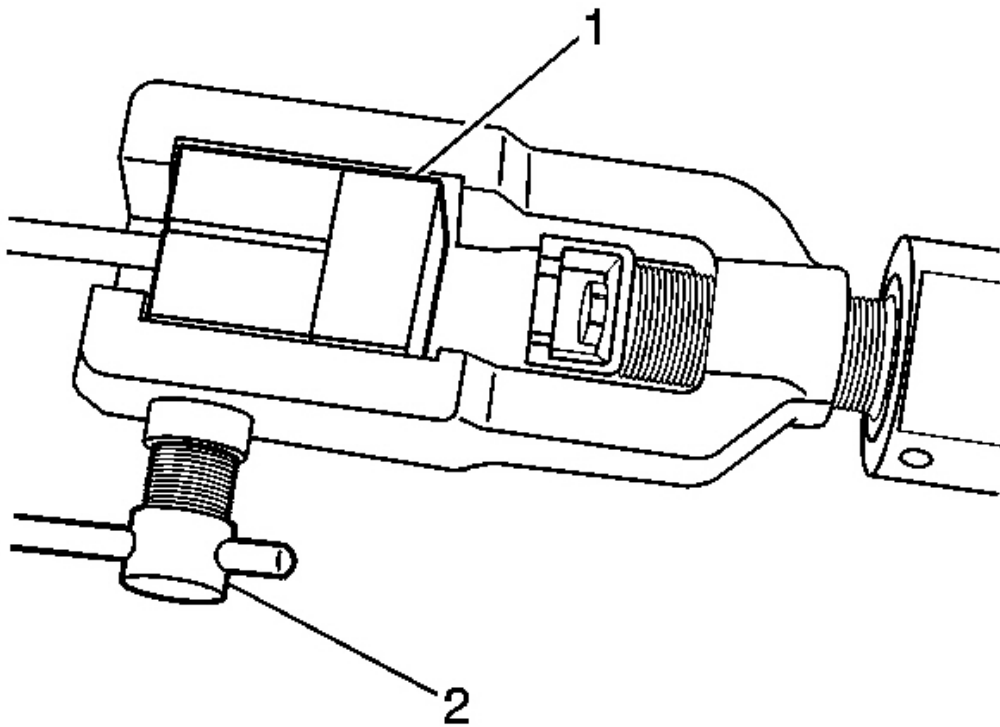
Courtesy of GENERAL MOTORS CORP.

10. Chamfer the inside and outside diameter of the pipe with the de-burring tool included in the **J-45405: Pipe Flaring Tool Kit**.
11. Install the tube nuts on the brake pipe, noting their orientation.
12. Clean the brake pipe and the **J-45405: Pipe Flaring Tool Kit** of lubricant, contaminants, and debris.



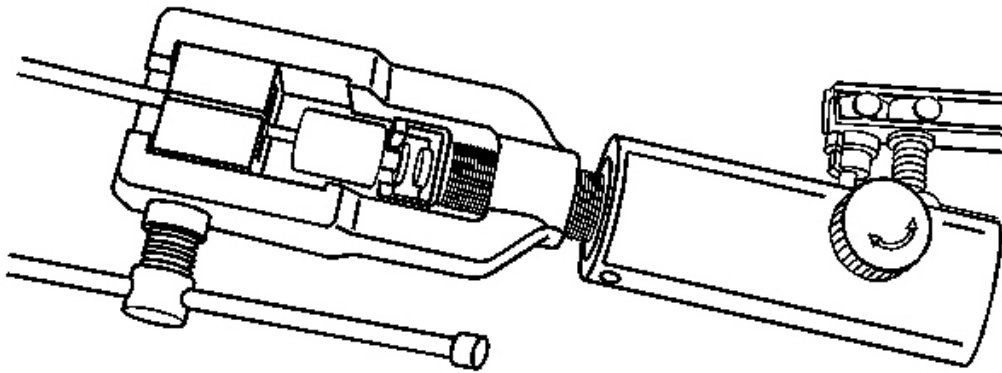
**Fig. 29: Installing Die Halves Into Die Cage**  
Courtesy of GENERAL MOTORS CORP.

13. Loosen the die clamping screw of the **J-45405: Pipe Flaring Tool Kit**.
14. Select the corresponding die set and install the die halves into the die cage with the full, flat face of one die facing the clamping screw, and the counterbores of both dies facing the forming ram.



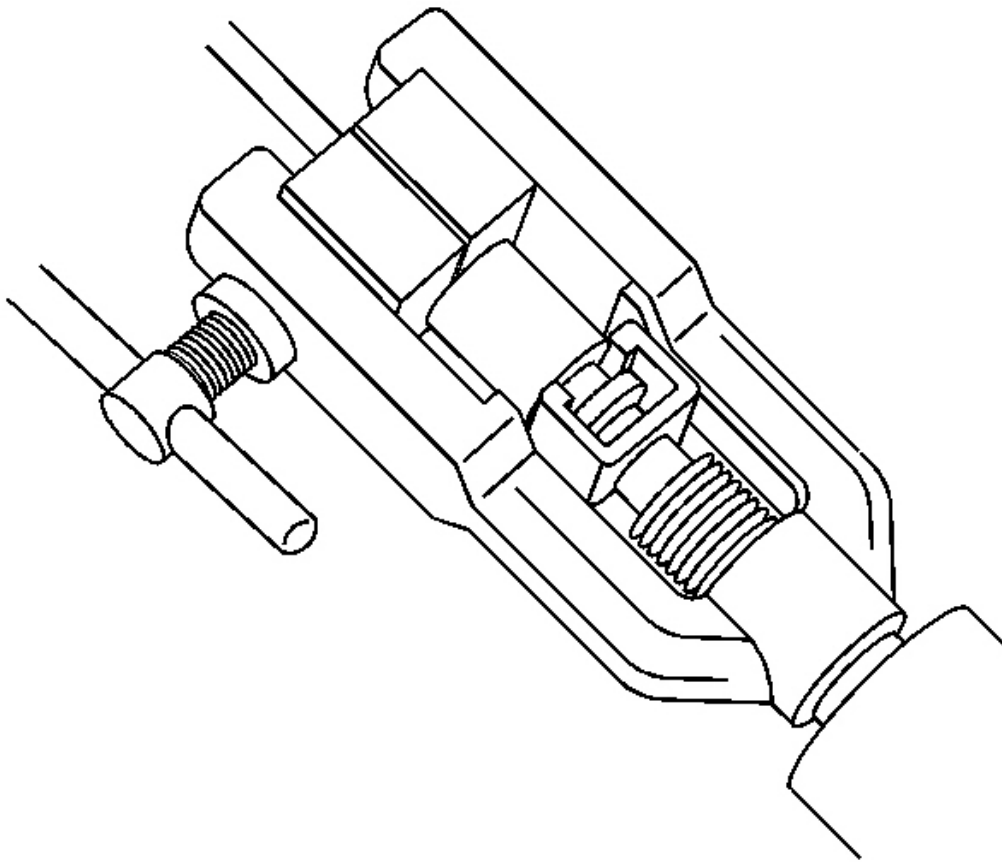
**Fig. 30: View Of Clamping Screw & Unused Die**  
**Courtesy of GENERAL MOTORS CORP.**

15. Place the flat face of an unused die (1) against the die halves in the clamping cage and hold firmly against the counterbored face of the dies.
16. Insert the prepared end of the pipe to be flared through the back of the dies until the pipe is seated against the flat surface of the unused die (1).
17. Remove the unused die (1).
18. Ensure that the rear of both dies are seated firmly against the enclosed end of the die cage.
19. Firmly hand tighten the clamping screw (2) against the dies.



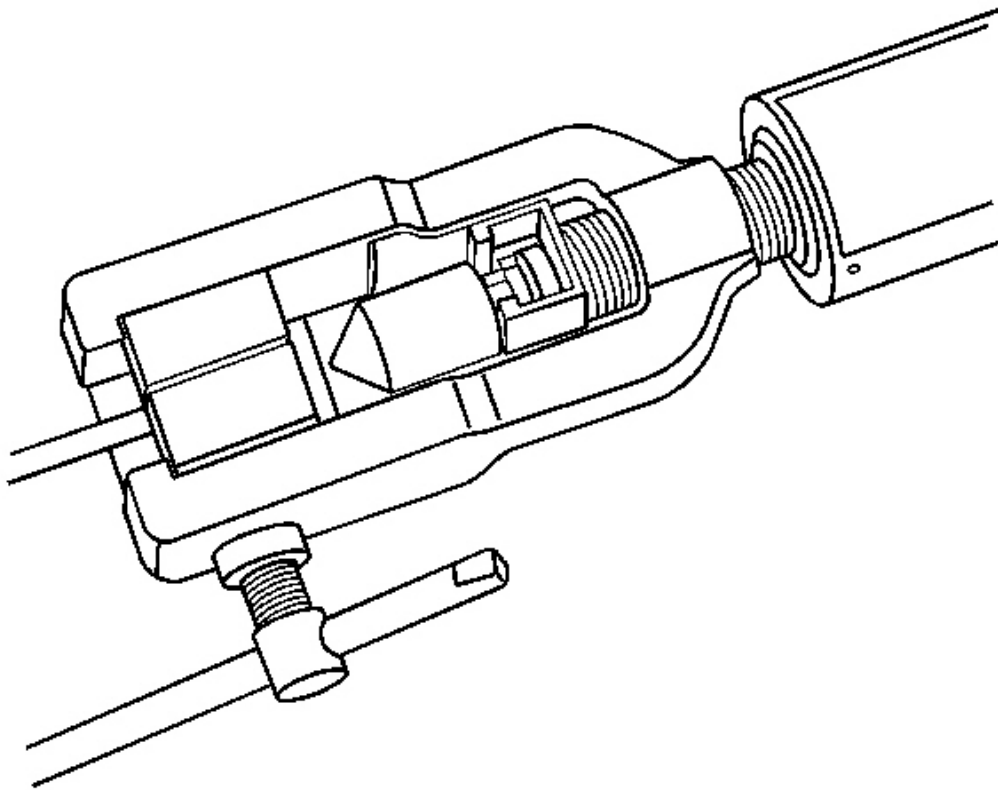
**Fig. 31: Rotating J 45405 To Bottom Against Die Cage**  
**Courtesy of GENERAL MOTORS CORP.**

20. Select the appropriate forming mandrel and place into the forming ram.
21. Rotate the hydraulic fluid control valve clockwise to the closed position.
22. Rotate the body of the **J-45405**: Pipe Flaring Tool Kit until it bottoms against the die cage.



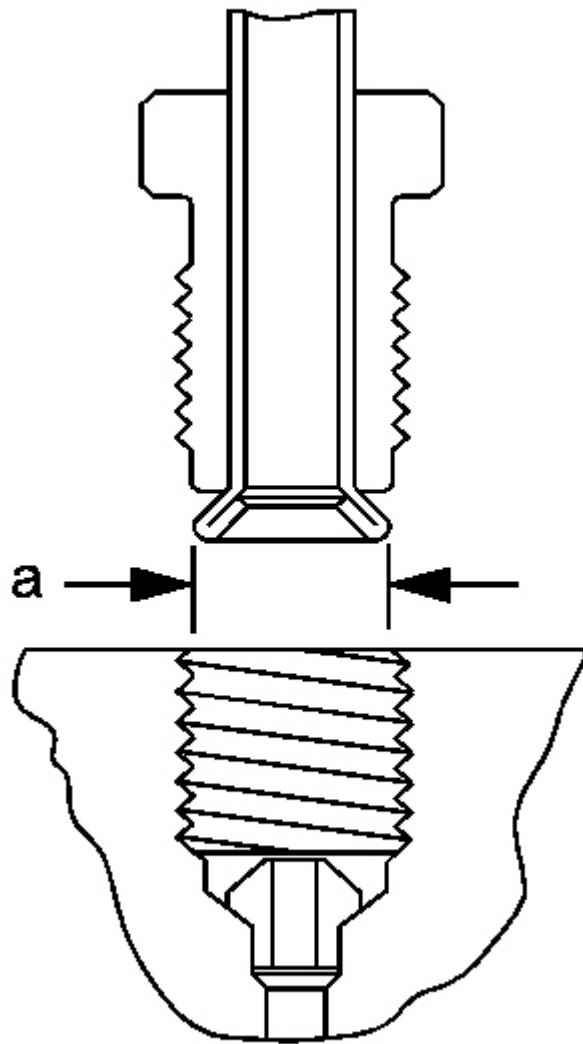
**Fig. 32: Bottoming Forming Mandrel Against Clamping Dies Using Pipe Flaring Tool**  
**Courtesy of GENERAL MOTORS CORP.**

23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the **J-45405: Pipe Flaring Tool Kit** until the forming mandrel bottoms against the clamping dies.
24. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.



**Fig. 33: Using Pipe Flaring Tool**  
**Courtesy of GENERAL MOTORS CORP.**

25. Insert the finishing cone into the forming ram.
26. Rotate the hydraulic fluid control valve clockwise to the closed position.
27. Rotate the body of the **J-45405: Pipe Flaring Tool Kit** until it bottoms against the die cage.
28. While guiding the finishing cone into the exposed end of pipe to be flared, operate the lever of the **J-45405: Pipe Flaring Tool Kit** until the finishing cone bottoms against the dies.
29. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.
30. Loosen the die clamping screw and remove the dies and pipe.
31. If necessary, lightly tap the dies until the die halves separate.



**Fig. 34: Identifying Correct Brake Pipe Flare Shape & Diameter**  
Courtesy of GENERAL MOTORS CORP.

32. Inspect the brake pipe flare for correct shape and diameter (a).

**Specification:**

- 6.74-7.10 mm (0.265-0.279 in) flare diameter for 4.76 mm (3/16 in) diameter pipe
- 8.57-9.27 mm (0.344-0.358 in) flare diameter for 6.35 mm (1/4 in) diameter pipe
- 10.42-10.79 mm (0.410-0.425 in) flare diameter for 7.94 mm (5/16 in) diameter pipe

33. If necessary, using the removed section of brake pipe as a template, shape the new pipe with a suitable brake pipe bending tool.

**NOTE:** When installing the pipe, maintain a clearance of 19 mm (3/4 in) from all moving or vibrating components.

34. Install the pipe to the vehicle with the appropriate brake pipe unions, as required.
35. If previously released, secure the brake pipe to the retainers.
36. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding (Manual) or Hydraulic Brake System Bleeding (Pressure).
37. With the aid of an assistant, inspect the brake pipe flares for leaks by starting the engine and applying the brakes.

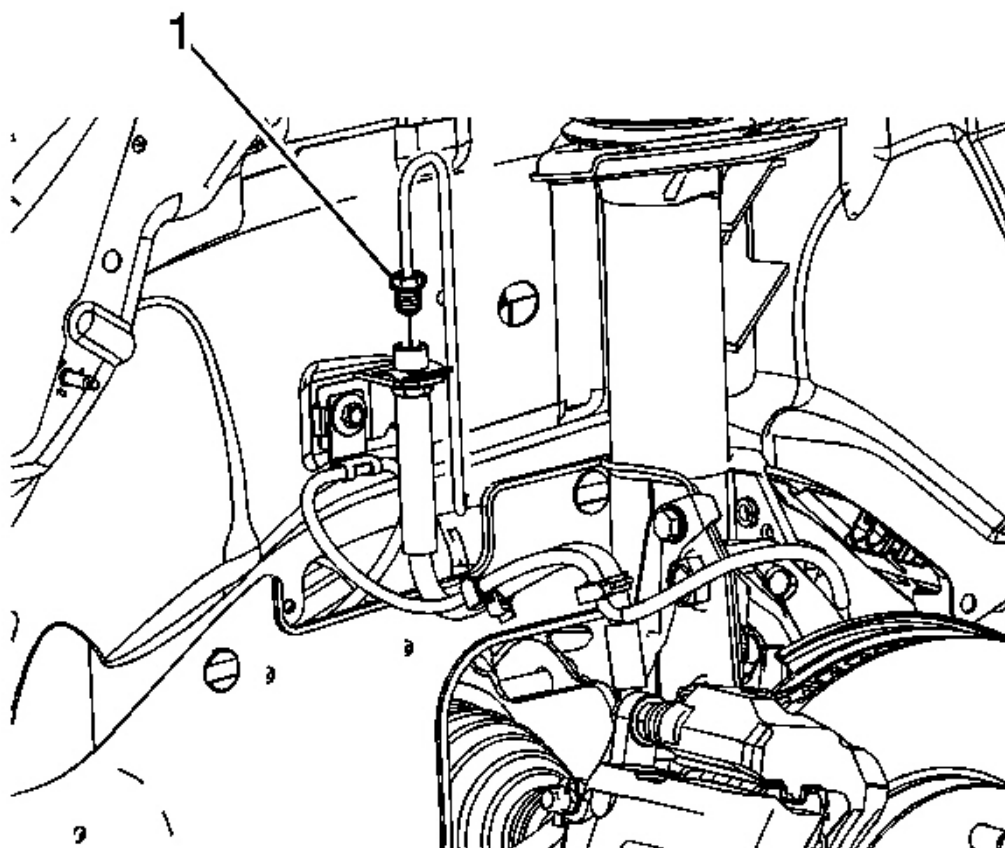
## FRONT BRAKE HOSE REPLACEMENT

### Removal Procedure

**WARNING:** Refer to Brake Fluid Irritant Warning .

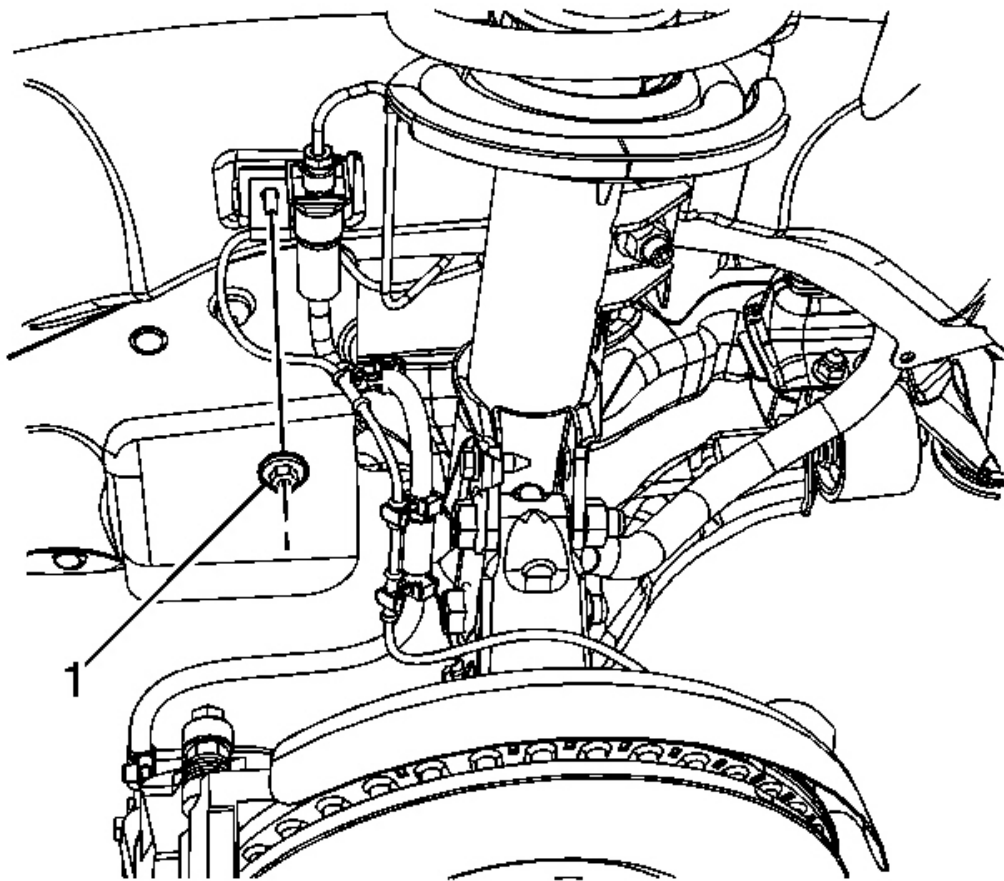
**CAUTION:** Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .



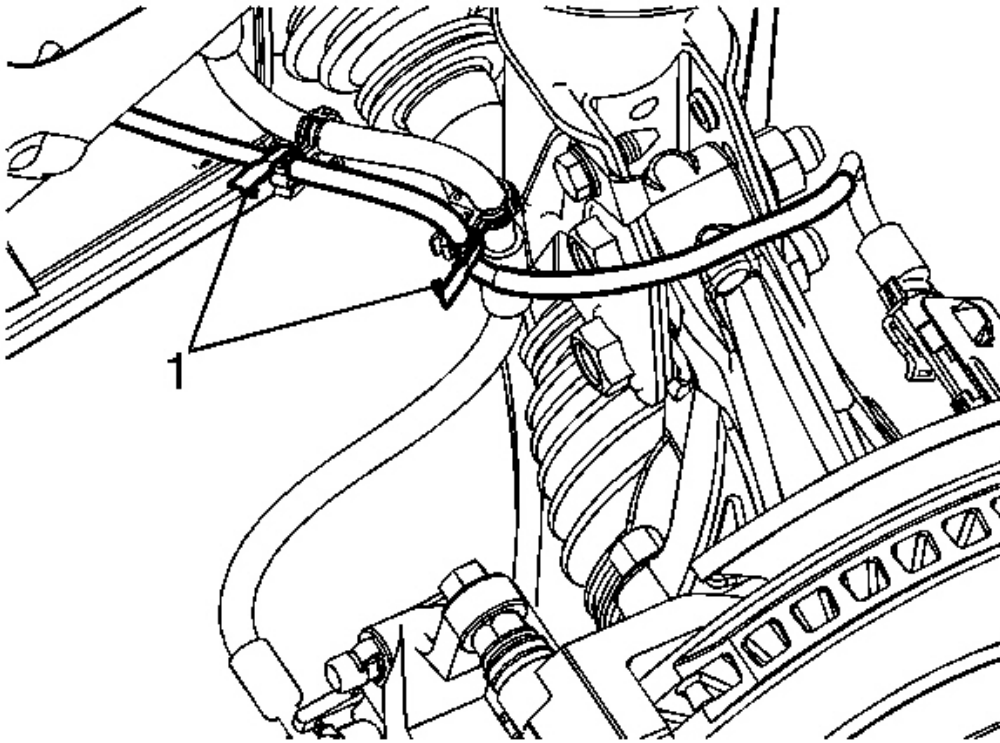
**Fig. 35: Brake Pipe Fitting**  
**Courtesy of GENERAL MOTORS CORP.**

3. Disconnect the brake pipe fitting (1) from the brake hose.
4. Cap the brake pipe fitting to prevent brake fluid loss and contamination.



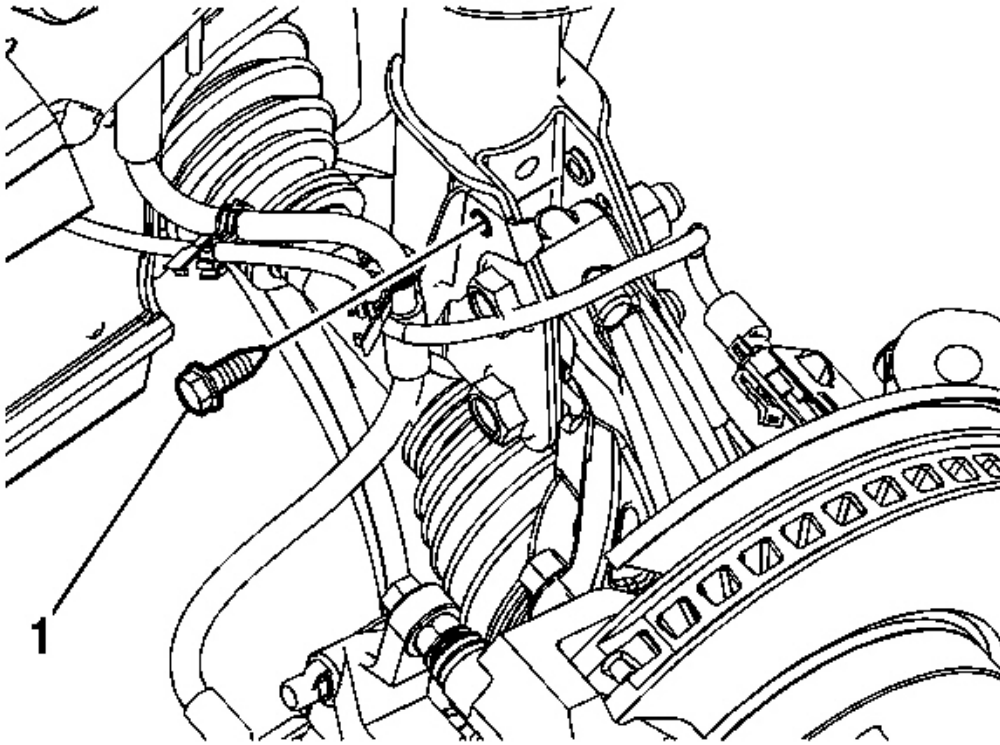
**Fig. 36: Brake Hose Bracket Nut**  
Courtesy of GENERAL MOTORS CORP.

5. Remove the brake hose bracket nut (1).



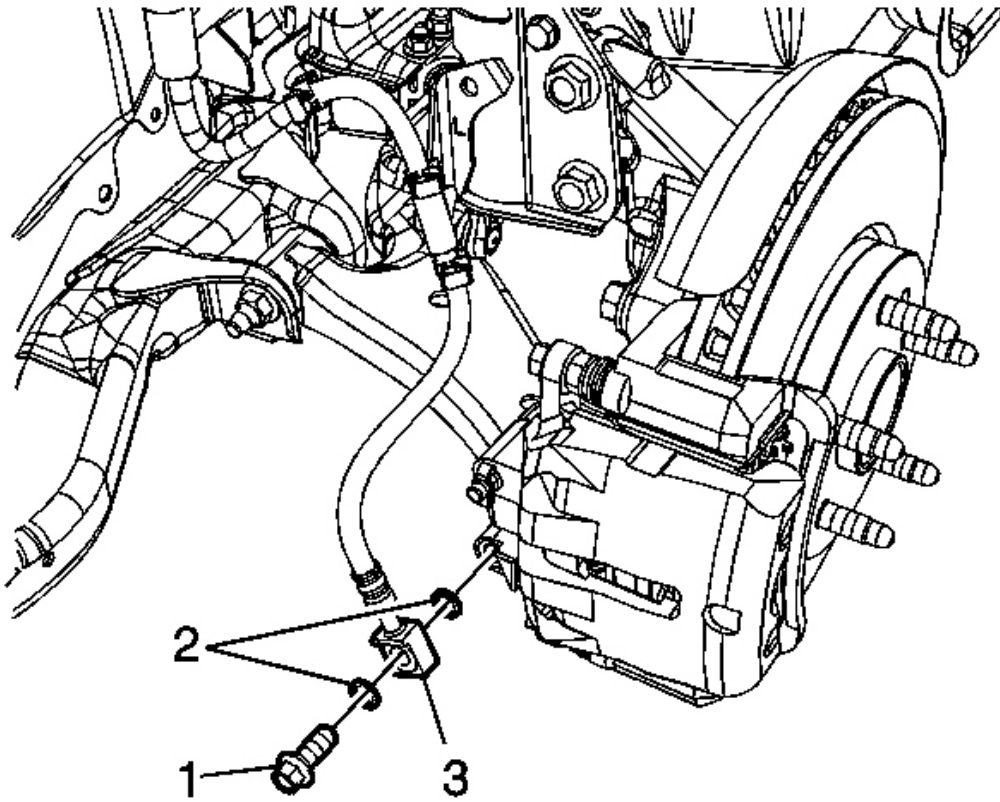
**Fig. 37: Identifying Wheel Speed Sensor Harness Retaining Clips**  
Courtesy of GENERAL MOTORS CORP.

6. Release the wheel speed sensor harness retaining clips (1) and release the harness.



**Fig. 38: Brake Hose Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the brake hose bracket bolt (1).



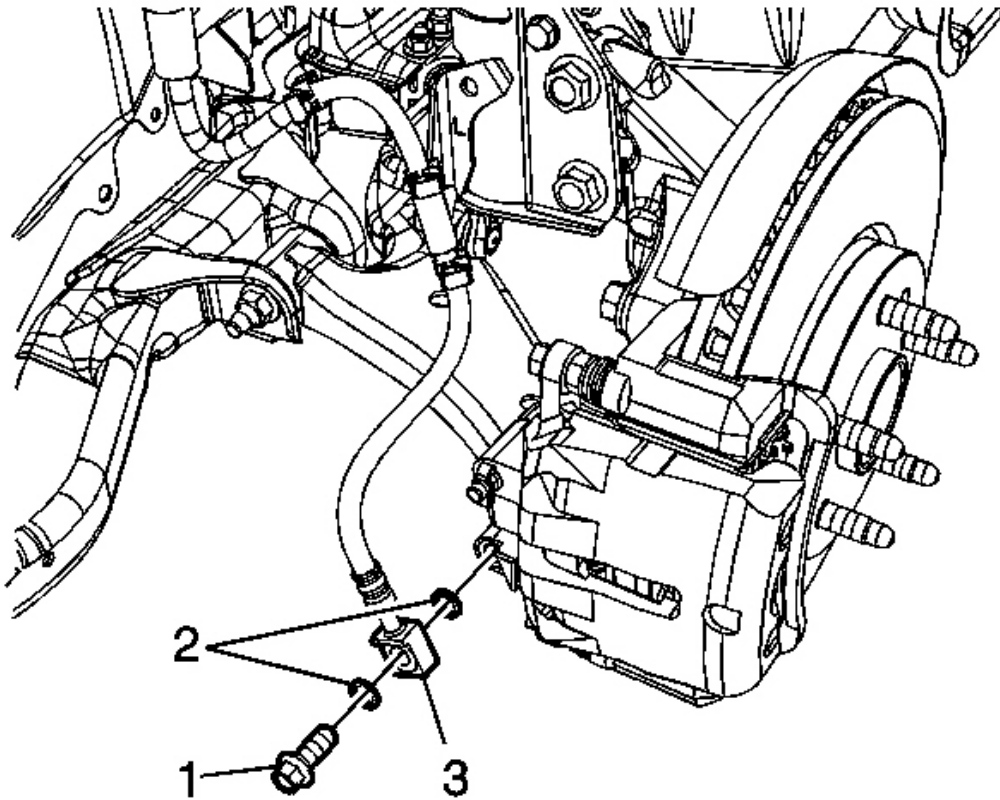
**Fig. 39: Brake Hose, Fitting Bolt & Fitting Gaskets**  
Courtesy of GENERAL MOTORS CORP.

8. Remove the brake hose fitting bolt (1) from the brake hose and the caliper.

**NOTE:**        **Do not reuse the brake hose fitting gaskets.**

9. Remove and discard the brake hose fitting gaskets (2) from the brake hose (3).
10. Remove the brake hose.

#### **Installation Procedure**



**Fig. 40: Brake Hose, Fitting Bolt & Fitting Gaskets**  
Courtesy of GENERAL MOTORS CORP.

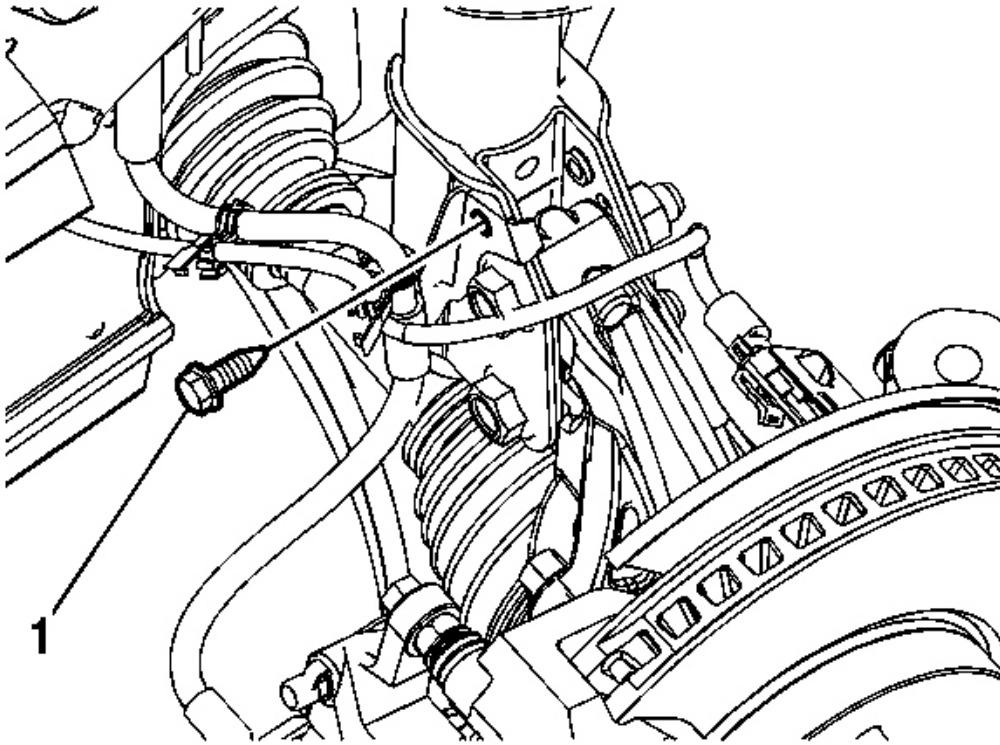
1. Install the brake hose.

**NOTE:** Install new brake hose fitting gaskets.

2. Assemble the brake hose fitting bolt (1) with 2 new brake hose fitting gaskets (2) to the brake hose (3).

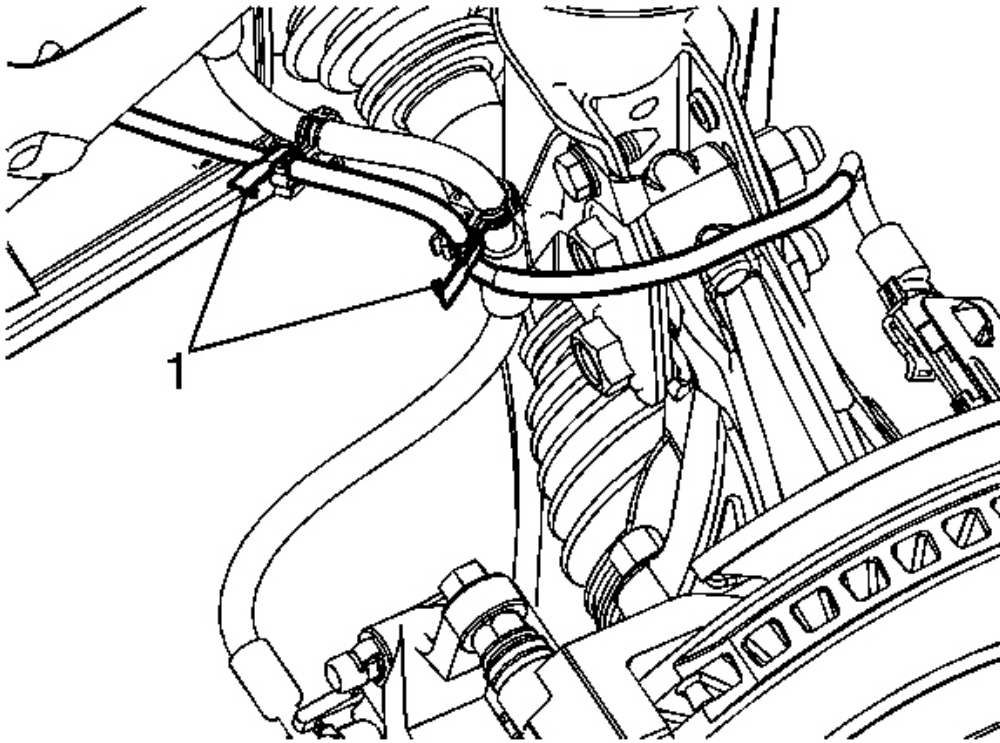
**CAUTION:** Refer to Fastener Caution .

3. Install the brake hose assembly to the brake hose and the caliper and tighten the brake hose fitting bolt to 40 N.m (30 lb ft).



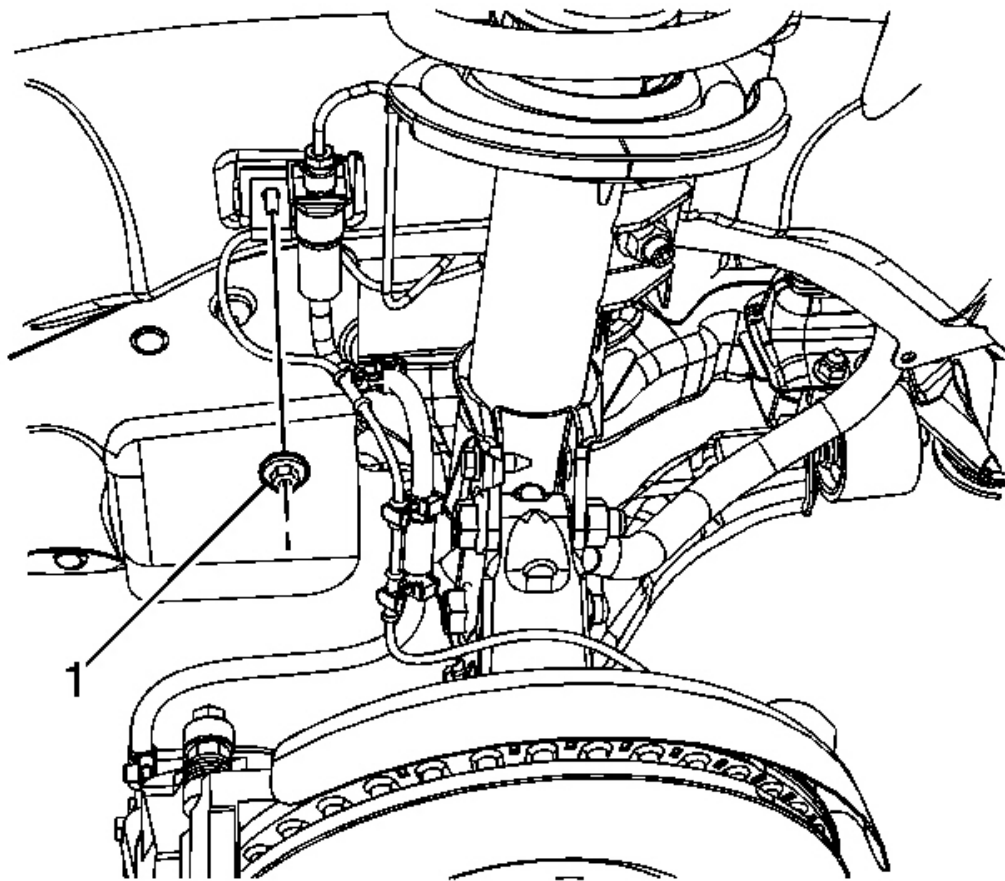
**Fig. 41: Brake Hose Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

4. Install the brake hose bracket bolt (1) and tighten to 16 N.m (12 lb ft).



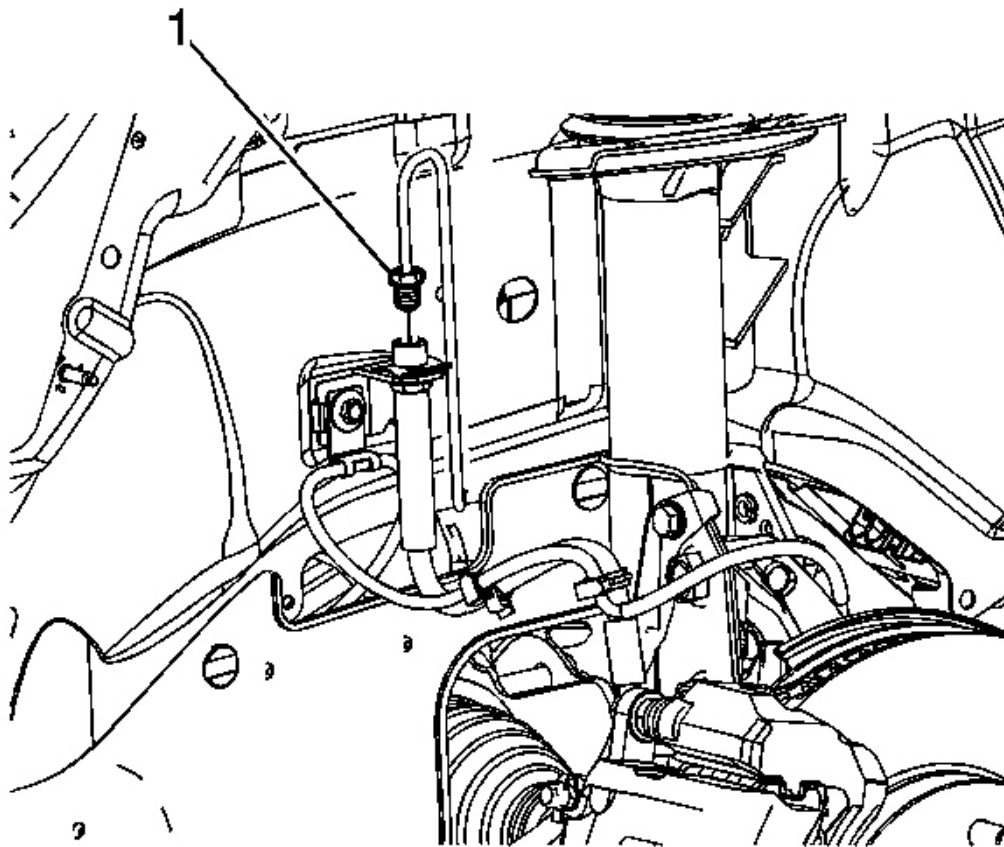
**Fig. 42: Identifying Wheel Speed Sensor Harness Retaining Clips**  
Courtesy of GENERAL MOTORS CORP.

5. Install the wheel speed sensor harness and secure the retaining clips (1).



**Fig. 43: Brake Hose Bracket Nut**  
Courtesy of GENERAL MOTORS CORP.

6. Install the brake hose bracket nut (1) and tighten to 10 N.m (89 lb in).



**Fig. 44: Brake Pipe Fitting**  
Courtesy of GENERAL MOTORS CORP.

7. Connect the brake pipe fitting (1) to the brake hose and tighten to and tighten to 18 N.m (13 lb ft).
8. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
9. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

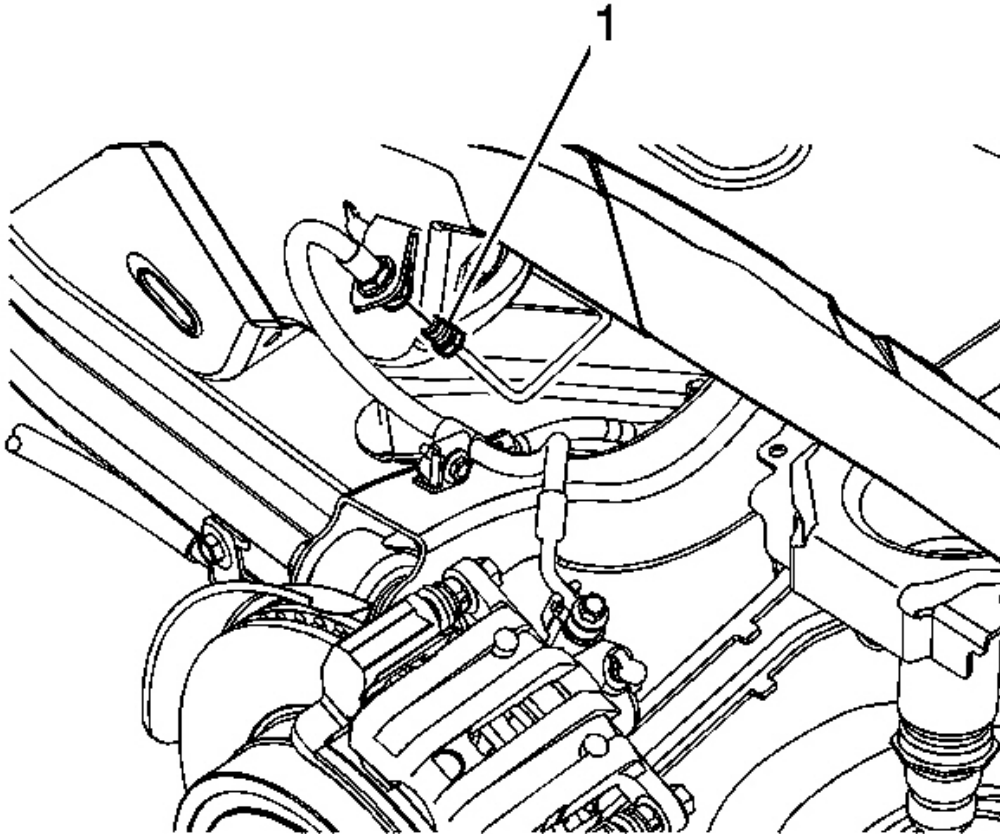
## REAR BRAKE HOSE REPLACEMENT

### Removal Procedure

**WARNING:** Refer to **Brake Fluid Irritant Warning** .

**CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

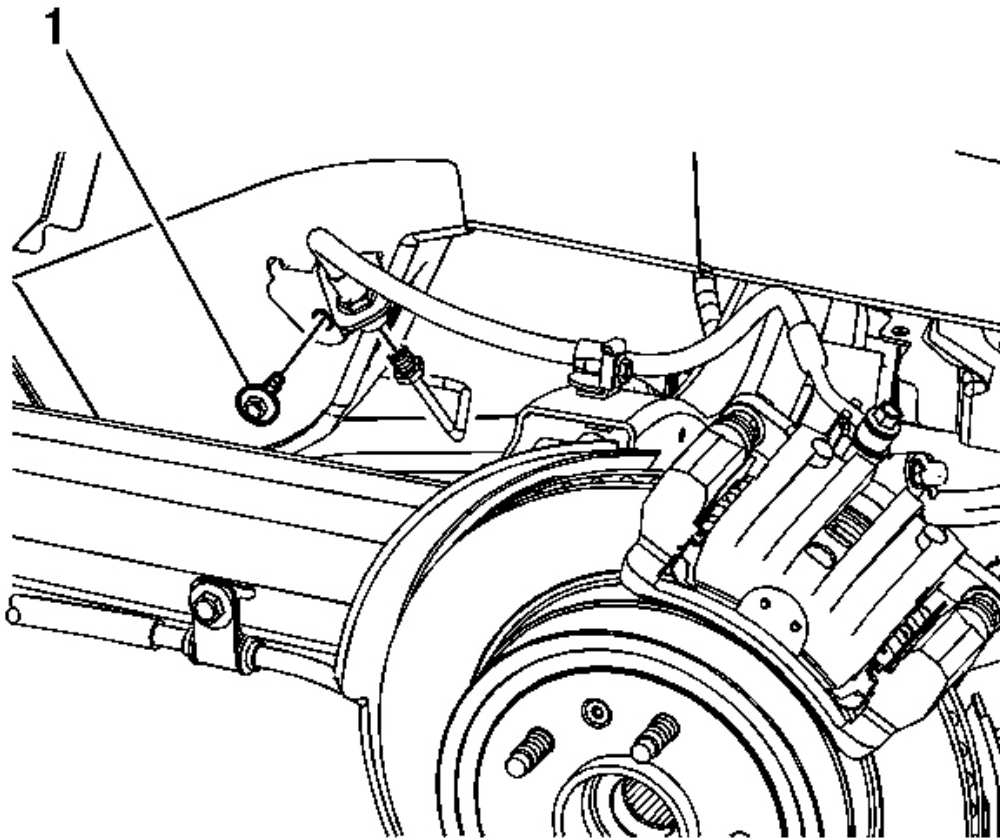
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .



**Fig. 45: Brake Pipe Fitting**

**Courtesy of GENERAL MOTORS CORP.**

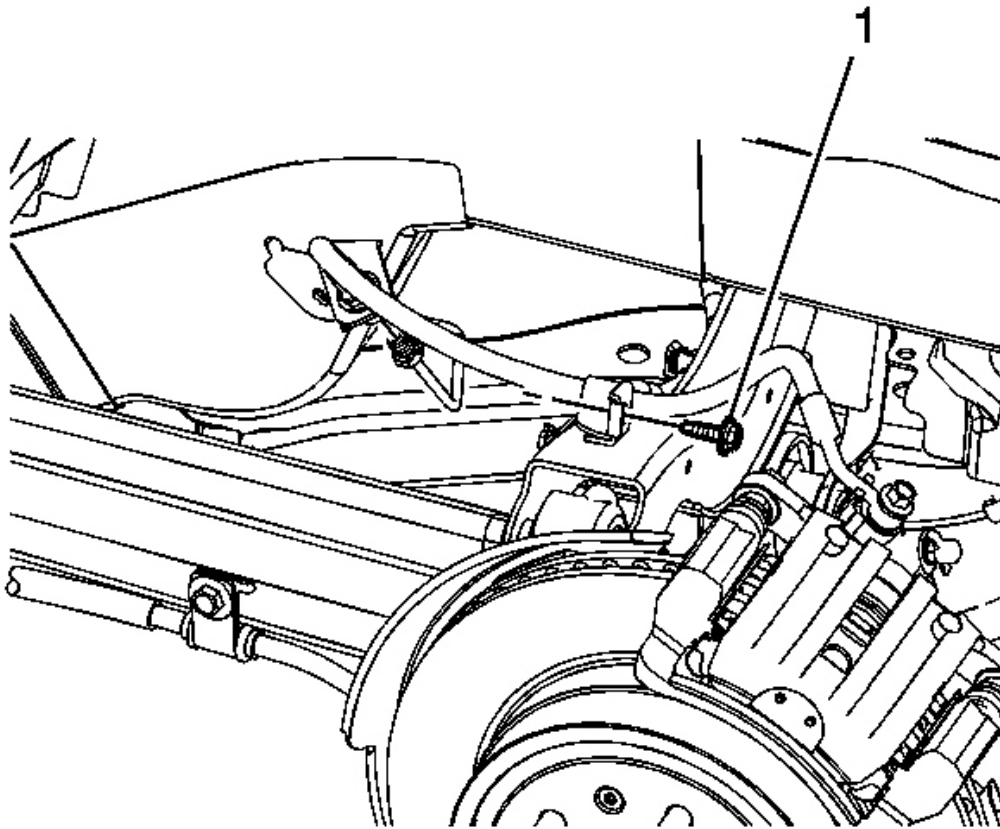
3. Disconnect the brake pipe fitting (1) from the brake hose.
4. Cap the brake pipe fitting to prevent brake fluid loss and contamination.



**Fig. 46: Brake Hose Bolt**

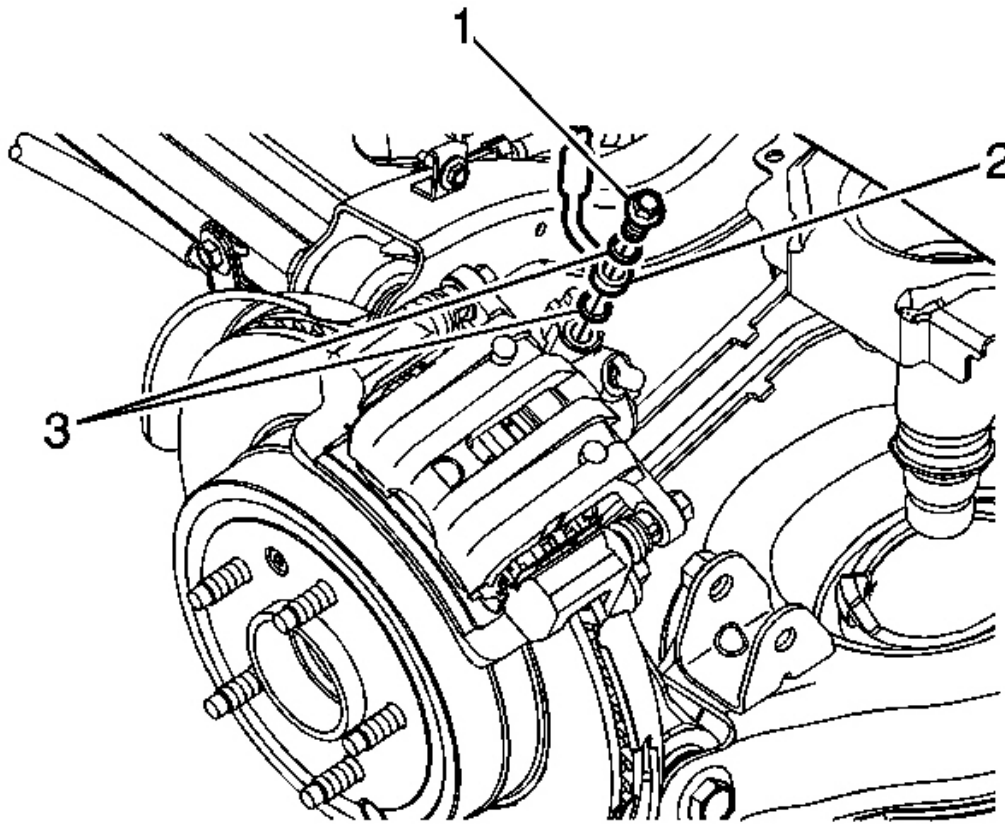
Courtesy of GENERAL MOTORS CORP.

5. Remove the brake hose bolt (1) securing the brake hose bracket to the wheelhouse.



**Fig. 47: Brake Hose Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the brake hose bracket bolt (1).



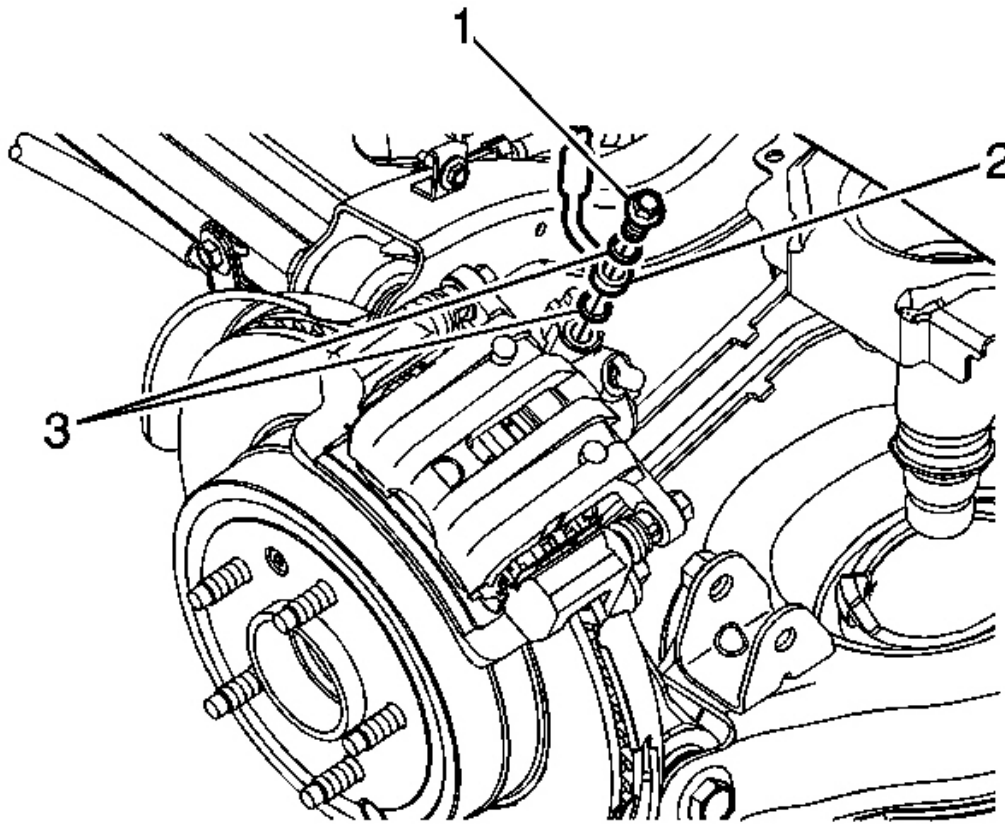
**Fig. 48: Brake Hose, Fitting Bolt & Fitting Gaskets**  
**Courtesy of GENERAL MOTORS CORP.**

7. Remove the brake hose fitting bolt (1) from the brake hose and the caliper.
8. Remove the brake hose (2) from the caliper.

**NOTE: Do not reuse the brake hose fitting gaskets.**

9. Remove and discard the brake hose fitting gaskets (3).
10. Remove the brake hose.

#### **Installation Procedure**



**Fig. 49: Brake Hose, Fitting Bolt & Fitting Gaskets**  
**Courtesy of GENERAL MOTORS CORP.**

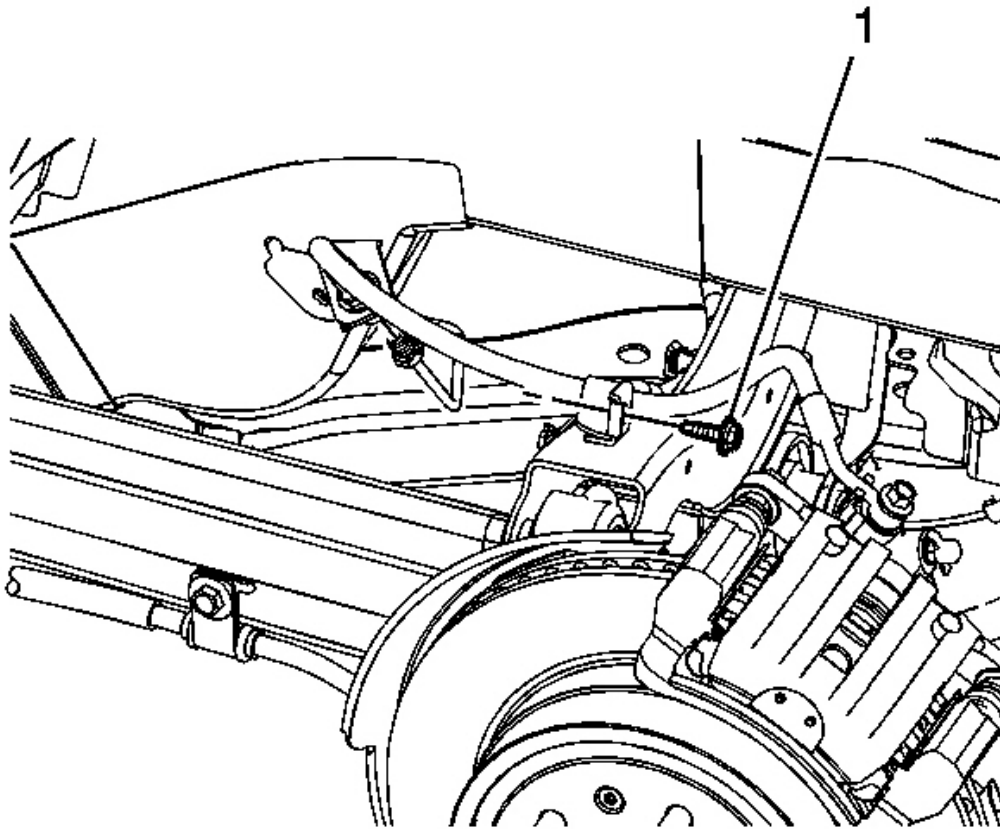
1. Install the brake hose.

**NOTE:**        **Install new brake hose fitting gaskets.**

2. Assemble the brake hose fitting bolt (1) to the brake hose (2) with 2 new brake hose fitting gaskets (3).

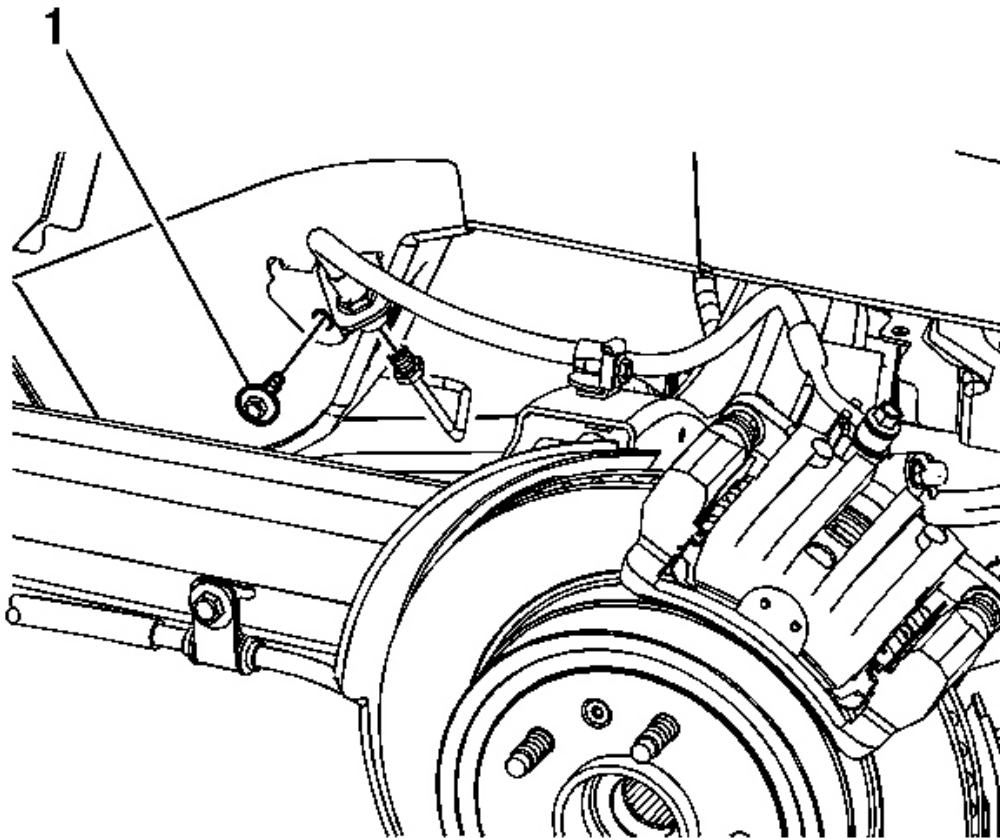
**CAUTION:** Refer to **Fastener Caution** .

3. Install the brake hose assembly and tighten the brake hose fitting bolt to 52 N.m (38 lb ft).



**Fig. 50: Brake Hose Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

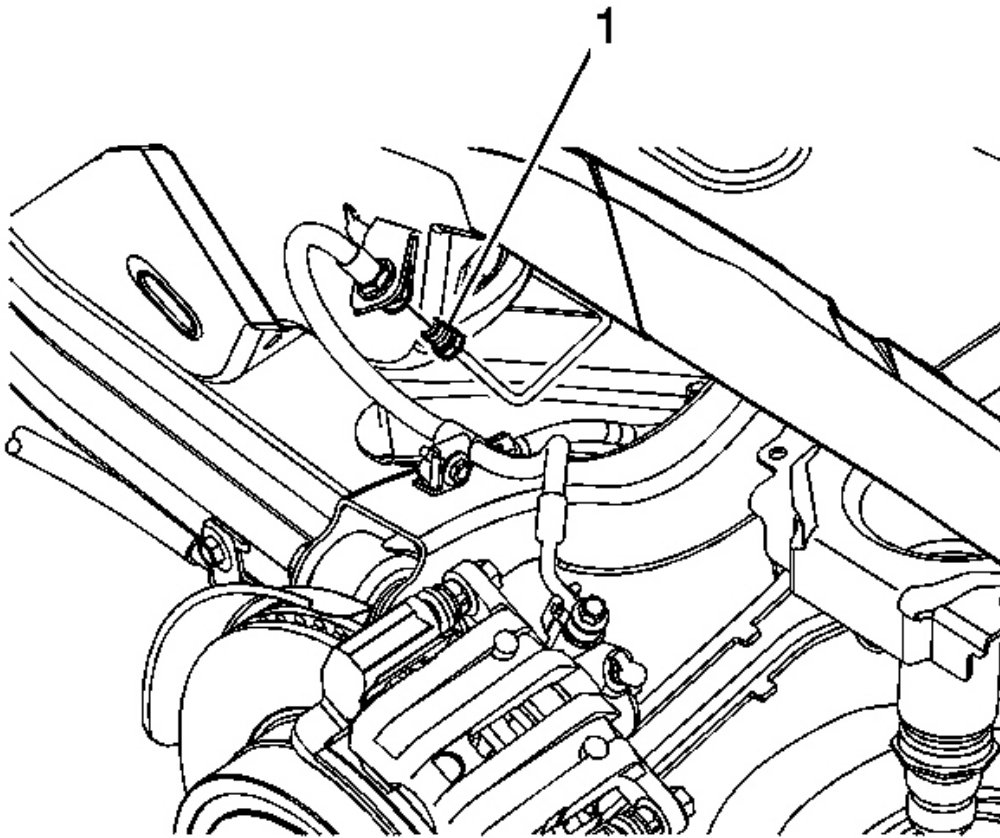
4. Install the brake hose bracket bolt (1) and tighten to 16 N.m (12 lb ft).



**Fig. 51: Brake Hose Bolt**

Courtesy of GENERAL MOTORS CORP.

5. Install the brake hose bolt (1) and tighten to 16 N.m (12 lb ft).



**Fig. 52: Brake Pipe Fitting**

Courtesy of GENERAL MOTORS CORP.

6. Connect the brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).
7. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
8. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.

#### **HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)**

**WARNING:** Refer to **Brake Fluid Irritant Warning**.

**CAUTION:** Refer to **Brake Fluid Effects on Paint and Electrical Components Caution**.

1. Place a clean shop cloth beneath the brake master cylinder to prevent brake fluid spills.
2. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
3. If you have performed a brake master cylinder bench bleeding on this vehicle, or if you disconnected the brake pipes from the master cylinder, you must perform the following steps:
  1. Ensure that the brake master cylinder reservoir is full to the maximum-fill level. If necessary, add GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations (USA and Canada)**.

If removal of the reservoir cap and diaphragm is necessary, clean the outside of the reservoir on and around the cap prior to removal.

2. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe from the front port of the brake master cylinder.
3. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder.
4. Reconnect the brake pipe to the master cylinder port and tighten securely.
5. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
6. Loosen the same brake pipe to purge air from the open port of the master cylinder.
7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of the master cylinder.
9. With the front brake pipe installed securely to the master cylinder, after all air has been purged from the front port of the master cylinder, loosen and separate the rear brake pipe from the master cylinder, then repeat steps 3.3-3.8.
10. After completing the final master cylinder port bleeding procedure, ensure that both of the brake pipe-to-master cylinder fittings are properly tightened.
4. Fill the brake master cylinder reservoir with GM approved brake fluid from a clean, sealed brake fluid container. Ensure that the brake master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to maintain the proper level. Refer to **Master Cylinder Reservoir Filling**.

Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.

5. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
6. Install a transparent hose over the end of the bleeder valve.
7. Submerge the open end of the transparent hose into a transparent container partially filled with GM approved brake fluid from a clean, sealed brake fluid container.
8. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
9. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
10. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
11. Wait 15 seconds, then repeat steps 8-10 until all air is purged from the same wheel hydraulic circuit.

12. With the right rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the right rear hydraulic circuit, install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
13. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
14. With the left front wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.
15. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
16. With the left rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
17. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
18. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves are properly tightened.
19. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
20. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

**NOTE:** If it is determined that air was induced into the system upstream of the **ABS modulator prior to servicing, the Antilock Brake System Automated Bleed must be performed.**

21. If the brake pedal feels spongy, repeat the bleeding procedure again. If the brake pedal still feels spongy after repeating the bleeding procedure, perform the following steps:
  1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection**.
  2. Pressure bleed the hydraulic brake system in order to purge any air that may still be trapped in the system.
22. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

**NOTE:** **DO NOT allow the vehicle to be driven until it is diagnosed and repaired.**

23. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle**.

## **HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)**

### **Special Tools**

- **J-29532:** Diaphragm Type Brake Pressure Bleeder, or equivalent
- **J-35589-A:** Master Cylinder Bleeder Adapter

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

**WARNING: Refer to Brake Fluid Irritant Warning .**

**CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Place a clean shop cloth beneath the brake master cylinder to prevent brake fluid spills.
2. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
3. If you have performed a brake master cylinder bench bleeding on this vehicle, or if you disconnected the brake pipes from the master cylinder, you must perform the following steps:
  1. Ensure that the brake master cylinder reservoir is full to the maximum-fill level. If necessary, add GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations (USA and Canada)** .

If removal of the reservoir cap and diaphragm is necessary, clean the outside of the reservoir on and around the cap prior to removal.

2. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe from the front port of the brake master cylinder.
  3. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder.
  4. Reconnect the brake pipe to the master cylinder port and tighten securely.
  5. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
  6. Loosen the same brake pipe to purge air from the open port of the master cylinder.
  7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
  8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of the master cylinder.
  9. With the front brake pipe installed securely to the master cylinder, after all air has been purged from the front port of the master cylinder, loosen and separate the rear brake pipe from the master cylinder, then repeat steps 3.3-3.8.
  10. After completing the final master cylinder port bleeding procedure, ensure that both of the brake pipe-to-master cylinder fittings are properly tightened.
4. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Master Cylinder Reservoir Filling**.

Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.

5. Install the **J-35589-A: Master Cylinder Bleeder Adapter** to the brake master cylinder reservoir.
6. Check the brake fluid level in the **J-29532: Diaphragm Type Brake Pressure Bleeder**, or equivalent, or equivalent. Add GM approved brake fluid from a clean, sealed brake fluid container as necessary to bring the level to approximately the half-full point.
7. Connect the **J-29532: Diaphragm Type Brake Pressure Bleeder**, or equivalent, or equivalent, to the **J-**

**35589-A: Master Cylinder Bleeder Adapter.**

8. Charge the **J-29532: Diaphragm Type Brake Pressure Bleeder**, or equivalent, or equivalent, air tank to 175-205 kPa (25-30 psi).
9. Open the **J-29532: Diaphragm Type Brake Pressure Bleeder**, or equivalent, or equivalent, fluid tank valve to allow pressurized brake fluid to enter the brake system.
10. Wait approximately 30 seconds, then inspect the entire hydraulic brake system in order to ensure that there are no existing external brake fluid leaks.

Any brake fluid leaks identified require repair prior to completing this procedure.

11. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
12. Install a transparent hose over the end of the bleeder valve.
13. Submerge the open end of the transparent hose into a transparent container partially filled with GM approved brake fluid from a clean, sealed brake fluid container.
14. Loosen the bleeder valve to purge air from the wheel hydraulic circuit. Allow fluid to flow until air bubbles stop flowing from the bleeder, then tighten the bleeder valve.
15. With the right rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the right rear hydraulic circuit, install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
16. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
17. With the left front wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.
18. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
19. With the left rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
20. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
21. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves are properly tightened.
22. Close the **J-29532: Diaphragm Type Brake Pressure Bleeder**, or equivalent, or equivalent, fluid tank valve, then disconnect the **J-29532: Diaphragm Type Brake Pressure Bleeder**, or equivalent, or equivalent, from the **J-35589-A: Master Cylinder Bleeder Adapter**.
23. Remove the **J-35589-A: Master Cylinder Bleeder Adapter** from the brake master cylinder reservoir.
24. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
25. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

**NOTE:** If it is determined that air was induced into the system upstream of the ABS modulator prior to servicing, the Antilock Brake System Automated Bleed must be performed.

26. If the brake pedal feels spongy, perform the following steps:

1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection** .
  2. Using a scan tool, perform the antilock brake system automated bleeding procedure to remove any air that may have been trapped in the brake pressure modulator valve (BPMV). Refer to **Antilock Brake System Automated Bleed** .
27. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

**NOTE:**            **DO NOT allow the vehicle to be driven until it is diagnosed and repaired.**

28. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

## **HYDRAULIC BRAKE SYSTEM FLUSHING**

**WARNING:** Refer to **Brake Fluid Irritant Warning** .

**CAUTION:** Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:
  - Fluid separation, indicating 2 types of fluid are present; a substance other than the recommended brake fluid has been introduced into the brake hydraulic system
    - Swirled appearance - oil-based substance
    - Layered appearance - silicone-based substance
  - Fluid discoloration, indicating the presence of moisture or particles that have been introduced into the brake hydraulic system
    - Cloudy appearance - moisture
    - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust
2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating brake fluid contamination.
3. If the brake fluid WAS contaminated with an oil-based or a silicone-based substance, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following:
  1. Remove ALL of the following components listed from the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Replacement**
- **Front Brake Hose Replacement**
- **Rear Brake Hose Replacement**

- **Front Brake Caliper Replacement**
  - **Rear Brake Caliper Replacement**
  - **Brake Pressure Modulator Valve Replacement**
2. Clean out all the hydraulic brake pipes using denatured alcohol, or equivalent.
  3. Dry the brake pipes using non-lubricated, filtered air.
  4. Repair or replace ALL of the following components listed and install them to the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Replacement** ; also perform the following:

Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to **Master Cylinder Reservoir Replacement** .

Replace the brake master cylinder reservoir cap diaphragm.

- **Front Brake Hose Replacement**
  - **Rear Brake Hose Replacement**
  - **Front Brake Caliper Replacement**
  - **Rear Brake Caliper Replacement**
  - **Brake Pressure Modulator Valve Replacement**
4. If the brake fluid was NOT contaminated with an oil-based or a silicone-based substance, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm. The diaphragm may have allowed the moisture or particles to enter the hydraulic system.
  5. Fill the brake master cylinder reservoir to the maximum-fill level with approved brake fluid from a clean, sealed brake fluid container as specified in the owners manual.
  6. Pressure bleed the hydraulic brake system. Begin the procedure with the pressure bleeder reservoir filled to the maximum-fill level with the correct brake fluid as indicated. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

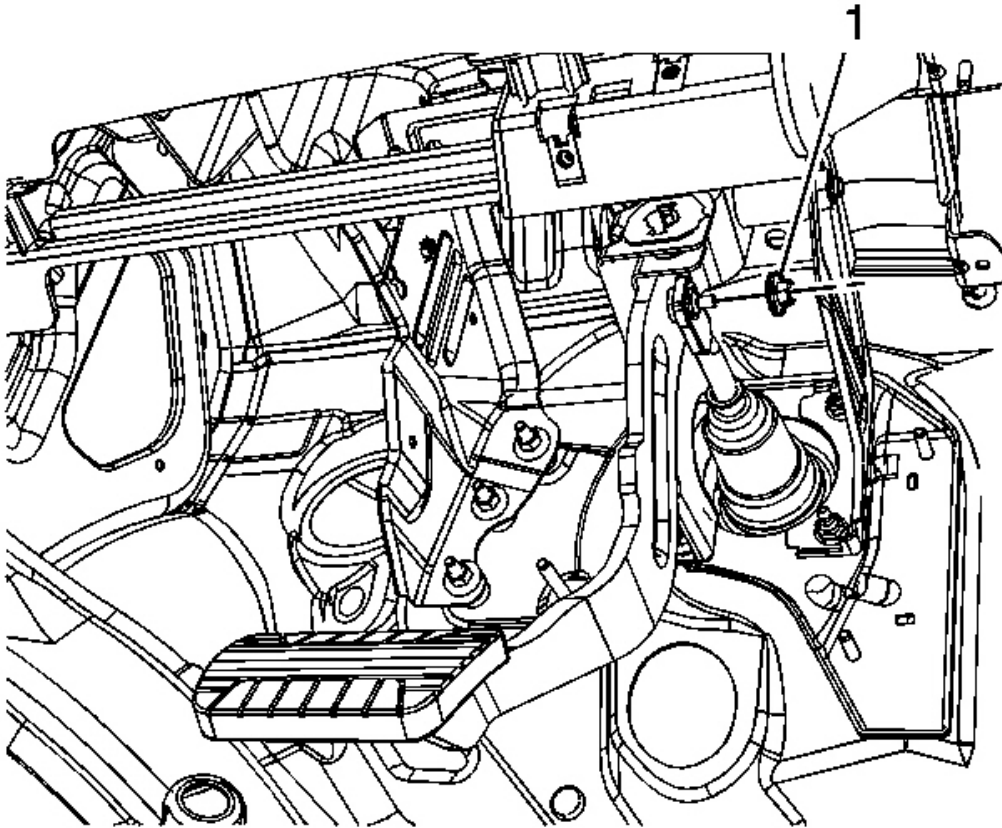
## **POWER VACUUM BRAKE BOOSTER REPLACEMENT**

### **Removal Procedure**

**WARNING:** Refer to **Brake Fluid Irritant Warning** .

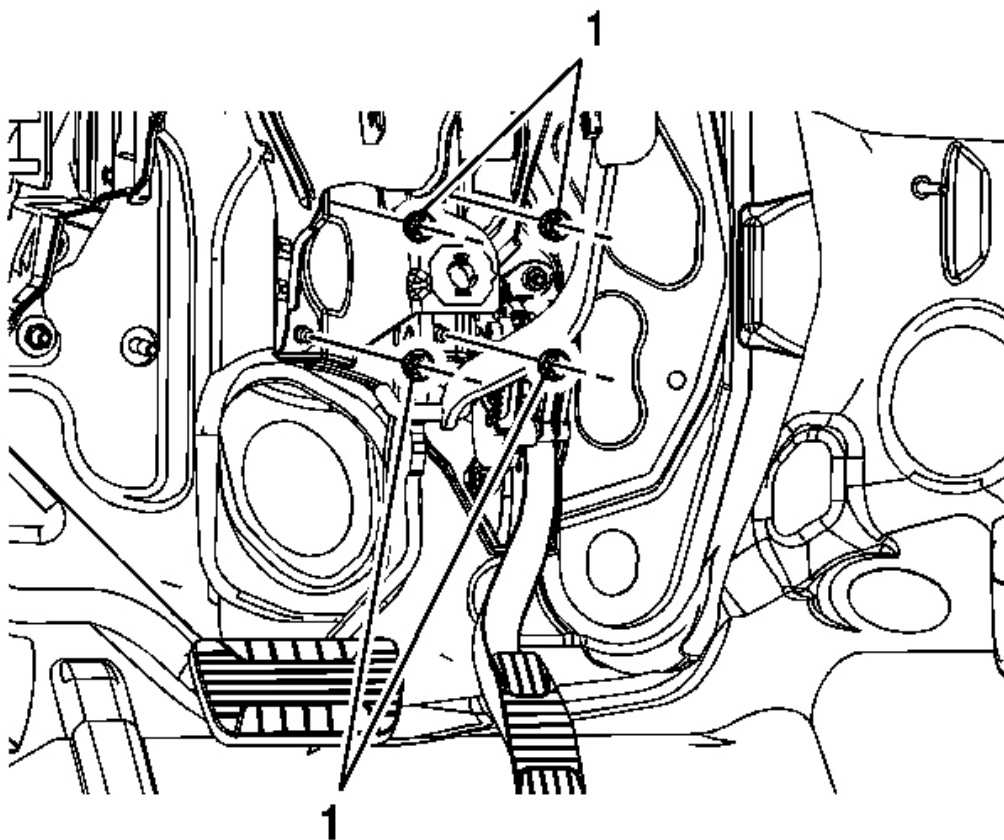
**CAUTION:** Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

1. Remove the vacuum brake booster vacuum sensor and hose from the vacuum brake booster and position aside. Refer to **Power Brake Booster Vacuum Sensor Replacement (2.4L)** or **Power Brake Booster Vacuum Sensor Replacement (3.0L)**.
2. Remove the master cylinder. Refer to **Master Cylinder Replacement**.
3. Remove the brake pressure modulator valve (BPMV). Refer to **Brake Pressure Modulator Valve Replacement**.
4. Remove the BPMV bracket. Refer to **Brake Pressure Modulator Valve Bracket Replacement**.



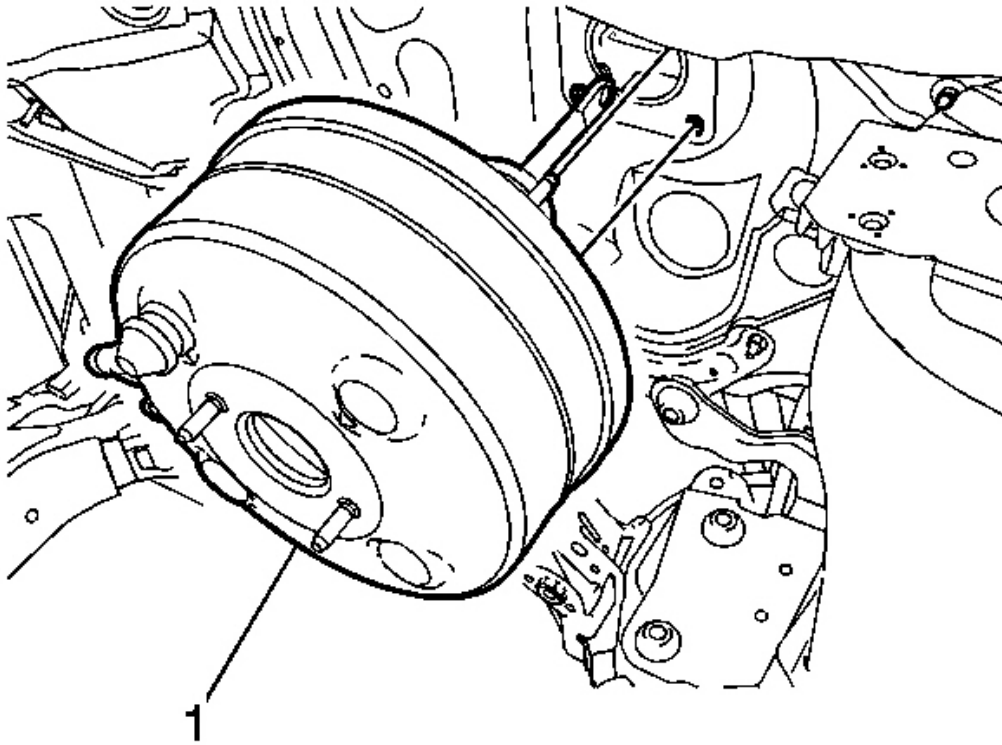
**Fig. 53: Brake Booster Pushrod Nut**  
Courtesy of GENERAL MOTORS CORP.

5. Remove the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement**.
6. Remove the vacuum brake booster pushrod retainer nut (1).
7. Disconnect the vacuum brake booster pushrod from the brake pedal.



**Fig. 54: Vacuum Brake Booster Nuts**  
Courtesy of GENERAL MOTORS CORP.

8. Remove the 4 vacuum brake booster nuts (1).

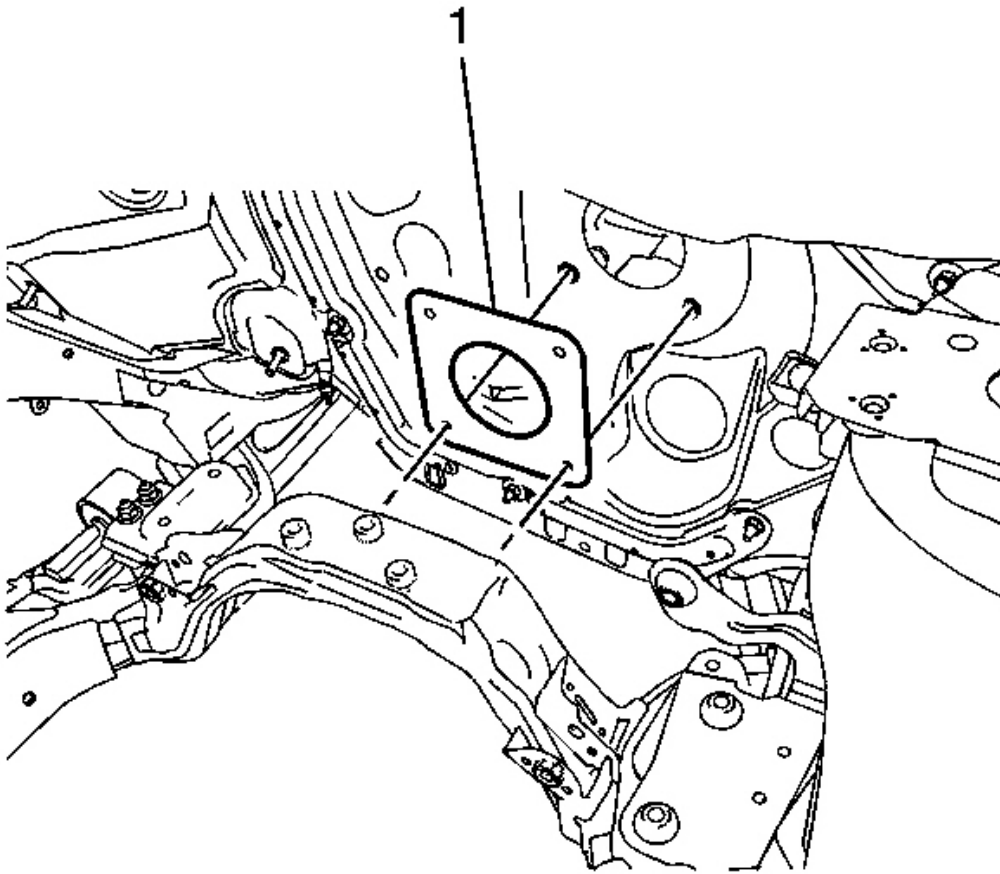


**Fig. 55: Vacuum Brake Booster**  
Courtesy of GENERAL MOTORS CORP.

9. Carefully pull the vacuum brake booster forward until the mounting studs clear the dash panel.

**NOTE:**        **Ensure the foam insulator on the mounting surface of the vacuum brake booster withdraws with the booster.**

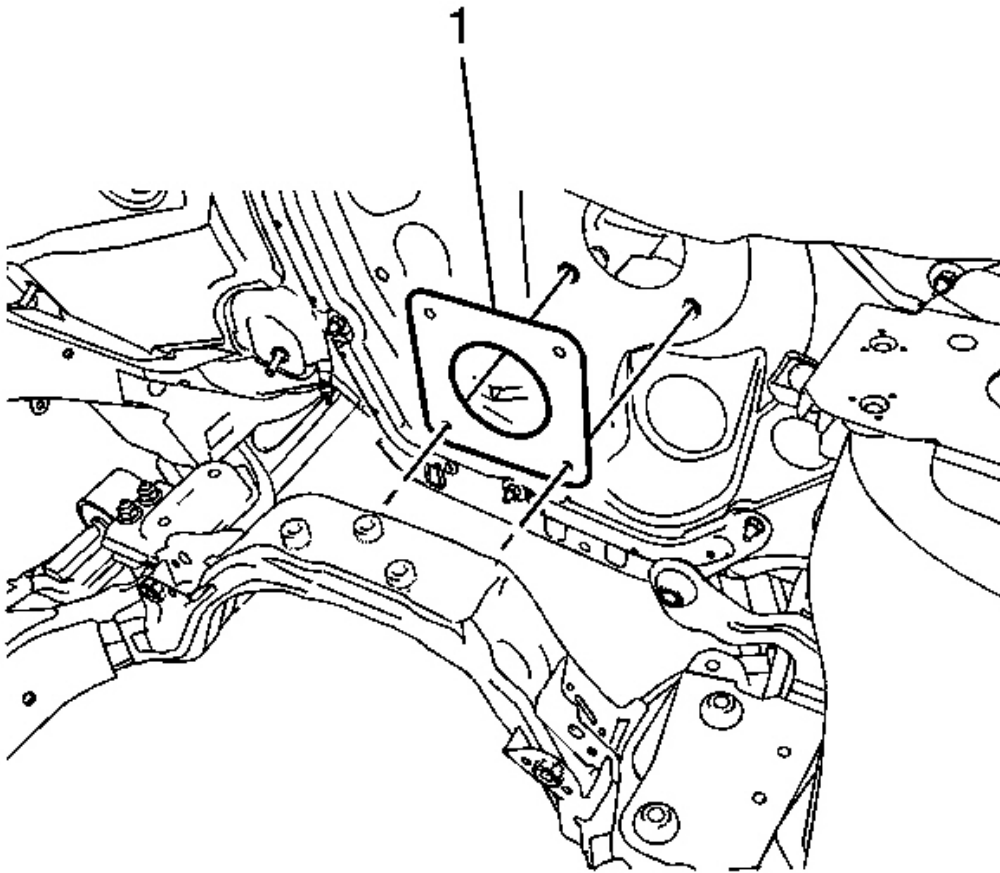
10. Remove the vacuum brake booster (1).



**Fig. 56: Vacuum Brake Booster Gasket**  
**Courtesy of GENERAL MOTORS CORP.**

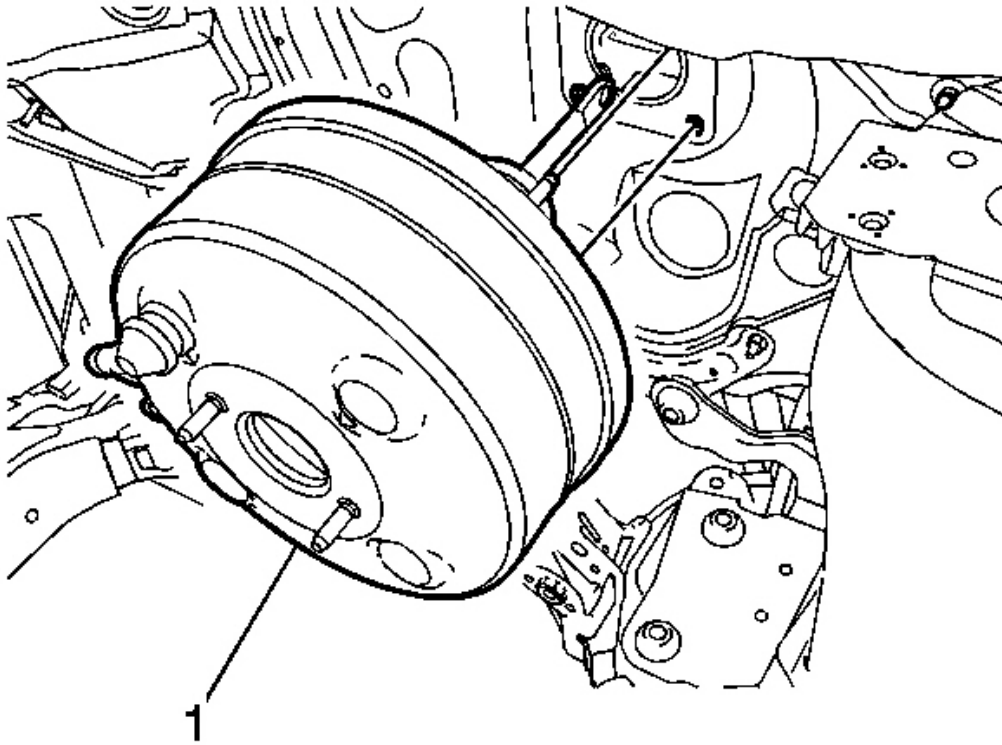
11. Inspect the vacuum brake booster gasket (1) for damage and replace if necessary.

#### **Installation Procedure**



**Fig. 57: Vacuum Brake Booster Gasket**  
**Courtesy of GENERAL MOTORS CORP.**

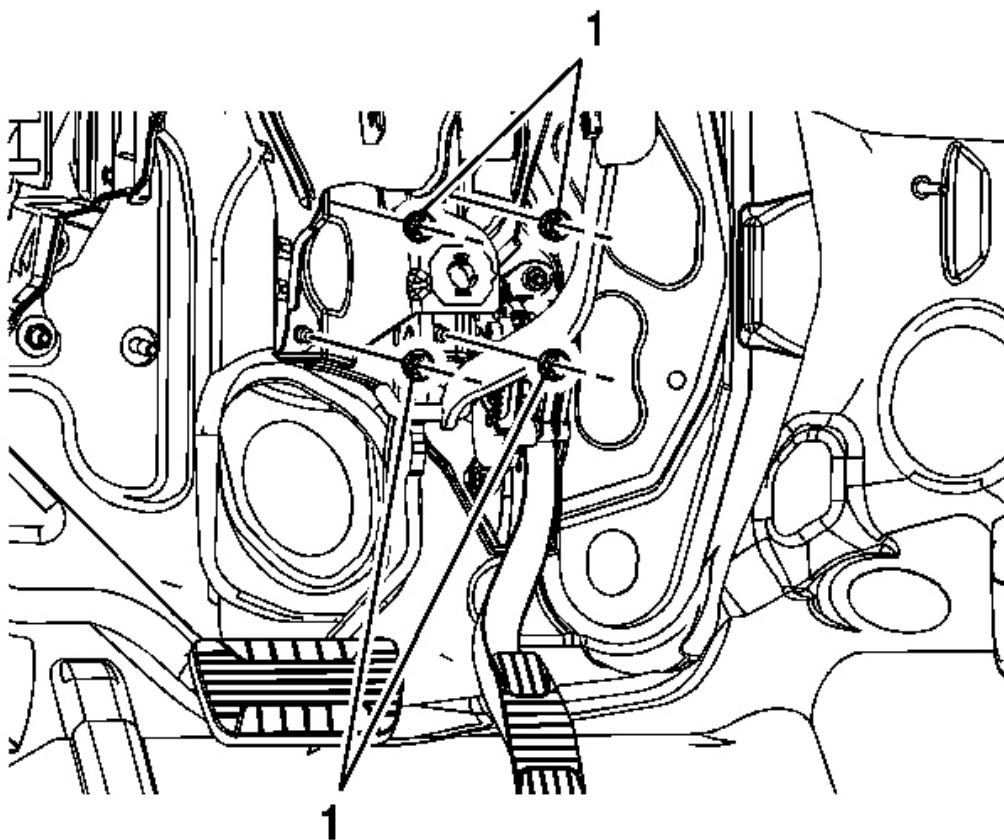
1. Install the vacuum brake booster gasket (1).



**Fig. 58: Vacuum Brake Booster**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Ensure the foam insulator on the mounting surface of the vacuum brake booster is properly installed on the booster.

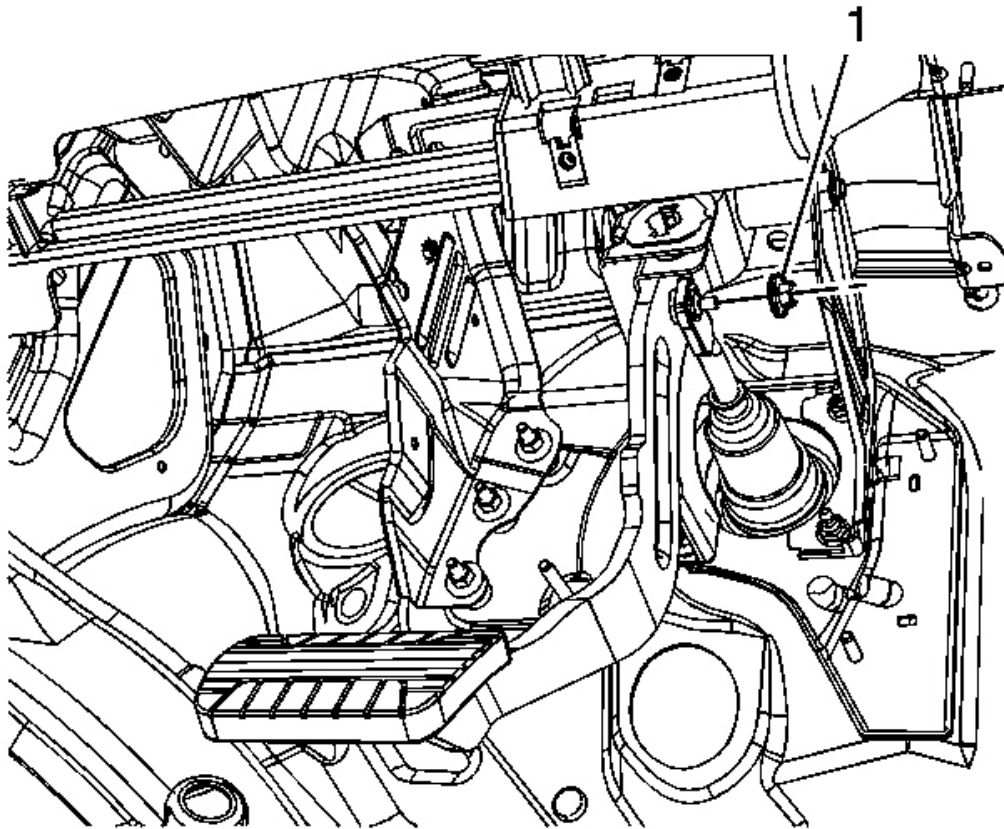
2. While guiding the brake booster pushrod and mounting studs through the dash panel, install the vacuum brake booster (1).



**Fig. 59: Vacuum Brake Booster Nuts**  
Courtesy of GENERAL MOTORS CORP.

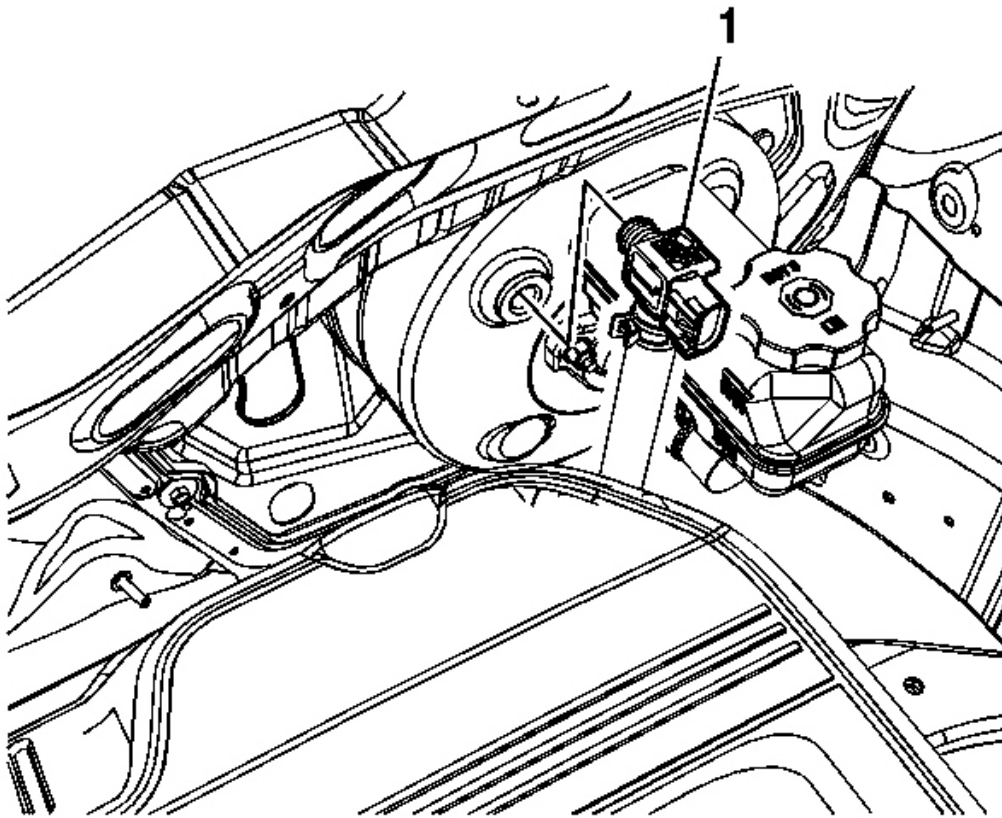
**CAUTION: Refer to Fastener Caution .**

3. Install the vacuum brake booster nuts (1) and tighten to 25 N.m (18 lb ft)..



**Fig. 60: Brake Booster Pushrod Nut**  
Courtesy of GENERAL MOTORS CORP.

4. Connect the vacuum brake booster pushrod to the brake pedal.
5. Install the vacuum brake booster pushrod retainer.
6. Rotate the vacuum brake booster pushrod retainer 360 degrees to ensure it is properly installed.
7. Install the vacuum brake booster pushrod retainer nut (1) and tighten to 25 N.m (18 lb ft)..
8. Install the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement** .
9. Install the BPMV bracket. Refer to **Brake Pressure Modulator Valve Bracket Replacement** .
10. Install the BPMV. Refer to **Brake Pressure Modulator Valve Replacement** .
11. Install the master cylinder. Refer to **Master Cylinder Replacement**.



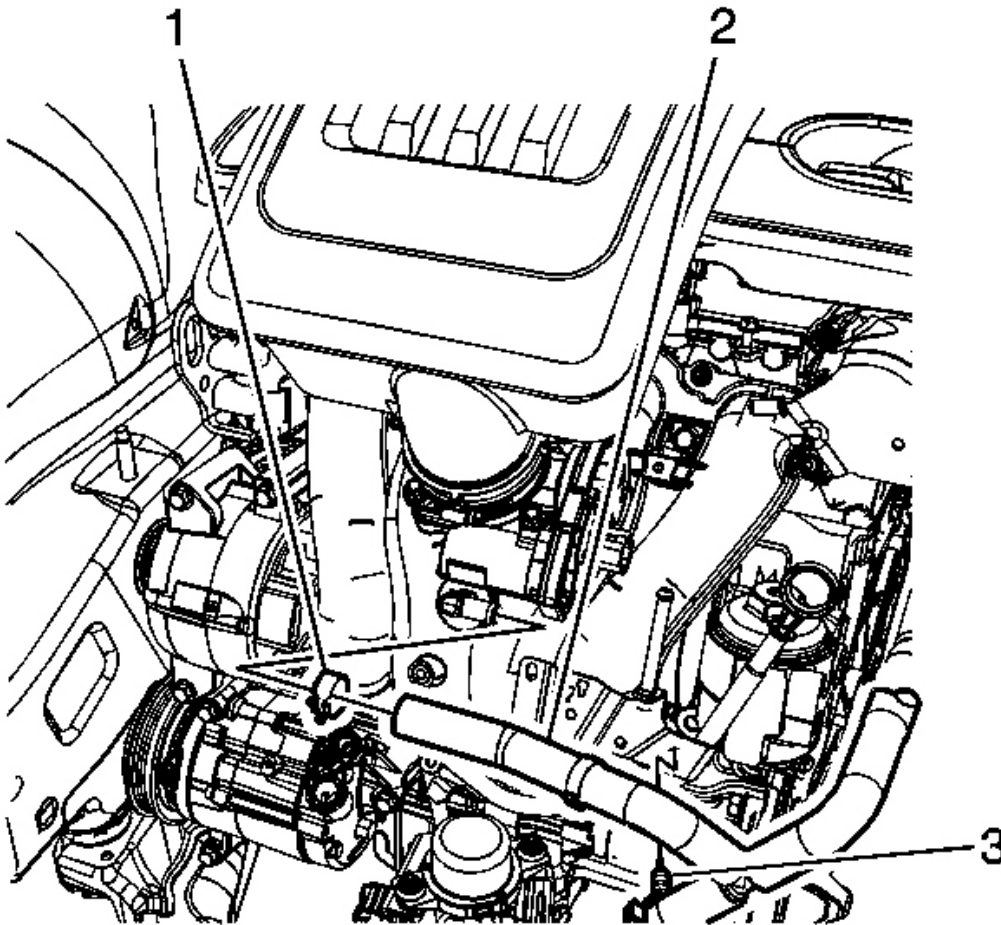
**Fig. 61: Power Brake Booster Vacuum Sensor**  
Courtesy of GENERAL MOTORS CORP.

12. Install the vacuum brake booster vacuum sensor (1) and hose to the vacuum brake booster. Refer to **Power Brake Booster Vacuum Sensor Replacement (2.4L)** or **Power Brake Booster Vacuum Sensor Replacement (3.0L)**.

## **POWER BRAKE BOOSTER VACUUM CHECK VALVE AND HOSE REPLACEMENT (2.4L)**

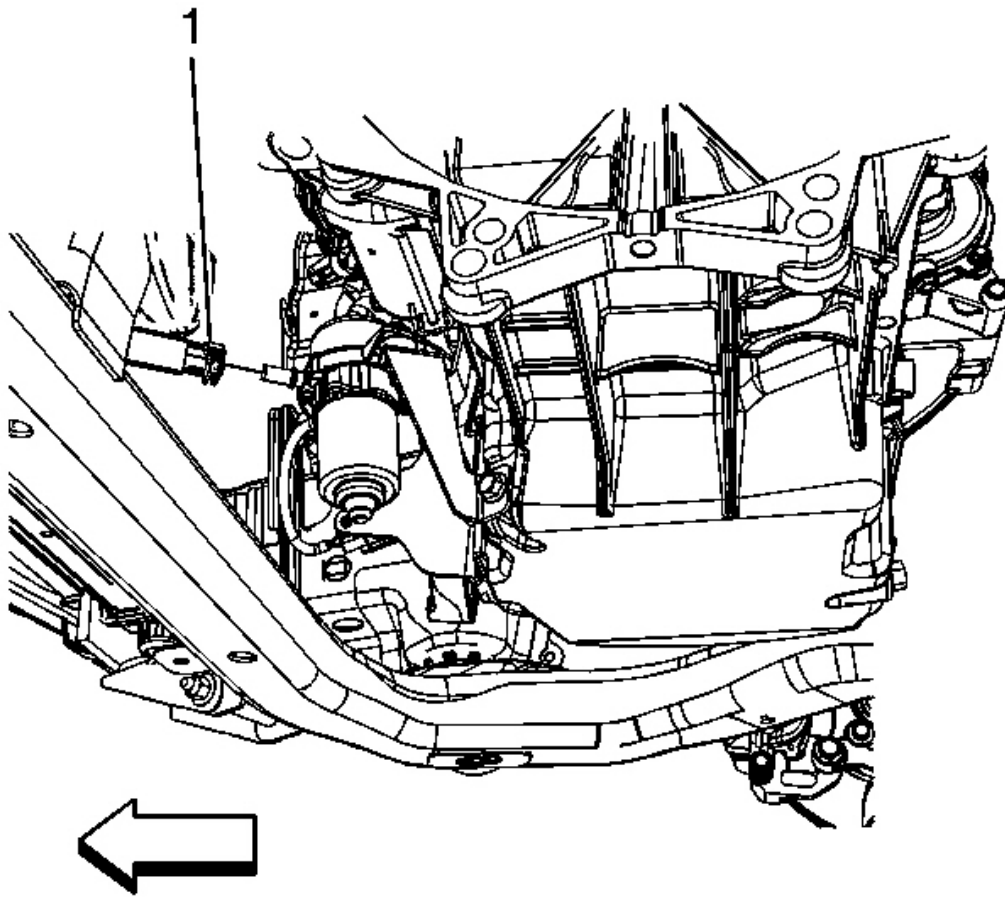
### **Removal Procedure**

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the power brake booster vacuum sensor. Refer to **Power Brake Booster Vacuum Sensor Replacement (2.4L)** or **Power Brake Booster Vacuum Sensor Replacement (3.0L)**



**Fig. 62: Power Brake Booster Vacuum Hose, Spring Clamp & Routing Clip**  
Courtesy of GENERAL MOTORS CORP.

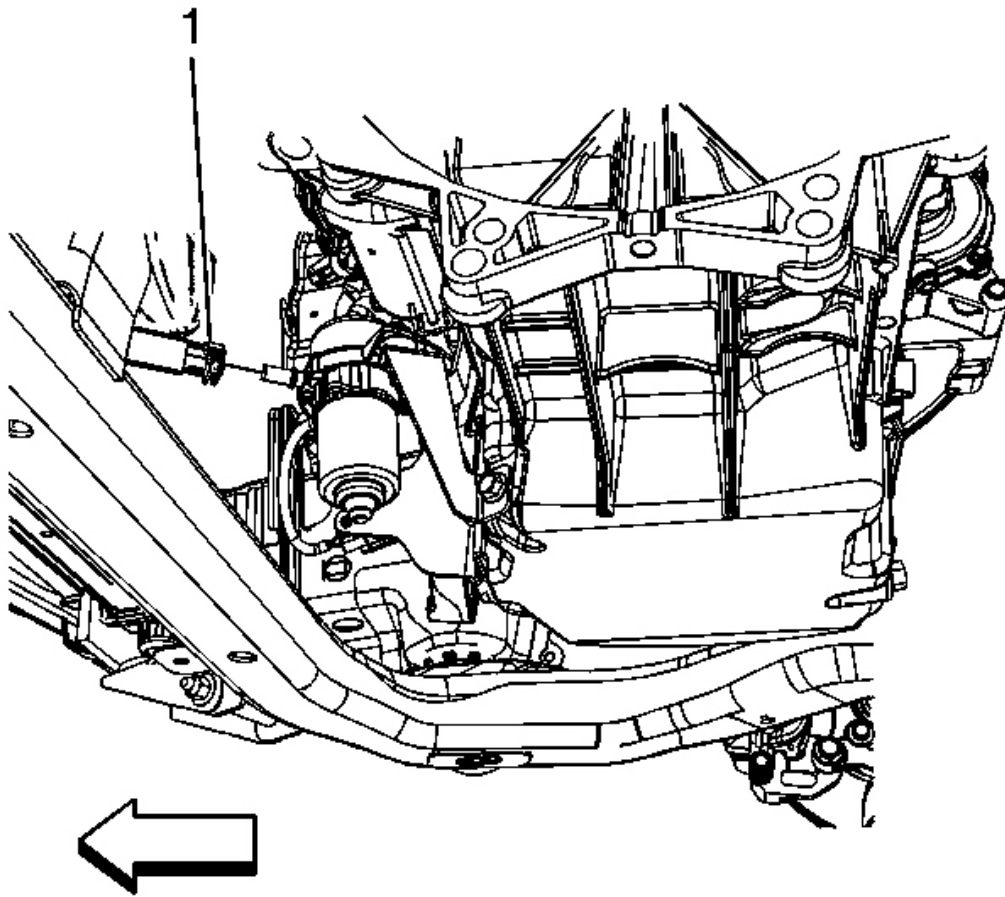
3. Release the spring clamp (1) and remove the power brake booster vacuum hose (2) from the intake manifold vacuum port.
4. Release the power brake booster vacuum hose from the routing clip (3) on the oil level indicator tube bracket.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**



**Fig. 63: Power Brake Booster Vacuum Hose Quick Connect**  
**Courtesy of GENERAL MOTORS CORP.**

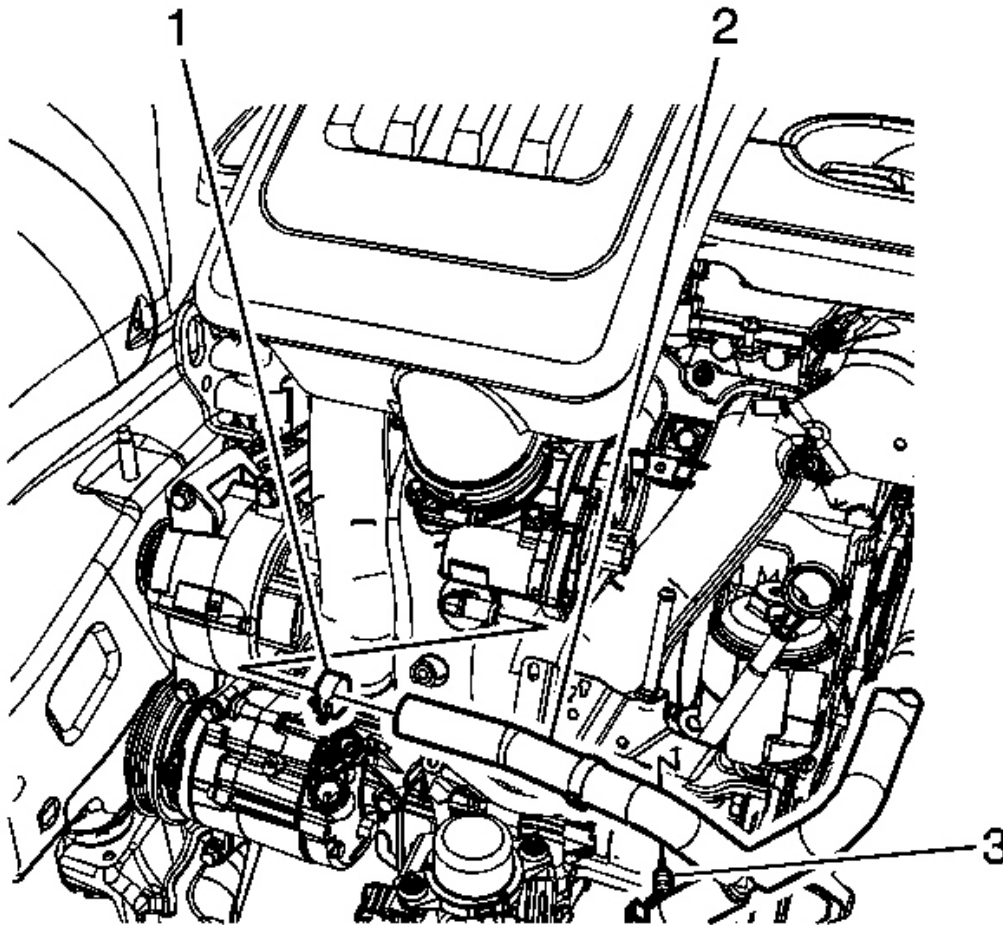
6. Disconnect the power brake booster vacuum hose quick connect (1).
7. Remove the power brake booster vacuum hose and check valve assembly.

#### **Installation Procedure**



**Fig. 64: Power Brake Booster Vacuum Hose Quick Connect**  
**Courtesy of GENERAL MOTORS CORP.**

1. Install the power brake booster vacuum hose and check valve assembly.
2. Connect the power brake booster vacuum hose quick connect (1).
3. Lower the vehicle.



**Fig. 65: Power Brake Booster Vacuum Hose, Spring Clamp & Routing Clip**  
Courtesy of GENERAL MOTORS CORP.

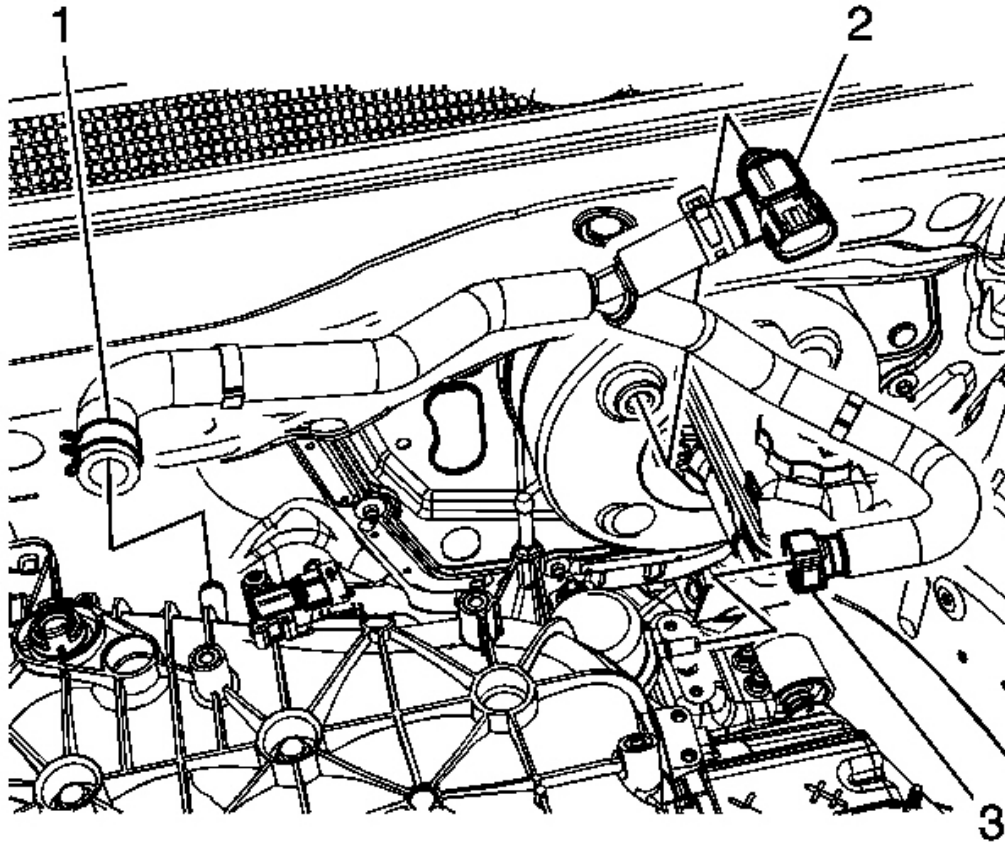
**NOTE:** A small amount of denatured alcohol may be used to ease assembly. Do not use soap.

4. Release the tension on the spring clamp (1) and install the power brake booster vacuum hose (2) to the intake manifold vacuum port.
5. Install the power brake booster vacuum hose to the routing clip (3) on the oil level indicator tube bracket.
6. Install the power brake booster vacuum sensor. Refer to **Power Brake Booster Vacuum Sensor Replacement (2.4L)** or **Power Brake Booster Vacuum Sensor Replacement (3.0L)**

#### **POWER BRAKE BOOSTER VACUUM CHECK VALVE AND HOSE REPLACEMENT (3.0L)**

## Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Disconnect the power brake booster vacuum sensor electrical connector.



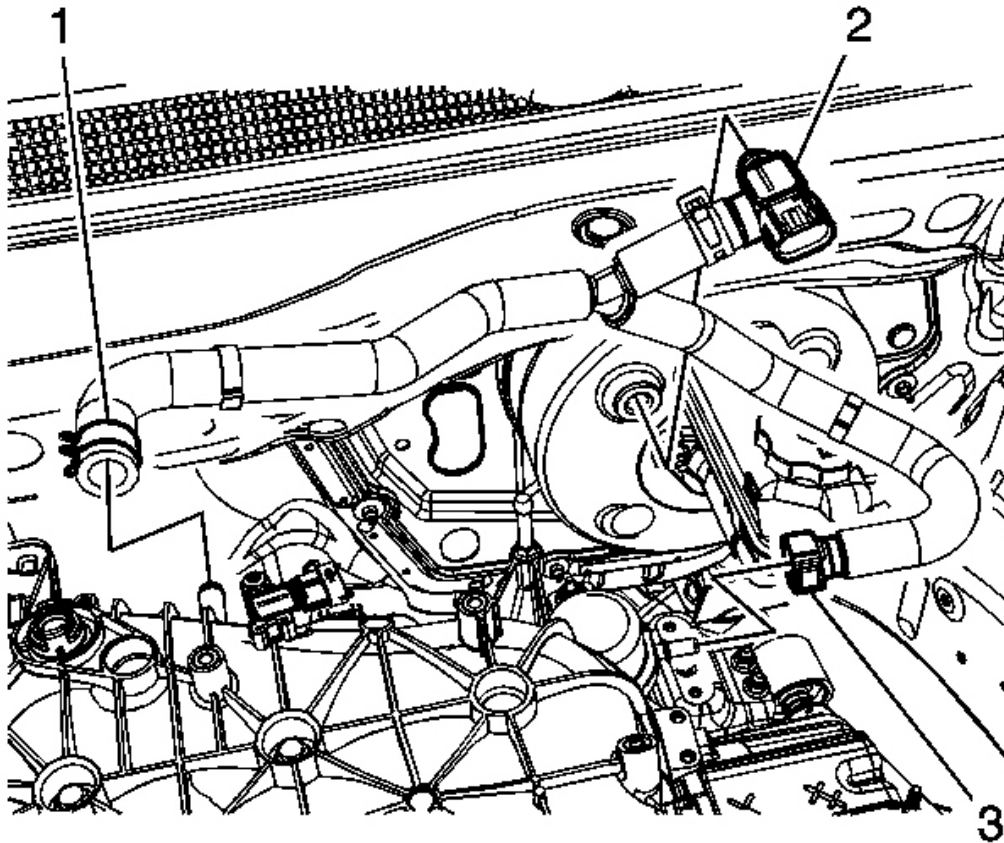
**Fig. 66: Power Brake Booster Vacuum Hose Quick Connect, Spring Clamp & Vacuum Sensor**  
**Courtesy of GENERAL MOTORS CORP.**

4. Release the spring clamp (1) and remove the power brake booster vacuum hose from the intake manifold vacuum port.
5. Remove the power brake booster vacuum sensor (2) from the power vacuum brake booster.
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
7. Disconnect the power brake booster vacuum hose quick connect (3) from the power brake booster pump.
8. Remove the power brake booster vacuum hose and check valve assembly.

9. Remove the power brake booster vacuum sensor. Refer to **Power Brake Booster Vacuum Sensor Replacement (2.4L)** or **Power Brake Booster Vacuum Sensor Replacement (3.0L)**.

#### Installation Procedure

1. Install the power brake booster vacuum sensor. Refer to **Power Brake Booster Vacuum Sensor Replacement (2.4L)** or **Power Brake Booster Vacuum Sensor Replacement (3.0L)**.
2. Install the power brake booster vacuum hose and check valve assembly.



**Fig. 67: Power Brake Booster Vacuum Hose Quick Connect, Spring Clamp & Vacuum Sensor**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** A small amount of denatured alcohol may be used to ease assembly. Do not use soap.

3. Release the tension on the spring clamp (1) and install the power brake booster vacuum hose to the intake

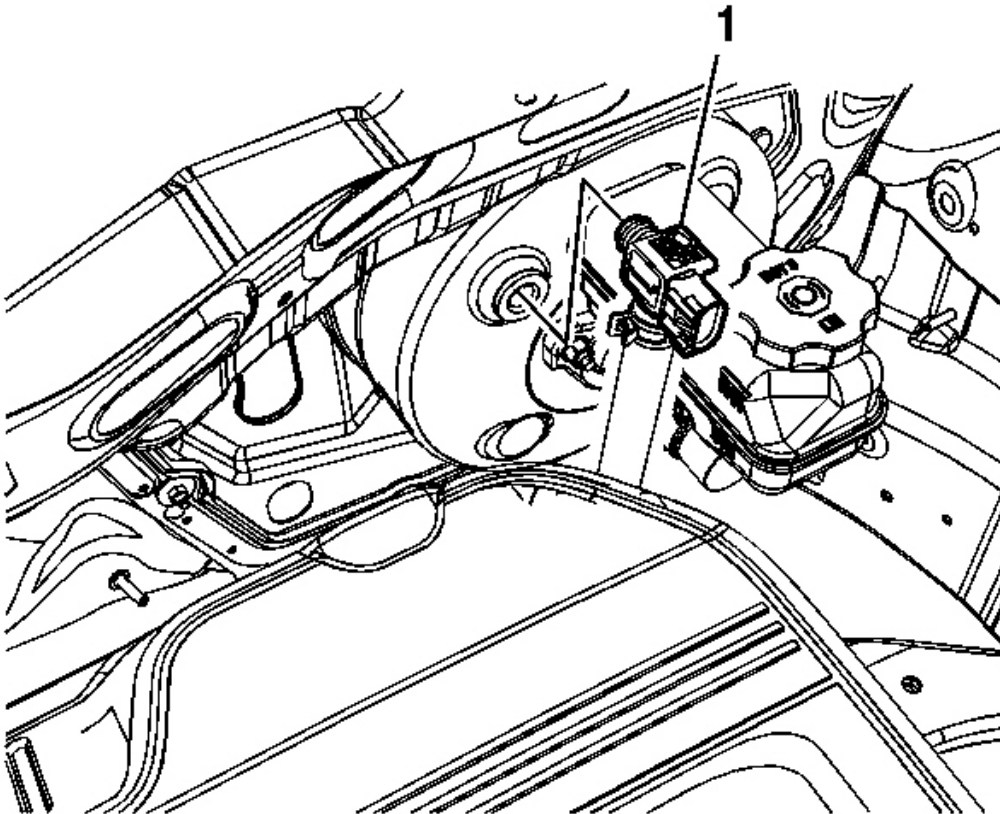
manifold vacuum port.

4. Install the power brake booster vacuum sensor (2) from the power vacuum brake booster.
5. Connect the power brake booster vacuum hose quick connect (3) from the power brake booster pump.
6. Connect the power brake booster vacuum sensor electrical connector.
7. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

## **POWER BRAKE BOOSTER VACUUM SENSOR REPLACEMENT (2.4L)**

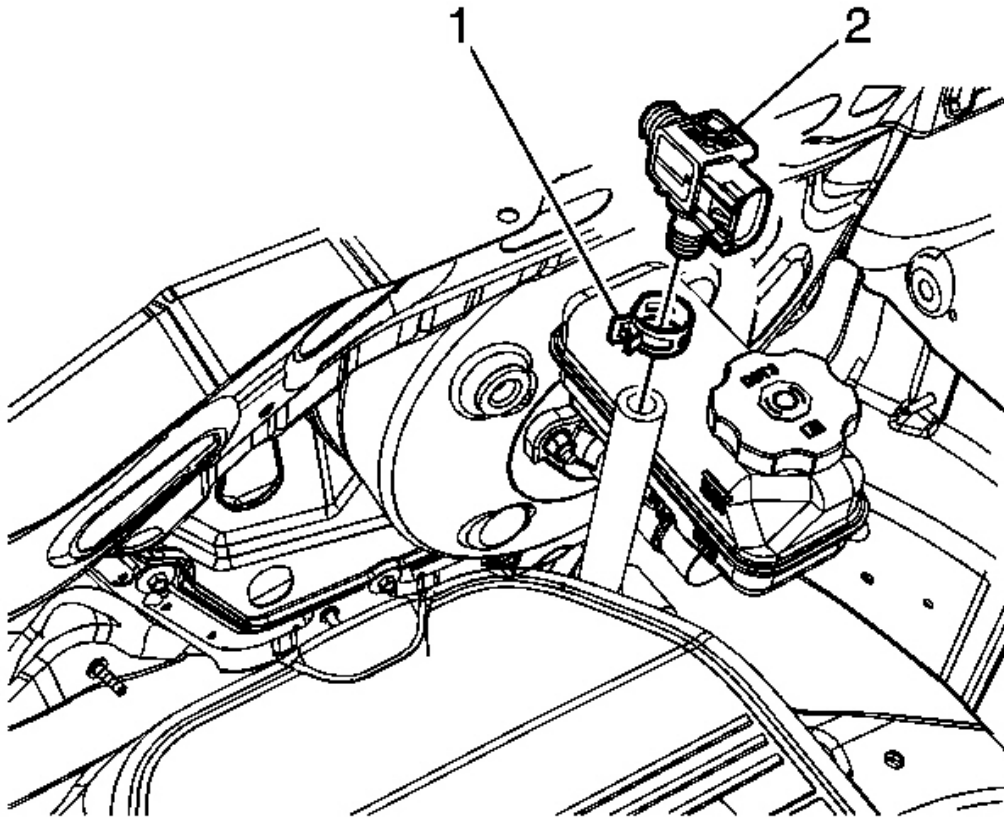
### **Removal Procedure**

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Disconnect the power brake booster vacuum sensor electrical connector.



**Fig. 68: Power Brake Booster Vacuum Sensor**  
**Courtesy of GENERAL MOTORS CORP.**

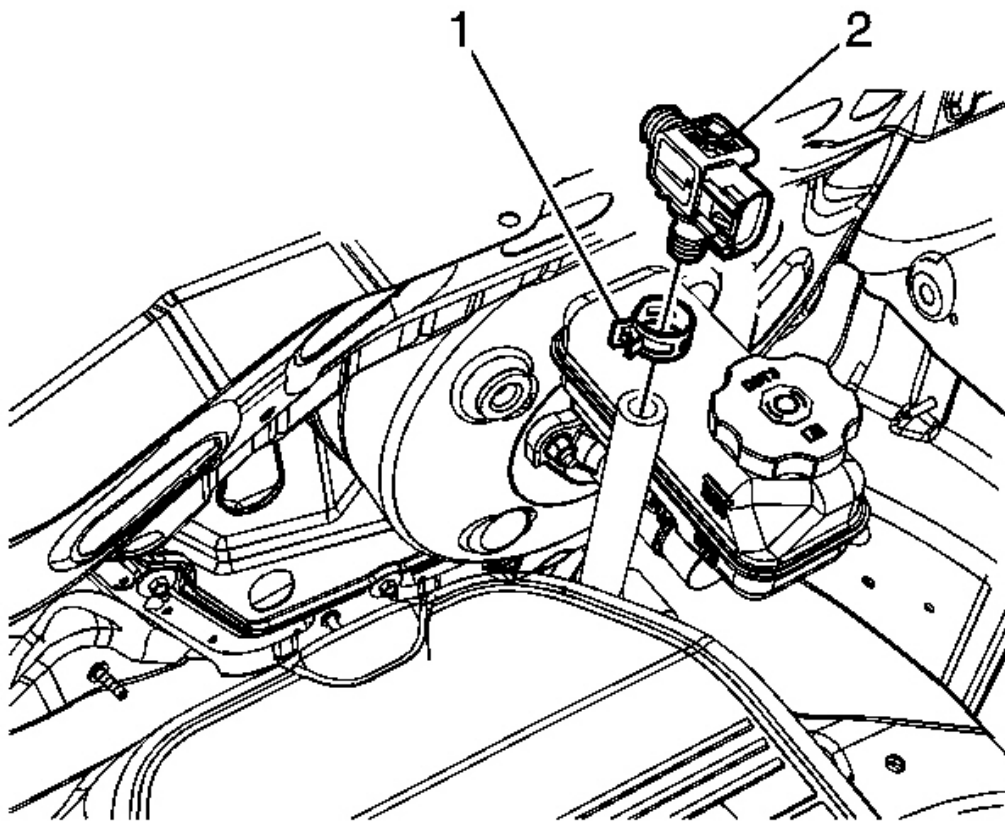
3. Remove the power brake booster vacuum sensor (1) from the power vacuum brake booster.



**Fig. 69: Power Brake Booster Vacuum Sensor & Spring Clamp**  
Courtesy of GENERAL MOTORS CORP.

4. Release the spring clamp (1) and remove the power brake booster vacuum hose from the power brake booster vacuum sensor (2).

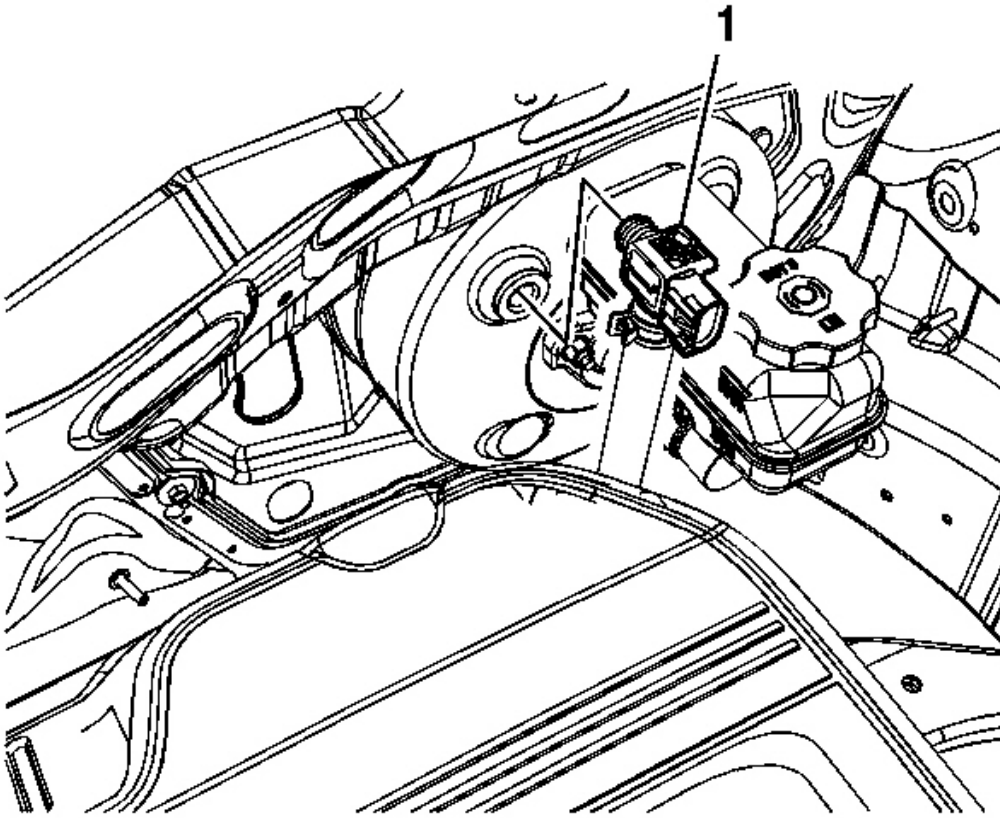
#### **Installation Procedure**



**Fig. 70: Power Brake Booster Vacuum Sensor & Spring Clamp**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** A small amount of denatured alcohol may be used to ease assembly. Do not use soap.

1. Release the tension on the spring clamp (1) and install the power brake booster vacuum hose to the power brake booster vacuum sensor (2).



**Fig. 71: Power Brake Booster Vacuum Sensor**  
Courtesy of GENERAL MOTORS CORP.

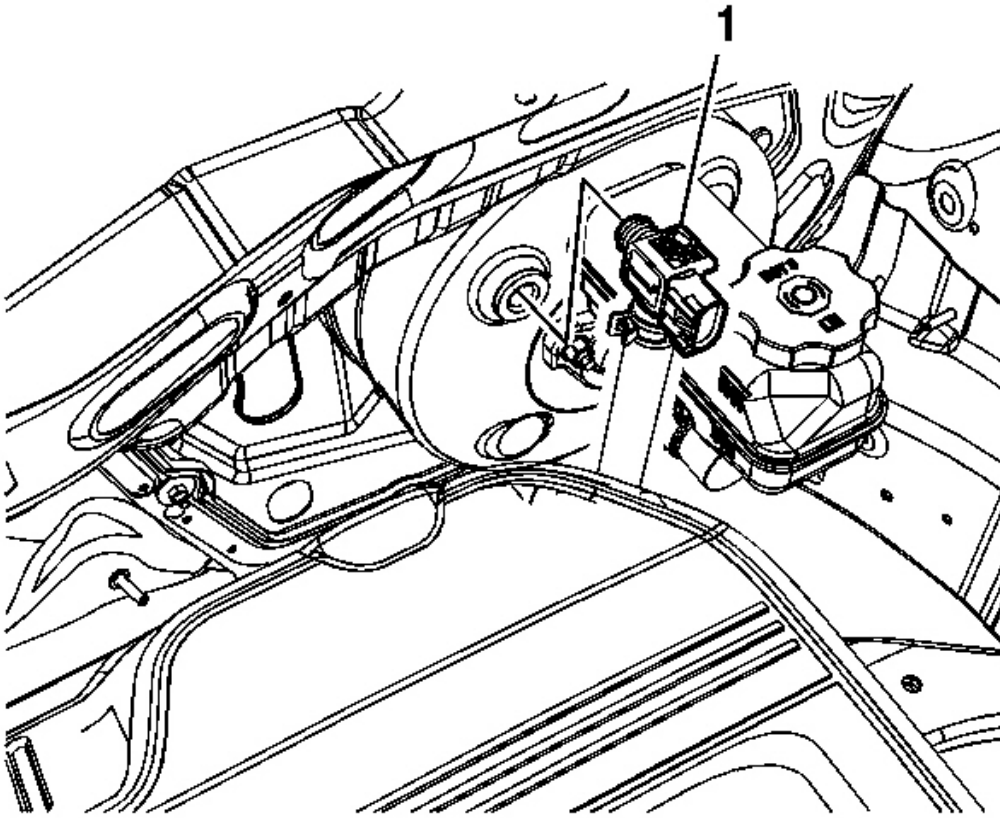
**NOTE:** A small amount of denatured alcohol may be used to ease assembly. Do not use soap.

2. Install the power brake booster vacuum sensor (1) to the power vacuum brake booster.
3. Connect the power brake booster vacuum sensor electrical connector.

### **POWER BRAKE BOOSTER VACUUM SENSOR REPLACEMENT (3.0L)**

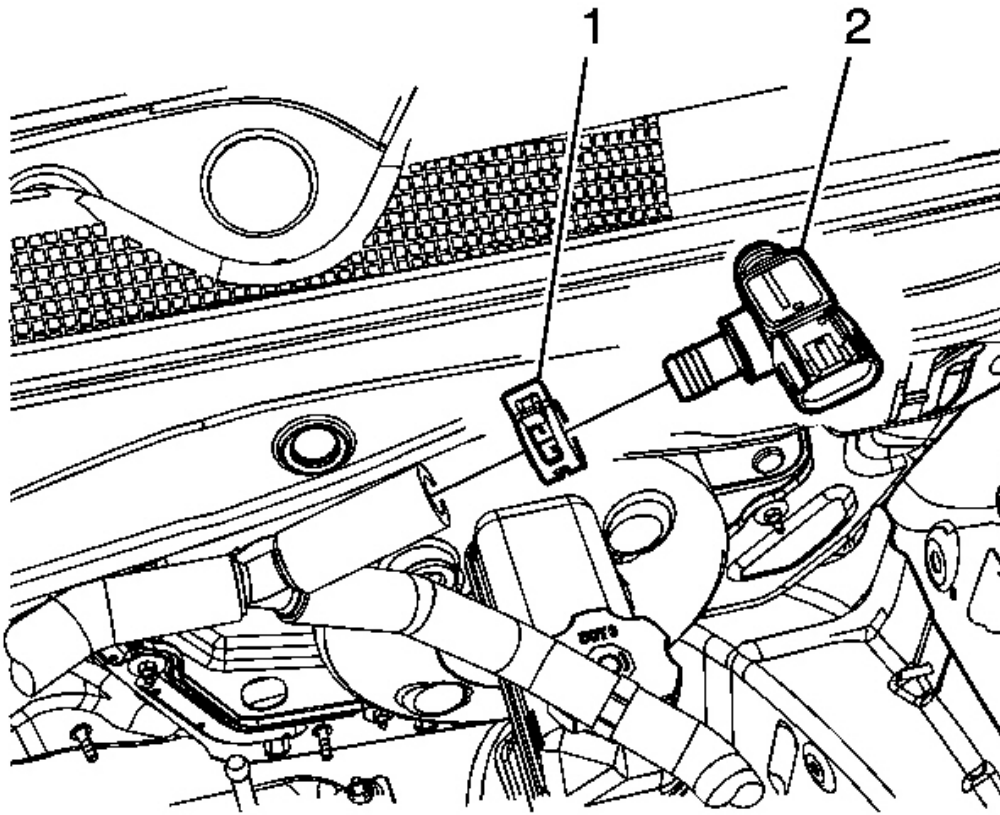
#### **Removal Procedure**

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Disconnect the power brake booster vacuum sensor electrical connector.



**Fig. 72: Power Brake Booster Vacuum Sensor**  
Courtesy of GENERAL MOTORS CORP.

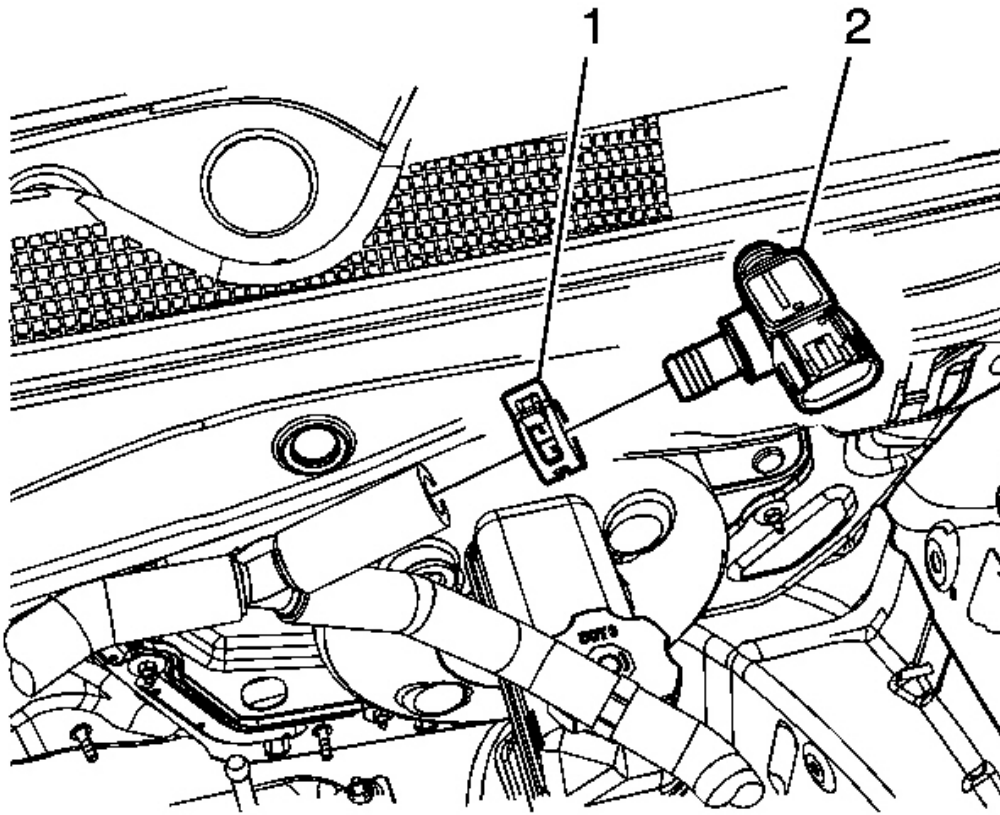
4. Remove the power brake booster vacuum sensor (1) from the power vacuum brake booster.



**Fig. 73: Power Brake Booster Vacuum Sensor & Spring Clamp**  
Courtesy of GENERAL MOTORS CORP.

5. Release the spring clamp (1) and remove the power brake booster vacuum hose from the power brake booster vacuum sensor (2).

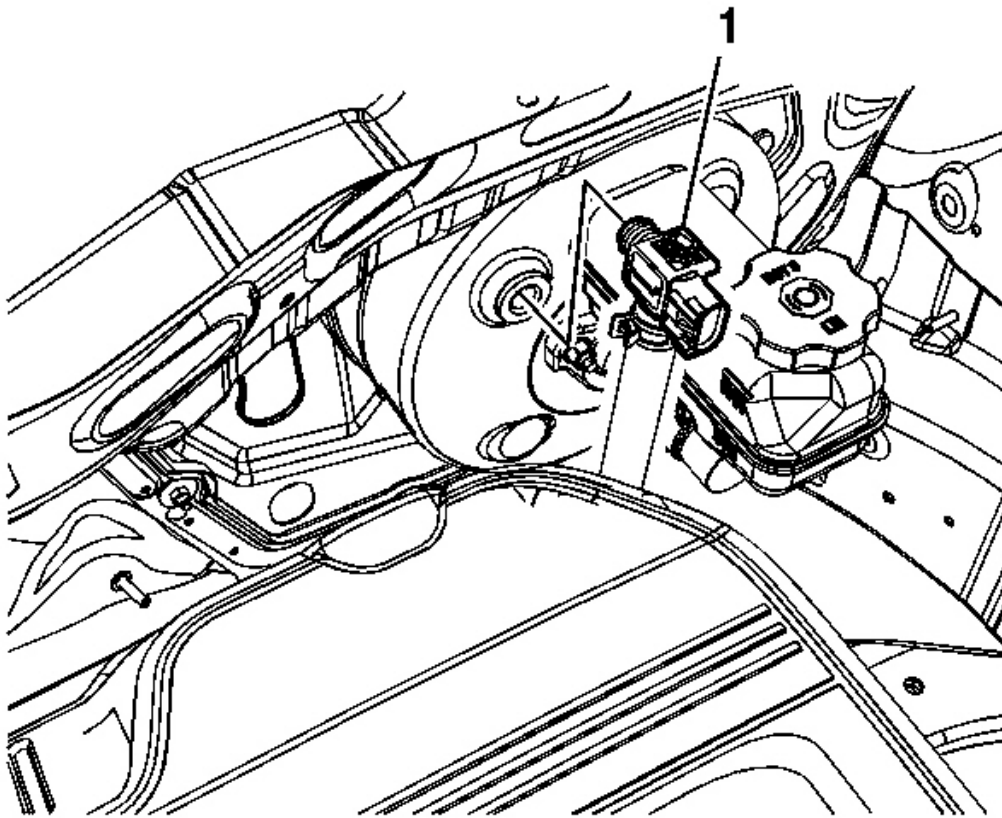
#### **Installation Procedure**



**Fig. 74: Power Brake Booster Vacuum Sensor & Spring Clamp**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** A small amount of denatured alcohol may be used to ease assembly. Do not use soap.

1. Release the tension on the spring clamp (1) and install the power brake booster vacuum hose to the power brake booster vacuum sensor (2).



**Fig. 75: Power Brake Booster Vacuum Sensor**  
Courtesy of GENERAL MOTORS CORP.

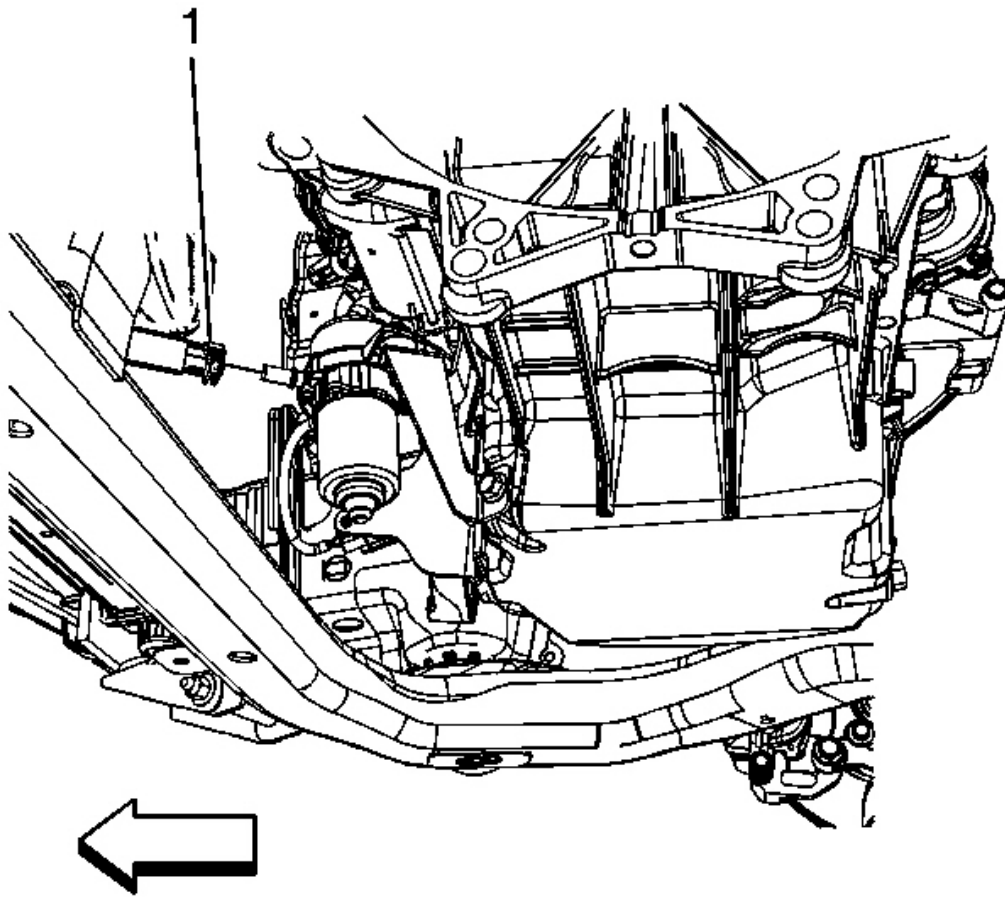
**NOTE:** A small amount of denatured alcohol may be used to ease assembly. Do not use soap.

2. Install the power brake booster vacuum sensor (1) to the power vacuum brake booster.
3. Connect the power brake booster vacuum sensor electrical connector.
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

## **POWER BRAKE BOOSTER PUMP REPLACEMENT (2.4L)**

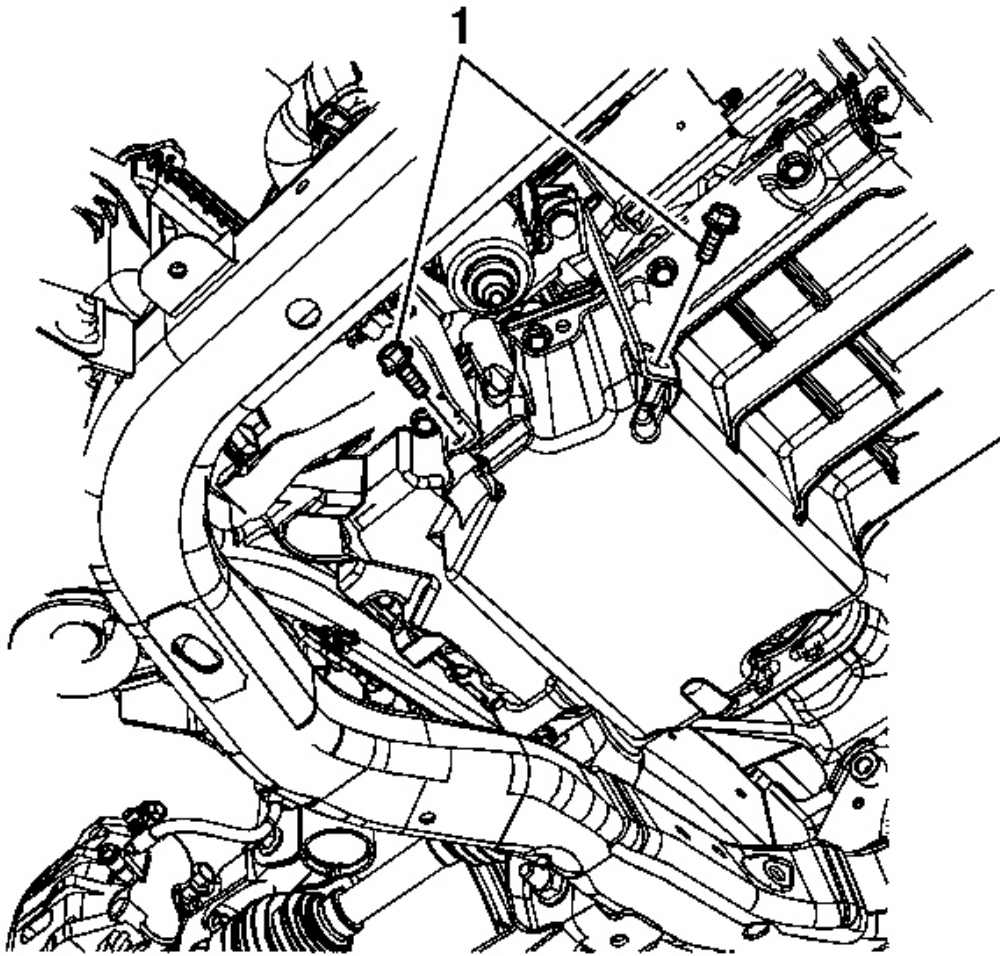
### **Removal Procedure**

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .



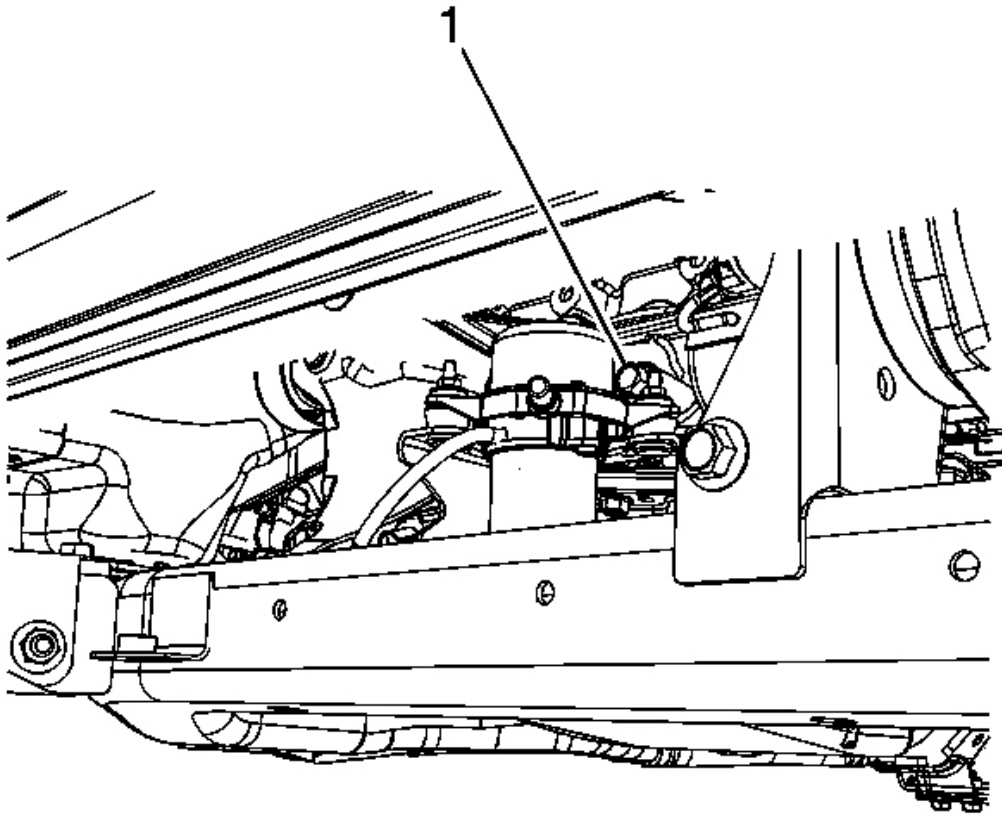
**Fig. 76: Power Brake Booster Vacuum Hose Quick Connect**  
**Courtesy of GENERAL MOTORS CORP.**

3. Disconnect the power brake booster pump hose quick connect (1).
4. Disconnect the power brake booster pump electrical connector.
5. Release the power brake booster pump electrical connector retainer from the pump bracket.



**Fig. 77: Power Brake Booster Pump Bolts**  
**Courtesy of GENERAL MOTORS CORP.**

6. Remove the lower 2 power brake booster pump bolts (1).



**Fig. 78: Upper Power Brake Booster Pump Bolt**  
**Courtesy of GENERAL MOTORS CORP.**

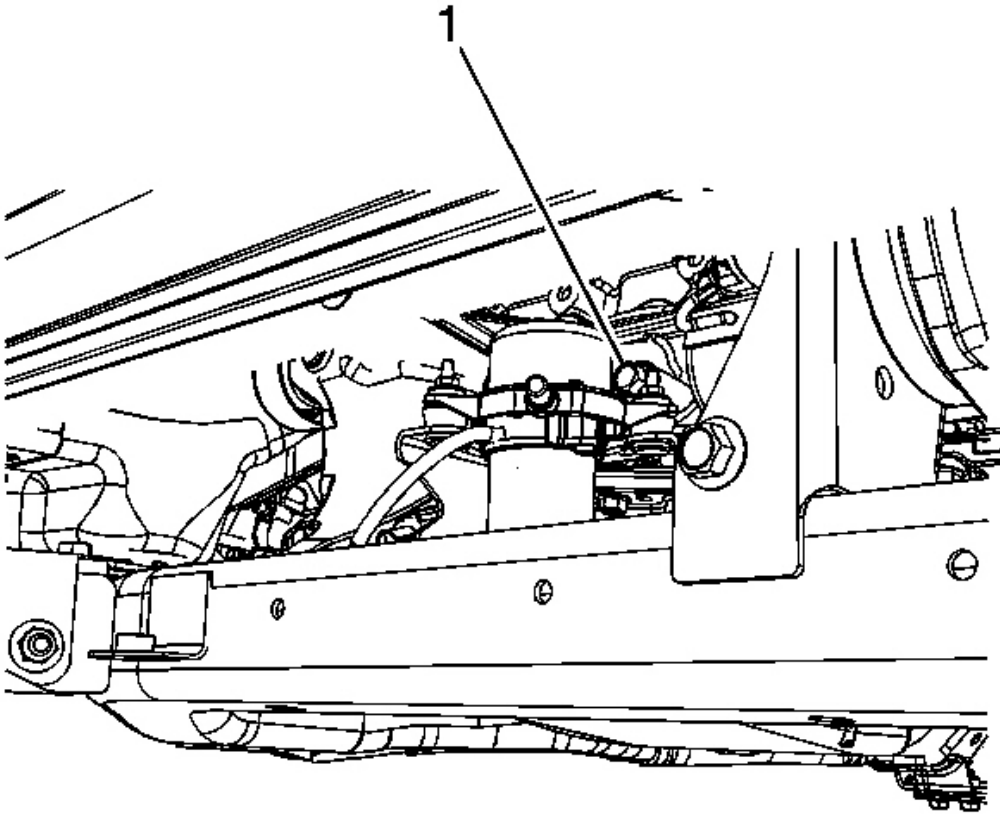
7. Remove the upper power brake booster pump bolt (1).
8. Remove the power brake booster pump assembly.
9. If removing the power brake booster pump bracket, remove the 2 power brake booster pump nuts and the bracket.

#### **Installation Procedure**

1. Inspect the power brake booster pump insulators for damage and replace, if necessary.
2. If removed, install the power brake booster pump to the bracket.

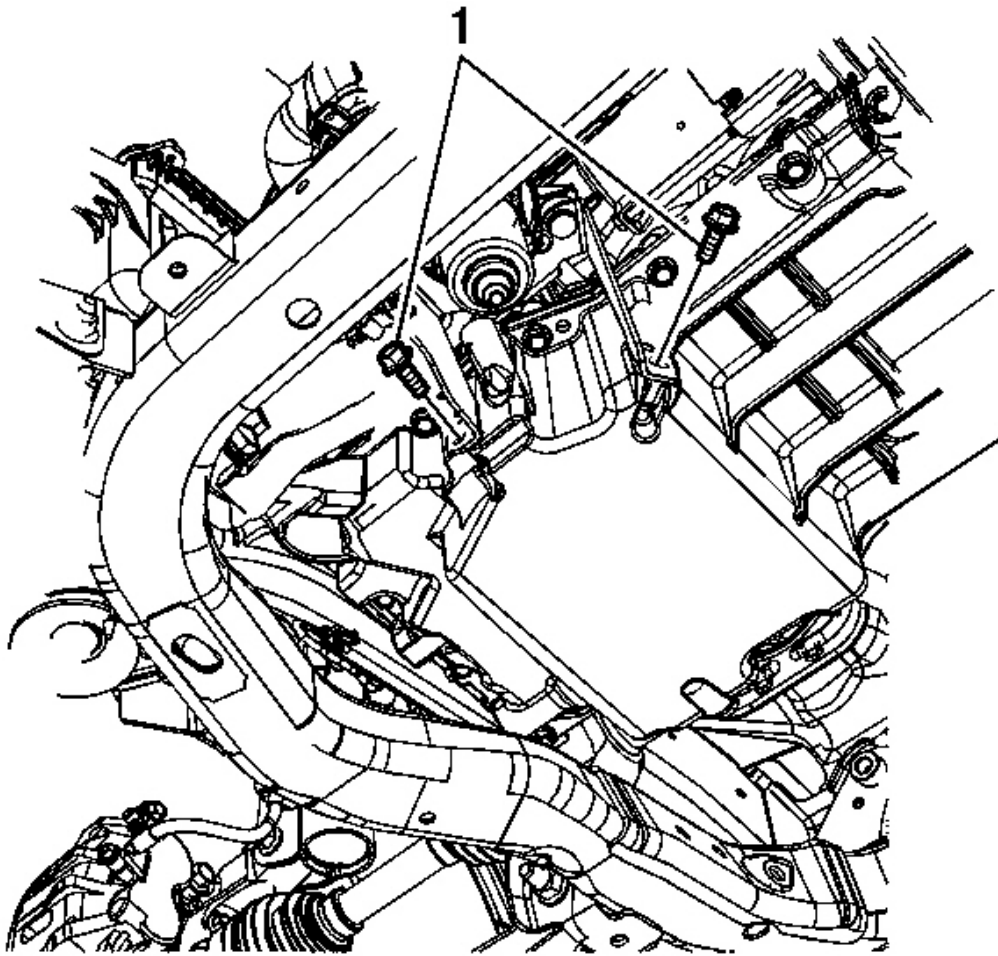
**CAUTION: Refer to Fastener Caution .**

3. Install the 2 power brake booster pump nuts and tighten to 9 N.m (80 lb in).



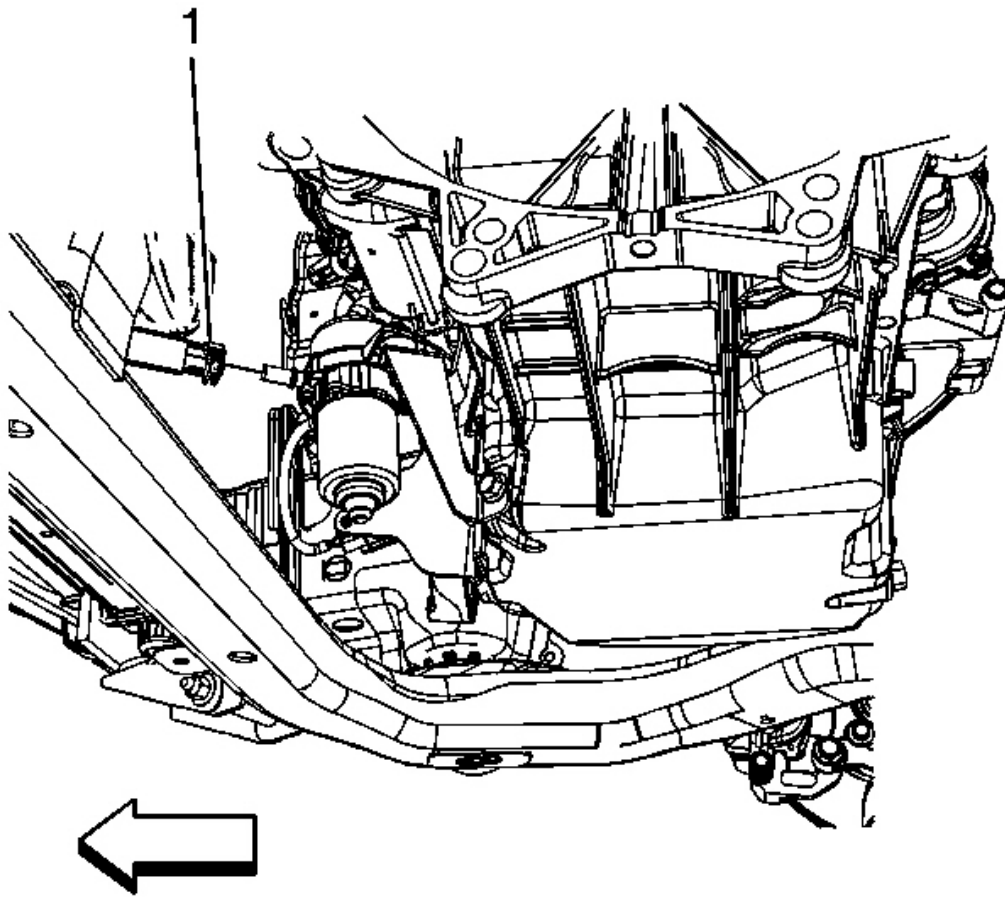
**Fig. 79: Upper Power Brake Booster Pump Bolt**  
**Courtesy of GENERAL MOTORS CORP.**

4. Install the power brake booster pump assembly.
5. Install the upper power brake booster pump bolt (1) and tighten to 22 N.m (16 lb ft).



**Fig. 80: Power Brake Booster Pump Bolts**  
**Courtesy of GENERAL MOTORS CORP.**

6. Install the power brake booster pump bolts (1).
7. Tighten the power brake booster pump M8 bolt to 22 N.m (16 lb ft).
8. Tighten the power brake booster pump M10 bolt to 50 N.m (37 lb ft).



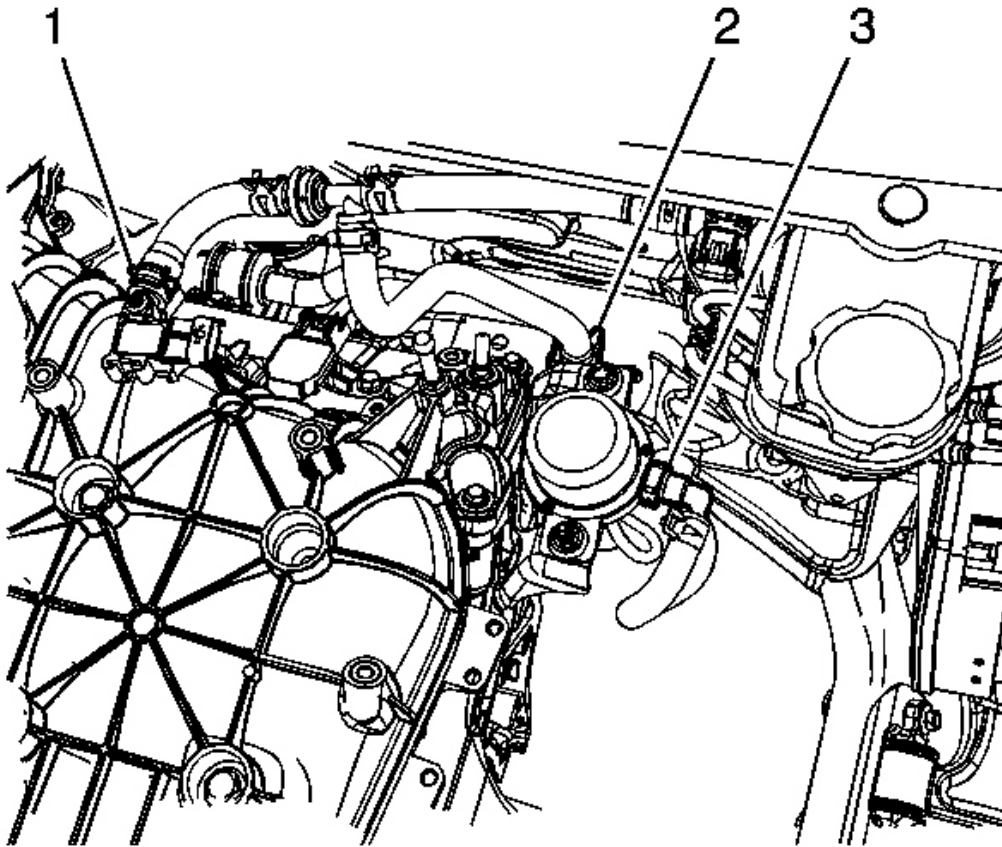
**Fig. 81: Power Brake Booster Vacuum Hose Quick Connect**  
Courtesy of GENERAL MOTORS CORP.

9. Connect the power brake booster pump hose quick connect (1).
10. Install the power brake booster pump electrical connector retainer to the pump bracket.
11. Connect the power brake booster pump electrical connector.

## **POWER BRAKE BOOSTER PUMP REPLACEMENT (3.0L)**

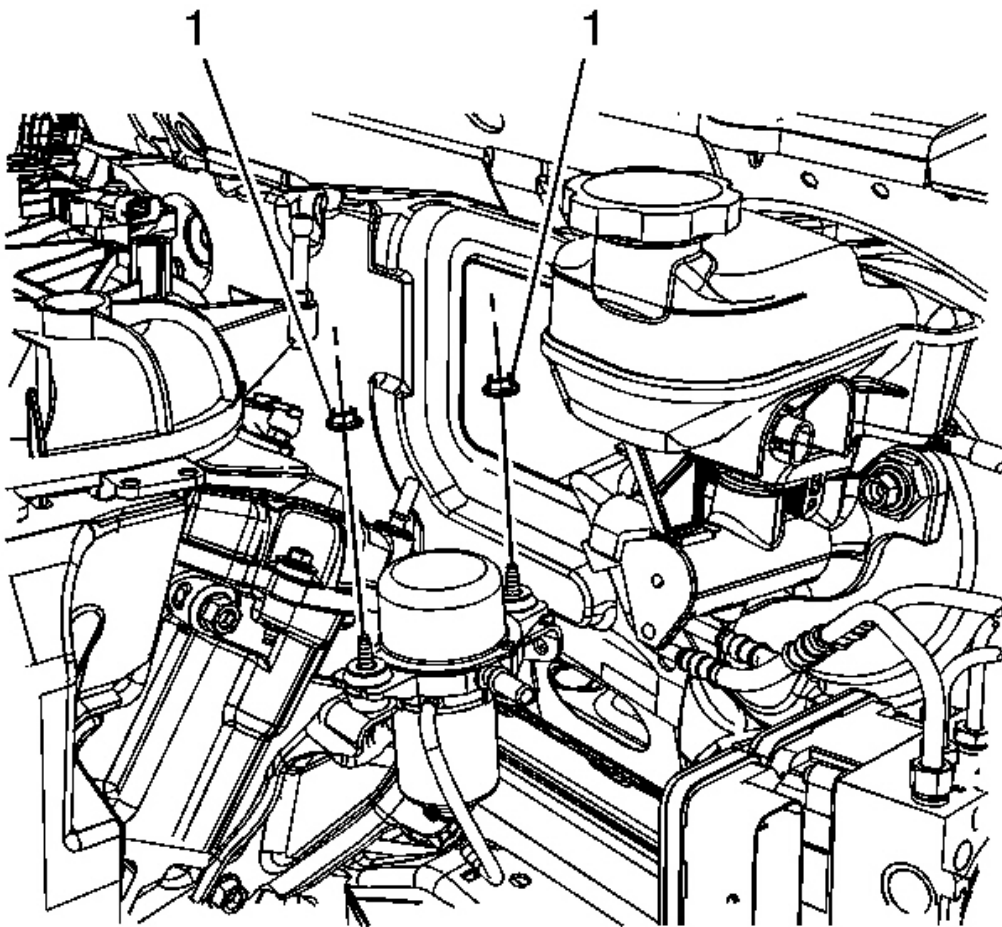
### **Removal Procedure**

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .



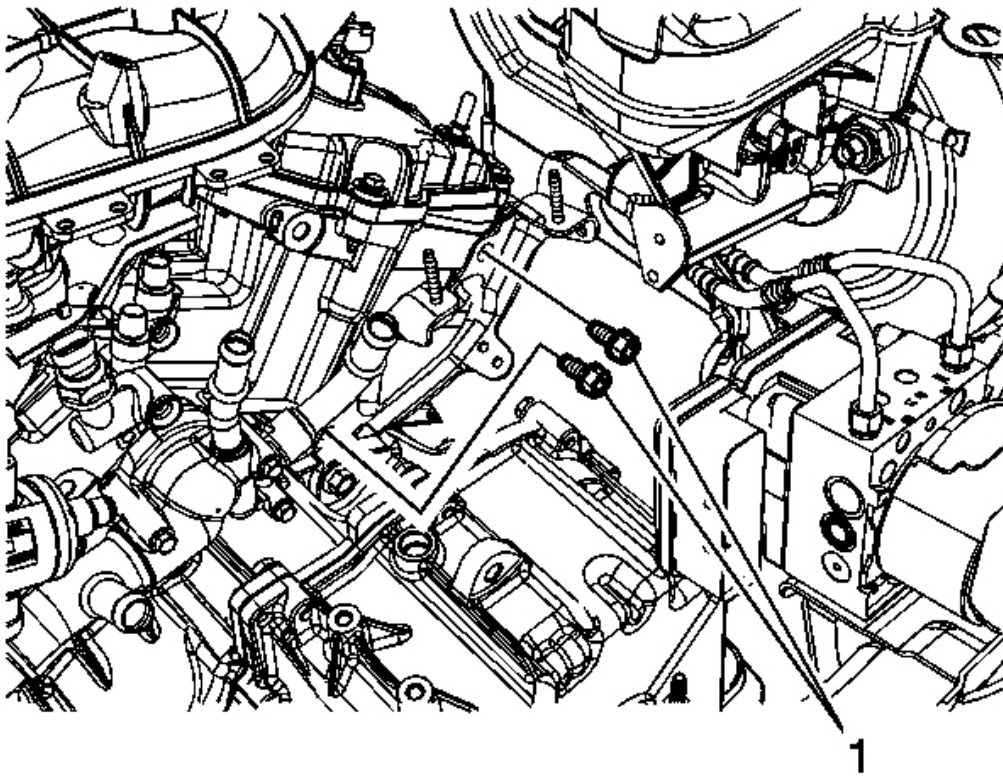
**Fig. 82: Power Brake Booster Vacuum Hose Quick Connect & Routing Clip**  
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the power brake booster vacuum hose quick connect (3).
4. Release the power brake booster vacuum hose from the routing clip (2) on the power brake booster auxiliary pump.
5. Disconnect the power brake booster auxiliary pump electrical connector.
6. Release the power brake booster auxiliary pump electrical connector retainer from the pump bracket.



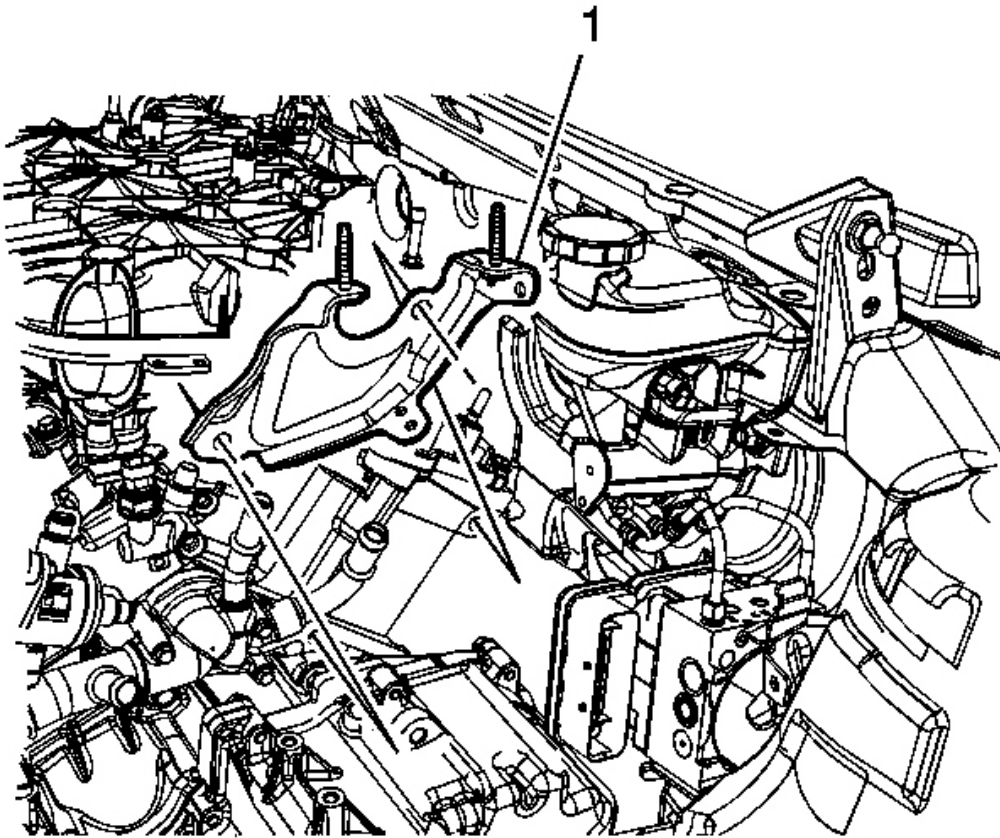
**Fig. 83: Power Brake Booster Auxiliary Pump Nuts**  
**Courtesy of GENERAL MOTORS CORP.**

7. Remove the power brake booster auxiliary pump nuts (1).
8. Remove the power brake booster auxiliary pump.



**Fig. 84: Power Brake Booster Auxiliary Pump Bracket Bolts**  
**Courtesy of GENERAL MOTORS CORP.**

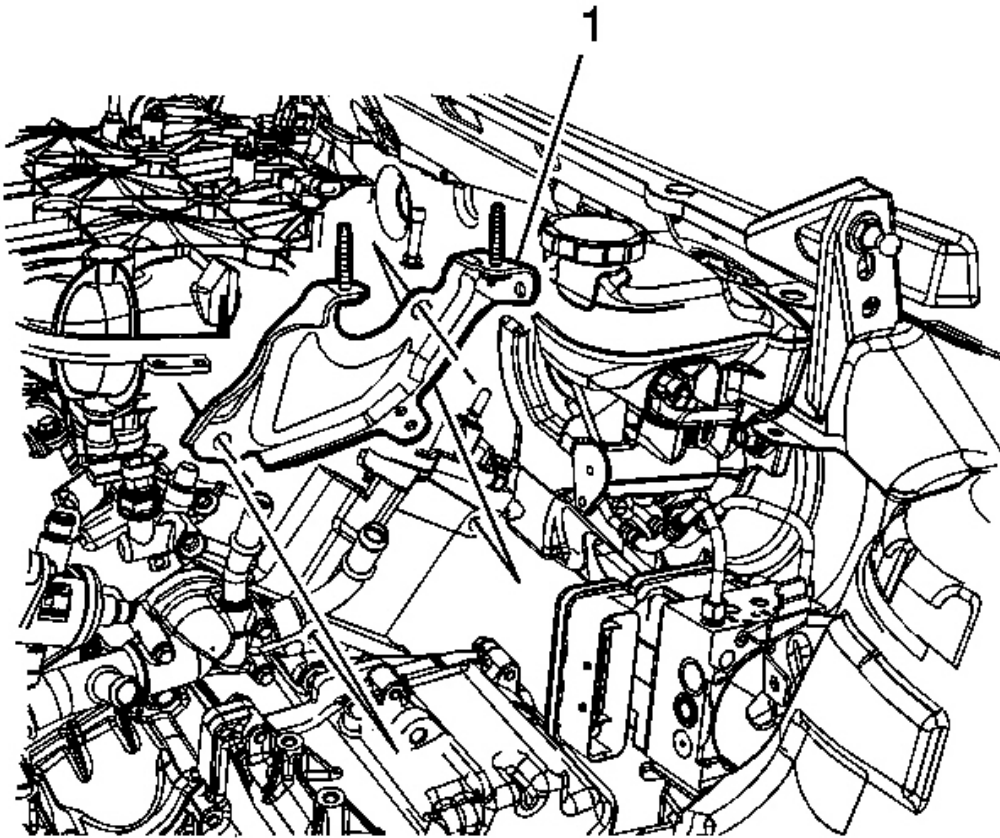
9. If removing the power brake booster auxiliary pump bracket, remove the power brake booster auxiliary pump bracket bolts (1).



**Fig. 85: Power Brake Booster Auxiliary Pump Bracket**  
**Courtesy of GENERAL MOTORS CORP.**

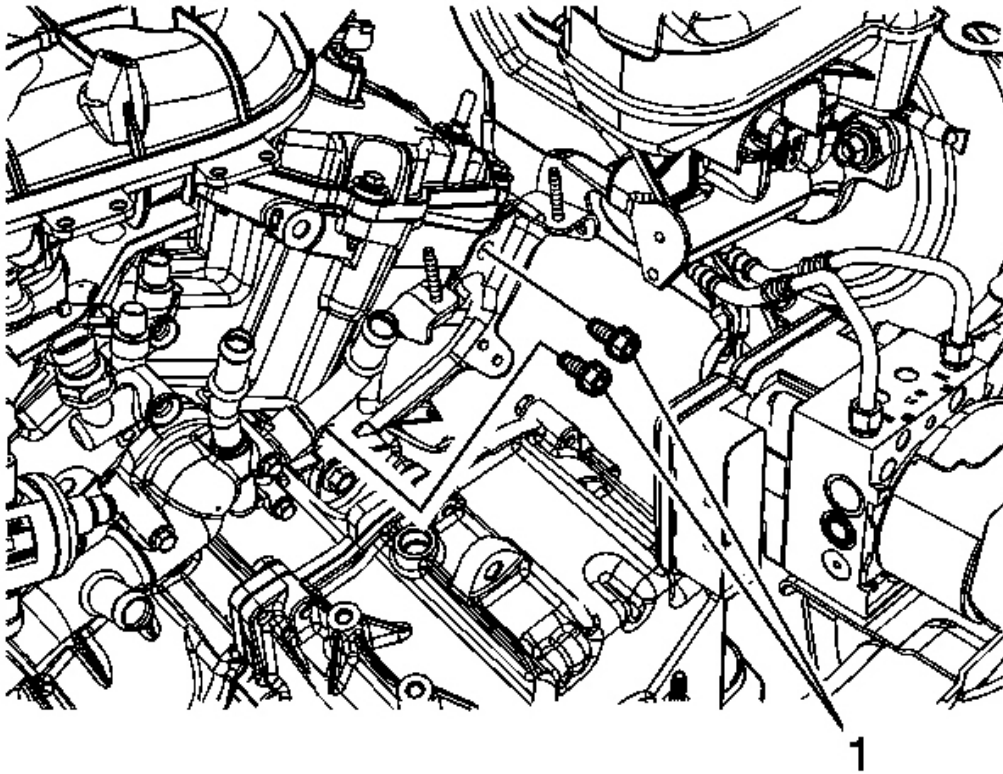
10. Remove the power brake booster auxiliary pump bracket (1).

#### **Installation Procedure**



**Fig. 86: Power Brake Booster Auxiliary Pump Bracket**  
**Courtesy of GENERAL MOTORS CORP.**

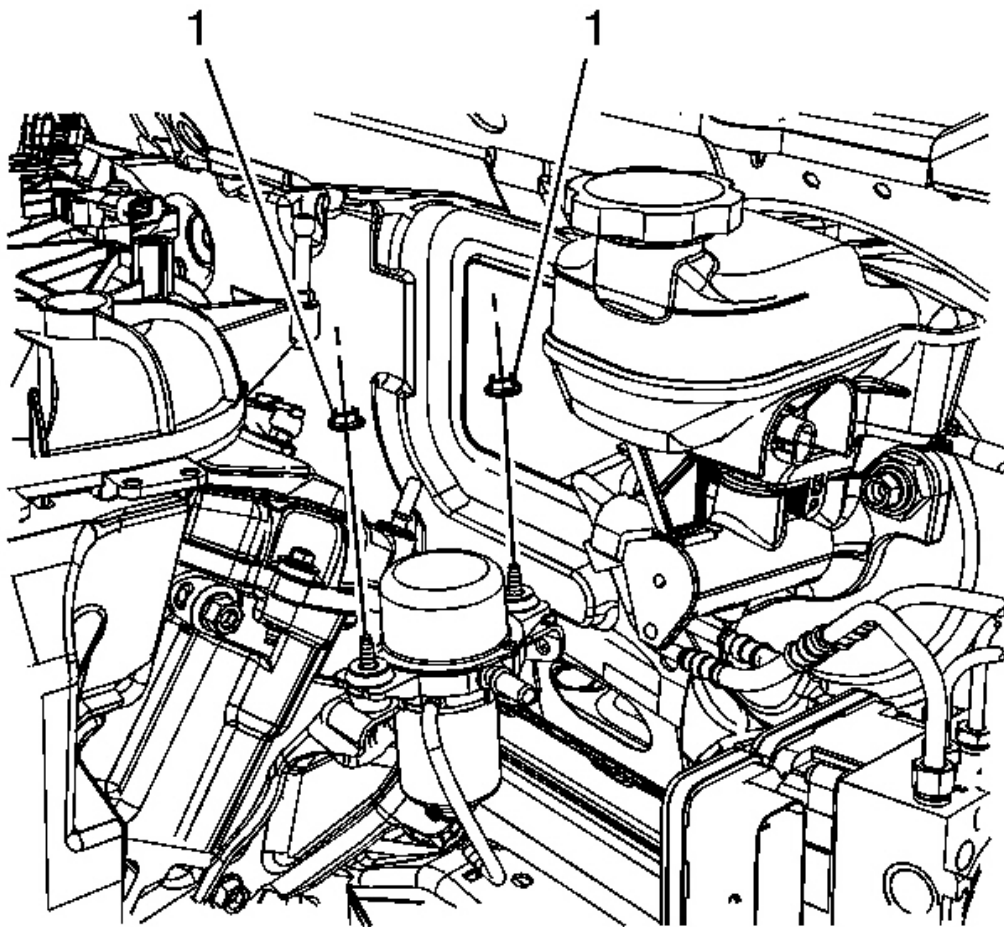
1. If removed, install the power brake booster auxiliary pump bracket (1).



**Fig. 87: Power Brake Booster Auxiliary Pump Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

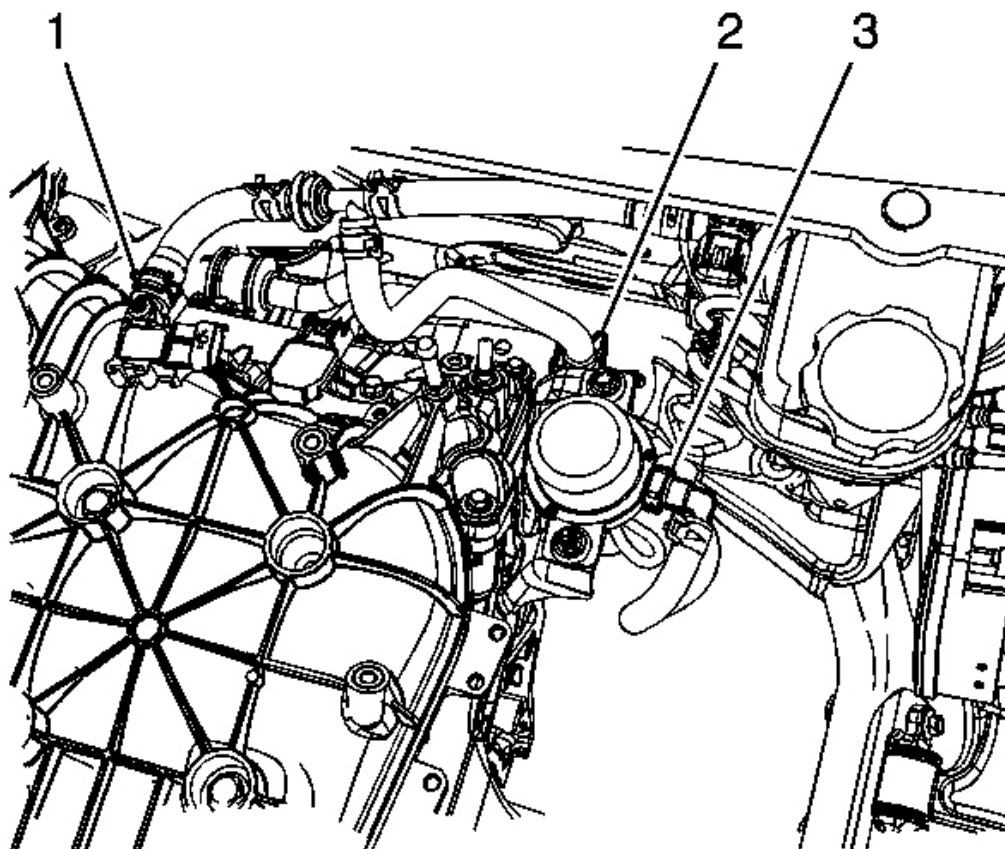
**CAUTION: Refer to Fastener Caution .**

2. Install the power brake booster auxiliary pump bracket bolts (1) and tighten to 50 N.m (37 lb ft).



**Fig. 88: Power Brake Booster Auxiliary Pump Nuts**  
**Courtesy of GENERAL MOTORS CORP.**

3. Install the power brake booster auxiliary pump to the pump bracket.
4. Install the power brake booster auxiliary pump nuts (1) and tighten to 9 N.m (80 lb in)



**Fig. 89: Power Brake Booster Vacuum Hose Quick Connect & Routing Clip**  
Courtesy of GENERAL MOTORS CORP.

5. Connect the power brake booster vacuum hose quick connect (3).
6. Connect the power brake booster auxiliary pump electrical connector.
7. Secure the power brake booster auxiliary pump electrical connector retainer to the pump bracket.
8. Secure the power brake booster vacuum hose from the routing clip (2) on the power brake booster auxiliary pump.
9. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

## DESCRIPTION AND OPERATION

### BRAKE ASSIST SYSTEM DESCRIPTION AND OPERATION

#### System Component Description

The brake assist system consists of the following:

### **Brake Pedal**

Receives, multiplies and transfers brake system input force from driver.

### **Brake Pedal Pushrod**

Transfers multiplied input force received from brake pedal to brake booster.

### **Vacuum Brake Booster**

Uses source vacuum to decrease effort required by driver when applying brake system input force. At rest, source vacuum is applied to both sides of the vacuum diaphragm for single boosters, or to both sides of each of the diaphragms for tandem boosters. Return springs maintain the booster in a rest position.

When brake system input force is applied, vacuum to the rear of the diaphragm(s) is cut off, and air at atmospheric pressure is admitted in its place. This provides a decrease in brake pedal effort required. When input force is removed, vacuum again replaces atmospheric pressure within the booster.

### **Vacuum Source**

Supplies force used by vacuum brake booster to decrease brake pedal effort.

The primary source for vacuum is typically the vehicle's internal combustion engine. Some vehicles may use a vacuum pump to ensure an adequate supply of vacuum under various operating conditions, such as during cold start-up, heavy throttle, and high altitude.

### **Vacuum Pump Relay**

Vehicles equipped with a vacuum pump will typically be equipped with a relay used to provide voltage to the vacuum pump motor, when commanded by the powertrain controller.

### **Vacuum Monitoring System**

Provides a feedback voltage signal relative to the amount of vacuum available for the vacuum power brake booster.

This typically consists of a vacuum sensor mounted either into the power vacuum brake booster, integrated with the vacuum check valve, or in-line within the vacuum hose. The sensor feedback is typically monitored by the powertrain control module(s).

### **Vacuum Source Control**

If equipped with a system to monitor available levels of vacuum for the brake assist system, the powertrain control module(s) typically perform the primary monitoring function.

The powertrain controller will typically monitor the feedback signal of a vacuum sensor, as it relates to available vacuum at the vacuum power brake booster. The powertrain controller uses the information to make sure available vacuum remains above predetermined levels. If additional vacuum is required, the powertrain controller may reactivate engine cylinders, if equipped, or command a vacuum pump ON, if

equipped, and/or may alter the operation of various other engine controls and devices, as necessary.

## **Vacuum Source Delivery System**

Enables delivery and retention of source vacuum for vacuum brake booster.

This typically consists of a vacuum check valve and a vacuum hose or pipe. If a vacuum pump is used, additional check valves may be used.

### **System Operation**

Brake system input force from the driver is multiplied by the brake pedal and transferred by the pedal pushrod to the hydraulic brake master cylinder. Effort required to apply the brake system is reduced by the operation of the vacuum brake booster.

When brake system force is applied, vacuum to the rear of the diaphragm(s) is cut off, and air at atmospheric pressure is admitted in its place. The vacuum acts to pull the diaphragm(s) forward, while the atmospheric pressure acts to push from behind. As a result, the amount of effort required by the driver is reduced. When input force is removed, vacuum again replaces atmospheric pressure within the vacuum power brake booster to help return the booster to rest. Return springs maintain the system in a rest position.

If the vehicle is equipped with a vacuum monitoring system, the powertrain control module(s) typically will alter powertrain functions and/or command the vacuum pump ON, if equipped, to provide for the vacuum needs of the brake assist system, as operating conditions warrant.

## **BRAKE BOOSTER VACUUM ASSIST DESCRIPTION AND OPERATION**

### **System Component Description**

The brake booster vacuum assist system consists of the following:

#### **Brake Booster Auxiliary Vacuum Pump**

The brake booster vacuum pump is a secondary vacuum supply to the brake booster to maintain sufficient vacuum for brake assist.

### **Vacuum Brake Booster**

Uses source vacuum to decrease effort required by driver when applying the brake.

When brake system input force is applied, air at atmospheric pressure is admitted to the rear of both vacuum diaphragms, providing a decrease in brake pedal effort required. When input force is removed, vacuum replaces atmospheric pressure within the booster.

### **Vacuum Source**

Vacuum is supplied by engine vacuum or by the brake booster vacuum pump.

### **System Operation**

The electronic brake control module (EBCM) actuates the brake booster vacuum pump to generate additional vacuum to the vacuum brake booster if an increase in braking force is needed.

## **BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION**

### **Brake Warning Indicator**

The instrument cluster turns the brake warning indicator ON when the following occurs:

- The instrument cluster performs the bulb check. The brake warning indicator illuminates for 5 seconds.
- When the EBCM detects a too low brake fluid level it sets DTC C0267 and sends a serial data message to the instrument cluster, which will illuminate.

Electronic brake control module (EBCM) monitors the brake fluid level in the brake fluid reservoir. When the fluid within the brake fluid reservoir is below the MIN level, contacts within the brake fluid level switch closes causing the voltage within the signal circuit to drop. The electronic brake control module (EBCM) will detect the voltage drop and will send a serial data message to the instrument cluster commanding the brake warning indicator to illuminate.

## **HYDRAULIC BRAKE SYSTEM DESCRIPTION AND OPERATION**

### **System Component Description**

The hydraulic brake system consists of the following:

#### **Hydraulic Brake Master Cylinder Fluid Reservoir**

Contains supply of brake fluid for the hydraulic brake system.

#### **Hydraulic Brake Master Cylinder**

Converts mechanical input force into hydraulic output pressure.

Hydraulic output pressure is distributed from the master cylinder through 2 hydraulic circuits, supplying front-rear opposed wheel apply circuits.

#### **Hydraulic Brake Pressure Balance Control System**

Regulates brake fluid pressure delivered to hydraulic brake wheel circuits, in order to control the distribution of braking force.

Pressure balance control is achieved through dynamic rear proportioning (DRP), which is a function of the ABS modulator. Refer to **ABS Description and Operation** for specific information on the operation of DRP.

#### **Hydraulic Brake Pipes and Flexible Brake Hoses**

Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components

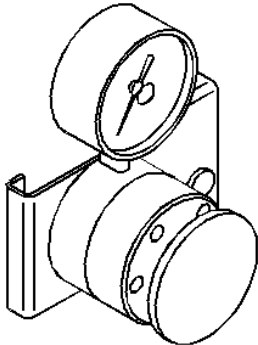
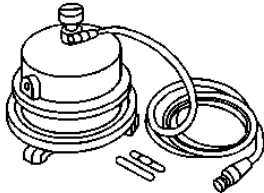
Converts hydraulic input pressure into mechanical output force.

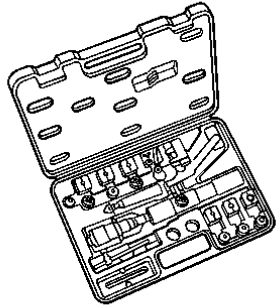
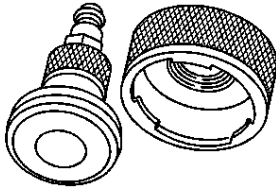
System Operation

Mechanical force is converted into hydraulic pressure by the master cylinder, regulated to meet braking system demands by the pressure balance control system, and delivered to the hydraulic brake wheel circuits by the pipes and flexible hoses. The wheel apply components then convert the hydraulic pressure back into mechanical force which presses linings against rotating brake system components.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

| Illustration                                                                        | Tool Number/ Description                    |
|-------------------------------------------------------------------------------------|---------------------------------------------|
|   | J 28662<br>Brake Pedal Effort Gauge         |
|  | J 29532<br>Diaphragm Pressure Bleeder       |
|                                                                                     | J 44894-A<br>Brake Pressure Bleeder Adapter |



J 45405  
Brake Pipe Flaring Kit