

2007 Saturn Outlook XE

2007 BRAKES Hydraulic Brakes - Outlook

2007 BRAKES

Hydraulic Brakes - Outlook

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Hose Bracket Bolt - Front	9 N.m	80 lb in
Brake Hose Bracket Bolt - Rear	12 N.m	106 lb in
Brake Hose Fitting Bolt - Front and Rear	40 N.m	30 lb ft
Brake Pedal Bracket Bolts	22 N.m	16 lb ft
Brake Pipe Fittings - Master Cylinder Outlet	20 N.m	15 lb ft
Brake Pipe Fittings - Front and Rear at Brake Hose	17 N.m	13 lb ft
Brake Pipe Fittings - Rear Crossover Brake Pipe Union	18 N.m	13 lb ft
Brake Pressure Modulator Valve (BPMV) Assembly Bracket Nuts	20 N.m	15 lb ft
Master Cylinder Nuts	20 N.m	15 lb ft
Vacuum Booster Nuts	25 N.m	18 lb ft

BRAKE SYSTEM SPECIFICATIONS

Brake System Specifications

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

SCHEMATIC AND ROUTING DIAGRAMS

HYDRAULIC BRAKE SCHEMATICS

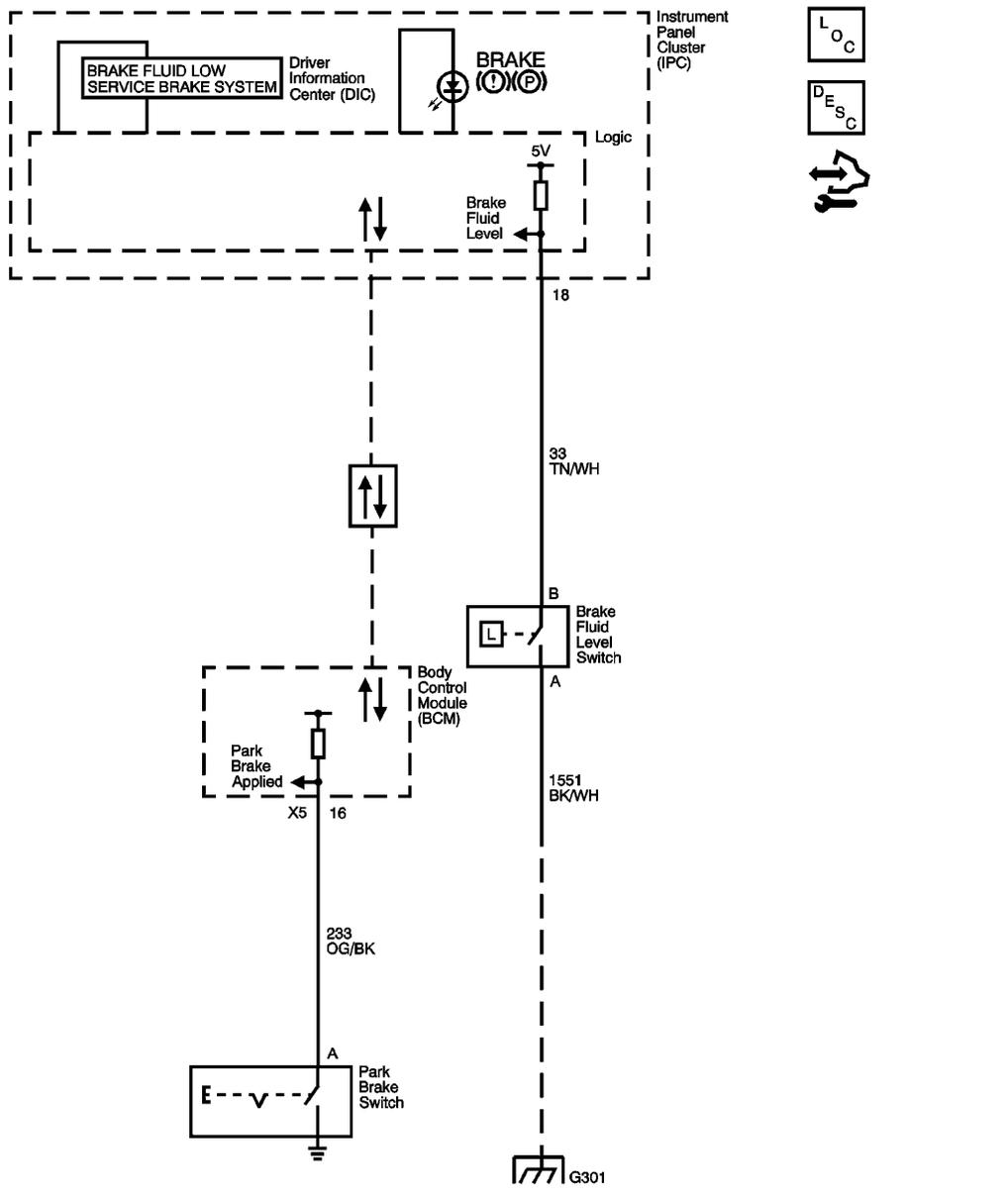


Fig. 1: Hydraulic Brake Schematic
 Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

HYDRAULIC BRAKE COMPONENT VIEWS

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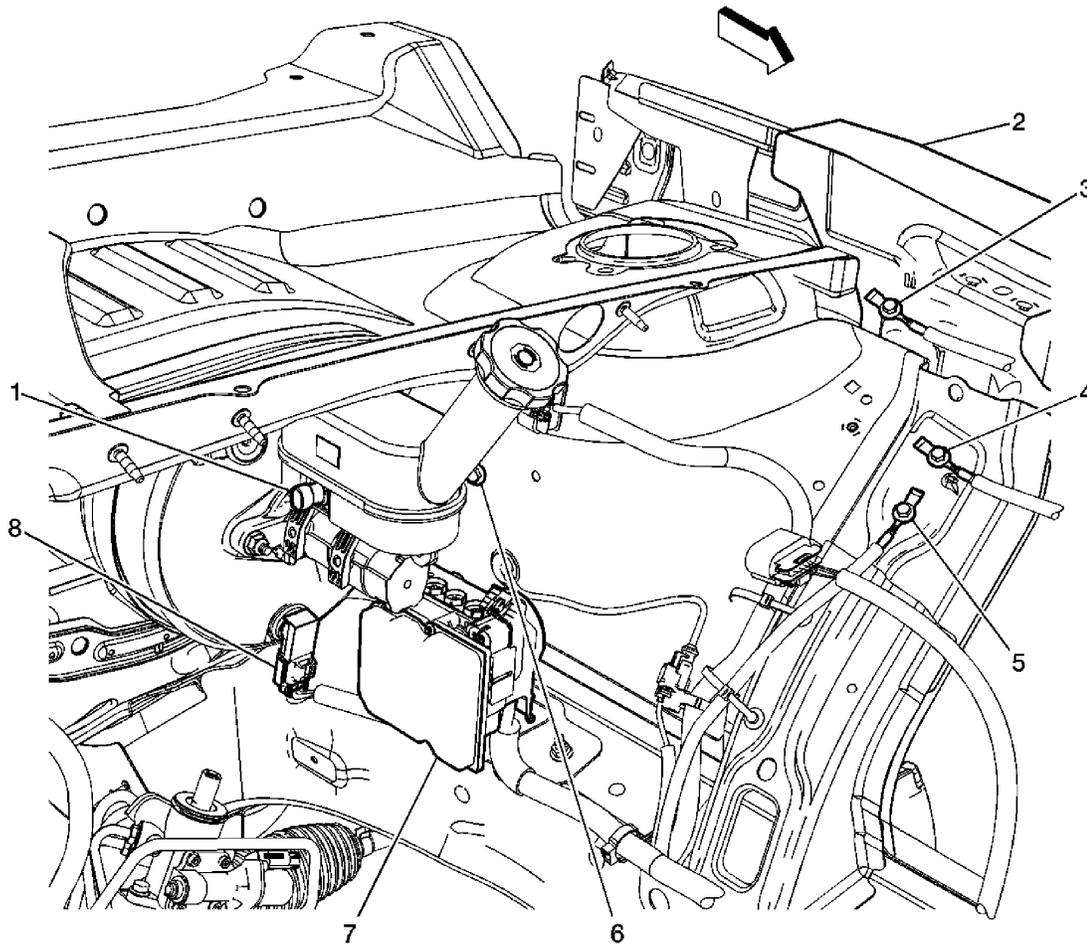


Fig. 2: View Near The Brake Booster
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 2

Callout	Component Name
1	Brake fluid Level Switch
2	LF Fender
3	G103
4	G115
5	Electronic Brake Control Module (EBCM)
6	Brake Booster Vacuum Sensor

HYDRAULIC BRAKE CONNECTOR END VIEWS

Brake Fluid Level Switch (WDA)

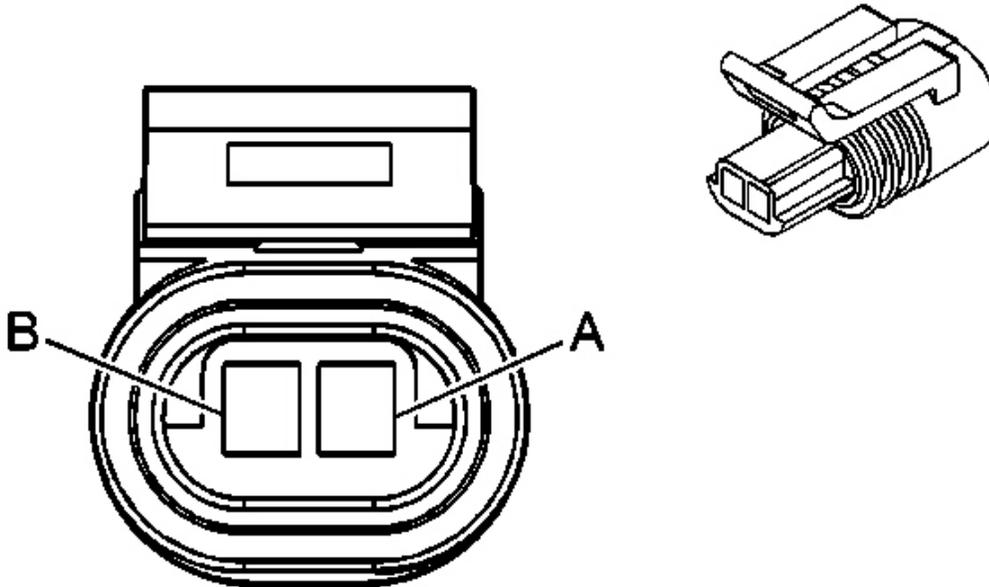


Fig. 3: Brake Fluid Level Switch (WDA) Connector End View
 Courtesy of GENERAL MOTORS CORP.

Brake Fluid Level Switch (WDA) Connector Parts Information

Connector Part Information

- OEM: 12162193
- Service: 88987993
- Description: 2-Way F Metri-Pack 150.2 Series, Sealed, Pull To Seat (BK)

Terminal Part Information

- Terminal/Tray: 12124075/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12180559-1/J-35616-14 (GN)

Brake Fluid Level Switch (WDA) Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	0.35 BK/WH	1551	Ground

B

0.35 TN/WH

33

Brake Warning Indicator Control

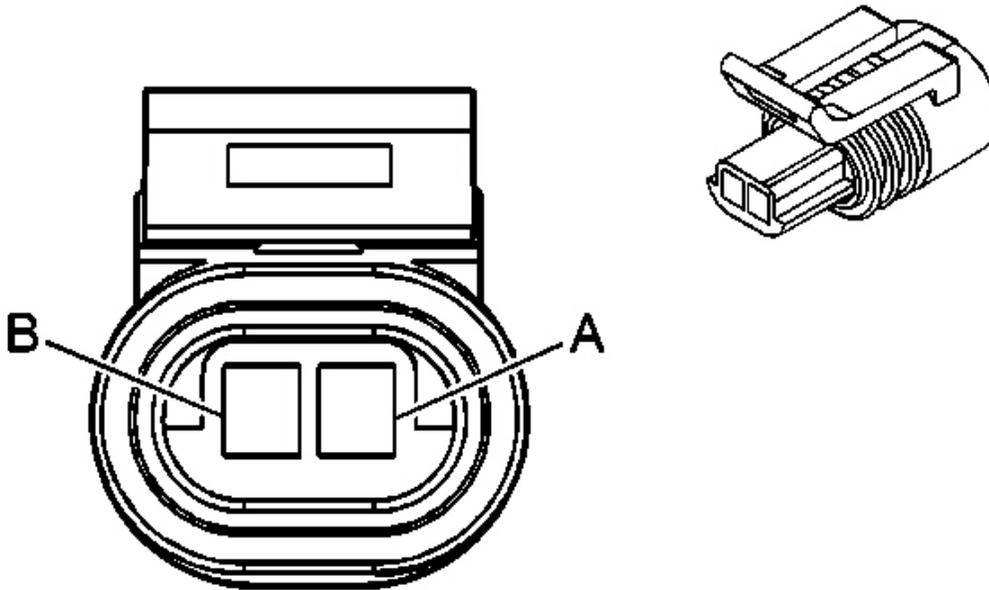
Brake Fluid Level Switch (Z88)

Fig. 4: Brake Fluid Level Switch (Z88) Connector End View
 Courtesy of GENERAL MOTORS CORP.

Brake Fluid Level Switch (Z88) Connector Parts Information**Connector Part Information**

- OEM: 12162193
- Service: 88987993
- Description: 2-Way F Metri-Pack 150.2 Series, Sealed, Pull To Seat (BK)

Terminal Part Information

- Terminal/Tray: 12124075/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12180559-1/J-35616-14 (GN)

Brake Fluid Level Switch (Z88) Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	0.35 BK/WH	1551	Ground
B	0.35 TN/WH	33	Brake Warning Indicator Control

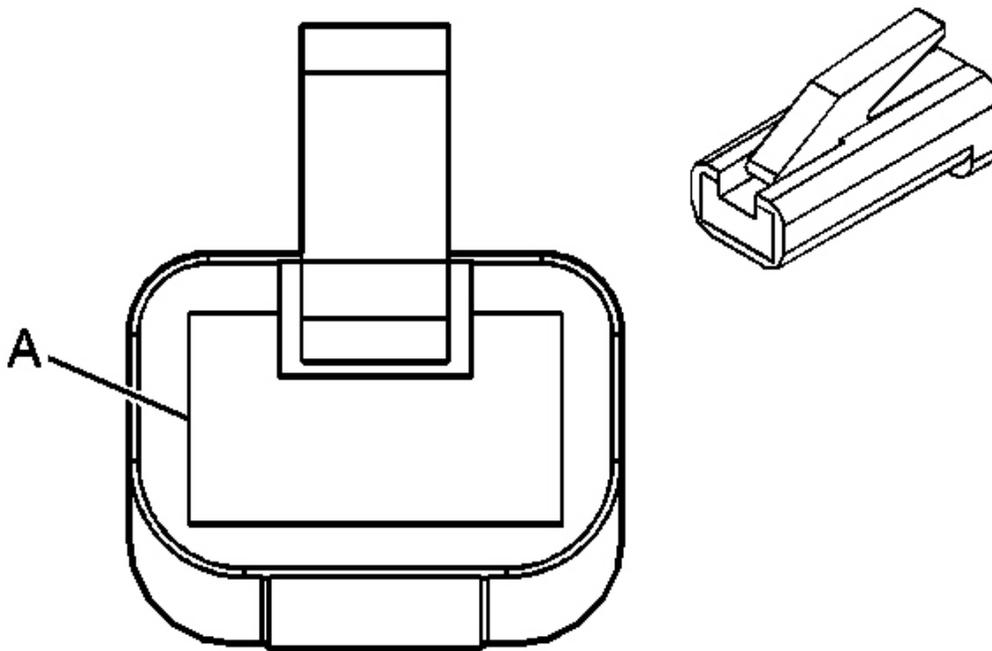
Park Brake Switch (WDA)

Fig. 5: Park Brake Switch (WDA) Connector End View
 Courtesy of GENERAL MOTORS CORP.

Park Brake Switch (WDA) Connector Parts Information**Connector Part Information**

- OEM: 12004267
- Service: 12102561
- Description: 1-Way F 56 Series Lock Type (BK)

Terminal Part Information

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- Terminal/Tray: 12124515/1
- Core/Insulation Crimp: C/D
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Park Brake Switch (WDA) Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	0.5 OG/BK	233	Park Brake Switch Signal

Park Brake Switch (Z88)

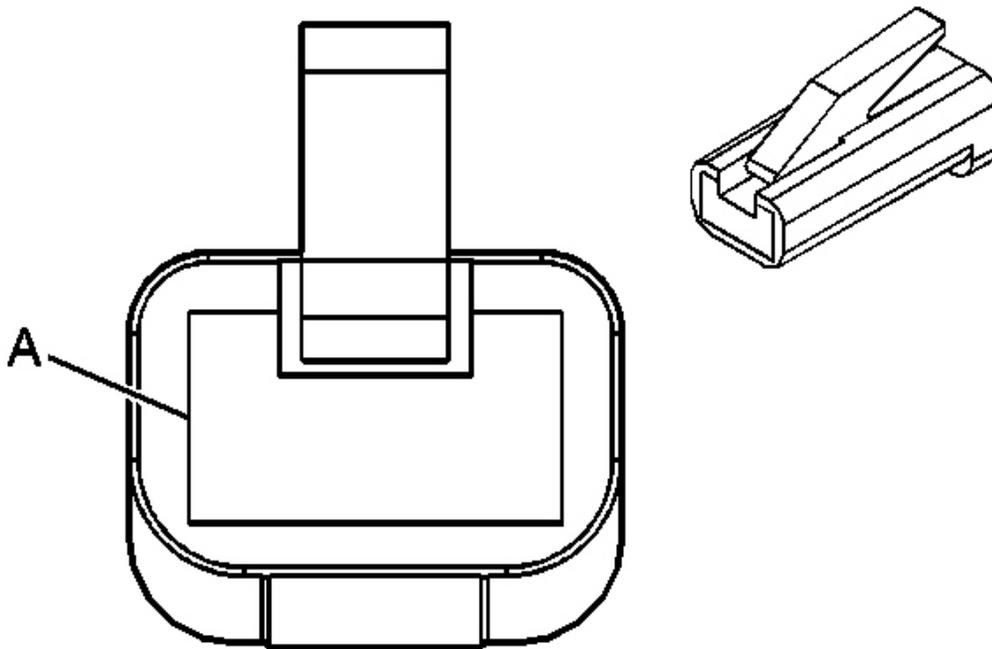


Fig. 6: Park Brake Switch (Z88) Connector End View
Courtesy of GENERAL MOTORS CORP.

Park Brake Switch (Z88) Connector Parts Information

Connector Part Information

- OEM: 12004267

- Service: 12102561
- Description: 1-Way F 56 Series Lock Type (BK)

Terminal Part Information

- Terminal/Tray: 12124515/1
- Core/Insulation Crimp: C/D
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Park Brake Switch (Z88) Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	0.5 OG/BK	233	Park Brake Switch Signal

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - HYDRAULIC BRAKES

Begin the system diagnosis by reviewing the system Description and Operation. Reviewing the Description and Operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the Description and Operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Hydraulic Brakes** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

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

Low Brake Fluid Indicated

Diagnostic Fault Information

DTC C0267

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	C0267	-	-	-

Circuit/System Description

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

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

Low brake fluid is detected.

Action Taken When the DTC Sets

- The EBCM disables the Antilock Brake System (ABS)/Traction Control System (TCS) dynamic rear proportion (DRP) and Vehicle Stability Enhancement System (VSES).
- The ABS indicator turns ON.
- The Traction Control indicator turns ON.
- The Red Brake Warning indicator turns ON.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

Ensure the master cylinder reservoir is at the proper fluid level.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

Hydraulic Brake Connector End Views

Electrical Information Reference

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

Scan Tool Reference

Scan Tool Data List for EBCM

Circuit/System Verification

Ignition ON, observe the scan tool IPC Brake Fluid parameter. The reading should be OK when fluid is at the proper level and low when the fluid is below the minimum level.

- If low, refer to **Brake Fluid Loss**.

Circuit/System Testing

IMPORTANT: This test should only be performed if brake fluid is not low.

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 1 ohm of resistance 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 IPC Brake Fluid parameter is OK.
 - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the IPC.
4. Install a 3A fused jumper wire between the signal circuit terminal and ground. Verify the scan tool IPC Brake Fluid 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 IPC.
5. If all circuits test normal, test or replace the brake fluid level.

Component Testing

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 2300 ohms between the ground terminal A and the 5-volt reference terminal B.
 - o If greater than specified value, replace the brake fluid level switch.

Repair Procedures

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

- **Master Cylinder Fluid Level Sensor Replacement**
- **Control Module References** for IPC replacement, setup and programming

SYMPTOMS - HYDRAULIC BRAKES

IMPORTANT: 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 Assist System Description and Operation**
 - **Hydraulic Brake Component Operation Visual Inspection**

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 Always On**
- **Brake Warning Indicator Inoperative**
- **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 Fluid Loss**
- **Hydraulic Brake System Diagnosis**
- **Brake Assist System Diagnosis**

BRAKE WARNING INDICATOR ALWAYS ON**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 instrument panel cluster (IPC) sees the brake fluid level switch input grounded and illuminates the Red Brake Warning indicator. The body control module (BCM) sees the park brake switch input grounded, it sends a serial data message to the IPC requesting illumination of the Red Brake Warning indicator.

Reference Information**Schematic Reference****Hydraulic Brake Schematics**

Connector End View Reference

Hydraulic Brake 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

Scan Tool Data List

Circuit/System Verification

1. Verify the park brake is released and the brake fluid is at the proper level.
 - If the brake fluid is not at the proper level, refer to **Brake Fluid Loss**.
2. Command the IPC display test with a scan tool, the Red Brake warning indicator should turn ON and OFF.
 - If the red brake warning indicator does not turn OFF, replace the IPC.
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 Release.
 - If the parameter does not cycle between the specified values, refer to Park Brake Switch Malfunction under **Circuit/System Testing**.
4. Verify the scan tool IPC Brake Fluid parameter is OK.
 - If the parameter does not cycle between the specified values, refer to Brake Fluid Level Switch Malfunction under **Circuit/System Testing**.

Circuit/System Testing

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal A and ground.

- If less than the specified range, test the signal circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the BCM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
3. 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 1.0 ohm of resistance 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 IPC Brake Fluid parameter is OK.
 - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the IPC.
4. Install a 3A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool IPC Brake Fluid 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 IPC.
5. If all the 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 not the specified value, replace the park brake switch.
3. Test for less than 1 ohm between the signal circuit 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 less than 2300 ohms between the ground terminal A and the signal terminal B.
 - 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 Fluid Level Sensor Replacement**
- **Park Brake Warning Lamp Switch Replacement**
- **Control Module References** for BCM and IPC replacement, setup and programming

BRAKE WARNING INDICATOR INOPERATIVE

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 instrument panel cluster (IPC) sees the brake fluid level switch input grounded and illuminates the Red Brake Warning indicator. The body control module (BCM) sees the park brake switch input grounded, it sends a serial data message to the IPC requesting illumination of the Red Brake Warning indicator.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

Hydraulic Brake 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

Scan Tool Data List

Circuit/System Verification

1. Verify the park brake is released and the brake fluid is at the proper level.
 - If the brake fluid is not at the proper level, refer to **Brake Fluid Loss**.
2. Command the IPC display test with a scan tool, the Red Brake warning indicator should turn ON and OFF.
 - If the red brake warning indicator does not illuminate, replace the IPC.
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 Release.
 - If the parameter does not cycle between the specified values, refer to Park Brake Switch Malfunction under **Circuit/System Testing**.
4. Verify the scan tool IPC Brake Fluid parameter is OK.
 - If not the specified value, refer to Brake Fluid Level Switch Malfunction under **Circuit/System Testing**.

Circuit/System Testing

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal A and ground.
 - If less than the specified range, test the signal circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the BCM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
3. 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 1.0 ohm of resistance 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 IPC Brake Fluid parameter is OK.
 - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the IPC.
4. Install a 3A fused jumper wire between the signal circuit terminal B and the ground circuit terminal A. Verify the scan tool IPC Brake Fluid 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 IPC.
5. If all the 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 not the specified value, replace the park brake switch.
3. Test for less than 1 ohm between the signal circuit 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 less than 2300 ohms between the ground terminal A and the signal terminal B.
 - 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 Fluid Level Sensor Replacement**
- **Park Brake Warning Lamp Switch Replacement**
- **Control Module References** for BCM and IPC replacement, setup and programming

BRAKE PULSATION

Brake Pulsation

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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 <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	1. Inspect the disc brake system for the following conditions. <ul style="list-style-type: none"> • Excessive thickness variation of rotor friction surfaces • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Hard spots, heat checks, bluing discoloration of rotor friction surfaces; possibly due to brake drag • Excessive corrosion of rotor friction surfaces; including red, gray or black oxidation • Loose, damaged or missing caliper or lining hardware • Bent or damaged caliper or mounting component • Excessive LRO of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings 2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 3	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	1. Install or connect components that were removed or disconnected		

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3	during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test.</u>		
	Is the condition still present?	Go to Step 2	System OK

BRAKE SYSTEM NOISE

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 Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	1. Inspect the disc brake system for the following conditions. <ul style="list-style-type: none"> • Lining wear indicator contact with rotor • Debris trapped between rotor and splash shield or backing plate; and/or debris trapped between rotor and linings • Contaminated linings • Aftermarket linings • Glazed linings • Distorted, cracked or damaged linings • Excessively worn linings • Damaged or excessively worn caliper hardware and/or lining hardware • Incorrectly installed, loose or missing caliper hardware 		

	<p>and/or lining hardware</p> <ul style="list-style-type: none"> • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Bent or damaged splash shield or backing plate • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p>		
	<p>Did you find and correct a condition?</p>	<p>Go to Step 9</p>	<p>Go to Step 3</p>
<p>3</p>	<p>1. Inspect the brake assist system for the following conditions.</p> <ul style="list-style-type: none"> • Lack of lubrication or excessively worn pushrod or pedal pivots or pivot bushings • Bent or damaged pedal pushrod, pedal or pedal bracket • Damaged or improperly operating vacuum booster and/or check valve, if equipped • Low power steering fluid level, if equipped with hydraulic boost • Improperly tensioned, excessively worn or damaged power steering belt, if equipped with hydraulic boost • Restricted return hose from 		

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	<p>hydraulic booster, if equipped</p> <ul style="list-style-type: none"> • Improperly operating hydraulic booster, if equipped • Improperly functioning power steering system, if equipped with a hydraulic booster assembly • Contaminated power steering fluid, if equipped with hydraulic boost <p>2. Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>.</p>		
	Did you find and correct a condition?	Go to Step 9	Go to Step 4
4	<p>1. Inspect the hydraulic brake system for the following conditions.</p> <ul style="list-style-type: none"> • Improper operation of caliper pistons • Contaminated brake fluid <p>2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.</p>		
	Did you find and correct a condition?	Go to Step 9	Go to Step 5
5	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 6	Go to Step 9
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 Step 7	Go to Step 9
	<p>1. Clean and inspect the park brake shoes for excessive wear and/or damage.</p> <p>2. Inspect the drum portion of the</p>		

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7	rotors for excessive wear, blueing discoloration, heat spots and excessive radial runout.		
	3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system.		
	Did you find and correct a condition?	Go to Step 9	Go to Step 8
8	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> .		Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	Did you find and correct a condition?	Go to Step 9	
9	1. Install or connect components that were removed or disconnected during diagnosis.		
	2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> .		
	Is the condition still present?	Go to Step 2	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.

Braking Action Uneven - Pulls to One Side

Step	Action	Yes	No
DEFINITION: Vehicle pulls to one side only when braking.			
	Were you sent here from the Hydraulic Brake Symptom table?		Go to Diagnostic

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1		Go to Step 2	<u>Starting Point - Hydraulic Brakes</u>
2	<p>1. Inspect the hydraulic brake system for the following conditions.</p> <ul style="list-style-type: none"> • Kinked, pinched or damaged brake pipe or flexible brake hose • Sticking or improperly operating caliper piston • Brake fluid leak <p>2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 6	Go to Step 3
3	<p>1. Inspect the disc brake system for the following conditions.</p> <ul style="list-style-type: none"> • Contaminated linings • Glazed linings • Distorted, cracked or damaged linings on one side • Loose, damaged or missing caliper hardware and/or lining hardware • Incorrect linings on one side • Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p>		

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	Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	<p>1. Inspect the suspension system for the following conditions.</p> <ul style="list-style-type: none"> • Incorrect tire pressures • Loose suspension component connections • Excessively worn or damaged suspension components <p>2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> .</p>		
	Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	<p>1. Inspect the steering system for the following conditions.</p> <ul style="list-style-type: none"> • Loose steering component connections • Excessively worn or damaged steering components <p>2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Power Steering System</u> .</p>		Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	Did you find and correct a condition?	Go to Step 6	
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 <u>Brake System Vehicle Road Test</u>.</p>		
	Is the condition still present?	Go to Step 2	System OK

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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.

Braking Action Uneven - Front to Rear

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 Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	1. Inspect the hydraulic brake system for the following conditions: <ul style="list-style-type: none"> • Improper operation of caliper pistons • Kinked, pinched or damaged brake pipe or flexible brake hose • Brake fluid leak • Improperly functioning proportion valve, if equipped • Improper operation of dynamic rear proportion (DRP) system, if equipped 2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u> .		
	Did you find and correct a condition?	Go to Step 6	Go to Step 3
	1. Inspect the disc brake system for the following conditions: <ul style="list-style-type: none"> • Contaminated linings 		

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3	<ul style="list-style-type: none"> • Glazed linings • Distorted, cracked or damaged linings • Excessively worn linings • Aftermarket linings • Damaged or excessively worn caliper hardware and/or lining hardware • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p>		
	Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	<p>1. Inspect the suspension system for the following conditions:</p> <ul style="list-style-type: none"> • Loose suspension component connections • Excessively worn or damaged suspension components <p>2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> .</p>		
	Did you find and correct a condition?	Go to Step 6	Go to Step 5
	<p>1. Inspect the brake assist system for the following conditions:</p> <ul style="list-style-type: none"> • Binding, bent or damaged pedal pushrod, pedal or pedal bracket • Damaged or improperly operating vacuum booster, if equipped 		

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5	<ul style="list-style-type: none"> • Damaged or improperly operating hydraulic booster, if equipped <p>2. Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 6	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
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 <u>Brake System Vehicle Road Test</u>.</p> <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE TRAVEL

Brake Pedal Excessive Travel

Step	Action	Yes	No
<p>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.</p>			
1	<p>Were you sent here from the Hydraulic Brake Symptom table?</p>	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	<p>Inspect the travel and feel of brake pedal applies. Perform the following:</p> <ol style="list-style-type: none"> 1. Apply the brake pedal several times to fully deplete the power reserve. 2. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel. 3. Apply the brake pedal with light, 		

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2	<p>steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply.</p> <p>4. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply.</p>		-
	<p>Did you complete the brake pedal travel and feel inspections?</p>	<p>Go to Step 3</p>	
3	<p>1. Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections:</p> <ul style="list-style-type: none"> ● Pedal feel was spongy <ul style="list-style-type: none"> ■ Air in hydraulic system ■ External brake fluid leaks ■ Soft, weak or damaged hydraulic hoses; expanding under pressure ● Pedal fell away and/or traveled to or almost to floor <ul style="list-style-type: none"> ■ External brake fluid leaks ■ Poor brake fluid quality; low boiling point ■ Internal brake fluid leaks; improperly functioning master cylinder ● Pedal was somewhat firm then dropped slightly or pedal rose with successive applies or pedal travel was different between slow and quick 		

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

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	<p>surfaces</p> <ul style="list-style-type: none"> • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p> <p>3. Re-inspect brake pedal apply travel and feel.</p>		
	<p>Did you find and correct a condition?</p>	<p>Go to Step 8</p>	<p>Go to Step 5</p>
<p>5</p>	<p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p>	<p>Go to Step 7</p>	<p>Go to Step 6</p>
<p>6</p>	<p>1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components.</p> <ul style="list-style-type: none"> • For the brake pedal pushrod component inspection, refer to <u>Brake Pedal Pushrod Inspection</u>. • 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. <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>	<p>Go to Step 8</p>	<p>Go to Step 7</p>
	<p>1. Inspect the brake assist system for the following conditions:</p>		

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7	<ul style="list-style-type: none"> • Vacuum leaks and/or improperly operating check valve, if equipped with vacuum assist • Damaged or improperly operating brake booster assembly <p>2. Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 8	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
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 <u>Brake System Vehicle Road Test</u>.</p> <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE EFFORT

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 Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	<p>1. Inspect the brake assist system for the following conditions:</p> <ul style="list-style-type: none"> • Vacuum leaks, if equipped with vacuum power assist • Lack of lubrication, binding or 		

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<p>2</p>	<p>excessively worn pushrod or pedal pivots or pivot bushings</p> <ul style="list-style-type: none"> • Bent or damaged pedal pushrod, pedal or pedal bracket • Damaged or improperly operating brake booster assembly <p>2. Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>.</p>		
	<p>Did you find and correct a condition?</p>	<p>Go to Step 5</p>	<p>Go to Step 3</p>
<p>3</p>	<p>1. Inspect the hydraulic brake system for the following conditions:</p> <ul style="list-style-type: none"> • Binding caliper pistons • Internally damaged flexible brake hoses; hindering fluid flow • External brake fluid leaks • Kinked or damaged flexible brake hoses and/or pipes • Internal brake fluid leaks; improperly operating master cylinder • Poor brake fluid quality; low boiling point <p>2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.</p>		
	<p>Did you find and correct a condition?</p>	<p>Go to Step 5</p>	<p>Go to Step 4</p>
	<p>1. Inspect the disc brake system for the following conditions:</p> <ul style="list-style-type: none"> • Excessively worn linings 		

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4	<ul style="list-style-type: none"> • Glazed linings • Cracked, distorted or damaged linings • Contaminated linings • Binding, damaged or excessively worn caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Excessively worn or corroded rotor friction surfaces • Glazed rotor friction surfaces • Hard spots, heat checks, blueing discoloration of rotor friction surfaces <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 5	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
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 <u>Brake System Vehicle Road Test</u>.</p> <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKES DRAG

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.			

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1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?	Go to Step 3	Go to Step 4
3	<ol style="list-style-type: none"> 1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing. 		
	Did you find and correct a condition?	Go to Step 14	Go to Step 4
4	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 5	Go to Step 7
5	<p>Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions.</p> <p>Are the park brake shoes adjusted too tightly?</p>	Go to Step 6	Go to Step 7
6	<ol style="list-style-type: none"> 1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration and heat spots. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. 		
	Did you find and correct a condition?	Go to Step 14	Go to Step 7
7	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> .		

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	Did you find and correct a condition?	Go to Step 14	Go to Step 8
8	<p>1. Inspect the disc brake system for the following conditions:</p> <ul style="list-style-type: none"> • 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 • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Distorted or damaged linings • Damaged or excessively worn caliper hardware and/or lining hardware • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p>		
	Did you find and correct a condition?	Go to Step 14	Go to Step 9
9	<p>1. Separate the brake booster pushrod from the brake pedal.</p> <p>2. Inspect the brake corners to determine if the brake drag condition is still present.</p>		
	Do the brake corners still exhibit the brake drag condition?	Go to Step 11	Go to Step 10
10	<p>1. Inspect the pushrod for improper positioning and/or damage. Correctly position or replace the pushrod if necessary.</p> <p>2. Inspect the brake pedal assembly for damage and replace if necessary.</p>		-

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

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Brake System Vehicle Road Test.

Is the condition still present?

Go to **Step 2**

System OK

BRAKE SYSTEM SLOW RELEASE

Brake System Slow Release

Step	Action	Yes	No
<p>DEFINITION: Brake system releases and returns to rest slowly; vehicle motion is hindered by brake system briefly after release of brake pedal.</p>			
1	<p>Were you sent here from the Hydraulic Brake Symptom table?</p>	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	<p>1. Inspect the hydraulic brake system for the following conditions:</p> <ul style="list-style-type: none"> • Improper operation of caliper pistons • Internally damaged flexible brake hoses; hindering brake release • Contaminated brake fluid • Damaged or improperly operating master cylinder <p>2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis.</u></p> <p>Did you find and correct a condition?</p>	Go to Step 5	Go to Step 3
	<p>1. Inspect the brake assist system for the following conditions:</p> <ul style="list-style-type: none"> • Binding, bent or damaged pedal pushrod, pedal or pedal bracket • Damaged or improperly operating vacuum booster, if equipped 		

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3	<ul style="list-style-type: none"> • Restricted return hose from hydraulic booster, if equipped • Damaged or improperly operating hydraulic booster, if equipped <p>2. Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 5	Go to Step 4
4	<p>1. Inspect the disc brake system for the following conditions:</p> <ul style="list-style-type: none"> • Damaged or excessively worn caliper hardware and/or lining hardware • Distorted or damaged linings • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 5	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
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 <u>Brake System Vehicle Road Test</u>.</p> <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKE FLUID LOSS

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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 Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	<p>1. Inspect the following hydraulic brake system components for brake fluid leaks:</p> <ul style="list-style-type: none"> • Flexible brake hose connections; threaded and bolted • Flexible brake hose crimp joints • Brake pipe fittings • Caliper piston seals • Wheel cylinder piston seals, if equipped • Master cylinder reservoir • Master cylinder reservoir low pressure hose, if equipped • Brake pressure modulator valve (BPMV) assembly, if equipped <p>2. Repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 8	Go to Step 3
3	Is the vehicle equipped with a vacuum brake booster?	Go to Step 4	Go to Step 6
4	<p>1. Disconnect the vacuum check valve from the booster to relieve vacuum reserve.</p> <p>2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes.</p>		

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	<p>3. Inspect the rear of the master cylinder for a brake fluid leak.</p> <p>4. Inspect for brake fluid in the vacuum brake booster.</p> <p>Did you find a brake fluid leak?</p>	Go to Step 5	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
5	<p>Replace the brake master cylinder and the vacuum brake booster.</p> <p>Did you complete the replacement?</p>	Go to Step 8	-
6	<p>1. Wipe clean the external surface of the master cylinder to hydraulic brake booster area, if equipped.</p> <p>2. Separate the master cylinder from the hydraulic brake booster, if equipped. Do not disconnect any brake pipes.</p> <p>3. Inspect the rear of the master cylinder for a brake fluid leak.</p> <p>Did you find a brake fluid leak?</p>	Go to Step 7	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
7	<p>Replace the brake master cylinder.</p> <p>Did you complete the replacement?</p>	Go to Step 8	-
8	<p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.</p> <p>Is the condition still present?</p>	Go to Step 2	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.

Disc Brake System Diagnosis

Step	Action	Yes	No
<p>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.</p>			
1	<p>Were you sent here from a Brake Symptom table?</p>	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	<p>Visually inspect the disc brake pads for the following conditions: Refer to <u>Brake Pad Inspection</u> .</p> <ul style="list-style-type: none"> • Lining thickness below specifications • Uneven and/or abnormal wear - edge-to-edge and/or side-to-side • Looseness or damage - including pad hardware • Evidence of contamination from an external substance 		

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	Did you find any conditions to indicate a concern with any of the front and/or rear disc brake pads?	Go to Step 3	Go to Step 12
3	Are any of the front and/or rear disc brake pads contaminated?	Go to Step 8	Go to Step 4
4	Are any of the front and/or rear disc brake pads worn unevenly?	Go to Step 7	Go to Step 5
5	Are any of the front and/or rear disc brake pads and/or pad hardware loose or damaged?	Go to Step 7	Go to Step 6
6	<ol style="list-style-type: none"> 1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage. 2. Replace the worn disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement</u> and/or <u>Rear Disc Brake Pads Replacement</u> . <p>Did you complete the inspection and replacement?</p>	Go to Step 12	-
	<p>NOTE: 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.</p> <p>IMPORTANT: Do NOT disconnect the hydraulic brake flex hoses from the calipers.</p> <ol style="list-style-type: none"> 1. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support 		

the calipers. Refer to **Front Brake Caliper Replacement** and/or **Rear Brake Caliper Replacement** .

2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions:

Refer to **Front Disc Brake Mounting and Hardware Inspection** and/or **Rear Disc Brake Mounting and Hardware Inspection** .

- Binding or seized hardware
 - Worn, damaged or missing hardware components
 - Loose, bent, cracked or damaged caliper mounting bracket
3. Replace components as required. Refer to the following procedures, as required:
 - **Front Brake Caliper Bracket Replacement**
 - **Rear Brake Caliper Bracket Replacement**
 - **Front Disc Brake Hardware Replacement**
 - **Rear Disc Brake Hardware Replacement**
 4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to **Front Disc Brake Pads Replacement** and/or **Rear Disc Brake Pads**

	<p><u>Replacement</u> .</p> <p>Did you complete the inspection and replacement?</p>	Go to Step 12	
8	<ol style="list-style-type: none"> 1. Inspect the disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak. 2. Replace any components found to be leaking brake fluid. Refer to the following procedures as required: <ul style="list-style-type: none"> • <u>Front Brake Caliper Replacement</u> • <u>Rear Brake Caliper Replacement</u> • <u>Front Brake Hose Replacement</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> <p>Did you find and correct the source of the leak causing contamination of the pads?</p>	Go to Step 11	Go to Step 9
9	<ol style="list-style-type: none"> 1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak. 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 <u>Front Wheel Drive Shaft Outer Joint and Seal Replacement</u> and/or <u>Rear Wheel Drive Shaft Outer Joint and Seal Replacement</u> . 		

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	<p>Did you find and correct the source of the leak causing contamination of the pads?</p>	<p>Go to Step 11</p>	<p>Go to Step 10</p>
<p>10</p>	<ol style="list-style-type: none"> 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. 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. 3. Replace any components found to be leaking fluid which may be the source of the contamination to the pads. <p>Did you find and correct the source of the leak causing contamination of the pads?</p>	<p>Go to Step 11</p>	<p>-</p>
	<ol style="list-style-type: none"> 1. Clean the remaining disc brake system components to remove any traces of the contaminant. <p>NOTE: 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.</p> <p>IMPORTANT: Do NOT disconnect the hydraulic</p>		

<p>11</p>	<p>brake flex hoses from the calipers.</p> <p>2. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to <u>Front Brake Caliper Replacement</u> and/or <u>Rear Brake Caliper Replacement</u> .</p> <p>3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions:</p> <p>Refer to <u>Front Disc Brake Mounting and Hardware Inspection</u> and/or <u>Rear Disc Brake Mounting and Hardware Inspection</u> .</p> <ul style="list-style-type: none"> • Binding or seized hardware • Distorted, worn, damaged or missing hardware components <p>4. Replace the caliper mounting/sliding hardware components as required. Refer to <u>Front Disc Brake Hardware Replacement</u> and/or <u>Rear Disc Brake Hardware Replacement</u> .</p> <p>5. Replace the contaminated disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement</u> and/or <u>Rear Disc Brake Pads Replacement</u> .</p> <p>Did you complete the cleaning, inspection and replacement?</p>	<p>-</p> <p>Go to Step 12</p>	
	<p>Visually inspect each of the rear disc brake rotor shields/backing plates, if equipped, for evidence of contact with</p>		

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<p align="center">12</p>	<p>the brake rotors. Are any of the brake rotor shields/backing plates contacting the brake rotors?</p>	<p align="center">Go to Step 13</p>	<p align="center">Go to Step 14</p>
<p align="center">13</p>	<p>Repair or replace the disc brake rotor shields/backing plates as required. Refer to <u>Front Brake Shield Replacement</u> and/or <u>Rear Disc Brake Backing Plate Replacement</u> . Did you complete the repair or replacement?</p>	<p align="center">Go to Step 14</p>	<p align="center">-</p>
<p align="center">14</p>	<p>1. Check the thickness of each of the disc brake rotors.</p> <p>IMPORTANT: 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 <u>Brake Rotor Thickness Measurement</u> .Does the disc brake rotor meet the minimum requirements for REFINISHING?</p>	<p align="center">Go to Step 15</p>	<p align="center">Go to Step 18</p>
<p align="center">15</p>	<p>IMPORTANT: 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 <u>Brake Rotor Thickness Variation Measurement</u> .Does the brake rotor exhibit thickness variation that exceeds</p>		

	the maximum acceptable level?	Go to Step 17	Go to Step 16
16	<p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <p>Refer to <u>Brake Rotor Surface and Wear Inspection</u> .</p> <ul style="list-style-type: none"> • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level <p>IMPORTANT: 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> <p>Does the brake rotor require REFINISHING?</p>		
17	<p>1. Refinish the brake rotor. Refer to <u>Brake Rotor Refinishing</u> .</p> <p>2. Inspect the brake rotor thickness. Refer to <u>Brake Rotor Thickness Measurement</u> .</p> <p>Were you able to REFINISH the brake</p>	Go to Step 17	Go to Step 22

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	rotor within the minimum requirements?	Go to Step 22	Go to Step 21
18	Is the brake rotor at or below the DISCARD requirements?	Go to Step 21	Go to Step 19
19	<p>IMPORTANT: 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 <u>Brake Rotor Thickness Variation Measurement</u> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?</p>	Go to Step 21	Go to Step 20
20	<p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <p>Refer to <u>Brake Rotor Surface and Wear Inspection</u> .</p> <ul style="list-style-type: none"> • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level <p>IMPORTANT: 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 replacement based upon the results of the inspection.</p>		

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	<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 Step 21	Go to Step 22
21	<p>IMPORTANT: 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 <u>Front Brake Rotor Replacement</u> or <u>Rear Brake Rotor Replacement</u> .Did you complete the replacement?</p>	Go to Step 24	-
22	<p>IMPORTANT: 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 <u>Brake Rotor Assembled Lateral Runout Measurement</u> .Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level?</p>	Go to Step 23	Go to Step 24
23	<p>Correct the LRO for each brake rotor that was determined to have LRO exceeding the maximum acceptable level. Refer to <u>Brake Rotor Assembled Lateral Runout Correction</u> . Did you complete the operation?</p>	Go to Step 24	-
24	<p>Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?</p>	Disc Brake System OK Return to Symptom Table	-

HYDRAULIC BRAKE SYSTEM DIAGNOSIS

Hydraulic Brake System Diagnosis

Step	Action	Yes	No
<p>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.</p>			
1	<p>Were you sent here from a Brake Symptom table?</p>	<p>Go to Step 2</p>	<p>Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u></p>
2	<p>Inspect and adjust the brake fluid level in the brake master cylinder. Refer to <u>Master Cylinder Reservoir Filling</u>. Was the brake fluid level low?</p>	<p>Go to Step 3</p>	<p>Go to Step 4</p>
3	<p>1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:</p> <ul style="list-style-type: none"> ● Fluid separation, indicating two types of fluid are present <ul style="list-style-type: none"> ■ Swirled appearance - oil-based substance ■ Layered appearance - silicone-based substance ● Fluid discoloration <ul style="list-style-type: none"> ■ Cloudy appearance - moisture ■ Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust <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>	<p>Go to Step 5</p>	<p>Go to Step 6</p>

<p>4</p>	<p>1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:</p> <ul style="list-style-type: none"> ● Fluid separation, indicating two types of fluid are present <ul style="list-style-type: none"> ■ Swirled appearance - oil-based substance ■ Layered appearance - silicone-based substance ● Fluid discoloration <ul style="list-style-type: none"> ■ Cloudy appearance - moisture ■ Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust <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> <p>1. Flush the hydraulic brake system. Refer to Hydraulic Brake System Flushing.</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> <ol style="list-style-type: none"> 1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. 2. Clean out the hydraulic brake 	<p>Go to Step 5</p>	<p>Go to Step 12</p>

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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. Each component contains internal rubber seals/linings which have been contaminated.

- **Master Cylinder Replacement**

- 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. 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**

3. If the brake fluid was NOT contaminated with an oil-based fluid,

	<p>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.</p> <p>4. Refill and bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>.</p> <p>Did you complete the operation and any required repairs and/or replacements?</p>		
<p>6</p>	<p>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:</p> <ul style="list-style-type: none"> • <u>Master Cylinder Replacement</u> Brake master cylinder reservoir cap diaphragm • <u>Front Brake Hose Replacement</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> • <u>Front Brake Caliper Replacement</u> • <u>Rear Brake Caliper Replacement</u> • <u>Brake Pressure Modulator Valve Replacement</u> <p>2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to</p>	<p>Go to Step 9</p>	

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	<p><u>Hydraulic Brake System Bleeding (Manual) or Hydraulic Brake System Bleeding (Pressure)</u>. While bleeding the hydraulic brake system, observe for the following conditions:</p> <ul style="list-style-type: none"> • 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 • An unrestricted and even flow of brake fluid per axle during the bleeding procedure 		
	Did you find and correct a condition?	Go to Step 7	Go to Step 12
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 Step 19	Go to Step 8
8	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 9	Go to Step 10
9	Inspect the hydraulic function of the brake calipers for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection</u> . Was the hydraulic function of the brake calipers operating properly?	Go to Step 21	Go to Step 14
10	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to Step 13	Go to Step 11
11	Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?	Go to Step 17	-
12	Inspect the hydraulic function of the brake calipers for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection</u> . Was the hydraulic function of the brake		

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	calipers operating properly?	Go to Step 15	Go to Step 13
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"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Open the suspected caliper bleeder valve. 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. 5. Close the caliper bleeder valve. <p>Was the flow of brake fluid unrestricted and did the caliper piston move freely?</p>		
		Go to Step 17	Go to Step 14
14	<p>Replace any brake caliper that was not operating properly. Refer to the appropriate procedure:</p> <ul style="list-style-type: none"> • <u>Front Brake Caliper Replacement</u> • <u>Rear Brake Caliper Replacement</u> <p>Did you complete the repair and/or replacement?</p>		-
		Go to Step 21	
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 <u>Hydraulic Brake System Bleeding (Manual)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>.</p>		

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	Was there air in the system?	Go to Step 19	Go to Step 16
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 21	Go to Step 17
17	<ol style="list-style-type: none"> 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 <u>Brake Pipe and Hose Inspection</u>. 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"> • <u>Front Brake Hose Replacement</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> 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. 		
	Did you find and correct a condition?	Go to Step 21	Go to Step 18
18	<p>Replace the brake pressure modulator valve (BPMV), in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to <u>Brake Pressure Modulator Valve Replacement</u> .</p> <p>Did you complete the replacement?</p>	Go to Step 21	-
19	<ol style="list-style-type: none"> 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. 2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system. 		

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	<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 Step 21	Go to Step 20
20	<p>1. Inspect the brake master cylinder for internal fluid leaks. Refer to <u>Brake System Internal Leak Test</u>.</p> <p>2. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to <u>Master Cylinder Replacement</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 21	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 Return to Symptom Table	-

BRAKE ASSIST SYSTEM DIAGNOSIS

Brake Assist System Diagnosis

Step	Action	Yes	No
<p>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.</p>			
1	Were you sent here from a Brake Symptom table?	Go to Step 3	Go to Step 2
2	Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?	Go to Step 5	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
3	<p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p>	Go to Step 5	Go to Step 4
	1. Inspect for worn, missing,		

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4	<p>misaligned, bent or damaged brake pedal system components.</p> <ul style="list-style-type: none"> • For the brake pedal pushrod component inspection, refer to <u>Brake Pedal Pushrod Inspection</u>. • Inspect the brake pedal bushings for excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. <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 Step 5	<p>Inspect for internal and external fluid leaks and air in the hydraulic brake system</p> <p>Go to <u>Hydraulic Brake System Diagnosis</u></p>
5	<p>Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to <u>Brake System Vacuum Source Test</u>.</p> <p>Is the vacuum reading within the acceptable limits?</p>	Go to Step 6	<p>Go to <u>DIAGNOSTIC INFORMATION AND PROCEDURES</u></p>
6	<p>Does the condition occur during cold start-up conditions?</p>	Go to Step 7	Go to Step 8
7	<p>Check engine vacuum under the same cold start-up conditions. Refer to <u>DIAGNOSTIC INFORMATION AND PROCEDURES</u> .</p> <p>Did you find and correct a condition?</p>	Go to Step 18	Go to Step 9
8	<p>During the vacuum source test, did the vacuum booster check valve operate properly?</p>	Go to Step 10	Go to Step 9
9	<p>Replace the vacuum booster check valve. Refer to <u>Vacuum Brake Booster Check Valve and/or Hose</u></p>		-

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	<p><u>Replacement.</u> Did you complete the replacement?</p>	Go to Step 10	
10	<p>If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot or damage. Does the vacuum sensor grommet exhibit any of the conditions listed?</p>	Go to Step 11	Go to Step 12
11	<p>Replace the vacuum sensor grommet. Did you complete the replacement?</p>	Go to Step 12	-
12	<ol style="list-style-type: none"> 1. 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 <u>Master Cylinder Replacement.</u> 2. 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. 3. If equipped with a vacuum seal that is part of the booster, inspect the seal for damage. 4. Inspect the master cylinder mating surface of the booster for deformation and or damage. <p>Does the vacuum seal and/or the master cylinder mating surface of the of the booster exhibit any of the conditions listed?</p>	Go to Step 13	Go to Step 14
	<ol style="list-style-type: none"> 1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as necessary. 		

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13	<p>2. If equipped with a vacuum seal that requires replacement and which is part of the booster, the booster assembly must be replaced.</p> <p>3. If the master cylinder mating surface of the booster was deformed and/or damaged, replace the booster.</p>		-
Did you complete the replacement?		Go to Step 14	
14	<p>Perform the vacuum boost functional test:</p> <ol style="list-style-type: none"> 1. Reinstall the master cylinder to the booster. 2. If the engine was started after reinstalling the master cylinder to the booster, perform the following: With the engine OFF, depress the brake pedal several times to deplete the vacuum reserve. 3. Depress and maintain moderate foot pressure on the brake pedal. IMPORTANT: The brake pedal should fall slightly, then hold. 4. Start the engine and observe pedal operation. <p>Is there an audible vacuum leak coming from the brake pedal area?</p>	Go to Step 17	Go to Step 15
15	Did the brake pedal fall slightly after the engine was started, then hold?	Go to Step 16	Go to Step 17
	Perform the vacuum booster leak-down test:		

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16	<ol style="list-style-type: none"> 1. Release the brake pedal. 2. Accelerate the engine to approximately 3,000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Wait 60 seconds. <p>IMPORTANT:</p> <ul style="list-style-type: none"> ● Both pedal applies should be assisted. ● The amount of assist could diminish slightly with the second apply. <ol style="list-style-type: none"> 5. Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. 		
	Were both pedal applies power assisted?	Go to Step 18	Go to Step 17
17	<p>Replace the vacuum brake booster. Refer to <u>Vacuum Brake Booster Replacement</u>.</p> <p>Did you complete the replacement?</p>	Go to Step 18	-
18	<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 Return to Symptom Table	-

BRAKE SYSTEM VEHICLE ROAD TEST

Preliminary Inspections

1. 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.
2. Inspect the brake master cylinder reservoir fluid level and adjust only if necessary for brake

system road testing. Refer to **Master Cylinder Reservoir Filling**.

3. Inspect the tire inflation pressures and adjust as necessary.
4. Inspect the tire tread patterns to ensure that they are the same or very similar, especially per axle.
5. Ensure that the vehicle is not loaded unevenly prior to brake system road testing.

Road Testing Procedure

CAUTION: 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.

1. Start the engine and allow it to idle.
2. Check to see if the brake system warning lamp remains illuminated.
3. 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**.
4. 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

Tools Required

J 28662 Brake Pedal Effort Gage. See **Special Tools**.

Measurement & Inspection Procedure

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** to the brake pedal. See **Special Tools**.

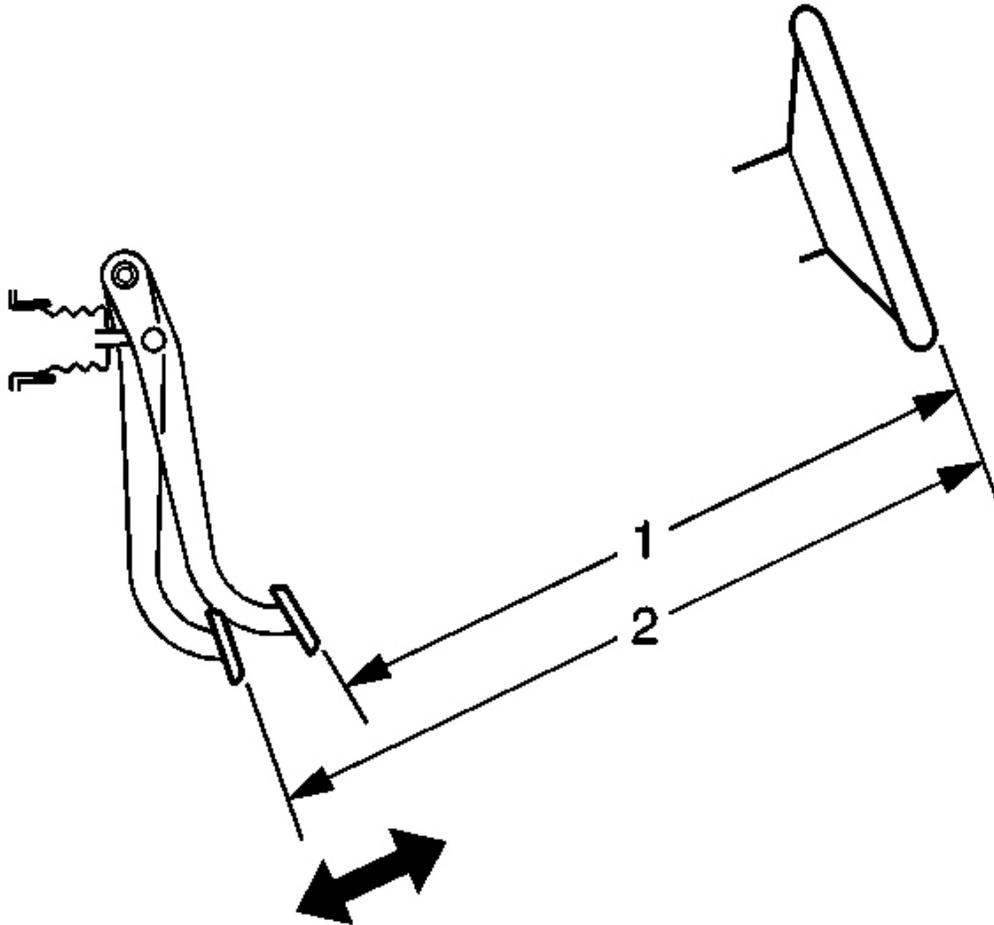


Fig. 7: Measuring Brake Pedal Travel
Courtesy of GENERAL MOTORS CORP.

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** . See **Special Tools**.
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: Hydraulic assist equipped, maximum brake pedal travel (measured with the ignition OFF, brake booster power assist depleted and the brakes cool): 90 mm (3.54 in)

BRAKE SYSTEM VACUUM SOURCE TEST

- IMPORTANT:**
- 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 gage 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 is within the specified normal range, proceed to step 10.
7. If the engine vacuum reading is 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 gage 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

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

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

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

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)**.

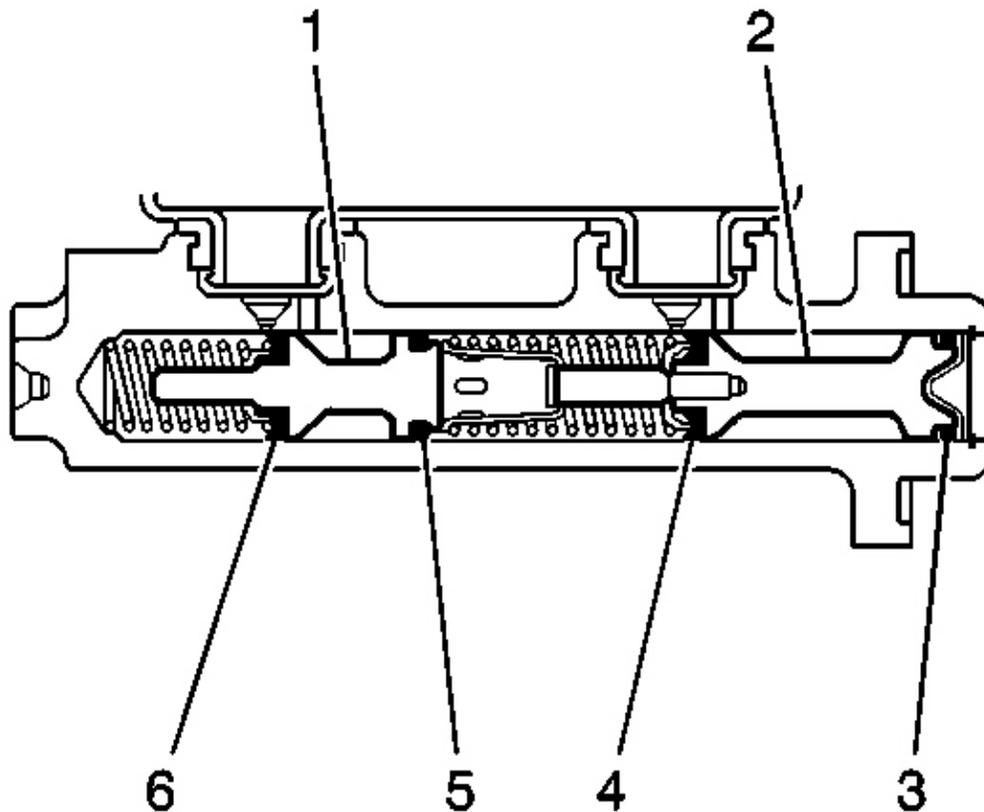


Fig. 8: Cross Sectional View Of Brake Master Cylinder
Courtesy of GENERAL MOTORS CORP.

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

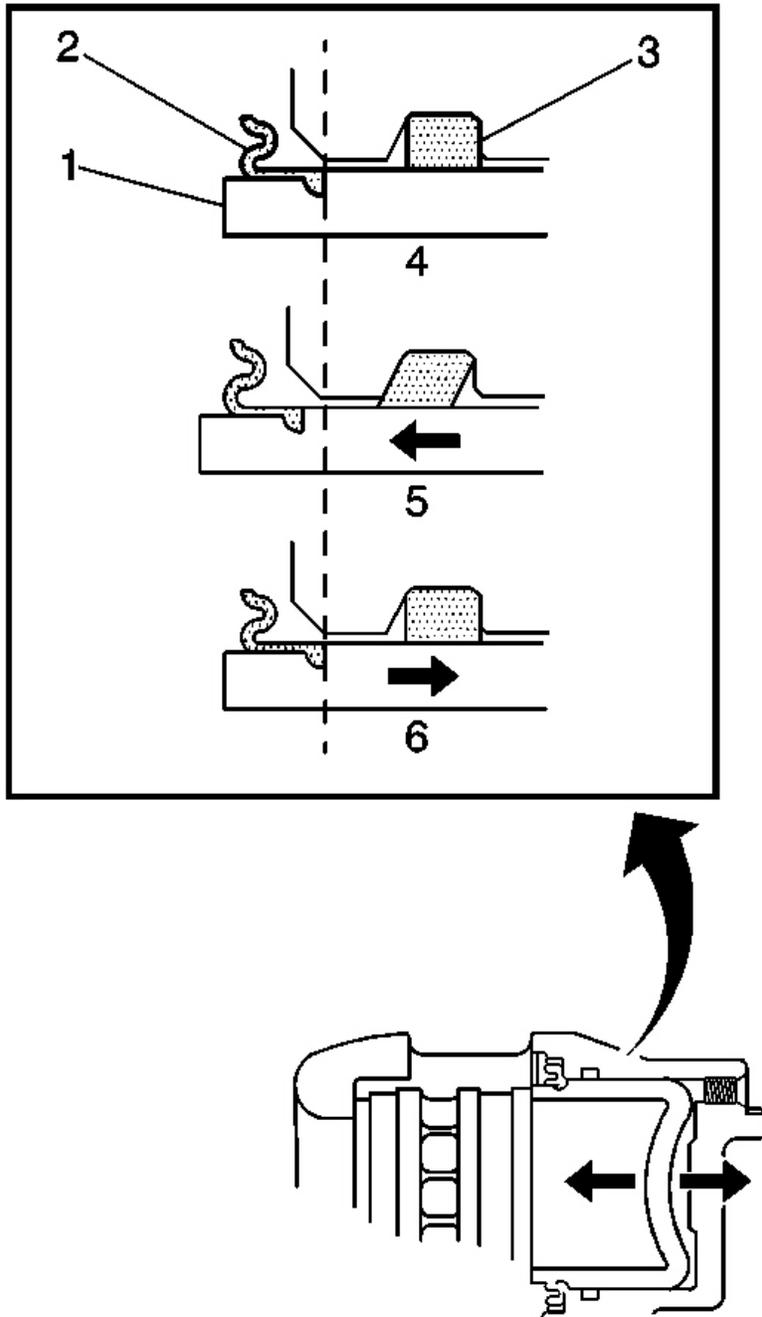


Fig. 9: Identifying Brake Caliper/Pad Inspection Areas
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

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

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

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.

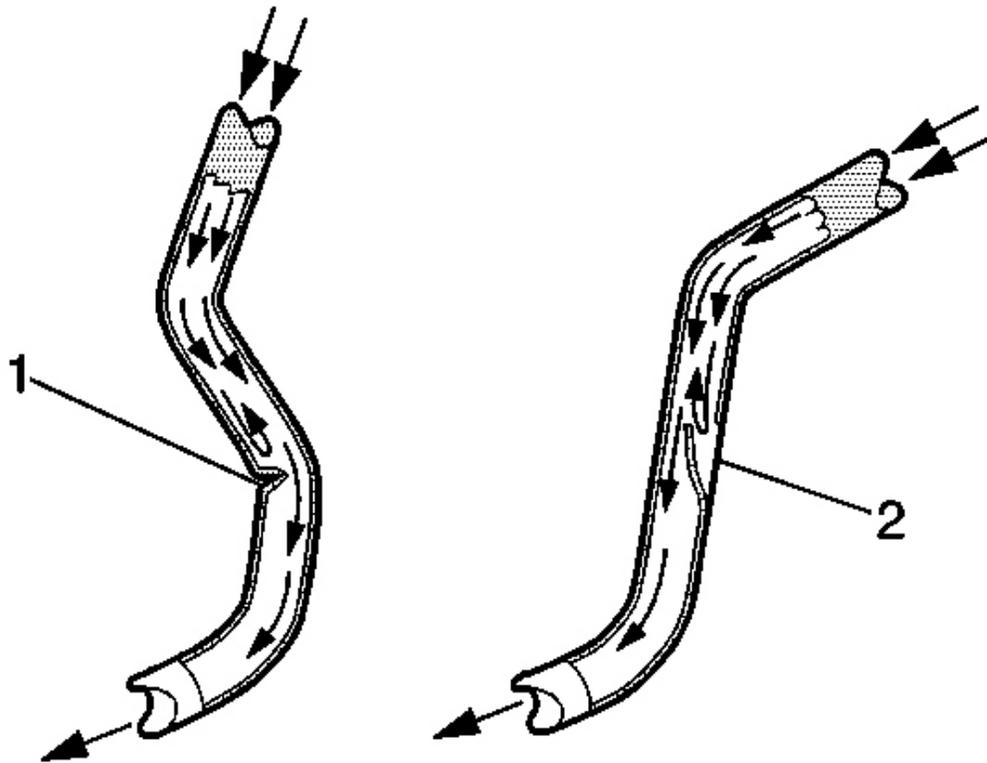


Fig. 10: Identifying Flexible Brake Hose Failure Conditions
Courtesy of GENERAL MOTORS CORP.

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.

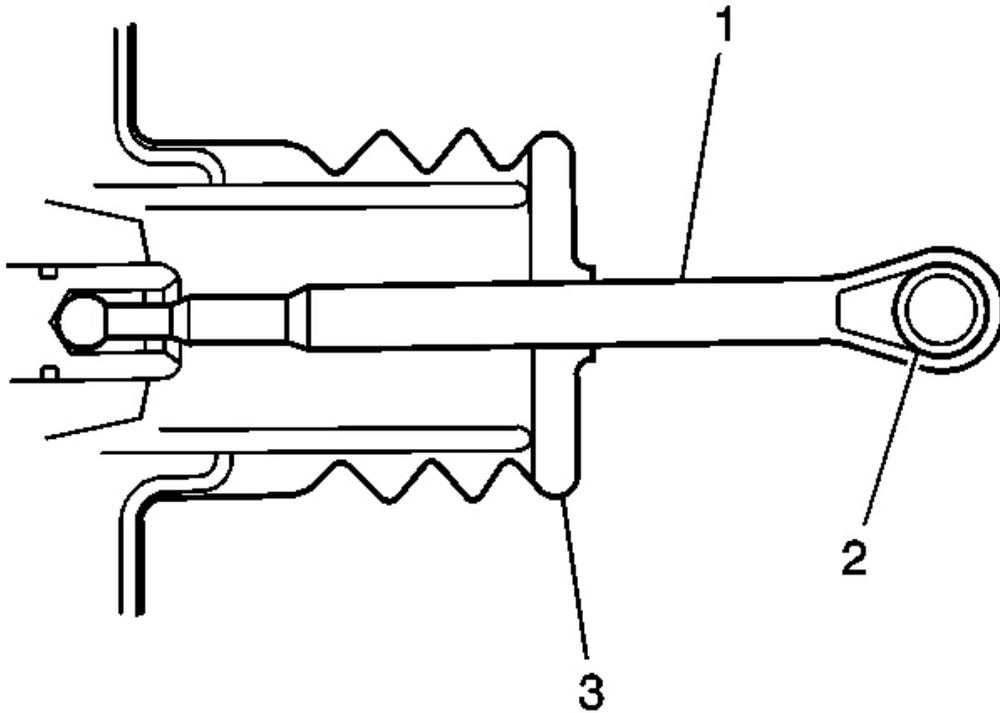


Fig. 11: View of Brake Pedal Pushrod
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

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 Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

MASTER CYLINDER RESERVOIR REPLACEMENT

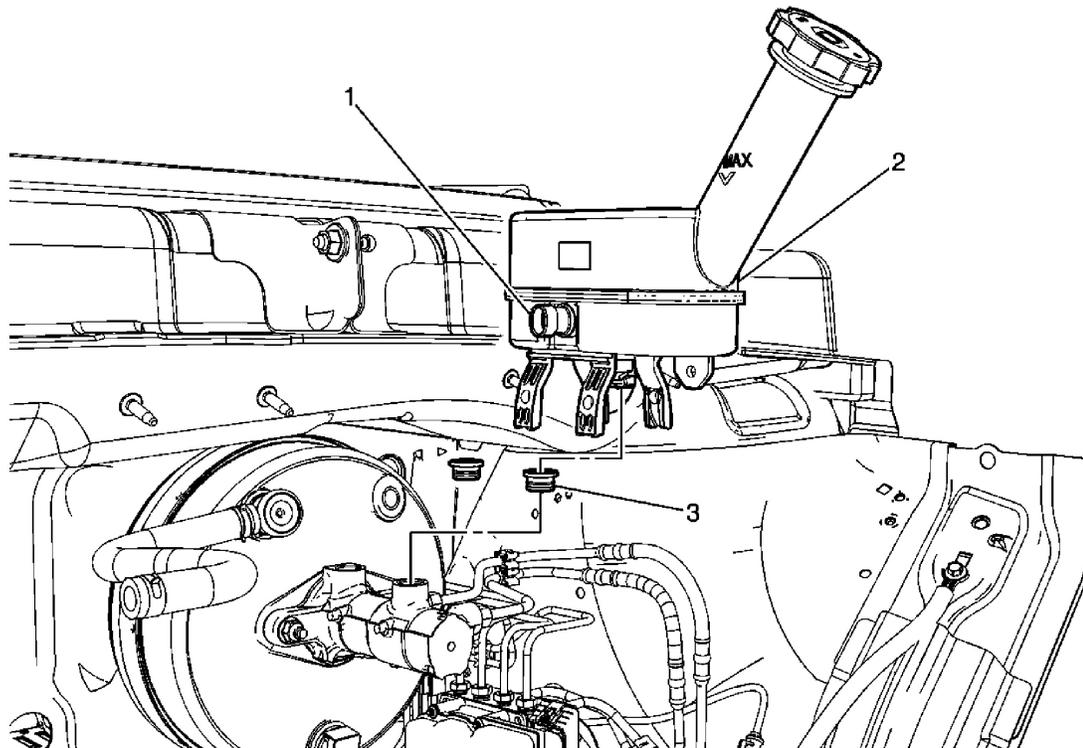


Fig. 12: Identifying Master Cylinder Reservoir
 Courtesy of GENERAL MOTORS CORP.

Master Cylinder Reservoir Replacement

Callout	Component Name
<p>CAUTION: Refer to <u>Brake Fluid Irritant Caution</u> .</p> <p>NOTE: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Notice</u> .</p>	
<p>Preliminary Procedures</p>	
<p>1. Using a suitable tool, remove the brake fluid from the brake master cylinder reservoir.</p> <p>2. Discard the brake fluid into an approved container.</p> <p>3. Remove the air cleaner element. Refer to <u>Air Cleaner Element Replacement</u> .</p>	
<p>1</p>	<p>Master Cylinder Fluid Level Sensor Electrical Connector</p> <p>Procedure: Disconnect the electrical connector.</p>

2	<p>Master Cylinder Reservoir</p> <p>Procedure: Carefully spread the 4 locking tabs and lift the master cylinder reservoir upward.</p>
3	<p>Master Cylinder Reservoir Seals (Qty: 2)</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Lubricate the seals and the outer surface area of the reservoir-to-housing barrels with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. 2. Place the new lubricated seals on the reservoir-to-housing barrels before installing the reservoir to the master cylinder housing. 3. Fill the brake master cylinder reservoir. Refer to <u>Master Cylinder Reservoir Filling</u>.

MASTER CYLINDER REPLACEMENT

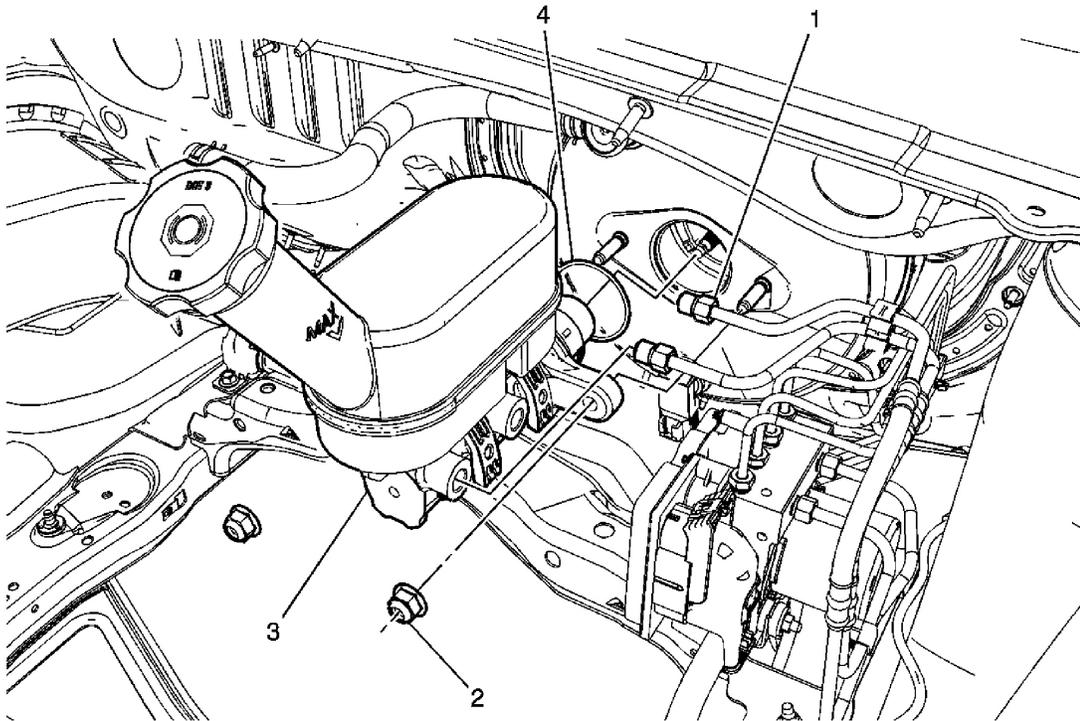


Fig. 13: View Of Master Cylinder
Courtesy of GENERAL MOTORS CORP.

Master Cylinder Replacement

Callout	Component Name
<p>CAUTION: Refer to <u>Brake Fluid Irritant Caution</u> .</p> <p>NOTE: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Notice</u> .</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none"> 1. Turn the ignition switch to the OFF position. 2. Apply the brake pedal several times until the brake pedal becomes firm to deplete the power brake booster vacuum reserve. 3. Remove the air cleaner element. Refer to <u>Air Cleaner Element Replacement</u> . 4. Using a suitable tool, remove the brake fluid from the brake master cylinder reservoir. 5. Discard the brake fluid into an approved container. 6. Disconnect the master cylinder fluid level sensor electrical connector. 	
1	<p>Brake Pipe Fitting (Qty: 2)</p> <p>NOTE: Refer to <u>Fastener Notice</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove any dirt or debris from the brake pipe fitting. 2. Cap the brake pipe fittings to prevent brake fluid loss and contamination. <p>Tighten: 20 N.m (15 lb ft)</p>
2	<p>Brake Master Cylinder Nut (Qty: 2)</p> <p>Tighten: 20 N.m (15 lb ft)</p>
3	<p>Brake Master Cylinder Assembly</p> <p>Procedure: After the installation is complete, bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>.</p>
	<p>Brake Master Cylinder to Vacuum Booster Seal</p>

Procedure

4

1. Inspect the brake master cylinder to vacuum booster seal for damage and replace if necessary.
2. Ensure the brake master cylinder to vacuum booster seal is seated properly against the face of the flange on the brake master cylinder housing.

MASTER CYLINDER BENCH BLEEDING

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11® , GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

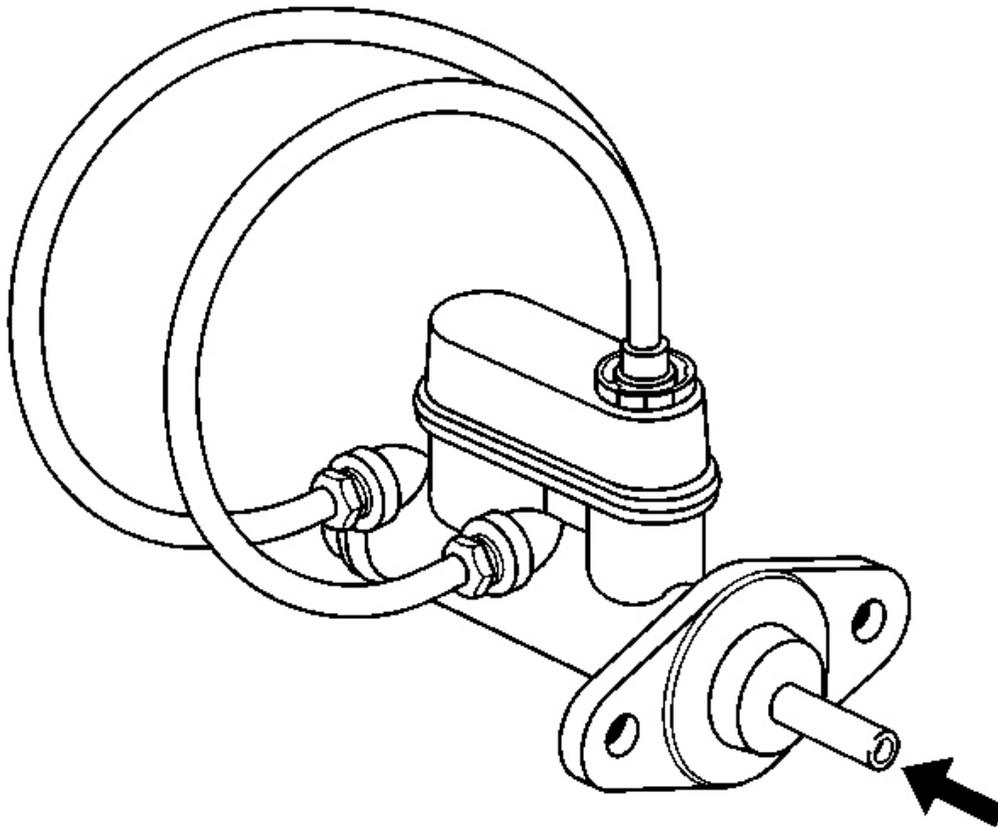


Fig. 14: View Of Bleeding Master Cylinder
Courtesy of GENERAL MOTORS CORP.

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 Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

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.

MASTER CYLINDER FLUID LEVEL SENSOR REPLACEMENT

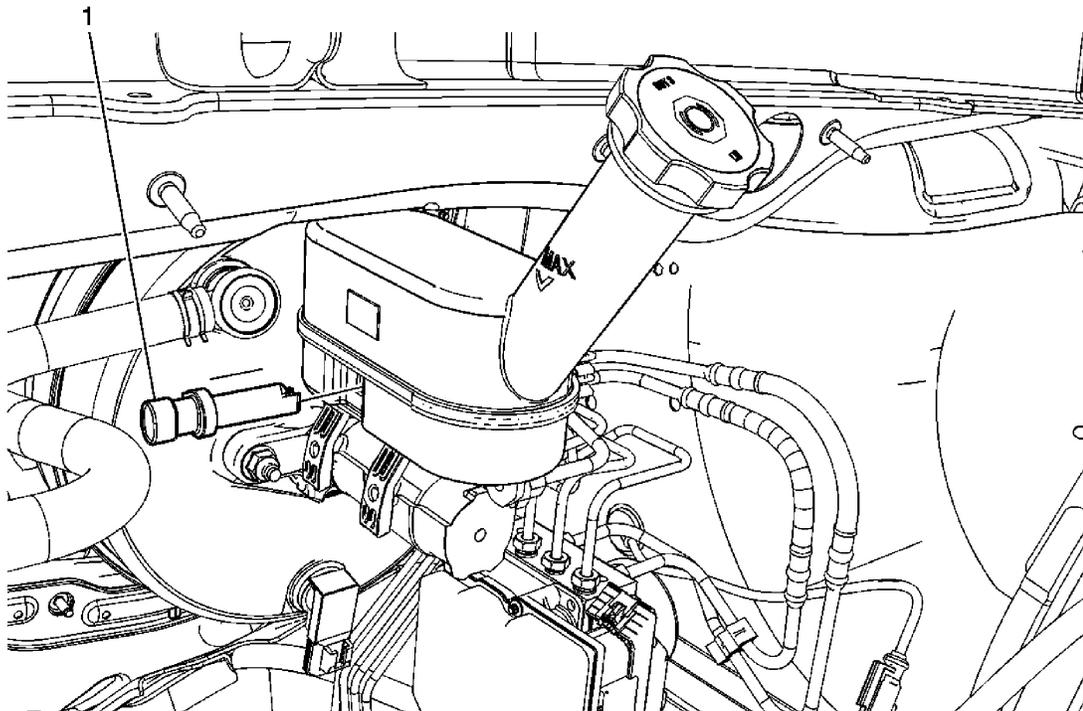


Fig. 15: Identifying Brake Fluid Level Sensor

Courtesy of GENERAL MOTORS CORP.

Master Cylinder Fluid Level Sensor Replacement

Callout	Component Name
Preliminary Procedure: Remove the air cleaner element. Refer to <u>Air Cleaner Element Replacement</u> .	
1	Master Cylinder Fluid Level Sensor Procedure 1. Disconnect the electrical connector. 2. Compress the locking tabs on the sensor to release the sensor from the brake master cylinder reservoir.

BRAKE PEDAL ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the left side instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .
2. Remove the knee bolster. Refer to **Knee Bolster Replacement** .
3. Without disconnecting the electrical connector, remove and position aside the accelerator pedal position sensor. Refer to **Accelerator Pedal Position Sensor Replacement** .

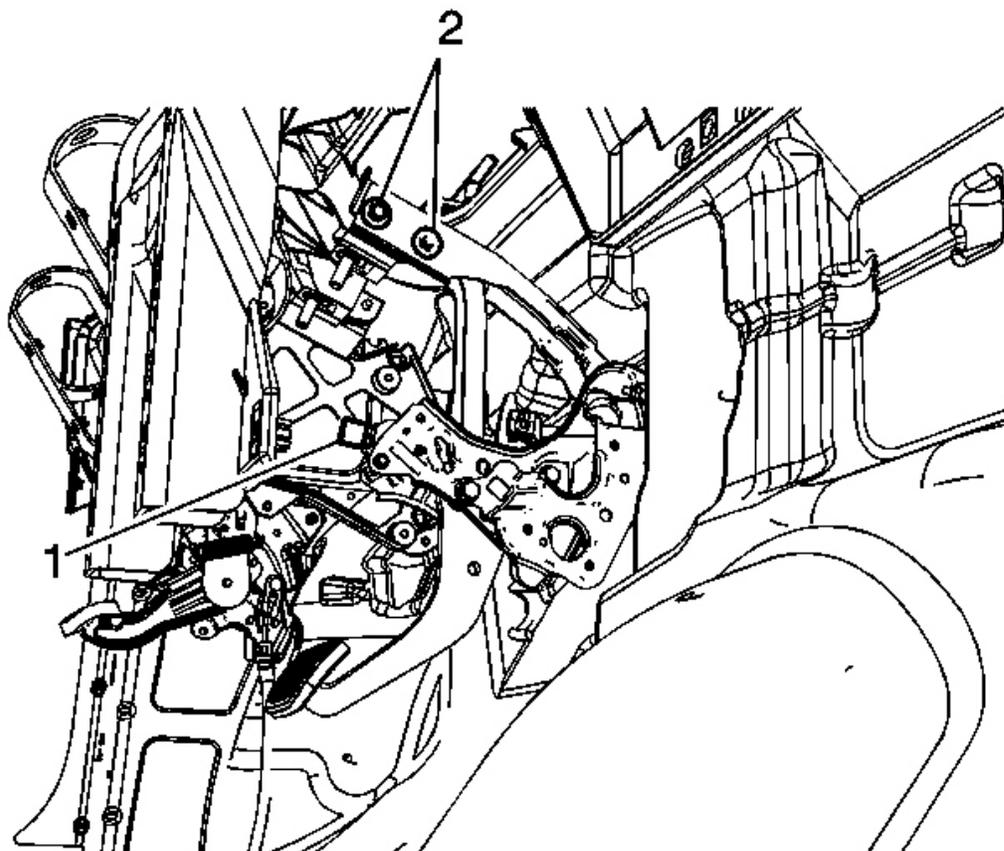


Fig. 16: Identifying Brake Pedal Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the brake pedal position sensor electrical connector (1).
5. Remove the 2 brake pedal bracket bolts (2).

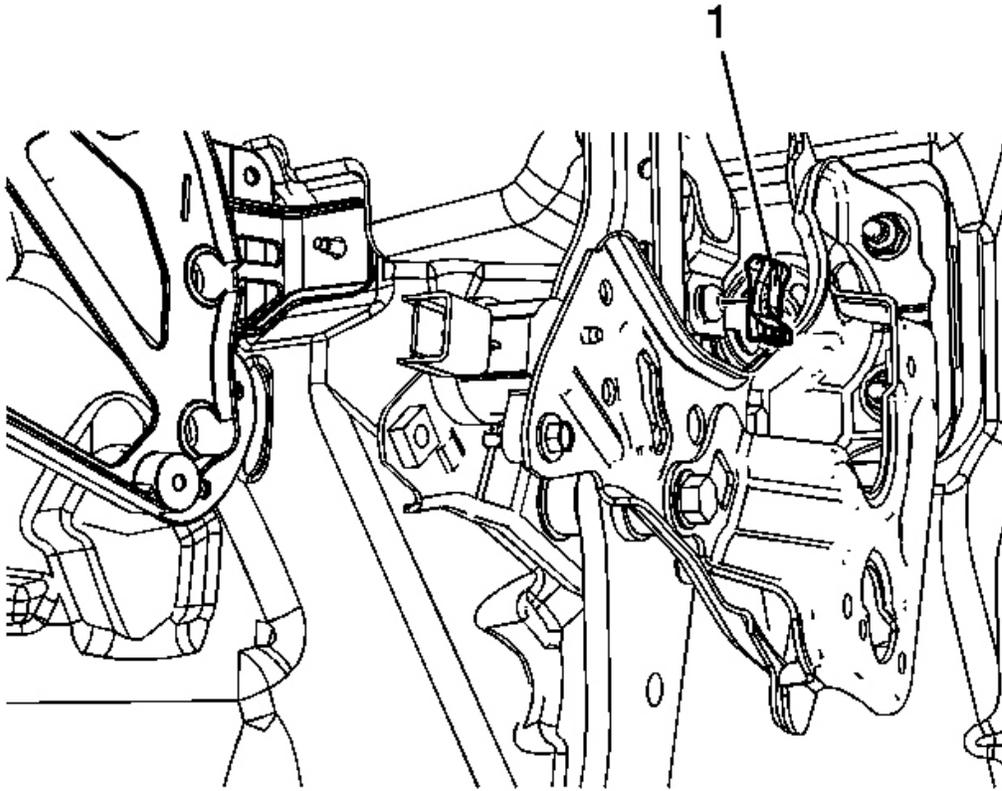


Fig. 17: View Of Brake Pedal Pushrod Retainer
Courtesy of GENERAL MOTORS CORP.

6. Remove the brake pedal pushrod retainer (1).

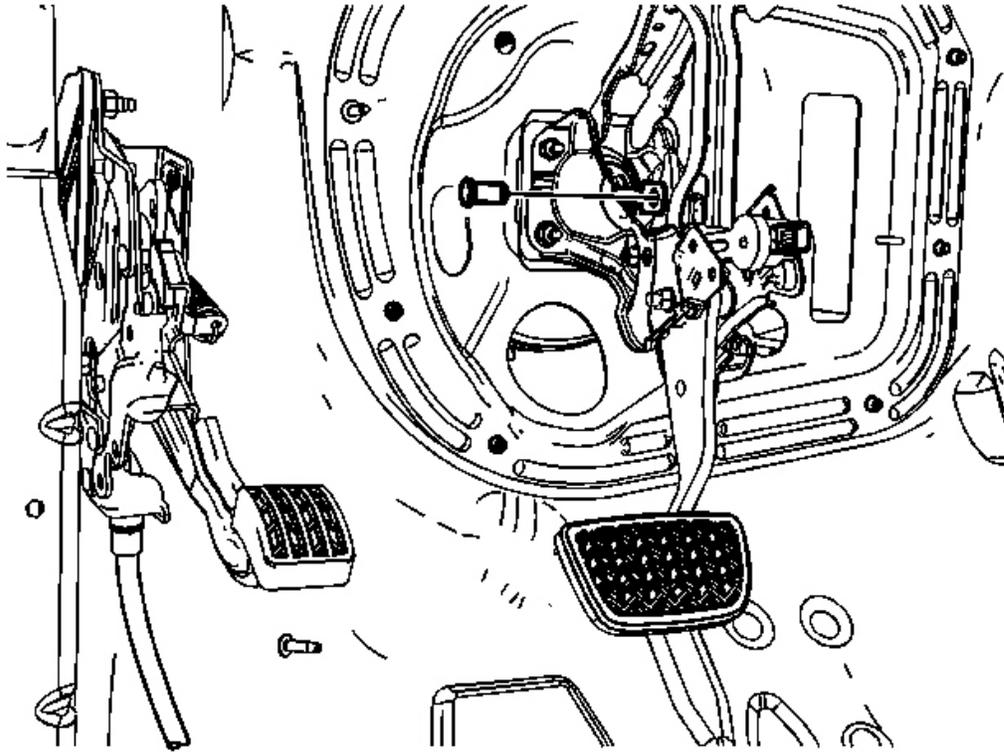


Fig. 18: Identifying Brake Pedal Pushrod Clevis Pin
Courtesy of GENERAL MOTORS CORP.

7. Remove the brake pedal pushrod clevis pin.

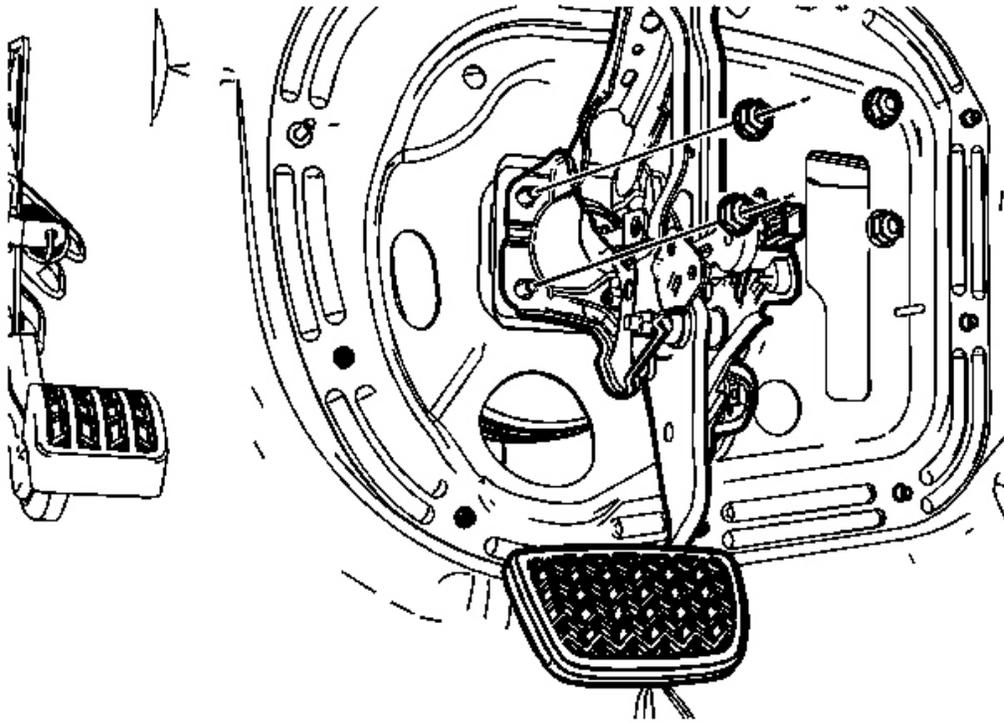


Fig. 19: Locating Vacuum Booster Nuts
Courtesy of GENERAL MOTORS CORP.

8. Remove the 4 vacuum booster nuts.
9. Position the vacuum brake booster and master cylinder assembly forward slightly to allow the brake pedal and bracket assembly to clear the booster studs.
10. Remove the brake pedal assembly.

Installation Procedure

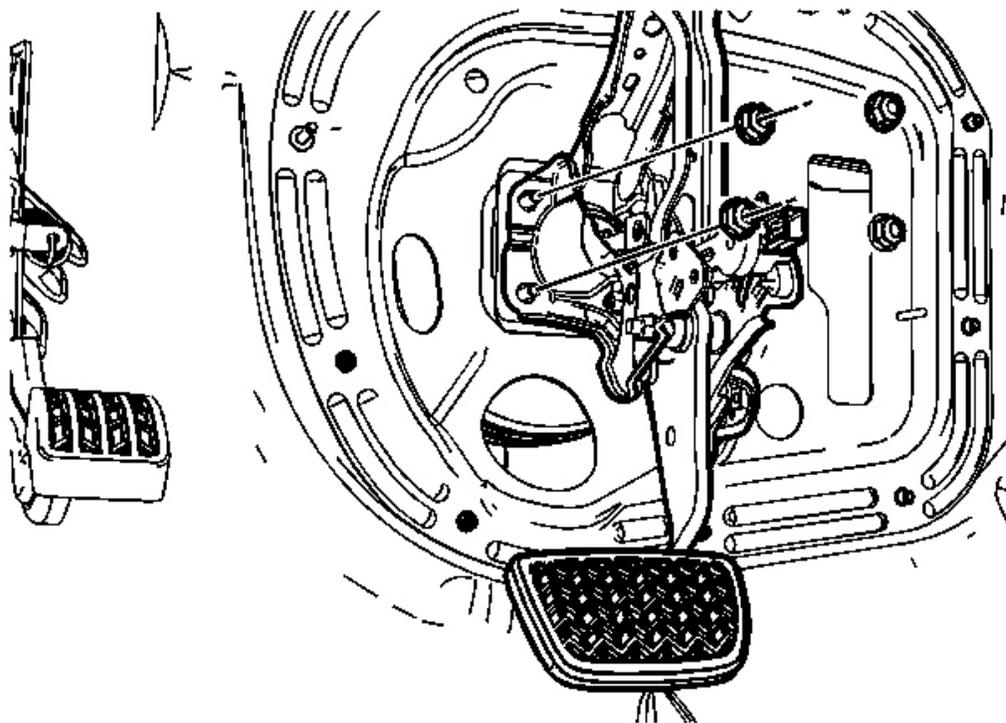


Fig. 20: Locating Vacuum Booster Nuts
Courtesy of GENERAL MOTORS CORP.

1. Position the brake pedal assembly to the dash panel.
2. Position the vacuum brake booster and master cylinder assembly to the dash panel.

NOTE: Refer to Fastener Notice .

3. Install the 4 vacuum booster nuts.

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

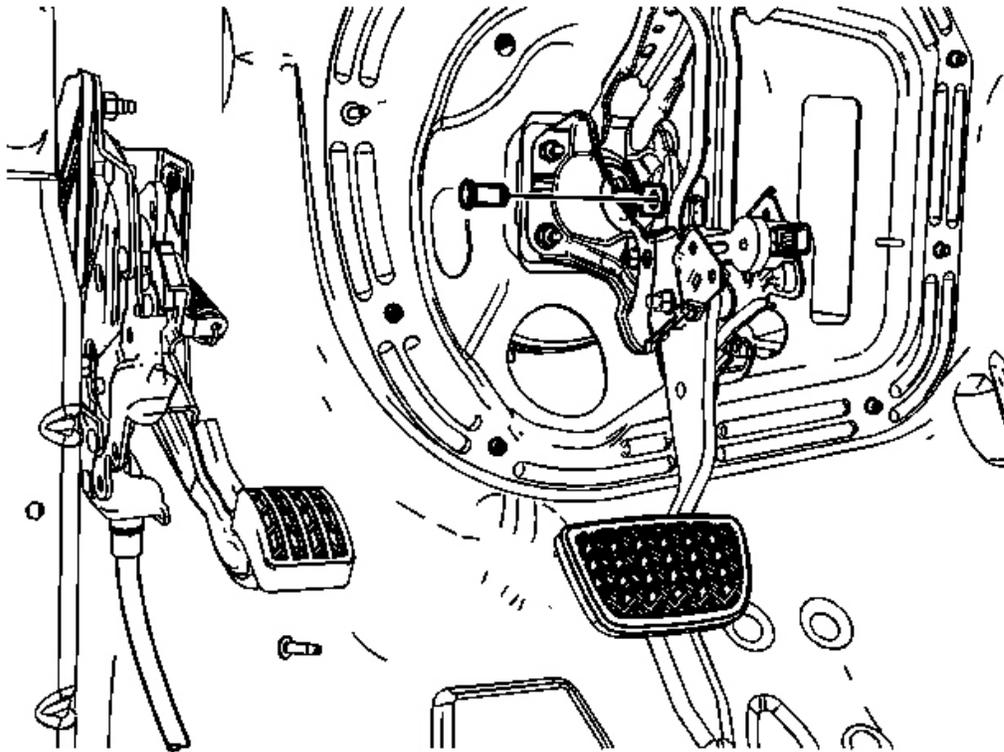


Fig. 21: Identifying Brake Pedal Pushrod Clevis Pin
Courtesy of GENERAL MOTORS CORP.

4. Position the brake pedal pushrod to the brake pedal.
5. Install the brake pedal pushrod clevis pin.

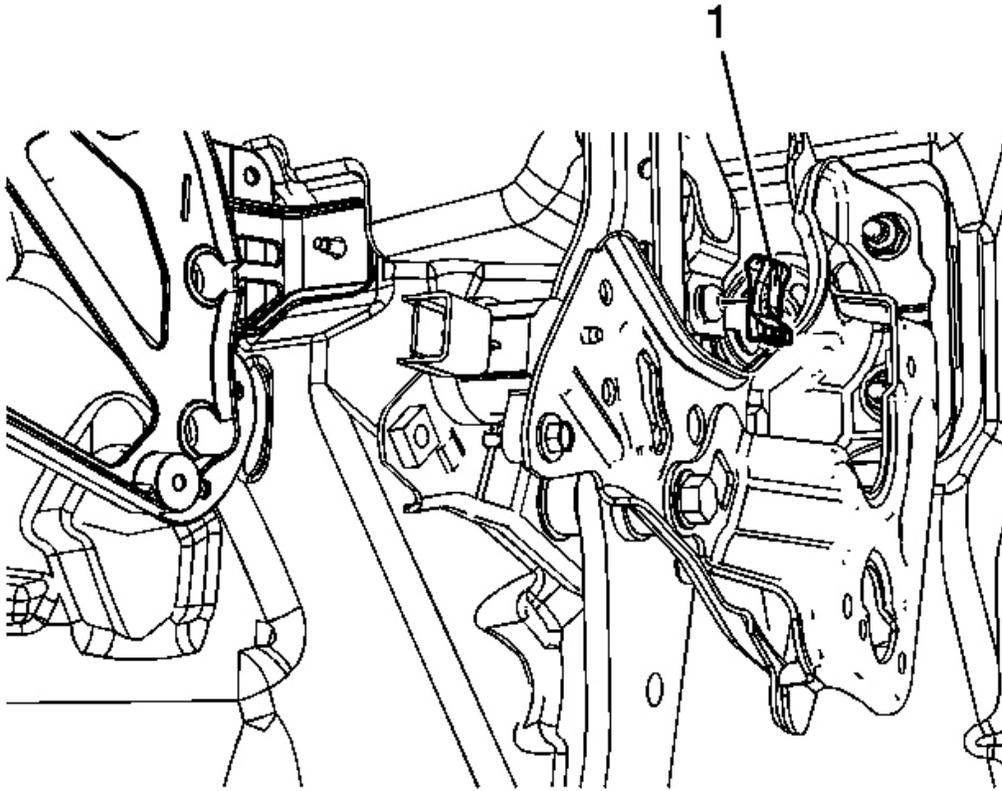


Fig. 22: View Of Brake Pedal Pushrod Retainer
Courtesy of GENERAL MOTORS CORP.

6. Install the brake pedal pushrod retainer (1).

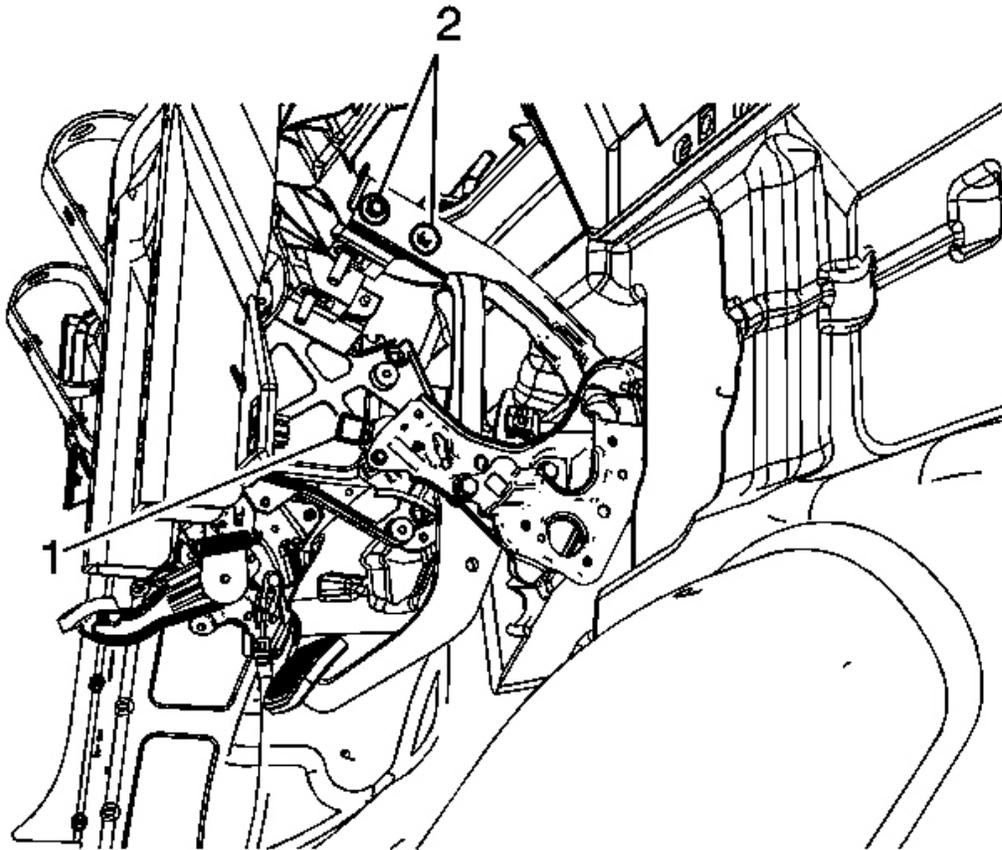


Fig. 23: Identifying Brake Pedal Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Install the 2 brake pedal bracket bolts (2).

Tighten: Tighten the bolts to 22 N.m (16 lb ft).

8. Connect the brake pedal position sensor electrical connector (1).
9. Connect the brake pedal position sensor electrical connector.
10. Install the accelerator pedal position sensor. Refer to **Accelerator Pedal Position Sensor Replacement** .
11. Calibrate the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Calibration** .

BRAKE PIPE REPLACEMENT

Tools Required

J 45405 Pipe Flaring Tool Kit. See Special Tools.

CAUTION: Refer to Brake Fluid Irritant Caution .

CAUTION: 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.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

IMPORTANT: When servicing brake pipes, note the following:

- If sectioning 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.

Replacement Procedure

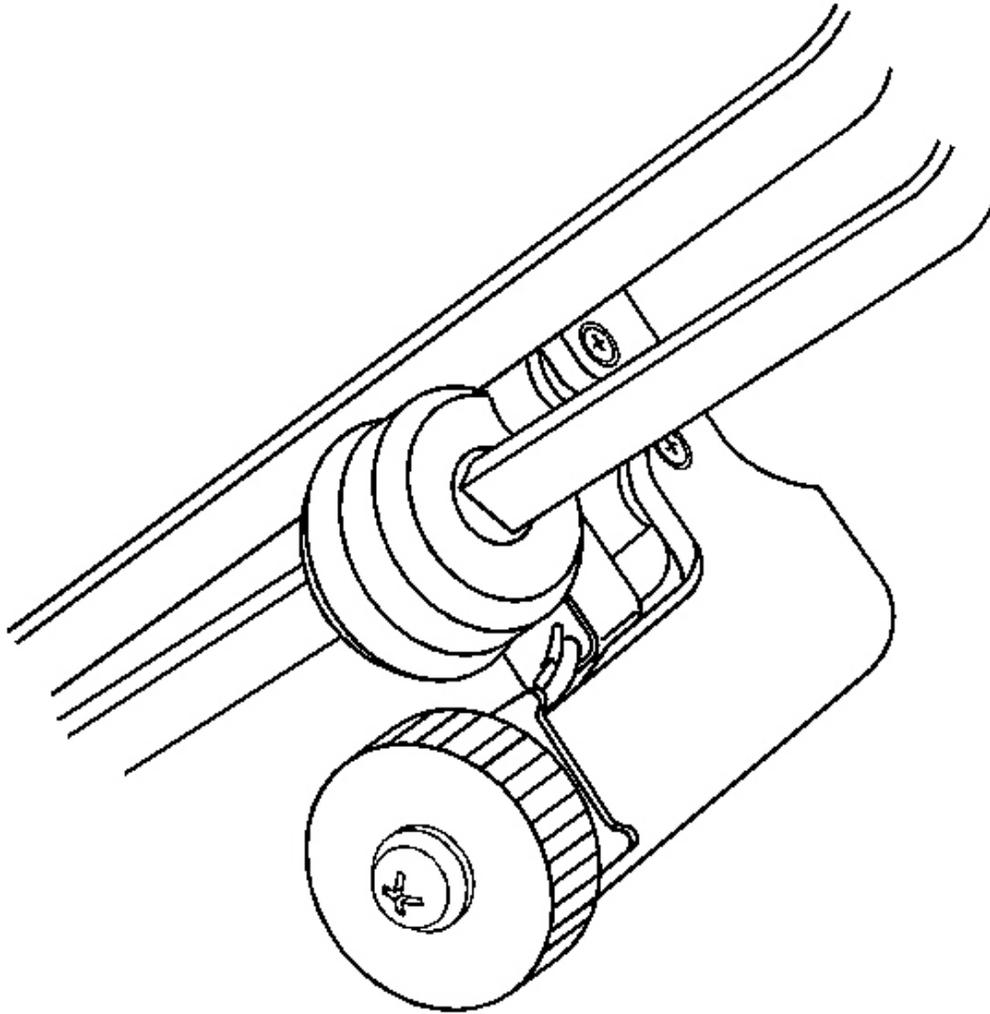


Fig. 24: View Of Brake Pipe & Pipe Cutter
Courtesy of GENERAL MOTORS CORP.

1. Inspect the section of brake pipe to be 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** . See **Special Tools**.
 - 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

IMPORTANT: 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** , carefully cut the brake pipe squarely to the measured length. See **Special Tools**.
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.

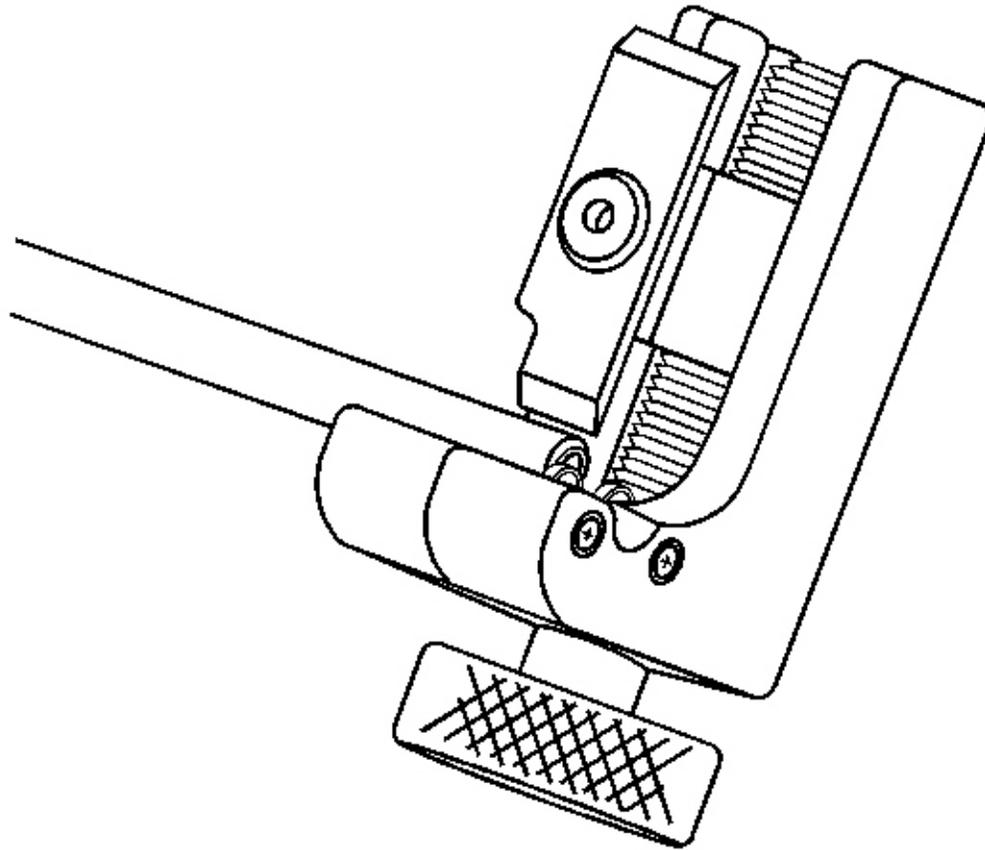


Fig. 25: View Of Pipe & Pipe Cutter
Courtesy of GENERAL MOTORS CORP.

9. Strip the nylon coating from the brake pipe ends to be flared, if necessary.
 - Select the appropriate blade on the coating stripping tool included in the **J 45405** by unthreading the blade block from the stripping tool and installing the block with the desired blade facing the tool rollers. See **Special Tools**.

Specification: 6.35 mm (0.250 in) blade for 4.76 mm (3/16 in) diameter pipe

- Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
- 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.

IMPORTANT: Do not gouge the metal surface of the brake pipe.

- Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against the tool roller ledges.
- 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.
- Loosen the thumbwheel of the tool and remove the brake pipe.

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

- 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

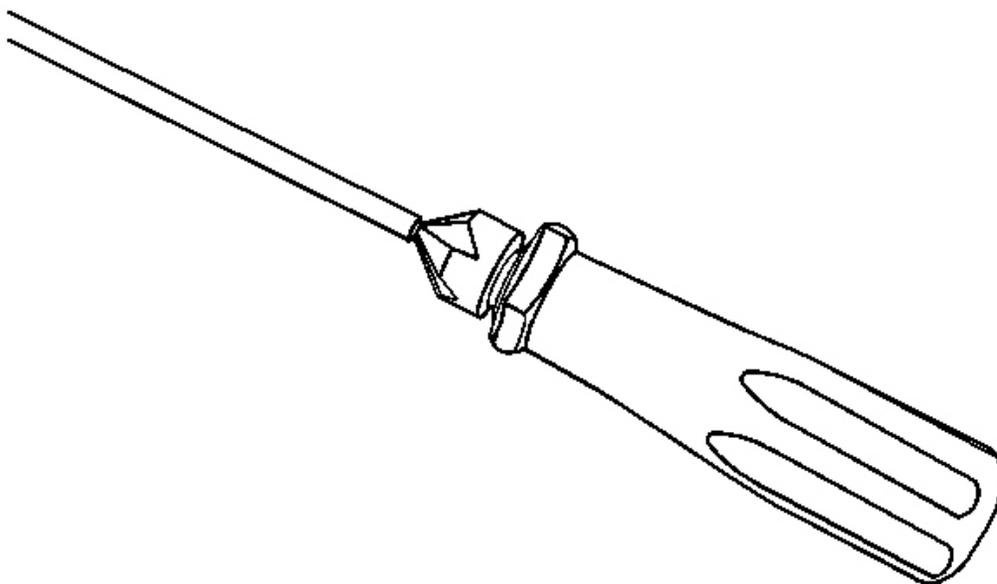


Fig. 26: View Of Pipe & De-Burring Tool

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** . See **Special Tools**.
11. Install the tube nuts on the brake pipe, noting their orientation.
12. Clean the brake pipe and the **J 45405** of lubricant, contaminants and debris. See **Special Tools**.

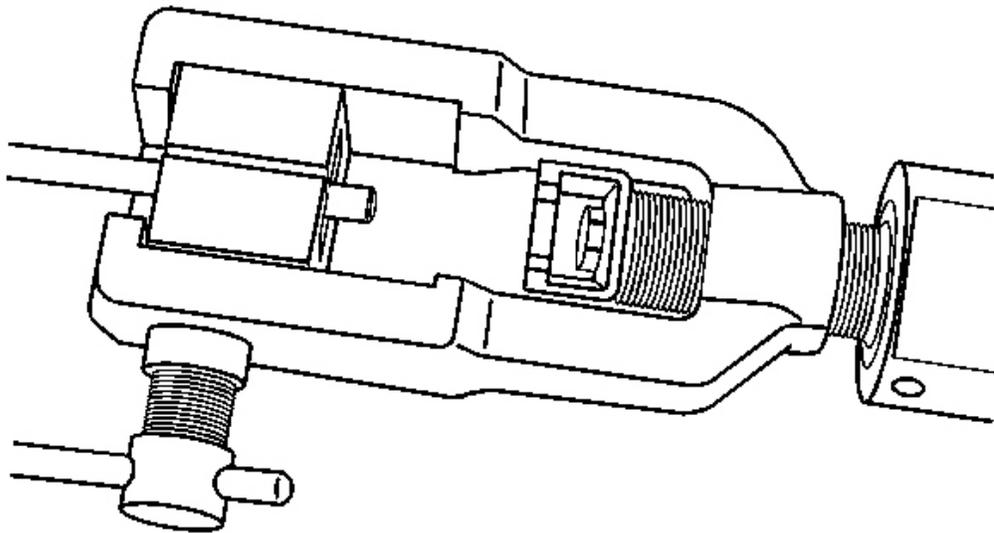


Fig. 27: View Of Die Halves & Die Cage
Courtesy of GENERAL MOTORS CORP.

13. Loosen the die clamping screw of the **J 45405** . See **Special Tools**.
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.

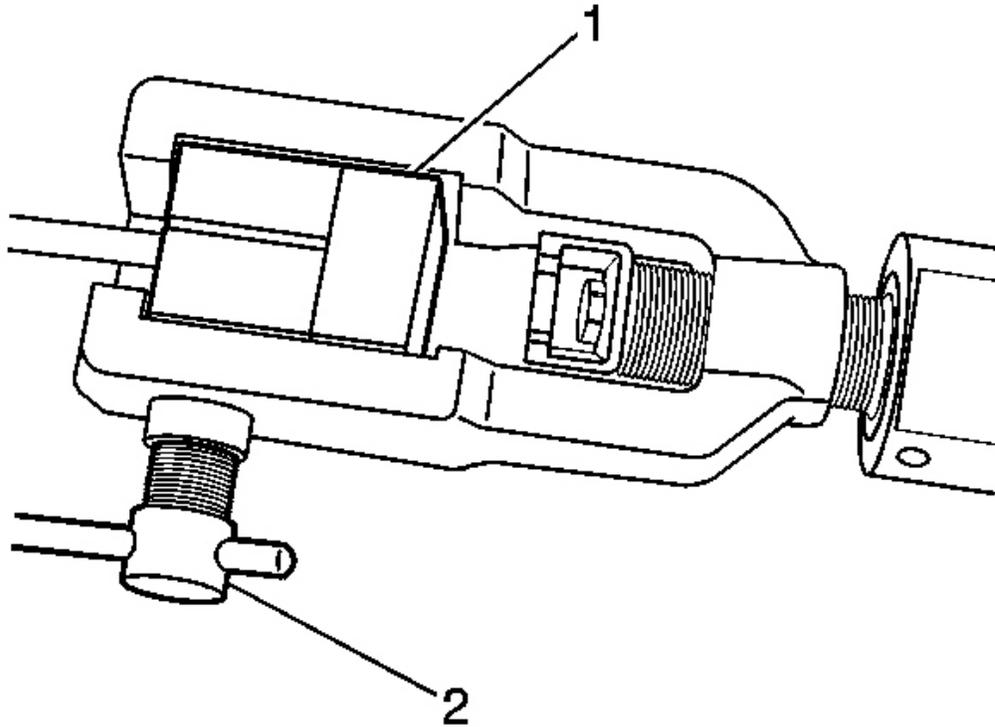


Fig. 28: View Of Clamping Screw & Unused Die
Courtesy of GENERAL MOTORS CORP.

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.

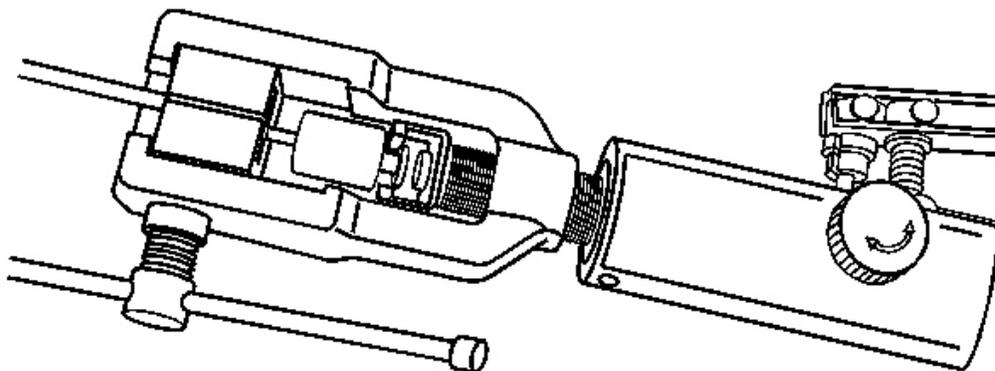


Fig. 29: Rotating J 45405 To Bottom Against Die Cage
Courtesy of GENERAL MOTORS CORP.

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** until it bottoms against the die cage. See **Special Tools**.

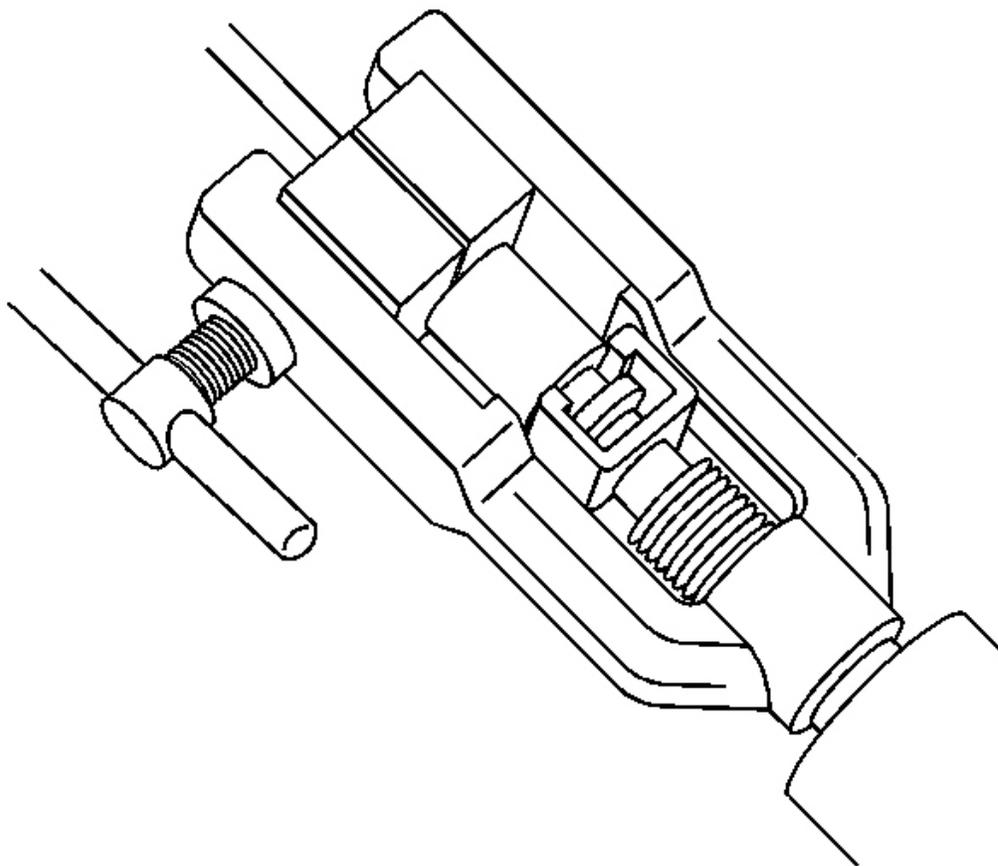


Fig. 30: View Of Pipe Flaring Tool
Courtesy of GENERAL MOTORS CORP.

23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the **J 45405** until the forming mandrel bottoms against the clamping dies. See **Special Tools**.
24. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.
25. Loosen the die clamping screw and remove the dies and pipe.
26. If necessary, lightly tap the dies until the die halves separate.

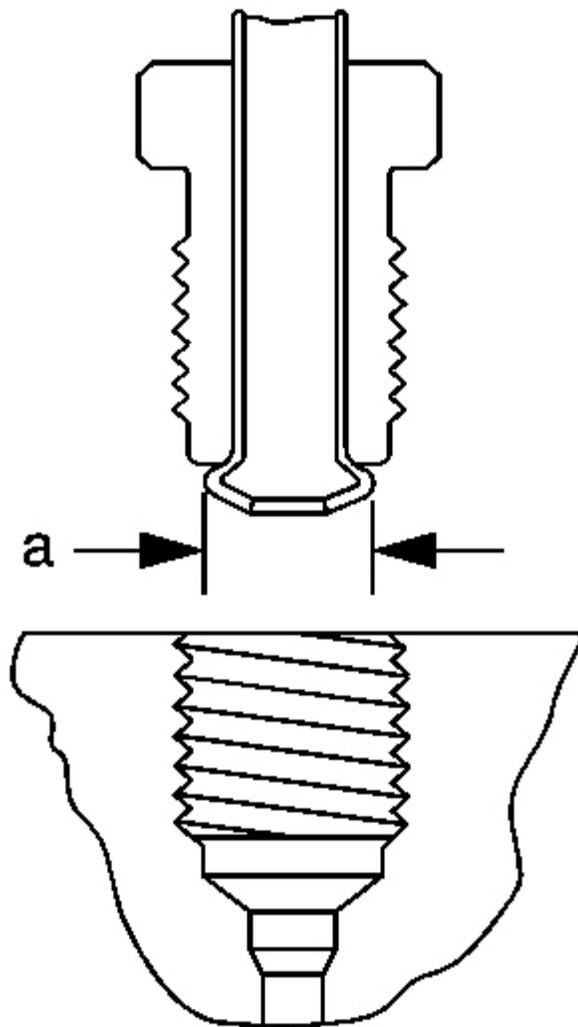


Fig. 31: Inspecting Brake Pipe Flare Diameter
Courtesy of GENERAL MOTORS CORP.

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

Specification: 7.10 mm (0.279 in) +/- 0.18 mm (0.007 in) flare diameter for 4.76 mm (3/16 in) diameter pipe

28. If necessary, using the removed section of pipe as a template, shape the new pipe with a

suitable brake pipe bending tool.

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

29. Install the pipe to the vehicle with the appropriate brake pipe unions as required.
30. If previously released, secure the brake pipe to the retainers.
31. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
32. 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

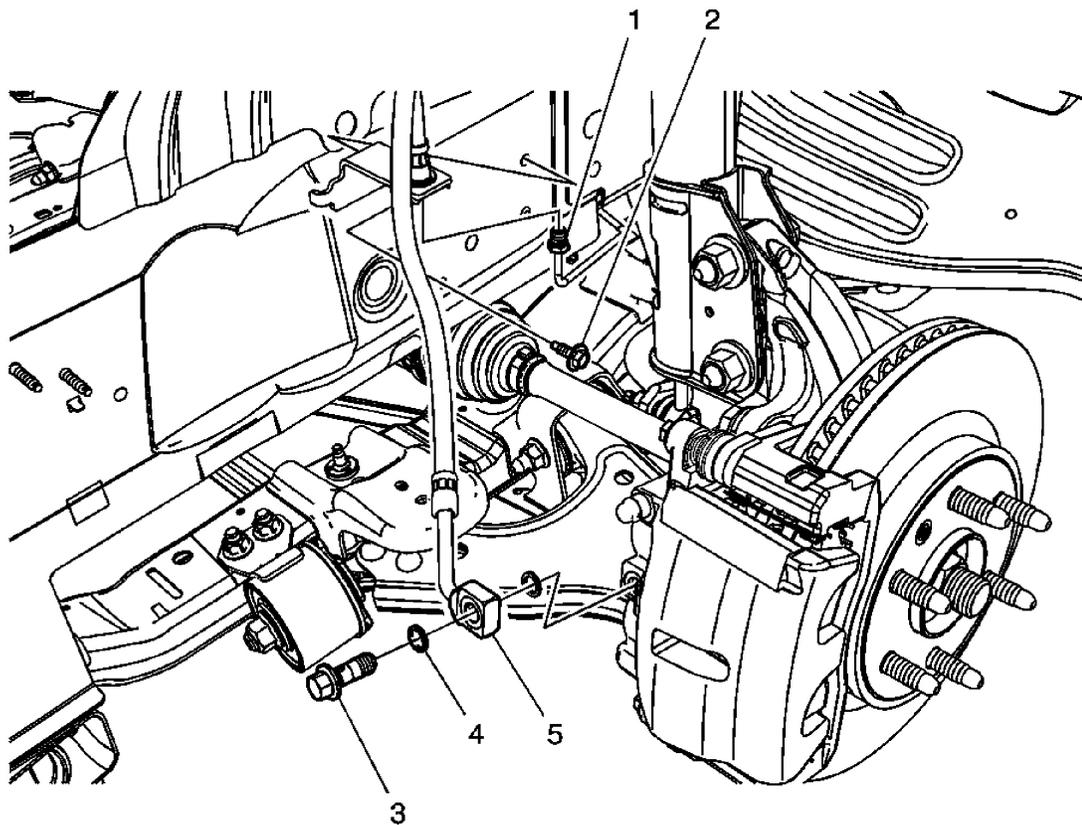


Fig. 32: Identifying Front Brake Hose
Courtesy of GENERAL MOTORS CORP.

Front Brake Hose Replacement

Callout	Component Name
<p>CAUTION: Refer to <u>Brake Dust Caution</u> .</p> <p>CAUTION: Refer to <u>Brake Fluid Irritant Caution</u> .</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 	
1	<p>Brake Pipe Fitting</p> <p>NOTE: Refer to <u>Fastener Notice</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove any dirt or debris from the brake pipe fitting. 2. Use a backup wrench on the brake hose fitting when disconnecting and connecting the brake pipe fitting. 3. Cap the brake pipe fitting to prevent brake fluid loss and contamination. <p>Tighten: 17 N.m (13 lb ft)</p>
2	<p>Brake Hose Bracket Bolt</p> <p>Tighten: 9 N.m (80 lb in)</p>
3	<p>Brake Hose Fitting Bolt</p> <p>Tighten: 40 N.m (30 lb ft)</p>
4	<p>Brake Hose Fitting Gasket (Qty: 2)</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Discard the brake hose fitting gaskets. 2. Install 2 new brake hose fitting gaskets.
	<p>Brake Hose</p>

5

Procedure:

Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

REAR BRAKE HOSE REPLACEMENT

Removal Procedure

CAUTION: Refer to Brake Dust Caution .

CAUTION: Refer to Brake Fluid Irritant 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** .

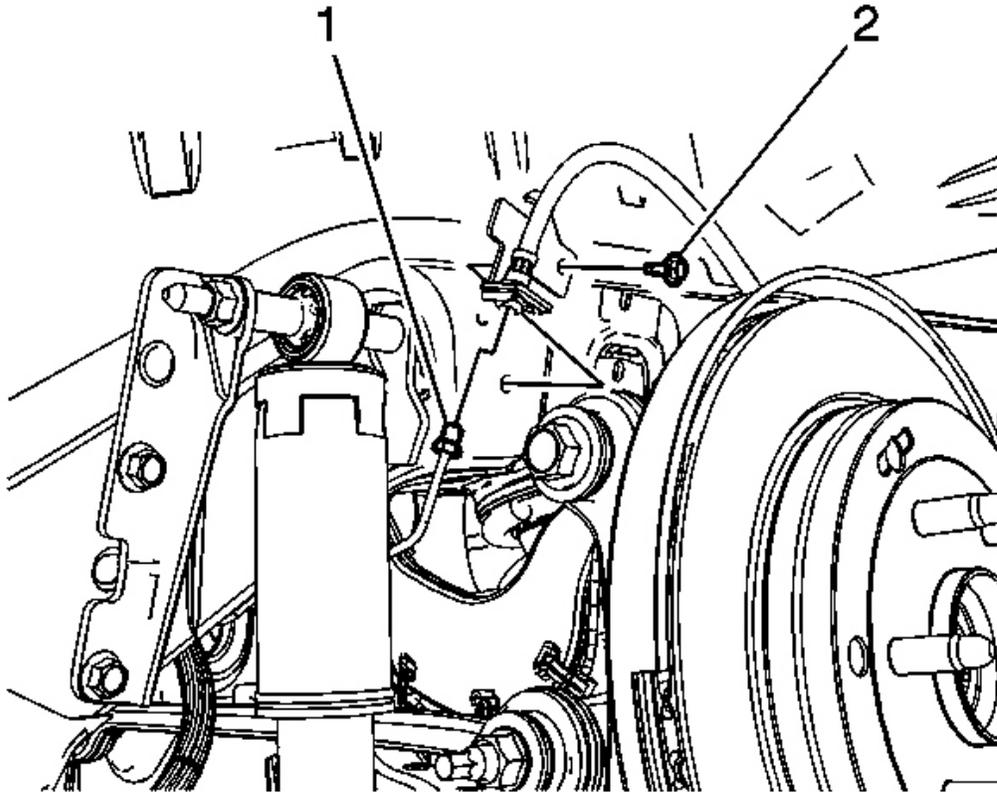


Fig. 33: View Of Brake Hose Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove any dirt or debris from the brake pipe fitting (1).
4. Using a backup wrench on the brake hose fitting, disconnect the brake pipe fitting.

Cap the brake pipe fitting to prevent brake fluid loss and contamination.

5. Remove the brake hose bracket bolt (2).

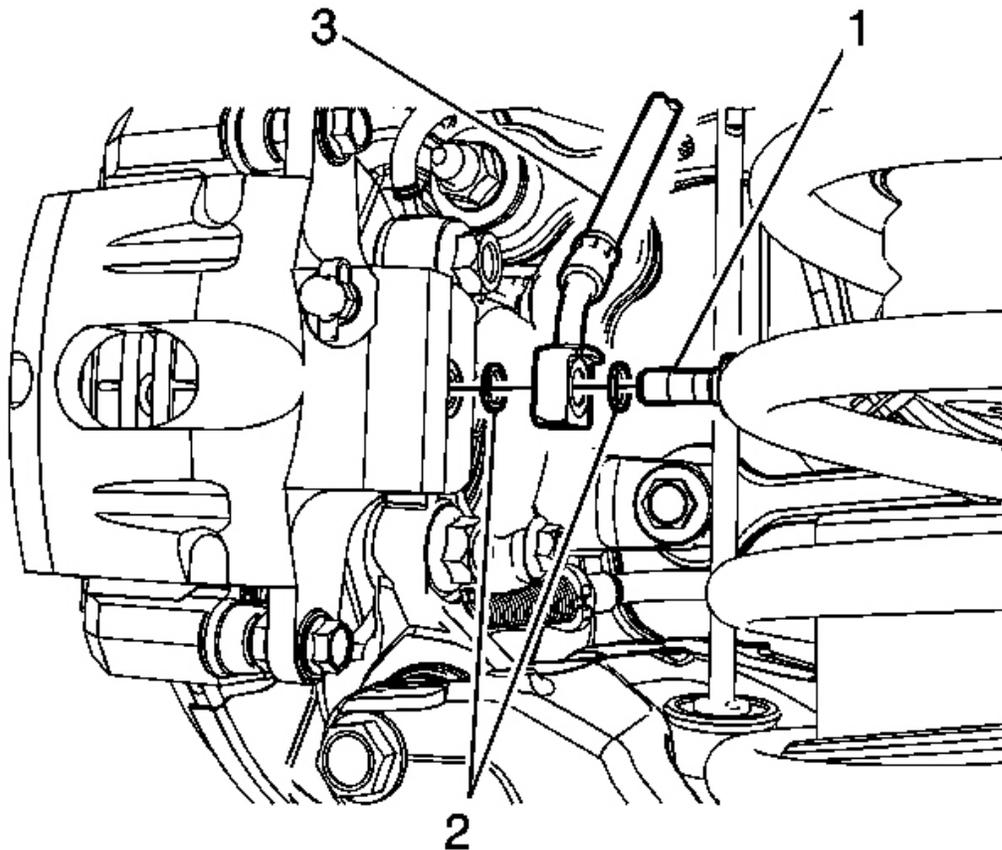


Fig. 34: Identifying Brake Hose Fitting Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the brake hose fitting bolt (1).
7. Remove and discard the 2 brake hose fitting gaskets (2).
8. Remove the brake hose (3).

Installation Procedure

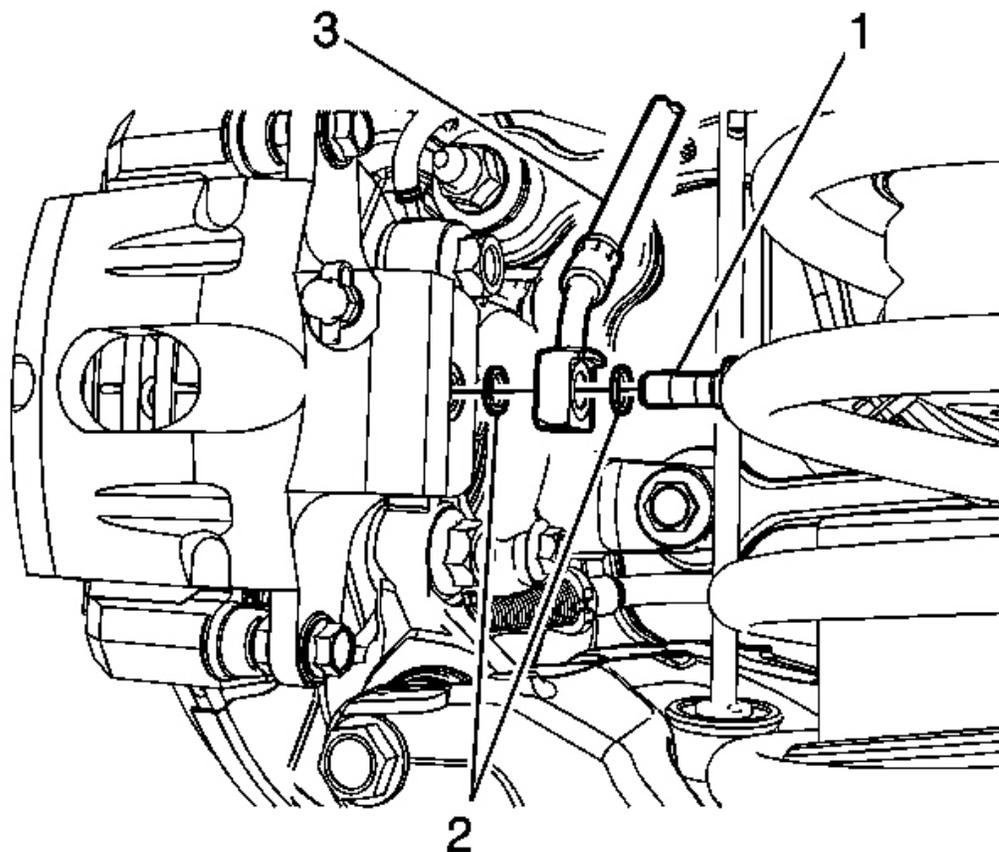


Fig. 35: Identifying Brake Hose Fitting Bolt
Courtesy of GENERAL MOTORS CORP.

1. Position the brake hose (3) to the vehicle.
2. Install 2 new brake hose fitting gaskets (2).

NOTE: Refer to Fastener Notice .

3. Install the brake hose fitting bolt (1).

Tighten: Tighten the bolt to 40 N.m (30 lb ft).

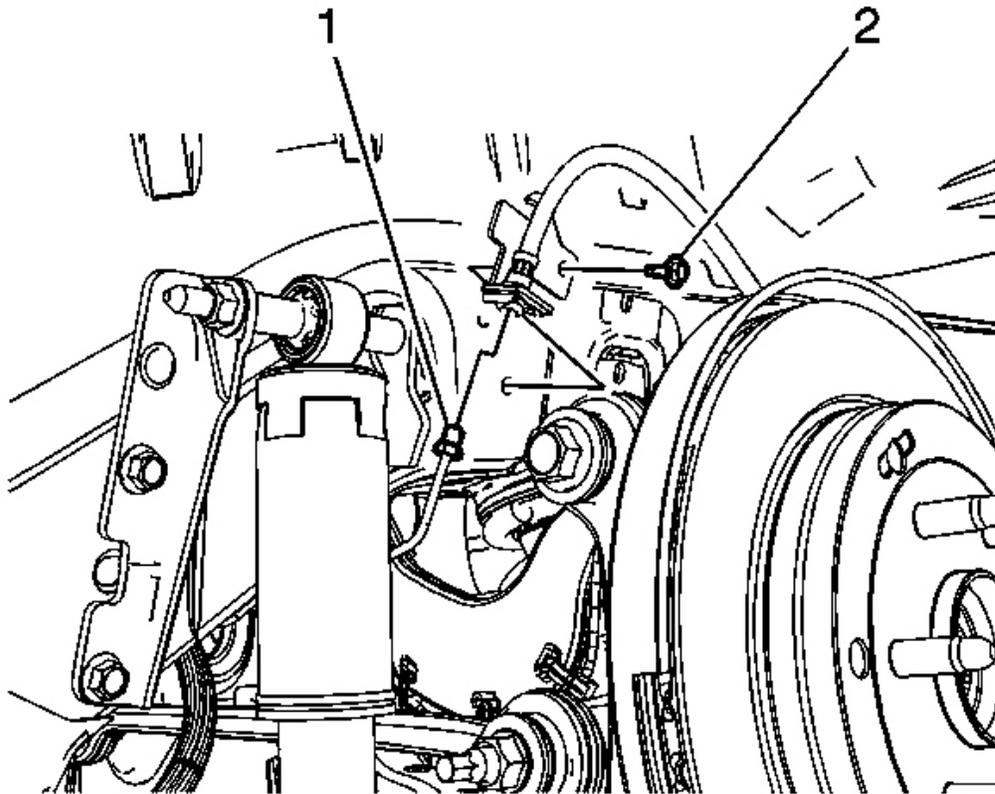


Fig. 36: View Of Brake Hose Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

4. Install the brake hose bracket bolt (2).

Tighten: Tighten the bolt to 12 N.m (106 lb in).

5. Using a backup wrench on the brake hose fitting, connect the brake pipe fitting.

Tighten: Tighten the bolt to 17 N.m (13 lb ft).

6. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.
8. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle**.

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

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 Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

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 Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 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.

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 Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 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 REAR 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 rear wheel hydraulic circuit bleeder valve tightened securely, after all air purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT 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 right front wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the right front hydraulic circuit, install a proper box-end wrench onto the

LEFT 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 Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
20. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.
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.

IMPORTANT: If the brake system warning lamp remains illuminated, 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 **Symptoms - Hydraulic Brakes**.

HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)

Tools Required

- **J 29532** Diaphragm Type Brake Pressure Bleeder or equivalent. See **Special Tools**.
- **J 44894-A** Brake Pressure Bleeder Adapter. See **Special Tools**.

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: When adding fluid to the brake master cylinder reservoir, use only GM approved or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid may cause contamination which

could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to BRAKE FLUID EFFECTS ON PAINT AND ELECTRICAL COMPONENTS NOTICE .

Bleeding Procedure

1. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
2. 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.
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 or if you have disconnected the brake pipes from the proportioning valve assembly or the brake modulator assembly, you must perform the following steps to bleed air at the ports of the hydraulic component:
 1. 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 brake pipes installed securely to the master cylinder, proportioning valve assembly or brake modulator assembly, loosen and separate one of the brake pipes from the port of the component.

For the proportioning valve assembly or the brake modulator assembly, perform these steps in the sequence of system flow; begin with the fluid feed pipes from the master cylinder.

3. Allow a small amount of brake fluid to gravity bleed from the open port of the component.
4. Reconnect the brake pipe to the component 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 component.
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 component.
9. With the brake pipe installed securely to the master cylinder, proportioning valve assembly or brake modulator assembly and after all air has been purged from the first port of the component that was bled, loosen and separate the next brake pipe from the component, then repeat steps 3.3-3.8 until each of the ports on the component has been

bled.

10. After completing the final component port bleeding procedure, ensure that each of the brake pipe-to-component fittings is properly tightened.
4. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
5. Install the **J 44894-A** to the brake master cylinder reservoir. See **Special Tools**.
6. Connect the **J 29532** or equivalent, to the **J 44894-A** . See **Special Tools**.
7. Charge the **J 29532** or equivalent, air tank to 175-205 kPa (25-30 psi). See **Special Tools**.
8. Open the **J 29532** or equivalent, fluid tank valve to allow pressurized brake fluid to enter the brake system. See **Special Tools**.
9. 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.

10. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
11. Install a transparent hose over the end of the bleeder valve.
12. 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.
13. With the right rear wheel hydraulic circuit bleeder valve tightened securely and 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.
14. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
15. With the left front wheel hydraulic circuit bleeder valve tightened securely and 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.
16. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
17. With the left rear wheel hydraulic circuit bleeder valve tightened securely and 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.
18. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
19. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves is properly tightened.
20. Close the **J 29532** or equivalent, fluid tank valve, then disconnect the **J 29532** or equivalent, from the **J 44894-A** . See **Special Tools**.

21. Remove the **J 44894-A** from the brake master cylinder reservoir. See **Special Tools**.
22. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.
23. 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. If equipped with antilock brakes, 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 Procedure**.
24. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

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

25. If the brake system warning lamp remains illuminated. Refer to **Symptoms - Hydraulic Brakes**.

HYDRAULIC BRAKE SYSTEM FLUSHING

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: When adding fluid to the brake master cylinder reservoir, use only GM approved or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:
 - Fluid separation, indicating two 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 Reservoir Replacement**
 - **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:

- 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.

- **Master Cylinder Replacement**
 - **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 which may have allowed the moisture or particles to enter the hydraulic system.
 5. 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)**.

VACUUM BRAKE BOOSTER REPLACEMENT

Removal Procedure

1. Place the vehicle on a level surface and apply the park brake.
2. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the vacuum reserve in the vacuum brake booster.
3. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

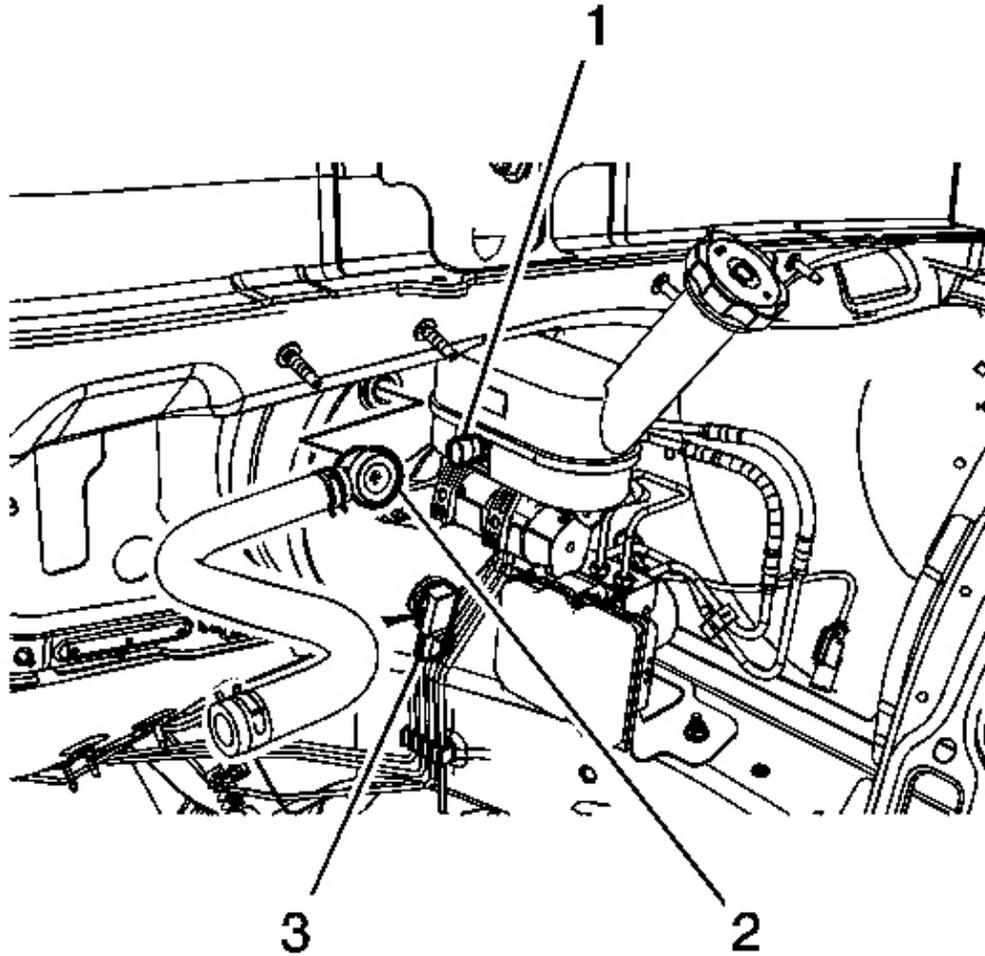


Fig. 37: Identifying Master Cylinder Fluid Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the master cylinder fluid level sensor electrical connector (1).
5. Remove the vacuum brake booster check valve hose from the vacuum brake booster check valve (2) and position aside.
6. Disconnect the vacuum brake booster vacuum sensor electrical connector (3) and position aside.

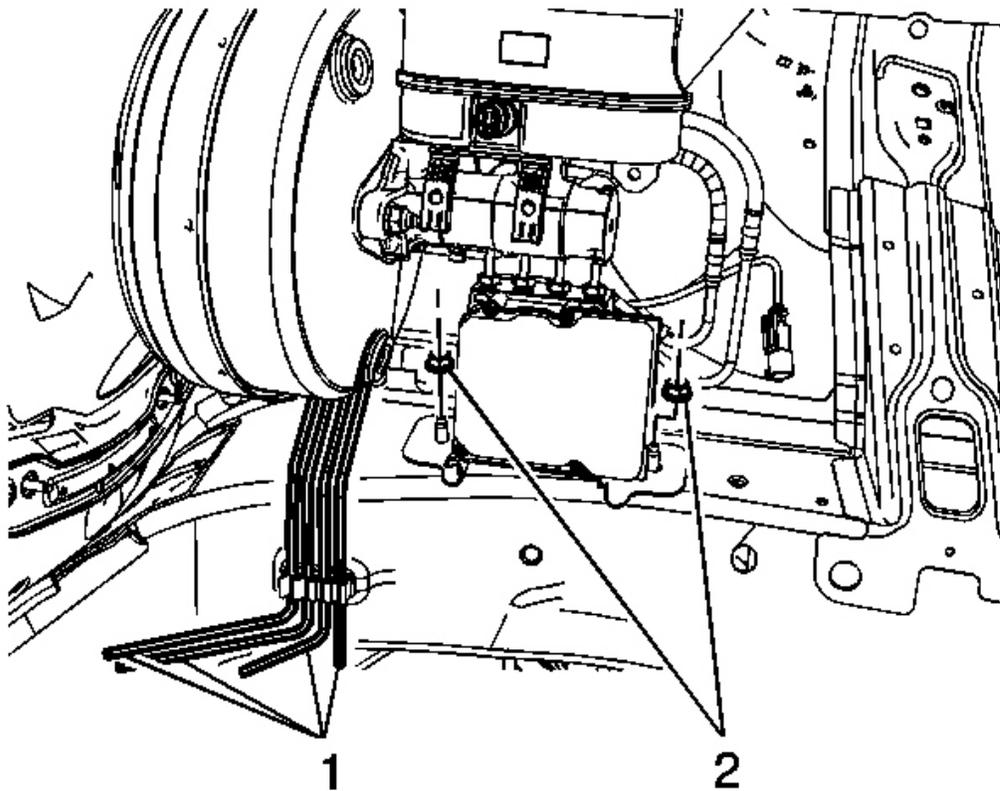


Fig. 38: View Of Front & Rear Brake Pipes
Courtesy of GENERAL MOTORS CORP.

7. Release the front and rear brake pipes (1) from the routing clip on the frame rail.
8. Remove the 2 nuts (2) from the brake pressure modulator valve (BPMV) assembly.

IMPORTANT: It is not necessary to disconnect the brake pipes from the BPMV assembly.

9. Carefully lift the BPMV assembly over the studs and position forward slightly.

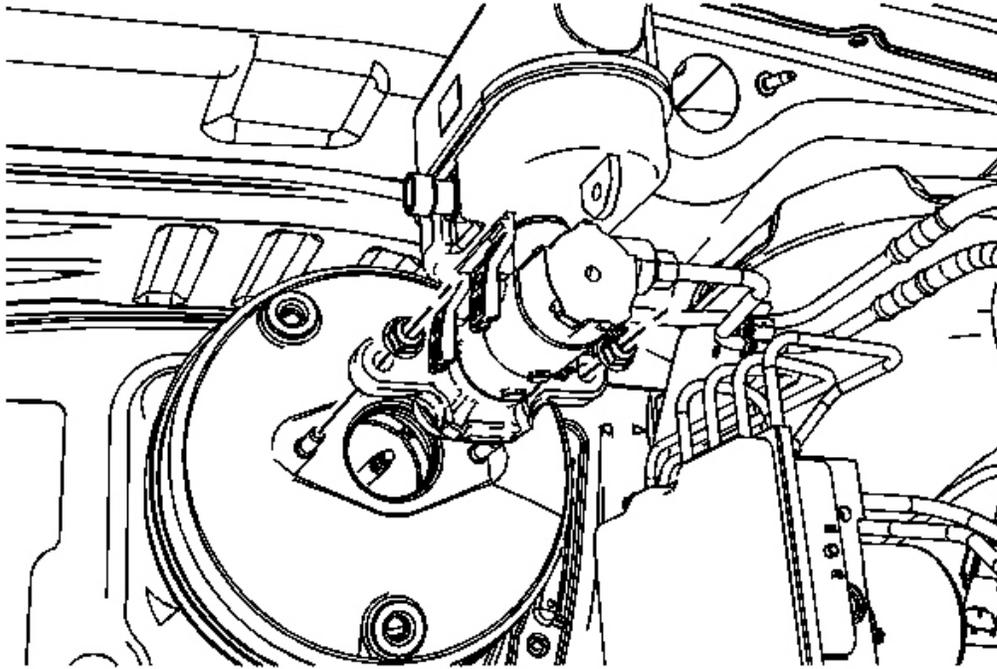


Fig. 39: View Of Brake Master Cylinder Nuts
Courtesy of GENERAL MOTORS CORP.

10. Remove the 2 brake master cylinder nuts.

IMPORTANT: It is not necessary to disconnect the brake pipes from the master cylinder.

11. Without disconnecting the brake pipes from the master cylinder, remove the master cylinder assembly and position aside.

Place the brake master cylinder in an upright position and support with heavy mechanics wire or equivalent.

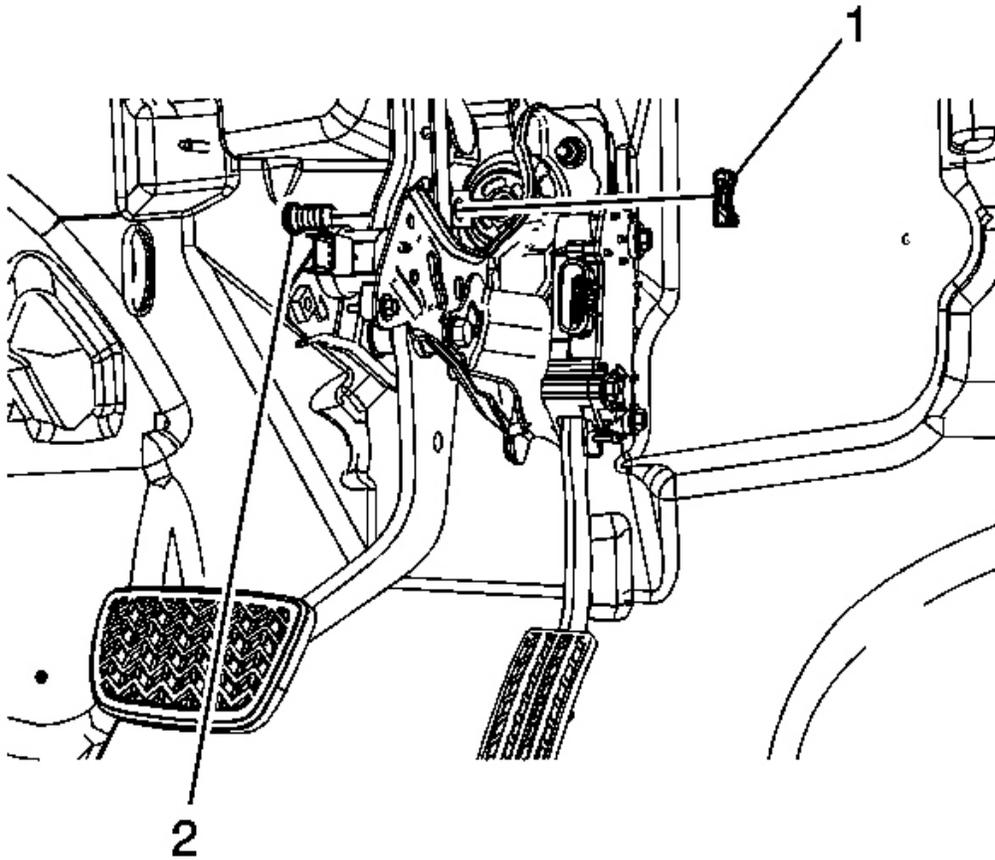


Fig. 40: Identifying Brake Pedal Pushrod Retaining Clip
Courtesy of GENERAL MOTORS CORP.

12. Remove the left side instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .
13. Remove the knee bolster. Refer to **Knee Bolster Replacement** .
14. Remove the brake pedal pushrod retaining clip (1).
15. Remove the brake pedal pushrod clevis pin (2) and disconnect the pushrod from the brake pedal.

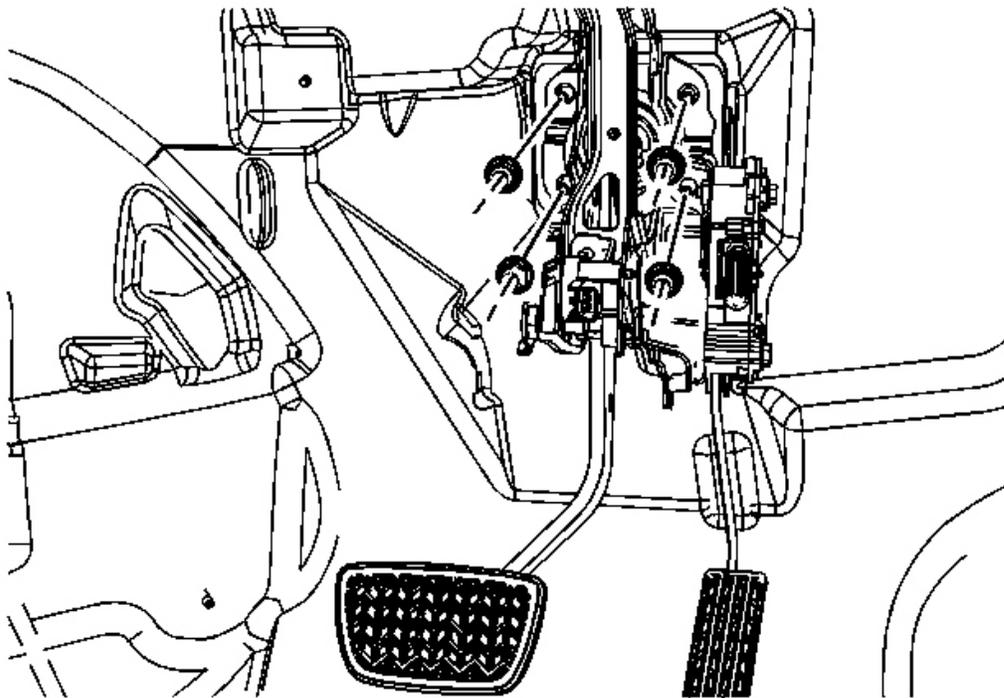


Fig. 41: View Of Vacuum Brake Booster Nuts
Courtesy of GENERAL MOTORS CORP.

16. Remove the 4 vacuum brake booster nuts.

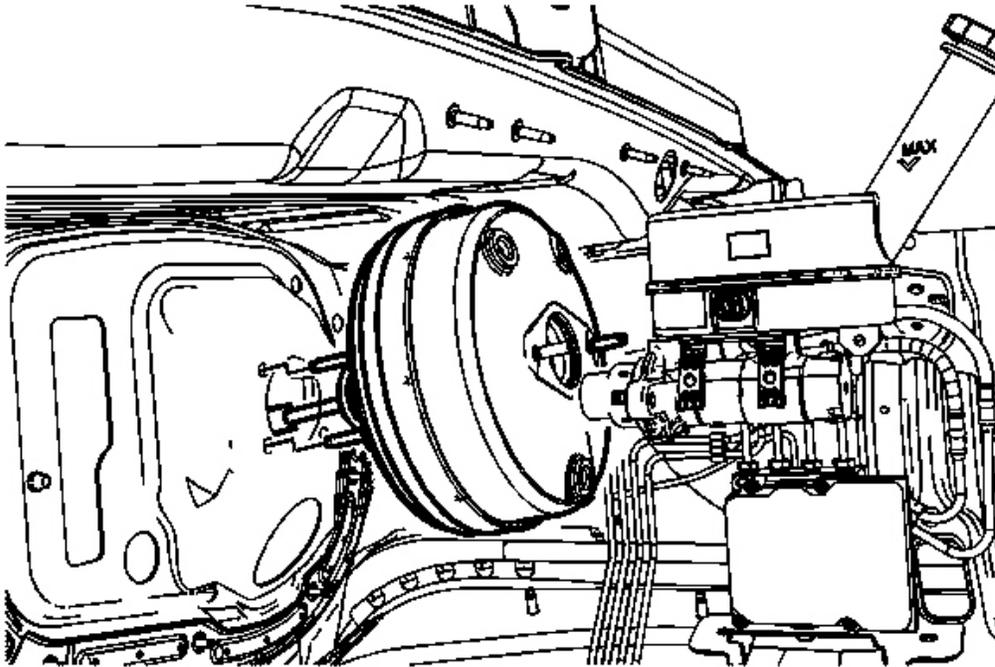


Fig. 42: Identifying Vacuum Brake Booster
Courtesy of GENERAL MOTORS CORP.

17. Pull the vacuum brake booster forward and tilt upward slightly until the mounting studs clear the dash panel.
18. Remove the vacuum brake booster.

Installation Procedure

IMPORTANT: Inspect the vacuum brake booster to dash panel gasket for damage and replace, if necessary.

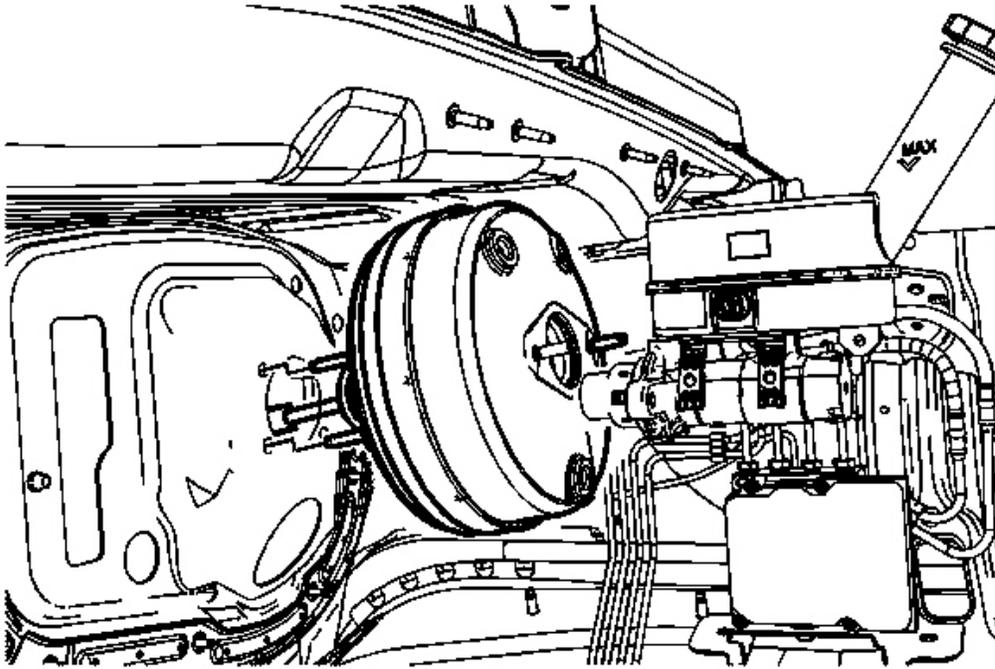


Fig. 43: Identifying Vacuum Brake Booster
Courtesy of GENERAL MOTORS CORP.

1. Align the vacuum brake booster mounting studs to the dash panel.
2. Install the vacuum brake booster.

NOTE: Refer to Fastener Notice .

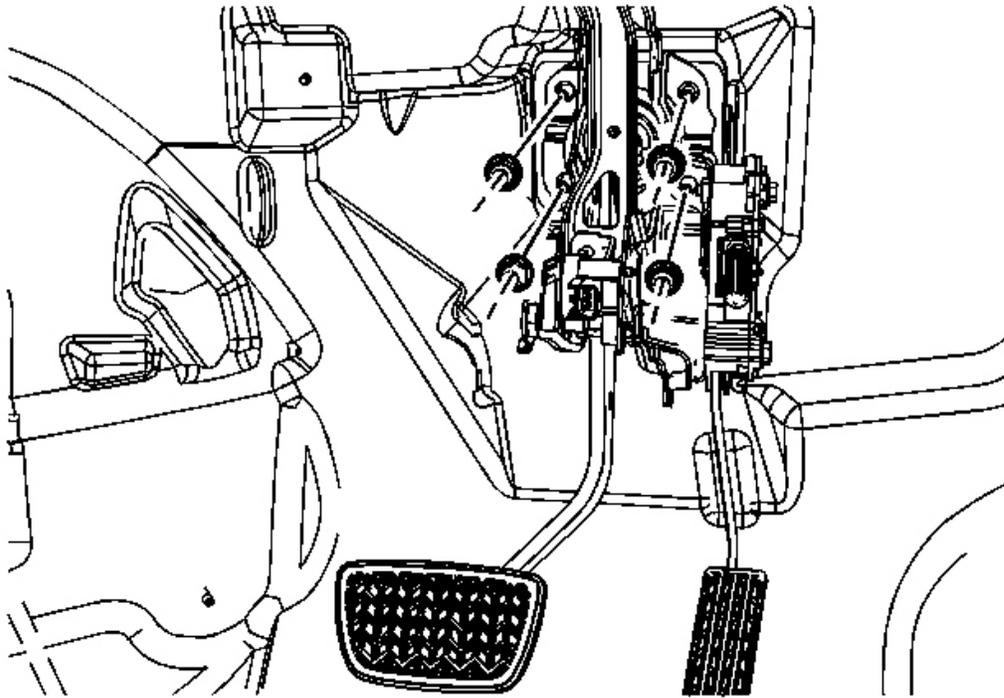


Fig. 44: View Of Vacuum Brake Booster Nuts
Courtesy of GENERAL MOTORS CORP.

3. Install the 4 vacuum brake booster nuts.

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

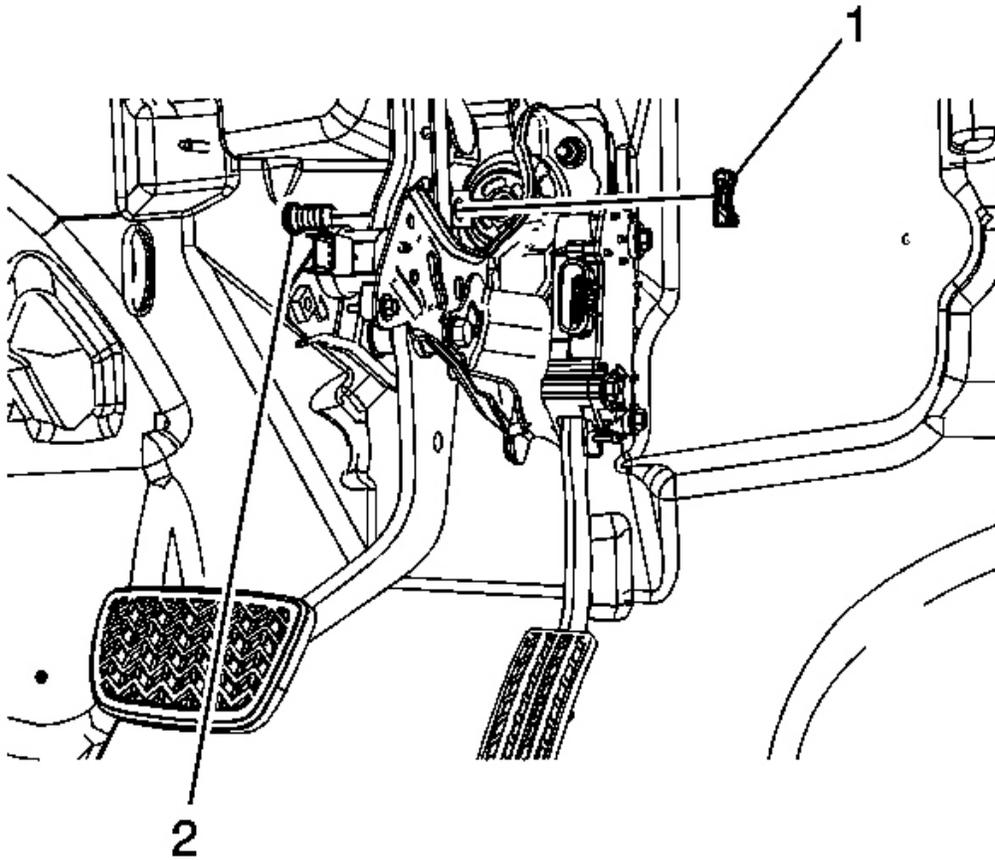


Fig. 45: Identifying Brake Pedal Pushrod Retaining Clip
Courtesy of GENERAL MOTORS CORP.

4. Connect the brake pedal pushrod to the brake pedal and install the clevis pin (2).
5. Install the brake pedal pushrod retaining clip (1).
6. Install the knee bolster. Refer to **Knee Bolster Replacement** .
7. Install the left side instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

IMPORTANT: Ensure the master cylinder to vacuum brake booster seal is properly installed on the back of the master cylinder housing against the face of the master cylinder flange. Inspect the seal for damage and replace, if necessary.

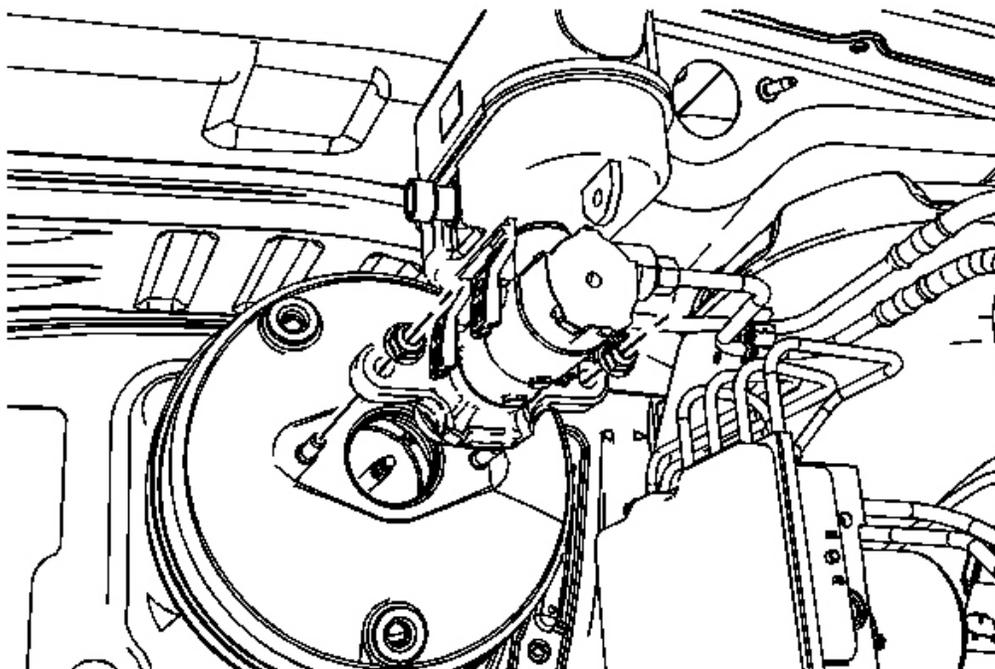


Fig. 46: View Of Brake Master Cylinder Nuts
Courtesy of GENERAL MOTORS CORP.

8. Position the master cylinder to the vacuum booster.
9. Install the 2 brake master cylinder nuts.

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

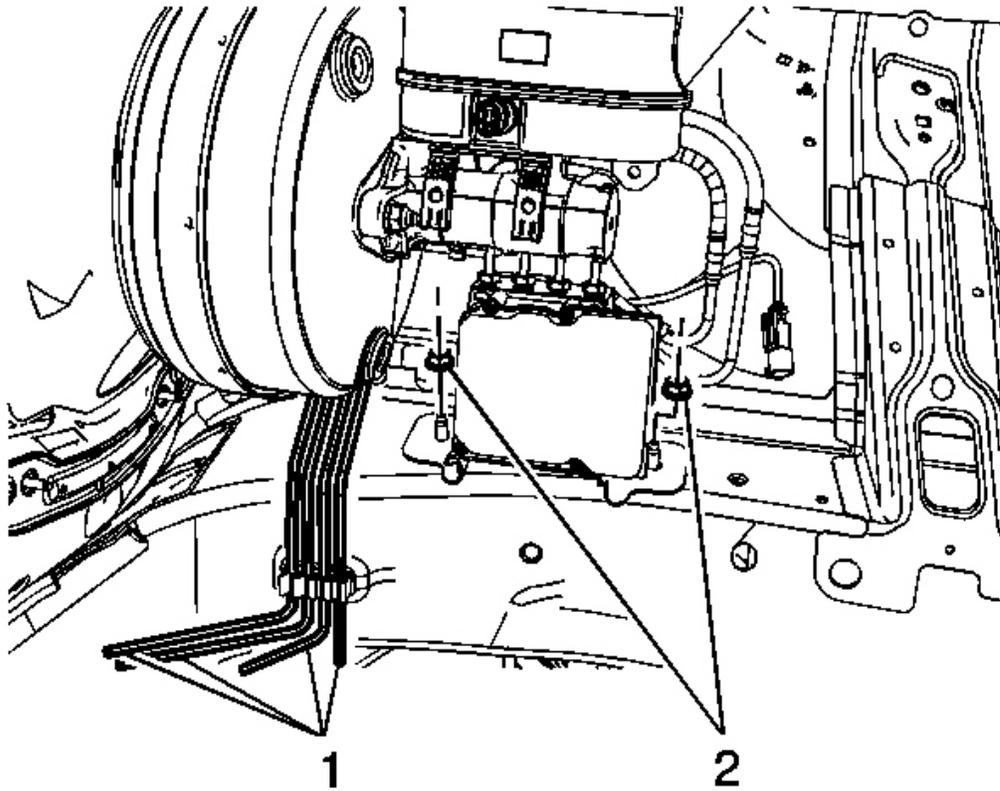


Fig. 47: View Of Front & Rear Brake Pipes
Courtesy of GENERAL MOTORS CORP.

10. Position the BPMV assembly over the studs.
11. Install the 2 nuts (2) to the brake pressure modulator valve (BPMV) and bracket assembly.

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

12. Install the front and rear brake pipes (1) to the routing clip on the frame rail.

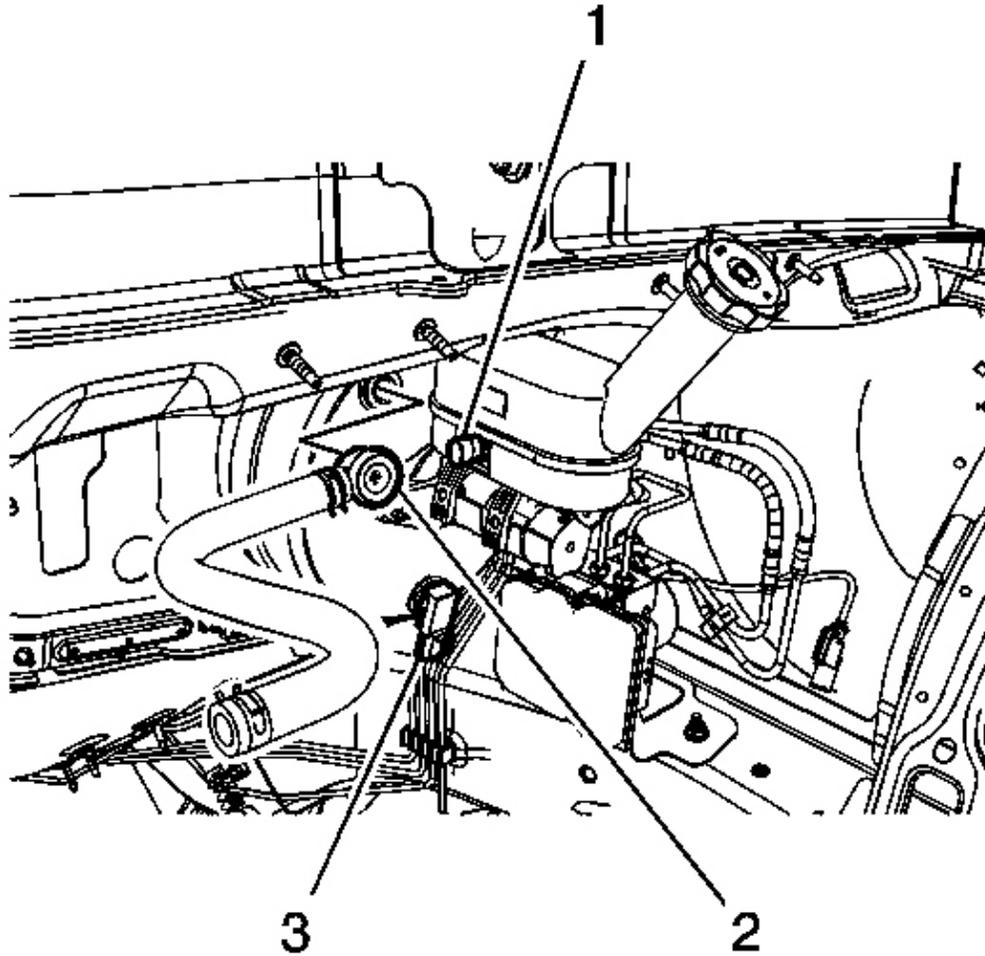


Fig. 48: Identifying Master Cylinder Fluid Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

13. Connect the master cylinder fluid level sensor electrical connector (1).
14. Connect the vacuum brake booster vacuum sensor electrical connector (3).

IMPORTANT: If necessary, a small amount of denatured alcohol may be used to aid installation of the brake booster check valve hose. Do not use soap.

15. Install the vacuum brake booster check valve hose to the vacuum brake booster check valve (2).
16. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .

VACUUM BRAKE BOOSTER CHECK VALVE AND/OR HOSE REPLACEMENT

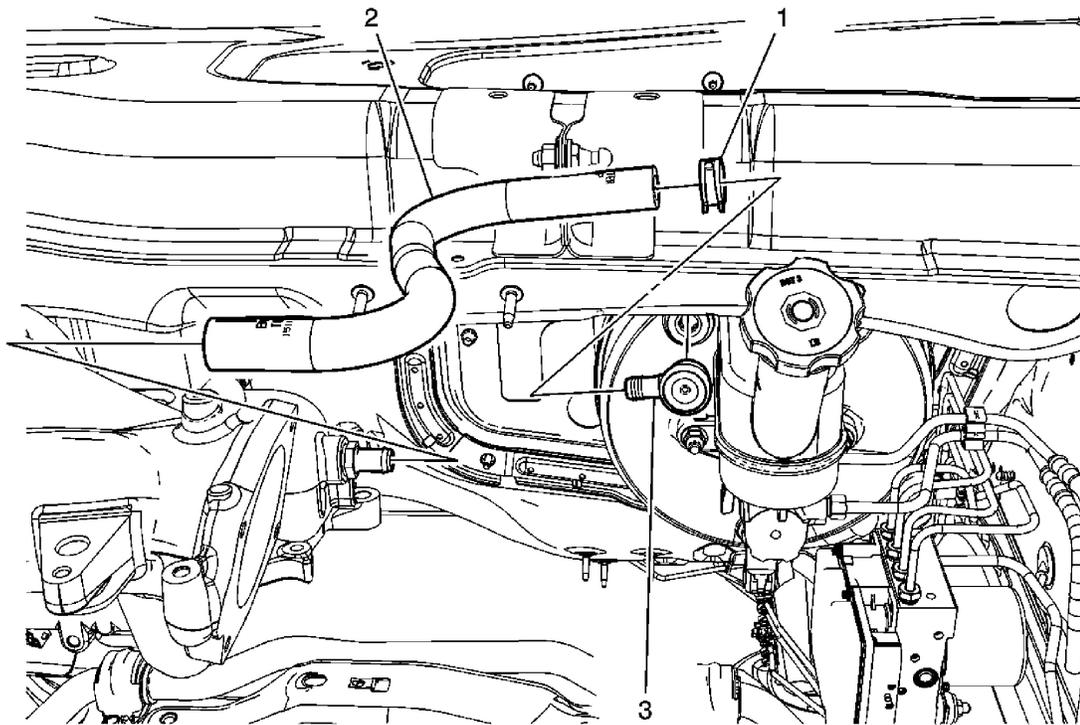


Fig. 49: View Of Vacuum Brake Booster Check Valve And Hose
 Courtesy of GENERAL MOTORS CORP.

Vacuum Brake Booster Check Valve and/or Hose Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Apply and release the brake pedal several times until the brake pedal becomes firm to deplete the brake booster vacuum reserve. 2. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 	
1	Vacuum Brake Booster Hose Clamp
2	Vacuum Brake Booster Hose Tip: If necessary, a small amount of denatured alcohol can be used as an

assembly aid for installing the vacuum hose to the check valve. Do not use soap.

3

Vacuum Brake Booster Check Valve

Tip: If necessary, a small amount of denatured alcohol can be used as an assembly aid for installing the check valve to the booster grommet. Do not use soap.

POWER BRAKE BOOSTER VACUUM SENSOR REPLACEMENT

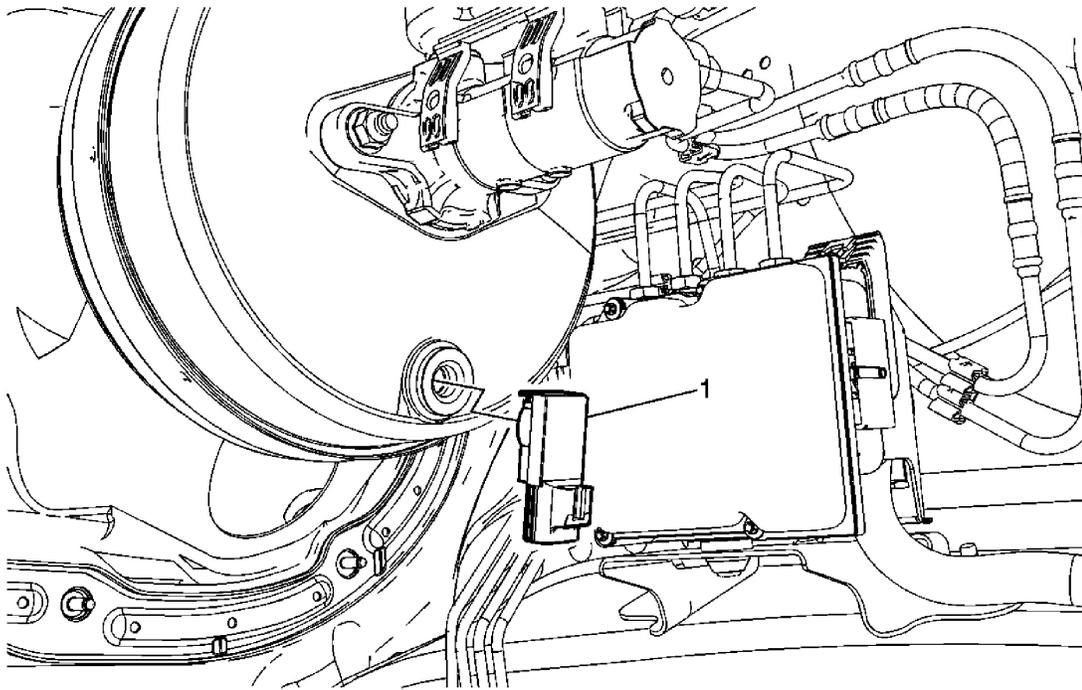


Fig. 50: Identifying Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS CORP.

Power Brake Booster Vacuum Sensor Replacement

Callout	Component Name
Preliminary Procedures	
1.	Turn the ignition switch to the OFF position.
2.	Apply the brake pedal several times until the brake pedal becomes firm to deplete the power brake booster vacuum reserve.
3.	Remove the air cleaner element. Refer to <u>Air Cleaner Element Replacement</u> .
4.	Disconnect the power brake booster vacuum sensor electrical connector.

1

Power Brake Booster Vacuum Sensor

Tip: If necessary, a small amount of denatured alcohol can be used as an assembly aid for installing the power brake booster vacuum sensor to the brake booster. Do not use soap.

DESCRIPTION AND OPERATION

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

Brake Warning Indicator

The instrument panel cluster (IPC) illuminates the Red Brake Warning indicator when one or more of the following occurs.

- The body control module (BCM) detects that the park brake is engaged.
- The IPC detects a low brake fluid condition. The IPC receives a low brake fluid signal from the low brake fluid switch in the master cylinder reservoir requesting illumination.
- The electronic brake control module (EBCM) detects an ABS malfunction which disables dynamic rear proportioning (DRP). The IPC receives a GMLAN message from the EBCM requesting illumination.
- The IPC performs the bulb check at the start of each ignition cycle. The Red Brake Warning indicator illuminates for approximately 3 seconds before turning OFF.
- The IPC detects a loss of GMLAN communications with the EBCM.

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.

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.

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

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

Vacuum Source Delivery System

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

System Operation

Brake system input force 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 vacuum brake booster.

SPECIAL TOOLS AND EQUIPMENT

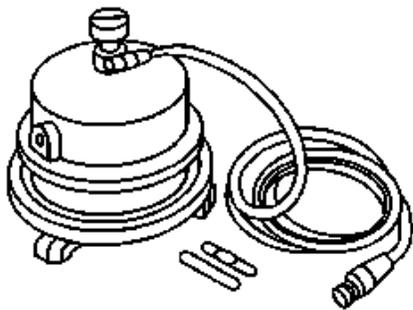
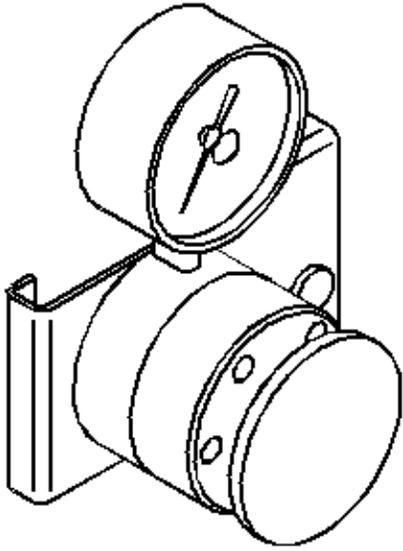
SPECIAL TOOLS

Special Tools

Illustration	Tool Number/Description
	<p data-bbox="932 1489 1295 1566">J 28662 Brake Pedal Effort Gage</p>

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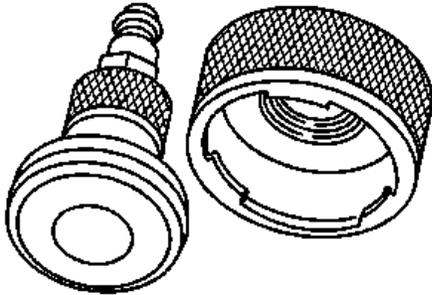
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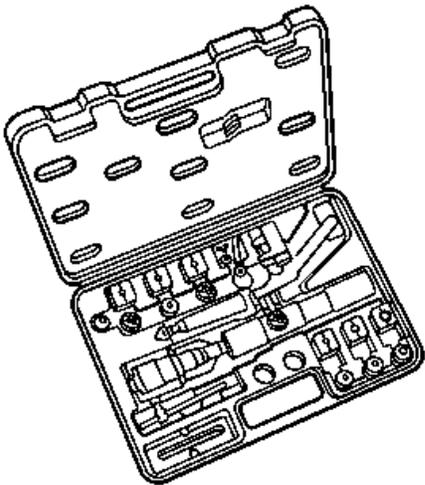
J 29532
Diaphragm Pressure Bleeder

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Brake Pressure Bleeder Adapter



J 45405
Brake Pipe Flaring Kit