

2006 Chevrolet HHR LT

2006 BRAKES Hydraulic Brakes - HHR

2006 BRAKES

Hydraulic Brakes - HHR

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Bolt, Accelerator Pedal Sensor	9 N.m	80 lb in
Bolt, Brake Caliper - Front	53 N.m	40 lb ft
Bolt, Brake Caliper - Rear	43 N.m	32 lb ft
Nut, Brake Pipe Fitting to Master Cylinder	21 N.m	15 lb ft
Nut, Brake Booster Mounting	50 N.m	37 lb ft
Nut, Brake Pipe Fittings	21 N.m	15 lb ft
Nut, Brake Pipe Fittings at the Proportioning Valve	19 N.m	14 lb ft
Nut, Master Cylinder Mounting	22 N.m	16 lb ft
Nut, Proportioning Valve to Bracket	10 N.m	89 lb in
Proportioning Valve Assembly Bracket Mounting Bolt	25 N.m	18 lb ft
Screw, Reservoir to Master Cylinder	9 N.m	80 lb in

BRAKE COMPONENT SPECIFICATIONS

Brake Component Specifications

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve	11 N.m	97 lb in
Drum Brake Wheel Cylinder Bleeder Valve	8 N.m	71 lb in

BRAKE SYSTEM SPECIFICATIONS

Brake System Specifications

Application	Specification	
	Metric	English
Brake Pedal Travel Maximum specification with 445 N (100 lbs) of force applied to the brake pedal with	38.1 mm	1.50 in

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the ignition OFF and the booster power reserve depleted.

SCHEMATIC AND ROUTING DIAGRAMS

BRAKE WARNING SYSTEM SCHEMATICS

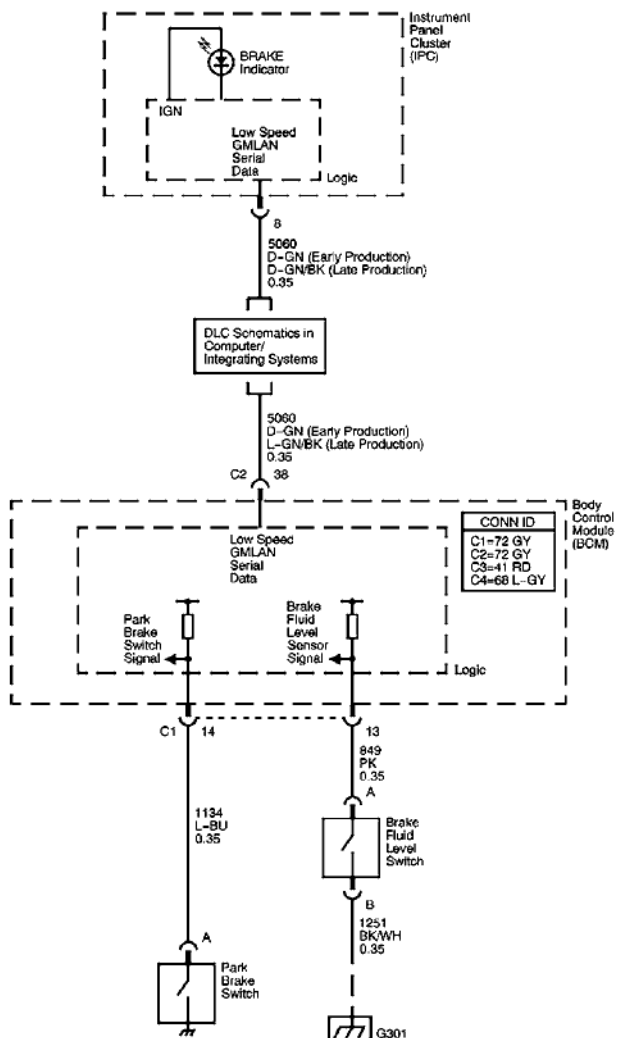


Fig. 1: Brake Warning System Schematic
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

HYDRAULIC BRAKES COMPONENT VIEWS

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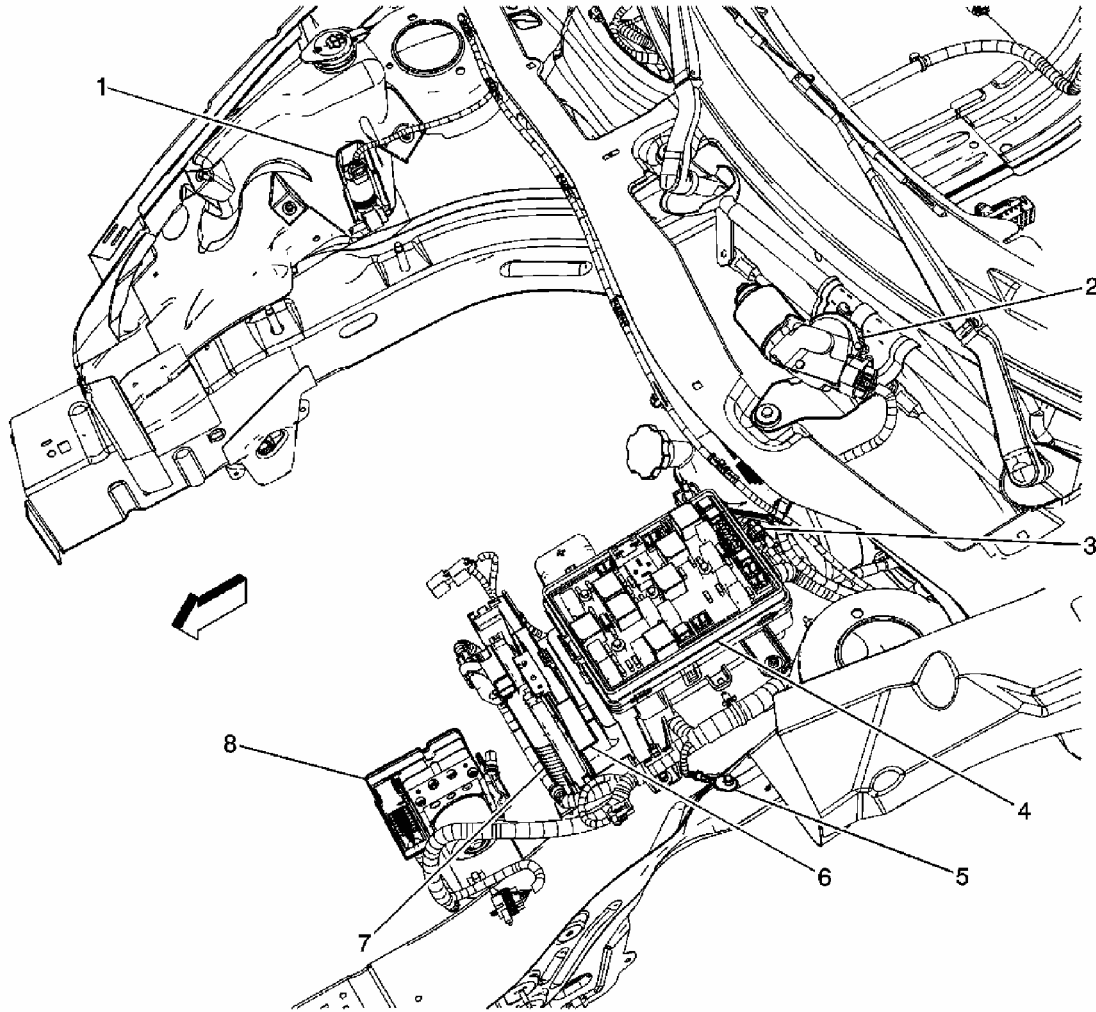


Fig. 2: LF of the Engine Compartment
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 2

Callout	Component Name
1	Windshield Washer Fluid Pump
2	Windshield Wiper Motor Assembly
3	Brake Fluid Level Switch
4	Fuse Block - Underhood
5	G111
6	Transmission Control Module (TCM) (MN5)
7	Engine Control Module (ECM)
8	Electronic Brake Control Module (EBCM)

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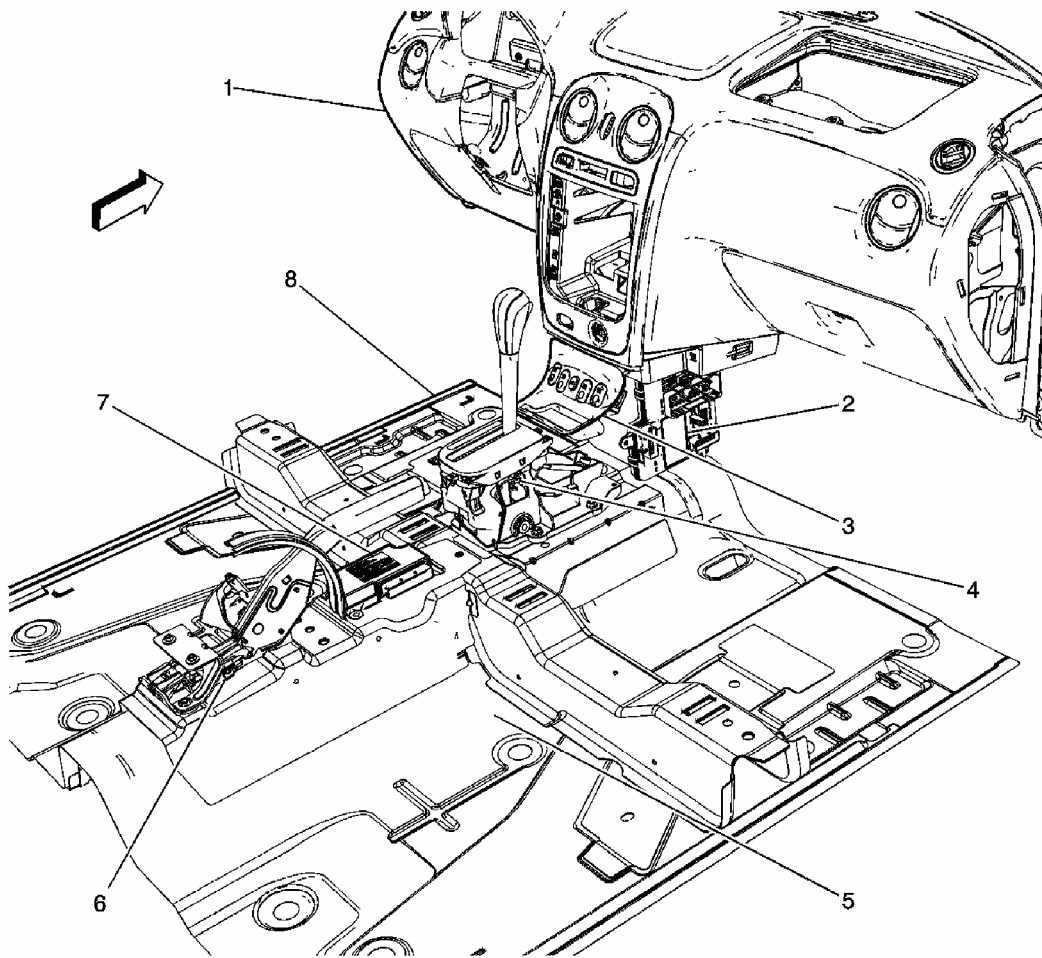


Fig. 3: Center Console Components
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 3

Callout	Component Name
1	I/P Trim
2	Body Control Module (BCM)
3	Master Window Switch
4	A/T Shift Lock Control Solenoid (MN5)
5	Floor Panel
6	Park Brake Switch
7	Inflatable Restraint Sensing and Diagnostic Module (SDM)
8	Floor Panel

HYDRAULIC BRAKES CONNECTOR END VIEWS

Brake Fluid Level Switch

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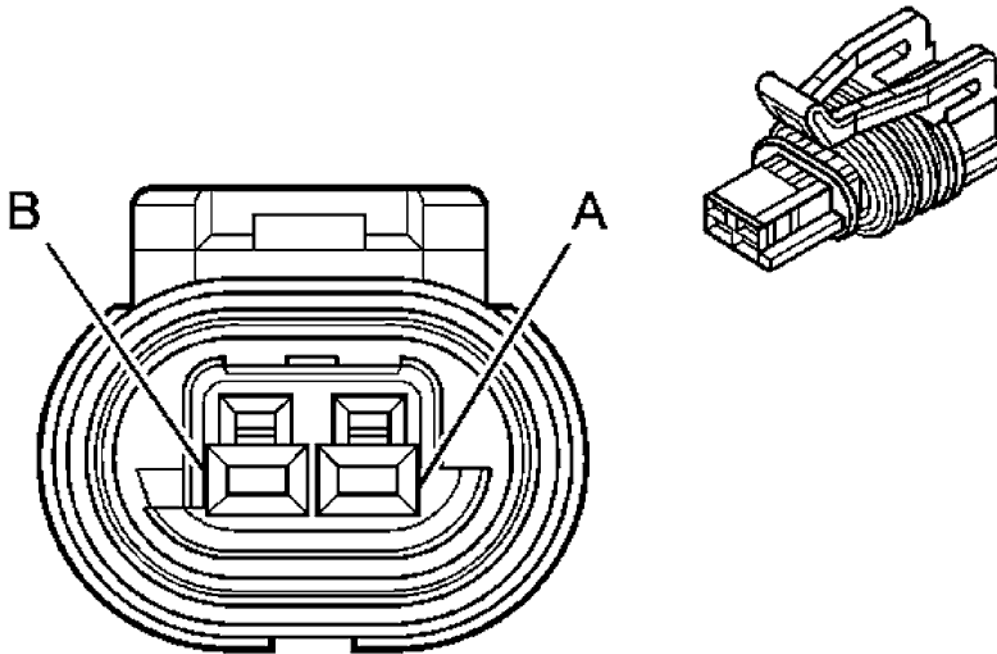


Fig. 4: Brake Fluid Level Switch Connector
Courtesy of GENERAL MOTORS CORP.

Hydraulic Brakes Connector End Views

Connector Part Information

- OEM: 15449028
- Service: 88987978
- Description: 2-Way F 150 GT Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Brake Fluid Level Switch

Pin	Wire Color	Circuit No.	Function
A	PK	849	Brake Fluid Level Sensor Signal (1)
B	BK/WH	1251	Signal Ground

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Park Brake Switch

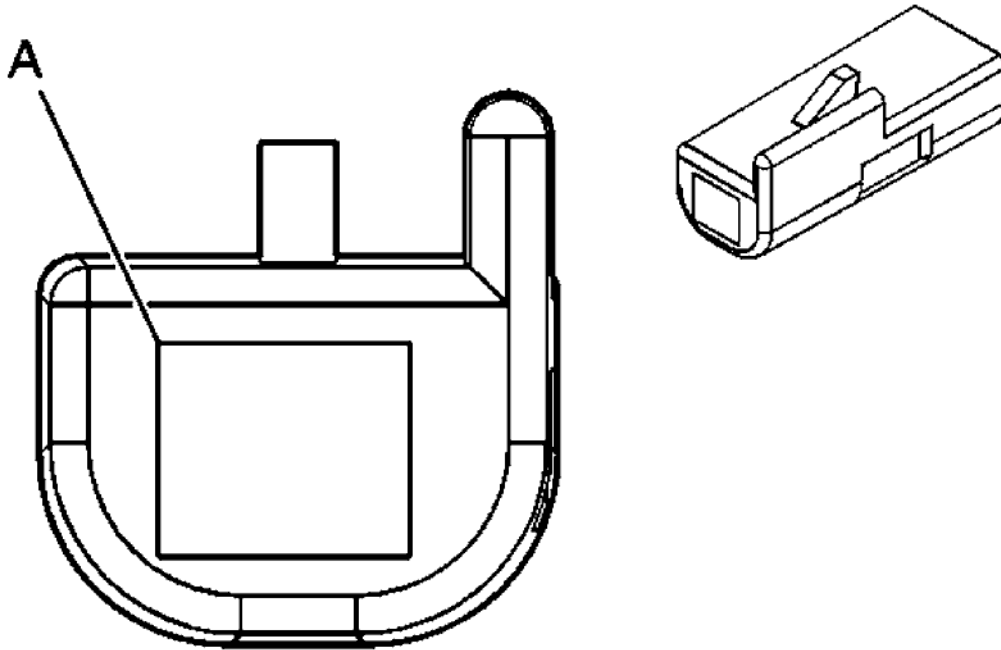


Fig. 5: Park Brake Switch Connector
Courtesy of GENERAL MOTORS CORP.

Hydraulic Brakes Connector End Views

Connector Part Information

- OEM: 12047682
- Service: 12101850
- Description: 1-Way F M/P 150 (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Park Brake Switch

Pin	Wire Color	Circuit No.	Function
A	L-BU	1134	Park Brake Switch Signal

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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.

SCAN TOOL DATA LIST

Instrument Panel Cluster (IPC)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition ON, engine OFF, brake fluid level normal, and park brake released			
Brake Fluid Switch	Data	OK/Low	OK
Park Brake Switch	Inputs	On/Off	Off

SCAN TOOL DATA DEFINITIONS

Brake Fluid Switch

The scan tool displays OK or Low. The status of the brake fluid level sensor signal.

Park Brake Switch

The scan displays Off or On. The status of the park brake switch signal.

DTC C0267

DTC Descriptor

DTC C0267

Low Brake Fluid Indicated

Diagnostic Fault Information

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

DTC C0267

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

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 indicator and sends a serial data message to the electronic brake control module (EBCM) that tells the 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).
- 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 and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Brake Warning System Schematics

Connector End View Reference

ABS Connector End Views

Electrical Information Reference

- Circuit Testing

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

Scan Tool Reference

Scan Tool Data List for EBCM

Circuit/System Verification

Inspect the master cylinder reservoir for the proper brake fluid level.

If brake fluid level is low, refer to **Brake Fluid Loss** Diagnostic Information and Procedures.

Circuit/System Testing

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

1. With the ignition OFF, disconnect the brake fluid level switch connector.
2. With the ignition ON, use a scan tool to observe the Brake Fluid Switch parameter in Instrument Panel Cluster.
 - If the Brake Fluid Switch parameter is OK, replace the brake fluid level switch.
 - If the Brake Fluid Switch parameter is Low, repair short to ground in signal circuit.
3. If all circuits test normal replace the IPC.

Repair Instructions

IMPORTANT: Always perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- Master Cylinder Fluid Level Sensor Replacement
- Control Module References for EBCM

Repair Verification

Diagnostic Repair Verification

SYMPTOMS - HYDRAULIC BRAKES

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

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1. Perform the Brake System Vehicle Road Test before using the hydraulic brake symptom tables in order to duplicate the customer 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
 - Disc Brake System Description and Operation

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- Brake Warning Indicator Always On
- Brake Warning Indicator Inoperative
- Brake Pulsation
- Braking Action Uneven - Pulls to One Side
- Braking Action Uneven - Front to Rear
- Brake Pedal Excessive Travel
- Brake Pedal Excessive Effort
- Brake System Slow Release
- Brake Fluid Loss

BRAKE WARNING INDICATOR ALWAYS ON

Diagnostic Fault Information

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to

using this diagnostic procedure.**Circuit/System Description**

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

Reference Information**Schematic Reference****Brake Warning System Schematics****Connector End View Reference****Computer/Integrating Systems 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****Circuit/System Testing**

1. With the scan tool, select instrument panel special functions Lamp Test. Command the instrument panel lamps OFF. Verify brake lamp turns OFF.
 - If the brake lamp does not turn OFF, replace the IPC.
2. Disconnect the park brake switch, with a scan tool observe park brake switch parameter. Verify parameter is reading ON.
 - If parameter is OFF, replace the park brake switch
3. Test the signal circuit of the park brake switch for a short to ground. Verify no short is found.
 - If short is found repair circuit.
4. Replace the BCM.

Repair Instructions

IMPORTANT: Always perform the Diagnostic Repair Verification after

completing the diagnostic procedure.

- **Park Brake Warning Lamp Switch Replacement**
- **Control Module References** for IPC replacement, setup, and programming

BRAKE WARNING INDICATOR INOPERATIVE**Diagnostic Fault Information**

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit/System Description

The body control module sees the park brake switch and brake fluid level switch input to grounded and illuminates the red brake 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 indicator.

Reference Information**Schematic Reference****Brake Warning System Schematics****Connector End View Reference****Computer/Integrating Systems 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****Circuit/System Testing**

1. With the scan tool, select instrument panel special functions Lamp Test. Command the instrument panel lamps ON. Verify brake lamp turns ON.
 - If the brake lamp does not turn ON, replace the IPC.
2. Release the park brake. Disconnect the brake fluid level switch. Connect a 3-amp

jumper wire between the signal circuit of the brake fluid level switch and the ground circuit of the brake fluid level switch. Ignition ON, verify brake lamp is ON.

- If the brake lamp does not turn ON, test the signal circuit and ground circuit for a high resistance/open or replace the brake fluid level switch.
- 3. Disconnect the park brake switch. Connect a 3-amp jumper wire between signal circuit of the park brake switch and ground. Ignition ON, verify brake lamp is ON.
 - If the brake lamp does not turn ON, test the signal circuit high resistance/open or replace the BCM.
- 4. Replace the park brake switch.

Repair Instructions

IMPORTANT: Always 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

Test Description

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

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

3: Antilock brake system operation could produce feedback through the brake pedal during application of the brake system.

Brake Pulsation

Step	Action	Yes	No
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	Inspect the suspension system for proper operation. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> in Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 3
	Inspect the antilock brake system, if		

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3	equipped, for proper operation. Refer to <u>Diagnostic Starting Point - Antilock Brake System</u> in Antilock Brake System. Did you find and correct a condition?	Go to Step 7	Go to Step 4
4	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 7	Go to Step 5
5	Inspect the drum brake system for proper operation. Refer to <u>Drum Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 7	Go to Step 6
6	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 7	Go to Diagnostic Starting Point - Hydraulic Brakes
7	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
1	Were you sent here from the Hydraulic Brake Symptom Table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 7	Go to Step 3
3	Inspect the drum brake system for proper operation. Refer to <u>Drum Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 7	Go to Step 4
4	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System Diagnosis</u> . Did you find and correct a condition?	Go to Step 7	Go to Step 5

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5	Inspect the hydraulic brake system for proper operation. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 7	Go to Step 6
6	Inspect the park brake system for proper operation. Refer to Park Brake System Diagnosis in Park Brake. Did you find and correct a condition?	Go to Step 7	Go to Diagnostic Starting Point - Hydraulic Brakes
7	Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test . Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - PULLS TO ONE SIDE**Test Description**

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

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

3: 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
1	Were you sent here from the Hydraulic Brake Symptom Table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the suspension system for proper operation. Refer to Diagnostic Starting Point - Suspension General Diagnosis in Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 3
3	Inspect the steering system for proper operation. Refer to Diagnostic Starting Point - Power Steering System in Power Steering System. Did you find and correct a condition?	Go to Step 7	Go to Step 4
4	Inspect the hydraulic brake system for proper operation. Refer to Hydraulic Brake		

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	System Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 5
5	Inspect the disc brake system for proper operation. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 6
6	Inspect the drum brake system for proper operation. Refer to Drum Brake System Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Diagnostic Starting Point - Hydraulic Brakes
7	Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - FRONT TO REAR**Test Description**

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

2: 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
1	Were you sent here from the Hydraulic Brake Symptom Table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the suspension system for proper operation. Refer to Diagnostic Starting Point - Suspension General Diagnosis in Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 3
3	Inspect the hydraulic brake system for proper operation. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 4
4	Inspect the disc brake system for proper operation. Refer to Disc Brake System		

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	Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 5
5	Inspect the drum brake system for proper operation. Refer to Drum Brake System Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 6
6	Inspect the brake assist system for proper operation. Refer to Brake Assist System Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Diagnostic Starting Point - Hydraulic Brakes
7	Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE TRAVEL**Brake Pedal Excessive Travel**

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom Table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect for proper brake pedal travel. Refer to Brake Pedal Travel Measurement and Inspection. Is the brake pedal travel distance within the acceptable level?	Go to Step 5	Go to Step 3
3	- Inspect for worn, missing or damaged brake pedal system components. - Replace the brake pedal system components that are worn, missing or damaged, refer to the following as necessary. Brake Pedal Assembly Replacement Vacuum Brake Booster Replacement (for pedal pushrod replacement)		

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	Did you find and replace any worn, missing or damaged brake pedal system components?	Go to Step 4	Go to Step 5
4	Reinspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u> . Is the brake pedal travel distance within the acceptable level?	Go to Step 9	Go to Step 5
5	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Step 6
6	Inspect the drum brake system for proper operation. Refer to <u>Drum Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Step 7
7	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Step 8
8	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Diagnostic Starting Point - Hydraulic Brakes
9	Road test the vehicle 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 PEDAL EXCESSIVE EFFORT

Brake Pedal Excessive Effort

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 3
	Inspect the hydraulic brake system for		

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3	proper operation. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	Inspect the disc brake system for proper operation. Refer to Disc Brake System Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	Inspect the drum brake system, if equipped, for proper operation. Refer to Drum Brake System Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Diagnostic Starting Point - Hydraulic Brakes
6	Road test the vehicle to confirm proper operation. Refer to Brake System Vehicle Road Test . Is the condition still present?	Go to Step 2	System OK

BRAKES DRAG

Brakes Drag

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. Refer to Stop Lamp Switch Adjustment in Lighting Systems. 2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing. Refer to Cruise Release Switch Adjustment in Cruise Control. Did you find and correct a condition?	Go to Step 11	Go to Step 3
3	Inspect the drum brake system, if equipped, for proper operation. Refer to Drum Brake System Diagnosis . Did you find and correct a condition?	Go to Step 11	Go to Step 4

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4	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> in Park Brake. Did you find and correct a condition?	Go to Step 11	Go to Step 5
5	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 11	Go to Step 6
6	1. Separate the brake booster pushrod from the brake pedal. Refer to <u>Brake Pedal Assembly Replacement</u> . 2. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to Step 8	Go to Step 7
7	Replace the brake pedal assembly. Refer to <u>Brake Pedal Assembly Replacement</u> . Did you complete the replacement?	Go to Step 11	-
8	1. Separate the master cylinder from the brake booster. Do not disconnect any brake pipes. Refer to <u>Master Cylinder Replacement</u> . 2. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to Step 10	Go to Step 9
9	Replace the brake booster assembly. Refer to <u>Vacuum Brake Booster Replacement</u> . Did you complete the replacement?	Go to Step 11	-
10	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 11	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	1. Install or connect components that were removed or disconnected during diagnosis.		

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11	2. Road test the vehicle 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 SLOW RELEASE**Brake System Slow Release**

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom Table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis.</u> Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System Diagnosis.</u> Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	Inspect the drum brake system for proper operation. Refer to <u>Drum Brake System Diagnosis.</u> Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis.</u> Did you find and correct a condition?	Go to Step 6	Go to Diagnostic Starting Point - Hydraulic Brakes
6	Road test the vehicle 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 FLUID LOSS**Brake Fluid Loss**

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?		Go to Diagnostic Starting Point - Hydraulic

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		Go to Step 2	Brakes
2	Inspect the hydraulic brake system for proper operation. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 7	Go to Step 3
3	Inspect the disc brake system for proper operation. Refer to Disc Brake System Diagnosis . Did you find and correct a condition?	Go to Step 7	Go to Step 4
4	Inspect the drum brake system, if equipped, for proper operation. Refer to Drum Brake System Diagnosis . Did you find and correct a condition?	Go to Step 7	Go to Step 5
5	1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Refer to Master Cylinder Replacement. 2. Inspect the rear of the master cylinder for a brake fluid leak. 3. Inspect for brake fluid in the vacuum brake booster. Did you find a brake fluid leak?	Go to Step 6	Go to Diagnostic Starting Point - Hydraulic Brakes
6	Replace the brake master cylinder and the vacuum brake booster. Refer to Master Cylinder Replacement and Vacuum Brake Booster Replacement . Did you complete the replacement?	Go to Step 7	-
7	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	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.

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

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

20: 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
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Visually inspect the disc brake pads for the following conditions: Refer to <u>Brake Pad Inspection</u> in Disc Brakes. • 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 Did you find any conditions to indicate a concern with any of the disc brake pads?	Go to Step 3	Go to Step 12
3	Are any of the disc brake pads contaminated?	Go to Step 8	Go to Step 4

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4	Are any of the disc brake pads worn unevenly?	Go to Step 7	Go to Step 5
5	Are any of the disc brake pads and/or pad hardware loose or damaged?	Go to Step 7	Go to Step 6
6	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>Brake Pads Replacement</u> in Disc Brakes. Did you complete the inspection and replacement?	Go to Step 12	-
7	NOTE: Support the brake caliper with heavy mechanic's 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. IMPORTANT: Do NOT disconnect the hydraulic brake flex hoses from the calipers. 1. Remove the disc brake calipers from the mounting brackets and support the calipers. Refer to <u>Brake Caliper Replacement</u> in Disc Brakes. 2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions: Refer to <u>Disc Brake Mounting and Hardware Inspection</u> in Disc Brakes. • Binding or seized hardware • Worn, damaged or missing hardware components • Loose, bent, cracked, or damaged caliper mounting bracket 3. Replace components as required. Refer		-

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	to the following procedures in Disc Brakes, as required: • <u>Brake Caliper Bracket Replacement</u> • <u>Disc Brake Hardware Replacement</u> 4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to <u>Brake Pads Replacement</u> in Disc Brakes. Did you complete the inspection and replacement?	Go to Step 12	
8	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: • <u>Brake Caliper Overhaul</u> or <u>Brake Caliper Replacement</u> in Disc Brakes • <u>Brake Hose Replacement - Front</u> • <u>Brake Pipe Replacement</u> Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	Go to Step 9
9	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>Wheel Drive Shaft Outer Joint and Seal Replacement</u> in Wheel Drive Shafts. Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	Go to Step 10
	1. Inspect the automatic transmission		

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10	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. Replace any components found to be leaking fluid which may be the source of the contamination to the pads. Did you find and correct the source of the leak causing contamination of the pads?		-
11	1. Clean the remaining disc brake system components to remove any traces of the contaminant. NOTE: Support the brake caliper with heavy mechanic's 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. IMPORTANT: Do NOT disconnect the hydraulic brake flex hoses from the calipers. 2. Remove the disc brake calipers from the mounting brackets and support the calipers. Refer to <u>Brake Caliper Replacement</u> in Disc Brakes. 3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions: Refer to <u>Disc Brake Mounting and Hardware Inspection</u> in Disc Brakes. • Binding or seized hardware • Distorted, worn, damaged or missing hardware components 4. Replace the caliper mounting/sliding hardware components as required.	Go to Step 11	-

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	Refer to <u>Disc Brake Hardware Replacement</u> in Disc Brakes. 5. Replace the contaminated disc brake pads as a complete axle set. Refer to <u>Brake Pads Replacement</u> in Disc Brakes. Did you complete the cleaning, inspection and replacement?	Go to Step 12	
12	1. Check the thickness of each of the disc brake rotors. IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to <u>Brake Rotor Thickness Measurement</u> in Disc Brakes. Does the disc brake rotor meet the minimum requirements for REFINISHING?	Go to Step 13	Go to Step 16
13	IMPORTANT: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. 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> in Disc Brakes. Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 15	Go to Step 14
	1. Inspect each of the disc brake rotors for the following surface and wear conditions: Refer to <u>Brake Rotor Surface and Wear Inspection</u> in Disc Brakes.		

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14	• Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires refinishing. Does the brake rotor require REFINISHING?	Go to Step 15	Go to Step 20
15	1. Refinish the brake rotor. Refer to Brake Rotor Refinishing in Disc Brakes. 2. Inspect the brake rotor thickness. Refer to Brake Rotor Thickness Measurement in Disc Brakes. Were you able to REFINISH the brake rotor within the minimum requirements?	Go to Step 20	Go to Step 19
16	Is the brake rotor at or below the DISCARD requirements?	Go to Step 19	Go to Step 17
17	IMPORTANT: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to Brake Rotor Thickness Variation Measurement in Disc Brakes. Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 19	Go to Step 18

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18	1. Inspect each of the disc brake rotors for the following surface and wear conditions: Refer to <u>Brake Rotor Surface and Wear Inspection</u> in Disc Brakes. • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires replacement. Does the brake rotor require REPLACEMENT?	Go to Step 19	Go to Step 20
19	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. Replace the brake rotor. Refer to <u>Brake Rotor Replacement</u> in Disc Brakes. Did you complete the replacement?	Go to Step 22	-
20	IMPORTANT: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. 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</u>		

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	(LRO) Measurement in Disc Brakes. Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level?	Go to Step 21	Go to Step 22
21	Correct the LRO for each brake rotor that was determined to have LRO exceeding the maximum acceptable level. Refer to Brake Rotor Assembled Lateral Runout (LRO) Correction in Disc Brakes. Did you complete the operation?	Go to Step 22	-
22	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Disc Brake System OK Return to Symptom Table	-

DRUM BRAKE SYSTEM DIAGNOSIS**Test Description**

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

18: Drum brake backing plates that come in contact with brake drums may cause brake system noise.

Drum Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DRUM brake system in order to determine if the DRUM brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	- Remove the brake drums. Refer to Brake Drum Replacement in Drum Brakes. - Inspect the drum brake shoes for the following conditions: - Lining thickness below specifications - Uneven and/or abnormal wear - edge-to-edge and/or side-to-side		

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	• Contamination from an external substance • Looseness, damage, glazing, or incorrect lining material Did you find any conditions to indicate a concern with any of the drum brake shoes?	Go to Step 3	Go to Step 7
3	Are any of the brake shoes contaminated?	Go to Step 4	Go to Step 5
4	1. Inspect the wheel cylinders for evidence of an external brake fluid leak. 2. Replace any wheel cylinder that is found to be leaking brake fluid. Refer to Wheel Cylinder Replacement in Drum Brakes. Did you complete the inspection and replacement?	Go to Step 6	-
5	1. Inspect the drum brake hardware for any components which are worn, damaged, discolored due to stress, broken or missing. Refer to Drum Brake Hardware Inspection in Drum Brakes. 2. Replace components as required. Refer to Drum Brake Hardware Replacement in Drum Brakes. 3. Replace the drum brake shoes. Refer to Brake Shoe Replacement in Drum Brakes. Did you complete the inspection and replacement?	Go to Step 8	-
	1. Clean the remaining drum brake system components to remove any traces of the contaminant. 2. Inspect the drum brake hardware for any components which are worn, damaged, discolored due to stress, broken or missing. Refer to Drum Brake Hardware Inspection in Drum Brakes.		

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6	3. Replace the drum brake hardware components as required. Refer to <u>Drum Brake Hardware Replacement</u> in Drum Brakes. 4. Replace the contaminated brake shoes. Refer to <u>Brake Shoe Replacement</u> in Drum Brakes. Did you complete the cleaning, inspection and replacement?	Go to Step 8	-
7	1. Inspect the drum brake hardware for any components which are worn, damaged, discolored due to stress, broken or missing. Refer to <u>Drum Brake Hardware Inspection</u> in Drum Brakes. 2. Replace components as required. Refer to <u>Drum Brake Hardware Replacement</u> in Drum Brakes. Did you complete the inspection and, if necessary, the replacement?	Go to Step 8	-
8	1. Check the diameter of each of the brake drums. IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH drum. 2. Make a determination for each brake drum if the drum can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to <u>Brake Drum Diameter Measurement</u> in Drum Brakes. Does the brake drum meet the minimum requirements for REFINISHING?	Go to Step 9	Go to Step 11
	1. Inspect each of the brake drums for the following surface and wear conditions: Refer to <u>Brake Drum Surface and</u>		

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9	<u>Wear Inspection</u> in Drum Brakes. • Braking Surface Conditions ■ Heavy rust and/or pitting ■ Cracks and/or heat spots ■ Excessive blueing discoloration ■ Missing balance weights • Braking Surface Wear Conditions ■ Deep or excessive scoring beyond maximum acceptable level ■ Radial runout beyond maximum acceptable level IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH drum. 2. Make a determination for each brake drum if the drum requires refinishing based upon the results of the inspection. If the brake drum exhibits any of the following conditions, it requires refinishing. • Drum exhibits one or more of the Braking Surface Conditions listed previously • Drum is beyond the acceptable level in one or more of the Braking Surface Wear Conditions listed previously Does the brake drum require REFINISHING?	Go to Step 10	Go to Step 14
10	1. Refinish the brake drum. Refer to <u>Brake Drum Refinishing</u> in Drum Brakes. 2. Inspect the brake drum diameter. Refer		

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	to Brake Drum Diameter Measurement in Drum Brakes.		
	Were you able to REFINISH the brake drum within the minimum requirements?	Go to Step 14	Go to Step 13
11	Is the brake drum at or below the DISCARD requirements?	Go to Step 13	Go to Step 12
12	1. Inspect each of the brake drums for the following surface and wear conditions: Refer to Brake Drum Surface and Wear Inspection in Drum Brakes. • Braking Surface Conditions ■ Heavy rust and/or pitting ■ Cracks and/or heat spots ■ Excessive blueing discoloration ■ Missing balance weights • Braking Surface Wear Conditions ■ Deep or excessive scoring beyond maximum acceptable level ■ Radial runout beyond maximum acceptable level IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH drum. 2. Make a determination for each brake drum if the drum requires replacement based upon the results of the inspection. If a brake drum exhibits any of the following conditions, it requires replacement. • Drum exhibits one or more of the Braking Surface Conditions listed previously		

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	• Drum is beyond the acceptable level in one or more of the Braking Surface Wear Conditions listed previously Does the brake drum require REPLACEMENT?	Go to Step 13	Go to Step 14
13	Replace the brake drum. Refer to <u>Brake Drum Replacement</u> in Drum Brakes. Did you complete the replacement?	Go to Step 14	-
14	Inspect the brake shoes for proper adjustment. Refer to <u>Drum Brake Adjustment</u> in Drum Brakes. Are the brake shoes adjusted properly?	Go to Step 18	Go to Step 15
15	Inspect the components of the brake drum adjustment hardware system for free movement and correct operation. Refer to <u>Drum Brake Adjusting Hardware Inspection</u> in Drum Brakes. Do the drum brake adjusting hardware components operate freely and correctly?	Go to Step 17	Go to Step 16
16	Replace the drum brake adjusting hardware components as necessary. Refer to <u>Drum Brake Adjusting Hardware Replacement</u> in Drum Brakes. Is the replacement complete?	Go to Step 17	-
17	Adjust the drum brake shoes. Refer to <u>Drum Brake Adjustment</u> in Drum Brakes. Were you able to complete the adjustment?	Go to Step 20	Return to Symptom Table
18	Inspect the drum brake backing plate for the following: • Excessive wear or rust • Damage and/or evidence of contact with the brake drum Does the drum brake backing plate exhibit any of these conditions?	Go to Step 19	Go to Step 20
19	Repair or replace the drum brake backing plate as necessary. Refer to <u>Drum Brake Backing Plate Replacement</u> in Drum Brakes.		-

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	Did you complete the repair or replacement?	Go to Step 20	
20	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Drum Brake System OK Return to Symptom Table	-

HYDRAULIC BRAKE SYSTEM DIAGNOSIS**Hydraulic Brake System Diagnosis**

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the HYDRAULIC brake system in order to determine if the HYDRAULIC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect and adjust the brake fluid level in the brake master cylinder. Refer to Master Cylinder Reservoir Filling . Was the brake fluid level low?	Go to Step 3	Go to Step 4
3	- Inspect the brake fluid for the following conditions, indicating brake fluid contamination: - Fluid separation, indicating two types of fluid are present - Swirled appearance - oil-based substance - Layered appearance - silicone-based substance - Fluid discoloration - Cloudy appearance - moisture - Dark appearance/ suspended particles in fluid - dirt, rust, corrosion, brake dust - Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling,		

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	indicating fluid contamination.		
	Do any of the above conditions exist?	Go to Step 5	Go to Step 6
4	- Inspect the brake fluid for the following conditions, indicating brake fluid contamination: - Fluid separation, indicating two types of fluid are present - Swirled appearance - oil-based substance - Layered appearance - silicone-based substance - Fluid discoloration - Cloudy appearance - moisture - Dark appearance/ suspended particles in fluid - dirt, rust, corrosion, brake dust - Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination.		
	Do any of the above conditions exist?	Go to Step 5	Go to Step 12
	- Flush the hydraulic brake system. Refer to Hydraulic Brake System Flushing. - 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. - Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. - Clean out 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. Each component contains internal rubber seals/linings which have been contaminated.

- Replace the brake master cylinder reservoir cap diaphragm.
- **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.
- **Brake Hose Replacement - Front**
- **Brake Hose Replacement - Rear (Disc Brakes)**
- **Brake Caliper Overhaul or Brake Caliper Replacement** in Disc Brakes
- **Wheel Cylinder Replacement** , if equipped, in Drum Brakes
- **Proportioning Valve Replacement** , if equipped
- **Brake Pressure Modulator Valve (BPMV) Replacement** , if equipped, in Antilock Brake System

3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated with water or

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	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. 4. Refill and bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Pressure)</u> or <u>Hydraulic Brake System Bleeding (Manual)</u>. Did you complete the operation and any required repairs and/or replacements?	Go to Step 9	
6	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: • Brake master cylinder reservoir cap diaphragm • <u>Master Cylinder Replacement</u> • <u>Brake Hose Replacement - Front</u> • <u>Brake Hose Replacement - Rear (Disc Brakes)</u> • <u>Brake Pipe Replacement</u> • <u>Brake Caliper Overhaul</u> or <u>Brake Caliper Replacement</u> in Disc Brakes • <u>Wheel Cylinder Replacement</u> , if equipped, in Drum Brakes • <u>Proportioning Valve Replacement</u> , if equipped • <u>Brake Pressure Modulator Valve (BPMV) Replacement</u> if equipped, in Antilock Brake System 2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding</u>		

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	(Pressure) or Hydraulic Brake System Bleeding (Manual). While bleeding the hydraulic brake system, observe for the following conditions: • The presence of air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder, and/or the proportioning valve assembly, 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, and/or the proportioning valve assembly, 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 and/or wheel cylinders, if equipped for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection. Was the hydraulic function of the brake calipers/wheel cylinders 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/wheel cylinders for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection. Was the hydraulic function of the brake calipers/wheel cylinders operating properly?	Go to Step 15	Go to Step 13
	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating		

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13	properly: 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> in General Information. 2. Remove the tire and wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> in Tires and Wheels. 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. Was the flow of brake fluid unrestricted and did the caliper piston move freely?	Go to Step 17	Go to Step 14
14	Repair or replace any brake caliper/wheel cylinder that was not operating properly. Refer to the appropriate procedure. • <u>Brake Caliper Overhaul</u> or <u>Brake Caliper Replacement</u> in Disc Brakes • <u>Wheel Cylinder Replacement</u> , if equipped, in Drum Brakes Did you complete the repair and/or replacement?	Go to Step 21	-
15	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 (Pressure)</u> or <u>Hydraulic Brake System Bleeding (Manual)</u>. 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
	1. Inspect the hydraulic brake pipes and		

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17	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: • <u>Brake Hose Replacement - Front</u> • <u>Brake Hose Replacement - Rear (Disc Brakes)</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	• If equipped with non-ABS, replace the proportioning valve assembly. Refer to <u>Proportioning Valve Replacement</u>. • If equipped with ABS, replace the brake modulator assembly, in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to <u>Brake Pressure Modulator Valve (BPMV) Replacement</u> in Antilock Brake System.		-
	Did you complete the replacement?	Go to Step 21	
19	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. 3. Repair or replace any of the components		

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	found to be installed incorrectly or seeping brake fluid.		
	Did you find and correct a condition?	Go to Step 21	Go to Step 20
20	1. Inspect the brake master cylinder for internal fluid leaks. Refer to <u>Brake System Internal Leak Test</u>. 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>.		
	Did you find and correct a condition?	Go to Step 21	Return to Symptom Table
21	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Hydraulic Brake System OK Return to Symptom Table	-

BRAKE ASSIST SYSTEM DIAGNOSIS

Brake Assist System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the brake ASSIST system in order to determine if the brake ASSIST system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u> . Is the brake pedal travel distance within the acceptable limits?	Go to Step 5	Go to Step 3
	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. • For the brake pedal pushrod component inspection, refer to		

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3	<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. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Refer to the following procedures as necessary. <u>Brake Pedal Assembly Replacement</u> <u>Vacuum Brake Booster Replacement</u> - for a bent or damaged pedal pushrod replacement Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 4	Go to Step 5
4	Reinspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>. Is the brake pedal travel distance within the acceptable limits?	Go to Step 8	Go to Step 5
5	Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to <u>Brake System Vacuum Source Test (STS)</u>. Is the vacuum reading within the acceptable limits?	Go to Step 6	Go to Diagnostic Starting Point - Engine Mechanical in Engine Mechanical - 2.2L
6	During the vacuum source inspection, did the vacuum booster check valve operate properly?	Go to Step 8	Go to Step 7
7	Replace the vacuum booster check valve. Refer to <u>Vacuum Brake Booster Check Valve and/or Hose Replacement (L61 (2.2L))</u> or <u>Vacuum Brake Booster Check Valve and/or Hose Replacement (LE5</u>		-

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	(2.4L)). Did you complete the replacement?	Go to Step 8	
8	1. Pump the brake pedal several times until the brake pedal becomes hard. 2. Maintain moderate foot pressure on the brake pedal and start the engine. Observe pedal operation. Did the brake pedal drop slightly, then remain firm after the engine was started?	Go to Step 9	Go to Step 12
9	1. Release the brake pedal. 2. Turn the ignition OFF, then wait 15 seconds. 3. Pump the brake pedal two times to check for vacuum booster available vacuum reserve. Observe pedal effort. If operating properly, the vacuum brake booster should maintain assist for at least two pedal applications. Did the brake pedal effort increase significantly?	Go to Step 12	Go to Step 10
10	Inspect the brake pedal pushrod and the brake pedal for misalignment, a bent condition and/or damage. Is the brake pedal pushrod and/or the brake pedal misaligned, bent or damaged?	Go to Step 11	Go to Step 13
11	Replace the brake pedal pushrod and/or the brake pedal, as necessary. Refer to the following procedures: • Brake Pedal Assembly Replacement • Vacuum Brake Booster Replacement - for a bent or damaged pedal pushrod replacement Did you complete the replacement?	Go to Step 13	-
12	Replace the vacuum brake booster. Refer to Vacuum Brake Booster Replacement . Did you complete the replacement?	Go to Step 13	-

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13	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Brake Assist System OK Return to Symptom Table	-
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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, or equivalent. See **Special Tools**.

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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** , or equivalent, to the brake pedal. See **Special Tools**.

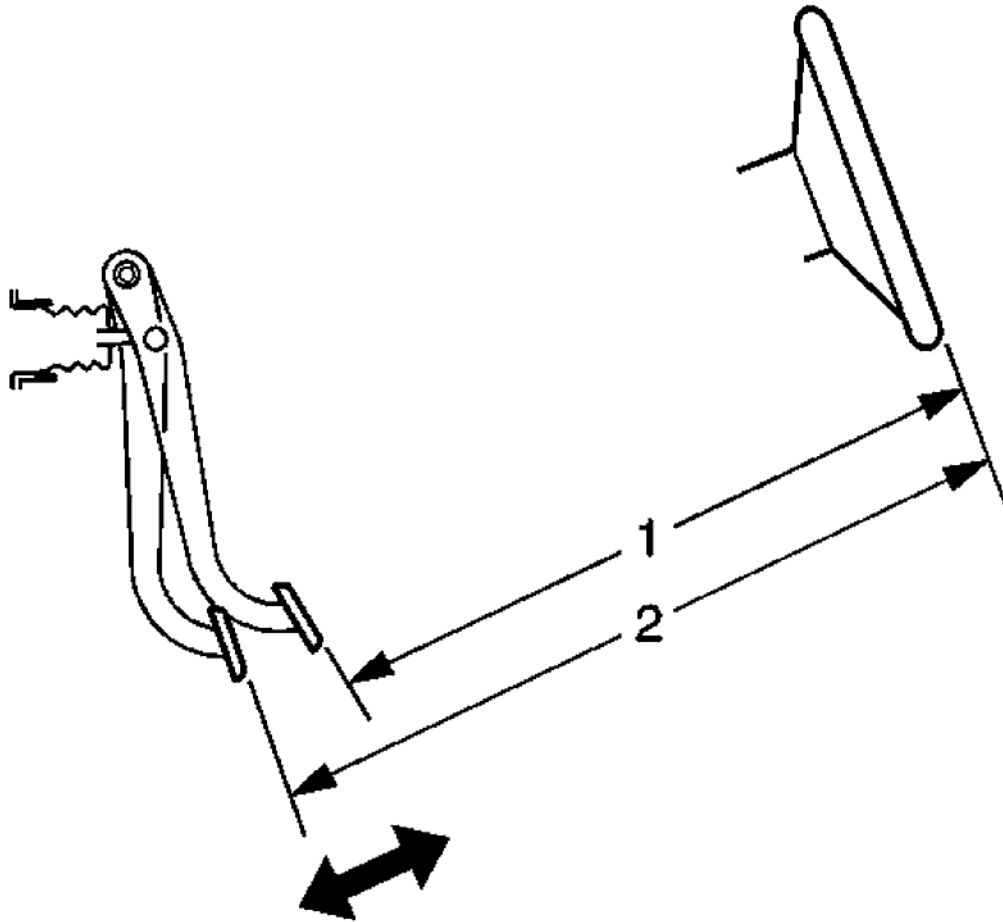


Fig. 6: Measuring Brake Pedal Travel
Courtesy of GENERAL MOTORS CORP.

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** , or equivalent. 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: Maximum brake pedal travel - measured with the ignition OFF, brake booster power assist depleted, and the brakes cool: 38.1 mm (1.50 in).

BRAKE SYSTEM VACUUM SOURCE TEST (STS)

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. 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.
 - Tight 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 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:
 - Firm 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 in Cautions and Notices.

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

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

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- 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 in Cautions and Notices.

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

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 (Pressure)Hydraulic Brake System Bleeding (Manual) .

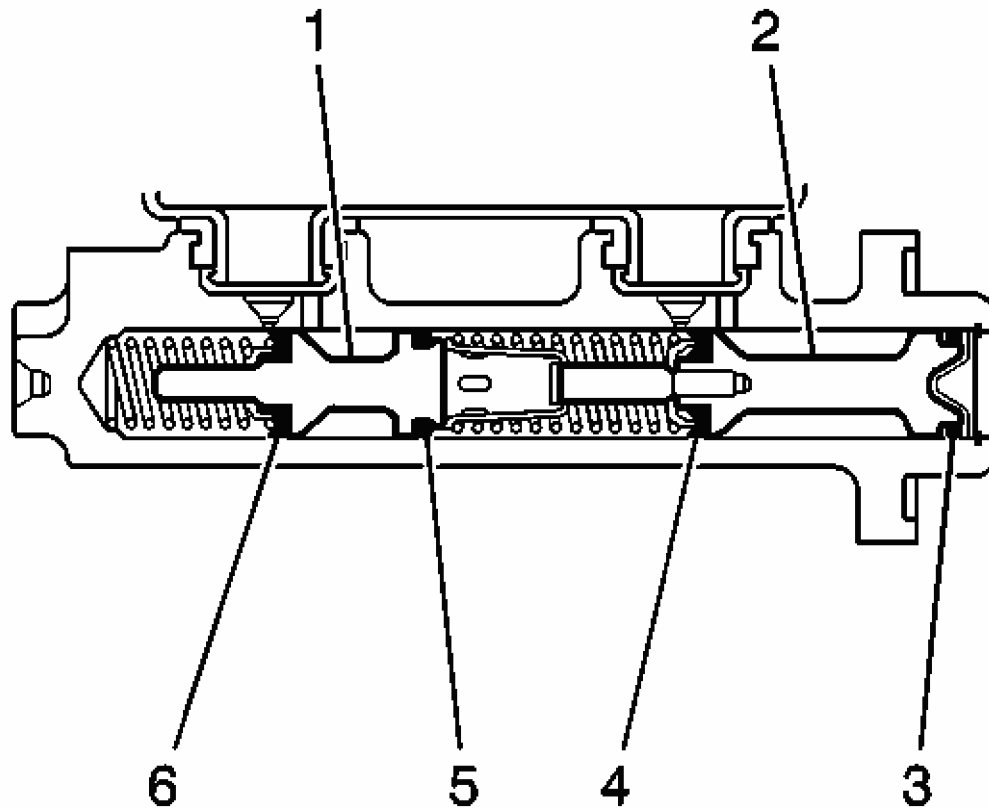


Fig. 7: Cross Sectional View Of Brake Master Cylinder
Courtesy of GENERAL MOTORS CORP.

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 (Pressure)** or **Hydraulic Brake System Bleeding (Manual)**.

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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

Disc Brake

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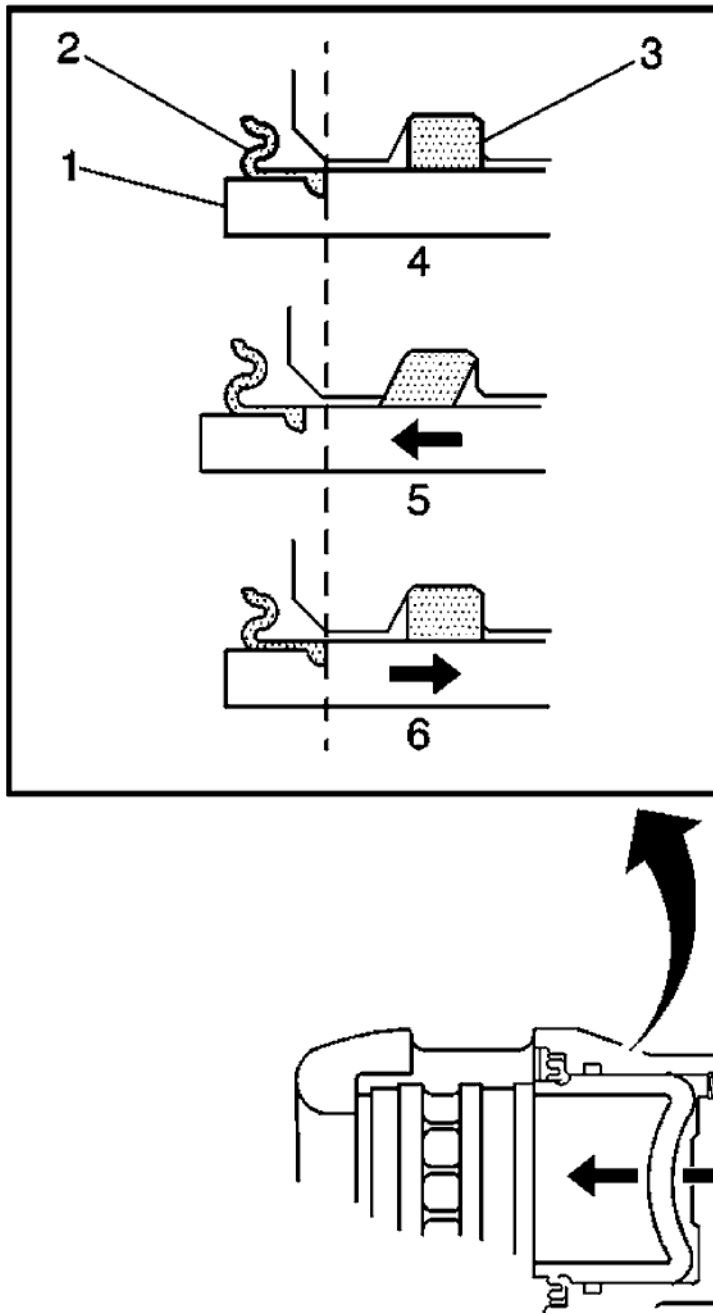


Fig. 8: Identifying Brake Caliper/Pad Inspection Areas
Courtesy of GENERAL MOTORS CORP.

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

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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.

Drum Brake

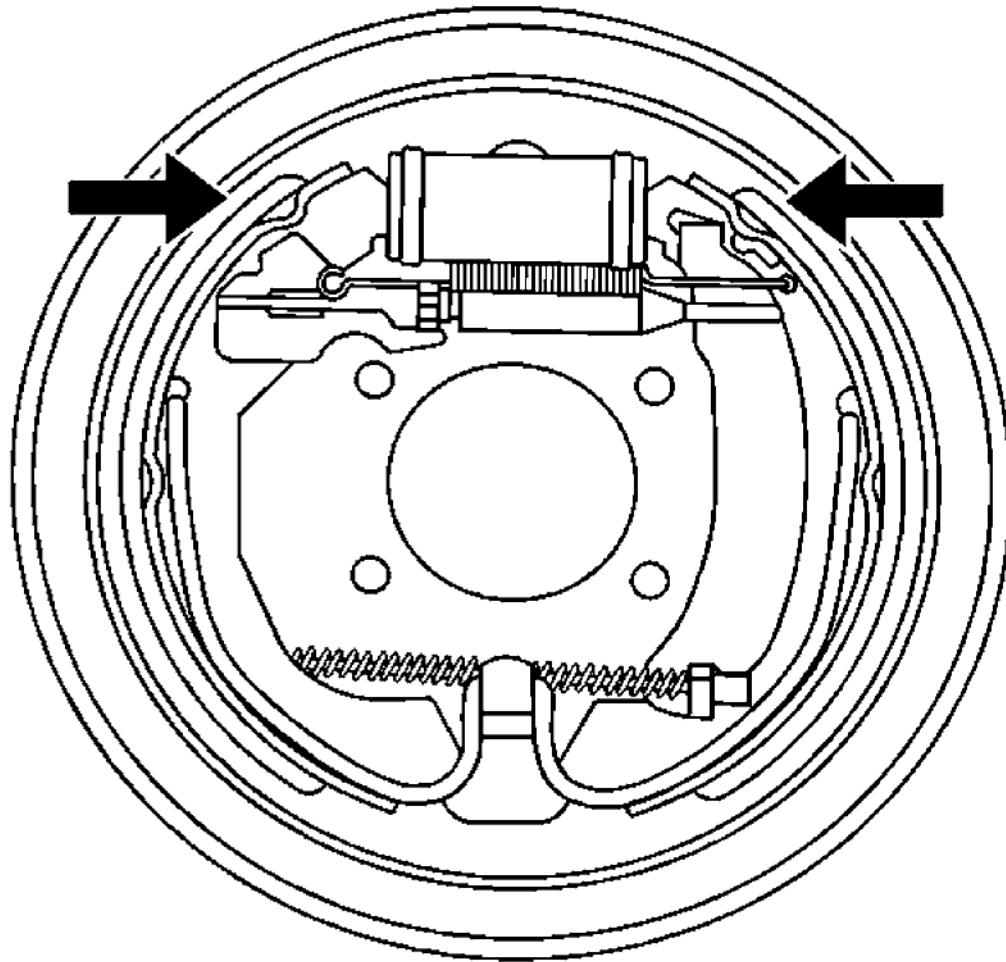


Fig. 9: Identifying Drum Brake
Courtesy of GENERAL MOTORS CORP.

1. With the rear tire and wheel assemblies and the brake drums removed, visually inspect the wheel cylinder pistons boot sealing areas to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake wheel cylinder requires replacement.
3. Using firm hand pressure, simultaneously and evenly apply force on both brake shoes in order to compress the wheel cylinder pistons into their bore.
4. Evenly release the force from both brake shoes to allow the wheel cylinder pistons to return.
5. If one or both of the wheel cylinder pistons did not exhibit unrestricted and even movement during apply and/or release of force, the wheel cylinder may require

replacement.

BRAKE PIPE AND HOSE INSPECTION

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

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.

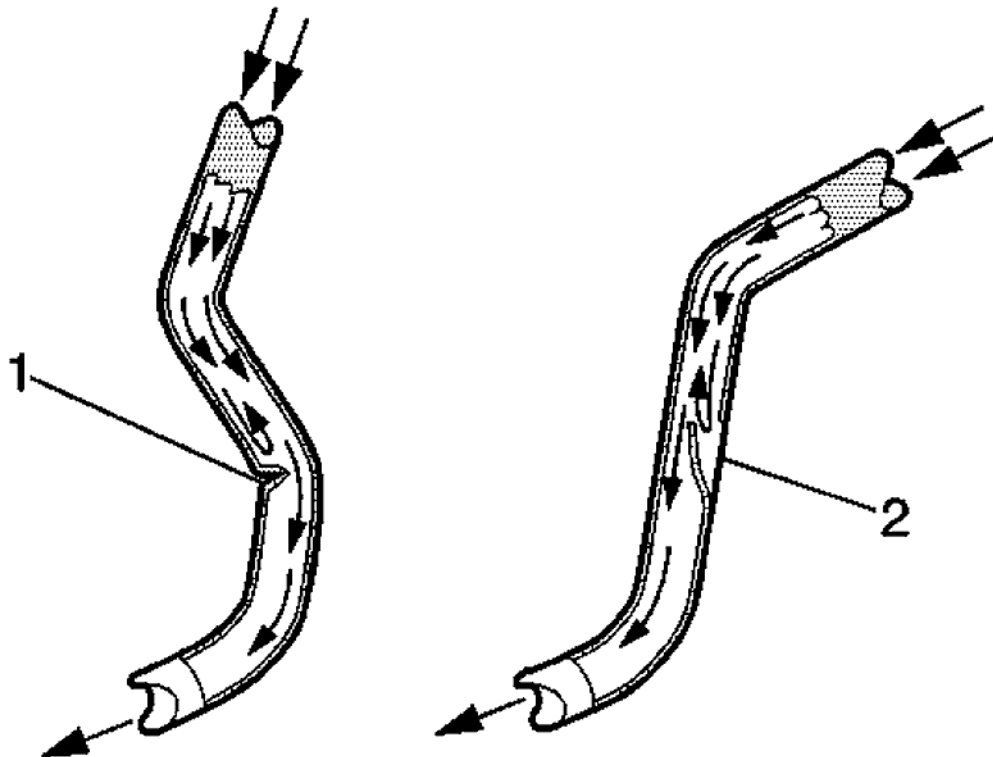


Fig. 10: Identifying Flexible Brake Hose Failure Conditions
Courtesy of GENERAL MOTORS CORP.

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.

BRAKE PEDAL PUSHROD INSPECTION

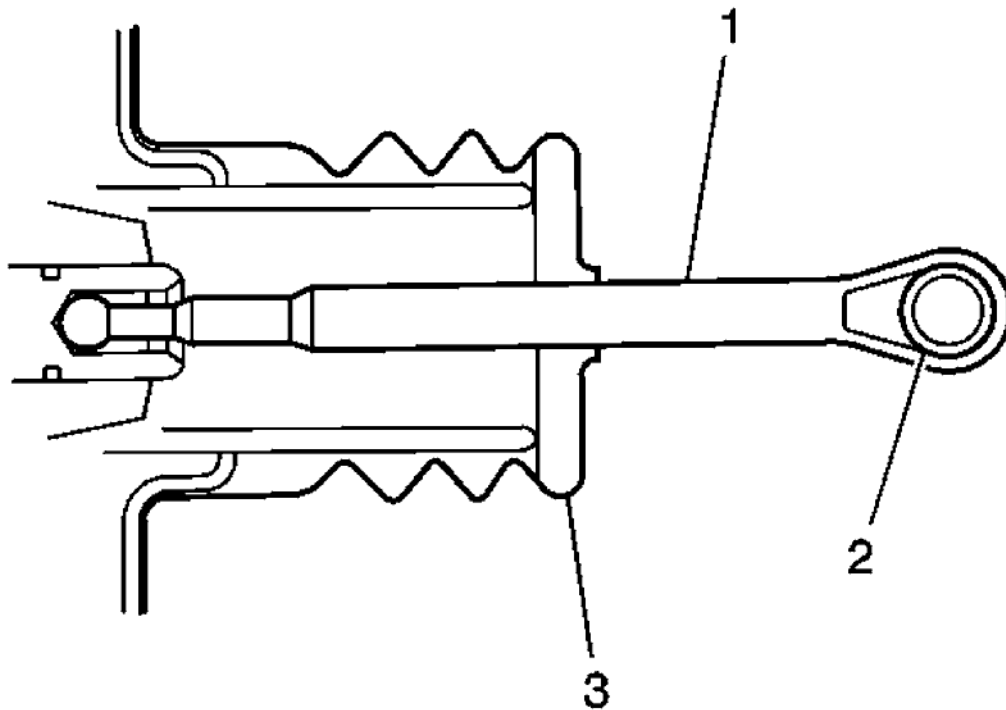


Fig. 11: View of Brake Pedal Pushrod
Courtesy of GENERAL MOTORS CORP.

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 in Cautions and Notices.

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 in Cautions and Notices.

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

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DOT-3 brake fluid from a clean, sealed brake fluid container.

MASTER CYLINDER RESERVOIR REPLACEMENT (GETRAG 5 SPEED)

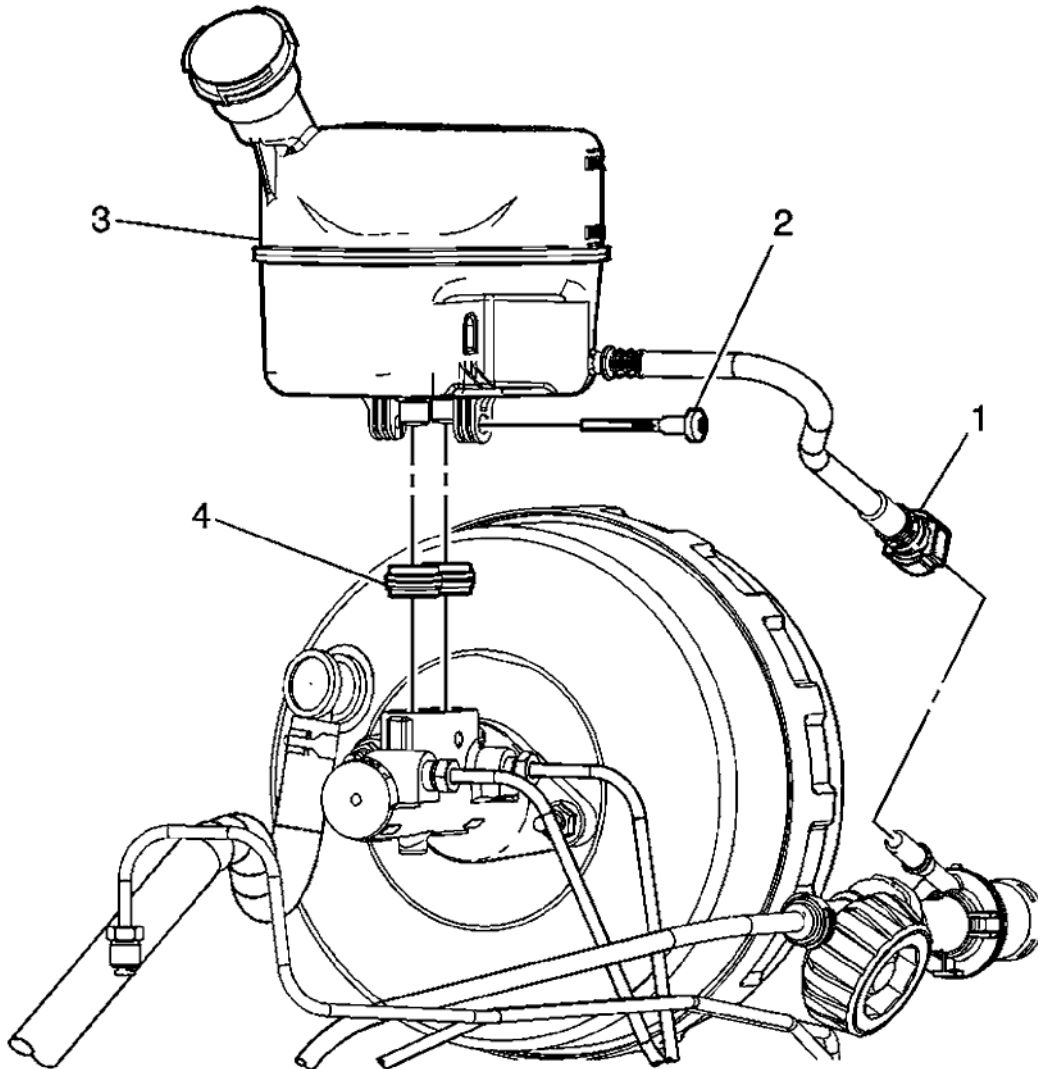


Fig. 12: Master Cylinder Reservoir Replacement (Getrag 5 Speed)
Courtesy of GENERAL MOTORS CORP.

Master Cylinder Reservoir Replacement (Getrag 5 Speed)

Callout	Component Name
CAUTION: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Notice</u> .	
CAUTION:	

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Refer to Brake Fluid Irritant Caution .

NOTE:

Refer to Fastener Notice .

Fastener Tightening Specifications: Refer to **Fastener Tightening Specifications**. **Preliminary Procedure:** Remove the master cylinder reservoir. Refer to **Master Cylinder Reservoir Replacement (Getrag 5 Speed)** or **Master Cylinder Reservoir Replacement (4T45-E Automatic)**.

1	Fitting, Clutch Master Cylinder Quick Disconnect
2	Bolt, Master Cylinder Reservoir Tighten: 6 N.m (53 lb in)
3	Reservoir, Master Cylinder Tip: • Cap or plug the master cylinder so as not to allow the brake system to become contaminated. Leave the cap on the reservoir until the reservoir is to be emptied. • Check the cap for any damage. If the on the cap is damaged, replace the cap.
4	Seal, Brake Master Cylinder (Qty: 2) Tip: • Replace the seals, DO NOT reuse them. Apply a small amount of clean GM or equivalent DOT 3 brake fluid to the seal before installing them. • Bleed the master cylinder. Refer to Hydraulic Brake System Bleeding (Pressure) or Hydraulic Brake System Bleeding (Manual).

MASTER CYLINDER RESERVOIR REPLACEMENT (4T45-E AUTOMATIC)

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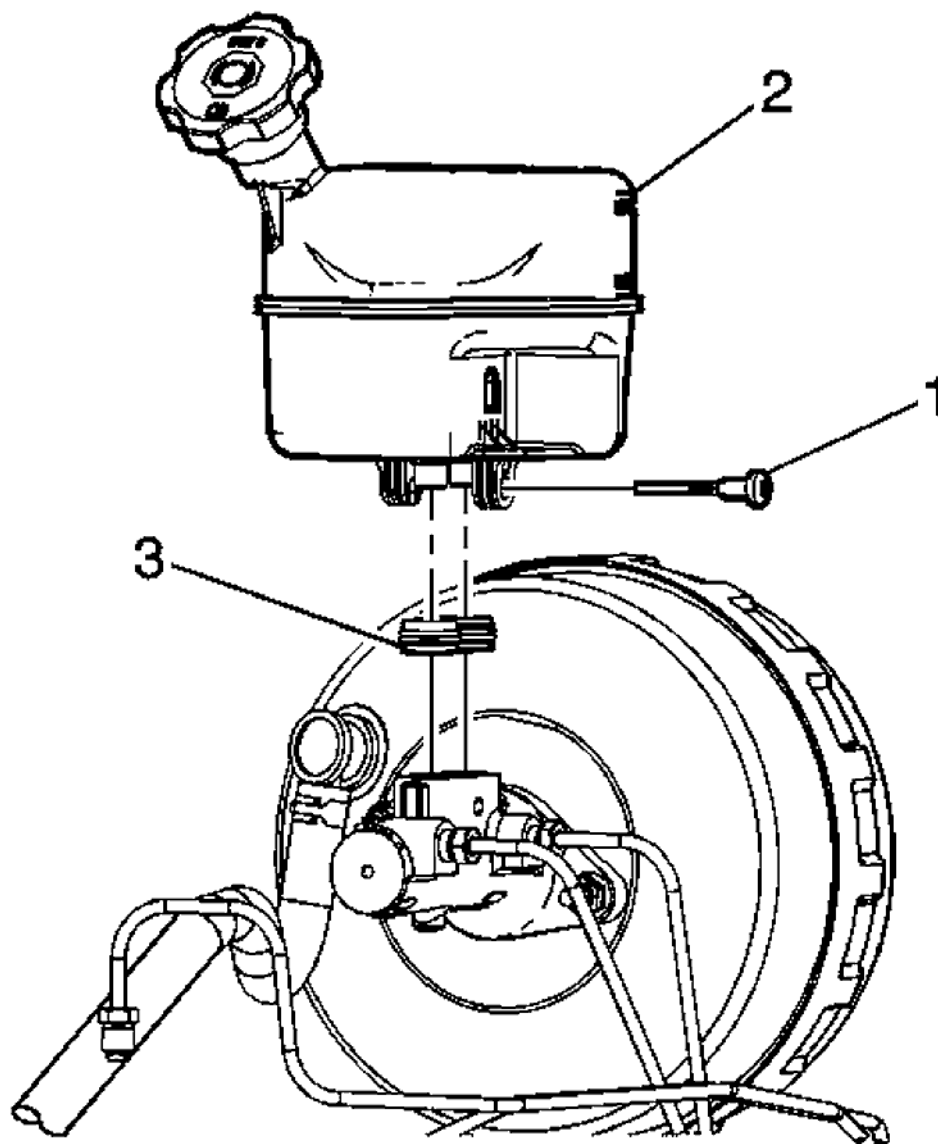


Fig. 13: Master Cylinder Reservoir Replacement (4T45-E Automatic)
Courtesy of GENERAL MOTORS CORP.

Master Cylinder Reservoir Replacement (4T45-E Automatic)

Callout	Component Name
CAUTION: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Notice</u> .	

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CAUTION:

Refer to Brake Fluid Irritant Caution .

NOTE:

Refer to Fastener Notice .

Fastener Tightening Specifications: Refer to Fastener Tightening

Specifications. **Preliminary Procedure:** Remove the master cylinder reservoir. Refer to Master Cylinder Reservoir Replacement (Getrag 5 Speed) or Master Cylinder Reservoir Replacement (4T45-E Automatic).

1	Bolt, Brake Master Cylinder Reservoir Tighten: 6 N.m (53 lb in)
2	Reservoir, Brake Master Cylinder Tip: • Cap or plug the master cylinder so as not to allow the brake system to become contaminated. Leave the cap on the reservoir until the reservoir is to be emptied. • Check the cap for any damage. If the on the cap is damaged, replace the cap.
3	Seal, Brake Master Cylinder (Qty: 2) Tip: • Replace the seals, DO NOT reuse them. Apply a small amount of clean GM or equivalent DOT 3 brake fluid to the seal before installing them. • Bleed the master cylinder. Refer to <u>Hydraulic Brake System Bleeding (Pressure)</u> or <u>Hydraulic Brake System Bleeding (Manual)</u>.

MASTER CYLINDER REPLACEMENT

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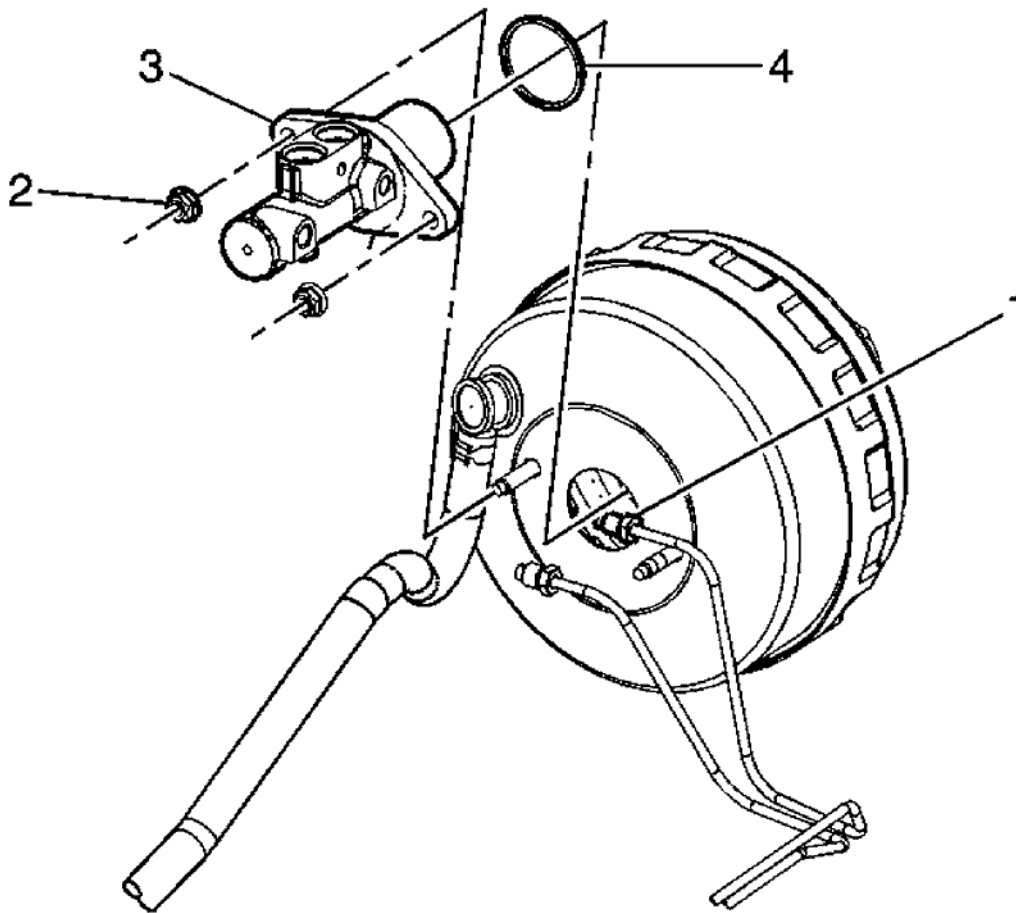


Fig. 14: Master Cylinder Replacement
Courtesy of GENERAL MOTORS CORP.

Master Cylinder Replacement

Callout	Component Name
CAUTION: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Notice</u> . CAUTION: Refer to <u>Brake Fluid Irritant Caution</u> . NOTE: Refer to <u>Fastener Notice</u> .	

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Fastener Tightening Specifications: Refer to **Fastener Tightening Specifications.Preliminary Procedure:** Remove the master cylinder reservoir. Refer to **Master Cylinder Reservoir Replacement (Getrag 5 Speed)** or **Master Cylinder Reservoir Replacement (4T45-E Automatic)**.

1	Fittings, Brake Pipe (Qty: 2) Tip: • Cap or plug the brake pipes so as not to allow the brake system to become contaminated. • After positioning the master cylinder on the mounting studs, finger tighten the brake pipe fittings. Tighten: 21 N.m (14 lb ft)
2	Nut, Master Cylinder Tighten: 22 N.m (15 lb ft)
3	Cylinder, Master Tip: • If removing the master cylinder to service the brake system, cap or plug the threaded holes for the brake pipes along with the mounting point for the reservoir so not to allow the master cylinder to become contaminated. • Bleed the brake system. Refer to Hydraulic Brake System Bleeding (Pressure) or Hydraulic Brake System Bleeding (Manual).
4	Seal, Master Cylinder Tip: • Inspect the seal. If the seal is found to be damaged, replace the seal DO NOT reuse. • Ensure that the seal is properly seated in the master cylinder before installing the master cylinder.

MASTER CYLINDER BENCH BLEEDING

CAUTION: Refer to **Brake Fluid Irritant Caution** in **Cautions and Notices**.

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice** in **Cautions and Notices**.

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.

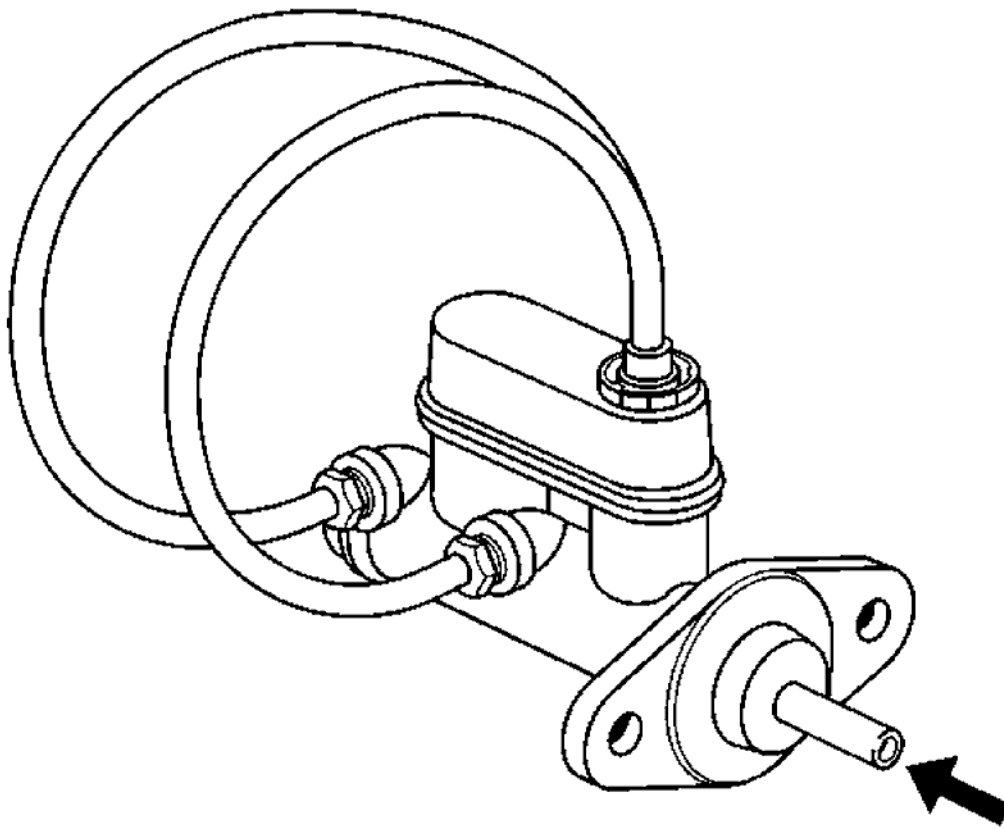


Fig. 15: Bleeding Master Cylinder
Courtesy of GENERAL MOTORS CORP.

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.

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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

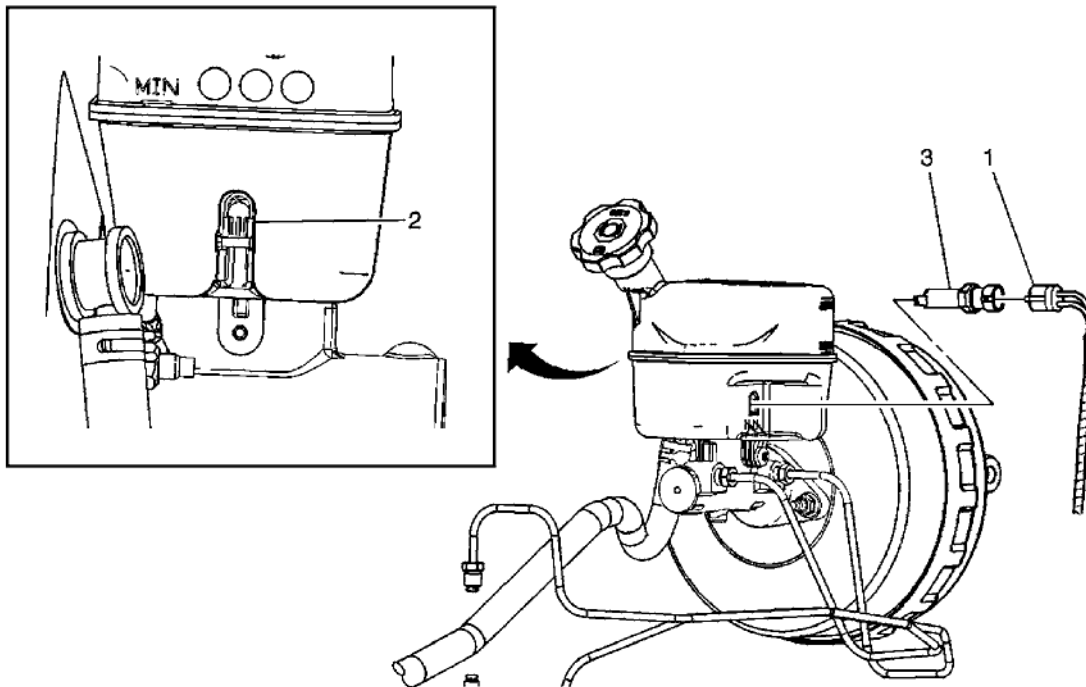


Fig. 16: Master Cylinder Fluid Level Sensor Replacement
Courtesy of GENERAL MOTORS CORP.

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Master Cylinder Fluid Level Sensor Replacement

Callout	Component Name
Fastener Tightening Specifications: Refer to Fastener Tightening Specifications .	
1	Connector, Fluid Level Sensor
2	Tab, Fluid Level Sensor Locking Tip: Use a pair of needle nose pliers to collapse the locking tabs in order to remove the fluid level sensor.
3	Sensor, Fluid Level

BRAKE PEDAL ASSEMBLY REPLACEMENT

Removal Procedure

1. Release the electric power steering (EPS) wiring harness from the brake pedal bracket.
2. Release the accelerator pedal position (APP) sensor jumper harness from the brake pedal bracket.

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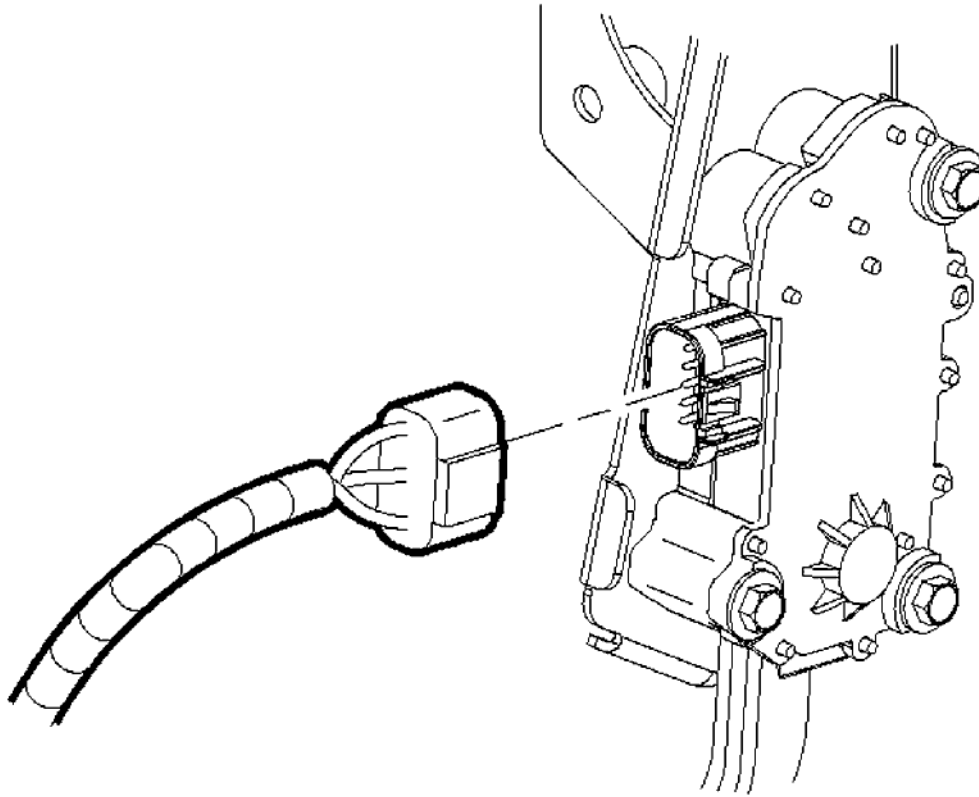


Fig. 17: View Of APP Sensor Harness Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the electrical connector from the APP sensor.

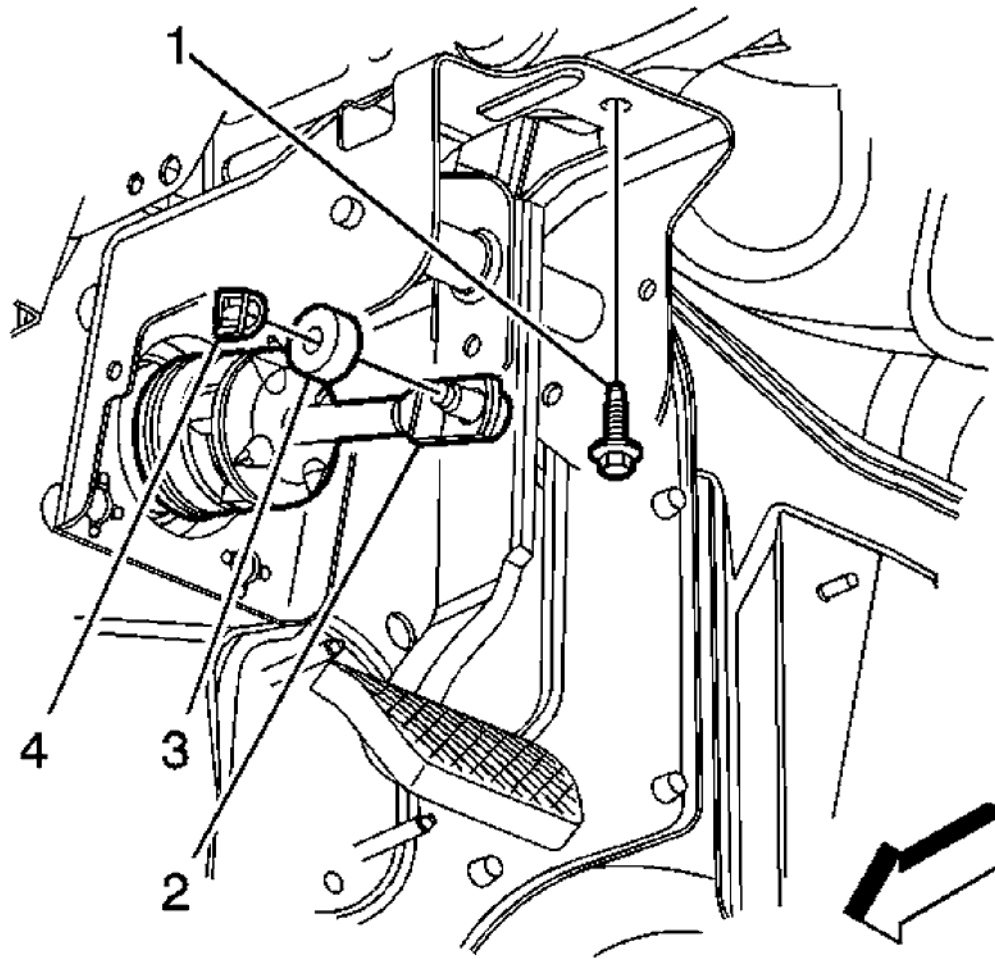


Fig. 18: View Of Brake Pedal Components
Courtesy of GENERAL MOTORS CORP.

4. Loosen the brake booster mounting nuts.
5. Remove the retaining clip (4) and washer (3) from the brake pedal.
6. Release the brake booster pushrod (2) from the brake pedal.
7. Remove the brake booster mounting nuts.
8. Remove the brake pedal bracket-to-steering column bracket bolt (1).

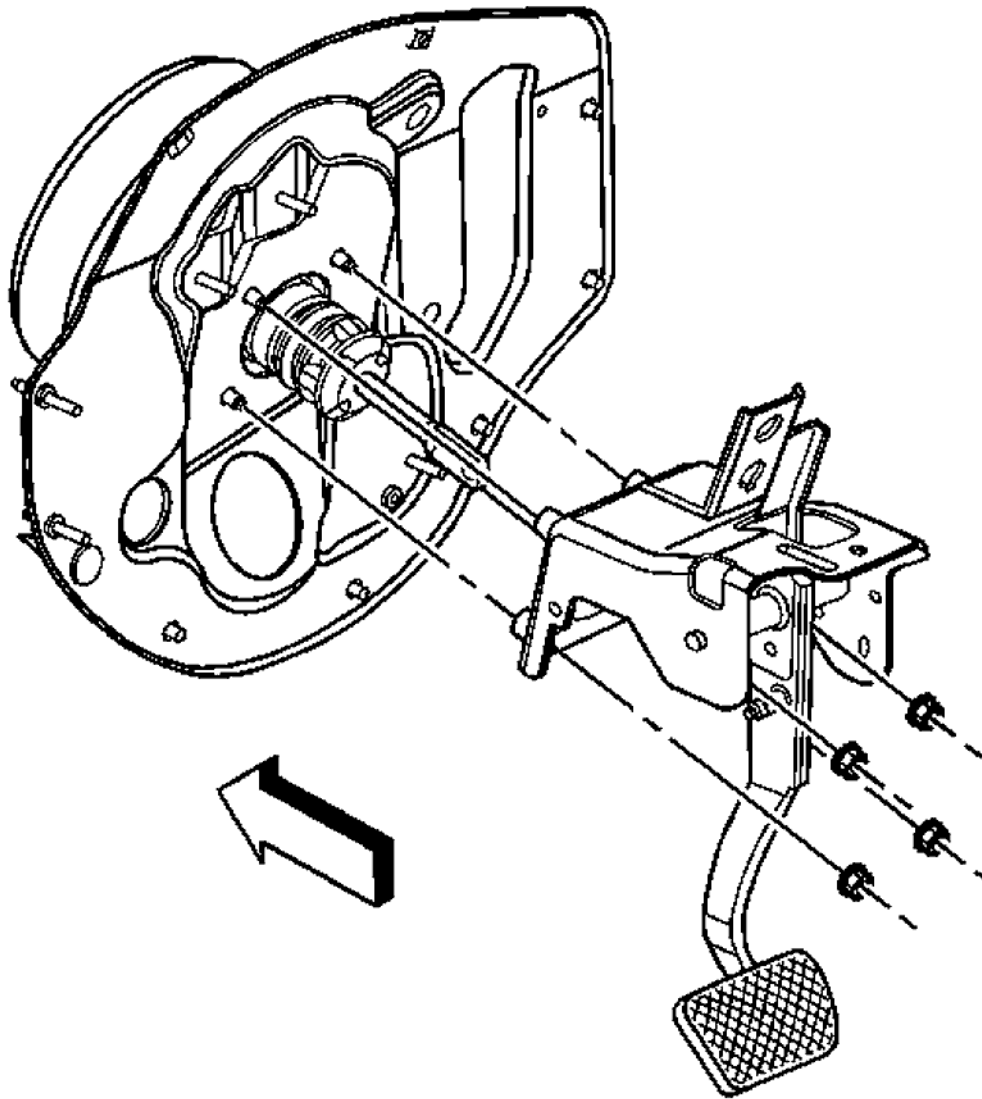


Fig. 19: View Of Brake Pedal Assembly
Courtesy of GENERAL MOTORS CORP.

9. Lower the brake pedal assembly to improve access for switch removal.
10. Remove the stop lamp switch from the pedal bracket. Refer to **Stop Lamp Switch Replacement** .
11. Remove the cruise control release switch, if equipped, from the pedal bracket. Refer to **Cruise Release Switch Replacement** .
12. Remove the brake pedal assembly, with the accelerator pedal assembly from the vehicle.

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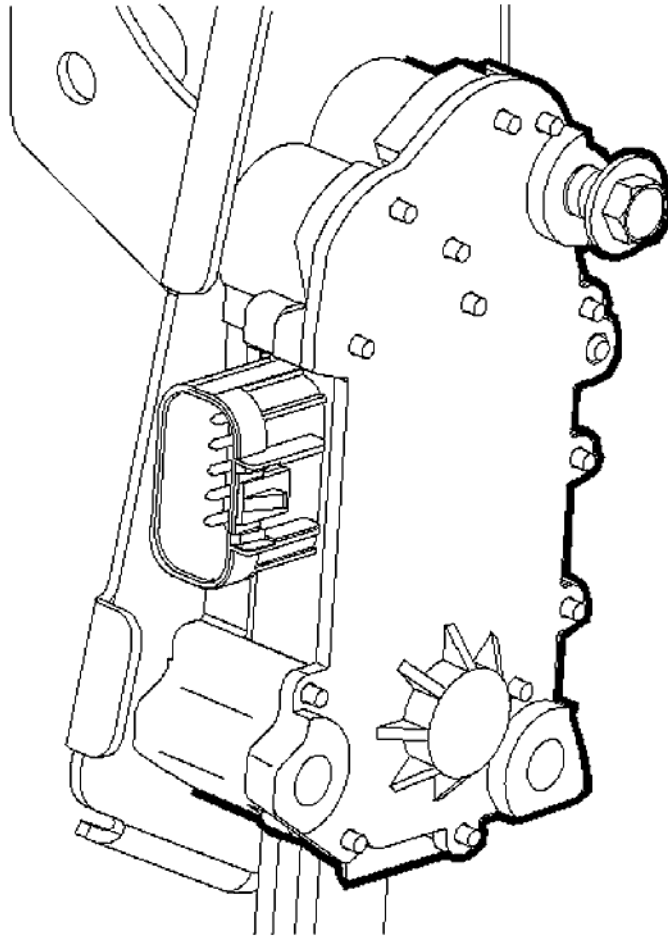


Fig. 20: View Of Accelerator Pedal Position Assembly
Courtesy of GENERAL MOTORS CORP.

13. Remove the accelerator pedal mounting bolts and remove the pedal assembly.

Installation Procedure

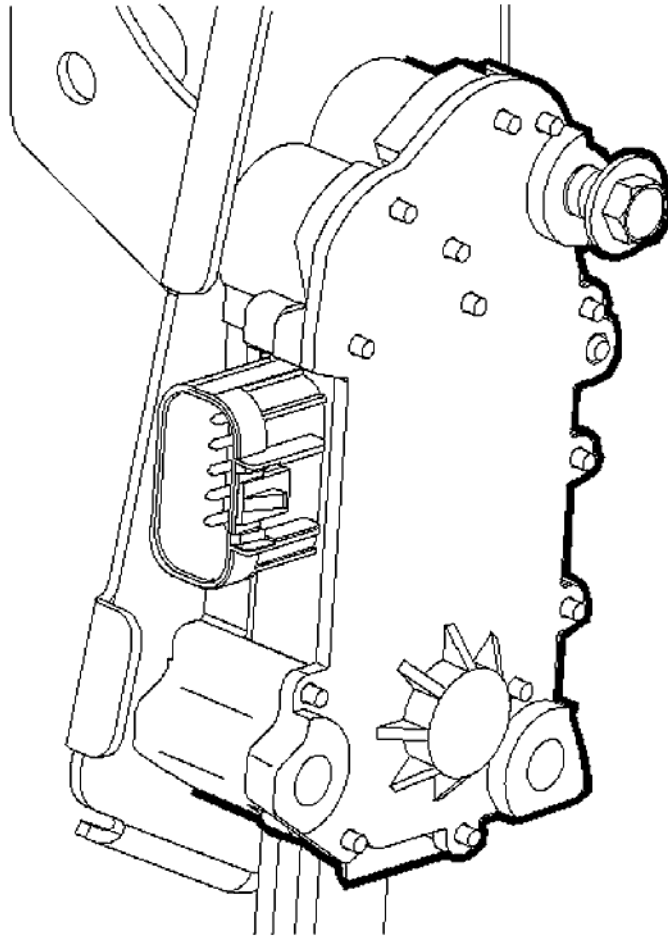


Fig. 21: View Of Accelerator Pedal Position Assembly
Courtesy of GENERAL MOTORS CORP.

1. Position the accelerator pedal assembly to the brake pedal bracket.

NOTE: Refer to Fastener Notice .

2. Install the accelerator pedal and sensor assembly mounting bolts.

Tighten: Tighten the bolts to 9 N.m (80 lb in).

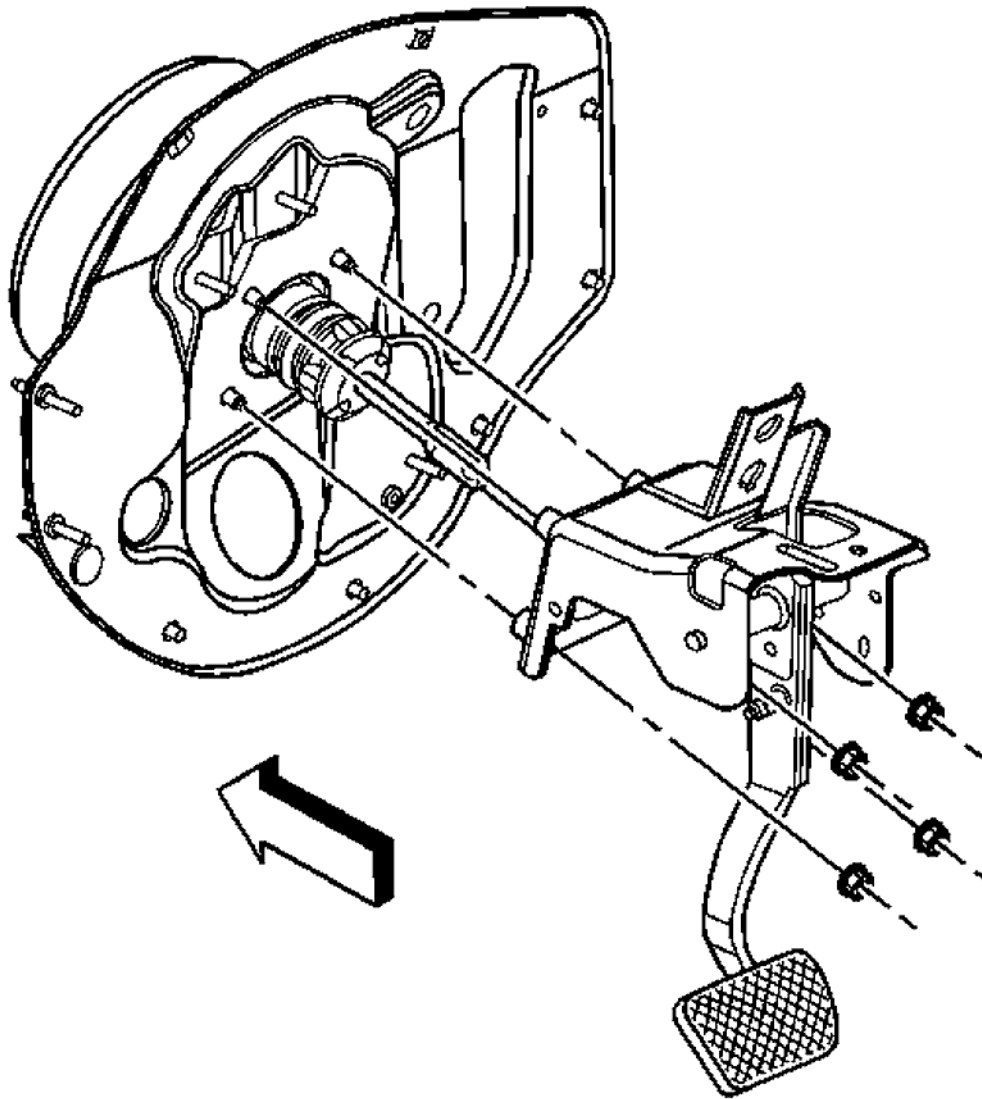


Fig. 22: View Of Brake Pedal Assembly
Courtesy of GENERAL MOTORS CORP.

3. Install the brake pedal assembly, with the accelerator pedal assembly to the vehicle.
4. Install the cruise control release switch, if equipped, to the pedal bracket. Refer to **Cruise Release Switch Replacement** .
5. Install the stop lamp switch to the pedal bracket. Refer to **Stop Lamp Switch Replacement** .
6. Move the brake pedal assembly to the installed position.

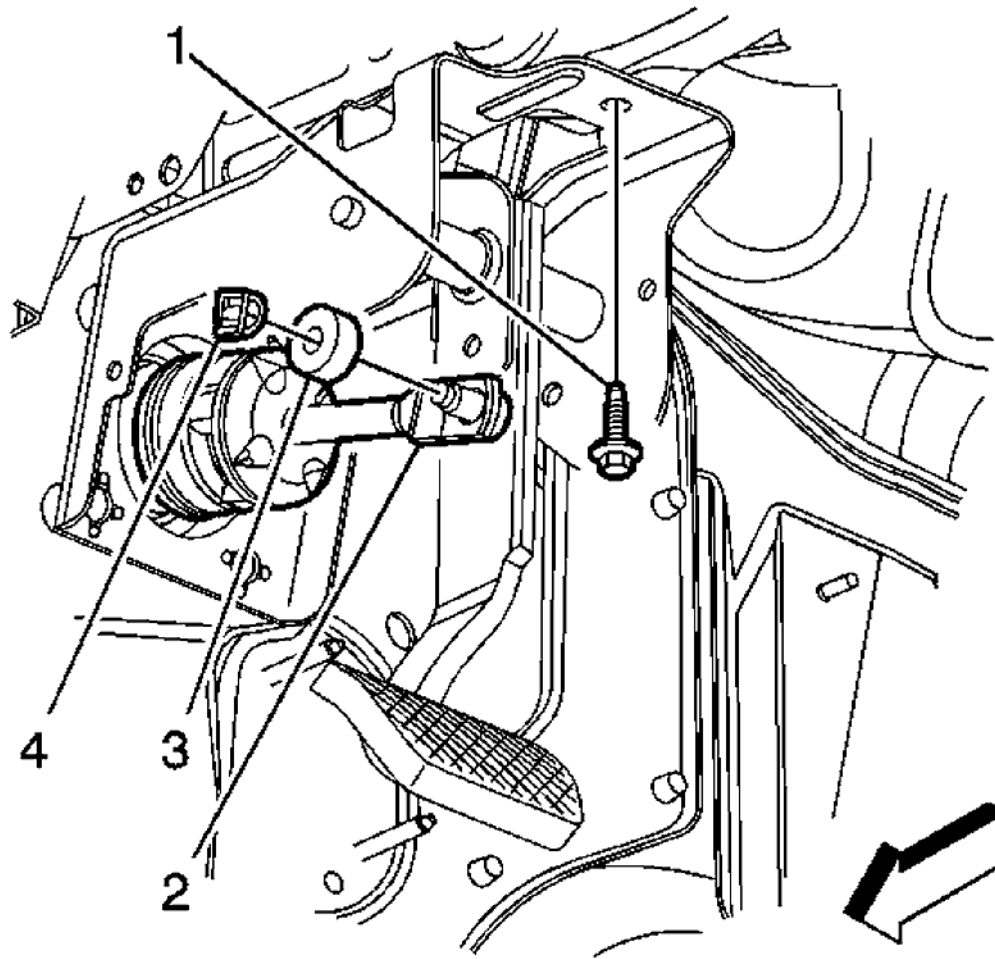


Fig. 23: View Of Brake Pedal Components
Courtesy of GENERAL MOTORS CORP.

7. Install the brake pedal bracket-to-steering column bracket bolt (1).

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

8. Loosely install the brake booster mounting nuts.
9. Apply a thin coating of high temperature grease GM P/N 2345996 (Canadian P/N 10953501) to the pushrod pin on the brake pedal.
10. Connect the brake booster pushrod (2) to the brake pedal.
11. Install the washer (3) and retaining clip (4) to the brake pedal.
12. Tighten the vacuum brake booster mounting nuts.

Tighten: Tighten the nuts to 17 N.m (14 lb ft).

13. Adjust the stop lamp switch. Refer to **Stop Lamp Switch Adjustment** .
14. Adjust the cruise control release switch, if equipped. Refer to **Cruise Release Switch Adjustment** .

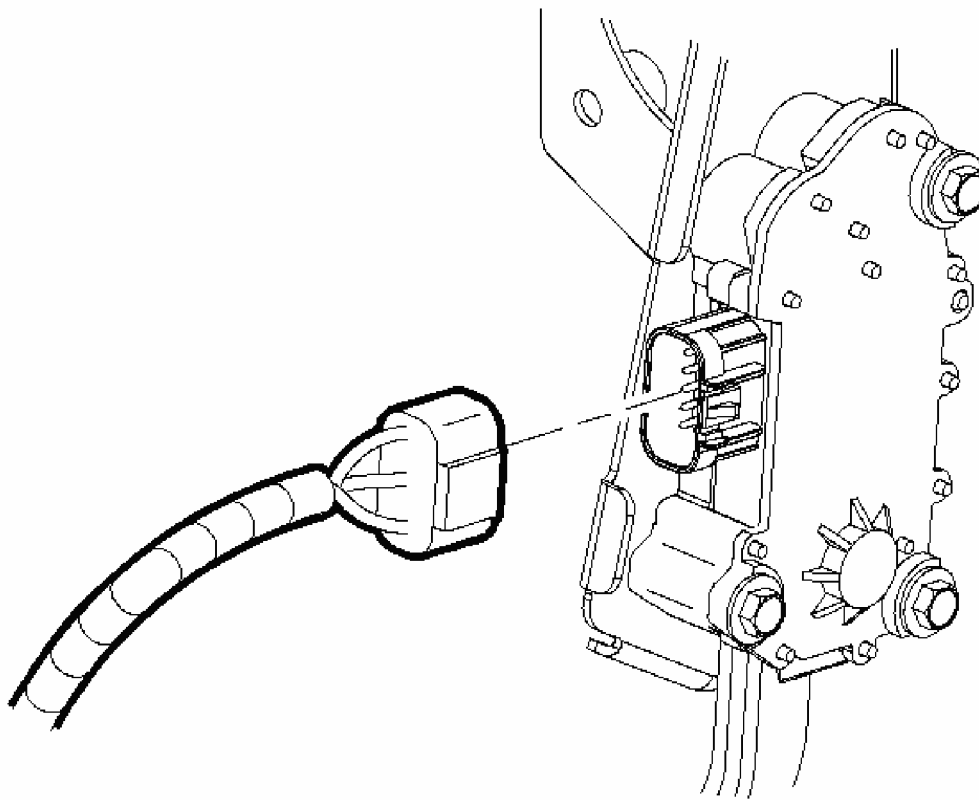


Fig. 24: View Of APP Sensor Harness Connector
Courtesy of GENERAL MOTORS CORP.

15. Connect the electrical connector to the APP sensor.
16. Secure the APP sensor jumper harness to the brake pedal bracket.
17. Secure the EPS wiring harness to the pedal bracket.

PROPORTIONING VALVE REPLACEMENT

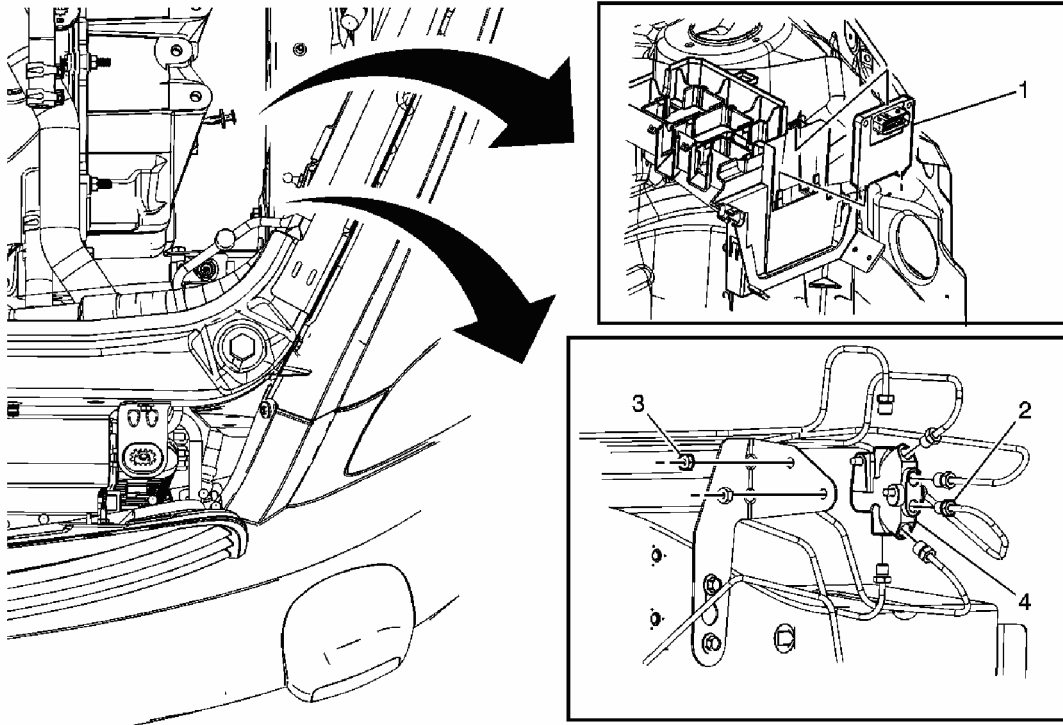


Fig. 25: Proportioning Valve Replacement
 Courtesy of GENERAL MOTORS CORP.

Proportioning Valve Replacement

Callout	Component Name
NOTE: Refer to Fastener Notice .	
Fastener Tightening Specifications: Refer to Fastener Tightening Specifications . Preliminary Procedure: Remove the engine control module (ECM). Refer to Engine Control Module (ECM) Replacement .	
1	Module, Transmission Control Tip: Remove the transmission control module (TCM) allow for more work area.
2	Fitting, Brake Pipe (Qty 6). Tip: Cap or plug the brake pipes so as not to allow leakage or contamination of the brake fluid. Tighten: 19 N.m (14 lb ft)
3	Nut, Proportioning Valve Mounting Tighten: 10 N.m (89 lb in)

BRAKE PIPE REPLACEMENT

Tools Required

J 45405 Brake Pipe Flaring Kit. See Special Tools.

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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 in Cautions and Notices.

IMPORTANT: When servicing the brake pipes, note the following:

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

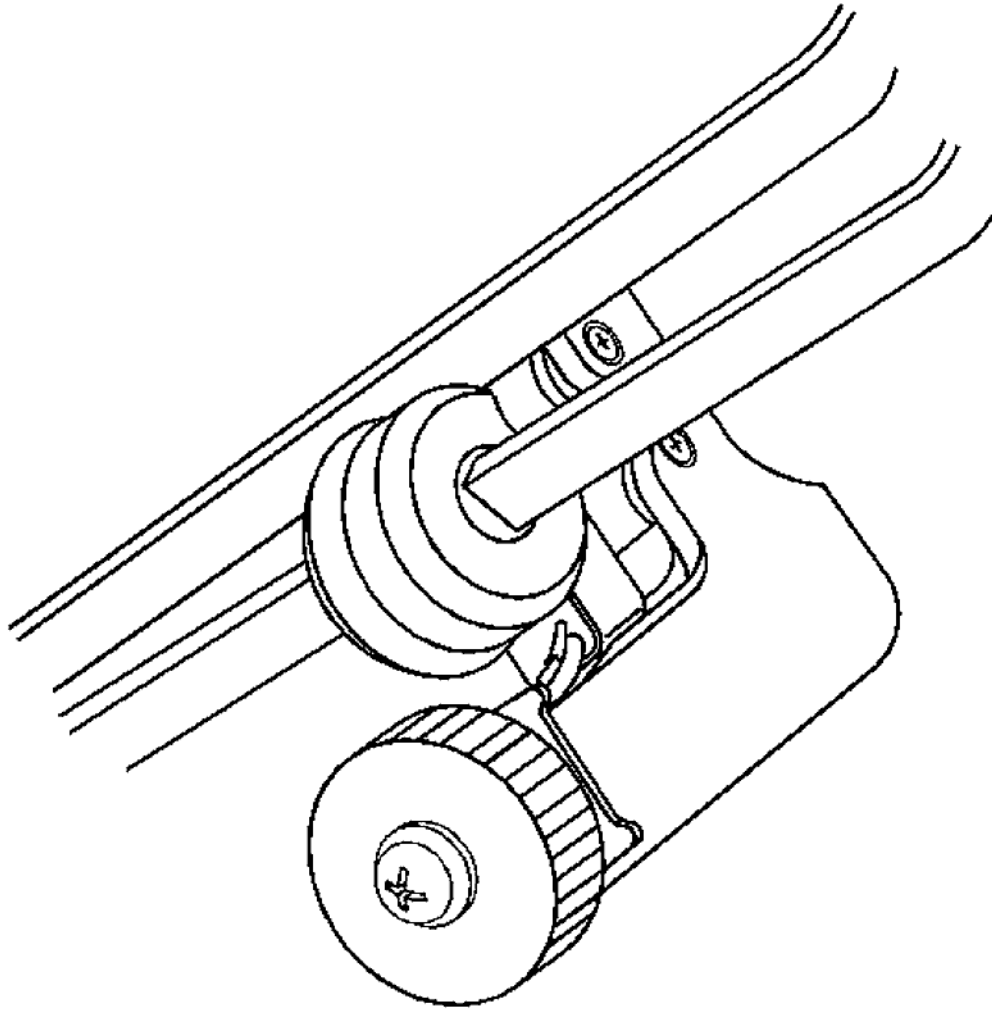


Fig. 26: Sectioning Brake Pipe Using Pipe Cutter
Courtesy of GENERAL MOTORS CORP.

1. Inspect the area of brake pipe to be repaired or replaced.
2. Release the brake pipe to be replaced from the retainers, as required.
3. Select an appropriate location to section the brake pipe, if necessary.
 - Allow adequate clearance in order to maneuver the **J 45405** . 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.

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Specification:

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

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.

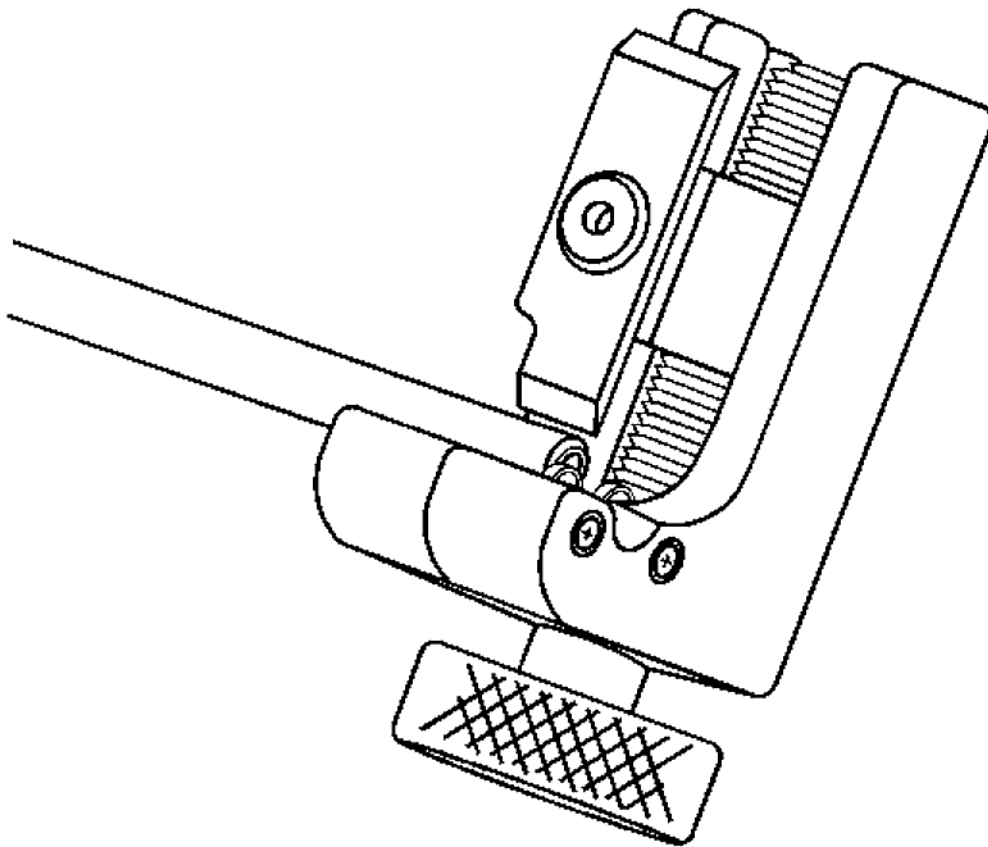


Fig. 27: Stripping Nylon Coating From Brake Pipe Ends
Courtesy of GENERAL MOTORS CORP.

9. Strip the nylon coating from the brake pipe end to be flared, if necessary.
- 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
 - 9.50 mm (0.374 in) blade for 6.35 mm (1/4 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
- 9.50 mm (0.374 in) for 6.35 mm (1/4 in) diameter pipe

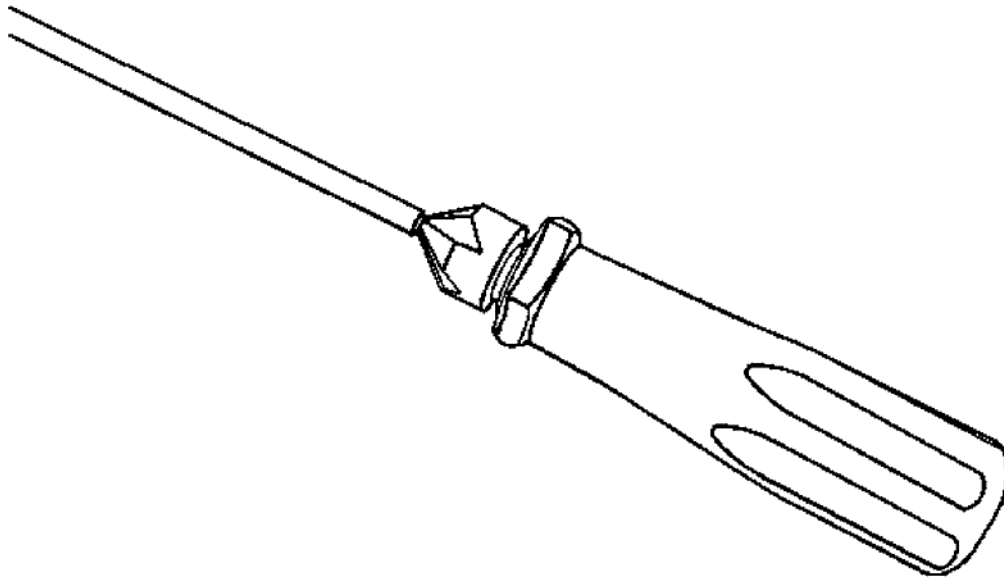


Fig. 28: Chamfering Pipe Using De-Burring Tool
Courtesy of GENERAL MOTORS CORP.

10. Chamfer the inside and outside diameter of the pipe with the de-burring tool included in the **J 45405** . 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**.

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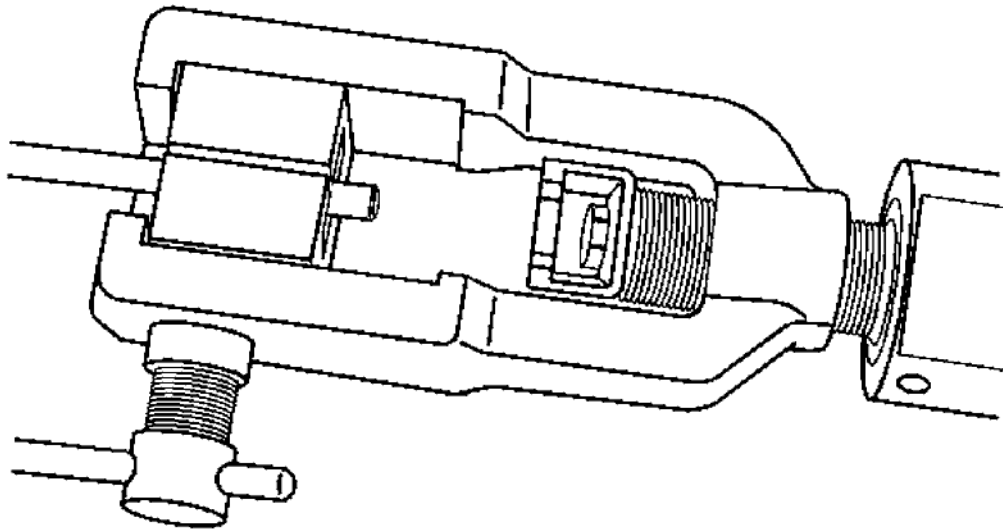


Fig. 29: Installing Die Halves Into Die Cage
Courtesy of GENERAL MOTORS CORP.

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.

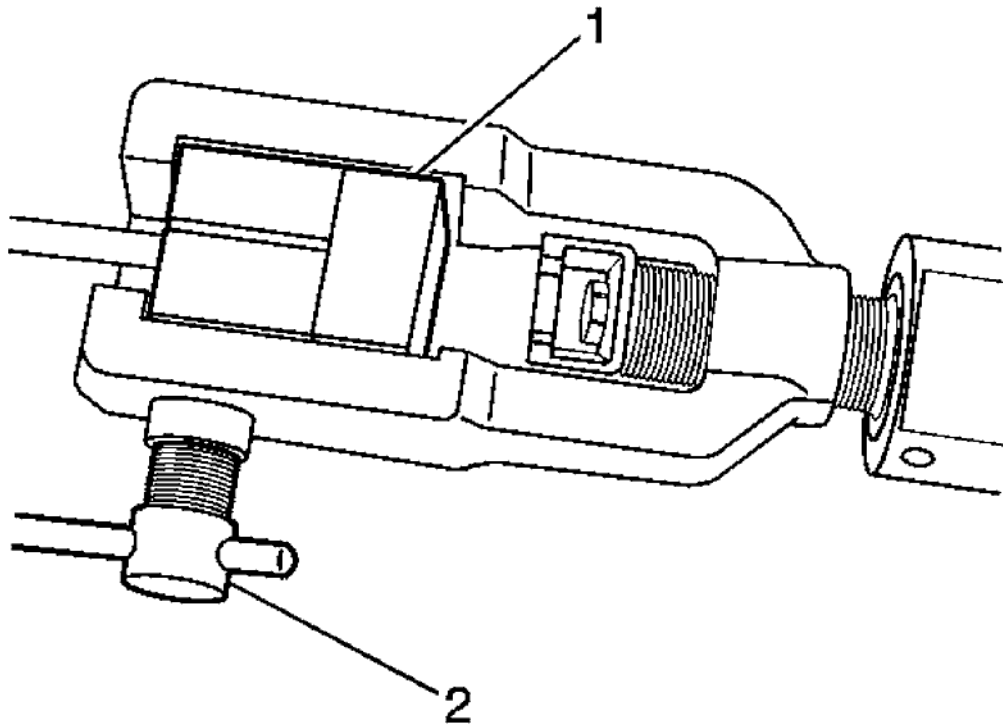


Fig. 30: View Of Clamping Screw & Unused Die
Courtesy of GENERAL MOTORS CORP.

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

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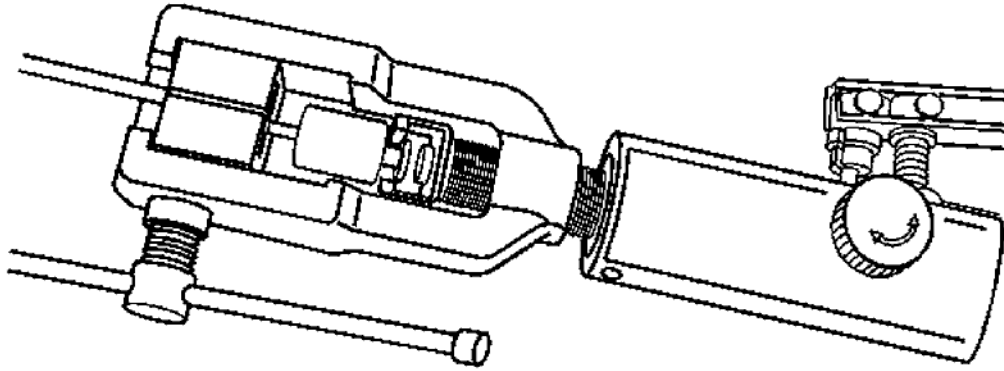


Fig. 31: Rotating J 45405 To Bottom Against Die Cage
Courtesy of GENERAL MOTORS CORP.

20. Select the appropriate forming mandrel and place into the forming ram.
21. Rotate the hydraulic fluid control valve clockwise to the closed position.
22. Rotate the body of the **J 45405** until it bottoms against the die cage. See **Special Tools**.

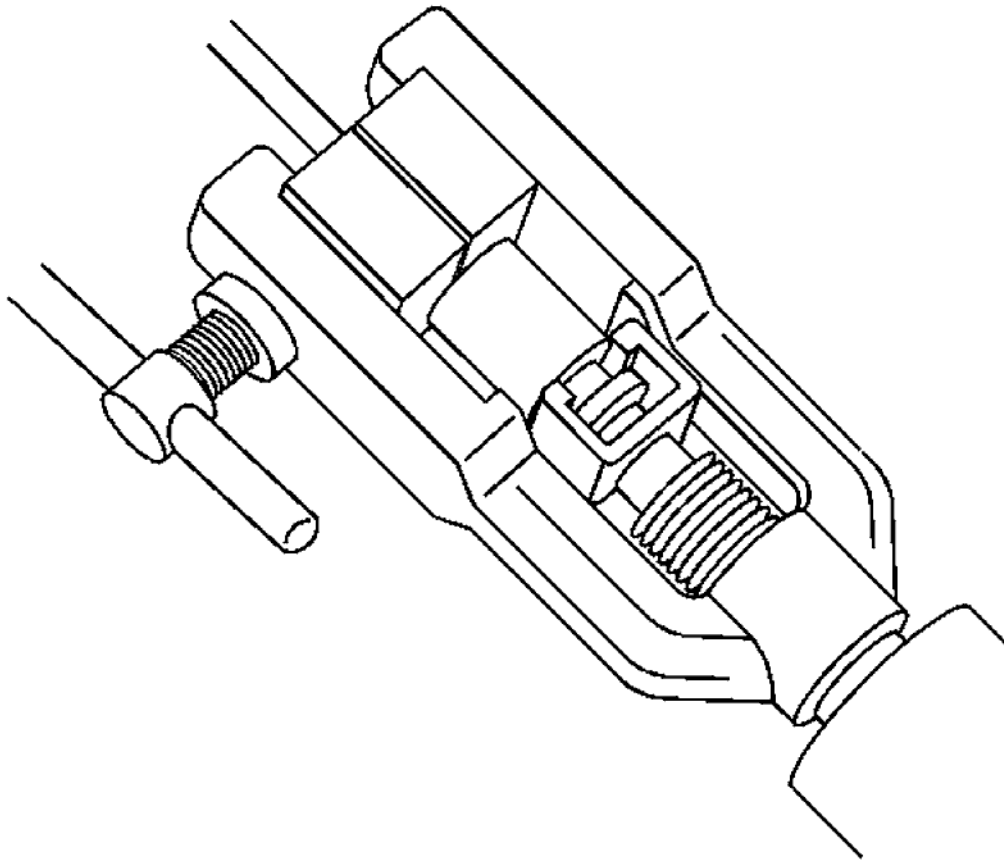


Fig. 32: Bottoming Forming Mandrel Against Clamping Dies Using Pipe Flaring Tool

Courtesy of GENERAL MOTORS CORP.

23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the **J 45405** 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.

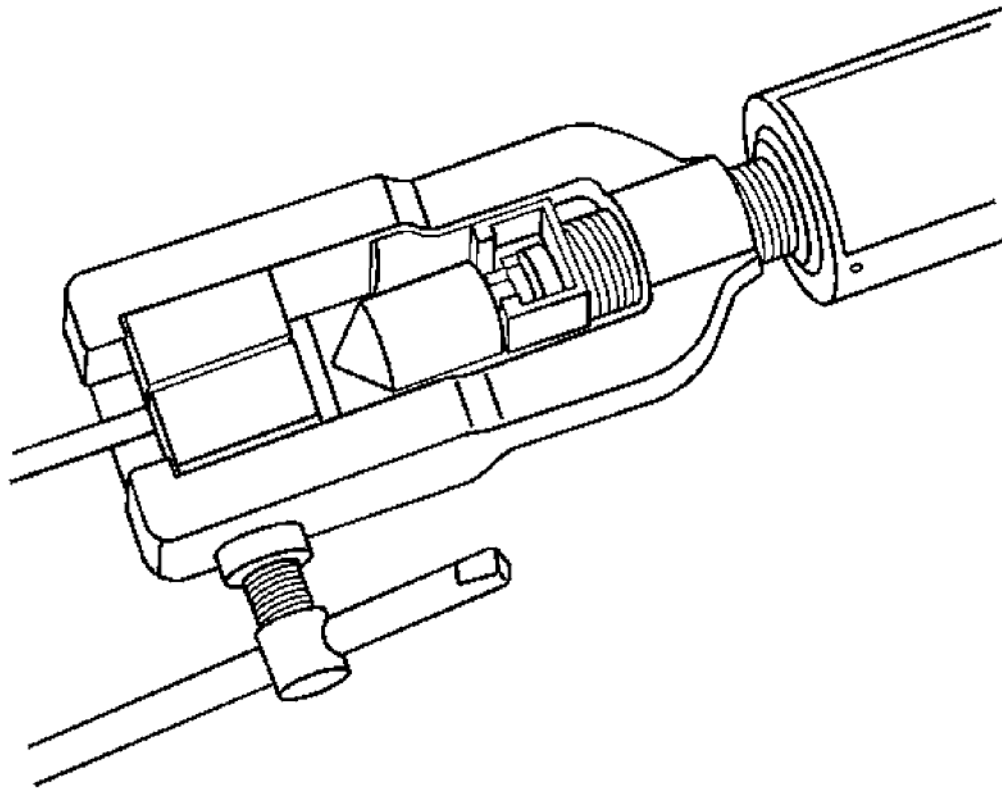


Fig. 33: Using Pipe Flaring Tool
Courtesy of GENERAL MOTORS CORP.

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

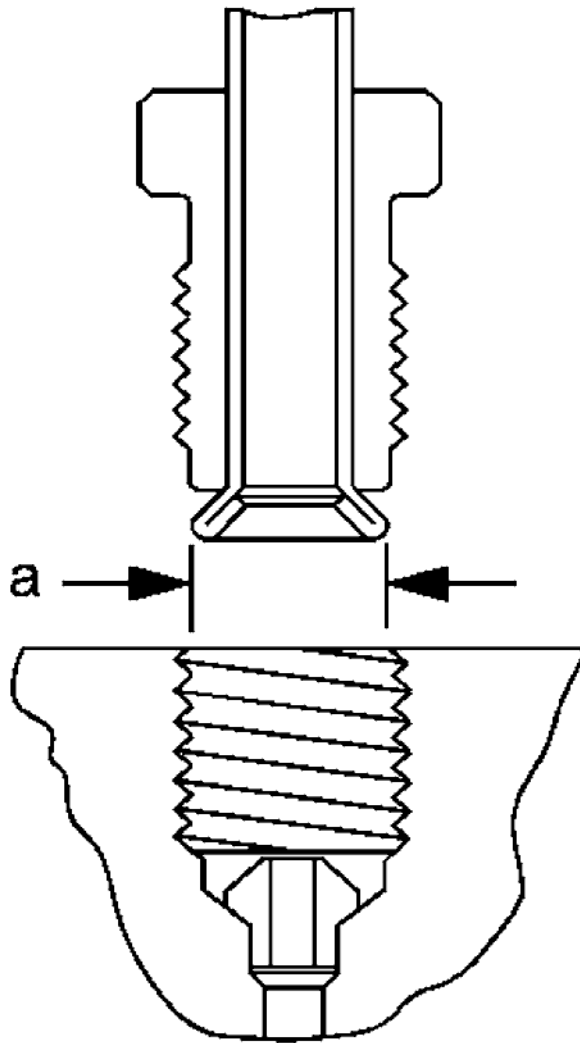


Fig. 34: Identifying Correct Brake Pipe Flare Shape & Diameter
Courtesy of GENERAL MOTORS CORP.

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

Specification:

- 6.92 mm (0.272 in) $\pm$ 0.18 mm (0.007 in) flare diameter for 4.76 mm (3/16 in) diameter pipe
- 8.92 mm (0.351 in) $\pm$ 0.18 mm (0.007 in) flare diameter for 6.35 mm (1/4 in) diameter pipe

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33. If necessary, using the removed section of brake 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.

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

BRAKE HOSE REPLACEMENT - FRONT

Removal Procedure

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
2. Remove tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.
3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.

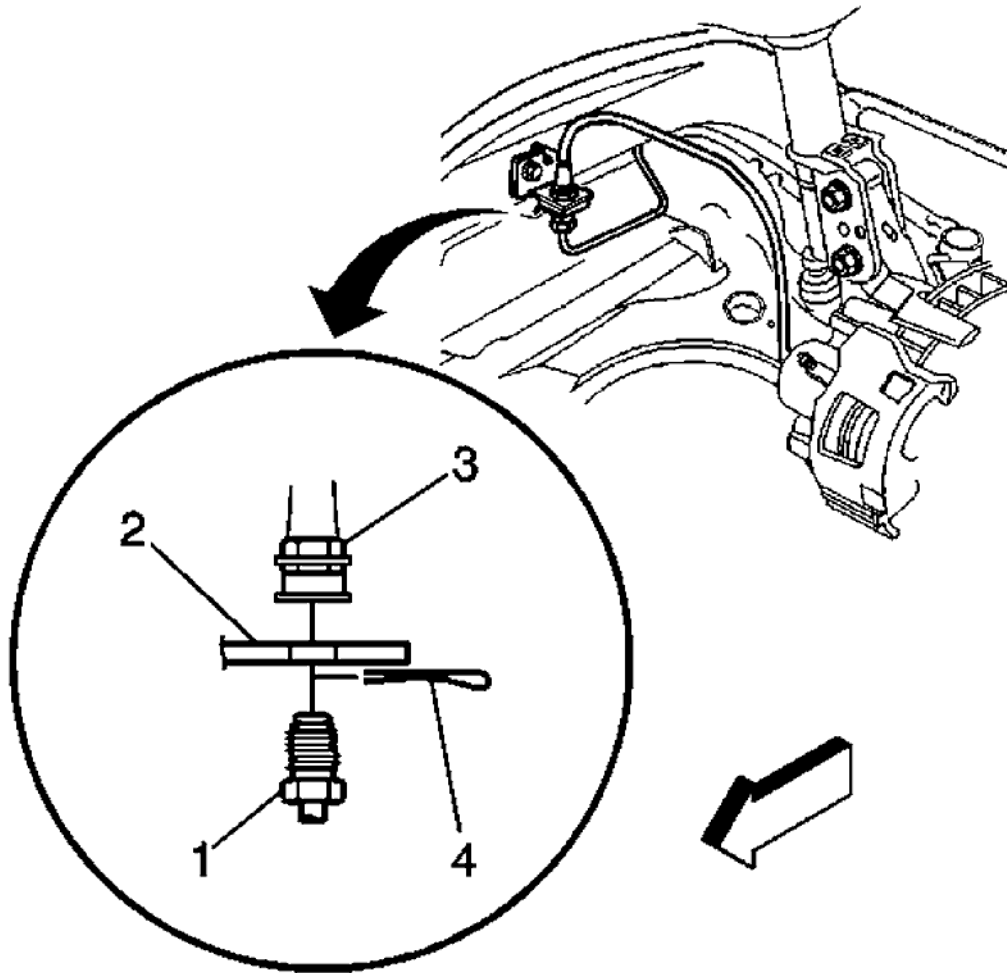


Fig. 35: Locating Brake Hose Retainer
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install a rubber cap or plug to the exposed brake pipe fitting end in order to prevent brake fluid loss and contamination.

4. Remove the brake pipe fitting (1) from the brake hose (3).
5. Use a flat-bladed tool in order to remove the brake hose retainer (4) from the brake hose (3).
6. Remove the brake hose (3) from the brake hose bracket (2).

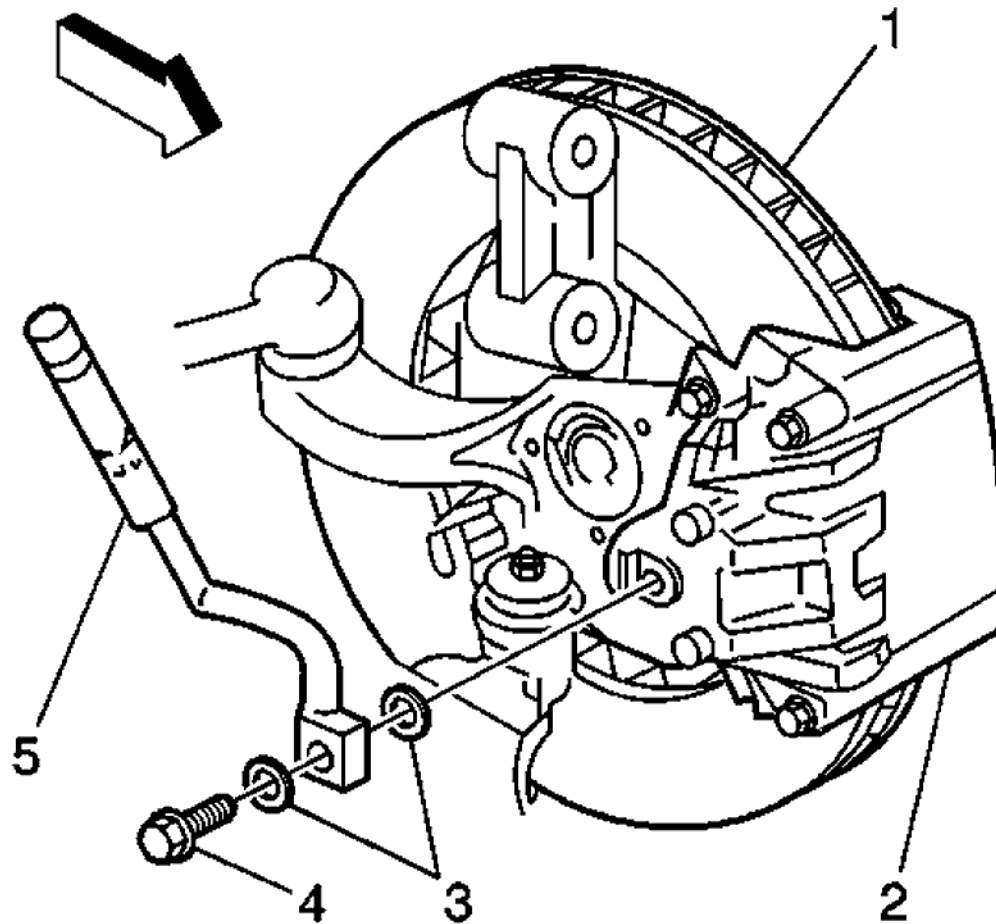


Fig. 36: Removing/Installing Brake Hose At Brake Caliper
Courtesy of GENERAL MOTORS CORP.

7. Remove the brake hose bolt (4) from the brake caliper (2).
8. Remove the brake hose (5) from the brake caliper (2).
9. Remove and discard the two copper brake hose gaskets (3). These gaskets may be stuck to the brake caliper and/or the brake hose end.
10. Install a rubber plug into the brake hose bolt hole of the brake caliper in order to prevent brake fluid loss and contamination.

Installation Procedure

1. Remove the rubber plug from the brake hose bolt hole of the brake caliper.

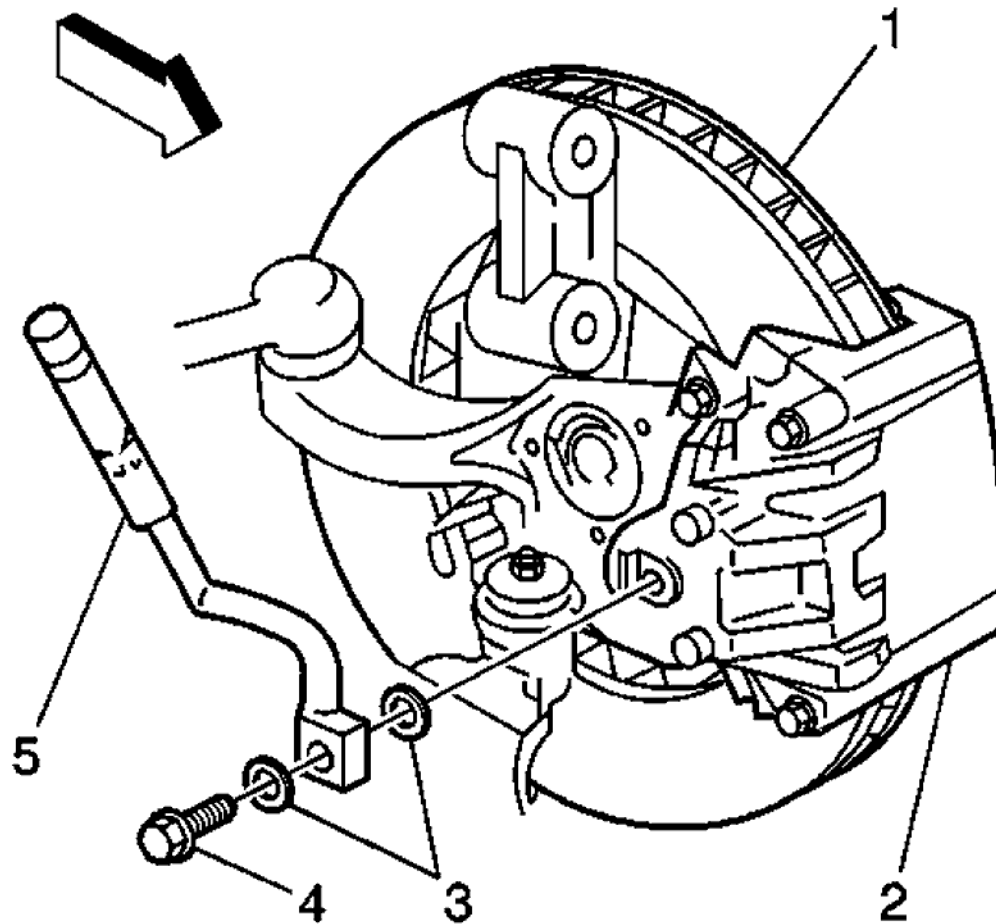


Fig. 37: Removing/Installing Brake Hose At Brake Caliper
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install **NEW** copper brake hose gaskets (3).

NOTE: Refer to Fastener Notice .

2. Assemble the brake hose bolt (4) and the NEW copper brake hose gaskets (3) to the brake hose (5).
3. Install the brake hose bolt (4) to the brake caliper (2).

Tighten: Tighten the bolt to 54 N.m (40 lb ft).

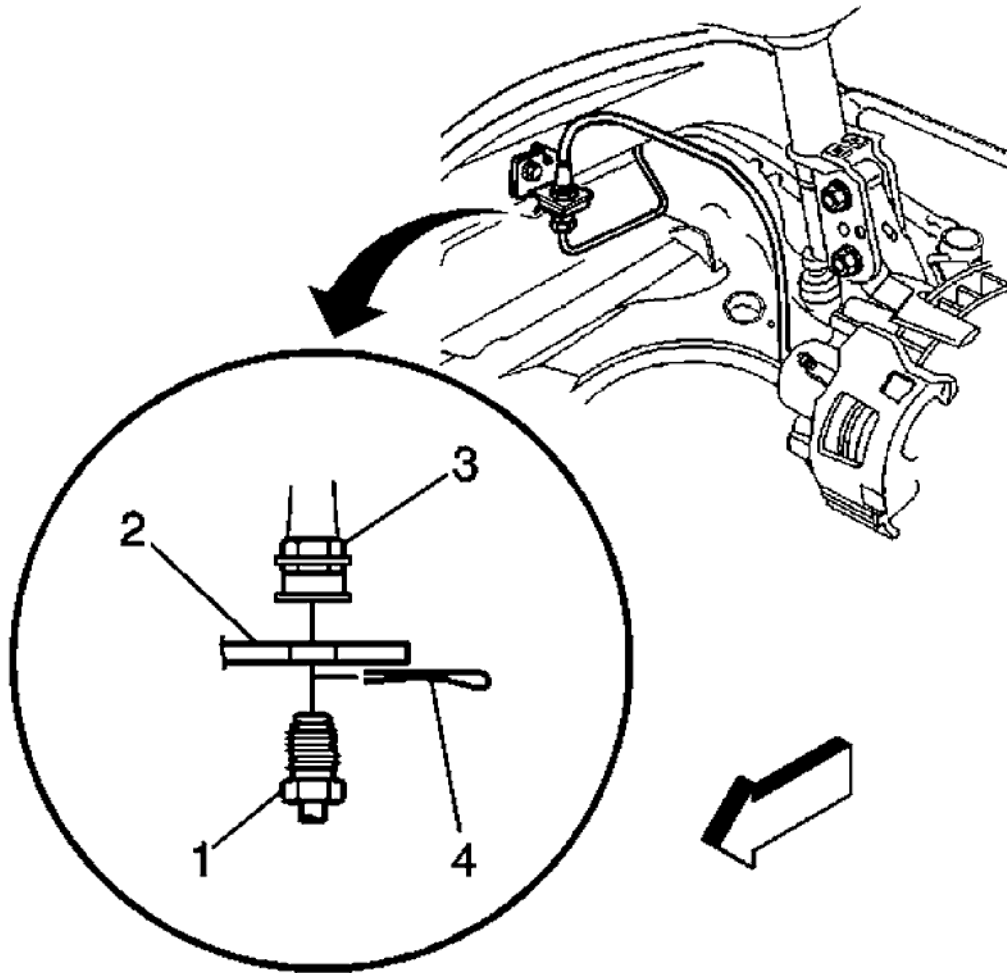


Fig. 38: Locating Brake Hose Retainer
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

IMPORTANT: Use the stripe on the brake hose in order to align the brake hose with the notch in the brake hose bracket.

4. Install the brake hose (3) to the brake hose bracket (2).
5. Install the brake hose retainer (4) to the brake hose (3).
6. Remove the rubber cap or plug from the exposed brake pipe fitting end.
7. Install the brake pipe fitting (1) to the brake hose (3).

Tighten: Tighten the fitting to 21 N.m (15 lb ft).

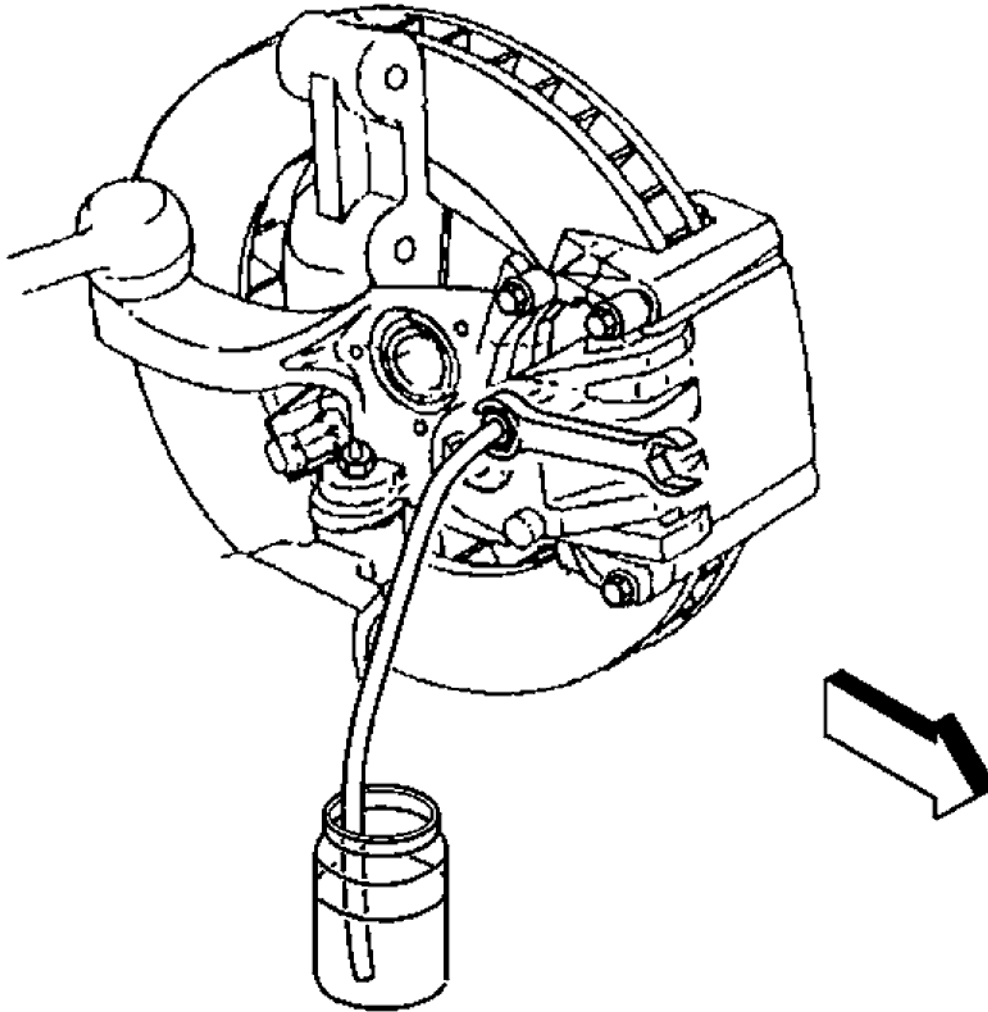


Fig. 39: Bleeding Brake Caliper
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not move the vehicle until a firm brake pedal is obtained. Air in the brake system can cause the loss of brakes with possible personal injury.

8. Bleed the brake caliper at the brake caliper bleeder screw. Refer to **Hydraulic Brake System Bleeding (Pressure)** or **Hydraulic Brake System Bleeding (Manual)**.
9. Install tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** in

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Tires and Wheels.

10. Lower the vehicle.

BRAKE HOSE REPLACEMENT - REAR (DISC BRAKES)

Removal Procedure

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
2. Remove tire and wheel assembly. Refer to Tire and Wheel Removal and Installation in Tires and Wheels.
3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.

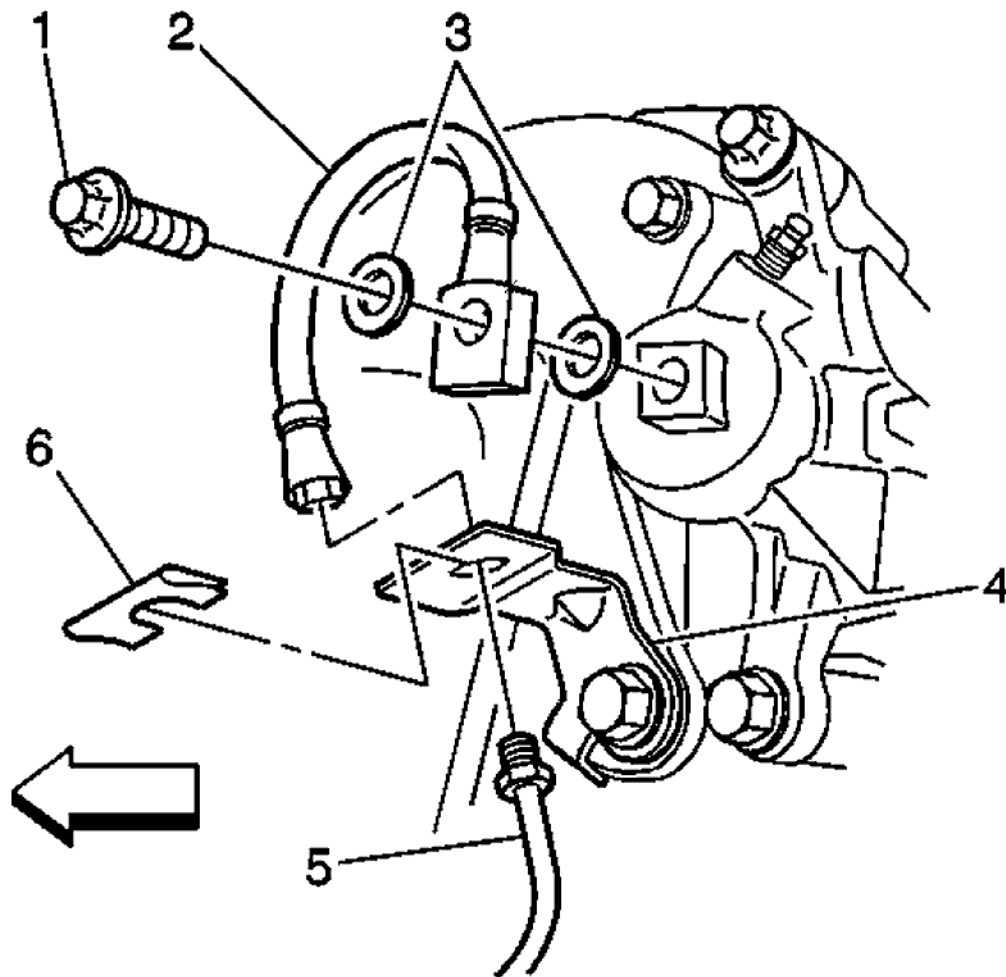


Fig. 40: Locating Brake Hose Components
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install a rubber cap or plug to the exposed brake pipe fitting end in order to prevent brake fluid loss and contamination.

4. Use a backup wrench on the hose fitting, disconnect the brake pipe fitting from the brake hose, then cap or plug the brake pipe fitting end.

IMPORTANT: Do not bend the brake pipe or the bracket.

5. Use a flat-bladed tool in order to remove the brake hose retainer clip (6) from the brake

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hose (2) mounting bracket.

6. Remove the brake hose (2) from the brake hose bracket (4).
7. Remove the brake hose bolt (1) from the brake caliper.
8. Remove the brake hose (2) from the brake caliper.
9. Remove and discard the 2 copper brake hose gaskets (3). These gaskets may be stuck to the brake caliper and/or the brake hose end.
10. Install a rubber plug into the brake hose bolt hole of the brake caliper in order to prevent brake fluid loss and contamination.

Installation Procedure

1. Remove the rubber plug from the brake caliper.

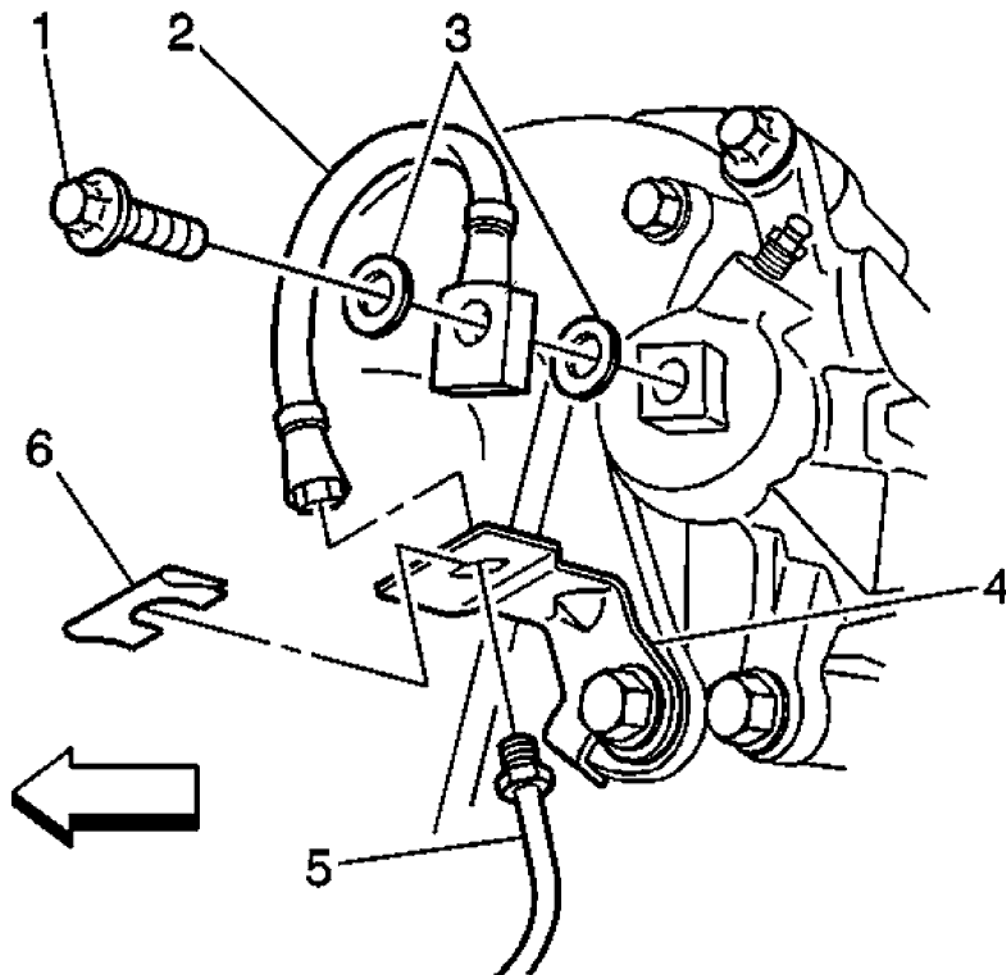


Fig. 41: Locating Brake Hose Components
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install NEW copper brake hose gaskets (3).

2. Assemble the brake hose bolt (1) and the NEW copper brake hose gaskets (3) to the brake hose (2).

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the brake hose bolt (1) to the brake caliper.

Tighten: Tighten the brake hose bolt at rear brake caliper to 43 N.m (32 lb ft).

NOTE: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

IMPORTANT: Use the stripe on the brake hose in order to align the brake hose with the notch in the brake hose bracket.

4. Install the brake hose (2) to the brake hose bracket (4).
5. Install the brake hose retainer clip (6) to the brake hose (2).
6. Remove the rubber cap or plug from the exposed brake pipe fitting end.
7. Connect brake pipe fitting to the brake hose; use a backup wrench on the hose fitting. Do not bend the bracket or pipe.

Tighten: Tighten the fitting to 21 N.m (15 lb ft).

8. Bleed the brake system. Refer to **Hydraulic Brake System Bleeding (Pressure)** or **Hydraulic Brake System Bleeding (Manual)**.
9. Install tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation in Tires and Wheels**.
10. Lower the vehicle.

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

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. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved 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 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 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. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved or equivalent DOT-3 brake fluid from a clean sealed brake fluid container. 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. Check the brake fluid level in the **J 29532** . See **Special Tools** . Add GM approved or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container as necessary to bring the level to approximately the half-full point.
7. Connect the **J 29532** , or equivalent, to the **J 44894-A** . See **Special Tools**.
8. Charge the **J 29532** , or equivalent, air tank to 175-205 kPa (25-30 psi). See **Special Tools**.
9. Open the **J 29532** , or equivalent, fluid tank valve to allow pressurized brake fluid to enter the brake system. See **Special Tools**.
10. Wait approximately 30 seconds, then inspect the entire hydraulic brake system in order to ensure that there are no existing external brake fluid leaks.

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

11. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
12. Install a transparent hose over the end of the bleeder valve.
13. Submerge the open end of the transparent hose into the transparent container partially filled with GM approved or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
14. Loosen the bleeder valve to purge air from the wheel hydraulic circuit. Allow fluid to flow until air bubbles stop flowing from the bleeder, then tighten the bleeder valve.
15. With the right rear wheel hydraulic circuit bleeder valve tightened securely after all air has been purged from the right rear hydraulic circuit, install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
16. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
17. With the left front wheel hydraulic circuit bleeder valve tightened securely after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.
18. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
19. With the left rear wheel hydraulic circuit bleeder valve tightened securely after all air has been purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
20. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
21. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each

of the 4 wheel hydraulic circuit bleeder valves is properly tightened.

22. Close the **J 29532** , or equivalent, fluid tank valve, then disconnect the **J 29532** , or equivalent, from the **J 44894-A** . See **Special Tools**.
23. Remove the **J 44894-A** from the brake master cylinder reservoir. See **Special Tools**.
24. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
25. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.
26. If the brake pedal feels spongy perform the following steps:
 1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection** .
 2. 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 **ABS Automated Bleed Procedure** .
27. 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.

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

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)

CAUTION: Refer to Brake Fluid Irritant Caution .

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

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 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, 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. Fill the brake master cylinder reservoir to the maximum-fill level with GM

approved 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 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 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. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. Ensure 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 GM approved 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 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.
13. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
14. With the left front wheel hydraulic circuit bleeder valve tightened securely after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.
15. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
16. With the left rear wheel hydraulic circuit bleeder valve tightened securely after all air has been purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
17. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
18. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves is properly tightened.
19. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved 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: 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 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 2 types of fluid are present. A substance other than the recommended brake fluid has been introduced into the brake hydraulic system.
 - Swirled appearance - oil-based substance
 - Layered appearance - silicone-based substance
 - Fluid discoloration, indicating the presence of moisture or particles that have been introduced into the brake hydraulic system
 - Cloudy appearance - moisture
 - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust
2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating brake fluid contamination.
3. If the brake fluid WAS contaminated with an oil-based or a silicone-based substance, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following:
 1. Remove ALL of the following components listed from the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Replacement**
- **Brake Hose Replacement - Front**
- **Brake Hose Replacement - Rear (Disc Brakes)**
- **Brake Caliper Replacement**
- **Wheel Cylinder Replacement** , if equipped

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

Refer to the procedures indicated:

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

Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to **Master Cylinder Reservoir Replacement (Getrag 5 Speed)****Master Cylinder Reservoir Replacement (4T45-E Automatic)** .

Replace the brake master cylinder reservoir cap diaphragm.

- **Brake Hose Replacement - Front**
 - **Brake Hose Replacement - Rear (Disc Brakes)**
 - **Brake Caliper Overhaul** or **Brake Caliper Replacement**
 - **Wheel Cylinder Replacement** , if equipped
 - **Proportioning Valve Replacement** , if equipped
 - **Brake Pressure Modulator Valve (BPMV) Replacement** , if equipped
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. Fill the brake master cylinder reservoir to the maximum-fill level with Saturn P/N 21013073, or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
 6. Pressure bleed the hydraulic brake system. Begin the procedure with the pressure bleeder reservoir filled to the maximum-fill level with the correct brake fluid as indicated. Refer to **Hydraulic Brake System Bleeding (Pressure)** or **Hydraulic Brake System Bleeding (Manual)**.

VACUUM BRAKE BOOSTER REPLACEMENT

2006 Chevrolet HHR LT

2006 BRAKES Hydraulic Brakes - HHR

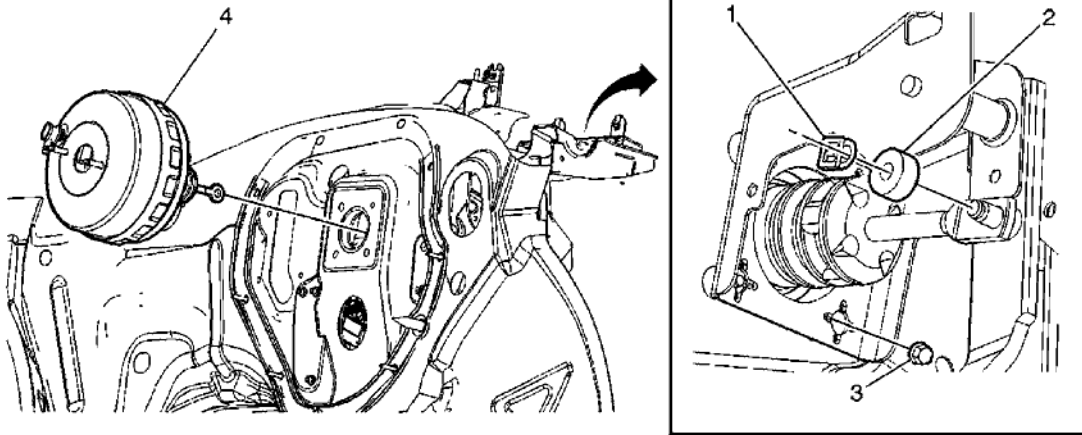


Fig. 42: Vacuum Brake Booster Replacement
Courtesy of GENERAL MOTORS CORP.

Vacuum Brake Booster Replacement

Callout	Component Name
CAUTION: Refer to <u>Brake Fluid Irritant Caution</u> .	
CAUTION: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Notice</u> .	
NOTE: Refer to <u>Fastener Notice</u> .	
Fastener Tightening Specifications: Refer to <u>Fastener Tightening Specifications</u> .	
Preliminary Procedure	
1. Remove the insulator. Refer to <u>Insulator Replacement - Instrument Panel (I/P)</u>	
2. Remove the kneel bolster. Refer to <u>Knee Bolster Replacement</u> .	
3. Remove the knee bolster reinforcement. Refer to <u>Knee Bolster Reinforcement Replacement</u> .	
4. Remove the brake master cylinder. Refer to <u>Master Cylinder Replacement</u> .	
1	Clip, Brake Pedal Pivot Retaining
2	Washer, Brake Pedal Pivot
3	Bolt, Vacuum Brake Booster Mounting
	Tighten: 50 N.m (37 lb ft)

Booster, Vacuum Brake.

Tip:

4

- Apply a thin coating of high temperature grease GM P/N 12345996 (Canadian P/N 10953501) to the brake pedal pushrod pivoting the brake pedal.
- If the seal between the vacuum brake booster and the bulk head is damaged, replace the seal.

VACUUM BRAKE BOOSTER CHECK VALVE AND/OR HOSE REPLACEMENT (L61 - 2.2L)

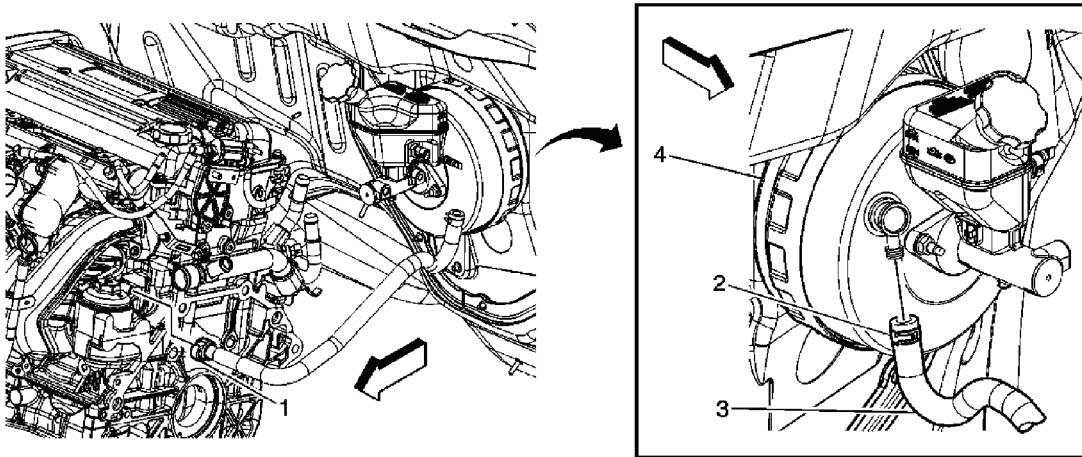


Fig. 43: Vacuum Brake Booster Check Valve and/or Hose Replacement (L61 - 2.2L)
Courtesy of GENERAL MOTORS CORP.

Vacuum Brake Booster Check Valve and/or Hose Replacement (L61 - 2.2L)

Callout	Component Name
NOTE: Refer to Fastener Notice .	
Fastener Tightening Specifications: Refer to Fastener Tightening Specifications . Preliminary Procedure: Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .	
1	Clamp, Brake Booster Vacuum Hose.
2	Clamp, Brake Booster Vacuum Hose.
3	Hose, Brake Booster Vacuum.
4	Valve, Brake Booster Vacuum Check

VACUUM BRAKE BOOSTER CHECK VALVE AND/OR HOSE REPLACEMENT (LE5 - 2.4L)

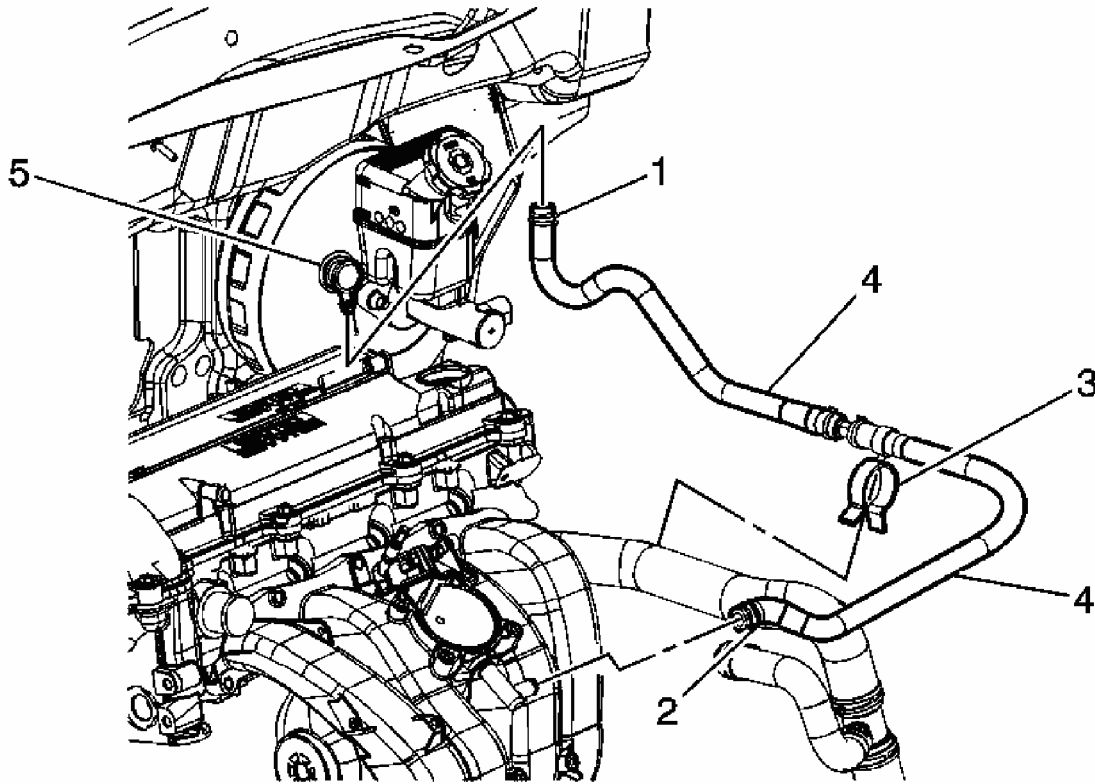


Fig. 44: Vacuum Brake Booster Check Valve and/or Hose Replacement (LE5 - 2.4L)
 Courtesy of GENERAL MOTORS CORP.

Vacuum Brake Booster Check Valve and/or Hose Replacement (LE5 - 2.4L)

Callout	Component Name
NOTE: Refer to Fastener Notice .	
Fastener Tightening Specifications: Refer to Fastener Tightening Specifications . Preliminary Procedure: Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .	
1	Clamp, Brake Booster Vacuum Hose.
2	Clamp, Brake Booster Vacuum Hose.
3	Clamp, Brake Booster Vacuum Hose Retaining.
4	Hose, Brake Booster Vacuum.
5	Valve, Brake Booster Vacuum Check.

DESCRIPTION AND OPERATION

BRAKE FLUID AND BRAKE FLUID HANDLING

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

Use extreme care when selecting brake system fluids or seal damage can result. Refer to Fluid and Lubricant Recommendations in Maintenance and Lubrication to select the correct fluid.

Do not reuse brake system fluids. Do not mix power steering fluid with brake fluid. Fluid contamination may result in swelling and deterioration of rubber parts. This can lead to reduced brake performance and the eventual loss of braking capability.

Service booster components in a clean work area separate from the brake servicing area. Wash hands before changing work areas. Do not use the same containers for brake and power steering fluids.

CAUTION: Brake fluid may be irritating to the skin or the eyes, or may cause nausea, vomiting, or diarrhea if swallowed. In case of contact or swallowing take the following actions:

- Eye contact - rinse thoroughly with water
- Skin contact - wash with soap and water
- If swallowed - Contact a physician immediately. Give two glasses of water and induce vomiting by sticking fingers down the throat.

NOTE: Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.

Always store brake fluid in a closed, sealed container. Never use previously opened containers of stored brake fluid. Always use new brake fluid from a sealed container. Brake fluid left in open or improperly sealed containers will absorb moisture. Moisture can lower the brake fluid boiling point, causing the following problems:

- Brake system contamination
- Corrosion
- Deterioration of rubber components

If the brake fluid contains improper fluid, water, or other contaminants, the brake fluid may boil or may deteriorate rubber components in the hydraulic brake system.

Evidence of rubber deterioration occurs in the following areas:

- Swollen master cylinder piston seals
- Swelling of the wheel cylinder boots
- Swelling of caliper boots
- Swelling of the master cylinder reservoir diaphragm

If rubber deterioration is found, replace all rubber parts, including the hoses, in the brake system. Inspect for brake fluid on the brake linings. Replace the brake linings that are contaminated with brake fluid.

If the brake fluid is contaminated and the master cylinder piston seals are good, check for leaks and excessive heat conditions. If no leaks or excessive heat conditions are found, flush the brake system.

Flushing The Hydraulic Brake System

In order to flush the brake hydraulic system, run new brake fluid through the brake system. Continue until the brake fluid at each bleeder valve comes out clear. Flushing is the only way to clean contaminated fluid out of the system. Flush the brake hydraulic system for the following reasons:

- New hydraulic brake parts are installed
- Contamination may be present
- You do not know the grade of brake fluid in the brake system
- Mineral oil is present in the brake fluid

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

Brake Warning Indicator

The instrument panel cluster (IPC) illuminates the brake warning indicator when one or more of the following occurs.

- The body control module (BCM) detects that the park brake is engaged.
- The BCM detects a low brake fluid condition. The IPC receives a GMLAN message from the BCM 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 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 two hydraulic circuits, supplying diagonally-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 on non-ABS equipped vehicles, is achieved through a proportioning valve assembly.

Pressure balance control on ABS equipped vehicles, 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

2006 Chevrolet HHR LT

2006 BRAKES Hydraulic Brakes - HHR

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

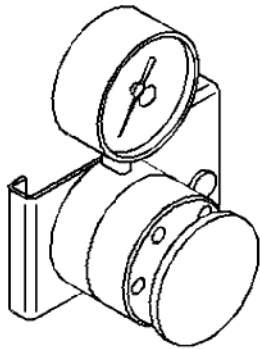
SPECIAL TOOLS

Special Tools

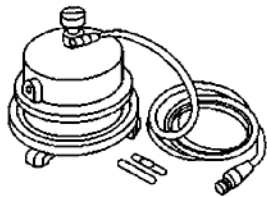
Illustration	Tool Number/ Description

2006 Chevrolet HHR LT

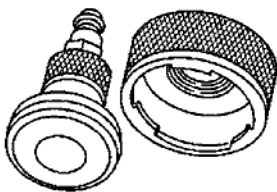
2006 BRAKES Hydraulic Brakes - HHR



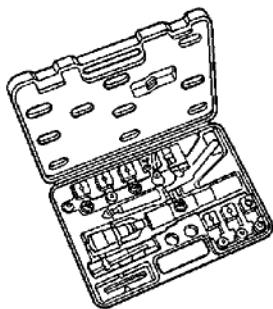
J 28662
Brake Pedal Effort Gage



J 29532
Diaphragm Pressure Bleeder



J 44894-A
Brake Bleeder Adapter



J 45405
Brake Pipe Flaring Kit