Hydraulic Brakes

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake and Clutch Pedal Release Bracket to Pedal Mounting Bracket Bolt	22 N•m	16 lb ft
Brake and Clutch Pedal Release Bracket to Steering Column Reinforcement Bracket Bolt	22 N•m	16 lb ft
Brake Hose Fitting Bolt	40 N•m	30 lb ft
Brake Pedal Bracket Bolt	9 N•m	80 lb in
Brake Pedal Bracket Nut	19 N•m	14 lb ft
Brake Pipe Fitting	18 N•m	13 lb ft
Master Cylinder Nut	50 N•m	37 lb ft
Power Brake Booster Pump Bracket Bolt	22 N•m	16 lb ft
Power Brake Booster Pump Bracket Bolt and Nut	22 N•m	16 lb ft
Power Vacuum Brake Booster Bolt	19 N•m	14 lb ft

Brake Component Specifications

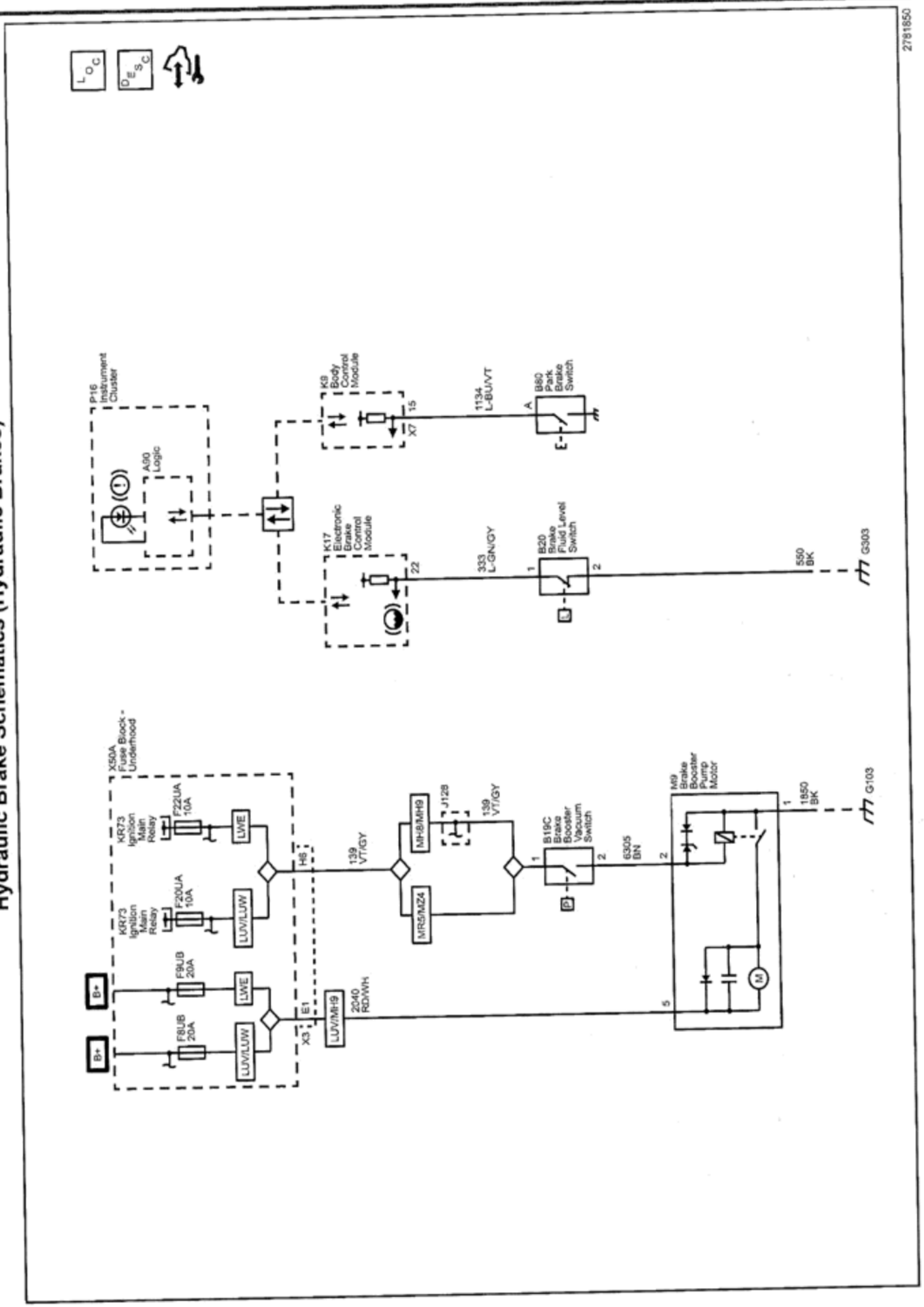
Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve	17 N•m	13 lb ft
Rear Brake Cylinder Bleeder Valve	9 N•m	80 lb in

Brake System Specifications

Application	Specification	
	Metric	English
Brake Pedal Travel Maximum specification with 450 N (101 lbs) of force applied to the pedal with the ignition OFF and the booster power reserve depleted.	48–58 mm	1.9–2.3 in

Schematic and Routing Diagrams

Hydraulic Brake Schematics (Hydraulic Brakes)



Diagnostic Information and Procedures

DTC C0267

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

DTC Descriptor

DTC C0267: Low Brake Fluid Indicated

For symptom byte information refer to *Symptom Byte List on page 6-85*.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	C0267 00	C0267 00	—	—
Ground	—	C0267 00	—	—

Circuit/System Description

The brake fluid level switch monitors the level of the brake fluid in the brake fluid reservoir. When the electronic brake control module sees low brake fluid level, the DTC is set.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

Low brake fluid level is detected for 8 s.

Action Taken When the DTC Sets

- The electronic brake control module disables the traction control and stability control for the duration of the ignition cycle.
- The traction control/stability control-active indicator turns ON.
- The brake warning indicator turns ON.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Hydraulic Brake Schematics on page 5-109

Connector End View Reference

Component Connector End Views on page 11-269

Description and Operation

Hydraulic Brake System Description and Operation on page 5-181

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Verify that the brake is above minimum level.

⇒ **If low**

Refer to *Brake Fluid Loss on page 5-127*.

⇓ **If above minimum level**

2. Ignition ON.
3. Verify the scan tool Brake Fluid Level Sensor parameter is OK.

⇒ **If the parameter is Low**

Refer to Circuit/System Testing.

⇓ **If the parameter is OK**

4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 10 Ω between the ground circuit terminal 2 and ground.

⇒ **If 10 Ω or greater**

2.1. Ignition OFF.

2.2. Test for less than 2 Ω in the ground circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, repair the open/high resistance in the ground connection.

⇒ **If less than 10 Ω**

3. Ignition ON.
4. Verify the scan tool Brake Fluid Level Sensor parameter is Low.

⇒ **If the parameter is not Low**

4.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.

4.2. Test for infinite resistance between the signal circuit terminal 1 and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K17 Electronic Brake Control Module.

⇓ **If the parameter is Low**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.
6. Verify the scan tool Brake Fluid Level Sensor parameter is OK.

⇒ **If the parameter is not OK**

6.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

6.2. Test for less than 1 V between the signal circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇓ If less than 1 V.

6.3. Test for less than 2 Ω in the signal circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the K17 Electronic Brake Control Module.

⇓ **If the parameter is OK**

7. Test or replace the B20 Brake Fluid Level Switch.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the repair.

- *Brake Fluid Level Indicator Switch Replacement on page 5-150*
- *Control Module References on page 6-3* for electronic brake control module replacement, programming and setup.

Symptoms - Hydraulic Brakes

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

1. Perform the *Brake System Vehicle Road Test on page 5-141* before using the hydraulic brake symptom tables in order to duplicate the customers 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 on page 5-181*
   - *Hydraulic Brake System Description and Operation on page 5-181*
   - *Brake Booster Vacuum Assist Description and Operation on page 5-180*
   - *Brake Assist System Description and Operation on page 5-180*
   - *ABS Description and Operation on page 5-51*

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the hydraulic brake system. Refer to *Checking Aftermarket Accessories on page 11-525*.
- 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 on page 11-531*.

Symptom List

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

- *Brake Booster Pump Motor Malfunction on page 5-112*
- *Brake Warning Indicator Malfunction on page 5-114*
- *Brake Pulsation on page 5-116*
- *Brake System Noise on page 5-117*
- *Braking Action Uneven - Pulls to One Side on page 5-118*
- *Braking Action Uneven - Front to Rear on page 5-120*
- *Brake Pedal Excessive Travel on page 5-121*
- *Brake Pedal Excessive Effort on page 5-123*
- *Brakes Drag on page 5-125*
- *Brake System Slow Release on page 5-126*
- *Brake Fluid Loss on page 5-127*

Brake Booster Pump Motor Malfunction

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Booster Pump Motor B+	1	1	—	—
Brake Booster Vacuum Switch Ignition	—	1	1	—
Brake Booster Pump Motor Control	1	1	2	—
Brake Booster Pump Motor Ground	—	1	1	—
1. Brake Booster Pump Motor Always Off 2. Brake Booster Pump Motor Always On				

Circuit/System Description

The brake booster vacuum switch monitors the amount of vacuum available to the power brake booster. When the vacuum within the system drops, the switch within the brake booster vacuum switch closes allowing voltage to be supplied to the brake booster pump motor.

Reference Information

Schematic Reference

Hydraulic Brake Schematics on page 5-109

Connector End View Reference

Component Connector End Views on page 11-269

Description and Operation

Brake Booster Vacuum Assist Description and Operation on page 5-180

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.

⇒ **If damage, leakage or incorrect installation is found**

Refer to *Brake Assist System Diagnosis on page 5-138*.

⇓ **If the inspection is OK**

2. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M9 Brake Booster Pump Motor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 1 and ground.

⇒ **If 10 Ω or greater**

2.1. Test for less than 2 Ω in the ground circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, repair the open/high resistance in the ground connection.

⇓ **If less than 10 Ω**

3. Ignition ON.

4. Verify that a test lamp illuminates between the B+ circuit terminal 5 and ground.

⇒ **If the test lamp does not illuminate and the circuit fuse is good**

4.1. Ignition OFF.

4.2. Test for less than 2 Ω in the B+ circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

⇒ **If the test lamp does not illuminate and the circuit fuse is open**

4.1. Ignition OFF.

4.2. Test for infinite resistance between the B+ circuit and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the M9 Brake Booster Pump Motor.

⇓ **If the test lamp illuminates**

5. Ignition OFF, connect the harness connector at the M9 Brake Booster Pump Motor and disconnect the harness connector at the B19C Brake Booster Vacuum Switch, ignition ON.
6. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.

⇒ **If the test lamp does not illuminate and the circuit fuse is good**

6.1. Ignition OFF.

6.2. Test for less than 2 Ω in the ignition circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

⇒ **If the test lamp does not illuminate and the circuit fuse is open**

6.1. Ignition OFF.

6.2. Test for infinite resistance between the ignition circuit and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇓ If infinite resistance

6.3. Disconnect the harness connector at the M9 Brake Booster Pump Motor.

6.4. Test for infinite resistance between the control circuit and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the M9 Brake Booster Pump Motor.

⇓ **If the test lamp illuminates**

7. Verify that a test lamp does not illuminate between the control circuit terminal 2 and ground.

⇒ **If the test lamp illuminates**

Repair the short to voltage on the control circuit.

⇓ **If the test lamp does not illuminate**

8. Connect a 10 A fused jumper wire between the ignition circuit terminal 1 and the control circuit terminal 2.
9. Verify the M9 Brake Booster Pump Motor activates.

⇒ **If the brake booster pump motor does not activate**

9.1. Ignition OFF

9.2. Test for less than 2 Ω in the control circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the M9 Brake Booster Pump Motor.

⇓ **If the brake booster pump motor activates**

10. Test or replace the B19C Brake Booster Vacuum Switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the M9 Brake Booster Pump Motor. Install a 30 A fused jumper wire between the B+ circuit terminal 5 and B+. Install a 7.5 A fused jumper wire between the ignition circuit terminal 2 and B+. Install a jumper wire between the ground circuit terminal 1 and ground.
2. Verify the M9 Brake Booster Pump Motor activates.

⇒ **If the brake booster pump motor does not activate**

Replace the M9 Brake Booster Pump Motor.

⇓ **If the brake booster pump motor activates**

3. All OK.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the repair.

Power Brake Booster Pump Replacement on page 5-178

Brake Warning Indicator Malfunction

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

Diagnostic Fault Information

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

Circuit/System Description

The instrument cluster turns ON the brake warning indicator for 5 s after ignition ON. The body control module monitors the parking brake switch and will request the instrument cluster via serial data to turn the brake warning indicator ON when the parking brake is applied. When the electronic brake control module detects a fault, it sends a serial data message to the instrument cluster commanding the indicator ON.

Reference Information

Schematic Reference

Hydraulic Brake Schematics on page 5-109

Connector End View Reference

Component Connector End Views on page 11-269

Description and Operation

Hydraulic Brake System Description and Operation on page 5-181

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Verify that the brake fluid is above minimum level.

⇒ **If low**

Refer to *Brake Fluid Loss on page 5-127*.

⇓ **If above minimum level**

2. Ignition ON.
3. Verify the scan tool Electronic Brake Control Module Brake Fluid Level Sensor is Ok.

⇒ **If the parameter is Low**

Refer to Circuit/System Testing - Brake Fluid Level Switch Malfunction.

⇓ **If the parameter is Ok**

4. Verify the scan tool Body Control Module Park Brake Switch parameter changes between Applied and Released while applying and releasing the parking brake.

⇒ **If the parameter does not change**

Refer to Circuit/System Testing - Park Brake Switch Malfunction.

⇓ **If the parameter changes**

5. Verify the brake warning indicator turns ON and OFF, when commanding the instrument cluster All Indicators On and Off with a scan tool.

⇒ **If the brake warning indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster.

⇓ **If the brake warning indicator turns ON and OFF**

6. All OK.

Circuit/System Testing

Note: Circuit/System Verification must be performed before Circuit/System Testing.

Brake Fluid Level Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 2 and ground.

⇒ **If 10 Ω or greater**

2.1. Ignition OFF.

2.2. Test for less than 2 Ω in the ground circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, repair the open/high resistance in the ground connection.

⇒ **If less than 10 Ω**

3. Ignition ON.
4. Verify the scan tool Electronic Brake Control Module, Brake Fluid Level Sensor parameter is Low.

⇒ **If the parameter is not Low**

4.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.

4.2. Test for infinite resistance between the signal circuit terminal 1 and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K17 Electronic Brake Control Module.

⇓ **If the parameter is Low**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.
6. Verify the scan tool Electronic Brake Control Module, Brake Fluid Level Sensor parameter is Ok.

⇒ **If the parameter is Low**

6.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

6.2. Test for less than 1 V between the signal circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇓ If less than 1 V.

6.3. Test for less than 2 Ω in the signal circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the K17 Electronic Brake Control Module.

⇓ **If the parameter is Ok**

7. Test or replace the B20 Brake Fluid Level Switch.

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the B80 Park Brake Switch.
2. Verify that the B80 Park Brake Switch has no physical damage or incorrect installation.

⇒ **If physical damage or incorrect installation is found**

Test or replace the B80 Park Brake Switch.

⇓ **If the inspection is OK**

3. Ignition ON.
4. Verify the scan tool Park Brake Switch parameter is Released.

⇒ **If the parameter is Applied**

4.1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.

4.2. Test for infinite resistance between the signal circuit terminal 1 and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K9 Body Control Module.

⇓ **If the parameter is Released**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.
6. Verify the scan tool Park Brake Switch parameter is Applied.

⇒ **If the parameter is Released**

6.1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.

6.2. Test for less than 1 V between the signal circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇓ If less than 1 V.

6.3. Test for less than 2 Ω in the signal circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the K9 Body Control Module.

⇓ **If the parameter is Applied**

7. Test or replace the B80 Park Brake Switch.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the repair.

- *Brake Fluid Level Indicator Switch Replacement on page 5-150*
- *Parking Brake Indicator Switch Replacement on page 5-188*
- *Control Module References on page 6-3* for body control module replacement, programming and setup.

Brake Pulsation

Step	Action	Yes	No
DEFINITION: Fluctuation or pulsation is felt through the brake pedal, steering wheel, seat, floor, and/or in the vehicle ONLY when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	1. Inspect the disc brake system for the following conditions: • Excessive thickness variation of rotor friction surfaces • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag • Excessive corrosion of rotor friction surfaces; including red, gray or black oxidation • Loose, damaged or missing caliper or lining hardware • Bent of damaged caliper or mounting component • Excessive LRO of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings 2. Adjust, repair or replace components as necessary. Refer to *Disc Brake System Diagnosis on page 5-128*. Did you find and correct a condition?	Go to *Step 4*	Go to *Step 3*
3	1. Inspect the drum brake system for the following conditions: • Out of round or damaged drum • Excessive radial runout of drum friction surface • Hard spots, heat checks, blueing discoloration of drum friction surface; possibly due to brake drag • Bent of damaged drum • Excessive radial runout of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings 2. Adjust, repair or replace components as necessary. Refer to *Drum Brake System Diagnosis on page 5-131*. Did you find and correct a condition?	Go to *Step 4*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
4	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to *Brake System Vehicle Road Test on page 5-141*. Is the condition still present?	Go to *Step 2*	System OK

Brake System Noise

Step	Action	Yes	No
DEFINITION: Vehicle exhibits abnormal noise when braking; vehicle may exhibit abnormal noise during motion just after brake pedal release.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	1. Inspect the disc brake system for the following conditions: • Lining wear indicator contact with rotor • Debris trapped between rotor and splash shield or backing plate; and/or debris trapped between rotor and linings • Contaminated linings • Aftermarket linings • Glazed linings • Distorted, cracked or damaged linings • Excessively worn linings • Damaged or excessively worn caliper hardware and/or lining hardware • Incorrectly installed, loose or missing caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Bent or damaged splash shield or backing plate • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to *Disc Brake System Diagnosis on page 5-128*. Did you find and correct a condition?	Go to *Step 10*	Go to *Step 3*
3	1. Inspect the drum brake system for the following conditions: • Glazed linings • Contaminated linings • Aftermarket linings • Distorted, damaged or excessively worn linings • Improper adjustment • Weak or damaged return spring or springs • Weak or damaged hold down spring or springs • Cracked, scored, excessively worn or damaged drum • Out of round or damaged drum • Hard spots, heat checks, blueing discoloration of drum friction surface • Threaded or spiral grooves in drum friction surface • Distorted or damaged backing plate • Lack of lubrication on backing plate • Excessive dust or foreign matter in drum 2. Adjust, repair or replace components as necessary. Refer to *Drum Brake System Diagnosis on page 5-131*. Did you find and correct a condition?	Go to *Step 10*	Go to *Step 4*

Brake System Noise (cont'd)

Step	Action	Yes	No
4	1. Inspect the brake assist system for the following conditions: • Lack of lubrication or excessively worn pushrod or pedal pivots or pivot bushings • Bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster and/or check valve, if equipped • Low power steering fluid level, if equipped with hydraulic boost • Improperly tensioned, excessively worn or damaged power steering belt, if equipped with hydraulic boost • Restricted return hose from hydraulic booster, if equipped • Improperly operating hydraulic booster, if equipped • Improperly functioning power steering system, if equipped with a hydraulic booster assembly • Contaminated power steering fluid, if equipped with hydraulic boost 2. Adjust, repair or replace components as necessary. Refer to *Brake Assist System Diagnosis on page 5-138*. Did you find and correct a condition?	Go to *Step 10*	Go to *Step 5*
5	1. Inspect the hydraulic brake system for the following conditions. • Improper operation of wheel cylinder pistons, if equipped • Improper operation of caliper pistons • Contaminated brake fluid 2. Adjust, repair or replace components as necessary. Refer to *Hydraulic Brake System Diagnosis on page 5-134*. Did you find and correct a condition?	Go to *Step 10*	Go to *Step 6*
6	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to *Step 7*	Go to *Step 9*
7	Ensure the park brake shoes are not adjusted too tightly, possibly causing a noise under certain conditions. Are the park brake shoes adjusted too tightly?	Go to *Step 8*	Go to *Step 9*
8	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration, heat spots, and excessive radial runout. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?	Go to *Step 10*	Go to *Step 9*
9	Inspect the park brake system for proper operation. Refer to *Park Brake System Diagnosis (Drum Brake) on page 5-183* or *Park Brake System Diagnosis (Disc Brake) on page 5-185*. Did you find and correct a condition?	Go to *Step 10*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
10	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to *Brake System Vehicle Road Test on page 5-141*. Is the condition still present?	Go to *Step 2*	System OK

Braking Action Uneven - Pulls to One Side

Test Description

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

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

Braking Action Uneven - Pulls to One Side

Step	Action	Yes	No
DEFINITION: Vehicle pulls to one side only when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	1. Inspect the hydraulic brake system for the following conditions: • Kinked, pinched or damaged brake pipe or flexible brake hose • Sticking or improperly operating caliper piston • Sticking or improperly operating wheel cylinder pistons • Brake fluid leak 2. Adjust, repair or replace components as necessary. Refer to *Hydraulic Brake System Diagnosis on page 5-134*. Did you find and correct a condition?	Go to *Step 7*	Go to *Step 3*
3	1. Inspect the disc brake system for the following conditions: • Contaminated linings • Glazed linings • Distorted, cracked or damaged linings on one side • Loose, damaged or missing caliper hardware and/or lining hardware • Incorrect linings on one side • Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to *Disc Brake System Diagnosis on page 5-128*. Did you find and correct a condition?	Go to *Step 7*	Go to *Step 4*
4	1. Inspect the drum brake system for the following conditions: • Improper adjustment or improper adjuster operation • Weak or damaged return spring or springs • Glazed linings • Contaminated linings • Distorted or damaged linings • Incorrect linings on one side • Excessively worn or damaged drum on one side 2. Adjust, repair or replace components as necessary. Refer to *Drum Brake System Diagnosis on page 5-131*. Did you find and correct a condition?	Go to *Step 7*	Go to *Step 5*
5	1. Inspect the suspension system for the following conditions: • Incorrect tire pressure • Loose suspension component connections • Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to *Symptoms - Suspension General Diagnosis on page 16-35*. Did you find and correct a condition?	Go to *Step 7*	Go to *Step 6*

Braking Action Uneven - Pulls to One Side (cont'd)

Step	Action	Yes	No
6	1. Inspect the steering system for the following conditions: • Loose steering component connections • Excessively worn or damaged steering components 2. Adjust, repair or replace components as necessary. Refer to *Symptoms - Power Steering System on page 15-11.* Did you find and correct a condition?	Go to *Step 7*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
7	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to *Brake System Vehicle Road Test on page 5-141.* 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:

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

Braking Action Uneven - Front to Rear

Step	Action	Yes	No
DEFINITION: Braking action or stopping force sensitive or grabbing and/or more pronounced at the front or at the rear axle. Sensitive or grabbing brakes: Excessive brake jump-in force relative to brake pedal input.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	1. Inspect the hydraulic brake system for the following conditions: • Improper operation of wheel cylinder pistons, if equipped • Improper operation of caliper pistons • Kinked, pinched or damaged brake pipe or flexible brake hose • Brake fluid leak • Improperly functioning proportioning valve, if equipped • Improper operation of dynamic rear proportioning (DRP) system, if equipped 2. Adjust, repair or replace components as necessary. Refer to *Hydraulic Brake System Diagnosis on page 5-134.* Did you find and correct a condition?	Go to *Step 7*	Go to *Step 3*
3	1. Inspect the disc brake system for the following conditions: • Contaminated linings • Glazed linings • Distorted, cracked or damaged linings • Excessively worn linings • Aftermarket linings • Damaged or excessively worn caliper hardware and/or lining hardware • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces 2. Adjust, repair or replace components as necessary. Refer to *Disc Brake System Diagnosis on page 5-128.* Did you find and correct a condition?	Go to *Step 7*	Go to *Step 4*

Braking Action Uneven - Front to Rear (cont'd)

Step	Action	Yes	No
4	1. Inspect the drum brake system for the following conditions. • Contaminated linings • Improper adjustment • Excessively worn or damaged linings • Weak or damaged return spring or springs • Excessively worn or damaged drums • Hard spots, heat checks, blueing discoloration of drum friction surface • Distorted or damaged backing plate 2. Adjust, repair or replace components as necessary. Refer to *Drum Brake System Diagnosis on page 5-131*. Did you find and correct a condition?	Go to *Step 7*	Go to *Step 5*
5	1. Inspect the suspension system for the following conditions: • Loose suspension component connections • Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to *Symptoms - Suspension General Diagnosis on page 16-35*. Did you find and correct a condition?	Go to *Step 7*	Go to *Step 6*
6	1. Inspect the brake assist system for the following conditions: • Binding, bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster, if equipped • Damaged or improperly operating hydraulic booster, if equipped 2. Adjust, repair or replace components as necessary. Refer to *Brake Assist System Diagnosis on page 5-138*. Did you find and correct a condition?	Go to *Step 7*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
7	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to *Brake System Vehicle Road Test on page 5-141*. Is the condition still present?	Go to *Step 2*	System OK

Brake Pedal Excessive Travel

Step	Action	Yes	No
DEFINITION: Brake pedal travels further than expected to obtain firm pedal and/or firm pedal cannot be obtained, pedal fades away, or pedal is spongy.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	Inspect the travel and feel of brake pedal applies. Perform the following: 1. Apply the brake pedal several times to fully deplete the power reserve. 2. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel. 3. Apply the brake pedal with light, steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply. 4. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply. Did you complete the brake pedal travel and feel inspections?	Go to *Step 3*	—

Brake Pedal Excessive Travel (cont'd)

Step	Action	Yes	No
3	1. Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections. • Pedal feel was spongy. – Air in hydraulic system – External brake fluid leaks – Soft, weak or damaged hydraulic hoses; expanding under pressure • Pedal fell away and/or traveled to or almost to floor. – External brake fluid leaks – Poor brake fluid quality; low boiling point – Internal brake fluid leaks; improperly functioning master cylinder • Pedal was somewhat firm then dropped slightly, or pedal rose with successive applies, or pedal travel was different between slow and quick applies. – Internal brake fluid leaks; improperly functioning master cylinder – Poor brake fluid quality; low boiling point – Binding wheel cylinder pistons, if equipped • Pedal returned to rest slowly after any of the applies. – Internally damaged flexible brake hoses; hindering fluid return – Binding caliper pistons – Binding wheel cylinder pistons, if equipped – Internal brake fluid leaks; improperly functioning master cylinder 2. Repair or replace components as necessary. Refer to *Hydraulic Brake System Diagnosis on page 5-134*. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?	Go to *Step 9*	Go to *Step 4*
4	1. Inspect the drum brake system, if equipped, for the following conditions: • Improper adjustment or improper adjuster operation • Glazed or excessively worn linings • Cracked, distorted or damaged linings • Cracked, excessively worn, distorted or damaged drums • Bell-mouth or barrel-shaped drum friction surface • Hard spots, heat checks, blueing discoloration of drum friction surface 2. Adjust, repair or replace components as necessary. Refer to *Drum Brake System Diagnosis on page 5-131*. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?	Go to *Step 9*	Go to *Step 5*
5	1. Inspect the disc brake system for the following conditions: • Cracked, excessively worn or damaged linings • Cracked, excessively worn or damaged rotors • Improperly operating, binding or damaged caliper hardware and/or lining hardware • Loose or missing caliper hardware and/or lining hardware • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to *Disc Brake System Diagnosis on page 5-128*. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?	Go to *Step 9*	Go to *Step 6*

Brake Pedal Excessive Travel (cont'd)

Step	Action	Yes	No
6	Inspect for proper brake pedal travel. Refer to *Brake Pedal Travel Measurement and Inspection on page 5-141*. Is the brake pedal travel distance within the acceptable limits?	Go to *Step 8*	Go to *Step 7*
7	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. • For the brake pedal pushrod component inspection, refer to *Brake Pedal Pushrod Inspection on page 5-145*. • Inspect the brake pedal bushings for binding, excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to *Step 9*	Go to *Step 8*
8	1. Inspect the brake assist system for the following conditions: • Vacuum leaks and/or improperly operating check valve, if equipped with vacuum assist • Power steering fluid leaks, if equipped with hydraulic power assist • Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary. Refer to *Brake Assist System Diagnosis on page 5-138*. Did you find and correct a condition?	Go to *Step 9*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
9	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to *Brake System Vehicle Road Test on page 5-141*. Is the condition still present?	Go to *Step 2*	System OK

Brake Pedal Excessive Effort

Step	Action	Yes	No
DEFINITION: Brake pedal requires an increased amount of input from the driver to obtain good braking action and/or stopping distance is increased.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	1. Inspect the brake assist system for the following conditions: • Vacuum leaks, if equipped with vacuum power assist • Power steering fluid leaks, if equipped with hydraulic power assist • Lack of lubrication, binding or excessively worn pushrod or pedal pivots or pivot bushings • Bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary. Refer to *Brake Assist System Diagnosis on page 5-138*. Did you find and correct a condition?	Go to *Step 6*	Go to *Step 3*

Brake Pedal Excessive Effort (cont'd)

Step	Action	Yes	No
3	1. Inspect the hydraulic brake system for the following conditions: • Binding caliper pistons • Binding wheel cylinder pistons, if equipped • Internally damaged flexible brake hoses; hindering fluid flow • External brake fluid leaks • Kinked or damaged flexible brake hoses and/or pipes • Internal brake fluid leaks; improperly operating master cylinder • Poor brake fluid quality; low boiling point 2. Adjust, repair or replace components as necessary. Refer to *Hydraulic Brake System Diagnosis on page 5-134*. Did you find and correct a condition?	Go to *Step 6*	Go to *Step 4*
4	1. Inspect the disc brake system for the following conditions: • Excessively worn linings • Glazed linings • Cracked, distorted or damaged linings • Contaminated linings • Binding, damaged or excessively worn caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Excessively worn or corroded rotor friction surfaces • Glazed rotor friction surfaces • Hard spots, heat checks, blueing discoloration of rotor friction surfaces 2. Adjust, repair or replace components as necessary. Refer to *Disc Brake System Diagnosis on page 5-128*. Did you find and correct a condition?	Go to *Step 6*	Go to *Step 5*
5	1. Inspect the drum brake system, if equipped, for the following conditions: • Excessively worn linings • Improper adjustment or improper adjuster operation • Glazed linings • Cracked, distorted or damaged linings • Contaminated linings • Out of round or damaged drum • Bell-mouth or barrel-shaped drum friction surface • Hard spots, heat checks, blueing discoloration of drum friction surface • Lack of lubrication on backing plate • Excessive dust or foreign matter in drum 2. Adjust, repair or replace components as necessary. Refer to *Drum Brake System Diagnosis on page 5-131*. Did you find and correct a condition?	Go to *Step 6*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to *Brake System Vehicle Road Test on page 5-141*. Is the condition still present?	Go to *Step 2*	System OK

Brakes Drag

Step	Action	Yes	No
DEFINITION: Brake system does not fully release or has delayed release; vehicle motion may be hindered by brake system without applying brakes.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?	Go to *Step 3*	Go to *Step 4*
3	1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing. Did you find and correct a condition?	Go to *Step 15*	Go to *Step 4*
4	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to *Step 5*	Go to *Step 7*
5	Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions. Are the park brake shoes adjusted too tightly?	Go to *Step 6*	Go to *Step 8*
6	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration and heat spots. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?	Go to *Step 15*	Go to *Step 8*
7	1. Inspect the drum brake system, if equipped, for the following conditions: • Improper adjustment • Weak or damaged return spring or springs • Distorted or damaged linings • Out of round or damaged drum • Weak or damaged hold down spring or springs • Lack of lubrication on backing plate • Distorted or damaged backing plate 2. Adjust, repair or replace components as necessary. Refer to *Drum Brake System Diagnosis on page 5-131*. Did you find and correct a condition?	Go to *Step 15*	Go to *Step 8*
8	Inspect the park brake system for proper operation. Refer to *Park Brake System Diagnosis (Drum Brake) on page 5-183* or *Park Brake System Diagnosis (Disc Brake) on page 5-185*. Did you find and correct a condition?	Go to *Step 15*	Go to *Step 9*
9	1. Inspect the disc brake system for the following conditions: • Binding, incorrectly installed or missing caliper hardware and/or lining hardware—Ensure free movement of linings and of caliper, if equipped with sliding type caliper. • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Distorted or damaged linings • Damaged or excessively worn caliper hardware and/or lining hardware • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to *Disc Brake System Diagnosis on page 5-128*. Did you find and correct a condition?	Go to *Step 15*	Go to *Step 10*
10	1. Separate the brake booster pushrod from the brake pedal. 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 12*	Go to *Step 11*

Brakes Drag (cont'd)

Step	Action	Yes	No
11	1. Inspect the pushrod for improper position and/or damage. Correctly position or replace the pushrod if necessary. 2. Inspect the brake pedal assembly for damage and replace if necessary. Did you complete the repair or replacement?	Go to *Step 15*	—
12	1. For vacuum boost systems, disconnect the vacuum check valve from the booster to relieve vacuum reserve. 2. Separate the master cylinder from the brake booster. Do not disconnect any brake pipes. 3. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to *Step 14*	Go to *Step 13*
13	Replace the brake booster assembly. Did you complete the replacement?	Go to *Step 15*	—
14	1. Inspect the hydraulic brake system for the following conditions: • Improper operation of wheel cylinder pistons, if equipped • Improper operation of caliper pistons • Contaminated brake fluid • Internally damaged flexible brake hoses; hindering brake release • Damaged or improperly operating master cylinder 2. Adjust, repair or replace components as necessary. Refer to *Hydraulic Brake System Diagnosis on page 5-134*. Did you find and correct a condition?	Go to *Step 15*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
15	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to *Brake System Vehicle Road Test on page 5-141*. Is the condition still present?	Go to *Step 2*	System OK

Brake System Slow Release

Step	Action	Yes	No
DEFINITION: Brake system releases and returns to rest slowly; vehicle motion is hindered by brake system briefly after release of brake pedal.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	1. Inspect the hydraulic brake system for the following conditions: • Improper operation of wheel cylinder pistons, if equipped • Improper operation of caliper pistons • Internally damaged flexible brake hoses; hindering brake release • Contaminated brake fluid • Damaged or improperly operating master cylinder 2. Adjust, repair or replace components as necessary. Refer to *Hydraulic Brake System Diagnosis on page 5-134*. Did you find and correct a condition?	Go to *Step 6*	Go to *Step 3*

Brake System Slow Release (cont'd)

Step	Action	Yes	No
3	1. Inspect the brake assist system for the following conditions: • Binding, bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster, if equipped • Restricted return hose from hydraulic booster, if equipped • Damaged or improperly operating hydraulic booster, if equipped 2. Adjust, repair or replace components as necessary. Refer to *Brake Assist System Diagnosis on page 5-138*. Did you find and correct a condition?	Go to *Step 6*	Go to *Step 4*
4	1. Inspect the drum brake system, if equipped, for the following conditions: • Weak or damaged return spring or springs • Distorted or damaged linings • Out of round or damaged drum • Lack of lubrication on backing plate • Distorted or damaged backing plate 2. Adjust, repair or replace components as necessary. Refer to *Drum Brake System Diagnosis on page 5-131*. Did you find and correct a condition?	Go to *Step 6*	Go to *Step 5*
5	1. Inspect the disc brake system for the following conditions: • Damaged or excessively worn caliper hardware and/or lining hardware • Distorted or damaged linings • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to *Disc Brake System Diagnosis on page 5-128*. Did you find and correct a condition?	Go to *Step 6*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to *Brake System Vehicle Road Test on page 5-141*. Is the condition still present?	Go to *Step 2*	System OK

Brake Fluid Loss

Step	Action	Yes	No
DEFINITION: Brake fluid level is low not related to lining wear.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to *Step 2*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
2	1. Inspect the following hydraulic brake system components for brake fluid leaks: • Flexible brake hose connections; threaded and bolted • Flexible brake hose crimping joints • Brake pipe fittings • Caliper piston seals • Wheel cylinder piston seals, if equipped • Master cylinder reservoir • Master cylinder reservoir low pressure hose, if equipped • Brake pressure modulator valve (BPMV) assembly, if equipped 2. Repair or replace components as necessary. Refer to *Hydraulic Brake System Diagnosis on page 5-134*. Did you find and correct a condition?	Go to *Step 5*	Go to *Step 3*

Brake Fluid Loss (cont'd)

Step	Action	Yes	No
3	1. Disconnect the vacuum check valve from the booster to relieve vacuum reserve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. 3. Inspect the rear of the master cylinder for a brake fluid leak. 4. Inspect for brake fluid in the vacuum brake booster. Did you find the brake fluid leak?	Go to *Step 4*	Go to *Symptoms - Hydraulic Brakes on page 5-111*
4	Replace the brake master cylinder and the vacuum brake booster. Did you complete the replacement?	Go to *Step 5*	—
5	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 on page 5-141*. 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.
12. Disc brake rotor shields/backing plates that come in contact with disc brake rotors may cause brake system noise.
15. Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.
19. Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.
22. Disc brake rotor assembled lateral runout (LRO) that exceeds the maximum acceptable level can lead to thickness variation.

Disc Brake System Diagnosis

Step	Action	Yes	No
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 correctly. 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 *Symptoms - Hydraulic Brakes on page 5-111*
2	Visually inspect the disc brake pads for the following conditions: Refer to *Brake Pad Inspection on page 5-58*. • Lining thickness below specifications • Uneven and/or abnormal wear – edge-to-edge and/or side-to-side • Looseness or damage – including brake pad hardware • Evidence of contamination from an external substance Did you find any conditions to indicate a concern with any of the front and/or rear disc brake pads?	Go to *Step 3*	Go to *Step 12*
3	Are any of the front disc brake pads contaminated?	Go to *Step 8*	Go to *Step 4*
4	Are any of the front disc brake pads worn unevenly?	Go to *Step 7*	Go to *Step 5*
5	Are any of the front disc brake pads and/or brake 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 *Front Disc Brake Pads Replacement on page 5-61*. Did you complete the inspection and replacement?	Go to *Step 12*	—

Disc Brake System Diagnosis (cont'd)

Step	Action	Yes	No
7	**Caution:** Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. **Note:** Do NOT disconnect the hydraulic brake flex hoses from the calipers. 1. Remove the front brake caliper, as appropriate, from the mounting bracket and support the brake caliper. Refer to *Front Brake Caliper Replacement on page 5-65.* 2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions: • Binding or seized hardware • Worn, damaged or missing hardware components • Loose, bent, cracked, or damaged brake caliper mounting bracket 3. Replace components as required. Refer to *Front Brake Caliper Bracket Replacement on page 5-70* 4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to *Front Disc Brake Pads Replacement on page 5-61.* 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: • *Front Brake Caliper Overhaul on page 5-69* • *Front Brake Caliper Replacement on page 5-65* • *Front Brake Hose Replacement on page 5-162* • *Brake Pipe Replacement on page 5-158* Did you find and correct the source of the leak causing contamination of the brake 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 brake pads. Refer to *Front Wheel Drive Shaft Outer Joint and Boot Replacement on page 7-11.* Did you find and correct the source of the leak causing contamination of the brake pads?	Go to *Step 11*	Go to *Step 10*
10	1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 2. Replace any components found to be leaking 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?	Go to *Step 11*	—

Disc Brake System Diagnosis (cont'd)

Step	Action	Yes	No
11	1. Clean the remaining disc brake system components to remove any traces of the contaminant. **Caution:** Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. **Note:** Do NOT disconnect the hydraulic brake flex hoses from the calipers. 2. Remove the front disc brake caliper from the brake caliper mounting bracket and support the brake caliper. Refer to *Front Brake Caliper Replacement on page 5-65.* 3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions: Refer to *Front Disc Brake Mounting and Hardware Inspection on page 5-59.* • Binding or seized hardware • Distorted, worn, damaged or missing hardware components 4. Replace the brake mounting/sliding hardware components as required. Refer to *Front Disc Brake Mounting and Hardware Inspection on page 5-59.* 5. Replace the contaminated brake pads as a complete axle set. Refer to *Front Disc Brake Pads Replacement on page 5-61.* Did you complete the cleaning, inspection and replacement?	Go to *Step 12*	—
12	1. Check the thickness of each of the disc brake rotors. **Note:** Make the following determination and answer the question individually for EACH rotor. 2. Make a determination for each brake rotor if the brake rotor can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to *Brake Rotor Thickness Measurement on page 5-55.* Does the brake rotor meet the minimum requirements for REFINISHING?	Go to *Step 13*	Go to *Step 16*
13	**Note:** Make the following determination and answer the question individually for EACH rotor. Inspect each of the brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to *Brake Rotor Thickness Variation Measurement on page 5-55.* Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to *Step 15*	Go to *Step 14*
14	1. Inspect each of the brake rotors for the following surface and wear conditions: Refer to *Brake Rotor Surface and Wear Inspection on page 5-56.* • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level **Note:** Make the following determination and answer the question individually for EACH rotor. 2. Make a determination for each brake rotor if the brake rotor requires refinishing based upon the results of the inspection. 3. 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*

Disc Brake System Diagnosis (cont'd)

Step	Action	Yes	No
15	1. Refinish the brake rotor. Refer to *Brake Rotor Refinishing on page 5-85.* 2. Inspect the brake rotor thickness. Refer to *Brake Rotor Thickness Measurement on page 5-55.* Were you able to REFINISH the brake rotor within the minimum requirements?	Go to *Step 20*	Go to *Step 19*
16	Is the brake disc at or below the DISCARD requirements?	Go to *Step 19*	Go to *Step 17*
17	**Note:** Make the following determination and answer the question individually for EACH rotor. Inspect each of the brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to *Brake Rotor Thickness Variation Measurement on page 5-55.* Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to *Step 19*	Go to *Step 18*
18	1. Inspect each of the brake rotors for the following surface and wear conditions: Refer to *Brake Rotor Surface and Wear Inspection on page 5-56.* • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level **Note:** 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	**Note:** Whenever a brake rotor is replaced, the assembled lateral runout (LRO) of the brake rotor must be measured to ensure optimum performance of the disc brakes. Replace the brake rotor. Refer to *Front Brake Rotor Replacement on page 5-77.* Did you complete the replacement?	Go to *Step 22*	—
20	**Note:** Make the following determination and answer the question individually for EACH rotor. Inspect each of the brake rotors for assembled lateral runout (LRO) that exceeds the maximum acceptable level. Refer to *Brake Rotor Assembled Lateral Runout Measurement on page 5-56.* 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 Correction on page 5-83.* 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 *Symptoms - Hydraulic Brakes on page 5-111*
2	1. Remove the brake drums. Refer to *Brake Drum Replacement (J93, J94) on page 5-90*. 2. 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 • 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 *Rear Brake Cylinder Replacement on page 5-102*. 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 on page 5-89*. 2. Replace components as required. Refer to *Drum Brake Hardware Replacement (J93, J94) on page 5-97*. 3. Replace the drum brake shoes. Refer to *Brake Shoe Replacement (J93, J94) on page 5-92*. Did you complete the inspection and replacement?	Go to *Step 8*	—
6	1. Clean the remaining drum brake system components to remove any traces of the contaminants. 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 on page 5-89*. 3. Replace the drum brake hardware components as required. Refer to *Drum Brake Hardware Replacement (J93, J94) on page 5-97*. 4. Replace the contaminated brake shoes. Refer to *Brake Shoe Replacement (J93, J94) on page 5-92*. 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 *Drum Brake Hardware Inspection on page 5-89*. 2. Replace components as required. Refer to *Drum Brake Hardware Replacement (J93, J94) on page 5-97*. 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. **Note:** Make the following determination and answer the question individually for EACH brake drum. 2. Make a determination for each brake drum if the drum can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to *Brake Drum Diameter Measurement on page 5-87*. Does the brake drum meet the minimum requirements for REFINISHING?	Go to *Step 9*	Go to *Step 11*

Drum Brake System Diagnosis (cont'd)

Step	Action	Yes	No
9	1. Inspect each of the brake drums for the following surface and wear conditions: Refer to *Brake Drum Surface and Wear Inspection on page 5-88.* • 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 **Note:** Make the following determination and answer the question individually for EACH brake 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 *Brake Drum Refinishing on page 5-91.* 2. Inspect the brake drum diameter. Refer to *Brake Drum Diameter Measurement on page 5-87.* 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 on page 5-88.* • Braking surface conditions – Heavy rust and/or pitting – Cracks and/or heat spots – Excessive blueing discoloration – Missing balance weights • Braking surface wear conditions – Missing balance weights – Radial runout beyond maximum acceptable level **Note:** Make the following determination and answer the question individually for EACH brake 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 • 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 *Brake Drum Replacement (J93, J94) on page 5-90.* Did you complete the replacement?	Go to *Step 14*	—

Drum Brake System Diagnosis (cont'd)

Step	Action	Yes	No
14	Inspect the brake shoes for proper adjustment. Refer to *Drum Brake Adjustment on page 5-105.* 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 *Drum Brake Adjusting Hardware Inspection on page 5-89.* 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 *Drum Brake Adjusting Hardware Replacement (J93, J94) on page 5-100.* Is the replacement complete?	Go to *Step 17*	—
17	Adjust the drum brake shoes. Refer to *Drum Brake Adjustment on page 5-105.* 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 *Rear Brake Backing Plate Replacement on page 5-95.* 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

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 *Symptoms - Hydraulic Brakes on page 5-111*
2	Inspect and adjust the brake fluid level in the brake master cylinder. Refer to *Master Cylinder Reservoir Filling on page 5-145.* Was the brake fluid level low?	Go to *Step 3*	Go to *Step 4*
3	1. 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 2. 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 6*

Hydraulic Brake System Diagnosis (cont'd)

Step	Action	Yes	No
4	1. 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 2. 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*
5	1. Flush the hydraulic brake system. Refer to *Hydraulic Brake System Flushing on page 5-172*. 2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following steps. Refer to the procedures indicated. 2.1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. 2.2. Clean out the hydraulic brake pipes using denatured alcohol, or equivalent. 2.3. Dry the brake pipes using non-lubricated, filtered air. 2.4. 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 on page 5-147* • 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. • *Front Brake Hose Replacement on page 5-162* • *Rear Brake Hose Replacement (Body to Axle - Drum Brake) on page 5-164* or *Rear Brake Hose Replacement (Body to Axle - Disc Brake) on page 5-165* or *Rear Brake Hose Replacement (Axle to Caliper) on page 5-167* • *Front Brake Caliper Overhaul on page 5-69* • *Front Brake Caliper Replacement on page 5-65* • *Rear Brake Cylinder Replacement on page 5-102* • *Brake Pressure Modulator Valve Replacement on page 5-40* 3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system. 4. Refill and bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*. Did you complete the operation and any required repairs and/or replacements?	Go to *Step 9*	—

Hydraulic Brake System Diagnosis (cont'd)

Step	Action	Yes	No
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 • *Master Cylinder Replacement on page 5-147* • *Front Brake Hose Replacement on page 5-162* • *Rear Brake Hose Replacement (Body to Axle - Drum Brake) on page 5-164* or *Rear Brake Hose Replacement (Body to Axle - Disc Brake) on page 5-165* or *Rear Brake Hose Replacement (Axle to Caliper) on page 5-167* • *Brake Pipe Replacement on page 5-158* • *Front Brake Caliper Overhaul on page 5-69* • *Front Brake Caliper Replacement on page 5-65* • *Rear Brake Cylinder Overhaul on page 5-104* • *Rear Brake Cylinder Replacement on page 5-102* • *Brake Pressure Modulator Valve Replacement on page 5-40* 2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*. 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 on page 5-144*. 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 on page 5-144*. Was the hydraulic function of the brake calipers/wheel cylinders operating properly?	Go to *Step 15*	Go to *Step 13*

Hydraulic Brake System Diagnosis (cont'd)

Step	Action	Yes	No
13	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly: 1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*. 2. Remove the tire and wheel assemblies. Refer to *Tire and Wheel Removal and Installation on page 16-60*. 3. Open the suspected brake caliper bleeder valve. 4. Using a large C-clamp, compress the brake caliper piston and observe for an unrestricted flow of brake fluid and for free movement of the brake 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. • *Front Brake Caliper Overhaul on page 5-69* • *Front Brake Caliper Replacement on page 5-65* • *Rear Brake Cylinder Replacement on page 5-102* 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 *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*. Was there air in the system?	Go to *Step 19*	Go to *Step 16*
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to *Step 21*	Go to *Step 17*
17	1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to *Brake Pipe and Hose Inspection on page 5-145*. 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: • *Front Brake Hose Replacement on page 5-162* • *Rear Brake Hose Replacement (Body to Axle - Drum Brake) on page 5-164* or *Rear Brake Hose Replacement (Body to Axle - Disc Brake) on page 5-165* or *Rear Brake Hose Replacement (Axle to Caliper) on page 5-167* 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	Replace the brake modulator assembly, in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to *Brake Pressure Modulator Valve Replacement on page 5-40*. 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 found to be installed incorrectly or seeping brake fluid. Did you find and correct a condition?	Go to *Step 21*	Go to *Step 20*

Hydraulic Brake System Diagnosis (cont'd)

Step	Action	Yes	No
20	1. Inspect the brake master cylinder for internal fluid leaks. Refer to *Brake System Internal Leak Test on page 5-143*. 2. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to *Master Cylinder Replacement on page 5-147*. 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

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 3*	Go to *Step 2*
2	Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?	Go to *Step 5*	Go to *Diagnostic Starting Point - Vehicle on page 6-66*
3	Inspect for proper brake pedal travel. Refer to *Brake Pedal Travel Measurement and Inspection on page 5-141*. Is the brake pedal travel distance within the acceptable limits?	Go to *Step 5*	Go to *Step 4*
4	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. • Inspect the brake pedal for a misaligned, bent and/or damaged condition. • Inspect the brake pedal bushings for excessive wear and/or damage. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to *Step 5*	Go to *Hydraulic Brake System Diagnosis on page 5-134* to check for internal and external fluid leaks and air in the hydraulic brake system
5	Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to *Brake System Vacuum Source Test on page 5-142*. Is the vacuum reading within the acceptable limits?	Go to *Step 6*	Go to Engine Controls Diagnostics Information to check for vacuum issues, including vacuum pump operation, if equipped
6	Does the condition occur during cold start-up conditions?	Go to *Step 7*	Go to *Step 8*
7	Check engine vacuum, and vacuum pump operation, if equipped, under the same cold start-up conditions. Refer to Engine Controls Diagnostics. Did you find and correct a condition?	Go to *Step 22*	Go to *Step 9*
8	During the vacuum source test, did the vacuum booster check valve operate properly?	Go to *Step 10*	Go to *Step 9*
9	Replace the vacuum booster check valve, if equipped. Did you complete the replacement?	Go to *Step 10*	—
10	If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot, or damage. Does the vacuum sensor grommet exhibit any of the conditions listed?	Go to *Step 11*	Go to *Step 12*

Brake Assist System Diagnosis (cont'd)

Step	Action	Yes	No
11	Replace the vacuum sensor grommet. Did you complete the replacement?	Go to *Step 12*	—
12	1. If the vehicle is equipped with a vacuum sensor, install a scan tool. 2. Using the Data Display function, determine if brake booster vacuum sensor data is available within either the chassis brake controls area or the powertrain engine controls area. Is vacuum sensor data available through the scan tool?	Go to *Step 13*	Go to *Step 16*
13	Perform the vacuum booster leak-down test using a scan tool: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2–3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. **Note:** Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level. 6. Determine the rate of vacuum leak. **Specification** Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds Was the rate of vacuum leak within the specified allowable range?	Go to *Step 18*	Go to *Step 14*
14	1. Deplete the vacuum reserve by pressing the brake pedal several times, or by removing the vacuum booster check valve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Refer to *Master Cylinder Replacement on page 5-147*. 3. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. Replace the vacuum seal as necessary. 4. Carefully reinstall the master cylinder to the brake booster. Refer to *Master Cylinder Replacement on page 5-147*. Did you complete the operation?	Go to *Step 15*	—
15	Perform the vacuum booster leak-down test using a scan tool: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2–3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. **Note:** Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level. 6. Determine the rate of vacuum leak. **Specification** Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds Was the rate of vacuum leak within the specified allowable range?	Go to *Step 22*	Go to *Step 21*

Brake Assist System Diagnosis (cont'd)

Step	Action	Yes	No
16	1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by removing the check valve or applying the brake pedal several times. Refer to *Master Cylinder Replacement on page 5-147*. 2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. 3. If equipped with a vacuum seal that is part of the booster, inspect the seal for damage. Does the vacuum seal exhibit any of the conditions listed?	Go to *Step 17*	Go to *Step 18*
17	1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as necessary. Ensure the seal is positioned correctly during installation. 2. If equipped with a vacuum seal that requires replacement and which is part of the booster, the booster assembly must be replaced. 3. Carefully reinstall the master cylinder to the brake booster. Refer to *Master Cylinder Replacement on page 5-147*. Did you complete the replacement?	Go to *Step 18*	—
18	Perform the vacuum boost functional test: 1. If still separated, reinstall the master cylinder to the booster. Refer to *Master Cylinder Replacement on page 5-147*. 2. If the engine was started after reinstalling the master cylinder to the booster, perform the following: With the engine OFF, depress the brake pedal several times to deplete the vacuum reserve. 3. Depress and maintain moderate foot pressure on the brake pedal. 4. Start the engine and observe pedal operation. 5. Observe for audible vacuum leaks. The brake pedal should fall slightly, then hold. Is there an audible vacuum leak coming from the brake pedal area?	Go to *Step 21*	Go to *Step 19*
19	Did the brake pedal fall slightly after the engine was started, then hold?	Go to *Step 20*	Go to *Step 21*
20	Perform the vacuum booster leak-down test: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2–3 seconds and repeat once. 3. Turn the ignition OFF. 4. Wait 60 seconds. 5. Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. • Both pedal applies should be assisted • The amount of assist could diminish slightly with the second apply Were both pedal applies power assisted?	Go to *Step 22*	Go to *Step 21*
21	Replace the vacuum brake booster. Refer to *Power Vacuum Brake Booster Replacement on page 5-173*. Did you complete the replacement?	Go to *Step 22*	—
22	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	—

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 on page 5-145*.
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

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

1. Start the engine and allow it to idle.
2. Visually inspect if the brake warning indicator 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 on page 5-111*.
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 or Neutral, lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
   - If the brake pedal apply felt spongy, or the pedal travel was excessive, DO NOT drive the vehicle until it is repaired.
   - If the brake pedal apply did not feel spongy and the pedal travel was excessive, proceed to step 6.
6. Release and apply the brakes.
7. While continuing to apply the brakes, shift the transmission into DRIVE or 1st, 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.
8. 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.
   - 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.
   - If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 9.
9. 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 the assistant.
10. 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.
11. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
12. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
13. 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.
    - 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.
    - If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 14.
14. 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.
15. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.

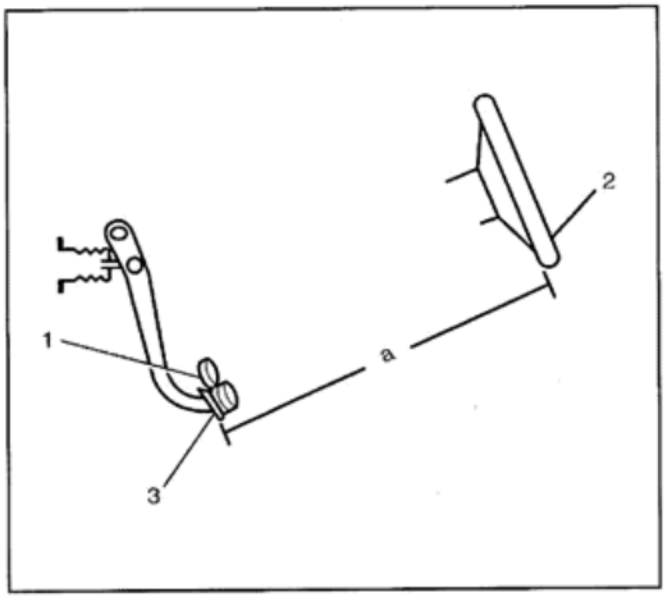
Brake Pedal Travel Measurement and Inspection

Special Tools

CH-28662 Brake Pedal Effort Gauge

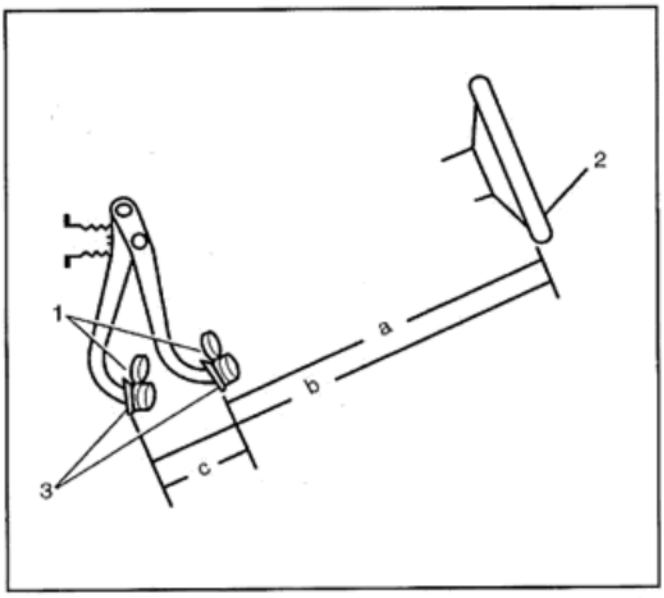
For equivalent regional tools, refer to *Special Tools on page 5-181*.

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.



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2. Install the *CH-28662* gauge (1), or equivalent, to the brake pedal (3).
3. Measure and record the distance (a) from the brake pedal (3) to the rim of the steering wheel (2). Note the points of measurement.



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4. Apply and maintain a force of 445 N (100 lb) to the brake pedal, as indicated on the *CH-28662* gauge (1), or equivalent.
5. While maintaining 445 N (100 lb) of force to the brake pedal (3), measure and record the distance (b) from the same point on the brake pedal (3) to the same point on the rim of the steering wheel (2).
6. Release the brake pedal (3) 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 for the 2 applies of the brakes.
8. Subtract the initial unapplied distance (a), from the average applied distance (b) to obtain the brake pedal travel measurement (c).

Specification

Maximum brake pedal travel – measured with the ignition OFF, brake booster power assist depleted, and the brakes cool.

Brake System Vacuum Source Test

Note:

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

1. Disconnect the engine vacuum hose from the vacuum brake booster check valve.
2. Install a vacuum gauge to the engine vacuum hose.
3. Install a scan tool to the vehicle.
4. Start the engine and allow the engine to idle until normal operating temperatures are reached.

Note: To obtain the gauge pressure from the manifold absolute pressure (MAP) sensor, subtract the absolute pressure of the MAP sensor from atmospheric pressure.

5. With the vehicle in PARK or NEUTRAL with the park brake on, the engine idling, and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is the gauge pressure calculated from the pressure of the MAP sensor indicated on the scan tool.
6. Turn the ignition OFF.
7. If the engine vacuum reading is within the specified normal range, proceed to step 11.
8. If the engine vacuum reading is NOT within the specified normal range, inspect the engine vacuum hose for the following conditions.
   - Loose connection to the engine
   - Collapse, deformation or contamination
   - Cracks, cuts, or brittleness
9. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2–5.
10. 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.
11. Remove the vacuum brake booster check valve from the booster.
12. Install the check valve to the engine vacuum hose.
13. Install the vacuum gauge to the check valve.
14. Start the engine and allow the engine to idle in park or neutral with the park brake on and with the A/C system OFF, until normal operating temperatures are reached.
15. Turn the ignition OFF.

Note: To obtain the gauge pressure from the manifold absolute pressure (MAP) sensor, subtract the absolute pressure of the MAP sensor from atmospheric pressure.

16. Visually inspect the engine vacuum reading is maintained at the same gauge pressure as the pressure obtained form the MAP sensor as indicated on the scan tool.
17. If the engine vacuum reading is maintained within the specified normal range, proceed to step 19.
18. If the engine vacuum reading is NOT maintained within the specified normal range, replace the vacuum brake booster check valve, then repeat steps 12–16.
19. Inspect the vacuum brake booster check valve grommet for the following conditions:
    - Loose connection to the vacuum brake booster
    - Deformation or contamination
    - Cracks, cuts or brittleness
20. If any of these conditions were found with the check valve grommet, replace the grommet.

Brake System External Leak Inspection

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7.*

1. In order to inspect for external brake fluid leaks, first inspect 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 on page 5-145.*
3. Start the engine and allow it to idle.
4. Apply constant, moderate foot pressure to the brake pedal.

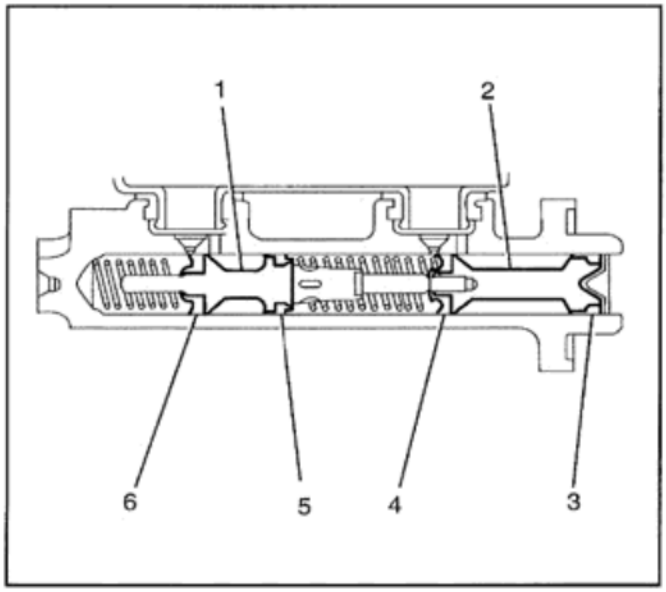
   If the brake pedal gradually falls away while under foot pressure, there may be a brake fluid leak.
5. Turn the ignition OFF.
6. Visually inspect the following brake system components for brake fluid leaks, excessive corrosion, and damage. Give particular attention to all brake pipe and flexible hose connections to ensure that there are not any slight brake fluid leaks – even though the brake pedal may feel firm and hold steady:
   - Master cylinder brake pipe fittings
   - All brake pipe connections
   - Brake pipes
   - Brake hoses and connections
   - Brake calipers and/or wheel cylinders
7. While slight dampness around the master cylinder reservoir can be considered acceptable, brake fluid leaking from any of the brake system components requires immediate attention. If any of these components exhibit signs of brake fluid leakage, repair or replace those components. After the repair or replacement, reinspect the hydraulic brake system to assure proper function.

Brake System Internal Leak Test

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7.*

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 the ignition OFF.
4. If the brake pedal apply felt spongy, but the brake pedal travel was not excessive, perform the following steps:
   4.1. Inspect the brake system for external leaks. Refer to *Brake System External Leak Inspection on page 5-143.*
   4.2. 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) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170.*



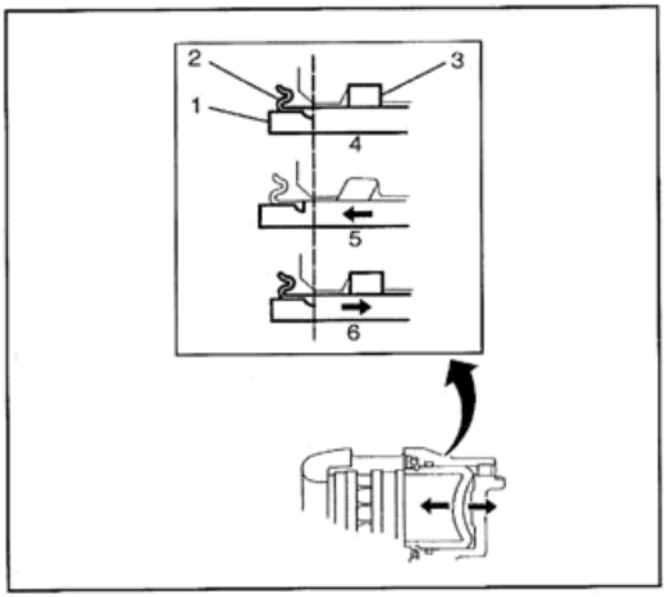
2327963

5. If the brake pedal apply did not feel spongy, but the brake pedal travel was excessive, perform the following steps:
   5.1. Loosen the master cylinder-to-vacuum brake booster retaining nuts.
   5.2. Carefully pull the master cylinder away from the vacuum brake booster just enough to inspect the mounting surface of the master cylinder.
   5.3. 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) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*.
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

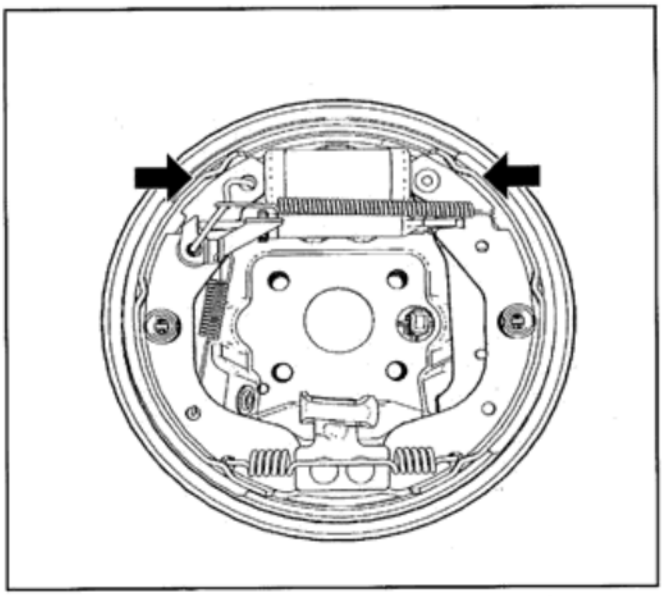
Disc Brake



2327961

1. With the tire and wheel assemblies removed and the brake rotors retained by wheel lug nuts, visually inspect the brake caliper piston dust boot (2) sealing area to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the brake caliper piston (1) in relation to the brake caliper housing.
4. Have an assistant apply and release the brake pedal several times while you observe the operation of the hydraulic brake caliper.
   4.1. Observe the brake caliper piston (1) for unrestricted and even movement during each apply of the brake system (5).
   4.2. Observe the brake caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the brake 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 brake caliper may require overhaul or replacement.

Drum Brakes



2327960

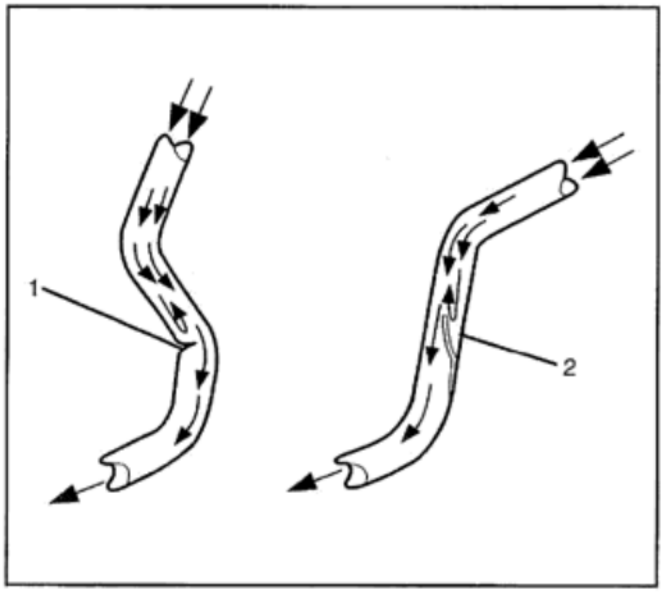
1. With the rear tire and wheel assemblies and the brake drums removed, visually inspect the wheel cylinder pistons boot sealing areas to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake wheel cylinder requires replacement.
3. Using firm hand 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

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7.*

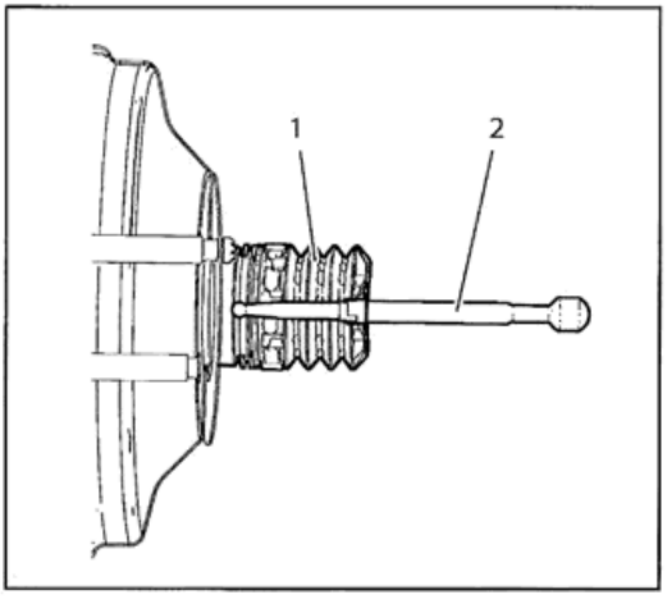
1. Visually inspect all of the brake pipes for the following conditions:
   - Kinks, incorrect routing, missing or damaged retainers
   - Leaking fittings, excessive corrosion
2. If any of the brake pipes exhibited any of the conditions listed, then the identified pipe, or pipes, require replacement.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



2327958

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, perished, cracked, blistered, brittle or bulging hoses
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 inspect for soft spots (2), indicating an internal restriction. Inspect 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



2027696

1. Disconnect the brake pedal pushrod (2) from the brake pedal.
2. Reposition the pedal pushrod boot (1) toward the front of the vehicle to expose as much of the pedal pushrod (2) as possible.
3. Inspect the brake pedal pushrod (2) for straightness.
4. If the brake pedal pushrod (2) is not straight, then the pushrod requires replacement.
5. Return the pedal pushrod boot (1) to its original position on the pedal pushrod (2).
6. Connect the brake pedal pushrod (2) to the brake pedal.

Repair Instructions

Master Cylinder Reservoir Filling

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7.*

1. Visually inspect the brake fluid level through the brake master cylinder reservoir.
2. If the brake fluid level is at or below the half-full point during routine fluid checks, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the half-full point during routine fluid checks, and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped-off up to the maximum-fill level.
4. If brake system service was just completed, the brake fluid may be topped-off up to the maximum-fill level.

5. If the brake fluid level is above the half-full point, adding brake fluid is not recommended under normal conditions.
6. If brake fluid is to be added to the master cylinder reservoir, clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm. Use only GM approved brake fluid from a clean, sealed brake fluid container.

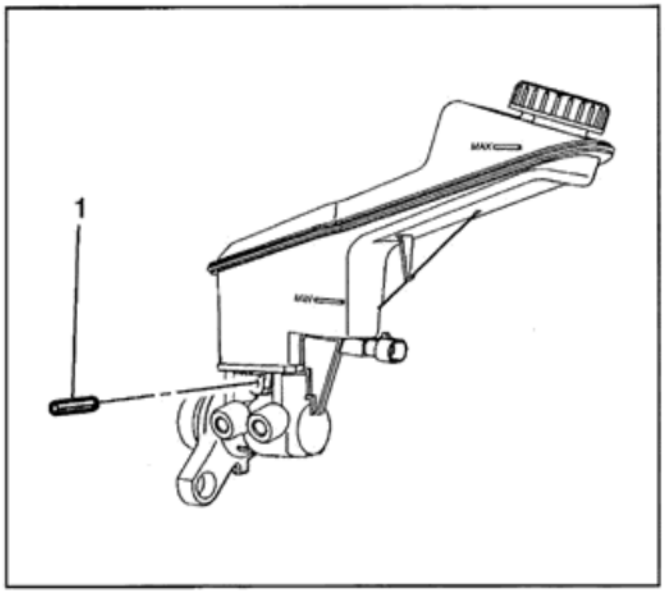
Master Cylinder Reservoir Replacement

Removal Procedure

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

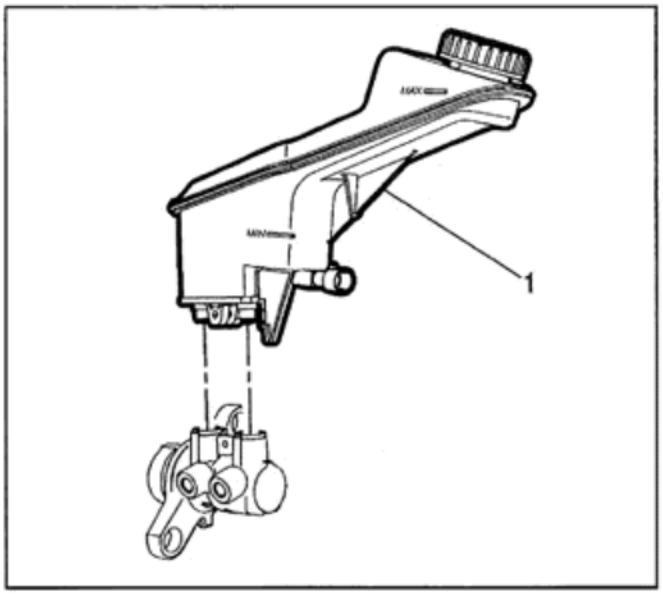
Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7.*

1. Remove the brake master cylinder. Refer to *Master Cylinder Replacement on page 5-147.*



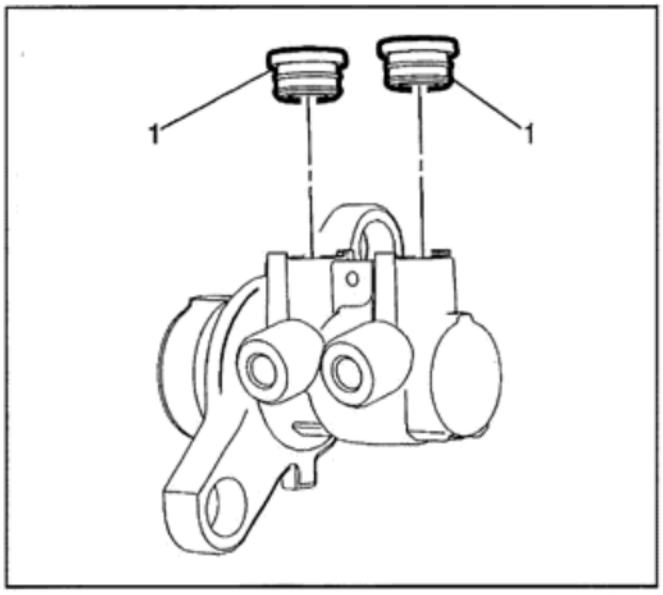
2511338

2. Remove and discard the brake master cylinder reservoir roll pin (1).



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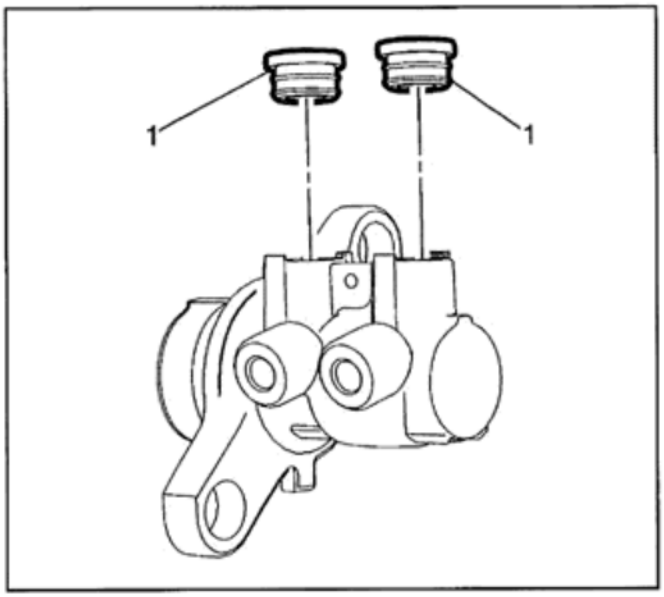
3. Remove the master cylinder reservoir (1) by carefully pulling straight upward.
4. Remove the brake fluid level indicator switch, if necessary. Refer to *Brake Fluid Level Indicator Switch Replacement on page 5-150.*



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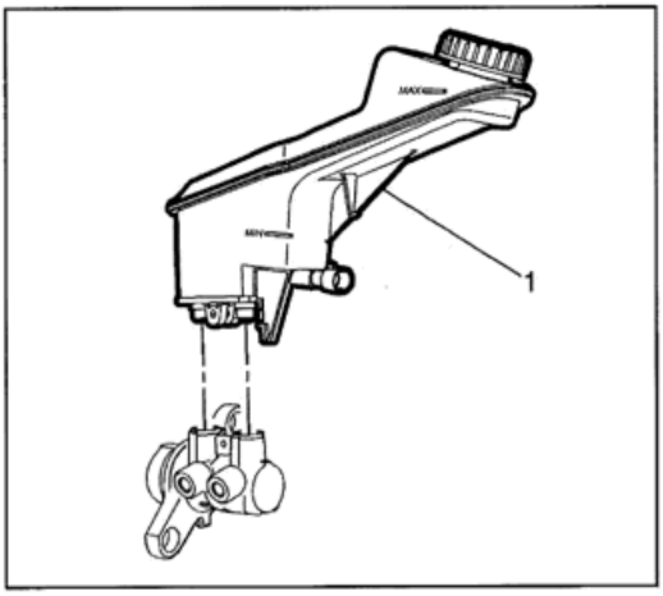
5. Remove the brake master cylinder reservoir seals (1).
6. If replacing the master cylinder reservoir, discard the reservoir seals.

Installation Procedure



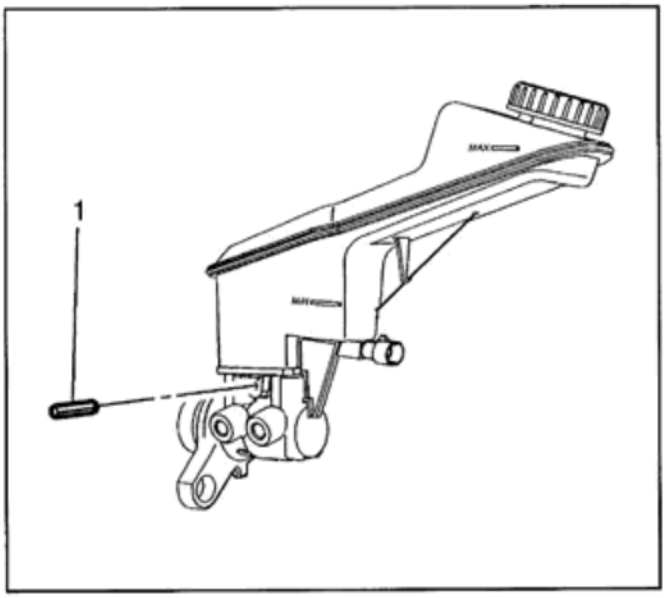
2511341

1. Lightly lubricate the brake master cylinder reservoir seals (1) with GM approved brake fluid from a clean, sealed, brake fluid container.
2. Install the lubricated brake master cylinder reservoir seals to the brake master cylinder.



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3. Install the master cylinder reservoir (1) by firmly pressing straight downward.
4. Install the brake fluid level indicator switch, if removed. Refer to *Brake Fluid Level Indicator Switch Replacement on page 5-150*.



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5. Install a new brake master cylinder reservoir roll pin (1).
6. Install the brake master cylinder. Refer to *Master Cylinder Replacement on page 5-147*.

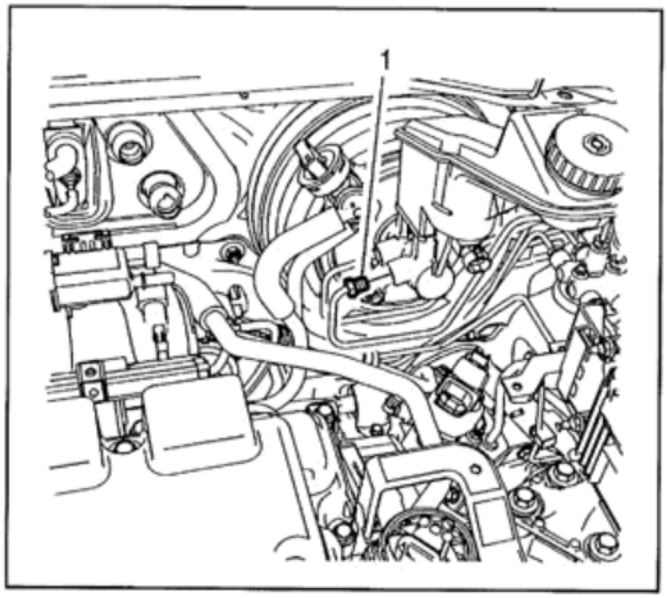
Master Cylinder Replacement

Removal Procedure

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

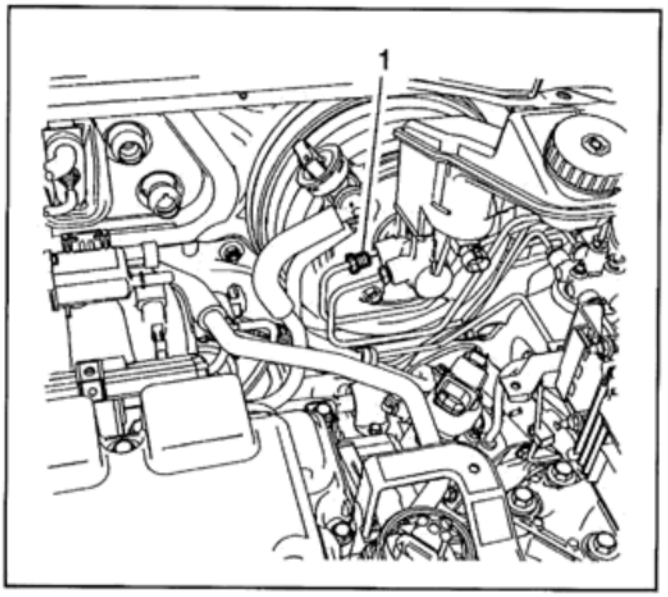
Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7*.

1. Place the ignition switch in the OFF position.
2. Remove the battery. Refer to *Battery Replacement on page 9-719*.
3. Disconnect the brake fluid level indicator switch electrical connector.
4. Using a suitable suction device, remove and properly discard the brake fluid from the brake master cylinder reservoir.
5. On manual transmission equipped vehicles, disconnect the clutch master cylinder reservoir hose. Refer to *Clutch Master Cylinder Reservoir Hose Replacement on page 17-407*



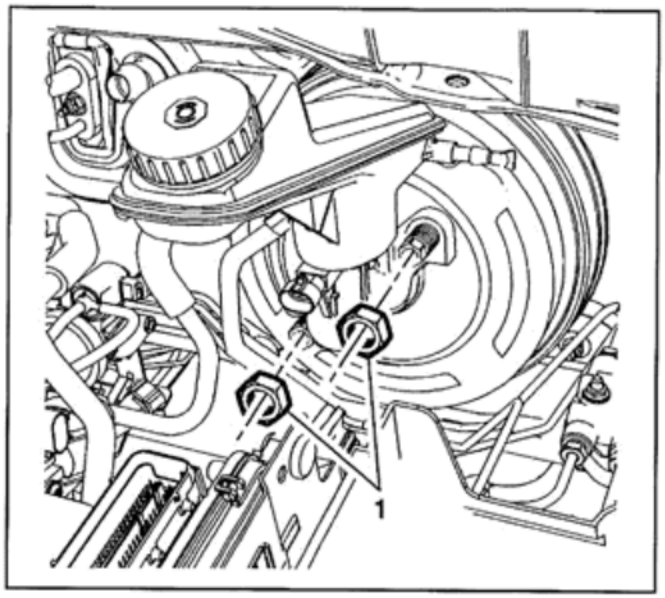
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6. Disconnect the master cylinder secondary brake pipe fitting (1).
7. Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.



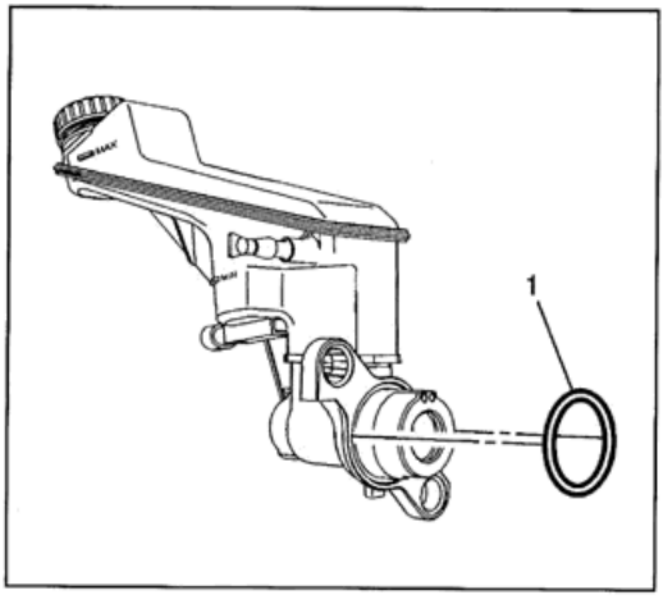
2511300

8. Disconnect the master cylinder primary brake pipe fitting (1).
9. Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.



2511323

10. Remove the master cylinder nuts (1).
11. Remove the brake master cylinder.



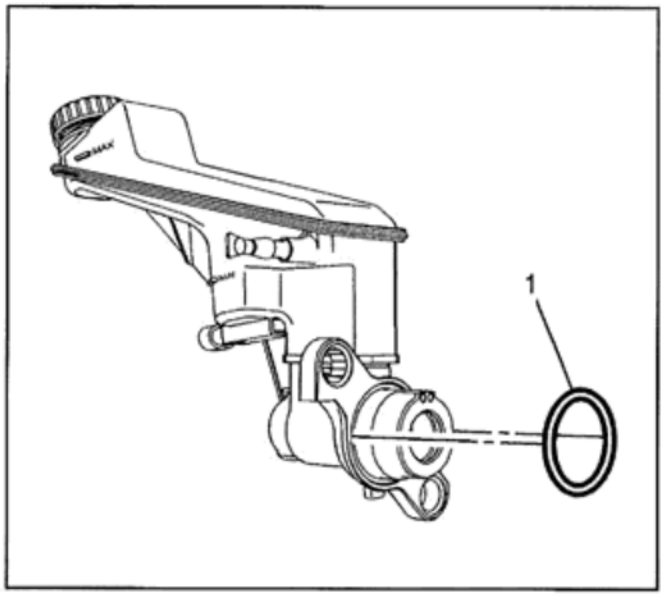
2511342

12. Remove the master cylinder seal (1).
13. Inspect the master cylinder seal for damage or deterioration and replace, if necessary.
14. Remove the brake fluid level indicator switch, if necessary. Refer to *Brake Fluid Level Indicator Switch Replacement on page 5-150*.
15. Remove the master cylinder reservoir, if necessary. Refer to *Master Cylinder Reservoir Replacement on page 5-146*.

Installation Procedure

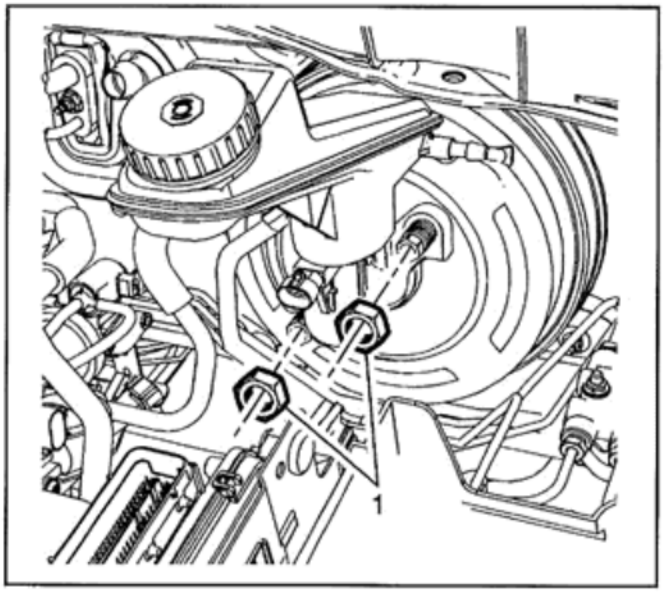
1. Install the master cylinder reservoir, if removed. Refer to *Master Cylinder Reservoir Replacement on page 5-146*.
2. Bench bleed the master cylinder. Refer to *Master Cylinder Bench Bleeding on page 5-150*.

3. Install the brake fluid level indicator switch, if removed. Refer to *Brake Fluid Level Indicator Switch Replacement on page 5-150*.



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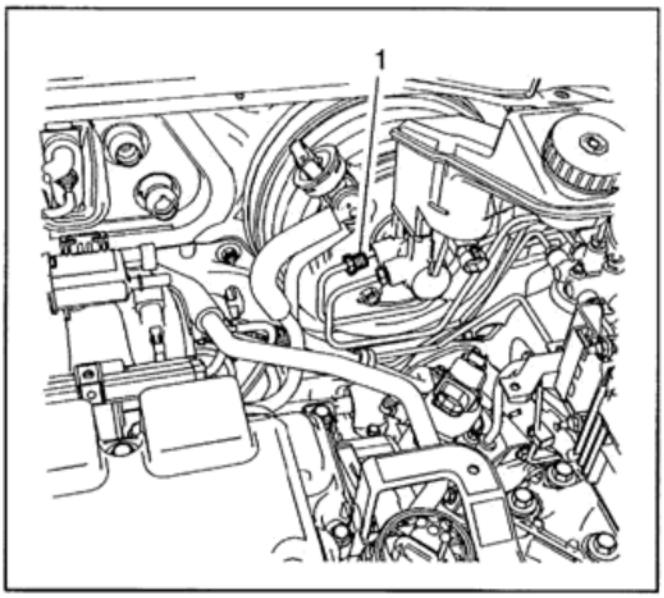
4. Install the master cylinder seal (1).
5. Install the master cylinder to the power vacuum brake booster.



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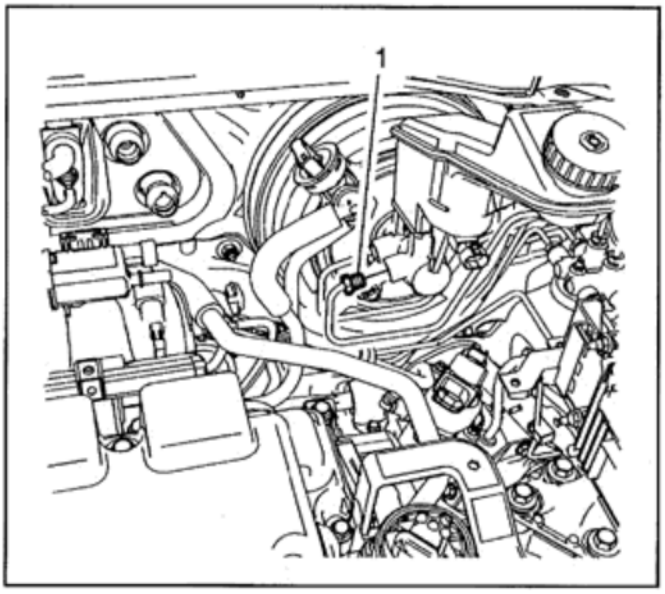
Caution: Refer to *Fastener Caution on page 0-8*.

6. Install the master cylinder nuts (1) and tighten to **50 N•m (37 lb ft)**.



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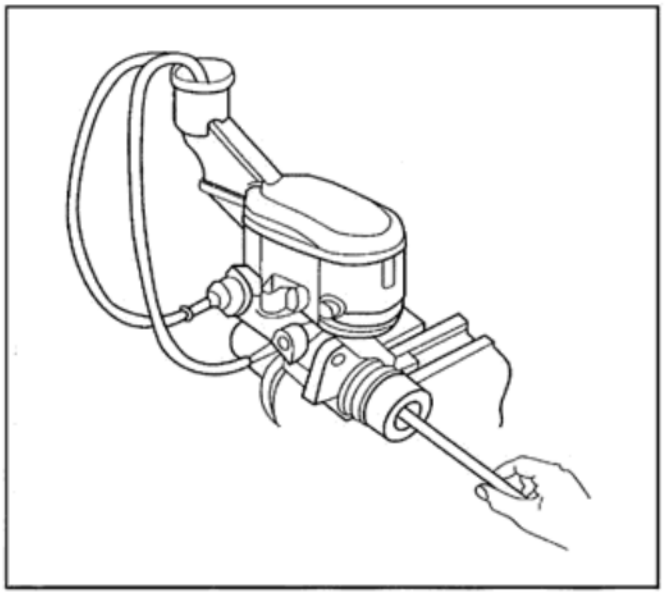
7. Connect the master cylinder primary brake pipe fitting (1) and tighten to **18 N•m (13 lb ft)**.



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8. Connect the master cylinder secondary brake pipe fitting (1) and tighten to **18 N•m (13 lb ft)**.
9. On manual transmission equipped vehicles, connect the clutch master cylinder reservoir hose. Refer to *Clutch Master Cylinder Reservoir Hose Replacement on page 17-407*
10. Connect the brake fluid level indicator switch electrical connector.
11. Install the battery. Refer to *Battery Replacement on page 9-719*.
12. Bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*.

Master Cylinder Bench Bleeding



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Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7.*

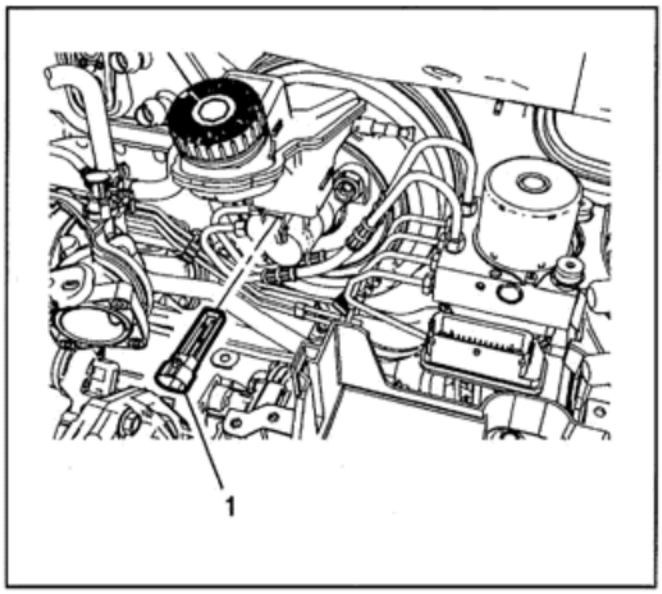
1. Secure the mounting flange of the brake master cylinder in a bench vice so that the rear of the primary piston is accessible.
2. Remove the master cylinder reservoir cap and diaphragm.
3. Install suitable fittings to the master cylinder ports that match the type of flare seat required and also provide for hose attachment.
4. Install transparent hoses to the fittings installed to the master cylinder ports, then route the hoses into the master cylinder reservoir.
5. Fill the master cylinder reservoir to the maximum fill level with brake fluid from a clean, sealed brake fluid container. Refer to *Master Cylinder Reservoir Filling on page 5-145.*
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 vice.

Brake Fluid Level Indicator Switch Replacement

Removal Procedure

1. Disconnect the brake fluid level indicator switch electrical connector.

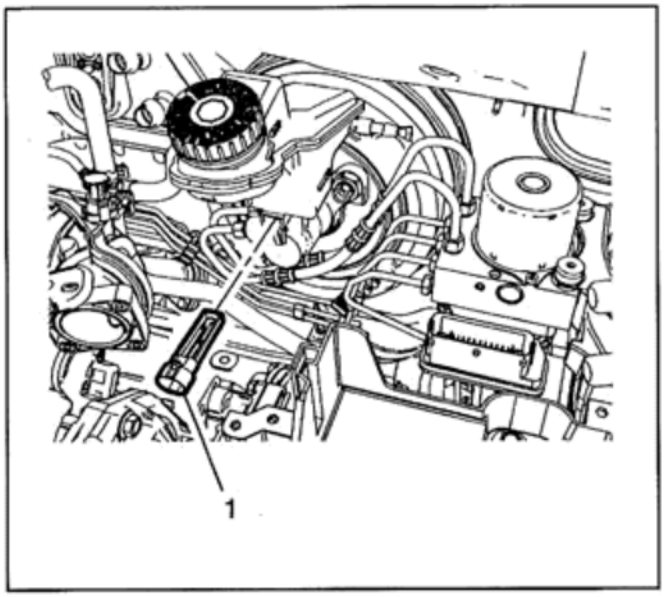


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2. Using a small, flat-bladed tool, lift the locking tab on the underside of the brake fluid level indicator switch (1) and remove the switch.
3. Inspect the master cylinder reservoir for damage and replace, if necessary. Refer to *Master Cylinder Reservoir Replacement on page 5-146.*

Installation Procedure

1. Install the master cylinder reservoir, if removed. Refer to *Master Cylinder Reservoir Replacement on page 5-146.*



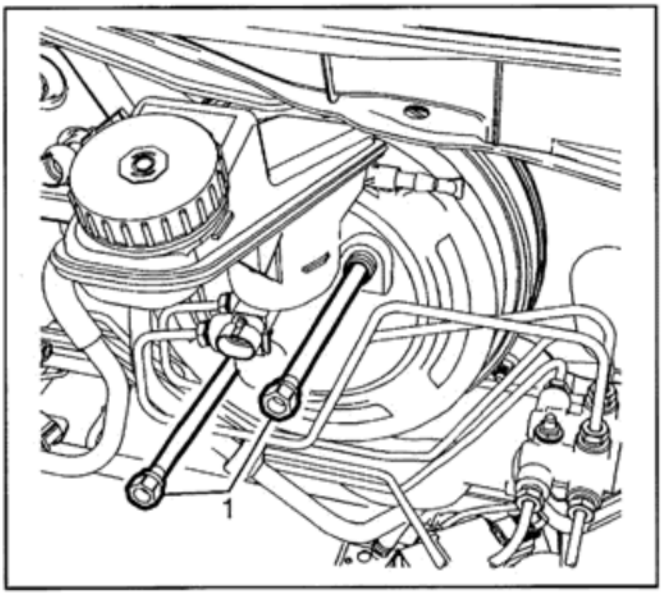
2910018

2. Install the brake fluid level indicator switch (1) by pressing the switch firmly into the brake master cylinder reservoir.
3. Connect the brake fluid level indicator switch electrical connector.

Brake Pedal Assembly Replacement

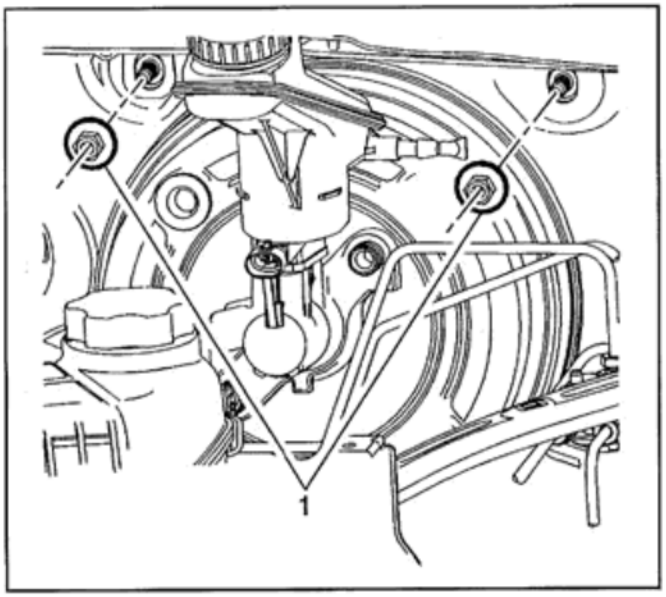
Removal Procedure

1. Remove the battery tray. Refer to *Battery Tray Replacement on page 9-721*.



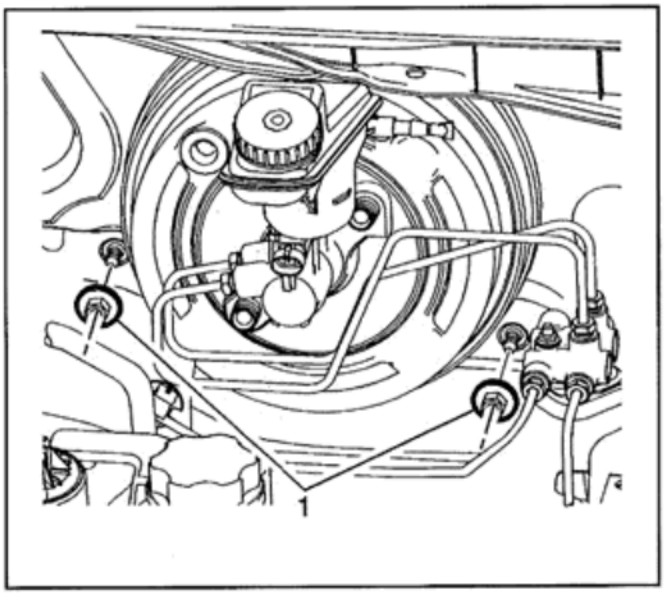
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2. Remove the power vacuum brake booster bolts (1).



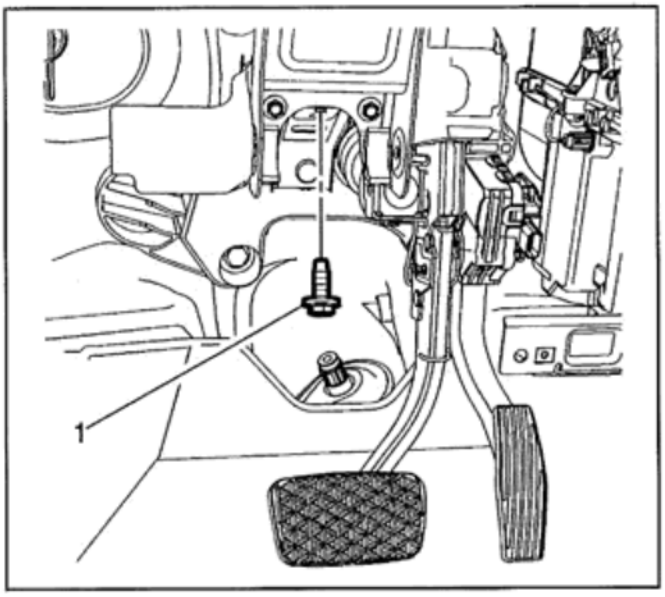
2539300

3. Remove the brake pedal assembly upper nuts (1)



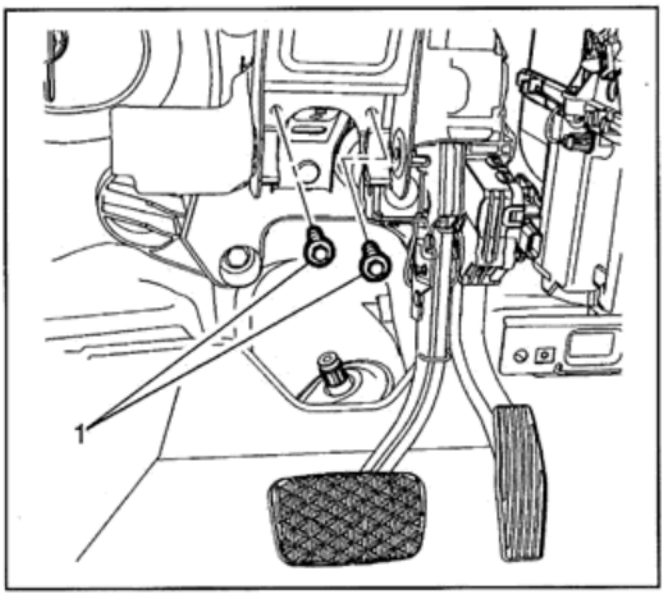
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4. Remove the brake pedal assembly lower nuts (1)
5. Remove the steering column. Refer to *Steering Column Replacement on page 15-33*.



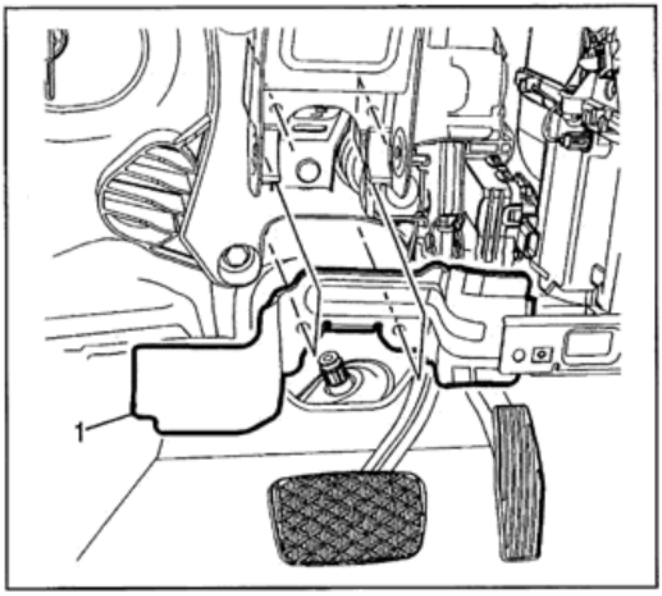
2539302

6. Remove the brake pedal release bracket bolt (1).



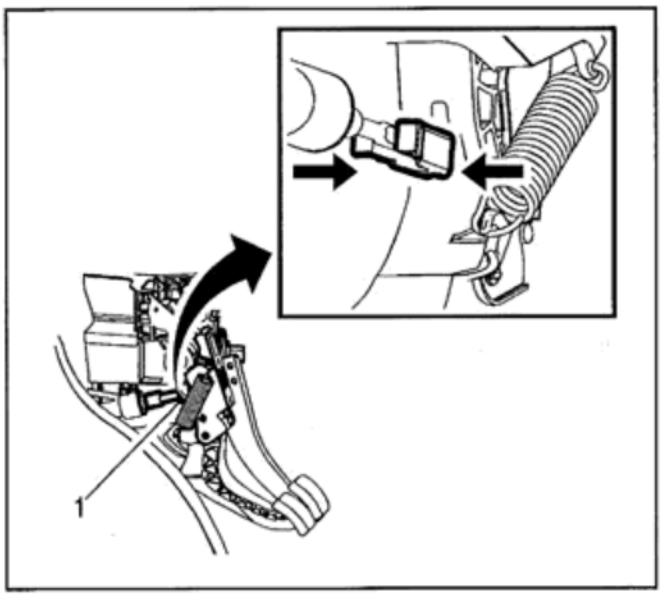
2539303

7. Remove the brake pedal release bracket bolts (1).



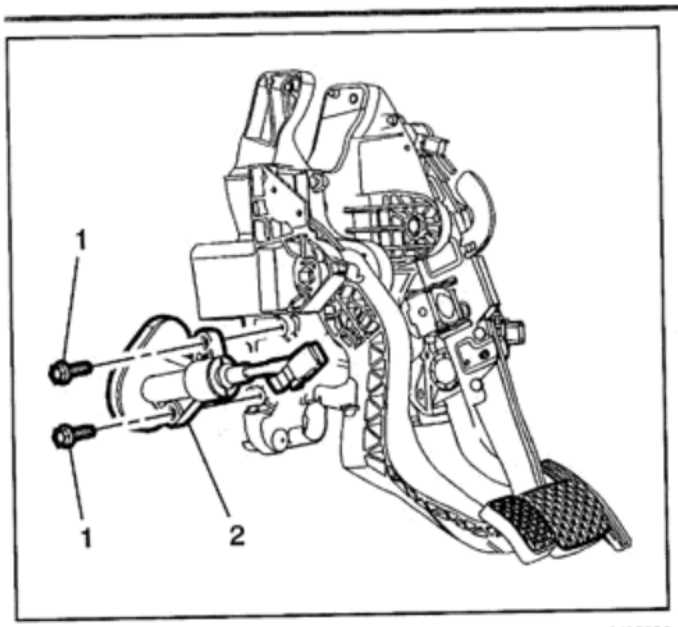
2539304

8. Remove the brake pedal release bracket (1).
9. Disconnect the brake pedal position sensor electrical connector.
10. On manual transmission equipped vehicles, disconnect the clutch pedal position sensor electrical connector.



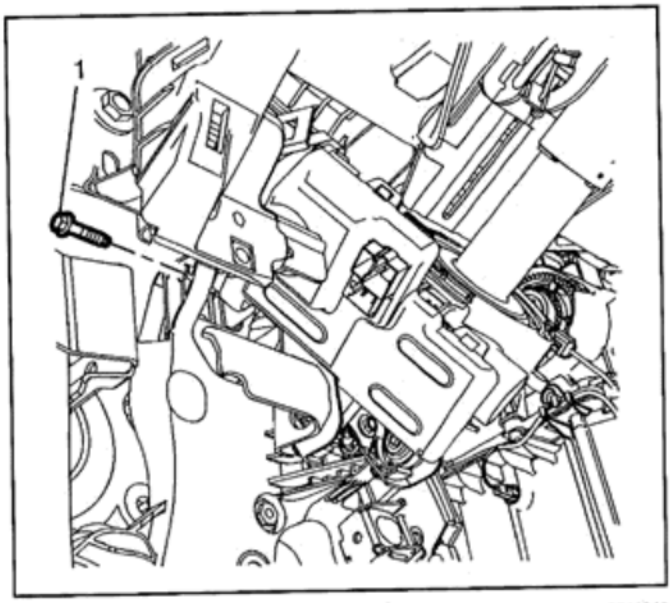
2530987

11. On manual transmission equipped vehicles, disconnect the clutch master cylinder pushrod retainer (1). Refer to *Clutch Master Cylinder Replacement on page 17-408*



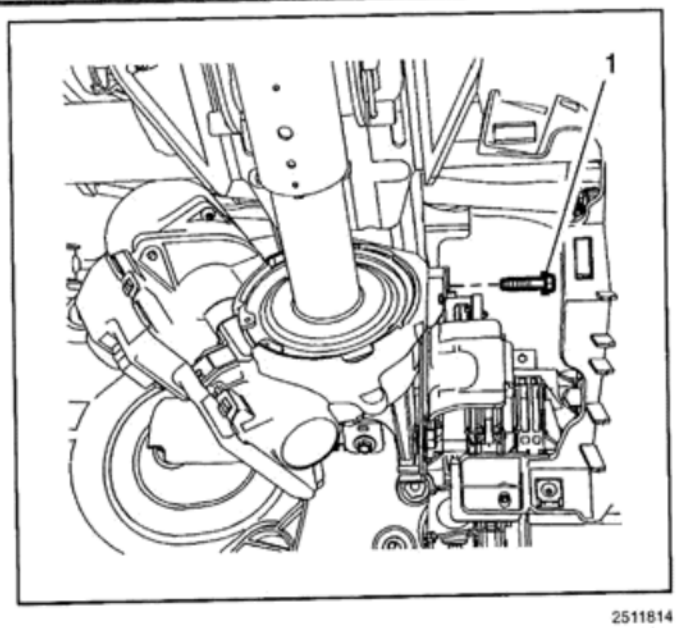
2492203

12. On manual transmission equipped vehicles, remove the clutch master cylinder bolts (1) and position aside the clutch master cylinder (2) without disconnecting the clutch fluid pipe. *Clutch Master Cylinder Replacement on page 17-408*
13. Position aside any wiring harnesses attached to the brake pedal assembly bracket, as necessary.



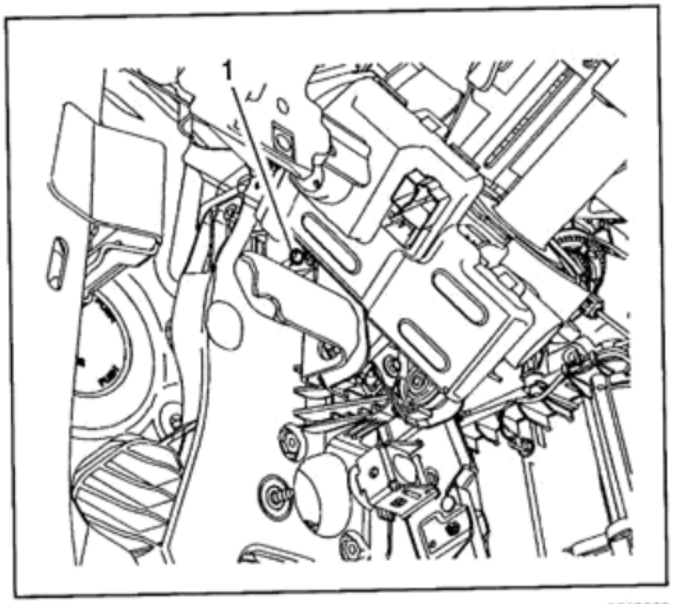
2511810

14. Remove the left upper brake pedal assembly bolt (1).



2511814

15. Remove the right upper brake pedal assembly bolt (1).

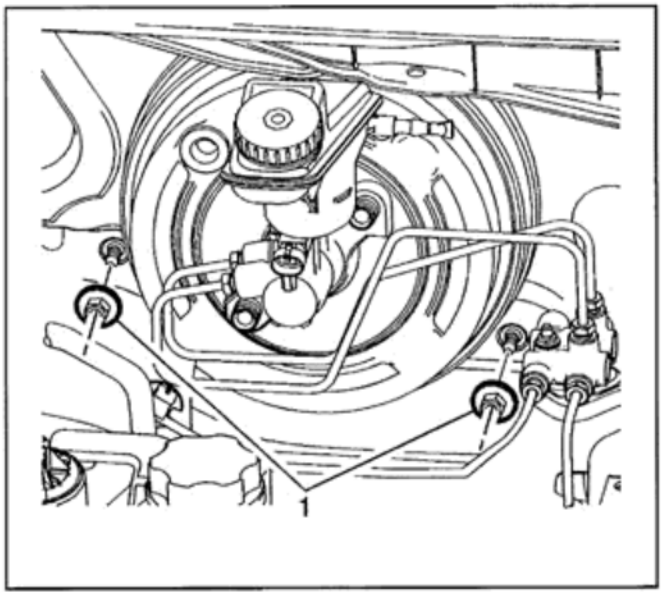


2512966

16. Using a suitable tool, carefully cut off the 2 upper brake pedal assembly locating pins (1).
17. Remove the brake pedal assembly from the vehicle.
18. Remove any necessary components from the brake pedal assembly.

Installation Procedure

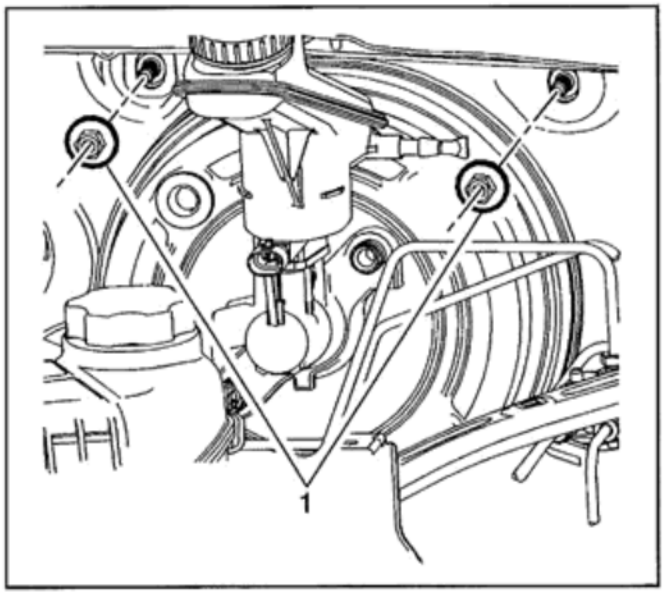
1. Using a suitable tool, carefully cut off the 2 upper brake pedal assembly locating pins.
2. Install any removed components from the brake pedal assembly.
3. Install the brake pedal assembly to the vehicle.



2539301

Caution: Refer to *Fastener Caution on page 0-8.*

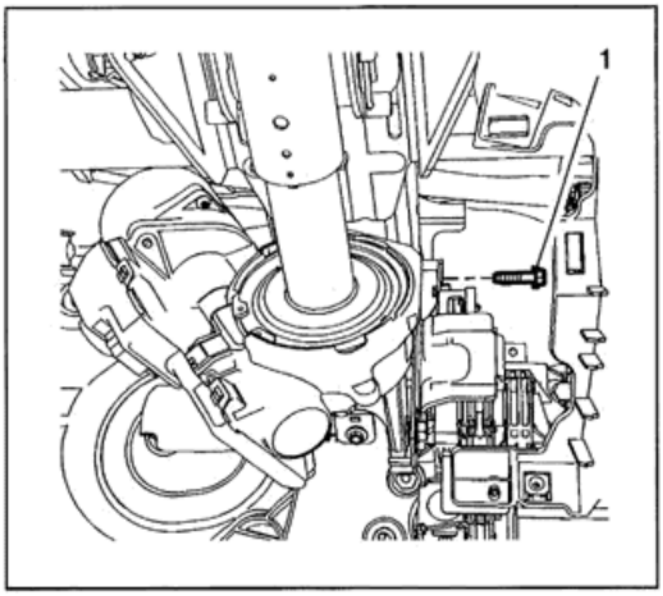
4. Install the brake pedal assembly lower nuts (1) and tighten to **19 N•m (14 lb ft)**.



2539300

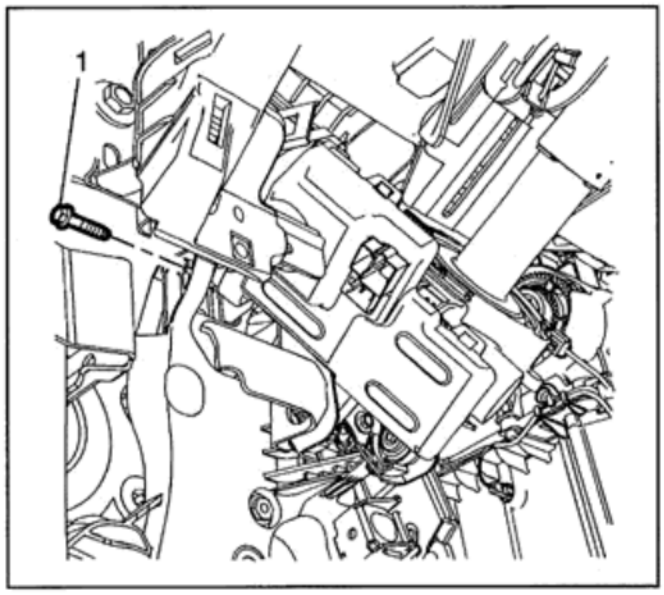
Caution: Refer to *Fastener Caution on page 0-8.*

5. Install the brake pedal assembly upper nuts (1) and tighten to **19 N•m (14 lb ft)**.



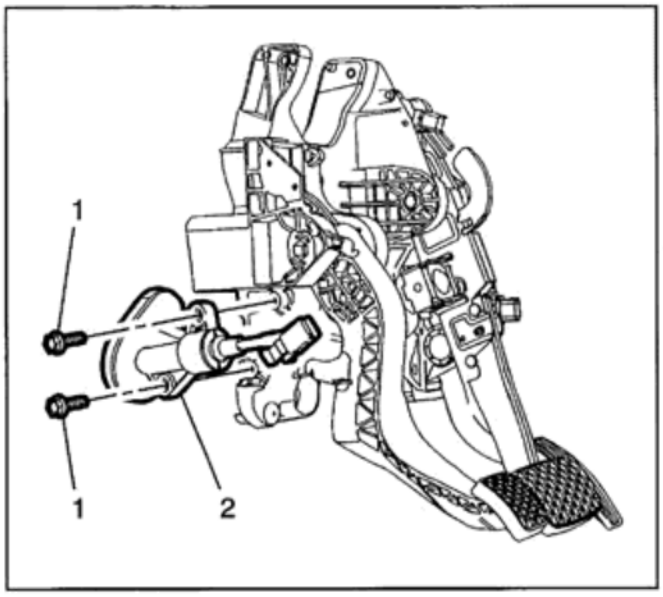
2511814

6. Install the right upper brake pedal assembly bolt (1) and tighten to **9 N•m (80 lb in)**.



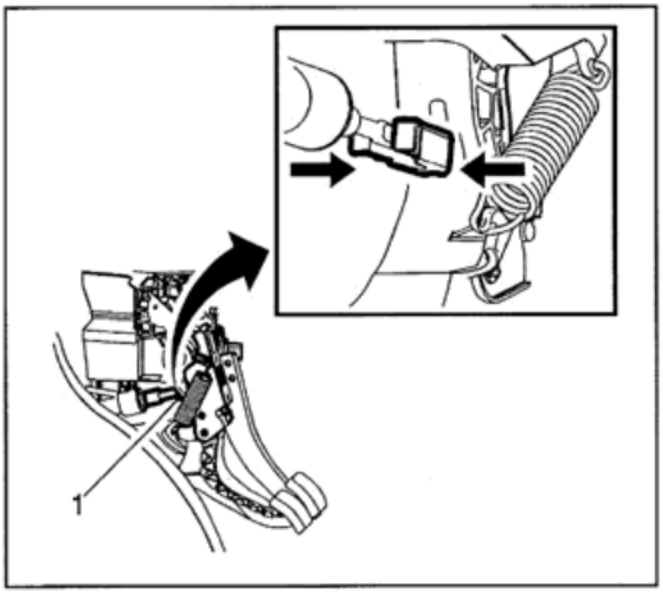
2511810

7. Install the left upper brake pedal assembly bolt (1) and tighten to **9 N•m (80 lb in)**.
8. Reposition any wiring harnesses attached to the brake pedal assembly bracket, as necessary.



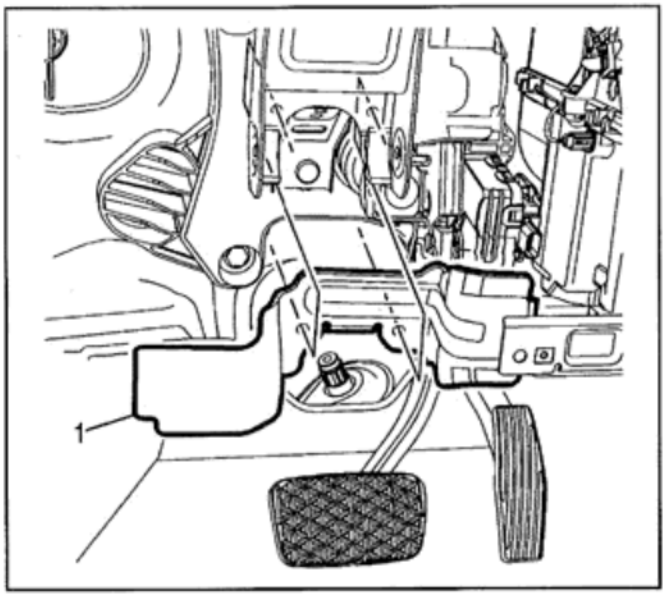
2492203

9. On manual transmission equipped vehicles, install the clutch master cylinder bolts (1) and the clutch master cylinder (2). Refer to *Clutch Master Cylinder Replacement on page 17-408*.



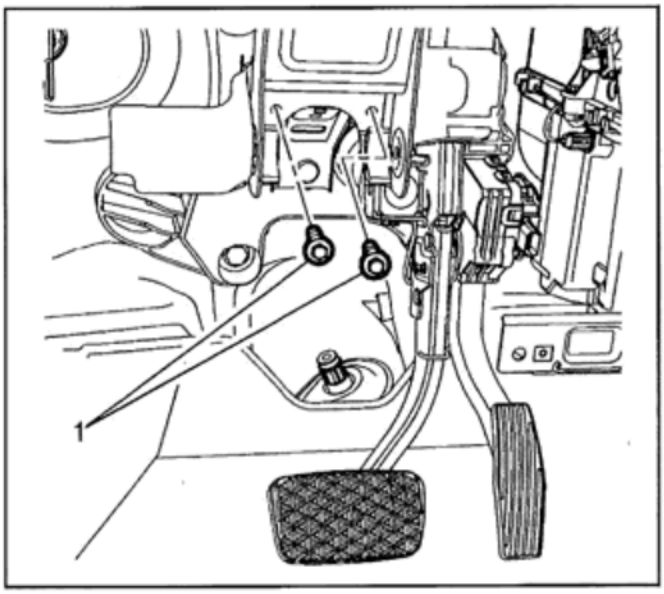
2530987

10. On manual transmission equipped vehicles, connect the clutch master cylinder pushrod retainer (1). Refer to *Clutch Master Cylinder Replacement on page 17-408*.
11. On manual transmission equipped vehicles, connect the clutch pedal position sensor electrical connector.



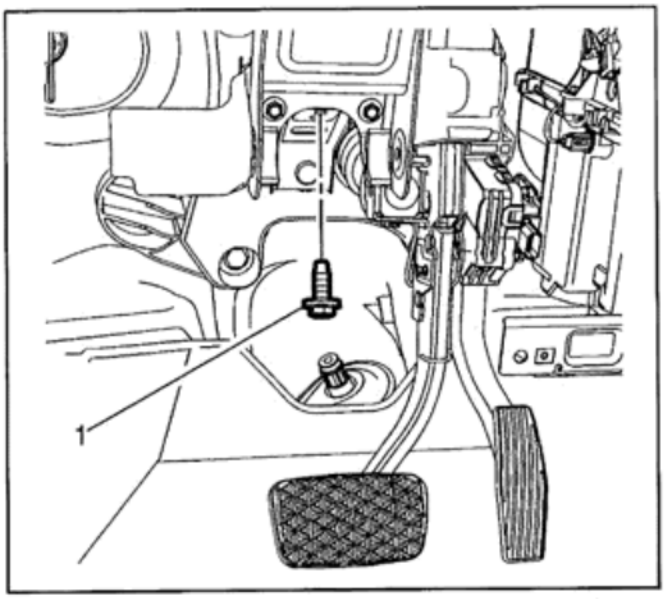
2539304

12. Install the brake pedal release bracket (1).



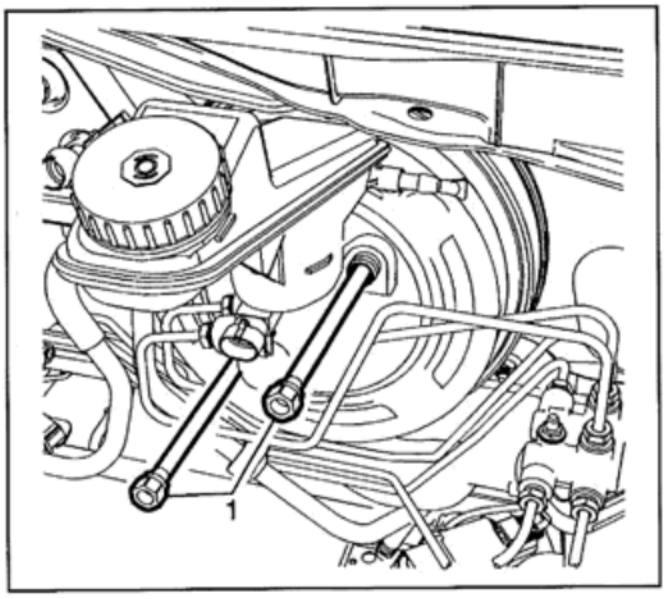
2539303

13. Install the brake pedal release bracket bolts (1) and tighten to **22 N·m (16 lb ft)**.



2539302

14. Install the brake pedal release bracket bolt (1) and tighten to **22 N•m (16 lb ft)**.
15. Connect the brake pedal position sensor electrical connector.
16. Install the steering column. Refer to *Steering Column Replacement on page 15-33*.



2539299

17. Install the power vacuum brake booster bolts (1) and tighten to **19 N•m (14 lb ft)**.
18. Install the battery tray. Refer to *Battery Tray Replacement on page 9-721*.

Brake Pressure Modulator Valve Pipe Replacement

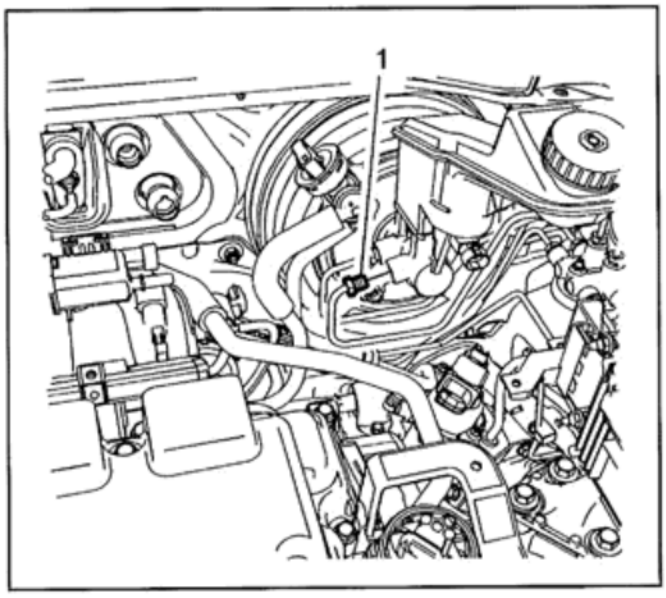
Removal Procedure

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7*.

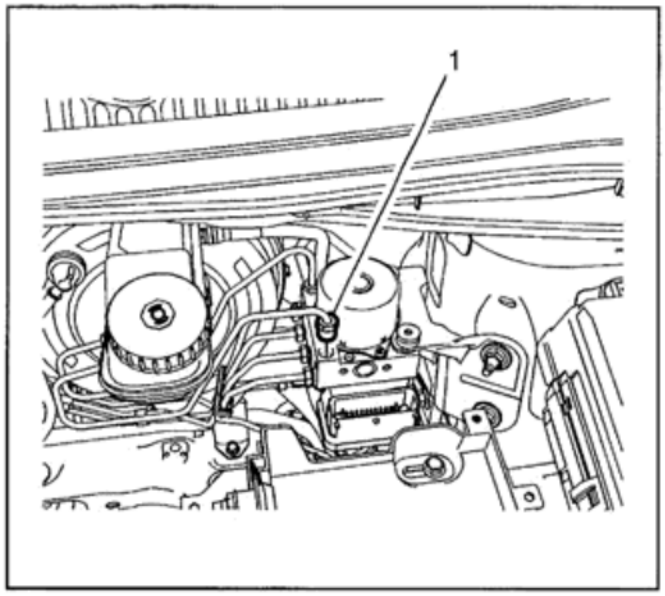
Caution: Always connect or disconnect the wiring harness connector from the EBCM/EBTCM with the ignition switch in the OFF position. Failure to observe this precaution could result in damage to the EBCM/EBTCM.

1. Remove the battery. Refer to *Battery Replacement on page 9-719*.
2. Clean the area surrounding the brake pressure modulator valve (BPMV) of any accumulated dirt and debris.



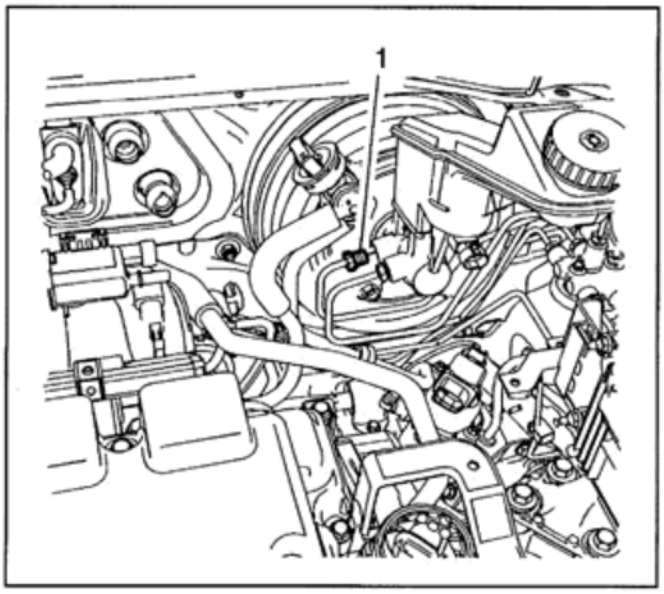
2511297

3. Disconnect the master cylinder secondary brake pipe fitting (1) from the master cylinder.
4. Plug the master cylinder outlet port to prevent brake fluid loss and contamination.



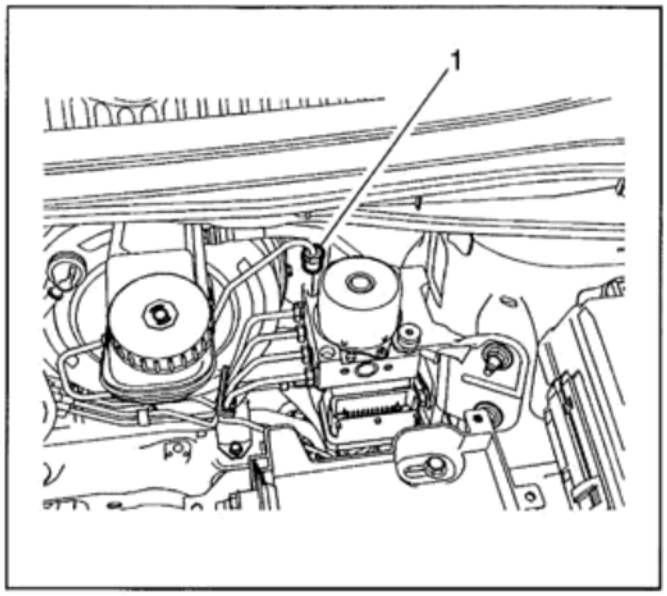
2495345

5. Disconnect the master cylinder secondary brake pipe fitting (1) from the BPMV.
6. Plug the BPMV inlet port to prevent brake fluid loss and contamination.
7. Remove the master cylinder secondary brake pipe assembly.



2511300

8. Disconnect the master cylinder primary brake pipe fitting (1) from the master cylinder.
9. Plug the master cylinder outlet port to prevent brake fluid loss and contamination.

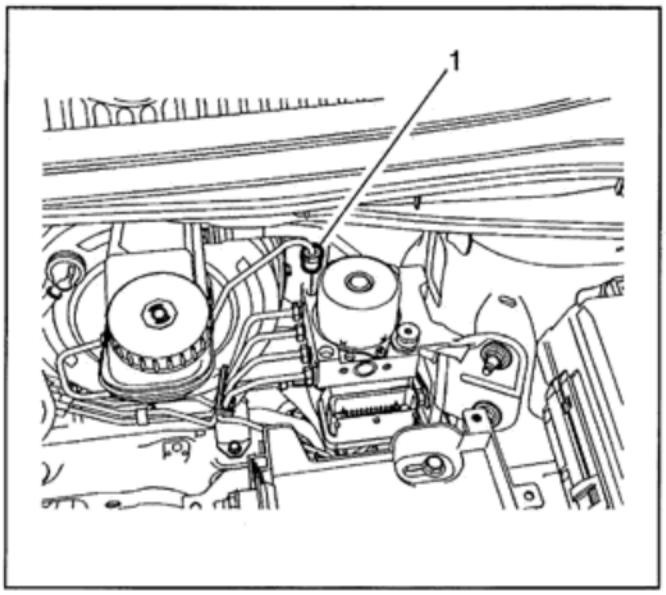


2495349

10. Disconnect the master cylinder primary brake pipe fitting (1) from the BPMV.
11. Plug the BPMV inlet port to prevent brake fluid loss and contamination.
12. Remove the master cylinder primary brake pipe assembly.

Installation Procedure

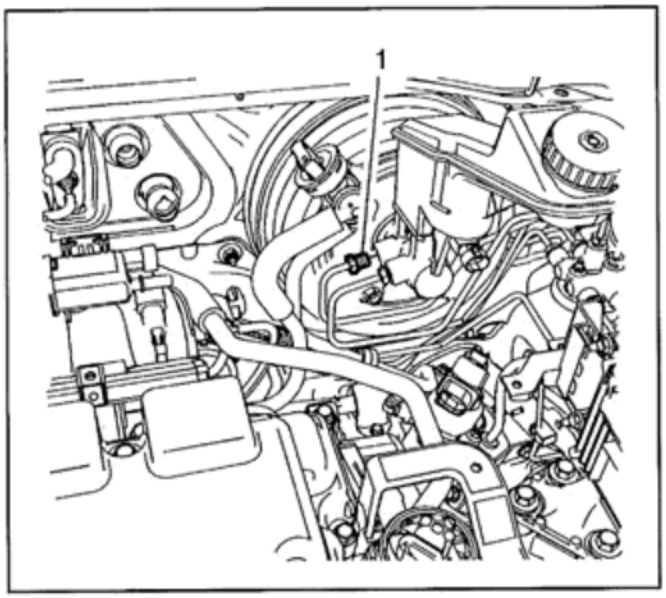
1. Install the master cylinder primary brake pipe assembly.



2495349

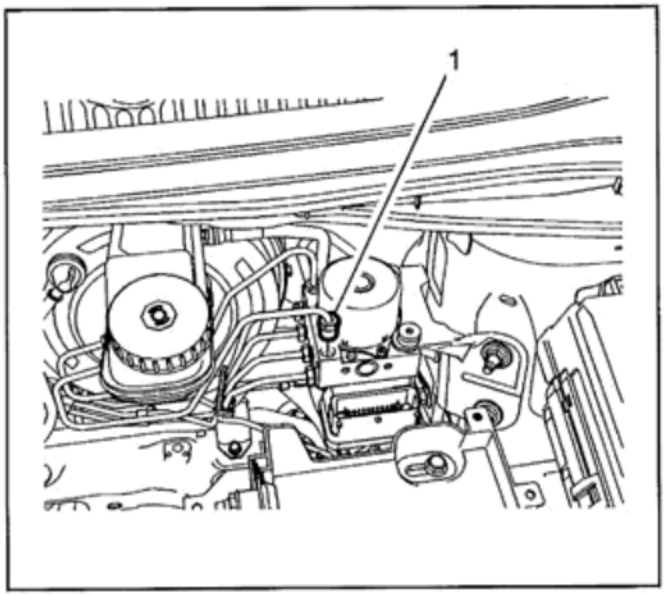
Caution: Refer to *Fastener Caution on page 0-8*.

2. Connect the master cylinder primary brake pipe fitting (1) to the BPMV and tighten to **18 N•m (13 lb ft)**.



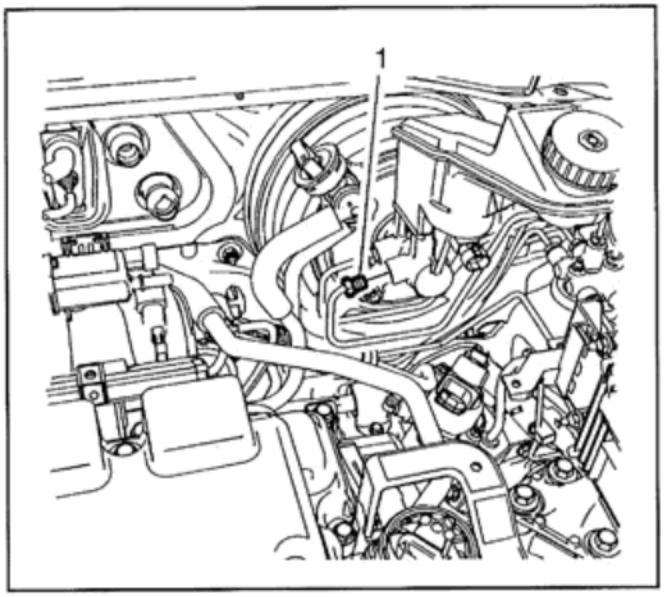
2511300

3. Connect the master cylinder primary brake pipe fitting (1) to the master cylinder and tighten to **18** N•m **(13 lb ft)**.
4. Install the master cylinder secondary brake pipe assembly.



2495345

5. Connect the master cylinder secondary brake pipe fitting (1) to the BPMV and tighten to **18** N•m **(13 lb ft)**.



2511297

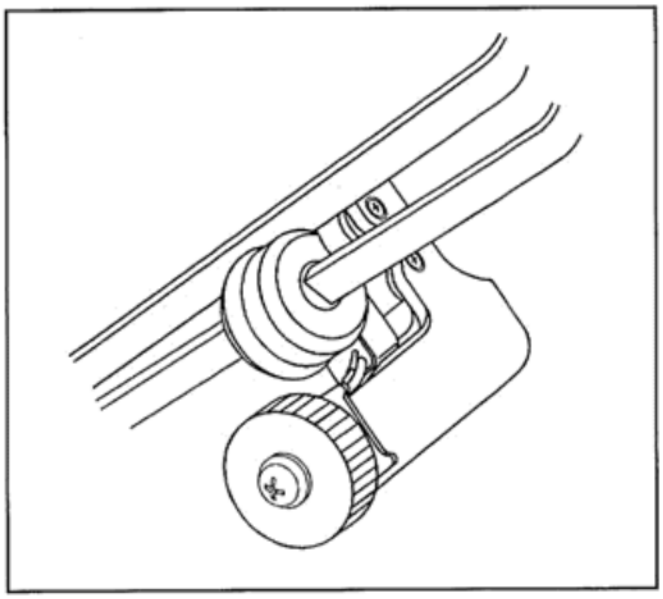
6. Connect the master cylinder secondary brake pipe fitting (1) to the master cylinder and tighten to **18** N•m **(13 lb ft)**.
7. Install the battery. Refer to *Battery Replacement on page 9-719*.
8. Bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*.

Brake Pipe Replacement

Special Tools

CH-45405 Brake Pipe Flaring Kit

For equivalent regional tools, refer to *Special Tools on page 5-181*.



900937

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

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

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7*.

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

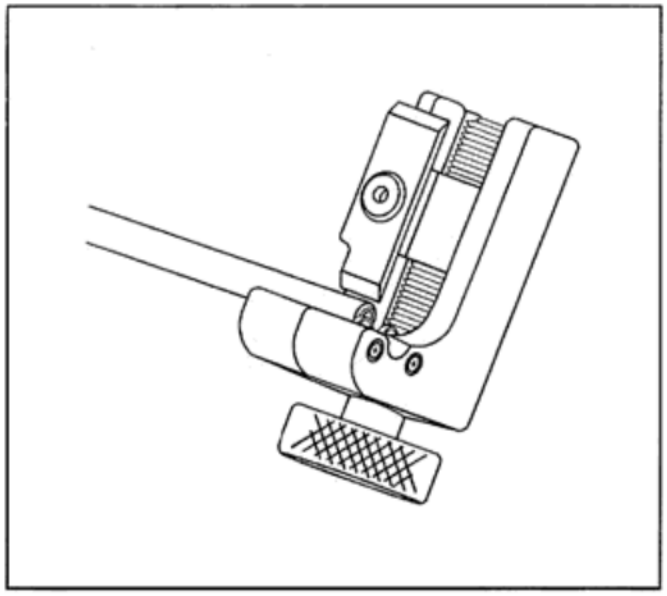
- If sectioning the brake pipe, use replacement pipe of the same type and outside diameter.
- Use fittings of the appropriate size and type.
- Only create flares of the same type or design as originally equipped on the vehicle.

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

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

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

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



900939

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

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

   9.2. Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
   9.3. While holding the brake pipe firmly against the stripping tool roller ledges, rotate the thumbwheel of the tool until the blade contacts the brake pipe coated surface.

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

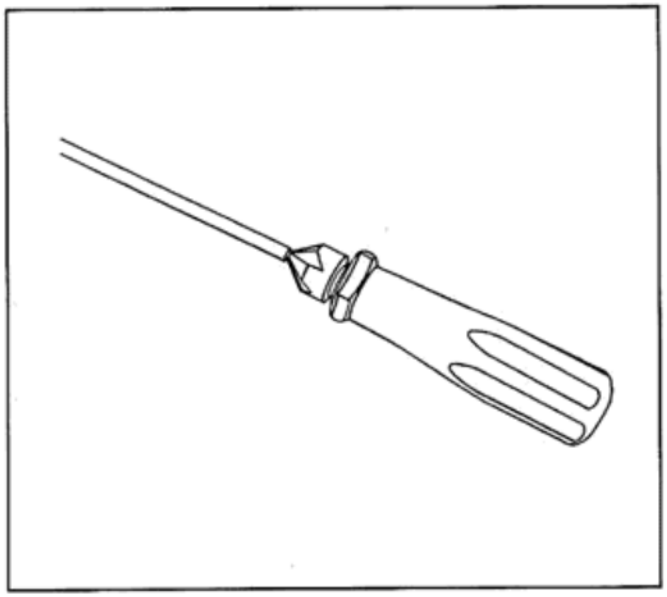
   9.4. Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against the tool roller ledges.
   9.5. After each successive revolution of the stripping tool, carefully rotate the thumbwheel of the tool clockwise, in order to continue stripping the coating from the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

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

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

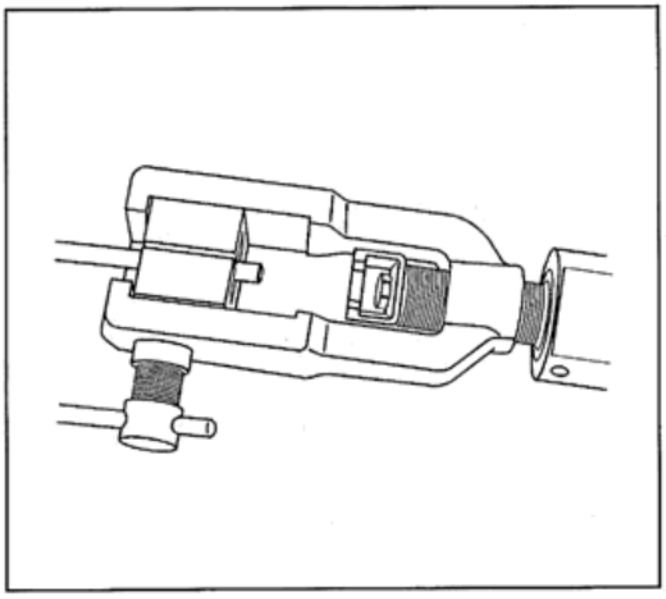
Specification

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



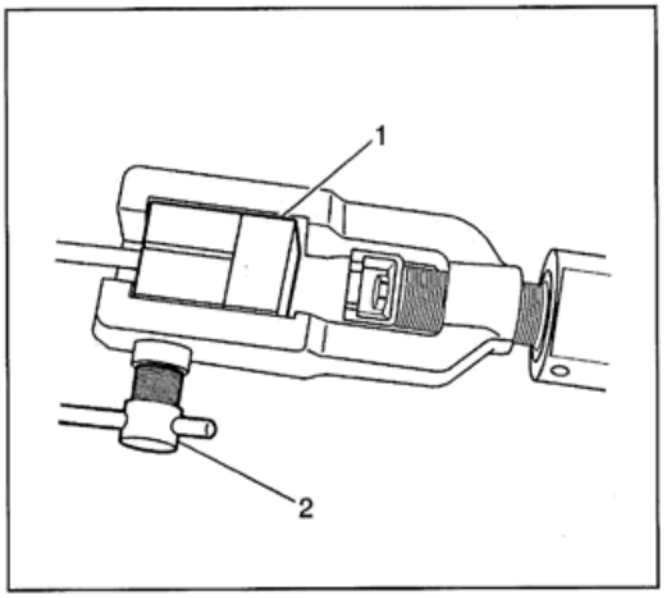
900947

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



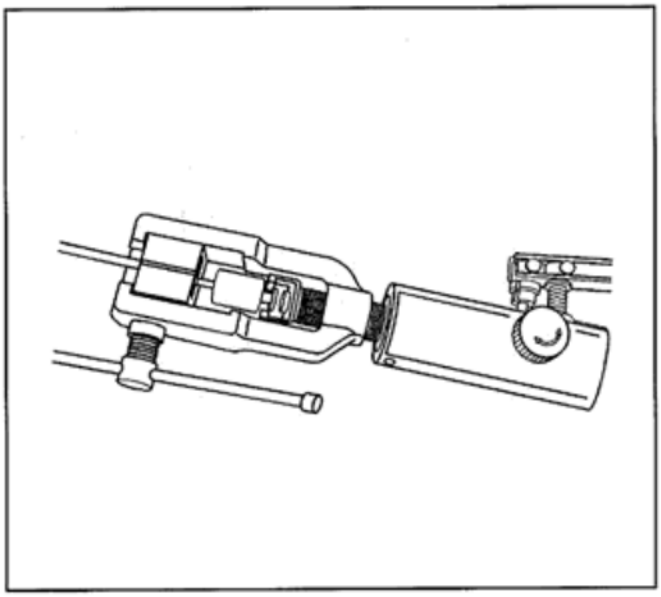
900942

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



900943

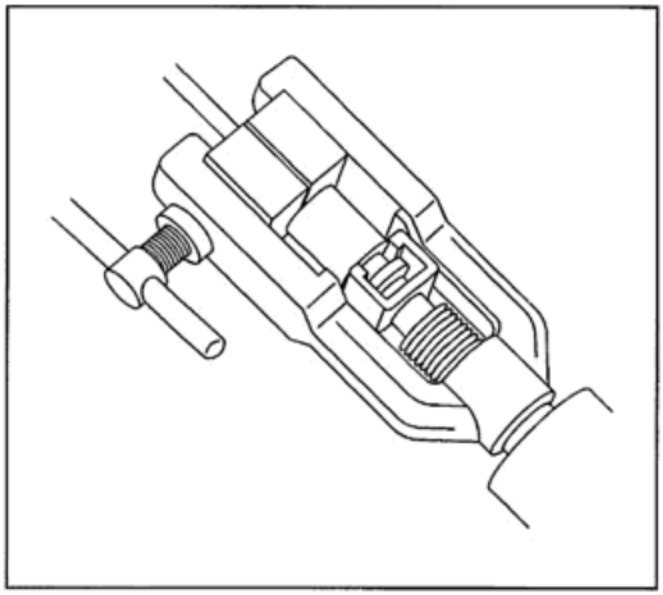
15. Place the flat face of an unused die (1) against the die halves in the clamping cage and hold firmly against the counterbored face of the dies.
16. Insert the prepared end of the pipe to be flared through the back of the dies until the pipe is seated against the flat surface of the unused die (1).
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.



900944

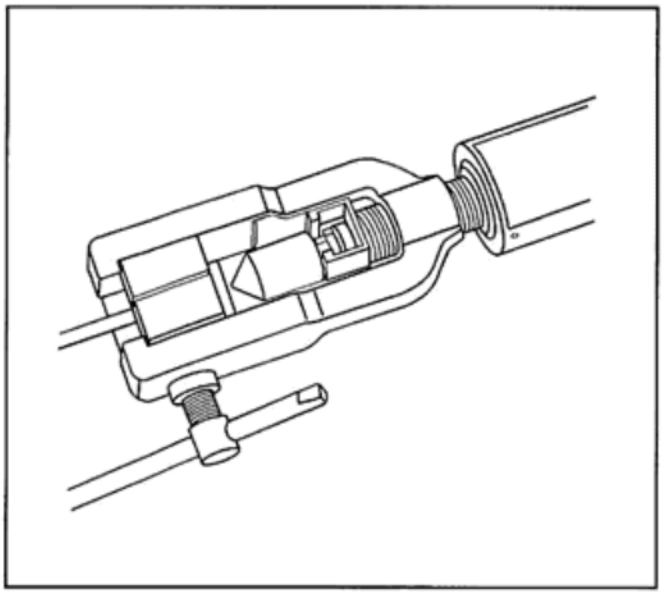
20. Select the appropriate forming mandrel and place into the forming ram.

21. Rotate the hydraulic fluid control valve clockwise to the closed position.
22. Rotate the body of the *CH-45405* Brake Pipe Flaring Kit until it bottoms against the die cage.



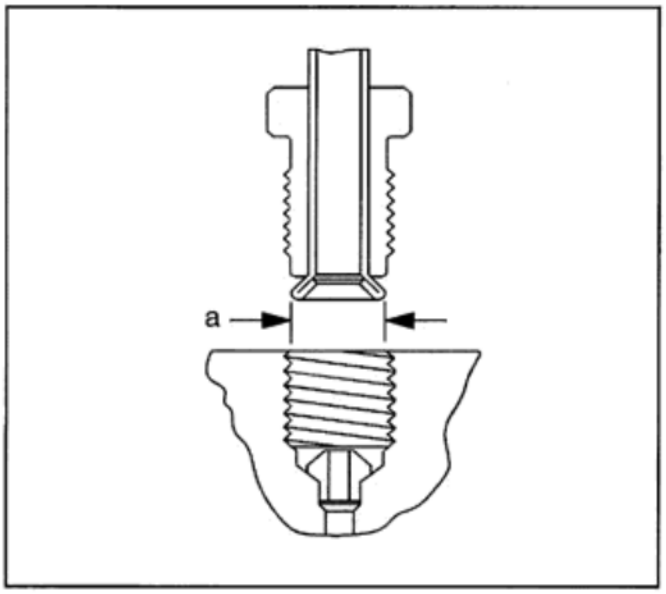
900946

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



900948

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



1201234

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

Specification

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

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

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

34. Install the pipe to the vehicle with the appropriate brake pipe unions, as required.
35. If previously released, secure the brake pipe to the retainers.
36. Bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*.
37. With the aid of an assistant, inspect the brake pipe flares for leaks by starting the engine and applying the brakes.

Front Brake Hose Replacement

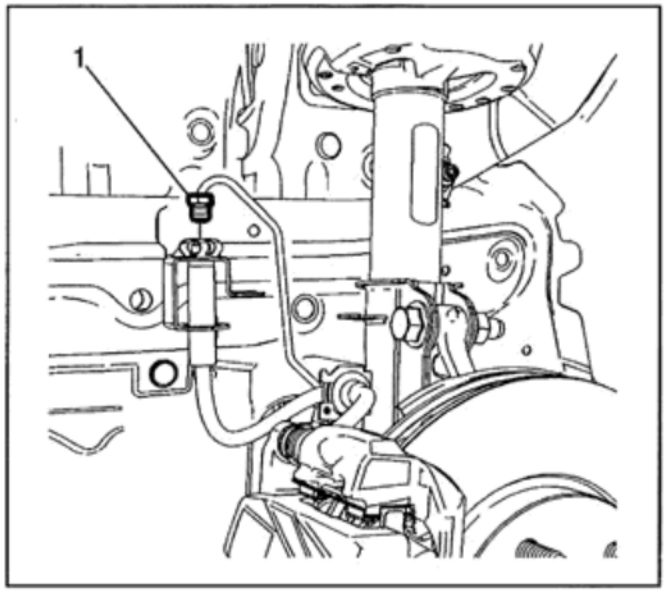
Removal Procedure

Warning: Refer to Brake Dust Warning on page 0-4.

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

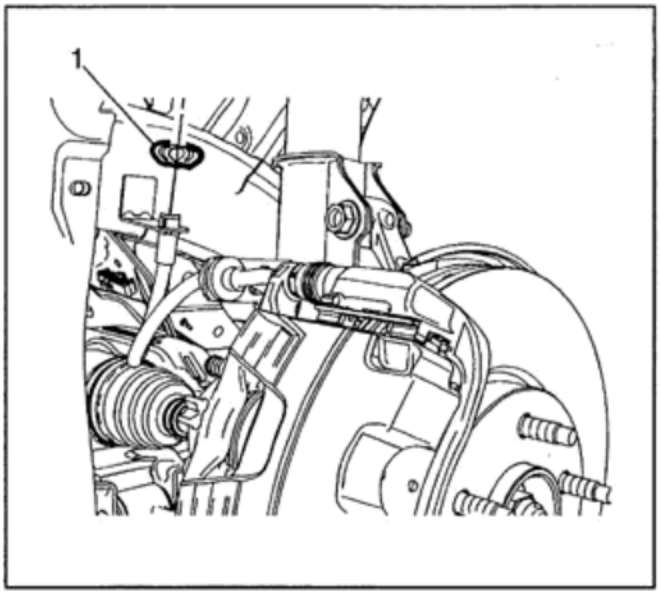
Danger: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.

1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
2. Remove the tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.



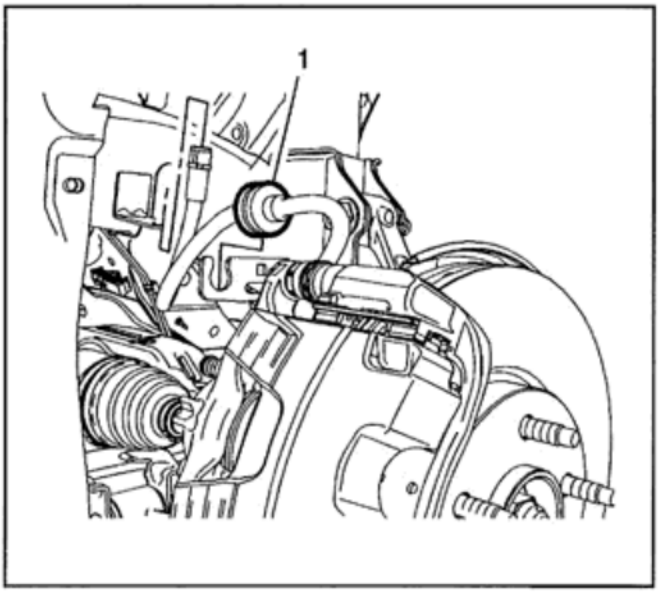
2512985

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



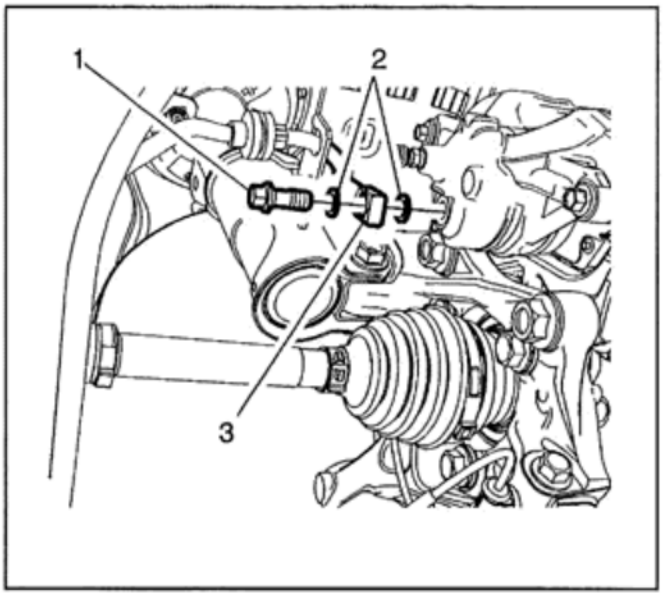
2396312

5. Remove the brake hose retainer (1).



2396315

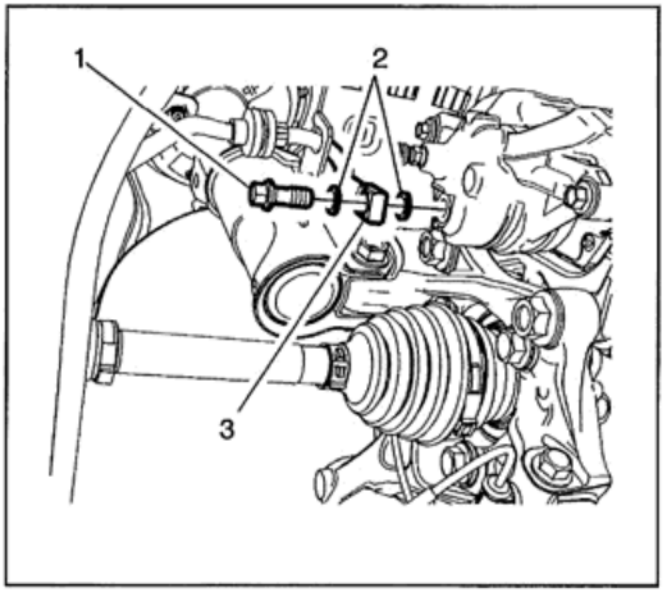
6. Release the brake hose grommet (1) from the strut bracket.



2387041

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

Installation Procedure

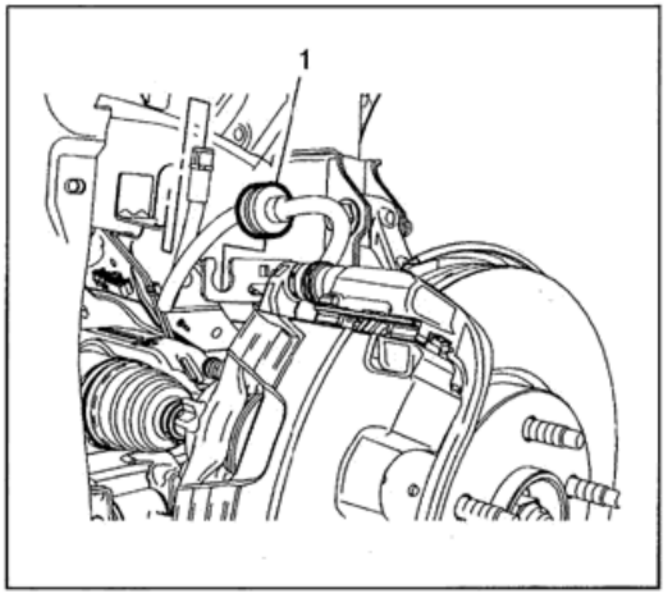


2387041

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

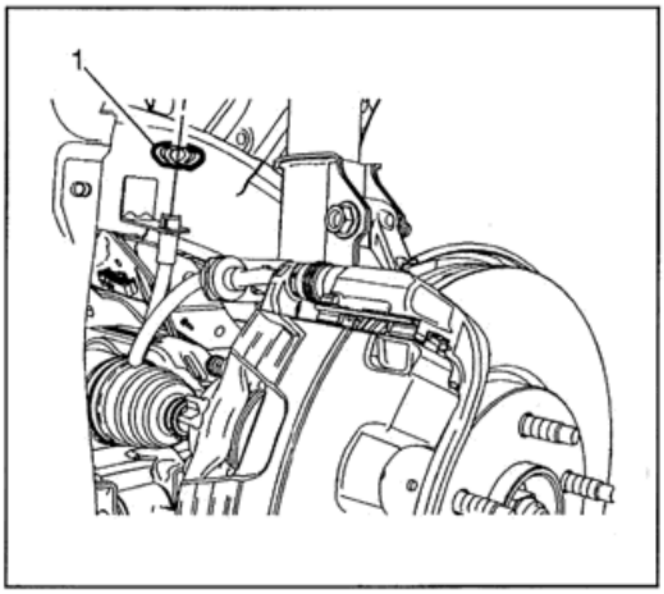
Caution: Refer to *Fastener Caution on page 0-8*.

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



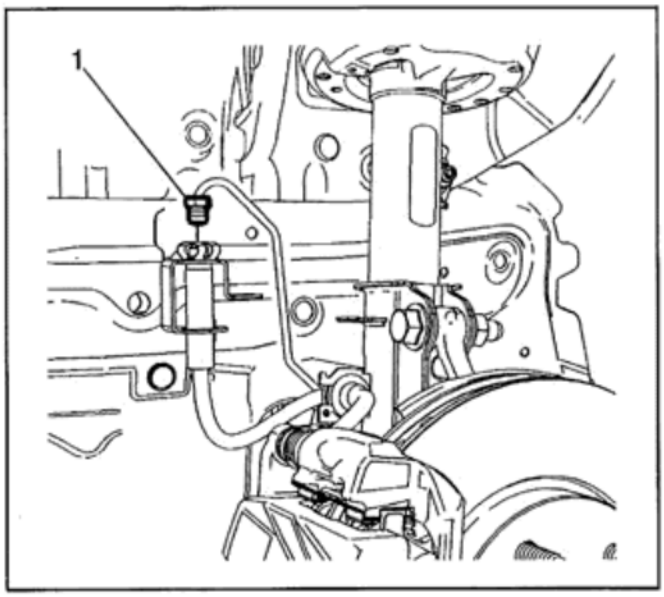
2396315

3. Install the brake hose grommet (1) to the strut bracket.



2396312

4. Install the brake hose to the wheelhouse bracket and install the retainer (1).



2512985

5. Install the brake pipe fitting (1) to the front brake hose and tighten the fitting to **18 N•m (13 lb ft)**.
6. Bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*.
7. Install the tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.

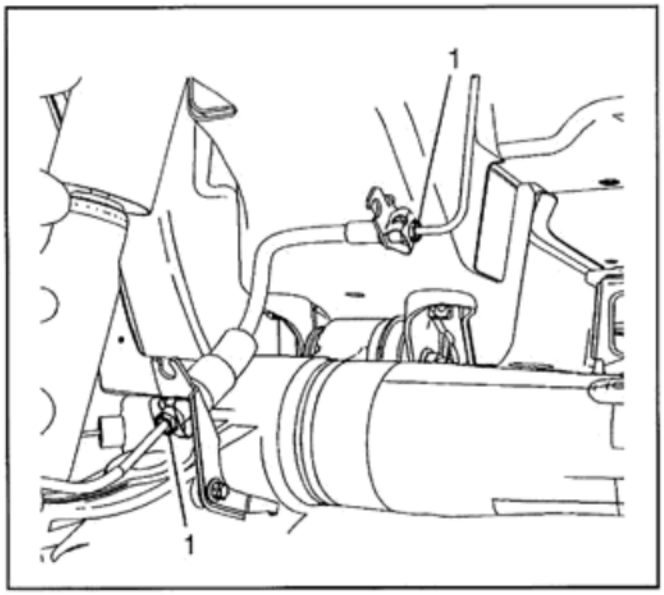
Rear Brake Hose Replacement (Body to Axle - Drum Brake)

Removal Procedure

Warning: Refer to Brake Dust Warning on page 0-4.

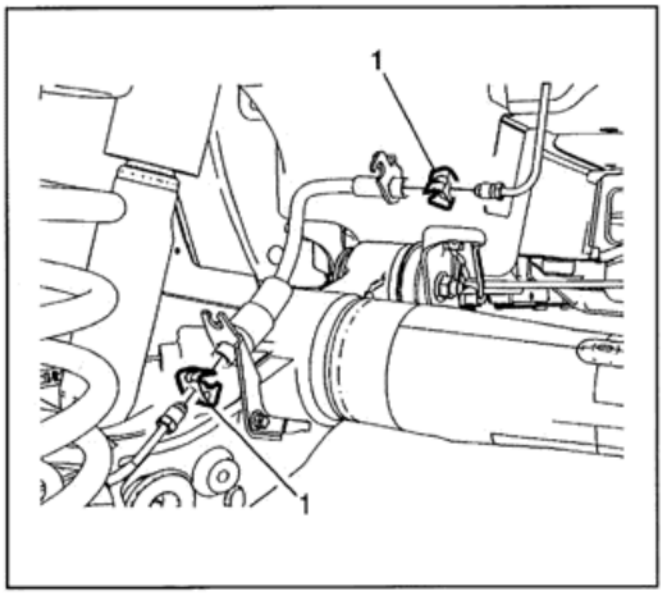
Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
2. Remove the tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.



2456822

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

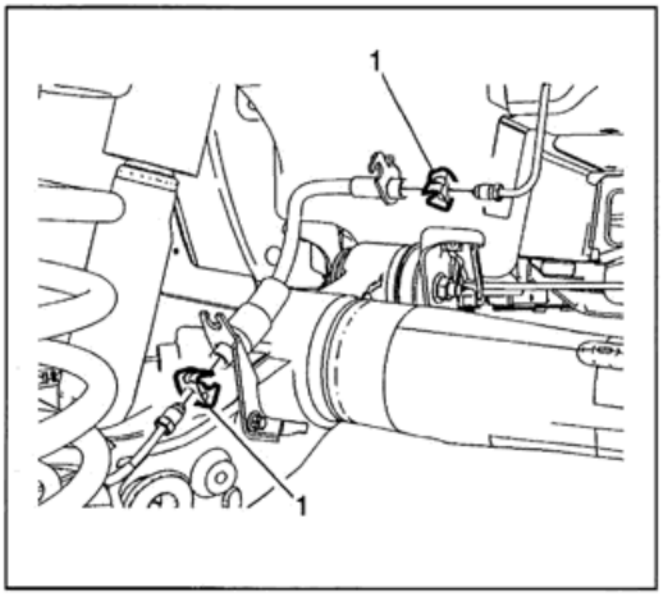


2456824

5. Remove the brake hose locking clips (1).
6. Remove the brake hose.

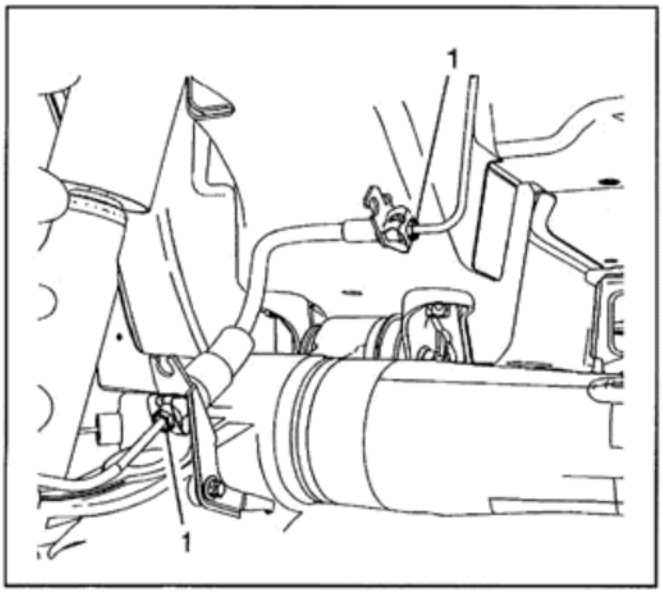
Installation Procedure

1. Install the brake hose to the brackets on the rear and axle and floor panel.



2456824

2. Install the brake hose locking clips (1).



2456822

Caution: Refer to *Fastener Caution on page 0-8.*

3. Connect the brake pipe fittings (1) to the brake hose and tighten to **18 N•m (13 lb ft)**.
4. Bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170.*
5. Install the tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60.*

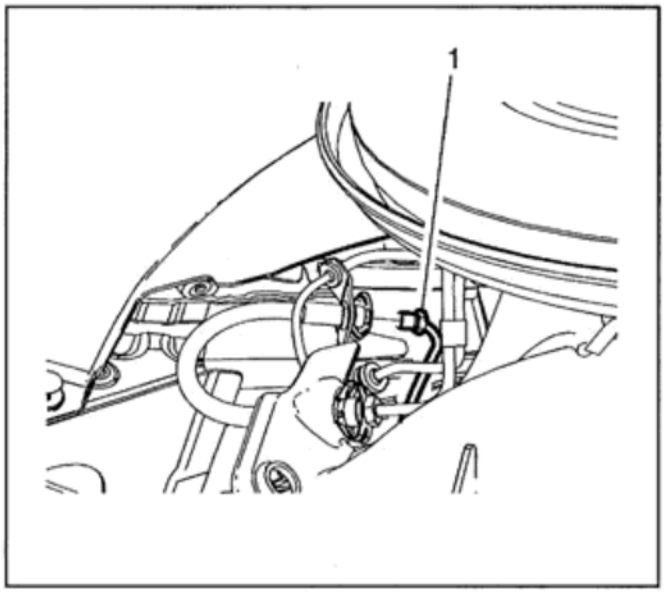
Rear Brake Hose Replacement (Body to Axle - Disc Brake)

Removal Procedure

Warning: Refer to Brake Dust Warning on page 0-4.

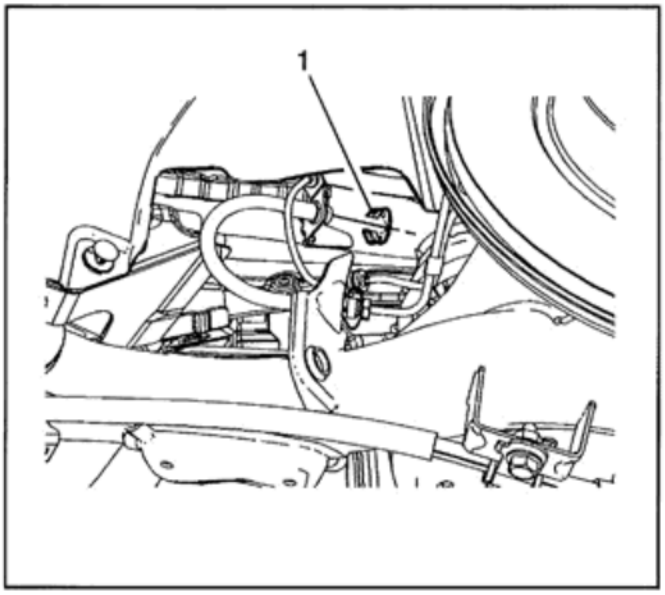
Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31.*
2. Remove the tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60.*



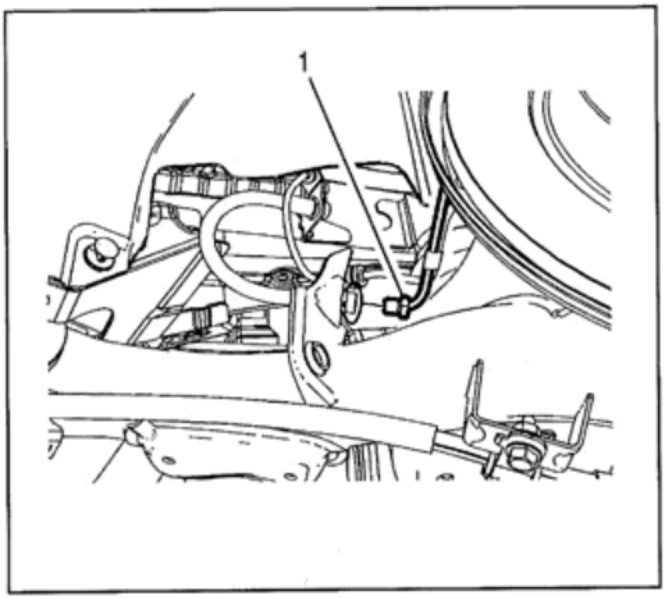
2844641

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



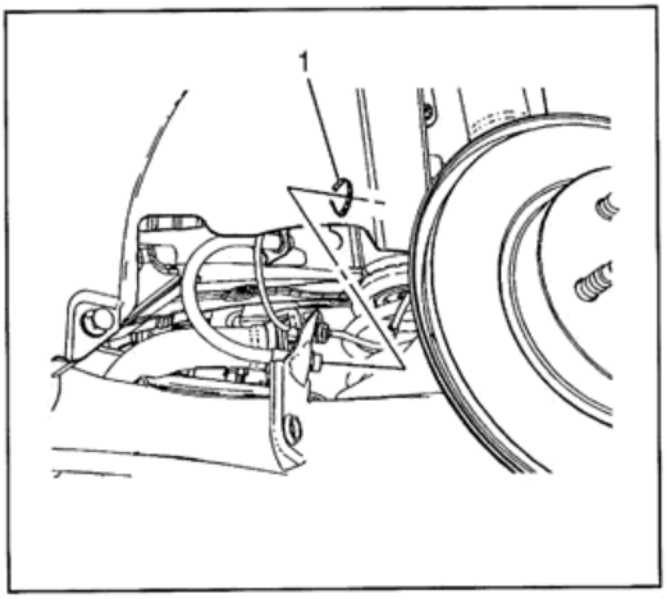
2844644

5. Remove the brake hose retainer (1).



2844649

6. Remove the brake pipe fitting (1) from the rear brake hose.
7. Cap the brake pipe fitting to prevent brake fluid loss and contamination.

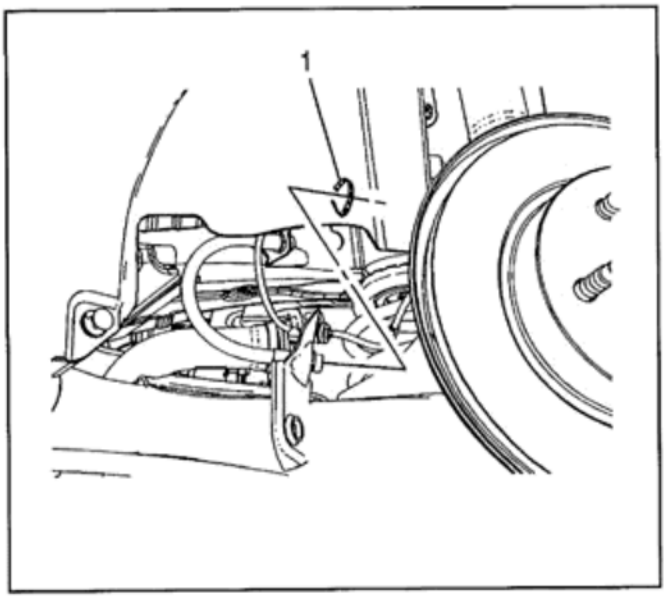


2844653

8. Remove the brake hose retainer (1).
9. Remove the brake hose.

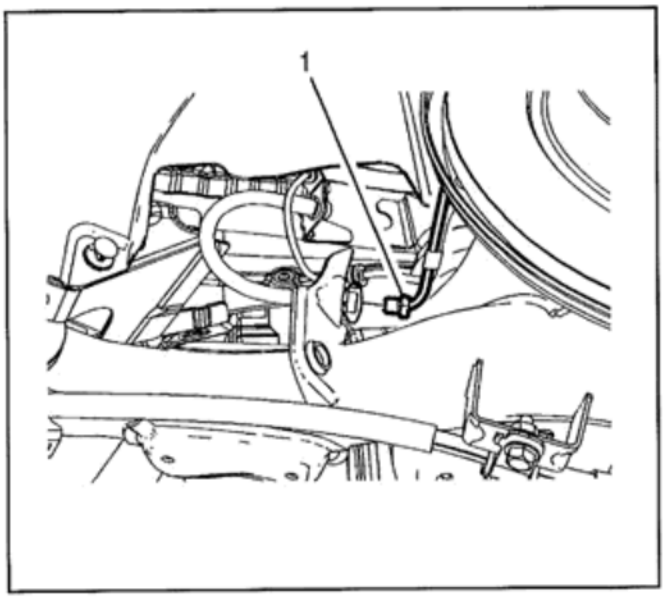
Installation Procedure

1. Install the brake hose.



2844653

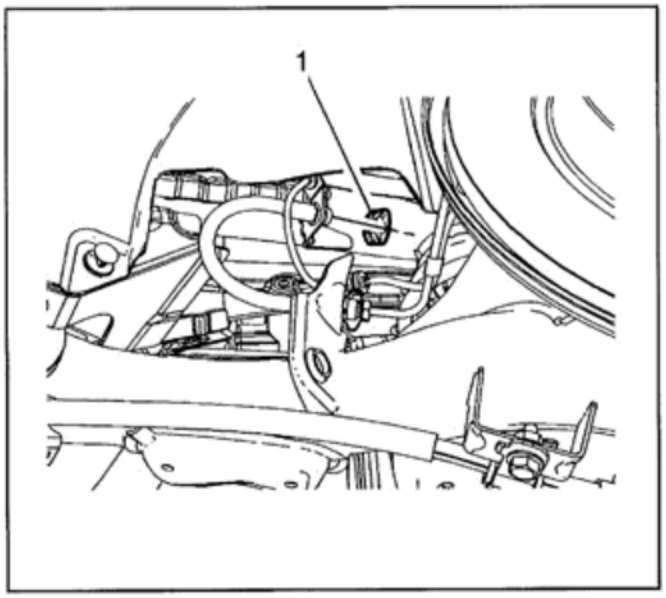
2. Install the brake hose retainer (1).



2844649

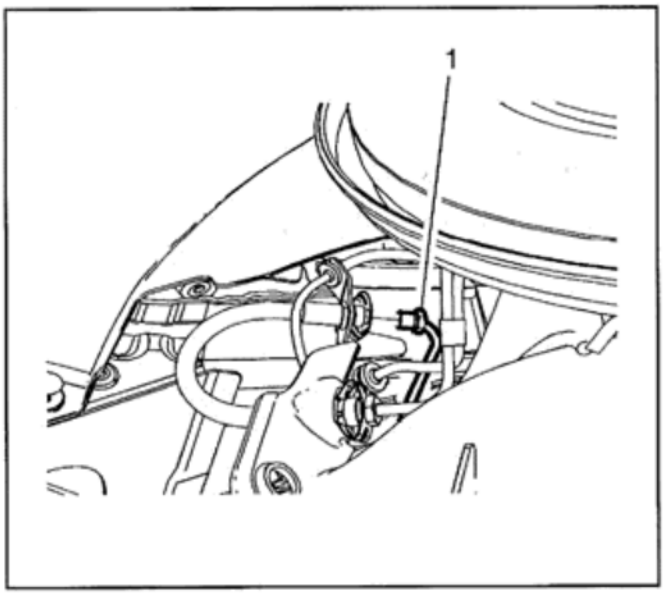
Caution: Refer to *Fastener Caution on page 0-8*.

3. Install the brake pipe fitting (1) to the rear brake hose and tighten the fitting to **18 N•m (13 lb ft)**.



2844644

4. Install the brake hose retainer (1).



2844641

5. Install the brake pipe fitting (1) to the rear brake hose and tighten the fitting to **18 N•m (13 lb ft)**.
6. Bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*.
7. Install the tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.

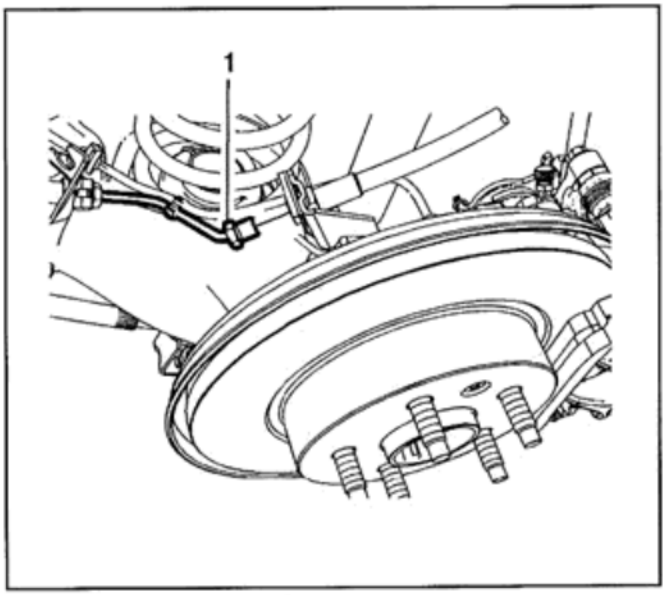
Rear Brake Hose Replacement (Axle to Caliper)

Removal Procedure

Warning: Refer to Brake Dust Warning on page 0-4.

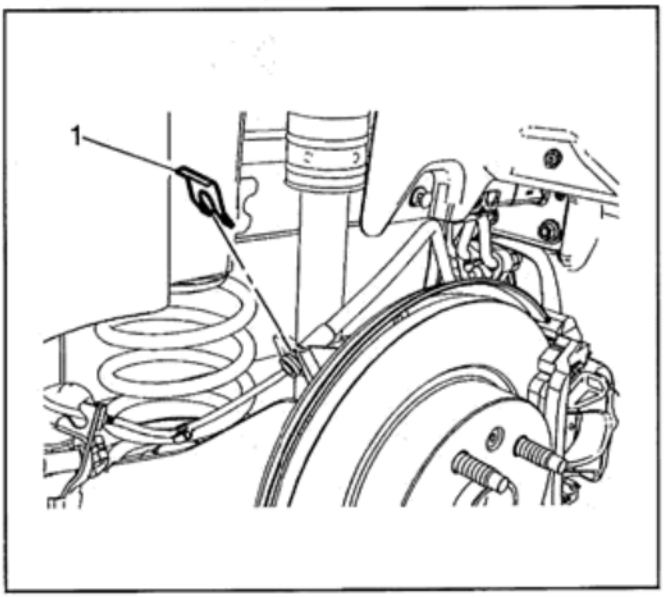
Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
2. Remove the tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.



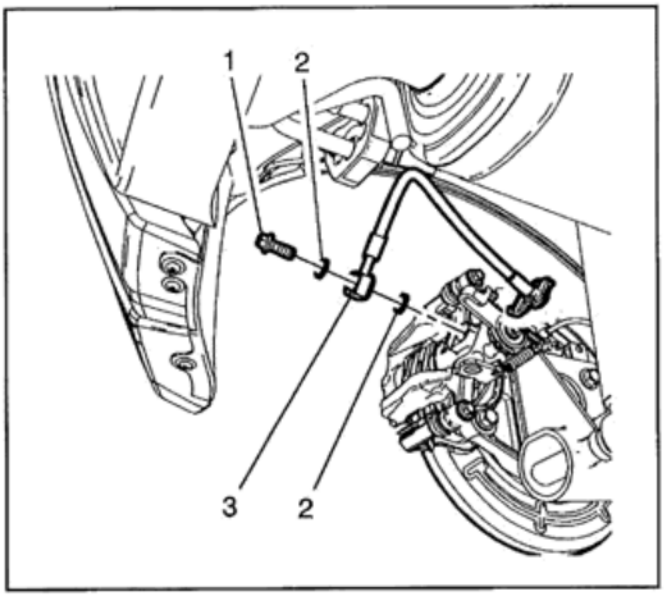
2844497

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



2844501

5. Remove the brake hose retainer (1).



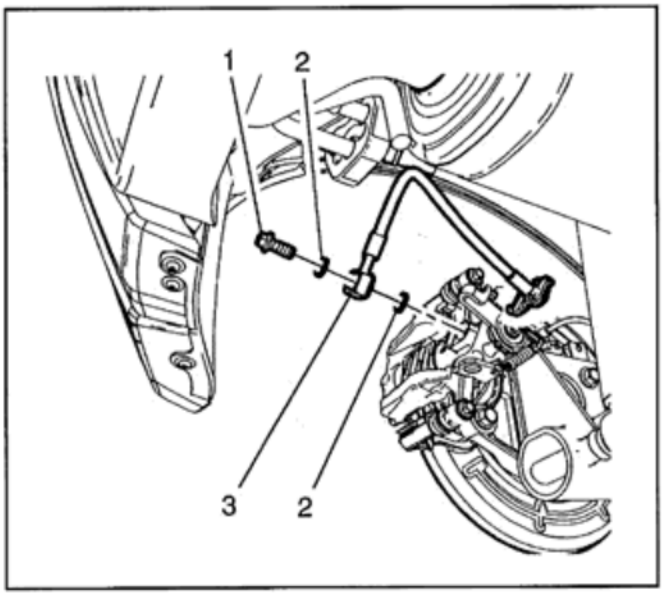
2843788

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

Note: Do not reuse the brake hose fitting gaskets.

7. Remove and discard the brake hose fitting gaskets (2) from the brake hose fitting (3).
8. Remove the brake hose.

Installation Procedure

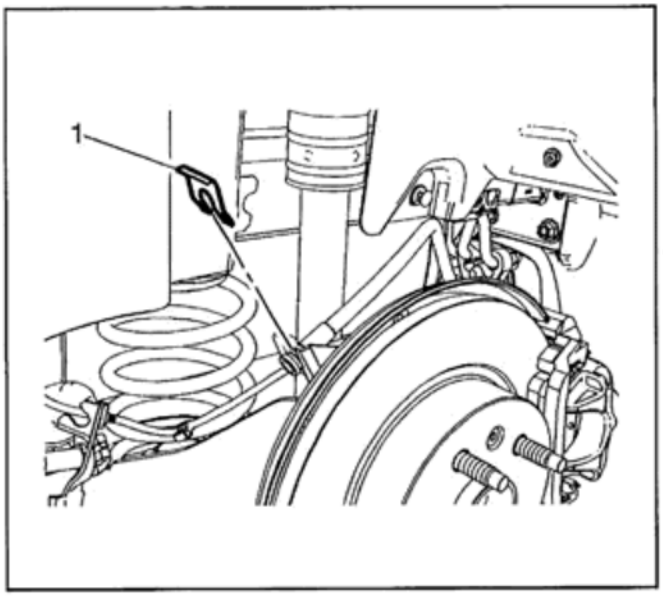


2843788

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

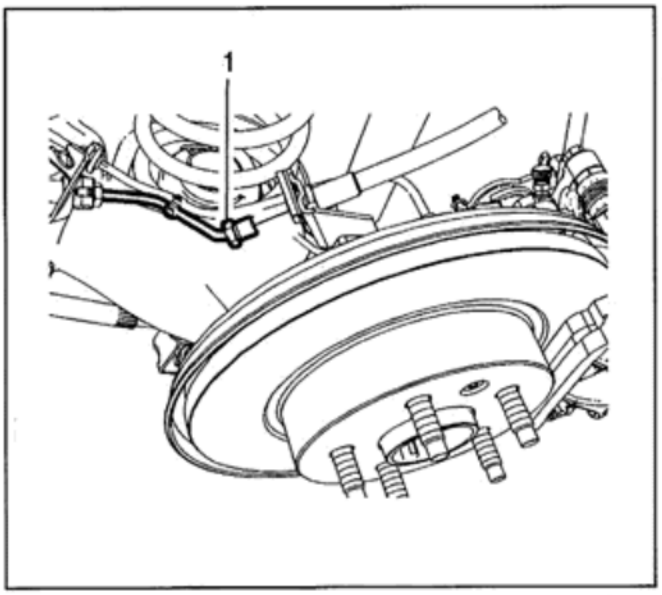
Caution: Refer to *Fastener Caution on page 0-8*.

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



2844501

3. Install the brake hose to the wheelhouse bracket and install the retainer (1).



2844497

4. Install the brake pipe fitting (1) to the rear brake hose and tighten the fitting to **18** N•m **(13 lb ft)**.
5. Bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*.
6. Install the tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.

Hydraulic Brake System Bleeding (Pressure)

Special Tools

- *CH-29532* Diaphragm Type Brake Pressure Bleeder
- *CH-35589-A* Brake Pressure Bleeder Adapter

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7.*

1. Place a clean shop cloth beneath the brake master cylinder reservoir 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, to deplete the brake booster power reservoir.
3. If you have performed a master cylinder bench bleeding on this vehicle, 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 components.
   3.1. Fill the master cylinder reservoir to the maximum-full level with the approved 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.

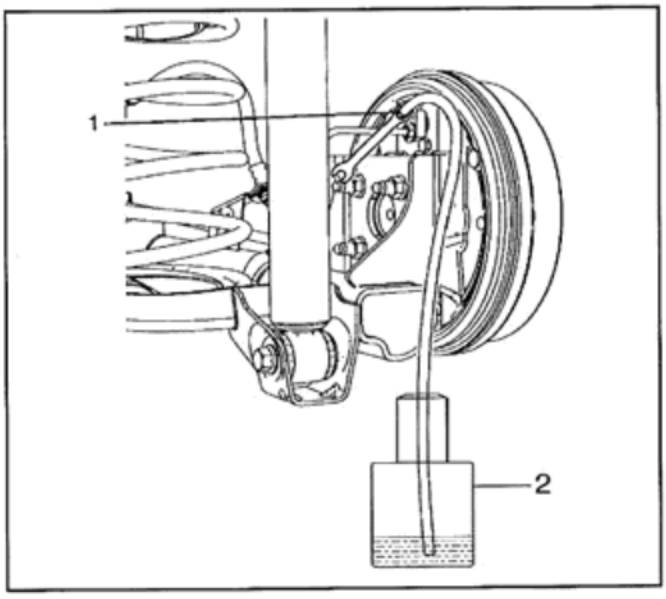
   3.2. With the brake pipes installed securely to the master cylinder, proportioning valve assembly, or the brake pressure modulator valve assembly, loosen and separate one of the brake pipes from the port of the component.

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

   3.3. Allow a small amount of brake fluid to gravity bleed from the open port of the component.
   3.4. Connect the brake pipe fitting to the component and tighten securely.
   3.5. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
   3.6. Loosen the same brake pipe fitting to purge air from the open port of the component.
   3.7. Tighten the brake pipe fitting, then have the assistant slowly release the brake pedal.
   3.8. Wait 15 seconds, then repeat steps 3.3–3.7 until all air is purged from the same port of each component.
   3.9. With the brake pipe fitting installed securely to the master cylinder, proportioning valve assembly, or brake pressure 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 and repeat steps 3.3–3.8 until each of the ports on the component has been bled.
   3.10. After completing the final component port bleeding procedure, ensure that each of the brake pipe fittings is properly tightened.
4. Fill the brake master cylinder reservoir to the maximum-fill level with the approved brake fluid from a clean, sealed brake fluid container. Ensure the master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to remain the proper level.

   Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
5. Set up the brake pressure bleeder following the manufacturer's instructions.
6. Open the brake pressure bleeder fluid valve to allow pressurized brake fluid to enter the brake system.
7. Wait approximately 30 seconds, and 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.



2327910

8. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve (1).
9. Install a transparent hose over the end of the wheel hydraulic circuit bleeder valve (1).
10. Submerge the open end of the transparent hose into a transparent container (2) partially filled with the approved brake fluid from a clean, sealed brake fluid container.
11. 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.
12. Tighten the wheel circuit bleeder valve securely.

13. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
14. Install a transparent hose over the end of the wheel hydraulic circuit bleeder valve, then repeat steps 10–12.
15. Install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.
16. Install a transparent hose over the end of the wheel hydraulic circuit bleeder valve, then repeat steps 10–12.
17. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
18. Install a transparent hose over the end of the wheel hydraulic circuit bleeder valve, then repeat steps 10–12.
19. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves is properly tightened.
20. Close the brake pressure bleeder fluid valve.
21. Remove the brake pressure bleeder from the brake master cylinder reservoir.
22. Fill the brake master cylinder reservoir to the maximum-full level with the approved brake fluid from a clean, sealed brake fluid container.
23. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.
24. 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 step:
    24.1. Inspect the brake system for external leaks. Refer to *Brake System External Leak Inspection on page 5-143*.
    24.2. If equipped with antilock brakes, using a scan toll, perform the antilock brake system automated bleeding procedure to remove any air that may have been trapped in the brake pressure modulator valve (BPMV). Refer to *Antilock Brake System Automated Bleed on page 5-38*
25. Turn the ignition ON, with the engine OFF. Check to see if the brake system warning lamp is illuminated.

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

26. If the brake system warning lamp remains illuminated, refer to *Symptoms - Hydraulic Brakes on page 5-111*.

Hydraulic Brake System Bleeding (Manual)

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7*.

Caution: Only use products that comply with GM specifications and check manufacturer information respectively. We recommend the use of GM genuine products. Instructions must be followed at all times. 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.

If hydraulic components were serviced on only one wheel hydraulic circuit, perform the following procedure.

Bleeding a Single Hydraulic Brake Circuit

1. 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.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to *Fluid and Lubricant Recommendations on page 1-35*.
5. Install a proper box-end wrench onto the wheel hydraulic circuit bleeder valve which has been serviced.
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 brake fluid from a clean, sealed brake fluid container.
8. Have an assistant slowly press 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 wheel hydraulic circuit.
12. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.
13. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
14. Slowly press and release the brake pedal. Observe the brake pedal feel.
15. If the brake pedal feels spongy, perform the Bleeding the Complete Brake Hydraulic System procedure:
16. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

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

17. If the brake system warning lamp remains illuminated, refer to *Diagnostic Starting Point - Vehicle on page 6-66*.

Bleeding the Complete Brake Hydraulic System

1. 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.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to *Fluid and Lubricant Recommendations on page 1-35*.
5. If the master cylinder was replaced, the master cylinder must be bench bled. Refer to *Master Cylinder Bench Bleeding on page 5-150*.
6. If the brake pipes have been removed from the master cylinder, the following steps must be performed.
   6.1. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe fitting from the front port of the brake master cylinder.
   6.2. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder. Capture and properly dispose of the brake fluid in an approved container.
   6.3. Install the front brake pipe fitting to the front port of the brake master cylinder and tighten the fitting. Refer to *Fastener Tightening Specifications on page 5-108*.
   6.4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
   6.5. Loosen the front brake pipe fitting from the front port of the brake master cylinder to purge air from the master cylinder port.
   6.6. Tighten the front brake pipe fitting, then have the assistant slowly release the brake pedal.
   6.7. Wait 15 seconds, then repeat steps 6.4-6.6 until all air is purged from the front brake pipe fitting of the front port of the master cylinder.
   6.8. After all air is purged from the front port of the brake master cylinder, tighten the front master cylinder brake pipe fitting. Refer to *Fastener Tightening Specifications on page 5-108*.
   6.9. With the front brake pipe fitting installed securely to the front port of the brake master cylinder, loosen and separate the rear brake pipe fitting from the rear port of the brake master cylinder.
   6.10. Repeat steps 6.2-6.7 for the rear port of the brake master cylinder.
   6.11. After all air is purged from the rear port of the brake master cylinder, tighten the rear master cylinder brake pipe fitting. Refer to *Fastener Tightening Specifications on page 5-108*.
   6.12. Slowly press and release the brake pedal. Observe the brake pedal feel.
   6.13. If the brake pedal feels spongy, proceed to step 7.
   6.14. If the brake pedal feels firm, proceed to step 24.
7. If the brake pipes have been removed from the brake pressure modulator valve (BPMV) assembly, if equipped, or the brake proportion valve assembly, if equipped, air must be purged from each port of the respective assembly beginning with the feed pipes from the master cylinder.
   7.1. Loosen and separate one of the master cylinder brake pipe fittings from the inlet port of the assembly to be bled.
   7.2. Allow a small amount of brake fluid to gravity bleed from the open port of the assembly. Capture and properly dispose of the brake fluid in an approved container.
   7.3. Install the brake pipe fitting and to the inlet port of the assembly and tighten securely.
   7.4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
   7.5. Loosen the same brake pipe fitting to purge air from the open port of the assembly.
   7.6. Tighten the brake pipe fitting, then have the assistant slowly release the brake pedal.
   7.7. Wait 15 seconds, then repeat steps 7.4-7.6 until all air is purged from the brake pipe fitting of the assembly.
   7.8. Repeat steps 7.1-7.7 for all of the remaining ports of the assembly.
   7.9. After bleeding each port of the assembly, tighten all of the brake pipe fittings on the assembly. Refer to *Fastener Tightening Specifications on page 5-108*.
   7.10. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.
   7.11. Slowly press and release the brake pedal. Observe the brake pedal feel.
   7.12. If the brake pedal feels spongy, proceed to step 8.
   7.13. If the brake pedal feels firm, proceed to step 24.
8. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
9. Install a transparent hose over the end of the bleeder valve.

10. Submerge the open end of the transparent hose into a transparent container partially filled with GM approved brake fluid from a clean, sealed brake fluid container.
11. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the brake pedal.
12. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
13. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
14. Wait 15 seconds, then repeat steps 11-13 until all air is purged from the wheel hydraulic circuit.
15. Tighten the RIGHT REAR hydraulic wheel circuit bleeder valve securely.
16. Install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
17. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
18. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
19. After completing the final wheel hydraulic circuit bleeding procedure, tighten all of the wheel hydraulic circuit bleeder valves and install the bleeder valve dust caps.
20. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.
21. Slowly press and release the brake pedal. Observe the brake pedal feel.
22. If the brake pedal feels spongy, perform the following procedure.
    22.1. If equipped with antilock brakes, install a scan tool and perform the *Antilock Brake System Automated Bleed on page 5-38* to remove air which may be trapped in the BPMV.
    22.2. Inspect the hydraulic brake system for external leaks. Refer to *Brake System External Leak Inspection on page 5-143*.
    22.3. Repeat the Bleeding the Complete Brake Hydraulic System procedure.
23. If the brake pedal still feels spongy, pressure bleed the hydraulic brake system. Refer to *Hydraulic Brake System Bleeding (Pressure) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*
24. Turn the ignition switch ON with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

Note: DO NOT allow the vehicle to be driven until the brake system is diagnosed and repaired.

25. If the brake system warning lamp remains illuminated, refer to *Diagnostic Starting Point - Vehicle on page 6-66*.

Hydraulic Brake System Flushing

Warning: Refer to Brake Fluid Irritant Warning on page 0-4.

Caution: Refer to *Brake Fluid Effects on Paint and Electrical Components Caution on page 0-7*.

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 and/or 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:
   3.1. 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 on page 5-147*
   - *Front Brake Hose Replacement on page 5-162*
   - *Rear Brake Hose Replacement (Body to Axle - Drum Brake) on page 5-164* or *Rear Brake Hose Replacement (Body to Axle - Disc Brake) on page 5-165* or *Rear Brake Hose Replacement (Axle to Caliper) on page 5-167*
   - *Front Brake Caliper Replacement on page 5-65*
   - *Rear Brake Cylinder Replacement on page 5-102*
   - *Brake Pressure Modulator Valve Replacement on page 5-40*

   3.2. Clean out all the hydraulic brake pipes using denatured alcohol, or equivalent.
   3.3. Dry the brake pipes using non-lubricated, filtered air.

3.4. 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:

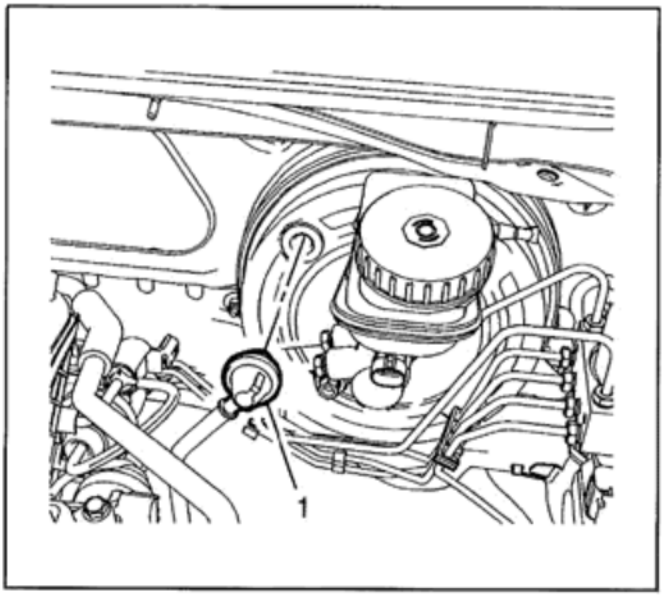
- *Master Cylinder Replacement on page 5-147* ; also perform the following:
- Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to *Master Cylinder Reservoir Replacement on page 5-146*.
- *Front Brake Hose Replacement on page 5-162*
- *Rear Brake Hose Replacement (Body to Axle - Drum Brake) on page 5-164* or *Rear Brake Hose Replacement (Body to Axle - Disc Brake) on page 5-165* or *Rear Brake Hose Replacement (Axle to Caliper) on page 5-167*
- *Front Brake Caliper Replacement on page 5-65*
- *Rear Brake Cylinder Replacement on page 5-102*
- *Brake Pressure Modulator Valve Replacement on page 5-40*

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 the approved 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) on page 5-169* or *Hydraulic Brake System Bleeding (Manual) on page 5-170*.

Power Vacuum Brake Booster Replacement

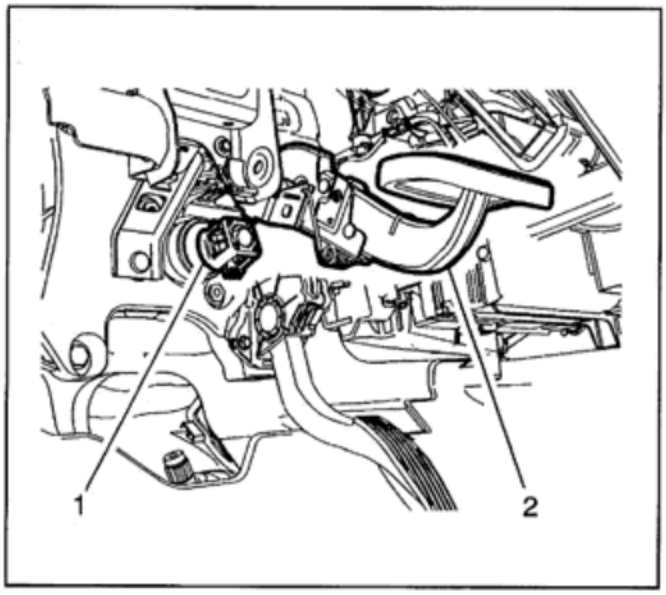
Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the battery tray. Refer to *Battery Tray Replacement on page 9-721*.
3. Disconnect the power vacuum brake booster vacuum sensor electrical connector, if equipped.



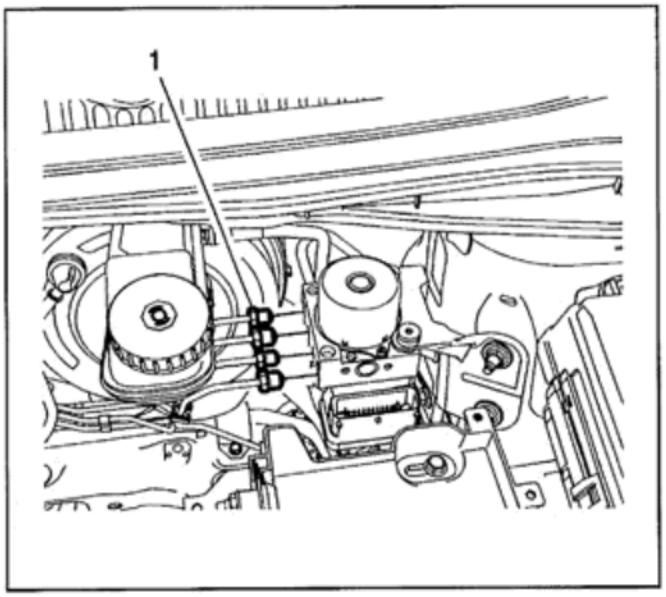
2512974

4. Remove the power brake booster vacuum check valve (1) from the power vacuum brake booster.
5. Remove the instrument panel lower trim pad cover. Refer to *Instrument Panel Lower Trim Pad Cover Replacement (Without AAL) on page 2-40* or *Instrument Panel Lower Trim Pad Cover Replacement (With AAL) on page 2-41*.



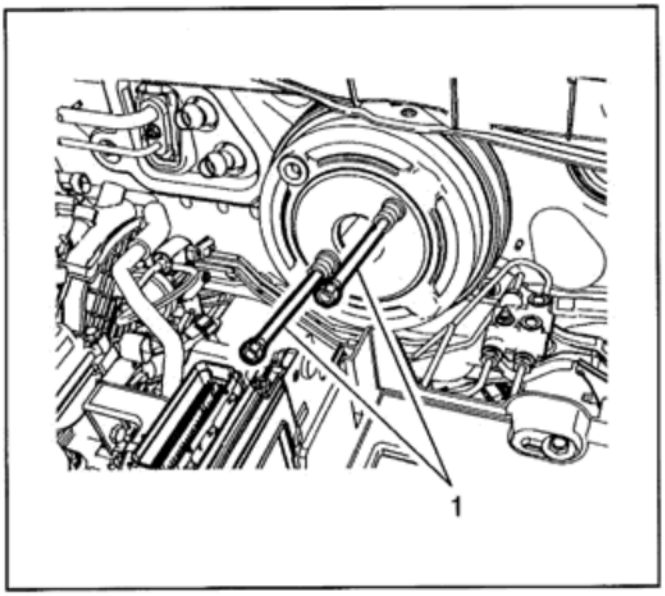
2539396

6. Compress the tabs on the top and bottom of the brake booster pushrod retainer (1) and lift the brake pedal (2) rearward to disconnect the brake pedal from the power brake booster pushrod.
7. Inspect the brake booster pushrod retainer for damage and replace, if necessary.
8. Remove the master cylinder. Refer to *Master Cylinder Replacement on page 5-147*.



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9. If equipped with antilock brakes, disconnect the front and rear brake pipe fittings (1) from the brake pressure modulator valve (BPMV). Refer to *Brake Pressure Modulator Valve Replacement on page 5-40*.

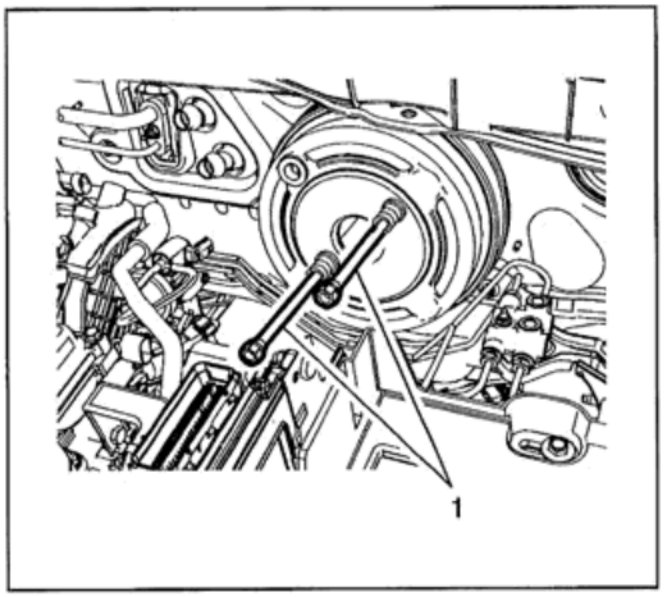


2511360

10. Completely loosen the power vacuum brake booster bolts (1).
11. Remove the power vacuum brake booster.
12. Inspect the power vacuum brake booster gasket for damage and replace, if necessary.

Installation Procedure

1. Install the power vacuum brake booster gasket, if removed.



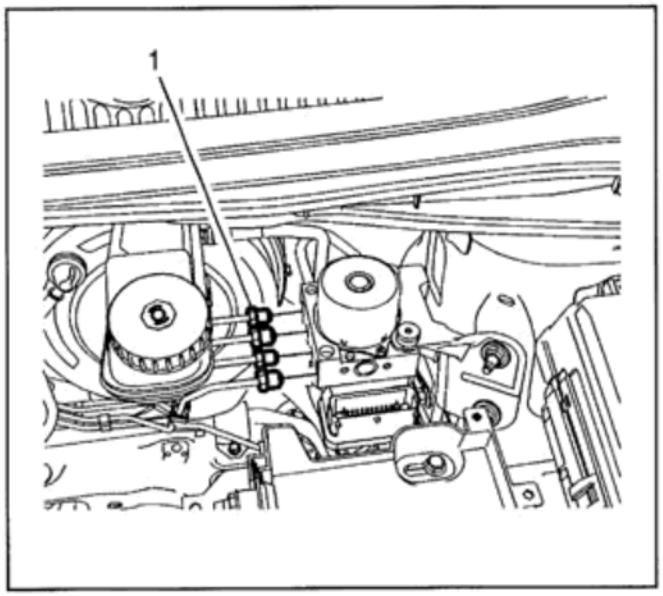
2511360

2. Install the power vacuum brake booster and bolts.

Caution: Refer to *Fastener Caution on page 0-8*.

Note: Do not over tighten the power vacuum brake booster bolts. If the power vacuum brake booster bolts are over tightened, the brake pedal may remain applied after a high pressure brake pedal application.

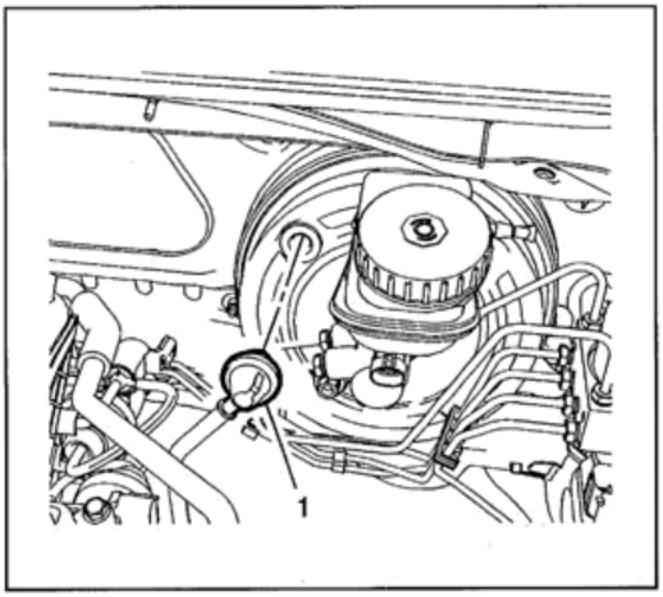
3. Install the power vacuum brake booster bolts (1) and tighten to **19 N·m (14 lb ft)**.



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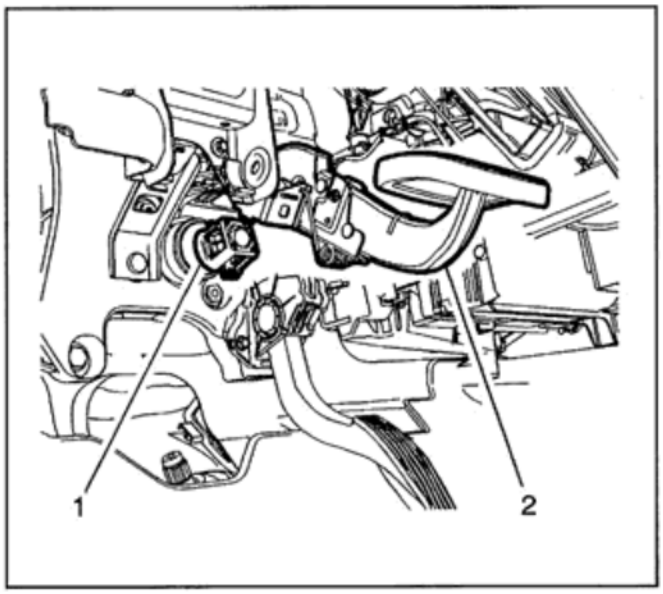
4. If equipped with antilock brakes, connect the front and rear brake pipe fittings (1) to the brake pressure modulator valve (BPMV). Refer to *Brake Pressure Modulator Valve Replacement on page 5-40*.

5. Install the master cylinder. Refer to *Master Cylinder Replacement on page 5-147*.



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6. Install the power brake booster vacuum check valve (1) to the power vacuum brake booster.
7. Connect the power vacuum brake booster vacuum sensor electrical connector, if equipped.



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8. Install the power brake booster pushrod retainer (1) to the power brake booster pushrod, if removed.

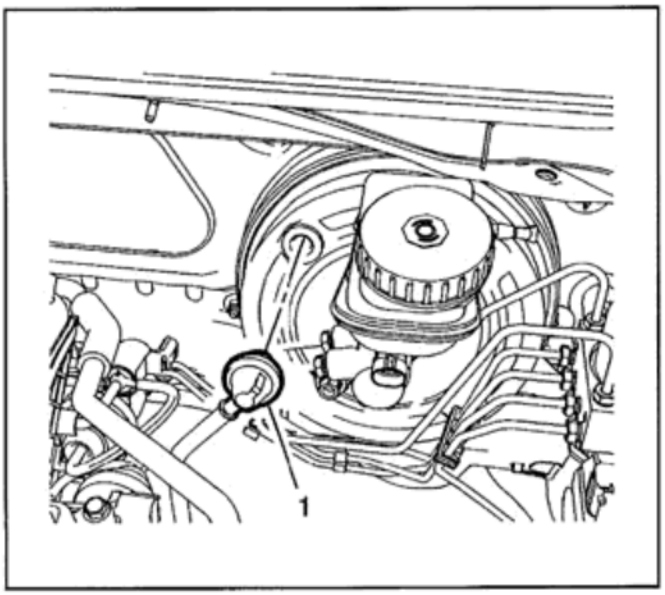
Note: Ensure the power vacuum brake booster pushrod retainer is fully seated in the brake pedal arm.

9. Position the brake pedal (2) to the power brake booster pushrod retainer and firmly seat the brake pedal to the retainer.
10. Install the instrument panel lower trim pad cover. Refer to *Instrument Panel Lower Trim Pad Cover Replacement (Without AAL) on page 2-40* or *Instrument Panel Lower Trim Pad Cover Replacement (With AAL) on page 2-41*.
11. Install the battery tray. Refer to *Battery Tray Replacement on page 9-721*.

Power Brake Booster Vacuum Check Valve and Hose Replacement

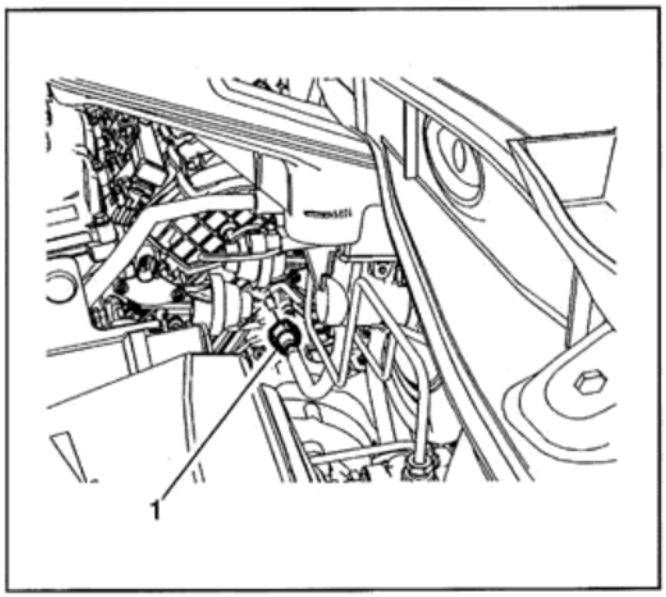
Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times to deplete the power vacuum brake booster vacuum reserve.



2512974

2. Disconnect the power brake booster check valve (1) from the power vacuum brake booster grommet.

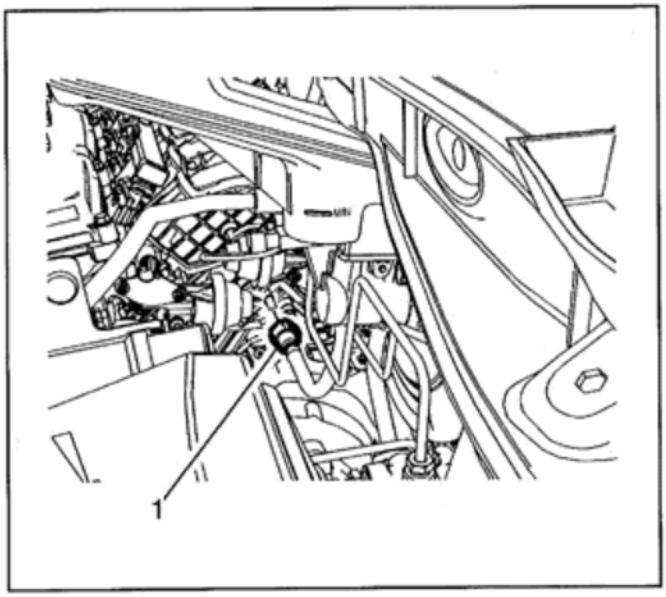


2511350

3. Disconnect the power brake booster vacuum pipe quick connect (1) from the intake manifold vacuum port.
4. Remove the power brake booster vacuum pipe.

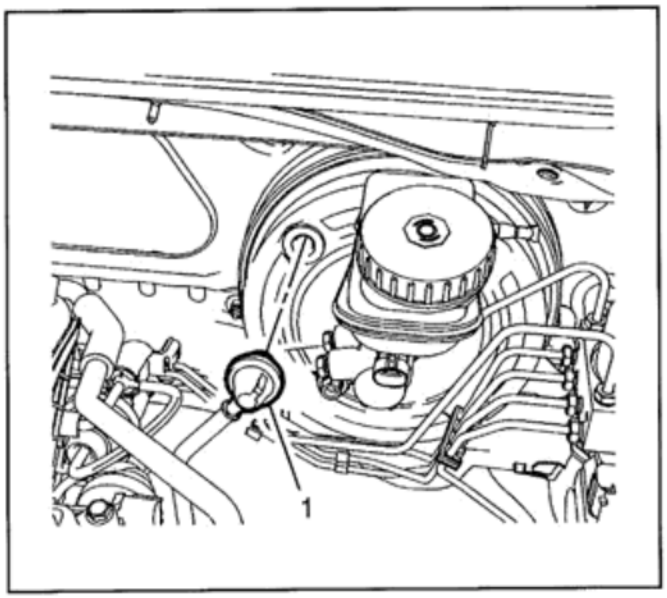
Installation Procedure

1. Install the power brake booster vacuum pipe to the vehicle.



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2. Connect the power brake booster vacuum pipe quick connect (1) to the intake manifold vacuum port.



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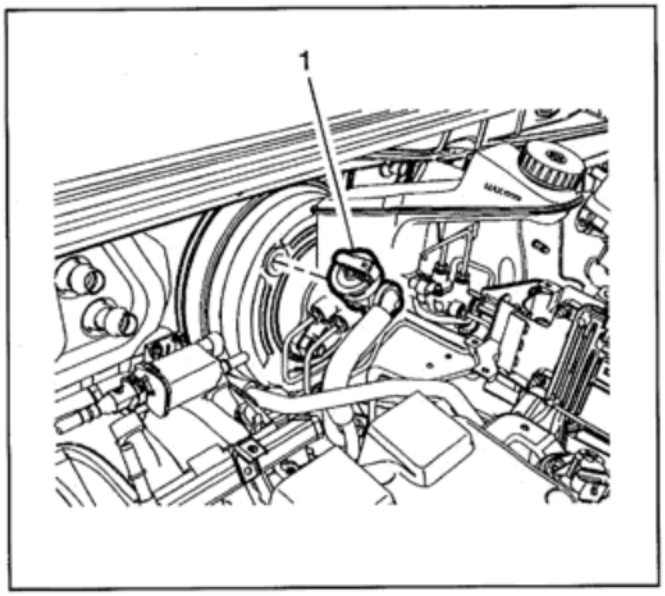
Note: A small amount of denatured alcohol may be used to lubricate the power vacuum brake booster grommet.

3. Install the power brake booster check valve (1) to the power vacuum brake booster grommet.

Power Brake Booster Vacuum Sensor Replacement

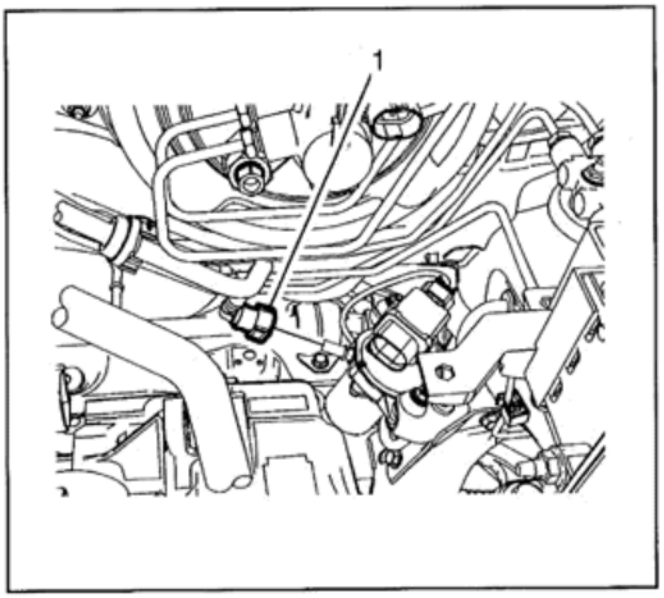
Removal Procedure

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



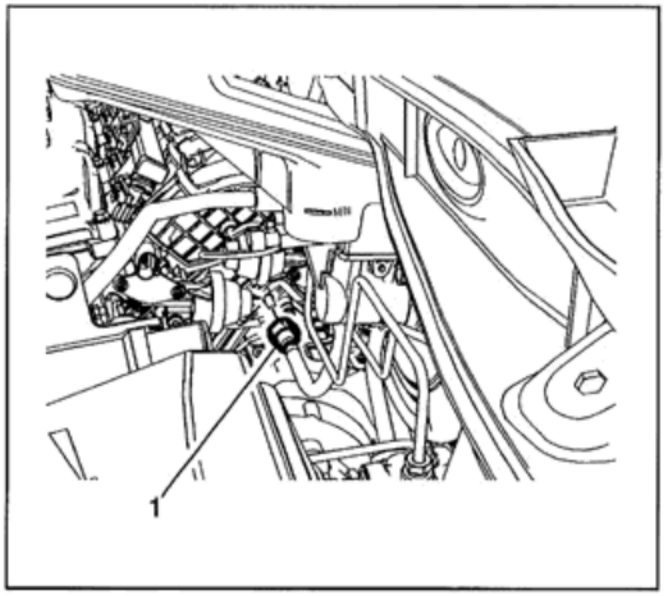
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3. Disconnect the power brake booster vacuum sensor (1) from the power vacuum brake booster grommet.



2511347

4. Disconnect the power brake booster vacuum pipe quick connect (1) from the power brake booster pump.

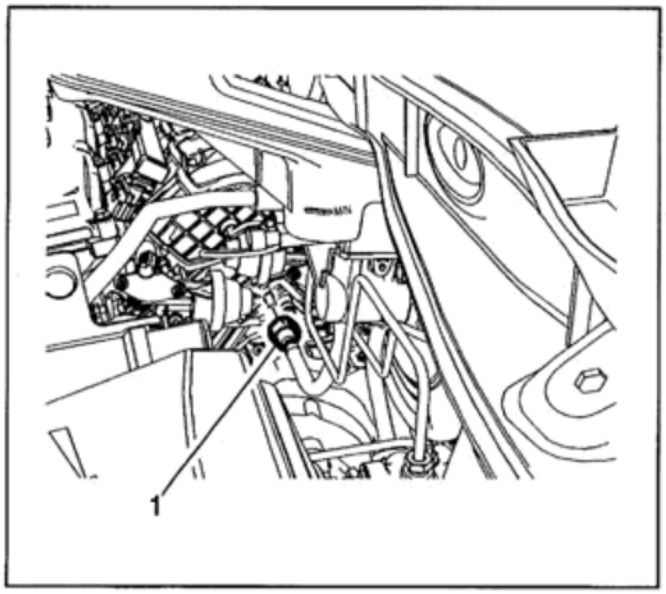


2511350

5. Disconnect the power brake booster vacuum pipe quick connect (1) from the intake manifold fitting.
6. Remove the power brake booster vacuum pipe and vacuum sensor assembly.

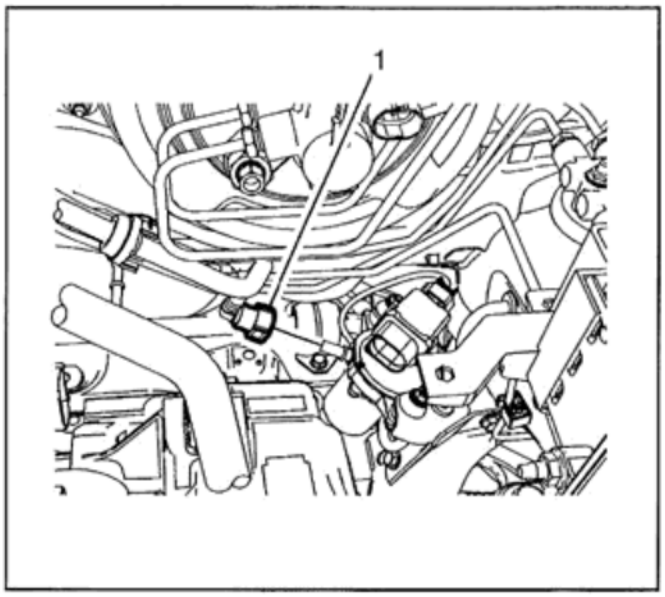
Installation Procedure

1. Install the power brake booster vacuum pipe and vacuum sensor assembly.



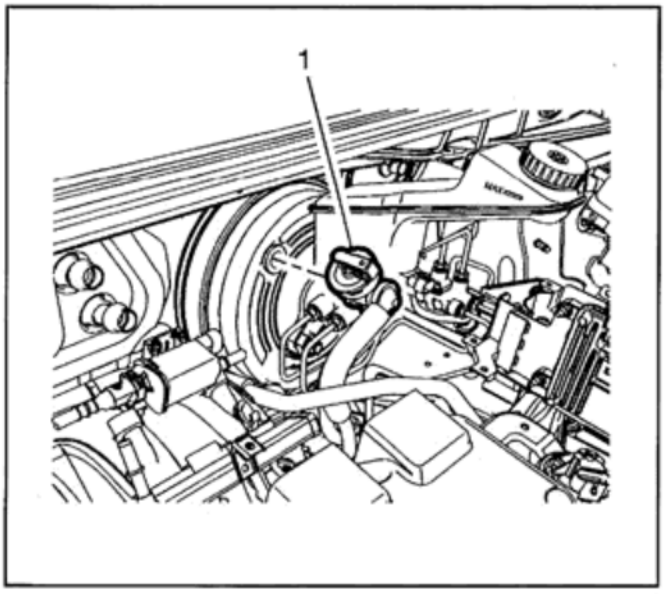
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2. Connect the power brake booster vacuum pipe quick connect (1) to the intake manifold fitting.



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3. Connect the power brake booster vacuum pipe quick connect (1) to the power brake booster pump.



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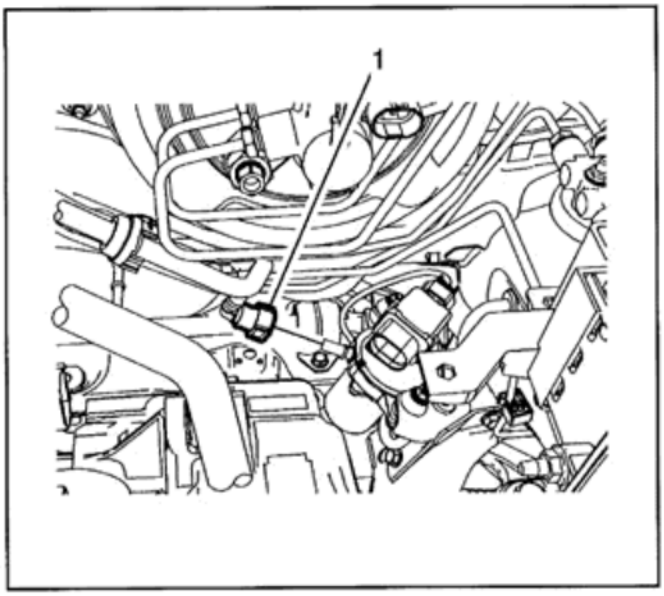
Note: A small amount of denatured alcohol may be used as a lubricant for assembly.

4. Connect the power brake booster vacuum sensor (1) to the power vacuum brake booster grommet.
5. Connect the power brake booster vacuum sensor electrical connector.

Power Brake Booster Pump Replacement

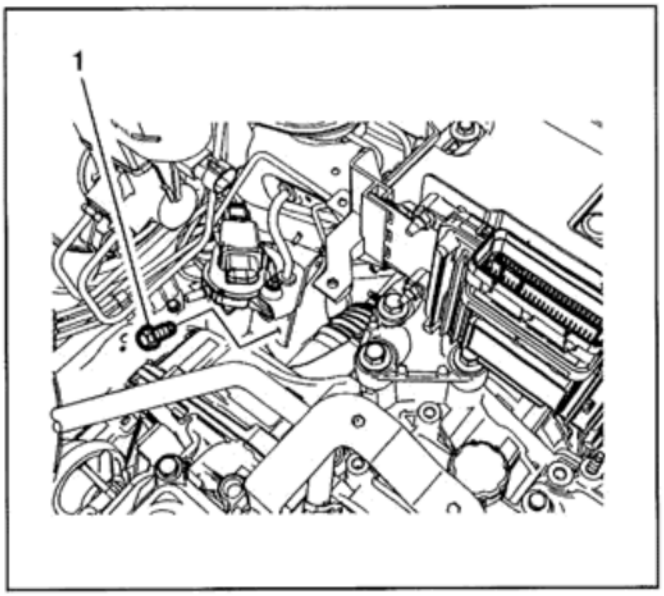
Removal Procedure

1. With the engine OFF, apply the brake pedal several times until the brake pedal becomes firm to deplete the vacuum brake booster vacuum reserve.
2. Remove the battery tray. Refer to *Battery Tray Replacement on page 9-721*.
3. Disconnect the power brake booster pump electrical connector.



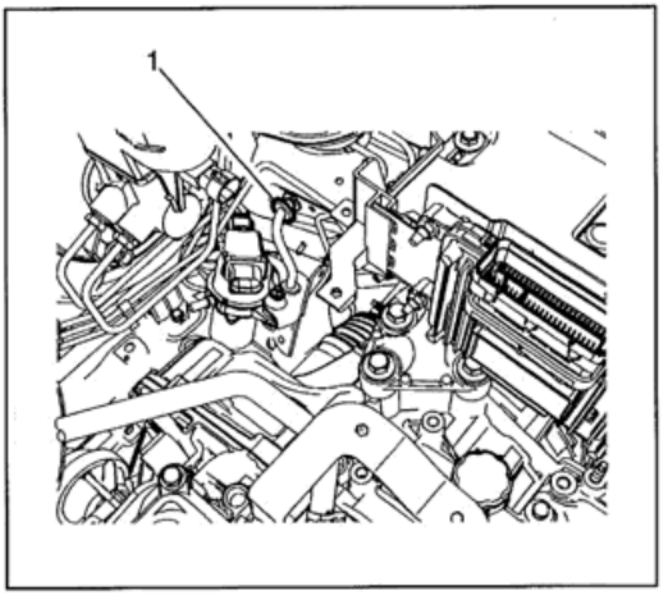
2511347

4. Disconnect the power brake booster vacuum pipe quick connect (1) from the power brake booster pump.
5. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
6. Remove the left front tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.



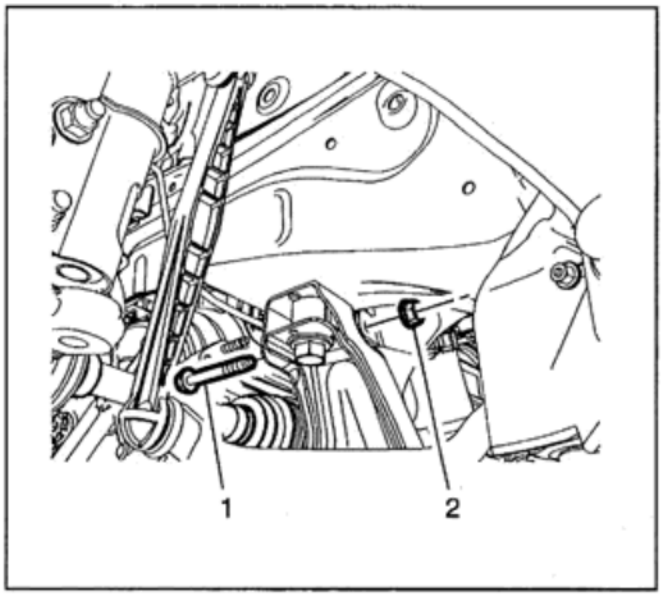
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7. Remove the power brake booster pump front bracket bolt (1).



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8. Disconnect the power brake booster pump vent hose grommet (1).
9. Release the vent hose from the vehicle body.

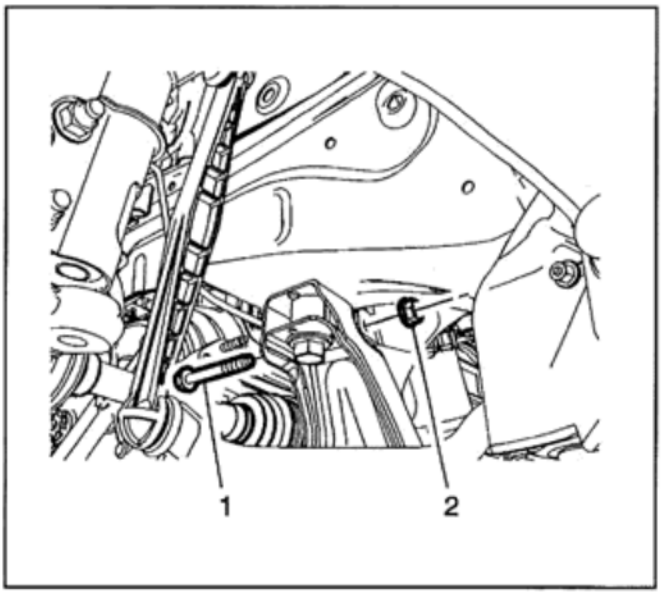


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10. Remove the power brake booster pump bracket bolt (**1**) and nut (2).
11. Lower the vehicle.
12. Remove the power brake booster pump.

Installation Procedure

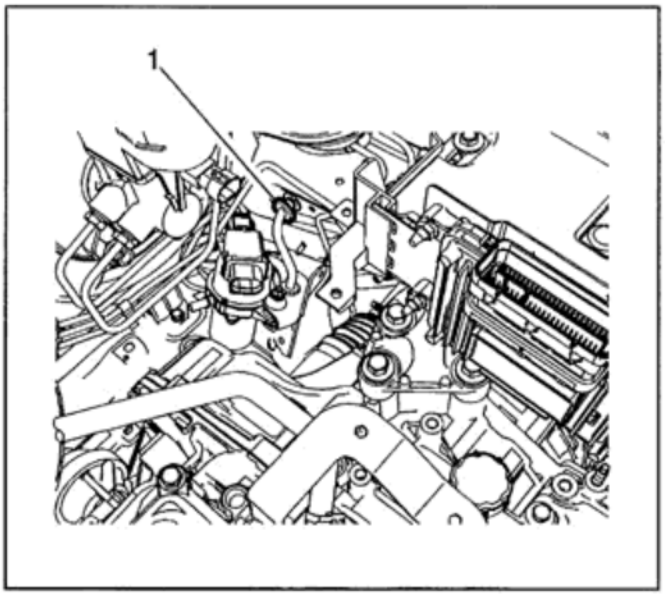
1. Install the power brake booster pump.
2. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.



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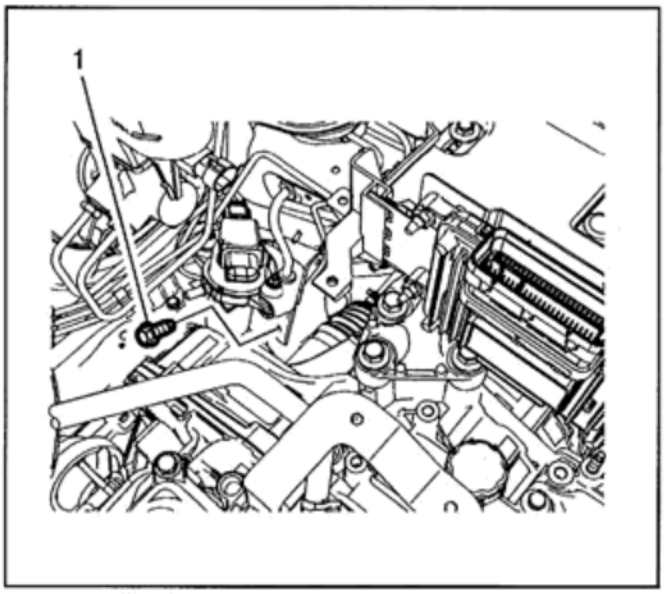
Caution: Refer to *Fastener Caution on page 0-8*.

3. Install the power brake booster pump bracket bolt (1) and nut (2) and tighten to **22** N•m **(16 lb ft)**.



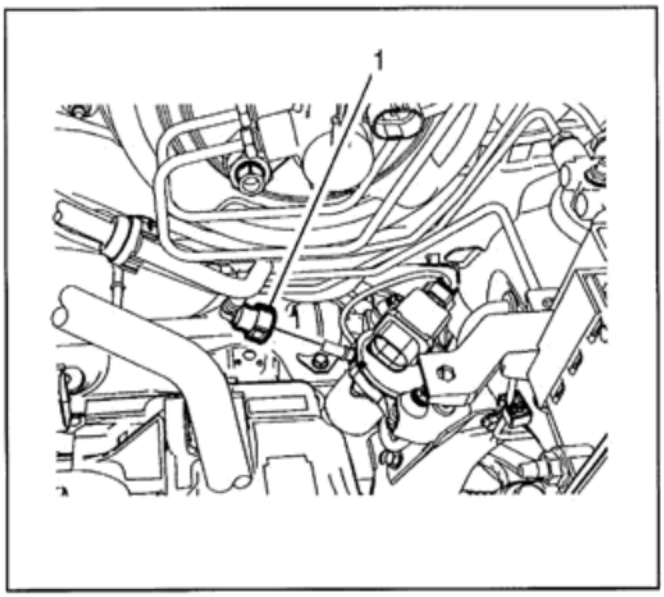
2511355

4. Install the vent hose to the vehicle body.
5. Connect the power brake booster pump vent hose grommet (1).



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6. Install the power brake booster pump front bracket bolt (1) and tighten to **22** N•m **(16 lb ft)**.
7. Install the left front tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.
8. Lower the vehicle.



2511347

9. Connect the power brake booster vacuum pipe quick connect (1) to the power brake booster pump.
10. Connect the power brake booster pump electrical connector.
11. Install the battery tray. Refer to *Battery Tray Replacement on page 9-721*.

Description and Operation

Brake Assist System Description and Operation

System Component Description

The brake assist system consists of the following:

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

Brake Pedal Pushrod: Transfers multiplied input force received from the brake pedal to the vacuum brake booster.

Vacuum Brake Booster: Uses source vacuum to decrease effort required by driver when applying brake system input force. At rest, source vacuum is applied to both sides of the vacuum diaphragm for single booster. Return springs maintain the booster in a rest position. When brake system input force is applied, vacuum to the rear of the diaphragm is cut off, and air at atmospheric pressure is admitted in its place. This provides a decrease in brake pedal effort required. When input force is removed, vacuum again replaces atmospheric pressure within the booster.

Vacuum Source: Supplies force used by vacuum brake booster to decrease brake pedal effort. The source vacuum for a spark ignition engine is normally derived from the intake manifold.

Vacuum Source Delivery System: Enables delivery and retention of source vacuum for vacuum brake booster.

System Operation

Under normal driving conditions, without the brakes applied, vacuum is allowed to act on both sides of the diaphragm within the vacuum brake booster. When the brake pedal is applied, the effort by the driver is multiplied due to the relative length of the brake pedal in relationship to its pivot point and the point at which the push rod to the vacuum brake booster is attached.

Movement of the push rod causes a valve within the vacuum brake booster to close between the two sides of the diaphragm, thus isolating each side. It also allows a valve to open that allows atmospheric pressure to act on the pedal side of the vacuum brake booster while maintaining vacuum on the vacuum source side of the diaphragm. The movement of the brake pedal pushrod is transferred to the hydraulic brake master cylinder via the vacuum brake booster. The pressure differential within the vacuum brake booster reduces the effort required by the driver in applying the brakes.

Brake Booster Vacuum Assist Description and Operation

In order to assure that vacuum is available to the vacuum brake booster, the car can contain a vacuum pump either in addition to the normal intake manifold vacuum source or as stand-alone. The pump provides negative pressure when the engine cannot properly accommodate the requirement, e.g. cold start, heavy throttle, high altitude and turbo pressure.

Mechanical

The mechanical vacuum pump is driven by a camshaft. The pump delivers maximum vacuum irrespective of engine RPM. This means that the pump, in certain situations, delivers more negative pressure than the system uses.

Electrical

A low vacuum switch controls the 12 V to the relay coil in the brake vacuum assist pump. When more vacuum is needed the vacuum switch closes. The relay coil closes the relay contact and connects the electric motor to ground. The electric motor is fed with 12 V. When sufficient vacuum is reached the switch opens and the pump stops.

A venturi is connected between the intake manifold and the vacuum brake booster, amplifying the vacuum. This reduces the on-time for the pump. To prevent air flowing in the wrong direction check valves are used.

Brake Warning System Description and Operation

Brake Warning Indicator

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

- The instrument cluster performs the bulb check. The brake warning indicator illuminates for 5 s.
- When the Electronic Brake Control Module (EBCM) detects low brake fluid level it sends a serial data message to the instrument cluster, which will illuminate the red brake indicator.
- The Body Control Module (BCM) detects that the parking brake is engaged. The instrument cluster receives a serial data message from the BCM requesting illumination.

Driver Information Center Messages

When the Electronic Brake Control Module (EBCM) detects low brake fluid level it sets DTC C0267 and sends a serial data message to the Driver Information Center , which will display Brake Fluid Low message.

Hydraulic Brake System Description and Operation

System Component Description

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Reservoir: Contains a 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 electronic brake distribution (EBD), which is a function of the ABS modulator.

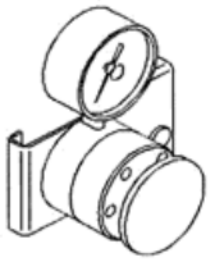
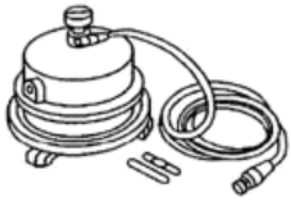
Hydraulic Brake Pipes and Flexible Brake Hoses: Carries brake fluid to and from hydraulic brake system components.

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 brake linings against rotating brake system components.

Special Tools and Equipment

Illustration	Tool Number/ Description
 1006	CH 28662 J 28662 Brake Pedal Effort Gauge
 153125	CH 29532 J 29532 Diaphragm Pressure Bleeder
 2352475	CH 35589-A J 35589-A Brake Pressure Bleeder Adapter
 900934	CH 45405 J 45405 Brake Pipe Flaring Kit