

GROUP

# BRAKE SYSTEM

# 06

(2000)

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## SECTION 06-00 Brake System—Service

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### VEHICLE APPLICATION

Capri.

### DESCRIPTION

**WARNING: CONTAINS ASBESTOS FIBERS, AVOID BREATHING DUST. BREATHING ASBESTOS DUST MAY CAUSE ASBESTOSIS AND CANCER.**

**BREATHING ASBESTOS DUST IS HAZARDOUS TO YOUR HEALTH.**

**DUST AND DIRT PRESENT ON WHEEL BRAKE AND CLUTCH ASSEMBLIES MAY CONTAIN ASBESTOS FIBERS THAT ARE HAZARDOUS TO YOUR HEALTH WHEN MADE AIRBORNE BY CLEANING WITH COMPRESSED AIR OR BY DRY BRUSHING.**

**WHEEL BRAKE ASSEMBLIES AND CLUTCH FACINGS SHOULD BE CLEANED USING A VACUUM CLEANER RECOMMENDED FOR USE WITH ASBESTOS FIBERS. DUST AND DIRT FROM THE VACUUM SHOULD BE DISPOSED OF IN A MANNER THAT PREVENTS DUST EXPOSURE, SUCH AS SEALED BAGS. THE BAG MUST BE LABELED PER OSHA INSTRUCTIONS AND THE TRASH HAULER NOTIFIED AS TO THE BAG'S CONTENTS.**

**DESCRIPTION (Continued)**

**IF A VACUUM SUITABLE FOR ASBESTOS IS NOT AVAILABLE, CLEANING SHOULD BE DONE WET. IF DUST GENERATION IS STILL POSSIBLE, TECHNICIANS SHOULD WEAR GOVERNMENT-APPROVED TOXIC DUST PURIFYING RESPIRATORS.**

**GRINDING OR SANDING ON BRAKE LININGS, PADS, ROTORS, DRUMS OR CLUTCH FACINGS SHOULD BE DONE ONLY WHILE USING PROPERLY EXHAUST-VENTILATED EQUIPMENT.**

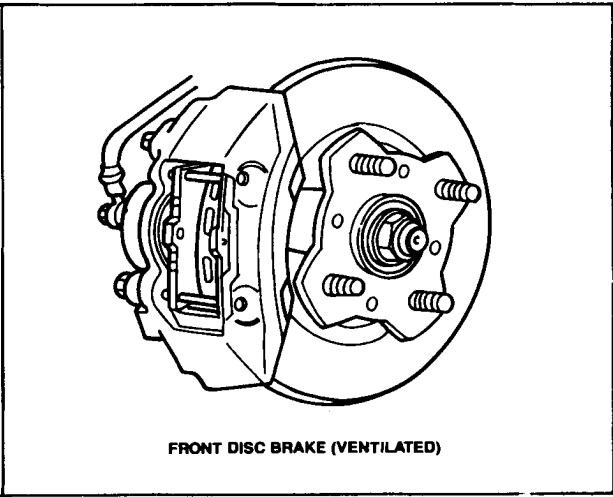
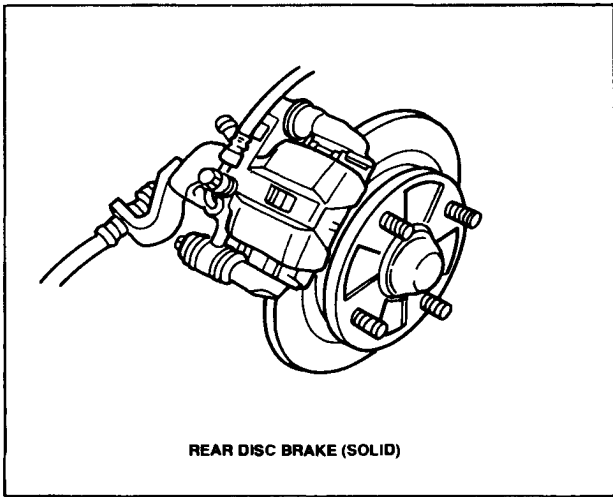
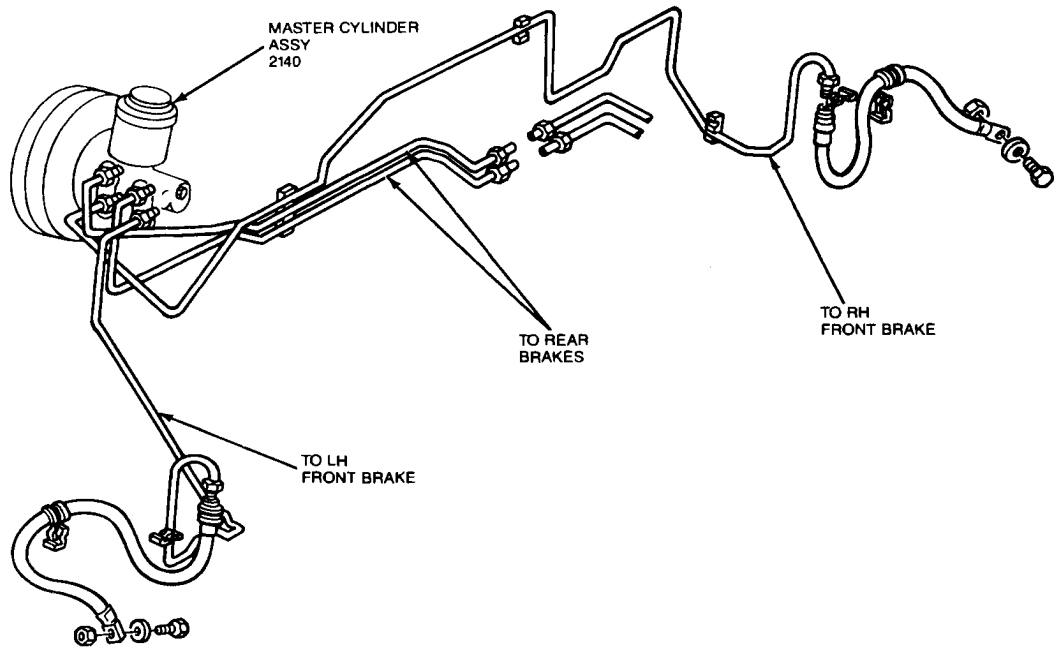
**OSHA REQUIRES AREAS WHERE ASBESTOS DUST GENERATION IS POSSIBLE TO BE ISOLATED AND POSTED WITH WARNING SIGNS. ONLY TECHNICIANS CONCERNED WITH PERFORMING BRAKE OR CLUTCH SERVICE SHOULD BE PRESENT IN THE AREA.**

**WARNING: BRAKE FLUID CONTAINS POLYGLYCOL ETHERS AND POLYGLYCOLS. AVOID CONTACT WITH EYES. WASH HANDS THOROUGHLY AFTER HANDLING. IF BRAKE FLUID CONTACTS EYES, FLUSH EYES WITH RUNNING WATER FOR 15 MINUTES. GET MEDICAL ATTENTION IF IRRITATION PERSISTS. IF TAKEN INTERNALLY, DRINK WATER AND INDUCE VOMITING. GET MEDICAL ATTENTION IMMEDIATELY.**

DESCRIPTION (Continued)

**Brake System, Dual**

The dual hydraulic brake system is a conventional, pedal-actuated system with a master cylinder, pressure control valve, brake tubes and hoses. The hydraulic brake line routing has been diagonally split left front to right rear and right front to left rear. The master cylinder has a reservoir, brake pressure control valve, and pressure differential warning indicator, all combined in one assembly.



H6888-A

## DESCRIPTION (Continued)

### Road Test

A road test should be performed to compare actual vehicle braking performance with the performance standards expected by the driver.

This experience has to include a thorough knowledge of brake system operation, acquired general performance guidelines and the ability to recognize brake performance that is characteristic of the vehicle being tested.

An experienced brake technician will always establish a route that will be used for all brake diagnosis road tests. The road selected will be reasonably smooth and level. Gravel or bumpy roads are unsuitable because the surface does not allow the tires to grip the road equally. Crowned roads are to be avoided because of the large amount of weight shifted to the low set of wheels. Once the route is established and consistently used, the road surface variable is eliminated from the test results.

Before a road test, get a complete description of the customer's complaint or suspected condition. From the description, experience will begin to match possible causes with symptoms. Certain components will be identified as possible suspects, while others are eliminated by the evidence. More importantly, the description can uncover unsafe conditions which should be checked or corrected before the road test. The description will also help form the basic approach to the road test by narrowing the concern to specific components, vehicle speed or conditions.

Begin the road test with a general brake performance check. Keeping the description in mind, test the brakes at different vehicle speeds using both light and heavy pedal pressure. To determine if the concern is in the front or rear brake system, first use the service brake pedal, then the parking brake. If the condition (i.e., pull, vibration, pulsation) occurs only with the hand brake, the concern is in the rear system. If the condition occurs when the service brake pedal is pressed, the concern is in the front system.

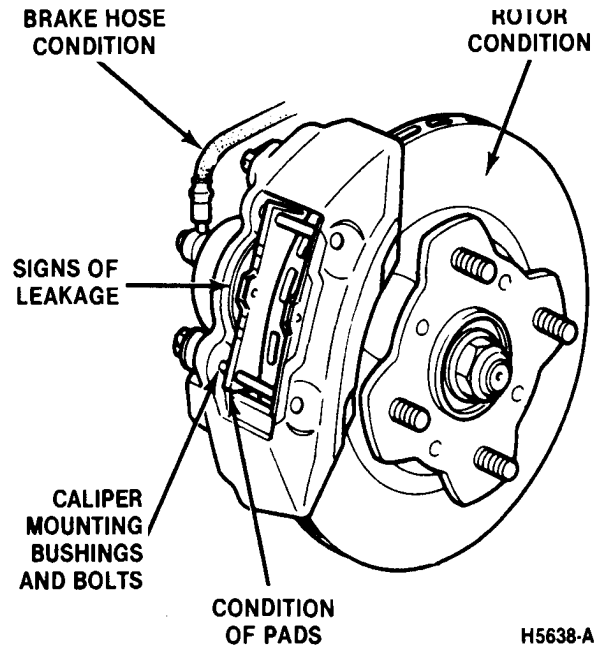
Avoid locking the brakes and sliding the tires. Locked brakes and sliding tires do not indicate brake efficiency. A heavily braked, but turning wheel will stop the vehicle in less distance than locked brakes. If the concern becomes evident during this check, make sure it fits the description given before the road test. If the concern is not evident, attempt to duplicate the condition using information from the description.

## INSPECTION

### Disc Brakes, Front

Inspect the caliper and caliper mounting for loose or damaged parts. Make sure the caliper and anchor retaining bolts are tightened to the specified torque. Refer to Section 06-03 or 06-04.

Check the brake hose and caliper fitting for leaks or damage. Carefully check the caliper for wet areas that might indicate a leaking caliper seal. Unless the damage is obvious, a visual inspection of the rotor will not determine the required rotor service—resurface, recondition or replace. Tolerances on rotor thickness, parallelism and runout are very critical and must be measured with precision tools. Use the Brake Rotor Diagnosis Chart as a guide for visual inspection and necessary measurements.



Whenever the pads are inspected, check for brake fluid contamination which might indicate a leaking caliper seal. If a seal is leaking, the caliper must be disassembled and inspected. Refer to Section 06-03.

Check for even wear from side-to-side. If the set of pads on one side of the vehicle is excessively worn, the caliper piston may be seized in the bore. If a seized piston is suspected, the caliper must be disassembled and inspected. Refer to Section 06-03.

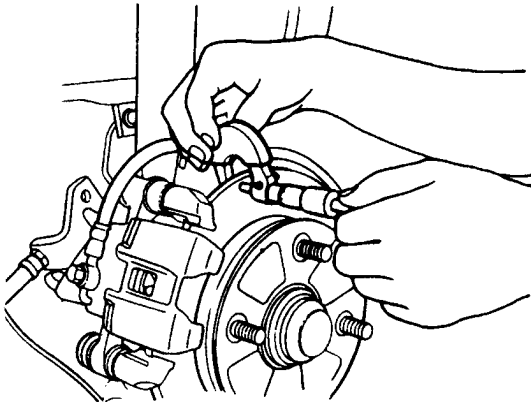
### Disc Brakes, Rear

The operation and diagnostic procedures on a rear disc brake are very similar to a front disc brake. The following items should be inspected when diagnosing rear disc brakes:

1. Check for leakage at the hose fittings.
2. Inspect the flex hose for cuts, abrasions, cracking and leakage.
3. Inspect the pads for general wear, gouges, scoring, cracking and contamination. Brake pad thickness cannot be less than 1.0mm (0.04 inch).

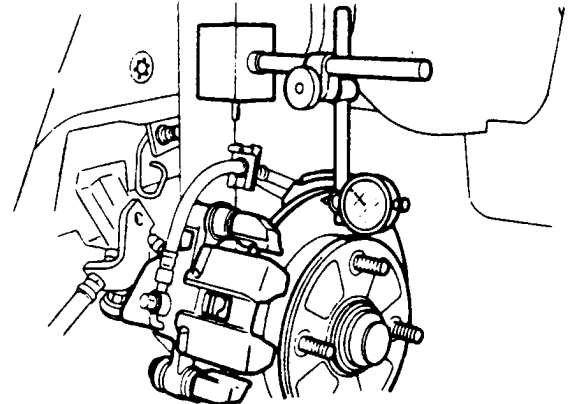
**INSPECTION (Continued)**

4. If there is uneven pad wear at the same caliper, check that the caliper moves back and forth easily on the anchor bolts. Check the condition of the anchor bolts. Be sure they are properly lubricated.
5. Check for a frozen caliper piston. Raise the rear of the vehicle. Refer to Section 00-02. Apply the brakes with a force of 60 Kg (132.3 lb) and then release the brakes. Each wheel should then turn over easily by hand. If they do not, the caliper piston is probably siezed. Before rebuilding the caliper, be sure the condition is not caused by the caliper not moving freely on the anchor bolts.
6. Check for rotor parallelism or thickness variation. The rotor thickness should not vary more than 0.01mm (0.0004 inch).



**THICKNESS VARIATION SHOULD NOT BE MORE THAN 0.01mm (0.0004 INCH)** H7350-B

7. Using a Dial Indicator with Bracketry TOOL-4201-C or equivalent, check for rotor runout. Runout should not be greater than 0.1mm (0.004 inch).
8. Refer to Section 06-04 for further inspection and diagnostic procedures.



**RUNOUT SHOULD NOT EXCEED 0.1mm (0.004 INCH)**

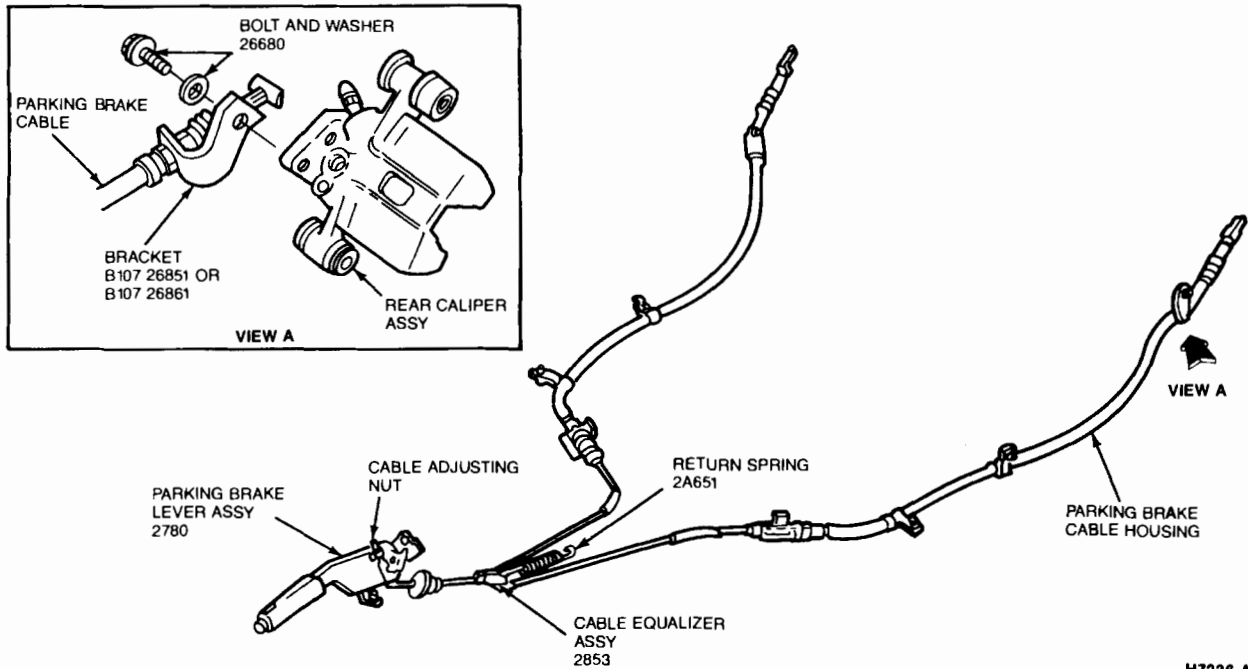
H7349-B

**Parking Brake**

Check the parking brake cable for damage and proper routing. If the cable is damaged it should be replaced. Refer to Section 06-05.

## INSPECTION (Continued)

Operate the parking brake lever and check for conditions that may cause binding and incomplete release of the parking brake. If the parking brake components are in good condition, check the cable adjustment.



H7236-A

### Hydraulic System

An inspection of the brake hydraulic system begins with a fluid level check at the reservoir. If the fluid level is below the MIN line in the reservoir, add the required amount of fluid. Make sure the brake fluid meets specifications. While in the master cylinder area, check the brake lines and master cylinder mounting. The brake lines and attaching nuts must be tight. Refer to Section 06-06. The brake line fittings must not show any signs of leakage.

The following conditions are considered normal and are not indications that the master cylinder is in need of service.

**Condition 1:** Low fluid level without signs of leakage. This condition is caused by displacement of fluid from the reservoir to the calipers to compensate for normal lining wear. Add fluid as needed.

**Condition 2:** A momentary or slight squirt of brake fluid from the master cylinder reservoir upon application of the brake pedal. This condition is caused by the fluid displacement through the reservoir compensating port as the master cylinder pistons move forward in the bore when the brakes are applied.

**Condition 3:** A slight turbulence in the reservoir fluid occurring when the brake pedal is released. Turbulence occurs as brake fluid returns to the master cylinder after releasing the brakes.

**Condition 4:** A trace of brake fluid exists on the brake booster shell below the master cylinder mounting flange. This condition results from the lubricating action of the master cylinder wiping seal.

Under the vehicle, inspect the brake lines for damage and proper routing. Look at the hoses connecting the brake lines to the calipers and the brake lines attached to the rear suspension control arms. The hoses must not show any signs of damage, cracking or softening. The hose fittings must be tight without signs of leakage.

If signs of leakage are not present and yet the master cylinder is low, it is possible that all evidence of fluid leakage may have been washed off by rain or snow because brake fluid is water soluble. Refill the system, bleed the system, and apply the brakes several times. Examine the system to verify the reservoir level is actually dropping. Locate and correct the external leak.

**INSPECTION (Continued)**

Internal and external leaks are the two conditions that can affect a brake hydraulic system. The hydraulic brake system does not cause the vehicle to vibrate, pull, brakes to grab, squeal, or the brake pedal to pulse. In most cases the hydraulic system will not even make the brakes drag. The sources of these concerns are found elsewhere in the brake system. But it is always a good policy to first check the entire hydraulic system for leaks before continuing to diagnose any other brake concerns.

**DIAGNOSIS AND TESTING**

If a concern exists, use the Brake System Diagnosis Chart to isolate it to a specific subsystem and condition description. From this description, a source list of possible causes can be used to further narrow the cause to a specific component or condition.

**Master Cylinder**

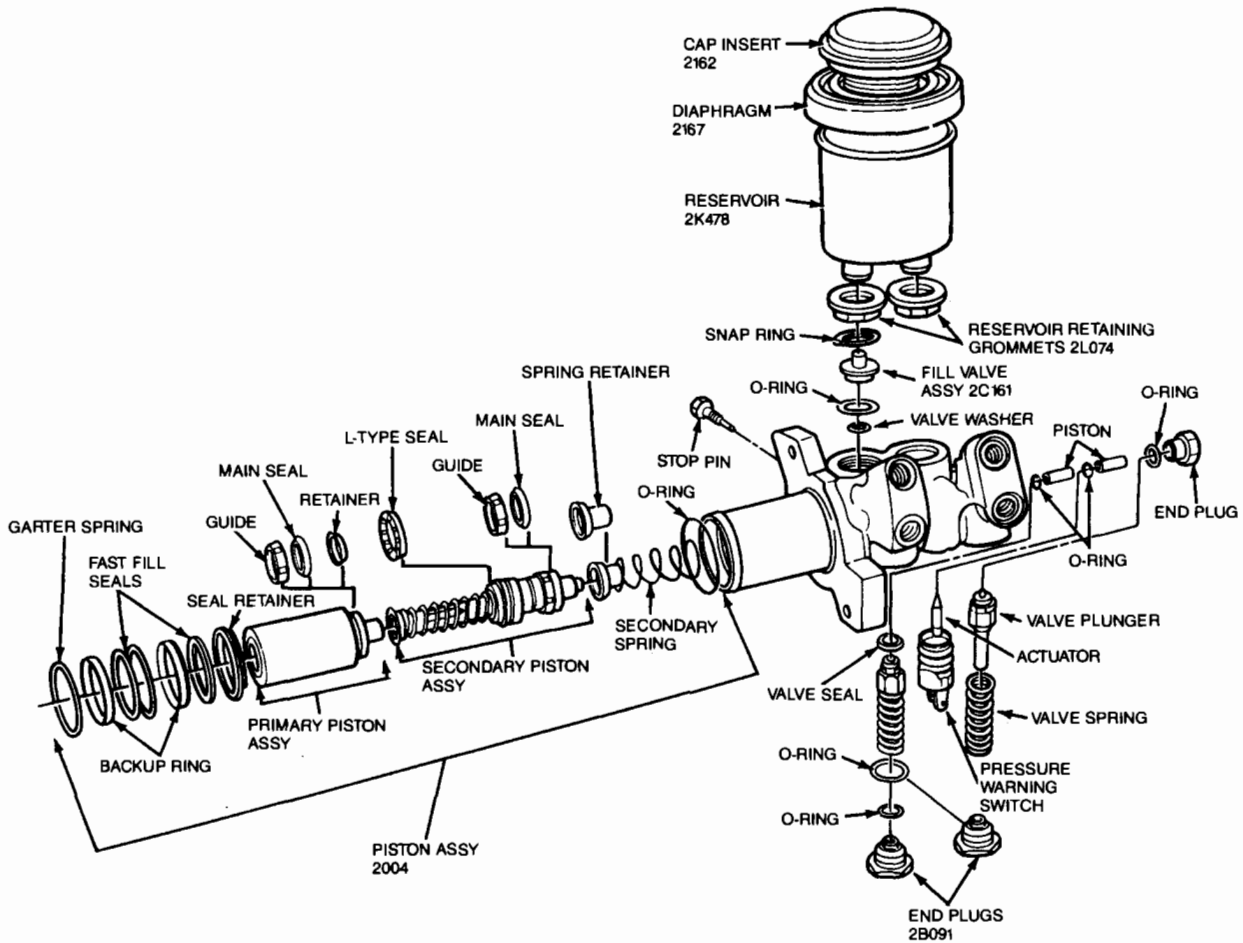
**NOTE:** Always check the fluid level in the master cylinder before performing the test procedures. If the fluid level is not at the correct level indicated on the master cylinder reservoir, add Heavy Duty Brake Fluid C6AZ-19542-A (ESA-M6C25-A) or Dot-3 equivalent.

Usually, the first and strongest indicator of anything wrong in the brake system is a feeling through the brake pedal. The Master Cylinder Chart uses pedal feel as evidence of a brake concern. It also employs two other indicators, such as the illumination of the brake warning indicator and the brake fluid level in the master cylinder's reservoir.

**DIAGNOSIS AND TESTING (Continued)**

Note that the Master Cylinder Diagnosis Chart refers to the use of diagnostic techniques. These techniques (Numbers 1 through 6) follow the diagnostic chart.

**NOTE:** Prior to performing any diagnosis, make certain that the brake system warning indicator is functional.



H7243-A



## DIAGNOSIS AND TESTING (Continued)

MASTER CYLINDER DIAGNOSIS	
BRAKE PEDAL FEEL CONDITIONS	DIAGNOSTIC ACTION
<p><b>Condition 1</b> — Pedal goes down fast and brake warning lamp comes on.</p>	<p>Pump brake pedal rapidly:</p> <p>If the brake pedal height builds up and holds, check for the presence of air. (Use Diagnostic Technique No. 1.)</p> <p>If the brake pedal height builds up and then sinks down, check for an external leak. (Use Diagnostic Technique No. 4), or a master cylinder by-pass (Use Diagnostic Technique No. 2.)</p> <p>If the brake pedal height fails to build up, check the fluid level in the master cylinder reservoir:</p> <p>If a reservoir is empty, add fluid; bleed the system; and check for external leak. (Use Diagnostic Techniques No. 3 and No. 4.)</p> <p>If the reservoirs are full, check for a gross master cylinder by-pass. (Use Diagnostic Technique No. 2.)</p>
<p><b>Condition 2</b> — Pedal eases down slowly and brake warning lamp comes on.</p>	<p>This condition could be caused by an external leak in the brake system or an internal by-pass in the master cylinder.</p> <p>Apply the brakes several times while observing the fluid levels in the reservoirs:</p> <p>If the net fluid level in a reservoir eases down with each stroke cycle, check for an external leak. (Use Diagnostic Technique No. 4.)</p> <p><b>If the fluid level in a reservoir rises while the pedal eases down and drops when the pedal is released, but the net fluid level remains unchanged, then service the master cylinder for a fluid by-pass condition.</b></p>
<p><b>Condition 3</b> — Pedal is low and brake warning lamp does not come on.</p>	<p>This condition may be caused by: air in the hydraulic system, or no fluid in one reservoir.</p> <p>If the reservoir is empty, add fluid, bleed, and check the system for external leaks. (See Diagnostic Techniques No. 3 and No. 4.)</p> <p>If the reservoir is full, check for the presence of air in the hydraulic system. (Use Diagnostic Technique No. 1.)</p> <p>If this condition happens occasionally, check the wheel bearings for looseness. (Loose wheel bearings allow the disc rotor to knock the caliper piston back, creating excessive lining clearance.)</p>
<p><b>Condition 4</b> — Pedal feels spongy.</p>	<p>This may be normal as newer brake systems are not designed to produce as hard a pedal as in the past. To verify this, compare the pedal feel with another like vehicle.</p> <p>Check for the presence of air in the hydraulic system. (Use Diagnostic Technique No. 1).</p>
<p><b>Condition 5</b> — Pedal erratic and no brake warning lamp.</p>	<p>This may be caused by incomplete brake release, loose wheel bearings, incorrect parking brake adjustment or blocked compensator holes in the master cylinder. To verify, check wheel rotation and bearing free play, parking brake tension and refer to Diagnostic Technique No. 6 for master cylinder compensator hole check.</p>

CH7237-A

## DIAGNOSIS AND TESTING (Continued)

BRAKE SYSTEM DIAGNOSIS		
CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> <li>● Brake Warning Indicator in Instrument Cluster On</li> </ul>	<ul style="list-style-type: none"> <li>● Low fluid level.</li> <li>● Leaking master cylinder primary piston cup.</li> <li>● Parking brake not fully released.</li> <li>● Parking brake wiring ground switch grounded.</li> </ul>	<ul style="list-style-type: none"> <li>● Fill system. Check for leaks.</li> <li>● Overhaul or replace master cylinder.</li> <li>● Free up and adjust parking brake. Replace damaged parts.</li> <li>● Service wiring. Replace switch.</li> </ul>
<ul style="list-style-type: none"> <li>● Low Pedal</li> </ul>	<ul style="list-style-type: none"> <li>● Caliper piston or slide pins sticking.</li> <li>● Loose wheel bearings.</li> </ul>	<ul style="list-style-type: none"> <li>● Service or replace caliper or slide pins.</li> <li>● Disassemble front spindles and inspect bearings.</li> </ul>
<ul style="list-style-type: none"> <li>● Pedal Goes to Floor</li> </ul>	<ul style="list-style-type: none"> <li>● Leak in hydraulic system.</li> <li>● Air in system.</li> <li>● Worn master cylinder piston cups or scored cylinder bore.</li> <li>● Disc brake "knock back" (pads push caliper piston back into caliper. Caused by excessive rotor lateral runout or loose wheel bearings.)</li> </ul>	<ul style="list-style-type: none"> <li>● Service leak. Check entire hydraulic system. Refill and bleed.</li> <li>● Bleed brakes. Check for leaks.</li> <li>● Overhaul or replace master cylinder.</li> <li>● Check rotor runout, machine or replace rotor. Adjust front wheel bearings.</li> </ul>
<ul style="list-style-type: none"> <li>● Brakes Grab</li> </ul>	<ul style="list-style-type: none"> <li>● Brake pads contaminated by grease or brake fluid.</li> <li>● Loose caliper slide pins or anchor bolts.</li> <li>● Hot-spotted rotors.</li> <li>● Binding caliper pistons.</li> <li>● Seized or incorrectly adjusted parking brake components.</li> </ul>	<ul style="list-style-type: none"> <li>● Replace brake pads. Service cause of contamination.</li> <li>● Tighten slide pins or bolts. Check for hole elongation.</li> <li>● Replace rotors.</li> <li>● Overhaul or replace calipers.</li> <li>● Service or replace seized components.</li> </ul>
<ul style="list-style-type: none"> <li>● Brakes Drag</li> </ul>	<ul style="list-style-type: none"> <li>● Seized or incorrectly adjusted parking brake components.</li> <li>● Caliper pistons seized.</li> <li>● Brake pedal binding at pivot points.</li> <li>● Stop lamp switch incorrectly adjusted, not letting pedal return.</li> <li>● Power booster binding, push rod adjustment or binding assist unit.</li> <li>● Master cylinder compensating ports plugged.</li> </ul>	<ul style="list-style-type: none"> <li>● Service or replace seized components.</li> <li>● Overhaul or replace calipers.</li> <li>● Service or replace brake pedal bushings or pedal assembly.</li> <li>● Adjust stop lamp switch.</li> <li>● Replace binding power booster.</li> <li>● Unplug compensating ports using compressed air. Replace if obstruction cannot be removed.</li> </ul>
<ul style="list-style-type: none"> <li>● Brake Pedal Pulsates</li> </ul>	<ul style="list-style-type: none"> <li>● Disc rotors have excessive lateral runout.</li> <li>● Loose wheel bearings.</li> <li>● Bent front / rear spindles.</li> <li>● Bent or distorted hub mounting flange.</li> </ul>	<ul style="list-style-type: none"> <li>● Machine rotors, replace if necessary.</li> <li>● Adjust wheel bearings.</li> <li>● Replace spindle.</li> <li>● Replace hub.</li> </ul>
<ul style="list-style-type: none"> <li>● Brake Noise</li> </ul>	<ul style="list-style-type: none"> <li>● Worn brake pads.</li> <li>● Cracked or heat-checked rotors.</li> <li>● Loose or missing disc brake anti-rattle springs.</li> <li>● Loose caliper mounting bolts.</li> </ul>	<ul style="list-style-type: none"> <li>● Replace pads.</li> <li>● Replace rotors.</li> <li>● Service or replace anti-rattle springs.</li> <li>● Tighten mounting bolts, check for hole elongation.</li> </ul>

**Diagnostic Technique No. 1****Air Trapped in Brake System**

1. Check the master cylinder fluid level.
2. Place the reservoir cap loosely on the master cylinder reservoir.

3. With one technician acting as an observer at the master cylinder, and another technician applying the brakes, pump the brakes rapidly 20 times.
4. On the final application, hold the pedal in the applied position.

**DIAGNOSIS AND TESTING (Continued)**

5. Remove the cap, and observe the fluid in the reservoir. Quickly release the brake pedal. A spout of fluid will appear in the reservoir if the system has air in it.

NOTE: Pumping the brake pedal compresses trapped air. When the brake pedal is released, the compressed air expands, forcing brake fluid back into the master cylinder with sufficient force to form a spout of fluid.

6. Bleed the system in which the spout of fluid occurs as outlined.

**Diagnostic Technique No. 2****Master Cylinder Bypass Condition—Check**

1. Check the master cylinder fluid level.
2. With the reservoir cap removed, observe the fluid level when the brake pedal is slowly depressed for one stroke and then quickly released.
3. If the fluid level in the reservoir rises while the pedal goes down and drops when the pedal is released, but the overall fluid level in the reservoir remains unchanged, the master cylinder is bypassing. Service master cylinder. Refer to Section 06-06.

**Diagnostic Technique No. 3****Checking the Cause of an Empty Reservoir Without an External Pressure Leak**

An empty reservoir condition may be caused by two types of non-pressure external leaks.

Type 1: An external leak may occur at the master cylinder reservoir cap because of improper positioning of the cap.

Type 2: An external leak may occur at the mounting end of the master cylinder because of a bore end seal leak. Service the master cylinder. Refer to Section 06-06.

**Diagnostic Technique No. 4****Checking for External Fluid Leaks in the Brake System**

Refer to Hydraulic System Visual Inspection as outlined.

**Diagnostic Technique No. 5****Brake Pedal Reserve—Check**

1. With the engine OFF, pump the brake pedal several times to deplete the vacuum reserve in the power booster.

2. Install Brake Pedal Effort Gauge 021-00001 or equivalent.
3. Press on the brake pedal with a force of about 220 N (50 lb) and measure the pedal height. Refer to the Brake Pedal Travel Measurement. If pedal travel is greater than 70mm (about 2-3/4 inch), bleed the brakes and recheck pedal travel. If the brake pedal is still believed to be bottoming out, pedal reserve can be confirmed as follows:
  - a. Press the brake pedal with moderate to severe pressure and note the amount of brake pedal travel.
  - b. Open a bleeder screw at one front and one rear caliper. Press the brake pedal and note the amount of pedal travel.
  - c. Close the bleeder screws and refer to the Master Cylinder and Brake System Diagnosis Charts for causes of excessive pedal travel.

**Diagnostic Technique No. 6****Checking the Master Cylinder for Open Compensator Port**

If it is believed that the master cylinder is failing to return to the fully released position, proceed as follows:

1. Raise vehicle on hoist. Refer to Section 00-02.
2. With brakes released, attempt to rotate both front wheels by hand. To minimize brake pad drag, rock the wheel on the spindle as it is rotated. If an excessive amount of brake drag is apparent at both wheels, the master cylinder may not be returning to the released position. Proceed to the next step. If an excessive amount of brake drag is apparent at only one wheel, it indicates a possible seized caliper piston.
3. Check the brake lamp switch adjustment to make sure the switch is not holding the brake pedal in the partially applied position. If the brake lamp switch is properly adjusted, proceed to the next step.
 

**CAUTION: Pump brake pedal several times to exhaust any vacuum in the booster. This will prevent brake fluid from coming in contact with painted surfaces.**
4. Loosen the nuts attaching the master cylinder to the power booster and pull the master cylinder away from the booster. If the brake drag disappears, the power booster is binding and should be replaced. If the brake drag continues, the master cylinder is not operating properly and should be serviced. Refer to Section 06-06.

**DIAGNOSIS AND TESTING (Continued)****Brake Booster Functional Test**

Inspect all vacuum hoses and connections. All unused vacuum connectors should be capped. Hoses and their connections should be properly secured and in good condition with no holes or no collapsed areas. Inspect the hose containing the check valve on the power booster for damage. Check the booster operation as follows:

1. Check the hydraulic brake system for leaks or insufficient fluid.
2. With the transaxle in PARK or NEUTRAL, stop the engine, and apply the parking brake. Depress the service brake pedal several times to exhaust all vacuum in the system.
3. With the engine turned OFF and all vacuum in the system exhausted, depress the service brake pedal and hold it in the applied position. Start the engine. If the vacuum system is operating, the pedal will tend to move downward under constant foot pressure. If no motion is felt, the vacuum booster system is not functioning.
4. Remove the vacuum hose from the brake booster. Manifold vacuum should be available at the booster end of the hose with the engine at idle speed and the transaxle in NEUTRAL. Ensure that all unused vacuum outlets are properly secured, and vacuum hoses are in good condition.

When it is established that manifold vacuum is available to the booster, connect the vacuum hose to the booster and repeat Step 3. If no downward movement of the brake pedal is felt, replace the brake booster. Refer to Section 06-07.

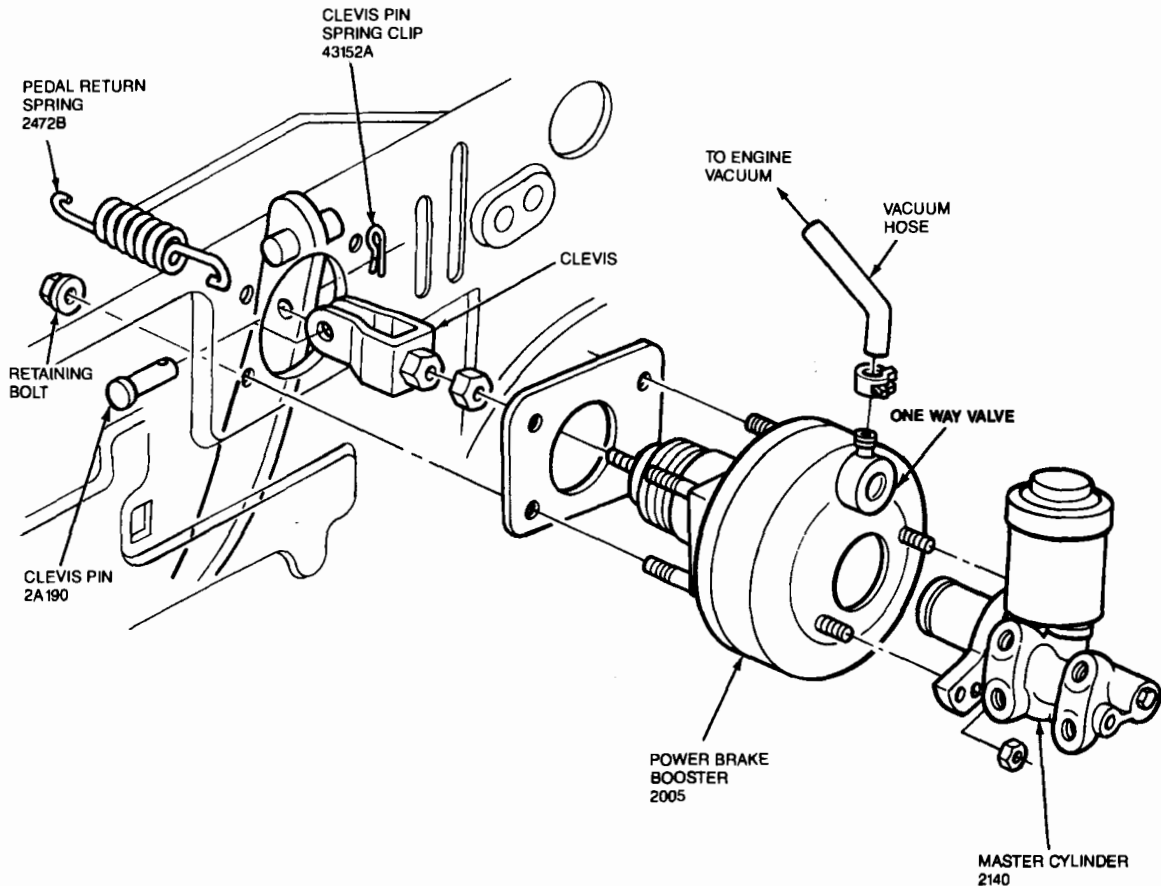
5. Operate the engine a minimum of 10 seconds at fast idle. Stop the engine, and let the vehicle stand for 10 minutes; then, depress the brake pedal with approximately 89 N (20 lb) of force.

The pedal feel (brake application) should be the same as that noted with the engine operating. If the pedal feels hard (no power assist), replace the one way check valve, then repeat the test. If the pedal still feels hard, replace the brake booster.

If the brake pedal movement feels spongy, bleed the hydraulic system to remove air from the system as outlined. Refer to the Vacuum Brake Booster Diagnosis Chart for vacuum booster diagnosis.

**DIAGNOSIS AND TESTING (Continued)**

6. Run engine at fast idle for a minimum of 10 seconds. Depress brake pedal and listen for noise. Compare results with a known good system. If brake booster is noisy, replace it.



H6885-A

**PINPOINT TEST A: VACUUM BRAKE BOOSTER DIAGNOSIS EXCESSIVE BRAKE PEDAL EFFORT OR VACUUM LEAKS**

TEST STEP		RESULT	ACTION TO TAKE
A1	VERIFY CONDITION		
	<ul style="list-style-type: none"> <li>● With engine OFF, depress and release brake pedal five times to deplete all vacuum from booster. Depress pedal, hold with light pressure. Start engine.</li> <li>● Does pedal fall slightly, then hold?</li> </ul>	Yes No	<ul style="list-style-type: none"> <li>▶ GO to A2.</li> <li>▶ GO to A4.</li> </ul>
A2	VACUUM BOOSTER LEAK TEST		
	<ul style="list-style-type: none"> <li>● Run engine to medium speed, release accelerator and turn engine OFF. Wait 90 seconds and apply brakes. Two or more applications should be power assisted.</li> <li>● Are two or more applications power assisted?</li> </ul>	Yes No	<ul style="list-style-type: none"> <li>▶ Vehicle OK.</li> <li>▶ GO to A3.</li> </ul>

## DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A: VACUUM BRAKE BOOSTER DIAGNOSIS EXCESSIVE BRAKE PEDAL EFFORT OR VACUUM LEAKS  
(Continued)

TEST STEP		RESULT	ACTION TO TAKE
A3	POWER SECTION CHECK VALVE TEST		
	<ul style="list-style-type: none"> <li>Disconnect vacuum hose for booster check valve at manifold. Blow into hose attached to check valve.</li> <li><b>Does air pass through check valve?</b></li> </ul>	Yes	▶ INSTALL new check valve. REPEAT Step A2.
		No	▶ REPLACE booster. REPEAT Step A1.
A4	POWER SECTION TEST		
	<ul style="list-style-type: none"> <li>Disconnect vacuum hose from booster. Run engine at idle. Check vacuum supply with a vacuum gauge.</li> <li><b>Is vacuum above 40.5 kPa (12 inches Hg)?</b></li> </ul>	Yes	▶ REPLACE booster. REPEAT Step A1.
		No	▶ REPLACE or SERVICE vacuum hose and vacuum fittings. Also TUNE or SERVICE engine as required. REPEAT Step A1.

## PINPOINT TEST TEST B: VACUUM BRAKE BOOSTER DIAGNOSIS SLOW OR INCOMPLETE BRAKE PEDAL RETURN

TEST STEP		RESULT	ACTION TO TAKE
B1	VERIFY CONDITION		
	<ul style="list-style-type: none"> <li>Run engine at fast idle. Pull brake pedal rearward with approximately 10 lb force. Release the pedal and measure the distance to the floor. Make a heavy brake application. Release the brake pedal and measure the pedal-to-floor distance.</li> <li><b>Does pedal return to its original position?</b></li> </ul>	Yes	▶ Vehicle OK.
		No	▶ GO to B2.
B2	BRAKE PEDAL BINDING		
	<ul style="list-style-type: none"> <li>Check pedal to be sure it is operating freely.</li> <li><b>Is pedal operating freely?</b></li> </ul>	Yes	▶ GO to B3.
		No	▶ CORRECT any sticking or binding. REPEAT Step B1.
B3	PUSH ROD ADJUSTMENT		
	<ul style="list-style-type: none"> <li>Remove master cylinder reservoir cover and depress brake pedal rapidly. Fluid surface should have some movement or spout in forward reservoir.</li> <li><b>Does fluid have movement?</b></li> </ul>	Yes	▶ Vehicle OK.
		No	▶ ADJUST pushrod. REPEAT Step B1.

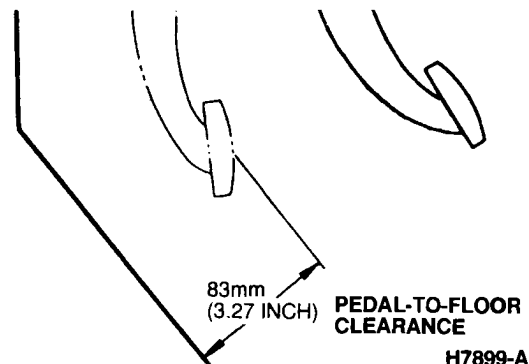
**Brake Pedal Height**

A low brake pedal complaint can occur because the owner's previous vehicle had different brake pedal feel. To determine if pedal height and travel are within specification, use the following procedures.

With the engine running for full power brake operation and the parking brake fully released, measure the brake pedal free height. Then, check brake pedal travel with the use of Rotunda Brake Pedal Effort Gauge 021-00001 or equivalent, as follows:

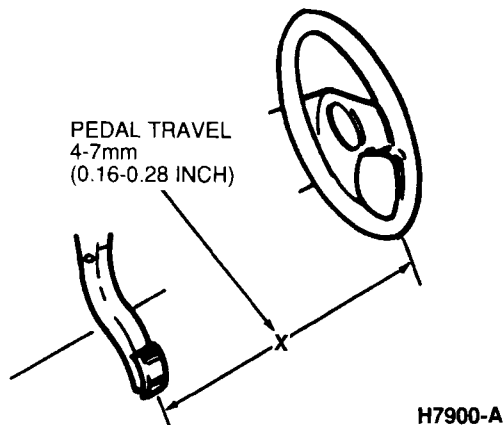
- Depress the pedal with a force of 588 N (132 lb). Measure the distance between the center top of the brake pedal pad and the floor.
- If the brake pedal position is not 83mm (3.27 inch), check the brake pedal for missing, worn, or damaged bushings, or loose retaining bolts. Replace them if required. Also check that the floorpan has not been distorted or the brake pedal bent.

- If the pedal free height is still out of specification, check the brake pedal, booster, or master cylinder to ensure the correct parts are installed. Replace the worn or damaged parts as necessary. Refer to Section 06-07 for proper brake booster adjustment procedures.



**DIAGNOSIS AND TESTING (Continued)****Brake Pedal Travel Measurement**

1. Ensure the parking brake is released.
2. Make sure the master cylinder is filled to the correct level.
3. Install Rotunda Brake Pedal Effort Gauge 02 1-0000 1 or equivalent on the brake pedal pad.
4. Make sure the rear brakes are fully adjusted by applying a 500 N (110 lb) load to the pedal.

**BRAKE PEDAL TRAVEL MEASUREMENT**

5. Attach a steel measuring tape to the brake pedal. Measure and record the distance from the brake pedal free height position to the reference point at the six o'clock position on the steering wheel rim.
6. With steel tape still attached to the brake pedal, depress the brake pedal by pressing downward on the Brake Pedal Effort Gauge. Apply a 22N (5 lb) load to the center of the pedal. Maintain the pedal load and measure the distance from the brake pedal to the fixed reference point on the steering wheel rim parallel to the centerline of the steering column.

7. The difference between the brake pedal free height and the depressed pedal measurement under a 22N (5 lb) load should be 4-7 mm (0.16-0.27 inch).
8. If the brake travel is not within specification, check the pedal assembly for missing or worn bushings or loose attachments.
9. If the above steps do not locate the concern, bleed the brake system.

**Brake Shudder**

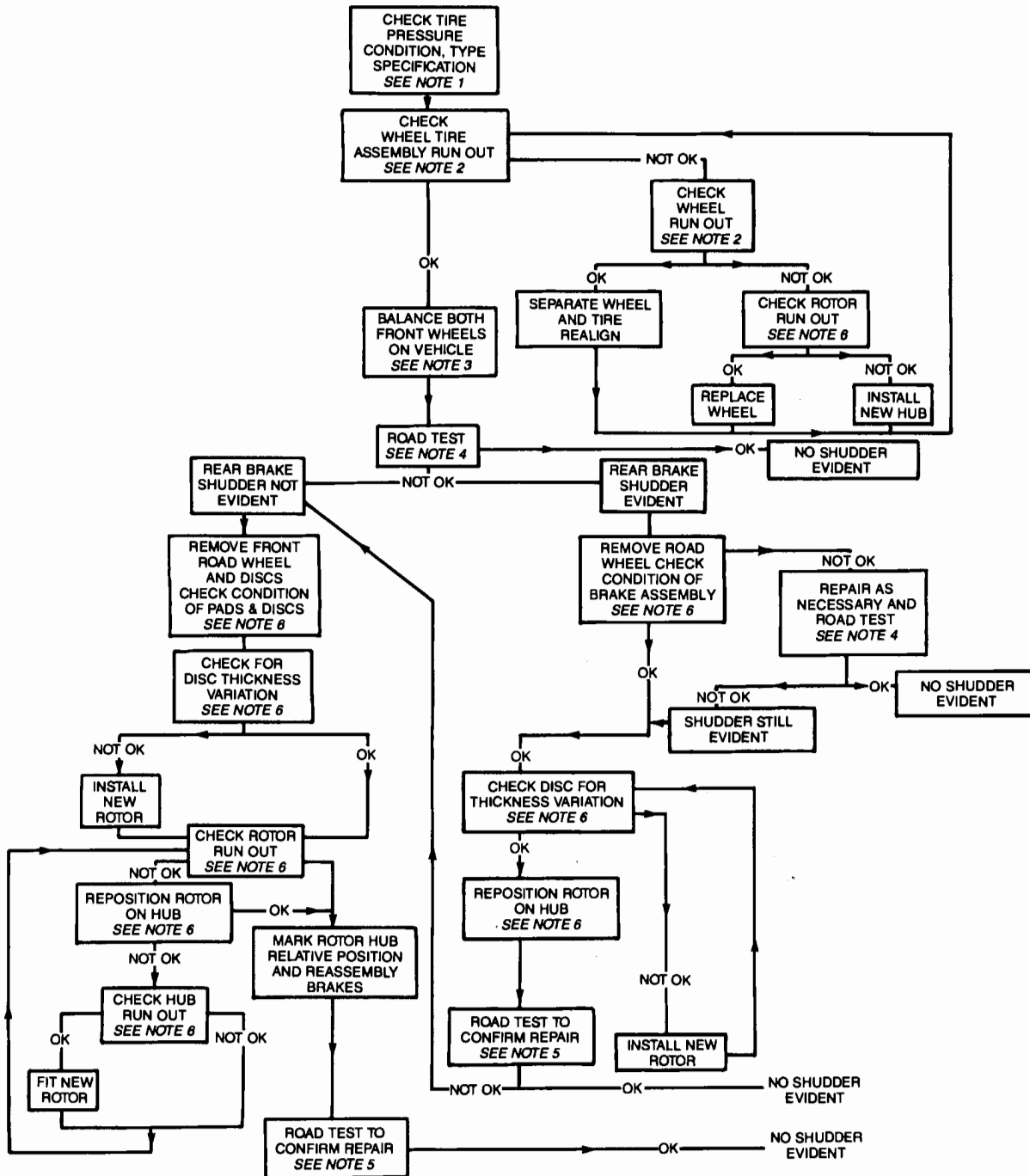
When investigating complaints of brake shudder, it is important that the condition is accurately diagnosed before carrying out corrective actions. Failure to do this may result in unnecessary work and replacement of serviceable components without correcting the concern.

Therefore, should a customer express concern about brake shudder, the sequence and procedures detailed in this procedure must be followed exactly to ensure that the shudder condition is eliminated.

This procedure is divided into two sections, a diagnostic procedure chart and explanatory notes for the chart.

DIAGNOSIS AND TESTING (Continued)

Brake Rotor Diagnosis Chart

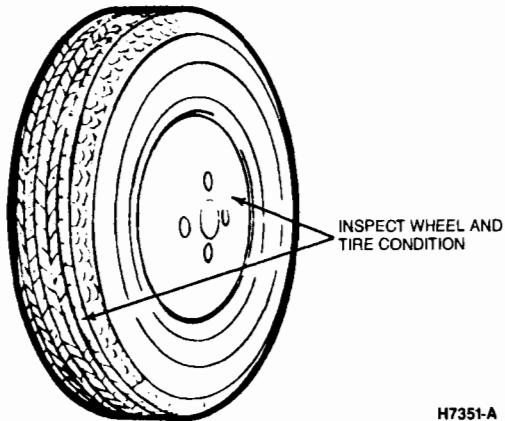


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## DIAGNOSIS AND TESTING (Continued)

### Note 1: Tire Condition / Specification Pressure



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Visually examine front and rear tires and wheel assemblies for damage such as uneven wear, tread wash-outs or sidewall damage. Ensure the tires are of the same size, type and when possible from the same manufacturer. Any tire or wheel that is damaged should be replaced. Refer to Section 04-04.

Wheels and tires must be cleared of any foreign matter and tire pressures adjusted to the correct specification. Refer to Section 04-04.

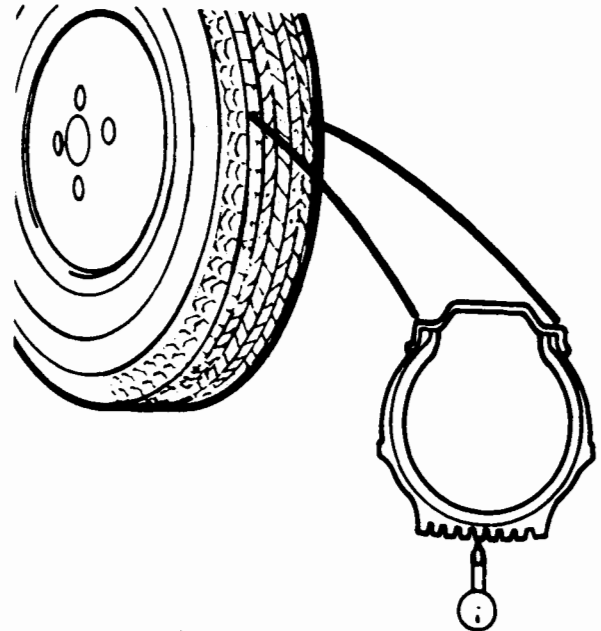
If tires exhibit uneven wear or feathering, the cause must be corrected. Check steering and suspension components for damage / wear and, if necessary, check and adjust steering alignment and rear toe alignment. Refer to Section 04-00.

### Note 2: Front Wheel, Tire and Hub Radial Runout

Wheel and tire assembly runout check:

Raise the front or rear of the vehicle, and place a support underneath the control arm to prevent suspension movement. Refer to Section 00-02. Using a Dial Indicator With Bracketry TOOL-4201-C or Rotunda Radial Runout Gauge 007-00014 or equivalent measure the radial runout of the tire at the center and outside ribs of the tread face. Mark low and high positions of radial runout. Radial runout must not exceed 1.59mm (0.062 inch).

Re-adjust the dial indicator mounting brackets, measure the wheel rim runout and record high and low positions. The wheel rim runout must not exceed 1.0mm (0.039 inch). Measure wheel radial runout at the wheel rim along the inside edge of the flange. If indicator reading is in excess of 1.0mm (0.039 inch), the hub radial runout must be checked as follows.



CHECK TOTAL RADIAL  
RUNOUT HERE

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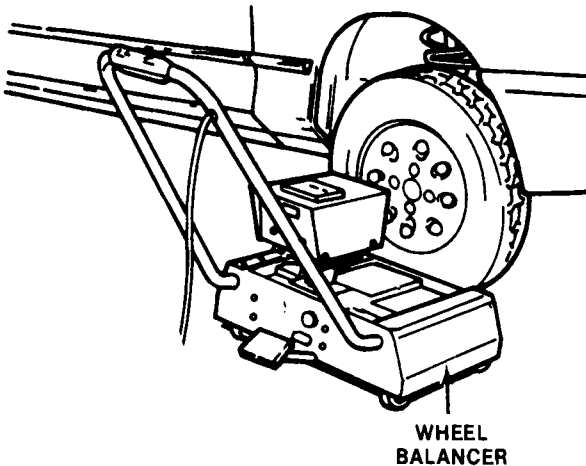
**NOTE:** If the reading for wheel runout is within specification and tire runout is outside specification, rotate tire on the wheel rim until the tire runout is within specification. Check tire radial runout until an acceptable specification is obtained.

Remove the wheel, reposition the dial indicator and measure the hub radial runout. The total indicator reading of the runout must not exceed 0.1mm (0.004 inch).

**NOTE:** If the hub runout is within specification, this indicates the wheel runout is out of specification and must be replaced. If the hub runout is out of specification, the hub should be replaced. Refer to Sections 04-01 and 04-02.

## DIAGNOSIS AND TESTING (Continued)

The wheel / tire and hub assembly radial runout should be checked until an acceptable condition is reached.



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### Note 3: Check Tire Balance

Check wheel and tire assembly balance. Refer to Section 04-04.

Wheels must be balanced on the vehicle, both statically and dynamically.

### Note 4: Road Test One

Complaints of brake shudder can often be influenced by factors independent of the braking system. Therefore, it is important that you adhere as closely as possible to the procedures detailed below so that the causes of the concerns can be accurately identified.

1. Drive the vehicle up to speed.

**NOTE:** Brake shudder has been found to be most apparent when braking from speeds around 112 to 120 km/h (70 to 75 mph). Therefore, subject to local road conditions / speed limits, the vehicle should be driven as near to the speed as possible during the road test.

2. When safe to do so, apply the foot brake and brake lightly to a stop, noting the speeds at which shudder is apparent. (Identified by steering wheel vibration and brake pedal pulsation.)
3. Repeat Steps 1 and 2 twice more, to confirm the critical speed ranges.

**NOTE:** Allow 1.6 km (1 mi) between each application to allow the brakes to cool.

4. Return to the critical shudder speed, but instead of applying the foot brake, apply the handbrake lightly with the release button depressed. Check for vibration through the handbrake and / or steering wheel.

If vibration is apparent when carrying out the handbrake test, rear brake shudder is present. This must be investigated and eliminated before investigating whether front brake shudder is also present.

If vibration is only apparent when the foot brake is applied, it can be assumed the rear brakes are functioning satisfactorily. In these circumstances continue with the front brake diagnostic sequence.

### Note 5: Road Test Two

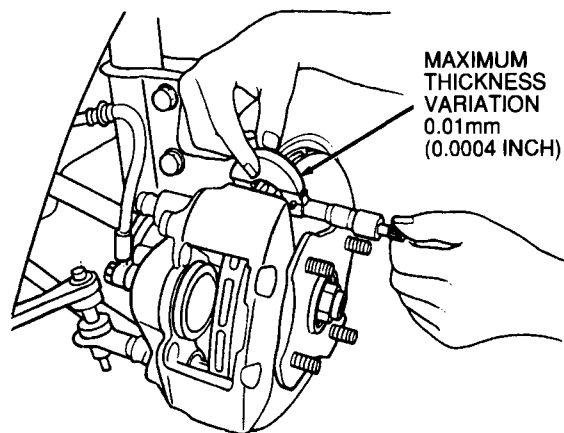
Road test the vehicle as outlined in Road Test One, Steps 1, 2, and 3 only. Continue with the front brake diagnostic sequence only if foot brake shudder is still apparent.

### Note 6: Front or Rear Brake Shudder

If the road test has established a brake shudder condition, the following procedure should be used to isolate the cause.

1. Raise the vehicle. Refer to Section 00-02.
2. Remove the wheel lug nuts. Before removing the wheel, mark the wheel and one of the wheel studs so that the wheel can be installed in its original position.
3. Examine the condition of the rotor and pad assemblies. If there is visible evidence of lining deposits or light corrosion on the rotor, this should be removed using emery paper and a flat block.
4. Check the thickness variation of the rotor using a suitable micrometer. Measure the rotor at eight positions, 45 degrees apart, about 12.7mm (1/2 inch) in from the outside diameter. If the difference between the highest and lowest readings varies by 0.01mm (0.0004 inch) or more, the rotor should be reconditioned or new rotors should be installed. Refer to Section 06-03 or 06-04.

**NOTE:** It is important to always check at a constant radius.



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5. Using a suitable dial indicator and holding fixture, measure the rotor runout. Measure the runout about 10mm (7/16 inch) in from the outside diameter.

**DIAGNOSIS AND TESTING (Continued)**

6. Rotate the hub and rotor assembly. Record indicator reading. If runout is greater than 0.1mm (0.004 inch) total indicator reading, the hub and rotor assembly must be removed and turned in a brake lathe. Refer to Sections 04-01 and 06-03 for front rotors or 04-02 and 06-04 for rear brakes.
7. Install the rotors, brake calipers, pads and wheel. Tighten the wheel lug nuts. Refer to Sections 04-04 and 06-03 or 06-04.
8. Perform a road test to confirm service.

**ADJUSTMENTS****Push Rod Length**

NOTE: Push rod length is not adjustable. To ensure the master cylinder is free to return to its rest position with no residual pressure, verify stoplamp switch adjustment. Refer to Section 17-01.

**Hydraulic System Bleeding**

When any part of the brake hydraulic system has been disconnected for service, air will enter the system and cause spongy pedal action. To remove the air, the system must be bled using either pressure bleeding equipment Rotunda Brake Bleeder 104-00064 or equivalent or the manual method. If only one system has been opened, normal pedal feel can usually be restored by bleeding only the opened system. This vehicle uses a diagonally split system. The left front and right rear are on one brake circuit, while the right front and left rear are on another brake circuit. When bleeding brakes, go to the rear brake first and then the front brake on the same circuit. This will ensure that the longest line in either system is being bled first.

**Manual Bleeding**

1. Clean all dirt from the master cylinder filler cap.
2. If the master cylinder is known or suspected of having air in the bore, it must be bled before any of the calipers. To bleed the master cylinder, follow the procedures under System Priming.
3. To bleed the calipers, proceed as follows:
  - a. Begin at the RH rear bleeder screw.
  - b. Attach a rubber drain hose to the bleeder screw. The end of the tube should fit snugly around the end of the bleeder screw.
  - c. Place the free end of the hose in a container partially filled with clean brake fluid.
  - d. Have assistant apply and maintain pressure on the brake pedal.

- e. Loosen the bleeder screw approximately three-quarter turn. It is very important for the helper to maintain constant pressure on the pedal until the pedal drops all the way down and the bleeder screw is closed again. If pedal pressure is released, air will be drawn back into the system.
- f. Tighten the bleeder screw and release the brake pedal.
- g. Repeat this operation until the fluid is clear and air bubbles no longer appear at the submerged end of the rubber hose.
- h. Repeat these steps at the other calipers. Proceed to LH rear, RH front, then LH front. Maintain proper fluid level in reservoir at all times.

4. Top up brake fluid when bleeding is completed.

NOTE: Never reuse brake fluid.

**Pressure Bleeding**

For pressure bleeding, use only diaphragm-type bleeder such as Rotunda Brake Bleeder 104-00064 or equivalent and follow the manufacturer's instructions.

**System Priming**

When a new master cylinder has been installed or the brake system emptied or partially emptied, fluid may not flow from the bleed screws during normal bleeding. It may be necessary to prime the system using the following procedure:

1. Using a tubing wrench, remove the brake lines from the master cylinder.
2. Install short brake lines in the master cylinder and position them so that they point back into the reservoir and the ends of the pipes are submerged in brake fluid.
3. Fill the reservoir with Heavy-Duty Brake Fluid C6AZ-19542-AA (ESA-M6C25-A) or equivalent.
4. Cover the reservoir with a shop towel.
5. Pump the brakes until clear, bubble-free fluid comes out of both brake lines. If any brake fluid spills on the paint, wash it off immediately with water.
6. Remove the short brake lines and re-install the ones from the vehicle.
7. Bleed each brake line at the master cylinder using the following procedure:
  - a. Have assistant pump the brake pedal 10 times and then hold firm pressure on the pedal.
  - b. Crack the rearmost brake line fittings on the master cylinder with a tubing wrench until a stream of brake fluid comes out. Have assistant maintain pressure on the brake pedal until the brake line fitting is tightened again.

## ADJUSTMENTS (Continued)

- c. Repeat this operation until clear, bubble-free fluid comes out from around the tubing fitting.
  - d. Repeat this bleeding operation at the front brake line fitting.
8. If any of the brake lines or calipers have been removed, it may be helpful to prime the system by gravity bleeding it. This should be done after the master cylinder is primed and bled.
- To prime the brake system:
- a. Fill the master cylinder with Heavy-Duty Brake Fluid C6AZ-19542-AA (ESA-M6C25-A) or equivalent.
- b. Loosen both rear caliper bleeder screws and leave them open until clear brake fluid flows out. Be sure to frequently check the reservoir fluid level and not let it run dry.
  - c. Tighten the caliper bleeder screws.
  - d. One at a time, loosen the front caliper bleeder screws. Leave the bleeder screw open until clear fluid flows out. Be sure to frequently check the reservoir level and not let it run dry.
  - e. Tighten the bleeder screws.
9. After the master cylinder has been primed, the lines bled at the master cylinder, and the brake system primed, normal brake system bleeding can resume at each wheel.

### Brake Tube Replacement

**CAUTION: Never use copper tubing because copper is subject to fatigue, cracking and corrosion which could result in brake failure. Use double-walled steel tubing only.**

To replace a brake tube, use the following general procedure.

1. Obtain the recommended tubing and steel fitting nuts of the correct size. (Outside diameter of tubing is used to specify size.)

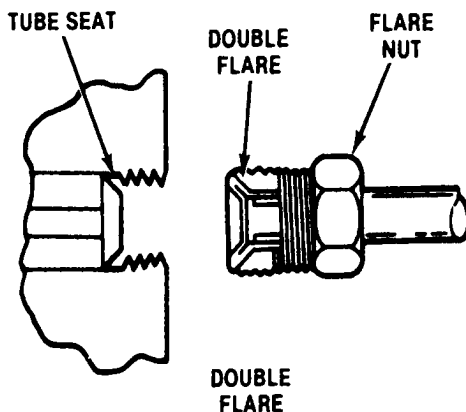
NOTE: All tubing fittings used on this vehicle are metric.

2. Cut the tubing to length. Correct length may be determined by measuring the old tubing using a cord and then adding 3mm (1/8 inch) for each double flare.
3. Ensure the fittings are installed before starting a flare.

- Double flare all tubing ends using a suitable flaring tool. Follow instructions included in the tool set.

NOTE: Double flaring tools must be used since single flaring tools cannot produce a flare strong enough to hold the necessary pressure.

4. Bend the new pipe assembly to match the old pipe by using a tubing bender. Clearance of 6mm (3/4 inch) must be maintained at all moving or vibrating parts on the vehicle.



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## SPECIFICATIONS

Description	Type	Diameter
Master Cylinder	Tandem, Integral Proportioning Valves	20.6mm (0.811 inch)
Front Caliper	Single Piston	50.8mm (2.0 inch)
Rear Caliper	Single Piston	30.2mm (1.19 inch)
Brake Booster Unit	Vacuum Diaphragm	228.6mm (9 inch)

**SPECIFICATIONS (Continued)**

Description	Diameter	Wear Limit	Maximum Thickness Variation	Maximum Runout
Brake Disc, Front	18mm (0.71 inch)	16mm (0.63 inch)	0.01mm (0.0004 inch)	0.1mm (0.004 inch)
Brake Disc, Rear	10mm (0.39 inch)	9mm (0.35 inch)	0.01mm (0.0004 inch)	0.1mm (0.004 inch)

**SPECIAL SERVICE TOOLS**

Tool Number	Description
D81L-1103-A	Brake Adjustment Gauge
TOOL-4201-C	Dial Indicator with Bracketry

ROTUNDA EQUIPMENT	
Model	Description
007-00014	Radial Runout Gauge
021-00001	Brake Pedal Effort Gauge
104-00064	Brake Bleeder