Automotive Technology 6th Edition
Chapter 109 Power Brake Unit Operation, Diagnosis/Service
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain learning objectives to students as listed below: 1. Discuss the need for power brake assist. 2. State the principles of vacuum and the vacuum booster theory. 3. Discuss the operation of a vacuum check valve, vacuum brake booster, dual-diaphragm vacuum boosters, and brake assist system. 4. Discuss the vacuum booster operation test, vacuum booster leak test and hydraulic system leak test. 5. Describe how to adjust the pushrod length and disassemble the vacuum brake booster for service. 6. Explain the operation and diagnosis of Hydro-boost hydraulic brake booster. 7. This chapter will help prepare for the Brakes (A5) ASE certification test content area "A" (Hydraulic, Power Assist, and Parking Brake Systems Diagnosis and Repair).
Establish the Mood or Climate	Provide a ***WELCOME,*** Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: Lesson plan is based on 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

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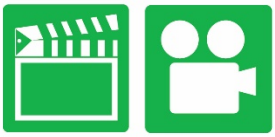
http://www.jameshalderman.com/automotive_principles.html

NOTE: You can use Chapter Images or possibly Power Point files:

ICONS	Chapter 109 Power Brakes
	**1. SLIDE 1 CH109 POWER BRAKE UNITS**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED**
	**http://www.jameshalderman.com/automotive_principles.html** **DOWNLOAD** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF**
	**Videos**
	**DEMONSTRATION: Show students an example of a pneumatic power brake booster and discuss how it works. Why do we need a booster?**
	**2. SLIDE 2 EXPLAIN Figure 109-1** Typical vacuum brake booster assembly. The vacuum hose attaches to the intake manifold of the engine. The brake pedal travel sensor is an input sensor for the antilock braking system.
	3. SLIDE 3 EXPLAIN Figure 109-2 wide brake pedal allows two-foot braking if power assist is lost.
	**4. SLIDE 4 EXPLAIN Figure 109-3** Atmospheric pressure varies with altitude.
	5. SLIDE 5 EXPLAIN Figure 109-4 A belt-driven auxiliary vacuum pump.
	6. SLIDE 6 EXPLAIN Figure 109-5 An electrically powered vacuum pump.
	**DEMONSTRATION: Show students a vacuum brake booster assembly. Ask students to explain how it works.**
	**DISCUSSION: Ask students to discuss the need for a power brake assist. What is the function and purpose of a power booster?**
	**DEMONSTRATION: Show students the diaphragm in a vacuum booster, and discuss how it works to equalize the pressure between the two vacuum booster chambers.**

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	**DISCUSSION:** Ask students to discuss the reasons for variations in manifold vacuum and explain how brake boosters are designed to work within this variance
	**Leaks in the vacuum line to the booster can cause drivability problems with the engine as well as problems with the brakes.**
	**Power Booster (View) (Download)** **Power Booster Vacuum Supply (View) (Download)**
	**HANDS-ON TASK:** Have students calculate amount of force created when a power-booster diaphragm has an atmospheric pressure (14.7 psi) on one side and an intake manifold vacuum of 20 in. Hg (10 psi of absolute pressure), & diaphragm size of 52 sq. in. (*Answer:* 244.4 pounds of force)
	**7. SLIDE 7 EXPLAIN Figure 109-6** Vacuum brake boosters operate on the principle of pressure differential
	**EXPLAIN TECH TIP:** ***Check the Vacuum, Then the Brakes.*** **A customer complained of a very rough idle and an occasional pulsating brake pedal. The customer was certain that engine required serious work since there were over 100,000 miles on vehicle. During troubleshooting procedure, a spray cleaner was used to find any vacuum (air) leaks. A large hole was found melted through a large vacuum hose next to vacuum hose feeding vacuum-operated power brake booster. After repairing vacuum leak, the vehicle was test driven again to help diagnose cause of pulsating brake pedal. The engine idled very smoothly after vacuum leak was repaired and brake pulsation was also cured. The vacuum leak resulted in lower-than-normal vacuum being applied to vacuum booster. During braking, when engine vacuum is normally higher (deceleration), the vacuum booster would assist, then not assist when the vacuum was lost. This on-and-off supply of vacuum to the vacuum booster**

was noticed by the driver as a brake pulsation. Always check the vacuum at the booster whenever diagnosing any brake problems. Most vehicle manufacturers specify a minimum of 15 in. Hg of vacuum at the booster. The booster should be able to provide at least two or three stops even with no vacuum. The booster should also be checked to see if it can hold a vacuum after several hours. A good vacuum booster, for example, should be able to provide a power assist after sitting all night without starting the engine.

8. **SLIDE 8 EXPLAIN Figure 109-7** charcoal filter traps gasoline vapors that are present in the intake manifold and prevents them from getting into the vacuum chamber of the booster.

DEMONSTRATION: Show students the charcoal filter used to trap gasoline vapors to keep them from entering the vacuum booster. Ask students to discuss the damage that can occur if these vapors are not trapped

9. **SLIDE 9 EXPLAIN Figure 109-7 (B)** Many vacuum brake booster check valves are located where the vacuum hose from the engine (vacuum source) attaches to the vacuum booster **(b)** one-way valve prevents loss of vacuum when the engine is off. The diaphragm inside allows air to flow in one direction only.

DEMONSTRATION: Show students HOW & WHY the vacuum check valve retains vacuum or the absence of pressure.

10. **SLIDE 10 EXPLAIN FIGURE 109-8** Cross-sectional view of a typical vacuum brake booster assembly

DEMONSTRATION: Show operation of vacuum booster in brake-released position. Ask students to describe position of air & floating control valves & describe state of vacuum within vacuum brake booster.

11. **SLIDE 11 EXPLAIN Figure 109-9** In the release position (brake pedal up), the vacuum is directed to both sides of the diaphragm.

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	**DEMONSTRATION: Show operation of vacuum booster as the brake pedal is depressed. Ask students to describe the position of the air and floating control valves and describe the state of vacuum within the vacuum brake booster.**
	**DISCUSSION: Ask students to discuss components & operation of power brake booster.**
	12. **SLIDE 12 EXPLAIN Figure 109-10** Simplified diagram of a vacuum brake booster in the apply position. Notice that the atmospheric valve is open and air pressure is being applied to the diaphragm.
	**EXPLAIN TECH TIP: *A Low, Soft Brake Pedal Is Not a Power Booster Problem.* Some technicians tend to blame power brake booster if vehicle has a low, soft brake pedal. A defective power brake booster causes a hard brake pedal, not a soft brake pedal. A soft or spongy brake pedal is usually caused by air being trapped somewhere in the hydraulic system. Many times, the technician has bled the system and, therefore, thinks that system is free of any trapped air. According to remanufacturers of master cylinders and power brake boosters, most of returned parts under warranty are not defective. Incorrect or improper bleeding procedures account for much of the problem.**
	13. **SLIDE 13 EXPLAIN Figure 109-11** Cross section of a vacuum brake booster in the hold position with both vacuum and atmospheric valves closed. Note that the reaction force from the brake fluid pressure is transferred back to the driver as a reaction force to the brake pedal.
	**DEMONSTRATION:Show operation of vacuum booster when desired brake-pedal force is reached. Ask students to describe position of air and floating control valves and describe state of vacuum within the vacuum brake booster. Compare this to state of the vacuum booster in brake-released position.**
	14. **SLIDE 14 EXPLAIN Figure 109-12** Cutaway showing a dual-diaphragm (tandem) vacuum brake booster.

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	**DEMONSTRATION: Show students an example of a dual-diaphragm or tandem-diaphragm vacuum booster, and discuss how these designs increase power assist without increasing the size of the vacuum booster.**
	**DISCUSSION: Ask students to discuss how power-assisted brakes function like conventional brakes in the event of a disruption in vacuum**
	**DISCUSSION: Ask students to talk about how brake assist systems (BAS) help drivers apply brakes with maximum force during a panic stop. How does BAS work with a vehicle's electronic stability control (ESC) system to provide maximum braking efficiency in emergency stops?**
	15. **SLIDE 15 EXPLAIN FIGURE 109-13** A typical brake assist system uses a brake pedal travel sensor and a BAS solenoid to apply the brakes during a panic condition 16. **SLIDE 16 EXPLAIN FIGURE 109-14** When the brake assist function operates, the brake force is much higher than normal. 17. **SLIDE 17 EXPLAIN Figure 109-15** Typical adjustable pushrod. This adjustment is critical for proper operation of the braking system. If the pushrod is too long, the brakes may be partially applied during driving. If the rod is too short, the brake pedal may have to be depressed farther down before the brakes start to work 18. **SLIDE 18 EXPLAIN FIGURE 109–16** Typical vacuum brake booster pushrod gauging tool. (a) The tool is first placed against the mounting flange of the master cylinder and the depth of the piston determined. (b) The gauge is then turned upside down and used to gauge the pushrod length. Some vacuum brake boosters do not use adjustable pushrods. If found to be the incorrect length, a replacement pushrod of the correct length should be installed. 19. **SLIDE 19 EXPLAIN FIGURE 109–17** holding fixture and a long tool being used to rotate the two halves of a typical vacuum brake booster.
	**HANDS-ON TASK: Have students perform a pushrod clearance test. What problems can result if the pushrod is too long?**

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             	**DEMONSTRATION:** Show students how to perform a vacuum booster operation test. Ask them to explain the results. **ON-VEHICLE ASEEDUCATION TASK: F1.** Check brake pedal travel with and without engine running to verify proper power booster operation. **ON-VEHICLE ASEEDUCATION TASK: F2.** Identify components of the brake power assist system (vacuum and hydraulic); check vacuum supply (manifold or auxiliary pump) to vacuum- type power booster. **ON-VEHICLE ASEEDUCATION TASK: F3.** Inspect vacuum-type power booster unit for leaks; inspect the check-valve for proper operation; determine needed action. . **ON-VEHICLE ASEEDUCATION TASK: F4.** Inspect and test hydraulically-assisted power brake system for leaks and proper operation; determine needed action. **HANDS-ON TASK:** Have students perform a **HYDRAULIC SYSTEM LEAK TEST** **ON-VEHICLE ASEEDUCATION TASK: F5.** Measure and adjust master cylinder pushrod length **DISCUSS FREQUENTLY ASKED QUESTION:** ***What Is Supplemental Brake Assist?*** Supplemental brake assist (SBA) is a motor-driven vacuum pump that can supplement engine vacuum to vacuum brake booster. This unit is used on some General Motors vehicles. When a vehicle is driven under a heavy load,

engine vacuum is low. To meet brake standards, some vehicles are equipped with brake assist system that consists of the following components:

- **A pressure sensor that is used to measure vacuum in vacuum booster.**
- **An intake manifold check valve that is used to prevent vacuum from escaping the vacuum boost.**
- **• A motor-driven vacuum pump. The vacuum pump motor will start and run if pressure sensor detects vacuum in the booster is below 7 in. Hg and will shut off after the vacuum level increases to 9 in. Hg.**
- **• SEE FIGURE 109–19.**

20. **SLIDE 20 EXPLAIN FIGURE 109–18** Exploded view of a typical dual-diaphragm vacuum brake booster assembly
21. **SLIDE 21 EXPLAIN FIGURE 109–19** supplemental brake assist (BAS) pump mounts on brake booster housing.

HANDS-ON TASK: Have students remove, disassemble, and overhaul a vacuum brake booster. Grade students on following proper procedures and achieving a satisfactory result.

When disassembling a vacuum booster you find brake fluid inside this would indicate a leak in the rear seal of the master cylinder

22. **SLIDE 22 EXPLAIN Figure 109-20** Hydro-Boost unit attaches between the bulkhead and the master cylinder and is powered by the power steering pump.
23. **SLIDE 23 EXPLAIN Figure 109-21** Exploded view of the Hydro-Boost unit

DEMONSTRATION: Show students an example of a hydro-boost system. Ask them to talk about the types of vehicles in which hydro-boost may be preferable to using a vacuum booster.

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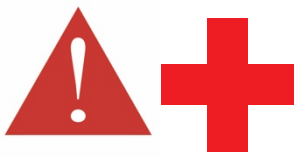
 	**DISCUSSION:** Ask students to discuss how a hydro-boost system operates. What happens in event of a hydraulic system failure? 24. **SLIDE 24 EXPLAIN Figure 109-22** Hydro-Boost hydraulic booster in the unapplied position
  	**DISCUSSION:** Have students talk about how an accumulator works. Have them talk about the possible problems that an accumulator can develop **SAFETY TIP:** Do not ever try to take an accumulator apart. The accumulator spring is under extreme pressure. 25. **SLIDE 25 EXPLAIN Figure 109-23** Hydro-Boost hydraulic booster as brakes are applied. 26. **SLIDE 26 EXPLAIN Figure 109-24** A Hydro-Boost hydraulic booster in the holding position.
 	**DISCUSSION:** Ask students to talk about the possible causes of slow brake-pedal return, grabby brakes, & booster chatter in a hydro-boost system. 27. **SLIDE 27 EXPLAIN Figure 109-25** A typical Hydro-Boost hydraulic line arrangement showing the pump, steering gear, and brake booster assembly. 28. **SLIDE 28 EXPLAIN Figure 109-26** Pressure and flow analyzer installation to check the power steering pump output.
	**EXPLAIN TECH TIP:** ***Hydro-Boost Accumulator Test*** **The accumulator stores hydraulic fluid under pressure to provide a reserve in the event of a failure of power steering system. The accumulator is designed to provide three or more power-assisted stops with engine off. • SEE FIGURE 109–27. If accumulator fails, it does not hold pressure. To check whether accumulator has lost its charge, simply grasp accumulator with your hand and try to twist or move it. Accumulator should have so much pressure on it that it should not move or wiggle. If the accumulator moves, it has lost its ability to**

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	**hold pressure and Hydro-Boost unit should be replaced.** 29. **SLIDE 29 EXPLAIN FIGURE 109-27** accumulator should be able to hold pressure and feel tight when hand force is used to try to move it.
	**HANDS-ON TASK: Have students perform a visual inspection of a hydro-boost system. Then use a power steering pump tester to check for proper pressure and volume from power steering pump.**
	**OPTIONAL HANDS-ON TASK: Have students remove, disassemble, & overhaul a hydro-boost hydraulic brake booster. Grade students on following proper procedures and achieving a satisfactory result.**
	**DEMONSTRATION: Show students how to do a hydro-boost function test. Select a student to explain the results**
	**DEMONSTRATION: Show students the chatter you will get in the brakes when the belt slips on the power steering pump**
	**HANDS-ON TASK: Have students perform a hydro-boost accumulator test. Does the accumulator move or wiggle? Ask students to interpret the results**
	**ON-VEHICLE ASEEDUCATION TASK: Inspect and test hydro-boost system for leaks and proper operation.**
	
	**SEARCH INTERNET: Have students use Internet to research how Brake Assist Plus (BAS Plus) system from Mercedes-Benz works to increase braking pressure in emergencies.**