Automotive Chassis Systems 7th Edition

Chapter 16 Power Brake, Unit Operation, Diagnosis, and Service

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Chassis Systems.** It correlates material to task lists specified by ASE and NATEF.
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 the chapter learning objectives to the students. 1. State the principles of vacuum and the vacuum booster. 2. Discuss how a vacuum brake booster operates. 3. Discuss the vacuum booster leak test and the hydraulic system leak test. 4. Explain the operation and diagnosis of hydro-boost hydraulic brake booster. **This chapter will help you prepare for the Brakes (A5) ASE certification test content areas "B" (Drum Brake Service) and "C" (DISC Brakes Service).**
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: This lesson plan is based on Automotive Chassis Systems 7th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 16: Chapter Images

ICONS	Ch16 Power Brake OP & Service
	**1. SLIDE 1 POWER BRAKE, UNIT OPERATION, DIAGNOSIS, & SERVICE**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **Videos**
	**At the beginning of this class, you can download the crossword puzzle & Word Search from the links below to familiarize your class with the terms in this chapter & then discuss them**
	**Word Search Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**
	**DEMONSTRATION: SHOW STUDENTS AN EXAMPLE OF A PNEUMATIC POWER BRAKE BOOSTER AND DISCUSS HOW IT WORKS. WHY DO WE NEED A BOOSTER?**
	**2. SLIDE 4 EXPLAIN Figure 16-1** 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 16-2 wide brake pedal allows two-foot braking if power assist is lost.
	**4. SLIDE 4 EXPLAIN Figure 16-3** Atmospheric pressure varies with altitude.
	5. SLIDE 5 EXPLAIN Figure 16-4 belt-driven auxiliary vacuum pump.
	6. SLIDE 6 EXPLAIN Figure 16-5 electrically powered vacuum pump.
	**Power Booster (View) (Download)** **Power Booster Vacuum Supply (View) (Download)**

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	**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 DIAPHRAGM IN A VACUUM BOOSTER, AND DISCUSS HOW IT WORKS TO EQUALIZE THE PRESSURE BETWEEN THE TWO VACUUM BOOSTER CHAMBERS.**
	**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)**
	7. **SLIDE 7 EXPLAIN Figure 16-6** Vacuum brake boosters operate on the principle of pressure differential
	**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)**
	8. **SLIDE 8 EXPLAIN FIGURE 16.7A** Many vacuum brake booster check valves are located where the vacuum hose from the engine (vacuum source) attaches to the vacuum booster. 9. **SLIDE 9 EXPLAIN FIGURE 16.7B** This one-way valve prevents the loss of vacuum when the engine is off. The diaphragm inside allows air to flow in one direction only

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	**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**
	10. **SLIDE 10 EXPLAIN FIGURE 16.8** Cross-sectional view of a typical vacuum brake booster assembly.
	**DEMONSTRATION: SHOW STUDENTS HOW & WHY THE VACUUM CHECK VALVE RETAINS VACUUM OR THE ABSENCE OF PRESSURE.**
	11. **SLIDE 11 EXPLAIN FIGURE 16.9** In the release position (brake pedal up), the vacuum is directed to both sides of the diaphragm.. 12. **SLIDE 12 EXPLAIN FIGURE 16.10** Simplified diagram of a vacuum brake booster in the apply position.
	**DEMONSTRATION: SHOW OPERATION OF VACUUM BOOSTER IN BRAKE-RELEASED POSITION. ASK STUDENTS TO DESCRIBE POSITION OF AIR & FLOATING CONTROL VALVES & DESCRIBE STATE OF VACUUM IN VACUUM BRAKE BOOSTER.**
	13. **SLIDE 13 EXPLAIN Figure 16-11** Cross section of a vacuum brake booster in the hold position with both vacuum and atmospheric valves closed
	**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.**
	14. **SLIDE 14 EXPLAIN FIGURE 16.12** Cutaway showing a dual-diaphragm (tandem) vacuum brake booster 15. **SLIDE 15 EXPLAIN FIGURE 16.13** A typical brake assist system uses a brake pedal travel sensor and a BAS solenoid to apply the brakes during a panic condition

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	**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.**
	16. **SLIDE 16 EXPLAIN Figure 16-14** When brake assist function operates, brake force much higher than normal.
	**DEMONSTRATION: SHOW EXAMPLE OF A DUAL-DIAPHRAGM OR TANDEM-DIAPHRAGM VACUUM BOOSTER, & DISCUSS HOW THESE DESIGNS INCREASE POWER ASSIST WITHOUT INCREASING SIZE OF 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?**
	17. **SLIDE 17 EXPLAIN Figure 16-15** 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.
	**HANDS-ON TASK: HAVE STUDENTS PERFORM A PUSHROD CLEARANCE TEST. WHAT PROBLEMS CAN RESULT IF THE PUSHROD IS TOO LONG?**
	**DEMONSTRATION: SHOW STUDENTS HOW TO PERFORM A VACUUM BOOSTER OPERATION TEST. ASK THEM TO EXPLAIN THE RESULTS.**

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	**ON-VEHICLE NATEF TASK: TEST PEDAL FREE TRAVEL; CHECK POWER ASSIST OPERATION**
	**ON-VEHICLE NATEF TASK: CHECK VACUUM SUPPLY TO VACUUM-TYPE POWER BOOSTER.**
	**ON-VEHICLE NATEF TASK: INSPECT VACUUM-TYPE POWER BOOSTER UNIT FOR VACUUM LEAKS; INSPECT THE CHECK VALVE FOR PROPER OPERATION; DETERMINE NECESSARY ACTION**
	**HANDS-ON TASK: HAVE STUDENTS PERFORM A HYDRAULIC SYSTEM LEAK TEST**
	18. **SLIDE 18 EXPLAIN Figure 16-16 (a)** 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.
	19. **SLIDE 19 EXPLAIN Figure 16-16 (b)** Typical vacuum brake booster pushrod gauging tool. (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
	**ON-VEHICLE NATEF TASK: MEASURE AND ADJUST MASTER CYLINDER PUSHROD LENGTH**
	20. **SLIDE 20 EXPLAIN Figure 16-27** A holding fixture and a long tool being used to rotate the two halves of a typical vacuum brake booster.
	21. **SLIDE 21 EXPLAIN Figure 16-18** Exploded view of a typical dual-diaphragm vacuum brake booster assembly.
	22. **SLIDE 22 EXPLAIN FIGURE 16.19** The supplemental brake assist (BAS) pump mounts on the brake booster housing.
	**HANDS-ON TASK: HAVE STUDENTS REMOVE, DISASSEMBLE, & OVERHAUL VACUUM BRAKE BOOSTER.**

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	**WHEN DISASSEMBLING A VACUUM BOOSTER YOU FIND BRAKE FLUID INSIDE THIS WOULD INDICATE A LEAK IN THE REAR SEAL OF MASTER CYLINDER**
	**ANIMATION: HYDRO-BOOST OPERATION**
	**23. SLIDE 23 EXPLAIN Figure 16-20** Hydro-Boost unit attaches between the bulkhead and the master cylinder and is powered by the power steering pump. **24. SLIDE 24 EXPLAIN Figure 16-21** 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.**
	**DISCUSSION: ASK STUDENTS TO DISCUSS HOW A HYDRO-BOOST SYSTEM OPERATES. WHAT HAPPENS IN EVENT OF A HYDRAULIC SYSTEM FAILURE?**
	**25. SLIDE 25 EXPLAIN Figure 16-22** 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. ACCUMULATOR SPRING IS UNDER EXTREME PRESSURE.**
	**26. SLIDE 26 EXPLAIN Figure 16-23** A Hydro-Boost hydraulic booster as the brakes are applied. **27. SLIDE 27 EXPLAIN Figure 16-24** A Hydro-Boost hydraulic booster in the holding position.

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	**DISCUSSION:** ASK STUDENTS TO TALK ABOUT THE POSSIBLE CAUSES OF SLOW BRAKE-PEDAL RETURN, GRABBY BRAKES, & BOOSTER CHATTER IN A HYDRO-BOOST SYSTEM.
	28. **SLIDE 28 EXPLAIN Figure 16-25** A typical Hydro-Boost hydraulic line arrangement showing the pump, steering gear, and brake booster assembly. 29. **SLIDE 29 EXPLAIN Figure 16-26** Pressure and flow analyzer installation to check the power steering pump output. 30. **SLIDE 30 EXPLAIN Figure 16-27** The 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 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
	**DEMONSTRATION:** SHOW STUDENTS HOW TO DO A HYDRO-BOOST FUNCTION TEST. SELECT A STUDENT TO EXPLAIN THE RESULTS
	**ON-VEHICLE NATEF 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.