Automotive Technology 6th Edition
Chapter 100 Brake Fluid & Lines
Opening Your Class

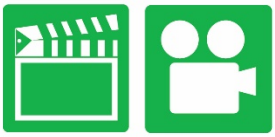
KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features 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 purpose, function, and specifications of brake fluids. 2. Describe brake service procedures and precautions. 3. Discuss the types of rubber that are used in brake system components. 4. Discuss the use of brake lines. 5. 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

DOWNLOAD Chapter 100 Chapter Images: From

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

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

ICONS	Chapter 100 Brake Fluid & Lines
	1. **SLIDE 1 CH100 Brake Fluid & Lines** 2. **SLIDE 2 EXPLAIN Figure 100-1** Brake fluid can absorb moisture from the air even through plastic, so many experts recommend that brake fluid be purchased in metal containers, if possible. 3. **SLIDE 3 EXPLAIN Figure 100-2** Brake fluid absorbs moisture from the air at the rate of about 2% per year. As the brake fluid absorbs water, its boiling temperature decreases.
	**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**
	**DISCUSS CHART 100-1 Chart showing the type of brake fluid and the wet and dry boiling temperatures for each rating.**
	**DISCUSS FREQUENTLY ASKED QUESTION: *What Is "Synthetic" Brake Fluid?* All glycol brake fluids are synthetic and are not petroleum based. Brake fluid OEMS get calls every week from people who have questions about brake fluid. EG, some are concerned because old familiar brands have changed from "premium" to "synthetic" on bottle. DOT class system sets standards and testing procedures only; ingredients used are up to OEM. If it meets standards, it will qualify as "brake fluid." Based on combination of properties determined by testing, glycol-based brake fluids labeled DOT 3, 4, or 5.1 are ALL synthetic.**

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	**DISCUSSION:** **Ask students to talk about types of brake fluids and their chemical characteristics. What must all brake fluids have in common? Ask students to discuss brake fluid specifications. What do SAE DOT specification standards signify? (Have students refer to Federal Motor Vehicle Standard 116 covering all fluids for use in hydraulic brake systems of motor vehicles, brake fluid containers, and brake fluid labeling issue**
	4. **SLIDE 4 EXPLAIN FIGURE 100–3** This Ford Escape requires DOT 4 as stated on the cap of the master cylinder.
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***What Are Types of DOT 4 European Brake Fluid?*** **There are several specifications under DOT 4 designation including following:** • **DOT 4—Specified for use in many European vehicles and some domestic vehicles. • SEE FIGURE 100–3.** • **DOT 4 (long life)** • **DOT 4+—Specified for use in many Mercedes and Volvo vehicles.** • **DOT 4 LV (low viscosity)—Specified for use in some BMW vehicles.** • **DOT 4 racing brake fluid—Usually blue in color to make it easy to see when all of the old fluid has been purged from system during a brake fluid replacement procedure.**
	5. **SLIDE 5 EXPLAIN FIGURE 100–4** DOT 5 brake fluid is used mostly in motorcycles because if spilled, it will not hurt painted surfaces.
	**DISCUSSION:** **discuss uses of DOT 3 brake fluid. Why is it the most commonly used brake fluid? Why is it important to keep DOT 3 brake fluid in a sealed container? Talk about performance characteristics and uses of DOT 4 brake fluid? What differentiates**

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	it from DOT 3 brake fluid, and why does it cost more? Why is it important to change brake fluid on a vehicle equipped with ABS every 30,000 miles (48,000 km)? Discuss performance characteristics and uses of DOT 5.1 brake fluid. What types of vehicles might use DOT 5.1 fluid? **DISCUSSION:** Ask students to talk about why they should *never* use mineral oil in a brake system designed for DOT brake fluids. Ask students to discuss the performance characteristics and uses of DOT 5 brake fluid. What are advantages of silicone-based brake fluids? What are disadvantages
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***What Is Hydraulic Brake System Mineral Oil?*** Some French-built Citroen and British-designed Rolls-Royce vehicles use hydraulic system mineral oil (HSMO) as part of their hydraulic control systems. The systems in these vehicles use a hydraulic pump to pressurize hydraulic oil for use in the suspension leveling and braking systems. CAUTION: Mineral hydraulic oil should never be used in a braking system that requires DOT 3 or DOT 4 polyglycolbased brake fluid. If any mineral oil, such as engine oil, transmission oil, or automatic transmission fluid (ATF), gets into a braking system that requires glycol brake fluid, every rubber part in the entire braking system must be replaced. Mineral oil causes the rubber compounds that are used in glycol brake fluid systems to swell. • **SEE FIGURE 100–5.** To help prevent hydraulic system mineral oil from being mixed with glycol brake fluid, hydraulic mineral oils are green.
	6. **SLIDE 6 EXPLAIN FIGURE 100–5** Both rubber sealing cups were exactly the same size. The cup on the left was exposed to mineral oil. Notice how seal greatly expanded.

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	7. **SLIDE 7 EXPLAIN FIGURE 100–6** If brake fluid is black in color, it should be replaced. 8. **SLIDE 8 EXPLAIN FIGURE 100-7** brake fluid test strip is being used to test the condition of the brake fluid. (b) The color of the test strip is then compared with a chart on the package 9. **SLIDE 9 EXPLAIN FIGURE 100–8** An electronic tester that measures the boiling temperature of brake fluid is useful to help determine if brake fluid needs to be replaced.
	**DEMONSTRATION: Show students how to use a brake fluid test strip. Show students how to use a brake fluid tester and discuss the results.**
	**ON-VEHICLE ASEEDUCATION TASK: Brake fluid usage and test for contamination.**
	
	**DISCUSSION: Ask students to discuss brake fluid servicing procedures. What precautions should they take to prevent contamination of brake fluid?**
	**If possible, store brake fluid in a moisture-free area, such as an old refrigerator.**
	**DISCUSS CASE STUDY: *Sinking Brake Pedal*** **This author has experienced what happens when brake fluid is not changed regularly. Just as many technicians will tell you, we do not always do what we know should be done to our own vehicles. While driving a four-year-old vehicle on vacation in very hot weather in a mountainous country, brake pedal sank to the floor. When vehicle was cold, the brakes were fine. But after several brake applications, pedal became soft and spongy and sank slowly to floor if pressure was maintained on brake pedal. Because the brakes were okay when**

cold, I knew it had to be boiling brake fluid. Old brake fluid (four years old) often has a boiling point under 300°F (150°C). With air temperature near 100°F (38°C), it does not take much more heat to start boiling the brake fluid. After bleeding over a quart (1 liter) of new brake fluid through system, brakes worked normally. I'll never again forget to replace brake fluid as recommended by OEM.

Summary:

- Complaint—Brake pedal would sink to the floor when driving in mountainous country.
- Cause—brake fluid was boiling causing the loss of brakes.
- Correction—brake fluid was replaced and the system bled.

DISCUSS CASE STUDY: ***Pike's Peak Brake Inspection*** All vehicles must stop about halfway down Pike's Peak Mountain in Colorado (14,110 ft [4,300 m]) for a "brake inspection." When this author stopped at the inspection station, a uniformed inspector simply looked at right front wheel and waved us on. I pulled over and asked inspector what he was checking. He said that when linings and drums/rotors get hot, the vehicle loses brake effectiveness. But if the brake fluid boils, the vehicle loses its brakes entirely. The inspector was listening for boiling brake fluid at front wheel and feeling for heat about 1 ft (30 cm) from wheel. The inspector used an infrared pyrometer to measure front wheel brakes and if brakes were too hot to continue, you would be instructed to pull over and wait for the brakes to cool. The inspector recommended placing the transmission into a

lower gear, which uses engine to slow vehicle during the descent without having to rely entirely on brakes.

Summary

- **Complaint—Vehicle was stopped for an inspection.**
- **Cause—brakes are too hot, the brake fluid can boil and as a result a total loss of brakes is likely.**
- **Correction—Informed driver that this is normal procedure and a safety precaution.**

DISCUSS CHART 100-2 Notice that if a rubber is OK to use for brake fluid, it is not OK to use for oil or grease.

10. **SLIDE 10 EXPLAIN FIGURE 100–9** master cylinder piston seals are usually constructed from EPDM rubber, and the diaphragm of the vacuum power brake booster is usually made from SBR.

11. **SLIDE 11 EXPLAIN Figure 100-10** Cross-sectional view of a typical drum brake wheel cylinder. Most wheel cylinder boots and cups are either SBR or EPDM rubber.
12. **SLIDE 12 EXPLAIN Figure 100-11** Exploded view of a typical disc brake caliper. Both the caliper seal and dust boot are constructed of EPDM rubber.
13. **SLIDE 13 EXPLAIN Figure 100-12** Steel brake tubing is double-walled for strength & plated for corrosion

WARNING: Copper tubing should never be used for brake lines. Copper tends to burst at a lower pressure than steel.

DEMONSTRATION: Show students the EPDM rubber parts found in master cylinder, drum brake wheel cylinder, and disc brake caliper and discuss the effect of brake fluid on these components.

DISCUSSION: Ask students to talk about the rubber components found in braking systems, including the master cylinder and disc and drum

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	**brake assemblies. How might these be affected by prolonged exposure to brake fluid?** **DISCUSS FREQUENTLY ASKED QUESTION:** ***Why Is The Government Asking Me To Wash My Vehicle?*** **If you live where salt is used to clear the roads of snow and ice, U.S. safety regulators have a message for you: "Wash underside of your vehicle." The message came from NTHSA, which closed a five-year investigation into rusting brake fluid lines which agency said was caused by road salt and a lack of washing. The agency urged people in 20 cold weather states and Washington, D.C., to get their car and truck undercarriages washed several times during and after winter, and to get their brake lines inspected for rust and replace them if necessary. • SEE FIGURE 100–13.**
	**14. SLIDE 14 EXPLAIN Figure 100-13** rust prone states are areas where snow and the use of salt contribute to the brake line rust. Vehicles that operate outside this area also rust, but not to the extent that they do in the states known for rust problems. **15. SLIDE 15 EXPLAIN FIGURE 100–14** Because of slight difference in flare angle, double-flare fitting seals cause a wedging action. **16. SLIDE 16 EXPLAIN FIGURE 100–15** An ISO fitting, also called a ball or bubble flare.
	**WARNING: According to OEM recommended procedures, compression fittings should never be used to join two pieces of steel brake line. Only use double flare ends and connections, if necessary, when replacing damaged steel brake lines.**
	**17. SLIDE 17 EXPLAIN FIGURE 100–16** Double flaring the end of a brake line. (a) Clamp the line at the correct height above the surface of the clamping tool using the shoulder of the insert as a gauge. (b) The insert is pressed into the end of the tubing. This creates the first bend. (c)

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	Remove insert and use pointed tool to complete the overlap double flare. (d) The completed operation as it appears while still in clamp. 18. **SLIDE 18 EXPLAIN FIGURE 100–17** Making an ISO flare requires a special tool. (a) Select proper size forming mandrel. (b)Clamp tubing flush with split die and place mandrel into tool. (c) Thread tool handle in until mandrel pilot seats into tubing. (d) Close tool valve and pump handle until Mandrel seats in die. (e) The strong hydraulic pressure forms ISO flare.. 19. **SLIDE 19 EXPLAIN FIGURE 100–18** coils in the brake line help prevent cracks caused by vibration. 20. **SLIDE 20 EXPLAIN FIGURE 100–19** Armored brake line is usually used in location where line may be exposed to rock or road debris damage. Even armored brake line can leak and a visual inspection is an important part of any brake service..
	**DEMONSTRATION: Show double-walled steel brake lines connecting the master cylinder to each brake, and discuss how their construction is designed to carry brake fluid**
 	**DEMONSTRATION: Show double-flare & ISO brake line ends, and talk about their purpose & function. Ask students to talk about why replacement brake lines must be same diameter as originals. Show students how to flare end of brake line by using a double-lap flare fitting**
	**After cutting or flaring brake lines, use dry shop air to blow out contaminates.**
	**HANDS-ON TASK: Have students double-lap flare a brake line. Use a small diameter line first than a larger diameter so they can see the difference**
	**EXPLAIN TECH TIP: *BEND IT RIGHT THE FIRST TIME* Replacing rusted or damaged brake line can be a difficult job. It is important that replacement brake line be located in same location as original to prevent possible damage from road debris or heat from exhaust. Often this means bending brake line with many angles and turns. To make job a lot easier, perform following steps:**

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	STEP 1 Use a stiff length of wire and bend wire into exact shape necessary. **STEP 2 Then use wire as pattern to bend brake line.** **STEP 3 Always use tubing bender to avoid kinking The Brake line. Kink not only restricts flow of brake fluid, but also weakens line. • SEE FIGURE 100–20.** **NOTE: Always use a tubing cutter instead of a hacksaw when cutting brake line. A hacksaw will leave a rough and uneven end that will not flare properly except when forming ISO flare. A hacksaw is used to provide a rough surface to allow the flaring tool to grip line during the procedure. Always check instructions for exact procedure to follow. • SEE FIGURE 100–21.**
	21. **SLIDE 21 EXPLAIN FIGURE 100–20** tube bender being used to bend a brake line 22. **SLIDE 22 EXPLAIN FIGURE 100–21** A tubing cutter is the preferred tool to use to cut brake line because it leaves a clean edge
	**DEMONSTRATION: Show students how to flare the end of a brake line by using an ISO fitting**
	**Show ANIMATION:** **SAE and ISO Flares (View) (Download)**
	**HANDS-ON TASK: Have students ISO flare a brake line. Use a small diameter line first than a larger diameter so they can see the difference.**
	23. **SLIDE 23 EXPLAIN FIGURE 100–22** Flexible brake hoses are used between the frame or body of vehicle and the wheel brakes. Because of suspension and/or steering movement, these flexible brake lines must be strong enough to handle high brake fluid pressures, yet remain flexible.. 24. **SLIDE 24 EXPLAIN FIGURE 100–23** (a) Typical flexible brake hose showing multiple layers of rubber and fabric. (b) The inside diameter (ID) is printed on hose (3 mm).

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	25. **SLIDE 25 EXPLAIN FIGURE 100–24** Typical flexible brake hose faults. Many faults cannot be seen, yet can cause brakes to remain applied after pedal is released. 26. **SLIDE 26 EXPLAIN FIGURE 100–25** Flexible brake hose should be carefully inspected for cuts or other damage, especially near sections where brake hose is attached to the vehicle. Notice the crack and cut hose next to the mounting bracket. 27. **SLIDE 27 EXPLAIN FIGURE 100–26** Whenever disconnecting or tightening a brake line, always use the correct size flare-nut wrench. A flare-nut wrench is also called a tube-nut wrench or a line wrench.
 	**ON-VEHICLE ASEEDUCATION TASK B6:** **Inspect brake lines, flexible hoses, and fittings for leaks, dents, kinks, rust, cracks, bulging, wear; and loose fittings/supports; determine needed action.**
 	**ON-VEHICLE ASEEDUCATION TASK B7:** **Replace brake lines, hoses, fittings, and supports**
 	**ON-VEHICLE ASEEDUCATION TASK B8:** **Fabricate brake lines using proper material and flaring procedures (double flare and ISO types).**
 	**ON-VEHICLE ASEEDUCATION TASK B9:** **Select, handle, store, and fill brake fluids to proper level; use proper fluid type per manufacturer specification**
 	**ON-VEHICLE ASEEDUCATION TASK B13.** **Test brake fluid for contamination.**