ATE5 Chapter 118 Power-Assisted Steering Operation & Service

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class provides complete coverage of the components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Real World Fixes, Videos, Animations, and NATEF Task Sheet references.
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. Describe how power steering hydraulic systems work. 2. Discuss the components and operation of power steering pumps and reservoirs. 3. Explain the purpose and function of integral power steering. 4. Discuss the purpose and function of variable-effort steering systems. 5. Discuss the purpose and function of electric power steering systems. 6. Discuss power steering diagnosis and service procedures.
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 the 5th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 118: ATE5 Chapter Images

ICONS	Chapter 118 Power Steering
     	**1. SLIDE 1 CH118 POWER-ASSISTED STEERING OP & SERVICE** **Check for ADDITIONAL VIDEOS & ANIMATIONS @** **http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **Videos** **2. SLIDE 2 EXPLAIN Figure 118-1** Hydraulic fluid transmits the same force whether it passes through a single chamber or two chambers connected by a narrow passage. **3. SLIDE 3 EXPLAIN Figure 118-2** A fluid applies a force equal to the applied force on a surface that is equal in size to the applying surface. If the surface is half the size, then the fluid exerts half the force: if the surface is twice as large, the fluid exerts twice the force. **DISCUSSION: Discuss the difference between pressure and force FIGURE 118-1** **4. SLIDE 4 EXPLAIN Figure 118-3** A typical integral power steering pump when the pump is mounted inside the reservoir. **5. SLIDE 5 EXPLAIN Figure 118-4** remote reservoir. **6. SLIDE 6 EXPLAIN Figure 118-5** power steering pump assemblies. **7. SLIDE 7 EXPLAIN Figure 118-6** GM vane-type pump. **8. SLIDE 8 EXPLAIN Figure 118-7** Vane pump operation. In phase 1, the rotor moves past the opposed suction ports, and the vanes move out to maintain contact with the ring. This creates a low-pressure area, drawing fluid into the cavities formed by the vanes. As the rotor continues to move during phase 2, the vanes follow the contour of the ring. The contour of the ring forms a larger cavity between the vanes. This increases the suction and draws more fluid into the pump.

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	**DEMONSTRATION: Show components of a typical integral power steering pump and remote reservoirs FIGURE 118-5**
	**DEMONSTRATION: Show internal parts of a vane pump. FIGURE 118-8, 9**
	9. **SLIDE 9 EXPLAIN Figure 118-8** Vane pump operation—continued. At phase 3, the vanes are at the end of the intake port of the pump and the cavity has reached its maximum volume. In phase 4, the rotor moves into alignment with the opposed discharge ports. 10. **SLIDE 10 EXPLAIN Figure 118-9** Vane pump operation—continued. As the rotor continues to move during phase 5, the volume of the cavity decreases, which increases the discharge pressure. At phase 6, the last phase, the contour of the ring results in the minimum cavity volume, and the discharge of fluid is completed. 11. **SLIDE 11 EXPLAIN Figure 118-10** Flow control valve. 12. **SLIDE 12 EXPLAIN Figure 118-11** The pressure-relief check ball unseats, allowing fluid to flow back into the pump inlet if the pressure rises above a certain limit.
	**DEMONSTRATION: Show examples of flow control valves. Show components of a typical pressure-relief valve. Show examples of power steering pressure and return hoses. FIGURE 118-10**
	13. **SLIDE 13 EXPLAIN Figure 118-12** The power steering fluid cooler, if used, is located in the return hose. Often the "cooler" is simply a length of return metal line that is arranged in a loop and routed near the front of the vehicle. The airflow past the return line helps reduce the temperature of the fluid.
 	**DISCUSSION: Ask the students to discuss why not all power steering units have a power steering fluid cooler FIGURE 118-12**
	**Power Steering Gear (View) (Download)** **Power Steering Hydraulics (View) (Download)**

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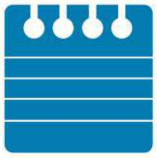
	**14. SLIDE 14 EXPLAIN Figure 118-13** Forces acting on the rack piston of an integral power steering gear. **15. SLIDE 15 EXPLAIN Figure 118-14** The rotary valve consists of inner and outer elements. The worm gear is part of the outer element and the torsion bar is part of the inner element. A pin attaches the worm gear to the bottom of the torsion bar to join the two elements together. **16. SLIDE 16 EXPLAIN Figure 118-15** When the steering wheel is in the straight-ahead position, all of the ports in a rotary valve are open equally to the pressure and return circuits.
 	**DEMONSTRATION: Show examples of rotary control valves and discuss their inner and outer elements FIGURE 118-15, 16**
	**Be careful when working on power steering systems. These systems can reach peak pressures of over 1,000 PSI.**
	**17. SLIDE 17 EXPLAIN Figure 118-16** During a left turn, the inner element turns so that the left-turn circuits are open to pressure and the right-turn circuits are open to the return circuit. **18. SLIDE 18 EXPLAIN Figure 118-17** During a left turn, the high-pressure fluid helps push the piston along the worm gear, thereby reducing the steering effort from the driver. **19. SLIDE 19 EXPLAIN Figure 118-18** During a right turn, the inner element turns so that the right-turn outlets are open to pressure and the left-turn outlets are open to the return circuit. **20. SLIDE 20 EXPLAIN Figure 118-19** During a right turn, high-pressure fluid pushes the piston up the worm gear, moving the sector shaft and pitman arm to provide assist during a right turn.
 	**DEMONSTRATION: Show examples of seals, O-rings, and fluid lines in a rack-and-pinion steering unit**
	**21. SLIDE 21 EXPLAIN Figure 118-20** During a left turn, the control valve directs pressure into the left-turn fluid line and the rack moves left. (See inset.) Fluid

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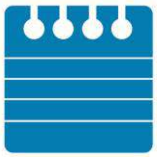
	pushed out of the right-turn fluid chamber travels back through the right-turn fluid line and control valve to the return circuit..
	**DEMONSTRATION: Show the students examples of control valves and check valves.** **FIGURE 118-20**
	**DISCUSSION: Ask the students to discuss how to determine whether the check valve is not operating properly.**
	**Fluid in bellows covering the inner tie rod indicates a bad seal in rack:**
	**HANDS-ON TASK: Have the students label fluid lines on a power steering rack. Have the students use sticky notes or masking tape.** **FIGURE 118-21**
	22. **SLIDE 22 EXPLAIN Figure 118-21** The control valve routes high-pressure fluid to the left-hand side of the power piston, which pushes the piston and assists in moving the rack toward the right when the steering wheel is turned right. 23. **SLIDE 23 EXPLAIN Figure 118-22** Low-speed flow control. 24. **SLIDE 24 EXPLAIN Figure 118-23** High-speed flow control operation. 25. **SLIDE 25 EXPLAIN Figure 118-24** Pressure-relief mode. In this mode the steering gear has blocked the flow of fluid from the pump and the pressure rises, which unseats the pressure-relief valve. Now fluid flows back to the inlet through the pressure-relief orifice and passage
	**DEMONSTRATION: Show an Electronic Variable Orifice (EVO) actuator assembly. FIGURE 118-25**
	**DISCUSSION: Ask students to discuss whether an Electronic Variable Orifice (EVO) system or Two-Flow Electronic (TFE) system is better**

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	**26. SLIDE 26 EXPLAIN Figure 118-25** EVO actuator assembly. **27. SLIDE 27 EXPLAIN Figure 118-26** Integrated with the pinion shaft is a spool valve that senses the level of torque in the shaft and applies hydraulic pressure to the steering rack whenever assistance is needed. The electromagnet acts in parallel with the input shaft from the steering wheel to open or close the spool valve. The electromagnet generates variable torque, which can either increase or decrease the amount of steering torque that is needed to open the spool valve. **28. SLIDE 28 EXPLAIN Figure 118-27** Magnasteer system.
	**DISCUSSION: Ask the students to discuss what could happen if the electromagnetic coil in a Magnasteer system goes bad FIGURE 118-26**
	**DEMONSTRATION: Show the students how to use the ON-LINE service manual (or database) component locator**
	**HANDS-ON TASK: Have the students use ON-LINE service manual (or database) component locator to find the EVO actuator assembly**
	**DEMONSTRATION: Show examples of electric power steering (EPS) assemblies FIGURE 118-28**
	**Become familiar with servicing procedures for electric power steering units. Many vehicles now include them, & more vehicles will be including them in near future.**
	**29. SLIDE 29 EXPLAIN Figure 118-28** Toyota Prius EPS **30. SLIDE 30 EXPLAIN Figure 118-29** torque sensor converts the torque the driver is applying to the steering wheel into a voltage signal. **31. SLIDE 31 EXPLAIN Figure 118-30** The electric power steering in Toyota/Lexus SUVs uses a brushless DC motor around the rack of the unit and operates on 42 volts. **32. SLIDE 32 EXPLAIN Figure 118-31** Photo of the electric power steering gear on a Lexus RX 400h taken from underneath the vehicle.

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	33. **SLIDE 33 EXPLAIN Figure 118-32** A cross-sectional view of a Honda electric power steering (EPS) gear. 34. **SLIDE 34 EXPLAIN Figure 118-33** Honda electric power steering unit cutaway. 35. **SLIDE 35 EXPLAIN Figure 118-34** The Power Steering Control Module (PSCM) is attached to the motor of the electric power steering assembly. 36. **SLIDE 36 EXPLAIN Figure 118-35** Schematic showing the electric power steering and the torque/position sensor. 37. **SLIDE 37 EXPLAIN Figure 118-36** electrohydraulic power steering assembly on Chevrolet hybrid P/U
	**DEMONSTRATION: Show the students an example of a scan tool and explain how it works to diagnose electric power steering**
	**DEMONSTRATION: Show various used belts and describe the different types of wear. Show the students how to use a belt tension gauge. Show OEM recommendations on how to properly set the tension on the accessory drive belt of a power steering unit**
	**HANDS-ON TASK: Have the students inspect a vehicle's accessory drive belt for wear**
	38. **SLIDE 38 EXPLAIN Figure 118-37** A typical service manual illustration showing the method to use to properly tension the accessory drive belt.
	**HANDS-ON TASK: Have the students adjust the tension of accessory drive belt to factory specifications by using a belt tension gauge** **FIGURE 118-37**
	**DEMONSTRATION: Show the students power steering fluid, both new and used. Students should know look and smell. FIGURE 118-38**
	**ON-VEHICLE NATEF TASK: Determine proper fluid and flush power steering system. Page 360** **FIGURE 118-38**

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	**40. SLIDE 40 EXPLAIN Figure 118-39** Some power steering fluid is unique to the climate, such as this **cold climate fluid** recommended for use in General Motors vehicles when temperatures are low. **41. SLIDE 41 EXPLAIN Figure 118-40** Inspect both high-pressure and return power steering hoses. Make sure the hoses are routed correctly and not touching sections of the body to prevent power steering noise from being transferred to the passenger compartment. **42. SLIDE 42 EXPLAIN Figure 118-41** drawing showing how to connect a power steering pressure gauge to the system.
	**DEMONSTRATION: Show examples of power steering analyzers**
	**DEMONSTRATION: Show the students how to connect a power steering analyzer to a power steering system FIGURE 118-41**
	**HANDS-ON TASK: Have students connect a power steering analyzer to a power steering system**
	**43. SLIDE 43 EXPLAIN Figure 118-42** A power steering analyzer that measures both pressure and volume. The shut-off valve is used to test the maximum pressure of the pump. **44. SLIDE 44 EXPLAIN Figure 118-43** Typical power steering pump showing the order of assembly. The high-pressure (outlet) hose attaches to the fitting (#16). The flow control valve can be removed from the pump by removing the fitting. **45. SLIDE 45 EXPLAIN Figure 118-44** Typical tools required to remove and install a drive pulley on a power steering pump. Often these tools can be purchased at a relatively low cost from automotive parts stores and will work on many different makes of vehicles. NOTE: Most replacement pumps are not equipped with a pulley. The old pulley must be removed and installed on the new pump. The old pulley should be carefully inspected for dents, cracks, or warpage. If the pulley is damaged, it must be replaced.

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	**DEMONSTRATION: Show the students how to remove and replace a power steering pump pulley.**
	**HANDS-ON TASK: Have the students remove and replace a power steering pump pulley** **FIGURE 118-44**
	46. **SLIDE 46 EXPLAIN Figure 118-45** typical submerged-type power steering pump. The pump is housed inside the fluid reservoir 47. **SLIDE 47 EXPLAIN Figure 118-46** punch is used to dislodge the retaining ring. 48. **SLIDE 48 EXPLAIN Figure 118-47** driveshaft attaches to drive pulley at one end and is splined to the pump rotor at the other end. Vanes are placed in slots of rotor. 49. **SLIDE 49 EXPLAIN Figure 118-48** pump ring must be installed correctly. If it is installed upside down, the internal passages will not line up and the pump will have no output. 50. **SLIDE 50 EXPLAIN Figure 118-49** shaft seal must be chiseled out. A thin metal shim stock should be used to protect the shaft from damage. Some technicians drill a small hole in the seal, then thread in a self-tapping sheet metal screw. Then pliers are used to pull out the old seal.
	51. **SLIDES 51-68 OPTIONAL EXPLAIN POWER STEERING RACK REMOVAL AND INSTALLATION**
	**ON-VEHICLE NATEF TASK: Remove, inspect, replace, and adjust power steering pump belt and pump; press fit pump pulley. Page 362**
	**ON-VEHICLE NATEF TASK: Inspect and replace power steering hoses and fittings. Page 363**
	**ON-VEHICLE NATEF TASK: Diagnose, test and diagnose components of electronically controlled steering systems using a scan tool. Page 364**
	**ON-VEHICLE NATEF TASK: Inspect and test electric power assist steering. Page 365**

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	**SEARCH INTERNET:** search Internet to research tilt mechanisms and telescoping steering columns. Divide the students into two debate groups. Have the first group defend the tilt-mechanism steering column as the best choice, based on its features. Have the second group defend the telescoping steering column is best choice, based on features.
	**Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**