

Automotive Technology 6th Edition

Chapter 122 Power-Assisted Steering Operation & 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.	<p>Explain learning objectives to students as listed below:</p> <ol style="list-style-type: none"> 1. Describe the operation of hydraulic power steering hydraulic systems. 2. Discuss the components and operation of power steering pumps. 3. Explain the purpose and function of integral power steering. 4. Discuss the purpose and function of variable effort steering systems. 5. Discuss power steering diagnosis and troubleshooting. 6. Describe service of power steering components and fluid. 7. This chapter will help prepare for Suspension and Steering (A4) ASE certification test content area "A" (Steering 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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NOTE: You can use Chapter Images or possibly Power Point files:

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1. SLIDE 1 CH122 POWER-ASSISTED STEERING OP & SERVICE

Check for **ADDITIONAL VIDEOS & ANIMATIONS**
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2. **SLIDE 2 EXPLAIN Figure 122-1** 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 122-2** 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 122-2

4. **SLIDE 4 EXPLAIN Figure 122-3** A typical integral power steering pump when the pump is mounted inside the reservoir.
5. **SLIDE 5 EXPLAIN Figure 122-4** Typical remote reservoir.
6. **SLIDE 6 EXPLAIN FIGURE 122-5** Typical power steering pump assemblies.
7. **SLIDE 7 EXPLAIN Figure 122-6** GM vane-type pump.
8. **SLIDE 8 EXPLAIN Figure 122-7** 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

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cavity between the vanes. This increases the suction and draws more fluid into the pump.

DEMONSTRATION: Show components of a typical integral power steering pump and remote reservoirs FIGURE 122-5

DEMONSTRATION: Show internal parts of a vane pump. FIGURE 122-8, 9

9. **SLIDE 9 EXPLAIN Figure 122-8** 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 122-9** 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 122-10** Flow control valve.
12. **SLIDE 12 EXPLAIN Figure 122-11** pressure-relief check ball unseats, allowing fluid to flow back into the pump inlet if the pressure rises above a certain limit.

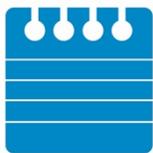
DEMONSTRATION: Show examples of flow control valves. Show components of a typical pressure-relief valve. Show examples of power steering pressure and return hoses. FIGURE 118-10

FIGURE 118-10

DISCUSS FREQUENTLY ASKED QUESTION:

What Is the Purpose of the PSP Switch in the High-Pressure Line? Under certain conditions, such as when the steering wheel is turned to or near full stop for more than a few seconds, pressure builds in the system and the pump must work harder to keep up with the demand. As a result, pump draws more power from the engine. If engine is running at idle, extra load can cause it to stall. A pressure switch, known

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as the power steering pressure (PSP) switch, transmits an electronic signal to PCM when the pressure in system is high enough to increase the load on engine. In response to PSP switch signal, PCM increases the engine idle speed to prevent stalling.

13. **SLIDE 13 EXPLAIN** Figure 122-12 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 122-12**

[Power Steering Gear \(View\) \(Download\)](#)

[Power Steering Hydraulics \(View\) \(Download\)](#)

14. **SLIDE 14 EXPLAIN** Figure 122-13 Forces acting on the rack piston of an integral power steering gear.
15. **SLIDE 15 EXPLAIN** Figure 122-14 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 122-15 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 122-15, 16**

Be careful when working on power steering systems. These systems can reach peak pressures of over 1,000 PSI.

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17. **SLIDE 17 EXPLAIN Figure 122-16** 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 122-17** 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 122-18** 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 122-19** 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 122-20** During a left turn, the control valve directs pressure into the left-turn fluid line and the rack moves left. (See inset.) Fluid 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 122-20

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 122-21

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QUESTION



QUESTION



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22. **SLIDE 22 EXPLAIN Figure 122-21** 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 122-22** Low-speed flow control.
24. **SLIDE 24 EXPLAIN Figure 122-23** High-speed flow control operation.
25. **SLIDE 25 EXPLAIN Figure 122-24** 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 122-25

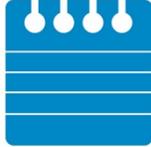
DISCUSSION: Ask students to discuss whether an Electronic Variable Orifice (EVO) system or Two-Flow Electronic (TFE) system is better

26. **SLIDE 26 EXPLAIN Figure 122-25** EVO actuator assembly.
27. **SLIDE 27 EXPLAIN Figure 122-26** 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 122-27** Magnasteer system.

DISCUSSION: Ask the students to discuss what could happen if the electromagnetic coil in a Magnasteer system goes bad FIGURE 122-26

DEMONSTRATION: Show the students how to use the ON-LINE service manual (or database) component locator

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HANDS-ON TASK: Have the students use **ON-LINE** service manual (or database) component locator to find the EVO actuator assembly

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 122–28 A typical service manual illustration showing method to use to properly tension the accessory drive belt.

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

EXPLAIN TECH TIP: Visual Test. Whenever diagnosing any power steering complaint, check level and condition of power steering fluid. Often this is best accomplished by putting your finger down into power steering fluid reservoir and pulling it out to observe texture and color of fluid. • **SEE FIGURE 122–29.** A common problem with some power rack-and pinion units is wearing of grooves in housing by Teflon sealing rings of spool (control) valve. When this wear occurs, aluminum particles become suspended in power steering fluid, giving it a grayish color and thickening fluid. Normally, clear power steering fluid that is found to be grayish in color and steering that is difficult when cold are clear indications as to what has occurred and why the steering is not functioning correctly.

30. SLIDE 30 **EXPLAIN** Figure 122-29 check of the power steering fluid should include inspecting not only the level but the condition and color of the fluid, which

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could indicate a possible problem with other components in the steering system.

HANDS-ON TASK: Have students adjust tension of accessory drive belt to factory specifications by using a belt tension gauge

DEMONSTRATION: Show the students power steering fluid, both new and used. Students should know look and smell

ON-VEHICLE ASE EDUCATION TASK B11: Inspect for power steering fluid leakage; determine needed action..

EXPLAIN TECH TIP: Multiple-Purpose Power Steering Fluid. Multiple-purpose power steering fluid does not mean all-purpose power steering fluid. Always check power steering reservoir cap, service information, or owner's manual for exact fluid to be used in vehicle being serviced. The main reason for using specified power steering fluid is compatibility of fluid with materials used in seals and hoses of system. Using wrong fluid (substituting ATF, for example) can lead to seal or hose deterioration and/or failure and fluid leaks. Always use power steering fluid recommended by OEM. The correct fluid to use is often imprinted on or near the power steering reservoir fill cap or is found in owner's manual or service information. • **SEE FIGURE 122-30.**

31. **SLIDE 31 EXPLAIN Figure 122-30** 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.
32. **SLIDE 32 EXPLAIN Figure 122-31** 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.

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33. SLIDE 33 **EXPLAIN** Figure 122-32 drawing showing how to connect a power steering pressure gauge to the system.

DISCUSS CASE STUDY: *Noisy Power Steering Pump.* A customer complained that power steering on their Dodge Grand Caravan minivan had a very loud whining/growling/squealing noise for about 3-10 seconds on cold mornings at start-up. The owner had received a quote for several hundred dollars to replace power steering pump, but then asked another shop for a second opinion. The second shop had experience with this issue and recommended replacing power steering filter located in bottom of power steering pump reservoir. The owner agreed to have filter and fluid replaced for an amount far less than previous quote. After replacing filter and flushing the power steering fluid, power steering was quiet and operated like new.

Summary:

- **Complaint**—Power steering was noisy especially when cold.
- **Cause**—screen in the bottom of reservoir plugs up and starves pump of oil causing the noise.
- **Correction**—filter was replaced and the fluid flushed.

DEMONSTRATION: Show examples of power steering analyzers

DEMONSTRATION: Show the students how to connect a power steering analyzer to a power steering system **FIGURE 122-31-33**

HANDS-ON TASK: Have students connect a power steering analyzer to a power steering system

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34. **SLIDE 34 EXPLAIN Figure 122-33** power steering analyzer that measures both pressure and volume. The shut-off valve is used to test maximum pressure of pump.
35. **SLIDE 35 EXPLAIN Figure 122-34** 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.
36. **SLIDE 36 EXPLAIN Figure 122-35** 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.

DEMONSTRATION: Show 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 122-35

EXPLAIN TECH TIP: Pocket the Ignition Key to Be Safe. When replacing any steering gear such as a rack-and pinion steering unit, be sure that no one accidentally turns steering wheel! If steering wheel is turned without being connected to steering gear, airbag wire coil (clock spring) can become off center. This can cause wiring to break when steering wheel is rotated after steering gear has been replaced. To help prevent this from occurring, simply remove the ignition key from ignition (make sure the steering wheel is locked) and put it in your pocket while servicing the steering gear.

37. **SLIDE 37 EXPLAIN Figure 122-36** typical submerged-type power steering pump. The pump is housed inside the fluid reservoir
38. **SLIDE 38 EXPLAIN Figure 122-37** punch is used to dislodge the retaining ring.

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39. **SLIDE 39 EXPLAIN** Figure 122-38 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.
40. **SLIDE 40 EXPLAIN** Figure 122-39 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.
41. **SLIDE 41 EXPLAIN** Figure 122-40 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.

41. SLIDES 41-58 OPTIONAL EXPLAIN POWER STEERING RACK REMOVAL AND INSTALLATION

ON-VEHICLE ASE EDUCATION TASK B4:

Diagnose power steering gear (non-rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine needed action.

ON-VEHICLE ASE EDUCATION TASK B5:

Diagnose power steering gear (rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine needed action.

ON-VEHICLE ASE EDUCATION TASK B7:

Remove and replace rack and pinion steering gear; inspect mounting bushings and brackets

ON-VEHICLE ASE EDUCATION TASK B12:

Remove, inspect, replace, and/or adjust power steering pump drive belt

ON-VEHICLE ASE EDUCATION TASK B13:

Remove and reinstall power steering pump.



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ON-VEHICLE ASE EDUCATION TASK B14:

Remove and reinstall press fit power steering pump pulley; check pulley and belt alignment.

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.