

## ATE5 Chapter 117 STEERING LINKAGE & SERVICE

### Opening Your Class

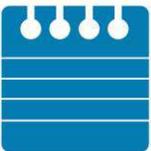
| KEY ELEMENT  | EXAMPLES  |
|--|---|
| <b>Introduce Content</b>   | This course or class provides complete coverage of the components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Real World Fixes, Videos, Animations, and NATEF Task Sheet references.  |
| <b>Motivate Learners</b>   | 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.  |
| <b>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.</b> | Explain learning objectives to students as listed below: <ol style="list-style-type: none"><li>1. Identify steering linkage components.</li><li>2. Describe rack-and-pinion inner tie rod ends.</li><li>3. Describe four-wheel steering systems.</li><li>4. Describe how to perform a dry park test to determine the condition of steering system components.</li><li>5. Explain how to replace steering linkage parts.</li></ol> |
| <b>Establish the Mood or Climate</b>   | Provide a <b>WELCOME</b> , Avoid put downs and bad jokes.   |
| <b>Complete Essentials</b>   | Restrooms, breaks, registration, tests, etc.  |
| <b>Clarify and Establish Knowledge Base</b>  | 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 5<sup>th</sup> Edition Chapter Images found on Jim's web site @**

**[www.jameshalderman.com](http://www.jameshalderman.com)**

**LINK CHP 117: [ATE5 Chapter Images](#)**

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### 1. SLIDE 1 CH117 STEERING LINKAGE & SERVICE

Check for **ADDITIONAL VIDEOS & ANIMATIONS @**  
<http://www.jameshalderman.com/>  
**WEB SITE IS CONSTANTLY UPDATED**

### Videos

[Electronic Power Steering \(View\) \(Download\)](#)  
[Steering Linkage Operation \(View\) \(Download\)](#)  
[Tie Rod End Replace \(View\) \(Download\)](#)

**If a customer complains of a pull to one side or other, check the steering linkage. One of the parts could have worked loose.**

- 2. SLIDE 2 EXPLAIN Figure 117-1** Steering movement is transferred from the pitman arm that is splined to the sector shaft (pitman shaft), through the center link and tie rods, to the steering knuckle at each front wheel. The idler arm supports the passenger side of the center link and keeps the steering linkage level with the road. This type of linkage is called a parallelogram-type design.
- 3. SLIDE 3 EXPLAIN Figure 117-2** most common type of steering is the parallelogram. Cross-steer and Haltenberger linkage designs are used on some trucks and vans.

**DEMONSTRATION: Show parallelogram steering linkage. FIGURE 117-2. Show examples of steering dampeners used on light trucks, vans, & some luxury cars. FIGURE 117-3**

- 4. SLIDE 4 EXPLAIN Figure 117-3** Typical steering dampener used on a Hummer H2.
- 5. SLIDE 5 EXPLAIN Figure 117-4a** A dual bearing design with a preload spring. The use of two bearing surfaces allows for one surface for rotation (for steering) and another surface for pivoting (to allow for suspension up-and-down movement).

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6. **SLIDE 6 EXPLAIN** Figure 117-4b nylon wedge bearing type allows for extended lube intervals. Wear is automatically compensated for by tapered design and spring-loaded bearing.
7. **SLIDE 7 EXPLAIN** Figure 117-5a rubber-bonded socket is constructed of a rubber casing surrounding the ball stud, which is then inserted into the socket of the tie rod end. The hole in the socket allows air to escape as the ball stud is installed and there is not a place for a grease fitting.
8. **SLIDE 8 EXPLAIN** Figure 117-5b socket is crimped over the ball so that part of the socket lip retains the stud.
9. **SLIDE 9 EXPLAIN** Figure 117-6 Rack-and-pinion steering systems use ball & socket-type inner tie rod end.
10. **SLIDE 10 EXPLAIN** Figure 117-7 variety of methods are used to secure inner tie rod end socket assembly to end of rack

**DEMONSTRATION:** Show examples of roll pin, set screw, and swaged socket types of inner tie rod end assemblies used in rack-and-pinion steering systems: **FIGURES 117-5, 6, & 7**

11. **SLIDE 11 EXPLAIN** Figure 117-8 Exploded view of a center-take-off-style rack-and-pinion steering gear assembly

**DEMONSTRATION:** Show examples of center-take-off rack-and-pinion steering gear assemblies: **FIGURES 117-8**

Some center-take-off rack-and-pinion steering gear assemblies also include an adjuster stud for adjusting linkage length. Be sure to check type of assembly before beginning work.

12. **SLIDE 12 EXPLAIN** Figure 117-9 In a rear-steer vehicle, the steering linkage is behind the centerline of the front wheels, whereas the linkage is in front on a front-steer vehicle.

**DISCUSSION:** Ask the students to discuss whether front steer or rear steer is better: **FIGURES 117-9**

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13. **SLIDE 13 EXPLAIN Figure 117-10** Opposite-phase four-wheel steer is usually used only at low vehicle speed to help in parking maneuvers. Same-phase steering helps at higher speeds and may not be noticeable by the average driver.
14. **SLIDE 14 EXPLAIN Figure 117-11** Being equipped with four-wheel steer allows a truck to make shorter turns than would otherwise be possible.
15. **SLIDE 15 EXPLAIN Figure 117-12** Quadrasteer includes many components that all work together.
16. **SLIDE 16 EXPLAIN Figure 117-13** Rear steer select switch schematic.
17. **SLIDE 17 EXPLAIN Figure 117-14** The dash-mounted select switch showing the three positions for the four-wheel steer system.
18. **SLIDE 18 EXPLAIN Figure 117-15** The output of the handwheel sensor digital signal.
19. **SLIDE 19 EXPLAIN Figure 117-16** Handwheel analog signal.
20. **SLIDE 20 EXPLAIN Figure 117-17** Handwheel position sensor analog signal to control module.
21. **SLIDE 21 EXPLAIN Figure 117-18** Handwheel position sensor digital signal to control module.
22. **SLIDE 22 EXPLAIN Figure 117-19** Quadrasteer system showing all of the components. Motor used to power rear steering rack can draw close to 60 amperes during a hard turn and can be monitored using a Tech 2.



### **DISCUSSION: Ask students to discuss steering systems similar to GM**

### **Quadrasteer™ system**

### **FIGURES 117-12 to 17**



23. **SLIDE 23 EXPLAIN Figure 117-20** Greasing a tie rod end. Some joints do not have a hole for excessive grease to escape, and excessive grease can destroy the seal.
24. **SLIDE 24 EXPLAIN Figure 117-21** Part of steering linkage lubrication is applying grease to the steering stops. If these stops are not lubricated, a grinding sound may be heard when the vehicle hits a bump when the wheels are turned all the way one direction or the other. This often occurs when driving into or out of a driveway that has a curb.

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DEMO



DEMO



DEMO



DEMO

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**DEMONSTRATION:** Show examples of Zerk fittings, both in hand and on the vehicle.

**DEMONSTRATION:** Show examples of grease guns and grease cartridges. Show how to use a grease gun and cartridge to grease a tie rod end  
**FIGURES 117-20, 21**

**ON-VEHICLE NATEF TASK:** Lubricate Suspension and steering system. **Page 354**

25. **SLIDE 25 EXPLAIN** Figure 117-22 Checking for freeplay in the steering.

26. **SLIDE 26 EXPLAIN** Figure 117-23 All joints should be felt during a dry park test. Even inner tie rod ends (ball socket assemblies) can be felt through the rubber bellows on many rack-and-pinion steering units.

**DEMONSTRATION:** Show how to check steering components by using the dry park test:  
**FIGURES 117-22, 23**

**HANDS-ON TASK:** Have the students do a **Dry Park Test:** **FIGURES 117-22, 23**

27. **SLIDE 27 EXPLAIN** Figure 117-24 The steering and suspension control arms must remain parallel to prevent the up-and-down motion of the suspension from causing the front wheels to turn inward or outward

28. **SLIDE 28 EXPLAIN** Figure 117-25 center link should be parallel to the ground.

29. **SLIDE 29 EXPLAIN** Figure 117-26 Typical parallelogram steering linkage. The center link can also be named the relay rod, drag link, or connecting link.

**DEMONSTRATION:** Show how to perform jounce/rebound test **FIGURES 117-24, 25**

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**HANDS-ON TASK:** Have students perform jounce/rebound test **FIGURES 117-24, 25**

**ON-VEHICLE NATEF TASK:** Identify and interpret steering concerns; determine necessary action. **Page 355**

- 30. SLIDE 30 EXPLAIN Figure 117-27** Some center links have ball joints while others have tapered socket holes to accept ball joints on the pitman arm, idler arm, and inner tie rod ends
- 31. SLIDE 31 EXPLAIN Figure 117-28** To check an idler arm, most vehicle manufacturers specify that 25 pounds of force be applied by hand up and down to the idler arm. The idler arm should be replaced if the total movement (up and down) exceeds 1/4 in. (6 mm).

**DISCUSSION:** Ask the students to discuss the symptoms that would suggest that a tie rod should be replaced

**DEMONSTRATION:** Show how to check an idler arm to determine if it needs to be replaced **FIGURE 117-28**

- 32. SLIDE 32 EXPLAIN Figure 117-29** Steering system component(s) should be replaced if any noticeable looseness is detected when moved by hand.
- 33. SLIDE 33 EXPLAIN Figure 117-30** All joints should be checked by hand for any lateral or vertical play

**DISCUSSION:** Define **Bump Steer**. discuss how lowering vehicle, or mixing and matching steering components may fix bump steer

**Bump Steer** can be found by placing vehicle on the alignment rack. Pull vehicle down on springs (by adding weight or chaining car down), measure toe change. Repeat procedure, but lift one side of front cross member, then other. Lift both sides together. Changes in toe are bump steer. **FIG 117-31**

- 34. SLIDE 34 EXPLAIN Figure 117-31** If a rack-and-pinion or any other steering linkage system is not level, the front tires will be moved inward and/or outward whenever the wheels of the vehicle move up or down

DEMO



35. **SLIDE 35 EXPLAIN Figure 117-32** The preferred method for separating the tie rod end from the steering knuckle is to use a puller such as the one shown. A pickle-fork-type tool should only be used if the tie rod end is going to be replaced. A pickle-fork-type tool can damage or tear the rubber grease boot.
36. **SLIDE 36 EXPLAIN Figure 117-33** Two hammers being used to disconnect a tie rod end from the steering knuckle. One hammer is used as a backing for the second hammer. Notice that the attaching nut has been loosened, but not removed. This prevents the tie rod end from falling when the tapered connection is knocked loose.

**DEMONSTRATION: Show how to disconnect a tie rod from the steering knuckle. Show examples of a puller tool & pickle-fork tool used to separate the tie rod from the steering knuckle: FIG.117-32**  
**When a pitman arm is being stubborn, put tension on it with puller & then hit pitman arm with a hammer. Then retighten puller. Do this several times; and pitman arm should fall off. FIG. 117-34**

37. **SLIDE 37 EXPLAIN Figure 117-34** pitman arm puller is used to remove the pitman arm from the pitman shaft.
38. **SLIDE 38 EXPLAIN Figure 117-35** Pitman arm and pitman shaft indexing splines.
39. **SLIDE 39 EXPLAIN Figure 117-36** Align the hole in the tie rod end with the slot in the retaining nut. If the holes do not line up, always tighten the nut farther (never loosen) until the hole lines up.
40. **SLIDE 40 EXPLAIN Figure 117-37** Replacement tie rods should be of the same overall length as the originals. Measure from the edge of the tie rod sleeve to the center of the grease fitting. When the new tie rod is threaded to this dimension, the toe setting will be close to original.
41. **SLIDE 41 EXPLAIN Figure 117-38** All tie rod ends should be installed so that the stud is in the center of its operating range, as shown.
42. **SLIDE 42 EXPLAIN Figure 117-39** (a) Tie rod adjusting sleeve. (b) Be sure to position the clamp correctly on the sleeve
43. **SLIDE 43 EXPLAIN Figure 117-40** An articulation test uses a spring scale to measure the amount of force needed to move the tie rod in the ball socket assembly.

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Most manufacturers specify a minimum of 1 lb (4.4 N) of force and a maximum of 6 lb (26 N).

44. **SLIDE 44 EXPLAIN Figure 117-41** Removing a staked inner tie rod assembly requires two wrenches—one to hold the rack and the other to unscrew the joint from the end of the steering rack.
45. **SLIDE 45 EXPLAIN Figure 117-42** When the inner tie rod end is reassembled, both sides of the housing must be staked down onto the flat shoulder of the rack.
46. **SLIDE 46 EXPLAIN Figure 117-43** After replacing an inner tie rod end, the socket assembly should be secured with a rivet or set screw depending on the style of the replacement part.

**DEMONSTRATION:** Show how to remove a staked inner tie rod assembly by using two wrenches. **FIGURE 117-41.** Show how to remove the roll pin from a pinned rack-and pinion unit by using two methods: using a puller, and drilling out the pin **FIGURE 117-42**

**HANDS-ON TASK:** Have the students remove roll pins from pinned rack-and-pinion units by drilling out the pins.

**ON-VEHICLE NATEF TASK:** Inspect and replace rack and pinion steering gear inner tie ends (sockets) and bellows boots. **Page 356**

**ON-VEHICLE NATEF TASK:** Inspect and replace pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings, and steering linkage damper. **Page 357**

**ON-VEHICLE NATEF TASK:** Inspect, replace, and adjust tie rod ends (sockets), tie rod sleeves and clamps. **Page 358**

**ON-VEHICLE NATEF TASK:** Diagnose conventional & rack and pinion steering gears; determine necessary action. **Page 359**

**SEARCH INTERNET:** use Internet TO research the history of airbags. Ask students to prepare presentations on the history of airbags. Have them share their presentations during the next class.

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[Crossword Puzzle \(Microsoft Word\) \(PDF\)](#)

[Word Search Puzzle \(Microsoft Word\) \(PDF\)](#)