

Automotive Technology 6th Edition

Chapter 121 STEERING LINKAGE & 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. Identify steering linkage components. 2. Describe rack-and-pinion inner tie rod ends. 3. Describe four-wheel steering systems. 4. Discuss steering linkage lubrication. 5. Describe the purpose and procedure for performing a dry park test. 6. List common wear items in steering systems. 7. Describe the steps for under-vehicle inspection of steering systems. 8. Explain how to replace steering linkage parts. 9. This chapter will help prepare for Suspension and Steering (A4) ASE certification test content area "A" (Steering System 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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Chapter 121 Steering Linkage & Service

1. SLIDE 1 CH121 STEERING LINKAGE & SERVICE

Check for **ADDITIONAL VIDEOS & ANIMATIONS**
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[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 121-1 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 121-2 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 121-2. Show examples of steering dampeners used on light trucks, vans, & some luxury cars. FIGURE 121-3

DISCUSS FREQUENTLY ASKED QUESTION:
Why Is a Grease Fitting Sometimes Called a Zerk Fitting? In 1922, zerk fitting was developed by Oscar U, Zerk, an employee of

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Chapter 121 Steering Linkage & Service

Alemite Corporation, a manufacturer of pressure lubrication equipment. A Zerk or grease fitting is also known as an Alemite fitting.

4. **SLIDE 4 EXPLAIN Figure 121-3** Typical steering dampener used on a Hummer H2.
5. **SLIDE 5 EXPLAIN Figure 121-4a** 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).
6. **SLIDE 6 EXPLAIN Figure 121-4b** 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 121-5a** 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 121-5b** socket is crimped over the ball so that part of the socket lip retains the stud.
9. **SLIDE 9 EXPLAIN Figure 121-6** Rack-and-pinion steering systems use ball & socket-type inner tie rod end.
10. **SLIDE 10 EXPLAIN Figure 121-7** 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 121-5, 6, & 7

11. **SLIDE 11 EXPLAIN Figure 121-8** 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 121-8

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Chapter 121 Steering Linkage & Service

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 121-9 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 121-9

13. SLIDE 13 **EXPLAIN** Figure 121-10 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 121-11 Being equipped with four-wheel steer allows a truck to make shorter turns than would otherwise be possible.

DISCUSS FREQUENTLY ASKED QUESTION:
What Is “Goofy Mode”? Trucks that are equipped with the Quadrasteer system have a 3-position switch on the dash:

1. 2WS
2. 4WS
3. Tow • **SEE FIGURE 121-12.**

The Quadrasteer module then determines the right amount of rear steer and in which direction based on vehicle speed and steering wheel angle. If trailer towing mode is selected and the truck is not towing a trailer, the computer will adjust steering as if there is a trailer and will slightly delay the rear steering action when changing lanes and other maneuvers. As a result, when steering wheel is turned, front wheels will, of course, turn in direct proportion to input from steering wheel; however, rear wheels will be delayed in their action to allow trailer to track properly. If,

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Chapter 121 Steering Linkage & Service

however, a trailer is not being towed, this delay feels “goofy” and could result in customer concerns about proper operation of QuadraSteer system. Be sure that control switch is placed in the off or normal modes unless a trailer is in fact being towed.

15. SLIDE 15 **EXPLAIN** Figure 121-12 dash-mounted select switch showing three positions for the four-wheel steer system.
16. SLIDE 16 **EXPLAIN** Figure 121-13 QuadraSteer includes many components that all work together.
17. SLIDE 17 **EXPLAIN** Figure 121-14 Greasing a tie rod end. Some joints do not have a hole for excessive grease to escape, and excessive grease can destroy the seal.
18. SLIDE 18 **EXPLAIN** Figure 121-15 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.

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

ON-VEHICLE ASE EDUCATION MLR TASK: Lubricate Suspension and steering system.

DISCUSS FREQUENTLY ASKED QUESTION: Why Do Only a Few Vehicles Use Grease Fittings? Many years ago, all vehicles were equipped with grease fittings, while today very few vehicles are so equipped. The reasons for this, as given by engineers, include:

ICONS

Chapter 121 Steering Linkage & Service



- It has been determined that use of wrong type of grease can cause more harm than good.
- If a grease fitting is used to allow grease to enter suspension or steering joint, then water can also get inside joint.
- Grease fittings are often ignored or greasing of joint is not performed by service technician.
- Low-friction joints do not require routine service like older metal-to-metal joints required.

19. SLIDE 19 **EXPLAIN** Figure 121-16 Checking for freeplay in the steering.

20. SLIDE 20 **EXPLAIN** Figure 121-17 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.

21. SLIDE 21 **EXPLAIN** Figure 121-18 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

DEMONSTRATION: Show how to check steering components by using the dry park test: FIGURES 121-17

HANDS-ON TASK: Have the students do a Dry Park Test: FIGURES 121-17, 18

EXPLAIN TECH TIP: Jounce/Rebound Test

All steering linkage should be level and “work” at same angle as suspension arms, as shown in • **FIGURE 121-18. A simple test to check these items is performed as follows:**

1. Park on a hard, level surface with the wheels straight ahead and the steering wheel in the unlocked position.

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Chapter 121 Steering Linkage & Service

2. **Bounce (jounce) vehicle up and down at front bumper while watching steering wheel. Steering wheel should not move during this test. If steering wheel moves while vehicle is being bounced, look for a possible bent steering linkage, suspension arm, or steering rack. • SEE FIGURE 121-19.**

22. **SLIDE 22 EXPLAIN Figure 121-19** center link should be parallel to ground.

23. **SLIDE 23 EXPLAIN Figure 121-20** 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

HANDS-ON TASK: Have students perform jounce/rebound test

ON-VEHICLE ASE EDUCATION TASK A2: Identify and interpret suspension and steering system concerns; determine needed action

EXPLAIN TECH TIP: *Wear and Nonwear Center Links.* Some center links are equipped with ball-and-socket joints, which can wear. Other center links are manufactured with holes for ball joint studs only. • SEE FIGURE 121-21. Generally, center links that do not use joints are unlikely to need replacement unless a joint becomes loose and wears the tapered stud hole. Knowing which style of center link is used will help determine the most likely location to check for excessive steering linkage play.

24. **SLIDE 24 EXPLAIN Figure 121-21** 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

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Chapter 121 Steering Linkage & Service

25. **SLIDE 25 EXPLAIN Figure 121-22** 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

26. **SLIDE 26 EXPLAIN Figure 121-23** Steering system component(s) should be replaced if any noticeable looseness is detected when moved by hand.
27. **SLIDE 27 EXPLAIN Figure 121-24** All joints should be checked by hand for any lateral or vertical play

DISCUSS CASE STUDY: *Bump Steer* • SEE FIGURE 121-25. Page 1488

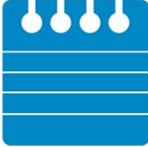
DISCUSSION: Define Bump Steer. discuss how lowering vehicle, or mixing and matching steering components may fix bump steer

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.

28. **SLIDE 28 EXPLAIN Figure 121-25** 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
29. **SLIDE 29 EXPLAIN Figure 121-26** 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.
30. **SLIDE 30 EXPLAIN Figure 121-27** Two hammers being used to disconnect a tie rod end from the steering

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Chapter 121 Steering Linkage & Service

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:

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.

31. **SLIDE 31 EXPLAIN** Figure 121-28 pitman arm puller is used to remove the pitman arm from the pitman shaft.
32. **SLIDE 32 EXPLAIN** Figure 121-29 Pitman arm and pitman shaft indexing splines.
33. **SLIDE 33 EXPLAIN** Figure 121-30 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.
34. **SLIDE 34 EXPLAIN** Figure 121-31 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.
35. **SLIDE 35 EXPLAIN** Figure 121-32 All tie rod ends should be installed so that the stud is in the center of its operating range, as shown.
36. **SLIDE 36 EXPLAIN** Figure 121-33 (a) Tie rod adjusting sleeve. (b) Be sure to position the clamp correctly on the sleeve
37. **SLIDE 37 EXPLAIN** Figure 121-34 An articulation test uses a spring scale to measure the amount of force needed to move the tie rod in the ball socket assembly. Most manufacturers specify a minimum of 1 lb (4.4 N) of force and a maximum of 6 lb (26 N).
38. **SLIDE 38 EXPLAIN** Figure 121-35 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.
39. **SLIDE 39 EXPLAIN** Figure 121-36 When the inner tie rod end is reassembled, both sides of the housing must be staked down onto the flat shoulder of the rack.

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Chapter 121 Steering Linkage & Service



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40. **SLIDE 40 EXPLAIN Figure 121-37** 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.
41. **SLIDE 41 EXPLAIN FIGURE 121-38** Using an inductive heater caused this retaining nut to be cherry red in a just a few seconds.

EXPLAIN TECH TIP: Inductive Heating Tool
Fasteners are often rusted and difficult to remove especially those that are part of the steering system where they are exposed to road moisture, dirt, and debris. A heating tool, such as the Mini-Ductor, which uses electrical induction to heat a coil at the tip, is the tool that many experts recommend to use when heating of a fastener is needed. Using this tool allows a technician to heat a part quickly without the hazard of using an open flame. • SEE FIGURE 121-38.

DEMONSTRATION: Show how to remove a staked inner tie rod assembly by using two wrenches. 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

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

ON-VEHICLE ASE EDUCATION TASK B8:
Inspect rack and pinion steering gear inner tie rod ends (sockets) and bellows boots; replace as needed.

ON-VEHICLE ASE EDUCATION TASK B16:
Inspect, remove and/or replace pitman arm, relay (centerlink/intermediate) rod, idler arm, mountings, and steering linkage damper..

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Chapter 121 Steering Linkage & Service

ON-VEHICLE ASE EDUCATION TASK B17:

Inspect, replace, and/or adjust tie rod ends (sockets), tie rod sleeves, and clamps.

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.