CHAPTER 13

Electronic Four-Wheel Steering Diagnosis and Service

Upon completion and review of this chapter, you should be able to:

- ❑ Perform a preliminary inspection on a four-wheel steering (4WS) system.
- ❑ Perform a trouble code diagnosis on a 4WS system with the ignition switch on.
- ❑ Perform a trouble code diagnosis on a 4WS system with the engine running.
- ❑ Remove and replace the rear steering actuator.
- ❑ Remove and replace the tie-rod ends on the rear steering actuator.
- ❑ Remove and replace tie rods and boots on the rear steering actuator.
- ❑ Remove and replace the rear main steering angle sensor.
- ❑ Remove and replace the rear sub steering angle sensor.
- ❑ Perform an electronic neutral check on a 4WS system.
- ❑ Adjust the front main steering angle sensor.
- ❑ Adjust the front sub steering angle sensor.
- ❑ Adjust the rear sub steering angle sensor.

Basic Tools

Basic technician's tool set
Service manual
Jumper wire
Floor jack
Safety stands
Wax marker
Silicone grease
Chassis lubricant
Cotter pins
Length of stiff wire

Service and adjustments on 4WS systems with adjustable sensors must be performed precisely as explained in the vehicle manufacturer's service manual. Inaccurate sensor adjustments may cause improper rear wheel steering operation, and this may result in reduced steering control. Always follow the service and adjustment procedures carefully and accurately!

Preliminary Inspection

Prior to any four-wheel steering diagnosis, the following concerns should be considered.

1. Have any suspension modifications been made that would affect steering?
2. Are the tire sizes the same as specified by the vehicle manufacturer?
3. Are the tires inflated to the pressure specified by the vehicle manufacturer?
4. Is the power steering belt adjusted to the vehicle manufacturer's specified tension?
5. Is the power steering pump reservoir filled to the proper level with the type of fluid specified by the vehicle manufacturer?
6. Is the engine idling at the speed specified by the vehicle manufacturer? Is the idle speed steady?
7. Is the steering wheel original equipment?

A fail-safe mode may be called a backup mode.

The Society of Automotive Engineers (SAE) J1930 terminology is an attempt to standardize electronics terminology in the automotive industry.

In the SAE J1930 terminology, the term malfunction indicator light (MIL) replaces other terms for computer system indicator lights.

Fail-Safe Function

If the four-wheel steering (4WS) control unit senses a failure in the system, the control unit switches to a **fail-safe mode.** In this mode, the control unit stores a trouble code or codes and illuminates the 4WS indicator light to inform the driver that a problem exists in the system. When this mode is entered, the 4WS control unit shuts off voltage to the rear steering unit and the rear wheels remain in the straight-ahead position.

The four-wheel steering control unit enters the **fail-safe mode** if a defect occurs in the system. In this mode, the rear wheels move to the centered position.

Damper Control

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When the 4WS control unit enters the fail-safe mode, a quick return of the rear wheels to the straight-ahead position would adversely affect steering under certain steering wheel and rear wheel positions. To prevent this action, the 4WS control unit energizes the damper relay when it enters the fail-safe mode. The rear steering actuator motor is spun by the steering shaft movement as this shaft is moved to the centered position by centering spring force. This action causes the motor armature to act as a voltage generator. The voltage generated by the armature is fed back through the damper relay to the motor armature. Under this condition, the motor rotation is slowed and the return spring slowly moves the rear steering shaft to the straight-ahead position. Without the action of the damper relay, the return spring would move the rear steering shaft quickly to the straight-ahead position.

Trouble Code Diagnosis

Road Test

CUSTOMER CARE: While discussing customers' automotive problems, always remain polite and never make statements that make customers feel uninformed about their vehicles.

The 4WS control unit stores a fault code and illuminates the 4WS indicator light if a defect occurs in the system, even if the defect is temporary. Always ask the customer about the conditions that caused the 4WS indicator light to come on, and duplicate this condition during a road test. If the 4WS light is not illuminated during the road test, the system is satisfactory electronically and does not require further electronic diagnosis. The troubleshooting procedures in the vehicle manufacturer's service manual assume that the problem is present at the time of diagnosis.

Trouble Code Display with Ignition Switch On

CAUTION: When diagnosing a computer system, never connect or ground any terminals unless instructed to do so in the vehicle manufacturer's service manual. This action may damage electronic components.

CAUTION: When diagnosing a computer system, never disconnect or connect any computer system component with the ignition switch on unless instructed to do so in the vehicle manufacturer's service manual. This action may damage the computer or system components.

CAUTION: When performing electronic diagnosis on a vehicle equipped with an air bag, most vehicle manufacturers recommend turning the ignition switch off, disconnecting the negative battery cable, and waiting one minute before proceeding with electronic component diagnosis or service.

CAUTION: When performing electronic diagnosis on a vehicle equipped with an air bag, follow all the service precautions recommended in the vehicle manufacturer's service manual. If these precautions are not followed, electronic components may be damaged.

Always follow the exact 4WS service and diagnostic procedures in the vehicle manufacturer's service manual. These procedures vary depending on the make and year of the vehicle.

The following are typical procedures for a Honda Prelude. These procedures should be avoided until after the diagnosis is complete because any of these procedures will erase trouble codes.

1. Disconnect the battery terminals.
2. Disconnect the 4WS control unit connector.
3. Remove the number 43 clock-radio 10-A fuse from the underhood fuse/relay box.

Follow these steps to obtain the trouble codes.

1. Remove the dual-terminal **service check connector** located behind the center console, and connect the two terminals in this connector with a jumper wire (Figure 13-1).
2. Turn on the ignition switch, but do not start the engine.
3. Observe the 4WS indicator light to read the trouble codes. Three longer flashes followed by a brief pause and one quicker flash indicates code 31. The codes are given in numerical order.
4. Record the fault codes.

When the two terminals on the **service check connector** are connected together, the 4WS computer supplies flash codes on the 4WS indicator light.

Trouble Code Display with Engine Running

The 4WS control unit actually contains two processing units that are referred to as the main and sub processing units. Each processing unit can store a maximum of ten trouble codes. If the trouble code diagnosis is performed with the engine running, the code display indicates whether the codes are stored in the main or sub processor.

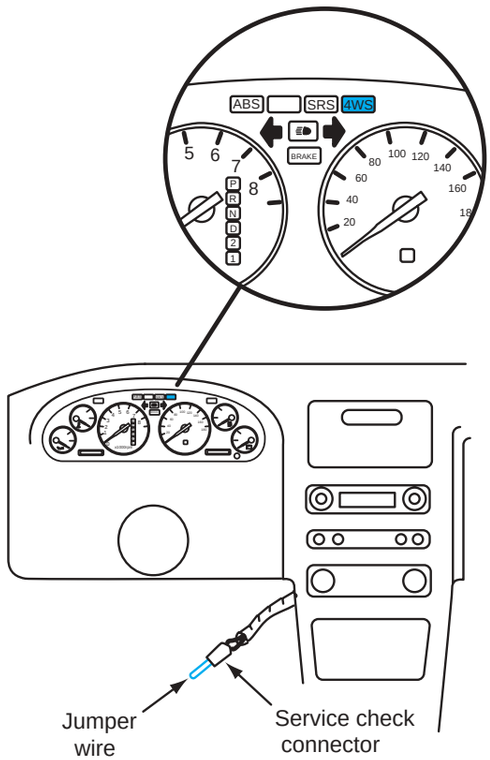

Figure 13-1 Dual-terminal service check connector positioned behind the center console.

When the service connector terminals are connected with a jumper wire and the engine is started, the 4WS indicator light follows this sequence if there are trouble codes in the main and sub processors.

1. blinks quickly once when the ignition switch is turned on
2. pauses for 3 seconds
3. displays codes stored in the main processor
4. pauses for 1.6 seconds
5. blinks quickly for 3 seconds to indicate a separation between the main and sub processor codes
6. pauses for 1.6 seconds
7. displays codes stored in the sub processor
8. pauses for 3 seconds, and then repeats the cycle (Figure 13-2)

Main Steering Angle Sensor Trouble Code

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If a defect occurs in the main steering angle sensor system, the clock-radio 10-A fuse must be disconnected to cancel the 4WS indicator light. When defects occur in other parts of the electronic 4WS system, the 4WS indicator light is cancelled when the ignition switch is turned off. However, the 4WS indicator light is illuminated again when the ignition switch is turned on, and the 4WS control unit detects the problem again.

Trouble Codes Representing Temporary Driving Conditions

Codes 70, 71, 73, and 74 represent problems resulting from abnormal or harsh driving conditions (Figure 13-3). When the 4WS control unit detects one of these problems, it does not illuminate the 4WS indicator light, but these codes are flashed during the diagnostic procedure.

Rear Steering Actuator Service

Rear Steering Actuator Removal

CAUTION: Many steering service and diagnostic procedures require the installation of the rear steering center lock pin in the rear steering actuator to lock this unit in the centered position. If this lock pin is not installed, diagnosis will be inaccurate.

CAUTION: Do not start the engine with the rear steering center lock pin in place. This action may damage the lock pin and rear steering actuator.

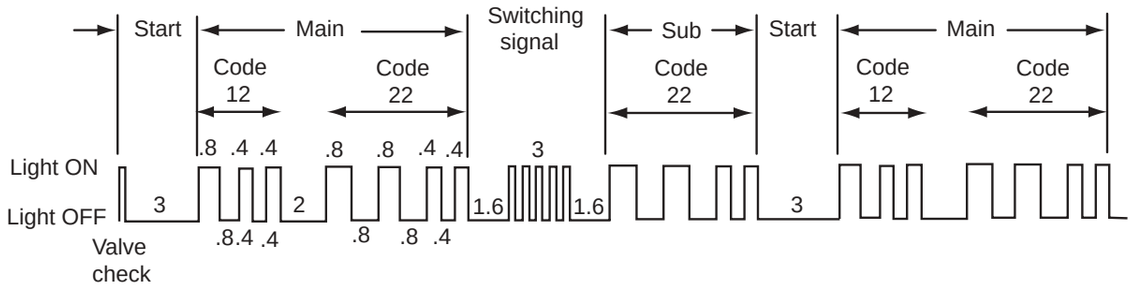

Figure 13-2 Trouble codes in main and sub processors obtained with engine running.

DTC	OPERATION	4WS INDICATOR LIGHT
70	The ignition is turned from OFF to ON while driving.	ON
71	The car is driven aggressively with the driver and three passengers on board, or the steering wheel is turned with a rear wheel blocked by the curb, etc.	——
73	The engine is started while quick-charging the battery.	——
74	Driving the car with the parking brake ON.	ON 5 minutes after detection

Figure 13-3 Codes that represent problems caused by abnormal or harsh driving conditions.

SERVICE TIP: Do not attempt to disassemble the rear steering actuator other than tie rods, tie-rod ends, and sensors. This actuator is serviced as an assembly. Because individual parts for the actuator are not available, disassembly is a waste of time.

CAUTION: Use the tie-rod end removal tool carefully to avoid damage to the tie-rod boot.

WARNING: When turning the front wheels on a car with 4WS, keep your hands away from the rear steering mechanism and rear wheels to avoid hand injuries.

Follow these steps to remove the rear steering actuator.

1. Raise the vehicle on a hoist or lift the rear of the vehicle with a floor jack, and support the chassis with safety stands placed in the vehicle manufacturer's recommended locations.
2. Remove the cotter pin and nut from each tie-rod end.
3. Install a 12-millimeter (mm) nut on each tie-rod end until the nuts are flush with the tie-rod stud.
4. Install the special tool on the tie-rod end, and with the tool arms parallel, tighten the screw on the tool to loosen the tie-rod end (Figure 13-4). Repeat the procedure on both tie-rod ends.

Special Tools

Tie-rod end removal tool

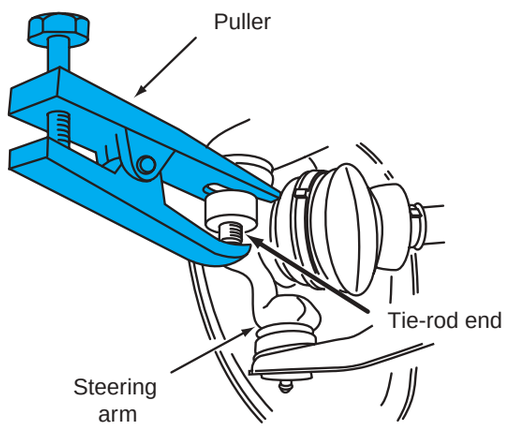

Figure 13-4 Removing a tie-rod end with a special tool.

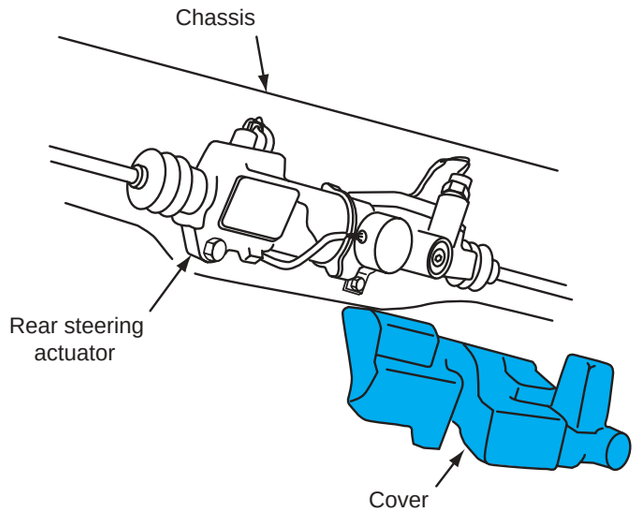

Figure 13-5 Removing the rear steering actuator cover.

5. Remove the nuts from the tie rods and remove the tie rods from the steering arms.
6. Remove the rear steering actuator cover (Figure 13-5).
7. Remove the cap bolt and washer and install the **rear steering center lock pin** (Figure 13-6).
8. Remove the ground cable connector and all wiring harness connectors on the rear steering actuator (Figure 13-7).
9. Remove the four mounting bolts and bracket, and remove the rear steering actuator (Figure 13-8).

The **rear steering center lock pin** locks the rear steering in the centered position for test and service purposes.

Tie Rod and Tie-Rod End Removal

Follow these steps for tie rod and tie-rod end removal.

1. Mark the relative position of the tie-rod end, locknut, and tie rod with a wax marker.
2. Hold the tie-rod end with a wrench and loosen the locknut (Figure 13-9).

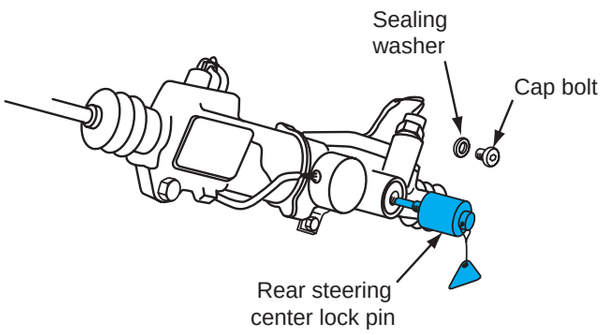

Figure 13-6 Removing the cap bolt and washer, and installing the rear steering center lock pin.

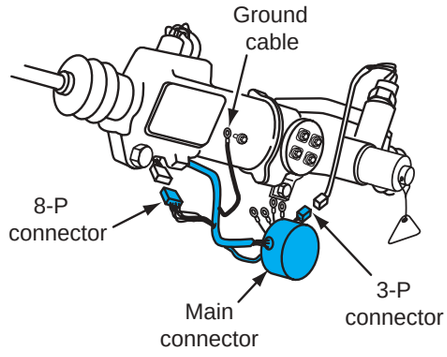

Figure 13-7 Removing the ground cable connector and all wiring harness connectors on the rear steering actuator.

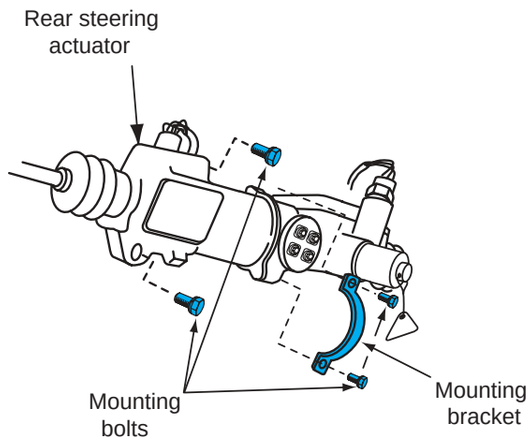

Figure 13-8 Removing the four mounting bolts, bracket, and rear steering actuator.

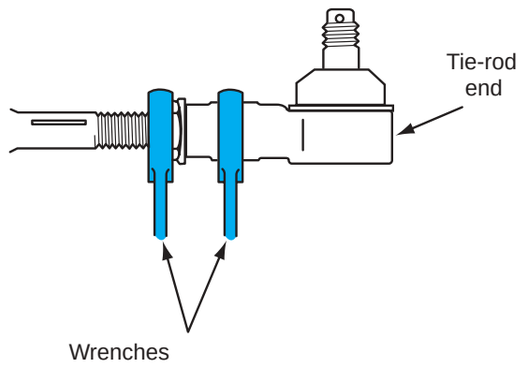

Figure 13-9 Loosening the tie-rod end locknut.

3. Remove the tie-rod end.
4. Remove the boot bands and clamps from the inner tie-rod ends (Figure 13-10).
5. Place the flat side of the rack holding tool toward the actuator housing and drive the special rack holding tool between the actuator housing and the stop washer with a soft hammer (Figure 13-11).
6. Straighten the tabs on the tie-rod lock washer.

Special Tools

Rack holding tool

SERVICE TIP: Hold the special holding tool firmly while loosening the tie rod to avoid applying rotational force to the shaft screw in the actuator.

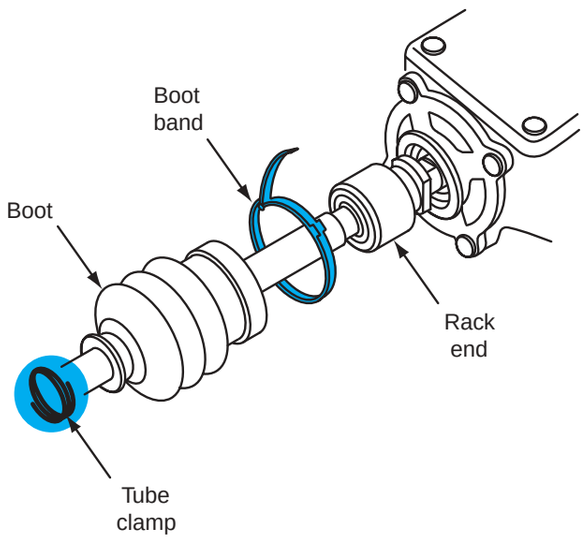

Figure 13-10 Removing boot bands and clamps from the inner tie-rod end.

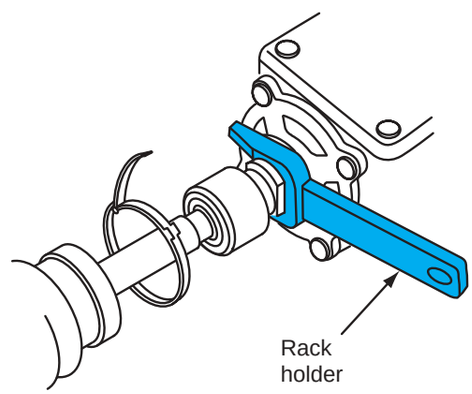

Figure 13-11 Installing the special rack holding tool between the actuator housing and the stop washer.

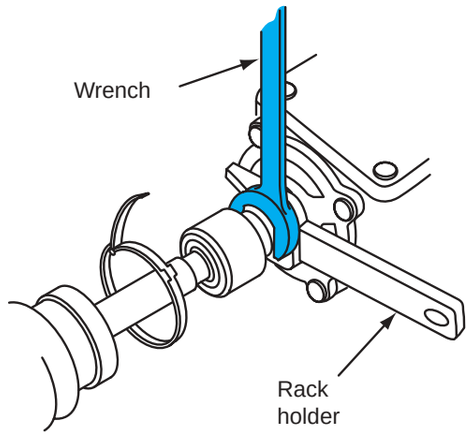

Figure 13-12 Removing the tie rod from the shaft screw.

7. Hold the shaft screw with the holding tool and loosen the tie rod with a wrench (Figure 13-12).
8. Thread the tie rod off the shaft screw and repeat this procedure on each tie-rod end.

Tie-Rod End Boot Removal and Replacement

Tie-rod end boots must be replaced if they are cracked, split, deteriorated, or loose.

Follow these steps to remove and replace the tie-rod end boots.

CAUTION: Do not put grease on the boot installation shoulder and tapered section of the ball pin in the tie-rod end. Grease may cause these components to become loose.

CAUTION: Do not allow dust, dirt, or foreign material to enter the tie-rod end ball joint or boot because this contamination causes rapid component wear.

1. Use a large screwdriver to pry the old boot from the tie-rod end.
2. Pack the interior of the new boot with the vehicle manufacturer's recommended grease and place a light coating of grease on the boot lip.
3. Wipe the grease off the sliding surfaces of the ball pin with a shop towel; then pack the lower area around the ball pin and body with grease (Figure 13-13).

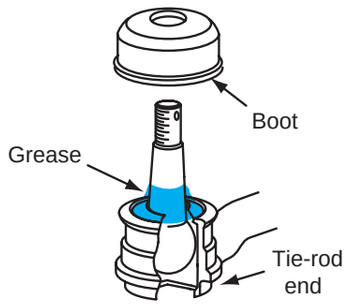

Figure 13-13 Packing the boot and tie-rod end with grease.

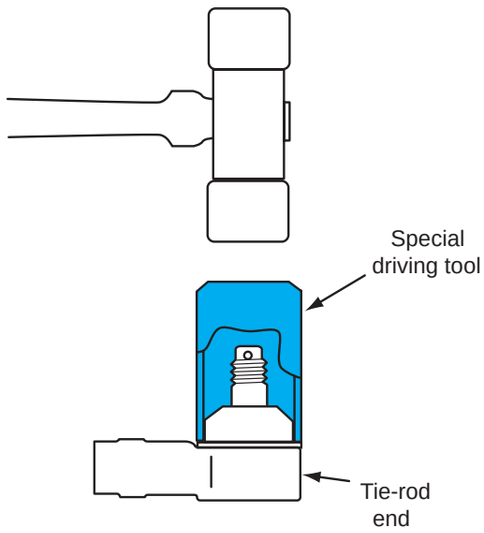

Figure 13-14 Driving the boot onto the tie-rod end with a special driving tool.

4. Use the special driving tool to install the new boot on the tie-rod end (Figure 13-14).
5. Wipe any grease from the tapered section of the ball pin with a shop towel. Apply sealant around the lower edge of the boot and tie-rod body.

Special Tools

Tie-rod boot driving tool

Installation of Tie Rods and Tie-Rod Ends

CAUTION: Never apply axial impact or rotational force to the shaft screw in the rear steering actuator. Either of these actions may cause internal actuator damage.

Inner tie-rod boots must be replaced if they are cracked, split, deteriorated, or damaged.

Follow these steps for tie rod and tie-rod end installation.

1. Install the tie-rod ends so the marks on the tie-rod ends, nuts, and tie rods are aligned, and tighten the tie-rod nuts to the specified torque.
2. Screw each inner tie rod onto the shaft screw while holding the lock washer so its tabs are in the inner tie-rod end. The stop washer must be installed on the shaft screw with the chamfered side facing outward (Figure 13-15).
3. Drive the special holding tool between the actuator housing and the stop washer with a soft hammer (Figure 13-16).
4. Hold the shaft screw with the holding tool and tighten the inner tie-rod end to the specified torque.
5. Bend the lock washer tabs against the flat on the inner tie-rod end.
6. Remove the special holding tool and apply silicone grease to the sliding surface of the tie rod (Figure 13-17). Place a light coating of silicone grease inside the tie-rod boot.
7. Apply the vehicle manufacturer's recommended grease to the circumference of the inner tie-rod joint housing.
8. Install the boots on the actuator housing; then install the boot bands with the locking tabs properly positioned in relation to the actuator housing (Figure 13-18).

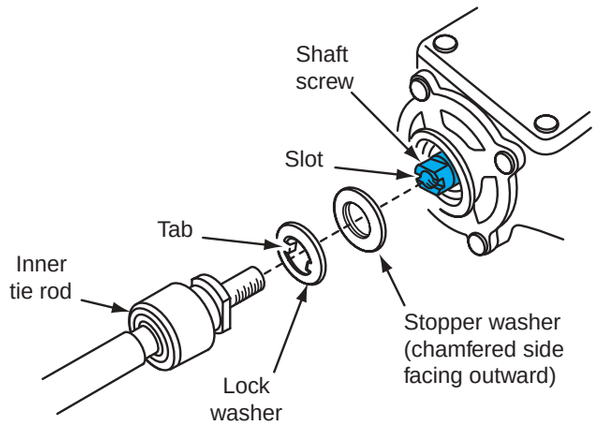

Figure 13-15 Installing the inner tie-rod end on the shaft screw.

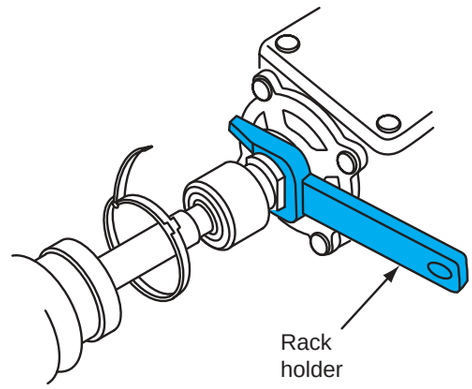

Figure 13-16 Installing the special tool to hold the shaft screw while tightening the inner tie-rod end.

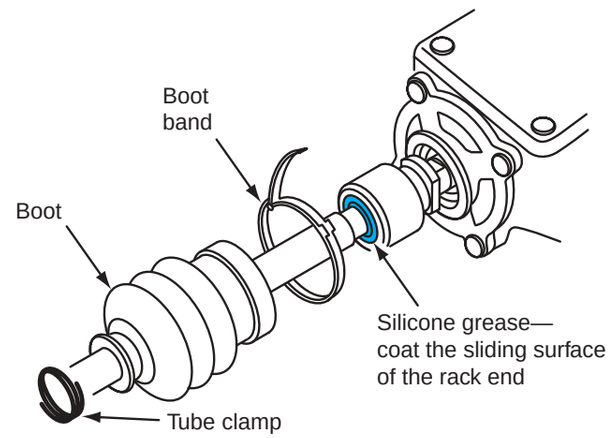

Figure 13-17 Lubrication of the inner tie-rod joint housing.

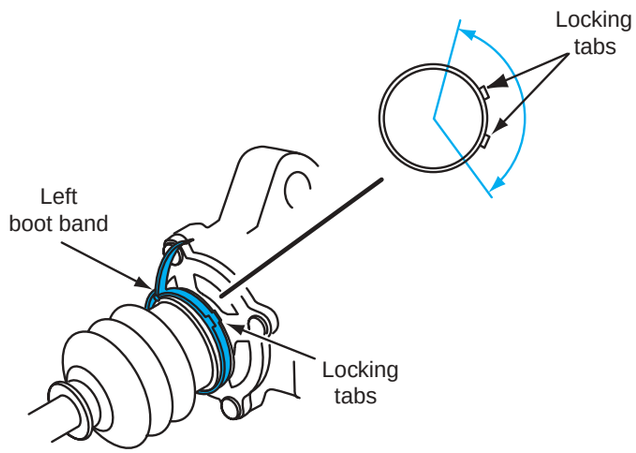

Figure 13-18 Proper boot band position in relation to the actuator housing.

CAUTION: While staking the boot clamps, be careful not to damage the inner tie-rod boots.

9. Tighten the boot bands and bend both sets of locking tabs over the band (Figure 13-19). Tap lightly on the doubled over portion of the band to reduce its height and stake the locking tabs firmly.

The **rear sub steering angle sensor** sends a voltage signal to the 4WS computer in relation to the amount of rack movement in the rear steering actuator.

Remove and Replace Rear Steering Actuator Sensors

Follow these steps to remove and replace the rear sub steering angle sensor and the rear main steering angle sensor.

1. Loosen the rear sub steering angle sensor locknut and rotate the sensor to thread it out of the housing (Figure 13-20). Discard the sensor O-ring.

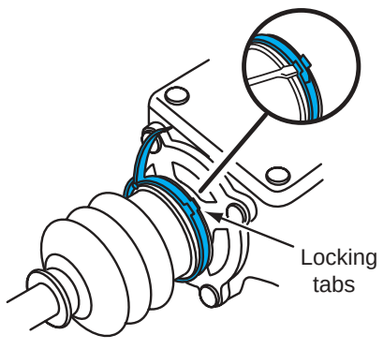

Figure 13-19 Tightening and staking the inner tie-rod boot clamps.

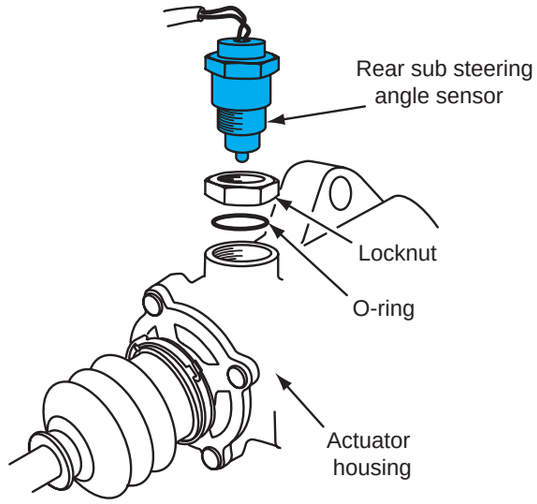

Figure 13-20 Removing the rear sub steering angle sensor.

2. Remove the two mounting bolts in the rear main steering angle sensor, and then remove the sensor from the actuator housing (Figure 13-21). Note the position of the dowel pins, and discard the O-ring.

   SERVICE TIP: Cover the rear main steering sensor and rear sub steering sensor openings in the actuator housing with masking tape or its equivalent to keep dirt and foreign material out of the actuator housing.

3. Install the locknut and a new O-ring on the rear sub steering angle sensor.

The **rear main steering angle sensor** sends a voltage signal to the 4WS computer in relation to ball screw rotation in the rear steering actuator.

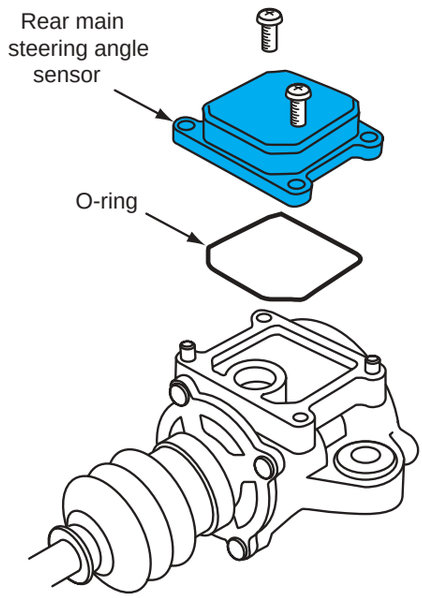

Figure 13-21 Removing the rear main steering angle sensor.

4. Place a light coating of grease on the O-ring and install the sensor in the actuator housing.
5. Rotate the sensor until it touches the tapered shaft and back it out one-half turn. Tighten the locknut finger tight. Final adjustment of the rear sub steering angle sensor is completed with the actuator installed in the vehicle.
6. Place a light coating of grease on the rear main steering angle sensor O-ring and install this O-ring on the sensor.
7. Install the rear main steering angle sensor and O-ring in the actuator housing with the dowel pins properly positioned, and tighten the mounting bolts to the specified torque.

Installing Rear Steering Actuator

Follow these steps for rear steering actuator installation.

1. Install the rear steering actuator and the four mounting bolts and bracket. The arrow on the bracket must face upward (Figure 13-22).
2. Tighten the rear steering actuator mounting bolts to the specified torque.

CAUTION: Tighten the castelated nut on the tie-rod ends to the specified torque, and then tighten these nuts enough to align the slots in the nut with the hole in the tie-rod pin. Do not loosen the nut to align the nut slots with the tie-rod pin hole. If this nut is loosened to align the slot with the hole, the tie-rod end may become loose in service.

3. Reconnect the tie-rod ends to the steering arms and tighten the castelated nut to the specified torque. If necessary, tighten the nut slightly to align the nut slots with the tie-rod pin hole.
4. Install the cotter pin in the nut and tie-rod end pin openings, and bend one leg of the cotter pin downward over the nut. Bend the other cotter pin leg upward over the top of the tie-rod end pin (Figure 13-23).
5. Check all the wiring connectors for contamination and clean as necessary. Install all the wiring connectors on the rear steering actuator and tighten all the terminal nuts to the specified torque (Figure 13-24).
6. Install the terminal cover on the rear main steering sensor terminals. Remove the rear steering lock pin and install the cap bolt and washer. Leave the steering actuator cover removed until after the final rear steering actuator adjustments.

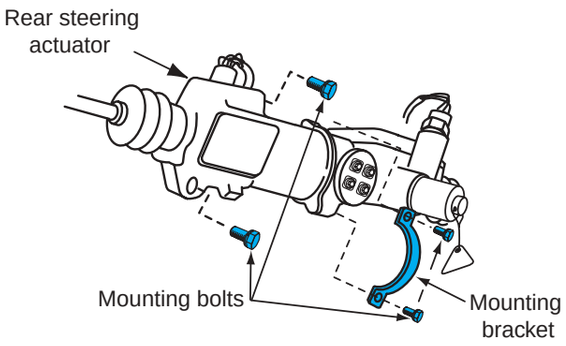

Figure 13-22 Installing the rear steering actuator, mounting screws, and bracket.

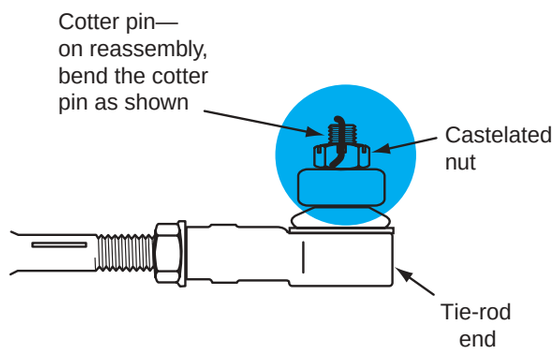

Figure 13-23 Proper installation of cotter pin in the tie-rod end.

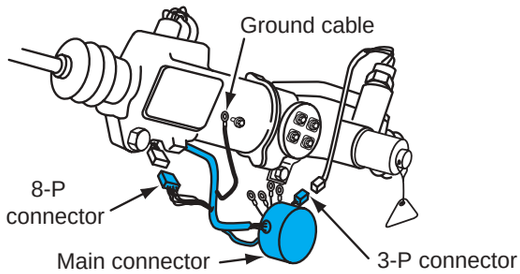

Figure 13-24 Installing wiring connectors on the rear steering actuator.

Rear Steering Actuator Adjustment

Electronic Neutral Check

Preliminary Checks

If the power to the 4WS control unit has been shut down for any of the following operations, start the engine and turn the steering wheel fully right and left.

1. Battery cables have been disconnected.
2. The 4WS control unit connector has been disconnected.
3. The number 43 clock-radio fuse has been disconnected.

CAUTION: Do not start the engine with the rear steering actuator lock pin in place. This action may damage the lock pin and rear steering actuator.

Prior to the electronic neutral check, be sure the steering wheel spoke is at the designated angle while driving straight ahead. Be sure the rear wheels are in the straight-ahead driving position before the electronic neutral check.

Steering Wheel Marking and Diagnostic Mode Entry

Follow these steps to mark the steering wheel, and enter the front steering sensor diagnostic mode.

Special Tools

Turning radius gauge turntables

1. Drive the vehicle on an alignment rack, and place all four wheels on turning radius gauge turntables. Be sure the wheels are in the center of the turntables with the wheels straight ahead and the turntables in the zero-degree position (Figure 13-25).

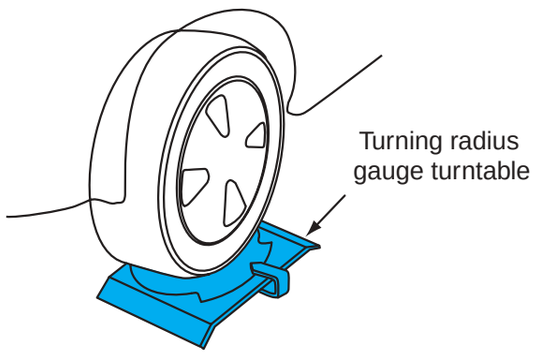

Figure 13-25 All four wheels must be on radius gauge turntables with the wheels straight ahead and the turntables in the zero-degree position.

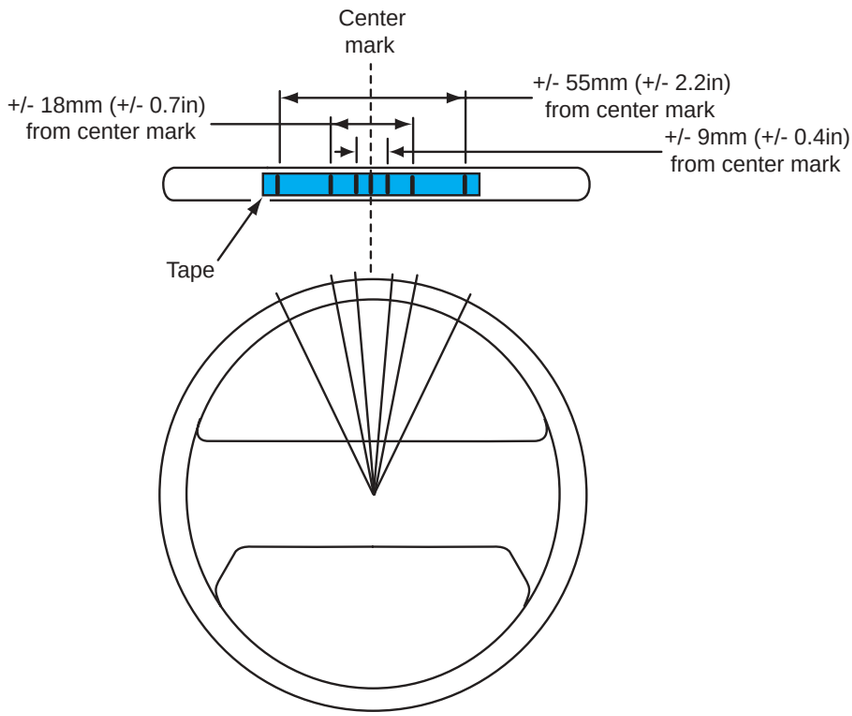

Figure 13-26 Steering wheel marking for electronically neutral check.

2. Place a piece of masking tape 12 in (300 mm) long on top of the steering wheel. Mark the tape at each of the following locations on the outer circumference of the wheel (Figure 13-26).
   - center, highest point on the wheel
   - 0.4 in (9 mm) right and left of the center mark
   - 0.7 in (18 mm) right and left of the center mark
   - 2.2 in (55 mm) right and left of the center mark
3. Bend a stiff piece of wire so it can be taped to the top of the dash with the outer end of the wire positioned over the steering wheel marks. Be sure the front wheels are straight ahead with the tip of the wire over the center mark on the steering wheel (Figure 13-27). Be sure the wire is securely taped to the top of the instrument panel.
4. Connect a jumper wire to the 4WS service check connector terminals. This is the same connection for obtaining 4WS control unit trouble codes. Check and verify the trouble codes prior to the electronic neutral check. The 4WS indicator light will not indicate the electronic neutral check and trouble codes at the same time.
5. Pull the parking brake fully on until the parking brake warning light is on, and turn on the ignition switch to set the front steering sensor test mode.

Front Sensor Inspection, Electronic Neutral Check

Follow these steps to check the front main steering sensor.

1. With the ignition switch on, turn the steering wheel slowly to the left and slowly to the right until the 4WS indicator light comes on. Repeat this step several times to find

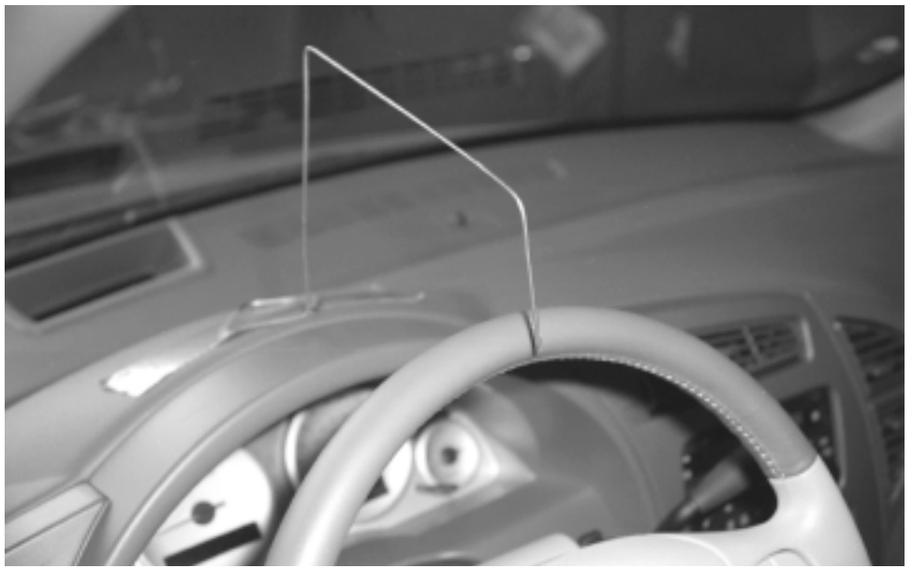

Figure 13-27 Front wheels straight ahead and wire pointer positioned over the center mark on the steering wheel.

the exact steering wheel position where the 4WS indicator light is illuminated for more than two seconds.

2. The 4WS indicator light should be illuminated when the steering wheel is 9 mm (0.4 in) to the left and right of the center mark on the steering wheel. If the 4WS indicator light comes on at a point outside of this specified range, the 4WS system requires adjustment.

Use the following procedure to check the front sub steering angle sensor:

The **front sub steering angle sensor** sends a voltage signal to the 4WS computer in relation to rack movement in the front steering gear.

1. Slowly turn the steering wheel to the left and right of the center position until the 4WS indicator light blinks at intervals of 0.2 seconds. Repeat this procedure several times to locate the exact steering wheel position where the indicator light begins blinking. The light should begin blinking within 2.2 in (55 mm) to the left or right of the center mark on the steering wheel.
2. If the 4WS indicator light does not begin flashing within this specified range, a 4WS system adjustment is necessary. After adjusting the front sub steering sensor, the 4WS indicator light should begin flashing when the steering wheel is turned 0.7 in (18 mm) to the left or right of the center mark on the steering wheel.

Rear Sensor Inspection, Electronic Neutral Check

Use the following procedure to complete the rear sensor inspection.

1. Release the parking brake and be sure the parking brake warning light is off. This causes the 4WS control unit to enter the rear steering sensor inspection mode.
2. Remove the rear cap bolt and sealing washer from the rear steering actuator and install the rear steering center lock pin until it bottoms in the actuator (Figure 13-28).
3. Position the front wheels in the straight-ahead position to prevent the rear wheels from steering if the engine is started by mistake.
4. Turn the ignition switch on and push the left rear wheel fully to the right by hand; then push this wheel fully to the left by hand while a coworker observes the 4WS

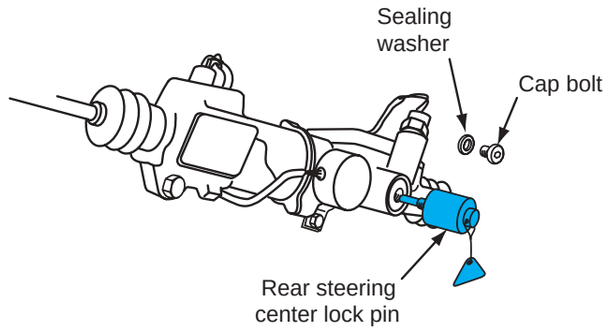

Figure 13-28 Removing the rear cap bolt and sealing washer, and installing the rear steering center lock pin.

indicator light (Figure 13-29). The 4WS indicator light should begin to flash at 0.2-second intervals when the left rear wheel is pushed to the left a small amount. If the 4WS indicator light does not flash, adjust the rear sub steering angle sensor.

5. With the ignition switch on, push the left rear wheel fully to the left by hand; then slowly push it to the right. The 4WS indicator light should be illuminated for more than two seconds when the left rear wheel is pushed to the right (Figure 13-30). If the 4WS indicator light is not illuminated, remove the rear main steering angle sensor and check it for damage.
6. Turn off the ignition switch.
7. Remove the rear steering center lock pin and install the cap bolt and washer. Tighten the cap bolt to the specified torque.
8. Remove the jumper wire from the service check connector.
9. Install the rear steering actuator cover.

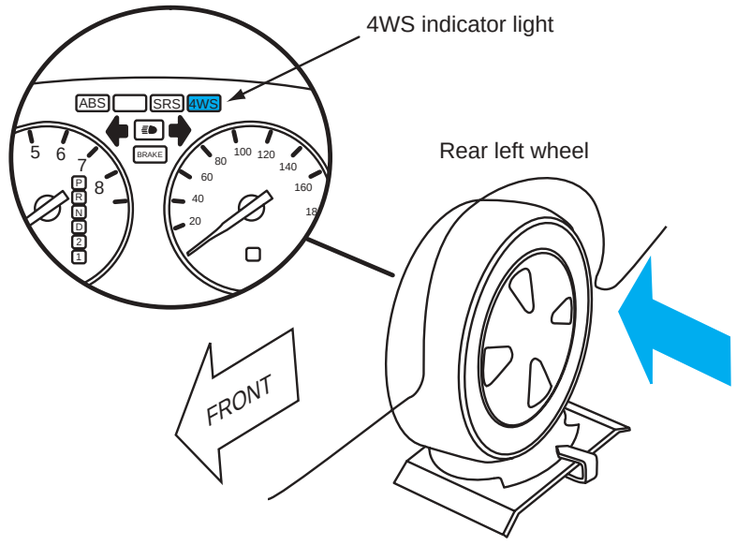

Figure 13-29 The 4WS indicator light should flash when the left rear wheel is pushed to the left, if the rear sub steering angle sensor is properly adjusted.

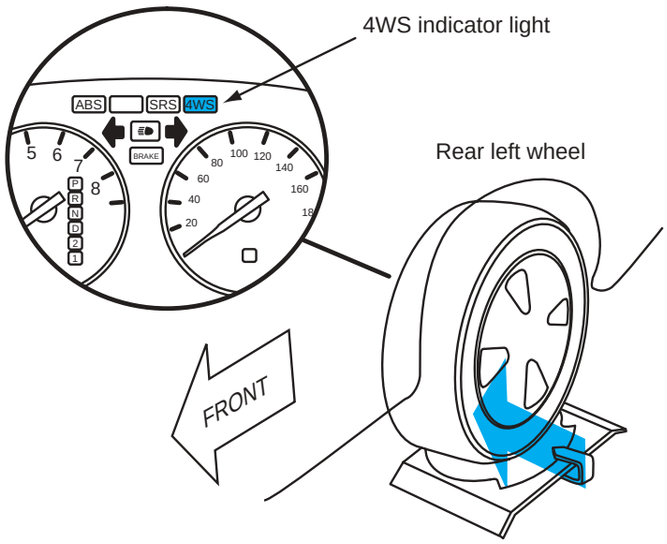

Figure 13-30 Pushing the left rear wheel to the right and observing the 4WS indicator light checks the rear main steering angle sensor.

Front Main Steering Angle Sensor Adjustment

Proceed as follows for the front main steering angle sensor adjustment.

The **front main steering angle sensor** sends a voltage signal to the 4WS computer in relation to steering wheel rotation.

1. Place the car on an alignment rack with each wheel on a turning radius gauge turntable. Turn the steering wheel fully to the right and then fully to the left; count the number of turns from fully right to fully left.
2. Turn the steering wheel back from full left exactly one-half the number of turns from fully right to fully left. This action centers the front steering rack. The steering wheel spoke should be within the vehicle manufacturer's specified number of degrees from the horizontal position. If the steering wheel is not within this specified position, proceed with the front main steering angle sensor adjustment and spoke angle adjustment.
3. Set the steering wheel so the front wheels are straight ahead, and remove the steering wheel retaining nut. Use a steering wheel puller to remove the steering wheel (Figure 13-31).

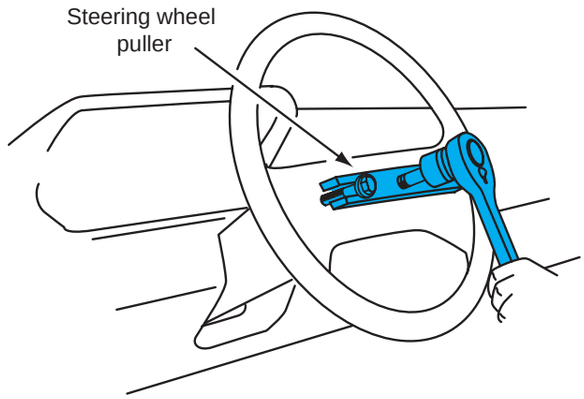

Figure 13-31 Removing the steering wheel.

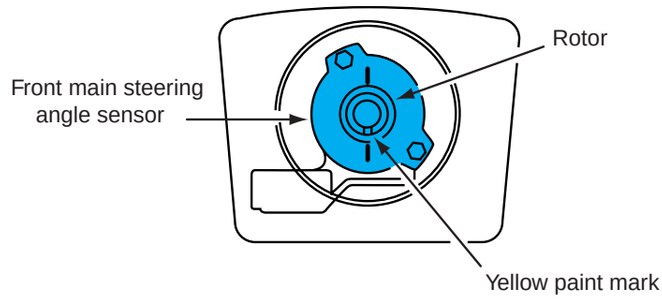

Figure 13-32 Yellow paint mark on the front main steering angle sensor indicating the electronically neutral sensor position.

4. Check to see if the yellow paint mark on the front main steering angle sensor is facing straight down (Figure 13-32). When this paint mark is facing down, the front main steering angle sensor is in the electronically neutral position.
5. If the yellow paint mark on the front main steering angle sensor is not facing downward, temporarily install the steering wheel with the spokes in the horizontal position. Turn the steering wheel until this yellow paint mark is facing downward.
6. Return the steering wheel to the horizontal position and remove the steering wheel.
7. Install the steering wheel, aligning it with the serration that makes the spoke angle closest to horizontal. Be sure the steering wheel openings fit over the pins on the **cable reel** for the air bag system (Figure 13-33). Do not push down hard on the steering wheel until the serrations and cable reel pins are properly aligned. When the serrations and cable reel pins are properly aligned, push the steering wheel down into place and install the retaining nut.
8. Hold the steering wheel and tighten the retaining nut to the specified torque.

The **cable reel** contains a conductive ribbon that connects the air bag module on top of the steering wheel to the air bag electrical system, while allowing steering wheel rotation.

Front Sub Steering Angle Sensor Adjustment

Use this procedure for the front sub steering angle sensor adjustment.

1. Raise the front and rear suspension with a floor jack and place safety stands under the proper chassis locations specified by the car manufacturer. All four wheels must be off the floor.

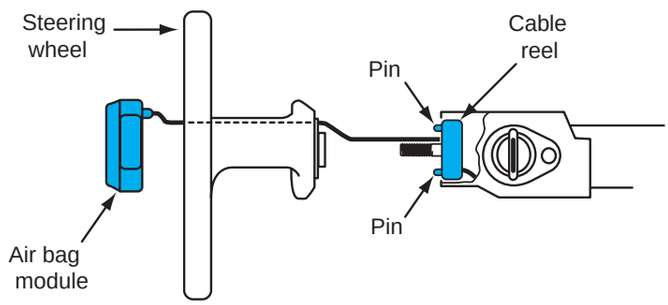

Figure 13-33 Proper alignment of the steering wheel openings and cable reel pins.

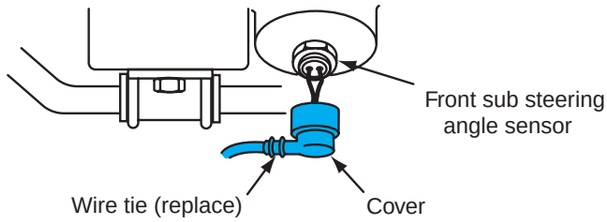

Figure 13-34 Cutting the tie strap and removing the front sub steering angle sensor cover.

2. Set the steering wheel in the straight-ahead driving position.
3. Connect a jumper wire across the 4WS system service check connector terminals.
4. Pull the parking brake on fully and turn on the ignition switch. Be sure the parking brake warning light is illuminated.
5. Turn the ignition switch off.
6. Cut the tie strap off the front sub steering angle sensor cover and remove this cover (Figure 13-34).
7. Remove the wiring harness from the clamp and disconnect the wiring harness connector.
8. Loosen the front sub steering angle sensor locknut; then tighten the locknut fully by hand. Back this locknut off three-quarters of a turn and connect the connector.
9. Be sure the front wheels are in the straight-ahead driving position and turn the steering wheel until the 4WS indicator light is illuminated. Keep the steering wheel in this position.
10. Slowly turn the front sub steering angle sensor clockwise until the 4WS indicator light goes off, and then mark the sensor position in relation to the housing.
11. Slowly rotate the front sub steering angle sensor counterclockwise until the 4WS indicator light begins to blink, and then mark the sensor in relation to the housing (Figure 13-35). Set the front sub steering angle sensor in the center of the range from where the light went off to where the light began to blink. Hold the sensor in this position and tighten the locknut to the specified torque.
12. Turn off the ignition switch. If the front sub steering angle sensor harness is twisted, disconnect the connector and straighten the harness. Install the harness in the clamp and install the sensor cover. Secure the cover with a new tie strap.
13. Perform the electronic neutral check described earlier in this chapter.

Rear Sub Steering Angle Sensor Adjustment

The rear main steering angle sensor is not adjustable.

Proceed with these steps to adjust the rear sub steering angle sensor.

1. Raise the front and rear suspension with a floor jack, and place safety stands under the proper chassis locations specified by the car manufacturer. All four wheels must be off the floor.
2. Connect a jumper wire across the terminals in the 4WS system service check connector, and be sure any trouble codes have been displayed.

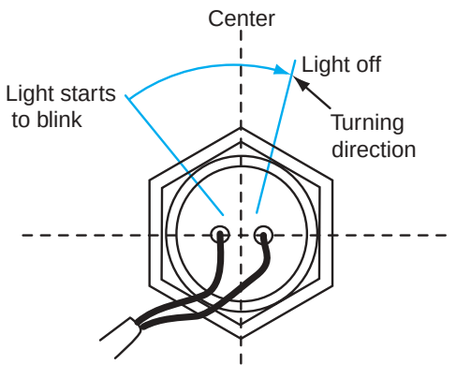

Figure 13-35 Adjusting the front sub steering angle sensor.

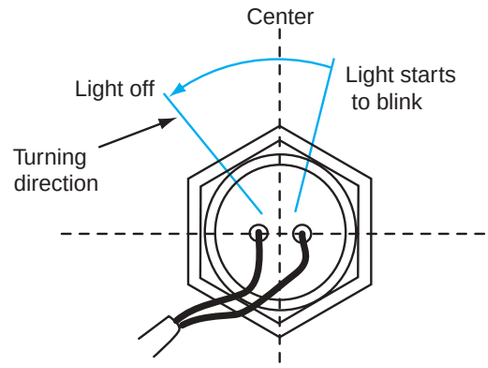

Figure 13-36 Adjusting the rear sub steering angle sensor.

3. Release the parking brake and turn the ignition switch on. Be sure the parking brake warning light goes off.
4. Turn off the ignition switch.
5. Remove the cap bolt and washer and install the rear steering center lock pin.
6. Remove the rear sub steering angle sensor wire from the clamp and disconnect the wiring harness connector.
7. Loosen the rear sub steering angle sensor locknut. Tighten this locknut fully by hand; then back it off approximately one-half turn.
8. Connect the rear sub steering angle sensor connector and set the front wheels in the straight-ahead driving position.
9. Turn on the ignition switch.
10. Push the left rear wheel fully to the left by hand, and then push this wheel slowly to the right until the 4WS indicator light comes on. This action places the main rear steering angle sensor in the electronically neutral position.
11. Slowly turn the rear sub steering angle sensor counterclockwise until the 4WS indicator light goes off, and mark the sensor in relation to the housing.
12. Slowly rotate this sensor clockwise until the 4WS indicator light starts to blink and mark the sensor in relation to the housing. Turn the sensor to the center position between where the indicator light went off and the light started to blink (Figure 13-36). Hold the sensor in this position and tighten the locknut to the specified torque.
13. Turn off the ignition switch.
14. If the rear sub steering angle sensor wiring is twisted, disconnect the connector, straighten the harness, and reconnect the connector.
15. Disconnect the jumper wire from the service check connector.
16. Remove the rear steering center lock pin and install the cap bolt and washer. Tighten the cap bolt to the specified torque.
17. Install the rear steering actuator cover and perform the electronic neutral check described earlier in this chapter.

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Chapter 13, page 307

Photo Sequence 13 shows a typical procedure for diagnosing an electronically controlled four-wheel steering system.

Photo Sequence 13
Typical Procedure for Diagnosing an Electronically Controlled Four-Wheel Steering System

P13-1 Road test the vehicle to check 4WS operation and indicator light.

P13-2 Raise the vehicle on a lift, and check all electrical connectors on the front steering gear and rear steering actuator.

P13-3 Lower the vehicle and locate the service check connector behind the center console.

P13-4 Look up the diagnostic procedure and trouble codes in the car manufacturer's service manual.

P13-5 Connect a jumper wire between the terminals in the service check connector.

P13-6 Turn on the ignition switch.

P13-7 Observe the 4WS indicator light flashes to obtain the fault codes.

P13-8 Turn off the ignition switch.

P13-9 Remove the jumper wire from the service check connector.

CASE STUDY

A customer complained about the 4WS indicator light coming on intermittently on a Honda Prelude with an electronic 4WS system. The technician asked the customer about any other steering problems, and the customer reported the car steered normally. The technician road tested the car, but the 4WS light did not come on, which indicated there were no electronic problems in the system. The customer was concerned about a possible safety hazard while driving this vehicle with the 4WS indicator light illuminated. In reply to this concern, the technician explained to the customer about the fail-safe function in the 4WS system and the rear wheels being centered in this mode.

The technician asked the customer about any recent service work completed on the vehicle. In response to this question, the customer replied that the car had been in a rear end collision recently, and when the body work was completed, the 4WS indicator light problem started occurring. The technician informed the customer that a 4WS system diagnosis and inspection should be performed.

Since the 4WS indicator light was not illuminated, the technician concluded that a trouble code diagnosis would probably not provide any diagnostic answers. However, the technician checked the system for codes in case there was a code caused by abnormal or harsh driving, which would not cause the indicator light to be illuminated.

When the technician raised the vehicle on a hoist, it was clearly visible that many of the rear suspension and body parts had been replaced recently. Even the rear steering actuator cover had been replaced. The technician removed the rear steering actuator cover to inspect the wiring on the actuator. All the wiring connectors were inspected, including the terminals on the rear main steering angle sensor. When the technician inspected the rear sub steering angle sensor wiring harness, he found this harness had been punctured by a sharp object near the sensor. The technician probed the sensor wires at the sensor and connected a pair of ohmmeter leads from each wire at the sensor to the corresponding colored wire in the sensor connector. Each wire showed a normal zero-ohm resistance. The technician repeated these ohmmeter connections and wiggled the wires at the damaged location. On one of the wires, the ohmmeter reading went to infinite while wiggling the wires, indicating an intermittent open circuit.

The technician replaced the rear sub steering angle sensor and performed the electronic neutral check and the rear sub steering angle sensor adjustment. During a road test, the 4WS indicator light did not come on.

Terms to Know

Cable reel
Fail-safe mode
Front main steering angle sensor
Front sub steering angle sensor
Rear main steering angle sensor
Rear steering center lock pin
Rear sub steering angle sensor
Service check connector

ASE-Style Review Questions

1. While discussing the fail-safe function:
Technician A says the 4WS indicator light is illuminated during the fail-safe function.
Technician B says the rear wheels steer normally when the 4WS control unit enters the fail-safe mode.
Who is correct?
A. A only **C.** Both A and B
B. B only **D.** Neither A nor B

2. While discussing the fail-safe function and damper control:
Technician A says the rear wheels move instantly to the centered position when the 4WS control unit enters the fail-safe mode.
Technician B says the return spring moves the rear wheels away from the centered position.
Who is correct?
A. A only **C.** Both A and B
B. B only **D.** Neither A nor B

3. While discussing trouble code diagnosis:
Technician A says the 4WS system service check connector is located under the driver's seat.
Technician B says when one of the service check connector terminals is grounded, the 4WS system enters the diagnostic mode.
Who is correct?
A. A only **C.** Both A and B
B. B only **D.** Neither A nor B

4. While discussing trouble code diagnosis:
Technician A says many 4WS system trouble codes are cancelled when the ignition switch is turned off.
Technician B says codes representing problems caused by abnormal or harsh driving conditions do not illuminate the 4WS indicator light.
Who is correct?
A. A only **C.** Both A and B
B. B only **D.** Neither A nor B

5. While discussing rear steering actuator service:
Technician A says the rear steering actuator is a replacement unit except for tie rods and sensors.
Technician B says the arrows on the rear steering actuator brackets must face downward.
Who is correct?
A. A only **C.** Both A and B
B. B only **D.** Neither A nor B

6. All of these statements about rear steering actuators and actuator service are true EXCEPT:
A. Axial impact on the shaft screw may damage the actuator.
B. Rotational force on the shaft screw may damage the actuator.
C. The engine may be started with the rear steering lock pin in place.
D. The shaft screw must be held with a special tool while loosening the tie rods.

7. While servicing and adjusting electronically controlled four-wheel steering systems:
A. the steering center lock pin must be installed in the left rear tie rod for many 4WS adjustments.
B. the electronic neutral check determines if the front or rear steering sensors require adjustment.
C. the electronic neutral check is performed with the rear wheels fixed in the straight-ahead position.
D. the 4WS indicator light is illuminated with the engine running if the inner tie rods are loose in the rear steering actuator.

8. While servicing and adjusting electronically controlled four-wheel steering systems:
   - **A.** the front main steering angle sensor is not adjustable.
   - **B.** the rear main steering angle sensor is adjustable.
   - **C.** removing the clock-radio fuse erases the diagnostic trouble codes.
   - **D.** if the 4WS light provides three long flashes followed by three short flashes in the diagnostic mode, code 3 is indicated.

9. While servicing and adjusting electronically controlled four-wheel steering systems:
   - **A.** in the diagnostic mode, the 4WS indicator light flashes quickly for 10 seconds between the main and sub processor DTCs.
   - **B.** a DTC may be set in the processor memory if the steering wheel is turned with a rear wheel against a curb and the engine running.
   - **C.** if the steering wheel is turned with the engine running and a rear wheel against a curb, the 4WS indicator light is illuminated.
   - **D.** driving the car with the parking brake on has no effect on the 4WS indicator light.

10. While servicing and adjusting electronically controlled four-wheel steering systems:
    - **A.** the 4WS indicator light will indicate DTCs and the electronic neutral check at the same time.
    - **B.** the parking brake must be released during the front steering sensor test mode.
    - **C.** the ignition switch must be on during the front steering test mode.
    - **D.** the brake pedal must be depressed during the rear steering test mode.

ASE Challenge Questions

1. While discussing electronic 4WS:
   Technician A says jumping the two terminals of the service check connector with the engine off will display DTCs.
   Technician B says jumping the service check connector then starting the engine displays the processor in which the codes are stored.
   Who is correct?
   - **A.** A only
   - **B.** B only
   - **C.** Both A and B
   - **D.** Neither A nor B

2. The Honda Prelude 4WS system uses a main and a sub processing unit, each storing 10 trouble codes. If the 4WS light on the dash blinks quickly and repeatedly for three seconds, it means:
   - **A.** a DTC is stored in the main processor.
   - **B.** a DTC is stored in the sub processor.
   - **C.** the system is moving from the main to the sub processor memory.
   - **D.** a DTC sequence will be repeated.

3. Honda Prelude temporary “abnormal or harsh driving” 4WS DTCs range from _____ to _____ .
   - **A.** 07/14
   - **B.** 70/74
   - **C.** 17/24
   - **D.** 44/47

4. The Honda Prelude 4WS light has gone on and remains on.
   Technician A says that before performing any diagnostic tests, the 10A fuse for the clock radio should be removed.
   Technician B says to retrieve the DTC, the 4WS control unit connector must be disconnected.
   Who is correct?
   - **A.** A only
   - **B.** B only
   - **C.** Both A and B
   - **D.** Neither A nor B

5. While discussing electronic 4WS:
   Technician A says that after repairing a defect of the main steering angle sensor in the Honda Prelude 4WS system, fuse #43 must be removed to cancel the code.
   Technician B says the battery terminal must be removed to cancel DTCs in parts of the Honda Prelude 4WS system other than the main steering angle sensor.
   Who is correct?
   - **A.** A only
   - **B.** B only
   - **C.** Both A and B
   - **D.** Neither A nor B

Job Sheet 39

39

Name _____ Date _____

Retrieve Diagnostic Trouble Codes (DTCs), Four-Wheel Steering (4WS) System

Upon completion of this job sheet, you should be able to retrieve diagnostic trouble codes (DTCs) on four-wheel steering (4WS) systems.

ASE Correlation

This job sheet is related to ASE Automotive Suspension and Steering Task: *Inspect, diagnose, adjust, service, or replace components of electronically controlled steering systems.*

Tools and Materials

Jumper wire

Describe the Vehicle Being Worked On:

Year _____ Make _____ Model _____
VIN _____ Engine type and size _____

Procedure

Task Completed

1. Be sure the ignition switch is off and remove the dual-terminal service check connector located behind the center console. Connect the two terminals in this connector with a jumper wire.

   Is the jumper wire properly connected? ☐ Yes ☐ No

   Instructor check _____

2. Turn the ignition switch on, but do not start the engine. h
3. Observe the 4WS indicator light to read the diagnostic trouble codes (DTCs). Three longer flashes followed by a brief pause and one quicker flash indicates code 31. The codes are given in numerical order. h
4. List the DTCs provided with ignition switch on and the engine not running and include the DTC interpretation.

   1. _____
   2. _____
   3. _____

5. Turn the ignition switch off and start the engine while observing the 4WS indicator light in the instrument panel. h
6. Does the 4WS indicator light blink once quickly when the ignition switch is turned on?

   4WS light operation: ☐ Satisfactory ☐ Unsatisfactory

   If the 4WS light operation is unsatisfactory, describe the light operation.

   _____

   _____

Task Completed

7. After the quick flash in step 6, did the 4WS indicator light pause for three seconds?

4WS light operation: ☐ Satisfactory ☐ Unsatisfactory

If the 4WS light operation is unsatisfactory, describe the light operation.

_____

_____

8. List the main processor DTCs displayed after the pause in step 7 and include the DTC interpretation.

1. _____
2. _____
3. _____

9. Did the 4WS indicator light pause for 1.6 seconds after the DTCs displayed in step 8?

☐ Yes ☐ No

4WS light operation: ☐ Satisfactory ☐ Unsatisfactory

If the 4WS light operation is unsatisfactory, describe the light operation.

_____

_____

10. Did the 4WS indicator light blink quickly for three seconds to indicate a separation between the main and sub processor codes? ☐ Yes ☐ No

4WS light operation: ☐ Satisfactory ☐ Unsatisfactory

If the 4WS light operation is unsatisfactory, describe the light operation.

_____

_____

11. Did the 4WS indicator light pause for 1.6 seconds? ☐ Yes ☐ No

4WS light operation: ☐ Satisfactory ☐ Unsatisfactory

If the 4WS light operation is unsatisfactory, describe the light operation.

_____

_____

12. List the sub processor DTCs displayed after the pause in step 11, and include the DTC interpretation.

1. _____
2. _____
3. _____

13. Did the 4WS indicator light pause for 3 seconds and then repeat the cycle?

☐ Yes ☐ No

4WS light operation: ☐ Satisfactory ☐ Unsatisfactory

If the 4WS light operation is unsatisfactory, describe the light operation.

_____

_____

14. On the basis of all the DTCs displayed, state the required diagnostic procedure to locate the exact cause of the defect(s) and explain the reasons for your diagnosis.

_____

_____

Instructor's Response _____

Job Sheet 40

40

Name _____ Date _____

Remove and Replace Rear Steering Actuator

Upon completion of this job sheet, you should be able to remove and replace a rear steering actuator.

ASE Correlation

This job sheet is related to ASE Automotive Suspension and Steering Task: *Inspect, diagnose, adjust, service, or replace components of electronically controlled steering systems.*

Tools and Materials

Tie-rod end puller
Torque wrench

Describe the Vehicle Being Worked On:

Year _____ Make _____ Model _____
VIN _____ Engine type and size _____

Procedure

Task Completed

1. Raise the vehicle on a hoist, or lift the rear of the vehicle with a floor jack, and support the chassis with safety stands placed under the chassis at the vehicle manufacturer's recommended locations. h
2. Remove the cotter pin and nut from each tie-rod end. h
3. Install a 12-millimeter (mm) nut on each tie-rod end until the nuts are flush with the tie-rod stud. h
4. Install the special tool on the tie-rod end and with the tool arms parallel, tighten the screw on the tool to loosen the tie-rod end. Repeat the procedure on both tie-rod ends. h
5. Remove the nuts from the tie rods and remove the tie rods from the steering arms. h
6. Remove the rear steering actuator cover. h
7. Remove the the cap bolt and washer and install the rear steering center lock pin.

   Is the rear steering center lock pin installed? ☐ Yes ☐ No

   Instructor check _____
8. Remove the ground cable connector and all wiring harness connectors on the rear steering actuator.

   Are the ground cable connector and all wiring harness connectors removed?
   ☐ Yes ☐ No

   Instructor check _____

Task Completed

h

9. Remove the four mounting bolts and bracket and remove the rear steering actuator.

10. Install the rear steering actuator, the four mounting bolts, the and bracket. The arrow on the bracket must face upward.

Is the arrow on the bracket facing upward? ☐ Yes ☐ No

Instructor check _____

11. Tighten the rear steering actuator mounting bolts to the specified torque.

Specified rear steering actuator mounting bolt torque _____

Actual rear steering actuator mounting bolt torque _____

CAUTION: Tighten the castelated nut on the tie-rod ends to the specified torque; then tighten these nuts enough to align the slots in the nut with the hole in the tie-rod pin. Do not loosen the nut to align the nut slots with the tie-rod pin hole. If this nut is loosened to align the slots with the hole, the nut may become loose in service.

12. Reconnect the tie-rod ends to the steering arms and tighten the castelated nut to the specified torque. If necessary, tighten the nut slightly to align the nut slots with the tie-rod pin hole.

Specified tie-rod end castelated nut torque _____

Actual tie-rod end castelated nut torque _____

13. Install the cotter pin in the nut and tie-rod end pin openings and bend one leg of the cotter pin downward over the nut. Bend the other cotter pin leg upward over the top of the tie-rod end pin.

Are the cotter pins properly installed in the tie-rod end nuts? ☐ Yes ☐ No

Instructor check _____

14. Check all the wiring connectors for contamination, and clean as necessary. Install all the wiring connectors on the rear steering actuator and tighten all the terminal nuts to the specified torque.

Wiring terminal condition: ☐ Satisfactory ☐ Unsatisfactory

Specified wiring terminal nut torque _____

Actual wiring terminal nut torque _____

15. Install the terminal cover on the rear main steering sensor terminals. Remove the rear steering lock pin and install the cap bolt and washer. Leave the steering actuator cover removed until after the final rear steering actuator adjustments.

Is the rear steering lock pin removed? ☐ Yes ☐ No

Are the cap bolt and washer properly installed in the rear steering lock pin hole? _____

Instructor check _____

Instructor's Response _____

Job Sheet 41

41

Name _____ Date _____

Remove and Replace Rear Steering Actuator Tie Rods and Tie-Rod Ends

Upon completion of this job sheet, you should be able to remove and replace rear steering actuator tie rods and tie-rod ends.

ASE Correlation

This job sheet is related to ASE Automotive Suspension and Steering Task: *Inspect, diagnose, adjust, service, or replace components of electronically controlled steering systems.*

Tools and Materials

Torque wrench
Wax marker
Rack holding tool

Describe the Vehicle Being Worked On:

Year _____ Make _____ Model _____
VIN _____ Engine type and size _____

Procedure

Task Completed

1. Road test the vehicle and describe the steering problems that indicate the rear steering actuator tie rods and tie-rod ends require replacement.

_____

_____

_____

_____

2. Visually inspect the rear steering actuator tie rods and tie-rod ends, and list the parts that require replacement. Explain the reasons for your diagnosis.

_____

_____

_____

_____

3. Mark the relative position of the tie-rod end, locknut, and tie rod with a wax marker. h

Are the tie rod, tie-rod end, and locknut properly marked? ☐ Yes ☐ No

4. Hold the tie-rod end with a wrench and loosen the locknut.

Task Completed

h **5.** Remove the tie-rod end.

h **6.** Remove the boot bands and clamps from the inner tie-rod ends.

h **7.** Place the flat side of the rack holding tool toward the actuator housing, and drive the special rack holding tool between the actuator housing and the stop washer with a soft hammer.

Is the rack holding tool properly installed with flat side toward the actuator housing?
☐ Yes ☐ No

h **8.** Straighten the tabs on the tie-rod lock washer.

Are the tabs straightened on tie-rod lock washer? ☐ Yes ☐ No

SERVICE TIP: Hold the special holding tool firmly while loosening the tie rod to avoid applying rotational force to the shaft screw in the actuator.

h **9.** Hold the shaft screw with the holding tool and loosen the tie rod with a wrench.

h **10.** Thread the tie rod off the shaft screw and repeat this procedure on each tie-rod end.

CAUTION: Do not allow dust, dirt, or foreign material to enter the tie-rod end ball joint or boot. This contamination causes rapid component wear.

CAUTION: Never apply axial impact or rotational force to the shaft screw in the rear steering actuator. Either of these actions may cause internal actuator damage.

11. Install the tie-rod ends so the marks on the tie-rod ends, locknuts, and tie rods are aligned, and tighten the tie-rod locknuts to the specified torque.

Marks on tie-rod ends, locknuts, and tie rods properly aligned? ☐ Yes ☐ No

Specified tie-rod end locknut torque _____

Actual tie-rod end locknut torque _____

Instructor check _____

12. Screw each inner tie rod onto the shaft screw while holding the lock washer so its tabs are in the inner tie-rod end. The stop washer must be installed on the shaft screw with the chamfered side facing outward.

Is the stop washer properly installed with chamfered side facing outward?
☐ Yes ☐ No

Instructor check _____

h **13.** Drive the special holding tool between the actuator housing and the stop washer with a soft hammer.

14. Hold the shaft screw with the holding tool and tighten the inner tie-rod end to the specified torque.

Specified inner tie-rod end torque _____

Actual inner tie-rod end torque _____

15. Bend the lock washer tabs against the flat on the inner tie-rod end.

Are the lock washer tabs bent against the flat on the inner tie-rod end?
☐ Yes ☐ No

Instructor check _____

Task Completed

16. Remove the special holding tool and apply silicone grease to the sliding surface of the tie rod. Place a light coating of silicone grease inside the tie-rod boot.

Is the sliding surface of the tie rod properly lubricated? ☐ Yes ☐ No

Is the inside surface of tie-rod boot properly lubricated? ☐ Yes ☐ No

Instructor check _____

17. Apply the vehicle manufacturer's recommended grease to the circumference of the inner tie-rod joint housing. h

Is the circumference of inner tie-rod joint housing properly lubricated?
☐ Yes ☐ No

Instructor check _____

18. Install the boots on the actuator housing and install the boot bands with the locking tabs properly positioned in relation to the actuator housing. h

Are the locking tabs properly positioned in relation to the actuator housing?
☐ Yes ☐ No

Instructor check _____

CAUTION: While staking the boot clamps, be careful not to damage the inner tie-rod boots.

19. Tighten the boot bands and bend both sets of locking tabs over the band. Tap lightly on the doubled over portion of the band to reduce its height and stake the locking tabs firmly. h

Are the boot bands properly installed? ☐ Yes ☐ No

Are the locking tabs properly staked? ☐ Yes ☐ No

Instructor check _____

Instructor's Response _____