



# Instructor's Guide

## Power Steering Systems: Service and Diagnosis

### Program Summary

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Automotive technicians work with vital vehicle components, and every decision requires fine-tuned knowledge. This program provides knowledge of the automobile as it relates to Power steering systems. Participants will be able to determine the proper replacement parts required after to inspection of old parts, and solve a wide range of problems related to customer concerns, requests, or descriptions of malfunctions. This translates into overall increased customer satisfaction and a successful career as an automotive technician.

### Learning Objectives

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**After viewing the program, participants will be able to:**

- Prepare for ASE Suspension and Steering (A4) Certification.
- Identify steering components.
- Describe the operation of a power steering pump.
- Describe the operation of a rack and pinion.
- Describe the operation of a steering gearbox.
- Perform steering system diagnostic tests.
- Explain how to flush power steering fluid.

## **National Standards**

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### **NATEF Tasks: Suspension and Steering / Steering System Diagnosis and Repair**

1. Disable and enable supplemental restraint system (SRS).
2. Remove and replace steering wheel; center/time supplemental restraint system (SRS) coil (clock spring).
3. Diagnose steering column noises, looseness, and binding concerns (including tilt mechanisms); determine necessary action.
4. Diagnose power steering gear (non-rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action.
5. Diagnose power steering gear (rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action.
6. Inspect steering shaft universal-joint(s), flexible coupling(s), collapsible column, lock cylinder mechanism, and steering wheel; perform necessary action.
7. Remove and replace rack and pinion steering gear; inspect mounting bushings and brackets.
8. Inspect rack and pinion steering gear inner tie rod ends (sockets) and bellows boots; replace as needed.
9. Determine proper power steering fluid type; inspect fluid level and condition.
10. Flush, fill, and bleed power steering system.
11. Inspect for power steering fluid leakage; determine necessary action.
12. Remove, inspect, replace, and adjust power steering pump drive belt.
13. Remove and reinstall power steering pump.
14. Remove and reinstall press fit power steering pump pulley; check pulley and belt alignment.
15. Inspect and replace power steering hoses and fittings.
16. Replace power steering pump filter(s).
17. Inspect and replace pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings, and steering linkage damper.

18. Inspect, replace, and adjust tie rod ends (sockets), tie rod sleeves, and clamps.
19. Identify hybrid vehicle power steering system electrical circuits and safety precautions.

## **ASE Task List A. Steering Systems Diagnosis and Repair**

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### **1. Steering Columns**

1. Diagnose steering column noises and steering effort concerns (including manual and electronic tilt and telescoping mechanisms); determine needed repairs.
2. Inspect and replace steering column, steering shaft U-joint(s), flexible coupling(s), collapsible columns, steering wheels (includes steering wheels and columns equipped with air bags and/or other steering wheel/column mounted controls, sensors, and components).
3. Disarm, enable, and properly handle airbag system components during vehicle service following manufacturers' procedures.

### **2. Steering Units**

1. Diagnose steering gear (non-rack and pinion type) noises, binding, vibration, free play, steering effort, steering pull (lead), and leakage concerns; determine needed repairs.
2. Diagnose rack and pinion steering gear noises, binding, vibration, free play, steering effort, steering pull (lead), and leakage concerns; determine needed repairs.
3. Inspect power steering fluid level and condition; determine fluid type and adjust fluid level in accordance with vehicle manufacturers' recommendations.
4. Inspect, adjust, align, and replace power steering pump belt(s), tensioners and pulleys.
5. Diagnose power steering pump noises, vibration, and fluid leakage; determine needed repairs.
6. Remove and replace power steering pump; inspect pump mounting and attaching brackets; remove and replace power steering pump pulley; transfer related components.
7. Perform power steering system pressure and flow tests; determine needed repairs.
8. Inspect and replace power steering hoses, fittings, O-rings, coolers, and filters.

9. Remove and replace steering gear (non-rack and pinion type).
10. Remove and replace rack and pinion steering gear; inspect and replace mounting bushings and brackets.
11. Adjust steering gear (non-rack and pinion type) worm bearing preload and sector lash.
12. Inspect and replace steering gear (non-rack and pinion type) seals and gaskets.
13. Adjust rack and pinion steering gear.
14. Inspect and replace rack and pinion steering gear bellows/boots.
15. Flush, fill, and bleed power steering system.
16. Diagnose, inspect, repair or replace components of variable-assist steering systems.

**3. Steering Linkage**

1. Inspect and adjust (where applicable) front and rear steering linkage geometry (including parallelism and vehicle ride height).
2. Inspect and replace pitman arm.
3. Inspect and replace center link (relay rod/drag link/intermediate rod).
4. Inspect, adjust (where applicable), and replace idler arm(s) and mountings.
5. Inspect, replace, and adjust tie rods, tie rod sleeves/adjusters, clamps, and tie rod ends (sockets/bushings).
6. Inspect and replace steering linkage damper(s).

**Steering Systems Lesson Plan**

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**Assignment: Steering Systems**

NATEF Standards	Start Date	End Date	Test Grades	Inst. Initials
General Suspension & Steering Systems 1 Steering Systems Diagnosis & Repair 1-19				

- A Read tutorial on steering systems.
- B Complete the pre-video discussions questions on steering systems.
- C View steering system video.
- D Complete post-video assessment questions on steering systems.

## **Automotive Steering Systems Tutorial**

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### **Overview:**

The direction of motion of a motor vehicle is controlled by a steering system. The steering system is connected to the steering wheel, with linkage connecting the steering system to the wheel assemblies and front suspension parts to allow the wheel assembly's pivot. When the driver turns the steering wheel, a shaft from the steering column turns a steering gear. The steering gear moves the tie rods that connect to the front wheels. The tie rods move the front wheels to turn the vehicle to the right or to the left. There are two basic types of steering systems: rack and pinion, and the recirculating gear box. In both types, the gearing in the steering system makes turning the wheels easier for the driver.

### **Rack and Pinion:**

A rack and pinion steering system has a steering wheel, a main-shaft, universal joints, and an intermediate shaft. When the steering wheel is turned, movement is transferred by the shafts to the pinion. The pinion is meshed with the teeth of the rack; pinion rotation moves the rack from side to side. Rack and pinion steering is quickly becoming the most common type of steering on cars, small trucks and SUVs. Rack and pinion steering systems are compact and lightweight. These systems have a very sharp steering response because the rack operates directly on the steering knuckle, providing very little rotational resistance. The rack and pinion serves two functions: it converts the rotational motion of the steering wheel into the linear motion needed to turn the wheels; and it provides gear reduction, making it easier to turn the wheels.

### **Recirculating Gear Box:**

The steering gear box, also known as recirculating ball, contains a worm gear which turns the sector shaft attached to the pitman arm. The pitman arm turns the wheels, usually through a parallelogram steering linkage. A steering gearbox provides a gear reduction, and a 90 degree change in direction. The steering gear converts and multiplies rotational force from the steering wheel into the force required to move the steering linkage, which steers the vehicle. Its heavy construction and durability makes it suitable for use on heavier vehicles.

### **Parallelogram Steering System:**

When turning the steering wheel, a gear in the steering gearbox turns a lever called a pitman arm. The pitman arm is connected to a center link (relay rod) which is connected to another pivoting lever called the idler arm. The idler arm is usually connected to the frame on the other side of the pitman arm. Tie rods are connected at the ends to the steering knuckle, which turns the wheels. The pitman arm and idler arm always move parallel to each other.

### **Power Steering Pump:**

The power steering pump transfers power steering fluid under pressure to steering gears, allowing the driver to steer with minimal effort. The pump is what drives the power steering. Inside the pump are rotary vanes that spin in an oval chamber. This takes the power steering fluid from the reservoir and pressurizes it. The fluid is then sent out the high pressure line to a steering gear and returns back to the pump reservoir via the low pressure return line. A belt connected to the engine runs the pump. In turn, the amount of flow of pressurized fluid depends on the speed that the engine is running. There

is a pressure relief valve in the pump that makes sure the pressure does not become too high while driving at high engine speeds.

**Pump Diagnosis:**

Listen for a squealing noise with the hood open and the engine running. It might sound similar to the whine the pump can make when cranking the steering wheel all the way to one side, but this squealing can happen with the steering wheel in any position. Check the tension on the serpentine belt to make sure the belt is not squealing instead. Check the fluid level in the power steering pump. Low fluid can cause poor pump performance and can also burn out the pump. Inspect the power steering lines for leaks, cracks or clogs.

**Pressure Test a Power Steering Pump:**

Test the fluid pressure on the power steering pump to confirm its failure. Turn off the engine, and unhook the pressure line from the power steering pump. Insert the pressure gauge in series between the pressure line and the pump, and turn on the engine. Crank the steering wheel all the way in one direction to remove any air. Check the pressure at 1,000 rpm and again at 3,000 rpm. Turn the steering wheel one direction until it stops. Check the power steering pump pressure. Always check the vehicle service manual for the proper specifications.

**Remember:**

Steering system tests generate high heat and high pressures in the pump. This valve should be closed momentarily in order to not damage the pump due to heat, and not damage a hose which may cause a fire hazard or bodily injuries. The steering system generates great amounts of power; always follow proper safety precautions when working on the system.

## **Steering System Troubleshooting Guide:**

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**Road Wander**

- Tire pressure incorrect or unequal
- Components in steering linkage loose or worn
- Wheel bearings improperly adjusted or worn
- Front end alignment out of specification
- Steering gear mounting loose on frame

**No Recovery**

- Low tire pressure
- Front end component bind
- Front alignment incorrect
- Steering gear improperly adjusted
- Steering gear bearings worn

**Shimmy:**

- Badly worn or unevenly worn tires
- Improperly mounted tire or wheel
- Wheel bearings improperly adjusted or worn
- Components in steering linkage loose or worn

**Over-Steering:**

- Components in steering linkage loose or worn
- Steering column binding
- Steering gear improperly adjusted
- Steering gear bearings worn

**High Steering Effort in One Direction:**

- Unequal tire pressure
- Vehicle overloaded
- Inadequate hydraulic system performance
- Excessive internal leakage in one direction
- Bad/worn steering gear valve

**High Steering Effort in Both Directions:**

- Low tire pressure
- Vehicle overloaded
- Low hydraulic fluid level
- Insufficient pump pressure and flow
- Component bind in steering system
- Restriction in return line
- Excessive internal leakage
- Oversize tires

**Lost Motion at Steering Wheel:**

- Steering column loose on shaft
- Loose connection between the steering gear, intermediate column, and steering column
- Steering gear loose on frame
- Pitman arm to shaft looseness
- Steering component wear
- Steering gear incorrectly adjusted

**Excessive Heat:**

- Excessive pump flow
- Undersized steering hoses
- Restriction in oil delivery system
- Steering gear valve worn/failed

## **Pre-Video Discussion Questions**

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1. What functions does a vehicle steering system serve?

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2. What is involved in making sure the steering system is functioning properly?

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3. What are some of the tools you can use to diagnose potential steering problems?

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4. How does customer service fit into understanding the vehicle steering system?

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5. List as many components as you can that relate to the vehicle steering system.

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## **Post-Video Assessment Questions**

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**Q1.** Two technicians are discussing a vehicle's steering system. Technician A says a rack and pinion changes rotational motion of the steering wheel to linear motion at the wheels. Technician B says power steering pumps can deliver over 1000 pounds per square inch of hydraulic pressure. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

**Q2.** During a visual inspection of a customer's steering system, what should you look for?

- A. Leaks
- B. Loose components
- C. Mounting hardware
- D. All of the above

**Q3.** Technician A says a vehicle pulling to one side could be caused by a spool valve problem in the rack and pinion assembly. Technician B says a vehicle with steering wander may be caused by loose rack and pinion mounts. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

**Q4.** When performing a power steering pump pressure test:

- A. hold the gauge in the closed position for 15 seconds
- B. when turning the wheels from steering stop to stop, the pressure should decrease
- C. hook the gauge up in series to the low pressure return line
- D. compare results with the manufacture specifications

**Q5.** Two technicians are discussing a steering gear box with a parallelogram steering system. Technician A says a worn pitman arm can cause excessive steering wheel free play. Technician B says a worn idler arm could cause excessive steering free play. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

## Answer Key:

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- Q1. C
- Q2. D
- Q3. C
- Q4. D
- Q5. C

## Vocabulary Terms

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**Center Link** – a link used to connect the idler arm to the pitman arm in a parallelogram steering system. The link transfers steering motion to vehicle tie rods.

**Flow Control Valve** – a valve used in a power steering pump to control the amount of flow from the pump.

**Gear Reduction** – a gear reduction is used to make large turns of the steering wheel into smaller turns of the tires to aid in steering for the driver.

**Idler Arm** – a component used to transmit steering forces from a center link to a tie rod in parallelogram steering system.

**Inner Tie Rod** – tie rod attached to the end of the rack that allows for suspension movement.

**Linear Motion** - movement in a straight line.

**Outer Tie Rod** – tie rod attached between the tie rod and the steering arm.

**Parallelogram Steering System** – a linking arrangement that allows the wheels to maintain the correct steering positions during jounce or rebound. Linkage components take the shape of a parallelogram. All components are parallel to one another from one side of the vehicle to the other.

**Pitman Arm** – an arm used to transfer rotational movement of the sector shaft to linear movement of the center link in a parallelogram steering system.

**Power Steering Pump** – hydraulic pump that provides assistance to the driver when turning the steering wheel.

**Rack and pinion Steering System** – a steering system that uses a pinion gear connected to the steering column shaft through a coupling to turn a long rack gear. The rack has tie rods on each end which move the steering arms, knuckles and spindle in the direction desired.

**Recirculating-Ball Steering Gear** – a steering gear that uses a worm gear to drive a ball nut through recirculating balls. The recirculated balls reduce friction between the worm and ball nut. Commonly used with parallelogram steering systems.

**Steering System** – term used to describe all of the components used when steering a vehicle.

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