Dorman Training Center Presents:

HD VEHICLE STEERING

2025

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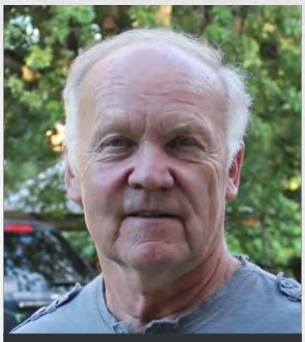
Your Instructor For This Webinar

Swede is the owner of a repair shop and is an ATTP Master Instructor. He's the author of "Medium/Heavy Duty Truck Electricity and Electronics" and has developed and presented training courses that specialize in brakes, electrical systems and other automotive repair topics.



Swede Oun

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What Will Be Covered:

01 HD Vehicle Steering Overview

02 System and Component Descriptions

03 Regulatory Requirements

04 Best practices

Instructions for this Webinar:

- This webinar will be approx. 1+ hour long
- All slides that are presented are in your handout and are numbered
- Have a pen or pencil and paper for notes
- Questions can be asked at anytime

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Steering

- **The steering system is another important safety component of a vehicle that must be properly maintained.**
- **Steering systems are made of many components starting with the steering wheel and ending at the road wheel.**
- **The purpose of the steering system is to give the operator directional control of the vehicle.**
- **Because of the safety aspect, the system and its components fall under federal regulations**
- **When a problem or complaint from a driver occurs, it is up to us to diagnose the system to figure out the cause.**

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Steering

- The steering system in commercial vehicles with weights often exceeding 40 tons of combined vehicle and cargo weight must deliver precise directional control.
- Ideally the system must perform this with little driver effort at the steering wheel.
- Most truck steering systems today are the Power Steering type instead of the manual steering type often used years ago.
- The steering system is also closely related to the front suspension, axle, and wheel/tire components.
- Improper steering adjustment or problems can lead to alignment and tire wear problems.
- At the same time, suspension, axle, and wheel problems can affect steering and handling.

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Steering

Steering is the one area I never take a chance at. I don't take any short cuts. Any problems I find gets documented and it gets thrown into the customer's lap.

If you lose brakes and steering, you are screwed.

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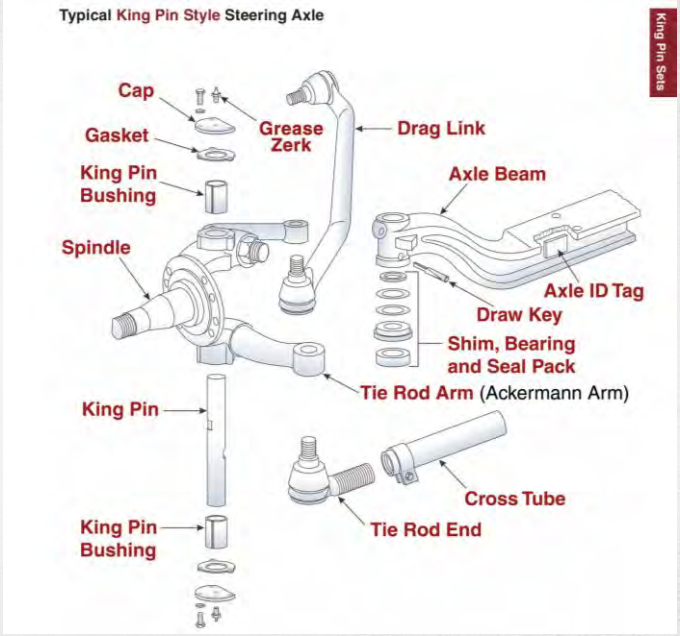
Steering

These are components that tend to be high maintenance items. Lack of proper lubrication will cause early failure.



Steering

King Pin Sets

King Pin Set Component Information

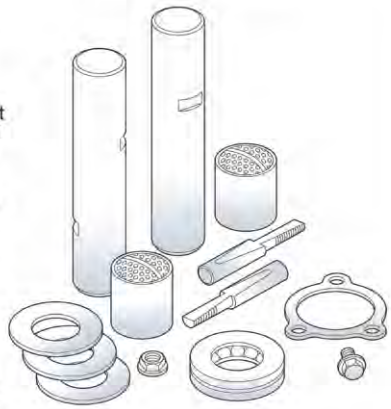
Function: The king pin serves as the pivot point which attaches the wheel spindle to the axle beam and is considered to be the most critical component of the axle assembly. It provides the means for the drag link, in connection with the steering arm, to change the lateral movement into turning motion.

Features and Benefits: Since the king pin is the very heart of the axle assembly, it is mandatory for a replacement part of this nature to be of the highest quality. All Dayton Parts pins utilize high quality steel and are heat treated for superior strength and long service life. A satin smooth micro-finish insures minimum steering effort yet retains the ability to hold grease for proper lubrication.

Bushing Types: Dayton Parts offers the installer a variety of distinct types of bushing materials and bushing types. Each has its own unique features and benefits.

Nylon (Delrin) bushings provide reduced steering effort and are fast to install since they do not have to be fitted. They are generally only recommended for vehicles which spend most of their time on-highway. They tend to wear out faster than bronze bushings in severe service applications.

Typical King Pin Set



Steel Backed Bronze (Bimetal) has traditionally been the bushing material of choice of many mechanics. Very close bushing to pin clearance can be obtained either by honing or reaming. They are more tolerant of contaminants than nylon and provide considerably longer milage in severe service applications such as refuse and dump vehicles, etc.

Composite bushings incorporate a steel backing as with the bronze bushings. However, the inside diameter features a low friction acetyl resin polymer surface which is dimpled and grease grooved for better grease distribution than the older nylon designs. Most composite bushings still require fitting depending on the axle manufacturer's design. However, only reamers can be used if required. In general, more care must be taken when installing to prevent damage to the bushing.

Needle Bearing bushings are used as direct replacements to OE bushings where other bushing types are not intended to be used as a comparable replacement.

No-Ream Bi-Metal bushings provide the same fit and function of steel-backed bronze bushings but without the added downtime. These bushings are engineered to match the king pin without the added step of reaming the bushing to match the king pin, saving hours in downtime when compared to traditional reamed bushings.

Spiral No-Ream bushings provide even more time savings benefits by having the ability to install these bushings by hand or with a T-handled hand tool. These bushings are designed to match the spindle opening and king pin without the needed steps of reaming or honing.

Inspection Procedures

Routine service and inspection should be performed as outlined in your steering axle service manual. When using Spiral No-Ream bushings as an OE replacement, preventative maintenance intervals may need to be shortened to ensure there is a proper amount of grease supplied to these king pin assemblies at all times.

Steering

Is today your lucky day?

Lucky Day

Not a lucky day.
Time to get your best tool out.

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Steering

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Steering

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Steering

These are the new components that must be installed and properly fit together.

Key component: "Bushing"

How much do you know about these Seals??

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Steering

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Everything fit together and more importantly, no binding and it took grease.

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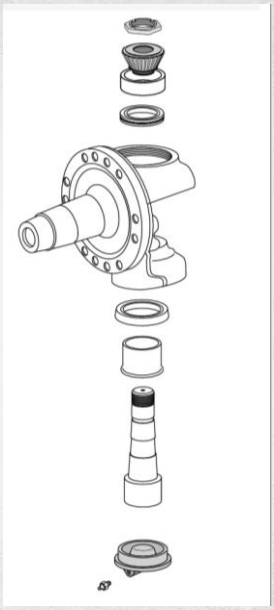
Steering

This is a tapered kingpin set used in Macks and Volvos.
Go on Dayton/Dorman site and get the 300-340 "Steering King Pin Repair Kit" Instructions.
Great step by step instructions. It's a must if you replace these style kingpins.



300-340	TRUEFIT®
Make	Mack/Volvo
Pin Type (Draw Keys)	TT
Pin Diameter	1.575
Pin Length	8.92
Large Diameter	2.360
Bush. Type (See Key)	P
Repl. Bushing	302-340 (2)
Thrust Bearing	BT1-0097C/BT1-0097Q
Dust Caps	304-340-1, 304-340-2
Shim Pack	MTP98210/MTP98212 (2)
Hardware Pack	–
Long Draw Key(s)	–
Short Draw Key(s)	–
Comments:	Full kit; nylon bushings; final torque spec for nut is 563-689 ft-lbs.; SKF bearing BT10097C

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Steering

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Steering

What do you See here? Is anything wrong?

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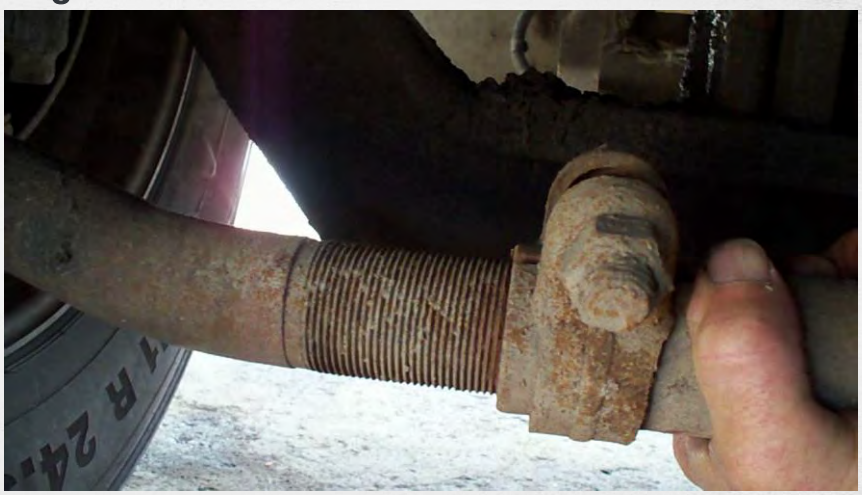
Steering



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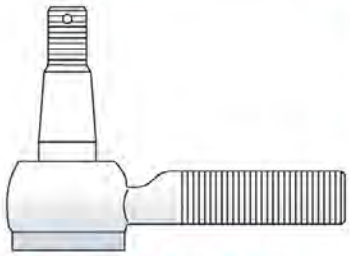
Steering

Tie Rod Ends Component Information



Typical Tie Rod End

Function: Connects the tie rod arms of the spindles to transfer the steering force. Provides the ability to fine tune wheel toe-in to achieve optimum tire wear.

Features and Benefits: Dayton Parts' tie rod ends feature a dual bearing along with a preloaded, self-adjusting spring that limits ball stud end movement and continuously compensated for ball and spherical bearing surface wear.

These features add up to a ball socket that withstands the punishment of severe service applications while providing significantly increaded service life over other designs.

Tie Rods

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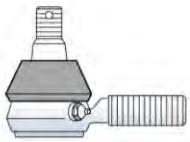
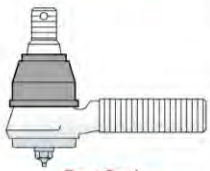
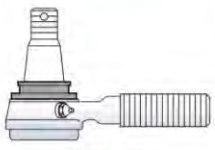


Sliding Seal



Boot Seal



Anti-tilt Seal

Seal Designs: Dayton Parts' sockets utilize the same seal design as specified by the O.E. axle manufacturer or truck builder.

The **"Sliding"** seal is the most common. When rocking motion of the ball stud occurs, the seal slides over the socket body maintaining full contact. The "Sliding" seal allows for the purging of contaminated grease during maintenance lubrication.

The **"Boot"** seal is always used in permanently lubricated sockets or may be specified in severe service environments with relube designs. A metal reinforcing ring molded into the seal aperture snaps over the socket body, holding it in position as the stud oscillates. The rocking motion of the ball stud is accommodated by flexing of the convoluted part of the seal.

The **"Anti-Tilt"** seals are useful in applications where the vehicle manufacturer wishes to restrict the ball stud movement or control a defined travel path. The rigid seal assembly pressed down over the ball stud and snaps firmly over the socket body shoulder. All angular movement of the ball stud is eliminated, while stud rotation is accommodated.

Inspection Procedures - Wear Limits

Grab and try to move the tie rod cross tube in any direction. If movement or looseness is felt between the tie rod ends and the tie rod arms, remove and replace the tie rod ends. Check the seals for rips at the time of lubrication.

If removed, use a torque wrench to measure the ball stud turning torque value. If it takes less than 5 inch pounds of torque to rotate the stud, replace the tie rod end.

For inspection station purposes, place the vehicle out of service if lateral movement (using hand pressure only) exceeds 1/8". Do not use leverage as this will overcome the preload spring.

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VEHICLE IDENTIFICATION

Unit	Type	Make	Year	State	Plate #	Equipment ID	VIN	GVWR	CVSA #	CVSA Issued #	OOS Sticker
1	TT	FRHT	2006	NY		01		52,000			
2	ST	STRI	1998	NY		U21487		65,000			

BRAKE ADJUSTMENTS

Axle #	1	2	3	4	5
Right	7/8	7/8	1 3/8	1 3/8	1 1/2
Left	7/8	1 1/4	2	1 3/8	1 1/8
Chamber	L-20	L-30	L-30	C-30	C-30

VIOLATIONS

Vio Code	Section	Unit	OOS	Citation #	Verify	Crash	Violations Discovered
393.209D	**393.209(d)**	**1**	**Y**		**U**	**N**	**Axle # 1 left side tie-rod ball socket is loose exceeding 1/8" up & down movement, measured with hand pressure only.**
393.207F	393.207(f)	1	N		N	N	Air suspension pressure loss, axle # 3 left side air bag is leaking @ the lower mounting flange.

HazMat: No HM Transported. **Placard:** No **Cargo Tank:**

Special Checks: No Data for Special Checks.

Steering

- **All the components of a truck's front axle , steering system, and suspension are aligned by the vehicles manufacturer to balance the forces created by centrifugal force, momentum while the vehicle is in motion, gravity and friction.**
- **When properly aligned, the wheels of a loaded vehicle will contact the road correctly, allowing the wheels to roll without dragging, scuffing or slipping on the road.**
- **The benefits of a properly aligned vehicle are:**
  - **Longer tire life**
  - **Directional stability**
  - **Better fuel economy**
  - **Less steering effort**
  - **Less wear on front-end parts**

Steering

- **The primary alignment angles and adjustments are:**
  - **Toe**
  - **Caster**
  - **Camber**
  - **Turning angle**
  - **Kingpin inclination**
  - **Ackerman geometry**
  - **Also, axle alignment because it can affect tire wear and steering characteristics**

Note: Don't bother with an alignment unless you check all the components first. Components such as tie-rod ends, shock absorbers, wheel bearings etc. Don't forget tire pressures and proper and equal height of the vehicle from the ground to some common point on the vehicle.

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Steering

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Steering

Toe Settings

- The purpose of toe is to allow the tire to run straight during normal operating conditions
- Deviation from this condition results in either:
  - Toe-in or positive toe
  - Toe-out or negative toe

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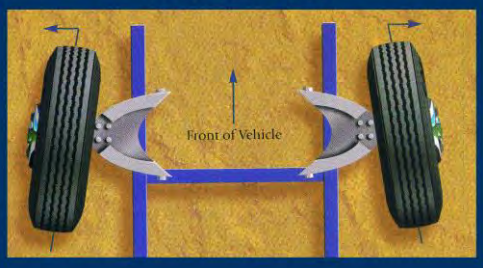
Steering

Factor #1
Toe

Toe In/Positive Toe



Positive toe is necessary for improved tread life

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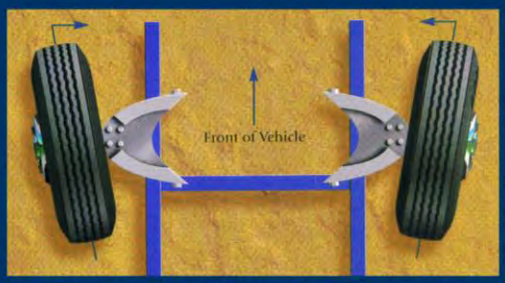
Factor #1 Toe

Toe-Out/Negative Toe



Negative Toe accelerates tread wear

Steering

Wear Characteristics Due to Excessive Toe

- Excessive toe-in/positive toe results in outside edge wear of the tire
- Excessive toe-out/negative toe results in inside edge wear of the tire

Steering

Toe Settings

- Steer axle toe is adjustable
- Drive axle toe and trailer axle toe are not normally adjusted

Steering

Alignment Specifications: Where Do They Come From?

- Chassis OEMs
- Axle OEMs
- Tire OEMs
- Alignment equipment OEMs
- Local alignment shops

Steering

Recommended Re-alignment Targets

Steer Axle:

Total Toe	1/16”
Camber	Less than 1/4° (3)
Caster	L +31/2 ° R +4 °
Setback	0” Or 0°

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Steering

Some heavy vehicles might use two gear boxes depending on their vocation.

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Steering

Most common issue you will run across.
Leaking seals, fittings and hoses.
One of the easier hits to find on a roadside inspection.

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Steering

Power Steering

- **A trucks power steering system is identical to the manual steering system in many ways.**
- **Both use the same steering axle, components and linkages.**
- **The difference is the addition of a hydraulic system.**
- **A pump is used to deliver hydraulic fluid under pressure to a power steering gear.**
- **The gear (box) incorporates hydraulic valve and passages that allow the hydraulic pressure to assist in turning the wheel.**

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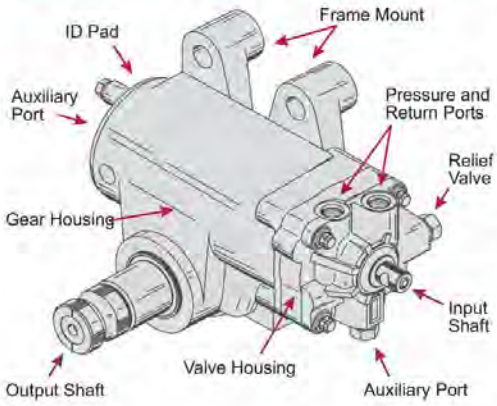
Identifying the Gear Components



Pressure and Return Ports: The connection points for the hydraulic lines to and from the power steering pump. Typically one of the ports will have an embossed letter in the casting. "P" for the pressure ports or "R" for the return port.

Valve Housing: This casting is bolted on to the cylinder bore of the gear housing and contains the mechanical valve of the steering gear.

Gear Housing: This is the main casting of the steering gear and contains the rack piston and output shaft.

ID Pad: On late model TRW gears, the gear part number is stamped on this machined surface.

Auxiliary Port: Some gears are equipped with 4 lines to provide hydraulic assist from the master gear to an auxiliary gear mounted on the opposite frame rail. If you have a 4 line gear, one of the auxiliary ports is on this end of the gear housing or in the "bowl" of the gear housing around the output shaft.

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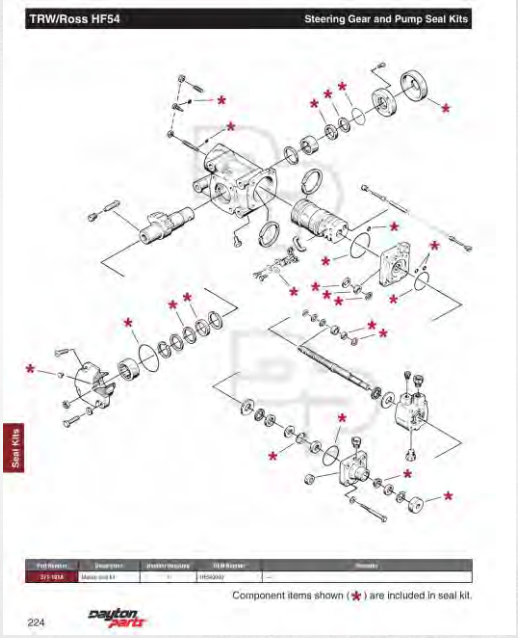

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Steering

Power Steering

- **Power Steering Pump:**
  - **Used to develop the hydraulic "flow" needed to provide the power assist to the steering gear.**
  - **The pump can be either gear driven, or belt driven.**
  - **The two basic types used on heavy trucks are the vane or roller. (some vehicles are equipped with gear or rotary pumps)**
- **Hydraulic fluid used in the pump could be stored either in a remotely mounted reservoir or an integral part of the pump assembly.**
  - **The fluid is routed between the reservoir and pump and between the pump and the steering gear via hoses and lines.**
- **Any excessive pressure is controlled by a relief valve.**

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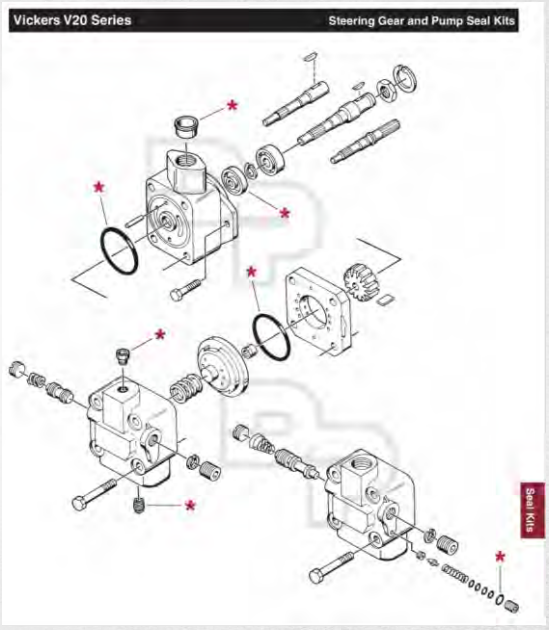
Power Steering Pump (Important Concepts)

➢ **Pumps do not pump pressure**

- **The pressure within a hydraulic system is caused by the resistance to flow.**
- **All components in a hydraulic system are affected by flow and pressure. This is a designed feature. Adhere to OEM specifications.**
- **Both PRESSURE and FLOW are required to accomplish work.**
- **"Atmospheric Pressure" is the force which sends oil to the pump (typically).**
- **"Working Pressure" is the pressure which occurs when the system is under load.**
- **"Relief Pressure" occurs when the oil is passed over the relief valve used to protect the system.**
- **Oil is used to lubricate all the components, "DISSIPATE HEAT" and carry away any contaminants so they can be removed by filtering.**

NOTE: Oil temperature and contamination are typically the cause of steering system hydraulic failures. Maintenance, Maintenance, Maintenance.

Steering Gear Pump



Vickers Identification Tag Example

V10 F 1 P 7 P 38 C 6 G 20

Flow Rate thru Orifice in Cover
1 1USgpm (V10P) **2** 2USgpm (V10F)
3 3USgpm (V10F Only) **4** 4Usgpm
5 (V10f Only) **6** 6USgpm

Pressure Setting
A 250PSI **D** 1000PSI **G** 1750 PSI
B 500PSI **E** 1250PSI **H** 2000PSI
C 750PSI **F** 1500PSI **J** 2250 PSI
K 2500PSI

Identification Tag

Steering

Power Steering Hydraulic Tests

- **If you suspect a problem with the power steering system, test the hydraulic supply system first. Proper power steering requires an adequate supply of oil pressure and oil flow.**
  - **Check manufacturers specifications for pressure and flow.**
- **High system oil temperatures reduce efficiency of the steering pump and gear. Most high temperatures are caused by restriction a restriction to flow or inadequate system oil capacity to allow for heat dissipation. A supply pump that constantly operates at maximum pressure relief will also generate more heat than can be dissipated.**
- **Pressure gauges and flow meters are used to diagnose power steering problems.**
  - **The gauge should be capable of reading in excess of 3000PSI**
  - **The flow meter should be capable of reading to 10 gpm.**
- **A shut-off valve downstream from the pressure gauge is used to isolate the steering pump from the steering gear. Closing the valve allows you to read maximum pump relief pressure.**
- **A thermometer in the reservoir will indicate system oil temperature.**

Test Gauges

This is as ample of test gauges, fittings and shutoffs we accumulated throughout the years to diagnose anything with hydraulics. Not just steering.

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Steering

The following is a general procedure:

1. Make all the necessary gauge and meter connections.
2. Start the engine to check system oil level and flow through the flow meter.
3. Place the thermometer in the reservoir to monitor oil temperature.
4. With the engine at idle, steer from lock to lock several times to allow the system to warm up (140-160 degrees Fahrenheit).
5. At the specified idle speed, slowly turn the shut-off valve until closed and read the pressure at which the pressure relief valve opens. Open the shutoff valve as quickly as possible. This pressure reading should equal the maximum pump pressure that is specified by the manufacturer.
6. With engine running at specified speed, turn the wheels from full right to full left and observe the flow meter.

Note: The flow must not fall below the minimum gpm flow specified.

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Steering

7. Increase the speed to 1500 rpm and note the flow rate with the steering wheel stationary. Compare this reading to the maximum specified flow rate. Excessive oil flow rate can cause high operating temperature and sluggish heavy steering response.

8. System oil temperature is best checked after a couple of hours of normal operation. Again, the normal temperature range is 160-180 degrees Fahrenheit.

Note: All these tests should be performed with a load on the front axle to duplicate real world conditions.

Steering

Steering complaints

- **Complaints usually start with the driver. So the best place to start is communicating with the driver.**
  - **Ask questions like what, when, where and how.**
  - **Duplicate the problem so you actually can feel or see it.**
  - **A good visual is a must of the whole truck to eliminate or discover the obvious.**
  - **Not all steering problems are for example the steering gear-box.**
  - **Think out of the box. " Tires, frozen components, alignment etc."**
- **Most component manufacturers have nice flow charts for diagnostics that address common complaints such as:**
  - **Hard Steering**
  - **Binding, Darting, and Over steer**
  - **Road Wander/ Loose Steering**
  - **Shimmy etc.**

Steering

The following are common complaints and or problems related to steering:

- **Hard Steering**
- **Binding, Over steer**
- **Loose Steering/Road Wander**
- **Shimmy**
- **Noises**
- **External Leakage**
- **Directional Pull**

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Trouble Shooting Guide

Symptom	Potential Cause	Solution
Oil leaking from steering gear output shaft	Damaged shaft seal	Replace seal and shaft if necessary
Fluid foaming or leaking from reservoir	Clogged oil filter	Change fluid and filter
	Air in System	Bleed system. Inspect suction side of supply pump for air leaks
	Poppets of steering gear not adjusted properly causing high temperatures	Adjust poppets
	Pump cavitation	Inspect pump supply lines for restriction
	Fluid overheating	Inspect steering gear return line for restriction
Hard turning in one or both directions	Bind in steering column	Inspect column drag
	Dirt or debris trapped in piston relief	Inspect piston relief
	Bent or damaged king pins and/or tie rods	Repair or replace king pins and/or tie rods
	Front end load too great	Reduce load
	Low Fluid level in steering system	Fill reservoir as needed
	Air in System	Bleed system and inspect for cause
Steering radius restricted	Poppets not adjusted properly	Adjust poppets

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Hard steering	Defective supply pump	Inspect pump flow
	Steering out of alignment	Align front end
	Fluid over heating	Find and correct overheating cause
High operating temperature	Fluid flow restriction	Inspect for back pressure
		Check maximum oil flow
Road wander/over steering	Oil flow too high	Pump not to specifications
	Air trapped in gear	Bleed system
	Looseness worn front end parts	Inspect and repair as required
	Front end alignment not correct	Align front end
	Overloaded	Reduce load
	Rear axle not parellel	Inspect and repair as needed
	Tight tie rod ends and/or drag link sockets	Inspect rotational torque and replace as needed

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Flushing

Required whenever a power steering pump, gear or reservoir is replaced.
Important Concept: Flush the old fluid from the "System" and replace with new fluid. Don't forget to replace any applicable filter.
Procedure:

- **Lift front axle off the ground and support with stands.**
- **Do not connect pressure and return hoses.**
- **Place pressure hose into clean container. (5 gallon).**

Important: Select the proper fluid for your application.
Note: You will wind up using twice the amount of fluid as the capacity of the entire system.

- **Have an assistant ready to crank the engine (preferably disconnect ignition, if possible, to prevent starting).**

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Flushing

Caution: Avoid hitting or holding against stop when turning the wheel. Maintain fluid level throughout flushing process. Flush until clean fluid is coming out of hose.

- **Remove return hose from reservoir, clean and air blow dry.**
- **Reinstall hose.**
- **After reinstalling hoses, fill reservoir and crank engine for (5) seconds.**
- **Turn steering wheel stop to stop "without cranking engine".**
- **Top off reservoir fluid.**
- **Start engine and turn steering wheel "stop to stop" approximately (6) times.**
- **Let run until system is at operating temperature and repeat stop to stop turning another (6) times.**
- **Caution: Avoid holding against axle stops.**
- **Lower to ground and inspect fluid level.**

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Flushing (Another recommended procedure)

Steering Gear and Pump Installation Instructions:

- **Disconnect return line at reservoir and direct it the return line into a container (minimum of 2 gallons).**
- **Plug the reservoir return port tube or fitting.**
- **Fill the reservoir with the recommended fluid. (Disconnect Ignition if possible).**
- **Jack front wheels off ground.**
- **Crank starter motor and turn wheels simultaneously to travel until oil is no longer pumped.**
- **Unplug reservoir return port tube or fitting. Reconnect return line to reservoir.**
- **Replace contaminated oil filter, if so equipped.**
- **Fill reservoir to capacity.**
- **Start engine and run for 30 seconds. Shut engine off.**

Flushing (Another recommended procedure)

- **Fill (or refill) the pump reservoir to the cold mark or just enough to cover the internal filter with the manufacturer's recommended fluid.**
- **Start the engine and let run at idle speed for a couple of minutes.**
- **Cycle the steering wheel a few times to eliminate entrapped air.**

Note: For pumps that have a dipstick showing hot full only, allow the truck to reach operating temperature before stopping engine. For units with cold fill marks, the engine maybe stopped after cycling.

- **Fill to indicated levels.**

Important: Read the specific manufactures recommended procedures.

Initial Poppet Setting Procedure

This procedure is for new and remanufactured steering gears from Dayton Parts, LLC. All Dayton Parts steering gears have had their poppet seats replaced and reset.

CAUTION: System must be flushed prior to installing new gear *(see section on page 3 "Flushing the System" for instructions).* This will ensure any debris or foreign material that is in the system is flushed out and does not damage your new gear.

1. Inspect axle stop bolts to ensure they are set to vehicle manufactures wheel cut or clearance specifications.
2. Jack up the front end of the vehicle until the tires are off the ground.
3. Start engine and let it idle.
4. Turn steering wheel to full left until you contact axle stop. Pull hard on the wheel *(do not hold against the axle stop for more than five (5) seconds).*
5. Now turn full right until you contact axle stops. Pull hard on the steering wheel *(do not hold against the axle stop for more than five (5) seconds).*
6. Turn vehicle off.

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Poppet Adjustment.

The previous slide was a procedure for doing an automatic poppet adjustment. The concept is to ensure that the relief valve plunger is capable of reducing steering pressure when the wheels have reached their limits of turn. This prevents the supply pump from operating at maximum relief pressure when the road wheels are at the steering limit (hitting the stops)

Note: For all this to occur properly the timing marks on the sector shaft are:

- **90 degrees from the center line of the worm shaft and**
- **Properly aligned with the mark on the pitman arm.**
- **Make sure the pitman arm positioning allows for the center point of the sector and the center point of the drag link to be plumb with each other. (perfectly vertical)**
- **With the wheels square to the frame, check the draglink for proper adjustment and install.**

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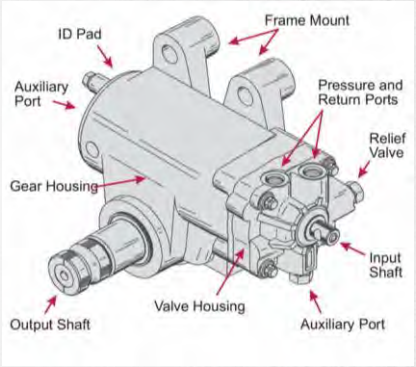
Poppet Adjustment (manual adjustment)

After flushing procedure in previous slides, do the following for a manual poppet adjustment:

- **With full weight of the vehicle on all wheels, turn the steering wheel in one direction until a high-pressure hiss is or the axle stops make contact.**
- **Turn the relief plunger located on both ends of gear in or out until the high-pressure hiss is heard when there is a 1/8-to-3/16-inch clearance between the axle stops.**
- **Repeat this procedure for the opposite direction of steer.**



Note: This procedure is meant for TRW (HF and HFB models, Sheppard (292,392,492 and 592 models) and a few others.

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Bleeding Air from a Single Gear System

NOTE: If this is a replacement steering gear, please follow the poppet/plunger adjustment procedure *(see page 4)* for automatic adjusting steering gears prior to bleeding system.

CAUTION: For Steps 1 and 2 do not turn steering wheel or air may be induced into system.

1. Fill reservoir to nearly full. Crank the engine for 10 seconds without allowing it to start. If it does start, shut off immediately. Check and refill the reservoir. Repeat process at least three times, checking the reservoir each time.

CAUTION: Do not allow fluid to drop significantly or run out of reservoir as this may induce air into system.

2. Start engine and let it idle for two minutes. Do not turn steering wheel. Shut off engine and check the reservoir fluid level. Refill if necessary.

3. Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary to full line on reservoir dipstick.

NOTE: The above procedure should remove all air from steering system. If the steering gear is mounted in an inverted position and is equipped with a manual bleed screw, commonly found with TRW/Ross steering gears, please continue to step 4.

4. Follow the above procedure. Leave engine idling. With the steering gear in centered position, loosen the bleed screw about one turn (5/16" inch socket required for TRW/Ross, 1/8" allen wrench for Sheppard). This allows the air and aerated fluid to "bleed out" around bleed screw until only clear (non-aerated) fluid is present. Close bleed screw and check and fill reservoir if necessary. Torque manual bleed screw to 27-33 inch pounds.

CAUTION: Do not turn steering wheel with manual bleed screw loosened.

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Diagnostics/Troubleshooting

Start Simple (Complaint Dependent)

Important: Start with tire pressures (especially steer axle).

In combination units, don't forget the 5th wheel and coupler plate/kingpin.

Binding: Disconnect drag link or pitman arm. (Do not steer the gear with linkage removed, to prevent mis adjustment of poppets).

- **With wheels off the ground pull and push tire from axle stop to axle stop.**
- **Tire should move and return.**
- **If example, you have a binding issue. For example, kingpin(s).**

Steering Column Binding:

- **Wheels off ground, slowly steer vehicle until you feel binding.**
- **Remove U-joint and/or column to find problem.**

Note: Frozen telescoping shaft can cause a steering not returning or binding complaint.

Diagnostics/Troubleshooting

Air in Hydraulic System

- **Inspect reservoir for air bubbles or foaming.**
- **If foaming, look for cracks, loose fittings or anything that might allow air to be sucked into system**
- **Look for oil level changes between engine off engine on cycles.**

Note: If fluid level increases when the vehicle is shut off, chances are pretty good there is an air pocket trapped in the steering gear. In this case, bleed the steering gear. Repeat the bleeding process three times and recheck oil in reservoir so you don't run it dry in the process.

Mechanical checks-

Axle Stop Setting-

- **Check to make sure axle stops are set to manufacturers spec's.**

Diagnostics/Troubleshooting

Mechanical Checks

Pitman Arm and Output shaft Alignment

- **Make sure timing marks are aligned.**
- **Make sure the right mark is used. Some "Pitman" arms have more than one mark.**

Misadjusted Drag Link

- **The length must be correct.**
- **Check the length "after timing marks aligned" and the gear is at its center position, and the road wheels are straight ahead.**

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Diagnostics/Troubleshooting

Steering System Lash (This is a two-person task).

- **One person turns steering wheel back and forth one-quarter turn each way.**
- **Second person checks for looseness(excessive movement) in components and areas that have "ANYTHING" to do with steering.**
- **That includes even: U-bolts, spring bushings/pins, hangers, brackets, shackles, wheel bearings, lug nuts etc.**
- **Don't forget binding brakes.**

Important: The above should be part of any preventive maintenance and/or "Inspection" task.

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Repair mistakes to avoid.

- **Disconnecting the drag link from the spindle, then rotating the steering gear to get the pitman arm out of the way to work at near by components.**

Tip: In the above case – make sure to disconnect the pitman armfrom the steering gear instead and don't rotate the steering gear.

- **Reposition the steering wheel to center after replacing a tie rod end or ends of draglink.**

Note: Any mistakes we make can lead to steering gear leaks and also result in driver complaints of hard steering, uneven effort when turning the wheel or hesitation during steering.

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Questions?

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