

# SECTION 14: STEERING

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1. STEERING SYSTEM

1.1 I-BEAM AXLE STEERING SYSTEM DESCRIPTION

The steering system consists of the steering wheel and column assembly, a vane-type hydraulic pump, reservoir, filter, interconnecting system lines and hoses, integral power steering gear, linkage and steering damper (Fig. 1). The steering linkage includes the pitman arm, drag link, steering arm, tie rod arms and tie rod.

Hydraulic components are added to transmit, increase and regulate steering control forces.

These elements are:

1. Steering stabilizer (damper);
2. A vane type hydraulic pump; and
3. Hydraulic reservoir and hoses.

The steering stabilizer reduces road shocks and vibrations in the system. The steering gearbox is self powered and provides movement with power assistance to the left wheel.

Steering stability and tire wear are influenced by wheels, hubs, tires, air suspension, brakes, front suspension and front end alignment which are all covered in their respective sections in this manual.

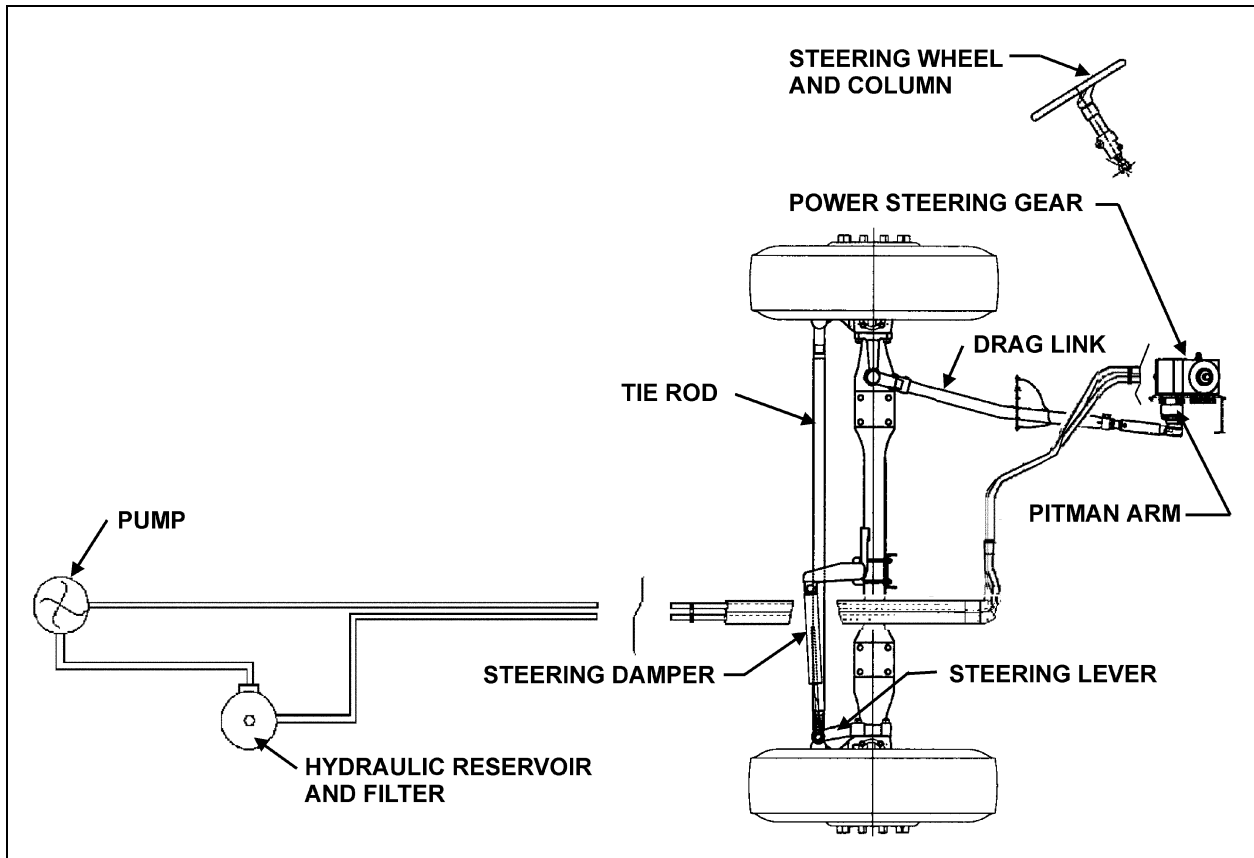


FIGURE 1: I-BEAM AXLE STEERING SYSTEM SETUP

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### 1.2 INDEPENDENT FRONT SUSPENSION STEERING SYSTEM DESCRIPTION

The steering system consists of the steering wheel and column assembly, a vane-type hydraulic pump, reservoir, filter, interconnecting system lines and hoses, integral power steering gear and linkage (Fig. 2). The steering linkage consists of tie rods connected to the bell crank and the steering arm at the left side of the coach, and to the idler arm and steering arm at the right side of the coach. The bell crank and idler arm are connected by a relay rod. A drag link connected to the bell crank and the pitman arm, which is mounted to the steering gear, transfers the turning motion of the steering wheel to the steering arms.

Hydraulic components are added to transmit, increase and regulate steering control forces.

These elements are:

1. A vane type hydraulic pump; and
2. Hydraulic reservoir and hoses.
3. Hydraulic power cylinder (X3-45 VIP & XLII Bus Shells only).

#### **NOTE**

*X3-45 VIP & XLII Bus Shells are also equipped with a hydraulic power cylinder. The hydraulic power cylinder provides an added source of assistance and being connected to the R.H. wheel, makes it such that the total steering forces are produced with minimal stress on mechanical linkages.*

The steering gearbox is self powered and provides movement with power assistance to the left wheel.

Steering stability and tire wear are influenced by wheels, hubs, tires, air suspension, brakes, front suspension and front end alignment which are all covered in their respective sections in this manual.

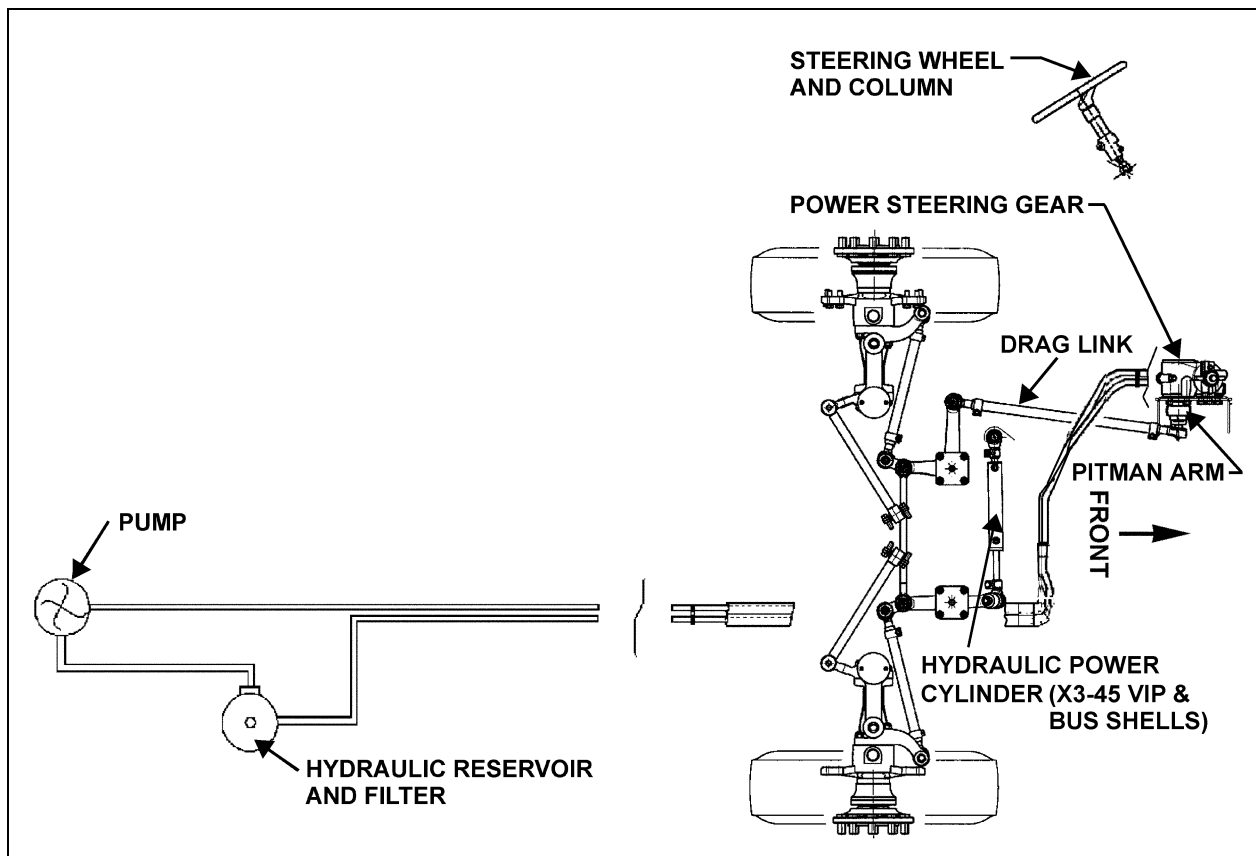


FIGURE 2: IFS STEERING SYSTEM SETUP

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## 2. POWER STEERING GEAR

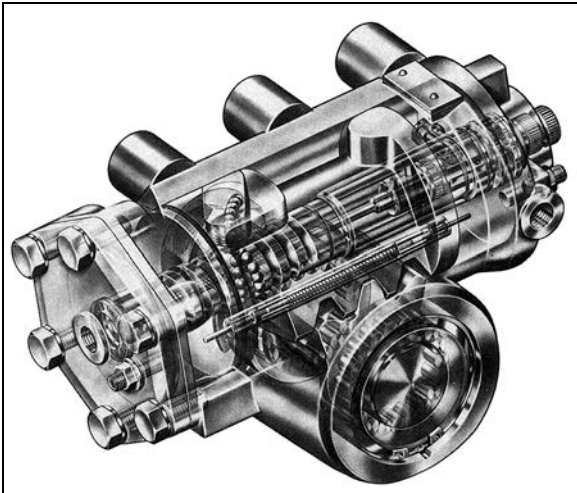


FIGURE 3: POWER STEERING GEAR

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### 2.1 DESCRIPTION

The power steering gear is located in the lower part of front service compartment (Figs. 3 & 4). The housing of the ZF-Servocom contains a control valve, working cylinder and a complete mechanical steering gear. The pressure oil for the steering is delivered by a motor-driven oil pump which is supplied with oil from an oil tank.

The housing is designed as a cylinder for the piston, which converts the rotation of the steering shaft and the worm into an axial movement and transfers this to the steering worm sector shaft. The serration of the sector shaft is straight-cut with a high surface quality in such a way that it is only possible to set a unique setting without play on installation in the straight-ahead driving area by means of the two eccentrically designed lateral housing covers.

The piston and worm are connected via a ball chain. When the worm is turned, the balls are collected by a circulating pipe at one end of the chain and fed in again at the other end, thus producing an endless ball chain.

The control valve consists of the valve slide in a needle bearing in the worm, with six control grooves on the circumference and the control sleeve on the worm, which also has six control grooves. The valve slide, designed with steering shaft connection, turns together with the worm as the steering wheel is turned.

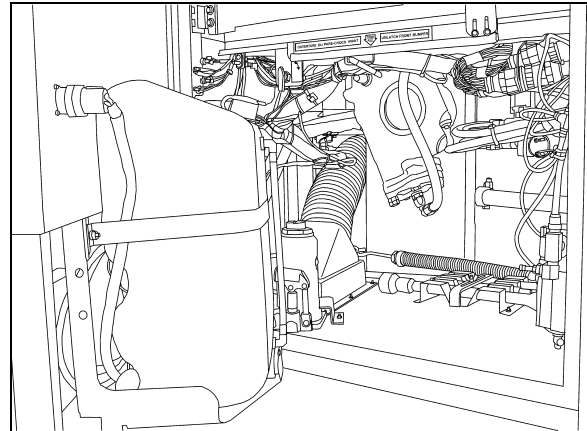


FIGURE 4: FRONT SERVICE COMPARTMENT

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A torsion bar, which is pinned with the valve slide and the worm, keeps the control valve in the neutral position as long as no opposing force is applied to the steering wheel. The steering housing contains a pressure relief valve, which limits the discharge pressure of the oil pump to the maximum value required. A replenishing valve can also be used, through which oil is sucked from the return if steering is not hydraulically boosted.

Compared with constant ratio, steering versions with variable ratio are more directly designed in the center area than outside the center area. The resulting smaller steering corrections benefit steering behavior in straight-ahead driving. At the same time, the indirect transmission means that there is a higher hydraulic torque available at the steering arm in parking movement. If the hydraulic assistance fails, the operating forces on the steering wheel are correspondingly lower in this area. This is achieved through a piston/steering worm sector shaft serration with differing modulus and angle of pressure.

Upon transfer of a torque from the steering shaft to the worm, or vice versa, the torsion bar is deformed in the elastic area so that there is torsion between the valve slide and the control sleeve. When the steering wheel is released, the torsion bar ensures that the valve is returned to the neutral position.

Refer to the "ZF-SERVOCOM Repair Manual" and "ZF-SERVOCOM Operating, Servicing /Maintenance and Inspection Instructions" annexed to this section for the functional aspects and maintenance procedure of the steering gear.

#### **NOTE**

*Also available is the ZF-Servocomtronic, which provides variable assistance in function of speed.*

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### 2.2 POWER STEERING GEAR REMOVAL



#### WARNING

The steering gearbox weighs approximately 100 lbs (45 kg) dry. Exercise caution when handling.

1. Put a container into place, then disconnect both the inlet and outlet hoses from the power steering gear. Cover fittings to prevent fluid contamination.
2. Mark both the pitman arm and sector shaft with a line, then remove pitman arm. Refer to "11.1 Pitman Arm Removal" procedure.
3. Mark both the steering shaft universal joint yoke and steering gear input shaft with a line, then disconnect universal joint.
4. Unscrew and remove the power steering gear.

### 2.3 POWER STEERING GEAR INSTALLATION

Reverse "Power Steering Gear Removal" procedure paying particular attention to the following:

1. Tighten fasteners as recommended under paragraph 14: "Torque Specifications".
2. Bleed air from the system as per step 3, next.

### 2.4 TROUBLESHOOTING

Perform troubleshooting of the steering gear as outlined in the "ZF-SERVOCOM REPAIR MANUAL", the "ZF-SERVOCOM Operating, Servicing/Maintenance and Inspection Instructions".

### 3. BLEEDING POWER STEERING HYDRAULIC SYSTEM

To bleed the power steering hydraulic system, refer to the "ZF-SERVOCOM Repair Manual" annexed to this section, under heading "Setting And Functional Test".

### 4. HYDRAULIC PRESSURE TEST

Perform a pressure test as outlined in the "ZF-SERVOCOM Repair Manual" annexed to this section under heading "Setting And Functional Test".

#### NOTE

For vehicles equipped with ZF-SERVOCOMTRONIC unit, refer to the supplement to the repair manual ZF-SERVOCOM.

## 5. POWER STEERING HYDRAULIC PUMP

### 5.1 DESCRIPTION

The power steering pump is a gear driven hydraulic unit which supplies hydraulic pressure for the operation of the steering gear. The pump is mounted on the engine, at the flywheel end and is also used for driving the fuel pump.

### 5.2 REMOVAL AND INSTALLATION

The pump is accessible through the engine compartment R.H. access door.

To remove the pump, proceed as follows:

- You must first remove the fuel feed pump.
- Clean around the fuel pump and fuel lines. Position a container to catch any fuel that might drain from the pump or lines.
- Remove the fuel pump.

#### NOTE

Only unfasten the bolts marked with arrows.

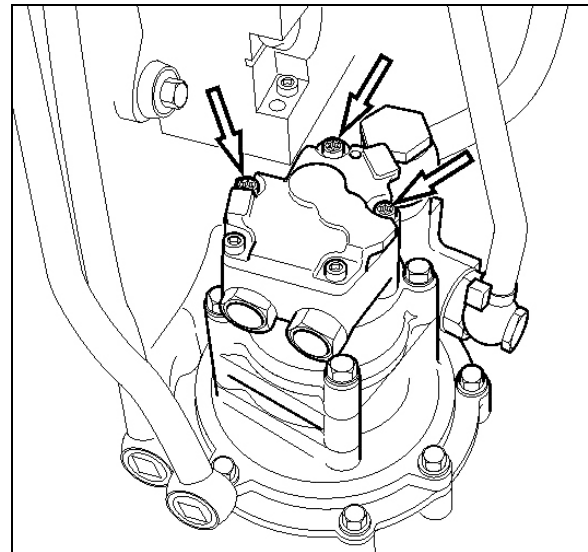


FIGURE 5: FUEL PUMP REMOVAL



#### CAUTION

Ensure to clean around the head of the bolts. Debris will prevent the tool from fitting properly and cause damage to the fasteners.

- Check that the adapter and fuel pump drive axle are not damaged.

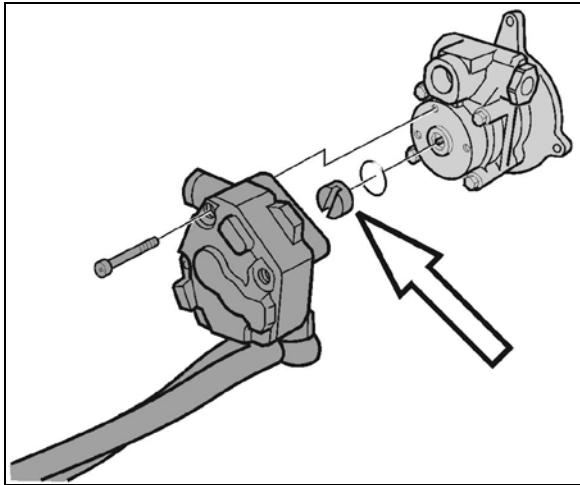


FIGURE 6: FUEL PUMP DRIVE AXLE

- Set the fuel pump aside.
- Clean around the power steering pump and loosen the steering lines. Position a container to catch any hydraulic fluid that might drain from the pump or lines.
- Unfasten the power steering pump bolts.

**NOTE**

Only unfasten the bolts marked with arrows.

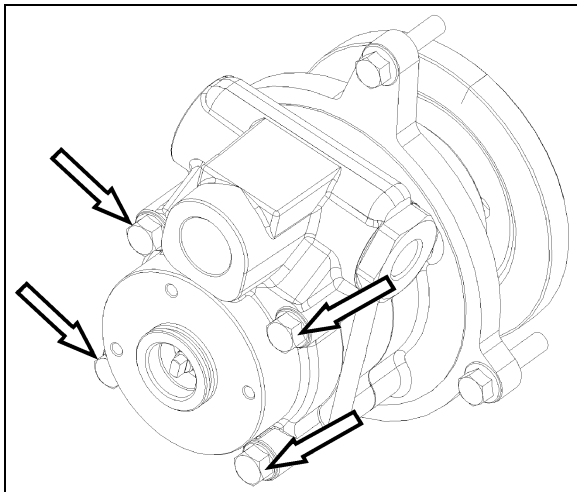


FIGURE 7: POWER STEERING PUMP REMOVAL

- Install the new power steering pump. Torque-tighten bolts to specification.

**NOTE**

Use a new gasket.

- Connect the hydraulic lines to the power steering pump.

- Install the fuel pump. Torque-tighten bolts to specification.

**NOTE**

Use a new sealing ring. Check that the fuel pump drive axle sits correctly in the power steering pump.

- Start the engine and let run for 5 minutes. Make sure that there are no leaks.

**6. STEERING COLUMN**

**6.1 REMOVAL**

To disassemble the steering column from system, refer to figure 8 & 9. The steering column has no lubrication points. The lower steering column U-joint is easily accessible through the front service compartment. The upper steering column U-joint and the steering slip joint are accessible from the front driver's area. To access these joints, proceed as follows:

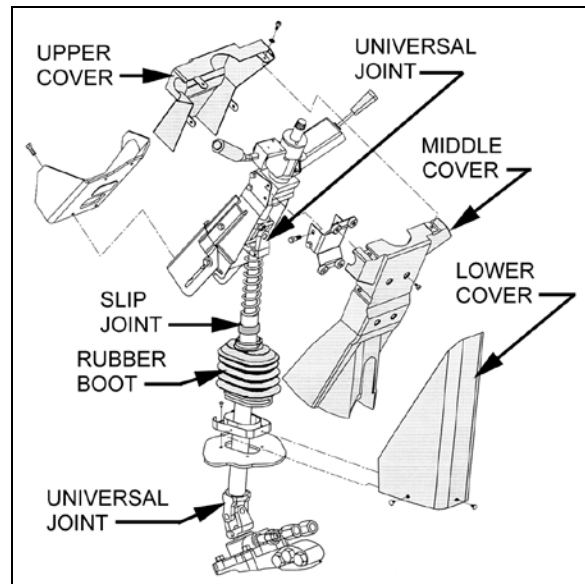


FIGURE 8: STEERING COLUMN COVERS

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1. From the front driver's compartment area, remove the three plastic fasteners on steering column lower cover. Remove the lower cover (Fig. 8).
2. Unscrew the four retaining screws on steering column middle cover.
3. Unscrew the four retaining screws fixing steering column upper cover to middle cover. Remove the steering column middle and upper covers.

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4. Position the steering wheel in order to gain access to the joints.

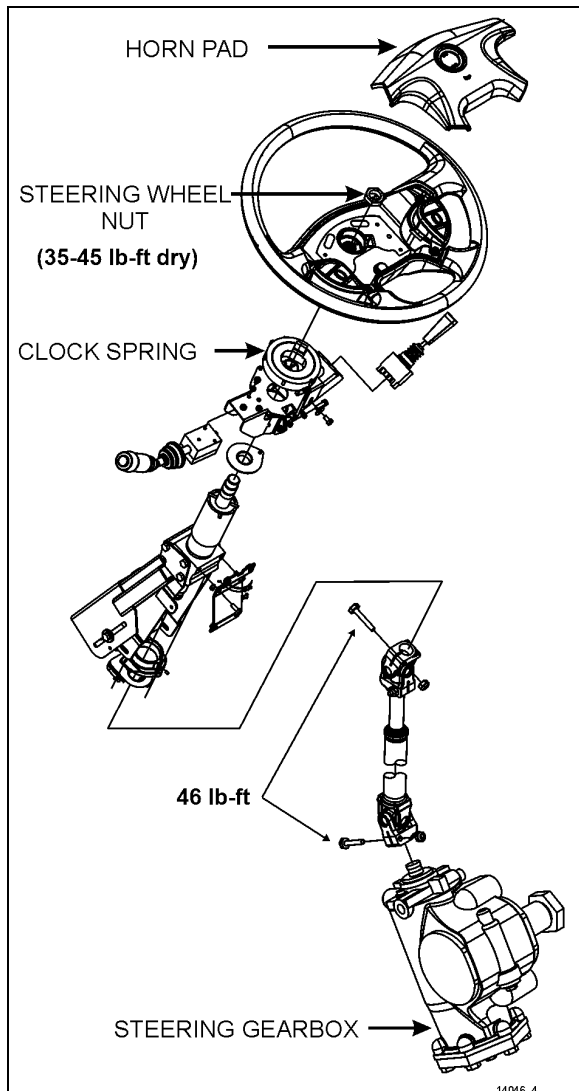


FIGURE 9: STEERING COLUMN

### 7. STEERING WHEEL

#### 7.1 REMOVAL

##### NOTE

*Before undertaking the steering wheel removal, assure that the front wheels are pointing straight ahead, aligned with the vehicle.*

1. Set the battery master switch located in the rear electrical compartment to the "OFF" position.
2. Pull the horn pad straight up gently to detach it from the steering wheel (Fig. 10).

3. Disconnect the horn wire (white) connected to the horn pad and the steering wheel harness 4-pin connector.

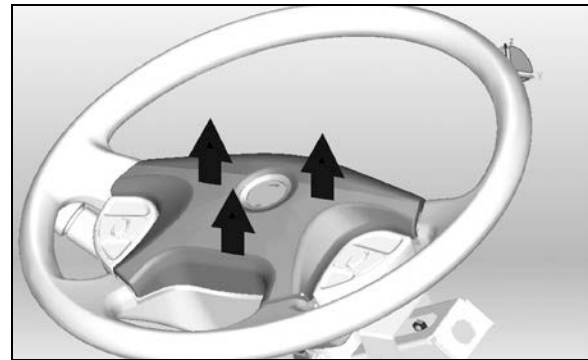


FIGURE 10: REMOVING THE HORN PAD

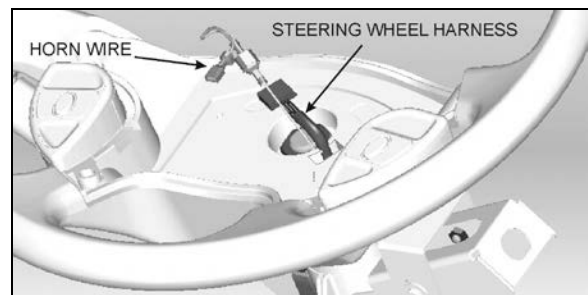


FIGURE 11: STEERING HARNESS & HORN WIRE

4. Unscrew the steering wheel nut. To simplify installation and ensure steering wheel alignment, mark the relationship of the spline shaft to the steering wheel hub (if marks don't already exist or don't line up).
5. Using an appropriate puller, separate the steering wheel from the spline shaft.
6. From behind the steering wheel, pull gently on the electrical wires passing through the rectangular opening in the steering wheel to finish removal of the steering wheel.
7. Once the steering wheel is removed, it is important to block any rotating movement of the clockspring in order to prevent it from losing its neutral position. Use two pieces of masking tape to lock it in place (Fig. 12).

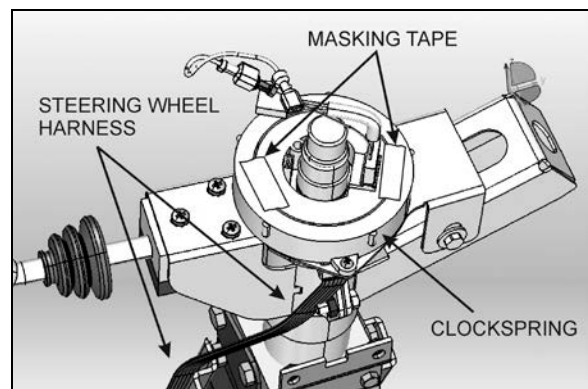




FIGURE 12: LOCKING THE CLOCKSPrING IN PLACE

**NOTE**

*The clockspring mechanism permits a certain number of turns in each direction. At the moment of reinstalling the steering wheel, if the clockspring is not at its neutral position, the number of available turns will be reduced. This may damage the clockspring if the steering wheel is turned to its maximum amplitude.*

7.2 INSTALLATION

1. Route the white horn wire and the 4-pin connector through the opening on the steering wheel.
2. Align the mark on the steering wheel hub with the mark on the spline shaft and slide the wheel onto the shaft.
3. Tighten wheel retaining nut to a torque of 35-45 lbf·ft.
4. Plug the 4-pin connector and connect the white horn wire to the center pad.
5. Reinstall the center pad and test for proper horn functioning.

7.3 CLOCKSPrING REPLACEMENT

1. Remove the steering wheel.
2. Remove the 2 clockspring mounting screws and then remove the clockspring. You will have to disconnect the clockspring harness connector located lower along the steering wheel column. If necessary, remove the steering column covers (Fig. 8).
3. Route the new clockspring harness through the opening in the clockspring support (Fig. 13). Plug the connector at the base of the steering wheel column and fix harness along the steering wheel column.

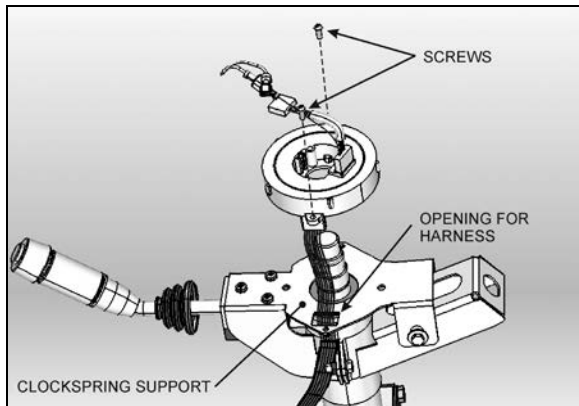


FIGURE 13: CLOCKSPrING INSTALLATION

4. Mount the clockspring in place with 2 screws.
5. Break the paper seal and rotate the center part of the clockspring about 50° clockwise (Fig. 14). This step is necessary for the installation of the steering wheel.

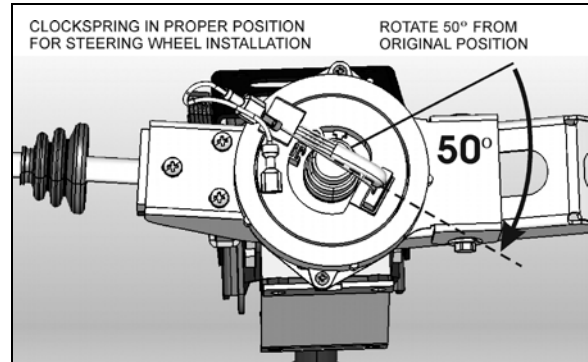


FIGURE 14: PROPER CLOCKSPrING POSITION

6. Reinstall the steering wheel.

8. TURNING ANGLE ADJUSTMENT

The maximum turning angle is set through two (2) steering stop screws installed on the knuckles, above the ABS wheel sensors. Steering stop screws are factory adjusted to accommodate the chassis design, and therefore, do not require adjustment on new vehicles. However, these should be checked and adjusted if necessary, any time a steering system component is repaired, disassembled or adjusted. Refer to section 10 "Front Axle" under heading "6.4 Turning Angle Adjustment".

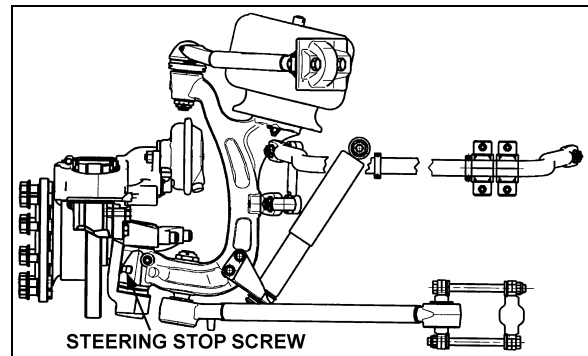


FIGURE 15: STEERING STOP SCREW ON IFS 14063

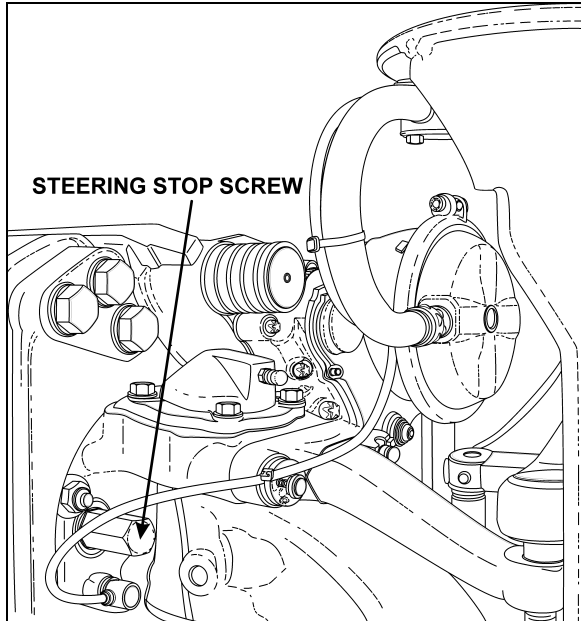


FIGURE 16: STEERING STOP SCREW ON I-BEAM AXLE



**CAUTION**

To prevent the steering damper from interfering with the adjustment of turning angles on vehicles equipped with I-Beam axle, make sure its fixing bracket is at correct location on the axle (refer to "12.2 Steering Stabilizer Cylinder (Damper)").

**Hydraulic Stop**



**CAUTION**

Never maintain the relief pressure for more than 5 seconds, since damage to the power steering pump may occur.



**CAUTION**

Reduce or shut off the power steering hydraulic pressure before the boss on the knuckle touches the stop screw. If not, the components of the front axle will be damaged (refer to "ZF-SERVOCOM Repair Manual" and "ZF-SERVOCOM Operating, Servicing /Maintenance and Inspection Instructions" annexed to this section, under heading "Setting The Steering Limiter").

**9. STEERING LINKAGE ADJUSTMENT**

Perform lubrication according to "DANA SPICER NDS Axles Lubrication and Maintenance" annexed to section 10 "Front Axle".

Drag link ends are provided with grease fittings. Under normal conditions, these should be serviced every 6,250 miles (10 000 km). Refer to section 24 "Lubrication".

Steering linkage pivot points should be checked each time they are lubricated. Looseness can be visually detected while rotating the steering wheel in both directions. Replace defective parts.

**9.1 X3-45 COACHES**

The steering linkage includes the pitman arm, drag link, steering arm, tie rod arms and tie rod.



**CAUTION**

Front wheel alignment should be checked and adjusted if necessary, any time a component of the steering system is repaired, disassembled or adjusted. Refer to section 10 "Front Axle" under heading 6. "Front Wheel Alignment".

**9.2 X3-45 VIP & XLII BUS SHELLS**

The steering linkage consists of tie rods connected to the bell crank and the steering arm at the left side of the bus shell, and to the idler arm and steering arm at the right side of the bus shell.



**CAUTION**

Front wheel alignment should be checked and adjusted if necessary, any time a component of the steering system is repaired, disassembled or adjusted. Refer to section 16 "Suspension" under heading: "Front End Alignment".

**10. PITMAN ARM**

**10.1 REMOVAL**

1. Remove cotter pin, nut and washers from drag link ball stud at pitman arm.
2. Disconnect drag link from pitman arm, using jaw style pullers (pressure screw type).



**WARNING**

Always wear approved eye protection when operating pullers.



**CAUTION**

Do not drive (hammer in) pitman arm on or off pitman shaft as this can damage the steering gear.



**CAUTION**

Heating of components to aid in disassembly is not allowed because it has a detrimental effect on axle components and steering linkages.

3. Using a cold chisel, undo punch mark that locks fixing nut to the pitman arm.
4. Remove pitman arm fixing nut.
5. Check the radial position of the pitman arm in relation to the sector shaft prior to removal of pitman arm.

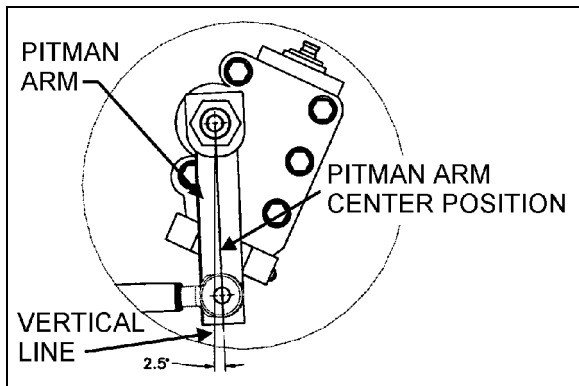


FIGURE 17: I-BEAM FRONT AXLE PITMAN ARM ADJUSTMENT 14037

6. Add reference marks to the arm and shaft if necessary to ensure correct alignment at reassembly.

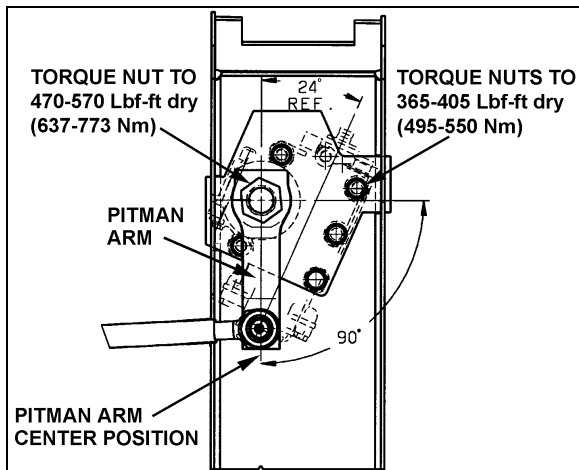


FIGURE 18: IFS PITMAN ARM ADJUSTMENT 14057

7. You must use a puller to remove pitman arm.

10.2 INSTALLATION

1. Position pitman arm on sector gear shaft with reference marks aligned.
2. Install fixing nut (Prevost #661050). Tighten nut to 470-570 lbf-ft (637-773 Nm).

**NOTE**

Use a new nut if the previously removed nut was punched.

3. Lock nut with sector shaft using a punch mark into the groove (Refer to figures 17 and 18).

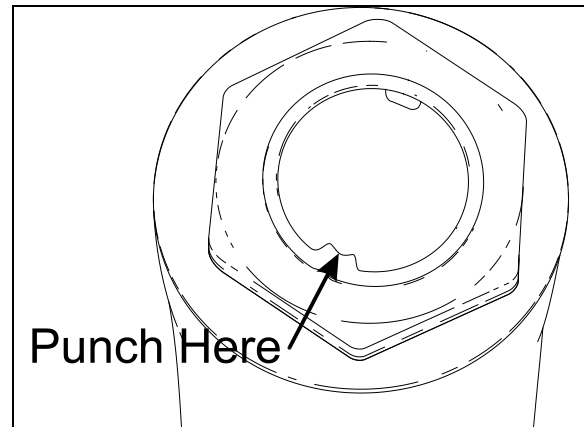


FIGURE 19: FIXING NUT PUNCH MARK 16098

4. Connect drag link to pitman arm while ensuring that rubber stabilizer is in place on the rod end. Install washers. Tighten nut to 150-200 lbf-ft (203-271 Nm). Afterwards, install a new cotter pin.



**CAUTION**

Input shaft marks must be aligned before adjusting pitman arm.

10.3 ADJUSTMENT

1. Disconnect the drag link from pitman arm. Center steering wheel by dividing the total number of steering wheel turns in two. Scribe a reference mark on steering gearbox at the center previously determined.
2. Using a protractor, check the angle of the pitman arm (refer to Fig. 17 and 18 for details).
3. The pitman arm should be adjusted with reference marks aligned or to an angle of 2.5° towards front of vehicle (I-Beam axle) or 90° (Independent Front Suspension) in relation with the vertical axis. If not, unscrew and remove fixing nut. Remove the pitman arm according to the procedure outlined under

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previous heading "Pitman arm removal". Adjust to the proper angle.

4. When adjustment is achieved, replace fixing nut and torque to 470-570 lbf-ft (637-773 Nm).

### 10.4 TAG AXLE UNLOADING SWITCH ADJUSTMENT (X3-45 COACHES ONLY)

1. Make sure vehicle wheels are straight and facing forward.
2. Line up switch lever with reference to the bracket center (Refer to figure 21).

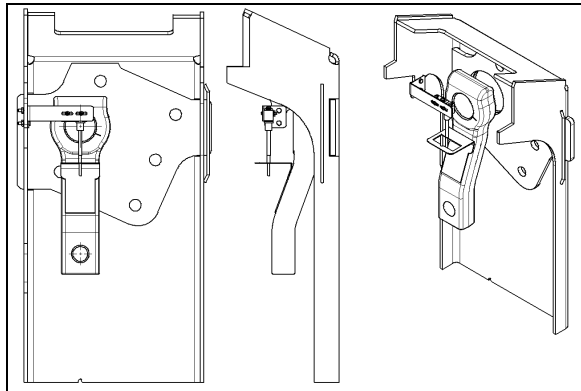


FIGURE 20: TAG AXLE UNLOADING SWITCH ADJUSTMENT 14061

### 11. DRAG LINK (I-BEAM AXLE)

The draglink on your vehicle connects the steering gear pitman arm to the front axle's steering arm.

For additional details please refer to ZF assembly instructions LMN404-3 and Lemförder service information leaflet for the fine adjustment system.

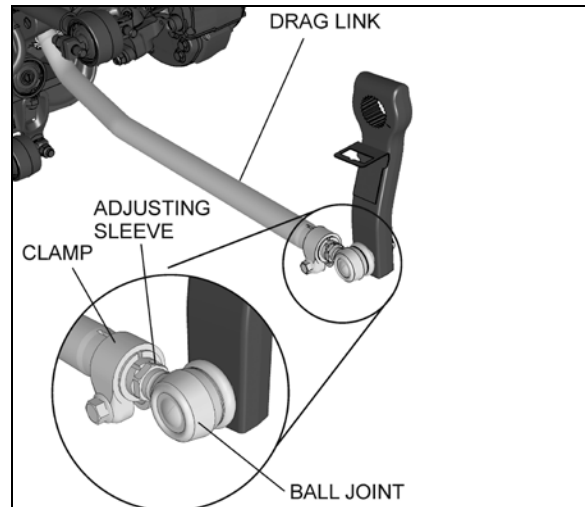


FIGURE 21: DRAG LINK

#### 11.1 FINE ADJUSTMENT

The drag link fore end is provided with an adjusting sleeve which has internal and external left and right threads. Turning this sleeve allows fine adjustments to the length of the draglink.

Apply a small amount anti-seize compound on the threads for corrosion protection. Be sure to avoid smearing the ball joint boot.

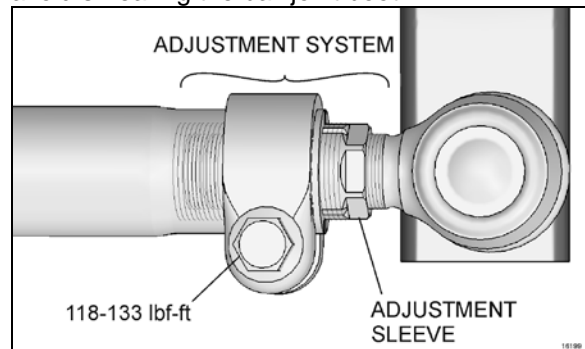


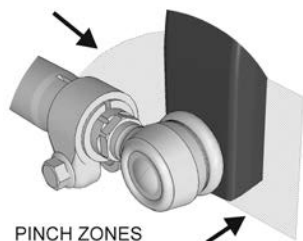
FIGURE 22: DRAG LINK ADJUSTMENT SYSTEM



#### PINCH HAZARD

Keep hands and fingers clear of pinch zones around pitman arm.

Pinch zones are between pitman arm and clamp, and between front of pitman arm and vehicle structure.



#### CAUTION

Too little pressure on the clamp can destroy the threaded adjustment system sleeve.

Apply the recommended torque of 118-133 lbf-ft for clamp nut!

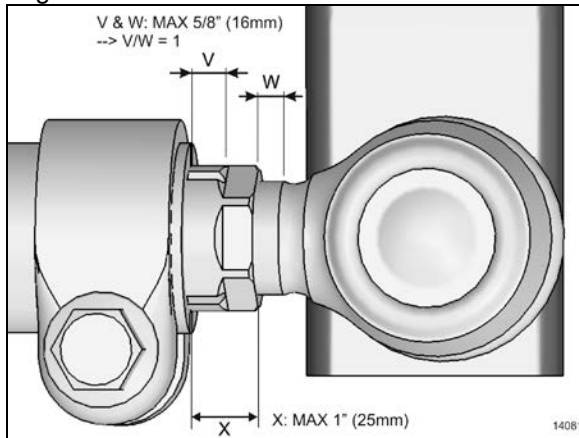
Fine adjustment of the drag link length should be performed exclusively by turning the adjuster sleeve.

##### 11.1.1 Adjustment System Thread Lengths

When assembling the adjuster sleeve or ball joint, be sure to assemble the parts within the following prescribed maximum thread lengths

and values to preserve the integrity of the adjusting system.

Lengths V and W should be measured prior to removal to restore the steering system to its original state.



**FIGURE 23: DRAG LINK ADJUSTMENT SYSTEM**

- Dimension V and W should be equal:  $V/W = 1$
- Max dimension V:  $5/8$ " (16mm)  $\pm 1$  thread pitch
- Max dimension W:  $5/8$ " (16mm)  $\pm 1$  thread pitch
- Max dimension X: 1" (25mm)

## 12. MAINTENANCE

### 12.1 POWER STEERING

The power steering system requires little maintenance. However, the system should be kept clean to ensure maximum operating performance and trouble-free service. Periodic inspections should also be made to check for leakage and all parts for damage or distortion.

When the slightest evidence of dirt, sludge or water is discovered in the system, disconnect fluid lines at the power steering gear to drain the system. Drain and refill the system with "Dexron-II or Dexron-III automatic transmission oil.

Air in the hydraulic system will cause spongy action and noisy operation. When a hose has been disconnected or when fluid has been lost for any reason, the system must be bled. Bleed system as outlined under heading 3: "BLEEDING POWER STEERING HYDRAULIC SYSTEM".



### CAUTION

Do not operate the pump without fluid in the power steering fluid reservoir.

If the steering linkage between the steering gear and the two front wheels is not properly adjusted, or if it is bent, twisted or worn, the steering of the

vehicle will be seriously impaired. Whenever a steering linkage part is repaired, replaced or adjusted, steering geometry and front wheel alignment must be checked and necessary corrections made. Refer to section 10 "FRONT AXLE" under heading 6: "FRONT WHEEL ALIGNMENT".

At regular lubrication intervals, the steering linkage should be thoroughly inspected for worn or loose components.

After the vehicle has been operated continually and high mileage figures have been reached, overhaul of the various steering units will be required. General overhaul procedure normally requires removal of the entire assembly, cleaning and inspection of all parts and final assembly. Careful inspection of all parts during overhaul is very important and must not be neglected.

Lubrication fittings must all be cleaned before applying lubricant. Moreover, always be sure the equipment used in applying lubricant is clean. Every precaution should be taken to prevent entry of dirt, grit, lint or other foreign matter into lubricant containers. Replace fittings that have become broken or damaged. Lubrication intervals, as well as the recommended lubricants for the steering components, are given in the "LUBRICATION AND SERVICING SCHEDULE" in Section 24 of this manual. The intervals given in the schedule are recommended for normal service. More frequent intervals may be required under severe operating conditions.

### 12.2 POWER STEERING RESERVOIR AND FILTER

The power steering reservoir is located on R.H. side of engine compartment, on front wall and accessible through the engine compartment R.H. side door. (Fig. 21).



### MAINTENANCE

At regular intervals, fluid level should be checked in the reservoir and filter assembly. Furthermore, the oil filter cartridge element in the power steering reservoir should be replaced every 50,000 miles (80 000 km) or once a year, whichever comes first.

Power steering fluid reservoir is equipped with a magnetic drain plug. Check for trapped metal particle when replacing filter cartridge element.

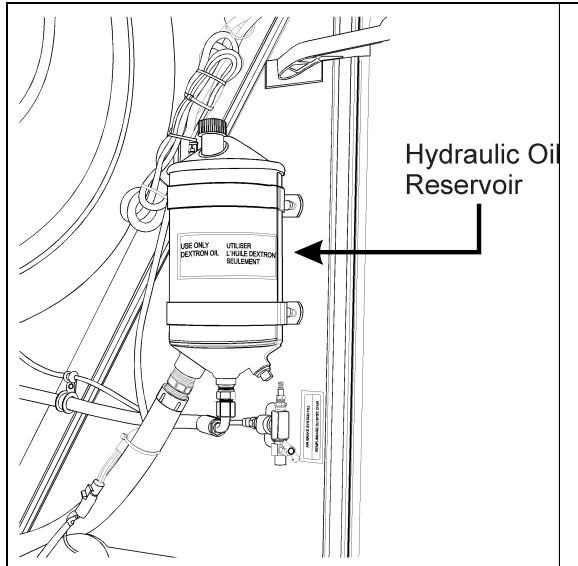


FIGURE 24: HYDRAULIC FLUID RESERVOIR LOCATION  
14043

### 12.2.1 Oil Level Check Procedure

1. Stop engine. Open engine compartment R.H. side door.
2. Unscrew and remove the dipstick located on top of reservoir and wipe with a clean rag.
3. Insert dipstick in reservoir. Remove it again to check fluid level (Fig. 21).
4. Adjust level to "FULL" mark using proper dipstick side depending on fluid temperature, use "Dexron-IIe or Dexron-III" automatic transmission oil.
5. Reinsert and tighten the dipstick.

### 12.2.2 Filter Replacement

1. Unscrew and remove the cover nut located on top of the power steering reservoir.
2. Remove the reservoir cover and the gasket.
3. Remove the retaining spring and finally the filter cartridge element.

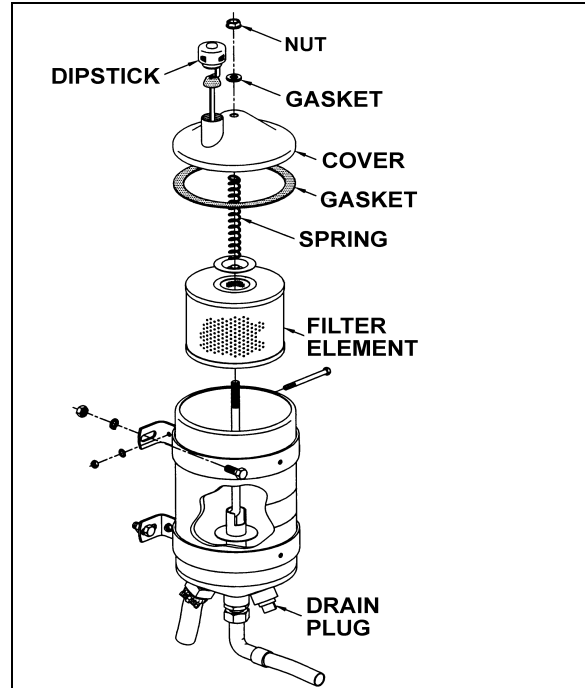


FIGURE 25: POWER STEERING FLUID RESERVOIR<sup>14018A</sup>

### 12.3 STEERING STABILIZER CYLINDER (DAMPER)

The steering damper is located on R.H. side, aft of front axle (Fig.23).

The cylinder is non-adjustable and non-repairable. Check for oil leaks or lack of resistance. Disconnect the cylinder from axle, and then carefully attempt to extend and collapse it manually.



## MAINTENANCE

Steering damper ball joint (rod end) is provided with grease fitting for pressure lubrication. Under normal conditions, it should be serviced every 6,250 miles (10 000 km) or twice a year, whichever comes first.

Check the ball joint for wear, and replace if necessary. Good quality lithium-base grease NLGI No. 2 like Shell Retinax LX is recommended.

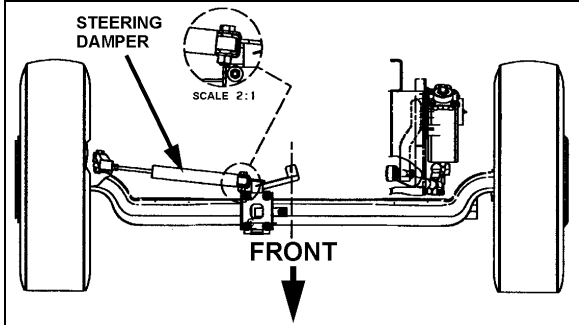


FIGURE 26: STEERING STABILIZER (DAMPER) 14053

12.4 DRAG LINK

Visually inspect drag link components for broken, corroded or deformed clamps, loose, bent or corroded nuts and gauges on tube from rubbing parts.

12.4.1 Independent Front Suspension

 <p><b>MAINTENANCE</b></p>
<p><b>Drag Link (with Independent Front Suspension)</b></p> <p>Drag link ends (ball joint) are provided with grease fittings for pressure lubrication. These grease fittings should be serviced every 6,250 miles (10 000 km) or every 6 months whichever comes first.</p> <p>To prevent corrosion from forming around the ball pin (particularly the drop type ball joint as it is exposed to dirt and water), remove the old grease bead and assure sufficient grease is applied to purge the old grease and fill the joint and dust seal.</p> <p>Good quality lithium-base mineral grease NLGI No.2 like Shell Retinax LX is recommended.</p>

12.4.2 Front I-beam Axle

On vehicles equipped with I-beam front axle, the drag link features **lubricated for life** ball joints and a compact fine adjustment system.

Although the ball joints do not require greasing, they do require regular inspection, refer to the following sections for ball joint maintenance.

**Adjustment System Visual inspection**

Inspect the adjustment system to ensure the threads are firmly seated. Also, a visual inspection should be carried-out looking for damage or corrosion to the adjustment system components. Replace any part showing corrosion or damage.

**Adjustment System Functional inspection**

Clean the adjustment system with a brush and compressed air prior to inspection, if required.

With the engine running and the vehicle on the ground (with a load on the axle) turn the steering wheel left and right.

To verify that the threads are tight and do not present any play, use one of the following methods:

- Visual inspection
- Place a finger on the separation line from the adjuster sleeve to the threaded ball joint shaft.  
**Keep fingers clear of pinch zones.**
- Use a dial gage clamped to the tube and feelers aligned on the ball joint to indicate any play

*When play is discovered in the adjusting system, replace the complete drag link.*


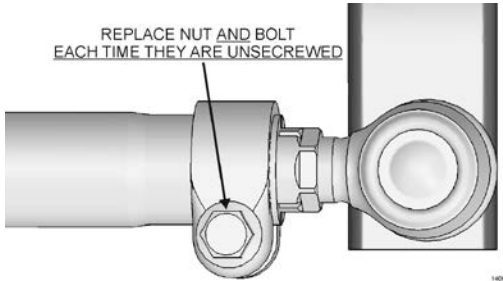

 <p><b>CAUTION</b></p>
<p><b>Do not re-use clamp hardware.</b></p> <p>Bolt <u>and</u> nut should be replaced every time they are unscrewed.</p> <p style="text-align: center;">REPLACE NUT AND BOLT EACH TIME THEY ARE UNSCREWED</p>  <p>While assembling the clamp, make sure the bolt <u>does not touch</u> the draglink tube.</p> 

FIGURE 27: I-BEAM FRONT AXLE DRAG LINK

## Section 14: STEERING

### 12.5 TIE ROD

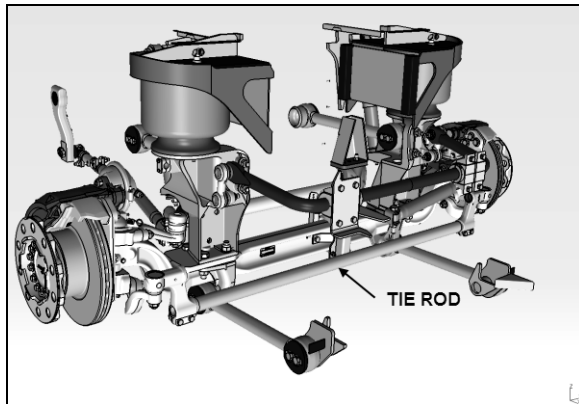



FIGURE 28: TIE ROD



### MAINTENANCE


Tie rod ends (ball joint) are provided with grease fittings for pressure lubrication. These grease fittings should be serviced every 6,250 miles (10 000 km) or every 6 months whichever comes first.

To prevent corrosion from forming around the ball pin, remove the old grease bead and assure sufficient grease is applied to purge the old grease and fill the joint and dust seal.

Good quality lithium-base mineral grease NLGI No. 2 like Shell Retinax LX is recommended.

### 12.6 DRAG LINK AND TIE ROD BALL JOINTS INSPECTION FOR CORROSION

Inspection of ball joints is important. Damaged sealing boots, salt and climatic conditions can cause loss of the corrosion protection coating applied at time of manufacturing.



### MAINTENANCE

Inspect drag link and tie rod ball joints for corrosion once a year.

1. Carefully clean the sealing boot or dirt seal contact area to ensure that no contaminants can get under the sealing boot or dirt seal during the following inspection procedure.
2. Use an appropriate inspection tool (e.g. spatula with cut out) to push up (sealing boot) or down (dirt seal) the seal (without damaging it) until ball pin surface is visible. Degrease the ball pin surface and inspect carefully.

3. If there is corrosion of the ball pin or the sealing boot has deteriorated through ageing or is damaged, replace the ball joint.
4. If there is corrosion of the steering arm or tie rod arm area which is in contact with the sealing boot or dirt seal, clean and eliminate all surface irregularities.
5. If there is no corrosion or damage to the sealing boot or dirt seal, smear the steering arm and tie rod arm with Lithium grease and push seal back into its properly seated position.

When dismantling tie rod or drag link, ensure that no damage is caused to the sealing boots, dirt seals or ball joint housings.

### 12.7 DROP TYPE BALL JOINT

#### 12.7.1 Drop Type Ball Joint End Play

If end play (direction of the ball pin axis) exceeds 0.047" (1.2 mm), readjustment is necessary.

Remove protective cap, using a suitable tool i.e.: a 1" x 1/8" x 9" long flat bar, tighten adjuster piece fully home (SOLID) locating thrust cup onto ball pin.

Still with tool located on adjuster piece, back off carefully (LEAST AMOUNT) until adjuster piece cotter pin is allowed to pass through body, then remove tool.

Reinstall protective cap.

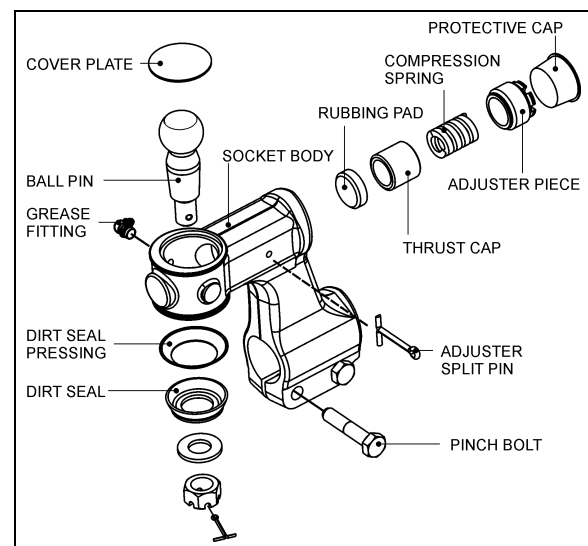


FIGURE 29: DROP TYPE BALL JOINT FOUND ON TIE ROD (2X)

10029



12.7.2 Dismantling Drop Type Ball Joint

1. Remove dirt seal and dirt seal pressing from ball pin.
2. Slacken pinch bolt nut then unscrew and remove ball joint assembly from tie rod having first marked ball joint body and tie rod to enable tracking on re-assembly.
3. Remove adjuster split pin from ball joint body.
4. Remove cap then using a suitable tool i.e.: a piece or 1"x1/8"x 9" flat bar, unscrew and remove adjuster piece. Waggle ball pin to free thrust cap.
5. Remove compression spring and thrust cap from ball joint body.
6. Relieve peening on socket body top then using a hide faced mallet, tap ball pin out of body. This operation will also remove cover plate from body.
7. The rubbing pad can now be removed from body.

**Thoroughly clean all parts and check for wear, renewing where necessary.**

12.7.3 Assembling Drop Type Ball Joint

1. Apply a bead of Loctite 638 sealant to mating corner of rubbing pad in socket body then knock rubbing pad into its recess in ball joint body.
2. Thoroughly grease rubbing pad and ball pin with Shell Retinax LX or equivalent.
3. Insert ball pin into body.
4. Insert thrust cap, compression spring and adjuster piece into body.
5. Tighten adjuster piece fully home (SOLID) locating thrust cup onto ball pin.
6. Still with tool located on adjuster piece, back off carefully (LEAST AMOUNT) until adjuster piece split pin is allowed to pass through body, and that ball pin shank can be moved by moved of hand, then remove tool.

NOTE: If ball pin does not rotate when re-adjusted in line with above instructions, this suggests that ball pin has local worn flats. In this instance ball pin, thrust cup and rubbing pad MUST be replaced, if not FAILURE could occur in service, i.e. ball pin not being able to move in assembly when turning from lock to lock.

7. Fit cover plate into top of ball joint body, re-peen using a cold chisel to secure.
8. Screw assembled ball joint onto tie rod. Lining up marks on both body and tie rod previously made, or retracking using manual instructions.
9. Fit pinch bolts and nuts then tighten nuts alternately and progressively to 65-75 lbf-ft (88-102 Nm.) thus securing ball joint to tie rod.
10. Fit dirt seal (pressing) and dirt seal (rubber) onto ball pin.
11. Locate ball joint and tie rod assembly with lever, carefully align and fit ball pin into hole in tie rod arm.

NOTE: Ball pin and ball pin tapers in bottom tie rod arms must be clean, dry and free from oil prior to assembly.

12. Fit pin washer onto ball pin.
13. Screw pin nut onto ball pin then tighten to 175 lbf-ft (237 Nm).
14. Using a 2lb hammer, tap tie rod arm to "shock" ball pin into taper hole.
15. Re-torque pin nut to 175 lbf-ft (23 7Nm).
16. Fit split pin, if slot/hole are not in line, adjust up to next slot.

**Pin nut torque 175 lbf-ft, max pin nut torque 200 lbf-ft.**

17. Re-charge ball joint with Shell "Retinax LX" or equivalent grease through grease fitting.

12.8 STRAIGHT BODY TYPE BALL JOINT

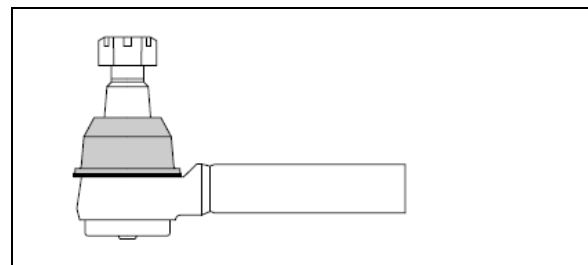


FIGURE 30: STRAIGHT BODY TYPE BALL JOINT

12.8.1 Visual Inspection

- Visually inspect for missing or damages grease fittings and replace if required.
- Damaged sealing boot or improper sealing requires seal replacement.

## Section 14: STEERING

- Check ball joint connection for missing cotter pins.
- Check for looseness in the ball/socket assembly.

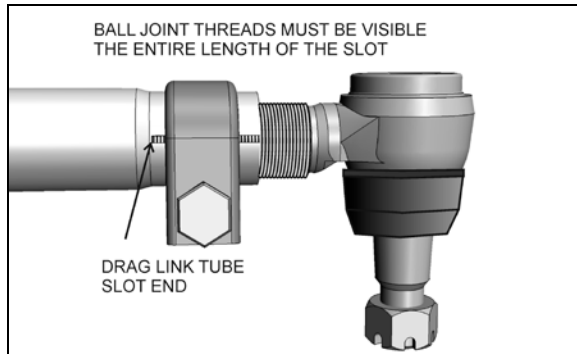


FIGURE 31: ADEQUATE CLAMPING CONDITION

For adequate clamping, the ball joint threads must be visible the entire length of the tube slot. If not, the drag link must be adjusted or replaced. It is either the wrong size, or improper adjustment was used to compensate for another problem (e.g. bent steering arm).

### 12.8.2 Straight Body Type Ball Joint End Play And Looseness

#### What creates movement in sockets?

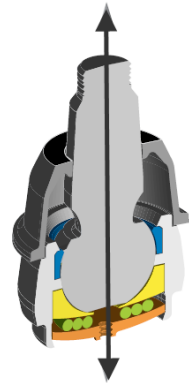
In each straight body type ball joints, the compressive force of the spring creates resistive torque by applying a constant load on the bearing and stud.

As wear occurs on the components, the spring creates less resistive torque. With less torque, you no longer have the precise joint needed for optimum steering, but you do still have a safe linkage. **When all compression is lost, it's time to replace the linkage.** This wear can be caused by impact, lack of lubrication and normal wear.

1. With vehicle engine on, lightly rock the steering wheel while checking for looseness in any threaded joint. Observe any looseness in the two mating tapers or any movement of the ball pin nut. Any looseness requires further inspection. If either of the mating tapered parts shows distortion or wear, both parts must be replaced.

2. With the engine off and wheels straight ahead and no force is being exerted on the linkage by the steering gear, push and pull the ball joint in and out by hand (approximately 100 lbs. force) in the direction of the ball pin. If no movement is detected, the ball joint is safe. **Any movement detected by hand requires replacement of the ball joint.**

Inspect for movement along vertical axis only.



### CAUTION

Do not use a wrench or other object to apply leverage when inspecting ball joint. Applying leverage can give distorted results and damage components.

### 13. DRIVING TIPS

In order to maximize power steering pump service life, do not attempt to turn the steering wheel when the vehicle is stationary, and especially when service brakes are applied (wheel locking will oppose the effect of steering geometry which tends to make the front wheels rotate in opposite directions).

Persisting in turning, or maintaining the steering wheel with an extra effort, could make the hydraulic system work at the relief pressure, and consequently, cause the hydraulic fluid to become overheated.



### CAUTION

Never maintain the hydraulic system at the relief pressure for longer than 5/10 seconds to avoid damaging the power steering pump.

#### NOTE

*Unequal or low tire pressure, oversize tires, and vehicle overloading are some of the causes that may increase steering effort.*

## 14. TROUBLESHOOTING

CONDITION	CAUSE	CORRECTION
Tires wear out quickly or have uneven tire tread wear.	<ol style="list-style-type: none"> <li>1. Tires have incorrect air pressure.</li> <li>2. Tires out-of-balance.</li> <li>3. Incorrect tag axle alignment.</li> <li>4. Incorrect toe-in setting.</li> <li>5. Incorrect steering arm geometry.</li> </ol>	<ol style="list-style-type: none"> <li>1. Put specified air pressure in tires.</li> <li>2. Balance or replace tires.</li> <li>3. Align tag axle.</li> <li>4. Adjust toe-in specified setting.</li> <li>5. Service steering system as necessary.</li> </ol>
Vehicle is hard to steer.	<ol style="list-style-type: none"> <li>1. Low pressure in the power steering system.</li> <li>2. Steering gear not assembled correctly.</li> <li>3. Steering linkage needs lubrication.</li> <li>4. King pins binding.</li> <li>5. Incorrect steering arm geometry.</li> <li>6. Caster improperly adjusted.</li> <li>7. Tie rod ends hard to move.</li> <li>8. Worn thrust bearing.</li> </ol>	<ol style="list-style-type: none"> <li>1. Repair power steering system.</li> <li>2. Assemble steering gear correctly.</li> <li>3. Lubricate steering linkage.</li> <li>4. Replace king pins.</li> <li>5. Service steering system as necessary.</li> <li>6. Adjust caster as necessary.</li> <li>7. Replace tie rod ends.</li> <li>8. Replace thrust bearing.</li> </ol>
Bent or broken steering arm, steering top lever or tie rod assembly.	<ol style="list-style-type: none"> <li>1. Too much pressure in the power steering system.</li> <li>2. Cut-off pressure of the power steering system improperly adjusted.</li> <li>3. Vehicle not powered on correctly.</li> <li>4. Power steering system not installed correctly.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), adjust power steering system to specified pressure.</li> <li>2. Make sure vehicle is powered on correctly.</li> <li>3. Correctly install the power steering system.</li> <li>4. Correctly install the power steering system.</li> </ol>
Worn or broken steering ball pin.	<ol style="list-style-type: none"> <li>1. Drag link fasteners tightened past specified torque.</li> <li>2. Lack of lubrication or incorrect lubricant.</li> <li>3. Power steering stops improperly adjusted.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), tighten drag link fasteners to specified torque.</li> <li>2. Lubricate linkage with specified lubricant.</li> <li>3. Adjust stops to specified dimension.</li> </ol>
Worn king pins and knuckle bushings.	<ol style="list-style-type: none"> <li>1. Worn or missing seals and gaskets.</li> <li>2. Incorrect lubricant.</li> <li>3. Axle not lubricated at scheduled frequency.</li> <li>4. Incorrect lubrication procedures.</li> <li>5. Lubrication schedule does not match operating conditions.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), replace seals and gaskets.</li> <li>2. Lubricate axle with specified lubricant.</li> <li>3. Lubricate axle at scheduled frequency.</li> <li>4. Use correct lubrication schedule to match operating conditions.</li> <li>5. Change lubrication schedule to match operating conditions.</li> </ol>
Vibration or shimmy of front axle during operation.	<ol style="list-style-type: none"> <li>1. Caster not adjusted properly.</li> <li>2. Wheels and/or tires out-of balance.</li> <li>3. Worn steering stabilizer cylinder.</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust caster.</li> <li>2. Balance or replace wheels and/or tires.</li> <li>3. Replace steering stabilizer cylinder.</li> </ol>

## Section 14: STEERING

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### 15. TORQUE SPECIFICATIONS

The torque specifications applicable to the front axle steering are grouped with information regarding the front suspension. Please refer to Section 16: SUSPENSION of this manual.

### 16. SPECIFICATIONS

#### Power Steering Gear

Make ..... ZF-SERVOCOMTRONIC  
Prevost number ..... 661044  
F.E.W. .... 16,600 lbs (7 545 kg)  
Pressure rating ..... 2,175 psi (150 Bar)  
Gear ratio (center) ..... 22.2 : 1  
Gear ratio (extremities) ..... 26.2 : 1  
Minimum pump flow for 1.5 hwt/sec ..... 4.22 gpm (16 lpm)

#### Power Steering Gear

Make ..... ZF-SERVOCOM  
Prevost number ..... 661045  
F.E.W. .... 16,600 lbs (7 545 kg)  
Pressure rating ..... 2,175 psi (150 Bar)  
Gear ratio (center) ..... 22.2 : 1  
Gear ratio (extremities) ..... 26.2 : 1  
Minimum pump flow for 1.5 hwt/sec ..... 4.22 gpm (16 lpm)

#### Power Steering Reservoir

Oil capacity ..... 4 US qts (3.7 liters)  
Prevost number ..... 660982  
Make ..... Nelson Muffler

#### Steering Stabilizer Cylinder (Damper)

Extended length ..... 32.73±0.12"  
Collapsed length ..... 20.26±0.12"  
Stroke ..... 12.47±0.12"