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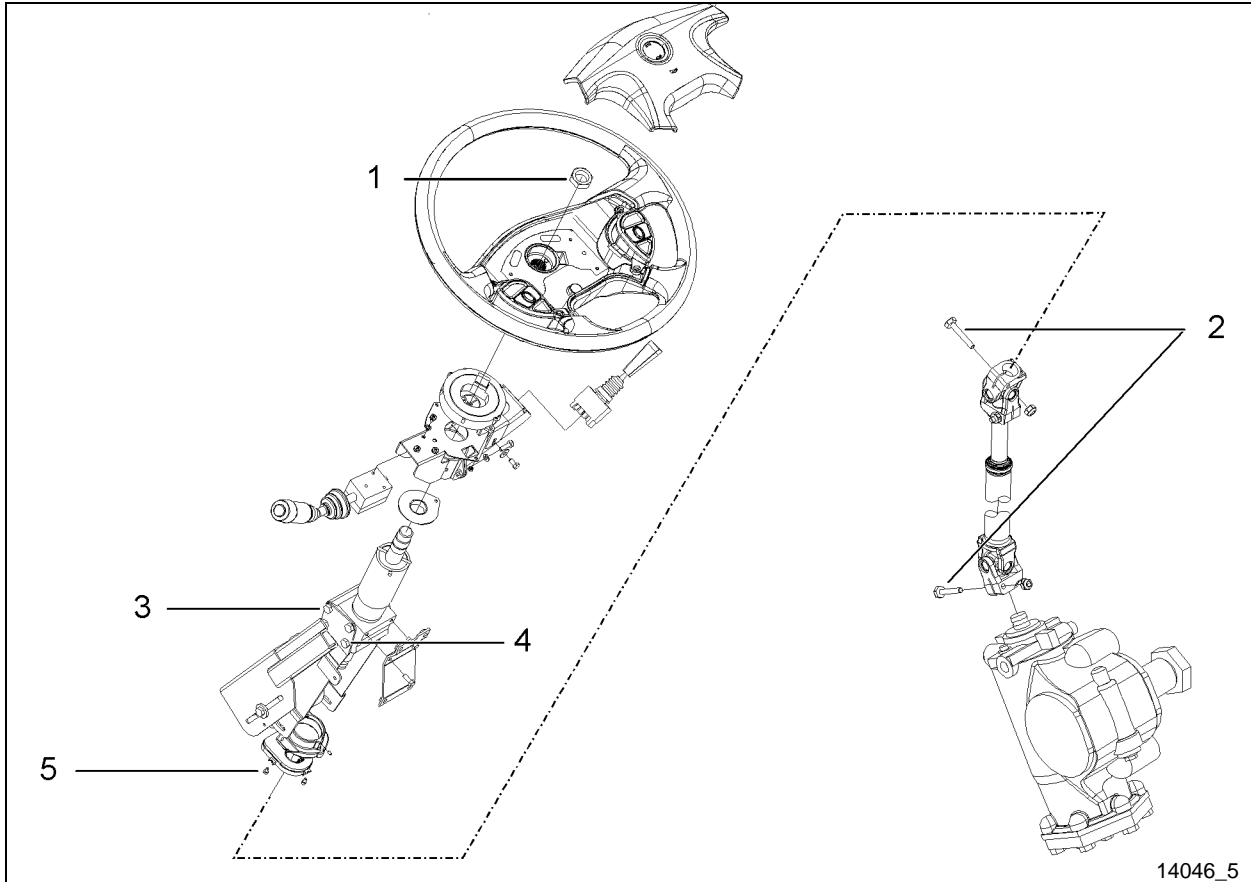
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1. TORQUE TABLES

1.1 STEERING COLUMN

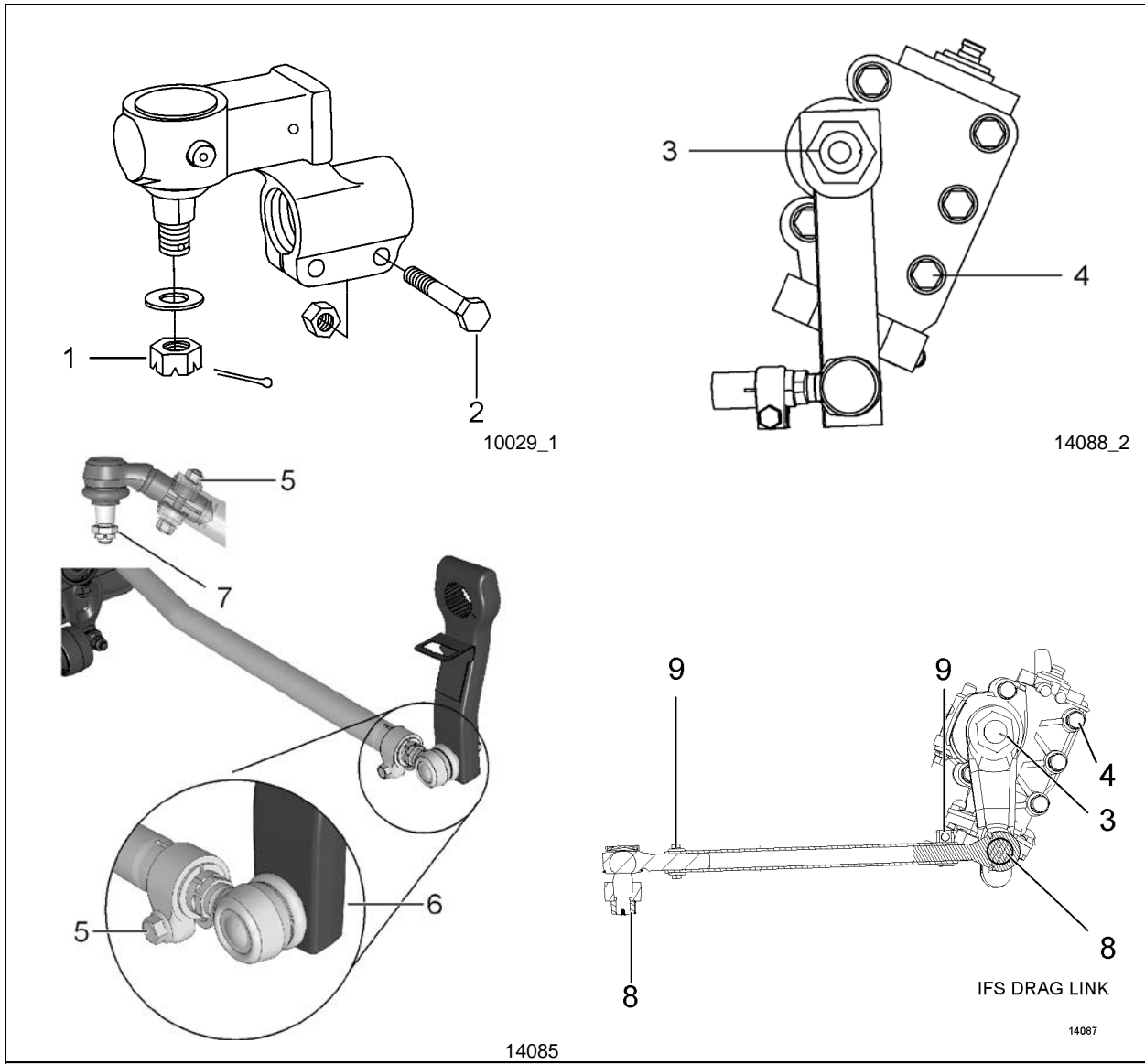


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**STEERING COLUMN**

No	DESCRIPTION	TORQUE
1	Steering Wheel Nut	35-45 lb-ft (47-61 Nm)
2	U-Joint Clamp Nut	48 lb-ft (65 Nm)
3	Column Support Fore Bolts	11-13 lb-ft (15-18 Nm)
4	Column Support Aft Bolts	15-19 lb-ft (20-26 Nm)
5	Steering Angle Sensor Mounting Screws	9-12 lb-in (1.02-1.36 Nm)

**1.2 MISCELLANEOUS TORQUES**



<b>MISCELLANEOUS</b>		
No	DESCRIPTION	TORQUE
1	Drop Type Ball Joint Castellated Nut - I-Beam Axle	175-200 lb-ft (237-271 Nm)
2	Drop Type Ball Joint Clamp Bolts - I-Beam Axle	65-75 lb-ft (88-102 Nm)
3	Pitman Arm Fixing Nut	470-570 lb-ft (637-773 Nm)
4	Steering Gear Mounting Bolts	365-405 lb-ft (495-549 Nm)
5	Drag Link Clamp Bolts - I-Beam Axle	118-133 lb-ft (160-180 Nm)
6	Drag Link Ball Joint Stud Nut (Fore) - I-Beam	165-236 lb-ft (224-320 Nm)
7	Drag Link Ball Joint Stud Nut (Aft) - I-Beam	140-200 lb-ft (190-271 Nm)
8	Drag Link Ball Joint Stud Nut - IFS	245-270 lb-ft (332-366 Nm)
9	Draglink Clamp Bolt - IFS	50-60 lb-ft (68-81 Nm)

## 2. STEERING SYSTEM

### 2.1 FRONT 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 (Figure 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.

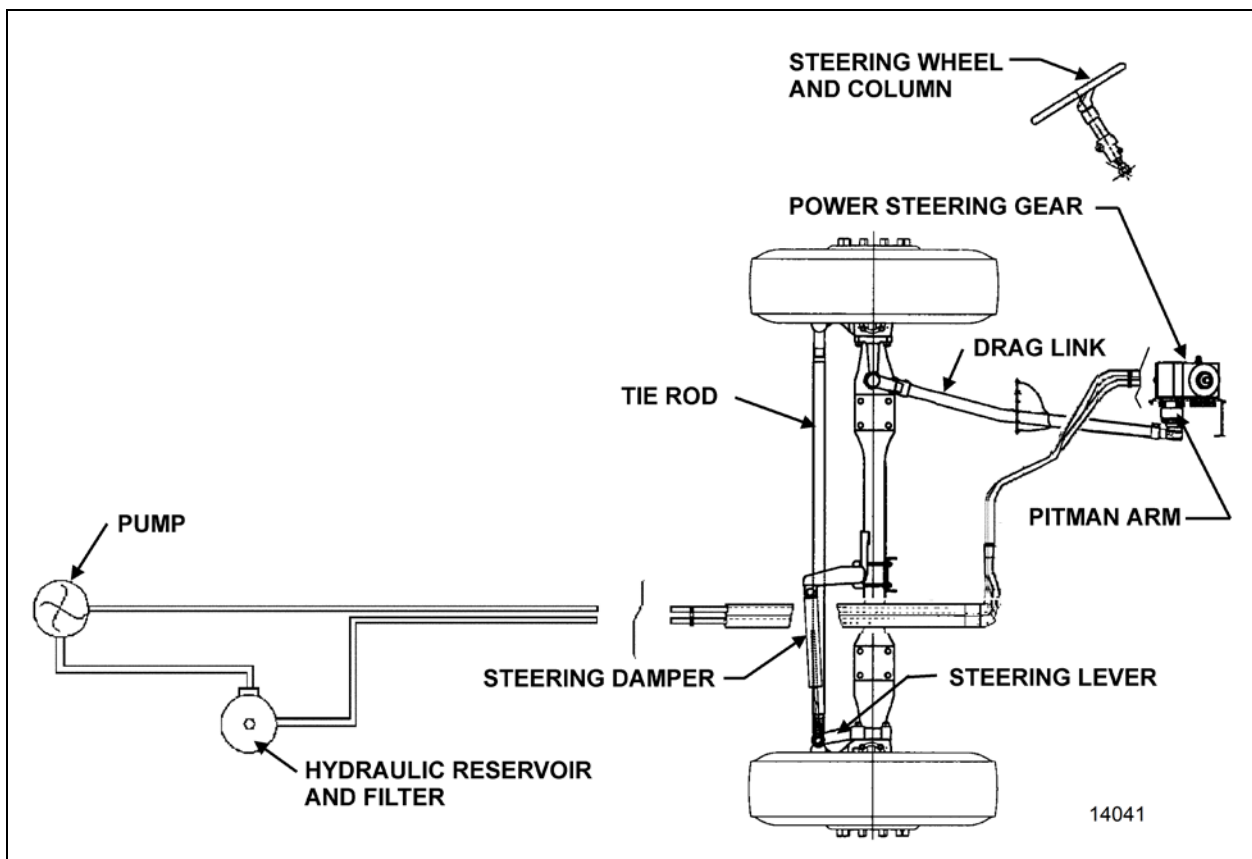


FIGURE 1: I-BEAM AXLE STEERING SYSTEM SETUP

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2.2 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 (Figure 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 (VIP & Bus Shells).

**NOTE**  
*VIP vehicles and 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.

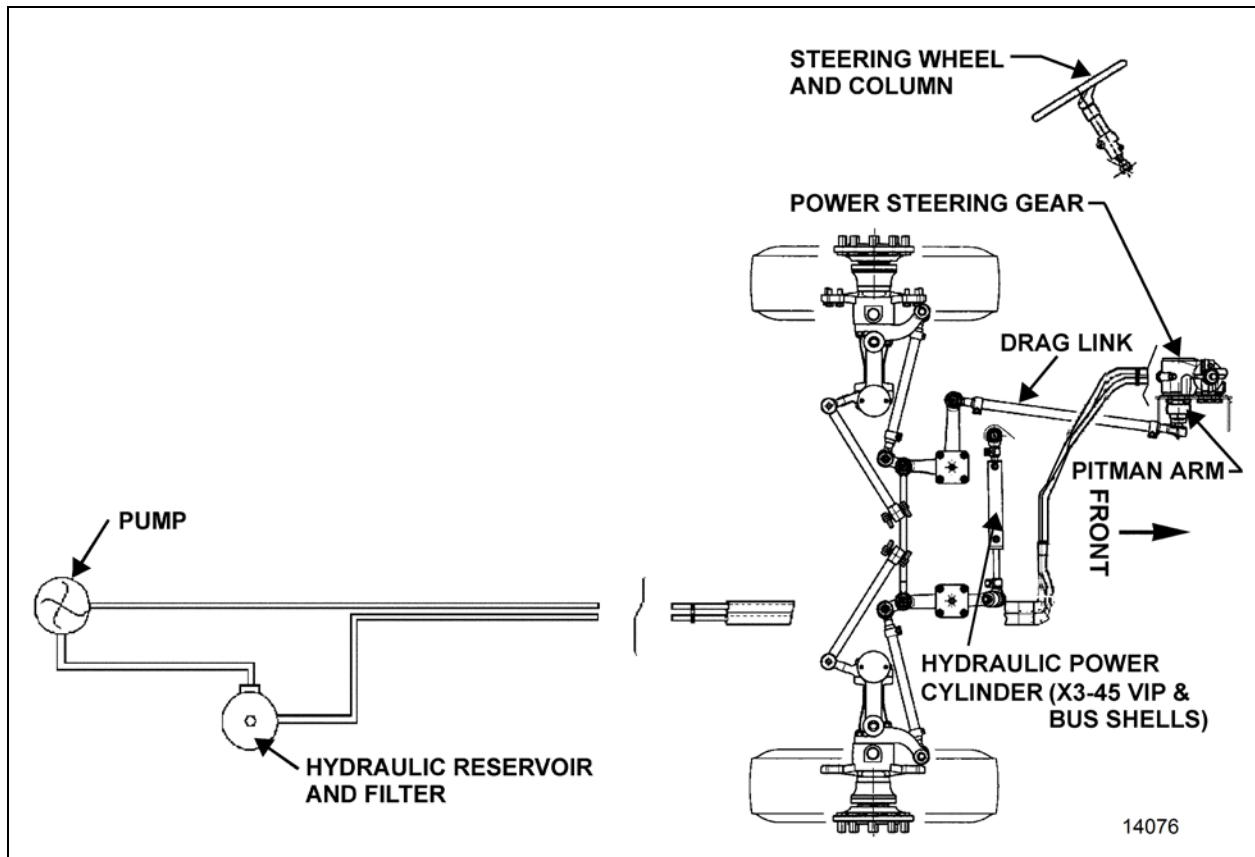


FIGURE 2: IFS STEERING SYSTEM SETUP

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### 3. POWER STEERING GEAR

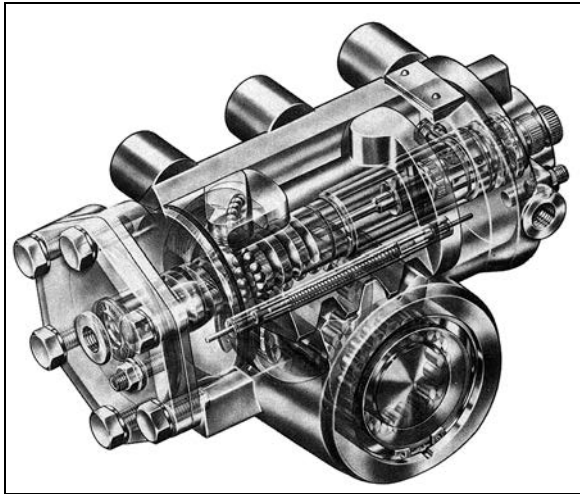


FIGURE 3: POWER STEERING GEAR

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#### 3.1 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.

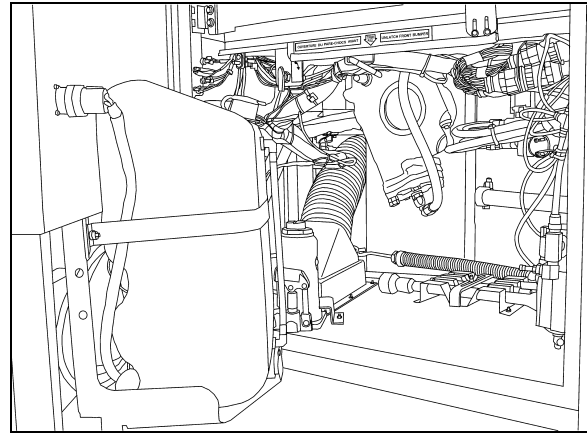


FIGURE 4: FRONT SERVICE COMPARTMENT

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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.

3.2 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, and 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.

3.3 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.

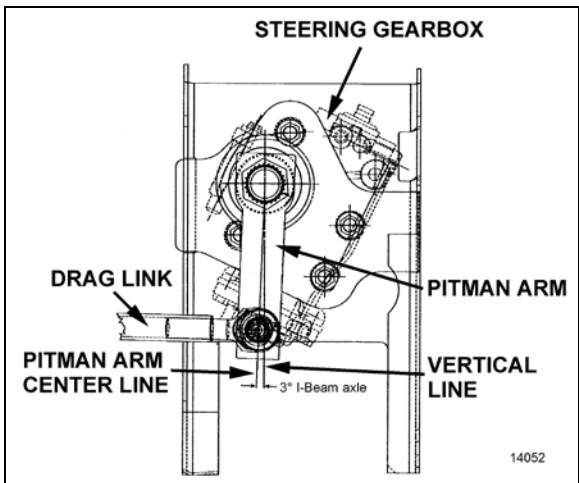


FIGURE 5: PITMAN ARM ADJUSTMENT

3.4 TROUBLESHOOTING

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

4. 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".

5. 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 (speed sensitive) unit, refer to the supplement to the repair manual ZF-SERVOCOM.

6. POWER STEERING HYDRAULIC PUMP

6.1 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.

6.2 REMOVAL AND INSTALLATION

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

To remove the pump, proceed as follows:

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

**NOTE**  
Only unfasten the bolts marked with arrows.

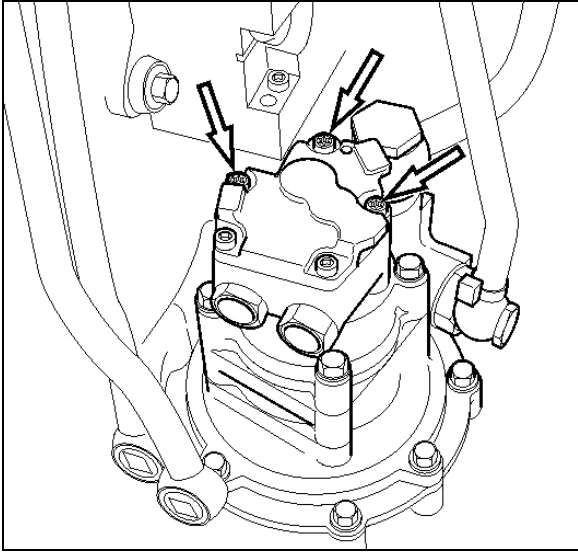


FIGURE 6: FUEL PUMP REMOVAL

**CAUTION**

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

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

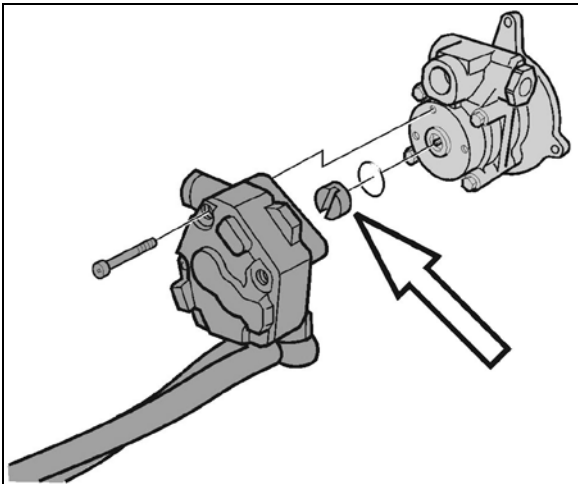


FIGURE 7: FUEL PUMP DRIVE AXLE

5. Set the fuel pump aside.
6. 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.
7. Unfasten the power steering pump bolts.

**NOTE**

Only unfasten the bolts marked with arrows.

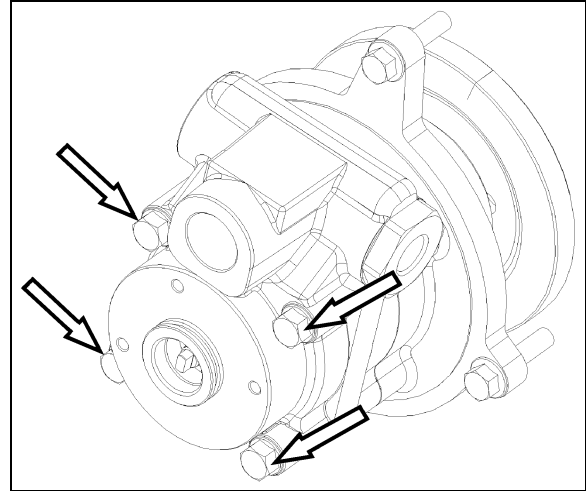


FIGURE 8: POWER STEERING PUMP REMOVAL

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

**NOTE**

Use a new gasket.

9. Connect the hydraulic lines to the power steering pump.
10. 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.

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

**7. STEERING COLUMN****7.1 REMOVAL**

To disassemble the steering column from system, refer to Figure 9 & Figure 10. 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:

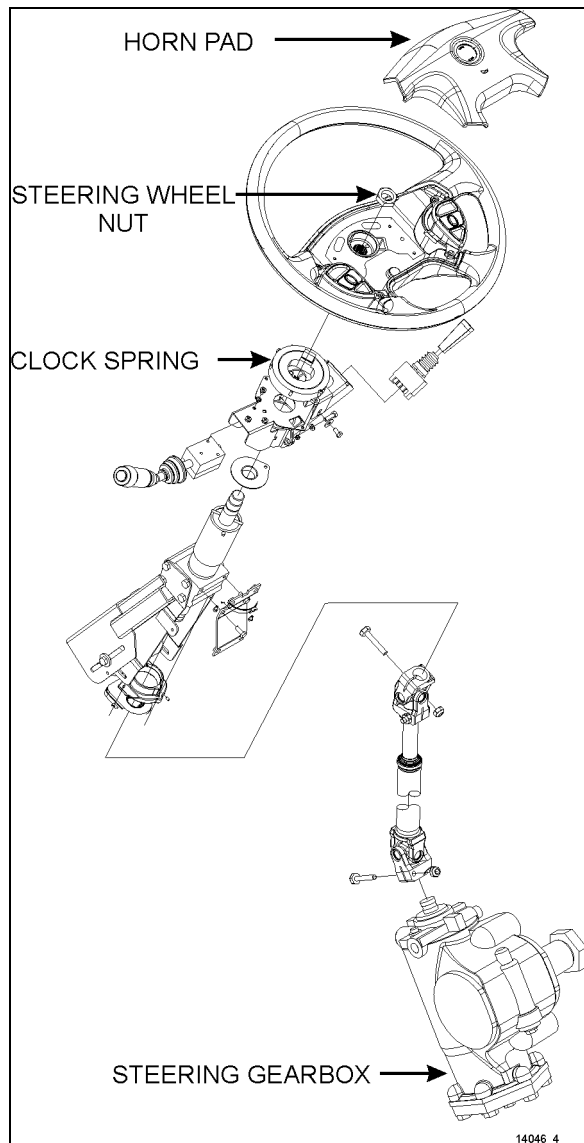


FIGURE 9: STEERING COLUMN

1. From the front driver's compartment area, remove the three plastic fasteners on steering column lower cover. Remove the lower cover (Figure 10).
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.
4. Position the steering wheel in order to gain access to the joints.

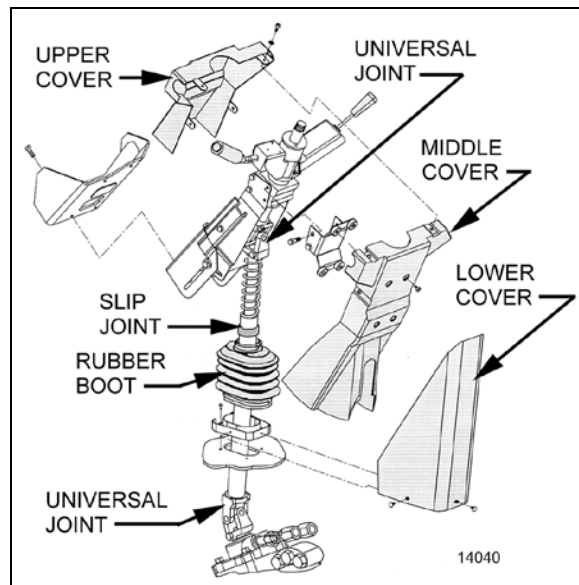


FIGURE 10: STEERING COLUMN COVERS

## 8. STEERING WHEEL

### 8.1 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 (Figure 11).
3. Disconnect the horn wire (white) connected to the horn pad and the steering wheel harness 4-pin connector.

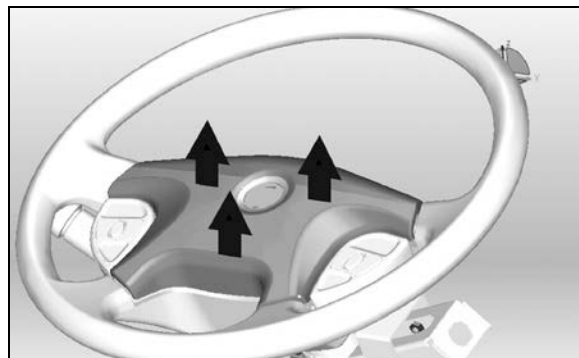


FIGURE 11: REMOVING THE HORN PAD

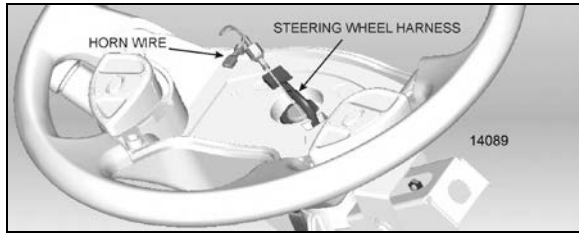


FIGURE 12: STEERING HARNESS &amp; HORN WIRE

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 (Figure 13).

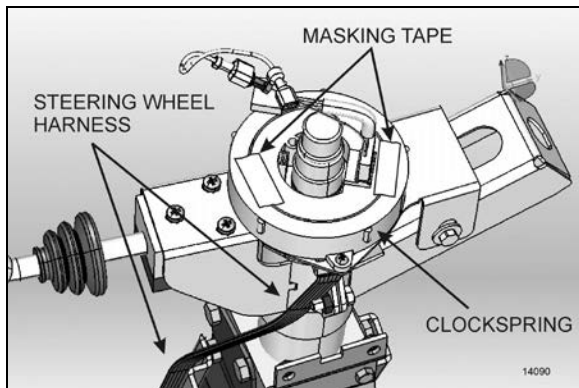


FIGURE 13: LOCKING THE CLOCKSPRING IN PLACE

**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.*

**8.2 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 steering wheel retaining nut.
 

**TORQUE: 35-45 lb-ft (47-61 Nm)**
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.

**8.3 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 (Figure 14).
3. Route the new clockspring harness through the opening in the clockspring support (Figure 14). Plug the connector at the base of the steering wheel column and fix harness along the steering wheel column.

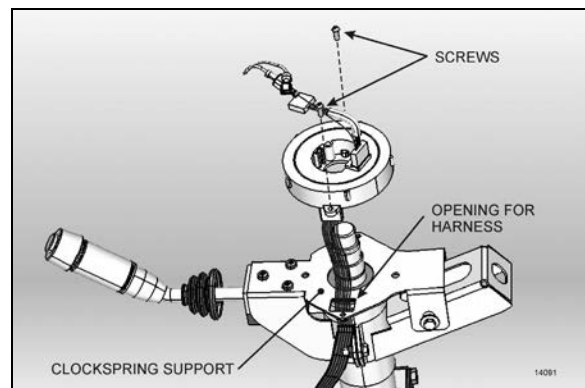


FIGURE 14: CLOCKSPRING INSTALLATION

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 (Figure 15). This step is necessary for the installation of the steering wheel.

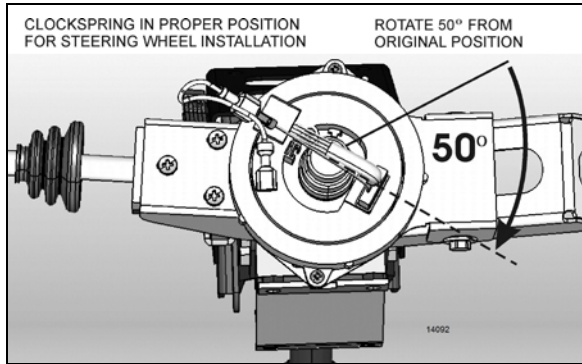


FIGURE 15: PROPER CLOCKSRRING POSITION

6. Reinstall the steering wheel.

**9. 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".

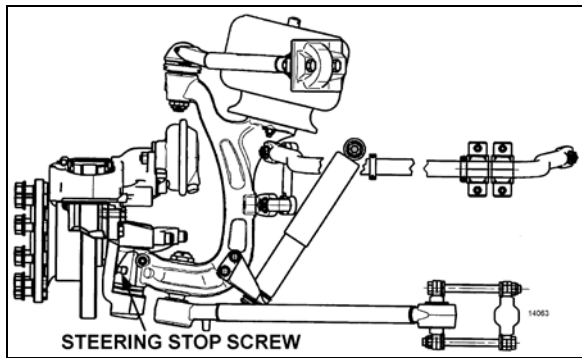


FIGURE 16: STEERING STOP SCREW ON IFS

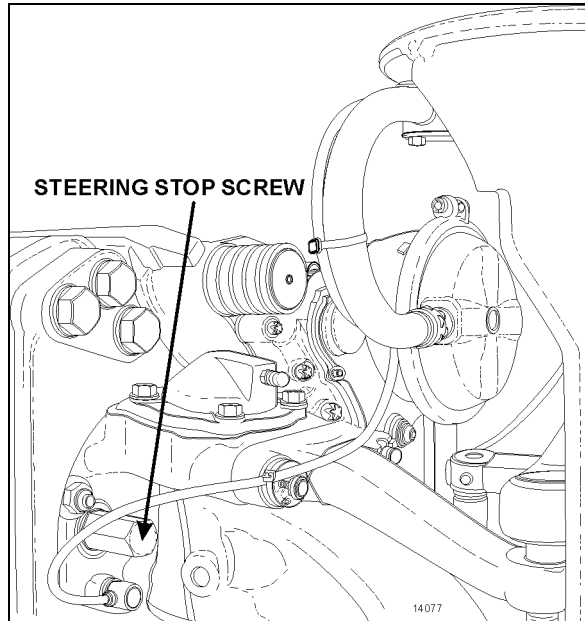


FIGURE 17: STEERING STOP SCREW ON I-BEAM AXLE



**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").

**10. STEERING LINKAGE ADJUSTMENT**

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.

**10.1 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".*

**10.2 VIP & 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".

**11. PITMAN ARM**

**11.1 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.

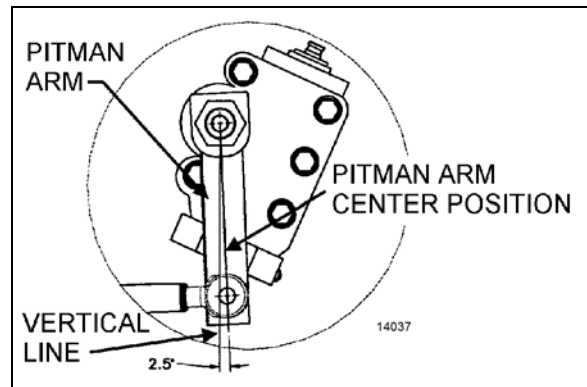


FIGURE 18: I-BEAM FRONT AXLE PITMAN ARM ADJUSTMENT

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

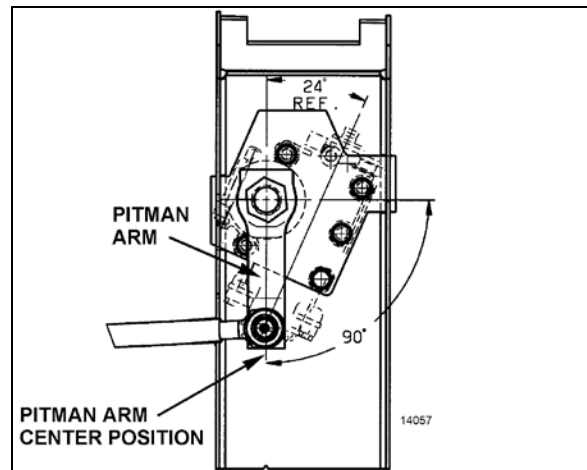


FIGURE 19: IFS PITMAN ARM ADJUSTMENT

- Use a suitable puller and remove pitman arm.

## 11.2 INSTALLATION

- Position pitman arm on sector gear shaft with reference marks aligned.
- Install fixing nut.

**TORQUE: 470-570 lb-ft (637-773 Nm)**

### NOTE

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

- Lock nut with sector shaft using a punch mark into the groove (Refer to Figure 20).



FIGURE 20: FIXING NUT PUNCH MARK 16098

- Connect drag link to pitman arm while ensuring that rubber stabilizer is in place on the rod end. Install washers. Tighten nut and install a new cotter pin. Depending on axle type, select the appropriate torque,

*IFS*, TORQUE: 245-270 lb-ft (332-366 Nm)

*I-BEAM*, TORQUE: 165-236 lb-ft (224-320 Nm)



## CAUTION

Input shaft marks must be aligned before adjusting pitman arm.

## 11.3 ADJUSTMENT

- 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.

- Using a protractor, check the angle of the pitman arm (refer to Figure 19 & Figure 19 for details).
- 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 0° (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 previous heading "Pitman arm removal". Adjust to the proper angle.
- When adjustment is achieved, replace fixing nut and tighten

**TORQUE: 470-570 lb-ft (637-773 Nm)**

## 11.4 TAG AXLE UNLOADING SWITCH ADJUSTMENT (OPTIONAL)

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

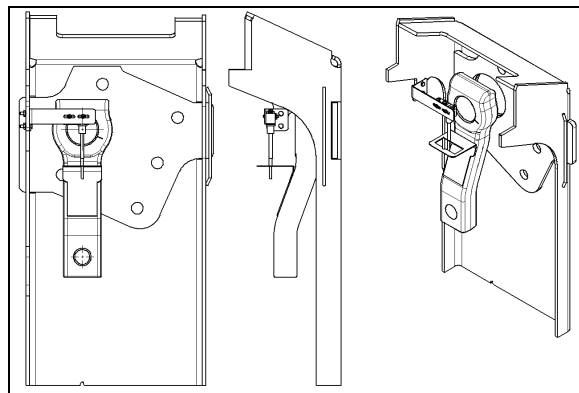


FIGURE 21: TAG AXLE UNLOADING SWITCH ADJUSTMENT 14061

## 12. 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.



## 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.

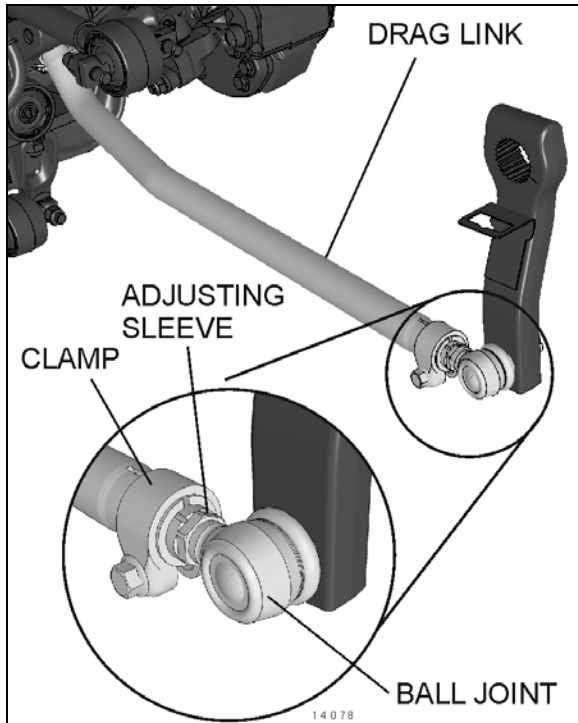
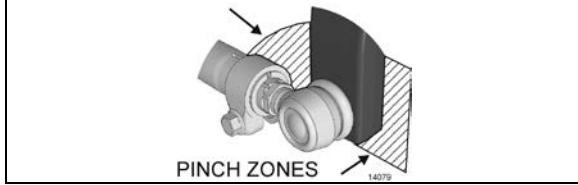


FIGURE 22: DRAG LINK

### 12.1 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.

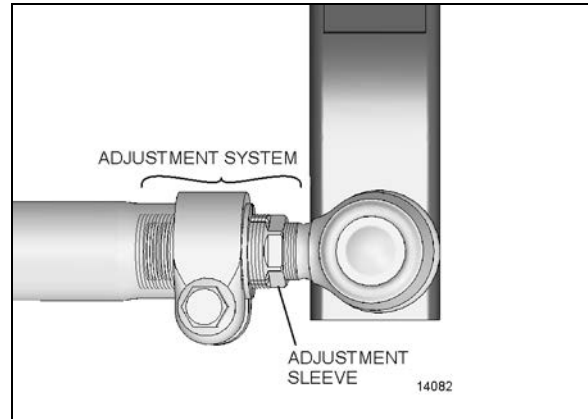


FIGURE 23: DRAG LINK ADJUSTMENT SYSTEM



### CAUTION

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

Apply the recommended torque for clamp nut.

**TORQUE: 118-133 lb-ft (160-180 Nm)**

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

#### 12.1.1 Adjustment System Thread Lengths

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

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

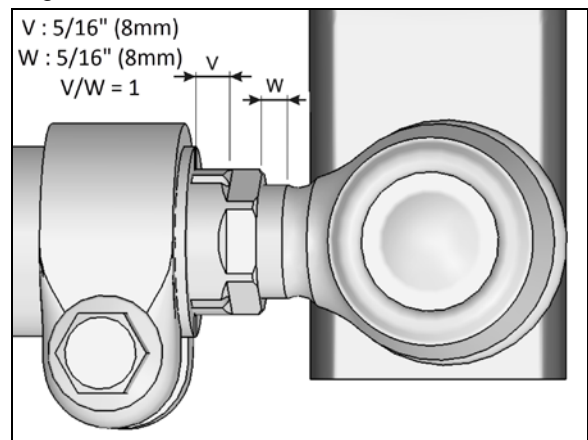



FIGURE 24: DRAG LINK ADJUSTMENT SYSTEM

- Dimension V and W should be equal:  $V/W = 1$
- Dimension V: 5/16" (8mm)
- Dimension W: 5/16" (8mm)



 **WARNING**

To preserve the integrity of the adjusting system, length V and W should *never* exceed 5/8"(16mm) ± 1 thread pitch.

Length V and W should be equal within ± 1mm


**13. MAINTENANCE**

**13.1 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 E 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.

**13.1 STEERING SYSTEM PLAY INSPECTION**

Basically, the steering system play is checked with the engine running and the front wheels in the straight ahead driving position. The steering wheel is slowly turned in one direction until there is a perceptible movement of a front wheel. If a point on the steering wheel rim moves more than the value indicated below before perceptible return movement of the wheel under observation, there is excessive free play in the steering system.

**Steering wheel travel covered:**

**Maximum 1.732 inch (44mm) with Prevost 18-inch steering wheel**

**NOTE**

The full procedure is described under paragraph **1.6.7 Checking the Steering Gear Play** in ZF SERVOCOM DESIGN, OPERATION, MAINTENANCE, INSPECTION (8090) manual.

**Take note that the maximum travel covered value specified in ZF's manual doesn't apply to the Prevost design which uses a 18-inch steering wheel.**

If the maximum value is exceeded, the steering system should be thoroughly inspected for worn or loose components, beginning with the steering linkage. If the steering linkage is in good condition, then the steering column and the steering gear should be inspected.

 **MAINTENANCE**

**I-BEAM FRONT AXLE**

Perform the steering play inspection every 185000 miles (300 000 km) or once a year whichever comes first.

**MAINTENANCE****INDEPENDENT FRONT SUSPENSION  
(Private use only)**

Perform the steering play inspection every 48 months.

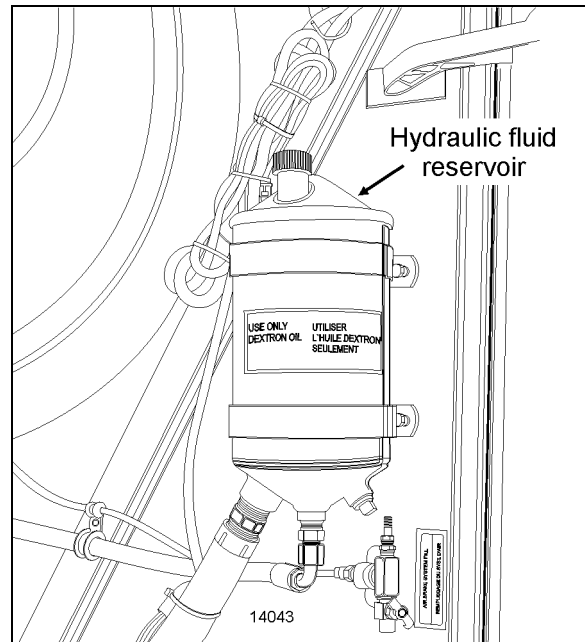
**13.2 POWER STEERING RESERVOIR AND FILTER**

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 (Figure 25).

**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 and power steering fluid should be replaced at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING

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

**FIGURE 25: HYDRAULIC FLUID RESERVOIR LOCATION****13.2.1 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 (Figure 26).
4. Adjust level to "FULL" mark using proper dipstick side depending on fluid temperature, use "Dexron-IIIE or Dexron-III" automatic transmission oil.
5. Reinsert and tighten the dipstick.

**13.2.2 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.

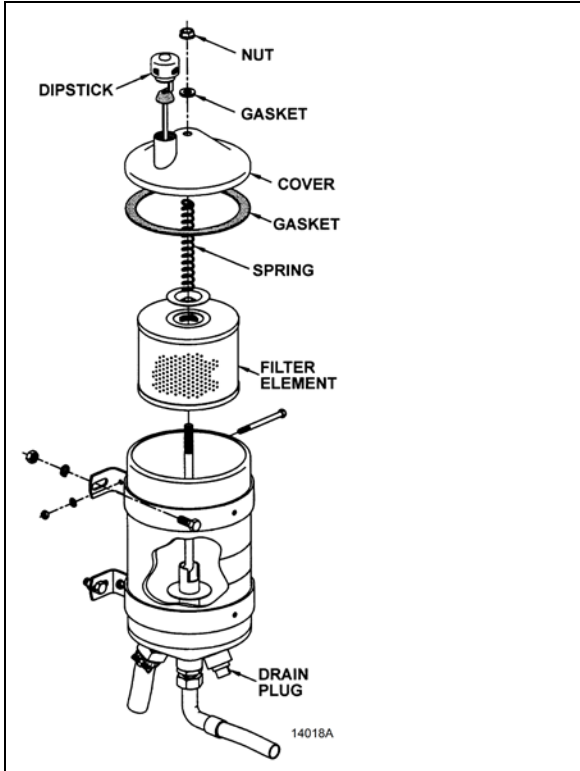



FIGURE 26: POWER STEERING FLUID RESERVOIR

13.3 STEERING STABILIZER CYLINDER (DAMPER)

The steering damper is located on R.H. side, aft of front axle (Figure 27).

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.

 <p><b>MAINTENANCE</b></p>
<p>Steering damper ball joint (rod end) is provided with grease fitting for pressure lubrication. Under normal conditions, it should be serviced at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION &amp; SERVICING.</p> <p>Check the ball joint for wear, and replace if necessary. Good quality lithium-base grease NLGI No. 2 like Shell Retinax LX is recommended.</p>

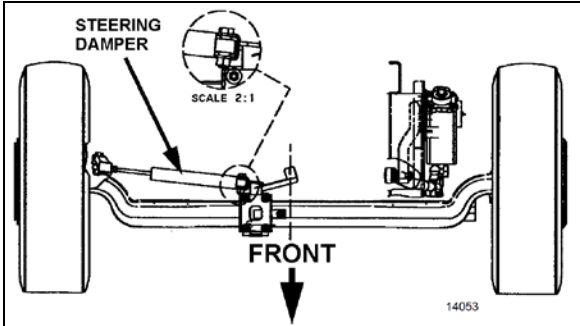


FIGURE 27: STEERING STABILIZER (DAMPER)

13.4 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.


13.4.1 Independent Front Suspension

**Lubrication Fittings**

All lubrication fittings must be clean before applying lubricant. Also, always be sure 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 fitting when become broken or damaged.

Re-charge ball joint until grease can be seen escaping from socket. On ball joints fitted with a rubber boot, do not add too much grease as the rubber boot might expand and rupture.

In selecting proper lubricants, supplier reputation must be considered. The supplier must be responsible for product quality. Figure 21 shows approximate location of steering lubrication fittings.

 <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.</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>



## MAINTENANCE

Intervals below are recommended for normal service. More frequent intervals may be applied under severe operating conditions.

The lubrication fittings (see FIGURE 28 ) should be serviced at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

- (1) **Drag Link Ends:** Lubricate at four fittings, two at each end of link with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).
- (2) **Relay Rod Ends:** Lubricate at two fittings, one at each end of rod with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).
- (3) **Tie Rod Ends:** Lubricate at four fittings, one at each end of both tie rods, with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).
- (4) **Steering Knuckle (swivel assembly):** Refer to DANA SPICER MAINTENANCE MANUAL NDS AXLES Lubrication and Maintenance" for more details.
- (5) **Idler Arm and Bell Crank:** Lubricate at two fittings, one on the idler arm and the other on the crank bell, with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent). Apply grease gun pressure to the fitting until lubricant appears at the top seal.
- (6) **Upper A-Arm Ball Joint:** Lubricate at fitting until you see some grease on the relief valve nearby, with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).

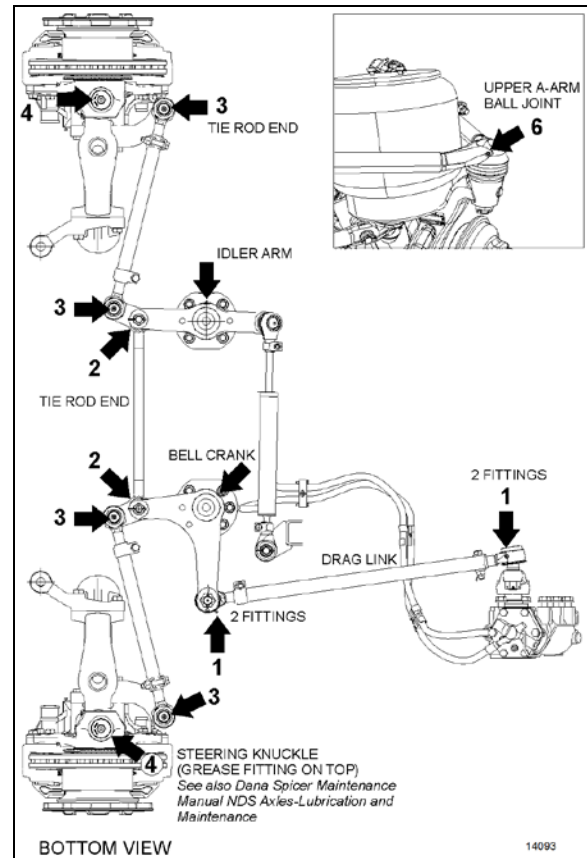


FIGURE 28: LUBRICATION FITTINGS LOCATION

### 13.4.2 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

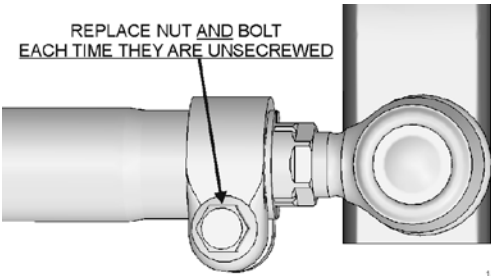
When play is discovered in the adjusting system, replace the complete drag link.



## CAUTION

**Do not re-use clamp hardware.**  
Bolt and nut should be replaced every time they are unscrewed.

REPLACE NUT AND BOLT  
EACH TIME THEY ARE UNSCREWED



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While assembling the clamp, make sure the bolt does not touch the draglink tube.

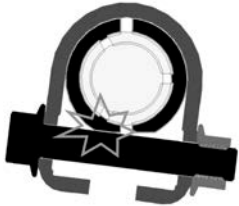


FIGURE 29: I-BEAM FRONT AXLE DRAG LINK

### 13.5 TIE RODS

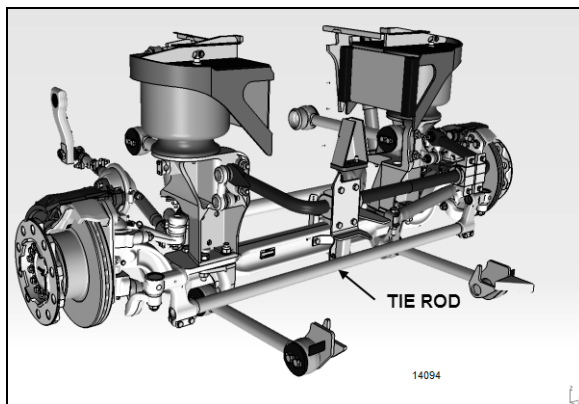


FIGURE 30: TIE ROD



## MAINTENANCE

Tie rod ends (ball joint) are provided with grease fittings for pressure lubrication. These grease fittings should be serviced at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

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.

### 13.6 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.

### 13.7 DROP TYPE BALL JOINT

#### 13.7.1 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.

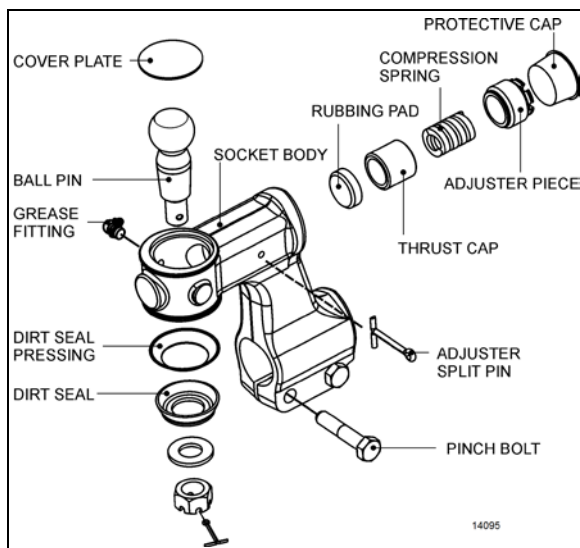


FIGURE 31: DROP TYPE BALL JOINT FOUND ON TIE ROD (2X)

#### 13.7.2 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.**

#### 13.7.3 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 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 thus securing ball joint to tie rod.

**TORQUE: 85-103 lb-ft (115-140 Nm)**

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.

**TORQUE:175-200 lb-ft (237-271 Nm)**

14. Using a 2lb hammer, tap tie rod arm to "shock" ball pin into taper hole.
15. Re-torque pin nut  
**TORQUE:175-200 lb-ft (237-271 Nm)**
16. Fit split pin, if slot/hole are not in line, adjust up to next slot.
17. Re-charge ball joint with Shell "Retinax LX" or equivalent grease through grease fitting.

### 13.8 STRAIGHT BODY TYPE BALL JOINT

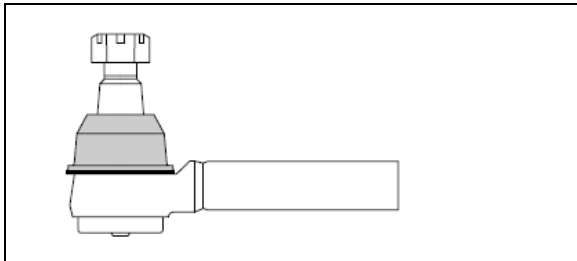


FIGURE 32: STRAIGHT BODY TYPE BALL JOINT

#### 13.8.1 Visual Inspection

- Visually inspect for missing or damages grease fittings and replace if required.
- Damaged sealing boot or improper sealing requires seal replacement.
- Check ball joint connection for missing cotter pins.
- Check for looseness in the ball/socket assembly.

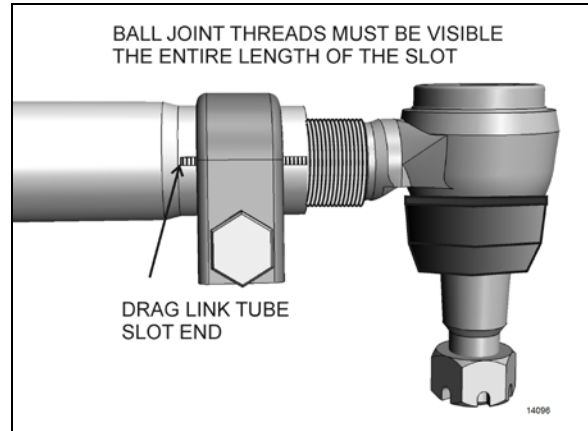


FIGURE 33: ADEQUATE CLAMPING CONDITION

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).

#### 13.8.2 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.**



### 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.

#### 14. 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.*



## 15. FRONT WHEEL ALIGNMENT

### 15.1 INDEPENDENT FRONT SUSPENSION ALIGNMENT

Proper front end alignment must be maintained to insure ease of steering and provide satisfactory tire life. When making front end alignment inspections, the vehicle must be level and empty with the full weight of the vehicle on the wheels.

Front end alignment inspections fall into two groups: regular service inspections performed at periodic intervals, and inspections to determine the extent of damage after a collision or severe service.

Regular service inspections concern toe-in, camber and caster.

Any variation from the specified alignment will indicate either a need for adjustment or a more thorough inspection to determine if parts replacement is required.



#### WARNING

During alignment, both camber and caster among other angles are adjusted. When adjusting these, we install or remove shims at the IFS lower A-arms. After performing alignment, make sure that the following is done:

- Installing a new lock nut after all shims are finalized.
- Torque replaced nuts as per Torque Table 2.
- Installing a longer bolt if less than 2 threads are remaining after the nut.
- Using a torque seal, leave a mark on the nut for future visual inspection.

#### 15.1.1 Alignment Terminology

**Wheel Camber:** Camber is the number of degrees the top of the wheel is tilted inward or outward from a true vertical (Figure 38).

**Wheel Toe-In:** a slight forward convergence given to the wheels of motor vehicles to improve steering and equalize tire wear (D minus E, Figure 38).

**Kingpin Inclination:** The inclination of the kingpin from vertical toward the center of the vehicle at the top and outward at the bottom (B, Figure 38).

**Front Axle Caster:** The inclination of the kingpin from vertical in the fore and aft direction (C, Figure 38).

#### 15.1.2 Front End Inspection

Before checking front end alignment, make the following inspection:

1. Check that the vehicle is at normal ride height (see paragraph 3.18 "Suspension Height Adjustment" in section 16 Suspension).
2. Check the tires for proper inflation.
3. Check wheel installation and run-out.
4. Check wheel bearing adjustment.
5. Check tie rods and drag link ends for looseness.
6. Check kingpins for looseness.
7. Check that the length of the torque rod is 21 17/64" (540 mm) and the length of the relay rod is 23 19/64" (592 mm).

#### 15.1.3 Front Wheel Camber

Positive camber is the outward inclination of the wheels at the top, negative or reverse camber is the inward inclination of the wheels at the top. Camber variations may be caused by wear at the wheel bearings, wheel spindle bushings, or bent suspension parts.

Check camber, with an accurate gauge. If camber is incorrect, check suspension parts for wear and replace worn parts. If wear is not perceptible, suspension parts may be bent or lower A-arm may be improperly shimmed.

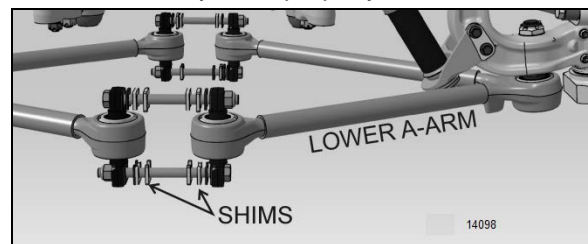


FIGURE 34: SHIMS AT THE LOWER A-ARMS

Check kingpin inclination. If kingpin inclination is incorrect, readjust the camber and check kingpin inclination again.

**NOTE**

*Camber is more important than kingpin inclination, so adjust camber and verify kingpin inclination.*

Shim the lower A-arm to adjust camber (Figure 35). If the kingpin inclination is incorrect, the wheel kingpin assembly may be bent and therefore should be replaced.

Excessive positive camber results in irregular wear of the tires at the outer shoulders. Negative or reverse camber causes wear at the inner shoulders.

**NOTE**

*Shim only the lower suspension arm to adjust the front wheel camber.*

**CAUTION**

Once the perfect shim combination is achieved, always install new Stover nuts because the self-locking effect is lost after tightening and loosening of the nut. It is recommended to punch marks to detect loosening of the nuts during future visual inspections.

## 15.1.4 Front Wheel Toe-In

Toe-in is measured from the center of the tire treads. Measurements at the front and rear of the tires must be made at the same height from the floor. Incorrect toe-in results in excessive tire wear and steering instability with a tendency to wander.

**Toe-In Check**

1. Check the camber adjustment and adjust if necessary.
2. Hoist the front of the vehicle and spin the wheels marking the centerline of the tire treads.
3. Place the wheels in the straight ahead position and lower the vehicle to rest on the floor.
4. Roll the vehicle ahead several feet. This removes any slack caused by looseness in the wheel bearings or steering connections.
5. Check the distance between the tire centerlines at the front and rear of the front tires. These two measurements must be

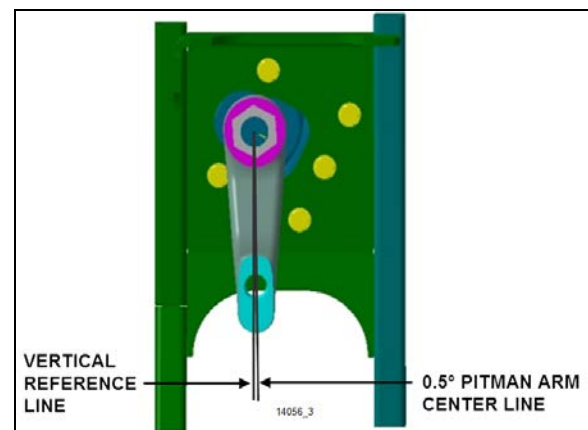
made at the same height above the floor. The front measurement must be  $3/32 \pm 1/32$  of an inch less than the rear measurement.

**Toe-In Adjustment**

1. Loosen the tie rod clamp bolts.
2. Using a pipe wrench, turn the tie rod tubes to obtain the toe-in measurement specified in step 5 under paragraph "Toe-in Check".
3. Tighten the tie rod clamp bolts and recheck toe-in.
4. Check that the angular relationship of the pitman arm to the steering gear is as shown in Figure 35.

**NOTE**

*Use only tie rods to adjust toe-in.*



**FIGURE 35: IFS PITMAN ARM ALIGNMENT**

## 15.1.5 Front Wheel Caster

Positive caster is the inclination of the top of the kingpins toward the rear of the vehicle. Negative or reverse caster is the inclination of the kingpins toward the front of the vehicle. This vehicle is designed with positive caster. The purpose of caster is to provide steering stability by keeping the wheels in a straight ahead position.

Caster variations may be caused by bent upper suspension A-arm, lower suspension A-arm, or kingpin housing. Caster should be adjusted with shims. Precision instruments should be used to measure caster. Shim bell crank and idler arm to adjust caster (Figure 38).

Variations from the specified caster will affect steering stability, cause wandering, wheel shimmy, and reduce steer re-centering when pulling out of curves.

**NOTE**  
 On Independent Front Suspension, caster on right wheel must be equal or greater than caster on left wheel, without exceeding 0.3°.

**15.1.6 Major Damage**

If the suspension has sustained major damage, it may be necessary to shim the bell crank and the idler arm to avoid the bump steer or roll steer. Moreover refer to paragraph "Front End Alignment".

**15.1.7 Alignment Specifications**

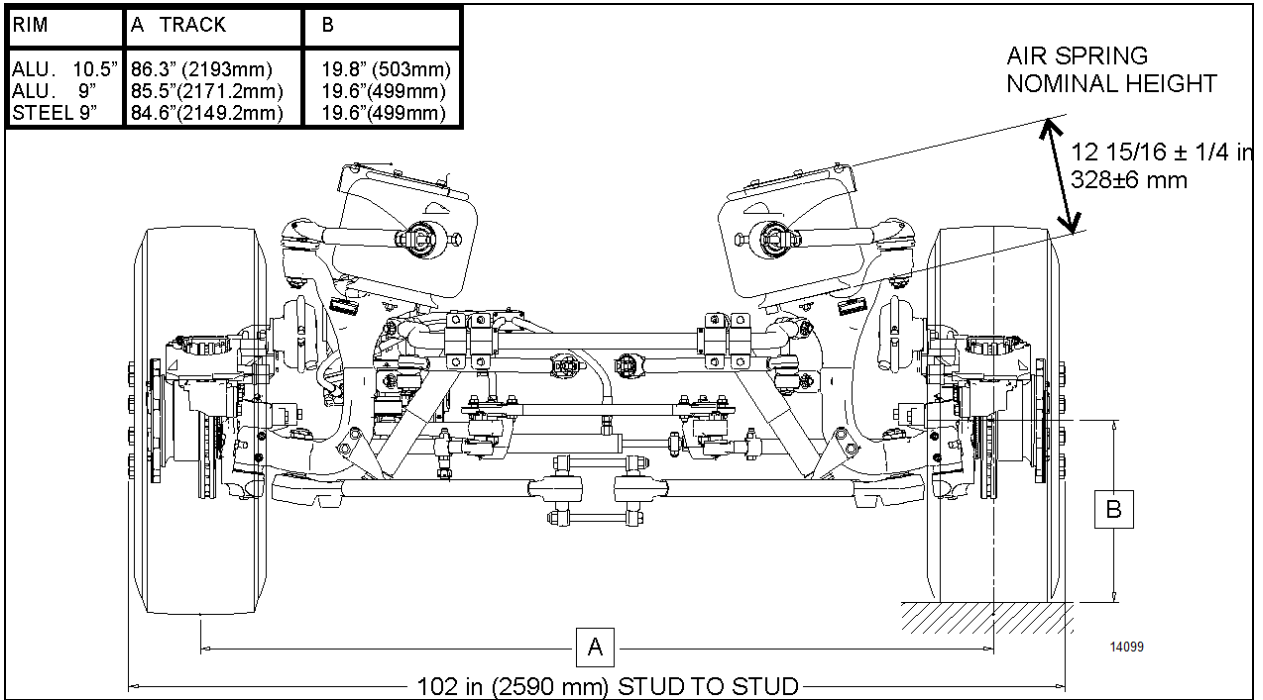
**NOTE**  
 On Independent Front Suspension, caster on right wheel must be equal or greater than caster on left wheel, with a maximum difference of 0.3°.

Use static wheel alignment systems which work with angle measurements only, such as Josam or Hunter systems.

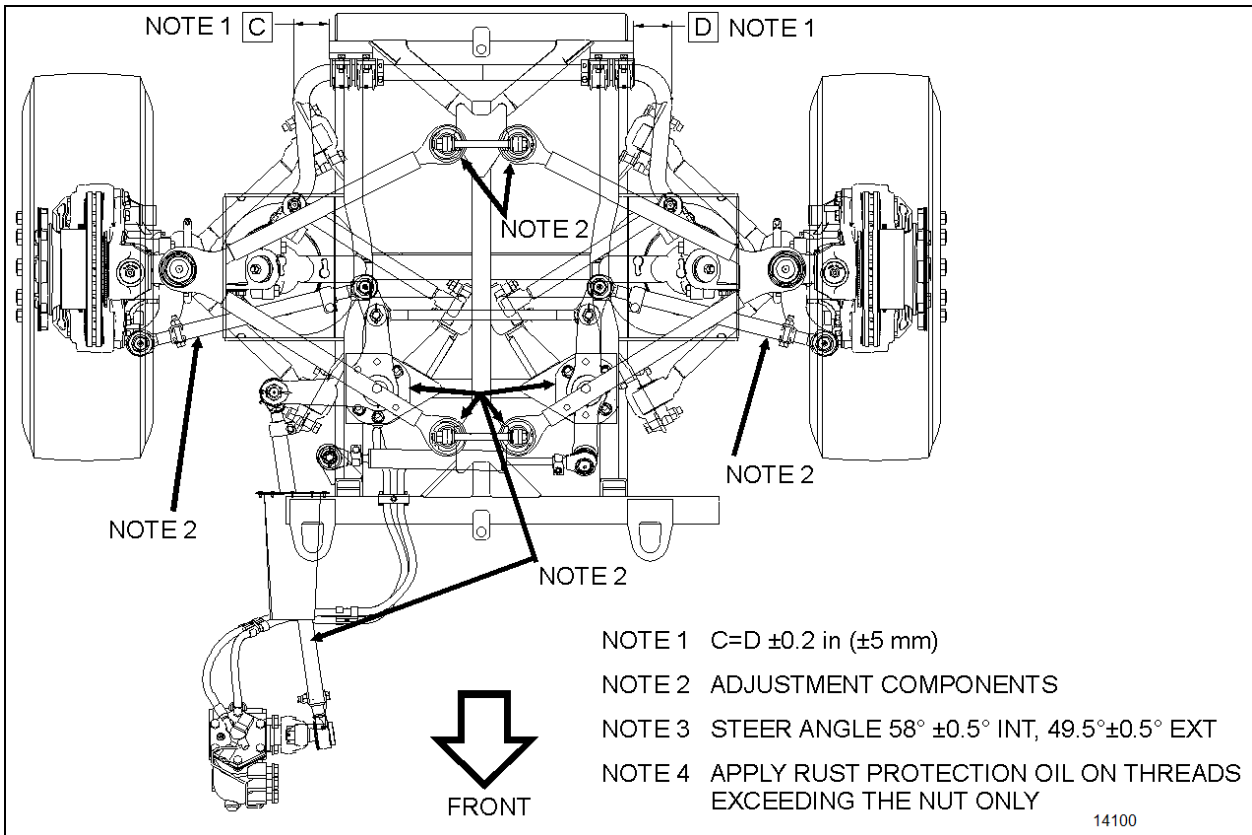
<b>X3-45 Coaches WITH INDEPENDENT FRONT SUSPENSION</b>			
	<b>Minimum value</b>	<b>Nominal value</b>	<b>Maximum value</b>
<b>Right camber</b>	0.0°	0.150°	0.30°
<b>Left camber</b>	0.0°	0.150°	0.30°
<b>Right caster</b>	2.35°	2.6°	2.85°
<b>Left caster</b>	2.35°	2.6°	2.85°
<b>Total toe-in</b>	0.04°	0.06°	0.08°

<b>X3-45 VIP INDEPENDENT FRONT SUSPENSION</b>						
<b>Load</b>	<b>Minimum value</b>		<b>Nominal value</b>		<b>Maximum value</b>	
	<b>Non-converted</b>	<b>Converted</b>	<b>Non-converted</b>	<b>Converted</b>	<b>Non-converted</b>	<b>Converted</b>
<b>Right camber</b>	0.20°	-0.20°	0.30°	0°	0.50°	0.20°
<b>Left camber</b>	0.20°	-0.20°	0.30°	0°	0.50°	0.20°
<b>Right caster</b>	2.55°		2.8°		3.05°	
<b>Left caster</b>	2.55°		2.8°		3.05°	
<b>Total toe</b>	0.02°	0.04°	0.04°	0.06°	0.06°	0.08°

**SECTION 14: STEERING**



**FIGURE 36: IFS NOMINAL DIMENSIONS**



**FIGURE 37: NOTE 2 INDICATES WHERE ADJUSTMENT MAY BE PERFORMED AT IFS ALIGNMENT**

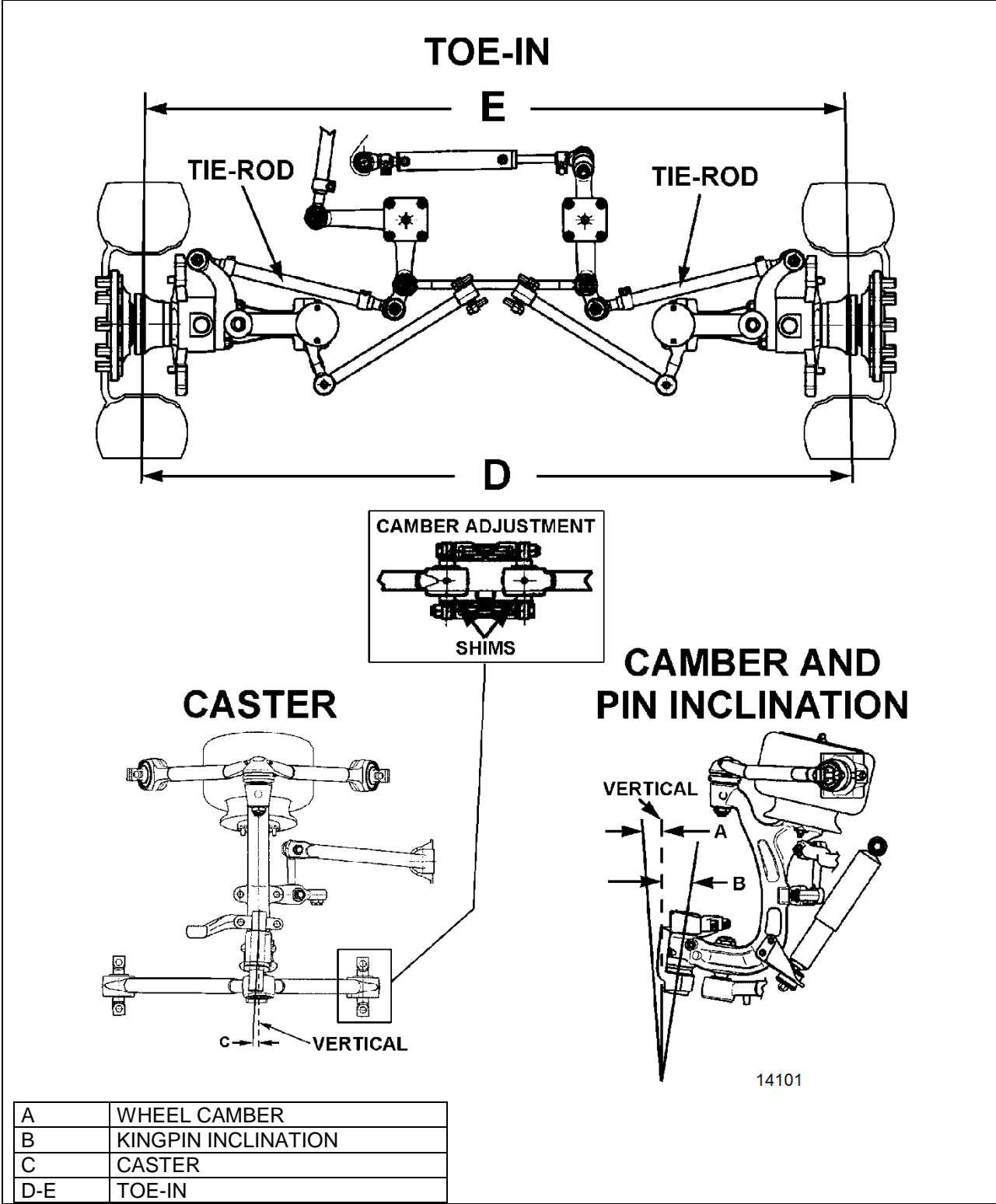


FIGURE 38: FRONT END ALIGNMENT DIAGRAM

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## 15.2 I-BEAM AXLE - FRONT WHEEL ALIGNMENT

Correct front wheel alignment must be maintained for steering comfort and satisfactory tire life. Road shocks and vibrations, as well as normal stress and strains on the front-end system can, under normal operating conditions, result in loss of front wheel alignment.

Check the front wheel alignment when the following occurs:

1. Every 200,000 miles (320 000 km) or 24 months (normal maintenance);
2. When the vehicle does not steer correctly; or
3. To correct a tire wear condition.

There are two types of front wheel alignment: minor alignment and major alignment.

### 15.2.1 Inspection Before Alignment

Check the following before doing a front wheel alignment:

1. Ensure that the vehicle is at normal riding height. See Section 16, "Suspension" under heading 7: "Suspension Height Adjustment".
2. Ensure that front wheels are not the cause of the problem. See Section 13, "Wheels, Hubs and Tires". Inspect the tires for wear patterns indicating suspension damage or misalignment.
  - a. Make sure the tires are inflated to the specified pressure.
  - b. Make sure the front tires are the same size and type.
  - c. Make sure the wheels are balanced.
  - d. Check wheel installation and straightness.
3. Check the wheel bearing adjustment. See Section 13, "Wheels, Hubs and Tires".
4. Check steering linkage for bending and pivot points for looseness.
5. Check knuckle pins for evidence of excessive wear.
6. Check radius rods for bending and rubber bushings for evidence of excessive wear.

7. Make sure all fasteners are tightened to the specified torque. Use a torque wrench for verification. As soon as the fastener starts to move, record the torque. Correct if necessary. Replace any worn or damaged fasteners.

### 15.2.2 Minor Front Wheel Alignment

Perform a minor front wheel alignment for all normal maintenance conditions.

Perform the minor front wheel alignment in the following sequence:

1. Inspect all the systems that affect the wheel alignment. See paragraph 14.2.1, "Inspection Before Alignment" in this section.
2. Check the hub bearings. See section 13, "Wheels, hubs and Tires" under heading 8: Front and Tag Axle Wheel Hubs.
3. Check and adjust the toe-in.

### 15.2.3 Major Front Wheel Alignment

Perform a major front wheel alignment to correct steering and tire wear conditions.

Perform the major front wheel alignment in the following sequence:

1. Inspect all systems affecting the wheel alignment. See paragraph 14.2.1, "Inspection Before Alignment" in this section.
2. Check the hub bearings. See section 13, "Wheels, hubs and Tires" under heading 8: Front and Tag Axle Wheel Hubs.

#### **NOTE**

*If steering angle stoppers are changed, a special procedure is required for readjusting gearbox steering limiter. See paragraph 14.2.7 "Hydraulic Stop" in this section.*

3. Check and adjust the turning angle adjustment.
4. Check the camber angle.
5. Check and adjust the caster angle.
6. Check and adjust the toe-in.

#### 15.2.4 Turning Angle Adjustment

The maximum turning angle is set through the two steering stop screws installed on the axle center. The turning angle is factory adjusted to accommodate the chassis design, and therefore, does not require adjustment on new vehicles. However, it should be checked and adjusted any time any component of the steering system is repaired, disassembled or adjusted.

Check if front tires rub against the frame or if the steering gear has been serviced.

Proceed with the following method to check the steering maximum turning angle:

#### 15.2.5 R.H. Turn Adjustment



### CAUTION

To prevent the steering damper from interfering with the adjustment of turning angles, make sure its fixing bracket is at the correct location on the axle center (refer to section 14 "Steering").

1. Turn steering wheel to the right until the boss on the axle center touches the right stop screw.
2. Verify the nearest point of contact of the ball socket body with the air bellows support assembly. Measure the distance between those two points.
3. The distance between these two points should be approximately 1/8 inch (3 mm). If not, the steering stop screws must be readjusted.
4. Verify the nearest point of contact of the drag link with the tire. Measure the distance between those two points.
5. The distance should be 1 inch (25 mm) or more. If not, the steering stop screws must be readjusted.
6. This must be done for a full right turn.
7. If readjustment is required:
  - a. Remove the swivel stop screw.
  - b. Add to the stop screw the required number of washers to obtain the proper measure, tighten the stop screw afterwards. Two washers of different thickness are available: 1/16 inch and 3/16 inch.

#### 15.2.6 L.H. Turn Adjustment

1. Turn steering wheel to the left until the boss on the axle center touches the left stop screw.
2. Verify the nearest point of contact of the ball socket body with the air bellows support assembly. Measure the distance between those two points.
3. The distance between these two points should be approximately 1/8 inch (3 mm). If not, the steering stop screws must be readjusted.
4. Check the stroke of the steering stabilizer cylinder (damper). It should not exceed 12.59 inches (320 mm).
5. The steering stopper screw must be in contact before the steering stabilizer reaches the end of the stroke.
6. This must be done for a full left turn.
7. If readjustment is required:
  - a. Remove the swivel stop screw.
  - b. Add to the stop screw the required number of washers to obtain the proper measure, tighten the stop screw afterwards. Two washers of different thickness are available: 1/16 inch and 3/16 inch.

#### 15.2.7 Hydraulic Stop

### NOTE

*Before steering limiter readjustment, verify vehicle wheel alignment and ensure that oil level is checked and that air bleeding is done.*

Refer to 'ZF-Servocom Repair Manual' annexed at the end of this section under heading 'Setting and Functional Test'.

#### 15.2.8 Front Wheel Camber

Wheel camber is the number of degrees the top of the wheel tilts outward (positive) or inward (negative) from a vertical angle (Figure 39).

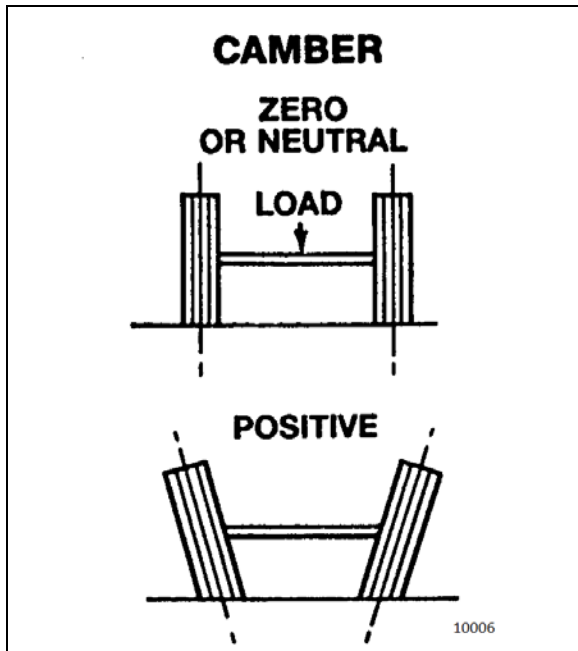


FIGURE 39: CAMBER

The camber angle is not adjustable. Camber variations may be caused by wear at the wheel bearings, steering knuckle pins or by a bent knuckle or sagging axle center. Steering effort is affected by improper camber, and uneven tire wear will result. Excessive positive camber causes an irregular wear of tire at the outer shoulder and excessive negative camber causes wear at the inner shoulder.

#### 15.2.9 Camber Check

For camber specifications, refer to paragraph 14.2.12: "SPECIFICATIONS" in this section

1. Use an alignment machine to check the camber angle.
2. If camber reading is not in the specifications, adjust the wheel bearings and repeat the check. If the reading is still not within specifications, verify the steering knuckle pins and axle center.
3. See instructions in "DANA SPICER Maintenance Manual Model NDS and Maintenance Manual NDS Axles".
4. Check the wheel lateral distortion as instructed in Section 13, "Wheels, Hubs and Tires" under heading, "Checking for Distorted Wheel on Vehicle". If distortion is excessive, straighten or replace wheel(s).

#### 15.2.10 Front Axle Caster

For caster specifications, refer to paragraph 14.2.12: "SPECIFICATIONS" in this section.

Positive caster is the rearward tilt from the vertical axis of the knuckle pin. Negative caster is the forward tilt from the vertical axis of the knuckle pin (Figure 40). This vehicle is designed with a positive caster. The purpose of the caster angle is to give a trailing effect. This results in stabilized steering and a tendency for the wheels to return to the straight-ahead position after taking a turn.

Excessive caster results in hard steering around corners. A shimmy may also develop when returning to the straight ahead position (pulling out of curves).

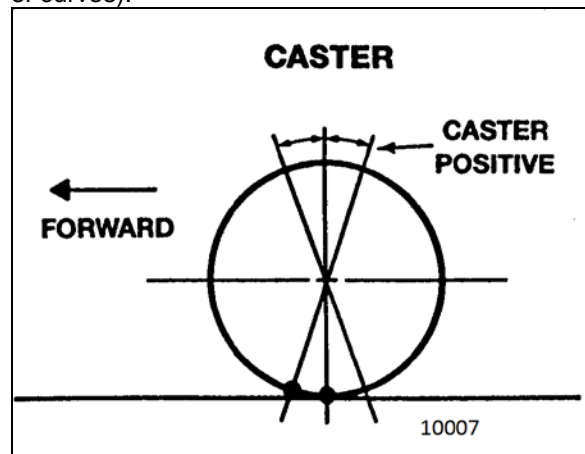


FIGURE 40: CASTER

Insufficient caster will cause wandering and steering instability. Caster variations may be caused by a bent axle, tilting or distortion of the side suspension supports, damaged radius rod bushings, or unequal tightening of the front and rear suspension support bolts. Incorrect caster must be corrected by replacing the damaged suspension parts. A precision instrument should be used to measure the caster.

#### NOTE

The caster of this vehicle is factory set and is not adjustable. However, if after replacing damaged parts or in case of improper caster due to irregular setting, the front axle caster needs adjustment; it can be adjusted by means of shims (Prevost #110663) on the left-hand side upper radius rod support in order to obtain minor adjustment.



15.2.11 Front Wheel Toe-In

Wheel toe-in is the degree (usually expressed in fractions of an inch) to which the forward part of the vehicle front wheels are closer together than the rear part, measured at wheel centerline height with the wheels in the normal "straight-ahead" position of the steering gear.

Incorrect toe-in results in excessive tire wear caused by side slippage and also steering instability with a tendency to wander. Toe-in may be measured from the center of tire tread or from the inside of the tires. Take measurements at both front and rear of axle (see "A" and "B" in Figure 41).

When setting toe-in adjustment, the front suspension must be neutralized; that is, all component parts must be in the same relative position when marking the adjustment as they will be when in operation.

To neutralize the suspension, the vehicle must be rolled forward, approximately ten feet.

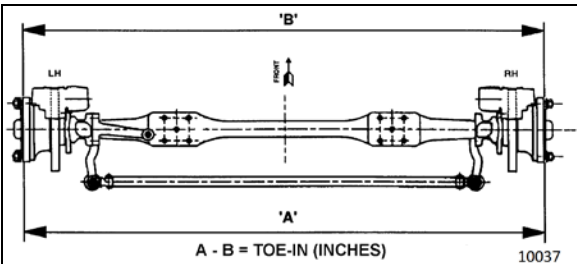


FIGURE 41: TOE-IN MEASUREMENT

For toe-in specifications, refer to paragraph 14.2.12 "Specifications" in this section.

By rolling the vehicle forward, all tolerances in the front suspension are taken up and the suspension is then in its normal operating position. Neutralizing the front suspension is extremely important, especially if the vehicle has been jacked up in order to mark the tires. Otherwise, the front wheels will not return to their normal operating position due to the tires gripping the floor surface when the vehicle jack is lowered.

**NOTE**  
 "Toe-in" measurements must be taken at the horizontal axis of the wheel centerline.

15.2.12 Inspection and Adjustment

Before checking front wheel toe-in, first check the camber angles and make the necessary corrections.

1. Measure the toe-in.
2. If the toe-in measurement is not within the specified tolerance, carry out the following procedure :
  - a. Loosen the pinch bolt nuts and bolts on each tie rod end.
  - b. Turn the tie rod until the specified toe-in measurement is obtained.
  - c. Tighten the pinch bolt nuts alternately and progressively thus securing all tie rod joints.

**TORQUE 85-103 lb-ft (115-140 Nm)**

Use static wheel alignment systems which work with angle measurements only, such as Josam or Hunter systems. Static alignment specifications are listed in the following tables:

FRONT WHEEL ALIGNMENT			
SPECIFICATIONS WITH I-BEAM AXLE			
Front Wheel Alignment	Minimal	Nominal	Maximal
Camber R.H. and L.H. * (degrees)	-0.250	0.125	0.375
Caster R.H. and L.H. (degrees)	2	2.75	3.5
Total toe (A minus B) (degrees)	0.04	0.06	0.08

## 16. 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>

**17. 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.

**18. SPECIFICATIONS****Power Steering Gear**

Make ..... ZF-SERVOCOMTRONIC  
 Type ..... Speed Sensitive  
 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  
 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 (with IFS)**

Make ..... ZF-SERVOCOM  
 Type ..... 8098  
 F.E.W. .... 19,000 lbs (8 618 kg)  
 Pressure rating ..... 2,320 psi (160 Bar)

**Power Steering Reservoir**

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

**Steering Stabilizer Cylinder (Damper)**

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

**Front I-Beam Axle**

Make ..... DANA SPICER EUROPE  
 Model ..... S84U  
 Front Track ..... 84.4 inches (2 145 mm)  
 Rated load capacity ..... 16,500 lbs (7 500 kg)