

# SECTION 16 : SUSPENSION

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## 1. DESCRIPTION

The vehicle is provided with an air suspension system. The system consists of air springs, height control valves, radius rods, sway bars, tripod and shock absorbers (Figure 1 to Figure 6). The system operation is fully automatic and maintains a constant vehicle height regardless of load, or load distribution.

The vehicle can also be equipped with systems such as:

- Front Kneeling + Front High-Buoy;
- Front Kneeling + Full High-Buoy;
- Front Kneeling + Front High-Buoy and Low-Buoy Combination;
- Front Kneeling + Full High-Buoy and Low-Buoy Combination;

For a description of each of these systems, refer to the appropriate heading in this section

## 2. FRONT I-BEAM AXLE SUSPENSION

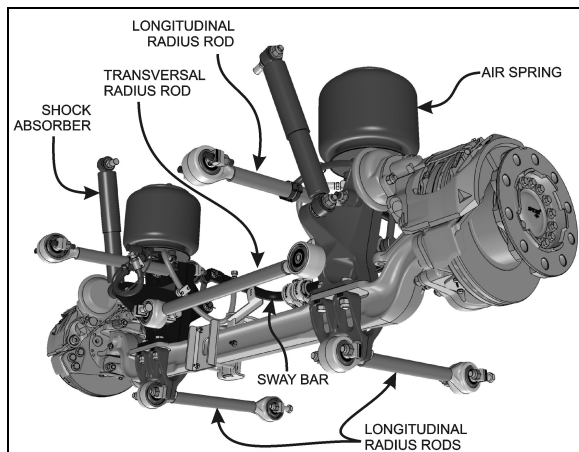


FIGURE 1: FRONT I-BEAM AXLE SUSPENSION 16105

### 2.1 AIR SPRINGS

The air springs are made from a special compound rubber molded to the proper contour and dimensions. The entire vertical load of the vehicle is supported by these springs. The I-beam front axle is provided with air springs that are attached to the subframe and to the axle (Figure 2).

### 2.1.1 Inspection

1. Check operation of bellows.
2. Visually inspect bellows for evidence of cracks, punctures, deterioration, or chafing. Replace the bellows if any damage is evident.
3. With the primary air system at normal operating pressure (122 - 140 psi (841 - 965 kPa)), coat all suspension air line connections and bellows mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.

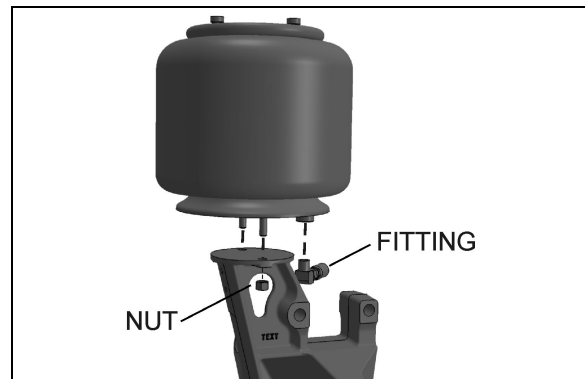


FIGURE 2: AIR SPRING 16052

#### NOTE

If air spring is removed from vehicle, bellows can be lightly inflated and submerged in water to detect any leakage. If any leakage is detected, replace bellows.



#### WARNING

To prevent personal injury, do not apply more than 10 psi (69 kPa) of air pressure to the uninstalled air spring.

### 2.1.2 Removal

#### NOTE

Front suspension air springs can be removed without removing the entire axle assembly.

1. Safely support vehicle at the recommended body jacking points. To gain access to a given air spring, the corresponding wheel can be removed as follows.

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- a) Jack vehicle until the tire clears the ground, and place safety supports underneath body.



### CAUTION

Only the recommended jacking points must be used as outlined in Section 18, "Body".

- b) Support the axle with a suitable hydraulic floor jack at the recommended jacking point.
  - c) Remove wheel.
2. Exhaust compressed air from accessory air tank by opening drain cock under reservoir.
  3. Disconnect the height control valve link and pull down the overtravel lever to ensure all air is exhausted from air springs.

### NOTE

*While performing this step, do not change the height control valve overtravel lever adjustment.*

4. Disconnect air line from air spring, remove elbow (if applicable), and cover both the line end and fitting to prevent the entry of foreign matter.
5. Remove the air spring upper nut, and then the two lower nuts. Remove air spring.

#### 2.1.3 Installation

1. Compress air spring as necessary, then aligning studs with their holes, position air spring between both the lower and upper supports. Thread the lower nuts and the small upper nut a few turns.

### NOTE

*To facilitate air spring installation, compress it manually then put a piece of tape over the air line threaded fitting. This prevents air from getting back into the bag and keeps it compressed, thus enabling to place the bag in between the mounting plates and greatly easing installation.*

2. Tighten and torque the lower stud nuts, and then the upper one according to Torque Table under heading Torque Specifications.
3. Thread the remaining upper nut (large nut) and tighten according to Torque Table under heading Torque Specifications.

4. Install elbow (if applicable), then connect air line.
5. Connect the height control valve link.
6. Build up air pressure in system.

### NOTE

*To accelerate this operation, air reservoirs can be filled from an exterior air supply connected to the accessory tank fill valve or to the emergency fill valve.*

7. Check operation of bellows with the primary air system at normal operating pressure (95 – 125 psi (655 – 860 kPa)), coat the air line connections and air spring mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.
8. Reinstall wheel.
9. Remove the hydraulic floor jack from under the axle, then lower vehicle to ground.

## 2.2 SHOCK ABSORBERS

Double-action, telescoping-type shock absorbers ensure a smooth ride and enhance vehicle stability on the road. All shock absorbers are eye-type mountings. The front axle is provided with two shock absorbers.

Shock absorbers are non-adjustable and non-repairable. Maintenance requirements involve replacement of the rubber mounting bushings, and tightening of all shock absorber pins at the proper torque of 500 - 550 lbf-ft (680 - 750 Nm) when shock absorber replacement occurs. If a shock absorber becomes inoperative, complete unit must be replaced.



### CAUTION

When a shock absorber is found defective, always replace with a new set on affected axle, except if there has been a recent replacement of one unit. The following method will help in determining if both shock absorbers on the same axle have to be replaced.

#### 2.2.1 Inspection


Loosen lower mounting of both shocks, and then carefully attempt to raise and lower the bottom portion of each shock. Note the rate of effort for

distance of travel. Replace both shocks if a definite differential rate is found.

The shock must be bench checked in an upright, vertical position. If checked in any other position, air will enter the cylinder tube and make the shock absorber appear defective.

Proceed as follows to check shock absorbers:

1. With the shock absorber in a vertical position (top end up), clamp the bottom mount in a vise.

	<h2>CAUTION</h2>
<p>Do not clamp the reservoir tube or the dust tube.</p>	

2. Rotate the dust tube. Notice any binding condition (may be compared with new unit). Binding condition indicates a scored rod. Units with scored rods should be replaced.
3. Fully extend shocks and check for leaks in the seal cover area. Shock fluid is a very thin hydraulic fluid that has a characteristic odor and dark brown tint. A slight trace of shock fluid around the seal cover area is not a cause for replacement. The shock seal is designed to permit a very slight seepage to lubricate the rod. Units that leak should be replaced.
4. Visually check shock for dents that could cause the shock to bind. Also, check for a bent rod.
5. Extend and collapse shock several times to determine that it has control (resistance) in both rebound and compression.
6. Visually inspect the shock mountings and vehicle mounting for:
  - a. Broken mounts;
  - b. Extreme bushing wear;
  - c. Shifted bushing or sleeve;
  - d. Deep cracks in bushing material (shallow surface cracks are normal);
  - e. Loose shock absorber pins;
  - f. Presence of convex washers, and their position relative to the rubber bushing.

### 2.2.2 Removal

1. Remove nuts and washers from shock absorbers on upper and lower mounting

pins, taking care to identify the inner and outer washers to ease reinstallation. Refer to figure 3 for details.

2. Remove the shock absorber assembly from pins.
3. Remove the two inner bushings from the shock absorber and discard them.

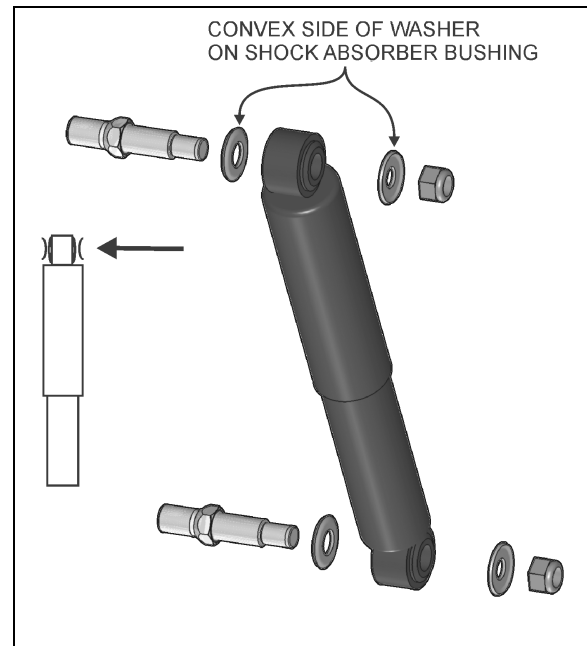


FIGURE 3: SHOCK ABSORBER

16008

### 2.2.3 Installation

1. Ensure that the shock absorber mounting pins are tight and that the threads are not stripped.
2. Install new rubber mounting bushings on shock absorbers (upper and lower).
3. Place the inner washers (with washer convex side facing the shock absorber rubber bushing) on each shock absorber pin (Figure 3).
4. Install the shock absorber eyes over the mounting pins, then the outer washers (with washer convex side facing the shock absorber rubber bushing) on each shock extremity.

#### NOTE

*If shock absorber pins are removed, they must be reinstalled using "Loctite" (see "Parts Specifications" in this section).*

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- Place the lower and upper mounting pin stud nuts and torque according to paragraph 13 Torque Specifications.

### 2.3 RADIUS RODS

Radius rods are used to secure the axles in the proper transversal and longitudinal positions. Five radius rods are provided on the front axle suspension (four longitudinal and one transversal). Refer to figures 1 for details. These rods transmit both braking and driving forces from the axles to the vehicle body.

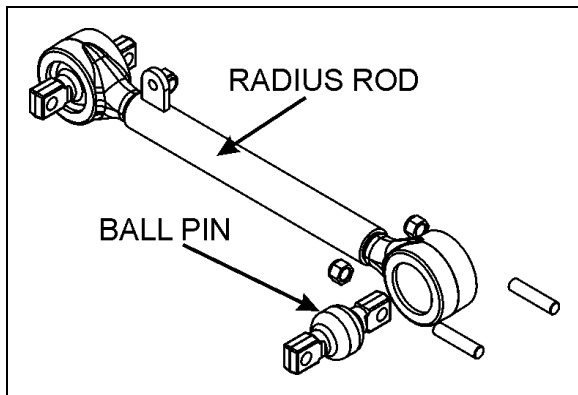


FIGURE 4: TYPICAL RADIUS ROD SETUP 16010

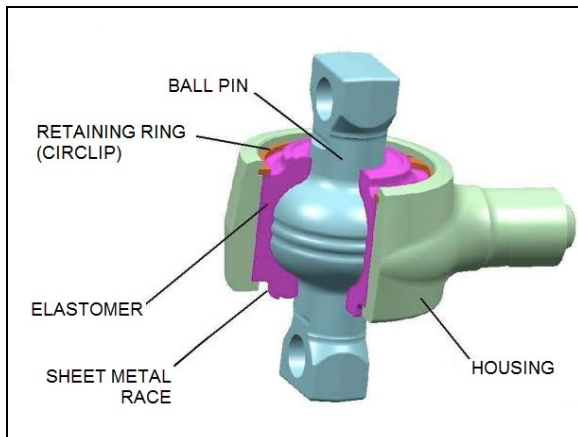


FIGURE 5: MOLECULAR BEARING CONSTRUCTION 16186

### Radius Rod Inspection

The following instructions apply to the radius rods used on the rear underframe suspension:

- Clean all parts thoroughly.
- Inspect radius rods for distortion and cracks. We recommend the "Magnaflux" process to detect cracks in the radius rod. Any damaged part should be replaced with a new one.

### NOTE

*New bushings should be used when rods are replaced.*

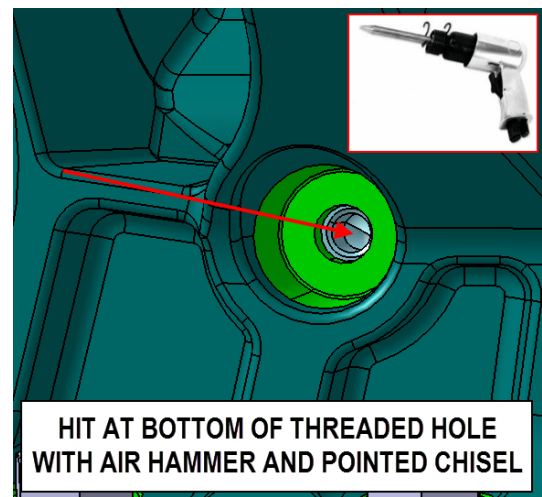
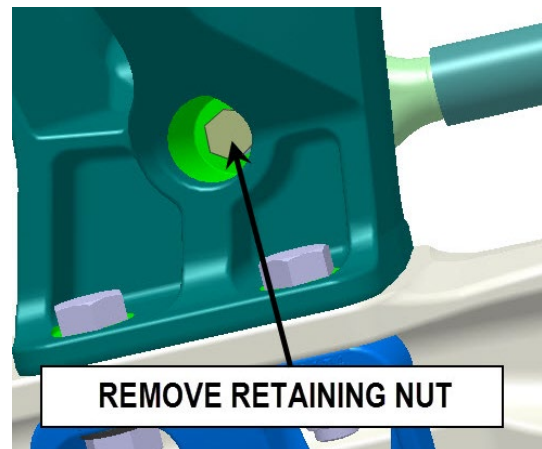
- The radius rod bushings should be checked periodically for signs of shearing, deterioration, or damage. Any defective part should be replaced with a new one.

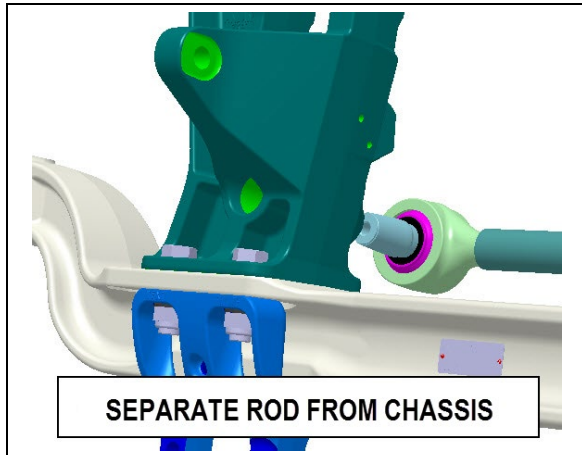
### Radius Rod Removal

- Unscrew the nuts (or bolts) at each extremity of the radius rod (Figure 4).
- Remove the radius rod.

### NOTE

*One end of the transversal radius rod is fitted with a conical (tapper) pin that will require the use of an air hammer and a pointed 13mm (1/2inch) diameter chisel to remove it from the chassis (after the retaining nut is removed from the rod end). **Care must be taken not to damage the rod pin threads.***





**CAUTION**

Do not hit the cast parts of the chassis to disengage taper radius rods; this could lead to cracking and/or deformations of the cast parts.

**Radius Rod Inspection**

Take off the load from the ball joint by lifting the vehicle. Apply a load on the joint in all of the degrees of freedom in an axial, radial, etc. sense with a suitable lever tool. After the load is taken off, the joint has to spring back into its starting position. Free play is not acceptable.

Separation of rubber from ball pin or sheet metal race is permissible up to a third of the circumference.

When the following characteristics are noted, the joint is to be changed:

- Free play between ball pin and housing;
- Radial cracking of the external sheet-metal race. (Figure 5)
- Any crack or fracture of a metal part.

- Plastic deformation of the sheet metal race
- Loosened bolt
- Broken bolt
- Loss of bolt
- Circlip (retaining ring) detached from groove
- Broken Circlip
- Loss of Circlip
- Incipient crack

If damage to the inner housing contour or the Circlip groove is found during replacement of the molecular bearing, the entire radius rod must be replaced.

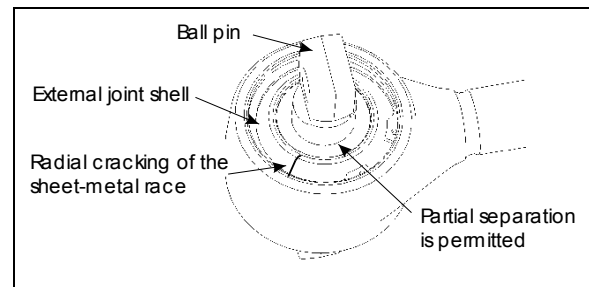


FIGURE 6: BALL JOINTS 16173

**Stripping Down**

Strip down the defective joint by removing the Circlip, and ball pin/bushing assembly.

Clean out housing bore and Circlip groove.

**Radius Rod Assembly**

The assembly work may be done only by a recognized specialized workshop. Ensure that old and new parts do not get mixed up with each other. It is for this reason that all the old parts are to be scrapped immediately after a joint has been stripped down.

A complete repair set must be used for each joint repaired, i.e. use of only part of a repair set is not permissible.

Execute assembly of the new joint parts in the following sequence:

1. Complete moistening of the contact surface between housing bore and ball pin elastomer through application of the grease.

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### **NOTE**

*Apply the supplied grease, only if you are using a repair kit.*

2. Insert ball pin/bushing, assembly. Ensure that the bolt bores are in the correct position in relation to the axis of the tube.
3. Place joint in receiving fixture and mount annular assembly tool on the housing. Then locate Circlip in the housing using axial load with the aid of assembly stamp.
4. Opening of the Circlip is located at 45° to the housing shaft axis. Make sure that the Circlip is perfectly engaged in the housing.

### **Radius Rod Installation**

1. Tighten the nuts (or bolts) lightly, and repeat at the other end.
2. Refer to heading "*Suspension Height Adjustment*" later in this section, and set the vehicle to normal ride height.
3. With the vehicle at normal ride height, tighten all radius rod anchor pin nuts or bolts as prescribed in Torque Table 3.



### **CAUTION**

It is extremely important upon reconnection of the rods that the proper clearance height between the axle and body be maintained. Otherwise, the rubber bushings in radius rod ends will become preloaded, thus reducing their life span.

### 2.4.1 Removal

1. Disconnect the two links from sway bar.
2. Safely support the sway bar. Unbolt the four bushing collars from subframe.
3. Remove sway bar.

### **NOTE**

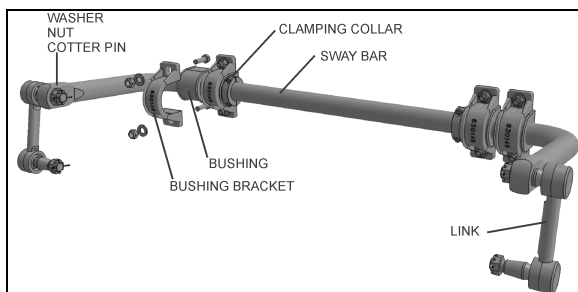
*Sway bar bushings are slit to ease their removal.*

### 2.4.2 Installation

1. Loosely install the sway bar.
2. Tighten the eight bushing collar nuts according to Torque Table 1 under heading Torque Specifications.
3. Install two sway bar link upper and lower nuts and tighten according to Torque Table 1 under heading Torque Specifications.
4. Install a cotter pin on each nut and bend.

## 2.4 SWAY BAR

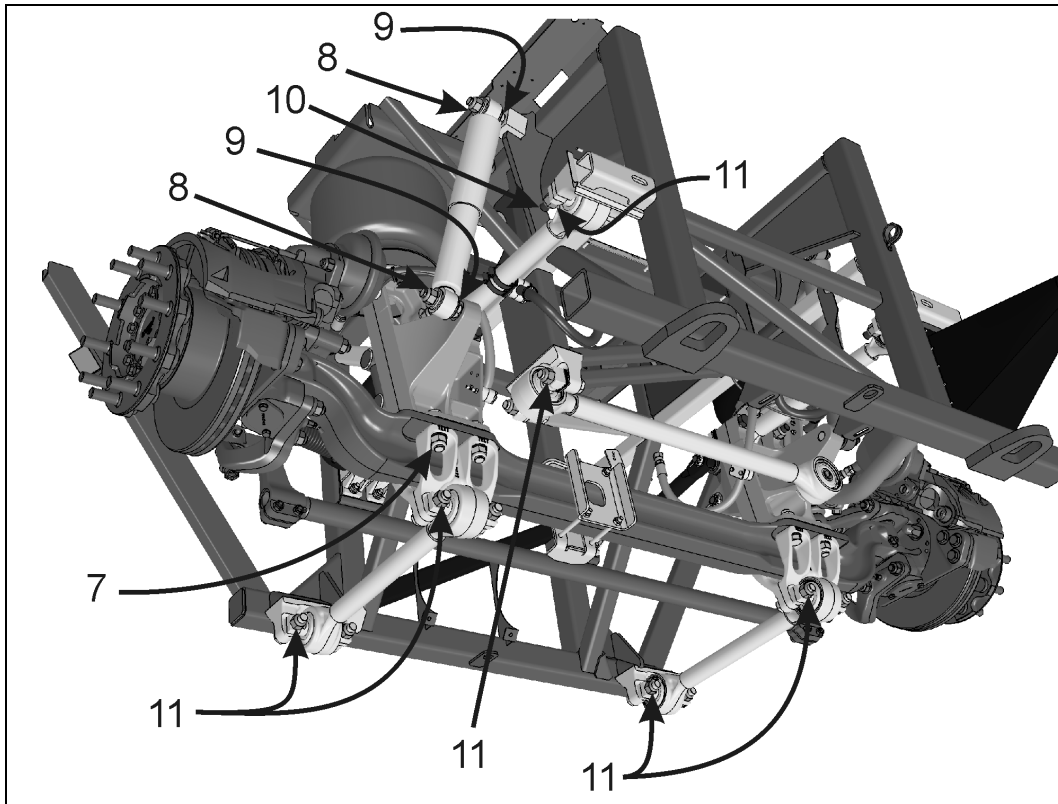
A sway bar is provided on the front axle to increase vehicle stability. It controls lateral motion (swaying movement) of the vehicle (Figure 7).



**FIGURE 7: I-BEAM FRONT AXLE SWAY BAR**

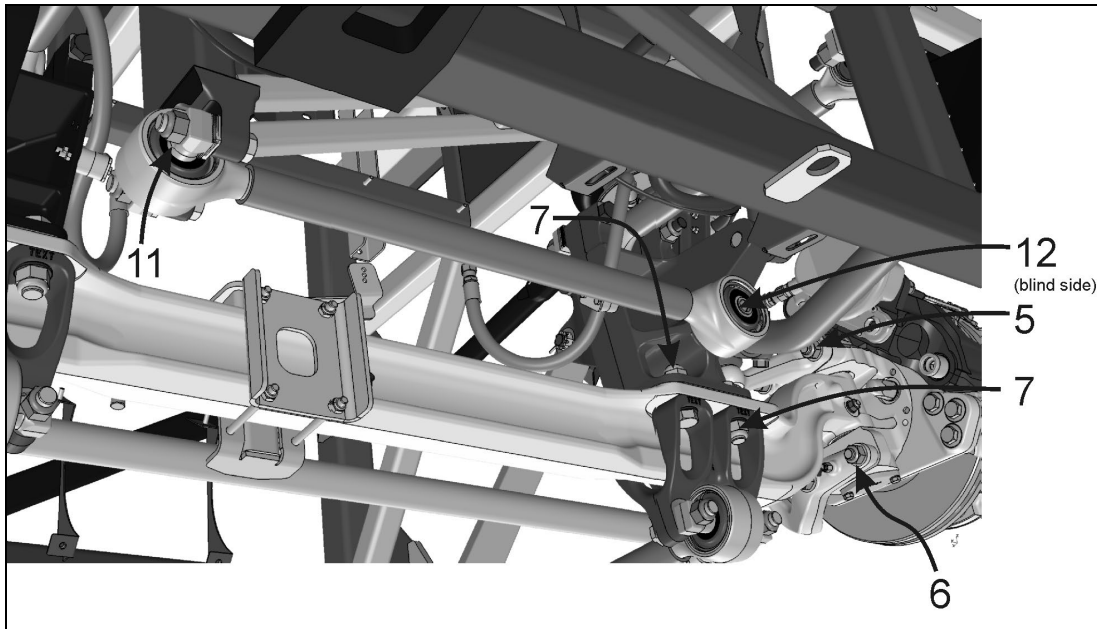
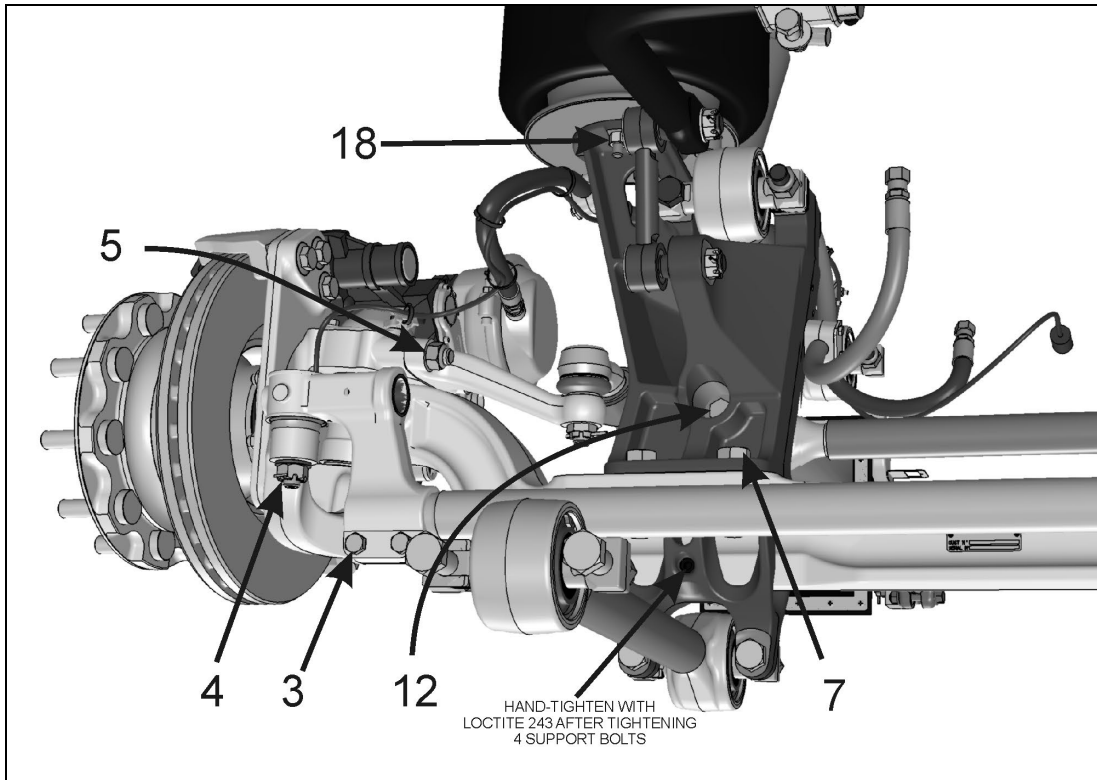
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2.5 TORQUE SPECIFICATIONS – FRONT I-BEAM AXLE SUSPENSION AND STEERING LINKAGE



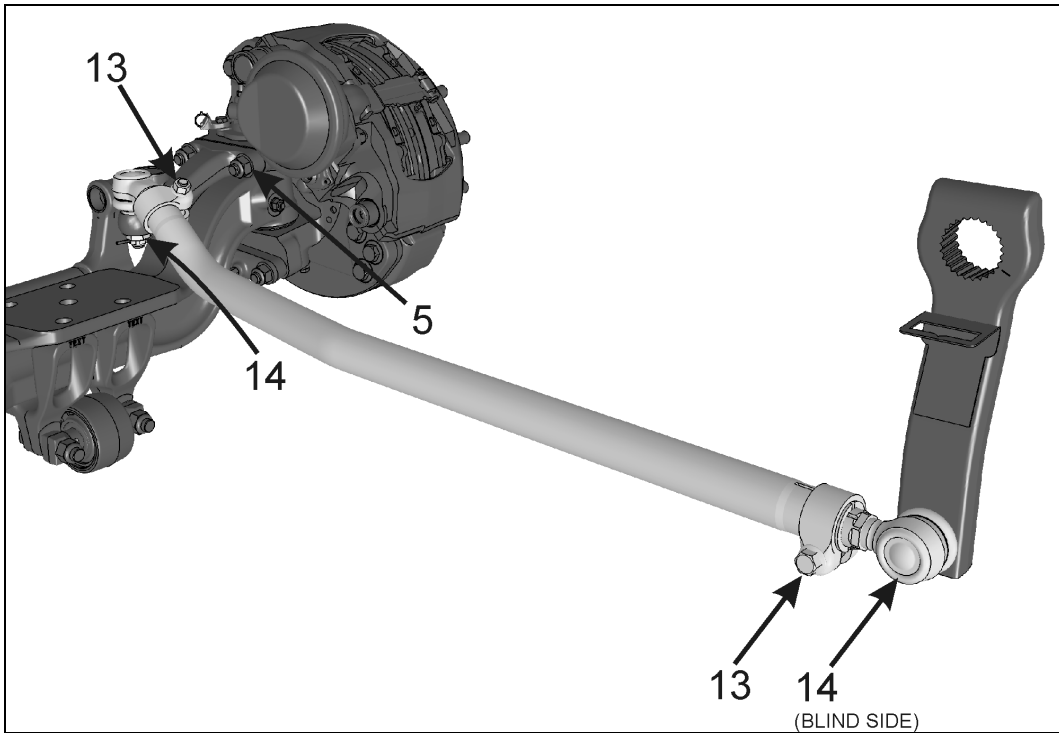
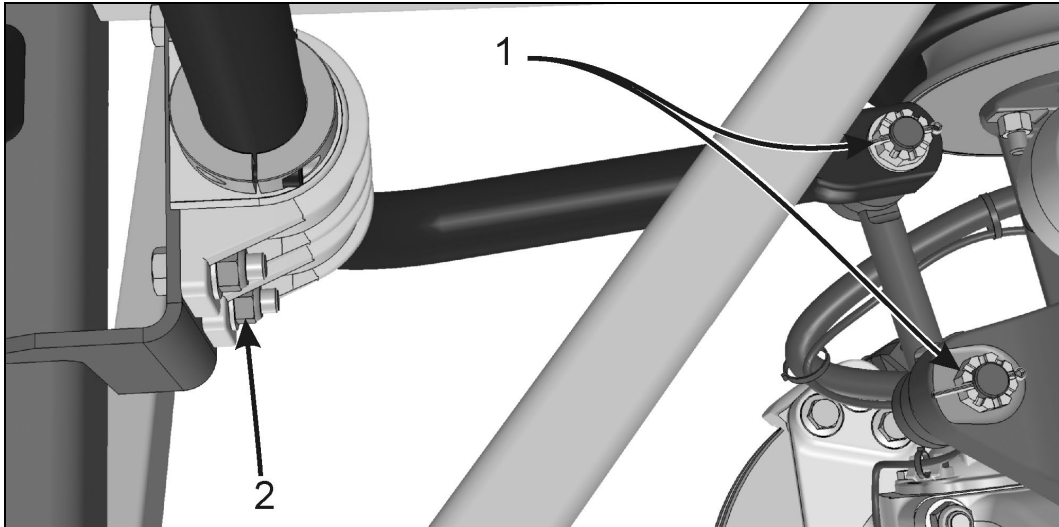
Refer to torque table 1

Section 16 : SUSPENSION



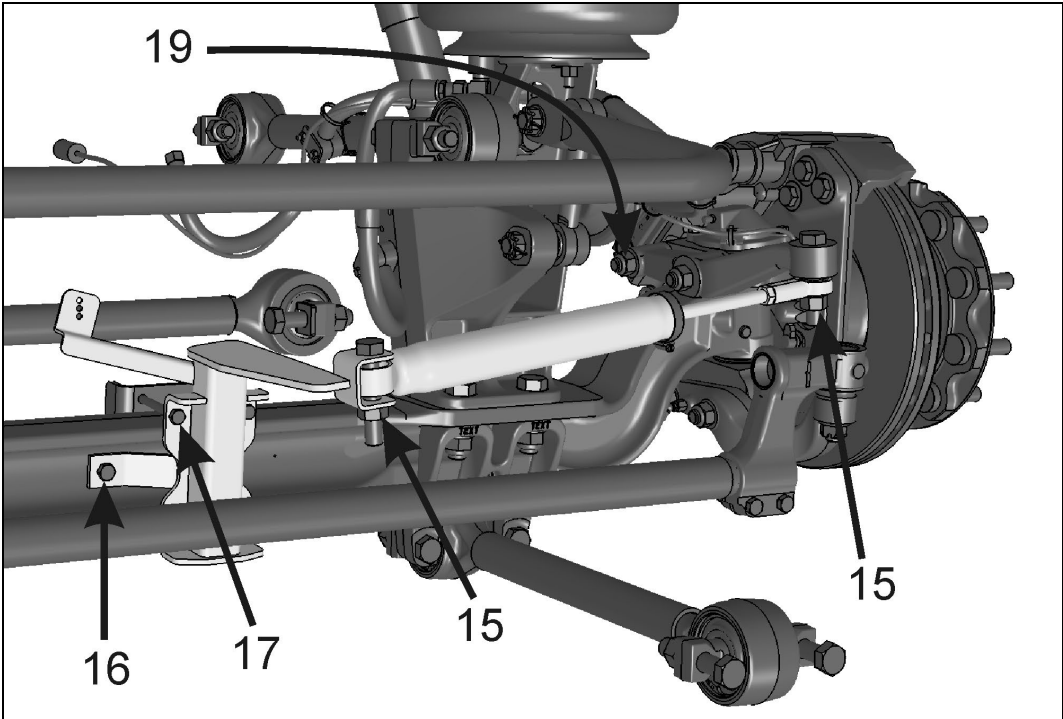
Refer to torque table 1





Refer to torque table 1

Section 16 : SUSPENSION



**Section 16: SUSPENSION**

The following table lists the tightening torques for fasteners requiring a specific torque value. When no torque specification is indicated, use the Standard Torque Specifications table found in Section 00: General Information of the Maintenance Manual.

<b>SPECIFIC TORQUE TABLE 1 – FRONT AXLE SUSPENSION &amp; STEERING</b>				
<b>REFERENCE</b>	<b>DESCRIPTION</b>	<b>QTY</b>	<b>TORQUE DRY (lbf-ft / Nm)</b>	
1	SWAY BAR LINK, UPPER AND LOWER NUTS	4	165-200	224-271
2	SWAY BAR BUSHING BRACKET	8	80-100	108-136
3	TIE ROD END CLAMP BOLTS	4	65-75	88-102
4	TIE ROD END BALL PIN NUTS	2	150-200	203-271
5	STEERING ARM STUD NUTS	2	285-315	386-427
6	TIE ROD ARM STUD NUTS	4	285-315	386-427
7	I-BEAM AXLE MOUNT NUTS	8	230-280	311-378
8	SHOCK ABSORBER UPPER & LOWER MOUNTING NUTS	2	99-121	134-164
9	SHOCK ABSORBER PINS, UPPER & LOWER	2	350-400	475-545
10	RADIUS ROD RETAINING STUDS	4	90-100	122-136
11	RADIUS ROD RETAINING NUTS	18	225-255	305-346
12	TRANSVERSE RADIUS ROD TAPER PIN NUT	1	171-209	232-283
13	DRAG LINK CLAMP BOLTS	2	118-133	160-180
14	DRAG LINK BALL JOINT STUD NUT	1	150-200	203-271
15	STEERING DAMPER NUTS	2	100-120	135-160
16	STEERING DAMPER BRACKET BOLT	1	39-45	53-61
17	STEERING DAMPER BRACKET NUTS	4	29-34	39-46
18	AIR SPRING NUT	4	31-38	42-52
19	STEERING DAMPER ARM NUTS	2	285-315	386-427

## Section 16 : SUSPENSION

### 3. VEHICLES EQUIPPED WITH AN INDEPENDENT FRONT SUSPENSION (IFS)

This section contains information and specifications unique to the independent front suspension (IFS), including suspension and steering.

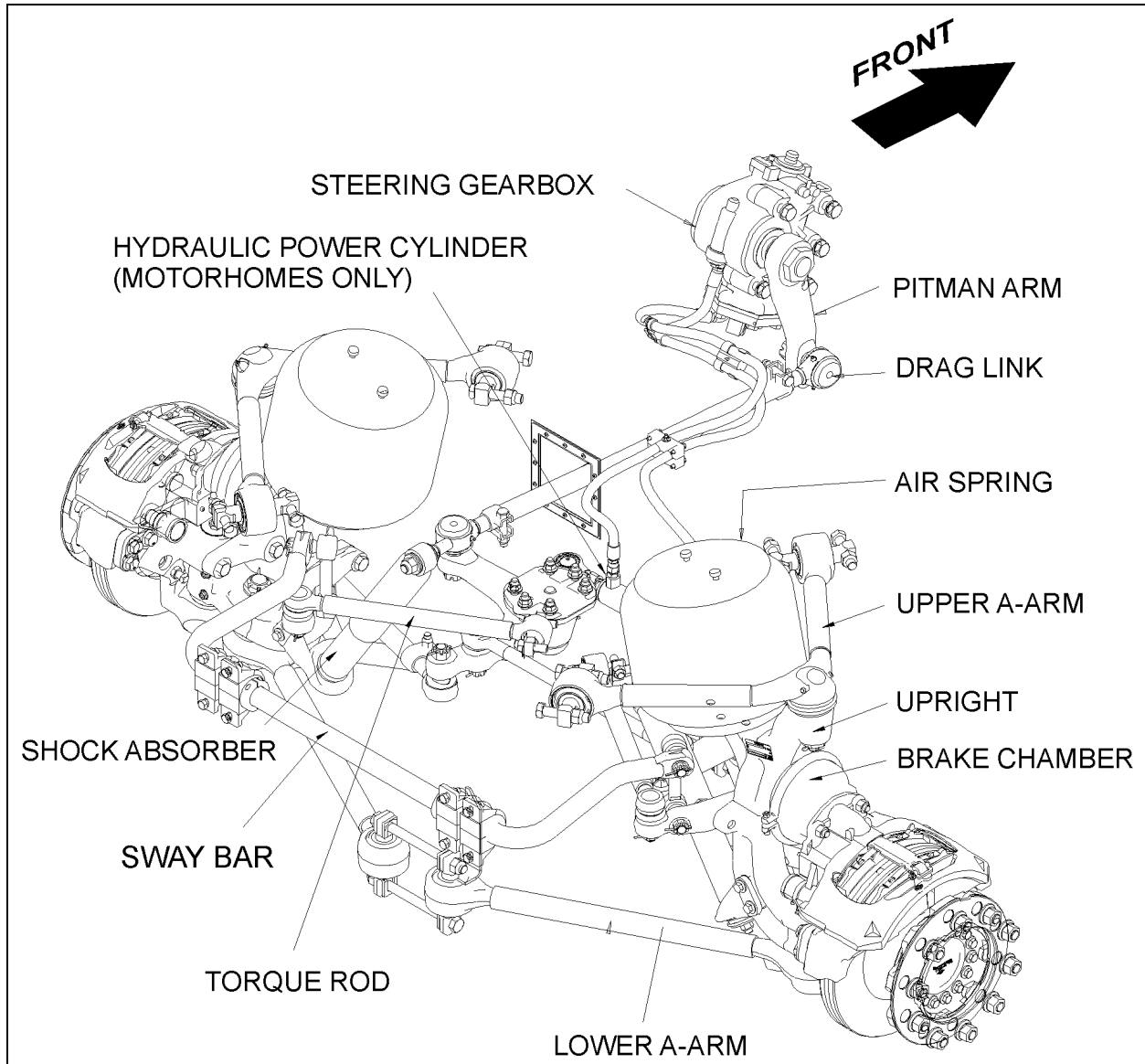


FIGURE 8: INDEPENDENT FRONT SUSPENSION

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#### 3.1 STEERING LINKAGE

Turning motion of the steering wheel is transferred by the steering gear and steering linkage to the steering arms at the right and left front wheels. The steering linkage consists of tie rods connected to the bell crank and the steering arm at the left side of the vehicle, and to the idler arm and steering arm at the right side of the vehicle. 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. X3-45 VIP & XLII Bus Shells are also equipped with a hydraulic power cylinder, which 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 (Figure 10).

Lower and upper A-arms are widely spaced. They are mounted on ball joints. Torque rods prevent rotation of the uprights around the lower and upper ball joints.

If the steering linkage is bent, twisted or worn, steering action of the vehicle will be seriously affected. Any time steering linkage components are replaced or adjusted, steering geometry and front wheel alignment must be checked as explained in this section.

### Turning Angle

The maximum turning angle is set mechanically through the two steering stop screws installed on the swivel assembly. The turning angle mechanical stop is factory adjusted to accommodate the chassis design, and therefore, does not require adjustment on new vehicles.

However, turning angle should be checked and adjusted hydraulically, if necessary, any time a component of the steering system is repaired, disassembled or adjusted.

Turning angles are as follows:

Exterior:  $49.5^\circ \pm 0.5^\circ$

Interior:  $58^\circ \pm 0.5^\circ$

Before checking the turning angle, be sure the front end is properly aligned as described under paragraph "Front End Alignment" in this section.

To check steering maximum turning angle, proceed with the following method:

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


and positioning of clamp bolts and nuts. Reposition if required.

**NOTE**

*Prior to steering limiter adjustment, verify vehicle wheel alignment, and ensure that oil level is adequate and that air bleeding is done.*

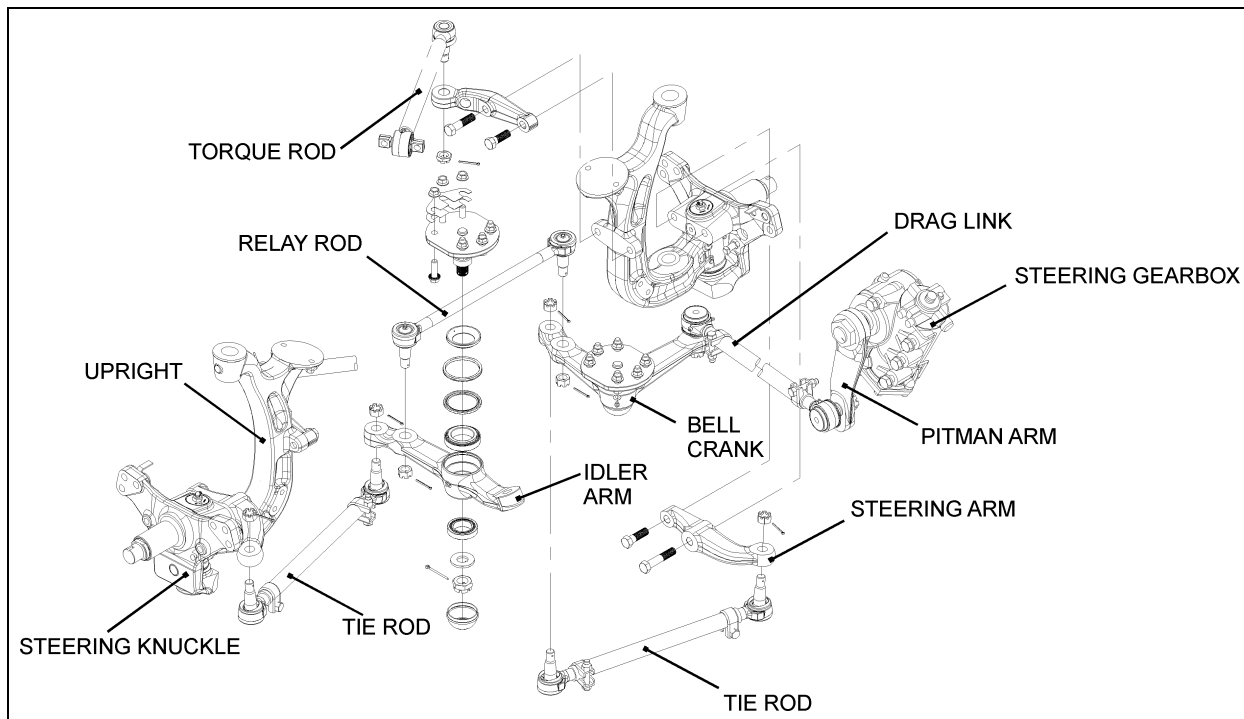
3. If necessary readjust hydraulic steering limiter. Refer to these manuals annexed to the Maintenance Manual, Section 14: STEERING:

- ZF-SERVOCOM Types 8090-8099 Single and Dual-Circuit Versions Repair Manual.
- ZF-SERVOCOM Types 8090, 8095, 8097 and 8098 Design, Operation' Maintenance, Inspection.

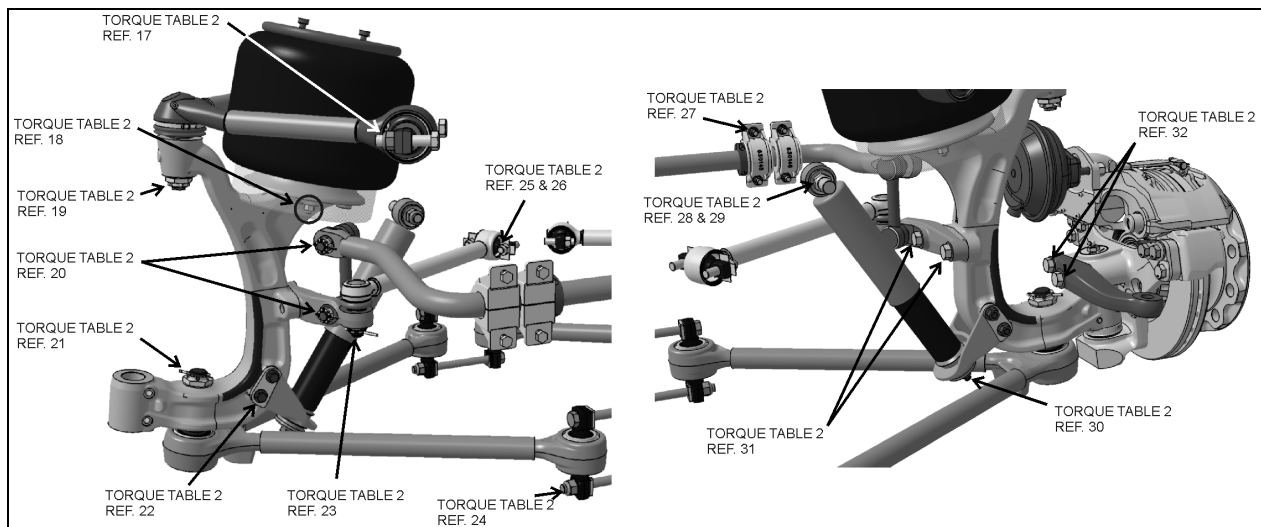
	<p><b>CAUTION</b></p>
<p>Clamp bolts are either in a vertical or horizontal position. Reinstall clamp bolts exactly as they were before removal as they might interfere with other components.</p>	

2. While performing a full left and right turn, check for proper position of the tie rod end clamp bolt and nut and drag link end clamps in order to avoid clamps interfering with close parts. Refer to figure 11 for location

**Section 16 : SUSPENSION**



**FIGURE 9: IFS STEERING LINKAGE OVERVIEW**



**FIGURE 10: IFS - SUSPENSION COMPONENTS**

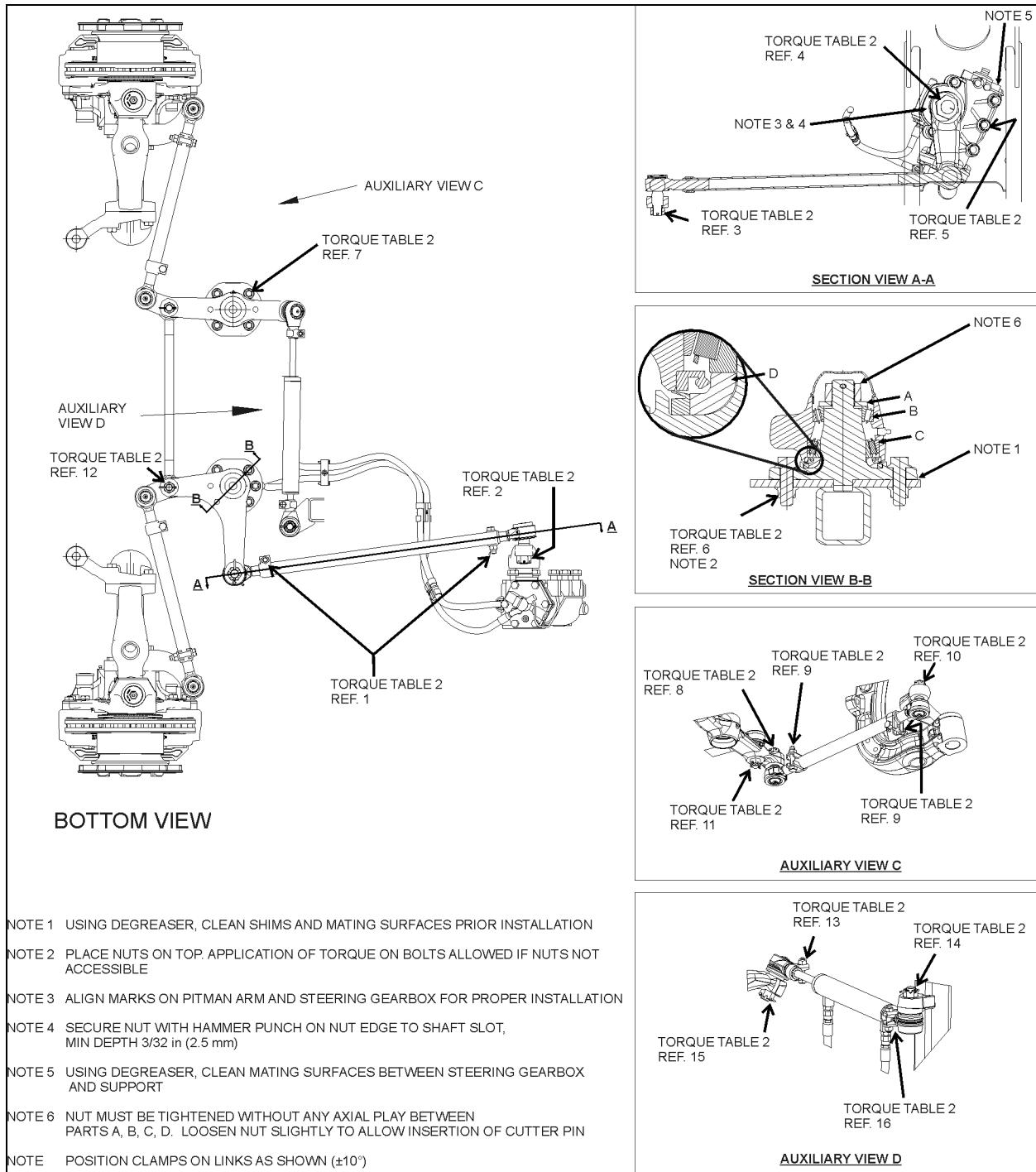


FIGURE 11: IFS STEERING LINKAGE

## Section 16 : SUSPENSION

The following table lists the tightening torques which do require a specific torque value. When no torque specifications are indicated, use the Standard Torque Specifications table found in Section 00: General Information of the Maintenance Manual.

<b>SPECIFIC TORQUE TABLE 2 – INDEPENDENT FRONT SUSPENSION</b>				
<b>DESCRIPTION</b>	<b>QTY</b>	<b>REFERENCE</b>	<b>TORQUE DRY</b>	
			<i>threads must be free of oil or other lubricant</i>	
			<i>lbf-ft</i>	<i>Nm</i>
<i>Drag link socket end clamp pinch bolt</i>	2	1	50-60	68-81
<i>Drag link ball stud nut to pitman arm</i>	1	2	245-270	332-366
<i>Drag link ball stud nut to bell crank</i>	1	3	245-270	332-366
<i>Pitman arm to steering gear fixing nut</i>	1	4	470-570	637-772
<i>Steering gearbox to mounting bracket bolt</i>	5	5	365-405	495-549
<i>Bell crank spindle mounting nut</i>	6	6	208-254	282-344
<i>Idler arm spindle mounting nut</i>	6	7	208-254	282-344
<i>Tie rod end ball stud nut to idler arm or bell crank</i>	2	8	150-200	203-271
<i>Tie rod end clamp pinch bolt</i>	4	9	50-60	68-81
<i>Tie rod end ball stud nut to steering arm stud *</i>	2	10	150-200	203-271
<i>Relay rod stud nut to idler arm *</i>	1	11	150-200	203-271
<i>Relay rod stud nut to bell crank *</i>	1	12	150-200	203-271
<i>Hydraulic power cylinder end clamp pinch bolt</i>	1	13	50-60	68-81
<i>Hydraulic power cylinder to bracket stud nut*</i>	1	14	150-200	203-271
<i>Hydraulic power cylinder to idler arm stud nut*</i>	1	15	150-200	203-271
<i>Hydraulic power cylinder end clamp pinch bolt</i>	1	16	50-60	68-81
<i>Upper a-arm ball joint</i>	4	17	230-255	312- 346
<i>Air spring lower stud nut (6 air springs)</i>	2	18	31-38	42- 51
<i>Upper a-arm central ball joint (castellated hex nut)*</i>	1	19	210-250	284-339
<i>Sway bar link, upper and lower ball stud nuts (front suspension)*</i>	2	20	165-200	224-271
<i>Lower a-arm central ball joint (castellated nut)*</i>	1	21	490-540	664- 732
<i>Shock absorber support</i>	4	22	145-165	196-224
<i>Torque Rod ball stud nut*</i>	1	23	150-200	203-271
<i>Lower a-arm ball joint</i>	4	24	270-300	366-407
<i>Torque rod, nut</i>	2	25	140-155	190-210
<i>Torque rod, stud</i>	2	26	90-110	122-150
<i>Sway bar bushing collar (front suspension)</i>	8	27	80-100	108-136
<i>Shock absorber mounting stud nut</i>	1	28	99-121	134-164
<i>Shock absorber mounting stud</i>	1	29	350-400	475-545
<i>Shock absorber lower mounting pin nut</i>	1	30	60-75	81-102
<i>Torque rod lever bolt (M20-2.5)</i>	2	31	520-575	705-780
<i>Steering arm bolt (M22-2.5)</i>	2	32	642-708	870-960

\* Tighten nut to specified torque, then advance to next aligning cotter pin slot and install a new cotter pin.

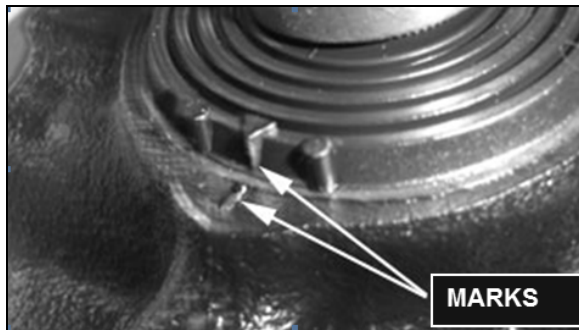


### 3.2 STEERING LINKAGE INSTALLATION SEQUENCE

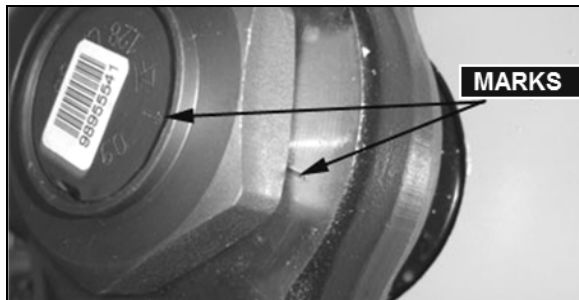
**NOTE**

*Whenever a steering linkage component has been removed and replaced, check steering geometry and front end alignment as directed in this Section. Check to insure that all stud nuts and mounting bolts and nuts have been tightened to prescribed torque.*

1. Position front wheels in straight ahead position.
2. Align the steering gearbox input shaft marks.
3. Afterwards, the pitman arm should be adjusted with output shaft and pitman arm reference marks aligned (for proper tightening torque, refer to Torque Table 2).



**FIGURE 12: STEERING GEARBOX INPUT SHAFT MARKS**



**FIGURE 13: STEERING GEARBOX OUTPUT SHAFT AND PITMAN ARM MARKS ALIGNED**

4. Locate centerline of vehicle then install relay rod in boss at steering bell crank and idler arm. Align center of relay rod with centerline of vehicle.
5. Install drag link to pitman arm and adjust opposite end of drag link to fit mounting stud hole in bell crank.
6. Install tie rods, and then adjust toe-in as per "Front End Alignment" in this Section.

### 3.3 PITMAN ARM REMOVAL

#### 3.3.1 Removal

1. Remove cotter pin, nut and washer 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 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. Remove pitman arm fixing nut.
4. Check the radial position of the pitman arm in relation to the sector shaft prior to removal of pitman arm.
5. Add reference marks to the arm and shaft if necessary to ensure correct alignment at reassembly.
6. Use a puller to remove pitman arm.

#### 3.3.2 Installation

1. Position pitman arm on sector gear shaft with reference marks aligned.
2. Install fixing nut. Tighten nut (dry) as per Torque Table 2.

**NOTE**

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

## Section 16 : SUSPENSION

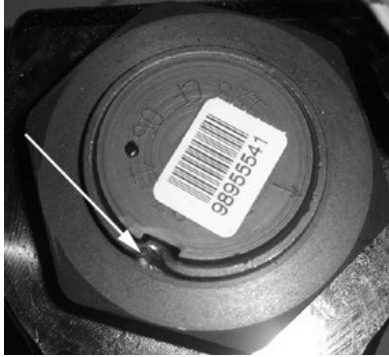


FIGURE 14: FIXING NUT PUNCH MARK

16098



### CAUTION

Lock nut with sector shaft using a punch mark into the groove (Refer to figure 14).

3. Connect drag link to pitman arm. Install washers. Tighten nut (dry) as per Torque Table 2. Advance nut to next alignment cotter pin slot and install a new cotter pin.

### 3.4 DRAG LINK

Drag link assembly consists of three parts; a drag link and two end assemblies. Both end assemblies are identical and they are retained on the drag link with a clamp bolt and nut.

Stud nuts at the pitman arm and bell crank ends of the drag link must be kept tight or hole at ball stud end of drag link and hole in pitman arm may become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs too far into holes and dust cover parts may become damaged which can result in component failure.

Drag link end sockets are equipped with lubrication fittings and should be lubricated as directed in "Lubrication Fittings" in this section.

#### NOTE

*The drag link nominal length is 41 17/32 inch (1055 mm) measured from the center of one ball socket to the other. Nominal length is given only for preliminary adjustment.*

#### 3.4.1 Adjustment

It should not be necessary to alter the length of the drag link except when a new link is installed or when removable end assembly has been replaced. If drag link adjustment is necessary, proceed as follows:

1. Position front wheels in straight ahead position.
2. Center steering gear as previously explained in paragraph "Steering Linkage Installation Sequence".
3. Remove cotter pin and stud from drag link at bell crank. Locate centerline of vehicle and center of relay rod. With center of relay rod aligned with centerline of vehicle, loosen clamp bolt at socket end (bell crank end) of drag link and adjust length of socket end assembly to fit in boss of bell crank.

#### NOTE

*Do not change position of pitman arm.*

4. Install stud nut and torque to proper torque. Align nut with cotter pin slot (tighten) and install a new cotter pin.
5. Torque mounting clamp bolt nut to nut to prescribed torque, then test the adjustment. Front wheels should turn from right to left extremities without noticeable binding at drag link ends.

### 3.5 BELL CRANK AND IDLER ARM

Bell crank and idler arm are equipped with one lubrication fitting and should be lubricated as directed in "Lubrication Fittings" in this Section.

#### 3.5.1 Bell Crank and Idler Arm Removal

#### NOTE

*Use a piece of wire to anchor loosen end of relay rod and tie rod in order to prevent placing an excessive load on opposite socket end.*

**Bell crank:** Disconnect drag link, tie rod and relay rod from bell crank by removing cotter pins, stud nuts and washers from ball studs. Separate socket assemblies from the bell crank.

**Idler arm:** Remove cotter pins, nuts and washers from ball studs connecting relay rod and tie rod to idler arm. Separate socket assembly from idler arm.

Remove nuts and washers from bolt attaching bell crank or idler arm mounting bracket to vehicle understructure. Remove bell crank or idler arm mounting spindle.

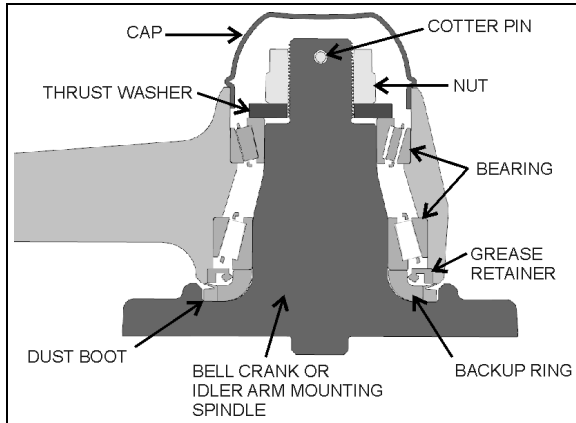


FIGURE 15: BELL CRANK OR IDLER ARM HUB

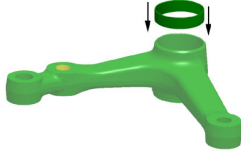
3.5.2 Bell crank or Idler Arm Ball Joint Disassembly


1. Remove adjacent link assemblies from bell crank or idler arm as previously described.
2. Remove the cap (Figure 15).
3. Remove the cotter pin, nut and tongue washer. Remove bearings, grease seal, bearing bushing and the bell crank or idler arm from its mounting spindle (Figure 15).

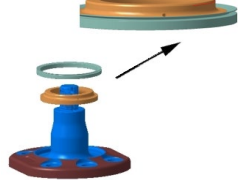
3.5.3 Bell Crank or Idler Arm Ball Joint Reassembly

**NOTE**  
For bearing installation use tool Prevost # 110684.

**NOTE**  
Install grease seal according to figure 15. Grease must be able to exit the bell crank or idler arm mechanism. For grease seal installation use tool Prevost # 110683.


1. Clean parts thoroughly with degreaser.
2. Insert the small bearing outer race into appropriate bore (done on a press). 
3. Insert the large bearing outer race into appropriate bore (done on a press).

4. Insert the large bearing into outer race and then, add grease retainer. 

5. Apply good quality lithium grease (#680752) on backup ring and dust boot. 

6. Install backup ring and dust boot on bell crank or idler arm spindle.

7. Apply a thin layer of grease on spindle shaft.

8. Install bell crank or idler arm onto its mounting spindle, while holding the bell crank or idler arm, slide on the small bearing assembly, thrust washer and secure using nut. 

9. Tighten nut to 130 lbf-ft.

10. Rotate assembly 3 turns in each direction.

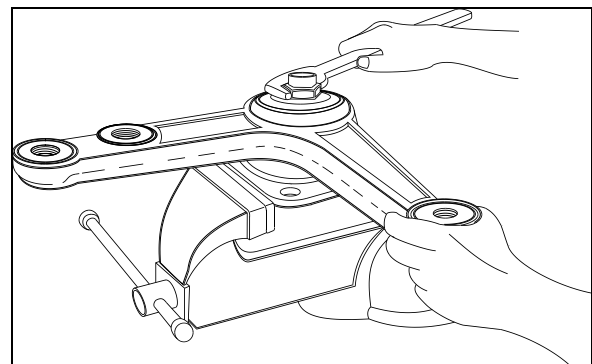


FIGURE 16: BELL CRANK

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11. Unscrew nut until bell crank or idler arm starts to turn with the application of 1 to 3 lbf load as shown on figure 17.

12. Check for loose bearings by applying an up and down load on bell crank or idler lever. The lever is not supposed to move in the vertical axis direction.

## Section 16 : SUSPENSION

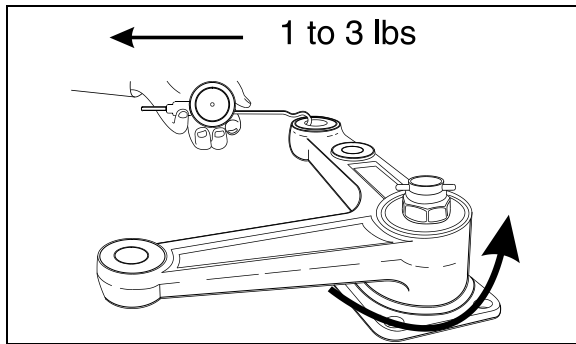


FIGURE 17: BELL CRANK 16045

13. Align nut with cotter pin slot (tighten) and install a new cotter pin.

### NOTE

*Bend cotter pin around the nut. Do not bend the cotter pin in the direction of the cap as it may interfere with the cap.*

14. Install the cap.
15. **Bell crank:** Install drag link, tie rod and relay rod as directed herein under each specific subject.
16. **Idler arm:** Install hydraulic power cylinder, tie rod and relay rod as directed herein under each specific subject.
17. Adjust turning angle as previously directed under paragraph "**Turning Angle**" and check front end alignment as specified under heading "Front End Alignment".

### 3.6 RELAY ROD

Relay rod ends are equipped with lubrication fittings and should be lubricated as directed in paragraph "Lubrication Fittings" in this section.

### NOTE

*The relay rod is crimped in place and it is not possible to remove the ball joints.*

#### 3.6.1 Replacement

1. Remove cotter pins from bell crank and idler arm end of relay rod. Loosen nuts flush with end of studs.
2. Use a puller or place a sledge hammer behind the adjacent part to absorb shocks. Strike the studs with a brass hammer to loosen end assemblies.
3. Remove stud nuts and washers then remove studs.

4. Position relay rod studs into bell crank and idler arm then tap stud ends with a brass hammer to seat tapered surfaces.
5. Install washers and stud nuts. Tighten nuts to prescribed torque (refer to Torque Table 2). Align cotter pin slot (tighten) and install a new cotter pin.

### 3.7 TIE RODS

Tie rod ends are connected to the bell crank and left steering arm, and to the idler arm and right steering arm. Each tie rod assembly consists of three parts; a tube and two socket end assemblies. The tie rod ends are threaded into the tube and secured with clamp bolts. Right and left hand threads are provided to ease toe-in adjustment. Tie rod assemblies are interchangeable from the right to the left side of the vehicle.

Tie rod end sockets require no maintenance other than periodic lubrication and inspection to see that ball studs are tight. Replace socket ends when there is excessive up and down motion, lost motion or end play at ball end of stud.

1. Periodically check bolt nut for tightness.
2. Inspect tie rod for bent condition and inspect tube for damaged threads. If tie rod is bent or threads are damaged, replace the assembly.
3. Lubricate tie rod end fittings as directed in paragraph "Lubrication Fittings" of this section.

#### 3.7.1 Removal

1. Remove cotter pins and stud nuts which attach tie rod socket ends to bell crank and left steering arm (or idler arm) and right steering arm.
2. Remove tie rod ball stud by tapping on steering arm and bell crank or idler arm with hammer, while using a sledge hammer to absorb shocks.

### NOTE

*If tie rod end assemblies are damaged in any way, they must be replaced*

3.7.2 Installation

1. Install socket end assemblies on tie rod. Be sure both ends are threaded an equal distance into the tube.
2. Make sure threads on stud and in stud nut are clean and not damaged.
3. Position ball studs (socket ends of tie rod) in holes in steering arm and bell crank or idler arm. Install a ball stud nut on each stud and tighten firmly.
4. Torque stud nuts to prescribed torque (refer to Torque Table 2). Align cotter pin slot (tighten) and install a new cotter pin.

**NOTE**

*Adjust toe-in as directed in paragraph "Toe-In Adjustment" of this section.*

5. Make sure tie rod ends are properly aligned with ball studs, and then torque tie rod end clamp bolts to prescribed torque (refer to Torque Table 2).

**NOTE**

*If tie rod is not properly aligned with stud, binding will result.*

3. Position tie rod ball stud in steering arm and tap with a brass hammer to seat ball stud in steering arm. Install washer and nut on stud. Torque nut to prescribed torque (refer to Torque Table 2). Tighten nut to nearest cotter pin slot and install a new cotter pin.
4. Install wheel as directed in Section 13, "Wheel, Hubs and Tires" under paragraph "Installation" of the maintenance manual.

3.8 STEERING ARMS

The left and right wheel steering arms are secured to a steering knuckle at one end and to a tie rod at the other end.

3.8.1 Removal

1. Remove wheel as directed in Section 13, "Wheel, Hubs and Tires" of the maintenance manual.
2. Remove cotter pin, washer and nut from stud securing tie rod to steering arm. Remove ball stud from steering arm by tapping on arm with a hammer, placing a sledge hammer underneath steering arm to absorb shocks.
3. Remove cotter pin and nut securing steering arm to steering knuckle assembly. Remove steering arm from steering knuckle.

3.8.2 Installation

1. Install steering arm onto steering knuckle.
2. Torque steering arm to steering knuckle fixing bolts. Torque bolt to prescribed torque (refer to Torque Table 2).

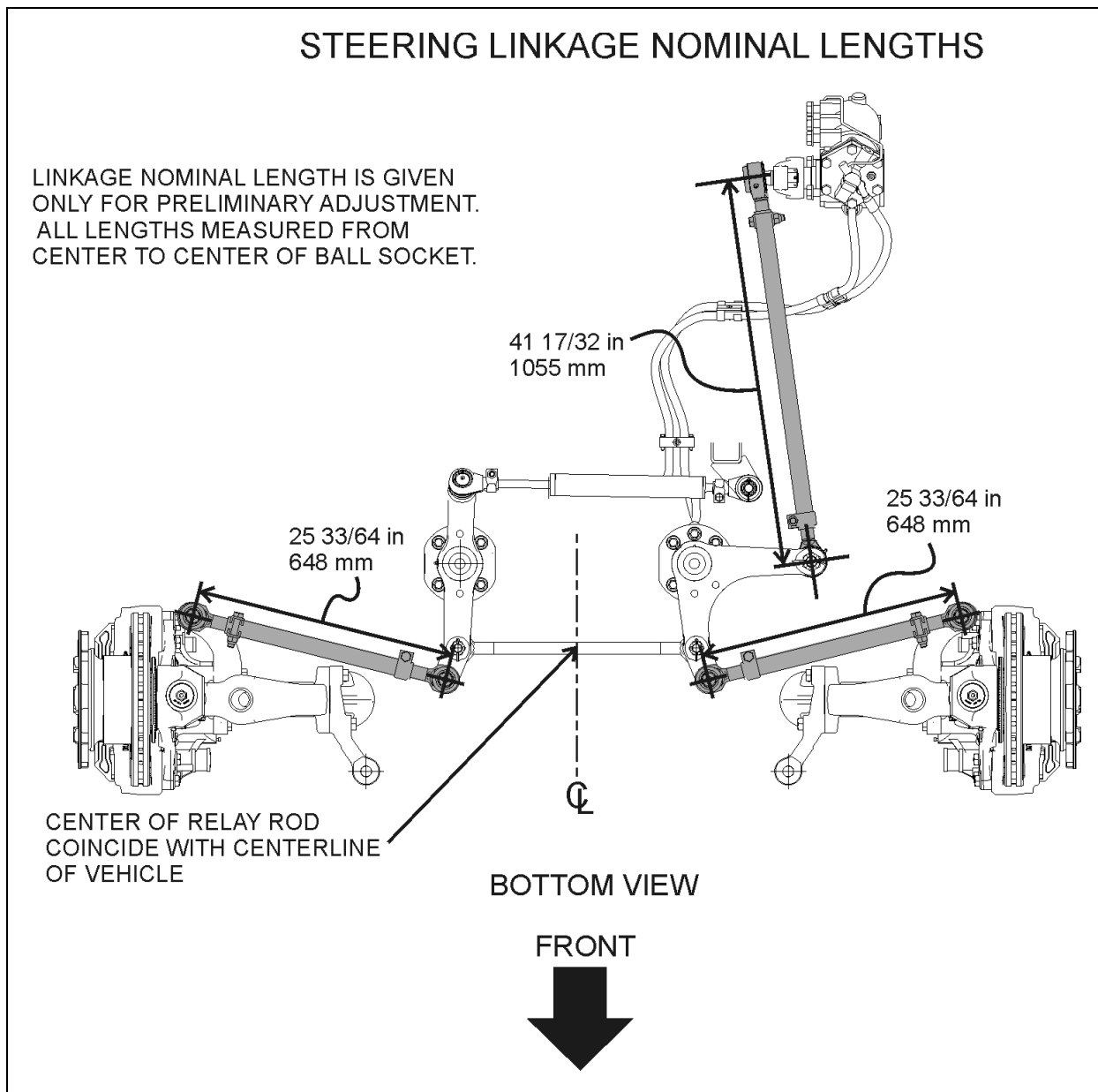


FIGURE 18: STEERING LINKAGE NOMINAL LENGTHS

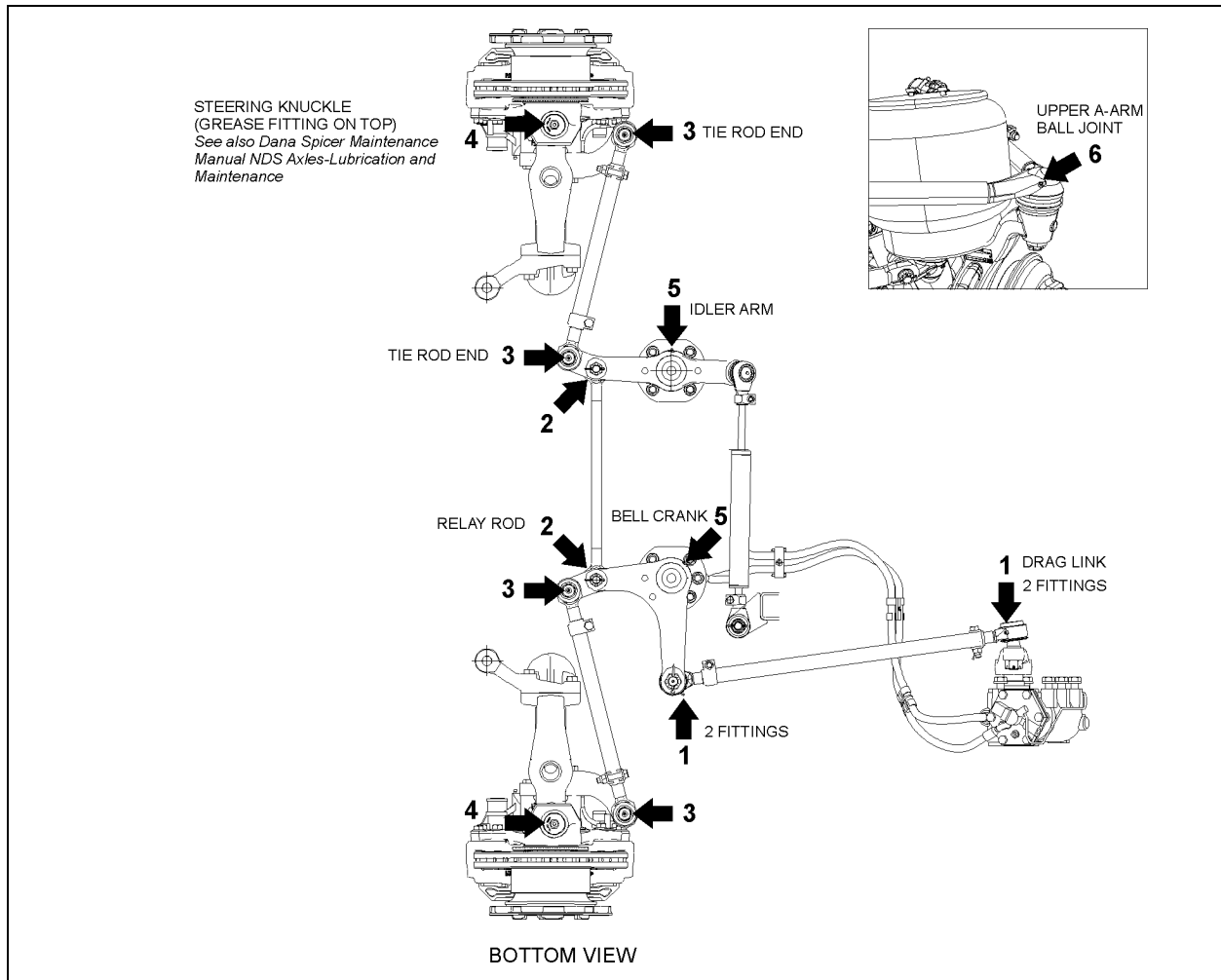


FIGURE 19: LUBRICATION FITTINGS LOCATION

### 3.9 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.

Intervals of application given in the following paragraphs are recommended for normal service. More frequent intervals may be applied under severe operating conditions. In selecting proper lubricants, supplier reputation must be considered. The supplier must be responsible for

product quality. Figure 19 shows approximate<sup>16046</sup> location of steering lubrication fittings.



## MAINTENANCE

1. **Drag Link Ends:** Lubricate at four fittings, two at each end of link, every 6,250 miles (10 000 km) 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, every 6,250 miles (10 000 km) 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, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell

## Section 16 : SUSPENSION

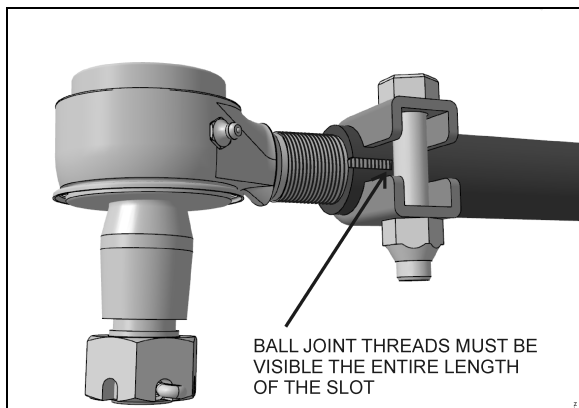
Retinax LX or equivalent).

4. **Steering Knuckle (swivel assembly):** Refer to DANA SPICER MAINTENANCE MANUAL NDS AXLES Lubrication and Maintenance" annexed at the end of section 10.
5. **Idler Arm and Bell Crank:** Lubricate at two fittings, one on the idler arm and the other on the crank bell, every 6,250 miles (10 000 km) 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, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).

### 3.10 BALL JOINTS – GENERAL RECOMMENDATIONS

#### Visual Inspection

- Visually inspect for missing or damages grease fittings and replace if required.
- Check ball joint connection for missing cotter pins.
- Check for looseness in the ball/socket assembly.



**FIGURE 20: 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).

Damaged sealing boots, salt and climatic conditions can cause loss of the corrosion protection coating applied at time of manufacturing. 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 (if applicable).

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

### 3.11 FRONT-END 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.

#### 3.11.1 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 25).



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 25).

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 25).

Front Axle Caster: The inclination of the kingpin from vertical in the fore and aft direction (C, Figure 25).

### 3.11.2 Front End Inspection

Before checking front end alignment, make the following inspection:

1. Check that the vehicle is at normal ride height (see paragraph "8. Suspension Height Adjustment").
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 if the length of the torque rod is 21 17/64" (540 mm) (Figure 11). Check if the length of the relay rod is 23 19/64" (592 mm).

### 3.11.3 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.

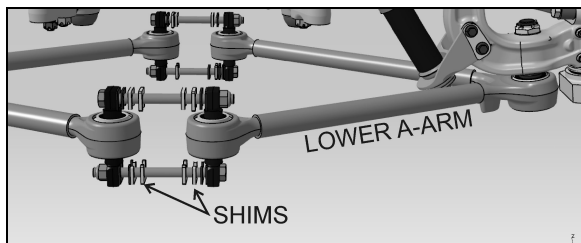


FIGURE 21: SHIMS AT THE LOWER AARMS

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 21). 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.

### 3.11.4 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.

## Section 16 : SUSPENSION

- 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

- Loosen the tie rod clamp bolts.
- Using a pipe wrench, turn the tie rod tubes to obtain the toe-in measurement specified in step 5 under paragraph "Toe-in Check".
- Tighten the tie rod clamp bolts and recheck toe-in.
- Check that the angular relationship of the pitman arm to the steering gear is as shown in figure 22.

#### NOTE

Use only tie rods to adjust toe-in.

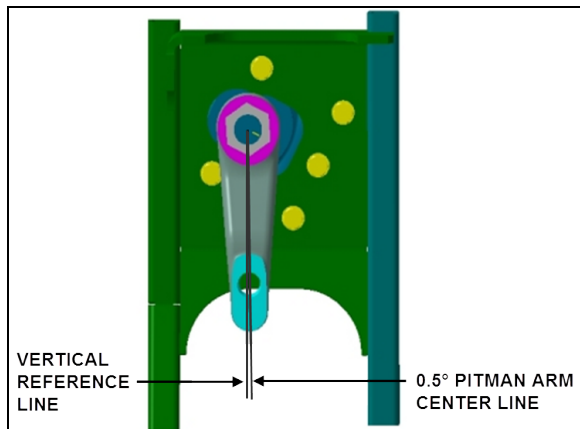


FIGURE 22: IFS PITMAN ARM ALIGNMENT

14056

### 3.11.5 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 25).

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  $0.3^\circ$ .

### 3.11.6 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".

### 3.11.7 Alignment Specifications

See figure 24 & 25.

#### NOTE

On Independent Front Suspension, caster on right wheel must be equal or greater than caster on left wheel, with a maximum difference of  $0.3^\circ$ .

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

X3 VIP Shell & XLII Shell INDEPENDENT FRONT SUSPENSION						
Load	Minimum value		Nominal value		Maximum value	
	Non-converted	Converted	Non-converted	Converted	Non-converted	Converted
Right camber	0.20°	-0.20°	0.30°	0°	0.50°	0.20°
Left camber	0.20°	-0.20°	0.30°	0°	0.50°	0.20°
Right caster	2.55°		2.8°		3.05°	

Left caster	2.55°		2.8°		3.05°	
	0.02°	0.04°	0.04°	0.06°	0.06°	0.08°

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



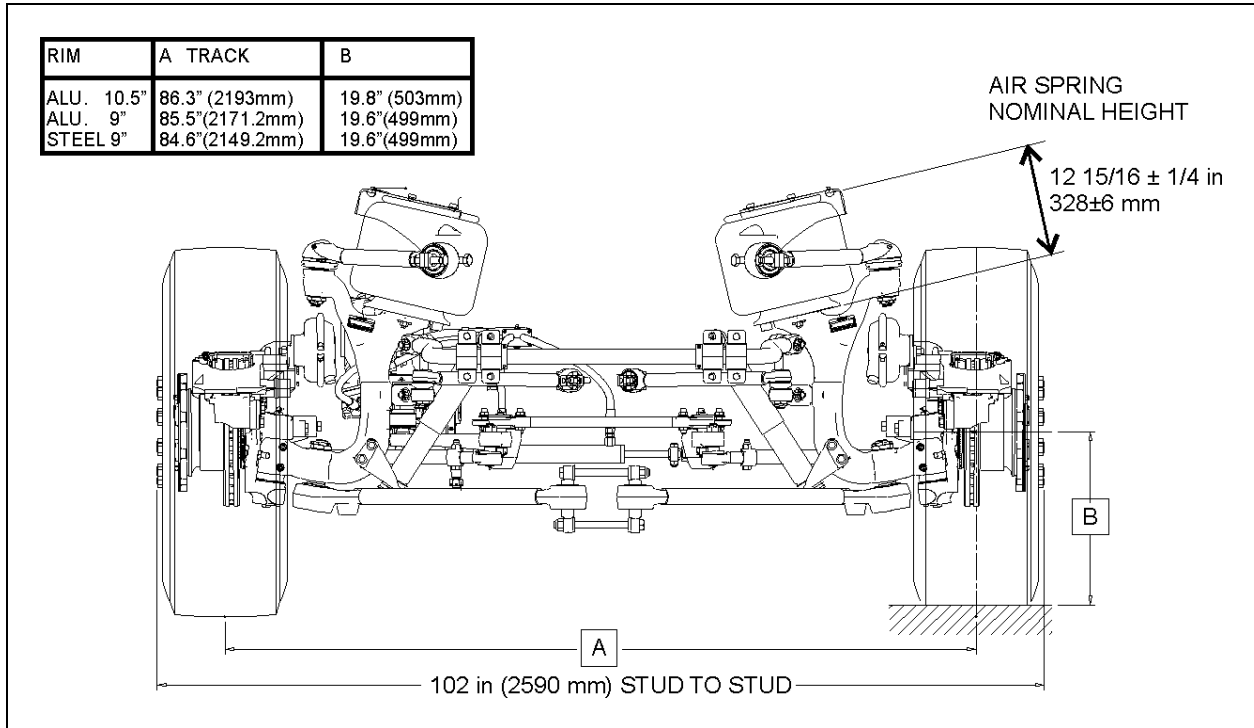


FIGURE 23: IFS NOMINAL DIMENSIONS

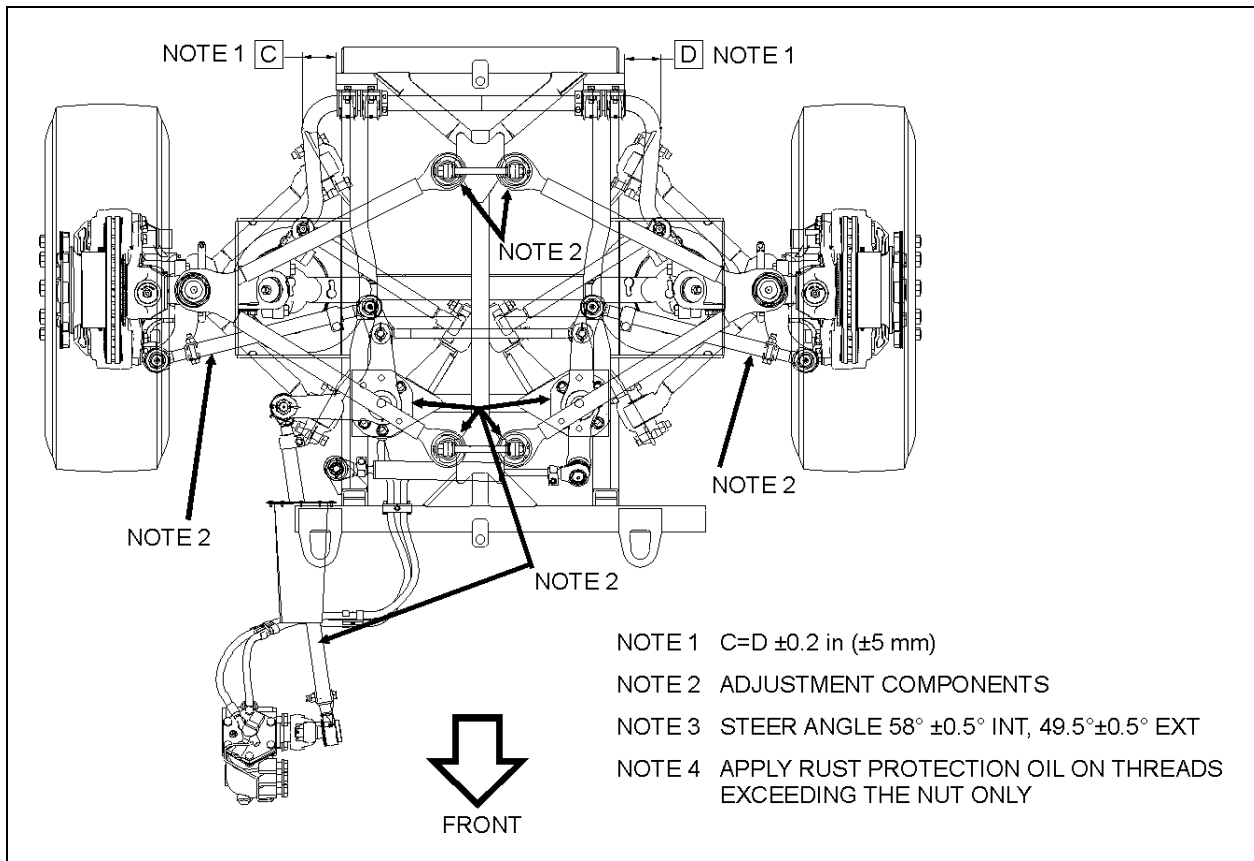


FIGURE 24: NOTE 2 INDICATES WHERE ADJUSTMENT MAY BE PERFORMED AT IFS ALIGNMENT

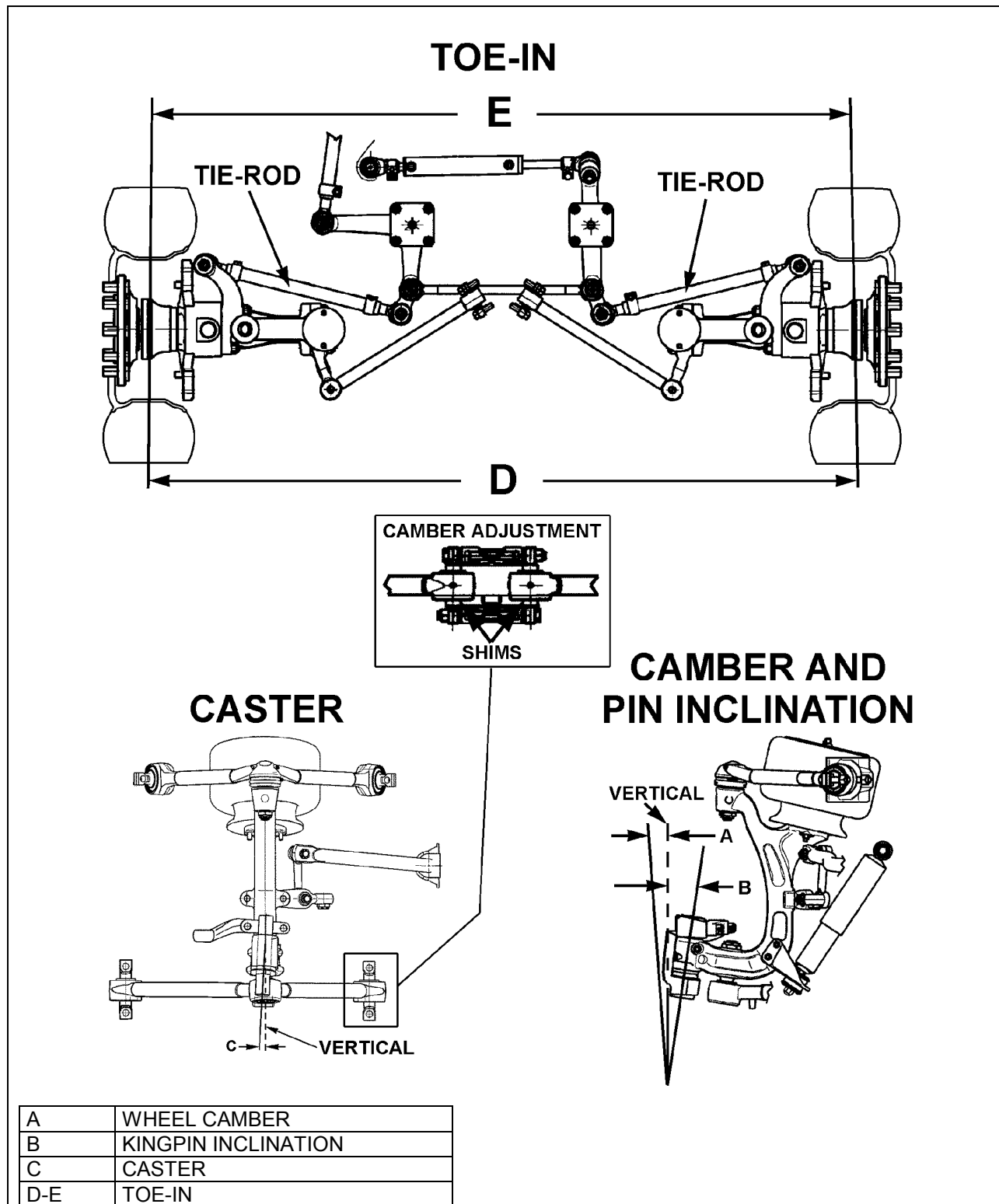


FIGURE 25: FRONT END ALIGNMENT DIAGRAM

16051

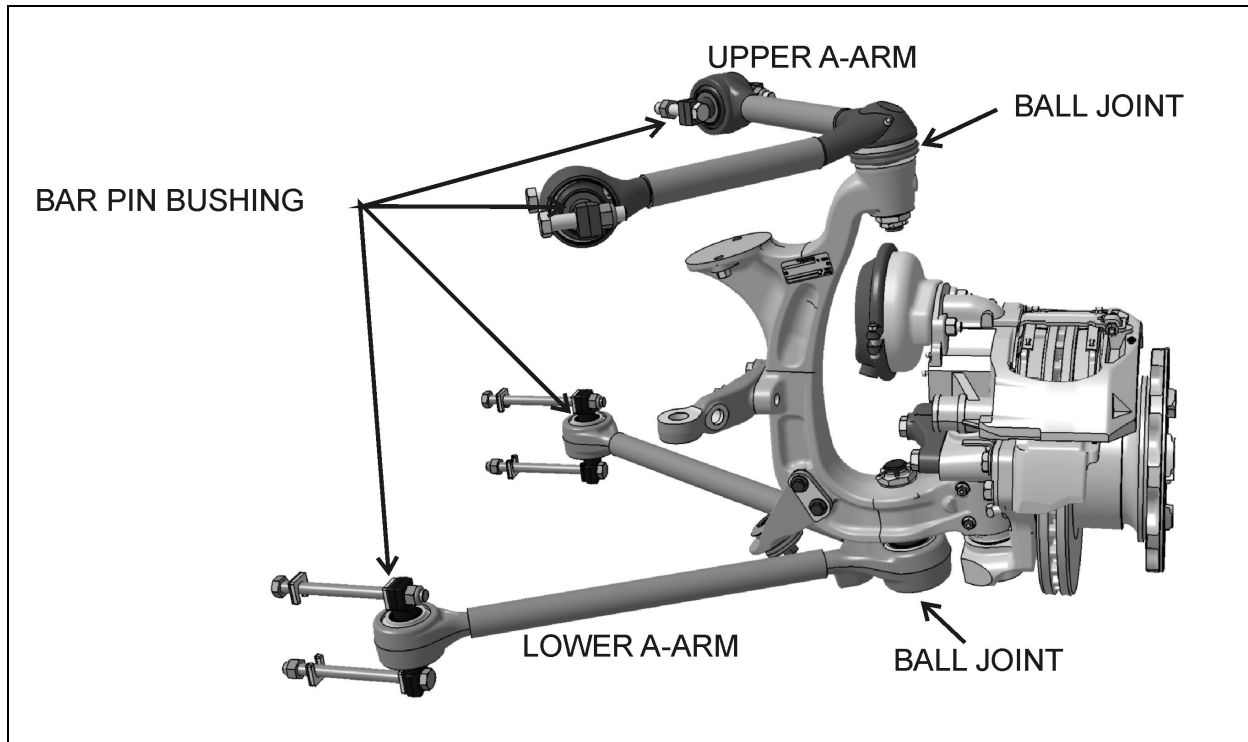


FIGURE 26: A-ARM JOINT IDENTIFICATION

### 3.12 LOWER AND UPPER A-ARM BAR PIN BUSHING REPAIR

The assembly work may be done only by a recognized specialized workshop. Ensure that old and new parts do not get mixed up with each other. It is for this reason that all the old parts are to be scrapped immediately after a joint has been stripped down. A complete repair set must be used for each joint repaired, i.e. use of only part of a repair set is not permissible.

#### 3.12.1 Inspection

Take off the load from the joint by lifting the front of the vehicle. Apply a load on the joint in all of the degrees of freedom in an axial, radial, etc. sense with a suitable lever tool. After the load is taken off, the joint has to spring back into its starting position. Free play is not acceptable.

Separation of rubber from bar pin or external joint shell is in accordance with "normal wear characteristics".

When the following characteristics are noted, the joint is to be changed:

-Free play;

-Radial cracking of the external sheet-metal race.

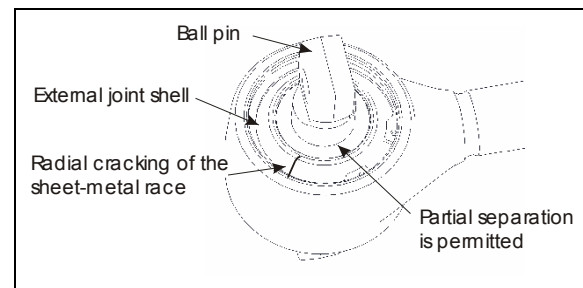


FIGURE 27: BAR PIN BUSHING

#### 3.12.2 Stripping Down

Strip down the defective joint through removal of retaining ring, annular spacer and bar pin bushing assembly and thereafter clean out housing bore and locking circlips groove.

#### 3.12.3 Assembly

Execute assembly of the new joint parts in the following sequence:

1. Complete moistening of the contact surface between housing bore and bar pin bushing through application of the grease.

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### NOTE

Apply grease, only in the case of repair kit (Prevost # 611114).

2. Insert bar pin bushing assembly. In case of the two-bolt type, ensure that the bolt bores are in the correct position in relation to the axis of the tube.
3. Place joint in receiving fixture and mount annular assembly tool on the housing. Then locate annular spacer and retaining ring in the housing using axial load with the aid of assembly matrix. If the ends of the annular spacer are not in contact with each other, the thus formed opening must be located at 180° to the opening of the retaining ring. Pay attention during assembly to ensure that the retaining ring eyelets are located at each side of the housing shaft axis (retaining ring eyelet lug points to tube), and that retaining ring is properly engaged in the groove of the housing.
4. When repairing defective ball pin assemblies, the necked down-bolt must regularly be replaced with a new one.

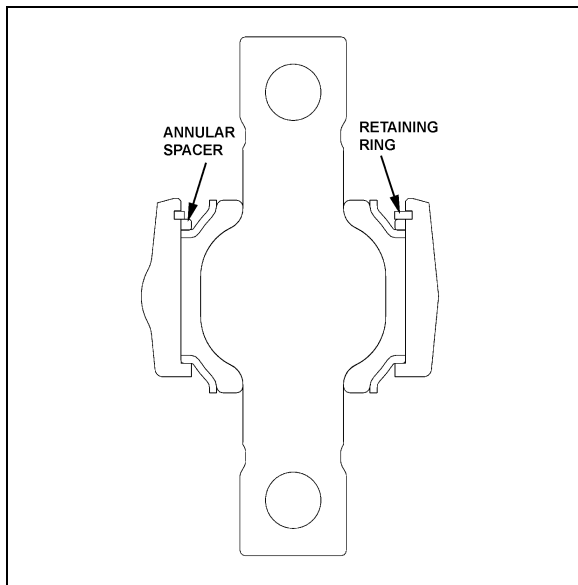


FIGURE 28: LOWER A-ARM BAR PIN BUSHING 16047

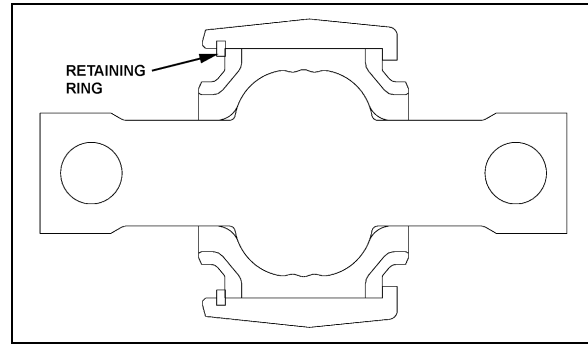


FIGURE 29: UPPER A-ARM BAR PIN BUSHING

### 3.13 LOWER A-ARM BALL JOINT REPAIR

Take off the load from the ball joint by lifting the front of the vehicle. Apply a load on the joint in all of the degrees of freedom in an axial, radial, etc. sense with a suitable lever tool. After the load is taken off, the joint has to spring back into its starting position. Free play is not acceptable.

Separation of rubber from ball pin or external joint bushing shell is in accordance with "normal wear characteristics".

When the following characteristics are noted, the joint is to be changed:

- Free play;
- Radial cracking of the external bushing shell.

#### 3.13.1 Stripping Down

Strip down the defective joint through removal of retaining ring, annular spacer and ball pin/bushing, assembly and thereafter clean out housing bore and locking circlips groove

#### 3.13.2 Assembly

Assemble the new component parts of the joint in the following sequence:

1. Complete moistening of the contact surface between housing bore and ball pin through application of the grease.
2. Place joint in receiving fixture and mount annular assembly tool on the housing. Then locate annular spacer and retaining ring in the housing using axial load with the aid of assembly matrix. If the ends of the annular spacer are not in contact with each other, the thus formed opening must be located at 180° to the opening of the retaining ring. Pay attention during assembly to ensure that the retaining ring eyelets are located at each



side of the housing shaft axis (retaining ring eyelet lug points to tube), and that retaining ring is properly engaged in the groove of the housing.

3. Faultlessly apply grease by mechanical means to bracket-outer core and ball-inner cone. Insert bracket outer cone in fixture with distance ring and then use press tool to apply pressure to press mount with ball-inner cone.

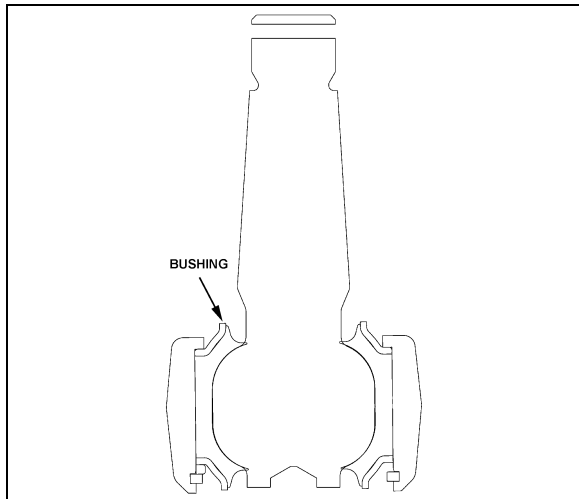


FIGURE 30: LOWER A-ARM BALL JOINT

### 3.14 UPPER A-ARM BALL JOINT

#### 3.14.1 Visual Inspection

Check the condition of the sealing boot, in particular:

Check if the retainer ring, which secures the sealing boot at the conical section of the ball stud, is still present.

Check if grease is present on the external surface of the sealing boots. Escaped fluid and accumulations of grease on the sealing boot may be the result of the sealing boot's rupturing. In this case, the ball joint must be systematically replaced.

#### 3.14.2 Play Measurement

1. Raise the vehicle and support through axle jacking points.
2. Using a caliper, measure dimension A on figure 31.
3. With a lever tool, exert sufficient force under the upper A-arm as to separate the upper A-arm from the upright in order to have the ball

joint to its maximum extent. Measure dimension A again. If the difference between the two dimensions is greater than 0.060" (1.5mm), then the ball joint should be replaced.

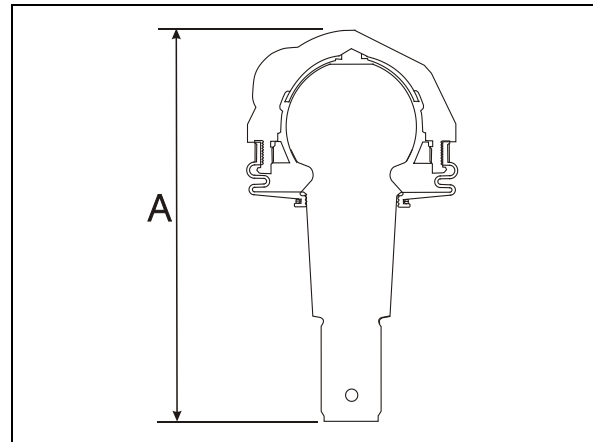


FIGURE 31: UPPER A-ARM BALL JOINT 16116

### 3.15 FRONT AIR SPRINGS

Two 14-inch "rolling lobe" type air springs are used with the independent front suspension, one at each wheel. These air springs are special and use the complete piston as an extra reservoir to lower the spring stiffness. Front air springs are attached to the subframe and to uprights.

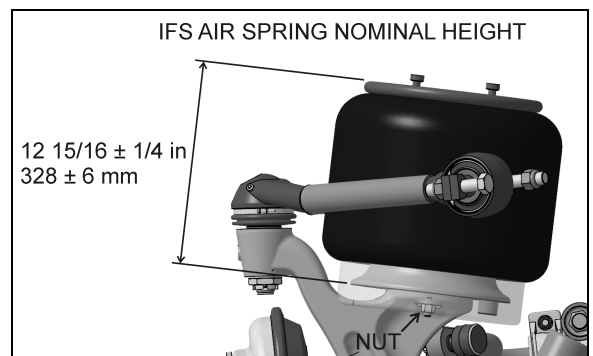


FIGURE 32: AIR SPRINGS 16052

#### 3.15.1 Inspection

1. Check operation of bellows.
2. Visually inspect bellows for evidence of cracks, punctures, deterioration, or chafing. Replace the bellows if damage is evident.
3. With the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa)), coat all suspension air line connections and bellow mounting areas with a water and soap solution. Bubbles will

## Section 16 : SUSPENSION

indicate an air leak, and none is permissible. Repair or replace defective parts.

### **NOTE**

*If air spring is removed from vehicle, bellows can be lightly inflated and submerged in water to detect any leakage. If leakage is detected, replace bellows.*



### **WARNING**

To prevent personal injury, do not apply more than 10 psi (69 kPa) air pressure to the dismantled air spring.

### 3.15.2 Removal

### **NOTE**

*Front air springs can be removed without removing the entire suspension assembly.*

1. Safely support vehicle at the recommended body jacking points and jack up body understructure.
2. To gain access to a given air spring, the corresponding wheel can be removed.



### **CAUTION**

Only the recommended jacking points must be used as outlined in Section 18, "Body" in the maintenance manual.

3. Support the assembly with a suitable jack.
4. Exhaust compressed air from accessory air tank by opening drain cock under reservoir.
5. Disconnect the height control valve link and pull down the overtravel lever to ensure all air is exhausted from air springs.

### **NOTE**

*While performing this step, do not change the height control valve overtravel lever adjustment.*

6. Disconnect air line from air spring, remove elbow (if applicable), and cover both the line end and fitting to prevent the entry of foreign matter.
7. Remove the air spring upper nut, and then the two lower nuts. Remove air spring and remove the back up plate from the top of the air spring.

### 3.15.3 Installation

### **NOTE**

*To facilitate air spring installation, compress it manually then put a piece of tape over the air line threaded fitting. This prevents air from getting back into the bag and keeps it compressed, thus enabling to place the bag in between the mounting plates and greatly easing installation.*

1. Compress air spring as necessary, then aligning studs with their holes, position air spring between both the lower and upper supports. Thread the lower nuts and the small upper nut a few turns.
2. Tighten and torque the lower stud nuts, and then the upper nut as prescribed in Torque Table 2.
3. Install elbow (if applicable), then connect air line.
4. Connect the height control valve link.
5. Build up air pressure in system.

### **NOTE**

*To accelerate this operation, air reservoirs can be filled from an exterior air supply connected to the accessory tank fill valve or to the emergency fill valve.*

6. Check operation of bellows and with the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa), coat the air line connections and air spring mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.
7. Remove the hydraulic floor jack from underneath shock absorber bracket.

### 3.16 SHOCK ABSORBERS

The two front shock absorbers are double-acting and telescopic type. Shock absorbers ensure a smooth ride and enhance vehicle stability on the road. Front shock absorbers have eye-type mountings on the upper side and bayonet type on lower side. Shock absorbers are non-adjustable and non-repairable.

**CAUTION**

When a shock absorber is found defective, always replace with a new set on affected axle, except if there has been a recent replacement of one unit. The following method will help in determining if both shock absorbers on the same axle have to be replaced.

## 3.16.1 Shock Absorber Removal

1. Remove the nut, washer and rubber joint from shock absorber mounting stud. Discard the rubber joints.
2. Remove the nut and washer from shock absorber mounting pin (upper side), taking care to identify the inner and outer washers to ease reinstallation. Refer to figure 33 for details.
3. Remove the shock absorber from the vehicle.
4. Remove inner: washers, rubber joint and bushings from the shock absorber. Discard bushings and rubber joint.

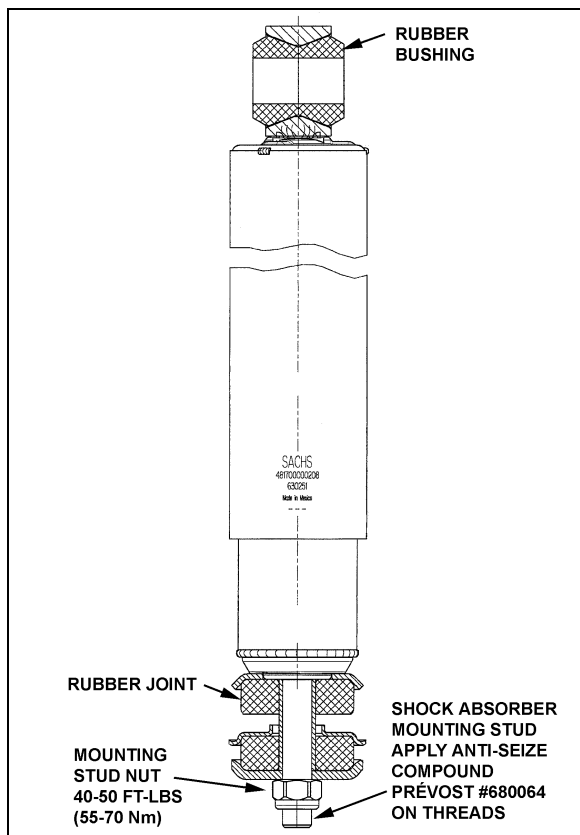


FIGURE 33: SHOCK ABSORBER

16112

## 3.16.2 Shock Absorber Installation

1. Check that the shock absorber mounting pin torque is proper (350-400 lbf-ft (475-545 Nm)). Ensure that the stud is clean and not stripped (upper side).
2. Install new rubber (mounting) bushing on shock absorber (upper side).
3. Place the inner washer on shock absorber pin (Figure 33).
4. Install washer and rubber joint on shock absorber mounting stud (lower side).
5. Install the shock absorber as shown in figure 33 with the mounting stud protruding through the hole in the mounting bracket and the shock absorber eyes over the mounting pins. Install the outer washer.
6. Place a rubber joint and washer on the shock absorber mounting stud. Place the lower shock absorber mounting stud nut and torque to 40-50 lbf-ft (55-70 Nm).
7. Place the upper mounting pin stud nut and torque to 70-85 lbf-ft (95-115 Nm).

## 3.17 SWAY BAR

A sway bar is provided on the front and rear suspensions to increase vehicle stability. It controls lateral motion (swaying movement) of vehicle.

## 3.17.1 Removal

1. Disconnect the two links from sway bar.
2. Safely support the sway bar. Unbolt bushing collars from subframe.
3. Remove sway bar.

**NOTE**

*Sway bar bushings are slit to ease their removal.*

## Section 16 : SUSPENSION

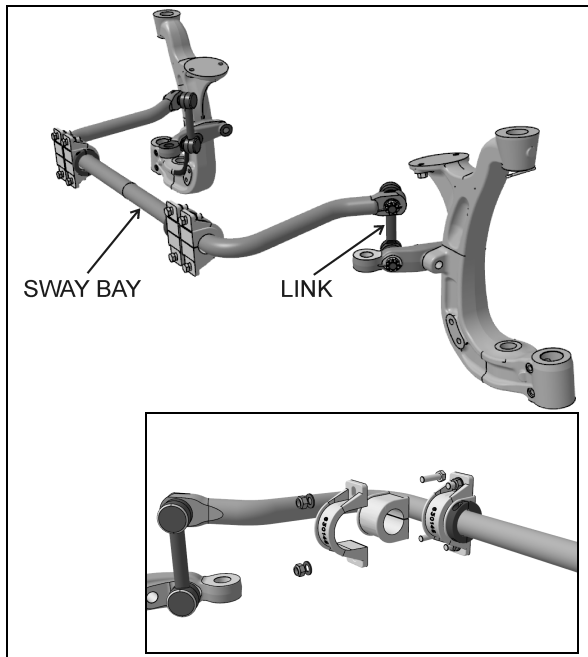


FIGURE 34: SWAY BAR (INDEPENDENT FRONT SUSPENSION)<sup>16138\_C</sup>

### 3.17.2 Installation

1. Loosely install the sway bar.
2. Torque bushing collar nuts as prescribed per Torque Table 2.
3. Torque sway bar link upper nuts as prescribed per Torque Table 2.
4. Torque sway bar link lower nuts as prescribed per Torque Table 2.

### 3.18 INDEPENDENT FRONT SUSPENSION HEIGHT ADJUSTMENT

VIP coach shells are equipped with "LEVEL-LOW" leveling system. The purpose of the "LEVEL-LOW" is to adjust suspension in three separate points; front, rear right and rear left air springs in order to level vehicle body. Three height control valves, automatically control air pressure in the three separate points (air springs) and maintains a constant vehicle height regardless of load, or load distribution. The control solenoid valve supplies air to the five way three-position air control valve, which bypasses the height control valve, and opens a passage to allow the air control and exhaust valve to release/supply air from air springs. To improve road comfort, an expansion air tank is installed in series with each air spring.

The flow of pressurized air from the accessory air tank to the air springs is controlled by three height control valves. The two rear valves are mounted to the subframe and connected to the rear axles through an arm and link connection. The front valve is mounted to the subframe and connected to the front air tank support (Figure 35). These connections allow the valves to apportion air pressure in the springs to the vehicle load, maintaining normal ride height.

Immediate response height control valves increase or decrease the air pressure in the suspension system as required. One height control valve is located **at center of front sway bar**, and regulates air to front suspension air springs in order to maintain the vehicle at the required height. Two are located at the drive axle, one on each inner side of rear wheelhousing.

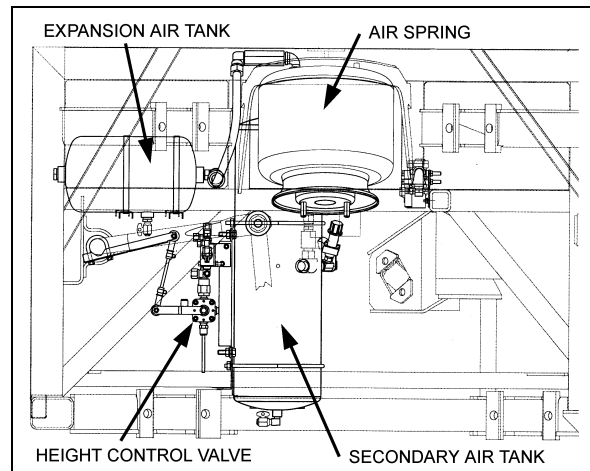


FIGURE 35: HEIGHT CONTROL VALVE LOCATION <sup>16057</sup>

The appropriate vehicle body height is obtained by measuring the clearance of all the air springs installed on the vehicle. The two front air springs clearance should be  $12 \frac{15}{16} \pm \frac{1}{4}$  in ( $328 \pm 6$  mm). Refer to figure 36 to identify the correct area to take measurement. The rear air springs clearance should be  $11 \frac{1}{2} \pm \frac{1}{4}$ " ( $292 \pm 6$  mm) (refer to paragraph "6.0 Suspension Height Adjustment" for rear height control valves' adjustment). At this point, it should not be necessary to make an adjustment under normal service conditions. However, if an adjustment is required, change the position of the overtravel lever in relation to the overtravel control body. The lever should be moved up to raise vehicle height, and down to lower it. Check that main air pressure is at normal operating pressure and raise the vehicle to the specified height.



**CAUTION**

Always adjust on "fill cycle". If it is necessary to lower vehicle height, release sufficient air to be well below height, and adjust to height or fill cycle.

- Loosen the clamp on the height control valve rubber coupling and bring it up or down (Figure 37).

**NOTE**

Allow suspension to stabilize before taking reading.

When the desired height is obtained, tighten clamp.

**Rear air springs clearance**

Refer to «Suspension Height Adjustment».

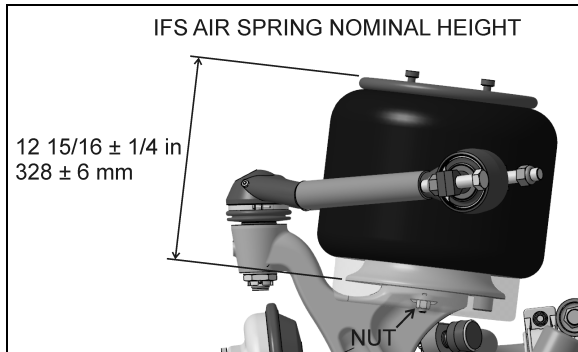


FIGURE 36: TYPICAL AIR SPRING CLEARANCE 16058

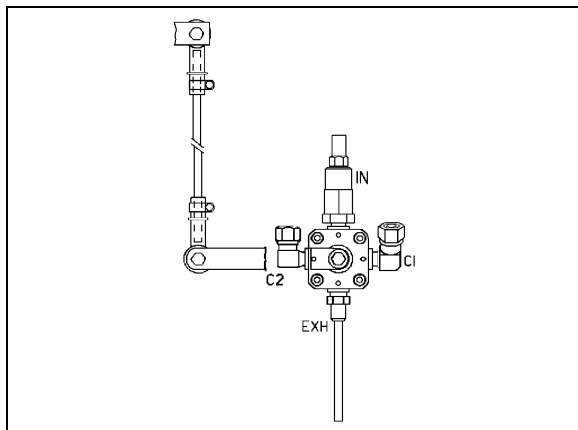


FIGURE 37: FRONT HEIGHT CONTROL VALVE 16100

The normal ride height is obtained by adjusting air spring clearance of both front and rear suspension as follows:

**Front air spring clearance**

- With the vehicle at normal operating air pressure (100 - 125 psi (689 - 860 kPa)), measure air spring clearance. This clearance should be 12 15/16 ± 1/4 in (328 ± 6 mm).

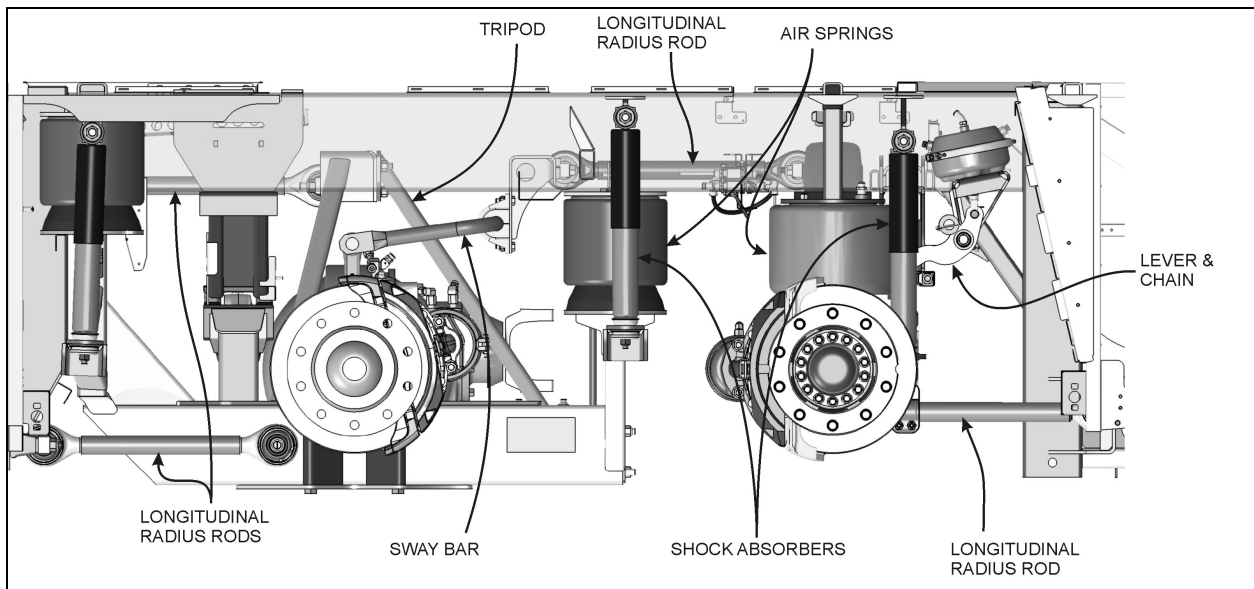
**NOTE**

The measurement should be taken from underneath the upper air spring support on subframe to top of air spring mounting surface on the upright. If adjustment is required, begin with the drive axle.

**Section 16 : SUSPENSION**

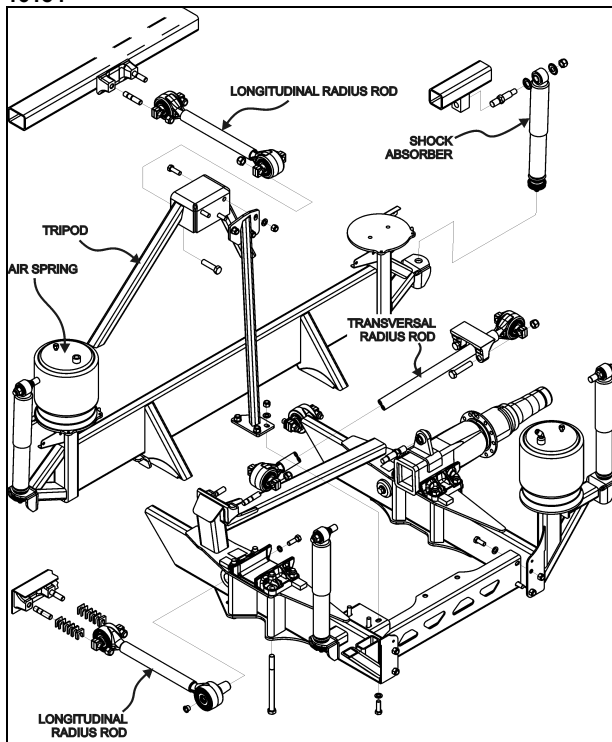
**4. REAR SUSPENSION**

For a description of all these systems, refer to the appropriate heading in this section.

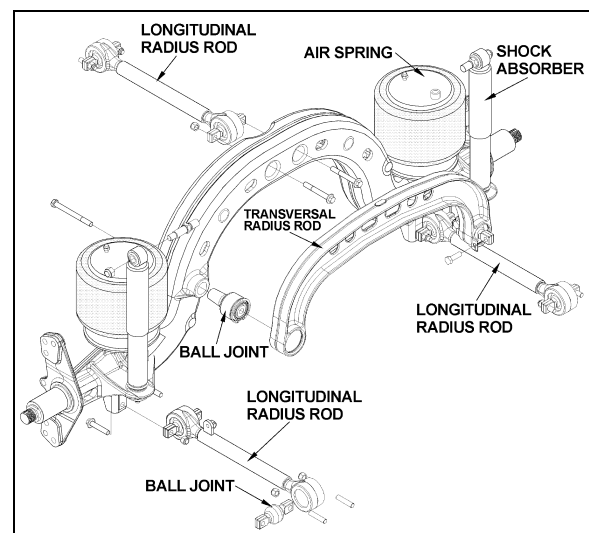


**FIGURE 38: REAR SUSPENSION COMPONENTS**

16184



**FIGURE 39: REAR UNDERFRAME SUSPENSION** 16106A



**FIGURE 40: TAG AXLE SUSPENSION** 16107

4.1 AIR SPRINGS

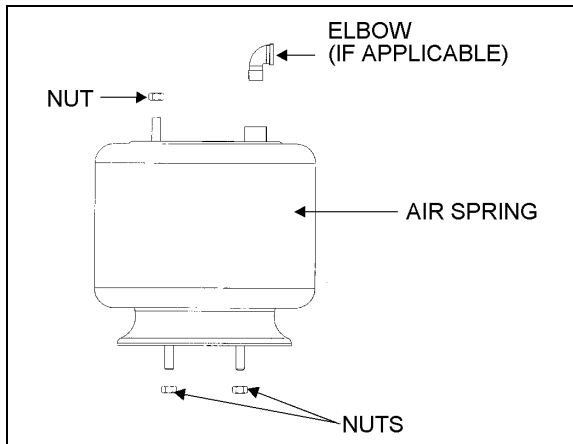


FIGURE 41: AIR SPRING 16052

The air springs are made from a special compound rubber molded to the proper contour and dimensions. The entire vertical load of the vehicle is supported by these springs. Each of the two axles is provided with air springs that are attached to the subframe and to the axles (Figure 41).

4.1.1 Inspection

1. Check operation of bellows.
2. Visually inspect bellows for evidence of cracks, punctures, deterioration, or chafing. Replace the bellows if any damage is evident.
3. With the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa)), coat all suspension air line connections and bellows mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.

**NOTE**

*If air spring is removed from vehicle, bellows can be lightly inflated and submerged in water to detect any leakage. If any leakage is detected, replace bellows.*

**WARNING**

To prevent personal injury, do not apply more than 10 psi (69 kPa) of air pressure to the uninstalled air spring.

4.1.2 Removal

**NOTE**

*Suspension air springs (drive and tag axles) can be removed without removing the entire axle assembly.*

1. Safely support vehicle at the recommended body jacking points. To gain access to a given air spring, the corresponding wheel can be removed as follows.
  - a) Jack vehicle until the tire clears the ground, and place safety supports underneath body.

**CAUTION**

Only the recommended jacking points must be used as outlined in Section 18, "Body".

- b) Support the axle with a suitable hydraulic floor jack at the recommended jacking point.
- c) Remove wheel.
2. Exhaust compressed air from accessory air tank by opening drain cock under reservoir.
3. Disconnect the height control valve link and pull down the overtravel lever to ensure all air is exhausted from air springs.

**NOTE**

*While performing this step, do not change the height control valve overtravel lever adjustment.*

4. Disconnect air line from air spring, remove elbow (if applicable), and cover both the line end and fitting to prevent the entry of foreign matter.
5. Remove the air spring upper nut, and then the two lower nuts. Remove air spring.

4.1.3 Installation

1. Compress air spring as necessary, then aligning studs with their holes, position air spring between both the lower and upper supports. Thread the lower nuts and the small upper nut a few turns.

2.

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### NOTE

To facilitate air spring installation, compress it manually then put a piece of tape over the air line threaded fitting. This prevents air from getting back into the bag and keeps it compressed, thus enabling to place the bag in between the mounting plates and greatly easing installation.

2. Tighten and torque the lower stud nuts, and then the upper one to 20 – 25 lbf-ft (27 – 34 Nm).
3. Thread the remaining upper nut (large nut) and tighten to 20 – 25 lbf-ft (27 – 34 Nm).
4. Install elbow (if applicable), then connect air line.
5. Connect the height control valve link.
6. Build up air pressure in system.

### NOTE

To accelerate this operation, air reservoirs can be filled from an exterior air supply connected to the accessory tank fill valve or to the emergency fill valve.

7. Check operation of bellows and with the primary air system at normal operating pressure (95 – 125 psi (655 – 860 kPa)), coat the air line connections and air spring mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.
8. Reinstall wheel.
9. Remove the hydraulic floor jack from under the axle, then lower vehicle to ground.

## 4.2 SHOCK ABSORBERS

Double-action, telescoping-type shock absorbers ensure a smooth ride and enhance vehicle stability on the road. All shock absorbers are eye-type mountings. The tag axle is provided with two shock absorbers while the drive axle is provided with four of them (Figure 42 & Figure 43).

Shock absorbers are non-adjustable and non-repairable. Maintenance requirements involve replacement of the rubber mounting bushings, and tightening of all shock absorber pins at the proper torque (refer to Table 3) when shock absorber replacement occurs. If a shock

absorber becomes inoperative, complete unit must be replaced.



### CAUTION

When a shock absorber is found defective, always replace with a new set on affected axle, except if there has been a recent replacement of one unit. The following method will help in determining if both shock absorbers on the same axle have to be replaced.

#### 4.2.1 Inspection

Loosen lower mounting of both shocks, and then carefully attempt to raise and lower the bottom portion of each shock. Note the rate of effort for distance of travel. Replace both shocks if a definite differential rate is found.

The shock must be bench checked in an upright, vertical position. If checked in any other position, air will enter the cylinder tube and make the shock absorber appear defective.

Proceed as follows to check shock absorbers:

1. With the shock absorber in a vertical position (top end up), clamp the bottom mount in a vise.



### CAUTION

Do not clamp the reservoir tube or the dust tube.

2. Rotate the dust tube. Notice any binding condition (may be compared with new unit). Binding condition indicates a scored rod. Units with scored rods should be replaced.
3. Fully extend shocks and check for leaks in the seal cover area. Shock fluid is a very thin hydraulic fluid that has a characteristic odor and dark brown tint. A slight trace of shock fluid around the seal cover area is not a cause for replacement. The shock seal is designed to permit a very slight seepage to lubricate the rod. Units that leak should be replaced.
4. Visually check shock for dents that could cause the shock to bind. Also, check for a bent rod.
5. Extend and collapse shock several times to determine that it has control (resistance) in both rebound and compression.



6. Visually inspect the shock mountings and vehicle mounting for:
  - a) Broken mounts;
  - b) Extreme bushing wear;
  - c) Shifted bushing or sleeve;
  - d) Deep cracks in bushing material (shallow surface cracks are normal);
  - e) Loose shock absorber pins;
  - f) Presence of convex washers, and their position relative to the rubber bushing.

#### 4.2.2 Removal

4. Remove nuts and washers from shock absorbers on upper and lower mounting pins, taking care to identify the inner and outer washers to ease reinstallation. Refer to figure 42 for details.
5. Remove the shock absorber assembly from pins.
6. Remove the two inner bushings from the shock absorber and discard them.

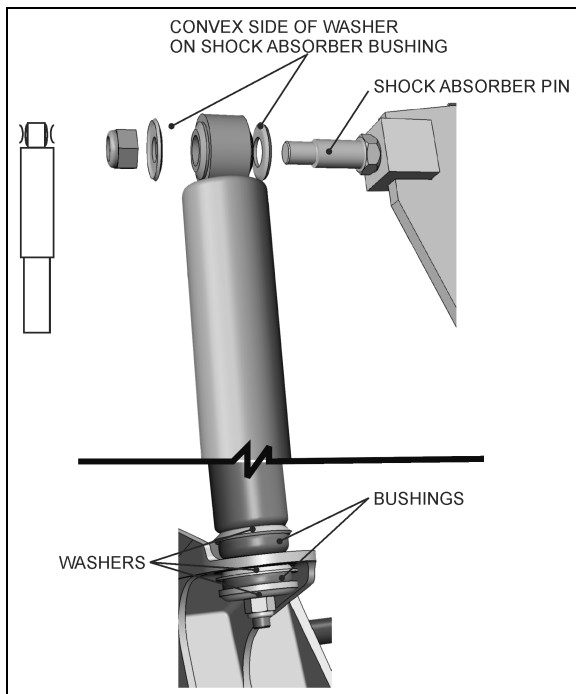


FIGURE 42: SHOCK ABSORBER 16008

#### 4.2.3 Installation

5. Ensure that the shock absorber mounting pins are tight and that the threads are not stripped.

6. Install new rubber mounting bushings on shock absorbers (upper and lower).
7. Place the inner washers (with washer convex side facing the shock absorber rubber bushing) on each shock absorber pin (Figure 43).

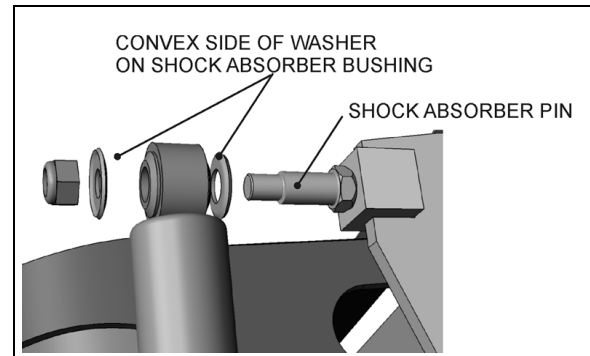


FIGURE 43: TYPICAL SHOCK ABSORBER SETUP 16009

8. Install the shock absorber eyes over the mounting pins, then the outer washers (with washer convex side facing the shock absorber rubber bushing) on each shock absorber extremity.

#### NOTE

*If shock absorber pins are removed, they must be reinstalled using "Loctite" (see "Parts Specifications" in this section).*

6. Place the lower and upper mounting pin stud nuts and torque according to paragraph 13 Torque Specifications.

#### 4.3 RADIUS RODS

Radius rods are used to secure the axles in the proper transversal and longitudinal positions. Four radius rods are provided on the drive axle suspension (three longitudinal and one transversal) and also four on the tag axle with a layout similar to the drive axle. Refer to figures 38, 39 and 40 for details. These rods transmit both braking and driving forces from the axles to the vehicle body.

#### Radius Rod Inspection

The following instructions apply to the radius rods used on the rear underframe suspension:

4. Clean all parts thoroughly.
5. Inspect radius rods for distortion and cracks. We recommend the "Magnaflux" process to detect cracks in the radius rod. Any

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damaged part should be replaced with a new one.

### NOTE

*New bushings should be used when rods are replaced.*

6. The radius rod bushings should be checked periodically for signs of shearing, deterioration, or damage. Any defective part should be replaced with a new one.

### Radius Rod Removal

1. Unscrew the nuts (or bolts) at each extremity of the radius rod (Figure 44).
2. Remove the radius rod.

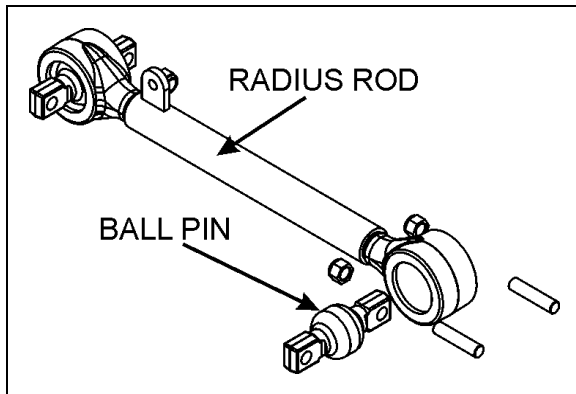
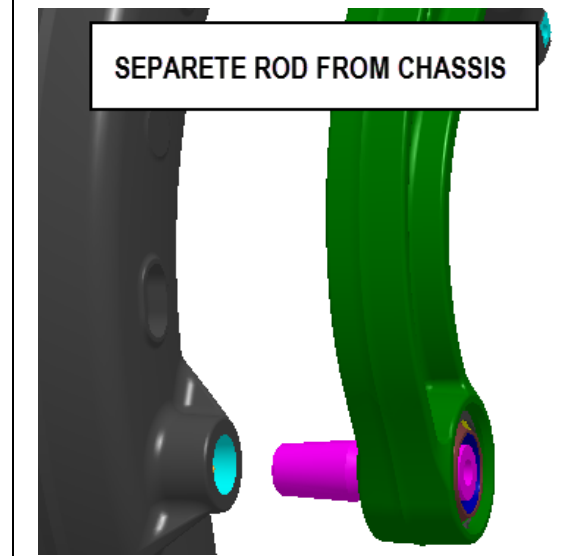
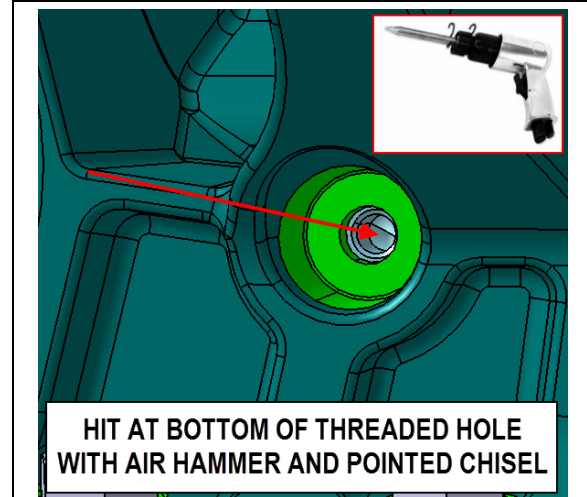
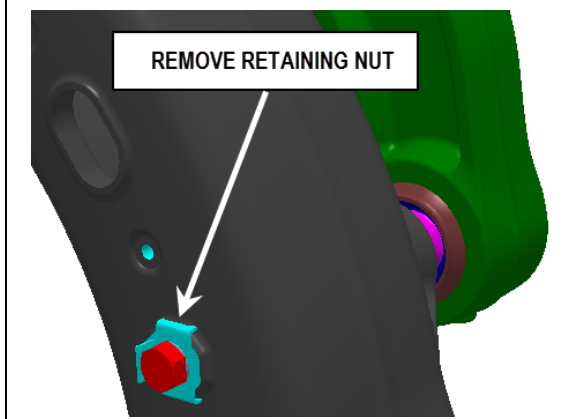


FIGURE 44: TYPICAL RADIUS ROD SETUP

16010

### NOTE

*Some rod ends are fitted with a conical (tapper) pin that will require the use of an air hammer and a pointed 13mm (1/2inch) diameter chisel to remove it from the chassis (after the retaining nut is removed from the rod end). **Care must be taken not to damage the rod pin threads.***



### CAUTION

Do not hit the cast parts of the chassis to disengage taper radius rods; this could lead to cracking and/or deformations of the cast parts.



### Radius Rod Inspection

Take off the load from the ball joint by lifting the rear of the vehicle. Apply a load on the joint in all of the degrees of freedom in an axial, radial, etc. sense with a suitable lever tool. After the load is taken off, the joint has to spring back into its starting position. Free play is not acceptable.

Separation of rubber from ball pin or external joint shell is in accordance with "normal wear characteristics".

When the following characteristics are noted, the joint is to be changed:

- Free play;
- Radial cracking of the external sheet-metal race.

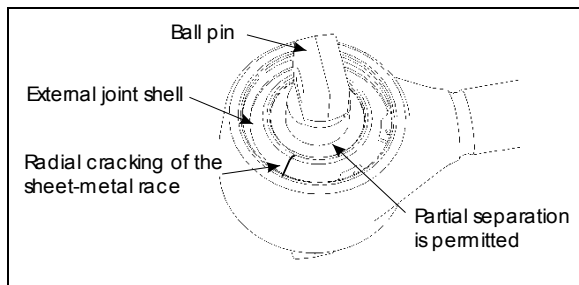


FIGURE 45: BALL JOINTS

16173

### Stripping Down

Strip down the defective joint through removal of retaining ring, annular spacer and ball pin/bushing, assembly and thereafter clean out housing bore and locking circlips groove.

### Radius Rod Assembly

The assembly work may be done only by a recognized specialized workshop. Ensure that old and new parts do not get mixed up with each other. It is for this reason that all the old parts are to be scrapped immediately after a joint has been stripped down. A complete repair set must be used for each joint repaired, i.e. use of only part of a repair set is not permissible.

Execute assembly of the new joint parts in the following sequence:

5. Complete moistening of the contact surface between housing bore and ball pin through application of the grease.

#### **NOTE**

*Apply grease, only in the case of repair kit.*

6. Insert ball pin/bushing, assembly. In case of the two-bolt type, ensure that the bolt bores are in the correct position in relation to the axis of the tube.
7. Place joint in receiving fixture and mount annular assembly tool on the housing. Then locate annular spacer and retaining ring in the housing using axial load with the aid of assembly matrix. If the ends of the annular spacer are not in contact with each other, the thus formed opening must be located at 180° to the opening of the retaining ring. Pay attention during assembly to ensure that the retaining ring eyelets are located at each side of the housing shaft axis (retaining ring eyelet lug points to tube), and that retaining ring is properly engaged in the groove of the housing.

When repairing defective ball pin assemblies, the necked down-bolt must regularly be replaced with a new one.

### Radius Rod Installation

4. Tighten the nuts (or bolts) lightly, and repeat at the other end.
5. Refer to heading "*Suspension Height Adjustment*" later in this section, and set the vehicle to normal ride height.
6. With the vehicle at normal ride height, tighten all radius rod anchor pin nuts or bolts as prescribed in Torque Table 3.



### **CAUTION**

It is extremely important upon reconnection of the rods that the proper clearance height between the axle and body be maintained. Otherwise, the rubber bushings in radius rod ends will become preloaded, thus reducing their life span.

### 5. SUSPENSION AIR SYSTEM

The suspension air system has its own air reservoir (accessory tank) which is located in the reclining bumper compartment. Pressurized air from the main tank (wet tank) flows through a pressure protection valve (PR-4), to the accessory air tank and through an air filter which is located in front service compartment.

The pressure protection valve (PR-4) is mounted to the supply port of the tank. This valve controls

## Section 16 : SUSPENSION

the pressure at which compressed air is delivered to the accessory air tank. The valve remains closed until a preset pressure is reached (approximately 70 psi (485 kPa)). It then opens and passes air out the delivery port.

The main use for this valve is to protect the main air system by ensuring at all times a sufficient air pressure in the main system (i.e. air delivered to the accessories will be shut off in case of a decrease in pressure). Maintenance and repair information on the pressure protection valve is supplied in the applicable booklet, annexed to Section 12, "Brakes and Air System" under reference number SD-03-2010.



### WARNING

Depressurize parts prior to removal.

#### 5.1 INSPECTION

The following inspection should be performed at established service inspection periods. Performing these procedures will allow substandard performance to be discovered before the condition becomes bad enough to cause operator complaints and failure on a run.

1. Visually inspect the suspension air lines for evidence of chafing on metal parts or other damage.
2. Visually inspect the air springs for cracks, abrasion or other damage.
3. Replace any parts found to be damaged.

#### 5.2 AIR LINE TEST

With the main air system at normal operating pressure, coat all suspension air line connections and air spring mountings with a solution of soap and water. Air leakage will produce soap bubbles. Any leak found must be corrected as no air leakage is permissible.

### 6. SUSPENSION HEIGHT ADJUSTMENT

The flow of pressurized air from the accessory air tank to the air springs is controlled by three height control valves. The two rear valves are mounted to the subframe and connected to the rear axles through an arm and link connection. The front valve is mounted to the subframe and connected to the front air tank support. These connections allow the valves to apportion air pressure in the springs to the vehicle load, maintaining normal ride height.

Immediate response height control valves increase or decrease the air pressure in the suspension system as required. One height control valve is located **at center of front sway bar**, and regulates air to front suspension air springs in order to maintain the vehicle at the required height. Two are located at the drive axle, one on each inner side of rear wheelhousing.

The appropriate vehicle body height is obtained by measuring the clearance of all the air springs installed on the vehicle. The two front air springs clearance should be  $11 \frac{11}{16} \pm \frac{1}{4}$ " ( $297 \pm 6$  mm). Refer to figure 24 to identify the correct area to take measurement. The rear air springs clearance should be  $11 \frac{1}{2} \pm \frac{1}{4}$ " ( $292 \pm 6$  mm). At this point, it should not be necessary to make an adjustment under normal service conditions. However, if an adjustment is required, change the position of the overtravel lever in relation to the overtravel control body. The lever should be moved up to raise vehicle height, and down to lower it. Check that main air pressure is at normal operating pressure and raise the vehicle to the specified height.

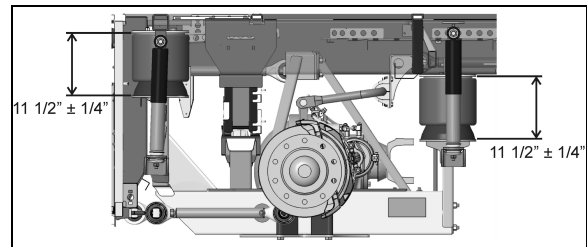


FIGURE 46: DRIVE AXLE AIR SPRING CLEARANCE 16195

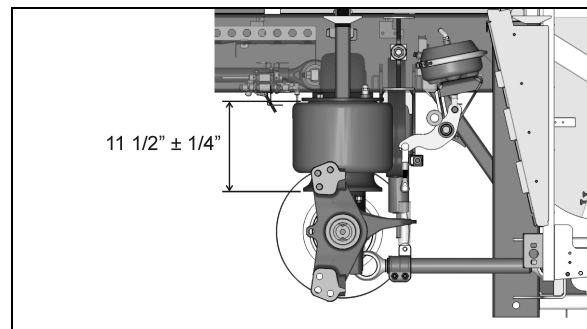


FIGURE 47: TAG AXLE AIR SPRING CLEARANCE 16195

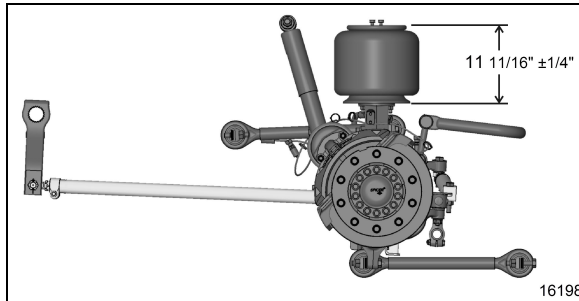


FIGURE 48: FRONT I-BEAM AXLE AIR SPRING CLEARANCE



**CAUTION**

Always adjust on "fill cycle". If it is necessary to lower vehicle height, release sufficient air to be well below height, and adjust to height or fill cycle.

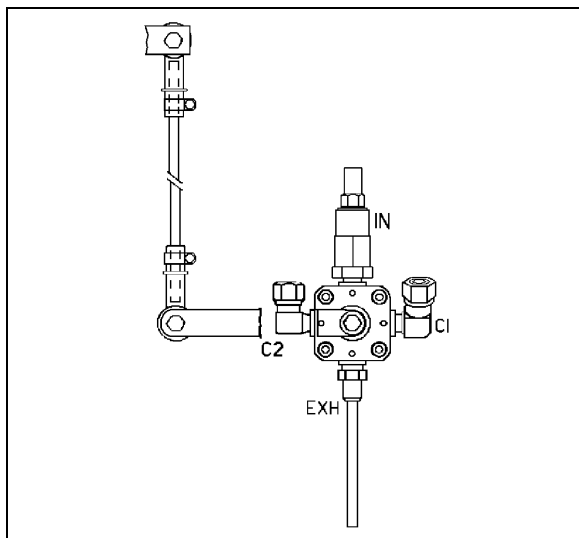


FIGURE 49: FRONT HEIGHT CONTROL VALVE

The normal ride height is obtained by adjusting air spring clearance of both front and rear suspension as follows:

**Front air spring clearance**

3. With the vehicle at normal operating air pressure [100 - 125 psi (689 - 860 kPa)], measure air spring clearance. This clearance should be  $11 \frac{11}{16} \pm \frac{1}{4}$ " (297 ± 6 mm).

**NOTE**

The measurement should be taken from underneath the upper air spring support on subframe to top of the lower air spring support on axle (refer to figure 21 for more details). If adjustment is required, begin with the drive axle.

4. Loosen the clamp on the height control valve rubber coupling and bring it up or down (Figure 49).

**NOTE**

Allow suspension to stabilize before taking reading.

When the desired height is obtained, tighten clamp.

**Rear air spring clearance**

1. With the vehicle at normal operating air pressure [100 - 125 psi (689 - 860 kPa)], measure air spring clearance. This clearance should be  $11 \frac{1}{2} \pm \frac{1}{4}$ " (292 ± 6 mm).

**NOTE**

The measurement should be taken from underneath the upper air spring support on subframe to top of the lower air spring support on axle (refer to figure 19, 20 for more details).

2. Loosen the clamp on the height control valve rubber coupling and bring it up or down (Figure 50).

**NOTE**

Allow suspension to stabilize before taking reading.

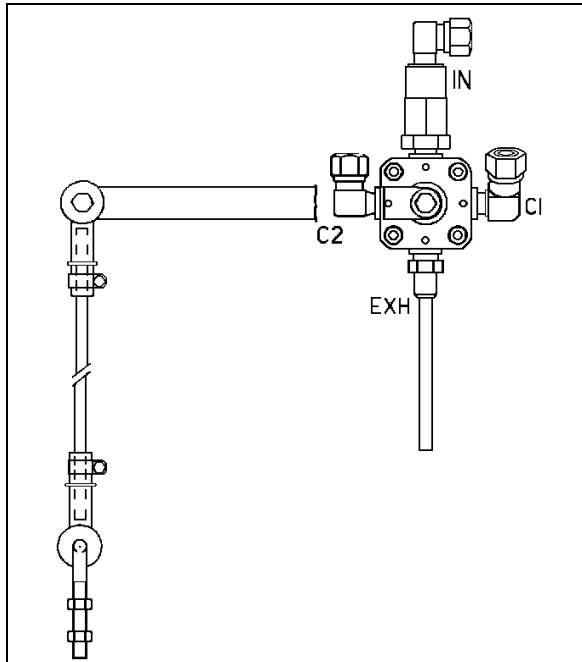


FIGURE 50: REAR HEIGHT CONTROL VALVE 16093

When the desired height is obtained, tighten clamp.

### 7. HEIGHT CONTROL VALVE

The height control valves automatically add air to, or release air from air springs to maintain constant suspension height regardless of load, or load distribution. Each valve adjusts independently according to the following conditions:

#### Loading Position

As the load increases and lowers the vehicle body, the overtravel lever commands the height control valve to add air to air springs.

#### Neutral Position

When vehicle body reaches the normal ride height, the height control valve overtravel lever reaches the "neutral" position and keeps both the supply and exhaust ports closed to ensure normal ride height is maintained. This condition remains static until the vehicle load is altered.

#### Unloading Position

As the load decreases and raises the vehicle body, the overtravel lever commands the height control valve to release air from air springs.

### 7.1 MAINTENANCE

The height control valve requires no periodic maintenance. Height control valve linkage operates on rubber bushings and no lubrication should be attempted at this location. Inspect the valve for loose joints, air leaks and worn bushings.

### 7.2 REMOVAL AND INSTALLATION

Before disconnecting a height control valve air line, securely support the vehicle by its jacking points on the body, and place safety supports underneath body. Refer to paragraph "16. Vehicle Jacking Points" in Section 18, "Body".

1. Exhaust air from air system by opening all air tank drain cocks. Remove height control valves.
2. Disconnect overtravel lever from link and pull down lever to exhaust remaining air from air springs.
3. Disconnect air supply and delivery lines from the height control valve. Cover line ends with tape to prevent entry of foreign matter.
4. Remove the nuts retaining the height control valve to the mounting bracket, then remove valve assembly.

Reverse removal procedure to replace height control valve. After installation, check for leakage using a soap and water solution.

### 8. AIR SYSTEM

The basic air system consists of an air compressor, tanks, valves, filters and interconnecting lines and hoses (refer to Section 12, "Brake and Air System" for complete information). It provides a means for braking, operating controls and accessories, and suspension. An air system schematic diagram is annexed at the end of this section for better understanding of the system.

The air coming from the air dryer is first directed to the wet air tank, then to the primary (for the primary brake system), secondary (for the secondary brake system), and accessory (for the pneumatic accessories) air tanks (Figure 51 and Figure 52).

In addition, an expansion air tank may be installed in series with each air spring.

8.1 AIR TANK MAINTENANCE

Ensure that the accessories air tank is purged during pre-starting inspection. A good practice is to purge this tank at the end of every driving day by the remote air tank drain valve located in the front service compartment (Figure 54).

Moreover, purge all tanks by their bottom drain valves at specified intervals.

8.1.1 Wet Air Tank

This tank is installed above the drive axle on the L.H. side, and is provided with a bottom drain valve. It is recommended to **purge** the wet air tank by its bottom drain valve every 12,500 miles (20 000 km), or once a year, whichever comes first.

A remote valve located in engine compartment and accessible through engine R.H. side door is used to **drain** the air dryer (Figure 53).

8.1.2 Primary Air Tank

The primary air tank is located above the drive axle on the R.H. side.

This tank is provided with a bottom drain valve. It is recommended to purge the primary air tank by its bottom drain valve every 12,500 miles (20 000 km) or once a year, whichever comes first.

8.1.3 Secondary Air Tank

This tank is located in front wheelhousing, between air springs. The tank may be installed vertically depending on type of front suspension and is provided with a bottom drain valve. It is recommended to purge the tank by its bottom drain valve, every 12,500 miles (20 000 km) or once a year, whichever comes first.

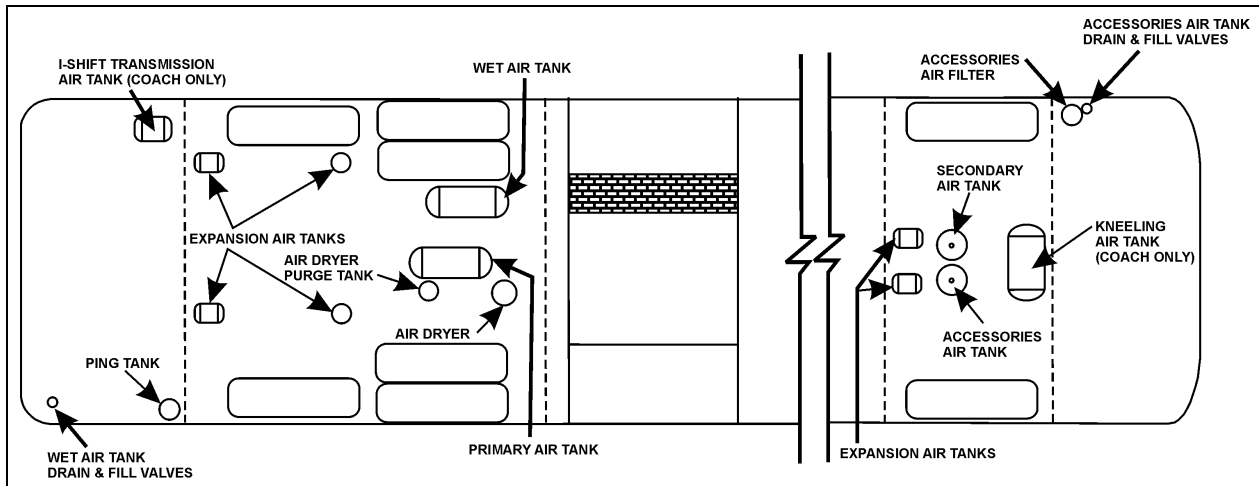


FIGURE 51: IFS AIR TANKS LOCATION

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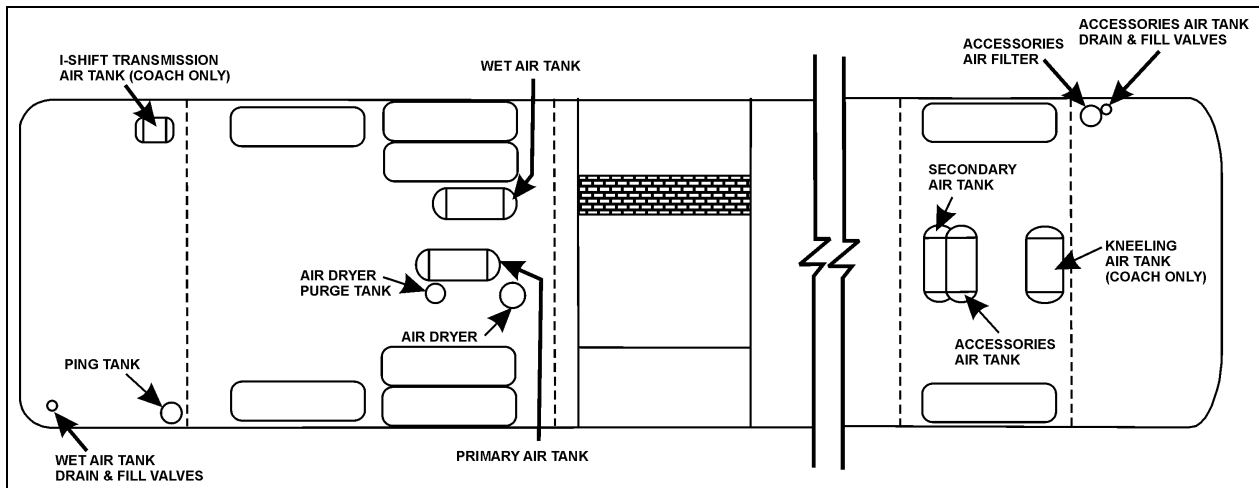


FIGURE 52: I-BEAM FRONT SUSPENSION AIR TANKS LOCATION

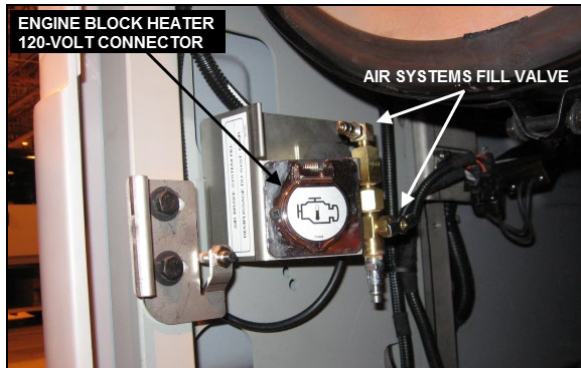


FIGURE 53: REAR VALVE LOCATION

#### 8.1.4 Accessory Air Tank

The accessory air tank is installed next to the secondary air tank. The tank may be installed vertically depending on type of front suspension and is provided with a bottom drain valve.

It is recommended to purge the tank by its bottom drain valve, every 12,500 miles (20 000 km) or once a year, whichever comes first.

A remote drain valve is located in front service compartment (Figure 54) underneath the accessory air filter. Refer to Section 12, paragraph "4. Accessory Air Filter" of the maintenance manual for daily purges procedure.

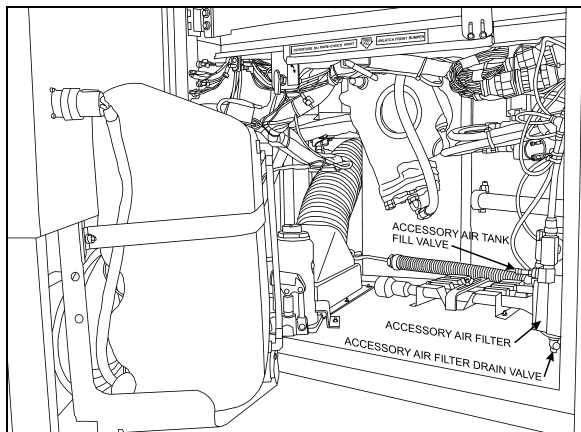


FIGURE 54: FRONT VALVE LOCATION 12210

#### 8.1.5 Expansion Air Tank

Two expansion tanks will be installed in front wheelhousing if the IFS was chosen as an option. These air tanks are located behind secondary and accessory air tank. Also, six expansion tanks are located near rear air springs. Expansion tanks are connected in series with air springs. Expansion tanks are used

to lower the stiffness of the air spring. They are provided with a bottom drain valve.

It is recommended to purge them, with all other tanks, every 12,500 miles (20 000 km) or once a year, whichever comes first.

### 8.2 EMERGENCY FILL VALVES

The vehicle is equipped with two air system emergency fill valves to supplement the air system when air pressure is low and engine cannot be operated.

The rear valve is located in engine compartment and accessible from engine R.H. side door (Figure 53).



#### CAUTION

No other point should be used to supply air system. The maximum allowable air pressure is 125 psi (860 kPa).

The front valve is located in the front service compartment close to accessory air filter (Figure 54).

These two air valves are fitted with the same valve stems as standard tires, and can be filled by any standard external air supply line.

The rear valve will supply air for all systems (brakes, suspension and accessories) while the front valve will supply air for accessories only.



#### CAUTION

Air filled through these two points will pass through the standard air filtering system provided by Prevost. Do not fill air through any other points.

### 9. HUB UNIT AND STEERING KNUCKLE ASSEMBLY

Refer to "DANA SPICER Service Manual General Information, Maintenance Manual Model NDS and Maintenance Manual NDS Axles" annexed to Section 10 of the maintenance manual.

### 10. "LEVEL LOW" LEVELING SYSTEM

X3-45 VIP & XLII Bus shells are equipped with a "LEVEL-LOW" leveling system. The purpose of the "LEVEL-LOW" is to adjust the suspension in three separate points (front, rear right and rear



left air springs) in order to level the vehicle body. Three height control valves, automatically control air pressure in the three separate points (air springs) and maintain a constant vehicle height regardless of load, or load distribution. The control solenoid valve supplies air to the five way three-position air control valve, which bypasses the height control valve, and opens a passage to allow the air control and exhaust valve to release/supply air from air springs. To improve road comfort, an expansion air tank is installed in series with each air spring.

In addition to the above suspension components the system also includes: sway bar, upper and lower A-arms, rods and shock absorbers.

**NOTE**

Only for preliminary adjustment, refer to figure 44. Torque rod length must be fixed to 21 17/64" (540 mm) and relay rod to 23 19/64" (592 mm).

**CAUTION**

Parts must be replaced by ones with the same part numbers or with equivalent parts, if replacement becomes necessary. Do not use parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

The purpose of the "level-low" leveling system is to adjust the suspension in three separate points (front, rear right and rear left) in order to level the vehicle body. This system can be put into service when the ignition key is turned to the "ON" position, and must be used only when the parking brake is applied. The "level-low" warning light on the dashboard indicates that the selector switch is not in the "OFF" position. Level low system controls are located on L.H. side control panel.

**10.1 PRINCIPLES OF OPERATION****DOWN:**

The (front/rear right/rear left) control solenoid valve supplies air to the (front/rear right/rear left) five-way three-position air control valve, which bypasses the (front/rear right/rear left) height control valve, and opens a passage to allow the air control and exhaust valve to release air from (front/rear right/rear left) air springs.

**UP:**

The (front/rear right/rear left) control solenoid valve supplies air to the (front/rear right/rear left) five-way three-position air control valve, which bypasses the (front/rear right/rear left) height control valve, and opens a passage to allow the air control and exhaust valve to supply air to (front/rear right/rear left) air springs.

**DRIVE:**

When the ignition key is turned to the "ON" position with selector knob in the "DRIVE" position, the drive control solenoid valve supplies air to all five-way three-position air control valves, each one opening a passage to allow height control valves to accomplish their function.

When the ignition key is turned to the "OFF" position and selector knob to the "DRIVE" position, the air is entrapped between air springs and five-way three-position air control valves to ensure the adjusted level will be kept.

**WARNING**

Never move vehicle with selector knob in any other position than the "DRIVE" position.

**10.2 MAINTENANCE**

Since the kneeling action is issued from both the air system and electrical system, refer to Section: 12, "Brake and Air System" and Section 06, "Electrical System".

For diagnosis and understanding of the system, refer to wiring diagrams, and to the appropriate air system schematic diagram annexed to Section 12, "Brake and Air System".

**11. FRONT KNEELING SYSTEM (X3-45 COACHES ONLY)**

The kneeling system is used to lower the front of vehicle. This allows passengers to board the vehicle with greater ease. The kneeling action is achieved by exhausting air from the front air springs (bellows). This system bypasses the height control valve to provide a fast up and down movement of the front suspension. Only seven seconds are required to lower vehicle from normal level to the lowered position, and approximately the same time to raise the vehicle back to normal level. The quick response is

## Section 16 : SUSPENSION

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achieved by an auxiliary air tank installed beside the secondary air reservoir (for exact position, refer to Section 12, *"Brake and Air System"*). This tank provides sufficient air supply to the kneeling system for some successive operations.

The system is provided with two safety features; first, a speed switch will enable the kneeling system to work only at less than 5 mph (8 km/h). Secondly, the parking brake is automatically applied, and a limit switch will keep it applied as long as the vehicle has not returned to a certain height where the driver will be able to manually remove the parking brake.

The purpose of the hi-buoy function in this system is to raise the front end of the vehicle to allow an extra ground clearance for particular situations. In driving condition, the height control valve is in operation and only the hi-buoy can be operated.

### 11.1 PRINCIPLE OF OPERATION

Refer to the air system schematic diagram annexed at the end of Section 12, *"Brake and Air System"*.

#### DOWN (FRONT KNEELING):

Both the bellows control and bellows exhaust solenoid valves are energized, so the air control valves release air from front air springs. The height control valve is bypassed to ensure no air is forwarded to air springs while lowering the front suspension.

#### UP (FRONT HIGH-BUOY):

Only the bellows control solenoid valve is energized, so the air coming from the kneeling air tank is routed through air control valves, and up to front air springs.

The height control valve is bypassed until the kneeling proximity switch signals the kneeling module to cut off the bellows control solenoid valve, about 1" (25 mm) below normal ride height. The final height adjustment is achieved by the height control valve.

### 11.2 MAINTENANCE

Since the kneeling action is issued from both the air system and electrical system, refer to Section: 12, *"Brake and Air System"* and Section 06, *"Electrical System"*.

For diagnosis and understanding of the system, refer to wiring diagrams, and to the appropriate air system schematic diagram annexed to Section 12, *"Brake and Air System"*.

### 11.3 BELLOWS CONTROL SOLENOID VALVES

#### 11.3.1 Removal and installation

1. On the rear side of steering compartment, locate both the bellows control and bellows exhaust solenoid valves.
2. Identify hoses and wires to ease reinstallation. Disconnect solenoid wires and the three flexible black hoses from solenoid valves.
3. Unscrew and remove the control solenoid valve and exhaust solenoid valve assembly. Place on a clean working place.

Reverse removal procedure to reinstall.



### CAUTION

Any cable tie that has been cut during removal procedure should be replaced with a new one.

## 12. HIGH-BUOY SYSTEM (X3-45 COACHES ONLY)

The purpose of the rear high-buoy system is to raise the entire vehicle body about 4" (100 mm) in order to increase ground clearance to board a ferryboat, to jump a curb, etc. This system can be put into service during normal vehicle operation.

### 12.1 PRINCIPLES OF OPERATION

The rear high-buoy system is added over the front kneeling (with front high-buoy). The front end uses the same valves as the front kneeling (with front high-buoy). A solenoid valve is added to send air to the double shuttle valves for the rear end. It uses the same dash switch as the kneeling (with front high-buoy).

UP:

The air coming from the control valve flows through double shuttle valves, to supply air springs. The double shuttle valves prevent height control valves from releasing air from air springs.

**DOWN:**

The control valve, on the dashboard, cuts off air supply, so the double shuttle valves allow height control valves to accomplish their function. Height control valves release air from air springs until suspension returns to its normal position.

**12.2 MAINTENANCE**

Refer to the air system schematic diagram "Opt. Front Kneeling with Rear High-Buoy Combination" annexed at the end of this Section.

**12.3 HIGH-BUOY – PRESSURE REGULATING VALVE**

The regulating valve is located in the front service compartment. This valve should be adjusted to 90 psi (621 kPa).

**12.3.1 Adjustment**

1. Before turning on system air pressure, release jam nut (2, Figure 55) then turn regulator adjustment counterclockwise until load is removed from the regulating spring.
2. Turn on system pressure.
3. Turn regulator adjustment clockwise until the desired outlet pressure is reached.
4. To avoid minor readjustment after making a change in pressure setting, always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce the pressure at a lower pressure, and then increase it to the desired level of pressure.
5. Tighten jam nut (2, Figure 55) to lock pressure setting.

**12.3.2 Disassembly**

1. Shut off inlet pressure and reduce pressure in inlet and outlet lines to zero. Turn regulator adjustment (1, Figure 55) counterclockwise until all load is removed from regulating spring. Regulator can be disassembled without removal from air line.
2. Disassemble regulator in accordance with the item numbers on the exploded view.

**12.3.3 Cleaning**

1. Clean parts with warm water and soap. Dry parts and blow out internal passages in body using clean, dry compressed air.
2. Inspect parts. Replace those found to be damaged.

**12.3.4 Reassembly**

1. Lubricate O-ring (14 and 16, Figure 55), valve stem (13, Figure 55), tip of adjusting screw (1, Figure 55), and the outer circumference and both sides of the thrust washer (9, Figure 55) with a light coat of good quality O-ring grease.
2. Assemble the regulator as shown on the exploded view.

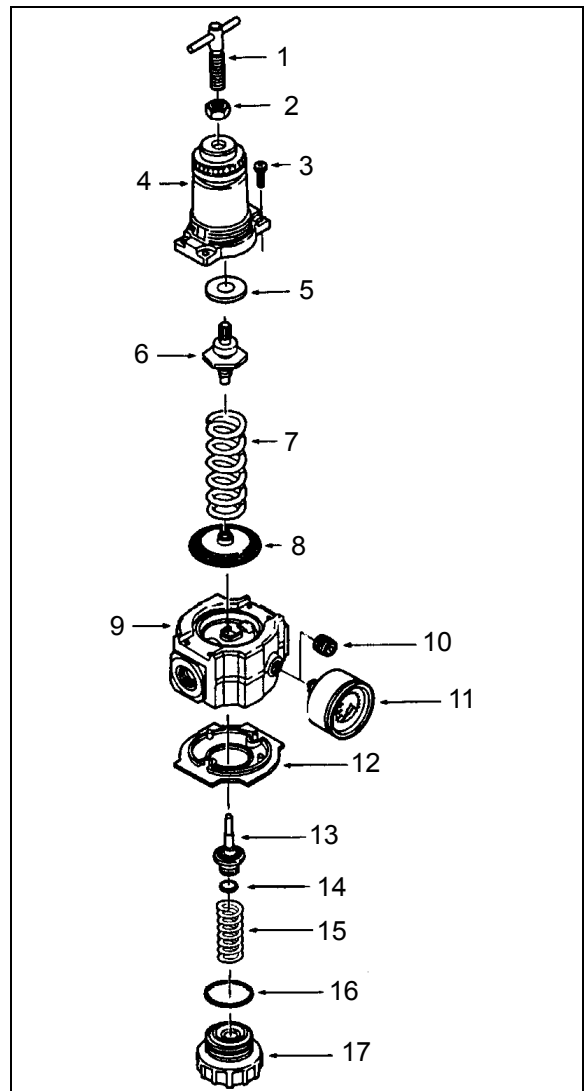


FIGURE 55: REGULATING VALVE

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## Section 16 : SUSPENSION

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Torque Table	
Item	Torque in lbf-inch (Nm)
3 (Screw)	25-35 (2.8-3.9)
17 (Bottom plug)	20-25 (2.3-2.8)

### 13. LOW-BUOY SYSTEM (X3-45 COACHES ONLY)

The purpose of the low-buoy system is to lower the whole suspension by about 4" (100 mm) in order to reduce the overall height for low clearances. This system can be put into service during normal vehicle operation.

#### 13.1 PRINCIPLES OF OPERATION

On X3 coaches, the rear low-buoy is added over the front kneeling system. The control valve on the left console panel sends an electric signal from its pressure switch to control the front suspension as if kneeling. It also removes air from a relay valve that exhausts air supply to all leveling valves and the quick release in the rear section. Air from the rear suspension can then be depleted through the check valve-quick release assembly.

#### **Down:**

The control valve, on the L.H. control panel, cuts off air supply, so air is released from air springs. A relay valve prevents height control valves from supplying air springs.

#### **Up:**

The control valve, on the L.H. control panel, supplies air to close the passage between both the delivery and supply ports. A relay valve opens and provides air springs until the suspension reaches the normal ride height.

#### 13.2 MAINTENANCE

Refer to the air system schematic diagram "Opt. Front Kneeling with Rear Low-Buoy Combination" annexed at the end of this Section.

14. TROUBLESHOOTING

Condition	Cause	Correction
Bellows deflate over time	<ol style="list-style-type: none"> <li>1. Defective check valve assembly.</li> <li>2. Defective exhaust valve assembly.</li> <li>3. Leak in air line and/or bellows.</li> <li>4. Defective valve cover, rubber O-rings or gasket.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace check valve assembly.</li> <li>2. Replace exhaust valve assembly.</li> <li>3. Replace air line or bellows.</li> <li>4. Replace valve cover, O-rings or gasket.</li> </ol>
Bellows raise to full height and fail to exhaust air pressure	<ol style="list-style-type: none"> <li>1. A clogged exhaust screen in height control valve assembly.</li> <li>2. A combination clogged exhaust screen and defective air inlet valve assembly.</li> </ol>	<ol style="list-style-type: none"> <li>1. Remove and clean screen.</li> <li>2. Clean exhaust screen and replace air inlet valve assembly.</li> </ol>
Erratic valve action	<ol style="list-style-type: none"> <li>1. Dirt or foreign matter in the air valve lever chamber.</li> <li>2. Defectives valves.</li> </ol>	<ol style="list-style-type: none"> <li>1. Remove valve cover and blow out dirt. Install cover using new gasket.</li> <li>2. Overhaul height control valve assembly</li> </ol>
Vehicle body fails to level to satisfactory ride height	<ol style="list-style-type: none"> <li>1. Improper height control valve overtravel lever adjustment</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust lever as directed.</li> </ol>

15. REAR SUSPENSION TORQUE SPECIFICATIONS (REFER TO TABLE 3)

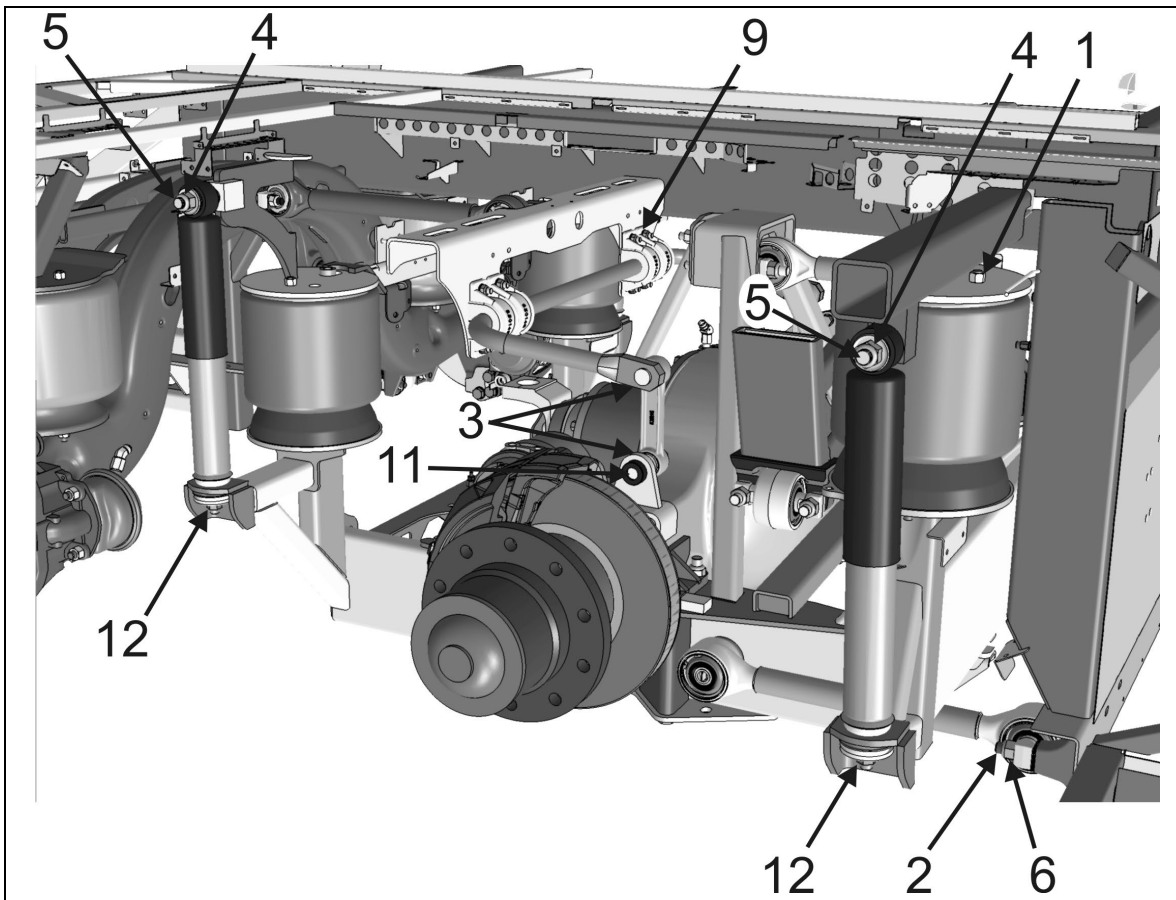


FIGURE 56: TORQUE SPECIFICATIONS – DRIVE AXLE

16158\_A

Section 16 : SUSPENSION

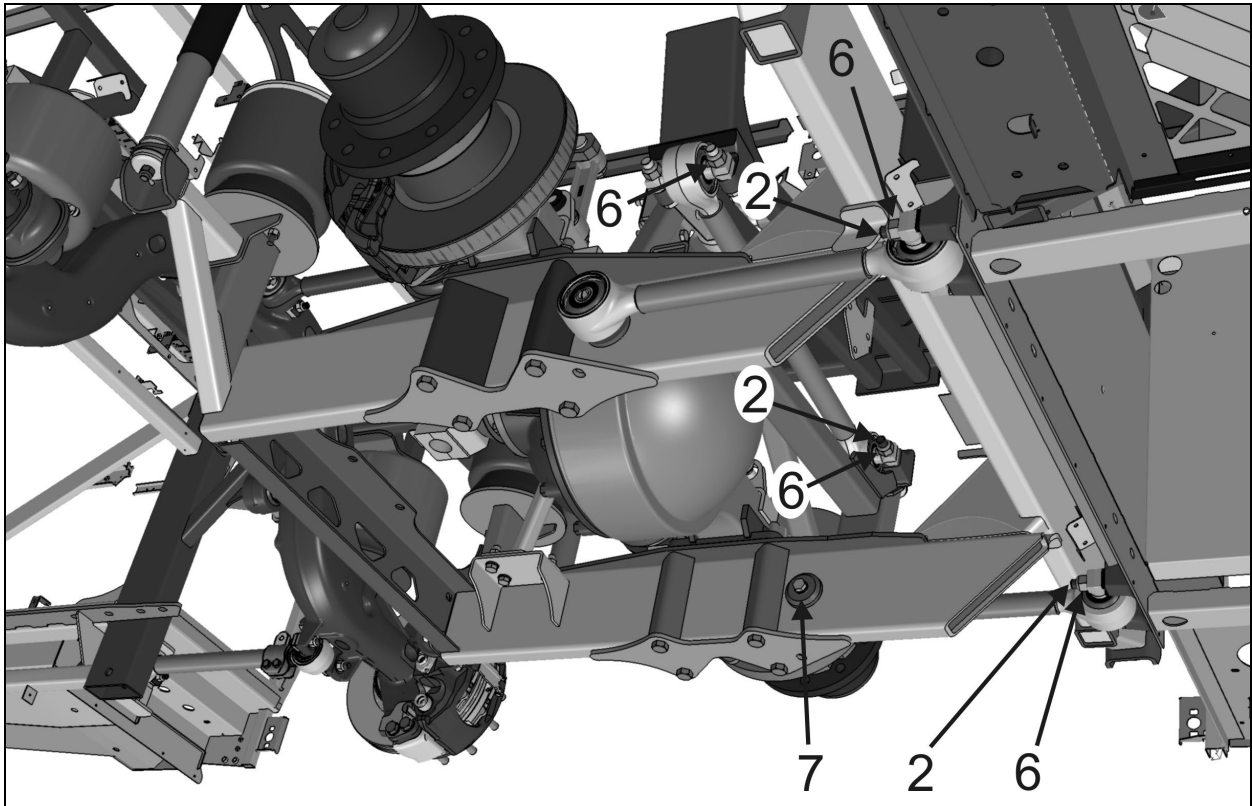


FIGURE 57: TORQUE SPECIFICATIONS – DRIVE AXLE

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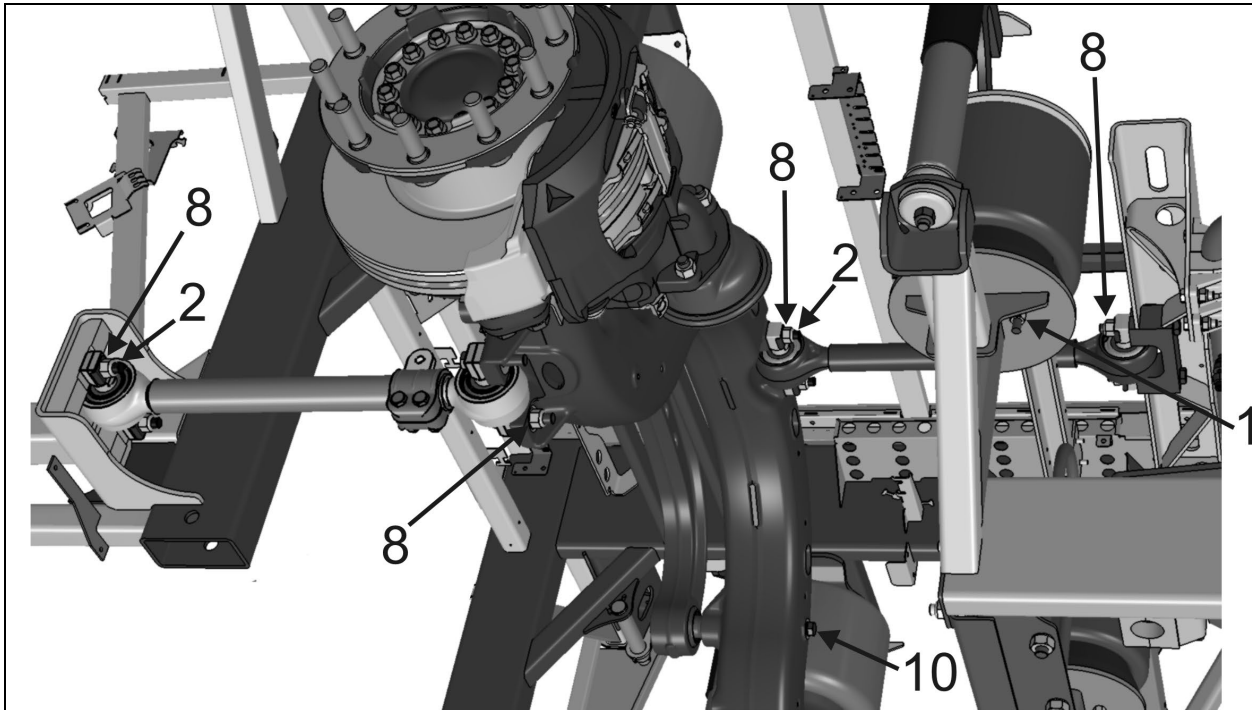


FIGURE 58: TORQUE SPECIFICATIONS – TAG AXLE

16160

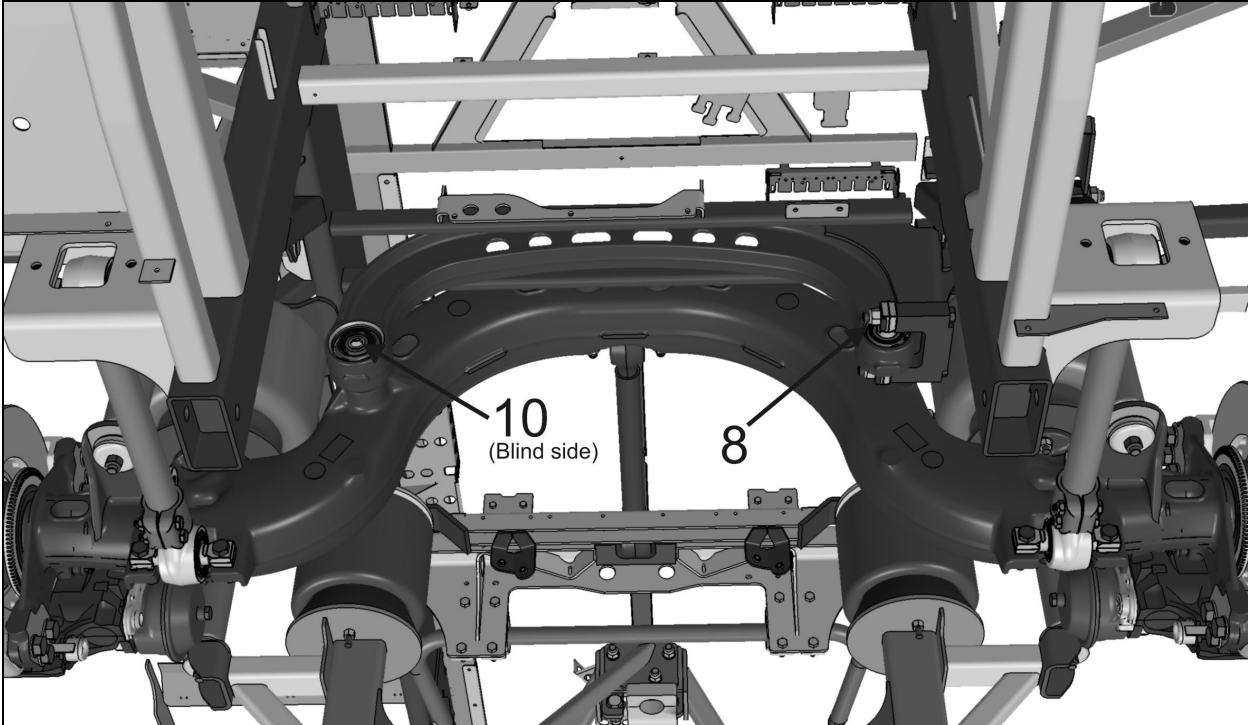


FIGURE 59: TORQUE SPECIFICATIONS – TAG AXLE

16161

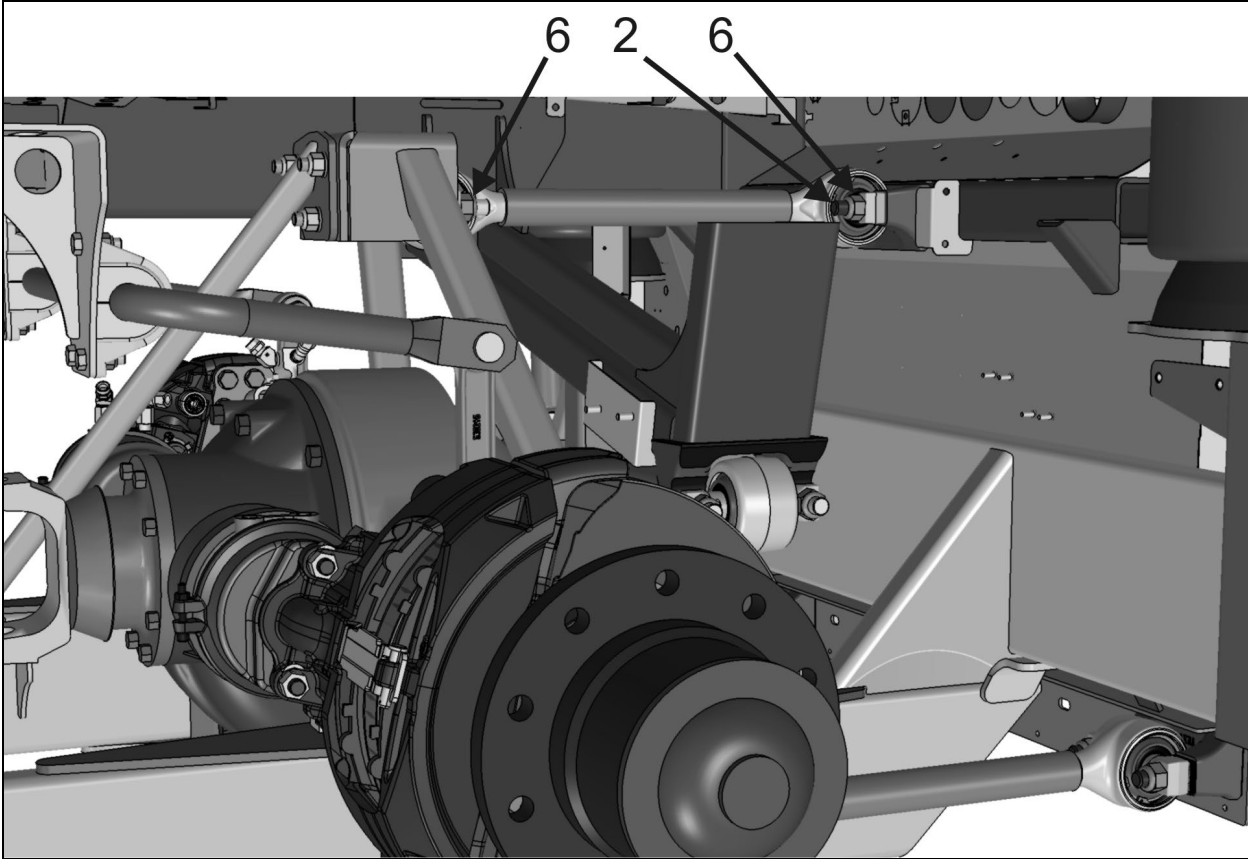


FIGURE 60: TORQUE SPECIFICATIONS – DRIVE AXLE, TOP

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The following table lists the tightening torques of bolts and nuts requiring a specific torque value. When no torque specifications are indicated, use the Standard Torque Specifications table found in Section 00: General Information of the Maintenance Manual.

<b>SPECIFIC TORQUE TABLE 3 – REAR SUSPENSION</b>			
<b>REFERENCE</b>	<b>DESCRIPTION</b>	<b>TORQUE DRY (lbf-ft / Nm)</b>	
1	Air Spring Upper & Lower Stud Nut (6 air springs)	31-38	42-52
2	Drive & Tag Axle Radius Rod threaded stud (12 supports)	90-110	122-149
3	Sway Bar Link Upper & Lower Nut	99-121	134-164
4	Shock Absorber Pin Nut (6 shock absorbers)	99-121	134-164
5	Shock Absorber Pin (6 shock absorbers) <sup>†</sup>	350-400	475-545
6	Drive axle Radius Rod Nut/bolt (6 supports)	225-255	305-346
7	Drive Axle Radius Rod Retaining Bolts (2 longitudinal radius rods)	228-232	309-314
8	Tag Axle Radius Rods Nut (6 supports)	228-252	309-341
9	Sway Bar Bushing Collar Bolt	80-100	108-136
10	Tag Axle Transversal Radius Rod (Casting) Retaining Bolt	188-192	255-260
11	Sway Bar Link Pin Stud	350-400	475-545
12	Shock Absorber Lower Nut (6 shock absorbers)	60-75	81-101

### **NOTE**

Apply corrosion-protective compound on exposed threads.



**16. PARTS SPECIFICATIONS****Independent Front Suspension Air Springs**

Make..... Goodyear Tire and Rubber  
 Model..... 1400  
 Type ..... Mae West  
 Diameter..... 14 inches  
 Air Inlet ..... 1/2"- 14 NPTF

**I-Beam Front Axle and tag axle air springs**

Make..... Goodyear Tire and Rubber  
 Model..... 1200  
 Type ..... Mae West  
 Nominal diameter ..... 12" (304 mm)

**Drive axle air springs**

Make..... Goodyear Tire and Rubber  
 Model..... 1100  
 Type ..... Double Flare  
 Nominal diameter ..... 11.5" (292 mm)

**Independent Front suspension shock absorbers**

Make..... Arvin  
 Color..... Black  
 Piston Diam. .... 1 5/8 inch  
 Collapsed length..... 14.16 inches  
 Extended length ..... 22.44 inches

**I-Beam Front suspension shock absorbers**

Make..... Sachs  
 Color..... Black  
 Type ..... NUV45X230HA  
 Ext. Diam..... 75 mm  
 Collapsed length..... 14.88" (378 mm)  
 Extended length ..... 23.86" (606 mm)

**Drive and tag axle shock absorbers**

Make..... Sachs

**Height control valve (Front only)**

Make..... Barksdale  
 Quantity used ..... 1

**Height control valve (Rear only)**

Make..... Barksdale  
 Quantity ..... 2

**Bellows control and exhaust solenoid valve assembly**

Make ..... Norgren

**Coil**

Voltage..... 24 V DC  
 Current draw ..... 29 amperes

**Valve (3-way, 2 positions)**

Type ..... N/C  
 Type ..... N/O

**Radius rod bushing**

Make ..... ZF Lemforder

**Loctite**

Make ..... Loctite

**Sway bar bushing (Front Suspension)**

Make ..... Prevost

**Sway bar link**

Make ..... Tennaco Automotive

**Air regulator**

Make ..... Norgren  
 Recommended pressure sett....90 psi (621 kPa)