4.18 ROTATOR

Removal

1. Remove the Platform and Platform Support. Refer to Section 4.17, Platform.
2. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.

NOTE: *The rotator approximately weighs 60 lb (27 kg).*

3. Supporting the rotator and jib assembly, remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1.
4. Remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 and remove the rotator.

Installation

NOTE: *The rotator approximately weighs 60 lb (27 kg).*

1. Supporting the rotator and jib assembly, align rotator with jib assembly mounting point and jib. Using a soft head mallet, install pin #1 to the jib assembly. Install hardware securing pin #1.
2. Using a soft head mallet install pin #2 to jib assembly and install the rotator. Install hardware securing pin #2.

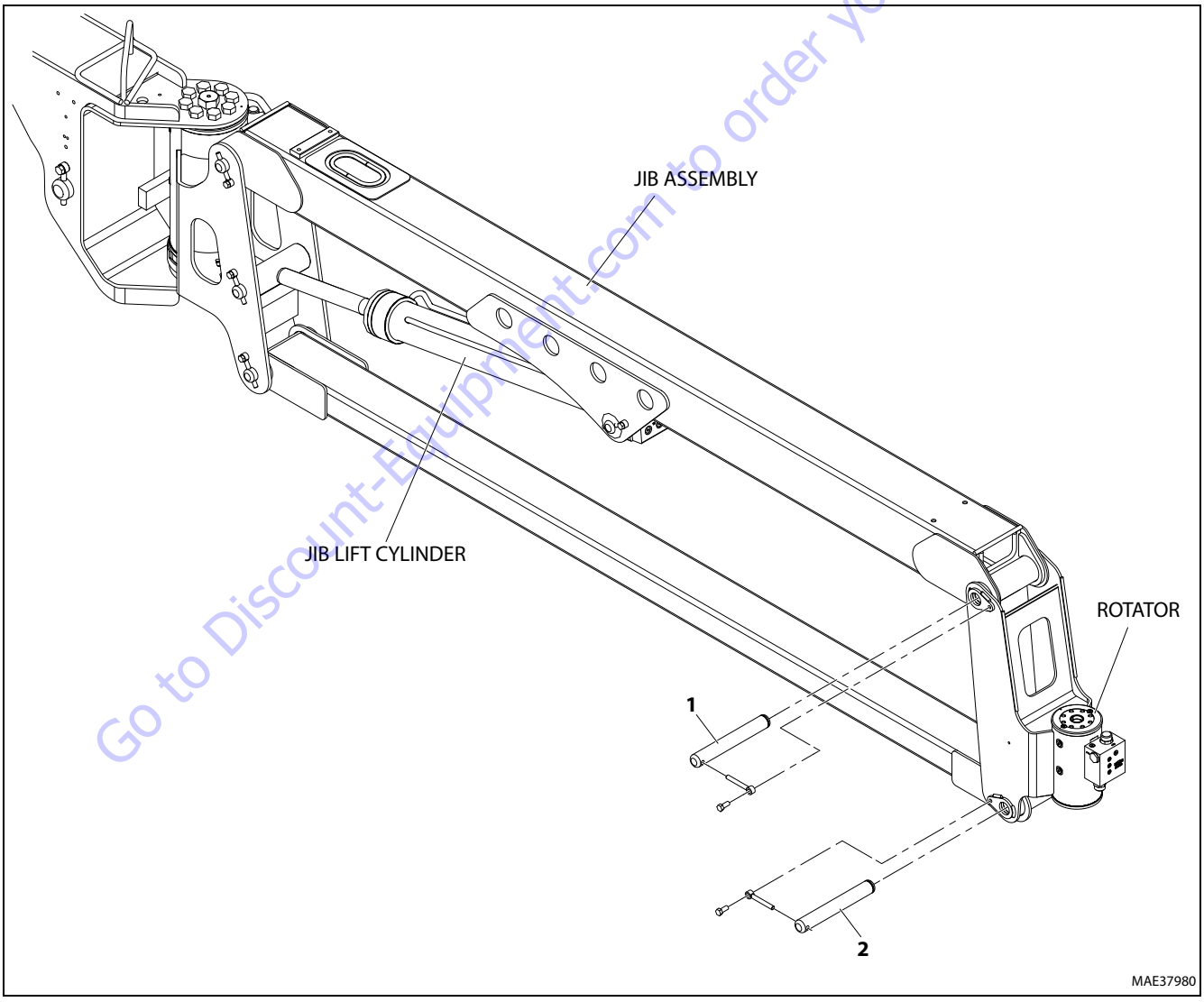


Figure 4-6. Rotator Removal/Installation

4.19 MAIN BOOM

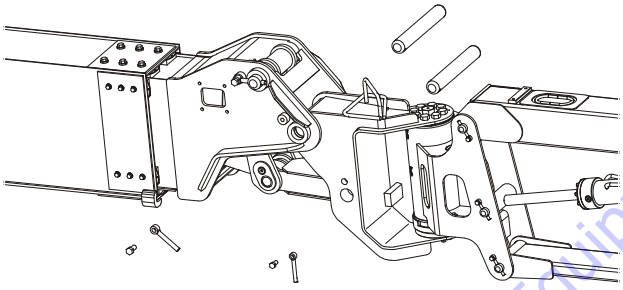
Disassembly

NOTE: *The following procedure allows the boom base section to remain attached to the machine.*

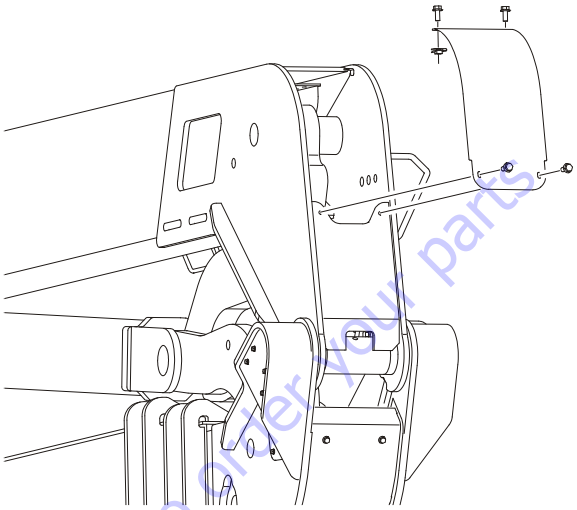
1. Make sure the machine is on a firm, level surface.

NOTE: *The jib and platform assembly weighs approximately 1000 lb (454 kg).*

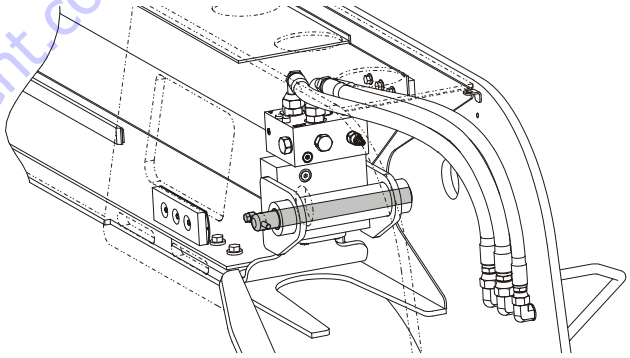
2. Support the jib sand platform assembly.
3. Tag and disconnect all electrical lines running to the jib and platform.
4. Tag and disconnect all hydraulic lines running to the jib and platform.
5. Remove the bolts, keeper pins, and pivot pins that secure the jib rotator support to the nose of the fly section.



6. Remove the jib/platform assembly from the boom.
7. Extend the fly section enough to attach an adequate lifting device for removing the fly section.
8. Remove the cover from the top of the main boom to gain access to the telescope cylinder attaching hardware.



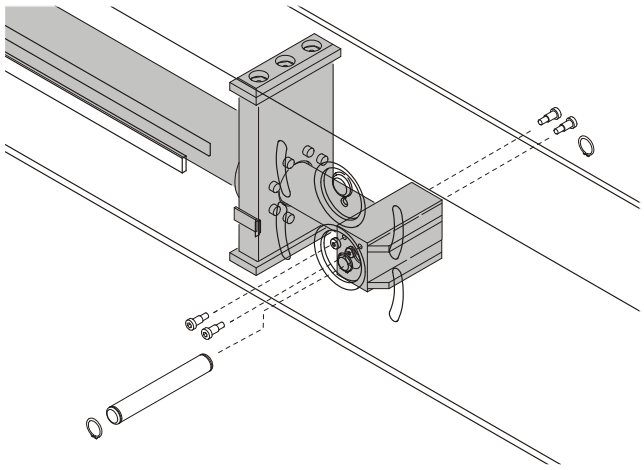
9. Remove the bolt, keeper pin, and retaining pin securing the barrel end of the telescope cylinder to the main boom base section.



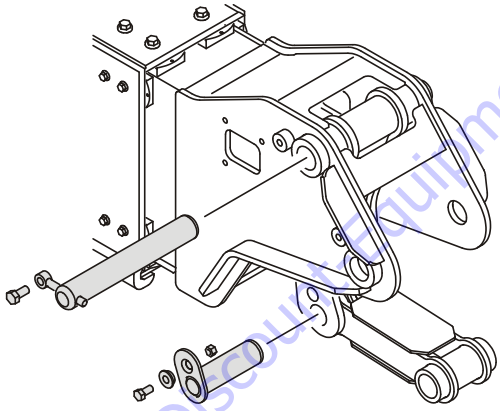
10. Using an adequate lifting device, pull the main fly section and telescope cylinder out of the main boom base section.

NOTE: *The main boom fly section including telescope cylinder and level cylinder weighs approximately 2000 lb (907 kg).*

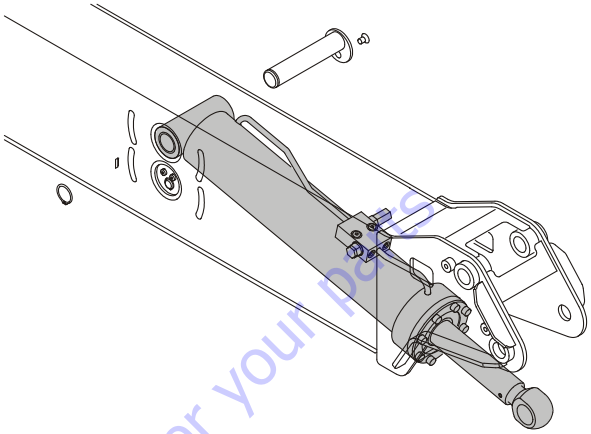
11. If necessary, remove the shoulder screws, retaining rings, and pin that secures the rod end of the telescope cylinder to the main boom fly section and remove the telescope cylinder from the fly section.



12. If necessary, remove the bolt, keeper pin, and pivot pin securing the upper link to the boom nose and remove the upper and lower links as an assembly. If necessary, remove the bolt, pin retainer sleeve, and nut securing the lower link to the upper link.

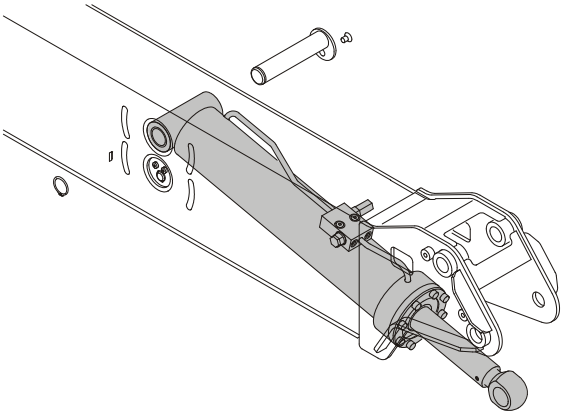


13. If necessary, remove the shoulder screws, retaining ring, and pin that secures the barrel end of the level cylinder to the main boom fly section and remove the level cylinder from the fly section.



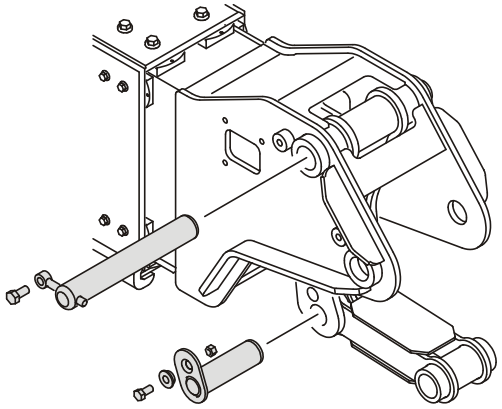
Assembly

1. If removed during assembly, install the level cylinder into the fly section. Install the shoulder screws, retaining ring, and pin that secures the barrel end of the level cylinder to the main boom fly section.

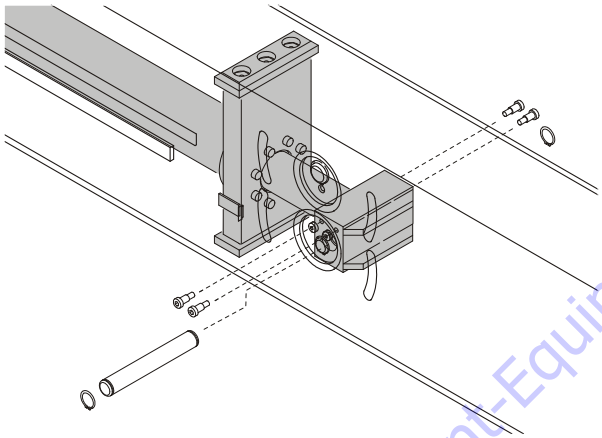


2. If removed during assembly, install the pin retainer sleeve, bolt, and nut securing the lower link to the upper link. On machines using the bolt and nut, torque to 190 ft. lbs. (260 Nm). Position the upper link to the boom

nose and secure in place with the pivot pin, keeper pin, and bolt.



3. If removed during assembly, install the telescope cylinder into the fly section. Install the shoulder screws, retaining rings, and pin that secures the rod end of the telescope cylinder to the main boom fly section.

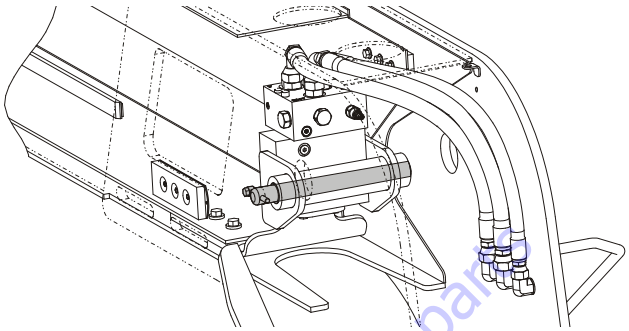


4. Using an adequate lifting device, slide the main fly section and telescope cylinder into the main boom base section.

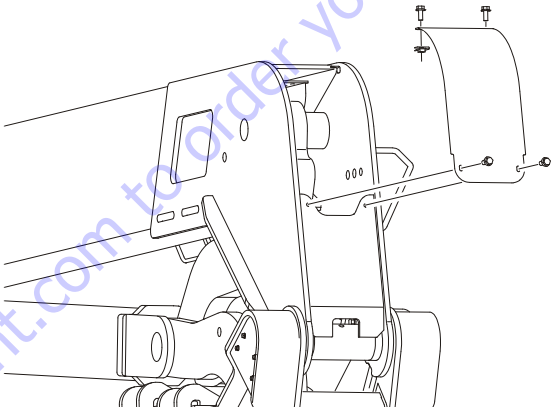
NOTE: *The main boom fly section including telescope cylinder and level cylinder weighs approximately 2000 lb (907 kg)*

.

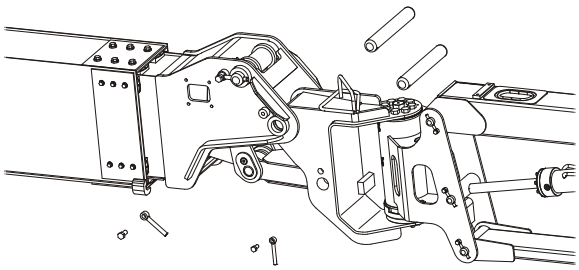
4. Install the bolt, keeper pin, and retaining pin that secures the barrel end of the telescope cylinder to the main boom base section.



5. Install the cover to the top of the main boom.



6. Install the jib/platform assembly onto the boom.
7. Extend the fly section enough to attach an adequate lifting device for removing the fly section.
8. Install the bolts, keeper pins, and pivot pins that secure the jib rotator support to the nose of the fly section.



9. Connect all hydraulic lines running to the jib and platform as tagged during disassembly.
10. Connect all electrical lines running to the jib and platform as tagged during removal.

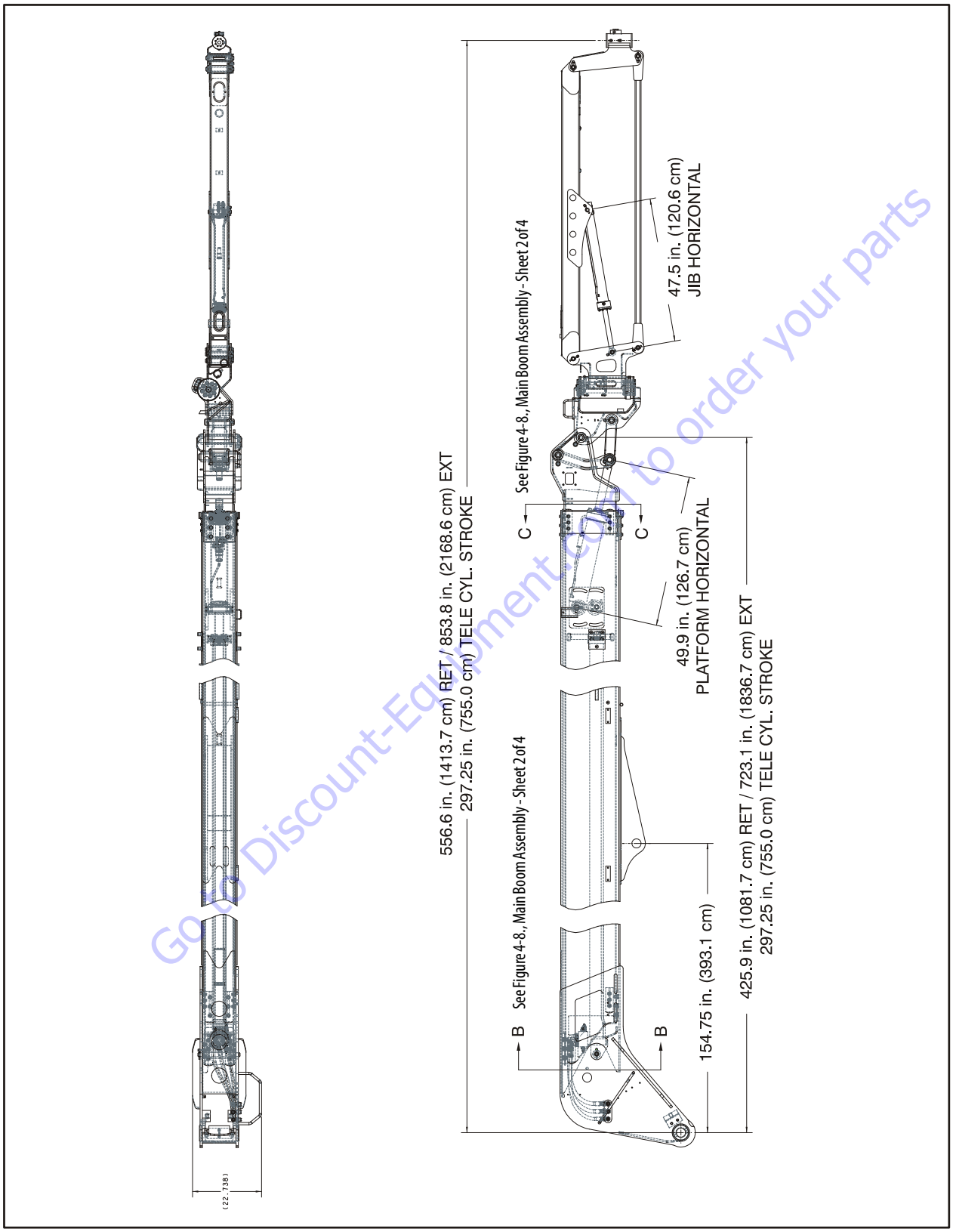


Figure 4-7. Main Boom Assembly - Sheet 1 of 4

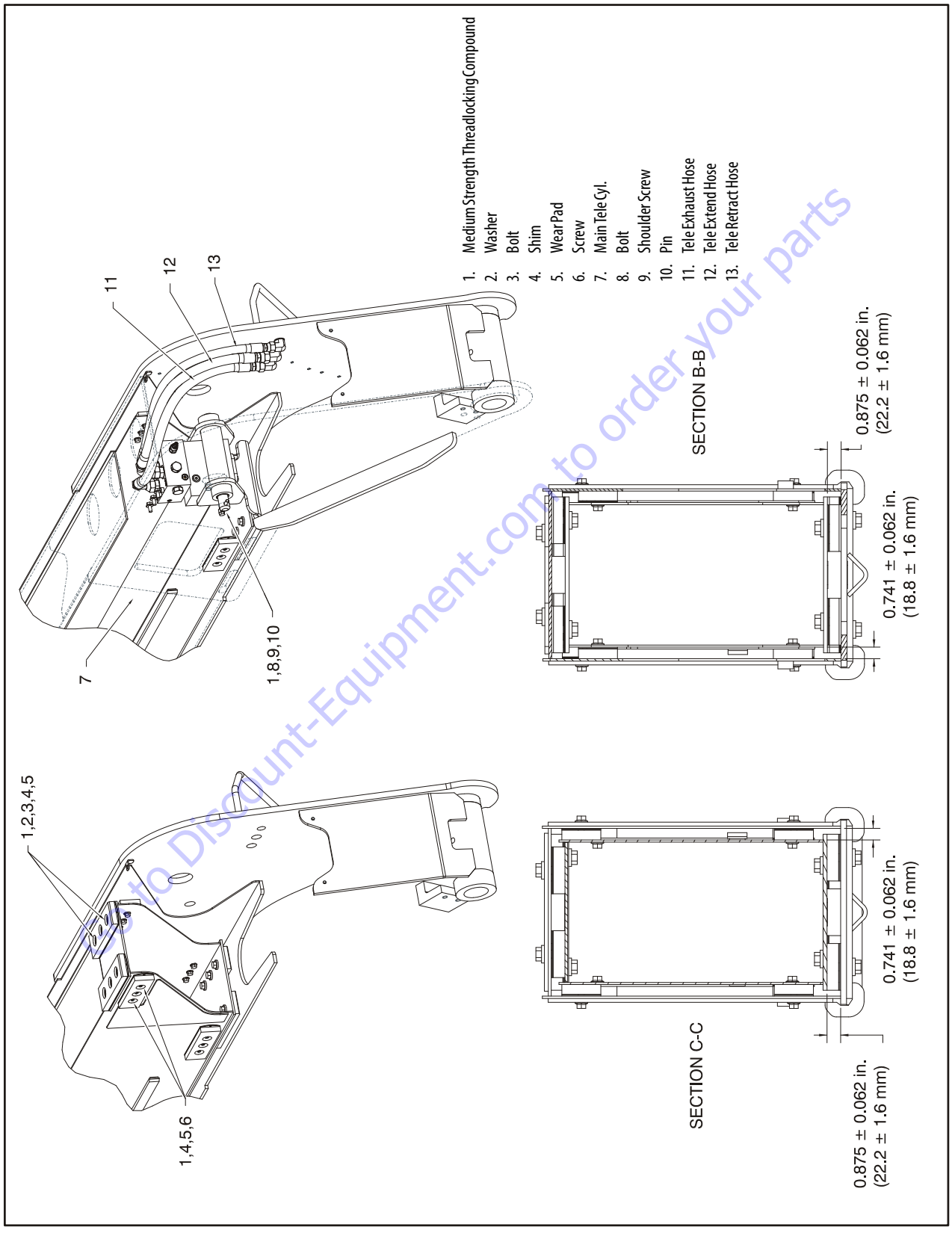


Figure 4-8. Main Boom Assembly - Sheet 2 of 4

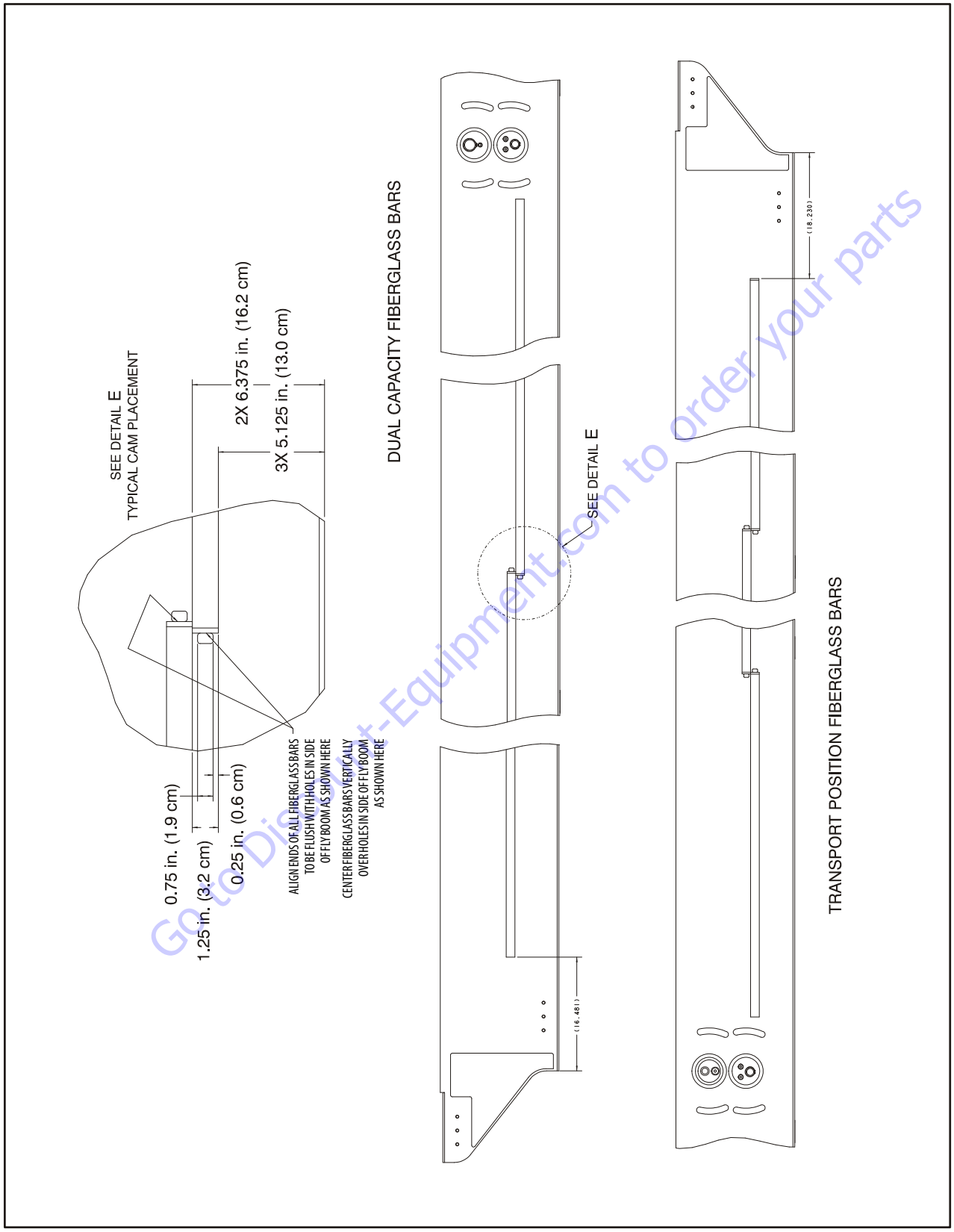
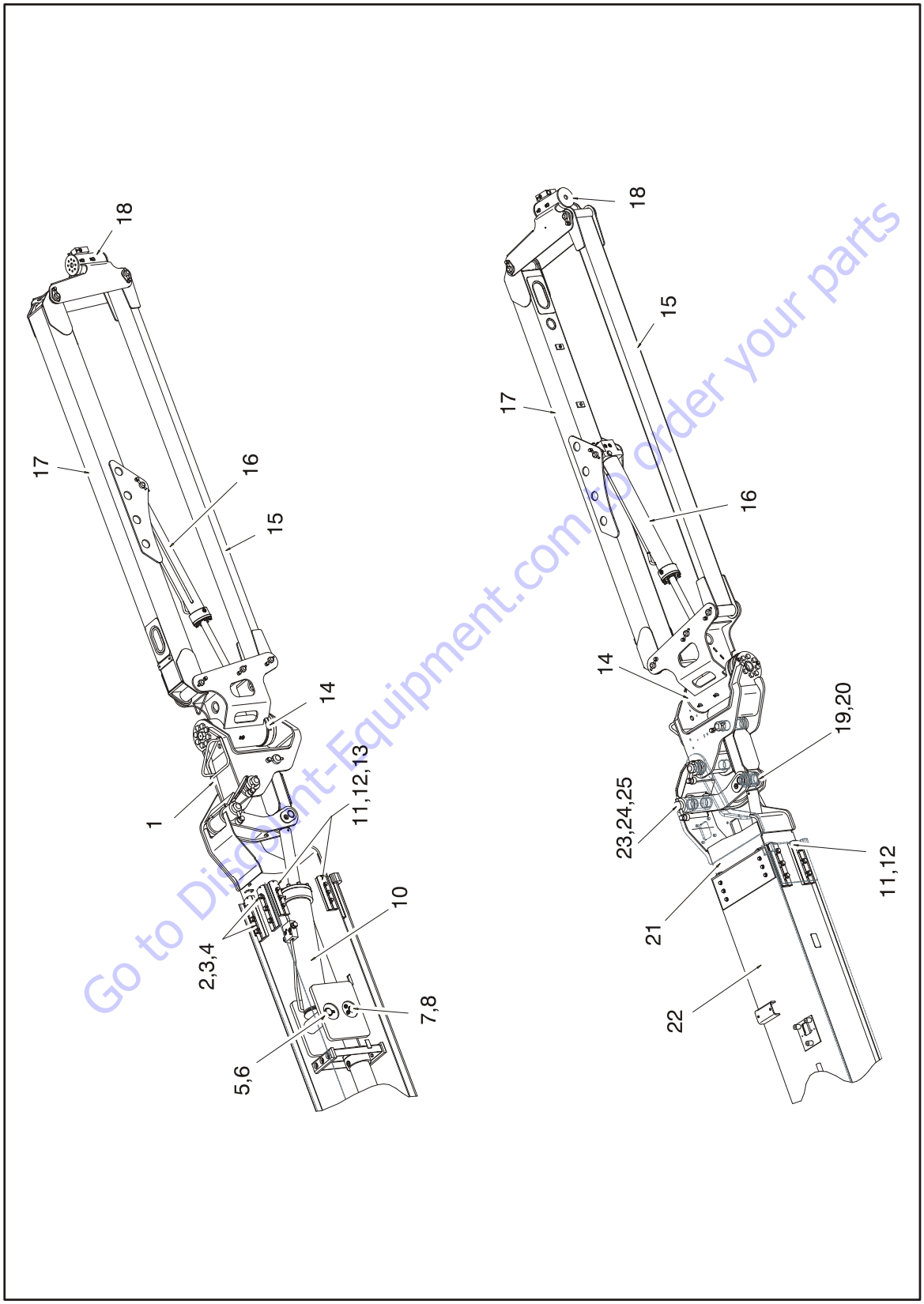


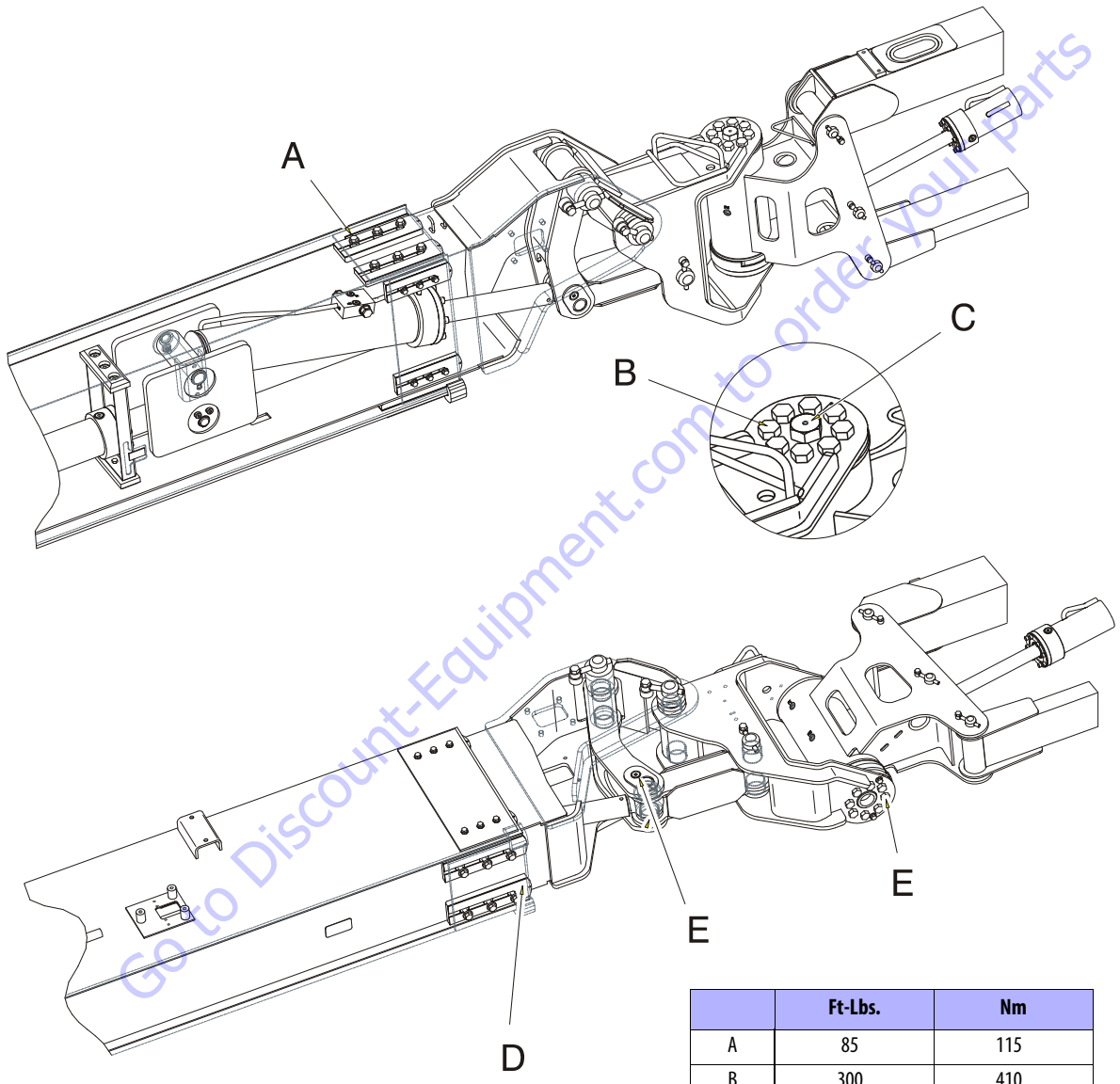
Figure 4-9. Main Boom Assembly - Sheet 3 of 4



1. Pivot Assembly
2. Upper Front Wear Pad
3. Shim
4. Bolt
5. Bolt
6. Level Cylinder Pin
7. Tele Cylinder Pin
8. Retaining Ring
9. Shoulder Screw
10. Level Cylinder
11. Side Wear Pad
12. Shim
13. Bolt
14. Jib Rotator
15. Lower Jib Link
16. Jib Cylinder
17. Upper Jib Link
18. Platform Rotator
19. Level Link Pin
20. Retaining Ring
21. Fly Boom Section
22. Base Boom Section
23. Bolt
24. Keeper
25. Pin

Figure 4-10. Main Boom Assembly - Sheet 4 of 4

NOTE: *If any rotator bolts are replaced, all bolts on the rotator should be retorqued. Check torque on the bolts every 150 hours of operation.*



	Ft-Lbs.	Nm
A	85	115
B	300	410
C	480	650
D	85	115
E	190	260

Figure 4-11. Main Boom Assembly Torque Values

4.20 TOWER BOOM

Installation and Assembly

NOTE: *To ease assembly of the tower base boom to the machine, have the base section slightly tilted downward towards the pivot pin bushings.*

1. Use an overhead crane or other suitable lifting device, and maneuver the tower boom base section in place. Install the pivot pin. Install the keeper pin and apply High Strength Threadlocking Compound to the retaining bolt. Torque the bolt to 285 ft. lbs. (386 Nm).

NOTE: *The tower lift cylinder weighs approximately 643 pounds (292 kg).*

2. Use a ratchet strap to carefully raise the lift cylinder up into position under the boom.

3. Place blocking under the front of the tower base and move the lifting strap out to the end of the tower base section.

4. Lift the tower base section up and extend the lift cylinder to align it with the attachment lugs. Refer to the Service Mode procedure in Section 4.26, Tower Lift Cylinder.

5. When the lift cylinder and tower base pivot holes are aligned, install the pivot pin. Install the keeper pin and apply High Strength Threadlocking Compound to the retaining bolt. Torque the bolt to 285 ft. lbs. (386 Nm).

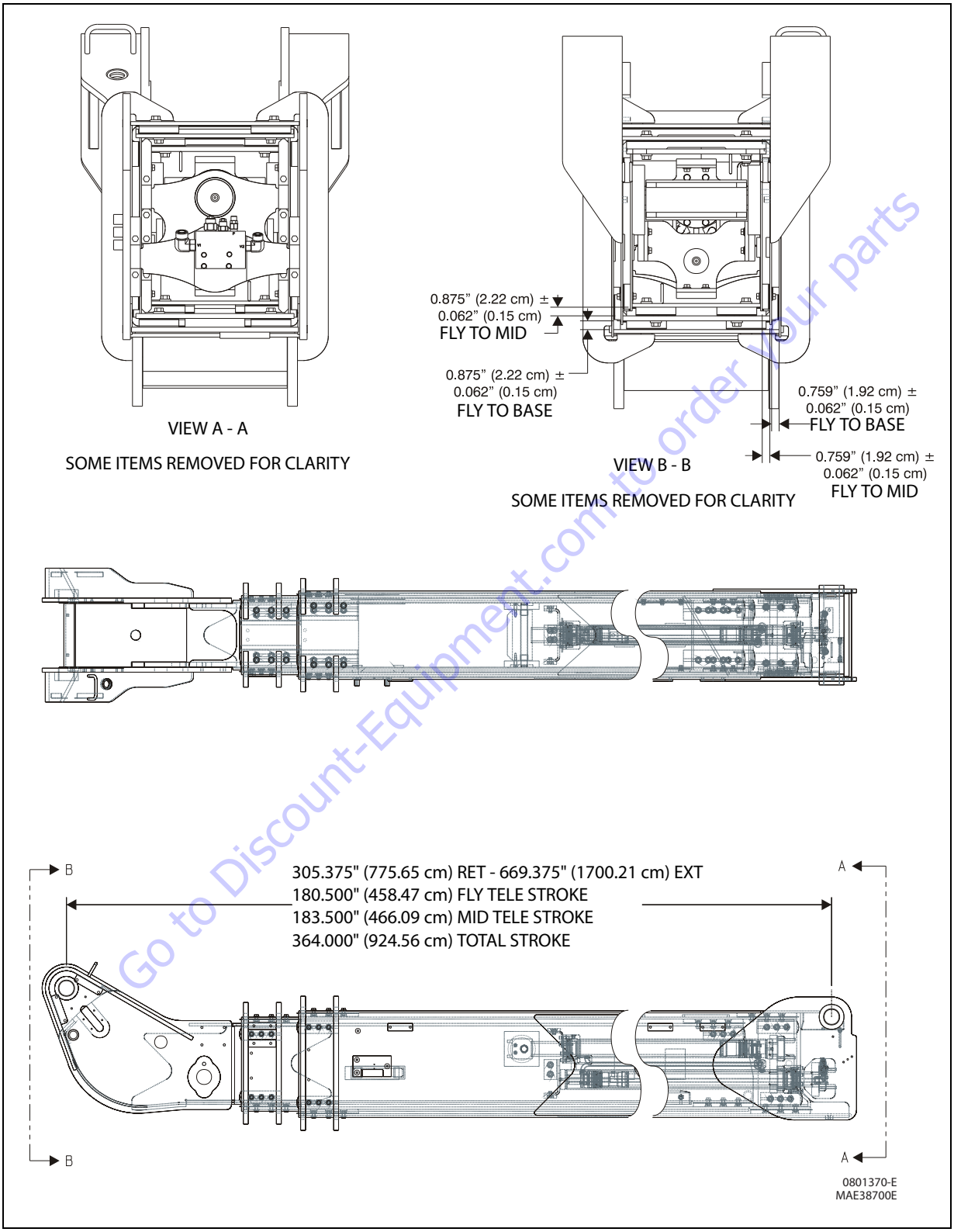
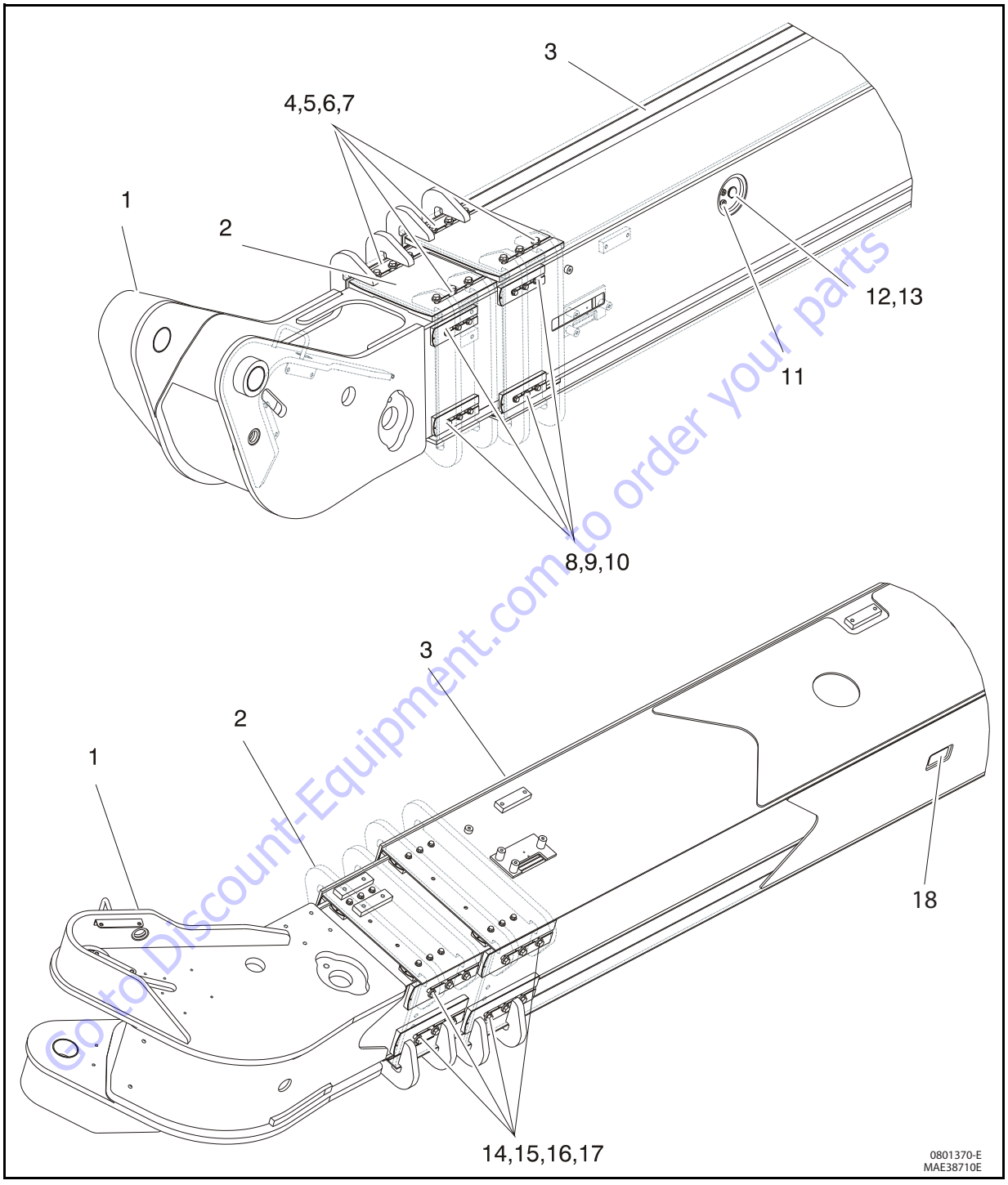
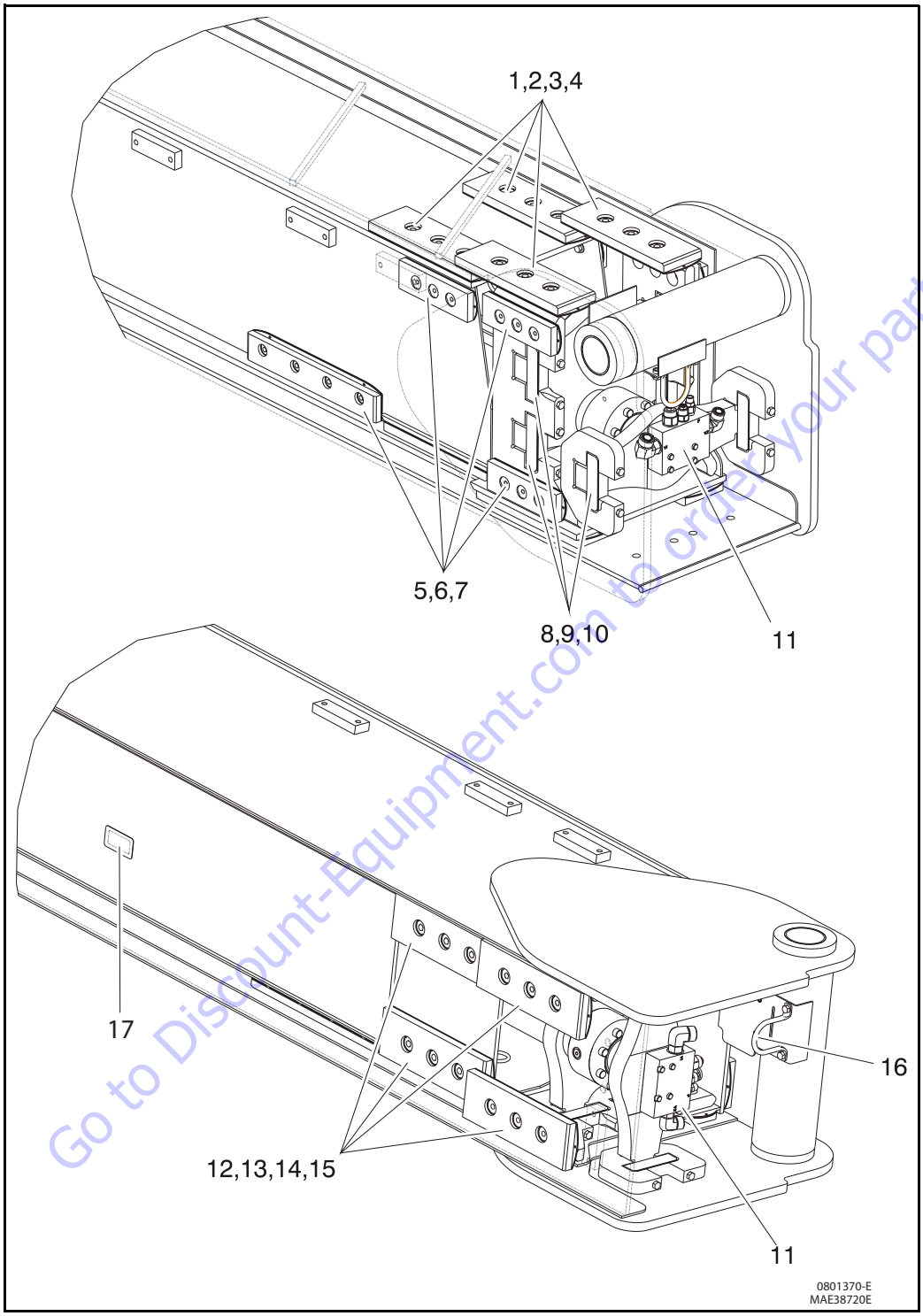


Figure 4-12. Tower Boom Assembly - Sheet 1 of 3



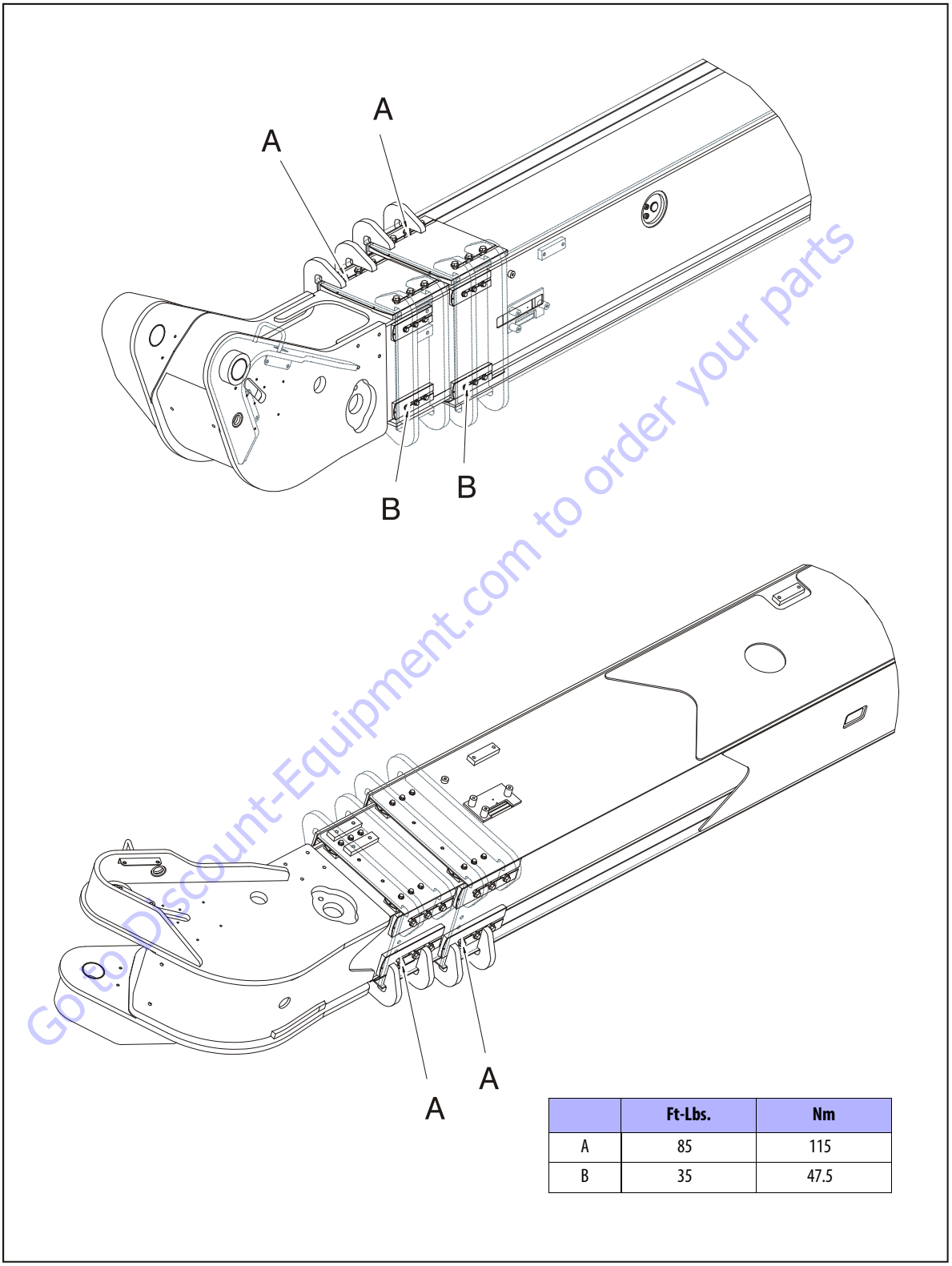
1. Tower Fly
2. Tower Mid
3. Tower Base
4. Front Upper Wear Pad
5. Wear Pad Shim
6. Bolt
7. Washer
8. Front Side Wear Pad
9. Wear Pad Shim
10. Screw
11. Shoulder Bolt
12. Snap Ring
13. Retaining Pin
14. Front Lower Wear Pad
15. Wear Pad Shim
16. Bolt
17. Washer
18. Cover

Figure 4-12. Tower Boom Assembly - Sheet 2 of 3



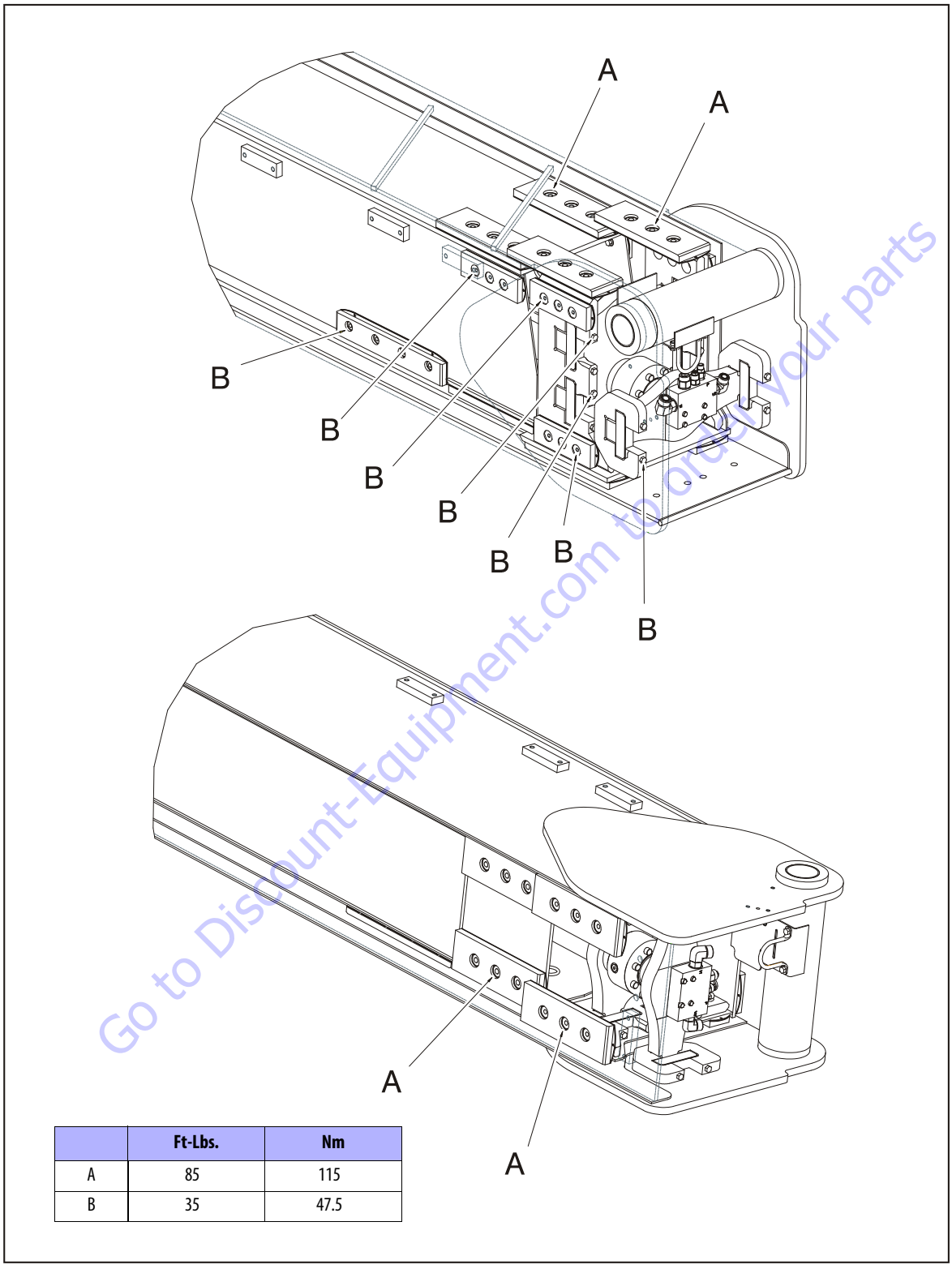
1. Upper Rear Wear Pad
2. Wear Pad Shim
3. Bolt
4. Washer
5. Rear Side Wear Pad
6. Wear Pad Shim
7. Screw
8. Trunnion Keeper Block
9. Keeper Shim
10. Bolt
11. Tower Tele Cylinder
12. Bottom Rear Wear Pad
13. Wear Pad Shim
14. Bolt
15. Washer
16. Hose Loop
17. Cover

Figure 4-13. Tower Boom Assembly - Sheet 3 of 3



	Ft-Lbs.	Nm
A	85	115
B	35	47.5

Figure 4-14. Tower Boom Assembly Torque Values - Sheet 1 of 2



	Ft-Lbs.	Nm
A	85	115
B	35	47.5

Figure 4-15. Tower Boom Assembly Torque Values - Sheet 2 of 2

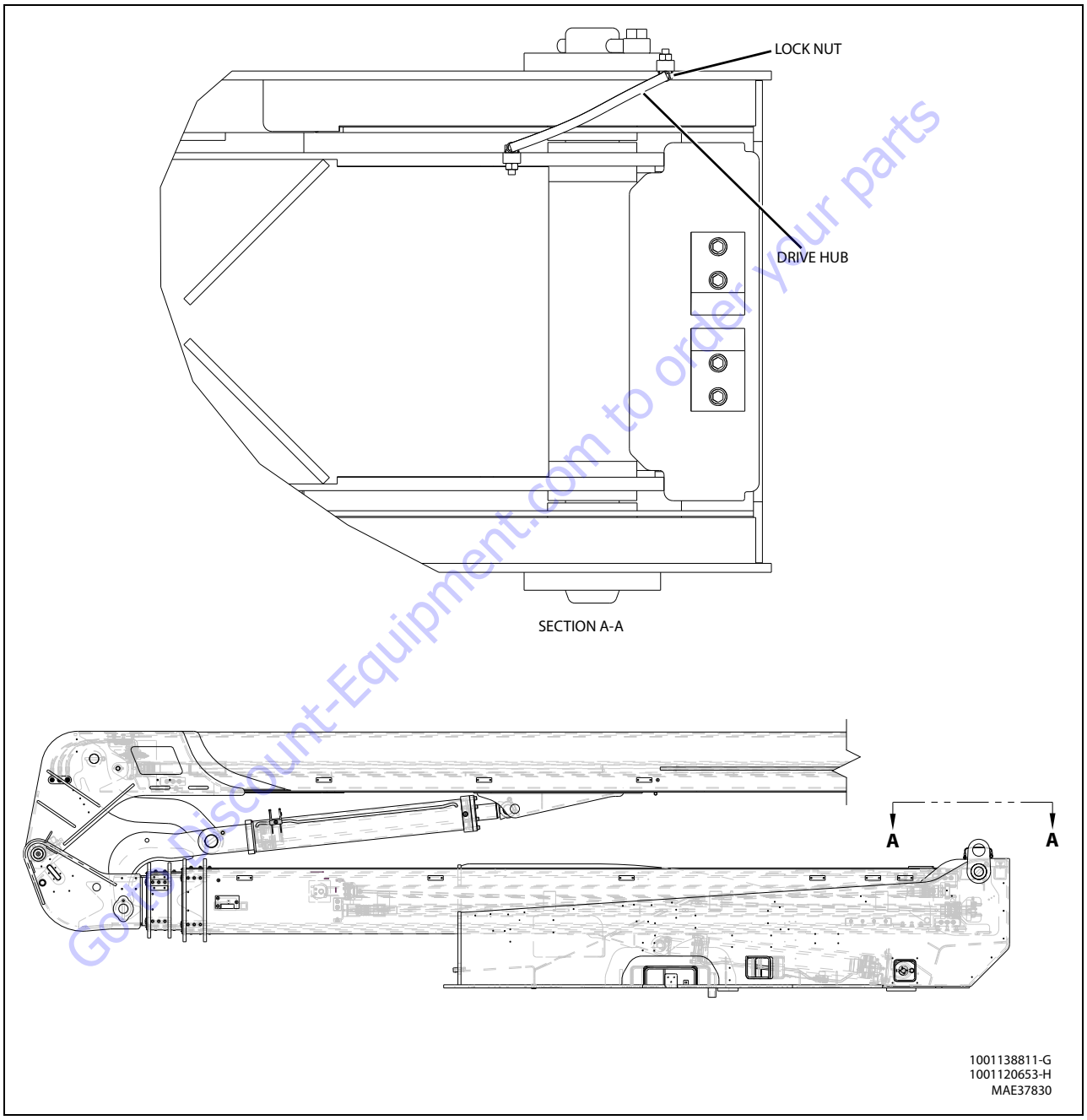


Figure 4-16. Boom & Cylinder Installation - Sheet 1 of 4

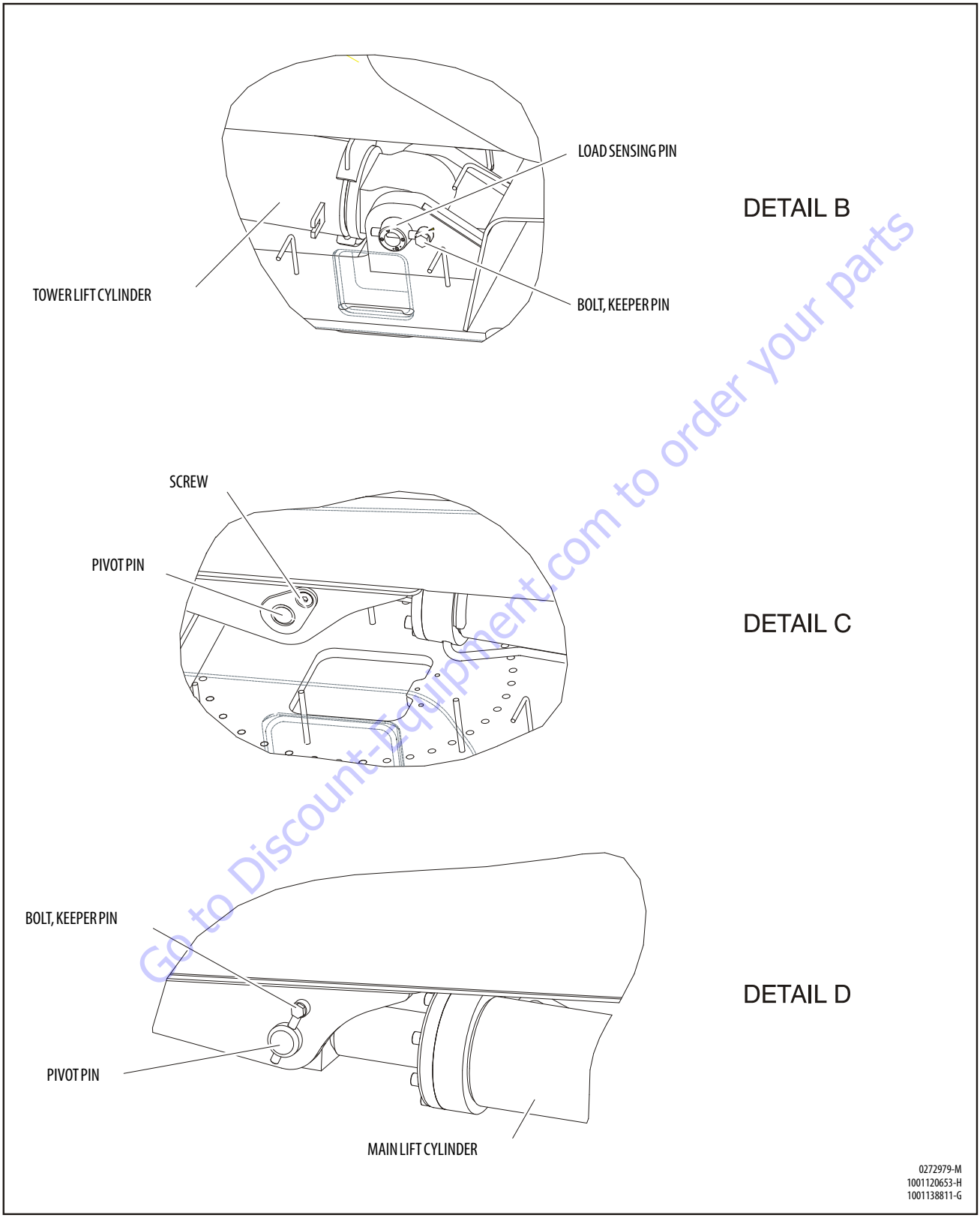
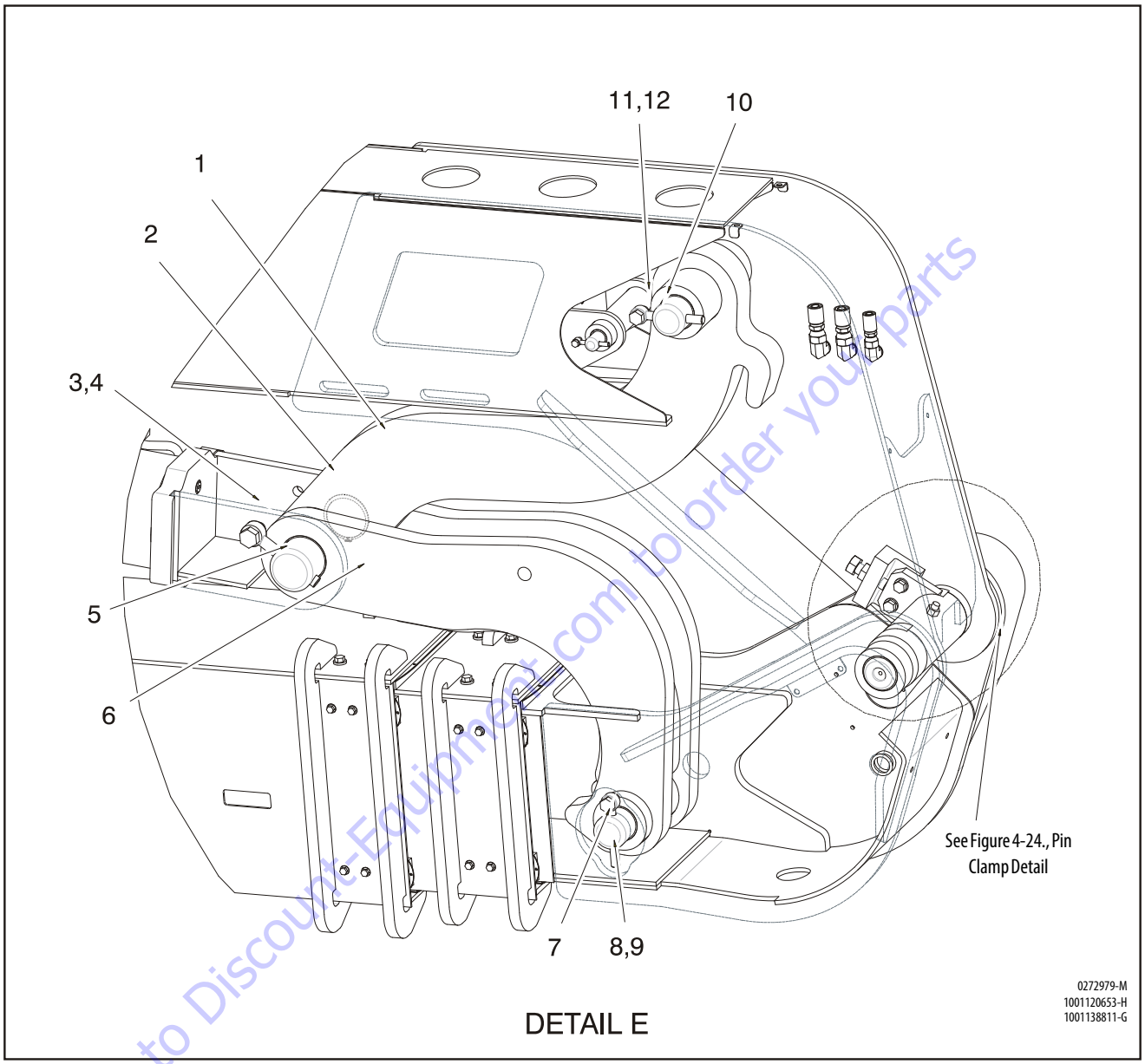


Figure 4-17. Boom & Cylinder Installation - Sheet 2of 4



1. Upper Link
2. Retaining Ring
3. Bolt
4. Keeper
5. Pin
6. Lower Link
7. Pin
8. Keeper
9. Bolt
10. Pin
11. Bolt
12. Keeper

Figure 4-18. Boom & Cylinder Installation - Sheet 3 of 4

NOTE: *If space is available install one thrust washer on each side of the boom assembly between the tower fly boom section and the main base boom section. If space only allows for the use of one thrust washer, install it on the same side as the proximity sensor. (Same as the left side or powertrack side of the machine.)*

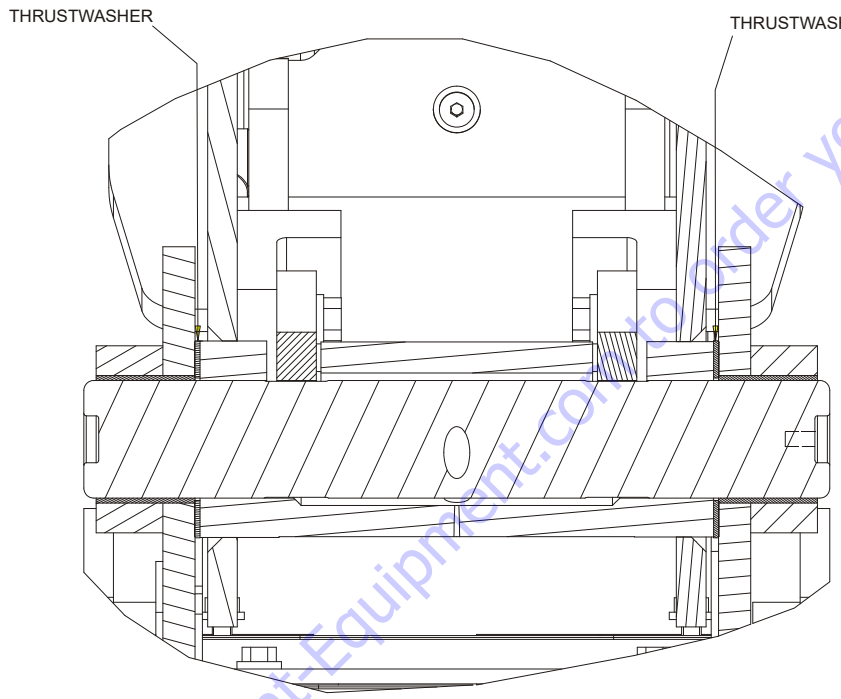
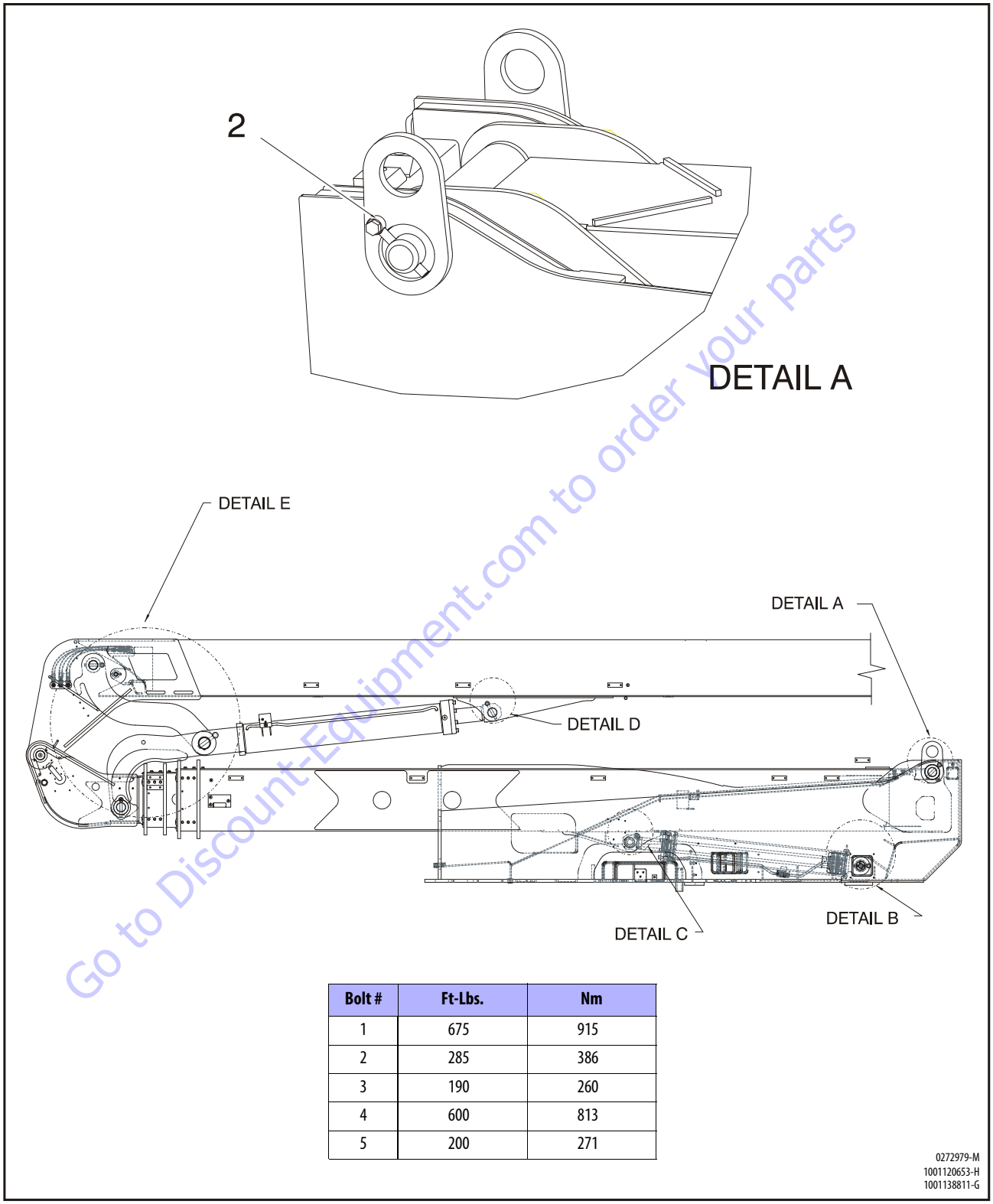


Figure 4-19. Boom & Cylinder Installation - Sheet 4 of 4



Bolt #	Ft-Lbs.	Nm
1	675	915
2	285	386
3	190	260
4	600	813
5	200	271

Figure 4-20. Boom and Cylinder Installation Torque Values - Sheet 1 of 3

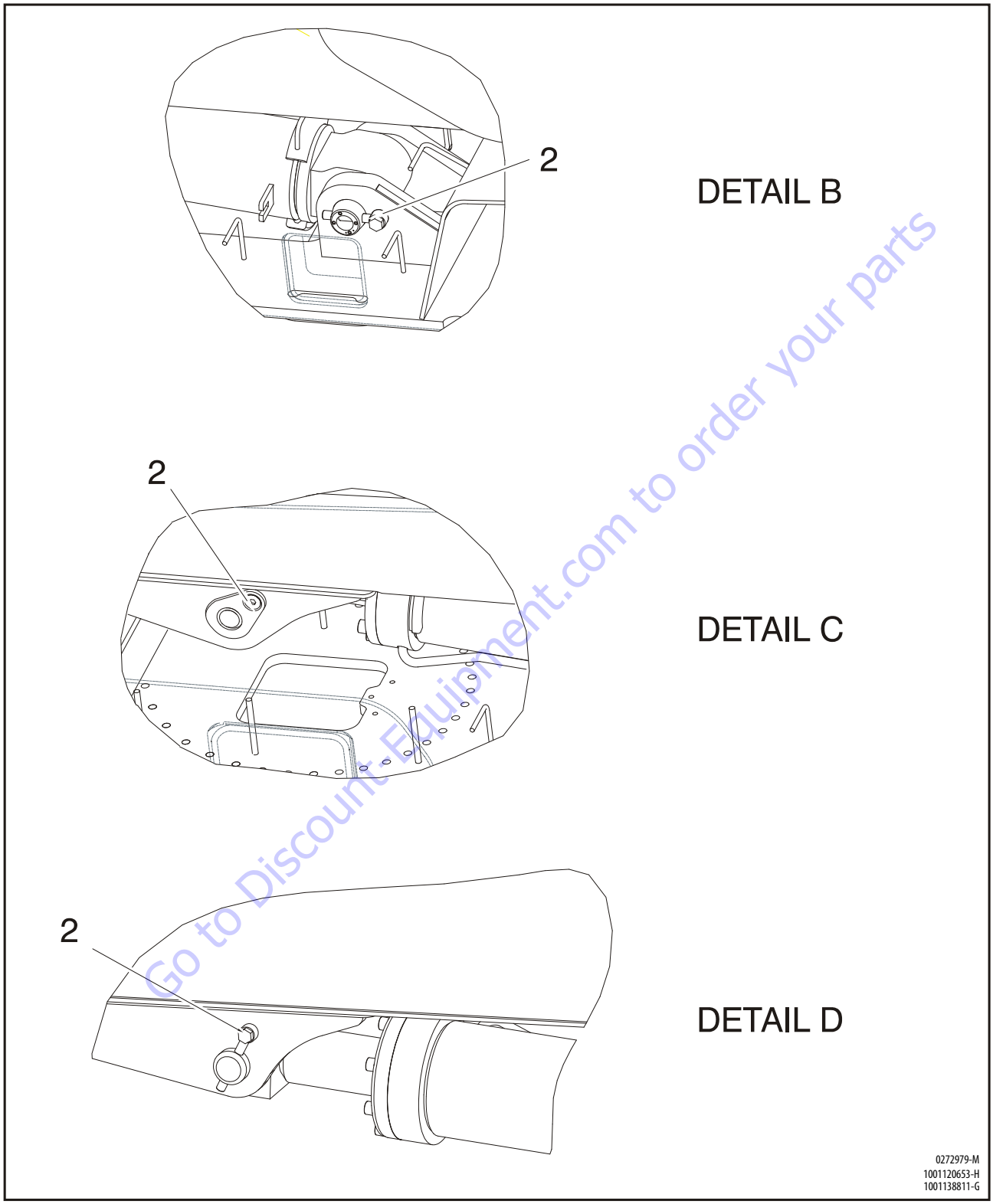
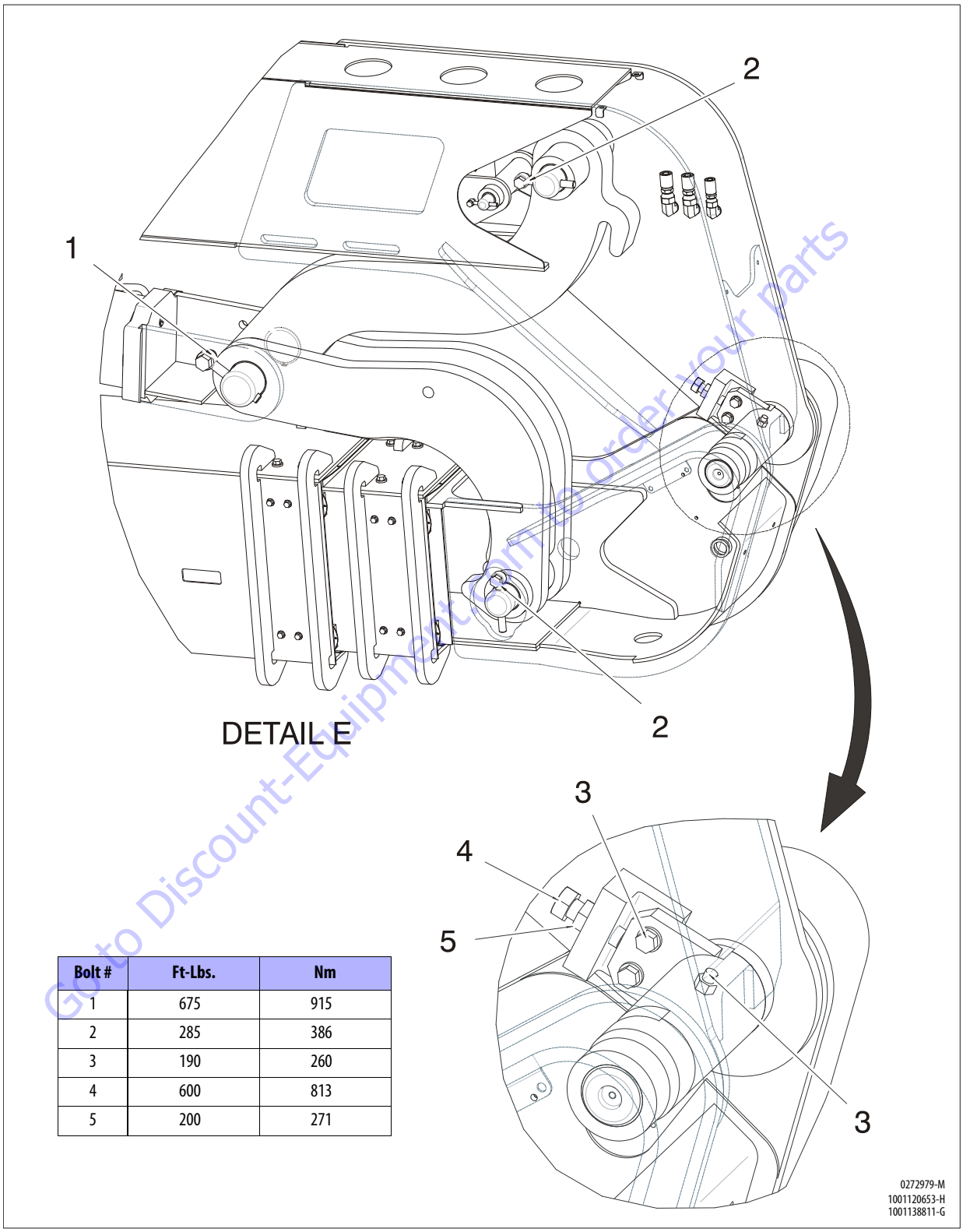
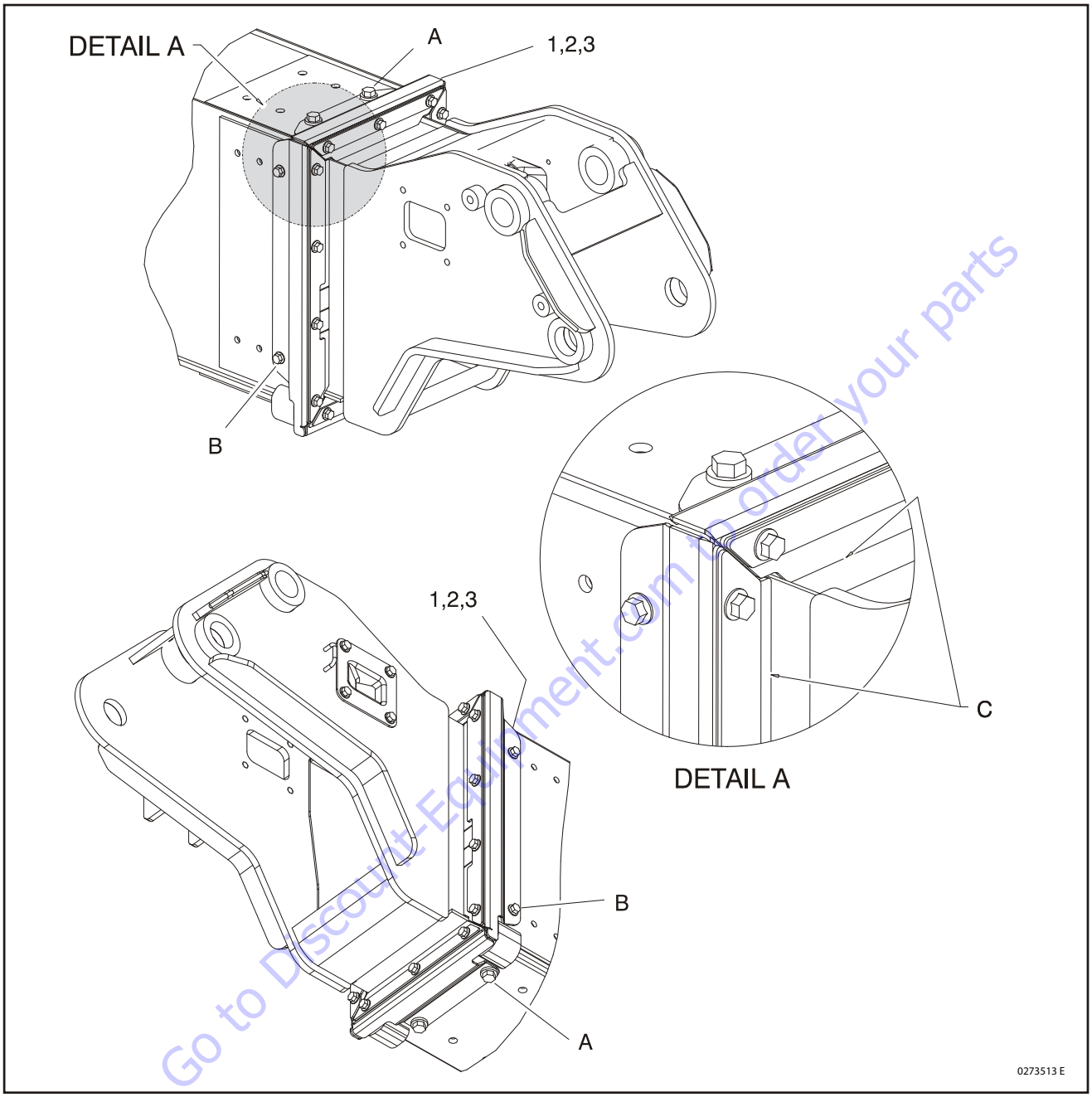


Figure 4-21. Boom and Cylinder Installation Torque Values - Sheet 2 of 3



Bolt #	Ft-Lbs.	Nm
1	675	915
2	285	386
3	190	260
4	600	813
5	200	271

Figure 4-22. Boom and Cylinder Installation Torque Values - Sheet 3 of 3



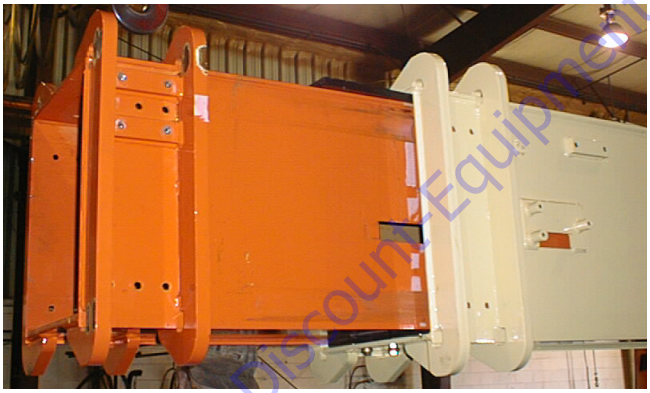
1. Bar
2. Blade
3. Plate

A Apply Medium Strength Threadlocking Compound & torque to 85 ft.lbs. (115 Nm)

B Apply Medium Strength Threadlocking Compound & torque to 35 ft.lbs. (47 Nm)

C Adjust all blades 0.000 to 0.063" (0 to 1.6 mm) from side boom plate

Figure 4-23. Boom Wiper Installation



1. Install the tower mid section into the tower base section. Install the wear pads in the tower base section.

NOTE: *Keep the tower fly section out of the tower mid section enough to allow for installation of the telescope cylinder retaining pin.*

2. Install the tower fly section into the tower mid section. Install the wear pads in the tower mid section.

3. Extend the telescope cylinder so the rod will be extended enough to install the retaining pin holes in the tower fly section. It may be necessary to secure one end to make sure the desired rod end extends. Install the telescope cylinder into the tower boom. Refer to the Service Mode procedure in Section 4.25, Tower Telescope Cylinder.

4. Align the telescope cylinder trunnions. Install the keepers and shims. Secure them in place with the retaining bolts.

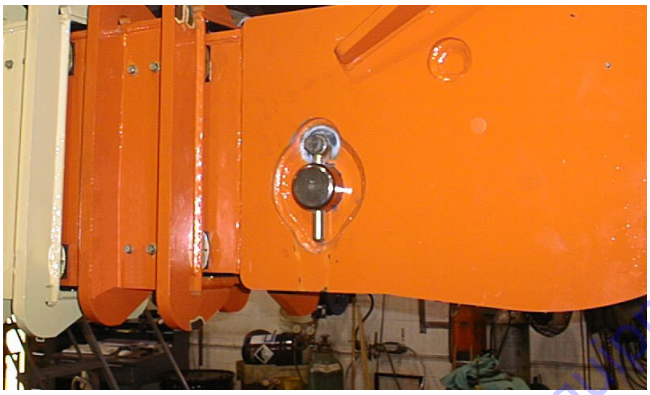
5. Install the upper and lower length sensors.

6. Connect all hoses and electrical lines as tagged during disassembly.

7. Install the power track to the side of the tower boom. Connect all hoses as tagged during disassembly.

NOTE: *The lower link weighs approximately 659 lb (299 kg).*

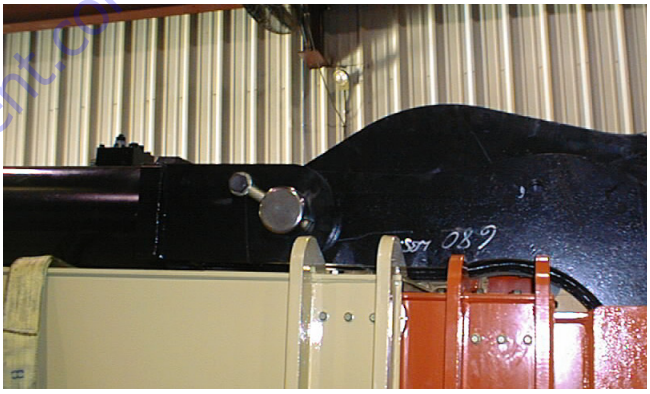
8. Insert a pin through the hole in the lower link so that a lifting strap can be used to position the link in the tower fly section.



9. Install the pivot pin. Install the keeper pin and apply High Strength Threadlocking Compound to the retaining bolt. Torque the bolt to 285 ft.lbs. (386Nm).

NOTE: *The main lift cylinder weighs approximately 785 lb (356 kg). The upper link weighs approximately 412 lb (187 kg).*

10. Lift the main lift cylinder into position with the lower link. Install the pivot pin in part way. Lift the upper link to align the pivot pin bushings in the lower link, lift cylinder, and upper link.



11. Install the pivot pin. Install the keeper pin and apply High Strength Threadlocking Compound to the retaining bolt. Torque the bolt to 675 ft. lbs. (915 Nm).

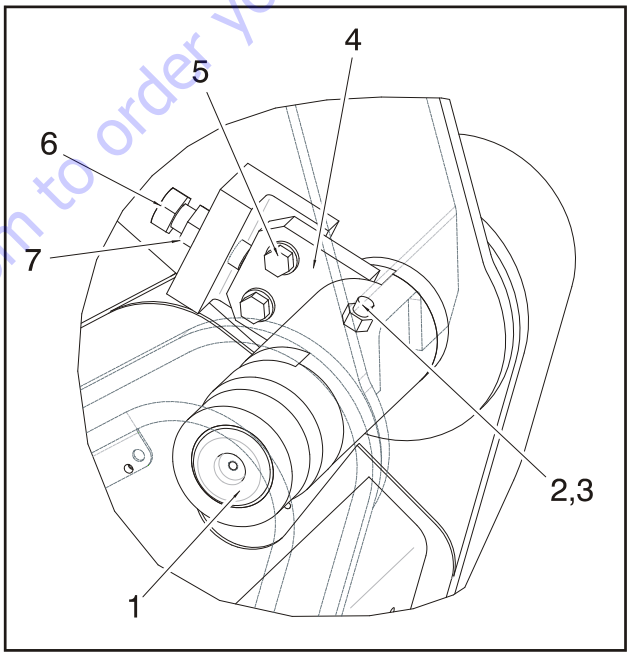
NOTE: *The main boom assembly weighs approximately 5,186 lb (2357 kg).*

12. Lift the main boom in position to align the pivot pin bushings in the main boom and tower boom. Install the main boom pivot pin as described in the Pin Clamp Installation Procedure below.

13. Lift the upper link into position to align the pivot pin holes in the main boom with the pivot pin bushings in the upper link. Install the keeper pin and apply High Strength Threadlocking Compound to the retaining bolt. Torque the bolt to 285 ft.lbs. (386Nm).

Pin Clamp Installation Procedure

1. Install the main boom pivot pin and loosely install the cross bolt and nut.
2. Install the pin clamp bar. Clamp the bolts and washers. Tighten the clamp bolts enough to hold the pin clamp in position for the following steps (5 ft. lbs. [7 Nm] maximum).
3. Install the jack screws and jam nuts. Torque the jack screws to 600 ft. lbs. (813 Nm). Torque the jam nuts to 200 ft. lbs. (271 Nm).
4. Torque the clamp bolts to 190 ft. lbs. (260 Nm).
5. Torque the cross bolt and nut to 190 ft. lbs. (260 Nm).



1. Pivot Pin
2. Cross Bolt
3. Nut
4. Pin Clamp Bar
5. Clamp Bolt
6. Jack Screw
7. Jam Nut

Figure 4-24. Pin Clamp Detail

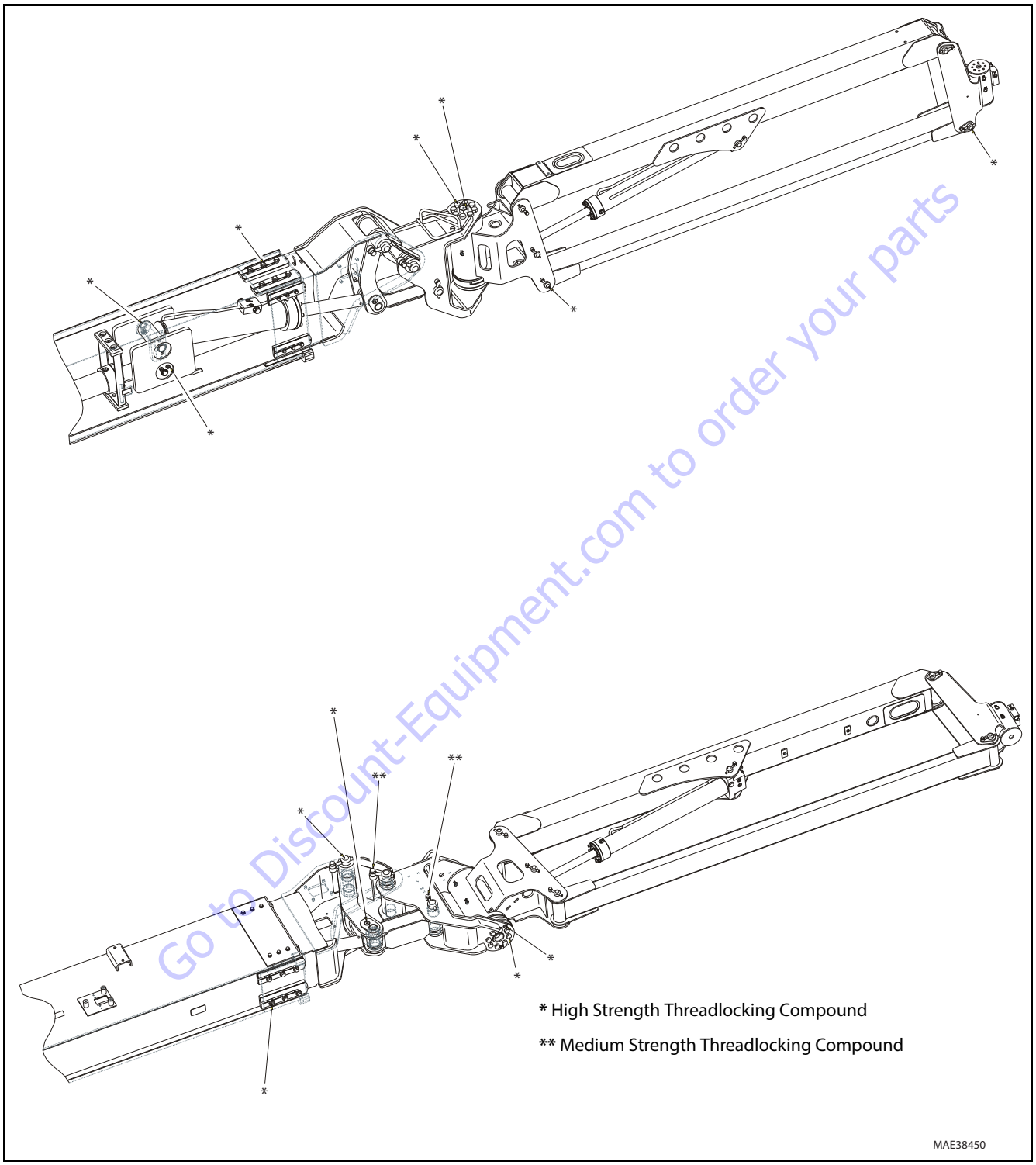


Figure 4-25. Locations for JLG Threadlocker Application - Sheet 1 of 5

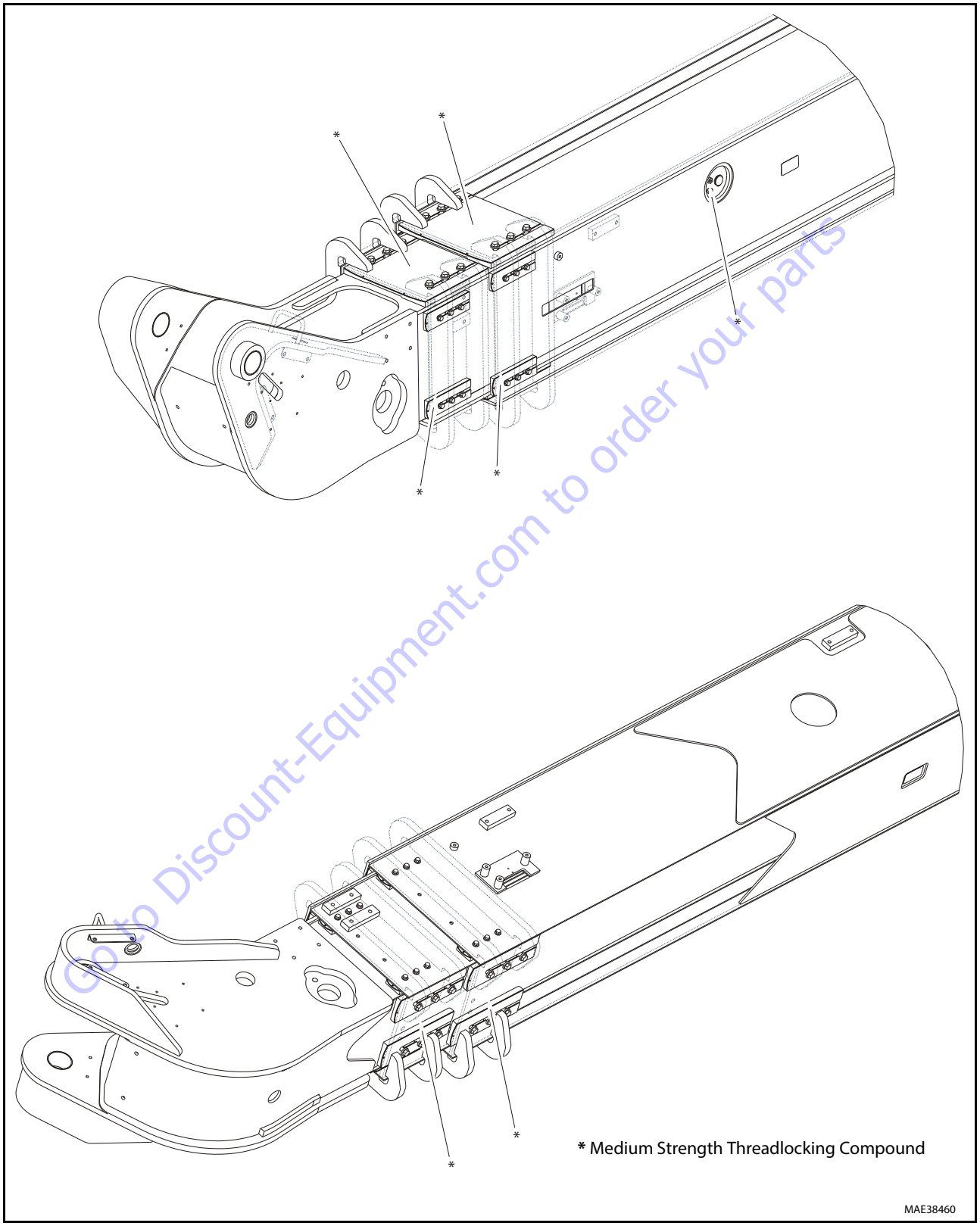


Figure 4-26. Locations for JLG Threadlocker Application - Sheet 2 of 5

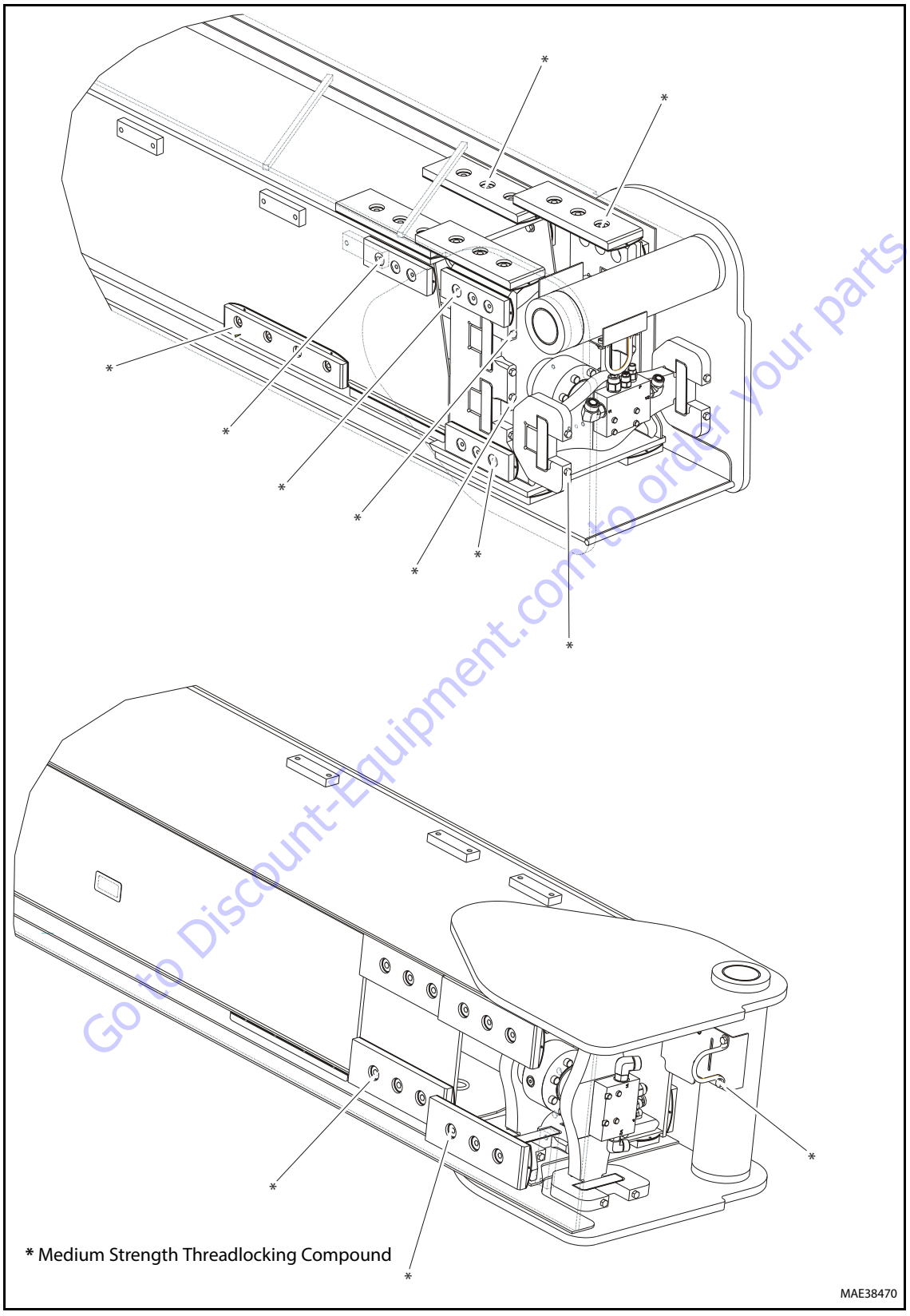


Figure 4-27. Locations for JLG Threadlocker Application - Sheet 3 of 5

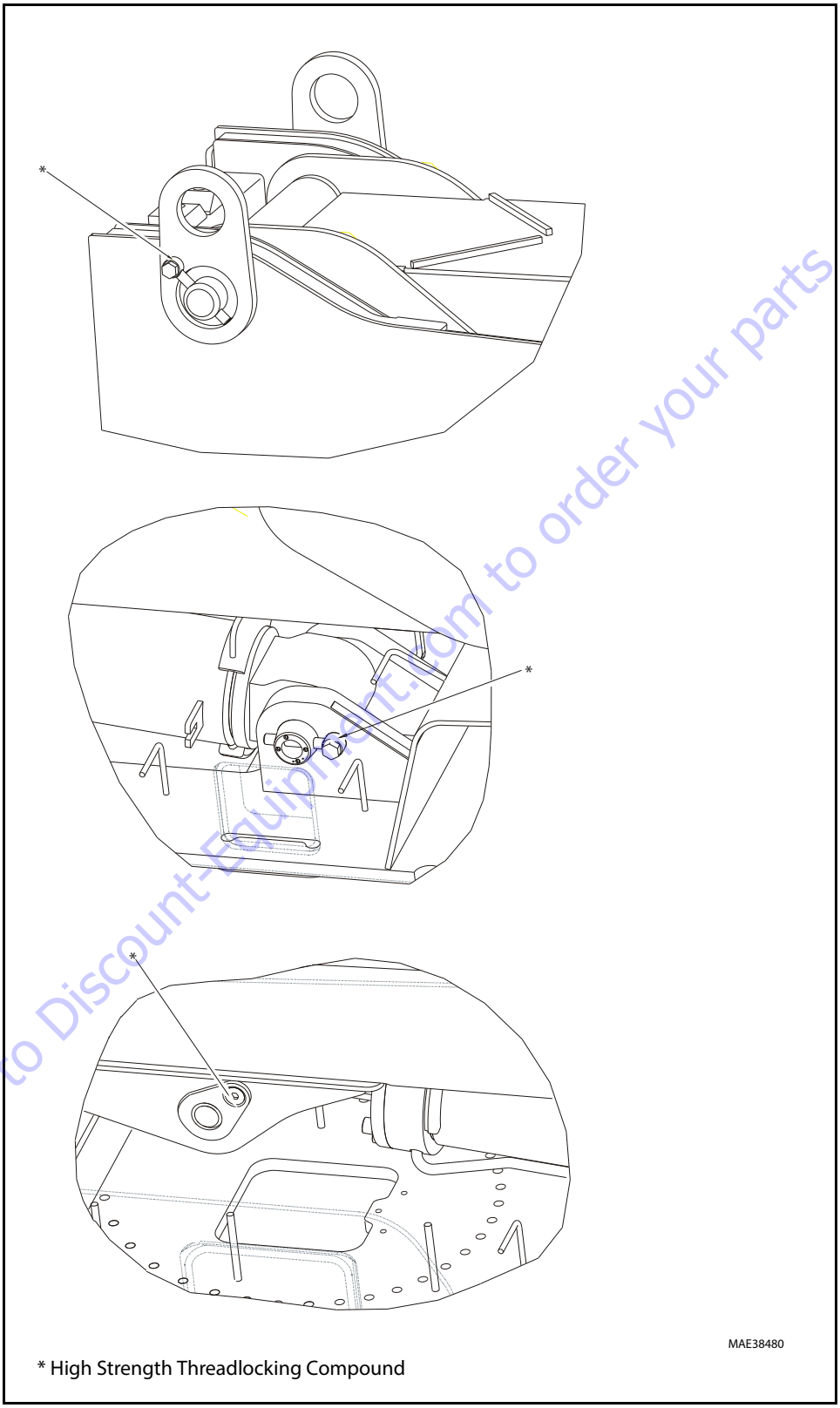


Figure 4-28. Locations for JLG Threadlocker Application - Sheet 4 of 5

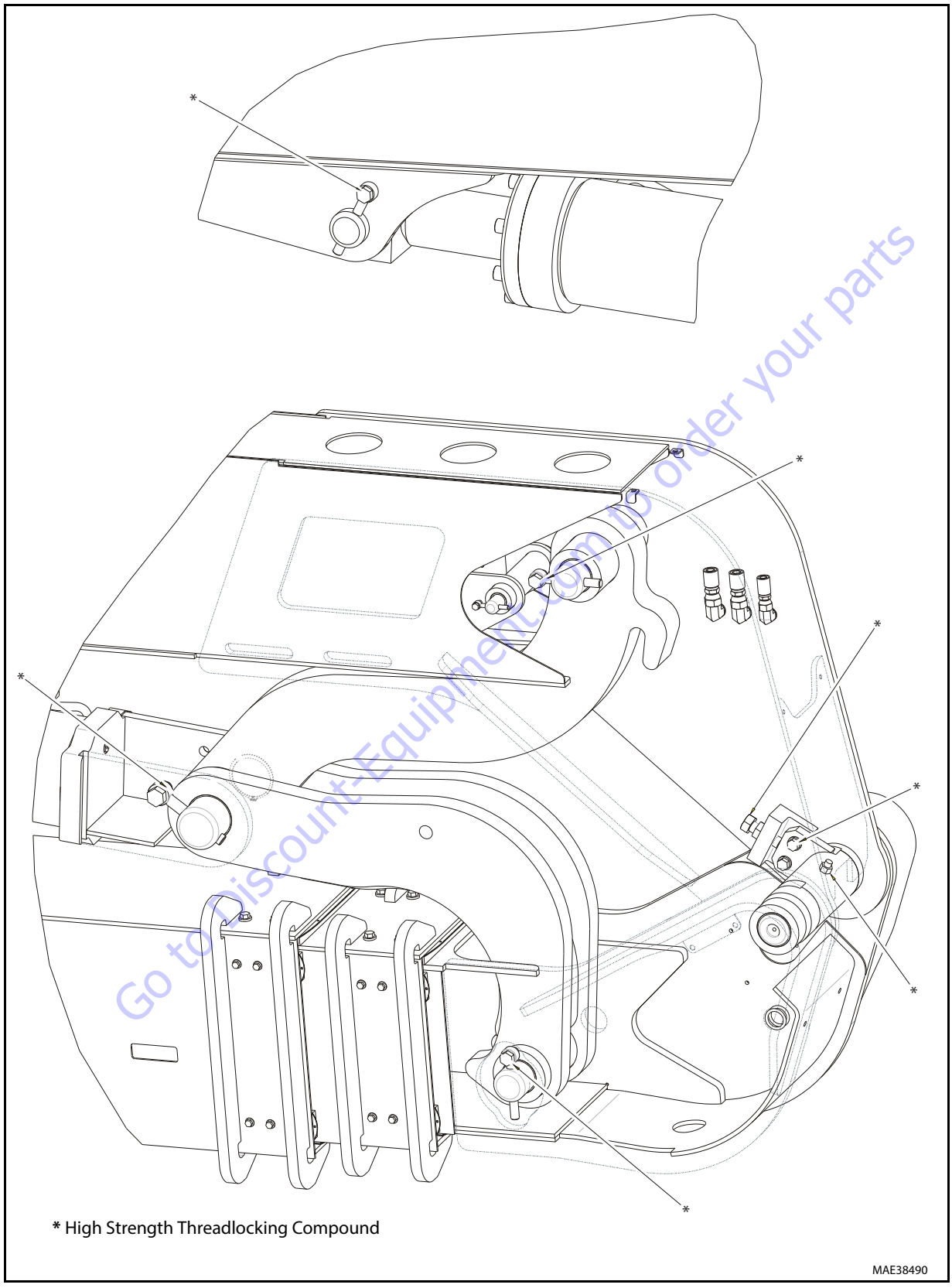


Figure 4-29. Locations for JLG Threadlocker Application - Sheet 5 of 5

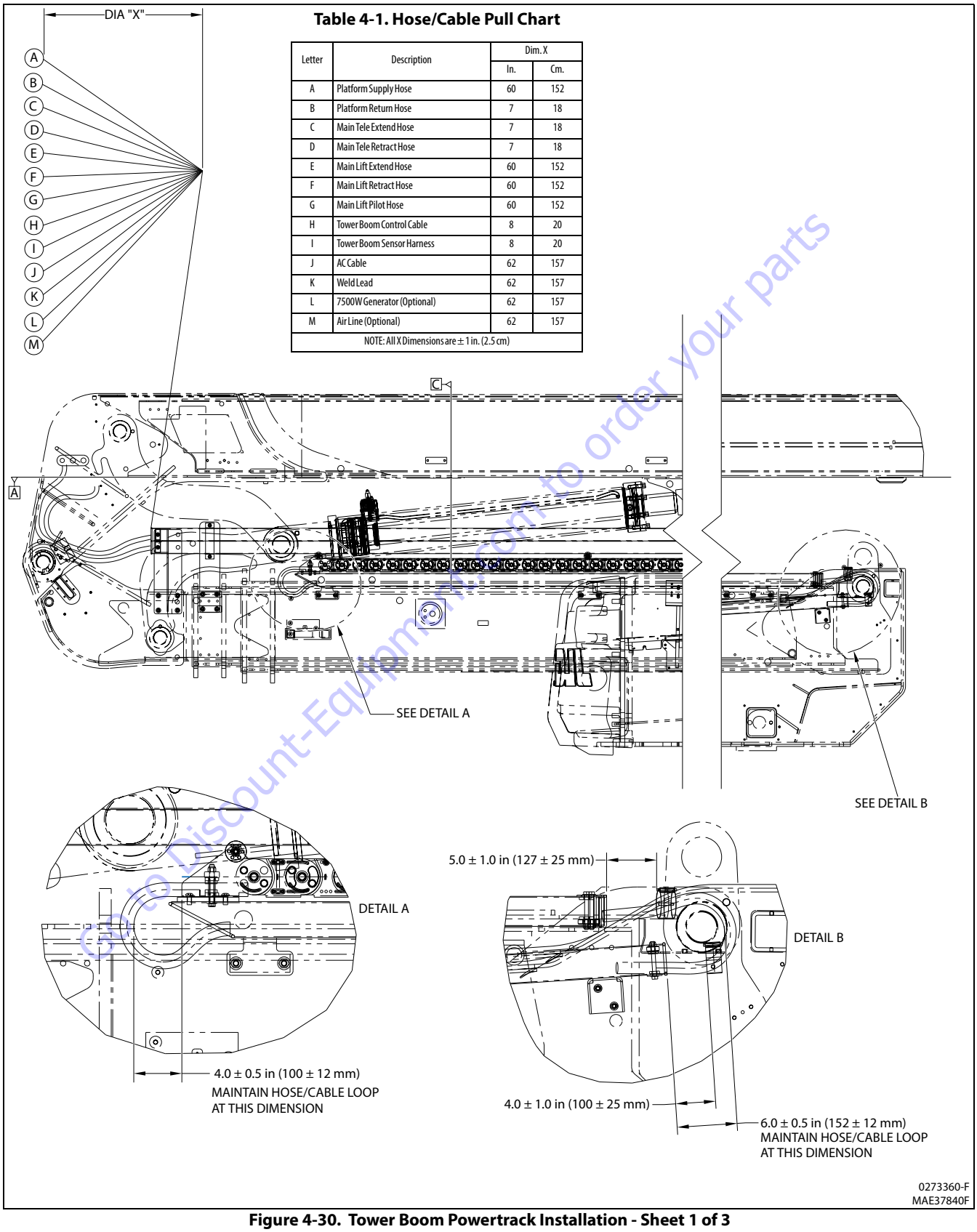


Table 4-1. Hose/Cable Pull Chart

Letter	Description	Dim. X	
		In.	Cm.
A	Platform Supply Hose	60	152
B	Platform Return Hose	7	18
C	Main Tele Extend Hose	7	18
D	Main Tele Retract Hose	7	18
E	Main Lift Extend Hose	60	152
F	Main Lift Retract Hose	60	152
G	Main Lift Pilot Hose	60	152
H	Tower Boom Control Cable	8	20
I	Tower Boom Sensor Harness	8	20
J	AC Cable	62	157
K	Weld Lead	62	157
L	7500W Generator (Optional)	62	157
M	Air Line (Optional)	62	157
NOTE: All X Dimensions are ± 1 in. (2.5 cm)			

Figure 4-30. Tower Boom Powertrack Installation - Sheet 1 of 3

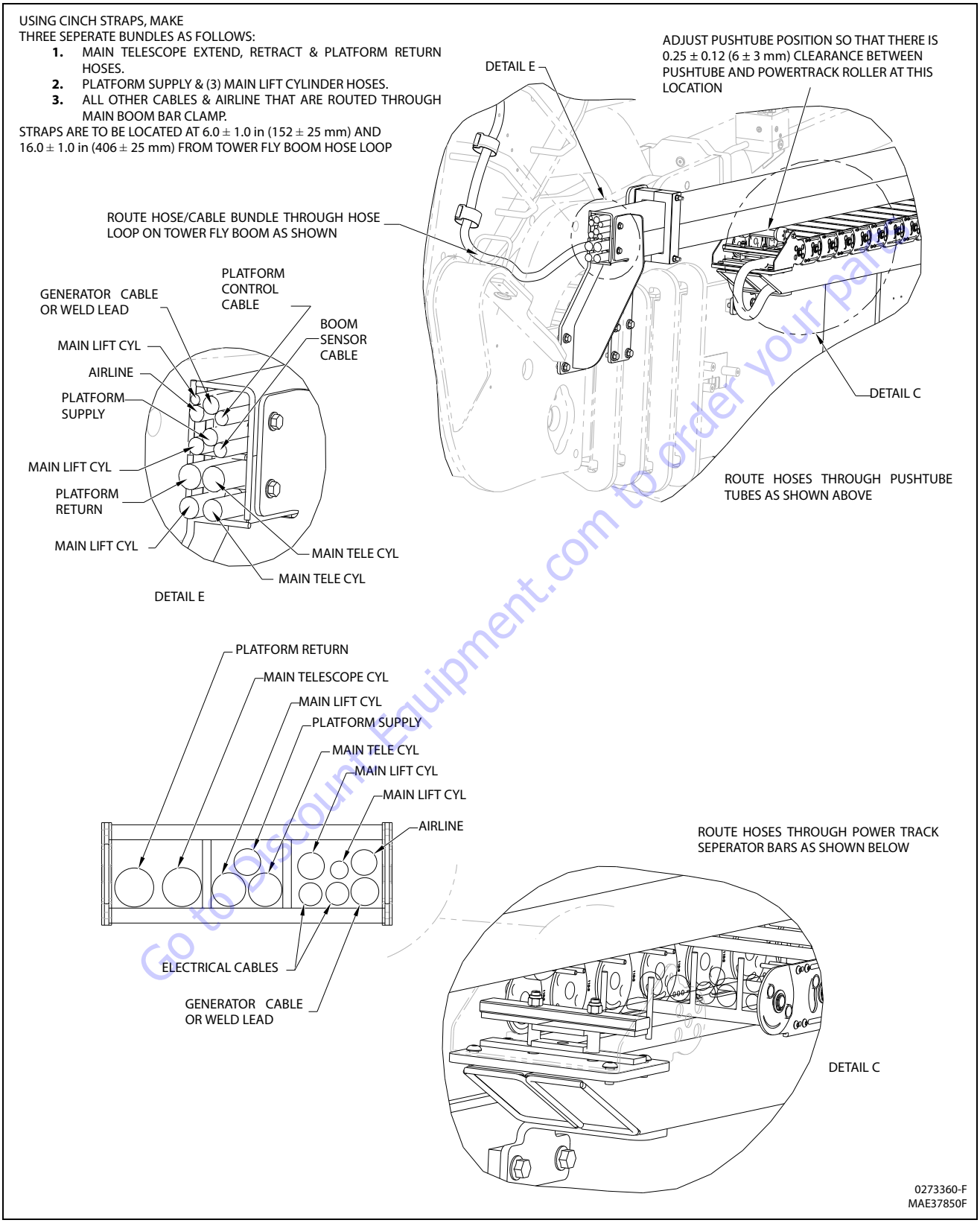


Figure 4-31. Tower Boom Powertrack Installation - Sheet 2 of 3

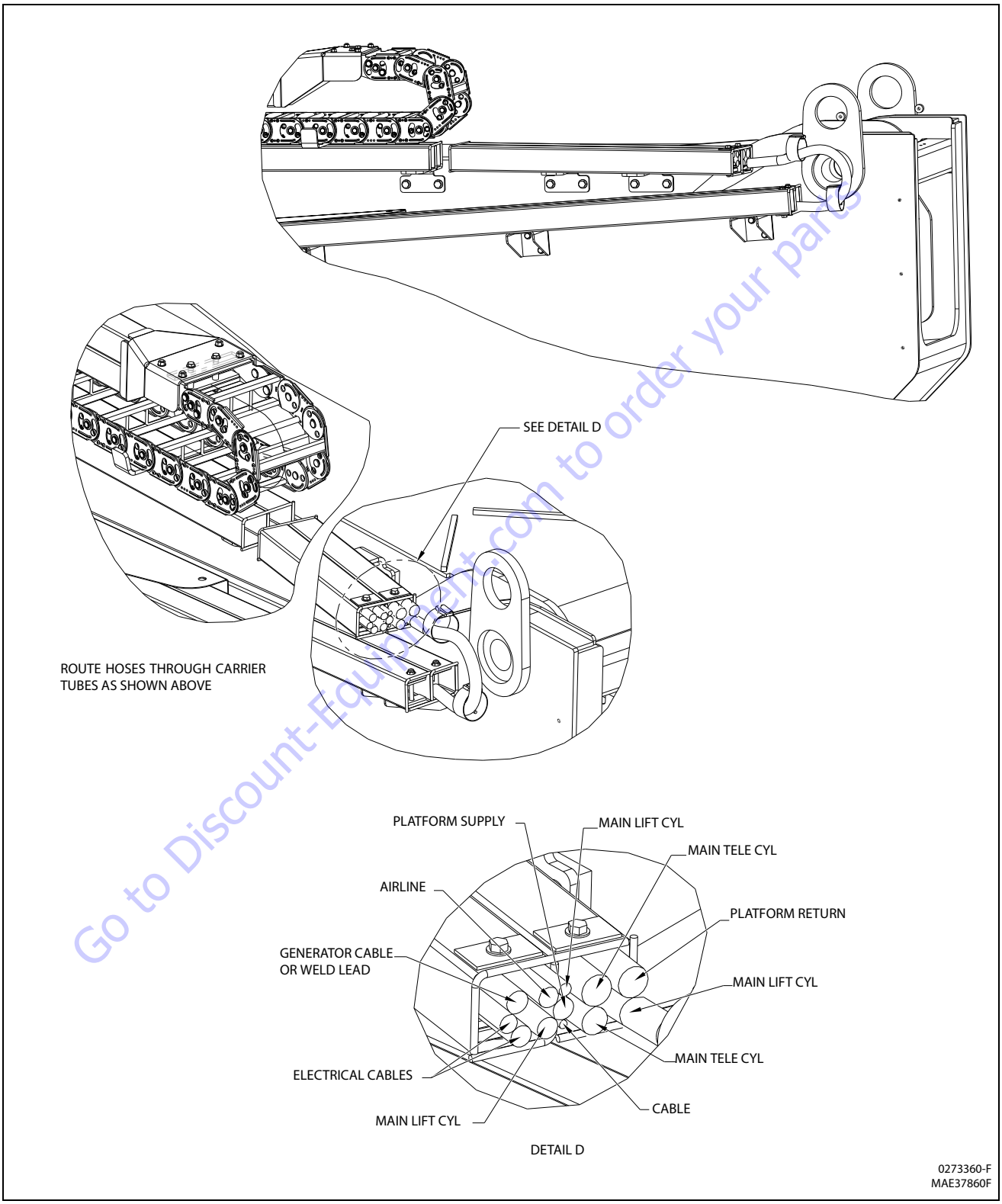
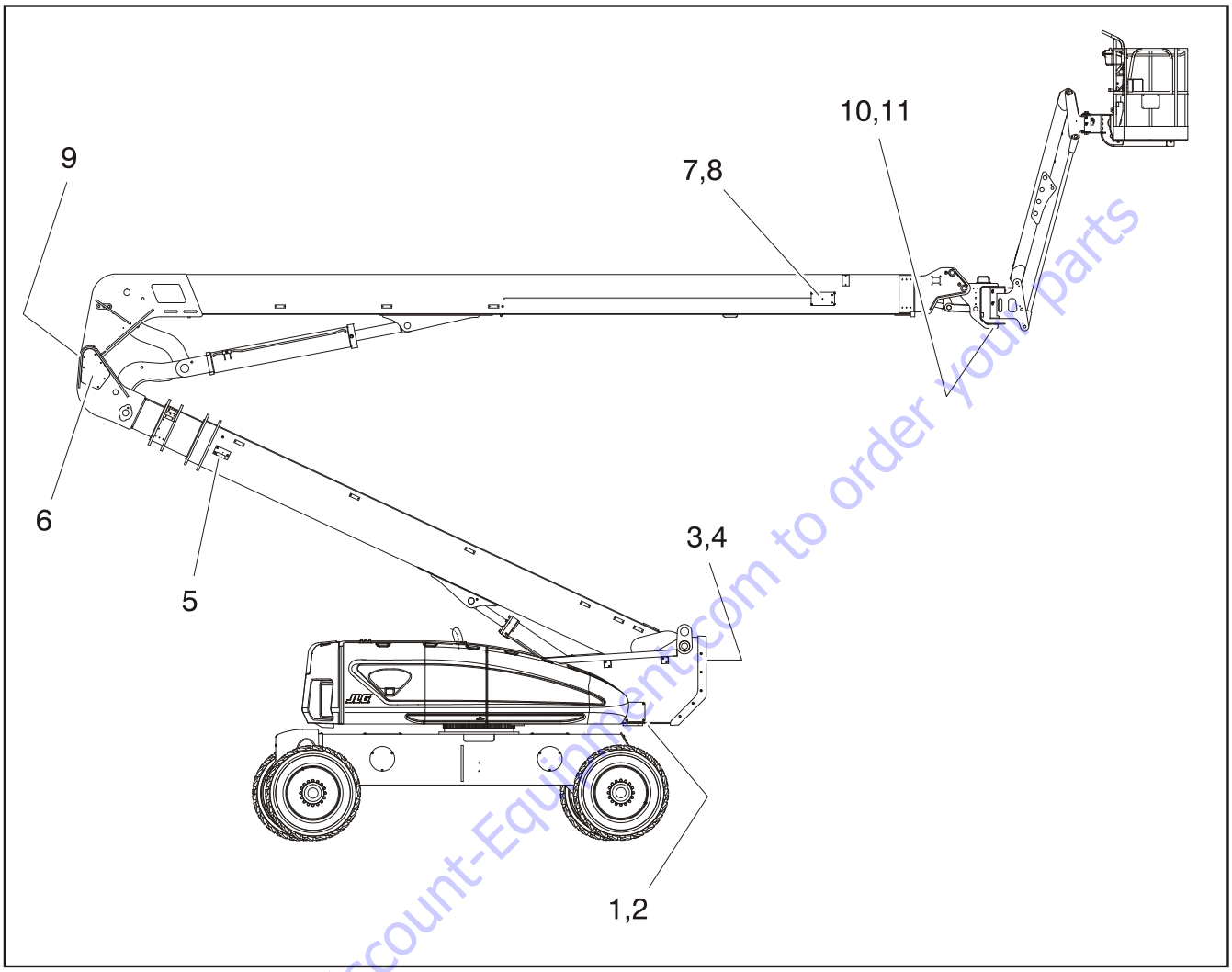


Figure 4-32. Tower Boom Powertrack Installation - Sheet 3 of 3



1. Tower Lift Cylinder Angle Sensor (1)
2. Load Pin (1)
3. Tower Angle Sensors (2)
4. Tower Length Sensors (2)
5. Tower Transport Length Switch (1)
6. Main Boom Angle Sensor (2)
7. Main Boom Transport Length Switch (2)
8. Dual Capacity Length Switch (2)
9. Main Boom Transport Angle Switch (1)
10. Jib Stow Switch (1)
11. Dual Capacity Jib Position Switch (1)

Figure 4-33. Boom Sensor Locations Overall View - Sheet 1 of 2

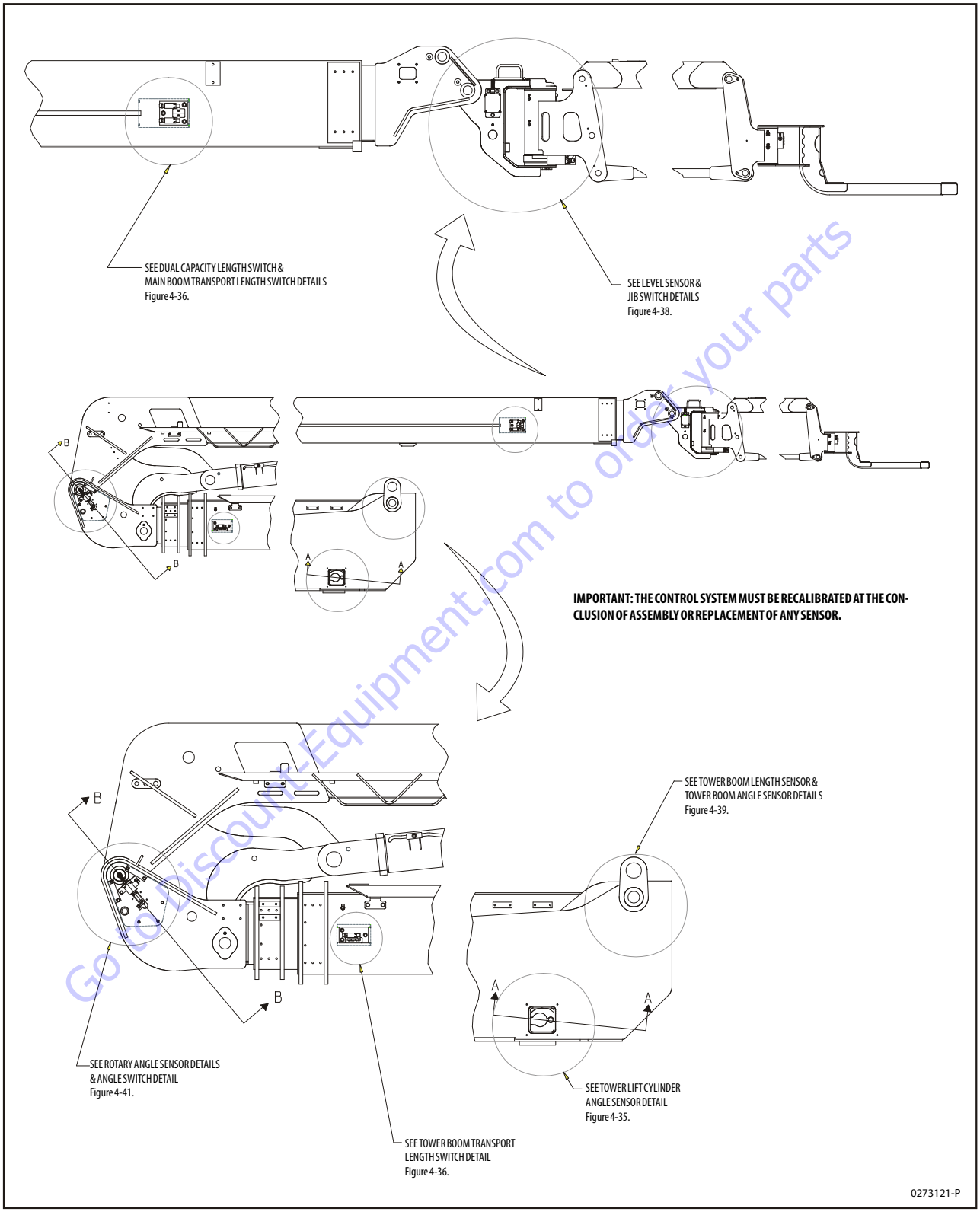


Figure 4-34. Boom Sensor Locations Overall View - Sheet 2 of 2

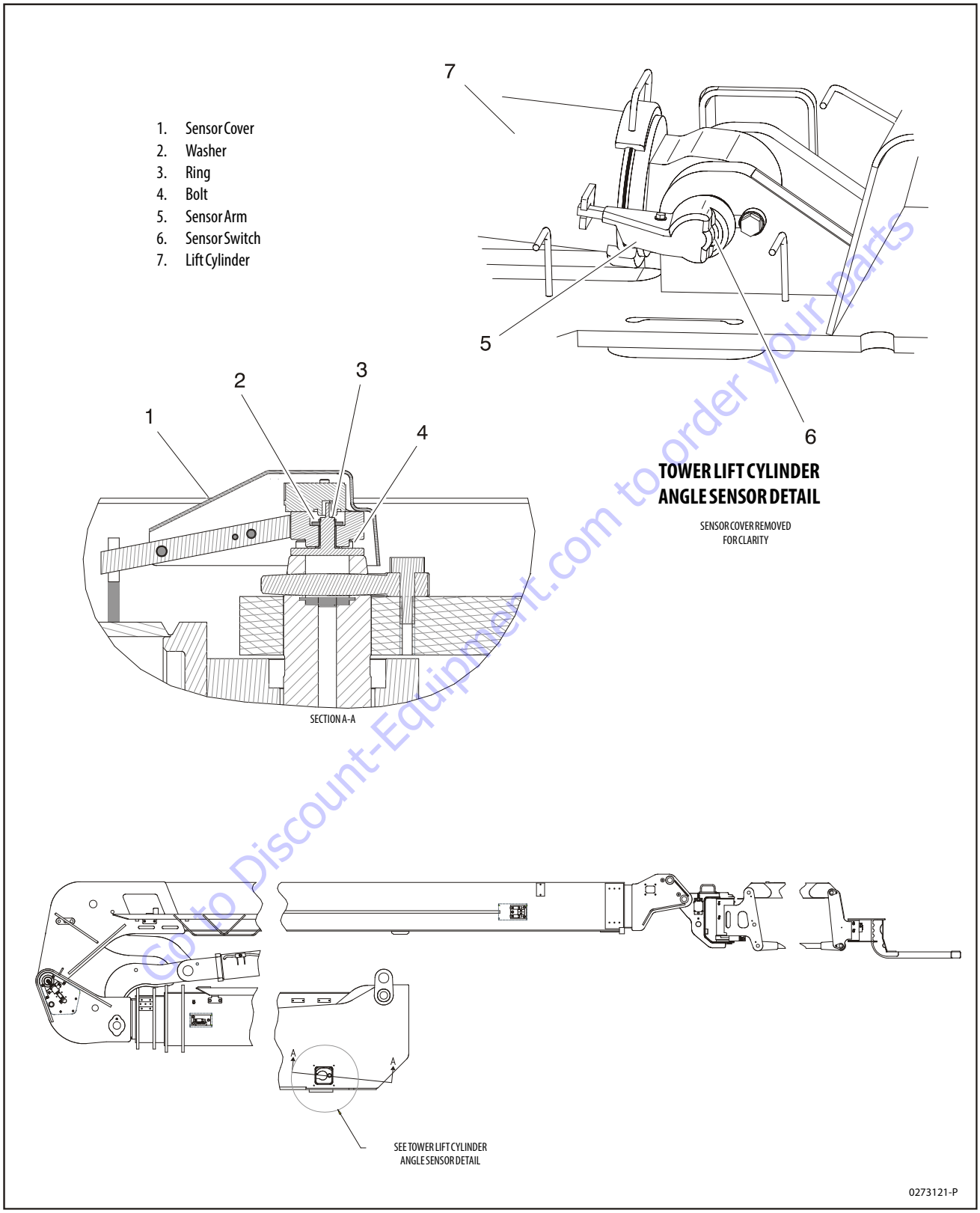


Figure 4-35. Boom Sensor Locations - Tower Lift Cylinder Angle Sensor

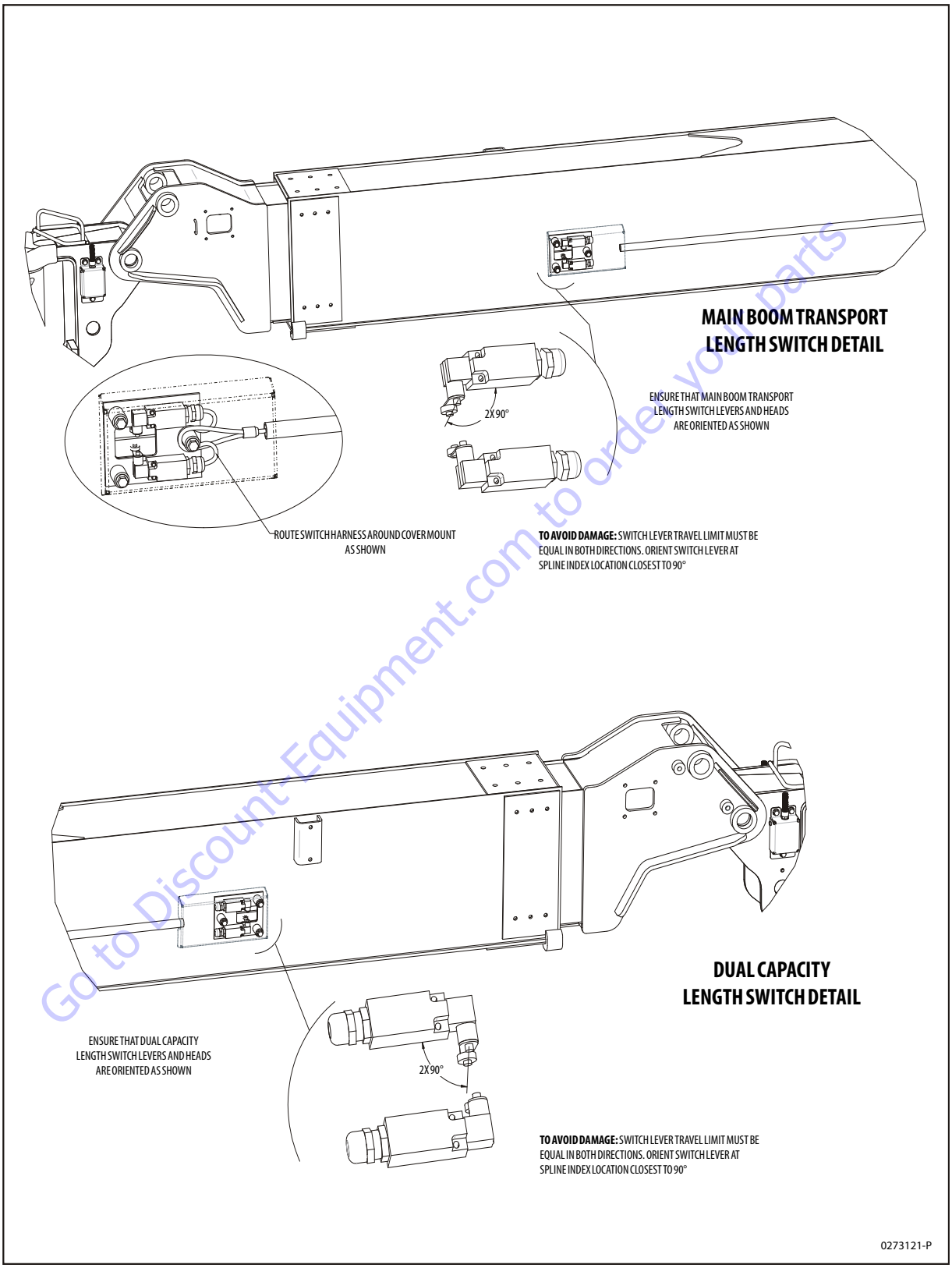


Figure 4-36. Boom Sensor Locations - Dual Capacity, Length, & Main Boom Transport

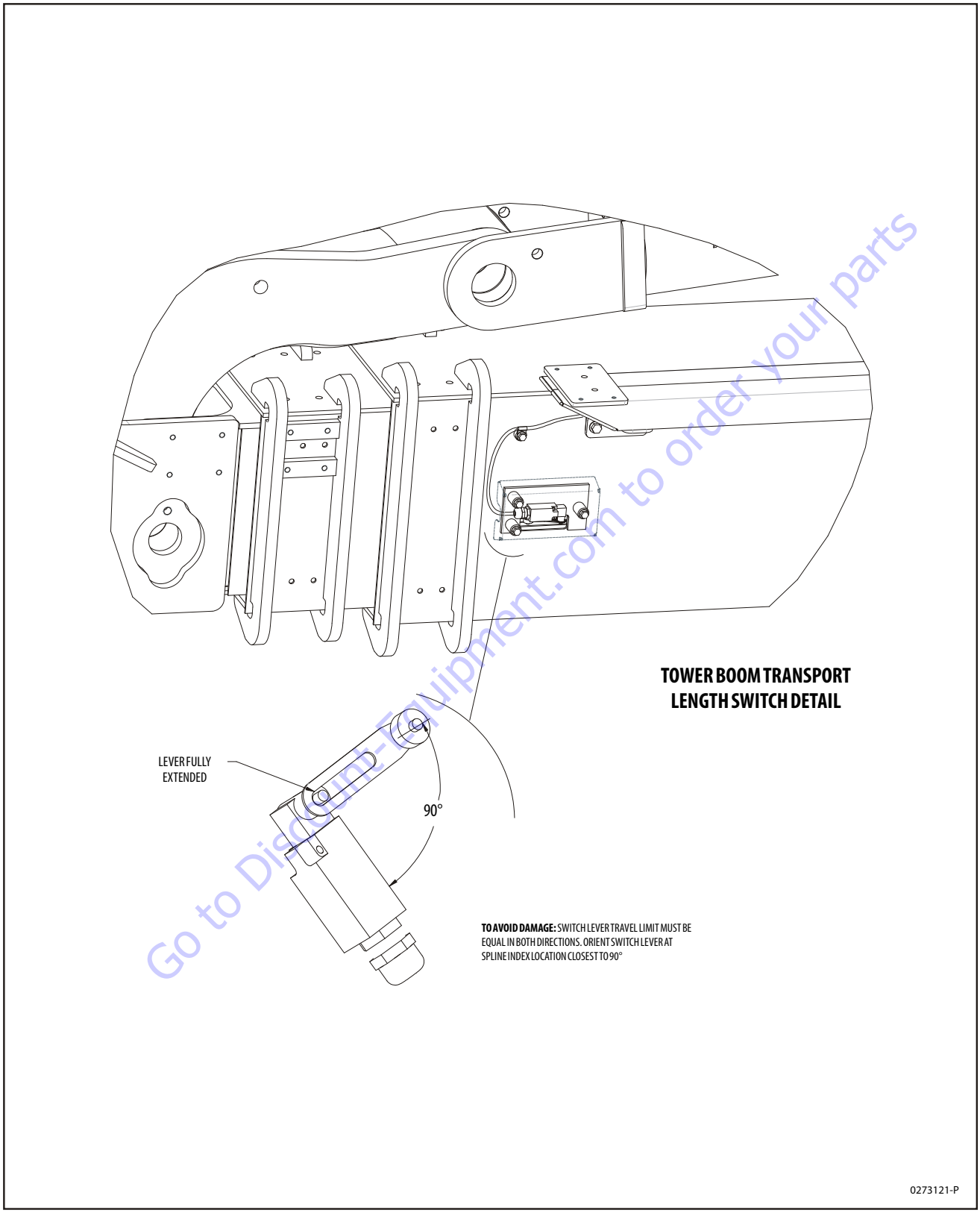


Figure 4-37. Boom Sensor Locations - Tower Boom Transport Length

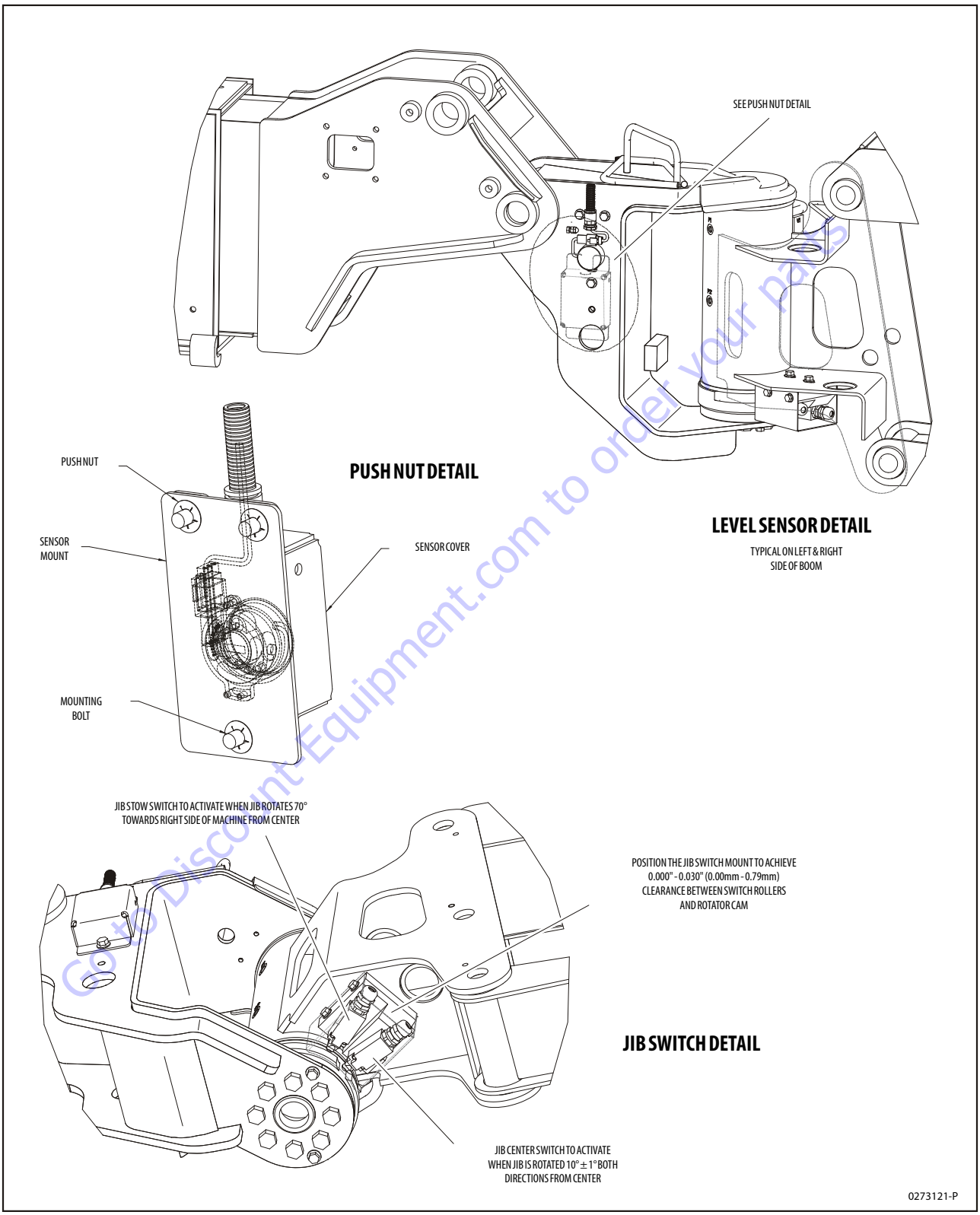


Figure 4-38. Boom Sensor Locations - Level & Jib Position Switches

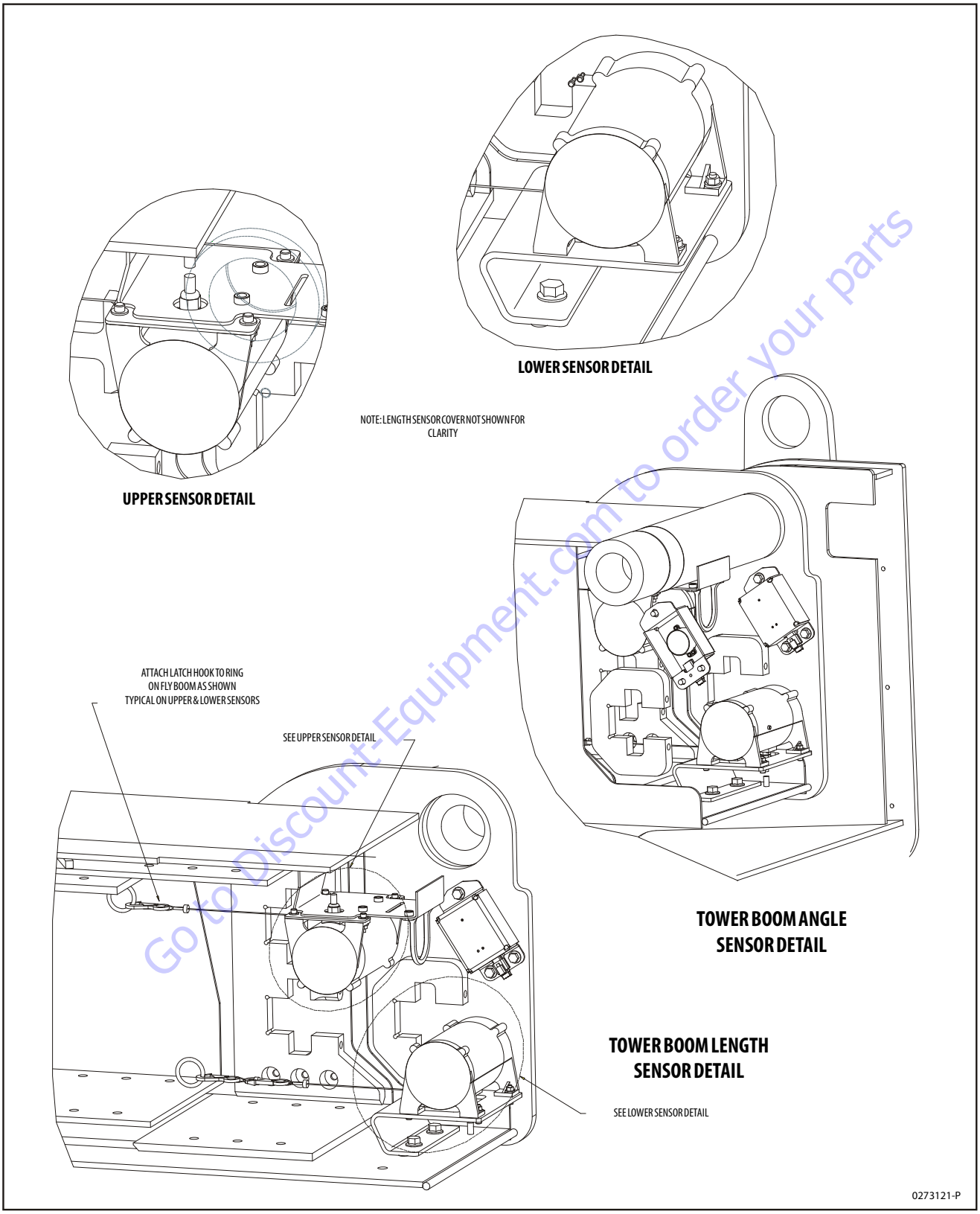


Figure 4-39. Boom Sensor Locations - Upper Length, Lower Length, & Tower Boom Angle - Sheet 1 of 2

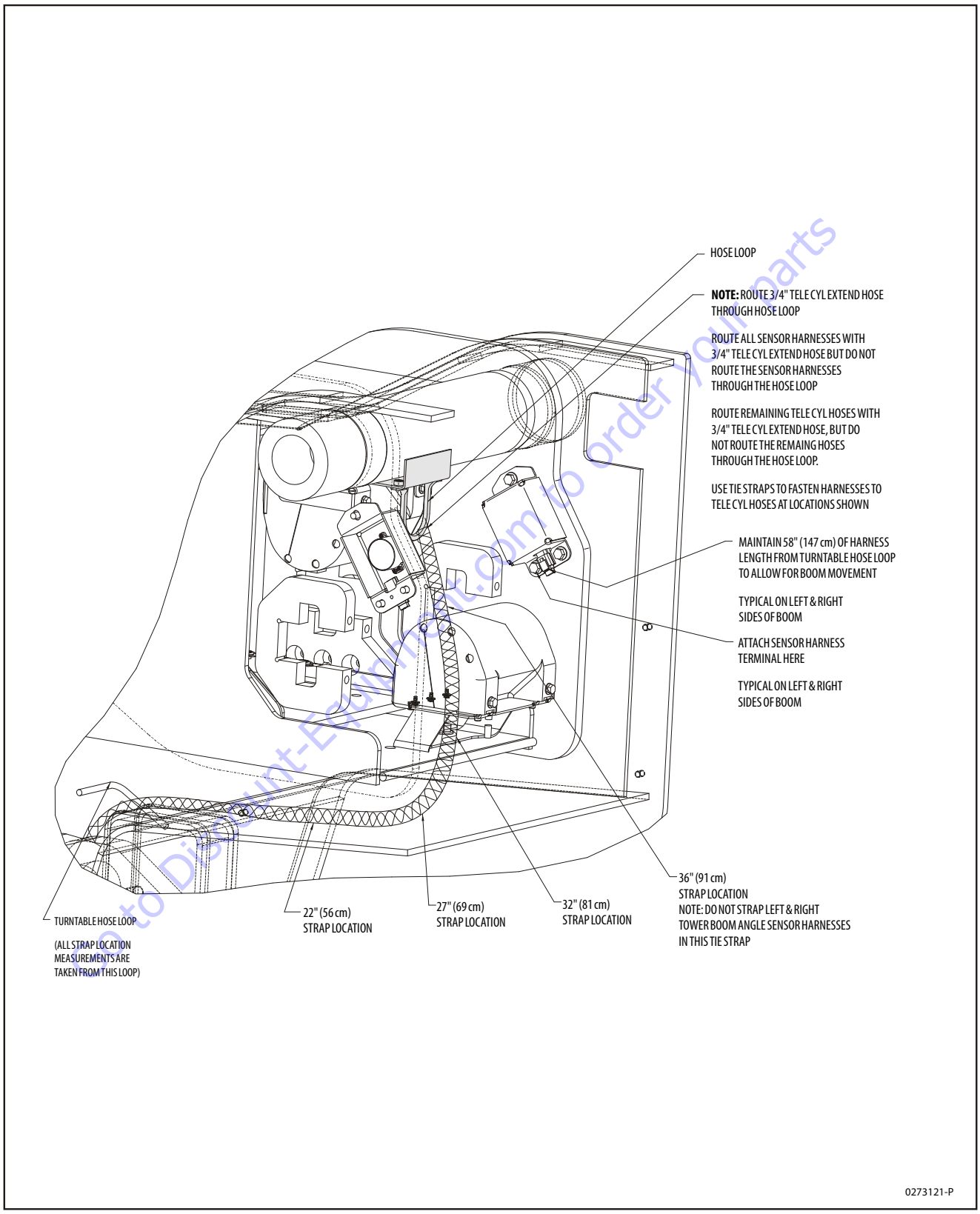


Figure 4-40. Boom Sensor Locations - Upper Length, Lower Length, & Tower Boom Angle - Sheet 2 of 2

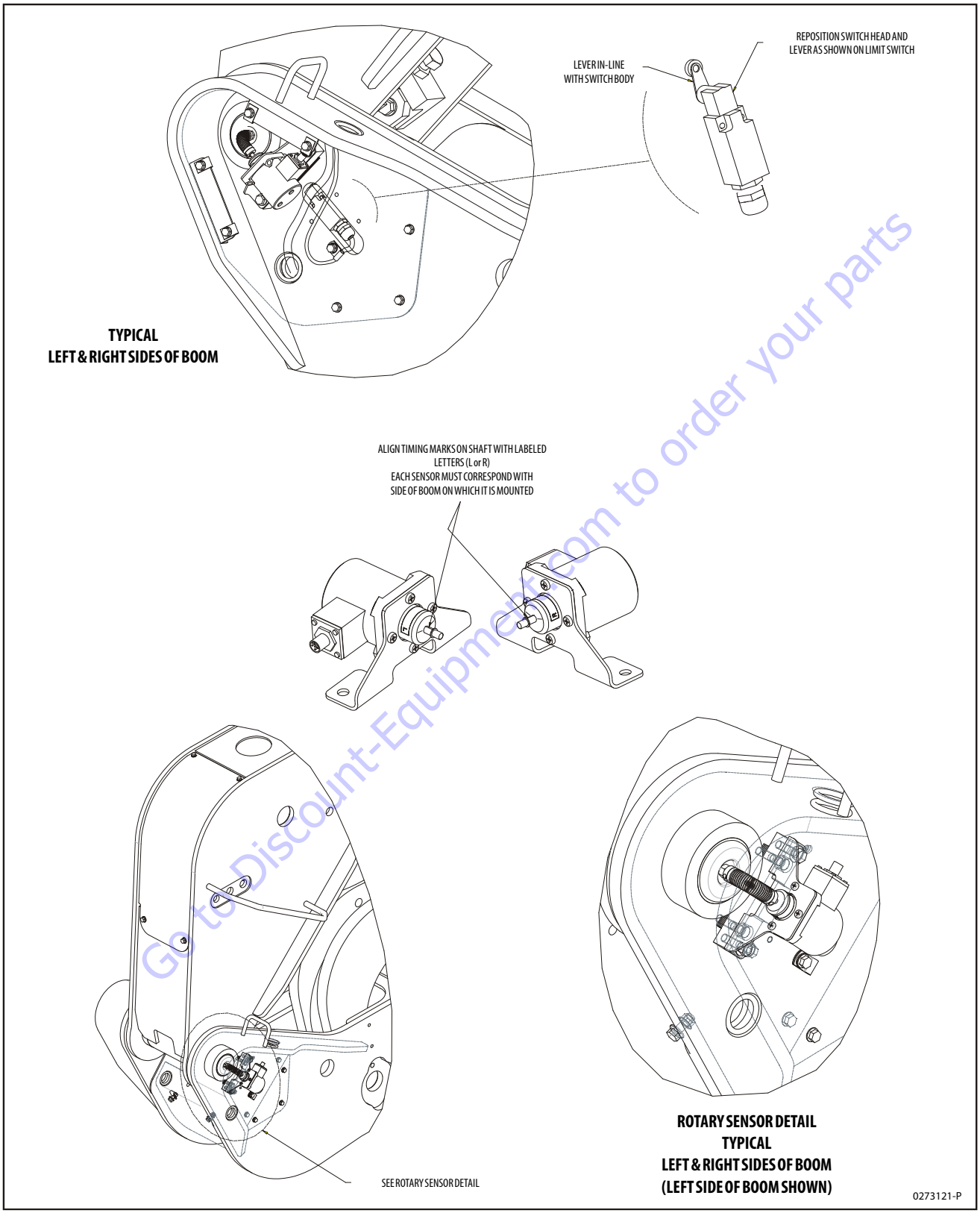


Figure 4-41. Boom Sensor Locations - Rotary Angle & Proximity Sensor - Sheet 1 of 2

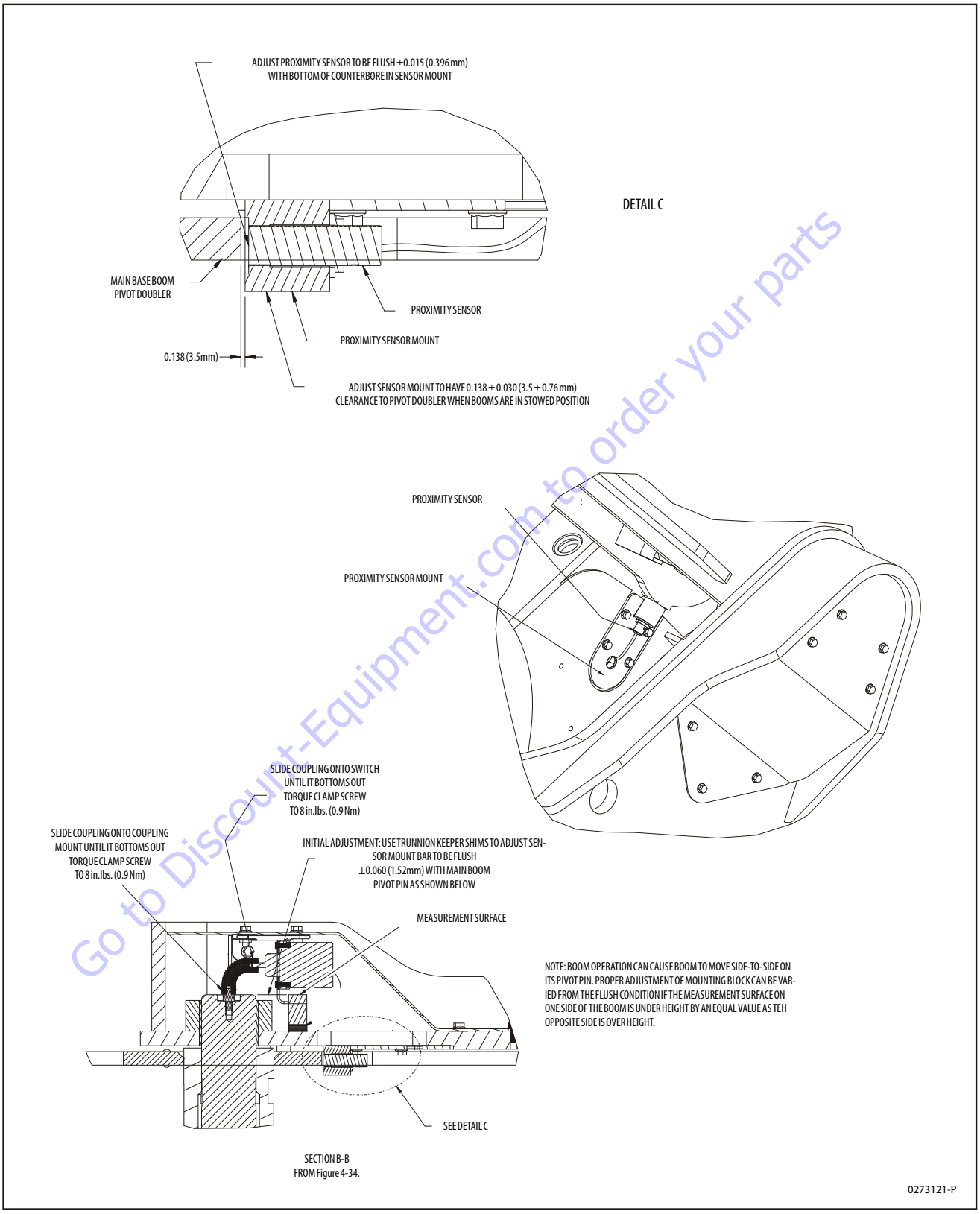


Figure 4-42. Boom Sensor Locations - Rotary Angle & Proximity Sensor - Sheet 2 of 2

4.21 MAIN BOOM TRANSPORT ANGLE SWITCH

See Figure 4-36., Boom Sensor Locations - Dual Capacity, Length, & Main Boom Transport and Figure 4-43., Main Boom Transport Angle Switch Wiring

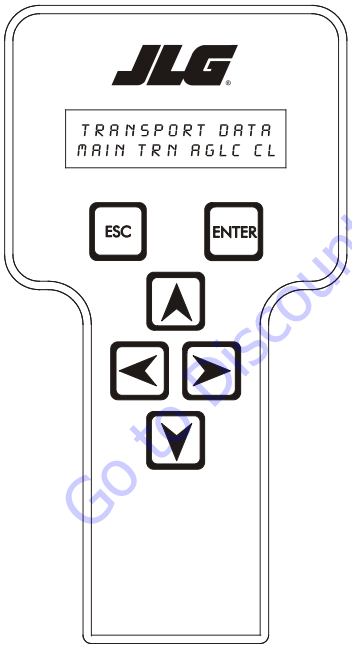
The Main Boom Transport Angle Switch is located on the left side of the tower fly boom underneath the cover. This switch is used as a backup for the rotary angle sensors and trips (activates) when the main boom is approximately 15° above the tower boom. It is used to find the transport position in the event of a rotary angle sensor failure and also used during Electrical Retrieval (see Section 4.9, Electrical Retrieval System) to assist in determining the angle of the main boom when a fault is detected to any sensor in the Envelope Control System (see Section 4.6, Envelope Control System).

While conducting boom sensor calibration (see Section 6.15, Boom Sensor Calibration), “position 2” states to lift up the main boom to stop. The control system will stop the main boom lift up function at the main boom angle limit switch trip point (approx 15°).

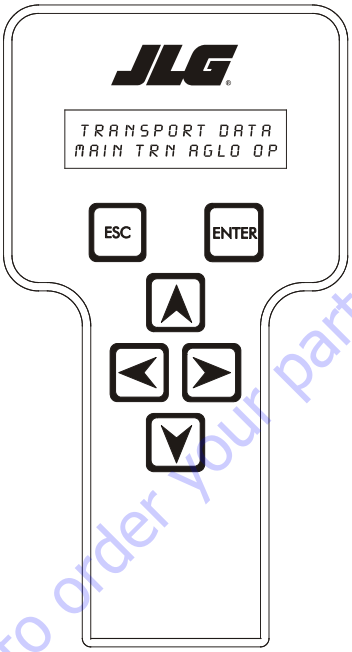
Analyzer Readings

The analyzer reading for these switches can be found in the Diagnostics menu under Transport Data.

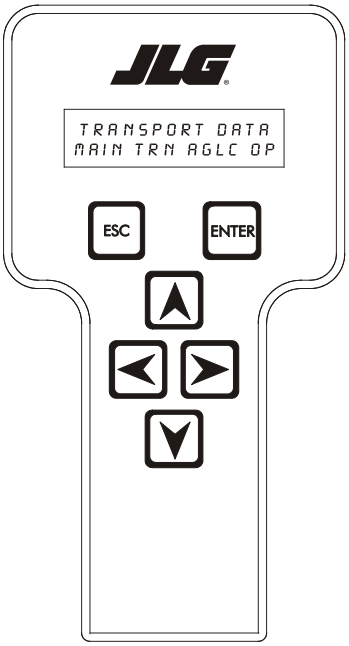
In the Transport position, the screen should read:



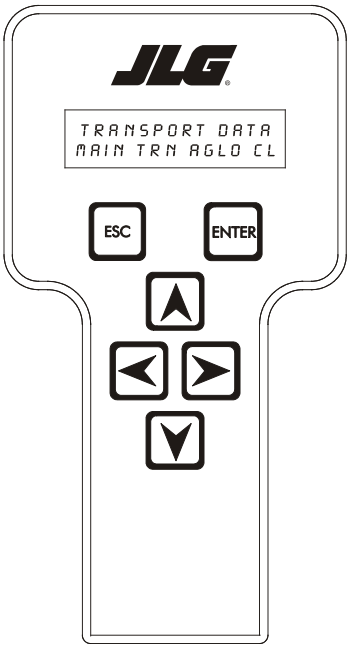
and



In the OUT of transport position, the screen should read



and



Possible Faults

1. Stuck Switch

- 8/4 Fault Code
- MAIN BOOM TRN AGL SW/SENSOR DISAGREEMENT Analyzer message.

2. Wire Broken/Disconnected

- 8/4 Code Fault Code
- MAIN BOOM TRN AGL SW FAILED Analyzer message

4.22 TOWER TRANSPORT LENGTH SWITCH

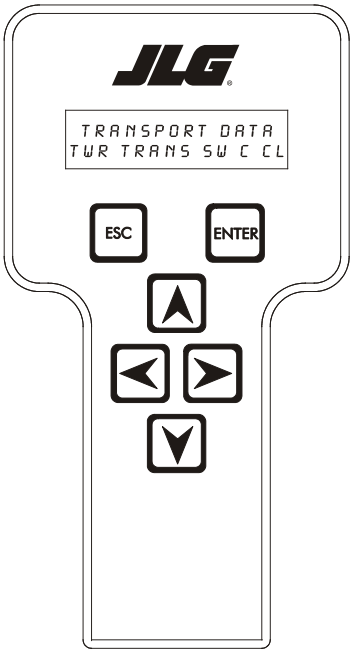
See Figure 4-36., Boom Sensor Locations - Dual Capacity, Length, & Main Boom Transport and Figure 4-44., Tower Transport Length Switch Wiring

The Tower Transport Length Switch is located on the left side of the tower base boom underneath the cover. This switch is used as a backup for the tower boom string pot length sensors and trips (activates) when the tower boom is extended approximately 7" (18 cm). It is used to find the transport position in the event of a tower length sensor failure and during Electrical Retrieval (see Section 4.9, Electrical Retrieval System) to assist in determining the length of the tower boom when a fault is detected to any sensor in the Envelope Control System (see Section 4.6, Envelope Control System).

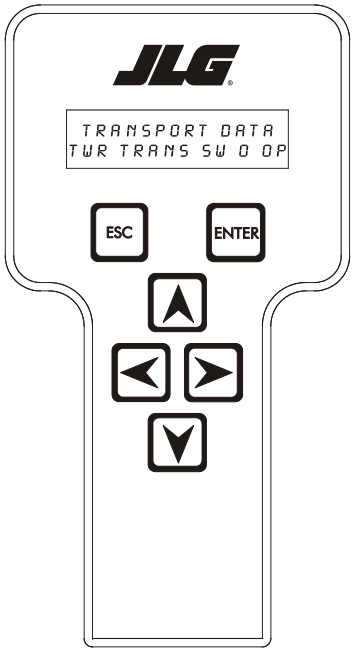
Analyzer Readings

The analyzer reading for these switches can be found in the Diagnostics menu under Transport Data.

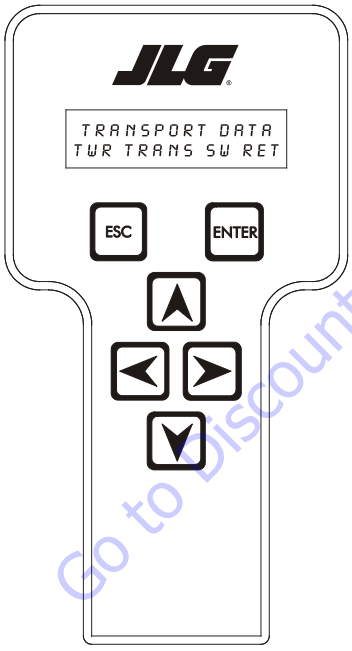
In the Transport position, the screen should read:



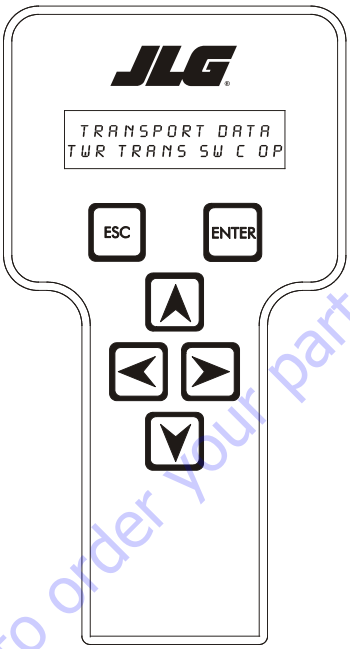
and



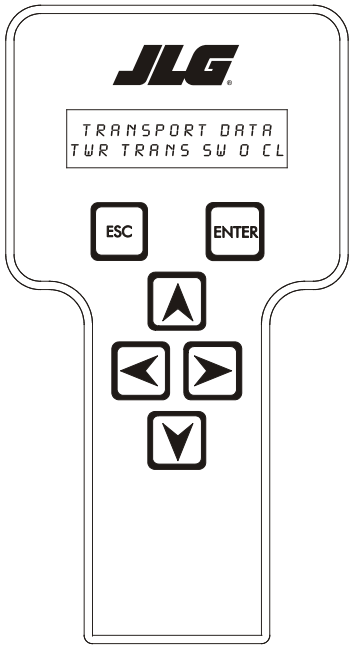
and



In the OUT of Transport position, the screen should read:



and



Possible Faults

1. Stuck Switch

- 8/4 Fault Code
- TWR LEN SW/SENSOR DISAGREEMENT Analyzer message.

2. Wire Broken/Disconnected

- 8/4 Code Fault Code
- TWR LEN SW DISAGREEMENT Analyzer message

4.23 MAIN BOOM TRANSPORT LENGTH SWITCHES

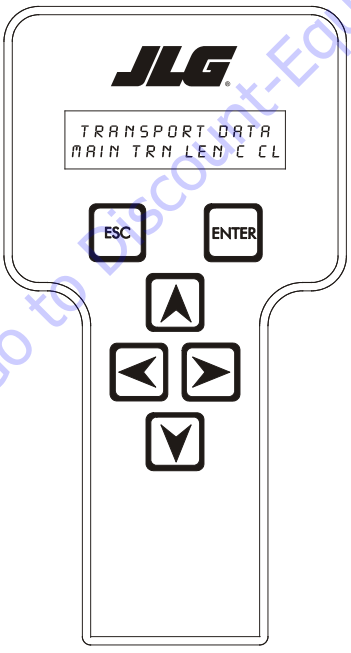
See Figure 4-36., Boom Sensor Locations - Dual Capacity, Length, & Main Boom Transport and Figure 4-45., Main Boom Transport Length Switch Wiring

The Transport Length Switches are located on the right side of the Main Base boom underneath the cover. These switches run on cams mounted to the upper fly boom to determine if the main boom is telescoped within or beyond the transport position. They also work with the Dual Capacity Switches to determine the length of the main boom to restrict the main boom length between the main boom angles of +55° and -45° for the 1000 lb (450 kg) envelope.

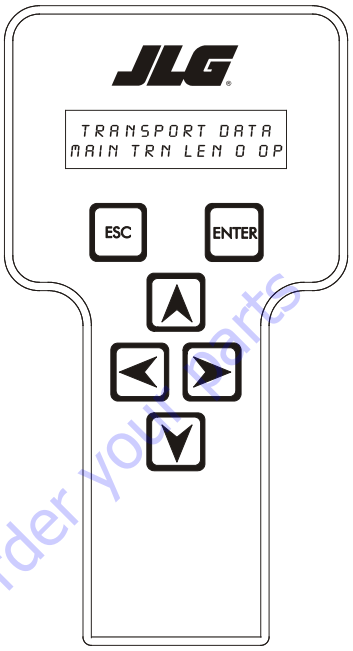
Analyzer Readings

The analyzer reading for these switches can be found in the Diagnostics menu under Transport Data.

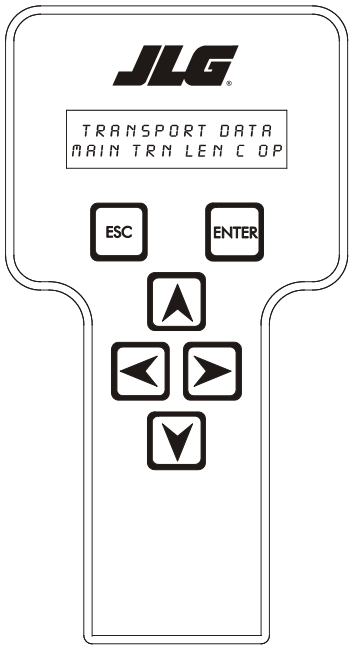
In Transport - Switch #1 off cam:



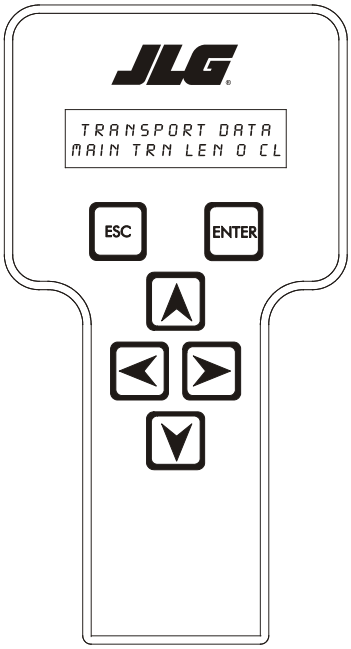
In Transport - Switch #2 on cam:



Out of Transport - Switch #1 on cam:



Out of Transport - Switch #2 off cam:



Possible Faults

1. Stuck Switch

- 8/4 Fault Code
- TRANS SW SW DISAGREEMENT* Analyzer message
  *This fault will not show up until telescope is activated.

2. Wire Broken/Disconnected

- 8/4 Code Fault Code
- TRANS SW SW DISAGREEMENT Analyzer message

4.24 DUAL CAPACITY SWITCHES

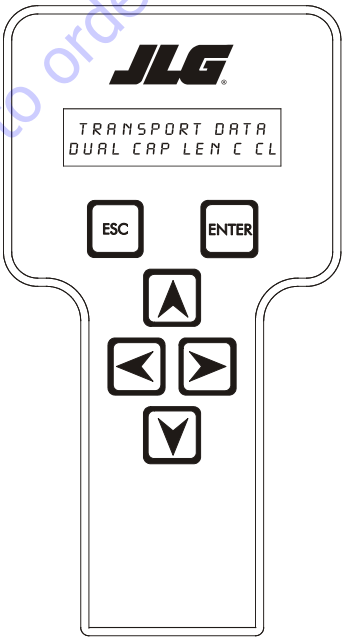
See Figure 4-36., Boom Sensor Locations - Dual Capacity, Length, & Main Boom Transport and Figure 4-46., Dual Capacity Switch Wiring

The Dual Capacity Switches are located on the left side of the Main Base boom underneath the cover. The Dual Capacity Switches along with the Main Boom Transport Length Switches run on a series of cams mounted on the fly boom to determine the length of the main boom. These switches restricts the main boom length between the main boom angles of +55° and -45° for the 1000 lb (450 kg) envelope.

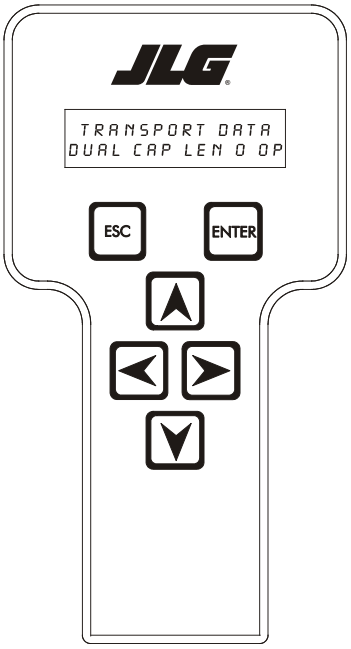
Analyzer Readings

The analyzer reading for these switches can be found in the Diagnostics menu under Transport Data.

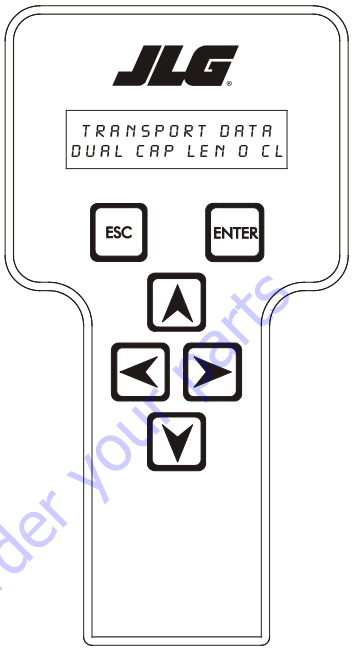
Switch #1 off cam:



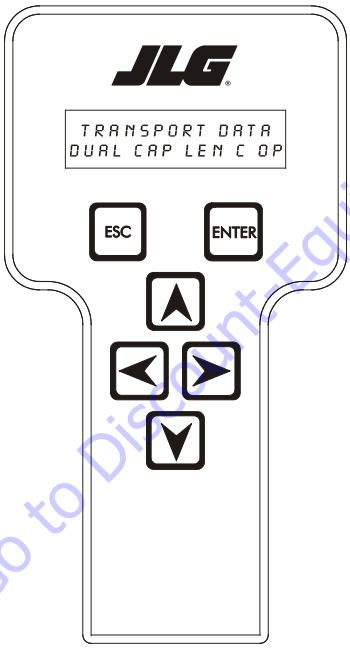
Switch #2 on cam:



Switch #2 off cam:



Switch #1 on cam:



Possible Faults

1. Stuck Switch

- 8/4 Fault Code
- CAP LEN SW DISAGREEMENT* Analyzer message
  *This fault will not show up until telescope is activated.

2. Wire Broken/Disconnected

- 8/4 Code Fault Code
- CAP LEN SW DISAGREEMENT Analyzer message

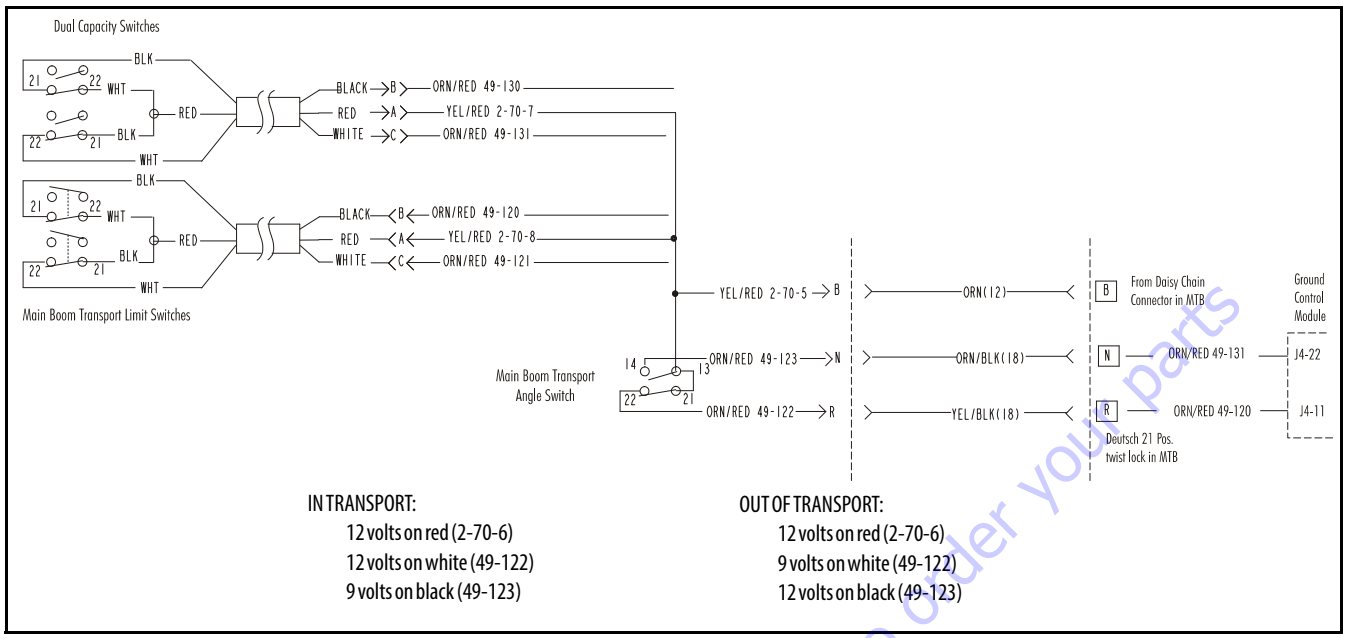


Figure 4-43. Main Boom Transport Angle Switch Wiring

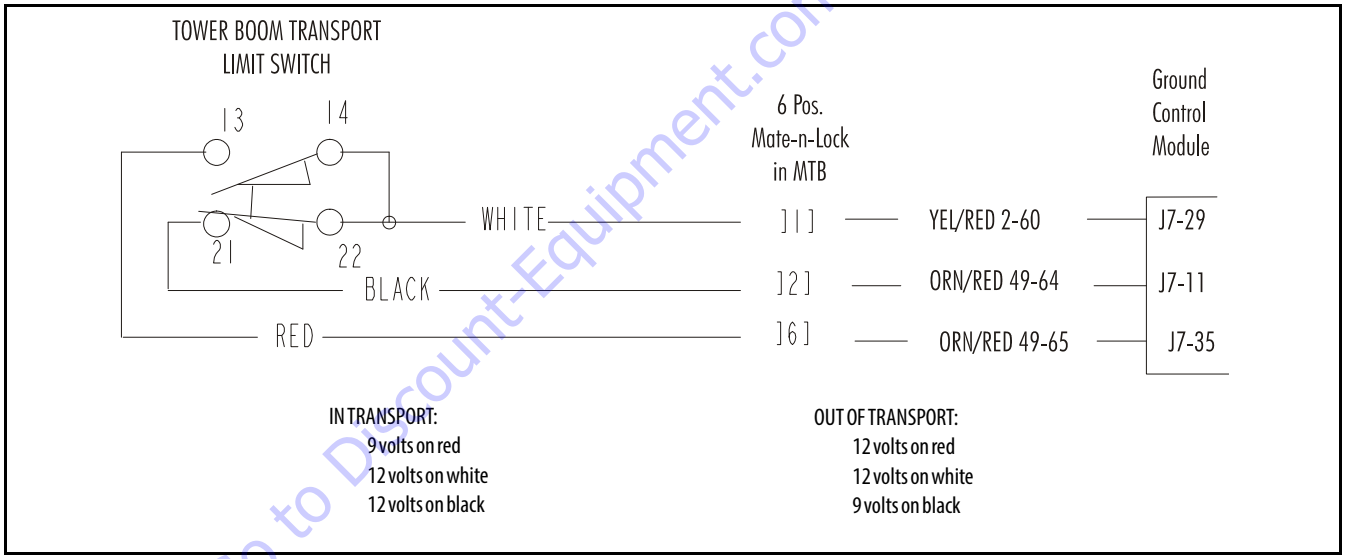
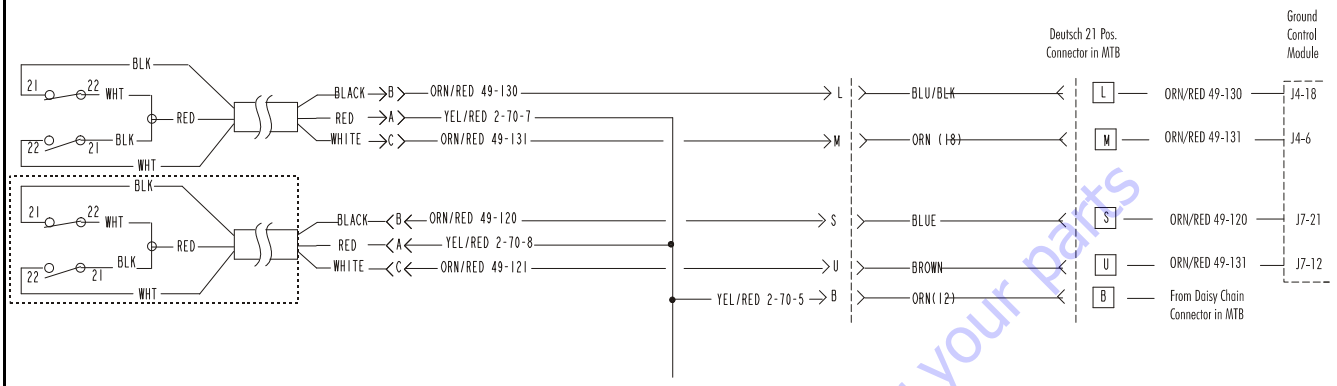


Figure 4-44. Tower Transport Length Switch Wiring

#1 MAIN BOOM TRANSPORT LIMIT SWITCH, MOUNTED ON THE RIGHT SIDE OF THE MAIN BOOM (TOP SWITCH). THIS SWITCH IS IN THE N.C. POSITION WHEN THE MAIN BOOM IS FULLY RETRACTED.

#2 MAIN BOOM TRANSPORT LIMIT SWITCH, MOUNTED ON THE RIGHT SIDE OF MAIN BOOM (BOTTOM SWITCH). THIS SWITCH IS OPEN WHEN THE MAIN BOOM IS FULLY RETRACTED.



IN TRANSPORT:
When Switch #1 (top switch) is off cam:
12 volts on white
12 volts on black

When Switch #2 (bottom switch) is on cam:
9 volts on white
12 volts on black

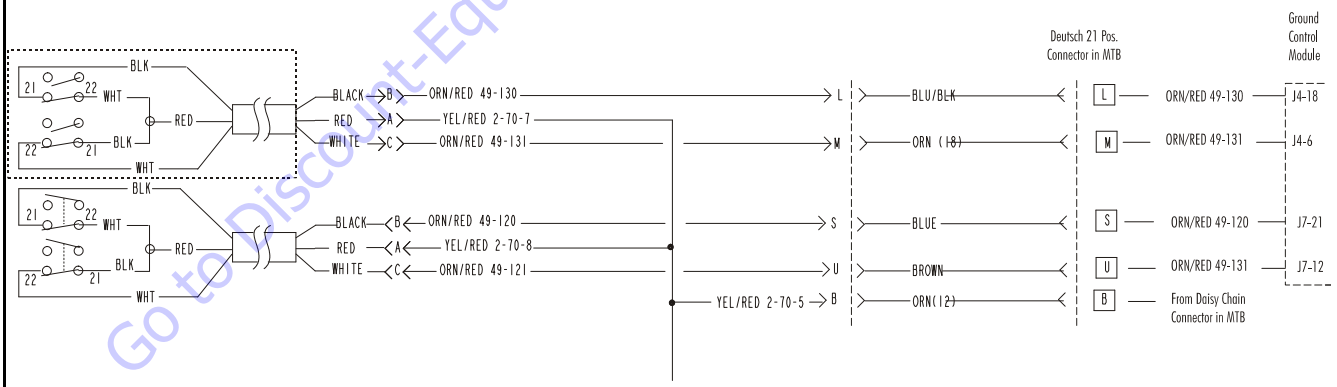
OUT OF TRANSPORT:
When Switch #1 (top switch) is on cam:
12 volts on white
9 volts on black

When Switch #2 (bottom switch) is off cam:
12 volts on white
12 volts on black

Figure 4-45. Main Boom Transport Length Switch Wiring

#1 DUAL CAPACITY LIMIT SWITCH, MOUNTED ON LEFT SIDE OF BOOM (TOP SWITCH). THIS SWITCH IS IN THE N.C. POSITION WHEN THE MAIN BOOM IS FULLY RETRACTED.

#2 DUAL CAPACITY LIMIT SWITCH, MOUNTED ON LEFT SIDE OF BOOM (BOTTOM SWITCH). THIS SWITCH IS OPEN WHEN THE MAIN BOOM IS FULLY RETRACTED.



When Switch #1 (top switch) is off cam:
12 volts on white
12 volts on black

When Switch #2 (bottom switch) is on cam:
9 volts on white
12 volts on black

When Switch #1 (top switch) is on cam:
12 volts on white
9 volts on black

When Switch #2 (bottom switch) is off cam:
12 volts on white
12 volts on black

Figure 4-46. Dual Capacity Switch Wiring

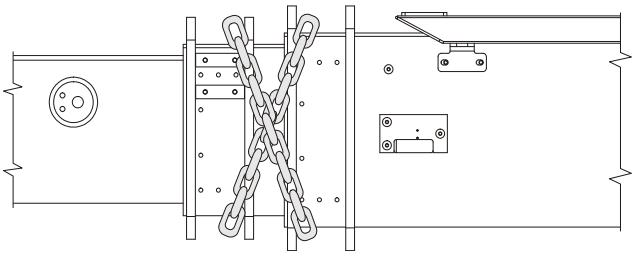
4.25 TOWER TELESCOPE CYLINDER

Removal

1. Place the machine on a firm, level surface with the axles fully extended or the turntable centered between the rear wheels.
2. Select lift up and raise the tower boom until it is in a horizontal position.

NOTE: *The main boom must be elevated approximately 12 inches (30 cm) above the boom rest but no more than 15° above the tower to prevent damage to the machine. Refer to Figure 4-47., Tower Telescope Only Restrictions.*

3. Support the main boom and tower boom in position using boom props or an adequate lifting device.
4. Chain the tower mid section to the tower base section to ensure that only the tower fly section will extend.



5. Position the Platform/Ground select switch to the Ground position.

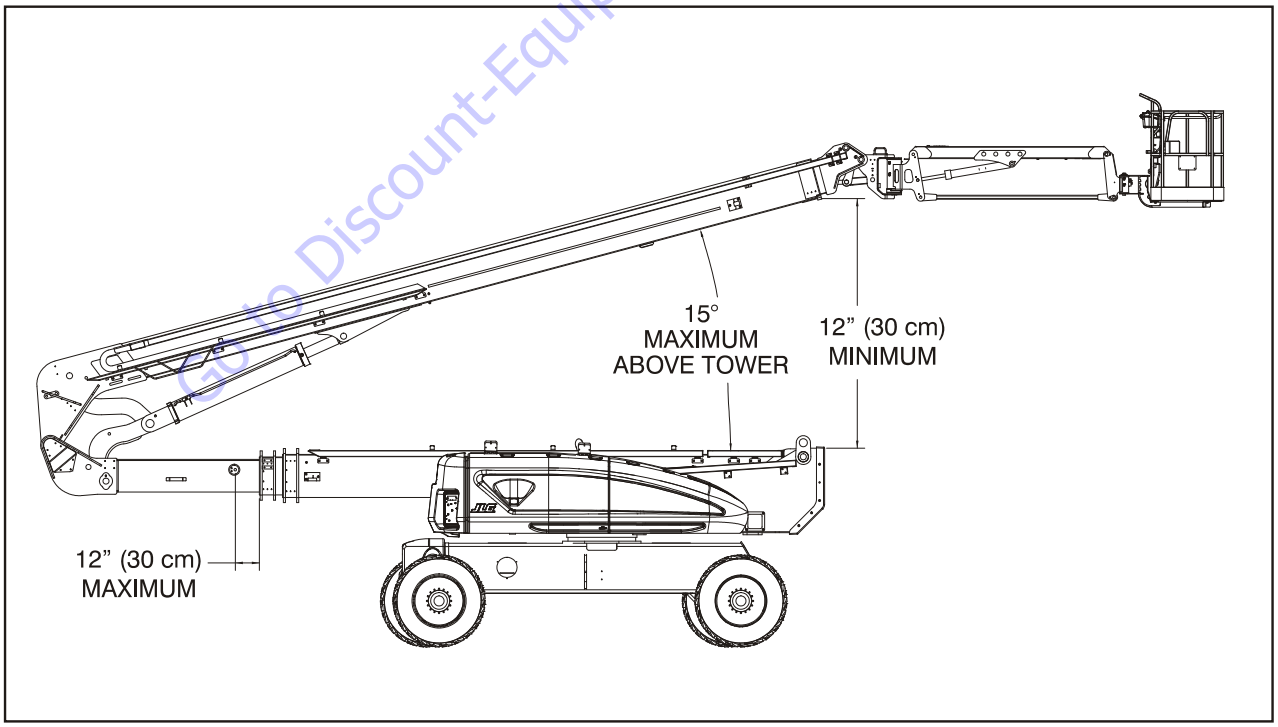
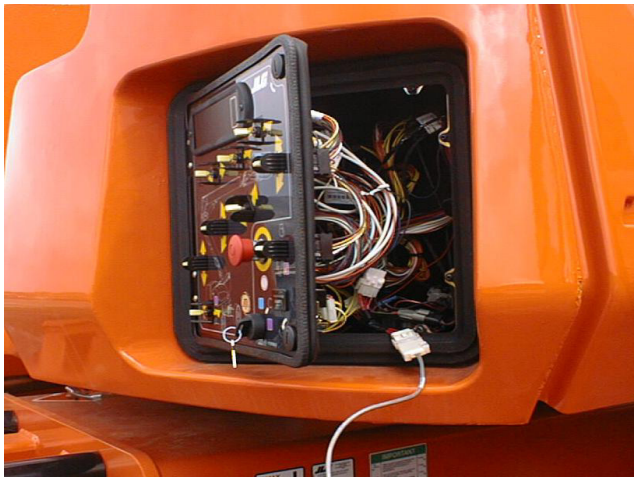
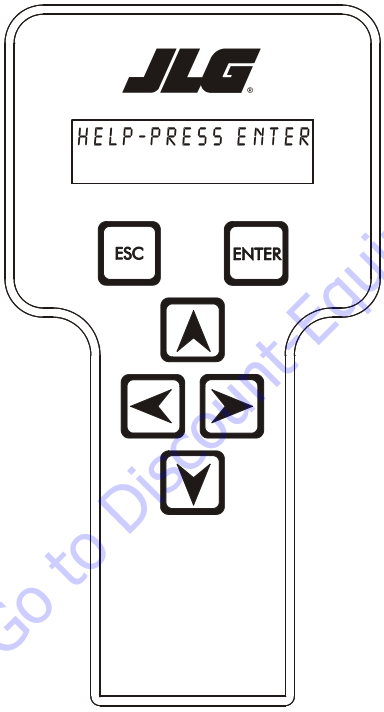


Figure 4-47. Tower Telescope Only Restrictions

6. Plug the analyzer into the connector inside the Ground control box.



7. Pull out the Emergency Stop switch and start the engine.
8. The analyzer screen should read:



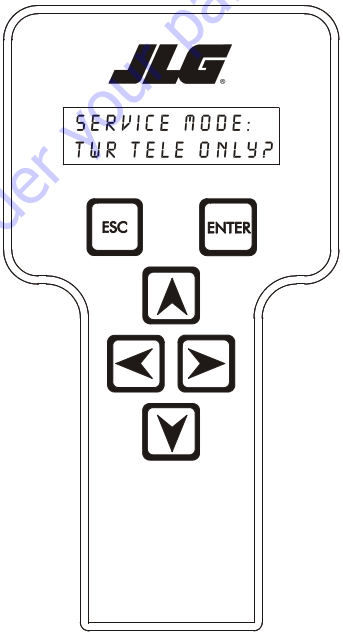
9. Use the arrow button to reach ACCESS LEVEL 2. Press the ENTER key.
10. Enter the Access Code, 33271 to get into Access Level 1 mode.

NOTE: *The service mode will only be displayed on the analyzer when in access level 1 in the ground mode and be hidden while in access level 2.*

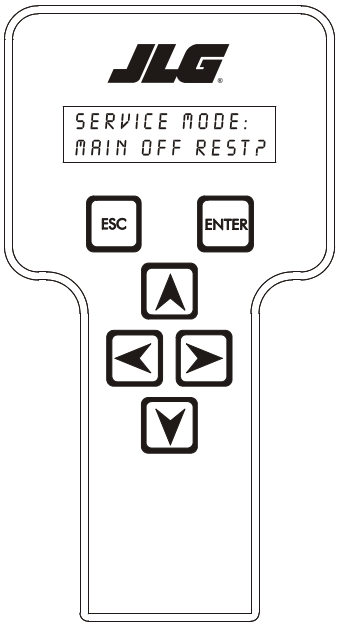
NOTICE

THE SERVICE MODE MENU WILL BE SELECTABLE AT THE TOP LEVEL OF THE ANALYZER MENU STRUCTURE. "SERVICE MODE" WILL BE DISPLAYED ON THE TOP LINE OF THE ANALYZER WITH THE CURRENT SUB-MENU SELECTION ON THE BOTTOM LINE. THE SUB-MENUS WILL SCROLL WITH THE LEFT AND RIGHT ARROW KEYS.

11. Scroll through the analyzer menu until "SERVICE MODE" is displayed. Press the ENTER key.
12. Scroll through the menu until "TWR TELE ONLY?" is displayed as shown below.



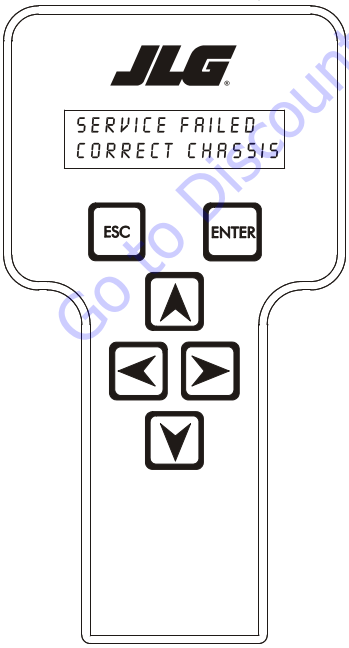
13. Press ENTER. The analyzer will read:



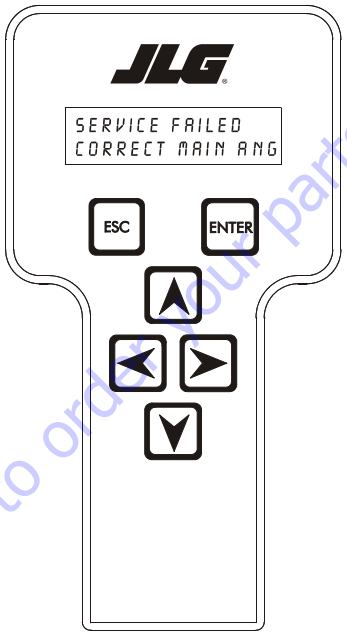
NOTE: *The main boom must be elevated approximately 12 inches (30 cm) above the boom rest but no more than 15° above the tower to prevent damage to the machine. Refer to Figure 4-47., Tower Telescope Only Restrictions.*

14. Press the ENTER key, the control system will perform the following checks:

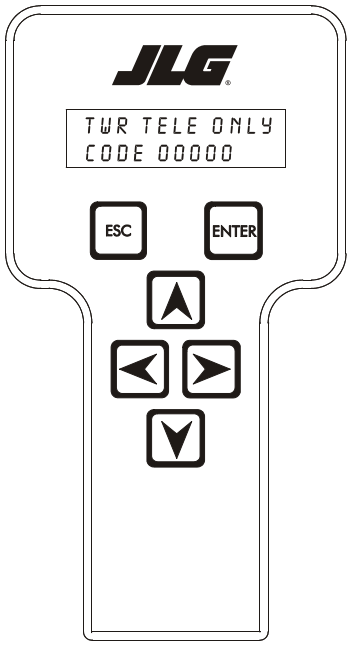
The axles must be extended or the DOS (Direction of Steering) switch must indicate the turntable is between the rear tires, otherwise the analyzer will read:



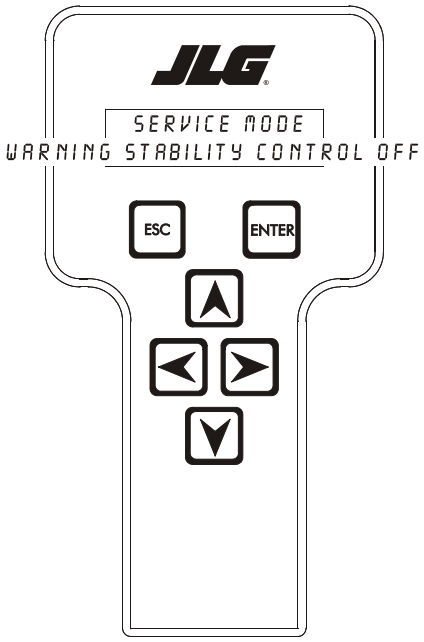
If the main boom angle sensors are calibrated and working properly the control system will verify the main boom angle readings are between +0.0° and +15.0° (ref tower boom). If they are calibrated and working properly and outside the angle limits, the analyzer will read:



15. After the successful completion of the checks, the analyzer will read:



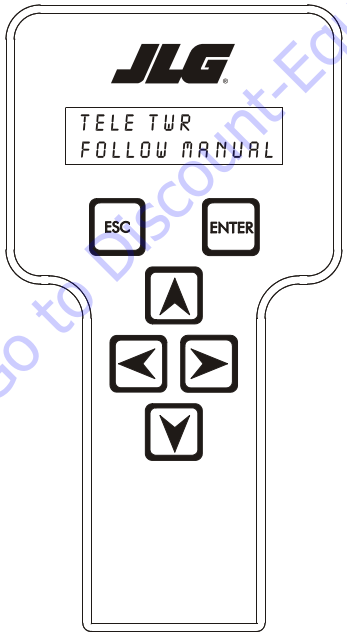
16. Enter code 95268. The analyzer will read:



⚠ DANGER

WHEN THE STABILITY CONTROL IS OFF THE MACHINE *WILL* TIP IF USED INCORRECTLY.

17. Press the ENTER key to acknowledge the stability control is turned off. The analyzer should read:

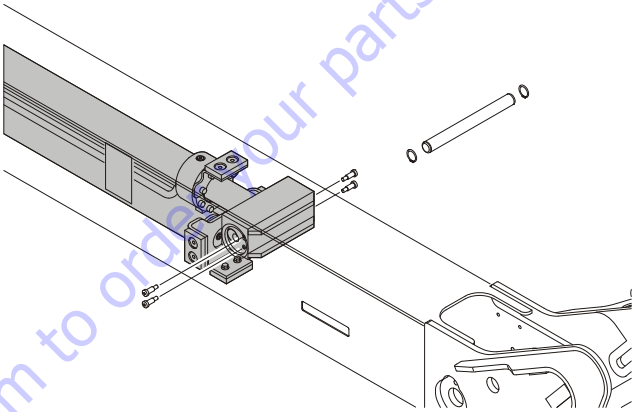


18. The control system will now allow only tower telescope using the tower lift switch on the ground console.

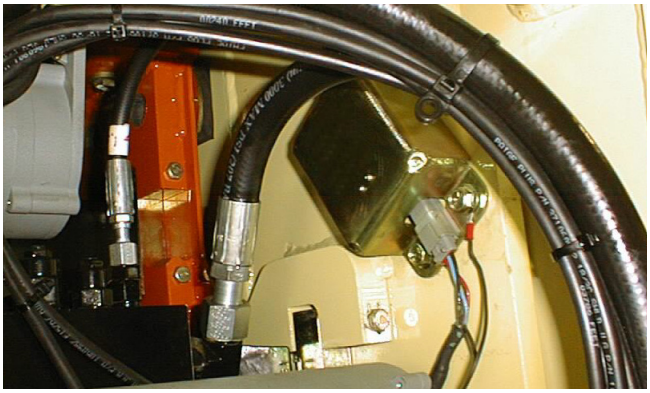
⚠ DANGER

BEFORE CONTINUING WITH THIS PROCEDURE, DOUBLE CHECK ALL SUPPORTING DEVICES AND MID BOOM RESTRAINING CHAIN.

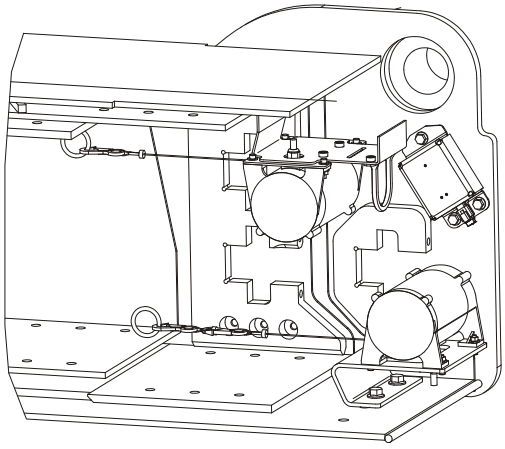
19. Extend the tower fly section no more than necessary to gain access to the telescope cylinder retaining pin (about 5.5 ft. [1.7 m]). When access is gained to the telescope cylinder retaining pin, remove the four shoulder bolts and two snap rings that hold it in place and remove the telescope cylinder retaining pin.



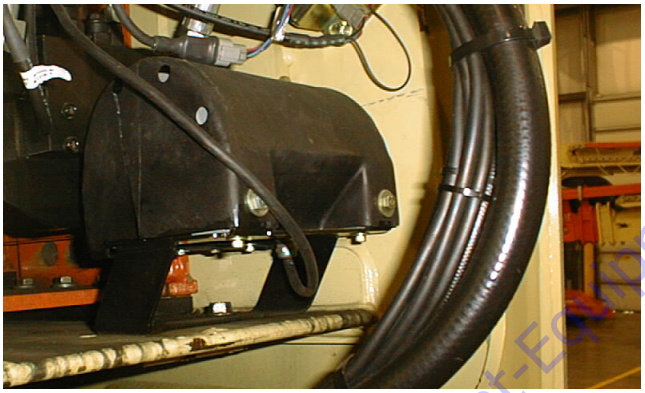
20. At the rear of the tower boom, tag and disconnect the wires going to the angle sensors. Remove the bolts and washers that fasten the angle sensors to the boom section and remove the angle sensors.



21. Disconnect the length sensor cables from the tower boom fly section.



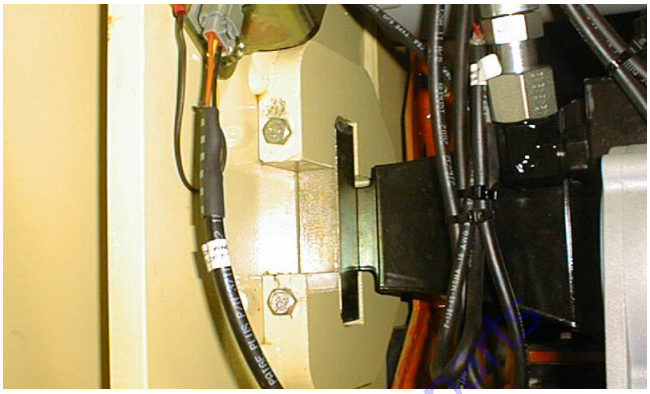
22. Tag and disconnect the electrical lines going to the upper and lower tower boom length sensors.



23. Remove the bolts and washers securing the length sensor mounting brackets and remove the sensors and brackets as an assembly.

24. Tag and disconnect all the hydraulic hoses running to the tower telescope cylinder. Cap or plug all openings.

25. Remove the bolts securing the trunnion keeper blocks and shims and remove the blocks and shims.



26. Place blocking under the tower telescope cylinder to prevent it from dropping suddenly and begin pulling the cylinder out of the boom using an adequate lifting device. Reposition the blocks and lifting straps as needed to prevent the cylinder from dropping suddenly and to keep it balanced.

NOTE: *The tower telescope cylinder weighs approximately 915 lb (415 kg).*

Installation

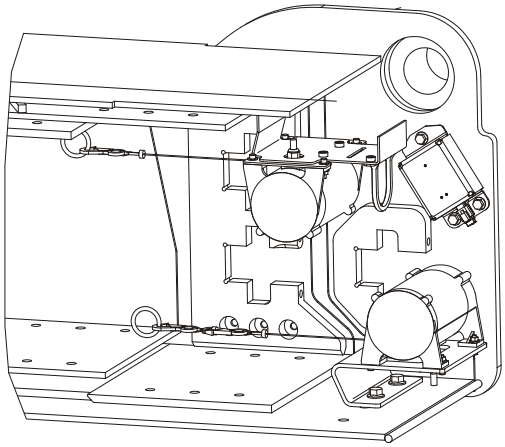
1. Place blocking for support under the tower telescope cylinder and begin pushing the cylinder into the boom using an adequate lifting device. Reposition the blocks and lifting straps as needed to prevent the cylinder from dropping and to keep it balanced.

NOTE: *The tower telescope cylinder weighs approximately 915 lb (415 kg).*

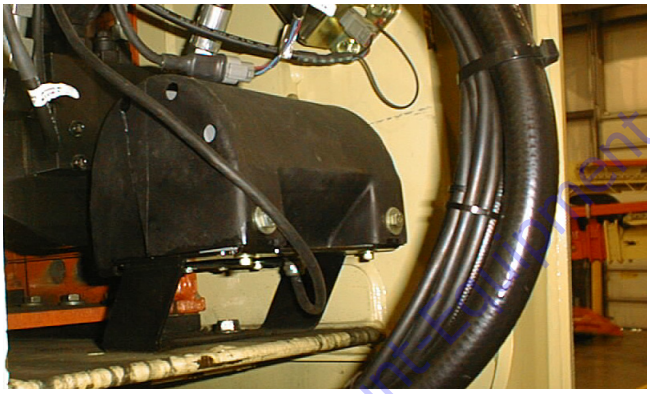
2. Position the telescope cylinder trunnions into place and install the shims and trunnion keeper blocks. Apply Medium Strength Threadlocking Compound to the retaining bolts and torque to 35 ft.lbs. (47.5 Nm).

3. Connect all the hydraulic hoses running to the tower telescope cylinder as tagged during removal.

4. Connect the length sensor cables to the tower boom fly section.

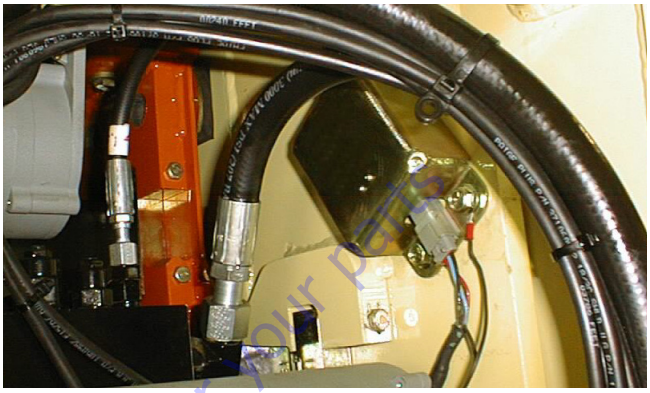


5. Install the length sensors and mounting brackets. Secure them in place with the retaining bolts and washers.



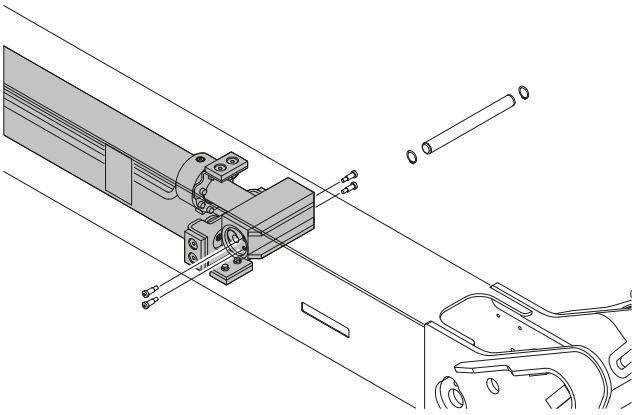
6. Connect the electrical lines going to the upper and lower tower boom length sensors as tagged during removal.

7. Secure the angle sensors to the boom section with the retaining bolts and washers. At the rear of the tower boom, connect the wires going to the angle sensors as tagged during removal.



8. If necessary, refer to Removal and use the analyzer Service Mode to cycle the cylinder in and out several times to purge air from the cylinder.

9. Install the telescope cylinder retaining pin. It may be necessary to use the analyzer Service Mode procedure to align the pin. Secure it in place with the four shoulder bolts and two snap rings.



10. If necessary, use the analyzer Service Mode procedure to telescope the boom in.

11. Place the machine in the stowed position.

4.26 TOWER LIFT CYLINDER

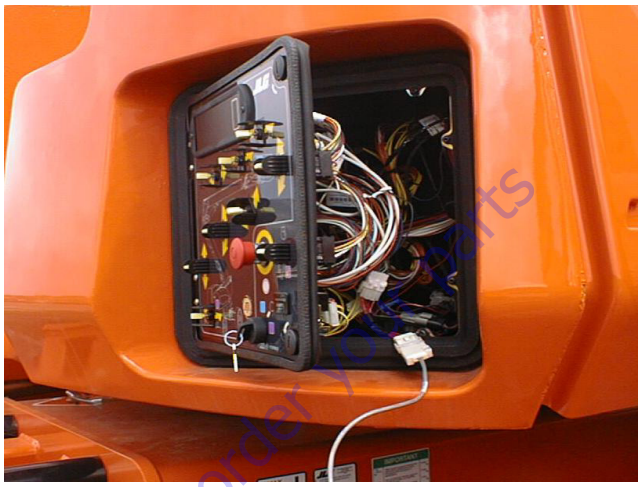
Removal

1. Place the machine on a firm, level surface with the axles fully extended or the turntable centered between the rear wheels.
2. Select lift up and raise the tower boom until it is in a horizontal position.

NOTE: *The main boom must be elevated approximately 12 inches (30 cm) above the boom rest but no more than 15° above the tower to prevent damage to the machine. Refer to Figure 4-48., Tower Lift Only Restrictions.*

3. Position the Platform/Ground select switch to the Ground position.

4. If the Boom Control System allows tower telescope, skip to step 18. If not, continue with step 6.
5. Plug the analyzer into the connector inside the Ground control box.



6. Pull out the Emergency Stop switch and start the engine.

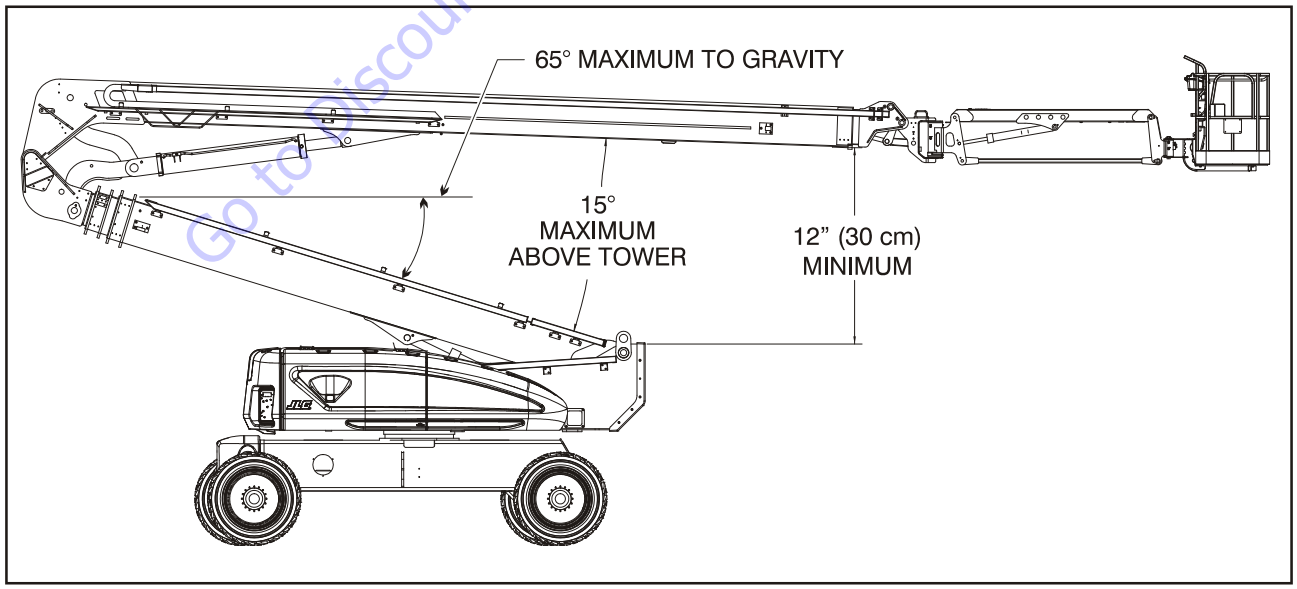
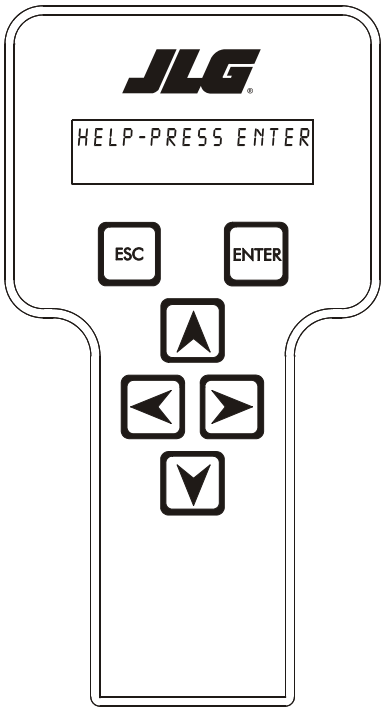


Figure 4-48. Tower Lift Only Restrictions

7. The analyzer screen should read:



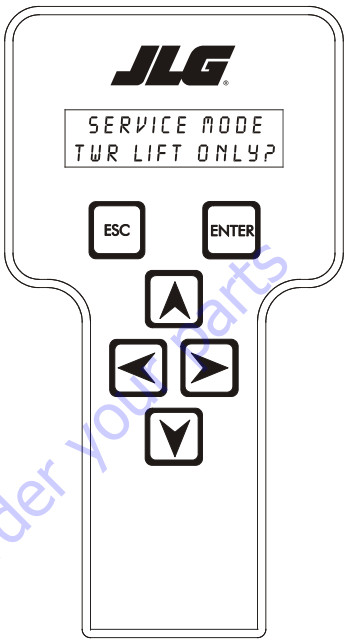
8. Use the arrow button to reach ACCESS LEVEL 2. Press the ENTER key.
9. Enter Code 33271 to get into Access Level 1 mode.

NOTE: *The service mode will only be displayed on the analyzer when in access level 1 in the ground mode and be hidden while in access level 2.*

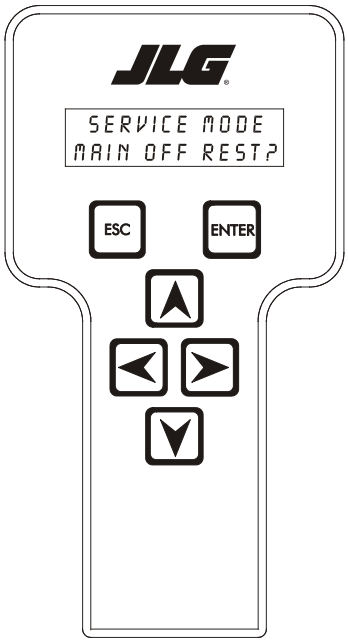
NOTICE

THE SERVICE MODE MENU WILL BE SELECTABLE AT THE TOP LEVEL OF THE ANALYZER MENU STRUCTURE. "SERVICE MODE" WILL BE DISPLAYED ON THE TOP LINE OF THE ANALYZER WITH THE CURRENT SUB-MENU SELECTION ON THE BOTTOM LINE. THE SUB-MENUS WILL SCROLL WITH THE LEFT AND RIGHT ARROW KEYS.

10. Scroll through the analyzer menu until "SERVICE MODE" is displayed. Press the ENTER key.
11. Scroll through the menu until "TWR LIFT ONLY?" is displayed as shown below.



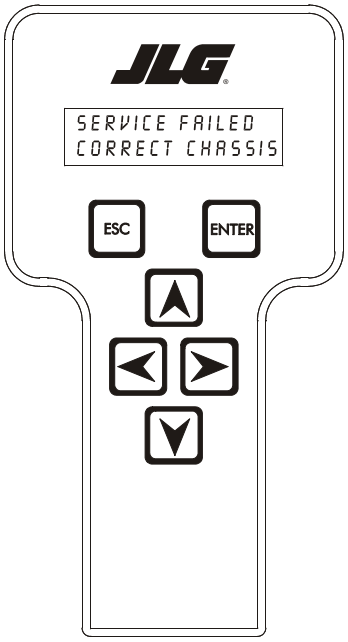
12. Press ENTER. The analyzer will read:



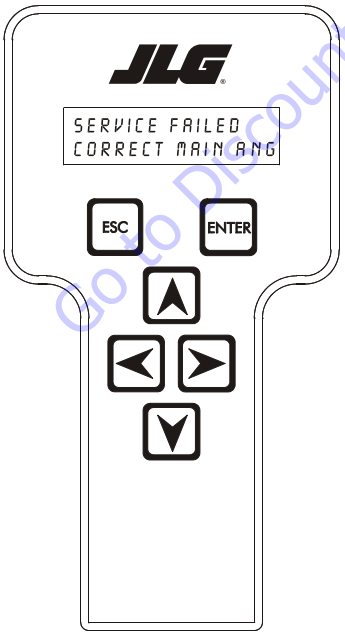
NOTE: *The main boom must be elevated approximately 12 inches (30 cm) above the boom rest but no more than 15° above the tower to prevent damage to the machine. Refer to Figure 4-48., Tower Lift Only Restrictions.*

13. Press the ENTER key. The control system will perform the following checks:

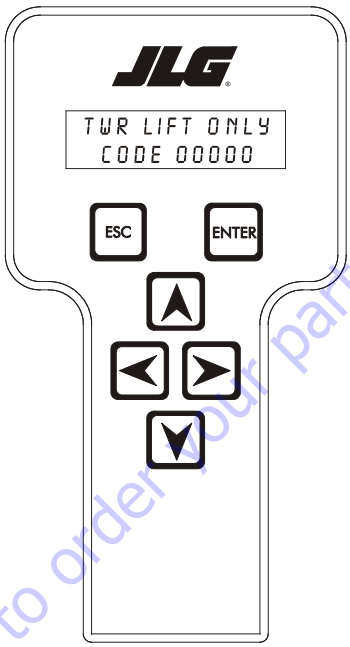
The axles must be extended or the DOS (Direction of Steering) switch must indicate the turntable is between the rear tires, otherwise the analyzer will read:



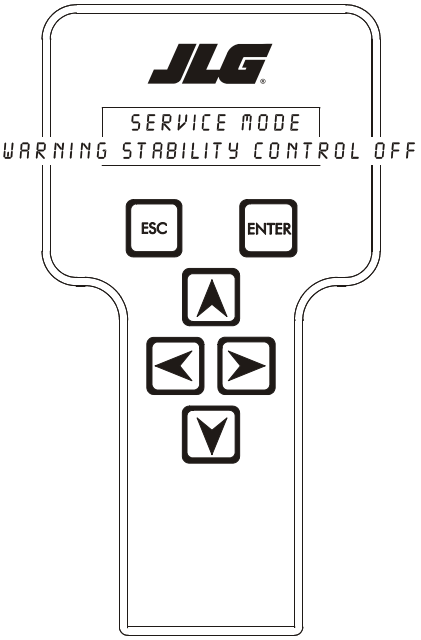
14. If the main boom angle sensors are calibrated and working properly the control system will verify the main boom angle readings are between +0.0° and +15.0° (ref tower boom). If they are calibrated and working properly and outside the angle limits, the analyzer will read:



15. After the successful completion of the checks, the analyzer will read:



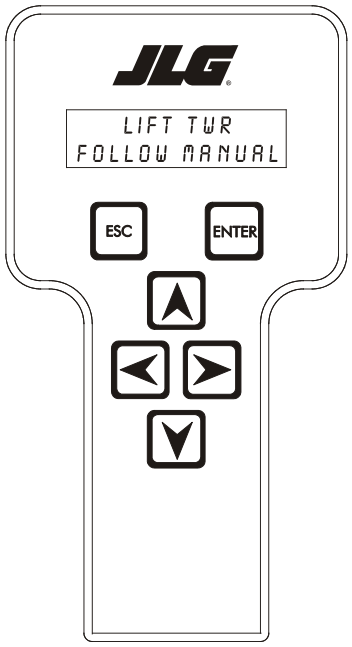
16. Enter code 74466. The analyzer will read:



⚠ DANGER

WHEN THE STABILITY CONTROL IS OFF THE MACHINE *WILL* TIP IF USED INCORRECTLY.

17. Press the ENTER key to acknowledge the stability control is turned off. The analyzer should read:



18. The control system will allow only tower lift (without auto tower telescope) using the tower lift switch on the ground console.

19. Activate tower lift enough to gain access to the tower lift cylinder.

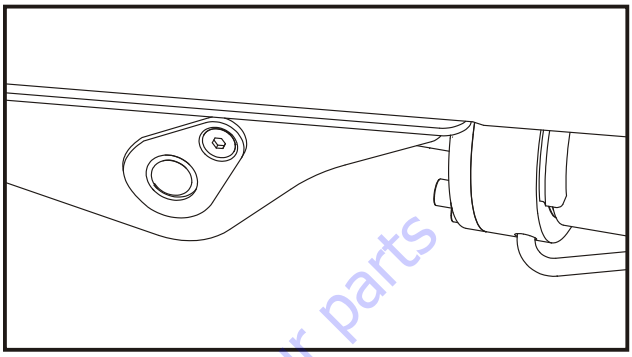
20. Use a crane or other suitable supporting device to support the weight of the tower and main boom assemblies.

NOTE: *The tower and main boom assemblies weigh approximately 14000 lb (6350 kg).*

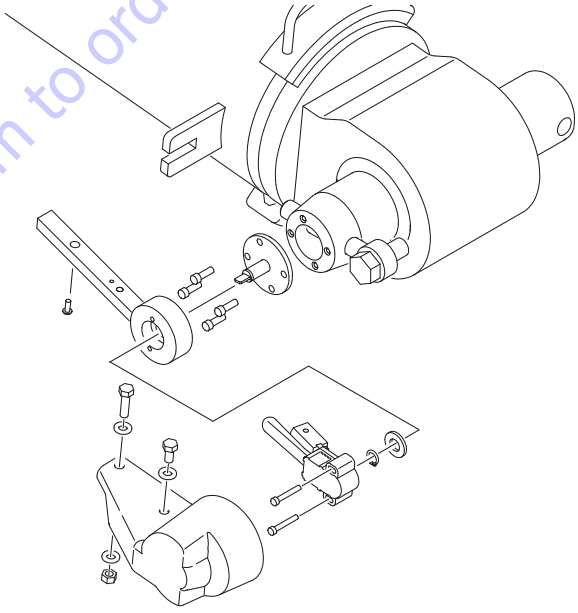
21. Put a nylon strap capable of supporting the weight of the lift cylinder around the cylinder.

NOTE: *The tower lift cylinder weighs approximately 644 lb (292 kg).*

22. At the rod end of the cylinder, remove the retaining bolt and pivot pin that secures that end of the cylinder to the tower boom.



23. At the barrel end of the cylinder, remove the sensor cover to gain access to the sensor. Remove the angle sensor, sensor arm, and sensor pin.



24. Loosen and remove the bolt that secures the retaining pin and remove the retaining pin.

25. Disconnect the wiring harness from the strain relief connector at the opposite side of the load sensing pin.

26. Use the Load Pin Removal Tool to prevent the pin from being damaged, and use a hammer to remove the pin. To make the tool refer to Figure 4-50., Load Pin Removal Tool, JLG PN 4846765. If the Load Pin Removal Tool is not available, use an arbor of the proper size (as shown below). If excessive force is necessary to move the pin, it may be necessary to carefully activate lift using the auxiliary power switch to relieve lift cylinder weight from the load sensing pin.

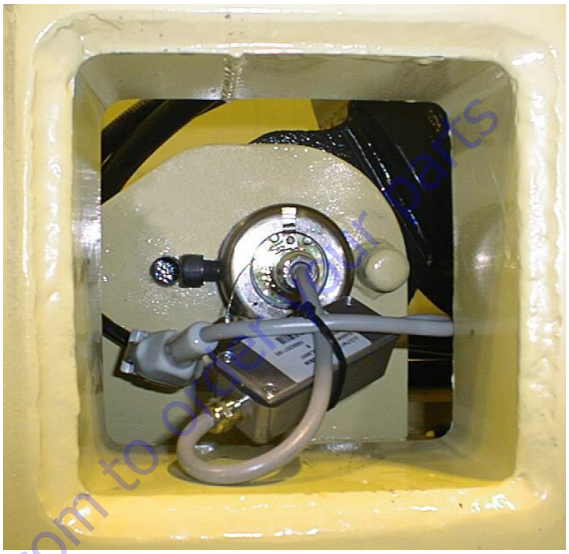
27. After both retaining pins have been removed, carefully remove the lift cylinder, repositioning the lifting strap as necessary.

Installation

NOTE: *The tower lift cylinder weighs approximately 644 lb (292 kg).*

1. Put a nylon strap capable of supporting the weight of the lift cylinder around the cylinder. Carefully position the lift cylinder in place, repositioning the lifting strap as necessary.

2. When installing a new load sensing pin, make sure all of the holes in the turntable and lift cylinder are aligned. If the new load sensing pin does not push 1/2 to 3/4 of the way in by hand, remove the pin and align the holes better. Also make sure the pin is installed with the strain relief connector opposing the pin orientation bar as shown.



3. Using a wooden block, carefully tap the pin until it is fully installed. Secure the pin in place with the retaining pin and retaining pin bolt.

NOTICE

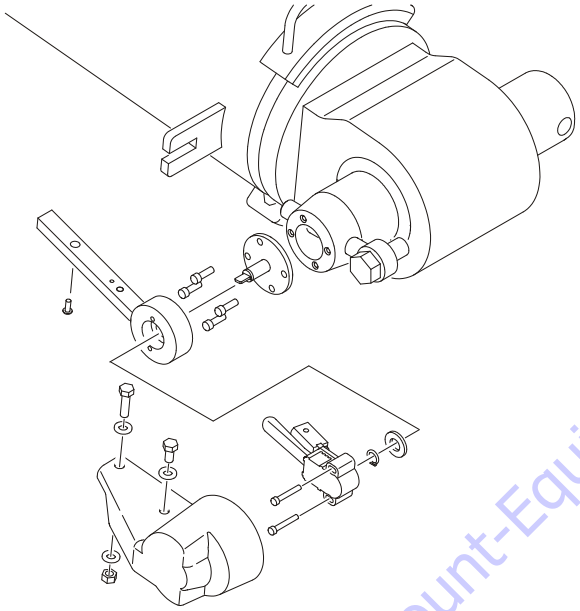
DO NOT TAP ON THE CENTER OF THE PIVOT PIN.

4. Connect the wiring harness to the strain relief connector as shown in Figure 4-49., Load Sensing Pin Harness Installation and re-calibrate the boom sensors.

Figure 4-49. Load Sensing Pin Harness Installation

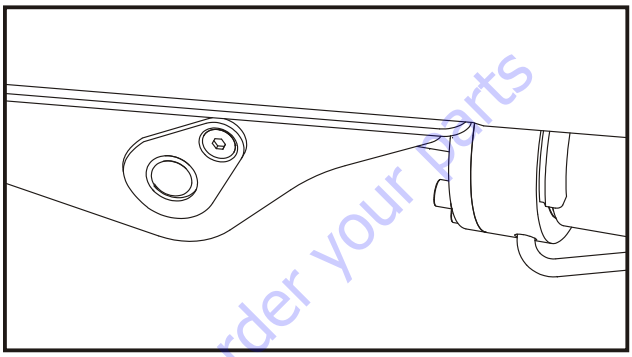
5. Secure the pin in place with the retaining pin and retaining pin bolt on the other end. Torque the bolt to 285 ft.lbs. (386 Nm).

6. Install the sensor pin, sensor arm, and angle sensor. Connect the wiring harness to the sensor and install the sensor cover.



7. Cycle the cylinder in and out several times to purge air from the cylinder. If necessary, refer to Removal and use the analyzer Service Mode.

8. At the rod end of the cylinder, install the retaining bolt and pivot pin that secures that end of the cylinder to the tower boom. It may be necessary to use the analyzer Service Mode to align the pin. Torque the bolt to 285 ft.lbs.99 (386 Nm).



9. If necessary, use the analyzer Service Mode procedure to lower the tower boom.

10. Re-calibrate the boom sensors. Refer to Section 6.15, Boom Sensor Calibration.

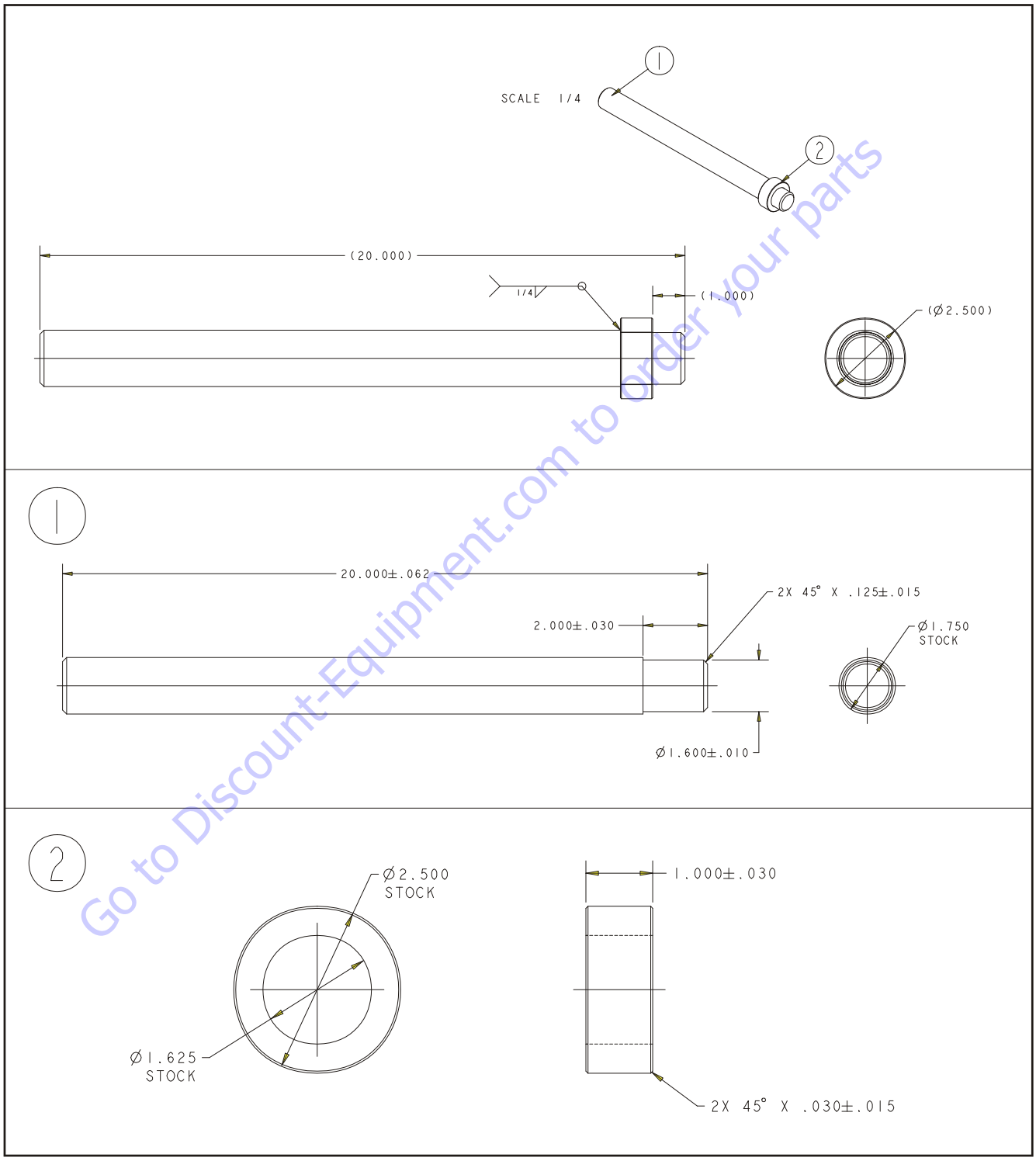


Figure 4-50. Load Pin Removal Tool, JLG PN 4846765

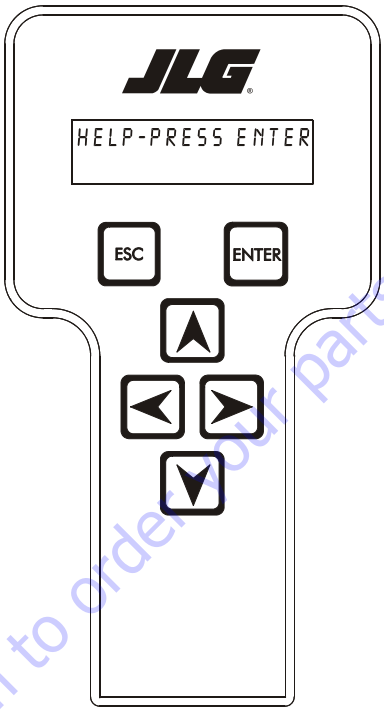
4.27 MAIN LIFT CYLINDER

Removal

1. Place the machine on a firm, level surface with the axles fully extended or the turntable centered between the rear wheels. The tower boom must also be fully lowered and retracted.
2. Connect the JLG Control System Analyzer to the connector at the ground control box.
3. Start the engine.
4. Position the Platform/Ground select switch to the Ground position.

5. Plug the analyzer into the connector inside the Ground control box.

6. Pull out the Emergency Stop switch and start the engine.
7. The analyzer screen should read:



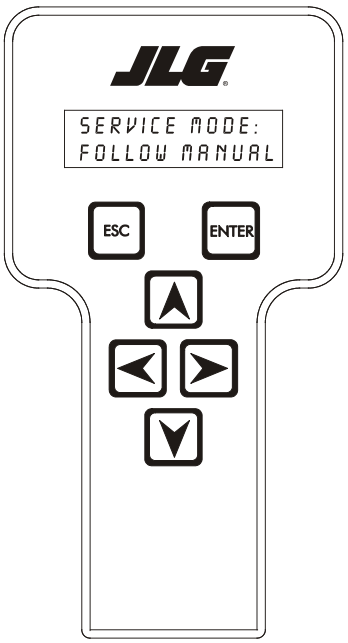
8. Use the arrow button to reach ACCESS LEVEL 2. Press the ENTER key.
9. Enter the Access Code, 33271 to get into Access Level 1 mode.

NOTE: *The service mode will only be displayed on the analyzer when in access level 1 in the ground mode and be hidden while in access level 2.*

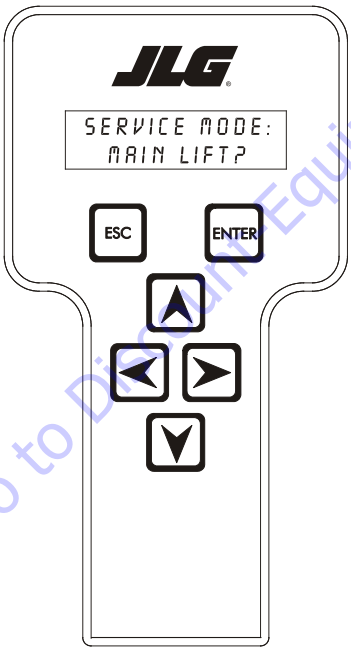
NOTICE

THE SERVICE MODE MENU WILL BE SELECTABLE AT THE TOP LEVEL OF THE ANALYZER MENU STRUCTURE. "SERVICE MODE" WILL BE DISPLAYED ON THE TOP LINE OF THE ANALYZER WITH THE CURRENT SUB-MENU SELECTION ON THE BOTTOM LINE. THE SUB-MENUS WILL SCROLL WITH THE LEFT AND RIGHT ARROW KEYS.

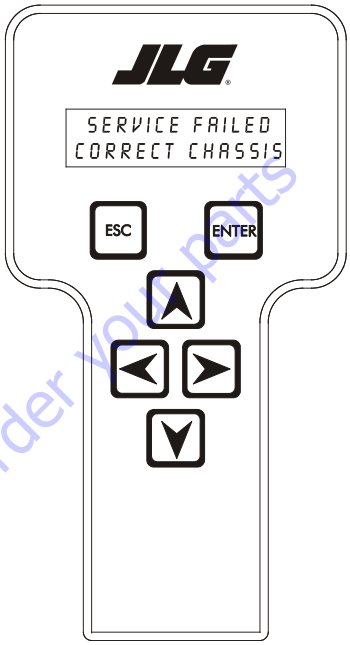
10. Scroll through the analyzer menu until SERVICE MODE is displayed. Press the ENTER key.



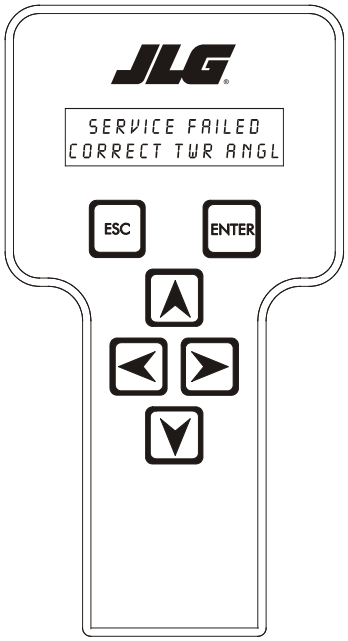
11. Scroll through the menu until the "MAIN LIFT?" is displayed as shown below.



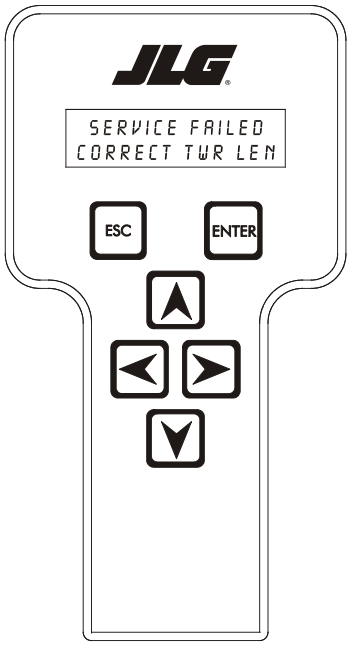
12. Press the ENTER key. The control system will perform several tests to make sure the machine is in the proper position. If the axles are not extended or the turntable is not centered between the rear wheels, the screen will read:



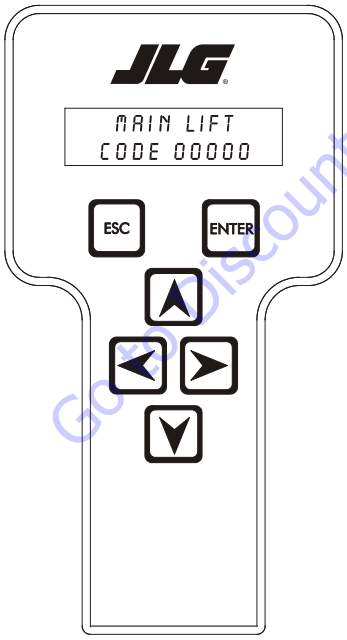
If the tower boom angle sensors are calibrated and operating properly, the control system will verify the tower boom angle readings are less than +5°. If the tower boom angle is outside the limit, the screen will read:



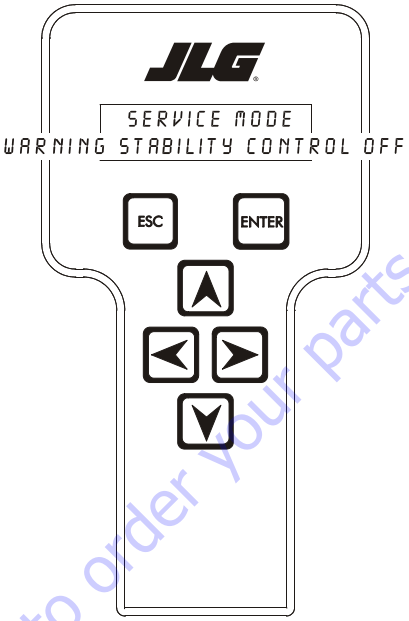
If the tower boom length sensors are calibrated and operating properly, the control system will verify the tower boom length readings are less than 6 in. (15.2 cm). If the tower boom length is not within the limits, the screen will read:



13. When the machine passes all the configuration checks, the screen will read:



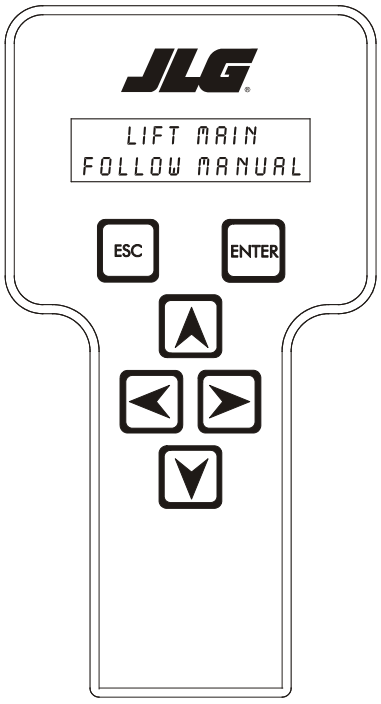
14. Enter code 55050. The analyzer will read:



⚠ DANGER

WHEN THE STABILITY CONTROL IS OFF THE MACHINE *WILL* TIP IF USED INCORRECTLY.

15. Press the ENTER key to acknowledge the stability control is turned off. The analyzer should read:



16. If the main boom angle sensors are calibrated and operating properly, the control system will now allow main lift up/down below main boom angles of +65°.

17. Activate main lift and elevate the boom enough to gain access to remove the main lift cylinder.

18. Use a crane or other suitable supporting device to support the weight of the main boom assembly.

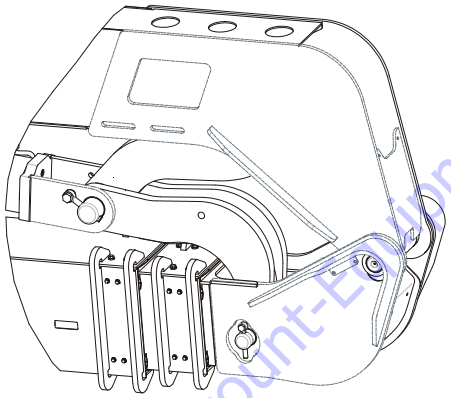
NOTE: *The main boom assembly weighs approximately 6500 lb (2950 kg).*

19. Put a nylon strap capable of supporting the weight of the lift cylinder around the cylinder.

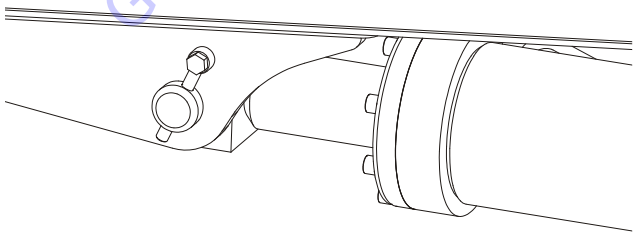
NOTE: *The main lift cylinder weighs approximately 785 lb (356 kg).*

20. At the barrel end of the cylinder, place blocking under the lower link and between the upper and lower links so they do not drop when the pivot pin is removed.

21. Remove the retaining bolt, keeper pin, and pivot pin securing the barrel end of the lift cylinder to the lower link.



22. At the rod end of the cylinder, remove the retaining bolt, keeper pin, and pivot pin securing the rod end of the lift cylinder to the boom.



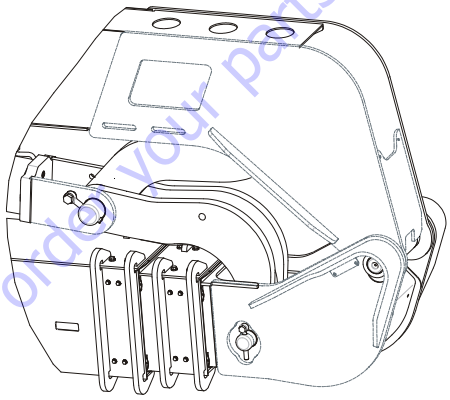
23. Remove the cylinder from the machine.

Installation

1. Using an adequate lifting device, position the main lift cylinder in place on the machine.

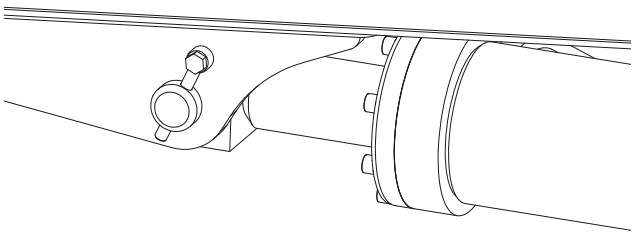
NOTE: *The main lift cylinder weighs approximately 785 lb (356 kg).*

2. Install the retaining bolt, keeper pin, and pivot pin securing the barrel end of the lift cylinder to the lower link.



3. If necessary, refer to Removal and use the analyzer Service Mode to cycle the cylinder in and out several times to purge air from the cylinder.

4. At the rod end of the cylinder, install the retaining bolt, keeper pin, and pivot pin securing the rod end of the lift cylinder to the boom. It may be necessary to use the analyzer Service Mode to align the pin.



5. Remove the blocking placed under the lower link and between the upper and lower links during removal.

6. Refer to Removal, and use the analyzer Service Mode procedure to lower the boom.

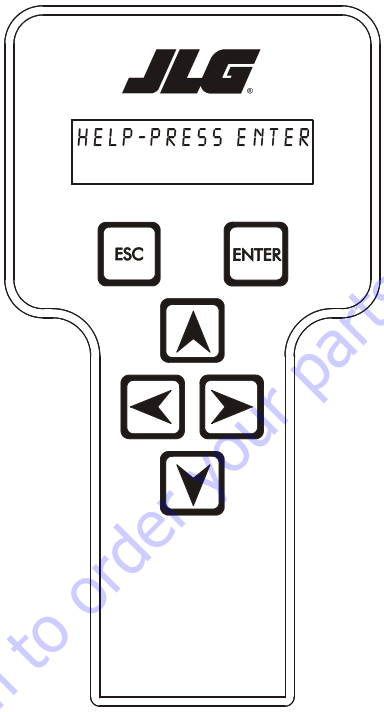
4.28 MAIN BOOM TELESCOPE CYLINDER

Removal

1. Place the machine on a firm, level surface with the axles fully extended or the turntable centered between the rear wheels. The tower boom must also be fully lowered and retracted.
2. Connect the JLG Control System Analyzer to the connector at the ground control box.
3. Start the engine.
4. Position the Platform/Ground select switch to the Ground position.

5. If the Boom Control System allows tower telescope, skip to step 18. If not, continue with step 6.
6. Plug the analyzer into the connector inside the Ground control box.

7. Pull out the Emergency Stop switch and start the engine.
8. The analyzer screen should read:



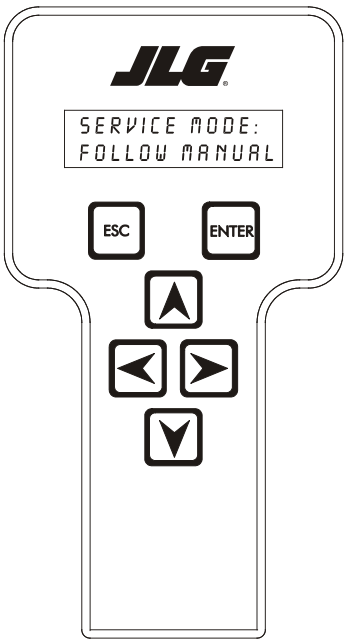
9. Use the arrow button to reach ACCESS LEVEL 2. Press the ENTER key.
10. Enter the Access Code, 33271 to get into Access Level 1 mode.

NOTE: *The service mode will only be displayed on the analyzer when in access level 1 in the ground mode and be hidden while in access level 2.*

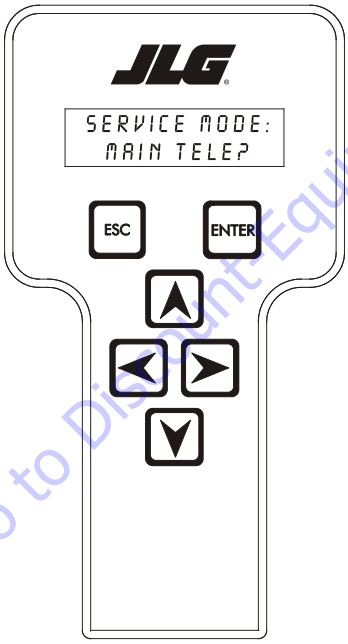
NOTICE

THE SERVICE MODE MENU WILL BE SELECTABLE AT THE TOP LEVEL OF THE ANALYZER MENU STRUCTURE. "SERVICE MODE" WILL BE DISPLAYED ON THE TOP LINE OF THE ANALYZER WITH THE CURRENT SUB-MENU SELECTION ON THE BOTTOM LINE. THE SUB-MENUS WILL SCROLL WITH THE LEFT AND RIGHT ARROW KEYS.

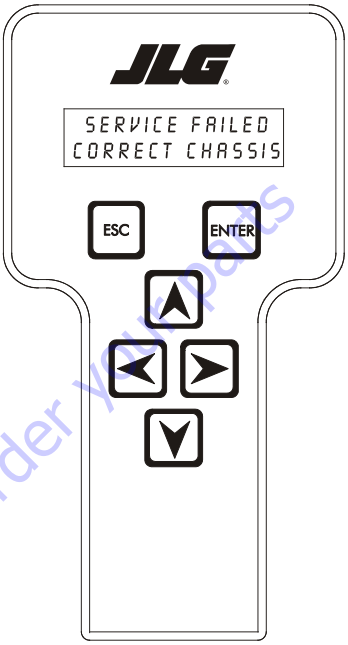
11. Scroll through the analyzer menu until SERVICE MODE is displayed. Press the ENTER key.



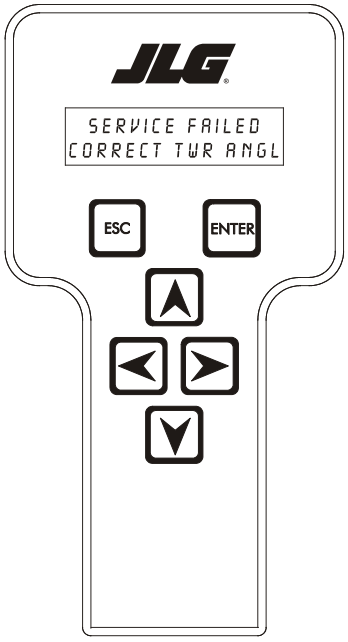
12. Scroll through the menu until the screen reads:



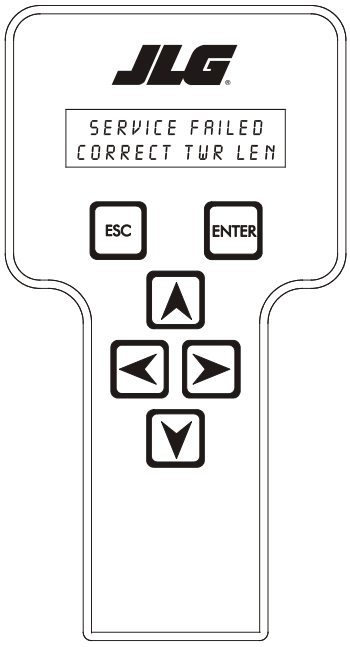
13. Press ENTER. The control system will perform several tests to make sure the machine is in the proper position. If the axles are not extended or the turntable is not centered between the rear wheels, the screen will read:



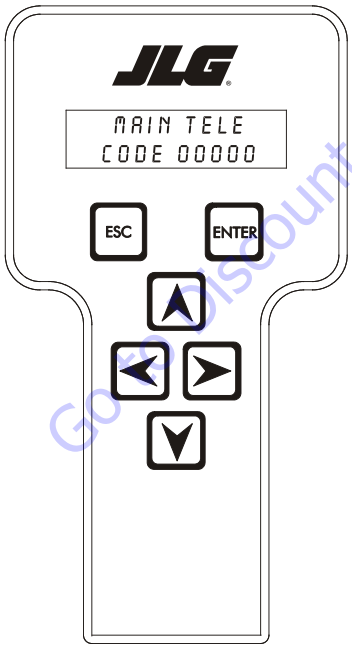
If the tower boom angle sensors are calibrated and working properly, the control system will verify the tower boom angle is less than +5°. If the tower boom is outside the limit, the analyzer screen will read:



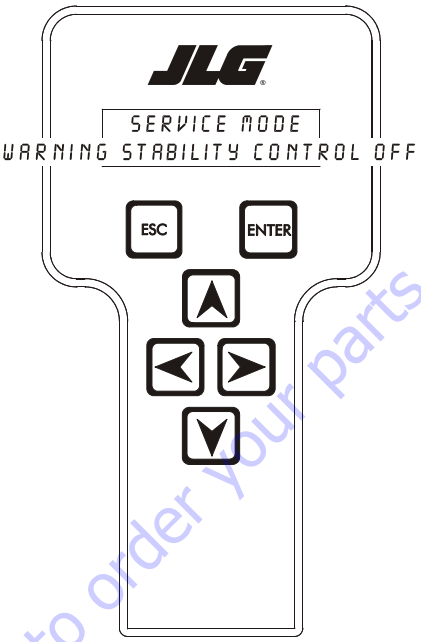
If the tower boom length sensors are calibrated and operating properly, the control system will verify the tower boom length is less than 6 in. (15.2 cm). If the tower boom is outside the length limit, the screen will read:



14. When the machine passes all the configuration checks, the screen will read:



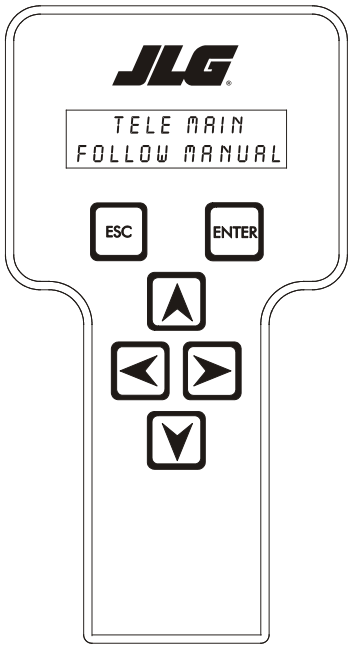
15. Enter code 69286. The analyzer will read:



⚠ DANGER

WHEN THE STABILITY CONTROL IS OFF THE MACHINE *WILL* TIP IF USED INCORRECTLY.

16. Press the ENTER key to acknowledge the stability control is turned off. The analyzer should read:



17. The control system will now allow main telescope using the telescope control switch on the ground console.

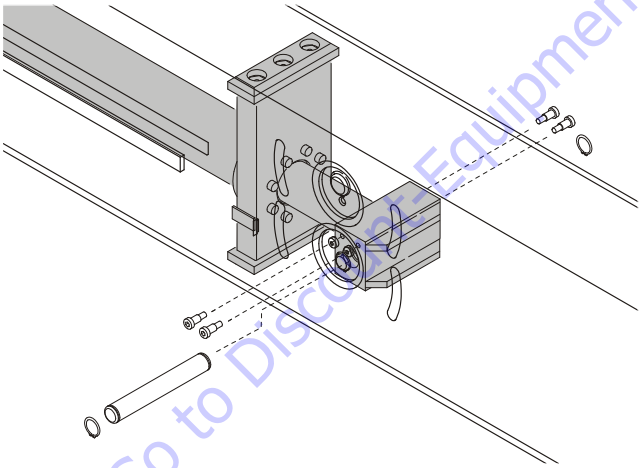
18. Telescope the main boom out until the retaining pin at the end of the telescope cylinder rod can be accessed.

19. Place blocking or boom supports under the main boom to support it.

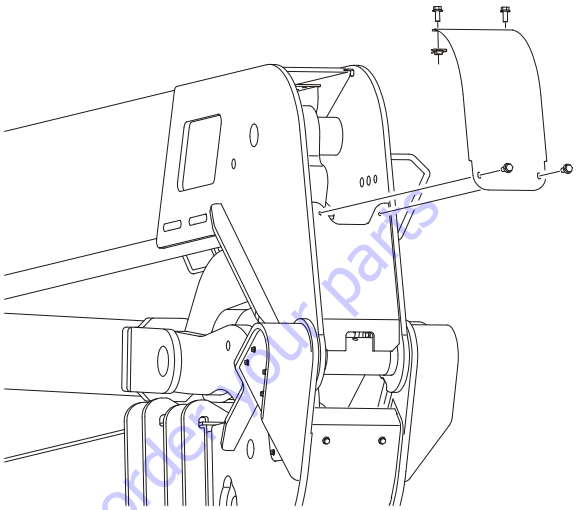
20. Place blocking under the main lift cylinder to support it.

21. Place blocking under the lower link to support it.

22. Remove the shoulder screws, retaining rings, and pin securing the end of the telescope cylinder.

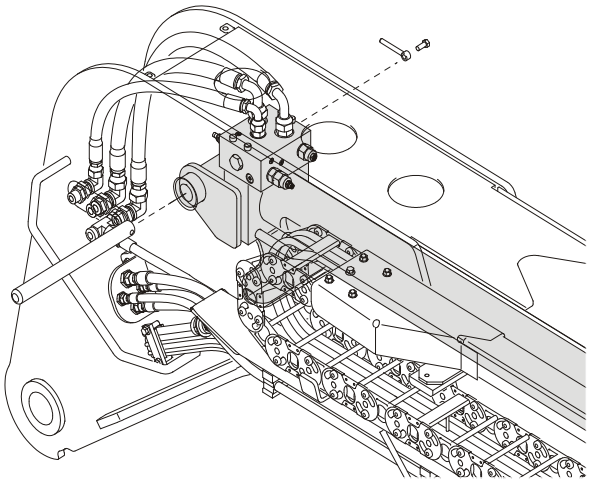


23. Remove the bolts securing the rear boom cover and remove the cover.



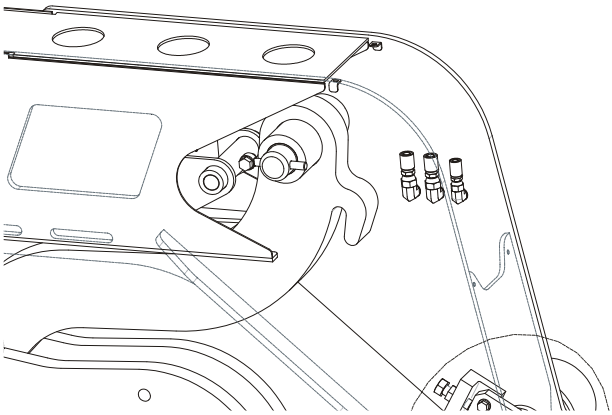
24. Place blocking under the telescope cylinder to prevent it from falling when the retaining pin is removed.

25. Remove the bolt and keeper pin securing the retaining pin in place. Remove the retaining pin.



26. Tag and disconnect the hydraulic lines running to the telescope cylinder. Cap or plug all openings.

27. Support the upper link using a nylon strap or blocking. Remove the bolt, keeper, and pin securing the upper link to the base boom. Carefully lower the upper link enough to allow the telescope cylinder to be removed.



NOTE: *The telescope cylinder weighs approximately 663 lb (300 kg).*

28. Carefully remove the telescope cylinder from the rear of the main boom, repositioning the blocking and lifting straps to prevent the cylinder from falling.

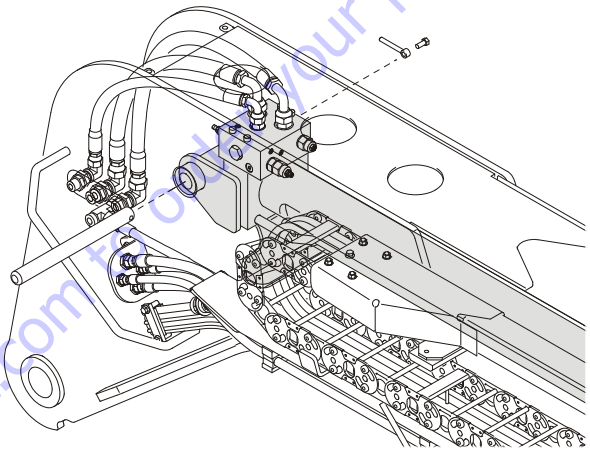
Installation

NOTE: *The telescope cylinder weighs approximately 663 lb (300 kg).*

1. Carefully install the telescope cylinder into the rear of the main boom. Place blocking under the cylinder to support it inside the boom and reposition the lifting straps balance the load.

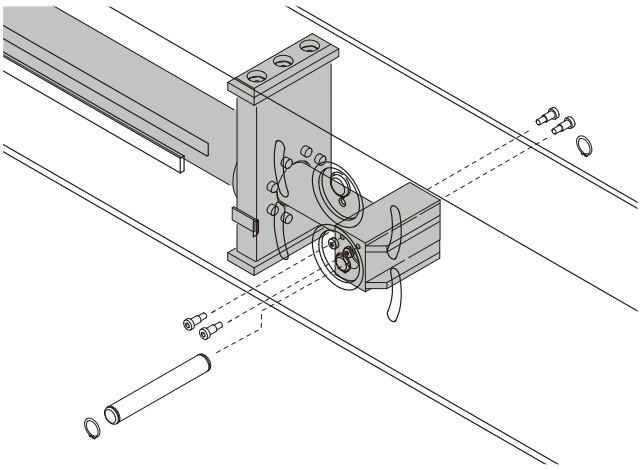
2. Connect the hydraulic lines running to the telescope cylinder as tagged during removal.

3. Install the bolt and keeper pin securing the cylinder retaining pin in place. Remove the retaining pin.

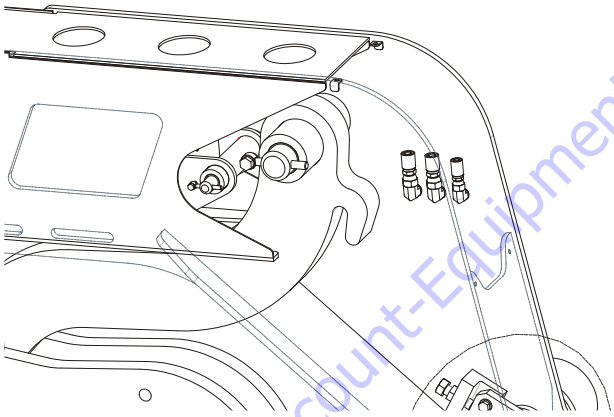


4. If necessary, refer to Removal and use the analyzer Service Mode to cycle the cylinder in and out several times to purge air from the cylinder.

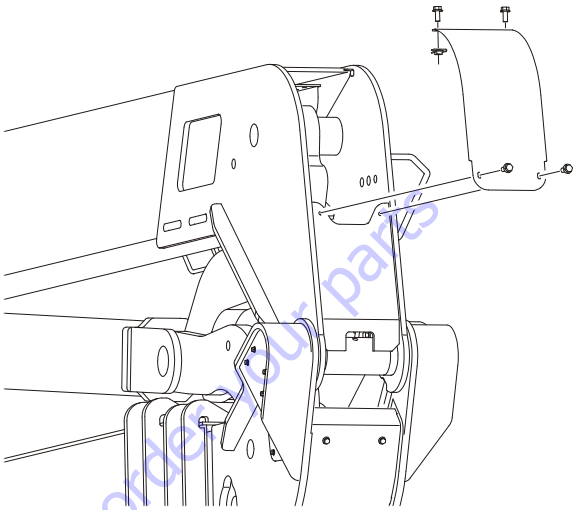
5. Install the shoulder screws, retaining rings, and pin securing the end of the telescope cylinder. It may be necessary to use the analyzer Service Mode to align the pin.



6. Carefully raise the upper link into position. Install the bolt, keeper, and pin securing the upper link to the base boom.



7. Install the rear boom cover and secure it in place with the retaining bolts.

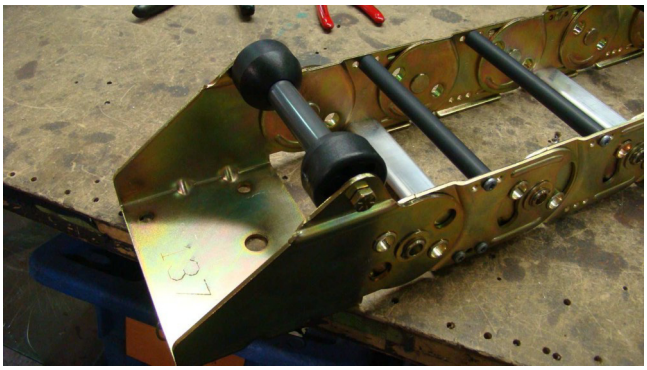


8. Remove all blocking used during the Removal procedure.
9. If necessary, refer to Removal, and use the analyzer Service Mode procedure to retract the boom.

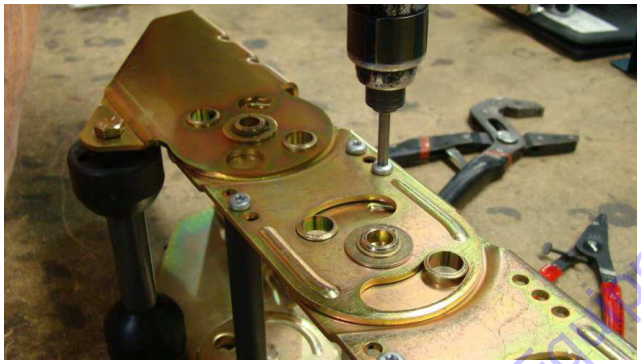
4.29 POWERTRACK MAINTENANCE

One Piece Bracket Maintenance

1. Place the powertrack on a workbench.



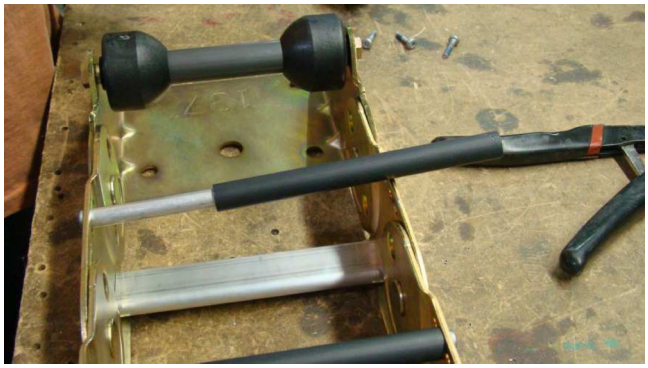
2. Remove the screws from the bars on one side of the powertrack on the first link.

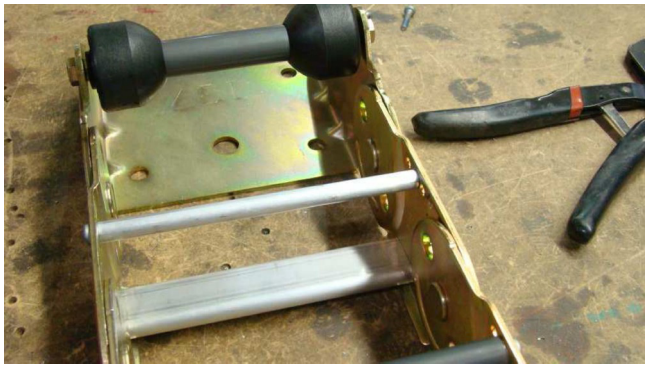


3. Remove the screws from the flat bar on the other side of the powertrack.

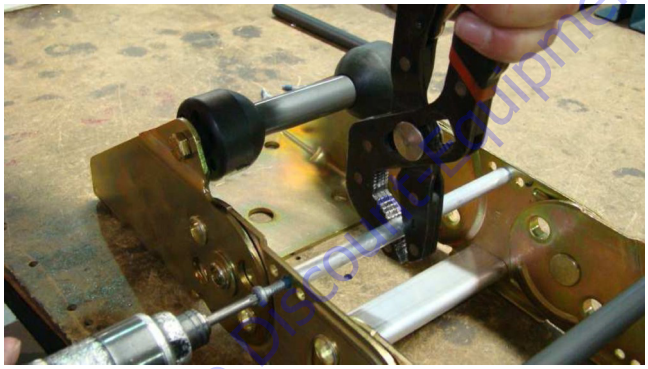
4. Pull up on the loose side of the round bar to allow the poly roller to slide off.

5. Slide the poly roller off of the round bar.

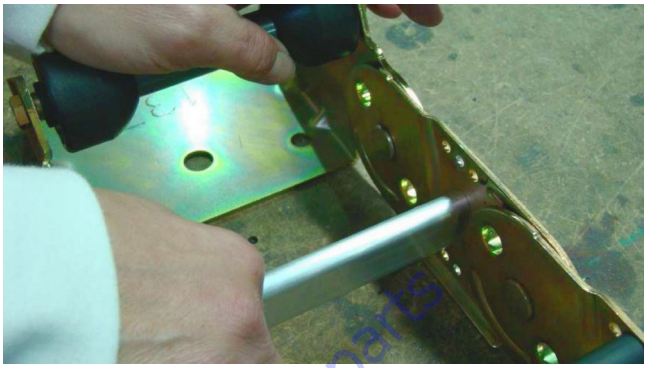


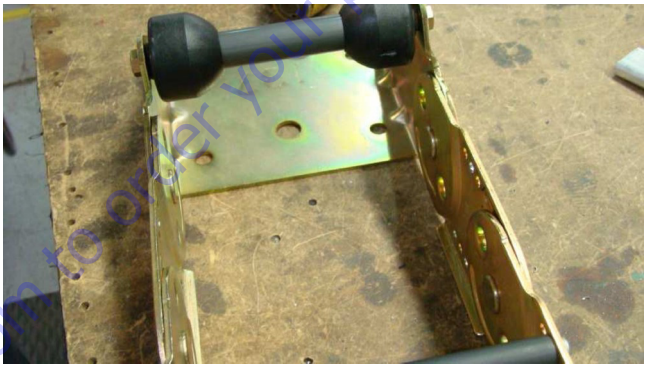


6. Hold the round bar to remove the other screw.

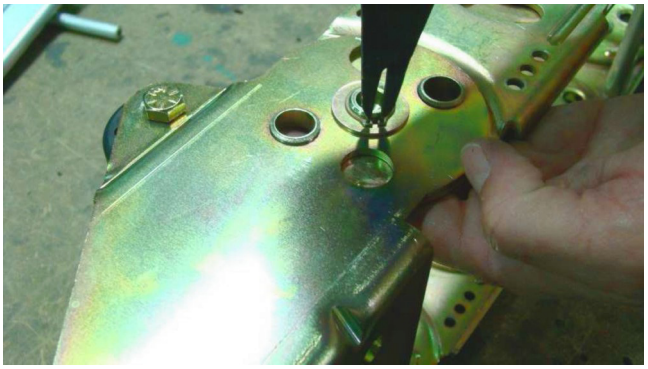


7. Slide the flat bar out.



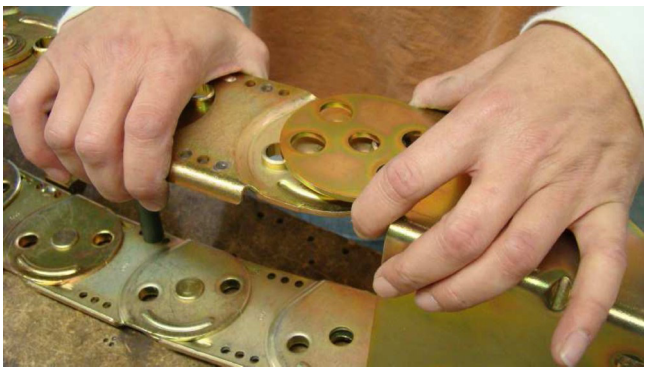


8. Remove the snap ring from one side of the bracket.



9. Remove the snap ring from the other side of the bracket.

10. Push down with slight pressure on the link and slide the bracket side up and over the extrusion on the link.

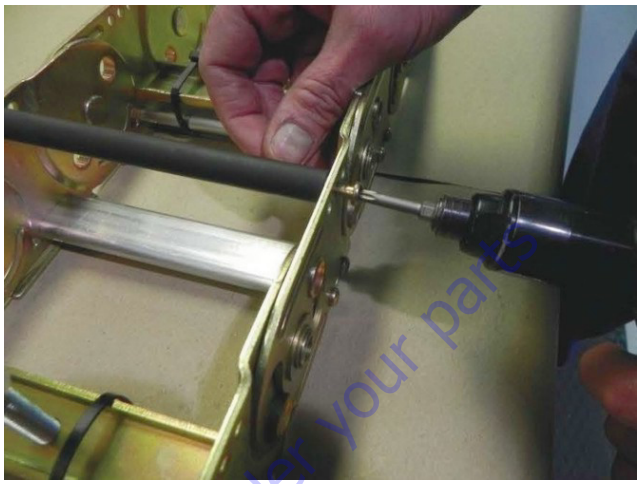


11. Repeat the previous step on the other side.

12. Slide the bracket off of the powertrack.

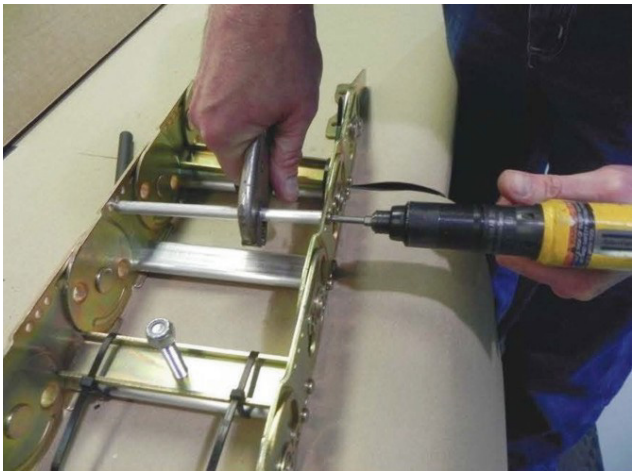
Two Piece Bracket Maintenance

1. Loosen the screw.

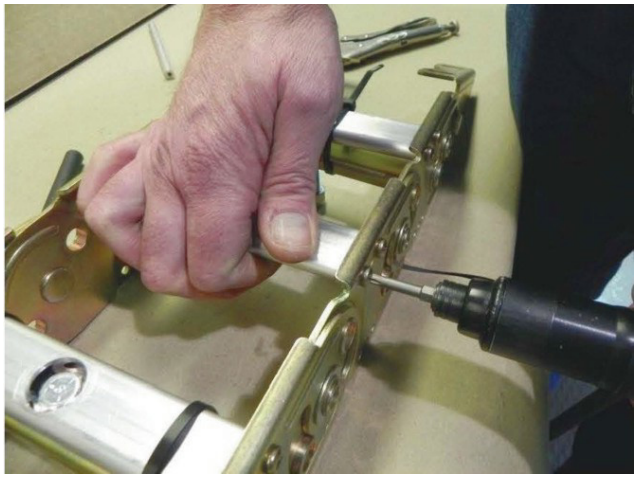


2. Slide the roller off the bar.

3. Hold the bar tightly and remove the other screw.

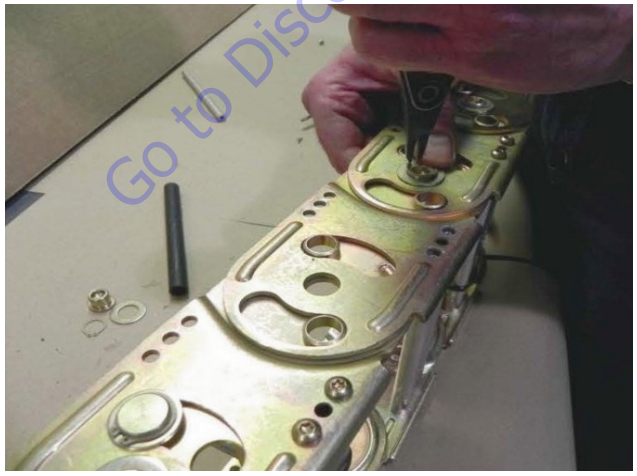


4. Hold the flat bar and remove the screws.

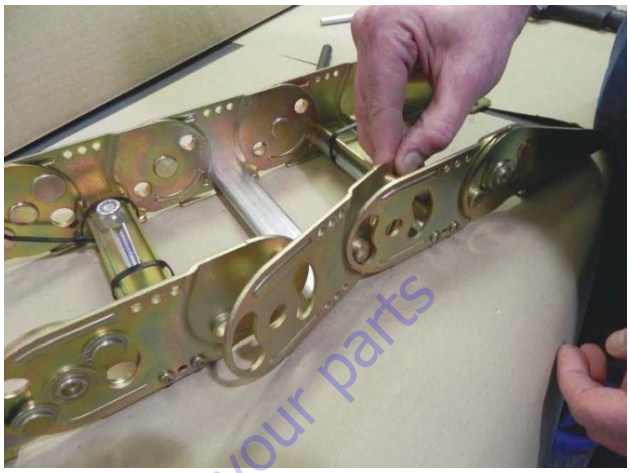


5. Remove the snap rings and pins.

6. Remove the screws from the bar. Remove the snap ring and pin.



7. Slide the link out.

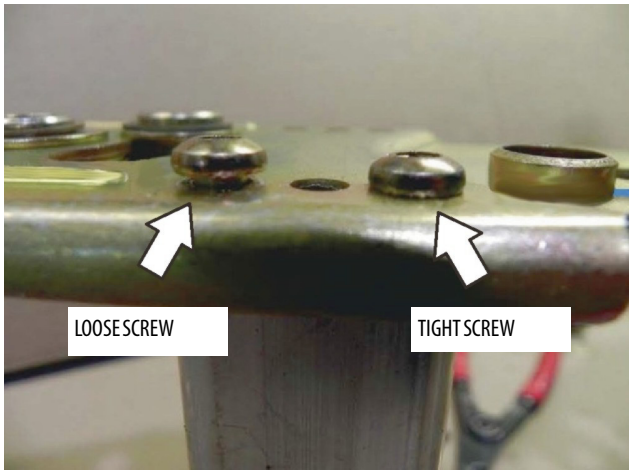


Snap Rings and Screws

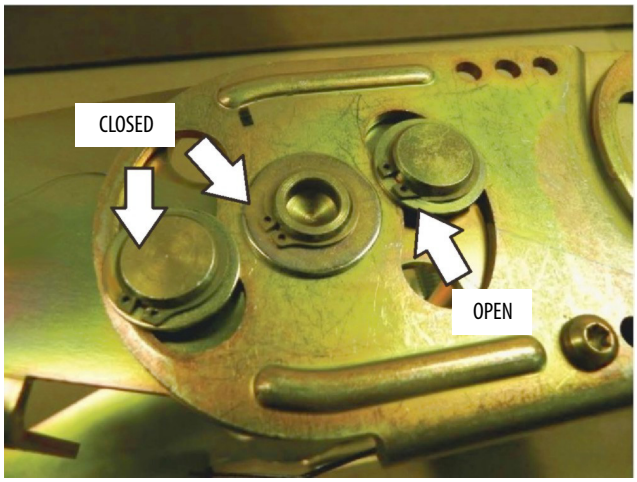
NOTICE

WHEN PERFORMING MAINTENANCE ON THE POWERTRACK, MAKE SURE TO DISCARD AND REPLACE ALL OLD SCREWS.

Make sure screws are tight and installed properly.

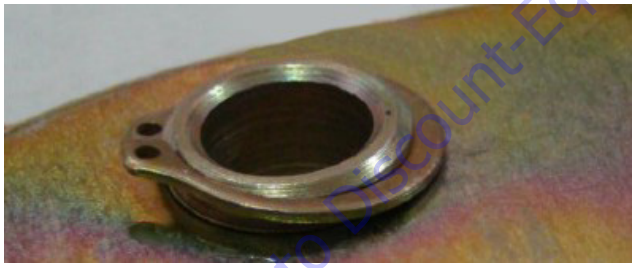


Make sure that all snap rings are closed and seated.



An open snap ring is shown below.

A snap ring that is not seated is shown below.



A seated and closed snap ring is shown below.

10-24 x 0.812 button torx socket head with blue locking patch:

- Tighten to 45-50 in.lbs. (5-5.6 Nm).
- Use T-25 torx bit.
- Do not reuse this screw. After removing replace with a new one.

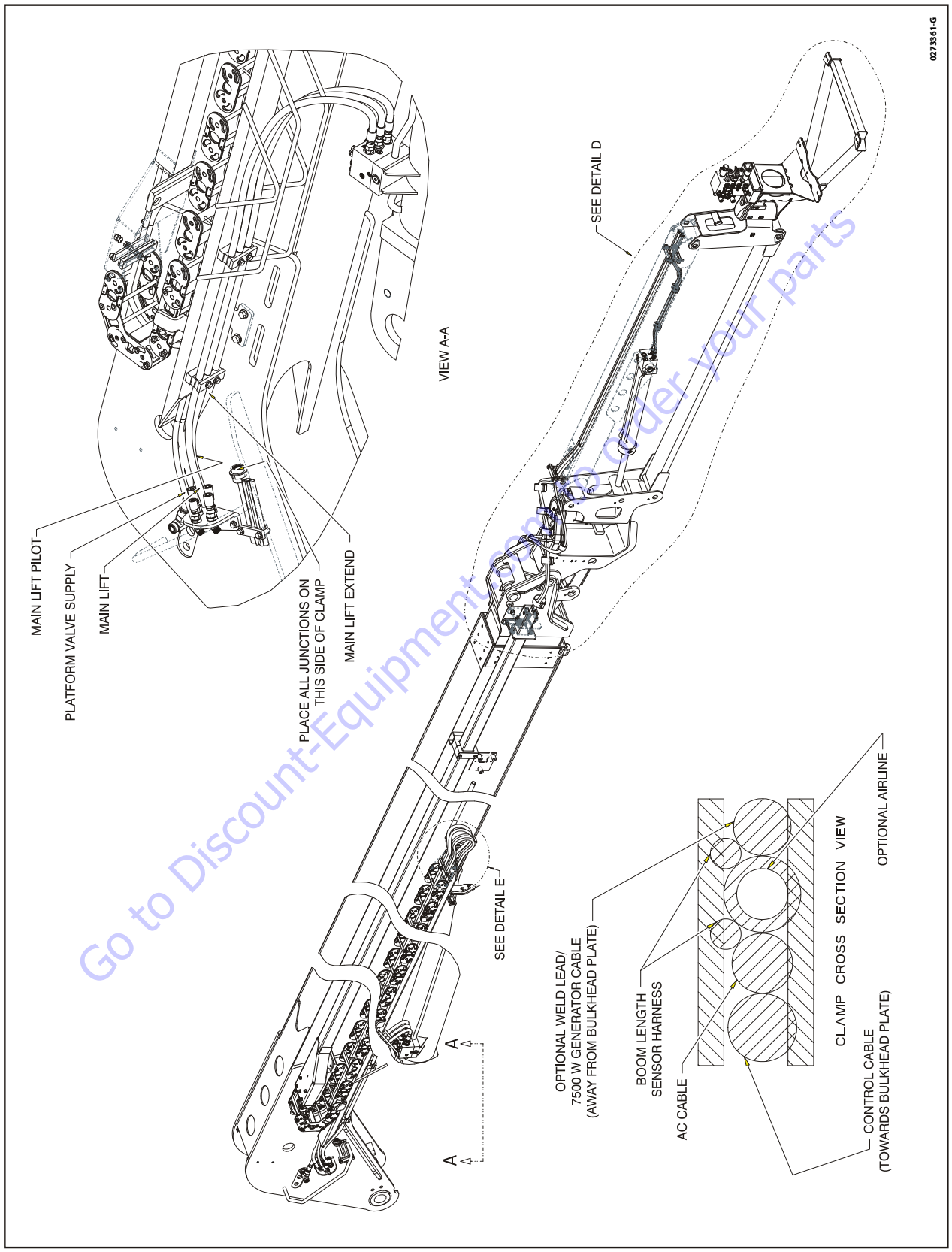


Figure 4-51. Main Boom Powertrack Installation - Sheet 1 of 3

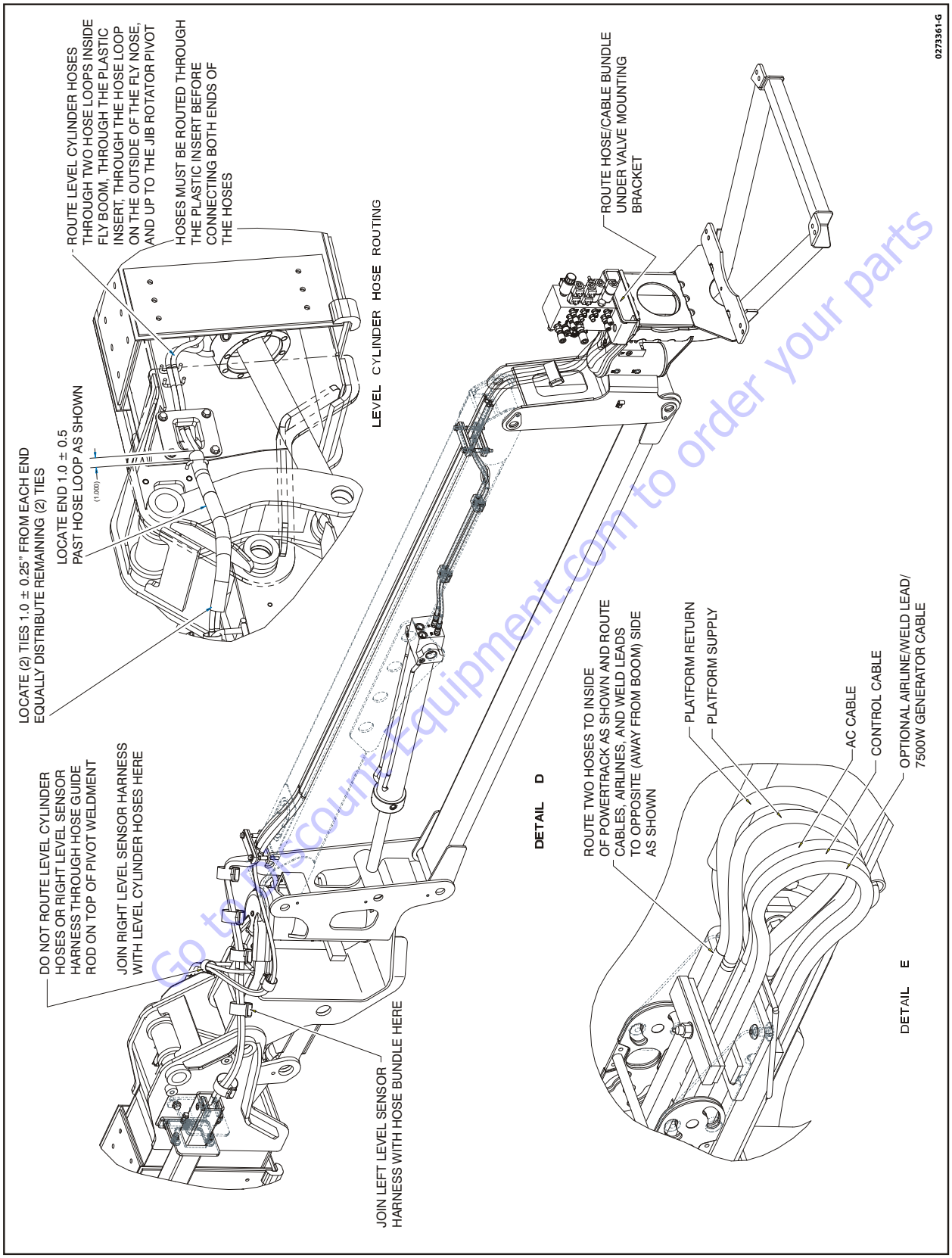


Figure 4-52. Main Boom Powertrack Installation - Sheet 2 of 3

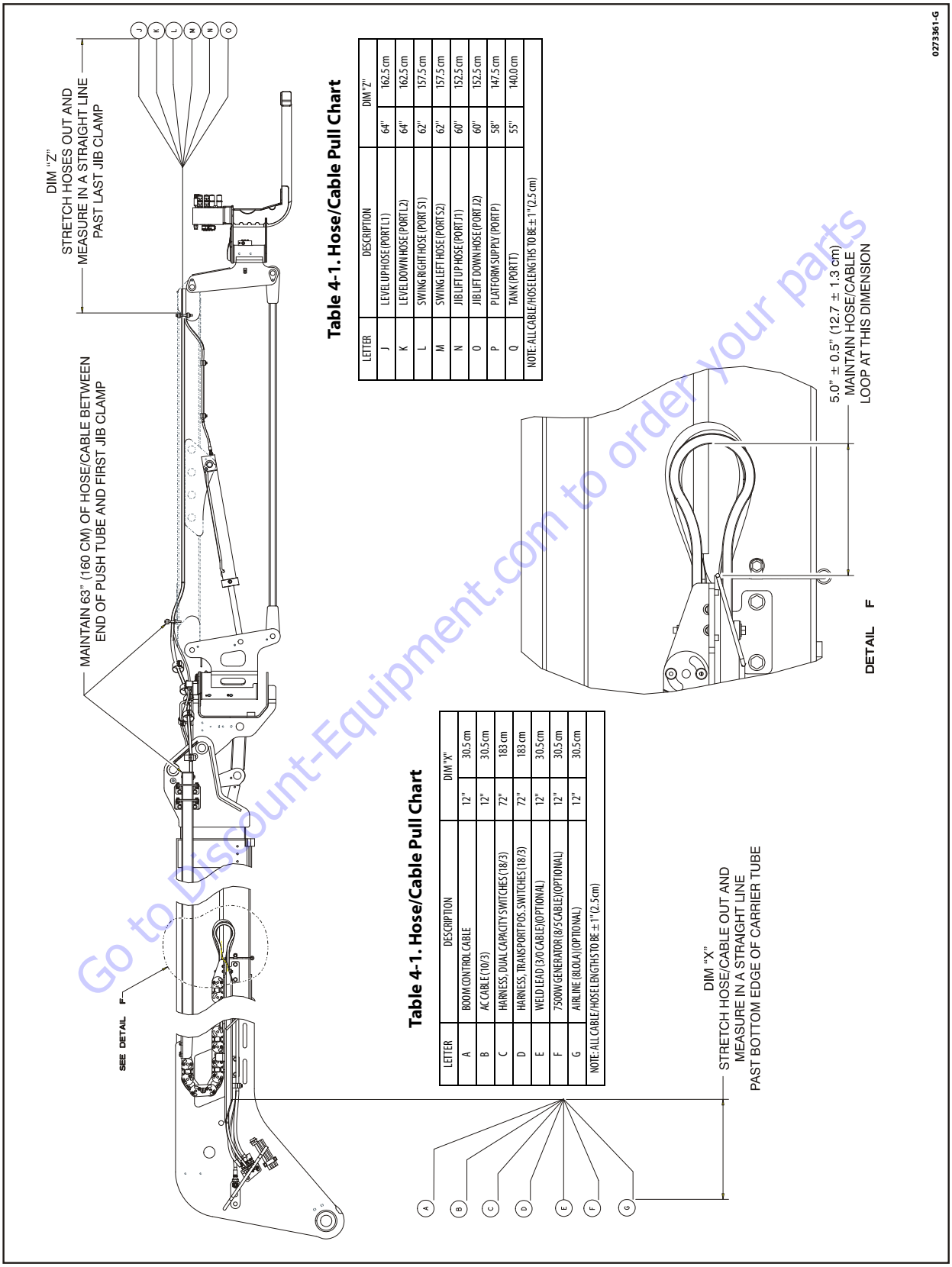


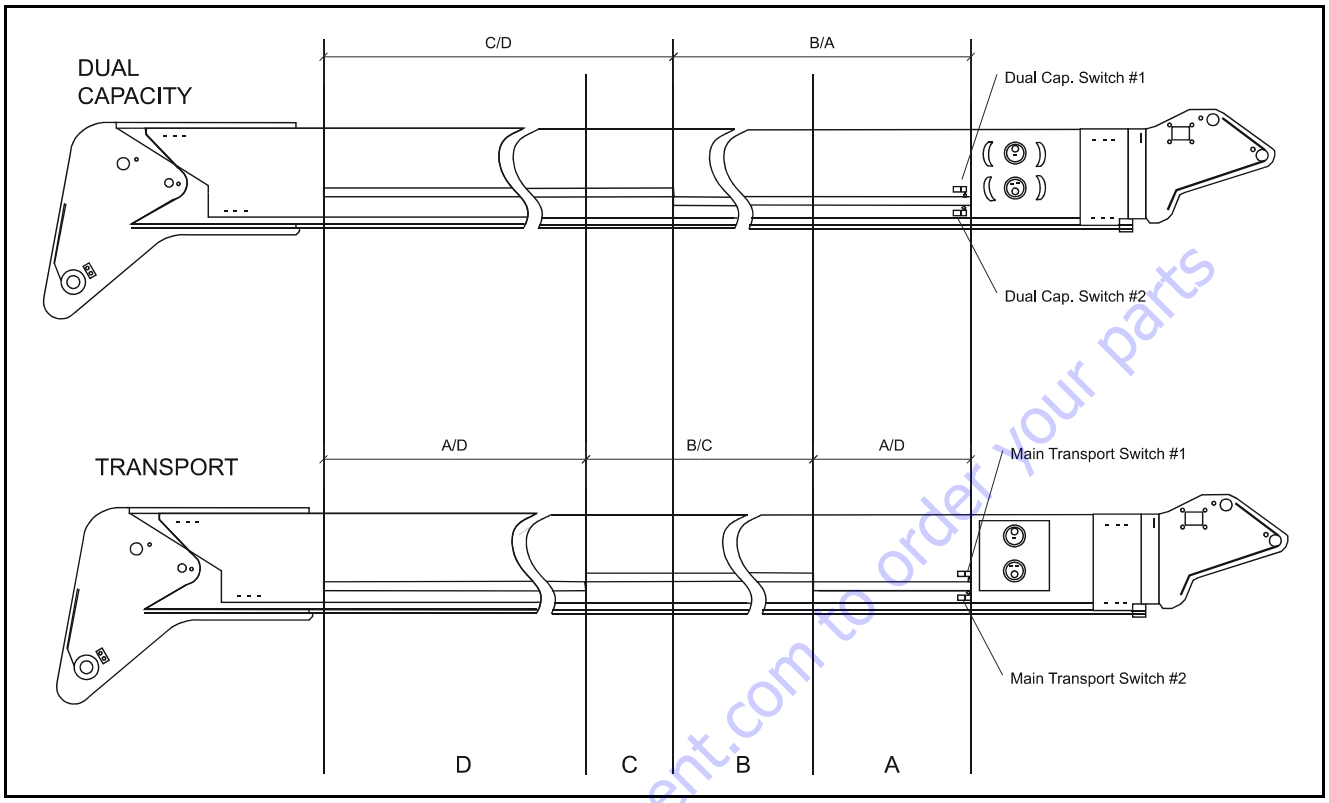
Table 4-1. Hose/Cable Pull Chart

LETTER	DESCRIPTION	DIM "Z"	
J	LEVEL UP HOSE (PORT L1)	64"	162.5 cm
K	LEVEL DOWN HOSE (PORT L2)	64"	162.5 cm
L	SWING RIGHT HOSE (PORT S1)	62"	157.5 cm
M	SWING LEFT HOSE (PORT S2)	62"	157.5 cm
N	JIB LIFT UP HOSE (PORT J1)	60"	152.5 cm
O	JIB LIFT DOWN HOSE (PORT J2)	60"	152.5 cm
P	PLATFORM SUPPLY (PORT P)	58"	147.5 cm
Q	TANK (PORT T)	55"	140.0 cm
NOTE: ALL CABLE/HOSE LENGTHS TO BE ± 1" (2.5 cm)			

Table 4-1. Hose/Cable Pull Chart

LETTER	DESCRIPTION	DIM "X"	
A	BOOM CONTROL CABLE	12"	30.5 cm
B	AC CABLE (10/3)	12"	30.5 cm
C	HARNESS, DUAL CAPACITY SWITCHES (18/3)	72"	183 cm
D	HARNESS, TRANSPORT POS. SWITCHES (18/3)	72"	183 cm
E	WELD LEAD (3/0 CABLE) (OPTIONAL)	12"	30.5 cm
F	7500W GENERATOR (8/5 CABLE) (OPTIONAL)	12"	30.5 cm
G	AIRLINE (8LOLA) (OPTIONAL)	12"	30.5 cm
NOTE: ALL CABLE/HOSE LENGTHS TO BE ± 1" (2.5 cm)			

Figure 4-53. Main Boom Powertrack Installation - Sheet 3 of 3



	Switch States / Boom Length Regions								
Dual Cap. Switch #1	Off Cam	Off Cam	Off Cam	Disagree	On Cam	On Cam	On Cam	Disagree	Disagree
Dual Cap. Switch #2	On Cam	On Cam	On Cam	Disagree	Off Cam	Off Cam	Off Cam	Disagree	Disagree
Control System Conclusion of Dual Cap. Switches	B/A	B/A	B/A	Disagree	C/D	C/D	C/D	Disagree	Disagree
Main Transport Switch #1	Off Cam	Disagree	On Cam	On Cam	On Cam	Disagree	Off Cam	Off Cam	Disagree
Main Transport Switch #2	On Cam	Disagree	Off Cam	Off Cam	Off Cam	Disagree	On Cam	On Cam	Disagree
Control System Conclusion of Main Transport Switches	A/D	Disagree	B/C	B/C	B/C	Disagree	A/D	A/D	Disagree
Control System Conclusion of Main Boom Length	A	A/B	B	B/C	C	C/D	D	Switch Fault	Switch Fault

Table 4-2. Boom Switch Logic

4.30 HOSE ROUTING PROCEDURE

For proper hose routing and cable wrap placement and clamping, refer to Figure 4-30., Figure 4-31., Figure 4-32., Figure 4-51., Figure 4-52., and Figure 4-53. It is important to periodically inspect hoses, wraps and clamps for proper slack adjustments and clamping integrity (pull check). Any changes as a result of inspection should be verified by performing full strokes of boom functions especially lift, telescope, jib, and platform rotate.

4.31 ELECTRONIC PLATFORM LEVELING

NOTE: *For more detailed information concerning system adjustment and operation, refer to Section 6 - JLG Control System.*

Description

Electronic platform leveling replaces the conventional hydraulic method of platform leveling.

To control electronic platform leveling the platform is equipped with a pair of tilt sensors, one primary and one secondary, mounted to the non-rotating portion of the platform rotator. The tilt sensors are monitored regularly and the platform level up and down valves are automatically controlled to maintain **set point** as the machine is operated.

PRIMARY AND SECONDARY TILT SENSOR INTERACTION

The secondary tilt sensor is used as a backup to the primary tilt sensor. Any time a tilt **set point** is reset, a value from each sensor shall be set.

If a fault occurs with the primary sensor, control will revert to the secondary sensor. (This is discussed in more detail in the error response section.)

Because of the mounting orientation of the tilt sensors, the primary tilt sensor will output ascending voltage values with increases in positive platform tilt angle. The backup or secondary tilt sensor will output descending voltage values with increases in positive platform angle.

PLATFORM VALVES

The platform specific valves are located in a manifold at the platform.

There are individual proportional control valves that control each of the four platform functions; Platform Level, Platform Rotate, Jib Lift, and Jib Swing.

There is also a Platform Dump Valve, located in the platform valve manifold, which is used to hydraulically isolate the control valves and to improve hydraulic response.

The Ground Module controls this valve to provide manual platform leveling in the event that the Platform Module is inoperable.

In ground mode, the platform dump valve is turned on whenever any platform or jib valve output is turned on. Whenever all platform and jib valves are turned off, the platform dump valve is turned off.

In platform mode, the platform dump valve is turned on whenever the footswitch is depressed.

Normal Operation

AUTOMATIC LEVELING

Two tilt sensors, mounted on either side of the platform support, are used to measure the incline of the platform with respect to gravity and control the automatic leveling function, one is used as the primary sensor and one as a secondary backup sensor.

The level system shall assume a new **fixed set point** (fixed incline of the platform with respect to gravity) each time the control system is powered up (cycling of the EMS).

Automatic platform leveling only functions while operating drive, telescope, lift or swing. It does not operate while operating any other function (e.g. rotate, jib, or steer).

The proportional control for these valves varies. This is dependant on the tilt variance from target as well as on the impact coil temperature is having on the current to the valves.

If a command from the Platform Level Up and Down toggle switch on either the platform or the ground is received, automatic platform leveling will cease and the appropriate output will be commanded to turn on.

When the toggle switch is released, after ¼ second, the current filtered value of tilt angle will be taken as **the new set point**.

In order to obtain acceptable performance while performing all hydraulic functions, five sets of parameters are used. These "zones" allow compensation for differences in how the basket level changes when doing different functions. These zones are as follows:

1. Lift up
2. Lift down
3. Other boom functions
4. Drive
5. Auxiliary

The other boom functions zone includes Swing, Telescope, Jib swing (It is not necessary to level with jib lift, since the mechanical linkage keeps the basket level).

These zones are prioritized when multiple functions are active. The priorities are as follows.

1. Auxiliary power and any other function, zone = auxiliary power
2. Drive and any other function, zone = Drive
3. Lift up and any other function, zone = Lift up
4. Lift down and any other function, zone = Lift down
5. Other boom functions, zone = Other boom functions

During the power-up procedure, function enable, in both Platform and Ground Mode, is delayed during the 1.5 second startup lamp test. During this 1.5 second startup period, the basket level up valve will be energized at 100% duty cycle for 0.5 second, and then the basket level down valve energized at 100% duty cycle for 0.5 second. This will help to keep the valves from sticking.

PLATFORM LEVEL MANUAL OVERRIDE

In addition to automatic leveling the operator is able to manually adjust the platform level position by means of the level override switches located at the platform and ground control positions (similar to a Master/Slave hydraulic system).

The level system assumes a **new set point** after a level override switch is operated. In other words the operator can chose a platform level incline other than level with gravity and the system will maintain this set point during automatic leveling.

4.32 TOWER BOOM DRIFT TEST

⚠ WARNING

NEVER DIAGNOSE A SUSPECTED TOWER BOOM LIFT CYLINDER DRIFT BY FULLY ELEVATING THE BOOMS. MACHINE TIPOVER COULD OCCUR.

⚠ WARNING

DO NOT LEAVE THE MACHINE UNATTENDED AT ANY TIME DURING THE TEST.

1. Place the machine on a firm, level surface with an empty platform, axles completely extended, tires to be oriented straight and both upper and tower booms retracted and in the transport position. The booms are to be parallel to the wheels.

NOTE: *The machine's hydraulic oil must be at ambient temperature prior to starting step 2.*

2. Connect the hand held analyzer inside the ground box. Place the key switch to the ground position. Pull out the emergency stop switch and start the engine. Using the analyzer, right arrow to *DIAGNOSTICS* and press ENTER. Press the right arrow to get to *BOOM SENSORS* and press ENTER. Press the right arrow until *TOWER CYLINDER ANGLE* is visible.
3. Using the control operations position the upper and jib booms at the maximum angle. The telescope cylinder must be completely retracted. Refer to Figure 4-53., Tower Boom Drift Test.
4. Using the ground controls and analyzer display, position the tower lift cylinder to an angle position between 17.0° and 18.0°. Record tower lift cylinder angle as displayed on the analyzer.
5. While still in the *DIAGNOSTICS/BOOM SENSORS* menu using the left arrow record the displayed value of the *TOWER ANGLE 1* and *TOWER ANGLE 2*. Press the escape button one time, press the left arrow to *SYSTEM* and press enter. Record the *CHASSIS TILT* angle. NOTE: The displayed value for Tower Angle #1 and Tower Angle #2 should be between 10.0° and 12.5° (see Figure 4-53., Tower Boom Drift Test).
6. Visually monitor the tower boom and analyzer display for drift.
   a. After residual boom movement has stopped and all angle readings listed above have been recorded, recheck each of the angles on the analyzer to ensure the values are not currently changing. If immediate tower boom drift is evident, return the upper boom to the transport position and then return the tower boom to the transport position. Discontinue use, tag the unit out of service and remove key. Contact JLG service or JLG service provider for diagnosis and repair information.
   b. If tower boom drift is not immediately evident, record the time at the start of test. Turn key switch to the off position and depress the emergency stop switch. Tag unit out of service and remove key.
7. After the unit has remained in this position for 60 minutes, pull out the emergency stop switch. Using the analyzer, right arrow to *DIAGNOSTICS* and press enter. Press the right arrow to get to *BOOM SENSORS* and press enter. Record the *TOWER ANGLE1, TOWER ANGLE 2* and *TOWER CYLINDER ANGLE* readings.
8. If the angular drift of any of the recorded values exceeds 0.3°, discontinue use, tag the machine out of service and remove the key. Contact JLG service for diagnosis and repair information. If the boom drift is less than 0.3°, the tower lift cylinder is fit for continued service.

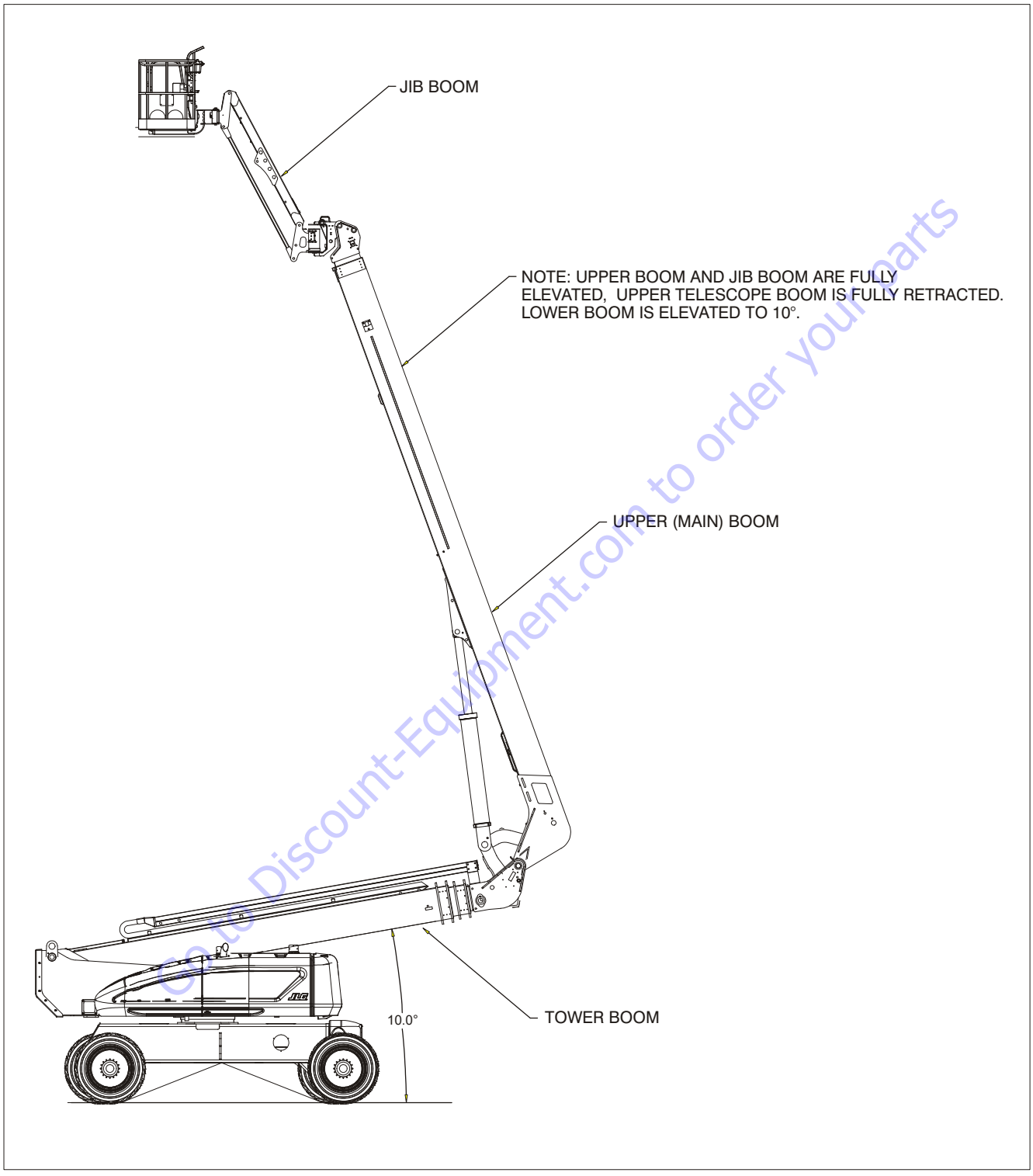
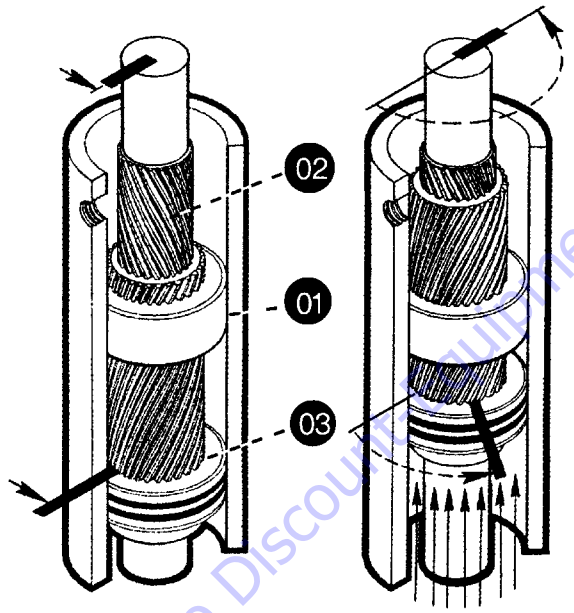


Figure 4-53. Tower Boom Drift Test

4.33 ROTARY ACTUATOR

Theory of Operation

The L20 Series rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert linear piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear teeth (01) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (02), and the annular piston sleeve (03). Helical spline teeth machined on the shaft engage matching splines on the in- side diameter of the piston. The outside diameter of the piston carries a second set of splines, of opposite hand, which engage with matching splines in the housing. As hydraulic pressure is applied, the piston is displaced axially within the housing - similar to the operation of a hydraulic cylinder - while the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the actuator, preventing piston movement and locking the shaft in position.



Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.

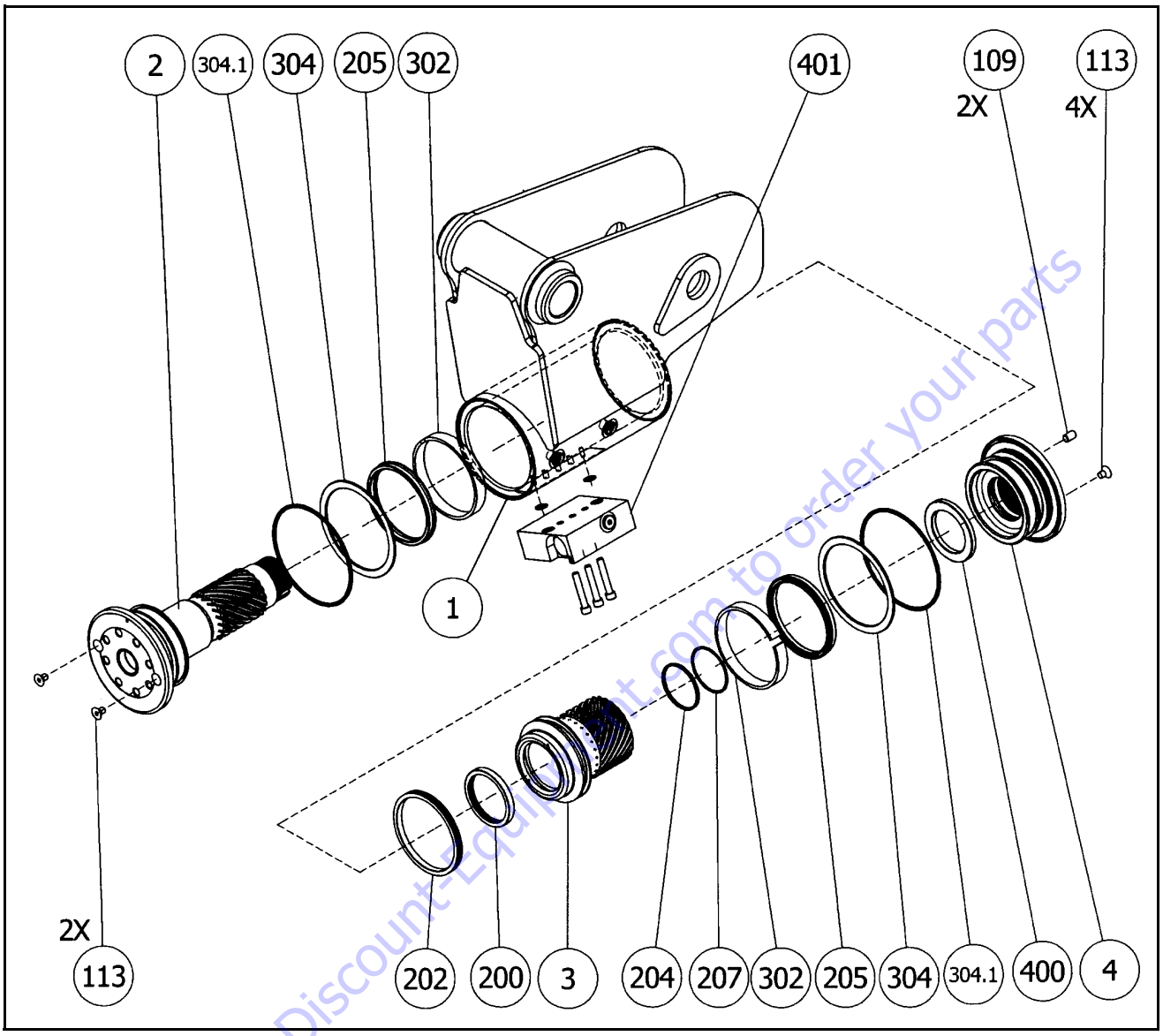
As fluid pressure is applied, the piston is displaced axially while the helical gearing causes the piston and shaft to rotate simultaneously. The double helix design compounds rotation: shaft rotation is about twice that of the piston.

The shaft is supported radially by the large upper radial bearing and the lower radial bearing. Axially, the shaft is separated from the housing by the upper and lower thrust washers. The end cap is adjusted for axial clearance and locked in position by set screws or pins.

Required Tools

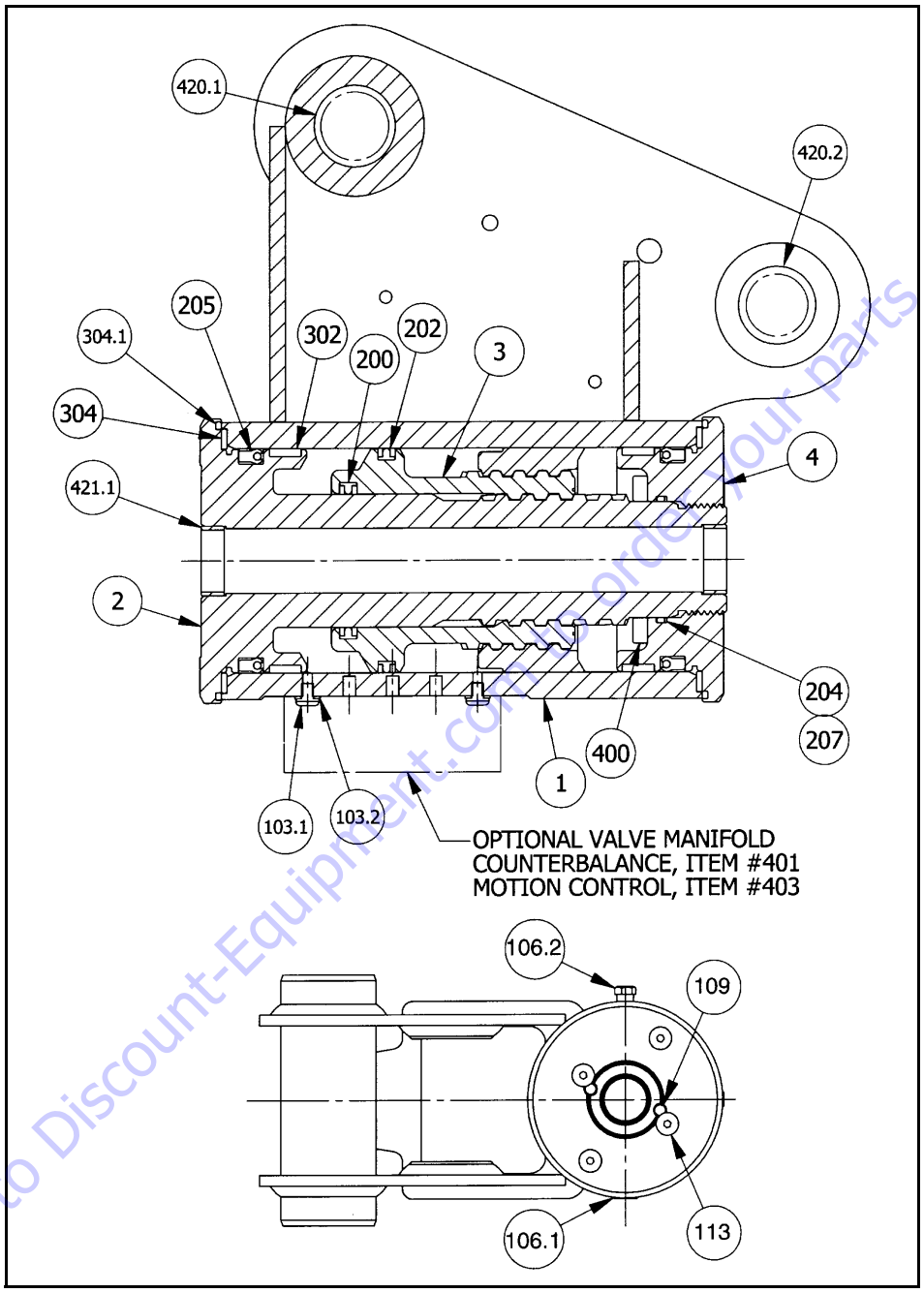
Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:

1. Flashlight - helps examine timing marks, component failure and overall condition.
2. Felt Marker - match mark the timing marks and outline troubled areas.
3. Allen wrench - removal of port plugs and set screws.
4. Box knife - removal of seals.
5. Seal tool - assembly and disassembly of seals and wear guides.
6. Pry bar - removal of end cap and manual rotation of shaft.
7. Rubber mallet- removal and installation of shaft and piston sleeve assembly.
8. Nylon drift - installation of piston sleeve
9. End cap dowel pins - removal and installation of end cap (sold with Helac seal kit).



PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109. Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-54. Rotary Actuator - Exploded View



PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
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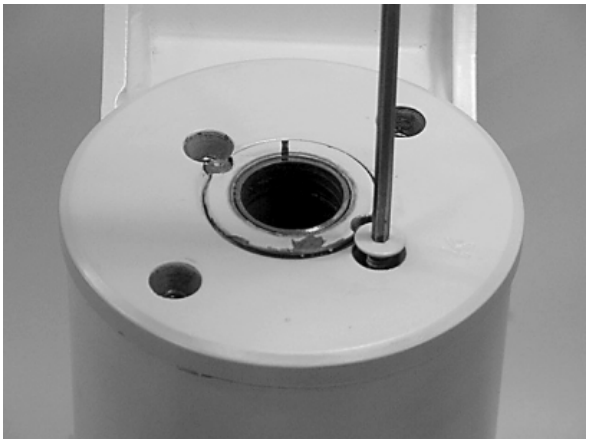
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109. Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-55. Rotary Actuator - Assembly Drawing

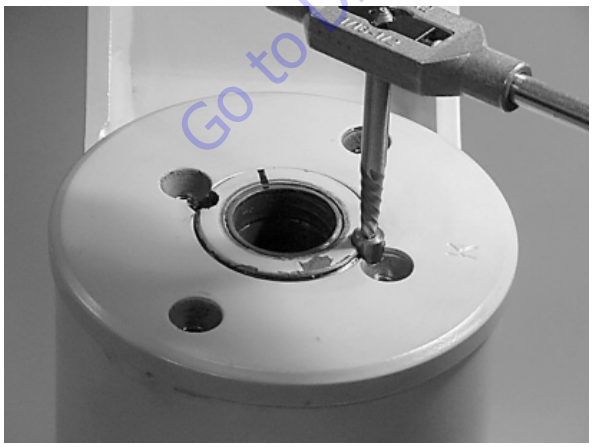
Disassembly

1. Remove the capscrews (113) over end cap lock pins (109).



2. Using a 1/8" (3.18mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/16" (4.76mm).

3. Remove the lock pins using an "Easy Out" (a size #2 is shown).



If the pin will not come out with the "Easy Out", use 5/16" drill bit to a depth of 1/2" (12.7mm) to drill out the entire pin.

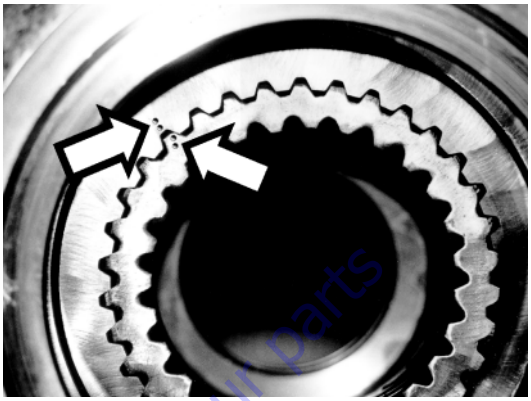
4. Install the end cap (4) removal tools provided with the Helac seal kit.

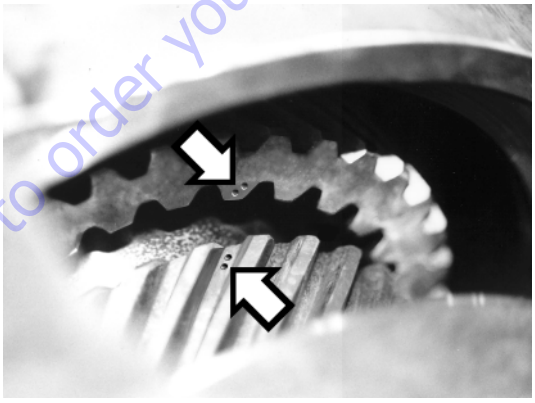
5. Using a metal bar, or something similar, unscrew the end cap (4) by turning it counterclockwise.

6. Remove the end cap (4) and set aside for later inspection.

7. Remove the stop tube if included. The stop tube is an available option to limit the rotation of the actuator.

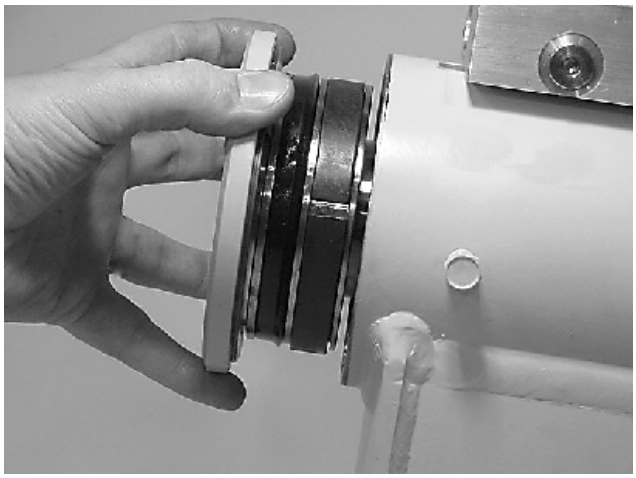
8. Every actuator has timing marks for proper engagement.





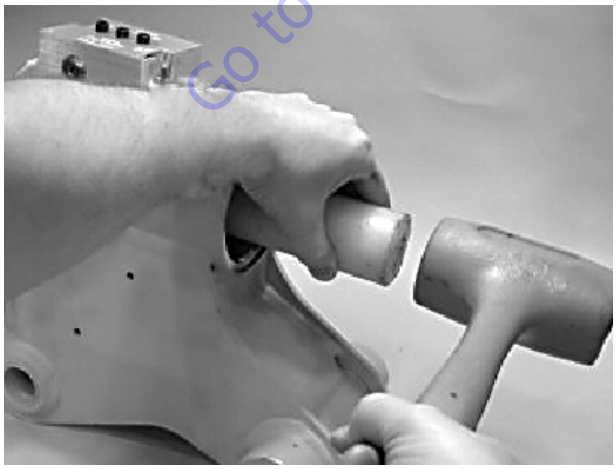
9. Prior to removing the shaft, (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.

10. Remove the shaft (2). It may be necessary to strike the threaded end of the shaft with a rubber mallet.

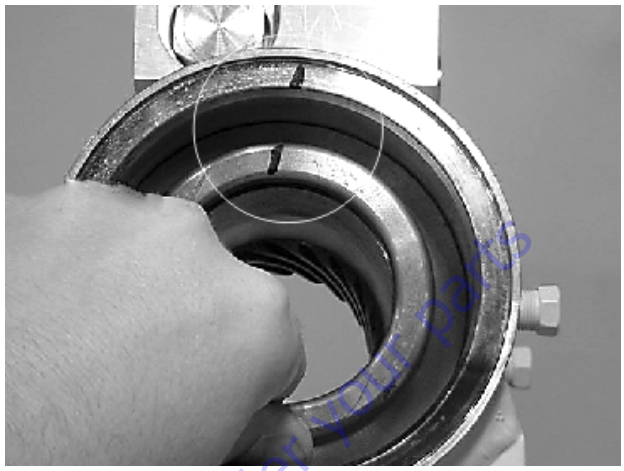


11. Before removing the piston (3), mark the housing (1) ring gear in relation to the piston O.D. gear. There should now be timing marks on the housing (1) ring gear, the piston (3) and the shaft (2).

12. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is not damaged.

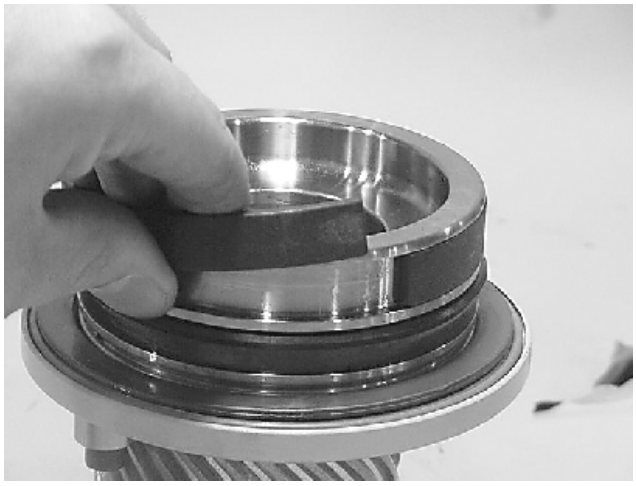


13. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.

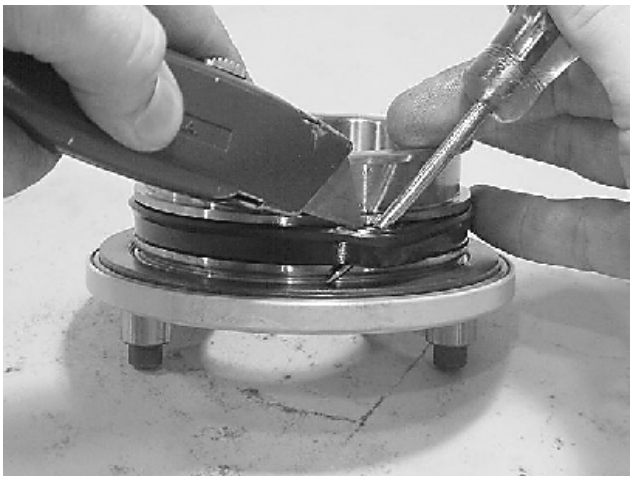


14. Remove the o-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.

15. Remove the wear guides (302) from the end cap (4) and shaft (2).



16. To remove the main pressure seals (205), it is easiest to cut them using a sharp razor blade being careful not to damage the seal groove.



17. Remove the thrust washers (304), from the end cap (4) and shaft (2).

18. Remove the wiper seal (304.1) from its groove in the end cap (4) and shaft (2).

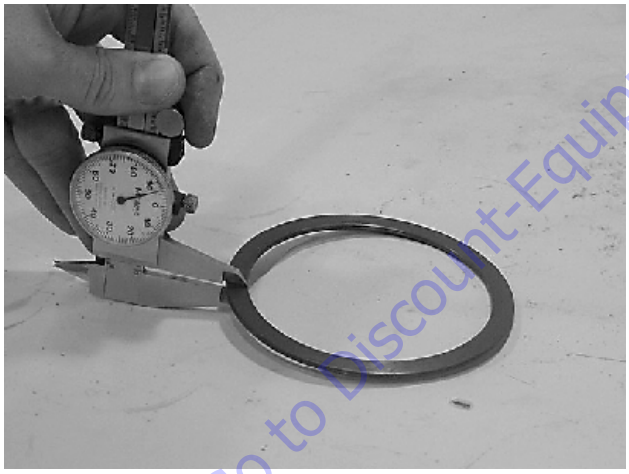
19. Remove the piston O.D. seal (202).

20. Remove the piston I.D. seal (200). You may now proceed to the inspection process.

Inspection

1. Clean all parts in a solvent tank and dry with compressed air prior to inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore and gear teeth.

2. Inspect the thrust washers (304) for rough or worn edges and surfaces. Measure it's thickness to make sure it is within specifications (Not less than 0.092" or 2.34 mm).

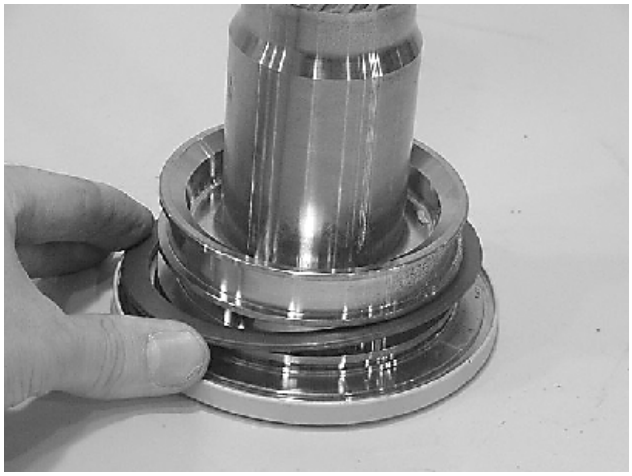


3. Inspect the wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).

Assembly

1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.

2. Install the thrust washer (304) onto shaft (2) and end cap (4).



3. Install the wiper seal (304.1/green 0-ring) into it's groove on the shaft (2) and end cap (4) around the outside edge of the thrust washer (304).

4. Using a seal tool install the main pressure seal (205) onto shaft (2) and end cap (4). Use the seal tool in a circular motion.

5. Install the wear guide (302) on the end cap (4) and shaft (2).

6. Install the inner T-seal (200) into the piston (3) using a circular motion.

   Install the outer T-seal (202) by stretching it around the groove in a circular motion.

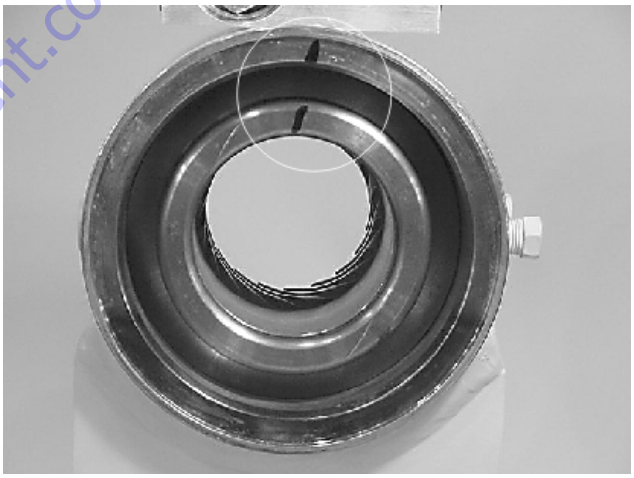
Each T-seal has 2 backup rings (see drawing for orientation).

Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

Repeat this step for the outer seal (202).

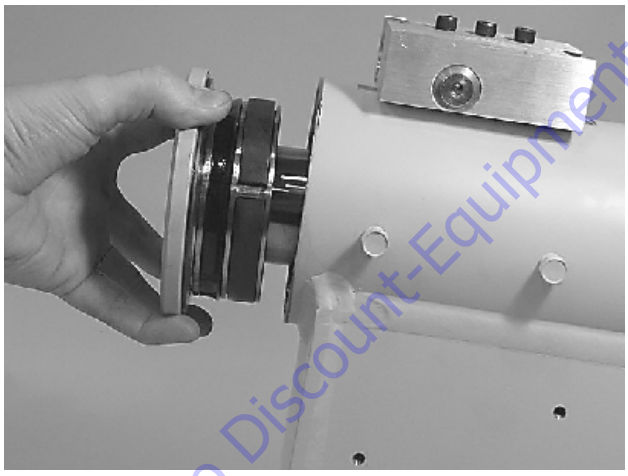
7. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.

8. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



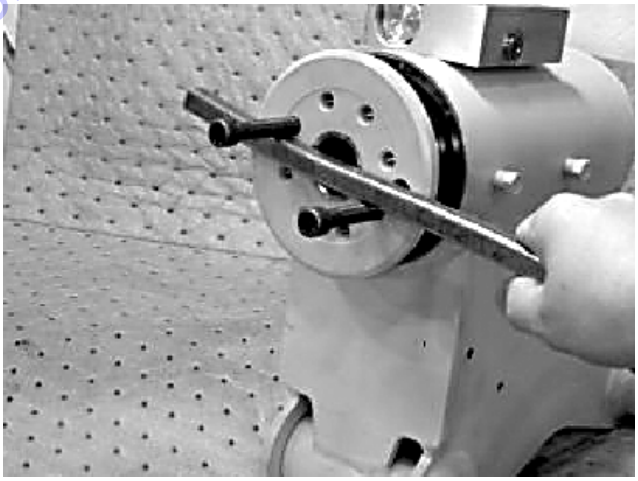
9. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.

10. Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.



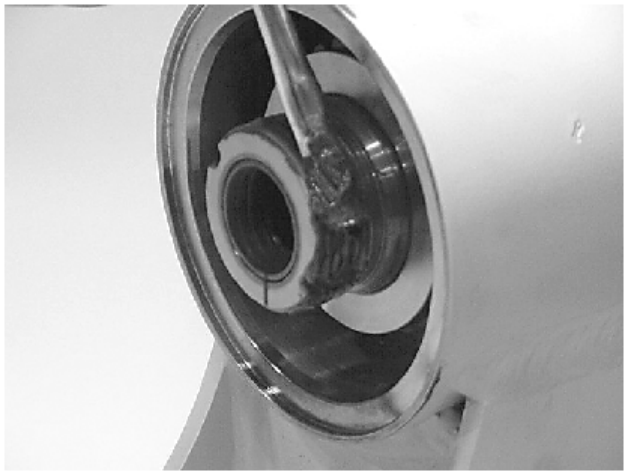
11. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.

12. Install 2 bolts in the threaded holes in the flange. Using a bar, rotate the shaft in a clockwise direction until the wear guides are seated inside the housing bore.



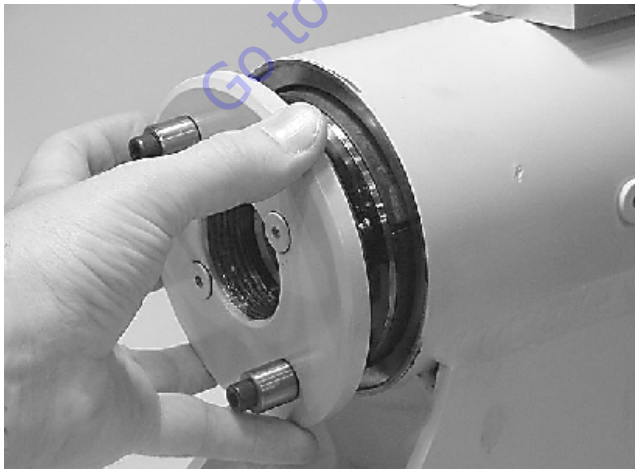
13. Install the stop tube onto the shaft end. Stop tube is an available option to limit the rotation of an actuator.

14. Coat the threads on the end of the shaft with anti-seize grease to prevent galling.

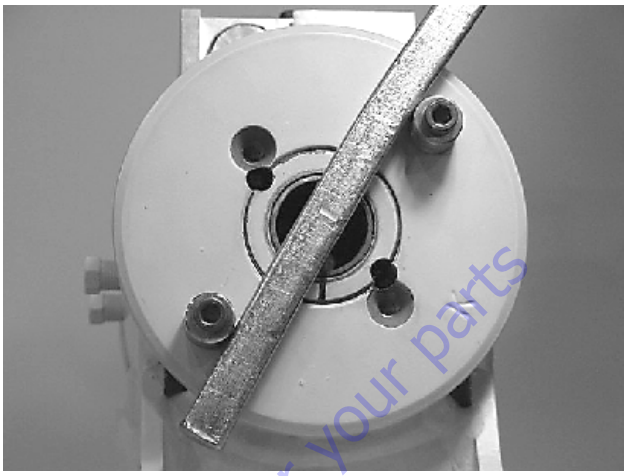


15. Install the 0-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).

16. Thread the end cap (4) onto the shaft (2) end. Make sure the wear guide stays in place on the end cap as it is threaded into the housing (1).

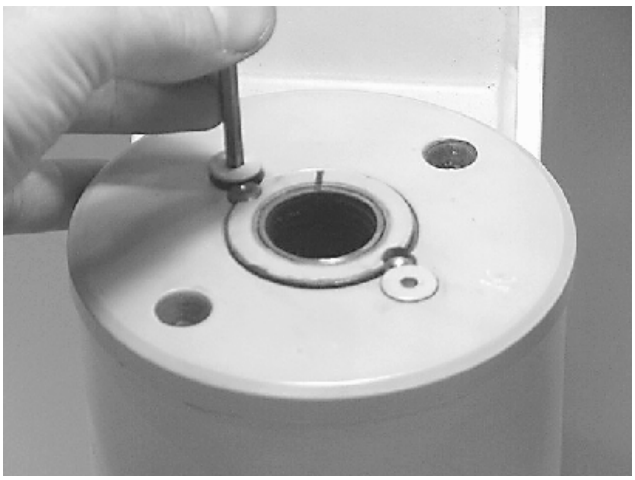


17. Tighten the end cap (4). In most cases the original holes for the lock pins will line up.



18. Place the lock pins (109) provided in the Helac seal kit in the holes with the dimple side up. Then, using a punch, tap the lock pins to the bottom of the hole.

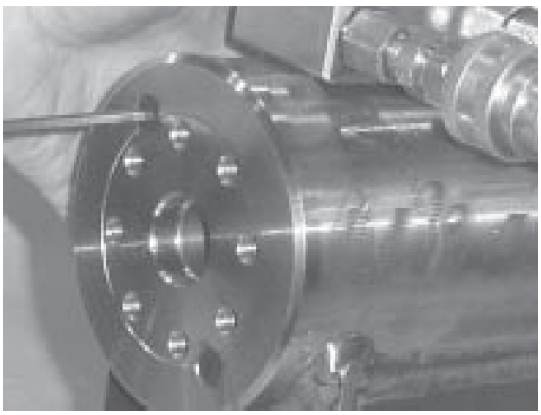
19. Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.825 Nm).



Greasing Thrust Washers

1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

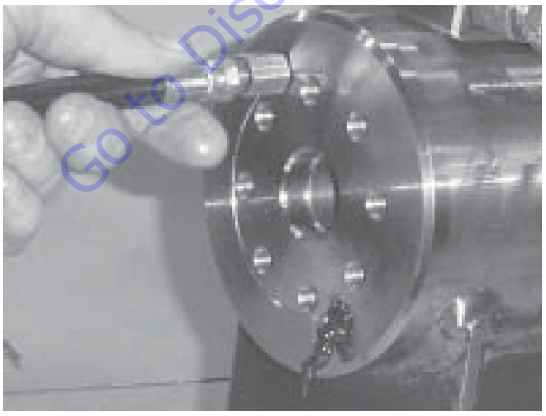
   There are two grease ports located on both the shaft flange and the end cap. They are plugged with capscrews (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)



NOTICE

IF A HYDRAULIC TEST BENCH IS NOT AVAILABLE, THE ACTUATOR CAN BE ROTATED BY HAND, OPEN THE PRESSURE PORTS AND USE A PRY BAR WITH CAPSCREWS INSERTED INTO THE SHAFT FLANGE TO TURN THE SHAFT IN THE DESIRED DIRECTION.

   Insert the tip of a grease gun into one port and apply grease to the shaft flange. Continue applying until grease flows from the opposite port. Cycle the actuator five times and apply grease again. Repeat this process on the end cap. Insert the capscrews into the grease ports and tighten to 25 in-lbs. (2.8 Nm).



Installing Counterbalance Valve

Refer to Figure 4-56., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old JLG Threadlocker.
2. Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. Medium Strength Threadlocking Compound should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4-inch bolts 110 to 120 inch pounds (12.4 to 13.5 Nm). Do not torque over 125 inch pounds (14.1 Nm). Torque the 5/16-inch bolts 140 inch pounds (15.8 Nm). Do not torque over 145 inch pounds (16.3 Nm).

Testing the Actuator

If the equipment is available, the actuator should be tested on a hydraulic test bench. The breakaway pressure — the pressure at which the shaft begins to rotate — should be approximately 400 psi (28 bar). Cycle the actuator at least 25 times at 3000 psi (210 bar) pressure. After the 25 rotations, increase the pressure to 4500 psi (315 bar) to check for leaks and cracks. Perform the test again at the end of the rotation in the opposite direction.

TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

If the actuator is equipped with a counterbalance valve, plug the valve ports. Connect the hydraulic lines to the housing ports. Bleed all air from the actuator (see Installation and Bleeding) Rotate the shaft to the end of rotation at 3000 psi (210 bar) and maintain pressure. Remove the hydraulic line from the non-pressurized side.

Continuous oil flow from the open housing port indicates internal leakage across the piston. Replace the line and rotate the shaft to the end of rotation in the opposite direction. Repeat the test procedure outlined above for the other port. If there is an internal leak, disassemble, inspect and repair.

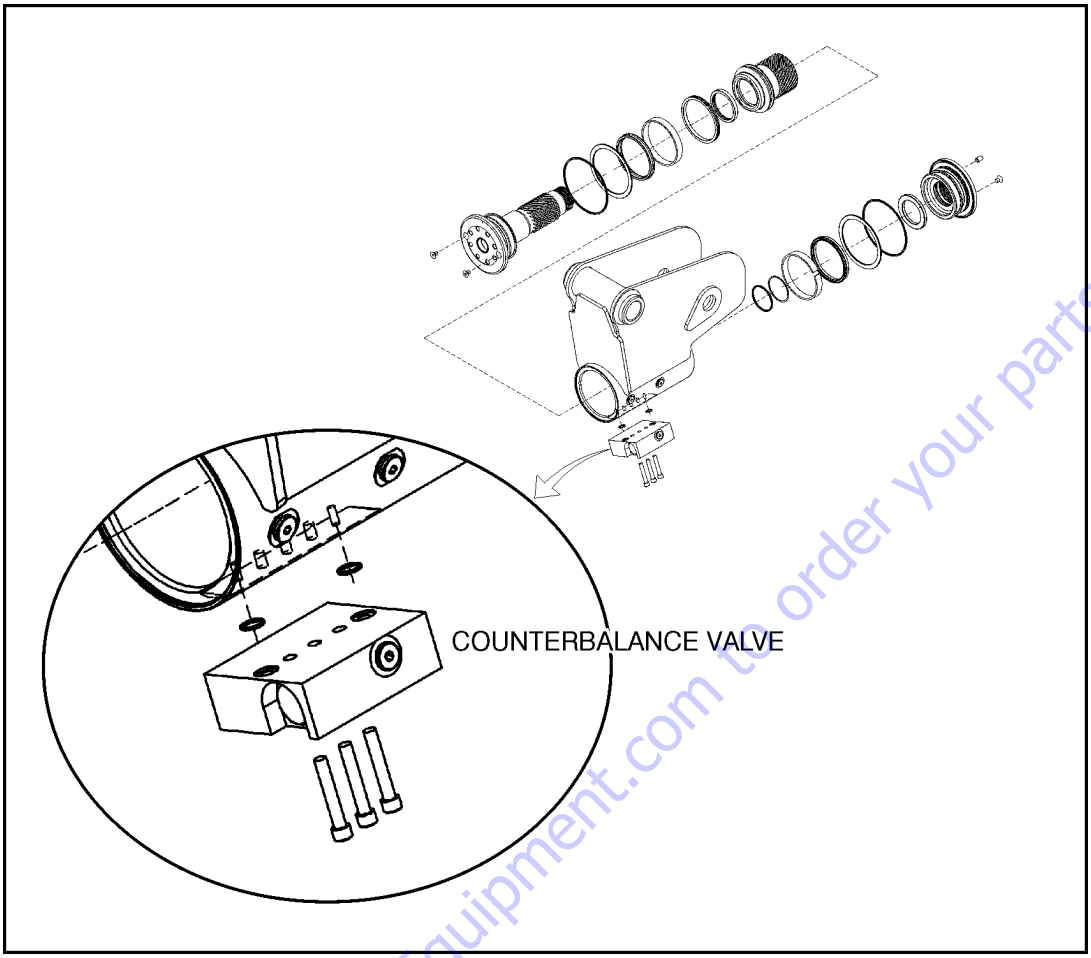
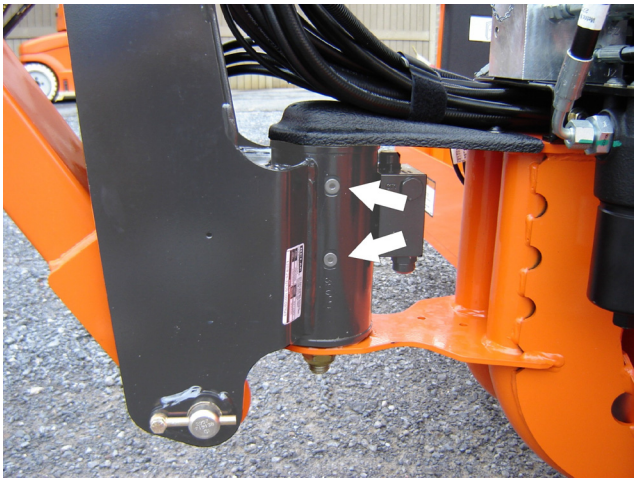


Figure 4-56. Rotator Counterbalance Valve

Bleeding After Installation

NOTE: *Bleeding will be necessary if excessive backlash is displayed after the actuator is installed. To do this, bleeder valves must be installed in the actuator at the locations shown below. The following steps are recommended when a minimum of two gallons (8 liters) is purged.*



1. Connect a 5 foot (1.5 m) long 3/16" inside diameter, 5/16" outside diameter clear vinyl drain tube to each of the two bleeder valves. Secure the tubes in place with hose clamps.
2. Place the end of the tubes in a clean 5 gallon (19 L) container to collect the purged oil. The oil can be returned to the reservoir when the procedure is complete.
3. Open both bleeder valves 1/4 turn. Using the hydraulic system, rotate the platform to the end of rotation and maintain hydraulic pressure. Oil with small air bubbles should be seen flowing through the tubes. Allow 1/2 gallon (2 L) of oil to be purged from the actuator.
4. Keep the bleeder valves open and rotate the platform in the opposite direction to the end of rotation. Maintain hydraulic pressure until an additional 1/2 gallon (2 L) of oil is pumped out.
5. Repeat steps 3 and 4. After the last 1/2 gallon (2 L) of oil is purged, close both bleed nipples before rotating away from the end of rotation.

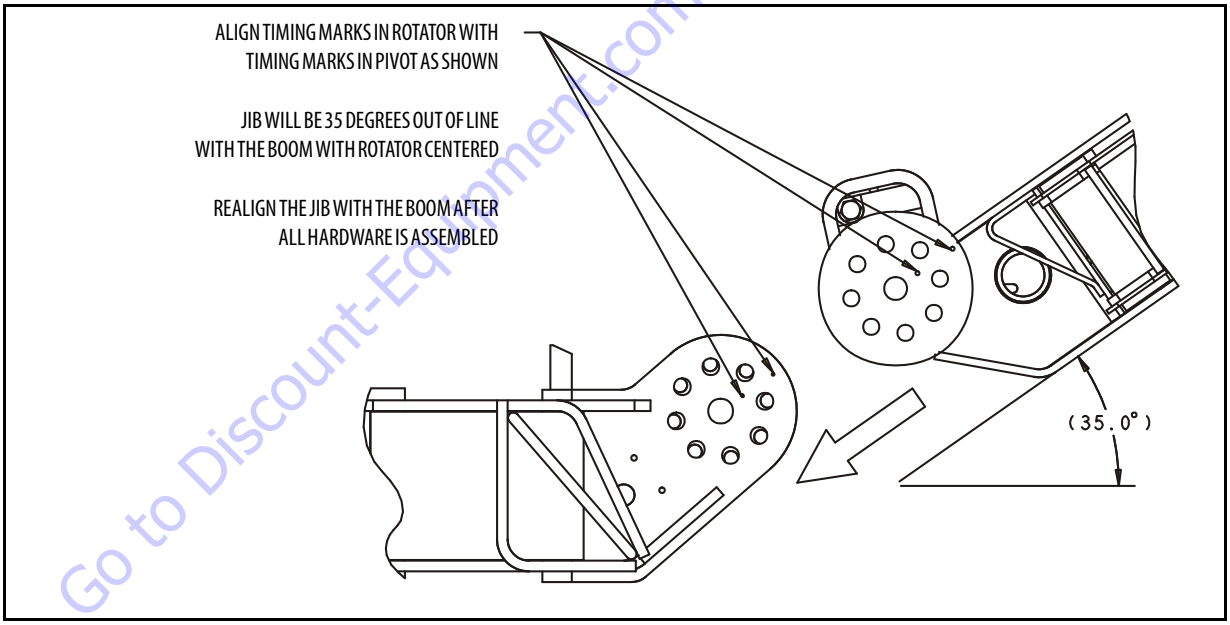


Figure 4-57. Jib Alignment Timing Marks

4.34 BOLT-ON EXTERNAL FALL ARREST

The bolt-on external fall arrest system is designed to provide a lanyard attach point while allowing the operator to access areas outside the platform. Exit/Enter the platform through the gate area only. The system is designed for use by one person.

Personnel must use fall protection at all times. A full body harness is required with lanyard not to exceed 6 ft. (1.8 M) in length, that limits the maximum arrest force to 900 lb (408 kg).

Bolt-on external fall arrest system capacity is 310 lb (140 kg) - one (1) person maximum.

Do not move the platform during use of the bolt-on external fall arrest system.

⚠ WARNING

DO NOT OPERATE ANY MACHINE FUNCTIONS WHILE OUTSIDE OF PLATFORM. BE CAREFUL WHEN ENTERING/EXITING THE PLATFORM AT ELEVATION.

⚠ WARNING

IF THE BOLT-ON EXTERNAL FALL ARREST SYSTEM IS USED TO ARREST A FALL OR IS OTHERWISE DAMAGED, THE ENTIRE SYSTEM MUST BE REPLACED AND THE PLATFORM FULLY INSPECTED BEFORE RETURNING TO SERVICE. REFER TO THE SERVICE MANUAL FOR REMOVAL AND INSTALLATION PROCEDURES.

THE BOLT-ON EXTERNAL FALL ARREST SYSTEM REQUIRES AN ANNUAL INSPECTION AND CERTIFICATION. THE ANNUAL INSPECTION AND CERTIFICATION MUST BE PERFORMED BY A QUALIFIED PERSON OTHER THAN THE USER.

Inspection Before Use

The bolt-on external fall arrest system must be inspected before each use of the mobile elevating work platform. Replace components if there are any signs of wear or damage.

Before each use, perform a visual inspection of the following components:

- Cable: Inspect cable for proper tension, broken strands, kinks, or any signs of corrosion.

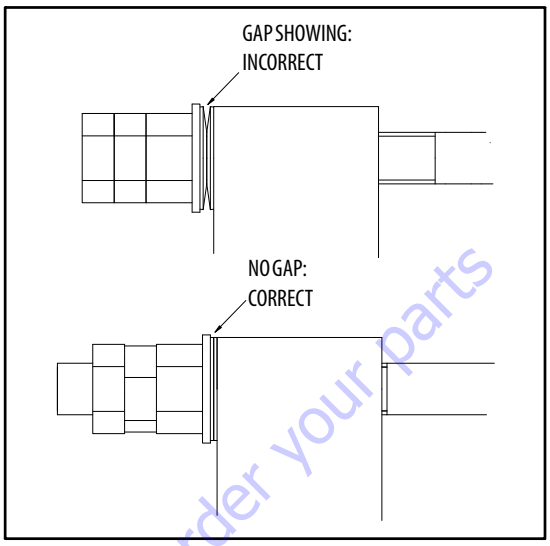
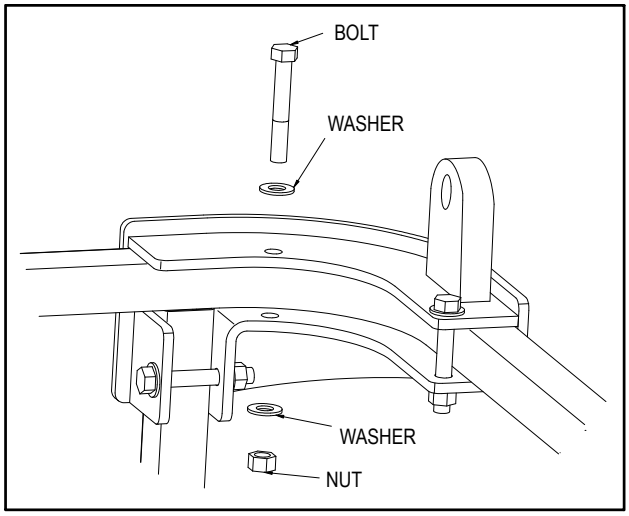


Figure 4-58. Bolt-On External Fall Arrest Cable Tension

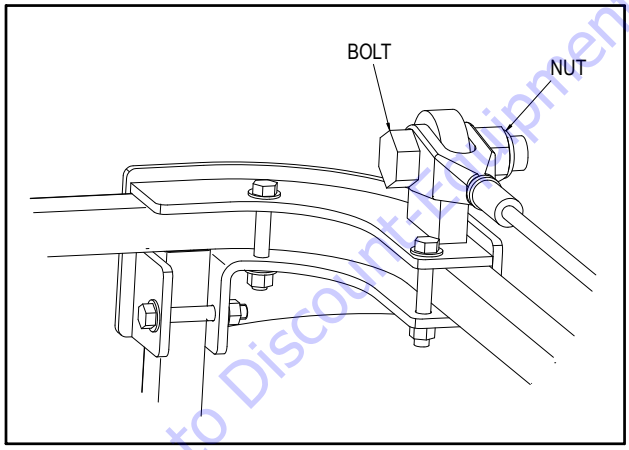
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are no missing components and hardware is properly tightened.
- Platform Rails: No visible damage is acceptable.

Installation

1. Install the retaining hardware (bolts, nuts, and washers) and secure the brackets to the platform rail. Tighten the nuts but do not torque them yet.

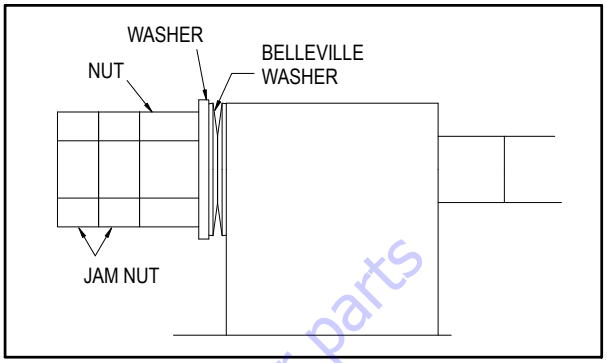


2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.

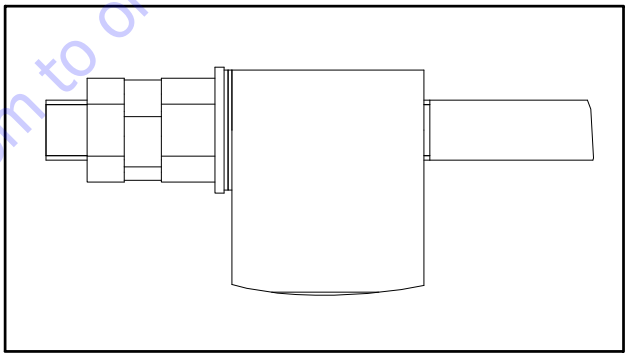


3. Install the Attachment Ring onto the cable.

4. Without twisting the fall arrest cable, pull it thru the left hand bracket and mark the top of the swaged cable end. Install the fall arrest cable through the left hand bracket and secure it using the belleville washers, washer, retaining nut, and jam nuts. Orient the hardware as shown below and with the belleville washers so the gap is present at the outside diameter of the washers. install the nuts onto the cable finger tight so the mark on the cable does not move.



5. Use the two jam nuts to prevent the cable from rotating while the nut is tightened. Tighten the nut until the belleville washers are fully compressed and no gap is present at the outside diameter of the washers. Ensure the cable has not rotated during tightening.



6. Tighten the first jam nut against the retaining nut to keep the nut from loosening. Tighten the remaining jam nut against the first jam nut.

7. Torque the nuts and bolts securing the brackets to 15 ft.lbs. (20 Nm).

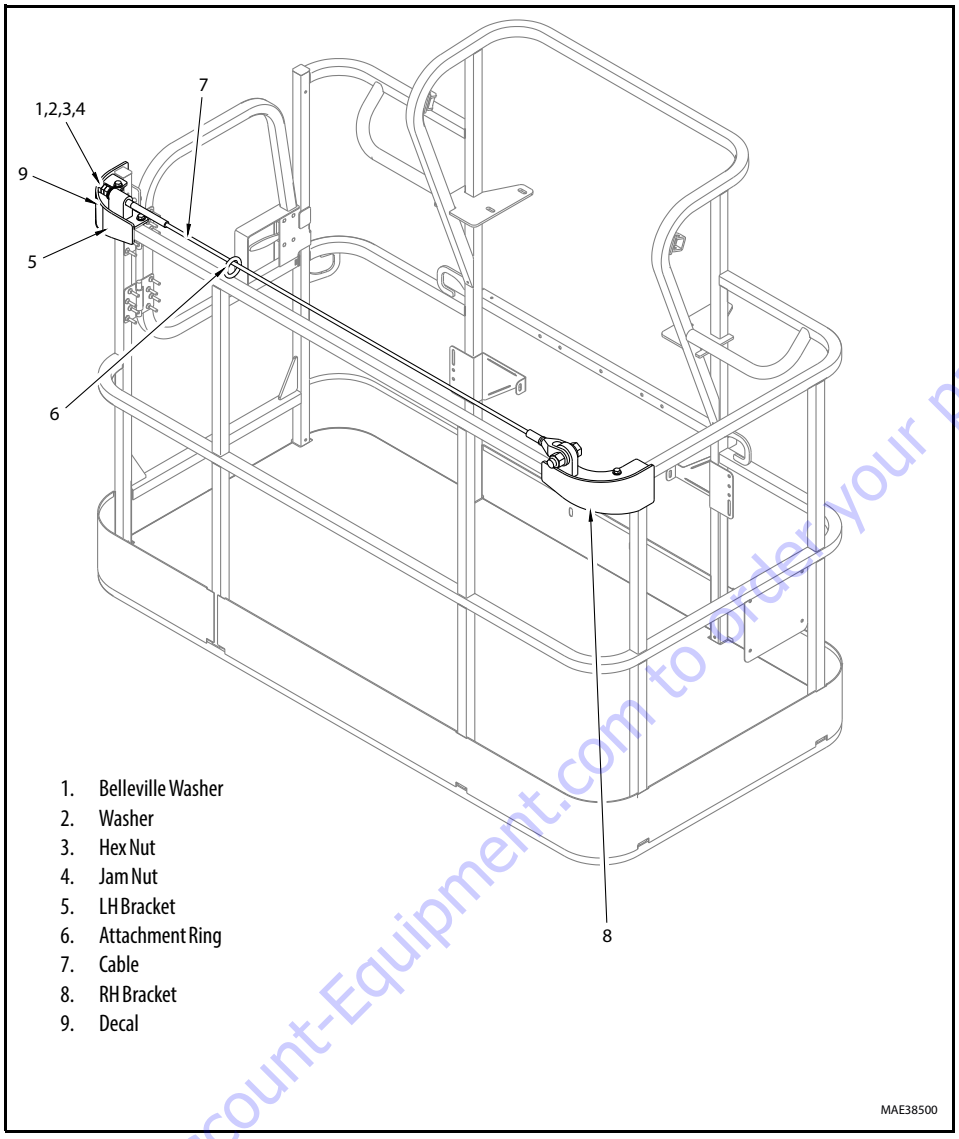


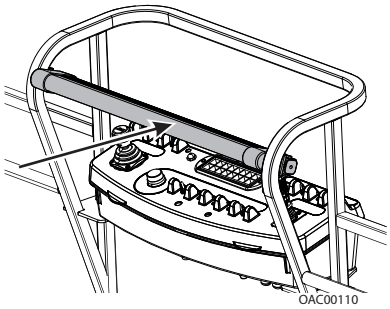
Figure 4-59. Bolt-On External Fall Arrest System

4.35 SKYGUARD

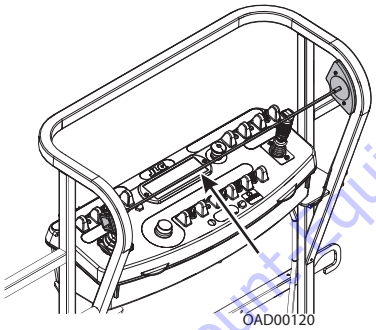
Operation

SkyGuard provides enhanced control panel protection. When the SkyGuard sensor is activated, functions in use at the time of actuation will reverse or cutout. The SkyGuard Function Table provides more details on these functions.

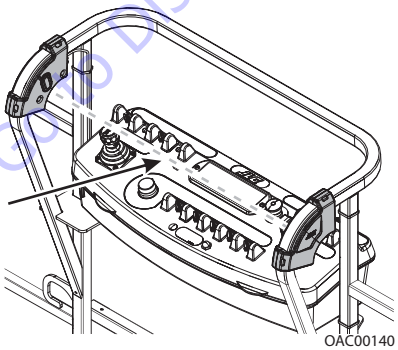
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™

⚠ WARNING

THE MACHINE OPERATOR IS REQUIRED TO PERFORM A DAILY FUNCTION TEST TO ENSURE PROPER OPERATION OF THE SKYGUARD SYSTEM.

Function Test

SKYGUARD ONLY

Perform this function test if **SkyGuard only** is selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops then telescope in function operates for a short duration. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure normal operation available.

In Ground Mode:

1. Operation is allowed regardless of SkyGuard activation.

BOTH SKYGUARD AND SOFT TOUCH

Perform this procedure if both SkyGuard and Soft Touch are selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

NOTE: *Machine will treat Soft Touch/SkyGuard override switch as if it is a Soft Touch and SkyGuard switch.*

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure sure normal operation is available.

In Ground Mode:

1. Operation is allowed regardless of SkyGuard activation.

SOFT TOUCH ONLY

If **Soft Touch only** is selected in machine setup (refer to Table 6-2), machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

SKYGUARD NOT SELECTED IN MACHINE SETUP

If the SkyGuard system is installed on the machine, but no option is selected in the machine setup (refer to Table 6-2), SkyGuard sensor status will be ignored. No function cutout or reversal will be implemented.

Diagnostics & Troubleshooting

If SkyGuard does not function when the sensor is engaged, first verify the configuration under the MACHINE SETUP: SKYGUARD OPTION menu using the handheld Analyzer. Ensure the selected configuration matches the actual system installed on the machine. If not, select the correct configuration, then verify operation.

Additionally, use the handheld analyzer to navigate to the DIAGNOSTICS: FEATURES → SKYGUARD INPUTS menu to determine additional SkyGuard fault information.

Engage the SkyGuard sensor and observe the Analyzer to determine if the switch/relay closes.

If the status of the switch/relay remains OPEN while the SkyGuard sensor is actively engaged, it is possible the sensor has failed and should be replaced immediately.

If the status of the switch/relay remains CLOSED while the SkyGuard sensor is actively engaged, a power or ground wire may not be making good contact or may be loose or broken. Additionally, there is a low probability that both relays may have failed.

If the switch/relay status is in disagreement, then one may have failed or is not installed correctly. In this case, the machine will be inoperable.

FAULT CODES

Refer to Table 6-2 for more fault code information

- **0039 -** SkyGuard switch activation fault
- **2563 -** switch disagreement fault

Table 4-3. SkyGuard Function Table

Drive Forward	Drive Reverse	Steer	Swing	Tower Lift Up	Tower Tele Out	Tower Lift Down	Tower Tele In	Boom Lift Up	Boom Lift Down	Boom Tele Out	Boom Tele In	Jib Lift	Jib Swing	Basket Level	Basket Rotate
R*/C**	R	C	R	C	C	C	C	R	R	R	C	C	C	C	C
R = Indicates Reversal is Activated															
C = Indicates Cutout is Activated															
* DOS (Drive Orientation System) Enabled															
** DOS Not Enabled, machine is driving straight without steering, and any other hydraulic function is active															
Note: If SkyGuard is enabled with the Soft Touch system, functions will cut out instead of reversing															

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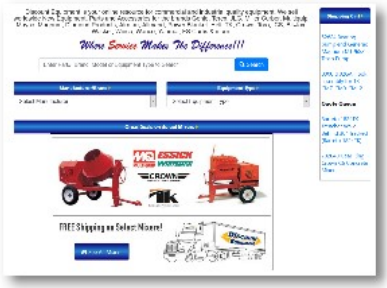

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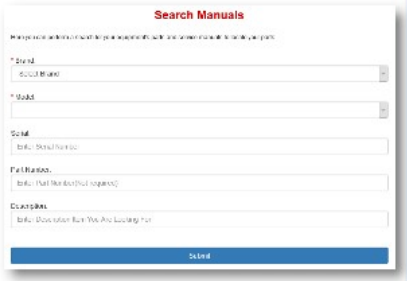

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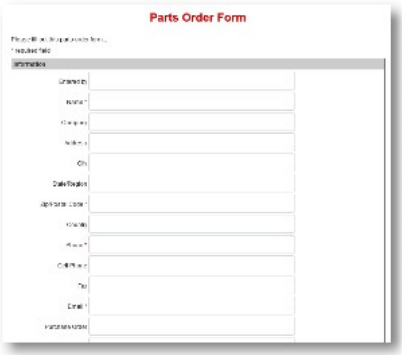

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SECTION 5. HYDRAULICS AND HYDRAULIC SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

NOTE: *All O-ring fittings must be pre-lubricated with hydraulic oil prior to assembly.*

Cup and Brush

The following is needed to correctly oil the o-ring in this manner:

- A small container for hydraulic oil
- Small paint brush

1. Hold the fitting in one hand while using the brush with the other hand to dip into the container. Remove excess hydraulic oil from the brush so an even film of oil is applied on the o-ring.

2. Holding the fitting over the hydraulic oil container, brush an even film of oil around the entire o-ring in the fitting, making sure the entire o-ring is completely saturated.

3. Turn the o-ring on the other side of the fitting and repeat the previous step, ensuring the entire o-ring is coated with hydraulic oil.

Dip Method

NOTE: *This method works best with Face Seal o-rings, but will work for all o-ring fitting types.*

The following is needed to correctly oil the o-ring in this manner:

- A small leak proof container
- Sponge cut to fit inside the container
- A small amount of hydraulic oil to saturate the sponge.

1. Place the sponge inside the container and add hydraulic oil to the sponge until it is fully saturated.
2. Dip the fitting into the sponge using firm pressure. Upon lifting the fitting, a small droplet will form and drip from the bottom of the fitting. This should signify an even coating of oil on the fitting.

3. O-ring Boss type fittings will require more pressure in able to immerse more of the fitting into the saturated sponge. This will also cause more oil to be dispersed from the sponge.

Spray Method

This method requires a pump or trigger spray bottle.

1. Fill the spray bottle with hydraulic oil.
2. Hold the fitting over a suitable catch can.
3. Spray the entire o-ring surface with a medium coat of oil.

Brush-on Method

This method requires a sealed bottle brush.

1. Fill the bottle with hydraulic oil.
2. Using slight pressure to the body of the spray bottle, invert the bottle so the brush end is in the downward position.
3. Brush hydraulic oil on the entire o-ring, applying an even coat of oil.

5.2 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION

Tapered Thread Types

NPTF = national tapered fuel (Dry Seal) per SAE J476/J512

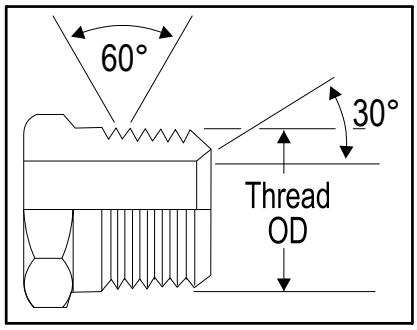


Figure 5-1. NPTF Thread

BSPT = British standard pipe tapered per ISO7-1

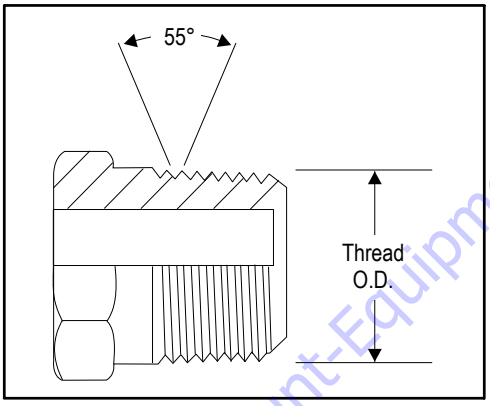


Figure 5-2. BSPT Thread

Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

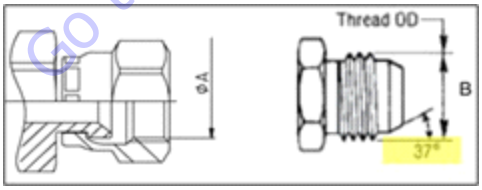


Figure 5-3. JIC Thread

SAE = 45° flare per SAE J512

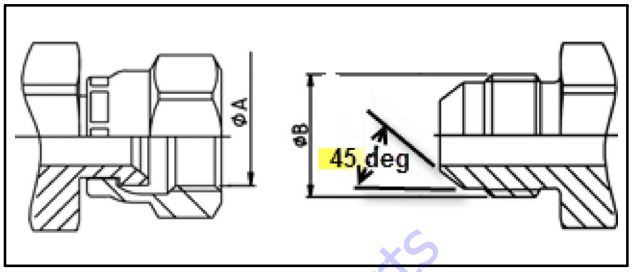


Figure 5-4. SAE Thread

ORFS = o-ring face seal per SAE J1453

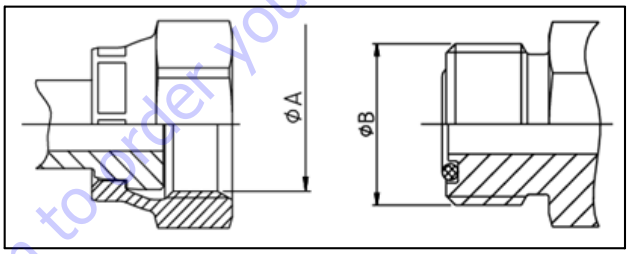


Figure 5-5. ORFS Thread

MBTL = metric flareless bite type fitting, pressure rating L (medium) per ISO 8434, DIN 2353

MBTS = metric flareless bite type fitting, pressure rating S (high) per ISO 8434, DIN 2353

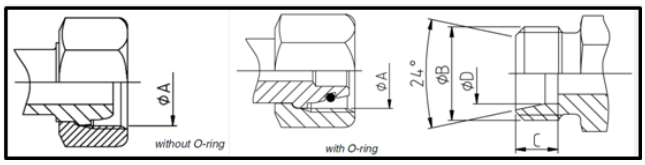


Figure 5-6. MTBL-MBTS Thread

BH = bulkhead connection – JIC, ORFS, MBTL, or MBTS types

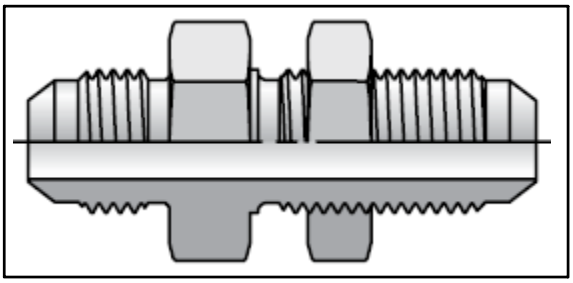


Figure 5-7. Bulkhead Thread

Straight Thread Types, Port Connections

ORB = o-ring boss per SAE J1926, ISO 11926

MPP = metric pipe parallel o-ring boss per SAE J2244, ISO 6149, DIN 3852

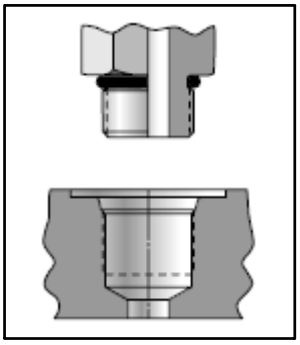


Figure 5-8. ORB-MPP Thread

MFF = metric flat face port per ISO 9974-1

BSPP = British standard parallel pipe per ISO 1179-1, DIN 3852-2

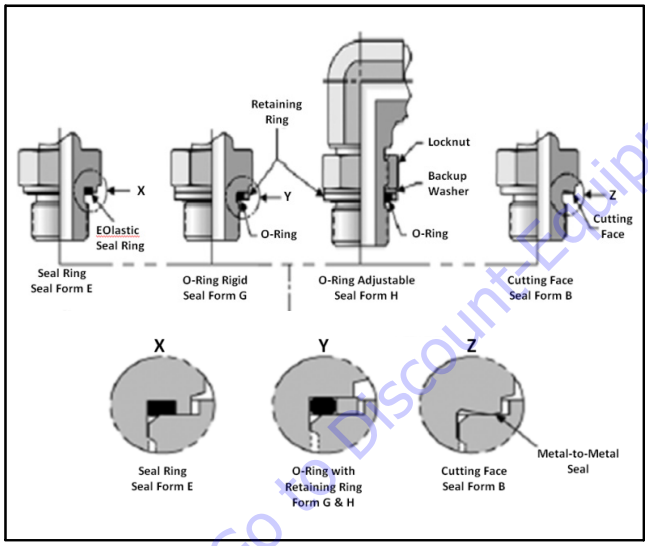


Figure 5-9. MFF-BSPP Thread

Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

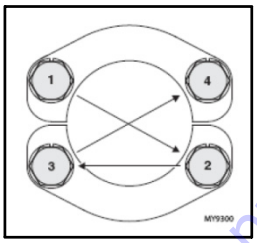


Figure 5-10. ORB-MPP Thread

Tightening Methods

Torque = Application of a twisting force to the applicable connection by use of a precise measurement instrument (i.e. torque wrench).

Finger Tight = The point where the connector will no longer thread onto the mating part when tightened by hand or fingers. Finger Tight is relative to user strength and will have some variance. The average torque applied by this method is 3 ft-lb [4 N-m] Also referred to as 'Hand Tight.'

TFFT = Turns From Finger Tight; Application of a preload to a connection by first tightening the connection by hand (fingers) and applying an additional rotation counted by a defined number of turns by use of a tool.

FFWR = Flats from Wrench Resistance; Application of a preload to a connection by tightening to the point of initial wrench resistance and turning the nut a described number of 'flats'. A 'flat' is one side of the hexagonal tube nut and equates to 1/6 of a turn. Also referred to as the 'Flats Method.'

Assembly And Torque Specifications

Prior to selecting the appropriate torque from the tables within this section, it is necessary to properly identify the connector being installed. Refer to the Figures and Tables in this section.

GENERAL TUBE TYPE FITTING ASSEMBLY INSTRUCTIONS

1. Take precautions to ensure that fittings and mating components are not damaged during storage, handling or assembly. Nicks and scratches in sealing surfaces can create a path for leaks which could lead to component contamination and/or failure.
2. When making a connection to tubing, compression or flare, inspect the tube in the area of the fitting attachment to ensure that the tube has not been damaged.
3. The assembly process is one of the leading causes for contamination in air and hydraulic systems. Contamination can prevent proper tightening of fittings and adapters from occurring.
   a. Avoid using dirty or oily rags when handling fittings.
   b. If fittings are disassembled, they should be cleaned and inspected for damage. Replace fittings as necessary before re-installing.
   c. Sealing compounds should be applied where specified; however, care should be taken not to introduce sealant into the system.
   d. Avoid applying sealant to the area of the threads where the sealant will be forced into the system. This is generally the first two threads of a fitting.
   e. Sealant should only be applied to the male threads.
   f. Straight thread fittings do not require sealants. O-rings or washers are provided for sealing.
   g. When replacing or installing an O-ring, care is to be taken while transferring the O-ring over the threads as it may become nicked or torn. When replacing an O-ring on a fitting, the use of a thread protector is recommended.
   h. When installing fittings with O-rings, lubrication shall be used to prevent scuffing or tearing of the O-ring. See O-ring Installation (Replacement) in this section.
4. Take care to identify the material of parts to apply the correct torque values.
   a. Verify the material designation in the table headings.
   b. If specifications are given only for steel fittings and components, the values for alternate materials shall be as follows: Aluminum and Brass- reduce steel values by 35%; Stainless Steel- Use the upper limit for steel.
5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.

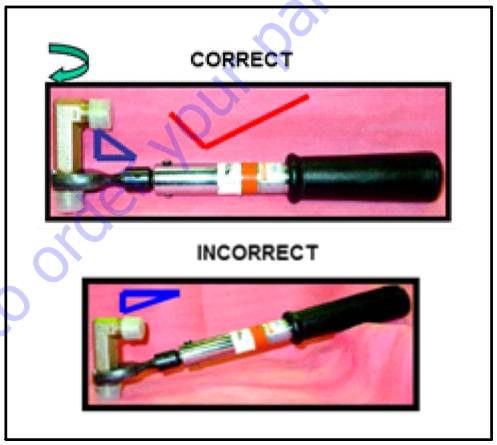


Figure 5-11. Torque Wrench Angle

6. Refer to the appropriate section in this manual for more specific instructions and procedures for each type of fitting connection

Assembly Instructions for American Standard Pipe Thread Tapered (NPTF) Connections.

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as High strength threadlocking compound, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

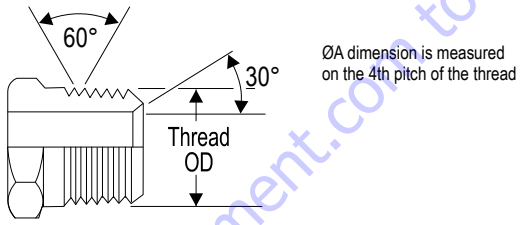
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-1, NPTF Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-1, NPTF Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-1. NPTF Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size (UNF)	ØA* (in)	ØA* (mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-27	0.40	10.24	2 to 3
	4	1/4-18	0.54	13.61	2 to 3
	6	3/8-18	0.67	17.05	2 to 3
	8	1/2-14	0.84	21.22	2 to 3
	12	3/4-14	1.05	26.56	2 to 3
	16	1-11 1/2	1.31	33.22	1.5 to 2.5
	20	1 1/4-11 1/2	1.65	41.98	1.5 to 2.5
	24	1 1/2-11 1/2	1.89	48.05	1.5 to 2.5
	32	2-11 1/2	2.37	60.09	1.5 to 2.5

* ØA thread dimension for reference only.

** See FFWR and TFFT Methods subsection for TFFT procedure requirements.

Assembly Instructions for British Standard Pipe Thread Tapered (BSPT) Connections

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as High strength threadlocking compound, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

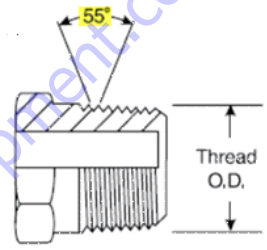
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-2, BSPT Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-2, BSPT Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-2. BSPT Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
MATERIAL	Dash Size	Thread Size (BSPT)	ØA* (in)	ØA* (mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-28	0.38	9.73	2 to 3
	4	1/4-19	0.52	13.16	2 to 3
	6	3/8-19	0.66	16.66	2 to 3
	8	1/2-14	0.83	20.96	2 to 3
	12	3/4-14	1.04	26.44	2 to 3
	16	1-11	1.31	33.25	1.5 to 2.5
	20	1 1/4-11	1.65	41.91	1.5 to 2.5
	24	1 1/2-11	1.88	47.80	1.5 to 2.5
	32	2-11	2.35	59.61	1.5 to 2.5

* ØA thread dimension for reference only.

** See Appendix B for TFFT procedure requirements.

Assembly Instructions for 37° (JIC) Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting and start threads by hand.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

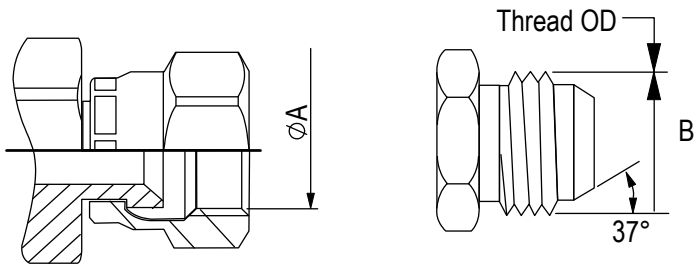
3. Torque assembly to value listed in Table Table 5-3, 37° Flare (JIC)Thread - Steel or Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass while using the Double Wrench Method per Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

NOTE: *Torque values provided in Table Table 5-3, 37° Flare (JIC)Thread - Steel and Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-3. 37° Flare (JIC)Thread - Steel

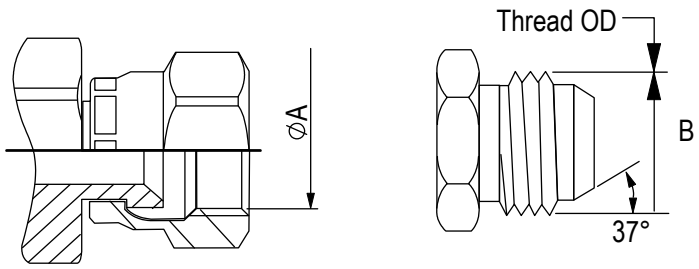


Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	7	8	9	10	--
	3	3/8-24	0.34	8.60	0.37	9.50	8	9	10	11	12	14	--
	4	7/16-20	0.39	10.00	0.44	11.10	13	14	14	18	19	19	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	14	15	15	19	20	21	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	22	23	24	30	31	33	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	42	44	46	57	60	63	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	60	63	66	81	85	89	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	84	88	92	114	120	125	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	100	105	110	136	142	149	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	118	124	130	160	168	176	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	168	176	185	228	239	251	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	195	205	215	264	278	291	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	265	278	292	359	377	395	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Table 5-4. 37° Flare (JIC)Thread - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	4	4	5	5	6	7	--
	3	3/8-24	0.34	8.60	0.37	9.50	5	6	7	7	8	9	--
	4	7/16-20	0.39	10.00	0.44	11.10	8	9	9	11	12	13	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	9	10	10	12	13	14	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	14	15	16	19	20	21	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	27	29	30	37	39	41	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	39	41	43	53	56	58	1 to 1-1/2
	12	11/16-12	0.97	24.60	1.06	27.00	55	57	60	74	78	81	1 to 1-1/2
	14	13/16-12	1.11	28.30	1.19	30.10	65	68	72	88	93	97	1 to 1-1/2
	16	15/16-12	1.23	31.30	1.31	33.30	77	81	84	104	109	114	3/4 to 1
	20	15/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	17/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
	32	21/2-12	2.42	61.50	2.50	63.50	172	181	189	234	245	257	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Assembly Instructions for 45° SAE Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting.
3. Tighten fitting by hand until hand tight.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

Torque fitting to value listed in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass while using the Double Wrench Method outlined in this section. Refer to FFWR and TFFT Methods for procedure requirements if using the TFFT method.

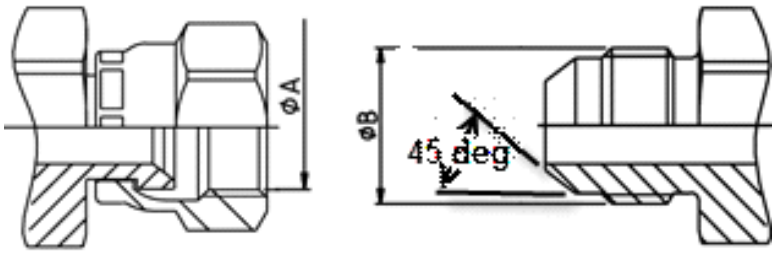
NOTE: *Torque values provided in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS

mating components.

Table 5-5. 45° Flare (SAE) - Steel

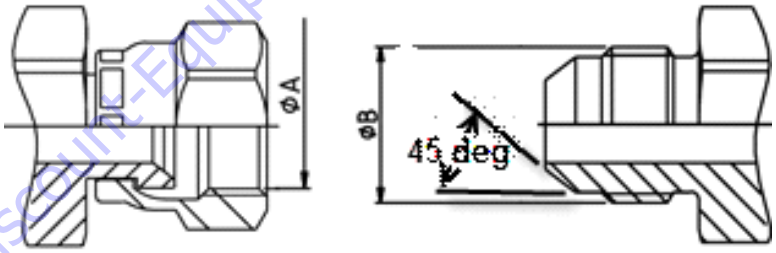


TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89
	12	11/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methodsfor FFWR procedure requirements.

Table 5-6. 45° Flare (SAE) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	8	9	9	11	12	12
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58
	12	11/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for TFFT procedure requirements.

Assembly Instructions for O-Ring Face Seal (ORFS) Fittings

1. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).
2. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Place the tube assembly against the fitting body so that the flat face comes in contact with the O-ring. Hand thread the nut onto the fitting body.
5. Torque nut to value listed in Table 5-7, O-ring Face Seal (ORFS) - Steel or Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass while using the Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

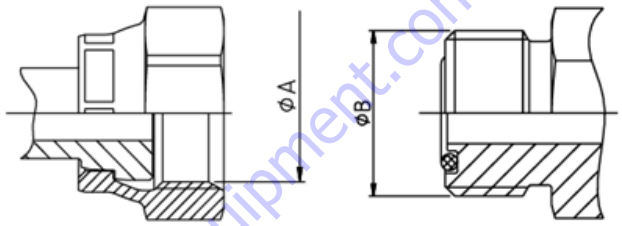
NOTE: *Torque values provided in Table 5-7, O-ring Face Seal (ORFS) - Steel and Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or

BRASS mating components

Table 5-7. O-ring Face Seal (ORFS) - Steel

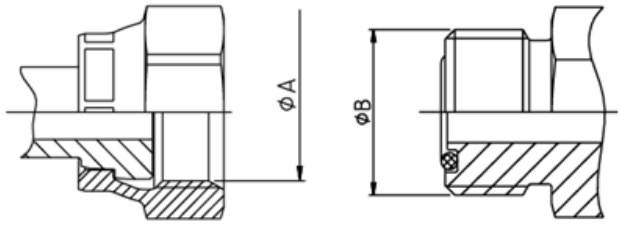


TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	18	19	20	25	26	27	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	30	32	33	40	43	45	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	40	42	44	55	57	60	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	60	63	66	81	85	89	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	85	90	94	115	122	127	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	111/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
	32	21/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methodsfor FFWR procedure requirements.

Table 5-8. O-ring Face Seal (ORFS) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	26	28	29	35	38	39	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	39	41	43	53	56	58	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	55	58	61	75	79	83	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	72	76	79	98	103	107	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

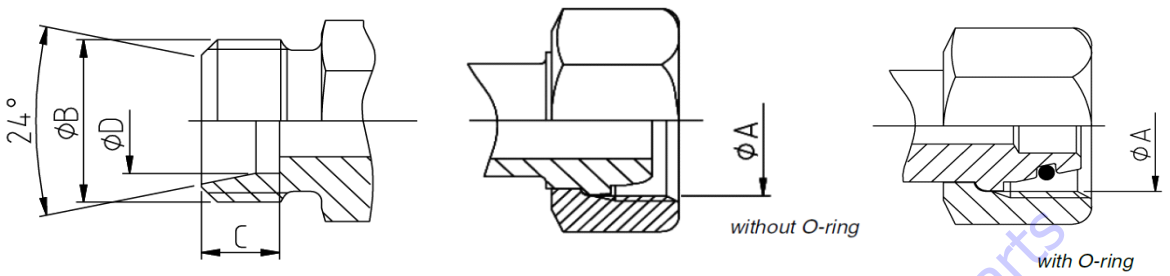
Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

⚠ CAUTION

A NON-SQUARE TUBE END CAN CAUSE IMPROPERLY SEATED FITTINGS AND LEAKAGE.

1. Inspect the components to ensure free of contamination, external damage, rust, splits, dirt, foreign matter, or burrs. Ensure tube end is visibly square. If necessary replace fitting or tube.
2. Lubricate thread and cone of fitting body or hardened pre-assembly tool, as well as the progressive ring and nut threads.
3. Slip nut and progressive ring over tube, assuring that they are in the proper orientation.
4. Push the tube end into the coupling body.
5. Slide collet into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed in Table Table 5-9, DIN 24°Cone (MBTL & MBTS) while using the Double Wrench Method. The tube must not turn with the nut.

Table 5-9. DIN 24°Cone (MBTL & MBTS)



TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)						
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [N-m] Min	Torque [N-m] Nom	Torque [N-m] Max	Flats from Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12x1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the						1.5 to 1.75
		8	M14x1.5	12.50	14.00	7.00	8.20							1.5 to 1.75
		10	M16x1.5	14.50	16.00	7.00	10.20							1.5 to 1.75
		12	M18x1.5	16.50	18.00	7.00	12.20							1.5 to 1.75
		15	M22x1.5	20.50	22.00	7.00	15.20							1.5 to 1.75
		18	M26x1.5	24.50	26.00	7.50	18.20							1.5 to 1.75
		22	M30x2	27.90	30.00	7.50	22.20							1.5 to 1.75
		28	M36x2	33.90	36.00	7.50	28.20							1.5 to 1.75
		35	M45x2	42.90	45.00	10.50	35.30							1.5 to 1.75
		42	M52x2	49.90	52.00	11.00	42.30							1.5 to 1.75
	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [N-m] Min	Torque [N-m] Nom	Torque [N-m] Max	Flats from Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14x1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the						1.5 to 1.75
		8	M16x1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
		10	M18x1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
		12	M20x1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
		14	M22x1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
		16	M24x1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
		20	M30x2	27.90	30.00	10.50	20.20							1.5 to 1.75
		25	M36x2	33.90	36.00	12.00	25.20							1.5 to 1.75
		30	M42x2	39.90	42.00	13.50	30.20							1.5 to 1.75
		38	M52x2	49.90	52.00	16.00	38.30							1.5 to 1.75

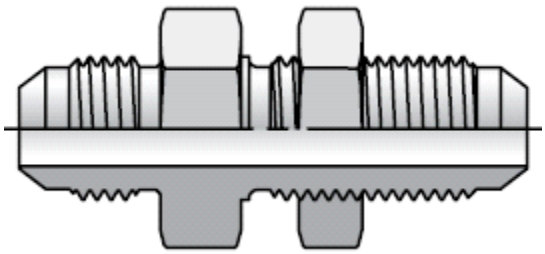
* ØA, ØB, C, & ØD thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Assembly Instructions for Bulkhead (BH) Fittings

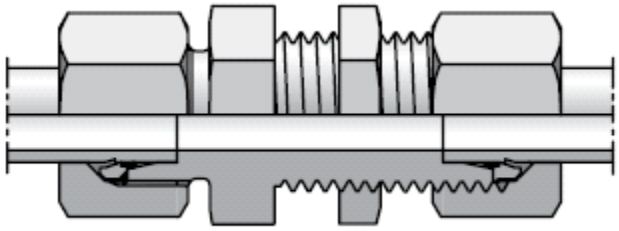
1. Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand thread the locknut onto the bulkhead end of the fitting body.
5. Torque nut onto fitting per Table 5-10 and Table 5-11 while using the Double Wrench Method.

Table 5-10. Bulkhead Fittings (BH) - INCH



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23
		6	11/16-16	25	27	28	34	37	38
		8	13/16-16	55	58	61	75	79	83
		10	1-14	85	90	94	115	122	127
		12	13/16-12	135	142	149	183	193	202
		14	15/16-12	170	179	187	230	243	254
		16	17/16-12	200	210	220	271	285	298
		20	111/16-12	245	258	270	332	350	366
		24	2-12	270	284	297	366	385	403
	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
	37° FLARE (JIC) BULKHEAD FITTING	3	3/8-24	8	9	9	11	12	12
		4	7/16-20	13	14	14	18	19	19
		5	1/2-20	20	21	22	27	28	30
		6	9/16-18	25	27	28	34	37	38
		8	3/4-16	50	53	55	68	72	75
		10	7/8-14	85	90	94	115	122	127
		12	11/16-12	135	142	149	183	193	202
		14	13/16-12	170	179	187	230	243	254
		16	15/16-12	200	210	220	271	285	298
		20	15/8-12	245	258	270	332	350	366
		24	17/8-12	270	284	297	366	385	403
		32	21/2-12	310	326	341	420	442	462

Table 5-11. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12x1.5	14	15	16	19	20	22
		8	M14x1.5	17	18	19	23	24	26
		10	M16x1.5	22	23	24	30	31	33
		12	M18x1.5	35	37	39	47	50	53
		15	M22x1.5	44	47	50	60	64	68
		18	M26x1.5	70	75	80	95	102	108
		22	M30x2	115	120	125	156	163	169
		28	M36x2	150	157	164	203	213	222
		35	M45x2	155	162	169	210	220	229
		42	M52x2	220	230	240	298	312	325
	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
		6	M14x1.5	17	15	16	23	20	22
		8	M16x1.5	22	18	19	30	24	26
		10	M18x1.5	35	23	24	47	31	33
		12	M20x1.5	40	35	37	54	47	50
		14	M22x1.5	44	47	50	60	64	68
		16	M24x1.5	70	75	80	95	102	108
		20	M30x2	115	120	125	156	163	169
		25	M36x2	150	157	164	203	213	222
		30	M42x2	155	162	169	210	220	229
		38	M52x2	220	230	240	298	312	325

Assembly Instructions for O-Ring Boss (ORB) Fittings

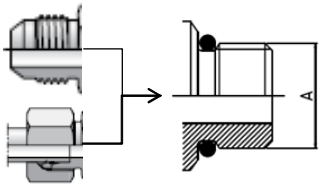
1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-12 thru Table 5-17 while using the Double Wrench Method.
   a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
   b. Torque values provided in Table 5-12 thru Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
   - STEEL fittings with ALUMINUM or BRASS mating components
   - ALUMINUM or BRASS fittings with STEEL mating components
   - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-12. O-ring Boss (ORB) - Table 1 of 6



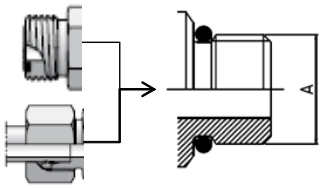
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-13. O-ring Boss (ORB) - Table 2 of 6

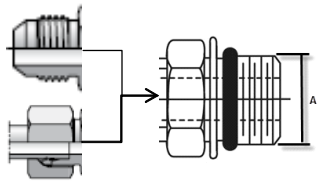


TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	26	27	28	35	37	38
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	17	18	18	23	24	24
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-14. O-ring Boss (ORB) - Table 3 of 6



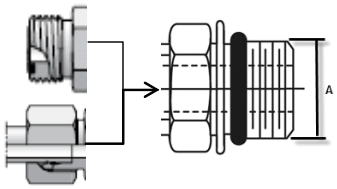
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	7	7
	3	3/8-24	0.37	9.52	(100)	(105)	(110)	11	12	12
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	21	22	23	28	30	31
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(39)	(41)	(43)	4	5	5
	3	3/8-24	0.37	9.52	(65)	(69)	(72)	7	8	8
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	15	19	20	20
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-15. O-ring Boss (ORB) - Table 4 of 6



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

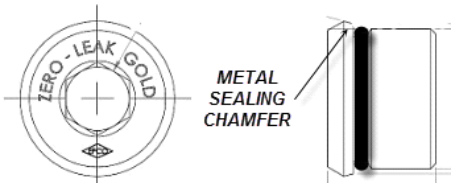
Table 5-16. O-ring Boss (ORB) - Table 5 of 6

TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-17. O-ring Boss (ORB) - Table 6 of 6



TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	11/16-12	1.06	27.00	51	54	57	69	73	77
	14	13/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	15/16-12	1.31	33.30						
	20	15/8-12	1.63	41.30						
	24	17/8-12	1.87	47.60						
	32	21/2-12	2.50	63.50						

TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	11/16-12	1.06	27.00	51	54	57	69	73	77
	14	13/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	15/16-12	1.31	33.30						
	20	15/8-12	1.63	41.30						
	24	17/8-12	1.87	47.60						
	32	21/2-12	2.50	63.50						

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Assembly Instructions for Adjustable Port End Metric (MFF) Fittings

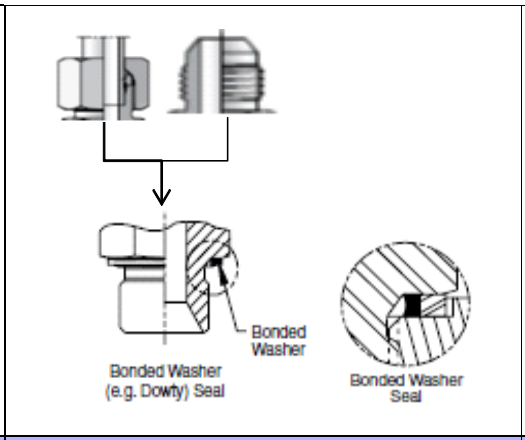
1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

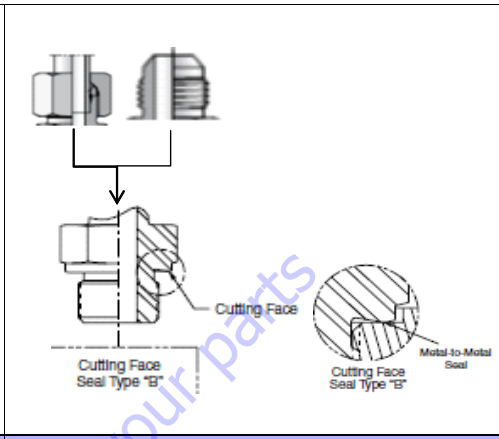
⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, or Table 5-23 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, and Table 5-23 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
   - STEEL fittings with ALUMINUM or BRASS mating components
   - ALUMINUM or BRASS fittings with STEEL mating components
   - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

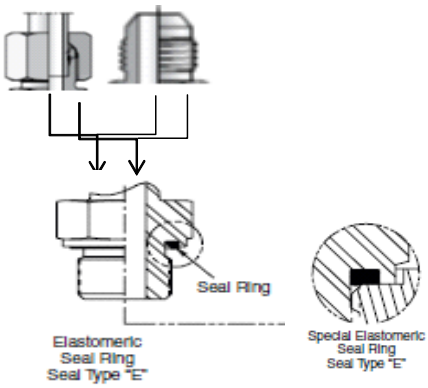
Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

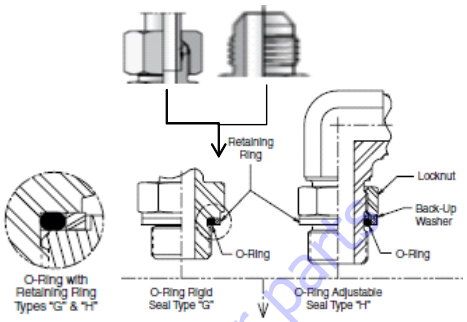




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 5-20. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

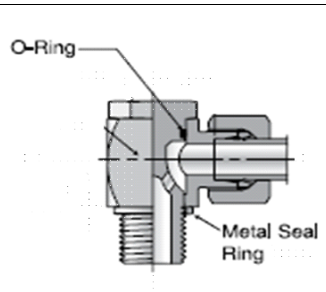
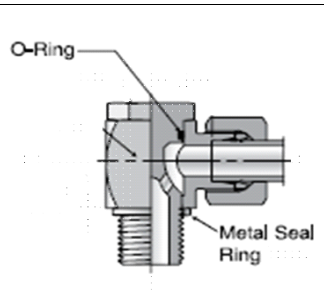
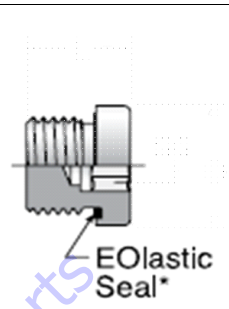
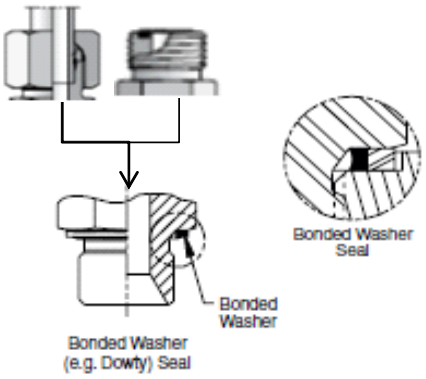
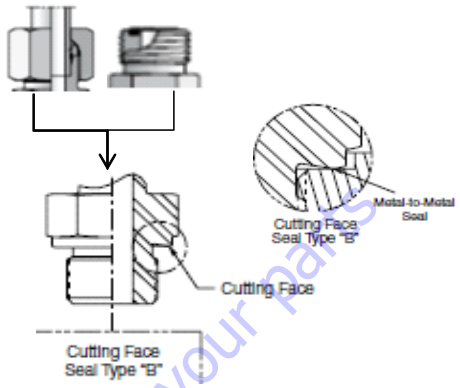
																				
TYPE/FITTING IDENTIFICATION			**BANJO FITTINGS with L series DIN (MBTL) opposite end**						**HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end**						**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**					
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	166	175	183	225	237	248
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	266	280	293	360	380	397
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	266	280	293	360	380	397
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	108	114	119	146	155	161
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	173	182	190	235	247	258
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	173	182	190	235	247	258

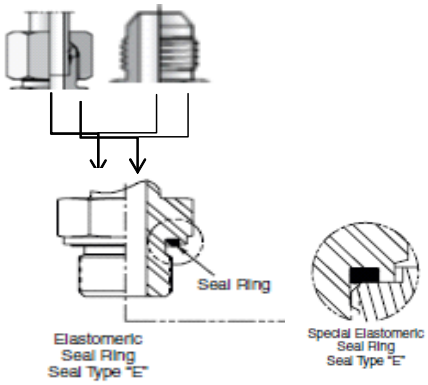
Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

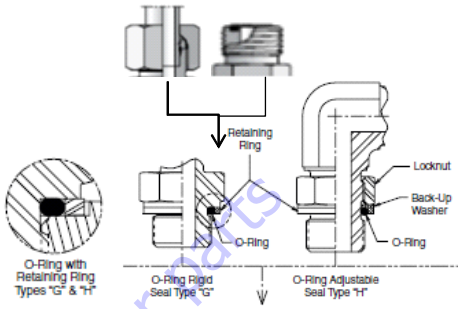




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297
	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

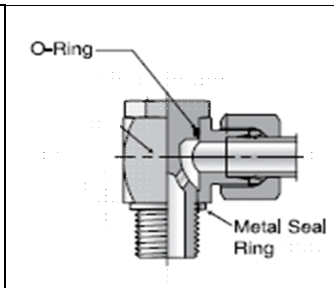
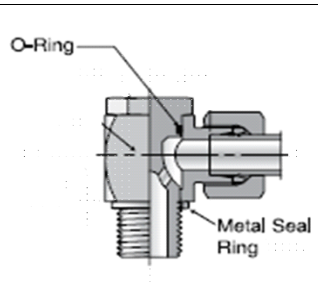
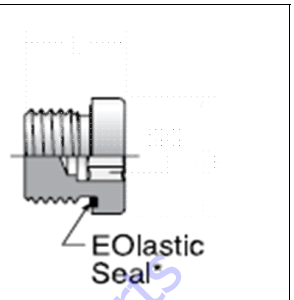
Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137
	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 5-23. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

																		
TYPE/FITTING IDENTIFICATION			**BANJO FITTINGS with S series DIN (MBTS) opposite end**						**HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end**						**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**					
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	--	--	--	--	--	--
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	--	--	--	--	--	--
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	--	--	--	--	--	--
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	--	--	--	--	--	--
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	--	--	--	--	--	--
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	--	--	--	--	--	--
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	--	--	--	--	--	--
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	--	--	--	--	--	--
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	--	--	--	--	--	--
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	--	--	--	--	--	--
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	--	--	--	--	--	--
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	--	--	--	--	--	--

Assembly Instructions for Metric ISO 6149 (MPP) Port Assembly Stud Ends

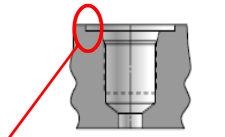
1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

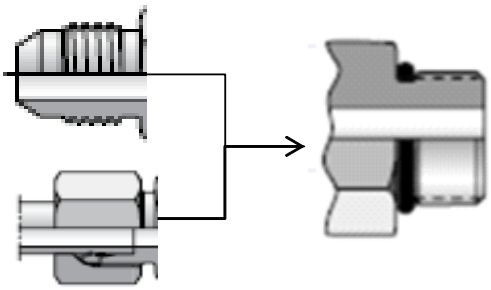
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

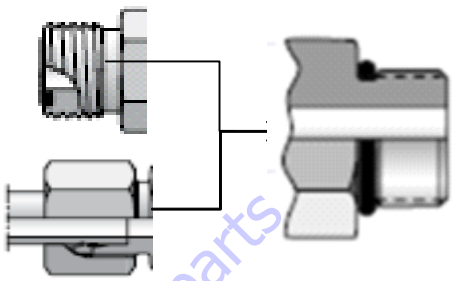
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-24 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-24 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
   - STEEL fittings with ALUMINUM or BRASS mating components
   - ALUMINUM or BRASS fittings with STEEL mating components
   - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)



Note: Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB),**but is not interchangeable.**





TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10x1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12x1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18x1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20x1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22x1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27x2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30x2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33x2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38x2	--	135	142	149	183	193	202	235	247	259	319	335	351
	M42x2	30	155	163	171	210	221	232	245	258	270	330	350	366
	M48x2	38	190	200	209	260	271	283	310	326	341	420	442	462
	M60x2	50	230	242	253	315	328	343	370	389	407	500	527	552
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10x1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12x1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18x1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20x1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22x1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27x2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30x2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33x2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38x2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42x2	30	101	106	111	137	144	150	159	168	176	216	228	239
	M48x2	38	124	130	136	168	176	184	202	212	222	274	287	301
	M60x2	50	150	157	164	203	213	222	241	253	265	327	343	359

Assembly instructions for Adjustable Port End (BSPP) Fittings

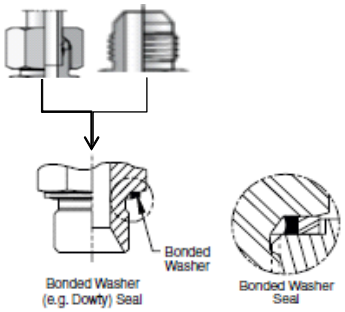
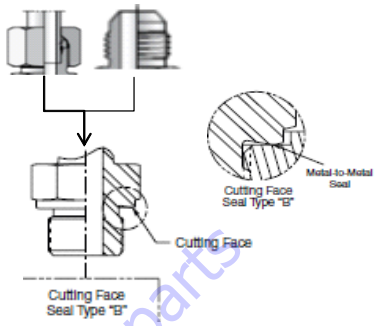
1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, or Table 5-30 while using the Double Wrench Method.
   a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.
   b. Torque values provided in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, and Table 5-30 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
   - STEEL fittings with ALUMINUM or BRASS mating components
   - ALUMINUM or BRASS fittings with STEEL mating components
   - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-25. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3

		
TYPE/FITTING IDENTIFICATION	**FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end**	**FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end**

MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G 1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G 1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G 3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G 1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G 1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694

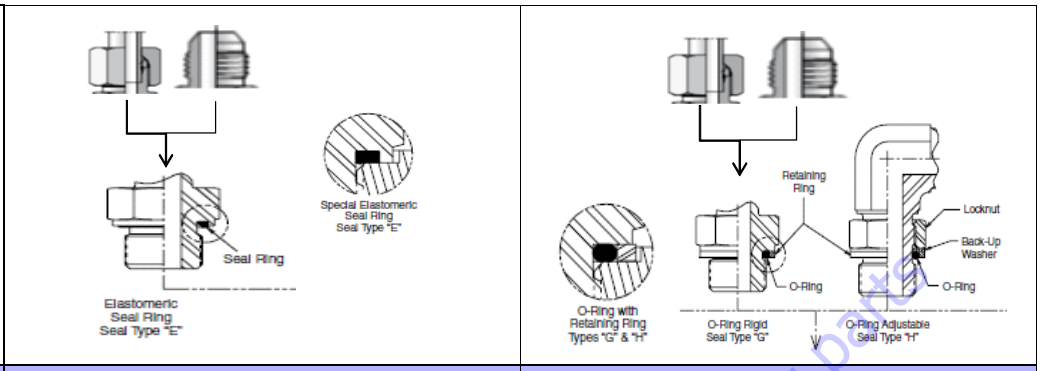
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G 1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G 1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G 3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G 1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G 1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	42	139	146	153	188	198	207	302	318	333	409	431	451

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-26. British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3



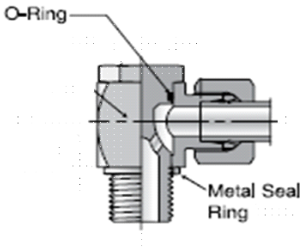
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	52	55	57	70	75	77	52	55	57	70	75	77
	G 1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99
	G 1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99
	G 3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	28	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	34	36	37	46	49	50	34	36	37	46	49	50
	G 1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64
	G 1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64
	G 3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	28	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	42	259	272	285	351	369	386	259	272	285	351	369	386

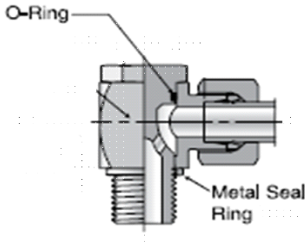
* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-27. British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3





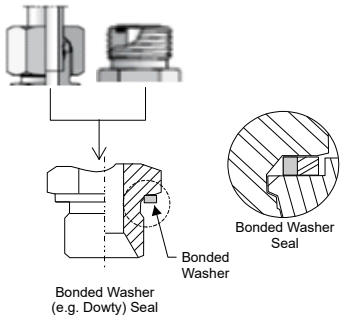
TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15
	G1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65
	G1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153
	G1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221
	G1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450
	G1-1/2A	42	--	--	--	--	--	--	516	542	568	700	735	770	332	349	365	450	473	495
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	G1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42
	G1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99
	G1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144
	G1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321
	G1-1/2A	42	--	--	--	--	--	--	335	352	369	454	477	500	216	227	237	293	308	321

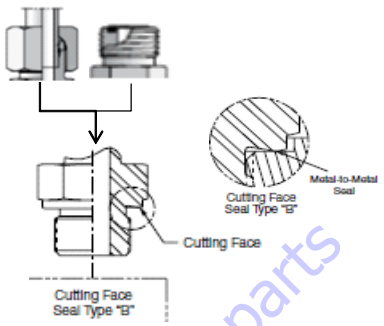
* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-28. British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3





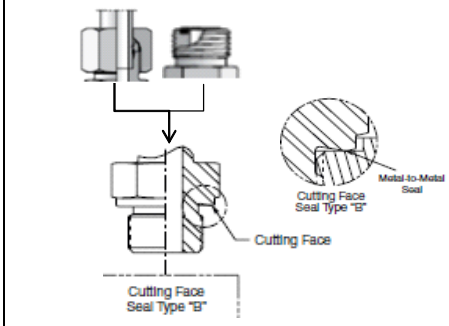
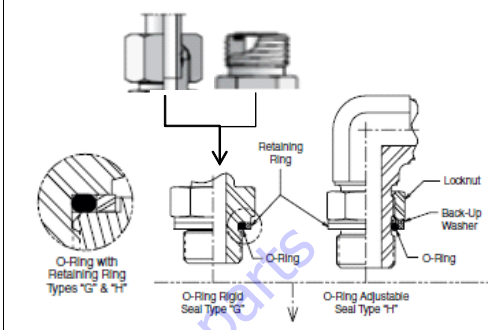
TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	26	28	29	35	38	39	41	43	45	55	58	61
	G 1/4A	8	26	28	29	35	38	39	41	43	45	55	58	61
	G 3/8A	10	33	35	36	45	47	49	66	70	73	90	95	99
	G 3/8A	12	33	35	36	45	47	49	66	70	73	90	95	99
	G 1/2A	14	48	51	53	65	69	72	111	117	122	150	159	165
	G 1/2A	16	48	51	53	65	69	72	96	101	106	130	137	144
	G 3/4A	20	66	70	73	90	95	99	199	209	219	270	283	297
	G 1A	25	111	117	122	150	159	165	251	264	276	340	358	374
	G 1-1/4A	30	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	17	18	19	23	24	26	27	28	29	37	38	39
	G 1/4A	8	17	18	19	23	24	26	27	28	29	37	38	39
	G 3/8A	10	21	22	23	28	30	31	43	45	47	58	61	64
	G 3/8A	12	21	22	23	28	30	31	43	45	47	58	61	64
	G 1/2A	14	31	33	34	42	45	46	72	76	79	98	103	107
	G 1/2A	16	31	33	34	42	45	46	62	66	69	84	89	94
	G 3/4A	20	43	45	47	58	61	64	129	136	142	175	184	193
	G 1A	25	72	76	79	98	103	107	163	171	179	221	232	243
	G 1-1/4A	30	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	38	139	146	153	188	198	207	335	352	369	454	477	500

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-29. British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3

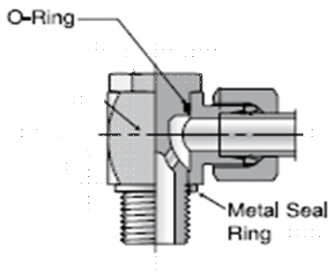
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G 1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G 3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G 3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G 1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G 1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G 3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G 1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G 3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G 3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G 1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G 1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G 3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386

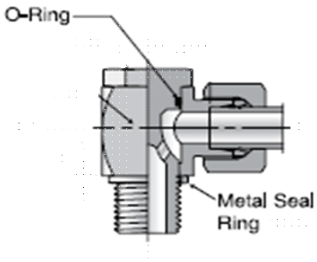
* Typical for JLG Straight Male Stud Fittings

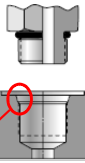
** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-30. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3







Note: BSPP O-ring only style (ISO 228-1) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB), **but is not interchangeable. Not typically used on JLG machines.**

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G 3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G 1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G 1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G 3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G 1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G 1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G 1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G 3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G 1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G 1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G 3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G 1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G 1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G 1-1/2A	38	--	--	--	--	--	--	335	352	368	454	477	499						

* Typical for JLG Straight Male Stud Fittings

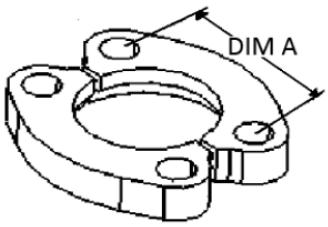
** Non typical for JLG Straight Male Stud Fittings, reference only.

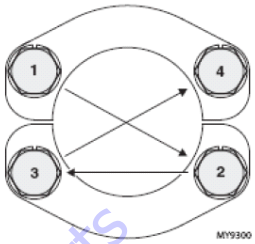
*** Typical for JLG Adjustable Fittings

Assembly Instructions for Flange Connections: (FL61 and FL62)

1. Make sure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter, or burrs.
2. See Figure for O-ring installation instructions.
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Position flange and clamp halves.
5. Place lock washers on bolt and bolt through clamp halves.
6. Tighten all bolts by hand.
7. Torque bolts in diagonal sequence in two or more increments to the torque listed on Table Table 5-31and Table 5-32.

Table 5-31. Flange Code (FL61 & FL62) -Inch Fasteners

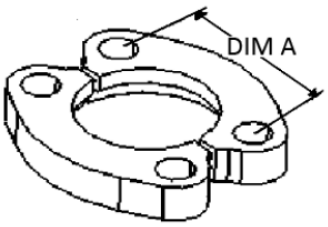


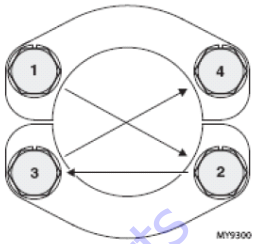


TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws						
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	5/16-18	18	19	19	24	25	26	24	25	26	32	34	35	
	12	0.75	19	1.88	47.75	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66	
	16	1.00	25	2.06	52.32	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66	
	20	1.25	32	2.31	58.67	7/16-14	52	54	57	70	74	77	68	71	75	92	97	101	
	24	1.50	38	2.75	69.85	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165	
	32	2.00	51	3.06	77.72	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165	
	40	2.50	64	3.50	88.90	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165	
	48	3.00	76	4.19	106.43	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325	
	56	3.50	89	4.75	120.65	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325	
	64	4.00	102	5.13	130.30	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325	
	80	5.00	127	6.00	152.40	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325	
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws						
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	5/16-18	--	--	--	--	--	--	24	25	26	32	34	35	
	12	0.75	19	2.00	50.80	3/8-16	--	--	--	--	--	--	44	46	49	60	63	66	
	16	1.00	25	2.25	57.15	7/16-14	--	--	--	--	--	--	68	71	75	92	97	101	
	20	1.25	32	2.62	66.55	1/2-13	--	--	--	--	--	--	111	116	122	150	158	165	
	20	1.25	32	2.62	66.55	--	--	--	--	--	--	--	--	--	--	--	--	--	
	24	1.50	38	3.12	79.25	5/8-11	--	--	--	--	--	--	218	228	239	295	310	325	
	32	2.00	51	3.81	96.77	3/4-10	--	--	--	--	--	--	332	348	365	450	473	495	

* A dimension for reference only.

Table 5-32. Flange Code (FL61 & FL62) - Metric Fasteners





TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
	12	0.75	19	1.88	47.75	M8x1.25	18	19	19	24	25	26	18	19	19	24	25	26
	16	1.00	25	2.06	52.32	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	32	2.00	51	3.06	77.72	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.43	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	56	3.50	89	4.75	120.65	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.30	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.40	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	M8x1.25	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10x1.5	--	--	--	--	--	--	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14x2	--	--	--	--	--	--	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16x2	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20x2.5	--	--	--	--	--	--	406	426	446	550	578	605

* A dimension for reference only.

Double Wrench Method

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one backup wrench. If two wrenches are not used, inadvertent component rotation may occur which absorbs torque and causes improper joint load and leads to leaks. For hose connections, the 'layline' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. See Figure 5-12. for double wrench method requirements.

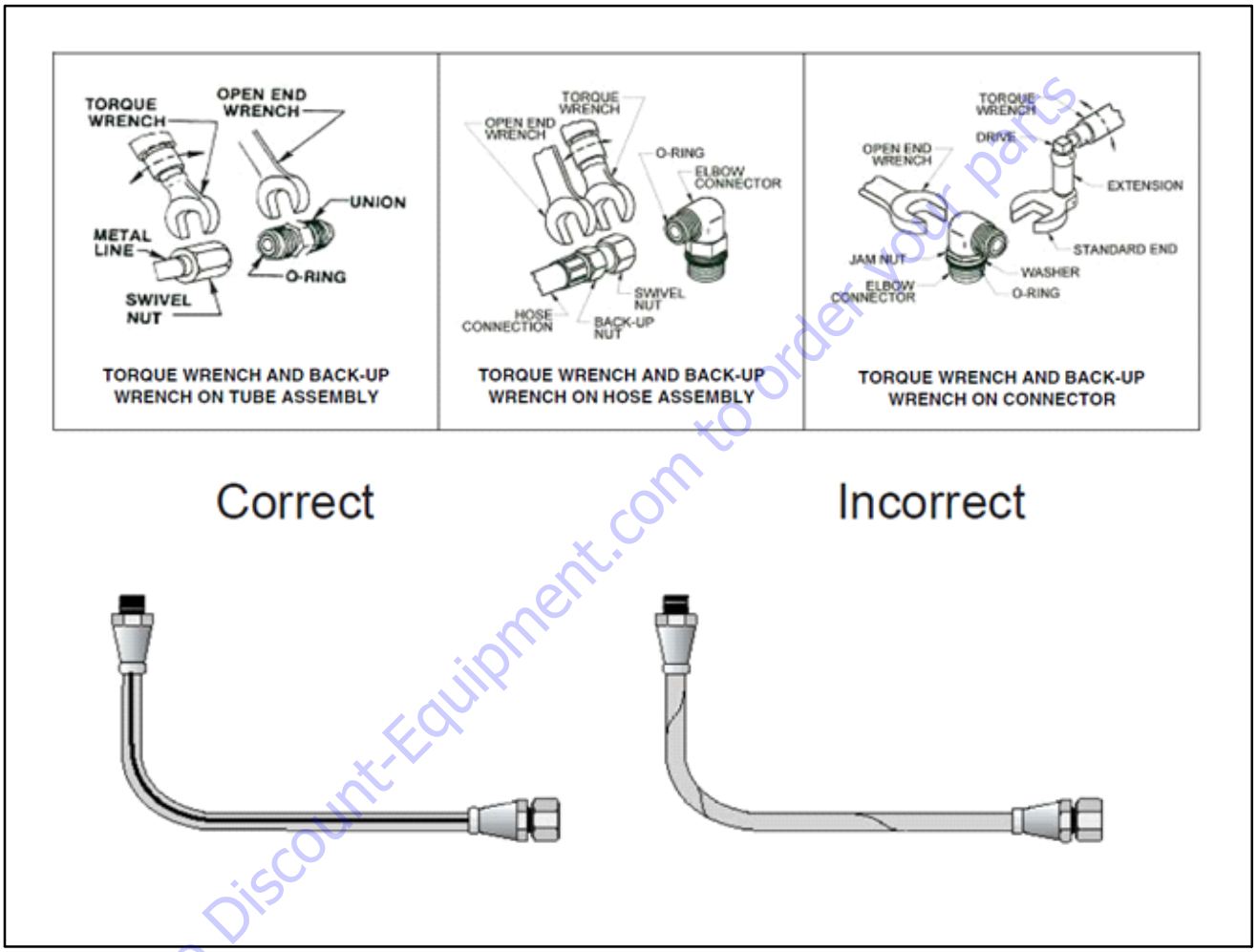


Figure 5-12. Double Wrench Method

FFWR and TFFT Methods

FFWR (FLATS FROM WRENCH RESISTANCE METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter. See Figure B.1.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten as shown in Figure B.1. The nut is to be rotated clockwise the number of hex flats as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened. See Figure 5-13.

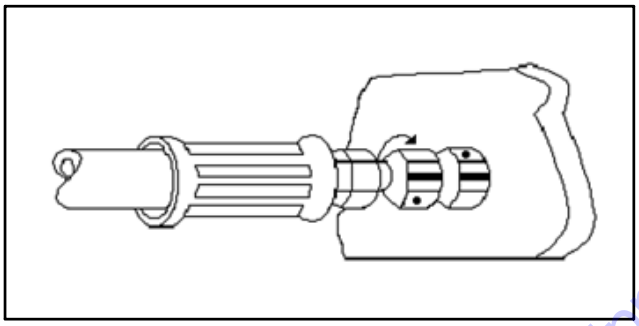


Figure 5-13. FFWR Method

TFFT (TURNS FROM FINGER TIGHT METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

Adjustable Stud End Assembly

For Adjustable Stud End Connections; the following assembly steps are to be performed:

1. Lubricate the o-ring with a light coat of hydraulic oil.
2. Position #1 – The o-ring should be located in the groove adjacent to the face of the backup washer. The washer and o-ring should be positioned at the extreme top end of the groove as shown.
3. Position #2 – Position the locknut to just touch the backup washer as shown. The locknut in this position will eliminate potential backup washer damage during the next step.
4. Position #3 – Install the connector into the straight thread box port until the metal backup washer contacts the face of the port as shown.
5. Position #4 – Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.
6. Position #5 – Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to tighten the locknut to the appropriate torque.
7. Visually inspect, where possible, the joint to ensure the o-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.

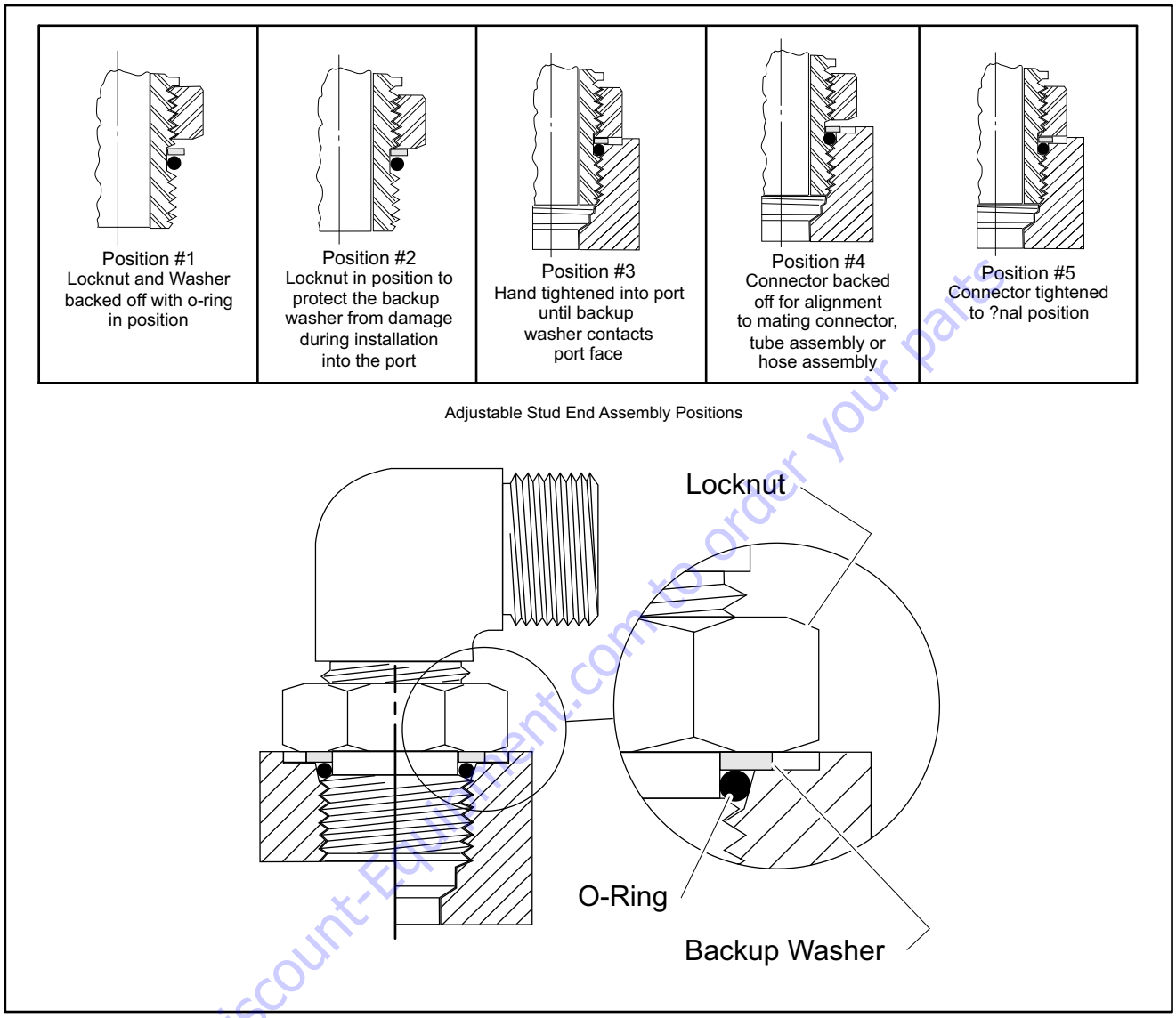


Figure 5-14. Adjustable Stud End Assembly

O-ring Installation (Replacement)

Care must be taken when installing O-rings over threads during replacement or installation. O-rings could become nicked or torn. A damaged O-ring could lead to leakage problems.

1. Inspect O-ring for tears or nicks. If any are found replace O-ring.
2. Ensure proper O-ring to be installed. Many O-rings look the same but are of different material, different hardness, or are slightly different diameters or widths.
3. Use a thread protector when replacing O-rings on fittings.
4. In ORB; ensure O-ring is properly seated in groove. On straight threads, ensure O-ring is seated all the way past the threads prior to installation.
5. Inspect O-ring for any visible nicks or tears. Replace if found.

5.3 CYLINDER REPAIR

NOTE: *The following are general procedures that apply to all of the cylinders on this machine. Procedures that apply to a specific cylinder will be so noted.*

Disassembly

NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

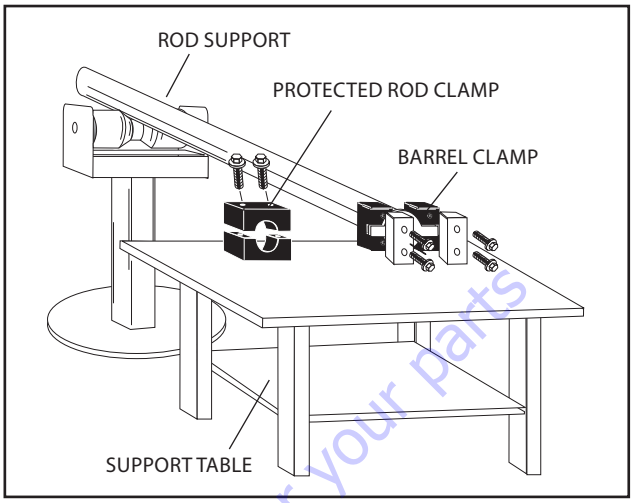


Figure 5-15. Cylinder Barrel Support

NOTE: *Step 5 only applies to the steer cylinder.*

5. Using a spanner wrench, unscrew the cylinder head from the barrel.
6. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the eight (8) cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

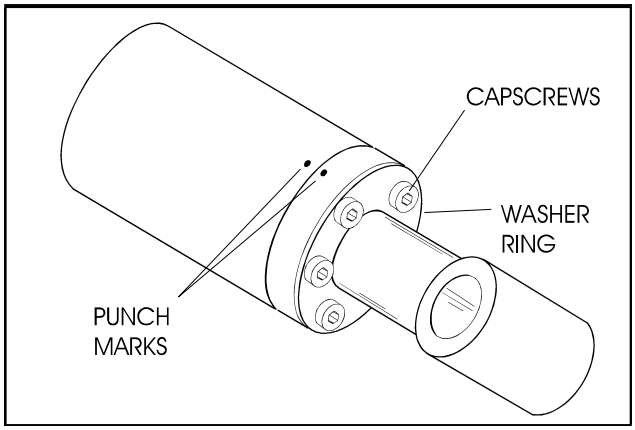


Figure 5-16. Capscrew Removal

7. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTE: *SERVICE INFORMATION NOT AVAILABLE AT TIME OF PUBLICATION.*

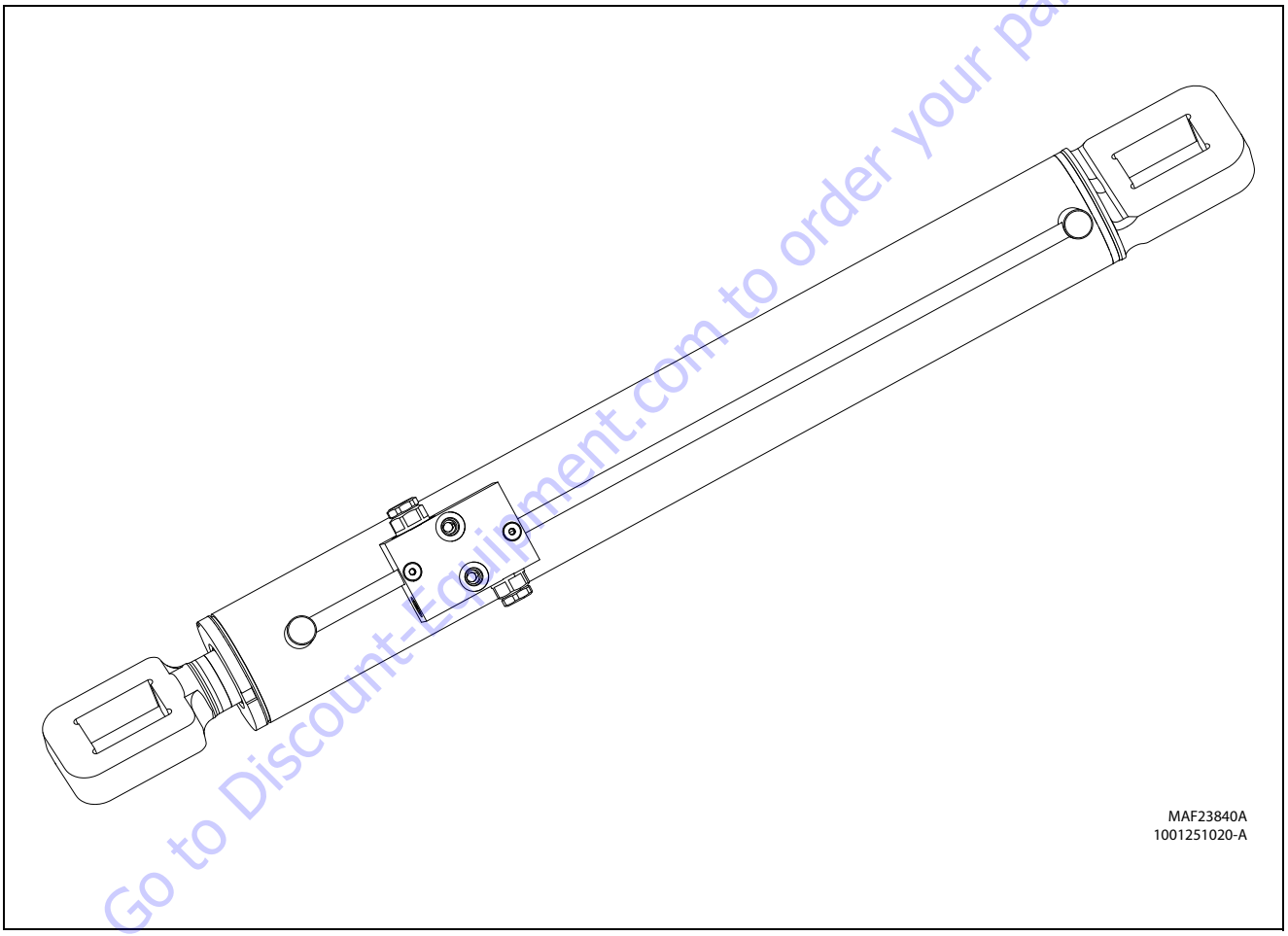
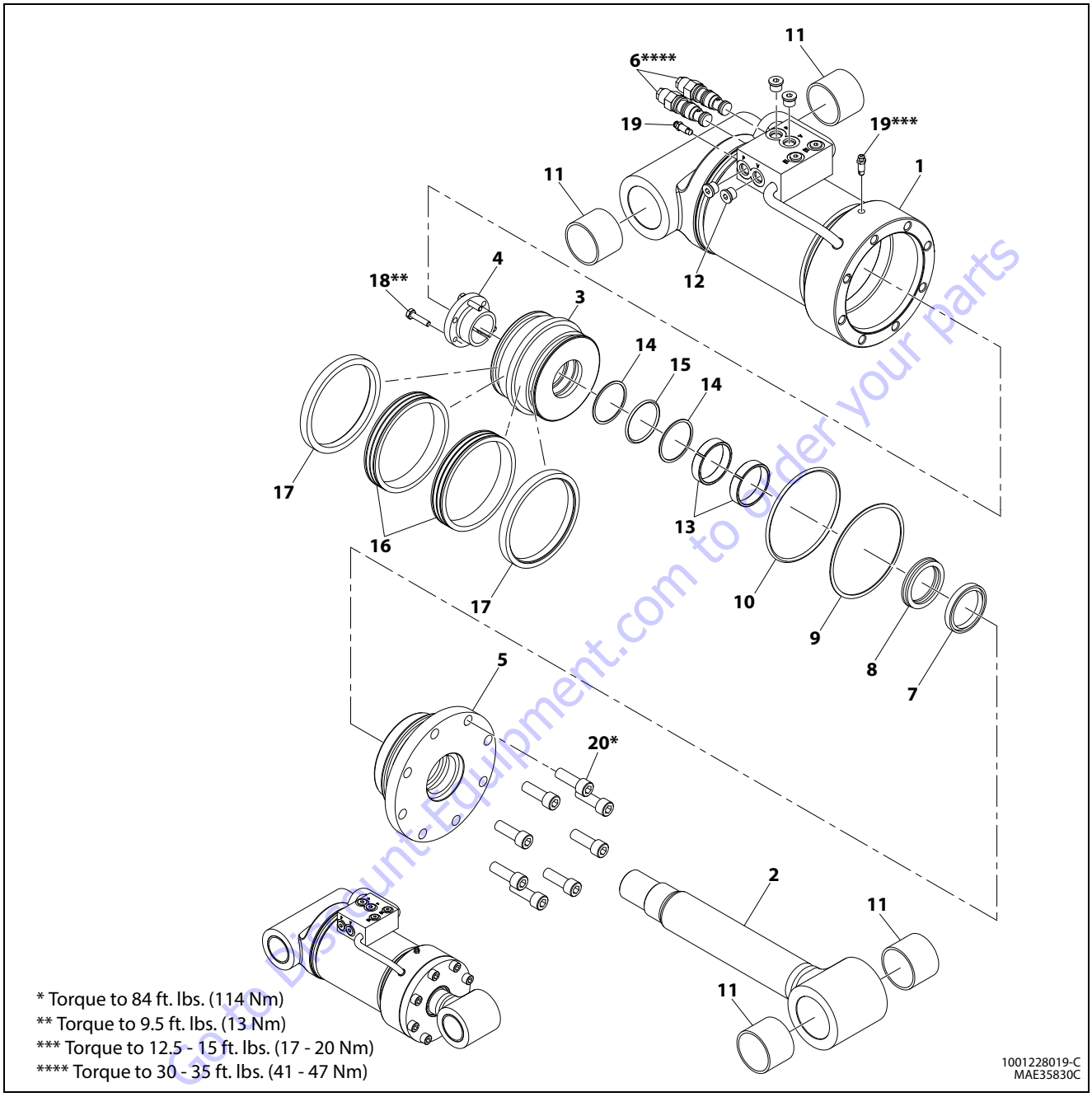
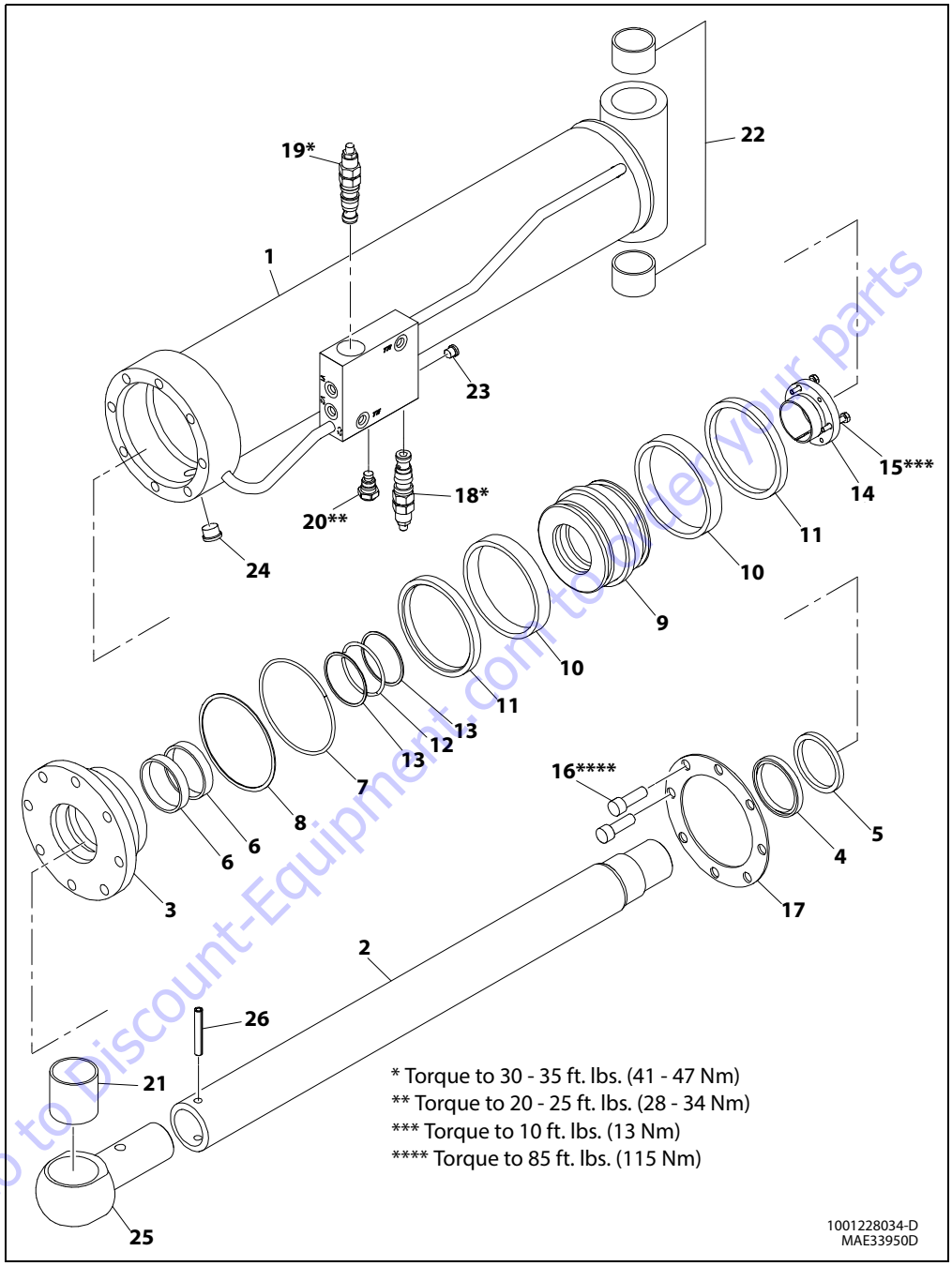


Figure 5-17. Axle Extension Cylinder



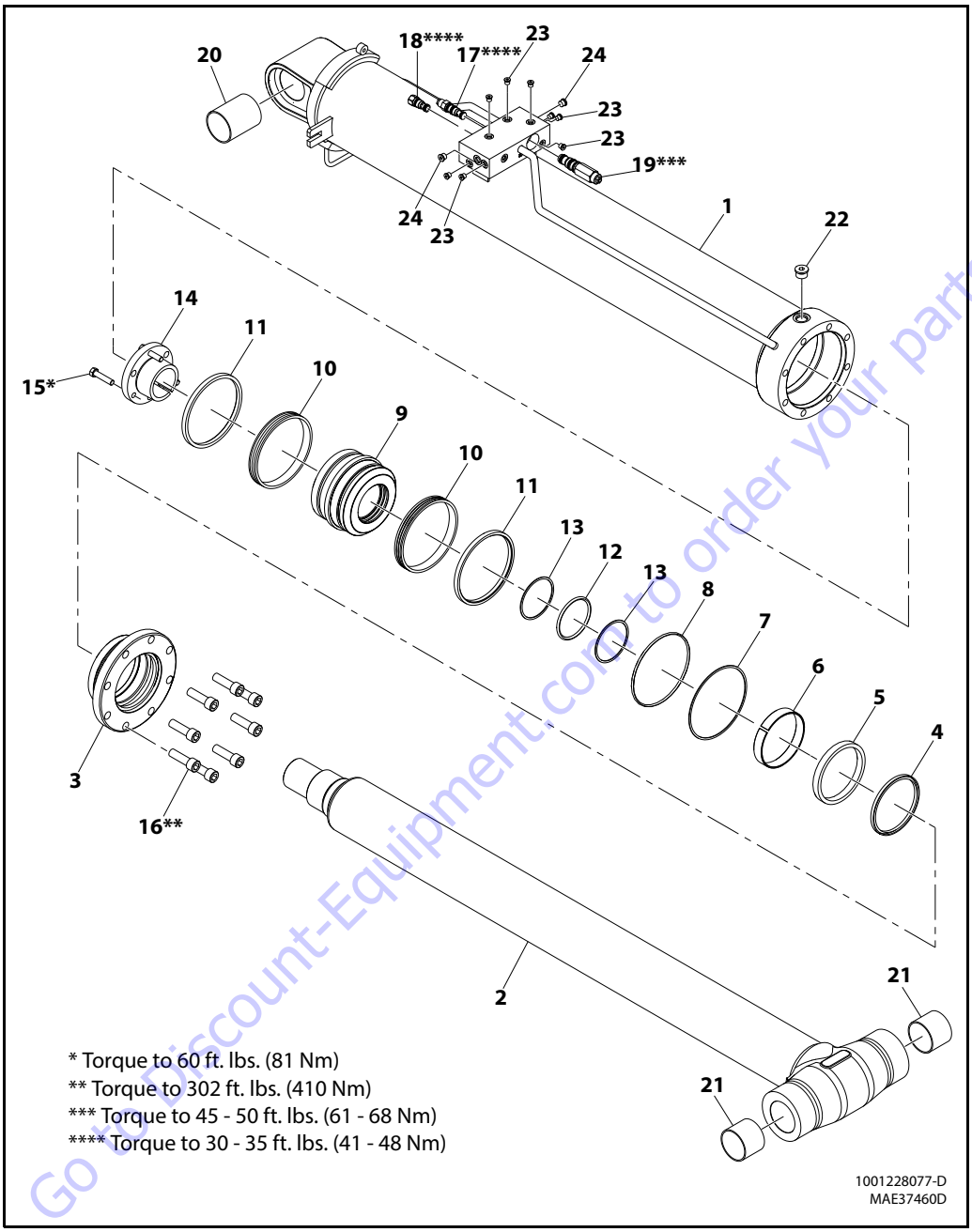
1.	Barrel	5.	Head	9.	Backup Ring	13.	Wear Ring	17.	Lock Ring
2.	Rod	6.	Counterbalance Valve	10.	O-Ring	14.	Backup Ring	18.	Capscrew
3.	Piston	7.	Wiper	11.	Bushing	15.	O-Ring	19.	Bleeder Valve
4.	Tapered Bushing	8.	Rod Seal	12.	O-Ring Plug	16.	Seal	20.	Capscrew

Figure 5-18. Axle Lockout Cylinder



1. Barrel
2. Rod
3. Head
4. Wiper Seal
5. Rod Seal
6. Wear Ring
7. O-ring
8. Backup Ring
9. Piston
10. Hydrolock Seal
11. Guidelock Ring
12. O-ring
13. Backup Ring
14. Tapered Ring
15. Capscrew
16. Capscrew
17. Washer Ring
18. Counterbalance Valve
19. Counterbalance Valve
20. Orifice Valve
21. Bushing
22. Bushing
23. Plug
24. Plug
25. Link Rod
26. Rollpin

Figure 5-19. Platform Level Cylinder



1. Barrel
2. Rod
3. Head
4. Wiper Ring
5. Rod Seal
6. Wear Ring
7. O-ring
8. Backup Ring
9. Piston
10. Hydrolock Ring
11. Lock Ring
12. O-ring
13. Backup Ring
14. Tapered Ring
15. Capscrew
16. Capscrew
17. Counterbalance Valve
18. Counterbalance Valve
19. Counterbalance Valve
20. Bushing
21. Bushing
22. Plug
23. Plug
24. Plug

Figure 5-20. Tower Lift Cylinder

NOTE: *SERVICE INFORMATION NOT AVAILABLE AT TIME OF PUBLICATION.*

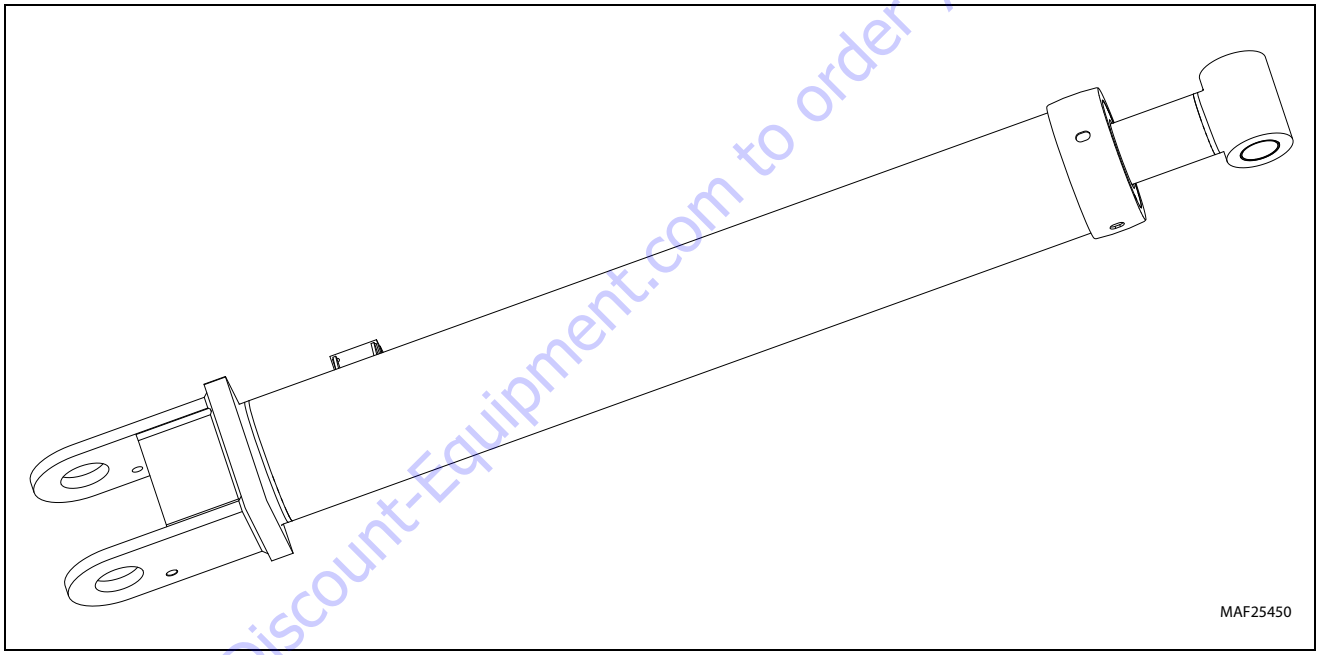
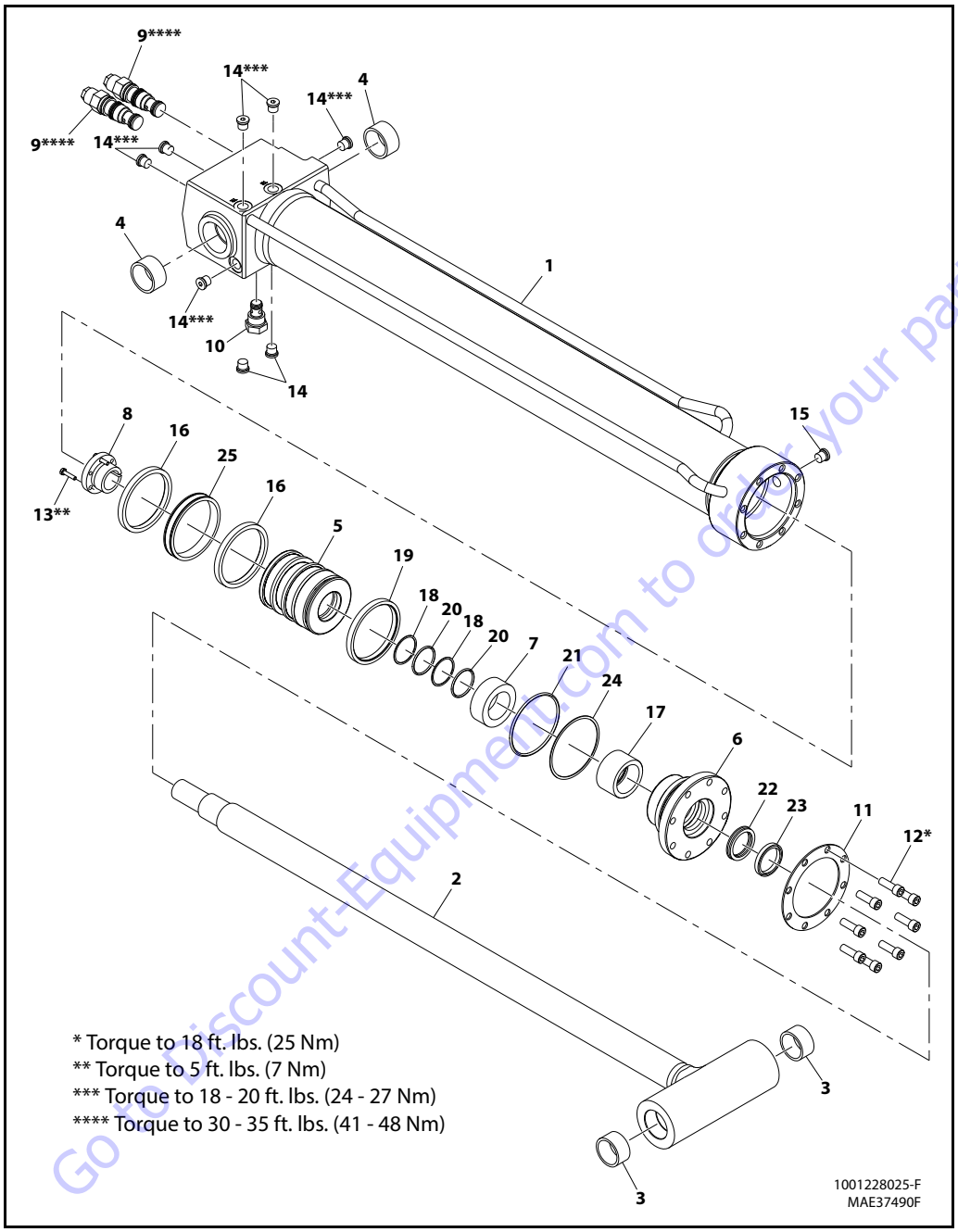
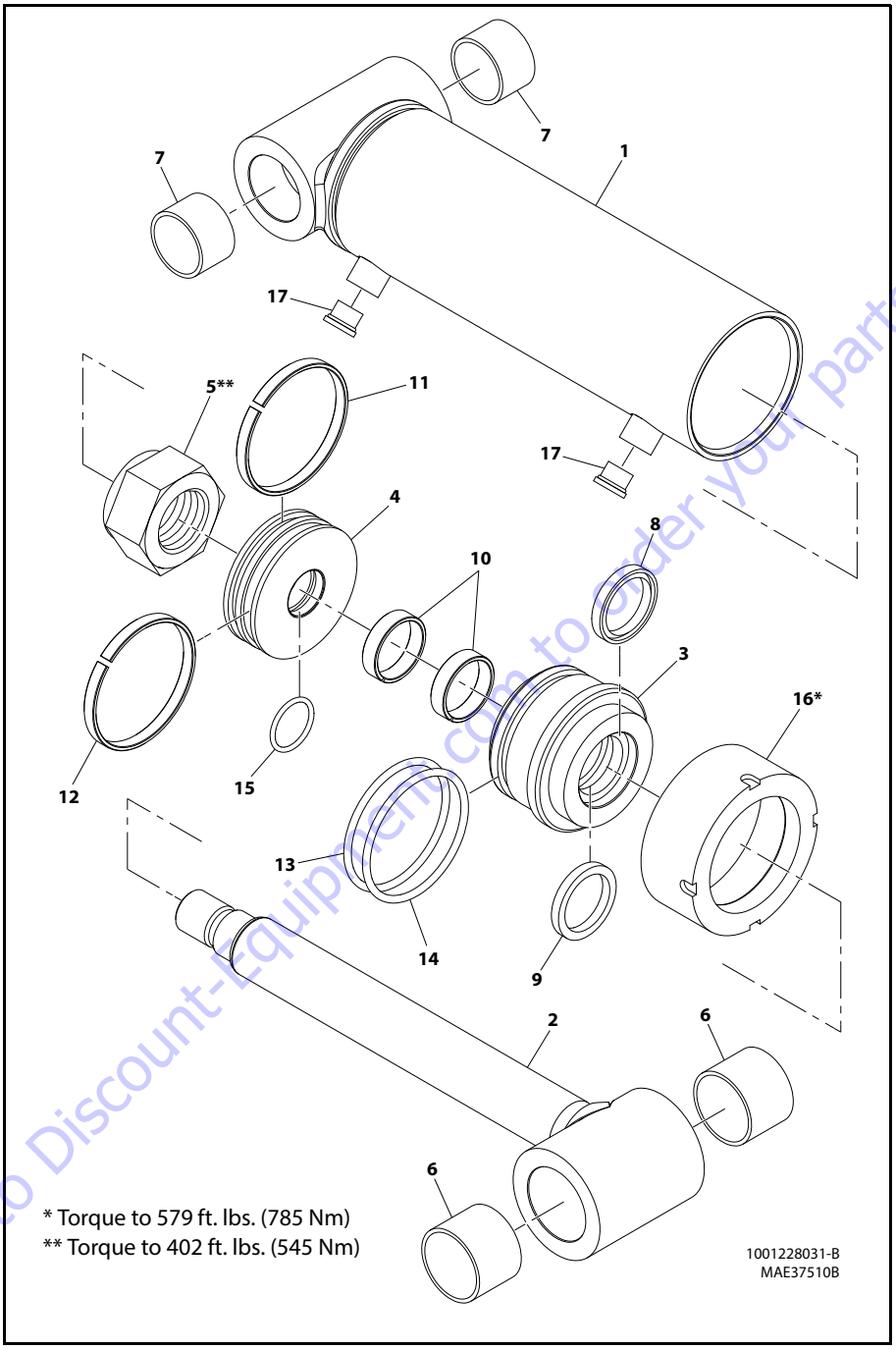


Figure 5-21. Main Boom Lift Cylinder



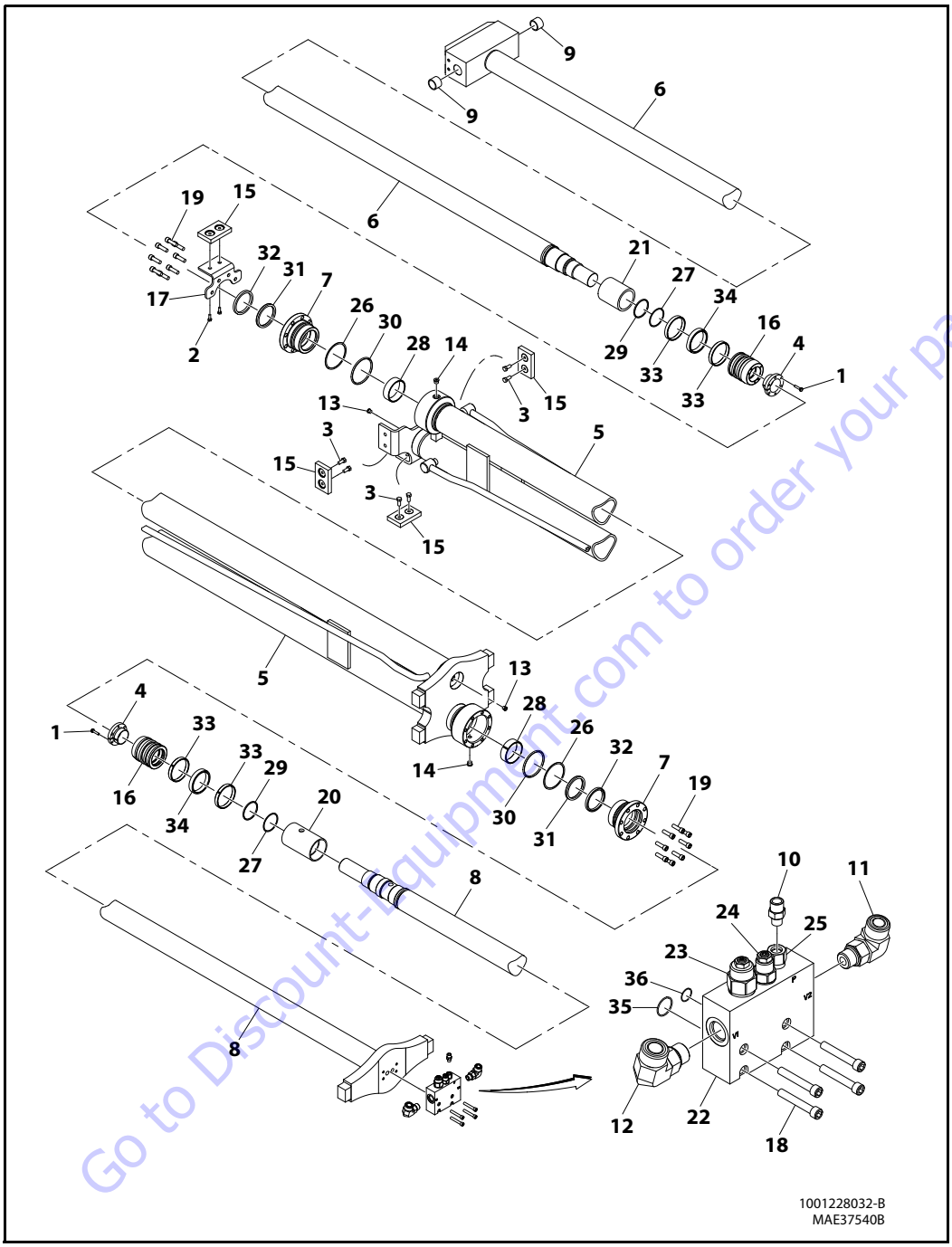
1.	Barrel	7.	Spacer	13.	Capscrew	19.	Seal	25.	Seal
2.	Rod	8.	Tapered Bushing	14.	O-ring Plug	20.	O-ring		
3.	Bushing	9.	Counterbalance Valve	15.	O-ring Plug	21.	O-ring		
4.	Bushing	10.	Check Vlave	16.	Wear Ring	22.	Seal		
5.	Piston	11.	Washer Ring	17.	Wear Ring	23.	Rod Wiper		
6.	Head	12.	Capscrew	18.	Backup Ring	24.	Backup Ring		

Figure 5-22. Jib Cylinder



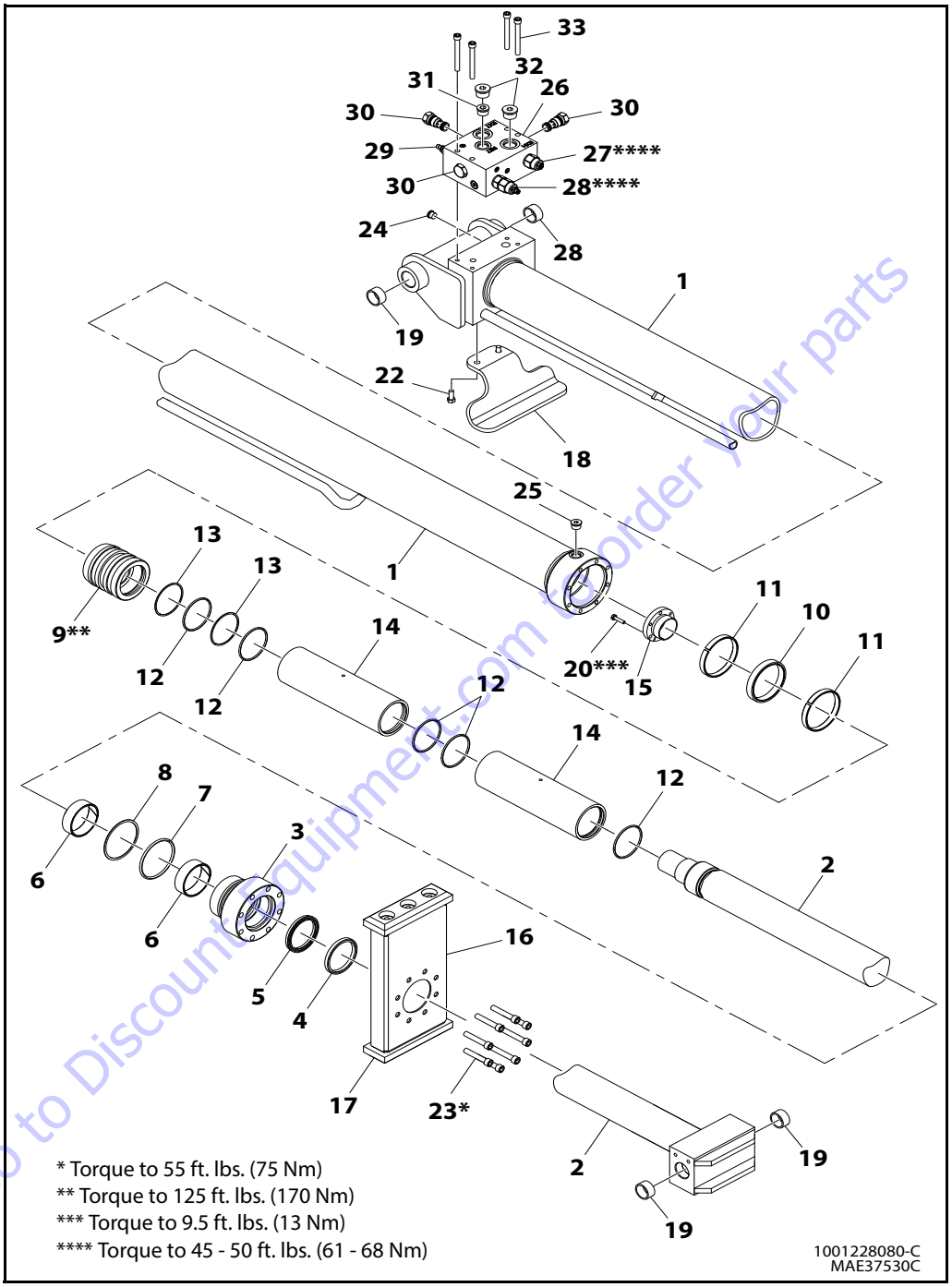
1. Barrel
2. Rod
3. Head
4. Piston
5. Nut
6. Bushing
7. Bushing
8. Wiper
9. Rod Seal
10. Wear Ring
11. Piston Seal
12. Wear Ring
13. O-ring
14. Backup Ring
15. O-ring
16. Cap Cylinder
17. Plug

Figure 5-23. Steer Cylinder



1. Barrel
2. Screw
3. Screw
4. Tapered Bushing
5. Barrel
6. Rod
7. Head
8. Rod
9. Bushing
10. Fitting
11. Fitting
12. Fitting
13. Plug
14. Plug
15. Wear Pad
16. Piston
17. Bracket
18. Capscrew
19. Capscrew
20. Spacer
21. Spacer
22. Valve
23. Valve
24. Valve
25. Valve
26. Backup Ring
27. Backup Ring
28. Wear Ring
29. O-ring
30. O-ring
31. Seal Rod
32. Rod Wiper
33. Wear Ring
34. Seal
35. O-ring
36. O-ring

Figure 5-24. Tower Boom Telescope Cylinder



1.	Barrel	7.	O-ring	13.	Backup Ring	19.	Bushing	25.	O-ring Plug	31.	Fitting
2.	Rod	8.	Backup Ring	14.	Spacer	20.	Capscrew	26.	Valve Assembly	32.	Fitting
3.	Head	9.	Piston	15.	Tapered Bushing	21.	Bolt	27.	Valve	33.	Capscrew
4.	Wiper	10.	Seal	16.	Wear Pad Plate	22.	Bolt	28.	Valve		
5.	Rod Seal	11.	Wear Ring	17.	Wear Pad	23.	Capscrew	29.	Valve		
6.	Wear Ring	12.	O-ring	18.	Telefoot Plate	24.	O-ring Plug	30.	Valve		

Figure 5-25. Main Boom Telescope Cylinder

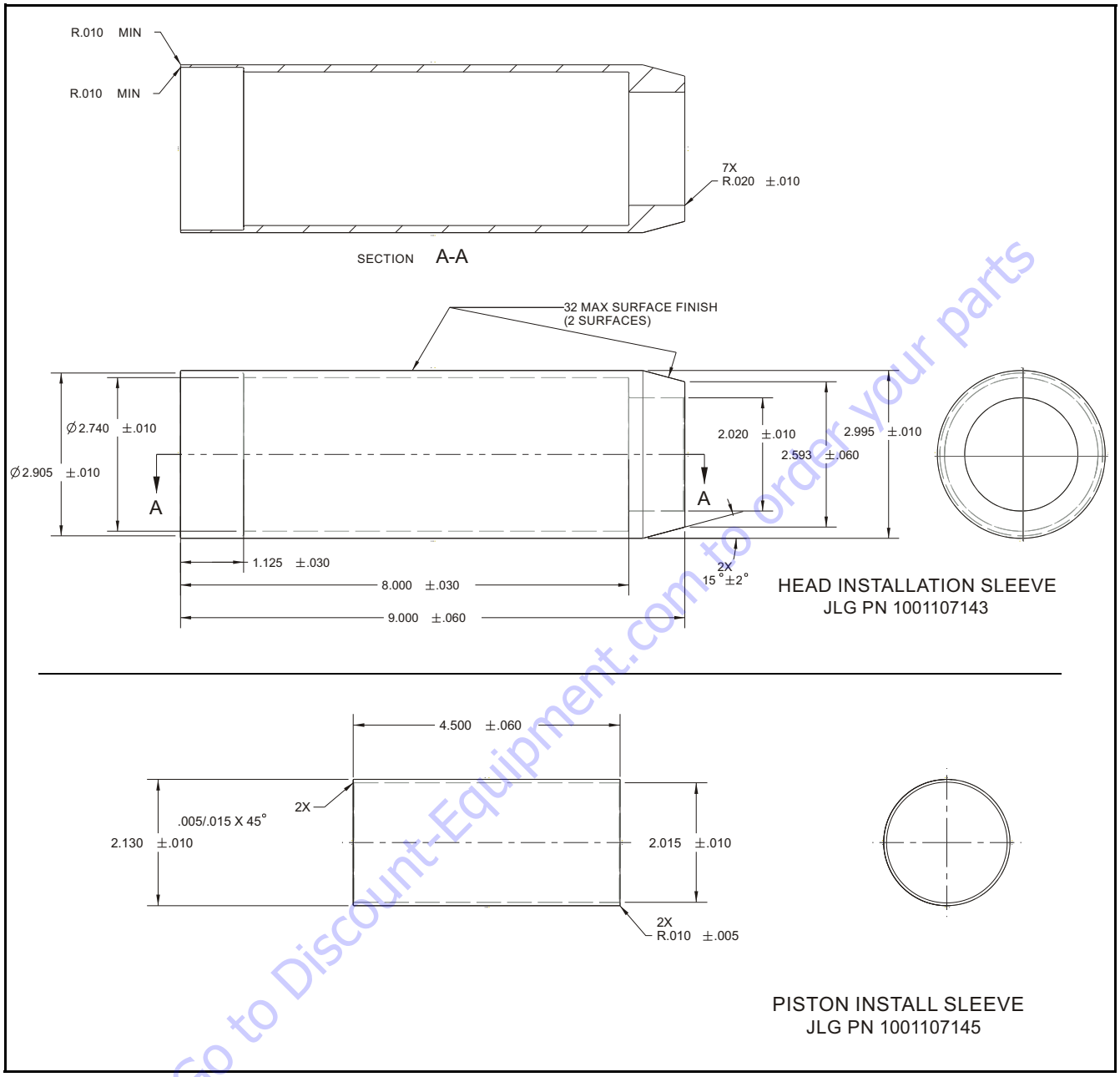


Figure 5-26. Special Tools for Tower Tele Cylinder - Sheet 1 of 2

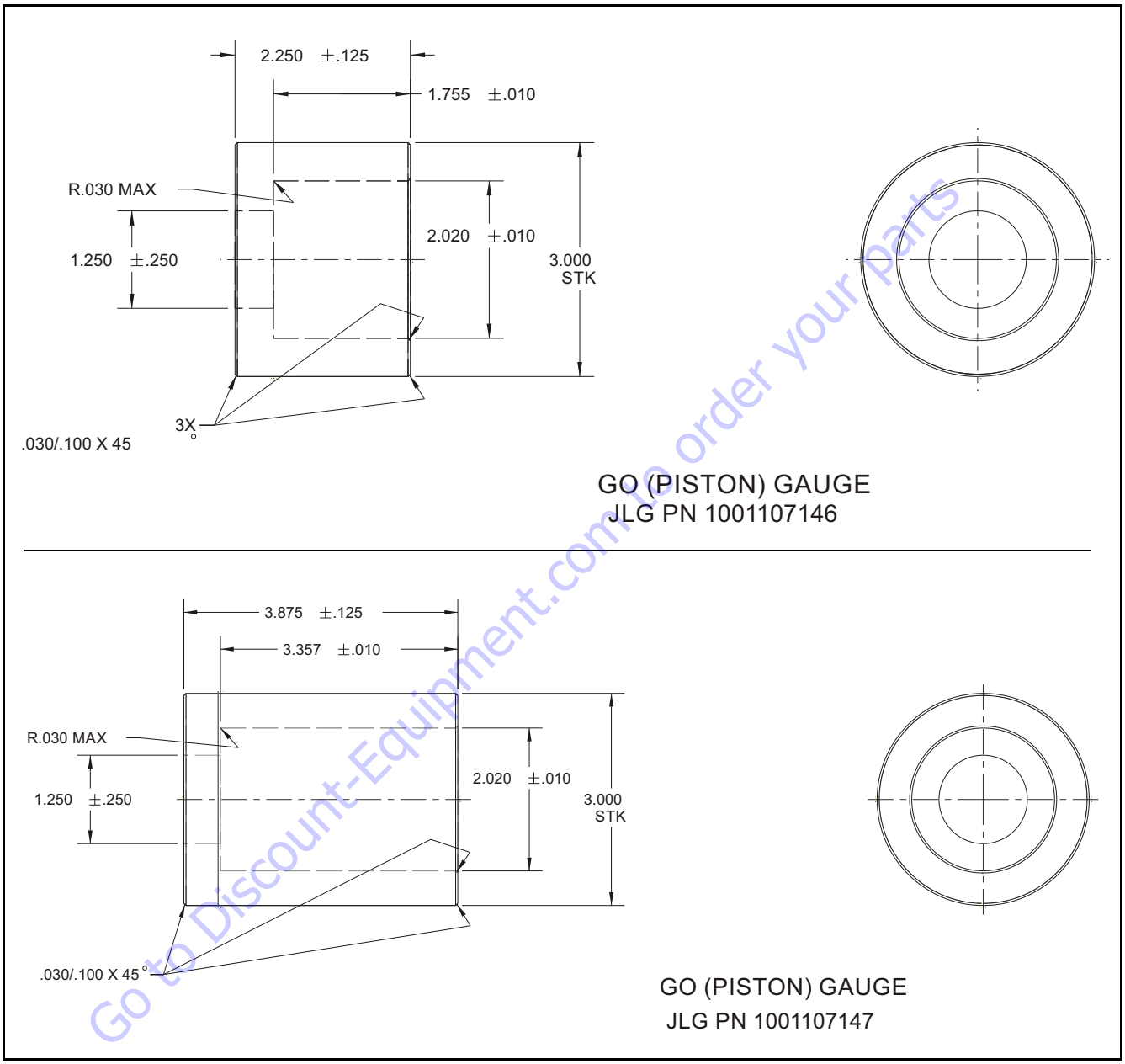


Figure 5-27. Special Tools for Tower Tele Cylinder - Sheet 2 of 2

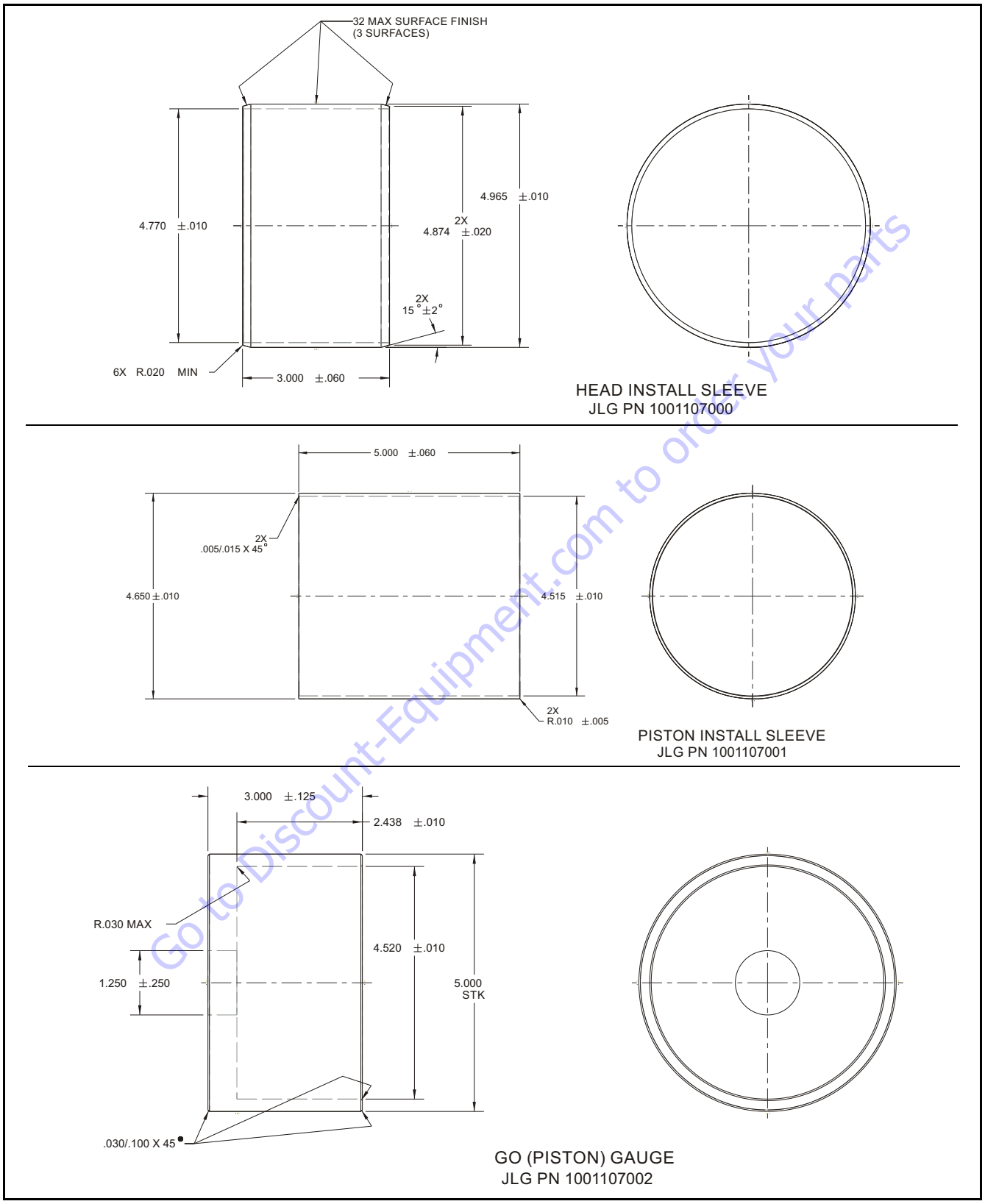


Figure 5-28. Special Tools for Upper Lift Cylinder

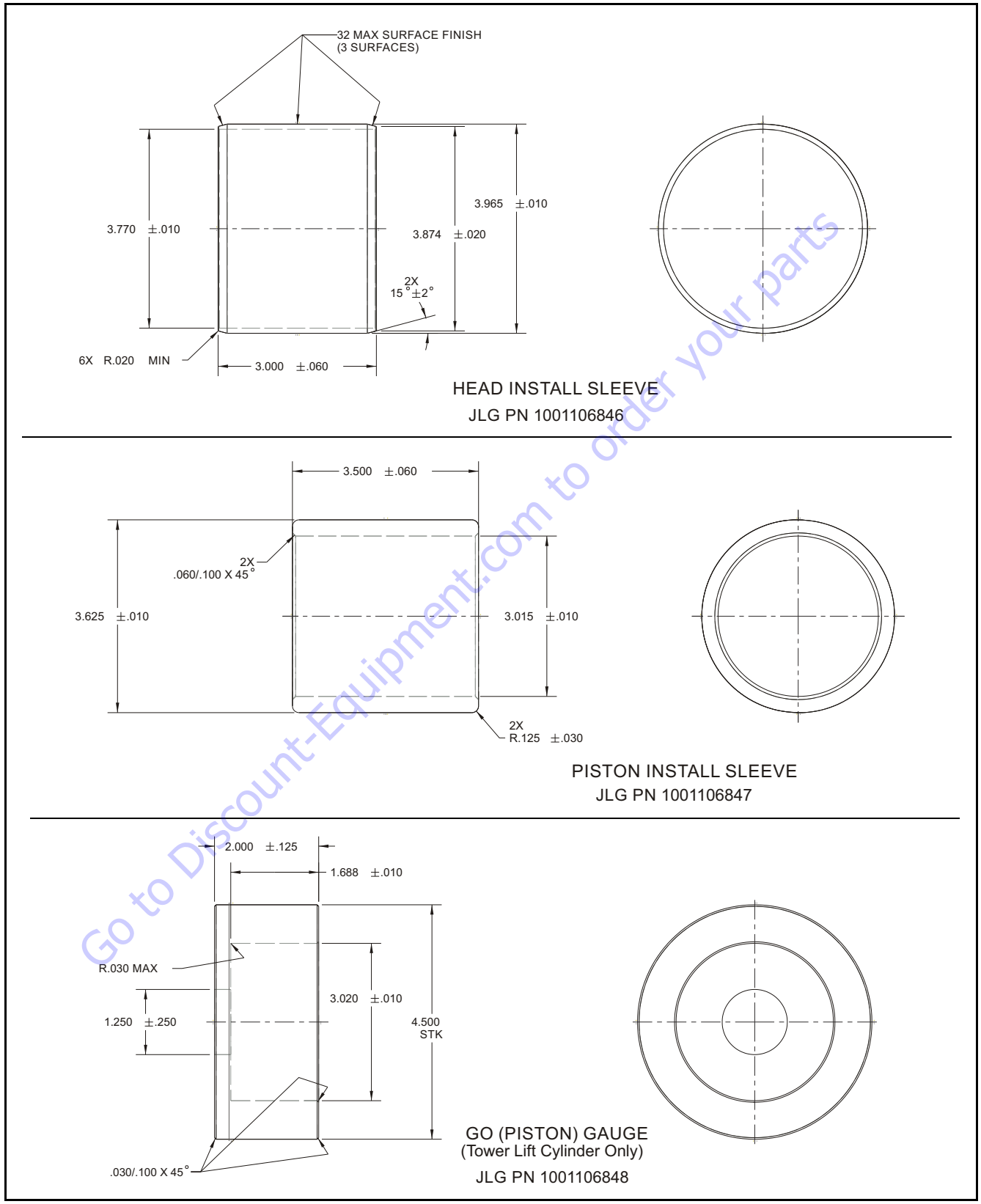


Figure 5-29. Special Tools for Main Lift Cylinder and Tower Lift Cylinder

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

8. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

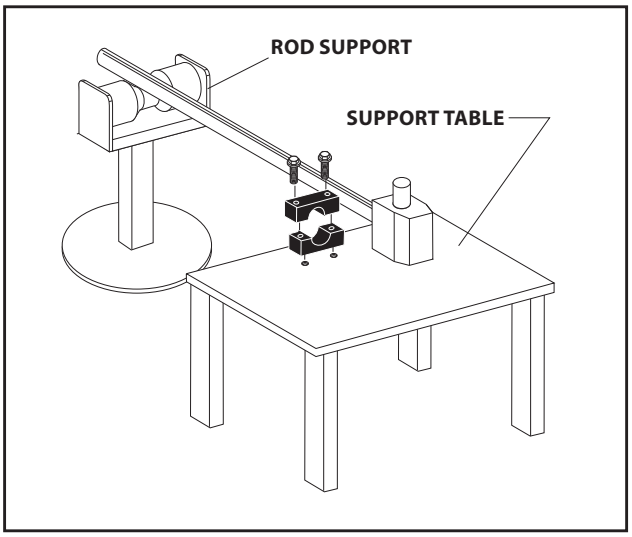


Figure 5-30. Cylinder Rod Support

9. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.

NOTE: *Step 10 applies only to the steer cylinder.*

10. Loosen and remove nut which attaches the piston to the rod, and remove the piston.
11. Loosen and remove the capscrew(s), if applicable, which attach the tapered bushing to the piston.
12. Insert the capscrew(s) in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrew(s) until the bushing is loose on the piston.
13. Remove the bushing from the piston.

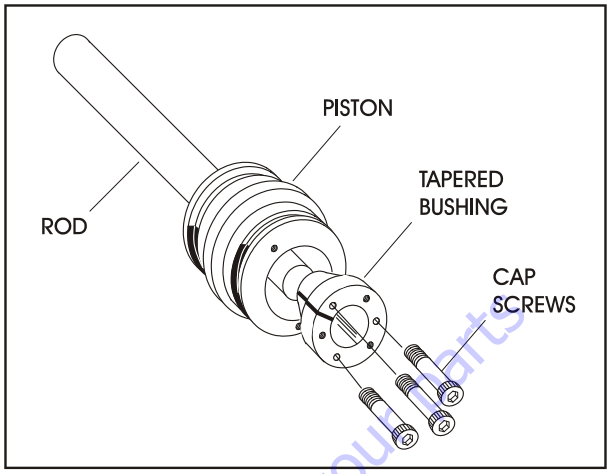


Figure 5-31. Tapered Bushing Removal

14. Screw the piston CCW, by hand, and remove the piston from cylinder rod.
15. Remove and discard the piston o-rings, seal rings, and backup rings.
16. Remove piston spacer, if applicable, from the rod.
17. Remove the rod from the holding fixture. Remove the cylinder head gland and retainer plate, if applicable. Discard the o-rings, backup rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.

4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*

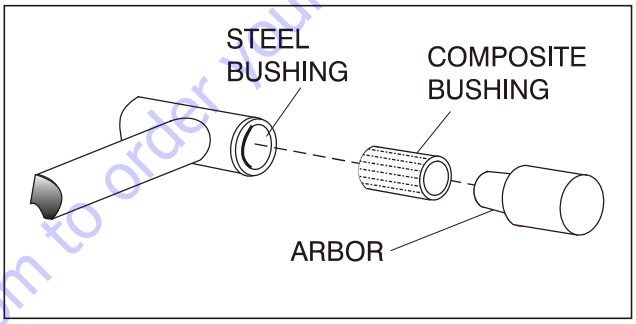


Figure 5-32. Composite Bearing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

Apply a light film of hydraulic oil to all components prior to assembly.

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

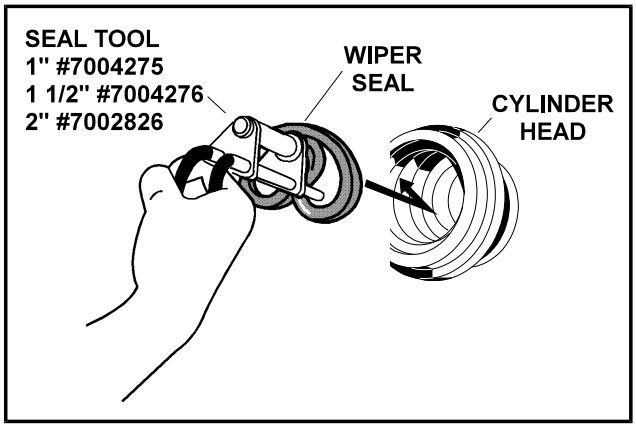


Figure 5-33. Rod Seal Installation

NOTICE

WHEN INSTALLING 'POLY-PAK' PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

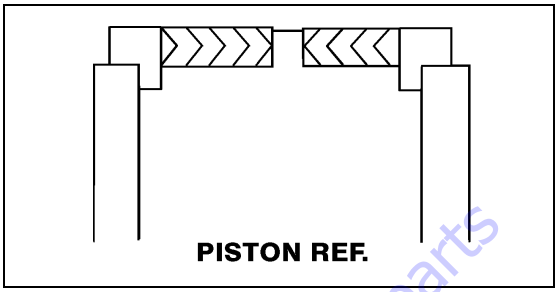


Figure 5-34. Poly-Pak Piston Seal Installation

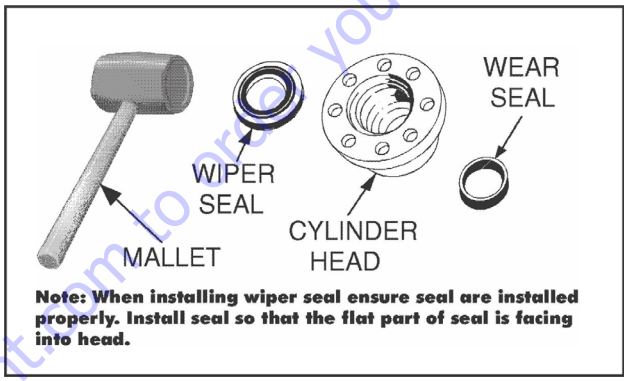


Figure 5-35. Wiper Seal Installation

3. Place a new "o"ring and backup seal in the applicable outside diameter groove of the cylinder head.

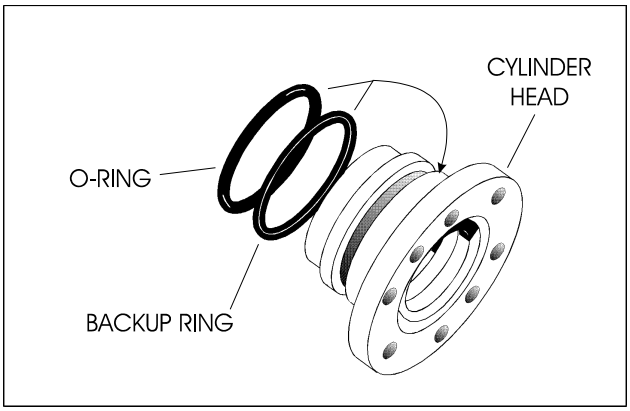


Figure 5-36. Installation of Head Seal Kit

4. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.

5. Carefully slide the piston spacer (if applicable) on the rod.

NOTE: *Main boom telescope cylinder piston has an o-ring installed inside the spacer.*

6. If applicable, correctly place new o-ring in the inner piston diameter groove. (The backup ring side facing the O-ring is grooved.)

7. If applicable, correctly place new seals and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D.of the piston is recommended to install the solid seal.)

NOTE: *The backup rings for the solid seal have a radius on one side. This side faces the solid seal.(See magnified insert in Figure 5-37.)The split of seals and backup rings are to be positioned so as not to be in alignment with each other.*

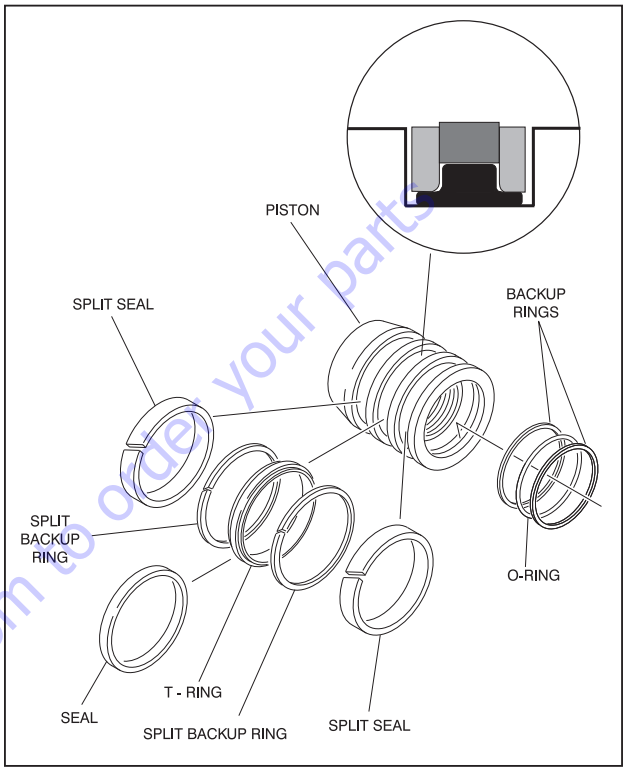


Figure 5-37. Piston Seal Kit Installation

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

9. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

10. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

⚠ WARNING

WHEN REBUILDING THE TELESCOPE, LIFT, JIB, LEVEL, AXLE LOCKOUT OR AXLE EXTENSION CYLINDERS, TIGHTEN SECURELY. (SEE TABLE 5-33)

11. Assemble the tapered bushing loosely into the piston and insert JLG capscrews (not vendor capscrews) through the drilled holes in the bushing and into the tapped holes in the piston.

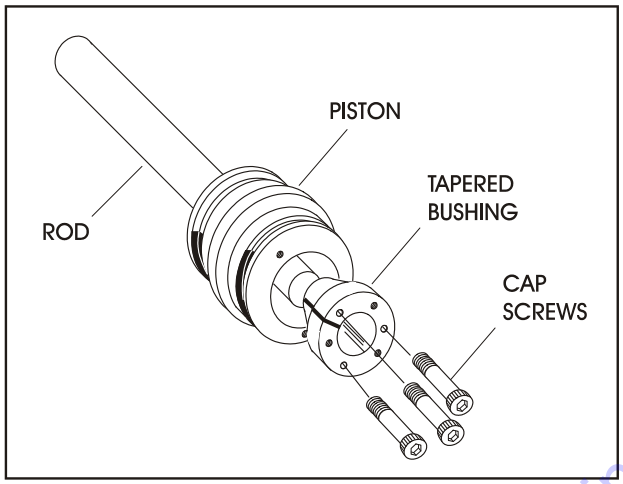


Figure 5-38. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to the specified torque value. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications).

13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

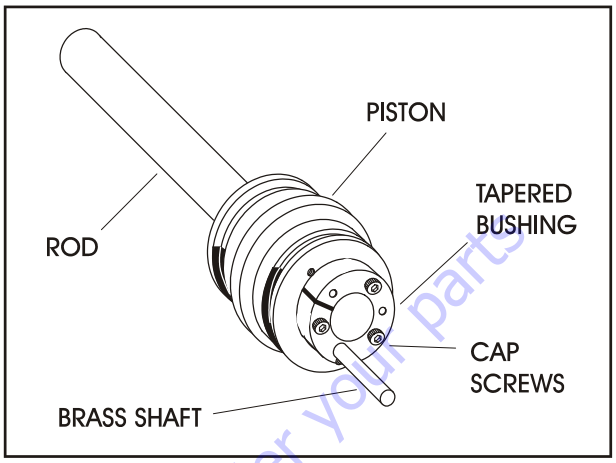


Figure 5-39. Seating the Tapered Bearing

14. Re-torque capscrews evenly and progressively in rotation to specified torque value. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications).

15. Remove the cylinder rod from the holding fixture.

16. Place new guide locks and seals in the applicable outside diameter grooves of the cylinder piston. (See Figure 5-37., Piston Seal Kit Installation)

17. Position the cylinder barrel in a suitable holding fixture.

NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

20. Secure the cylinder head gland using the washer ring and socket head bolts. (See Table 5-33, Cylinder Head and Tapered Bushing Torque Specifications and Table 5-34, Holding Valve Torque Specifications)

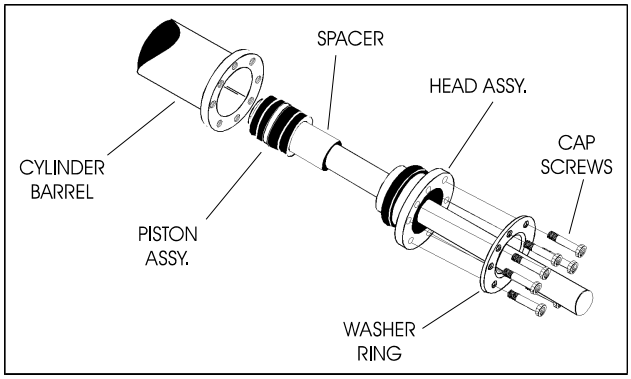


Figure 5-40. Rod Assembly Installation

21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.

22. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 5-34, Holding Valve Torque Specifications)

Table 5-33. Cylinder Head and Tapered Bushing Torque Specifications

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
Tower Tele Cylinder	80 ft. lbs. (108 Nm)	9 ft. lbs. (12.6 Nm)
Main Boom Tele Cylinder	80 ft. lbs. (108 Nm)	9 ft. lbs. (12.6 Nm)
Level Cylinder	120 ft. lbs. (168 Nm)	9 ft. lbs. (12.6 Nm)
Jib Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Tower Lift Cylinder	300 ft. lbs. (410Nm)	60 ft. lbs. (81 Nm)
Main Boom Lift Cylinder	300 ft. lbs. (410 Nm)	135 ft. lbs. (183 Nm)
Axle Oscillation Cylinder	120 ft. lbs. (168 Nm)	9 ft. lbs. (12.6 Nm)
Axle Extend Cylinder	50 ft. lbs. (70 Nm)	9 ft. lbs. (12.6 Nm)

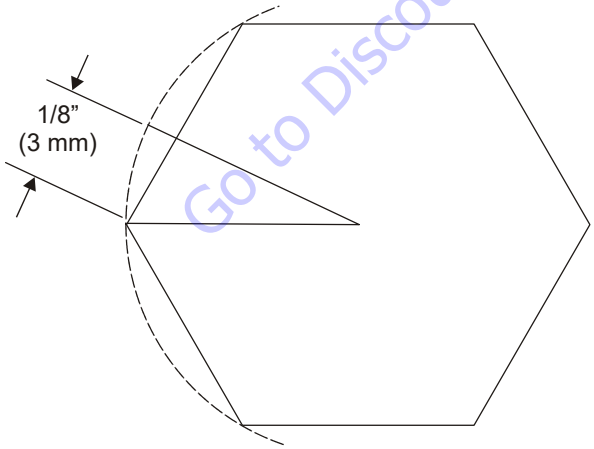
Table 5-34. Holding Valve Torque Specifications

Description	Torque Value
SUN - 7/8 HEX M20 X 1.5 THDS.	30-35 ft. lbs. (41-48 Nm)
SUN - 1 1/8 HEX 1 -14 UNS THDS.	45-50 ft. lbs. (61-68 Nm)
SUN - 1 1/4 HEX M36 X 2 THDS.	150-160 ft. lbs. (204-217 Nm)
RACINE - 1 1/8 HEX 1 1/16 - 12 THDS.	50-55 ft. lbs. (68-75 Nm)
RACINE - 1 3/8 HEX 1 3/16 - 12 THDS.	75-80 ft. lbs. (102-109 Nm)
RACINE - 1 7/8 HEX 1 5/8 - 12 THDS.	100-110 ft. lbs. (136-149 Nm)

5.4 COUNTERBALANCE VALVE CHECK

1. Position the machine on a firm level surface.
2. Ensure the tower boom and main booms are on their respective boom rests.
3. Swing the turntable to the side about 35-45° to gain access to the counterbalance valve.
4. Access the Tower Lift Cylinder Counterbalance Valve through the access hole in the bottom plate of the turntable.

5. Torque the counterbalance valve 45 to 50 foot pounds (61 to 68 Nm) and take note of how much the counterbalance valve moves.
6. If the valve moves less than 0.125" (3 mm) radially (see example below), proceed to the next step. If the valve moves more than 0.125" (3 mm) radially (see sketch below), replace the counterbalance valve, proceed to Step #8.



7. After applying the torque to the valve, examine the valve for hydraulic oil leaks. If the valve leaks, replace the counterbalance valve, see Step #10. If the valve does not leak, proceed to Step #13.
8. To replace the counterbalance valve:
   a. Remove the valve cartridge.
   b. Examine the removed cartridge for completeness of the valve, the o-rings and seals.
   c. If the valve, seals and o-rings are complete and accounted for, proceed to the next step.
   d. If any portion of the valve, o-rings or seals are missing, quarantine the machine. Do NOT allow the tower boom to be raised. Contact a certified service technician and make sure the missing parts are accounted for.

NOTICE

IF THE CARTRIDGE REQUIRES REPLACEMENT, THE PORT IN THE VALVE BLOCK MUST BE FREE OF RESIDUAL HYDRAULIC OIL BEFORE INSTALLING THE NEW CARTRIDGE OR THE CARTRIDGE SEALS MAY BE DAMAGED DURING INSTALLATION.

9. Inspect the new counterbalance valve for completeness of the valves, o-rings and seals.
10. Carefully install the new counterbalance valve into the valve block and torque 45 to 50 foot pounds (61 to 68 Nm).
11. Return the machine to the stowed position.

5.5 HYDRAULIC TANK

The hydraulic tank has a capacity of 53.3 gallons (201.7 liters) and includes the hydraulic return filter and two suction strainers. It is normal for the oil level to appear low when the boom is raised and should only be checked with the machine on level ground and with the boom fully retracted and lowered. The hydraulic oil should be maintained at the full level as shown by the decal and hydraulic oil level gauge located on the side of the tank as shown in Figure 5-41., Hydraulic Oil Level Gauge. This decal shows the proper full level for both hot and cold oil. Do not fill the hydraulic tank past the appropriate full mark. Overfilling can cause the oil to overflow from the top of the hydraulic tank during emergency lowering operations.

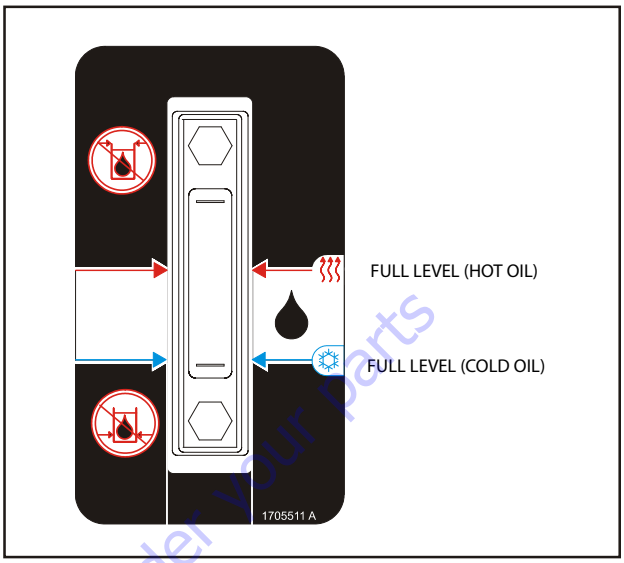


Figure 5-41. Hydraulic Oil Level Gauge

5.6 HYDRAULIC RETURN FILTER

Check the hydraulic return filter indicator with the hydraulic oil at normal operating temperature and the engine running. Replace the filter element before the indicator reaches the red filter restricted area or every 300 hours, whichever comes first.

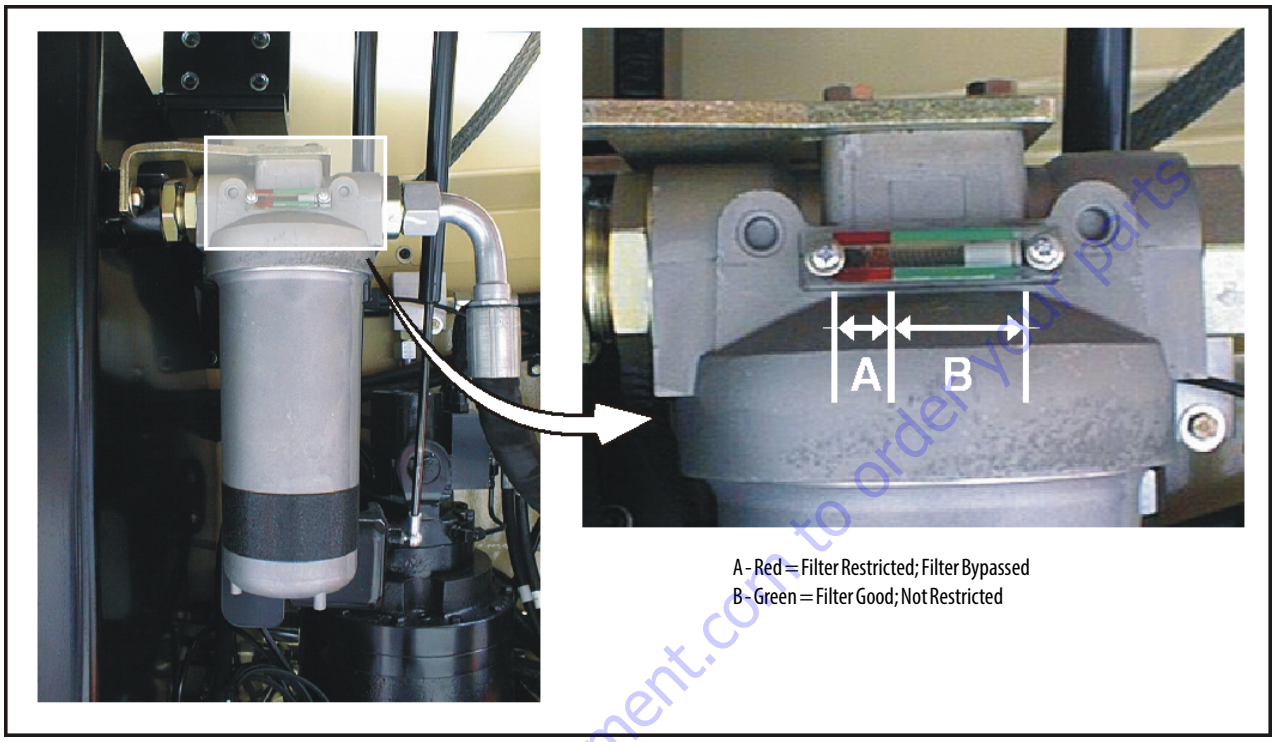
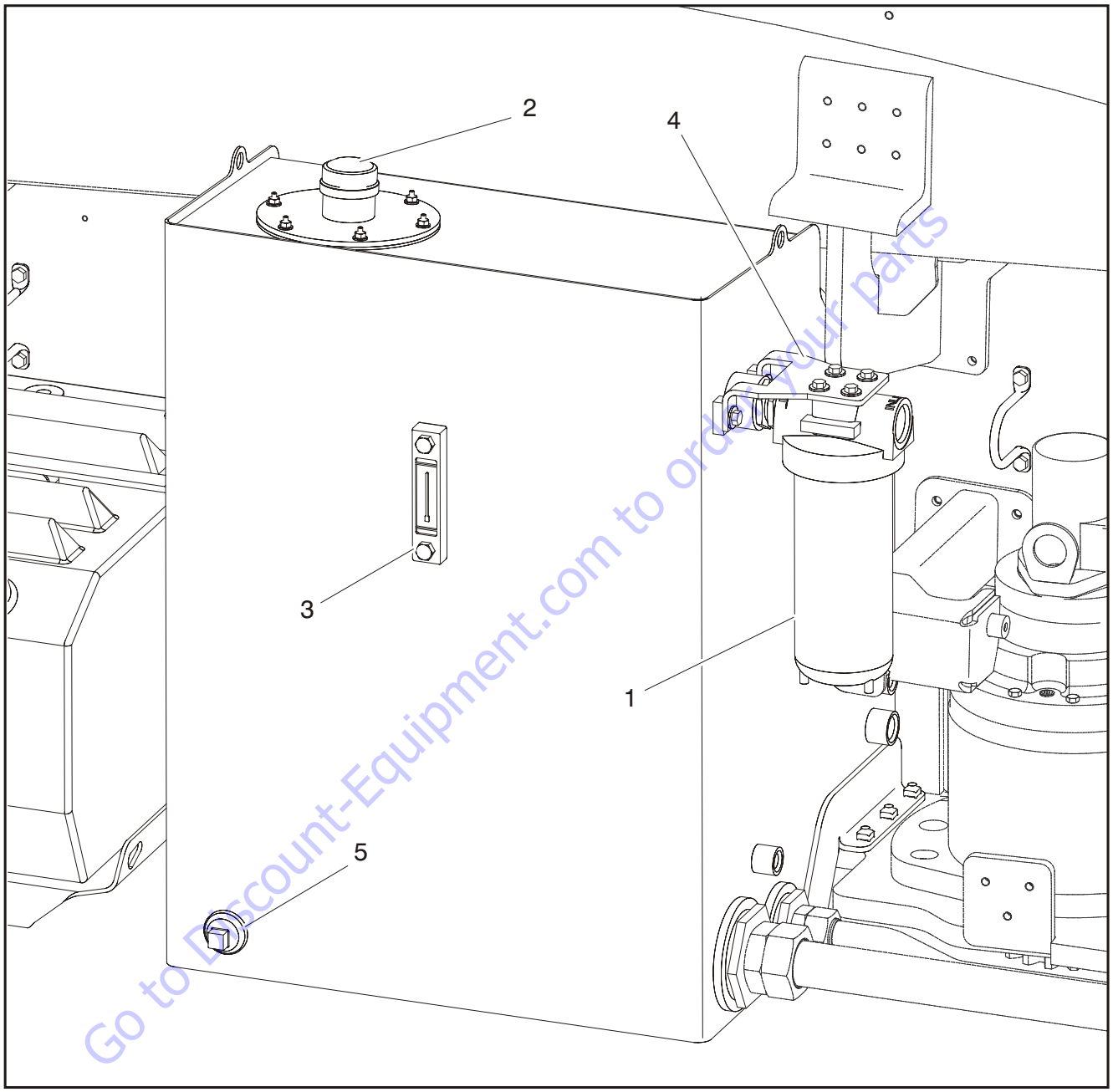


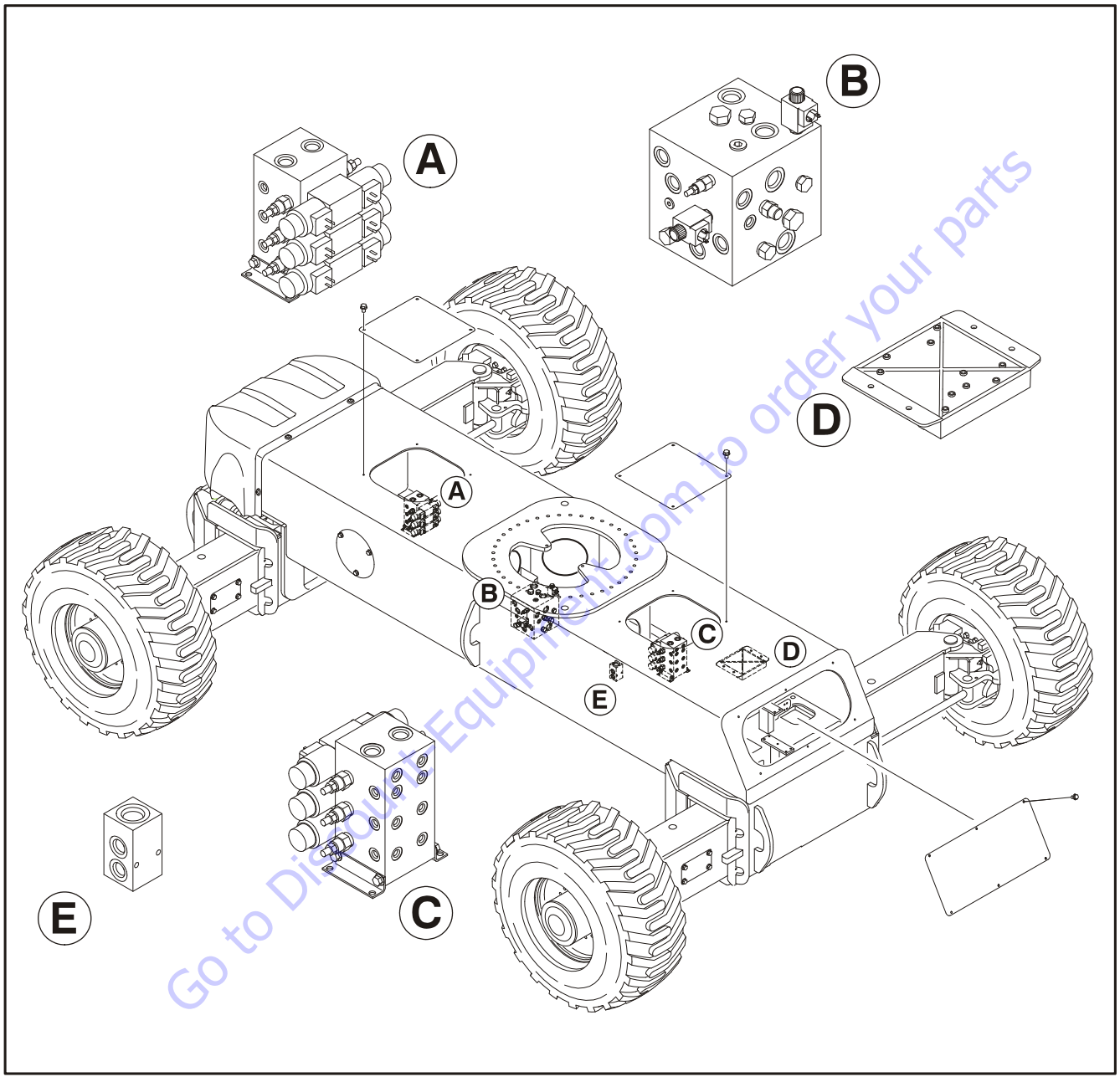
Figure 5-42. Hydraulic Return Filter Condition Indicator

Figure 5-43. Hydraulic Return Filter Condition Indicator



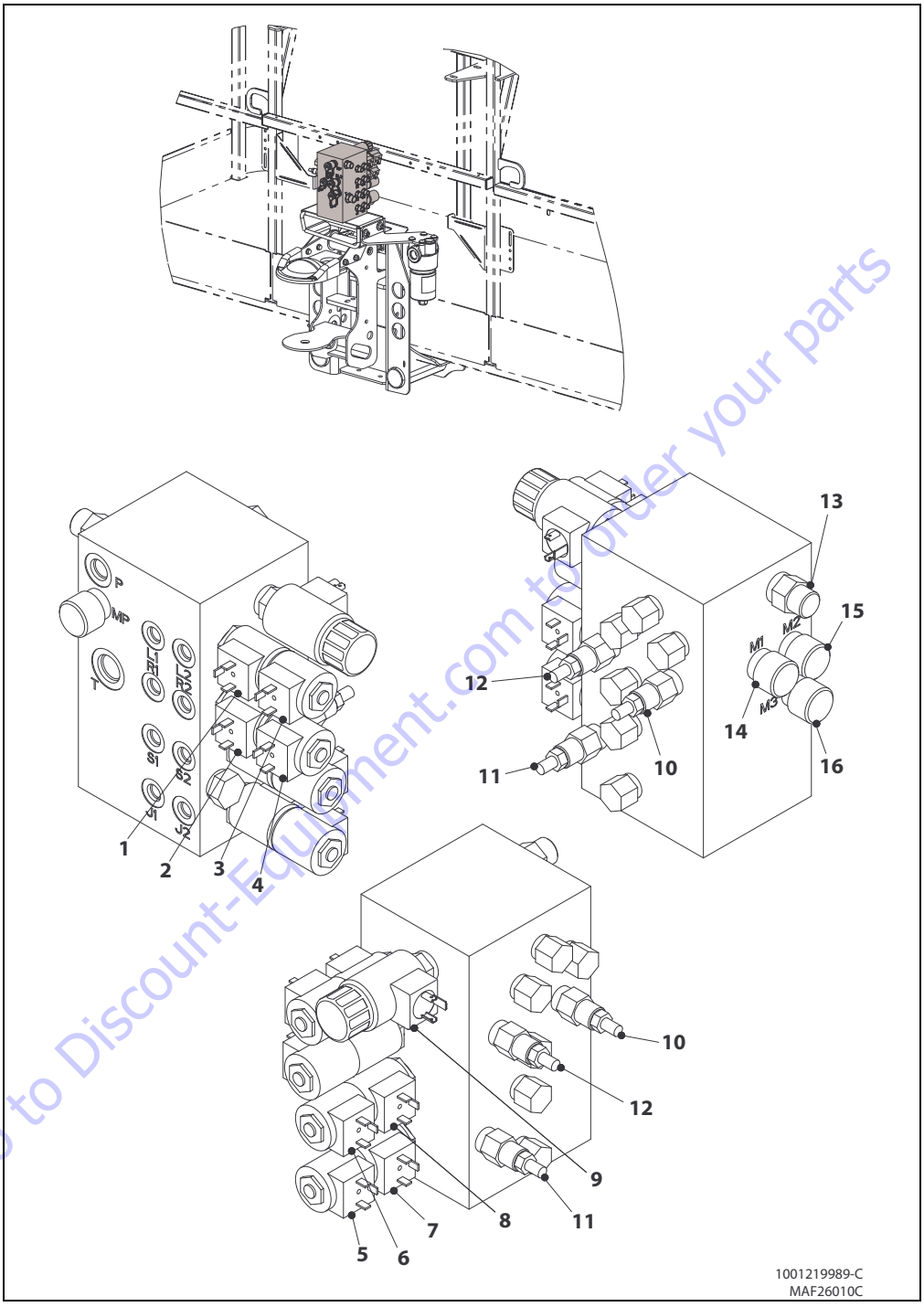
1. Return Filter
2. Vented Fill Cap
3. Sight/Temperature Gauge
4. Filter Mounting Bracket
5. Magnetic Drain Plug

Figure 5-44. Hydraulic Tank



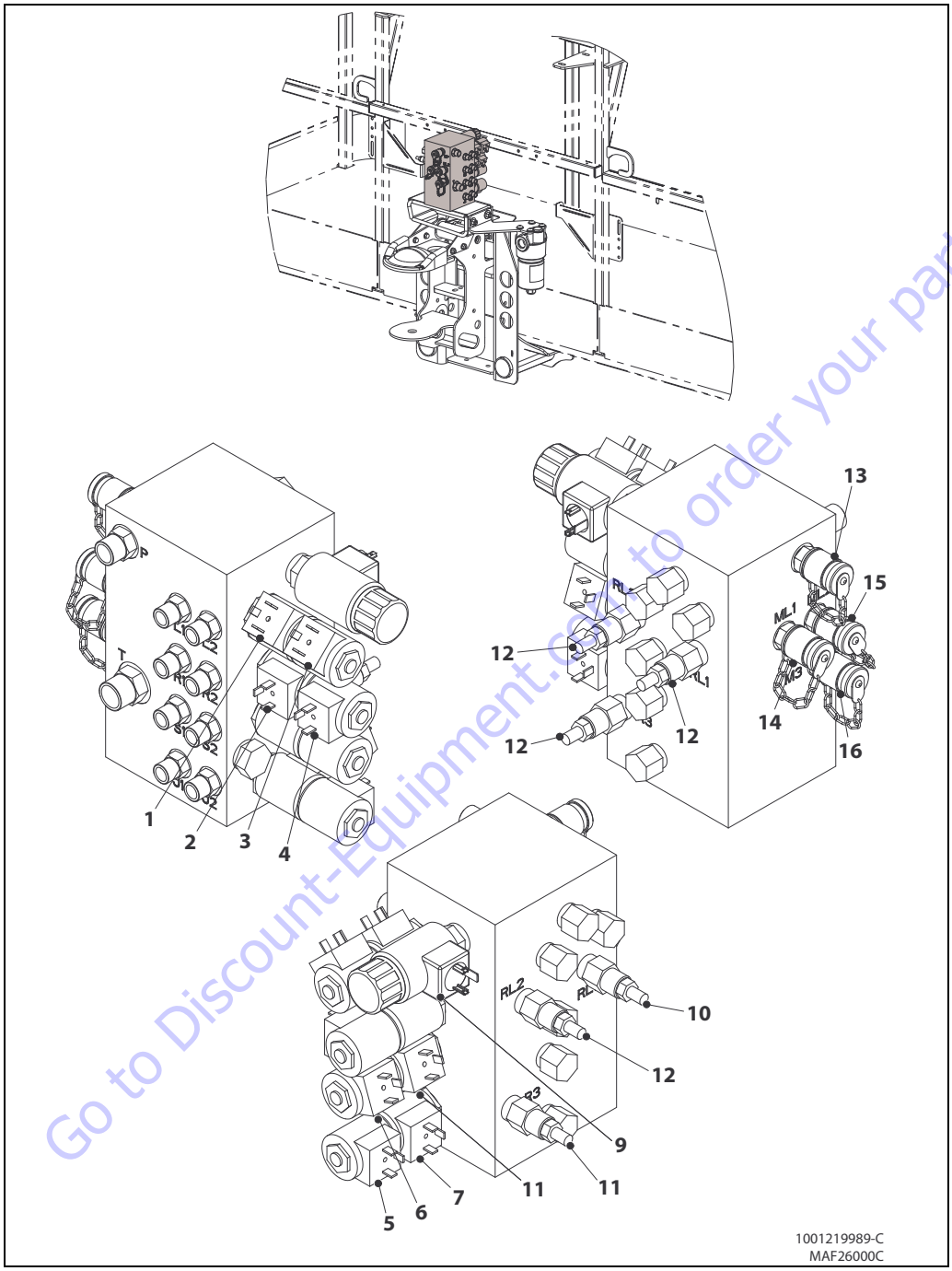
A. Front Steer Valve/Axle Extend
B. Traction Valve
C. Rear Steer Valve/Axle Extend
D. Chassis Module Controller
E. Junction Manifold Valve

Figure 5-45. Chassis Control Valve Locations



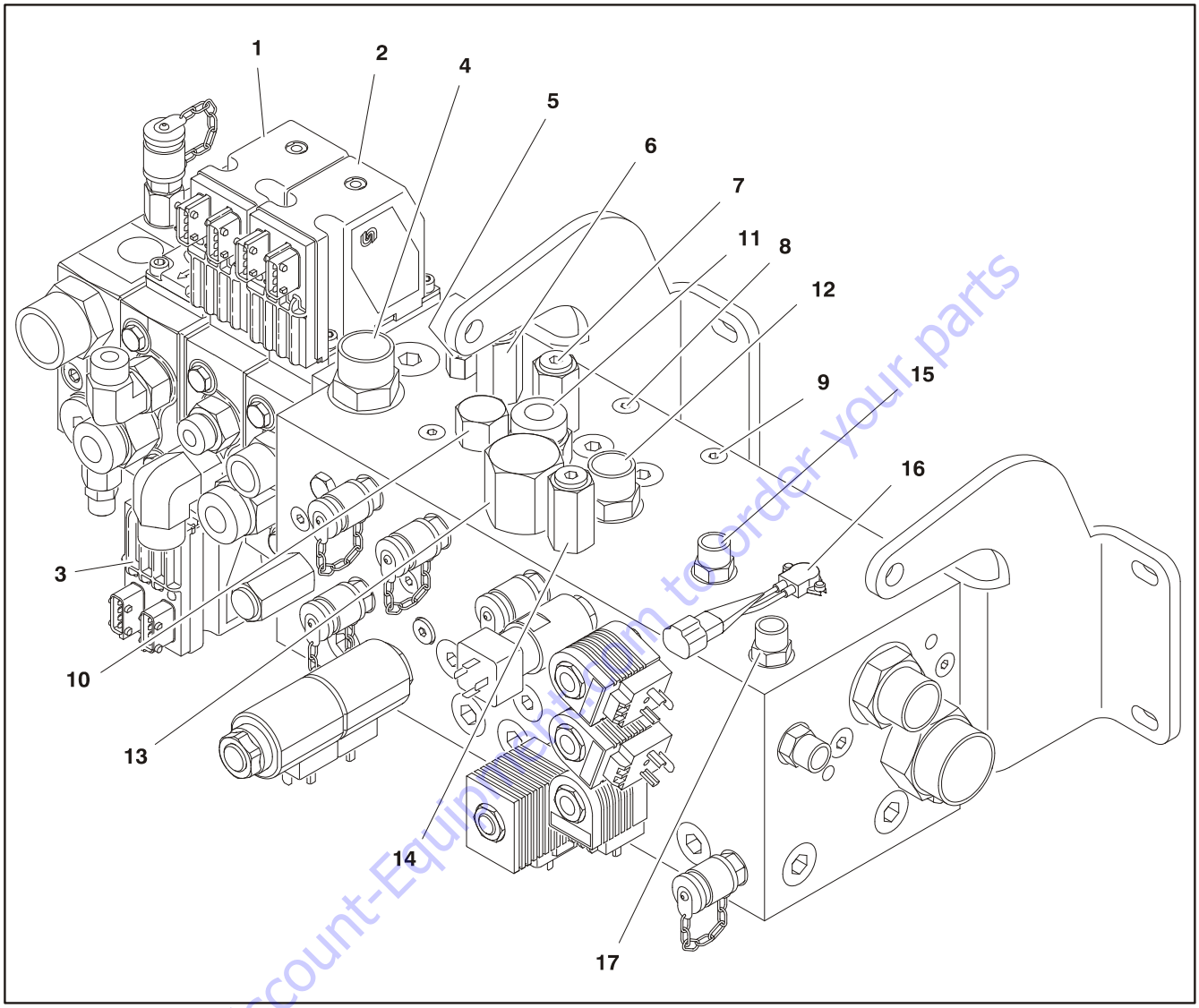
1. Level Up
2. Rotate Right
3. Level Down
4. Rotate Left
5. Jib Down
6. Jib Swing Left
7. Jib Up
8. Jib Swing Right
9. Platform Dump
10. Level Up Relief
11. Jib Up/Down Relief
12. Level Down Relief
13. Main Pressure Check Port
14. Level Up Test Port
15. Level Down Test Port
16. Jib Up/Down Test Port

Figure 5-46. Platform Valve Identification - JLG PN 4641266



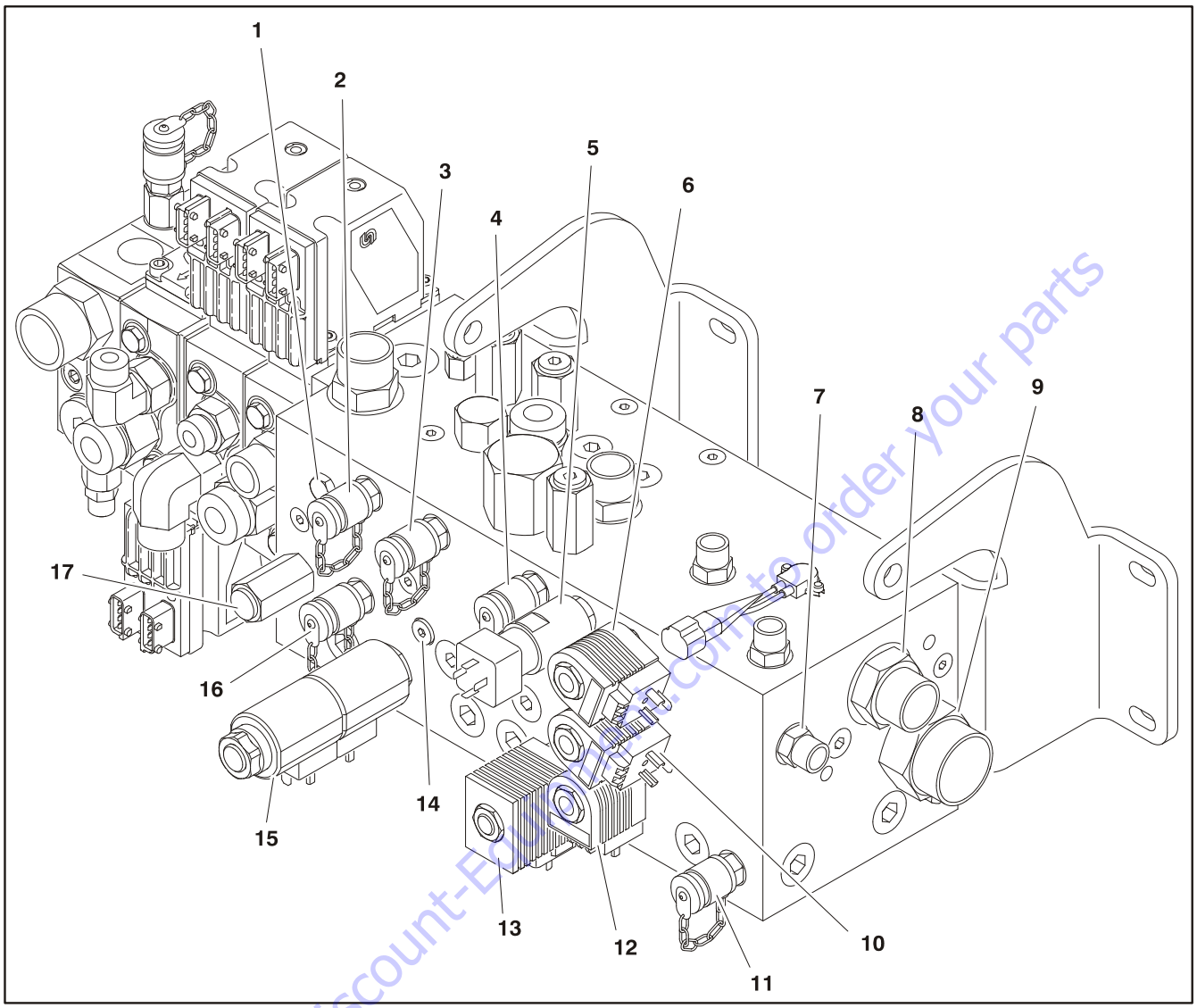
1. Level Up
2. Rotate Right
3. Level Down
4. Rotate Left
5. Jib Down
6. Jib Swing Left
7. Jib Up
8. Jib Swing Right
9. Platform Dump
10. Level Up Relief
11. Jib Up/Down Relief
12. Level Down Relief
13. Main Pressure Check Port
14. Level Up Test Port
15. Level Down Test Port
16. Jib Up/Down Test Port

Figure 5-47. Platform Valve Identification - JLG PN 4641460



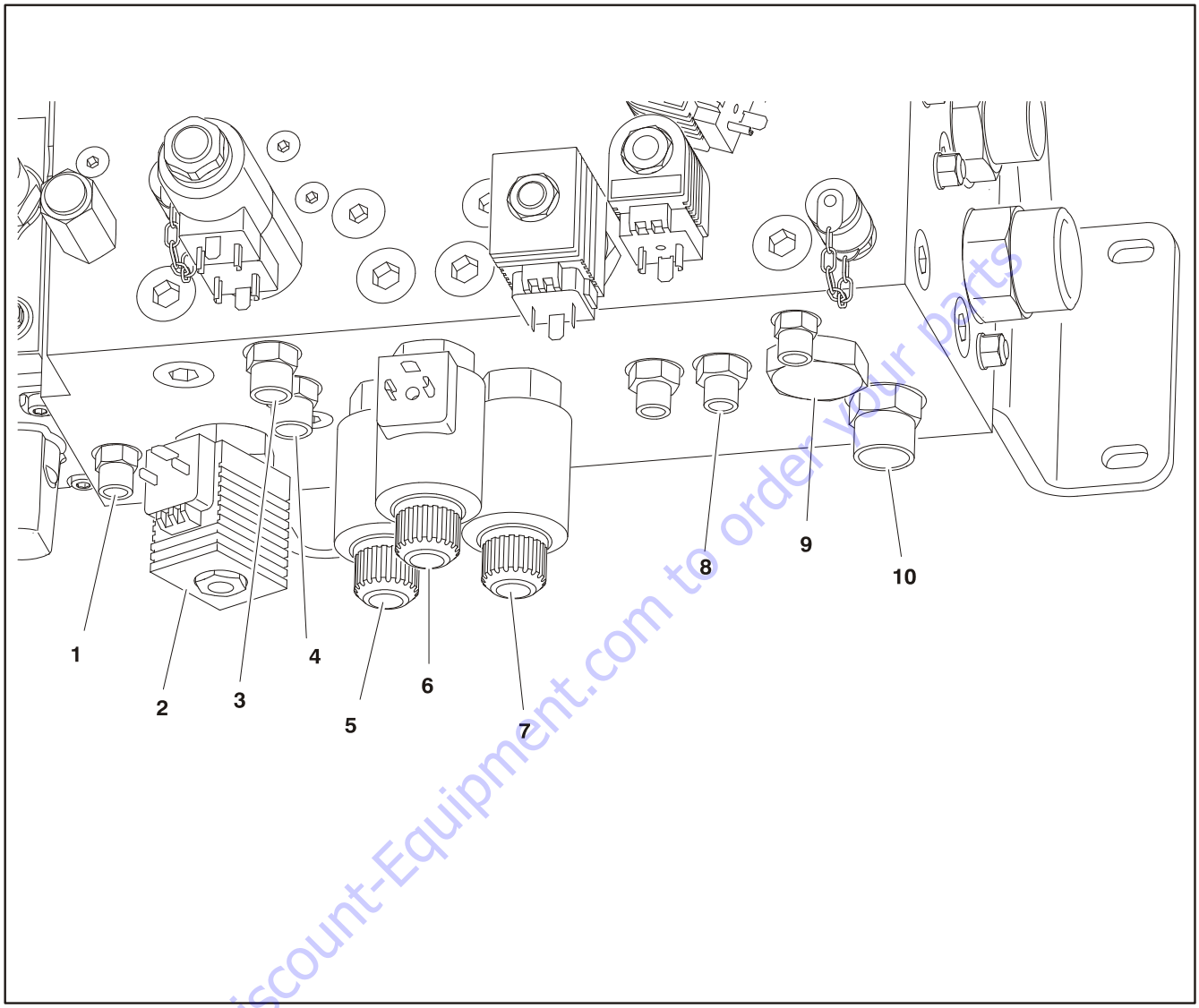
1. Tower Lift
2. Tower Tele
3. Main Lift
4. Main Tele Exhaust Port
5. Main Tele Exhaust Check
6. Swing Right Relief
7. Main Tele Extend Relief
8. Main Tele Extend Check
9. Main Tele Retract Check
10. Swing Differential Sensing
11. Main Tele Extend Port
12. Main Tele Retract Port
13. Main Tele Differential Sensing
14. Main Tele Retract Relief
15. Aux Port to Main Lift
16. Temperature Switch
17. Port to Platform Valve

Figure 5-48. Main Valve Identification - Top



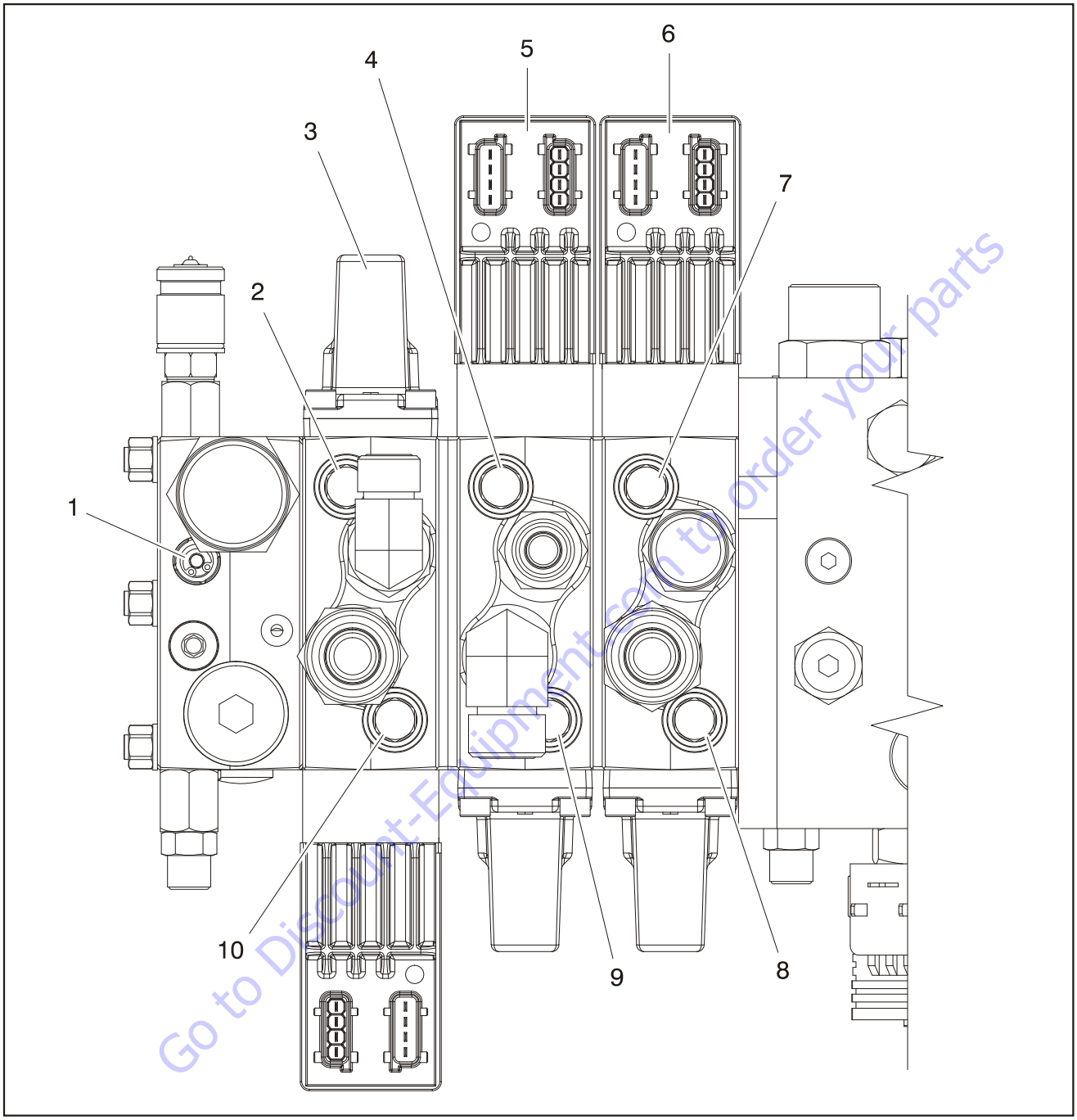
1. Main Tele Exhaust Check
2. Swing Right Test Port
3. Main Tele Extend Test Port
4. Main Tele Retract Test Port
5. Pressure Switch
6. Main Lift Solenoid
7. Pressure from Aux Pump
8. Return (Swivel)
9. Pressure from Function Pump
10. Tower Tele Solenoid
11. Main Pressure Port
12. Tower Lift Solenoid
13. Main Dump Solenoid
14. Swing Check Valve
15. Proportional Swing Valve
16. Swing Left Test Port
17. Swing Left Relief

Figure 5-49. Main Valve Identification - Front & Side



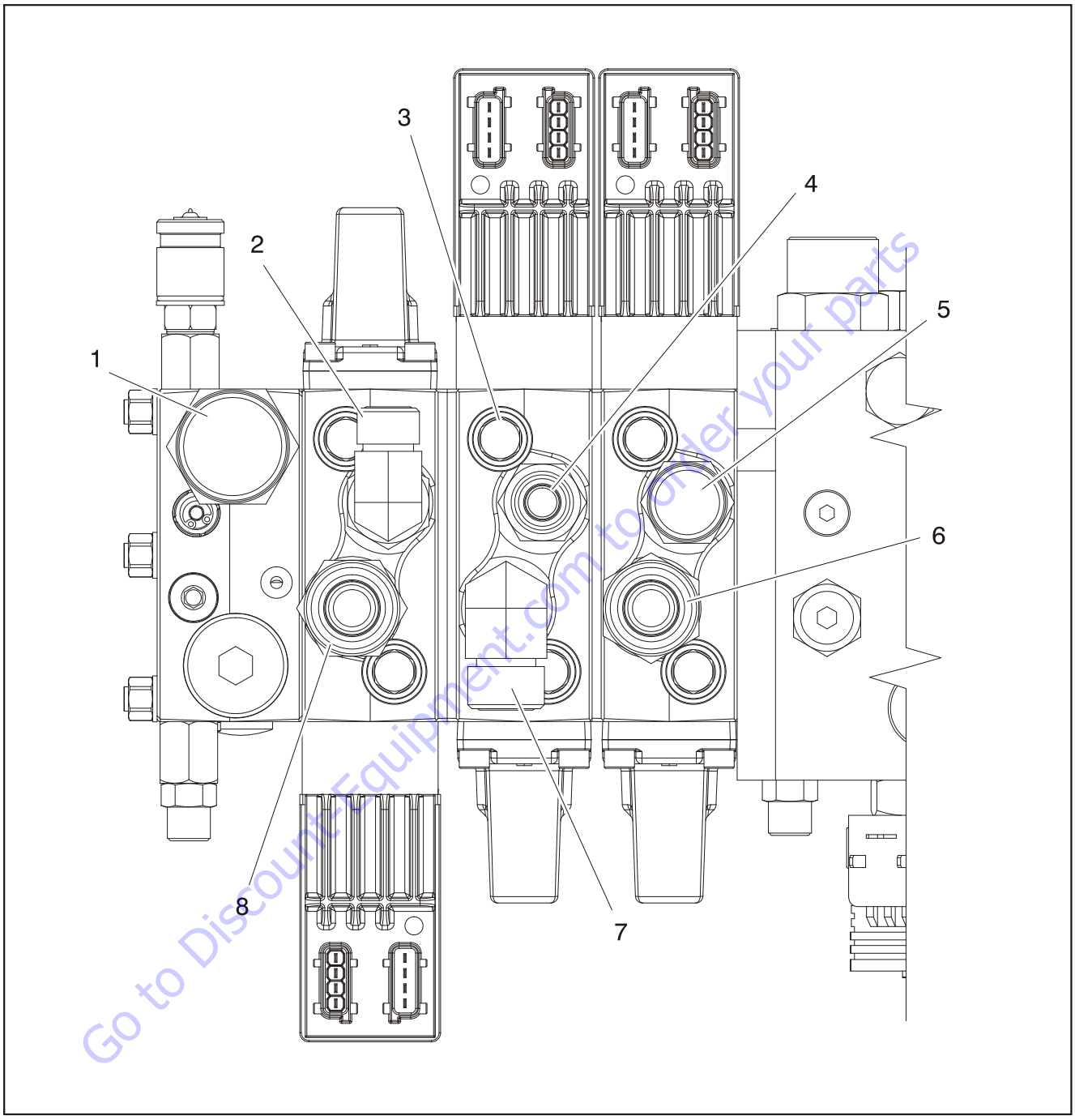
1. Load Sense Port
2. PVG Enable Solenoid Valve
3. Swing Left Port
4. Swing Right Port
5. Main Tele Extend Solenoid
6. Main Tele Proportional Valve
7. Main Tele Retract Solenoid
8. Aux Port to Tower Lift
9. Main Pressure Check
10. Swing Check

Figure 5-50. Main Valve Identification - Bottom



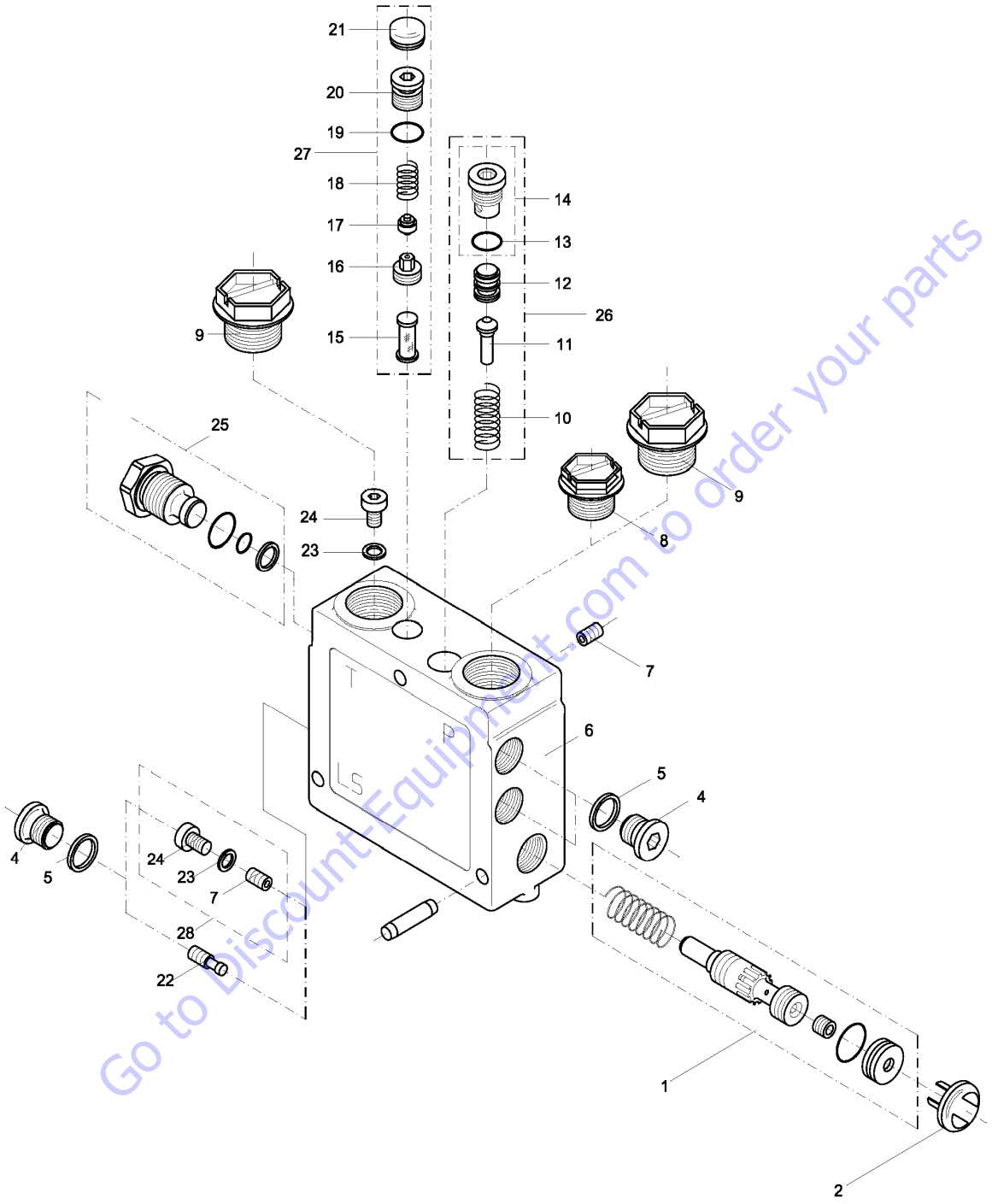
1. Pressure Adjustment
2. Main Lift Extend Shock Valve
3. Main Lift Section
4. Tower Lift Retract Shock Valve
5. Tower Lift Section
6. Tower Telescope Section
7. Tower Telescope Retract Shock Valve
8. Tower Telescope Extend Shock Valve
9. Tower Lift Extend Shock Valve
10. Main Lift Retract Shock Valve

Figure 5-51. PVG Section



1. Pressure Port
2. LS Port
3. Main Lift B Port
4. Tower Lift B Port
5. Tower Telescope B Port
6. Tower Telescope A Port
7. Tower Lift A Port
8. Main Lift A Port

Figure 5-52. PVG Section Ports



1. Inlet Compensator
2. Plug
4. Plug
5. Washer
6. Housing
7. Orifice
8. Plug
9. Plug
10. Spring
11. Cone
12. Spool
13. O-ring
14. Plug
15. Filter
16. Seat
17. Thrust Pad
18. Spring
19. O-ring
20. Adjusting Screw
21. Plug
22. Plug
23. Seal
24. Screw
25. Plug
26. Pilot Supply
27. Relief Valve
28. Conversion Kit

Figure 5-53. PVP Pump Side Module

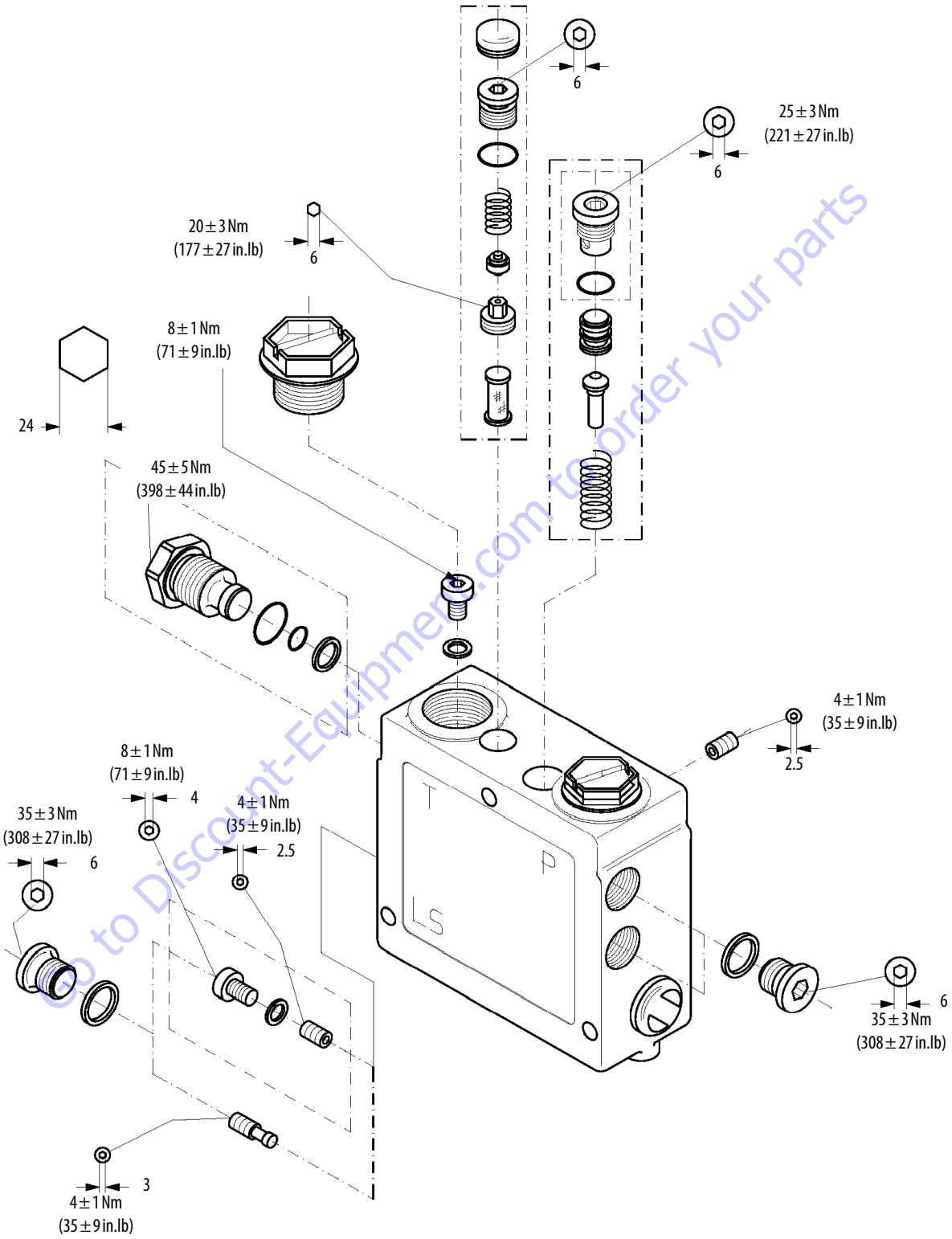
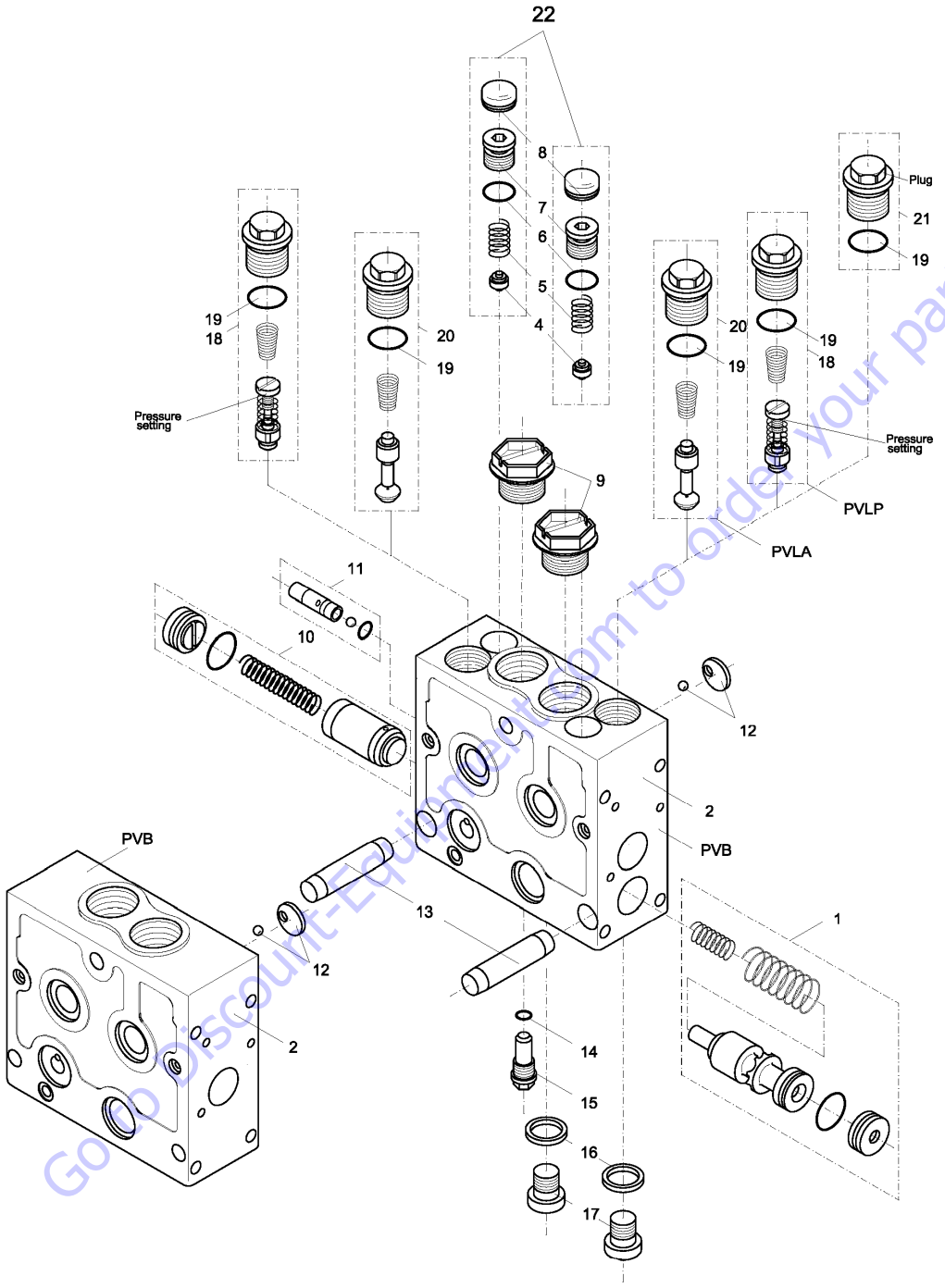


Figure 5-54. PVP Pump Side Module Torque Values & Tool Size



1. Compensator Valve
2. Housing
4. Thrust Pad
5. Spring
6. O-ring
7. Adjusting Screw
8. Plug
9. Plug
10. Check Valve
11. Shuttle
12. Shuttle
13. Pipe
14. O-ring
15. Screw
16. Washer
17. Plug
18. PVLP
19. O-Ring
20. PVLA valve
21. PVLA Plug
22. Relief Valve

Figure 5-55. PVB Basic Module

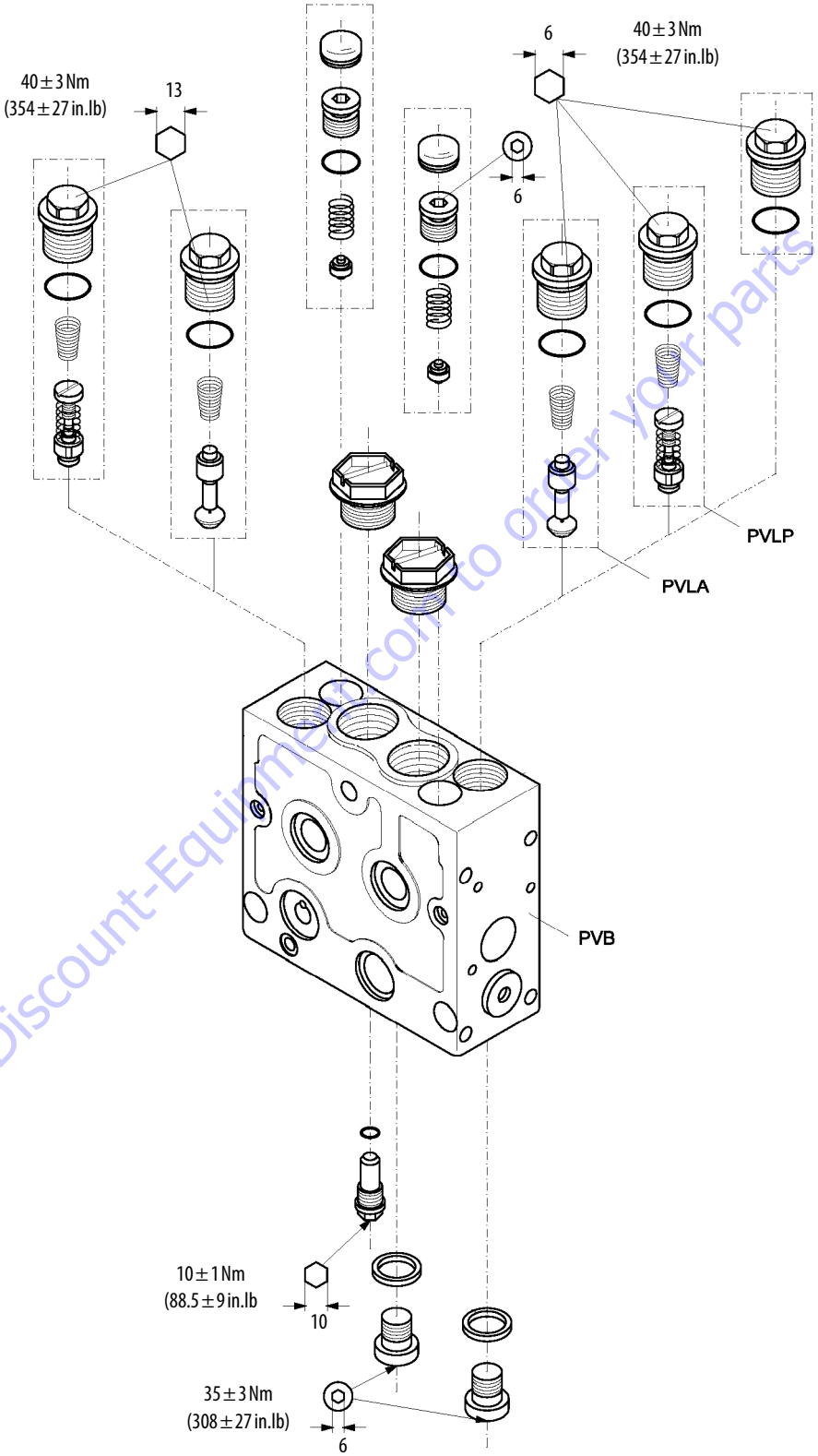
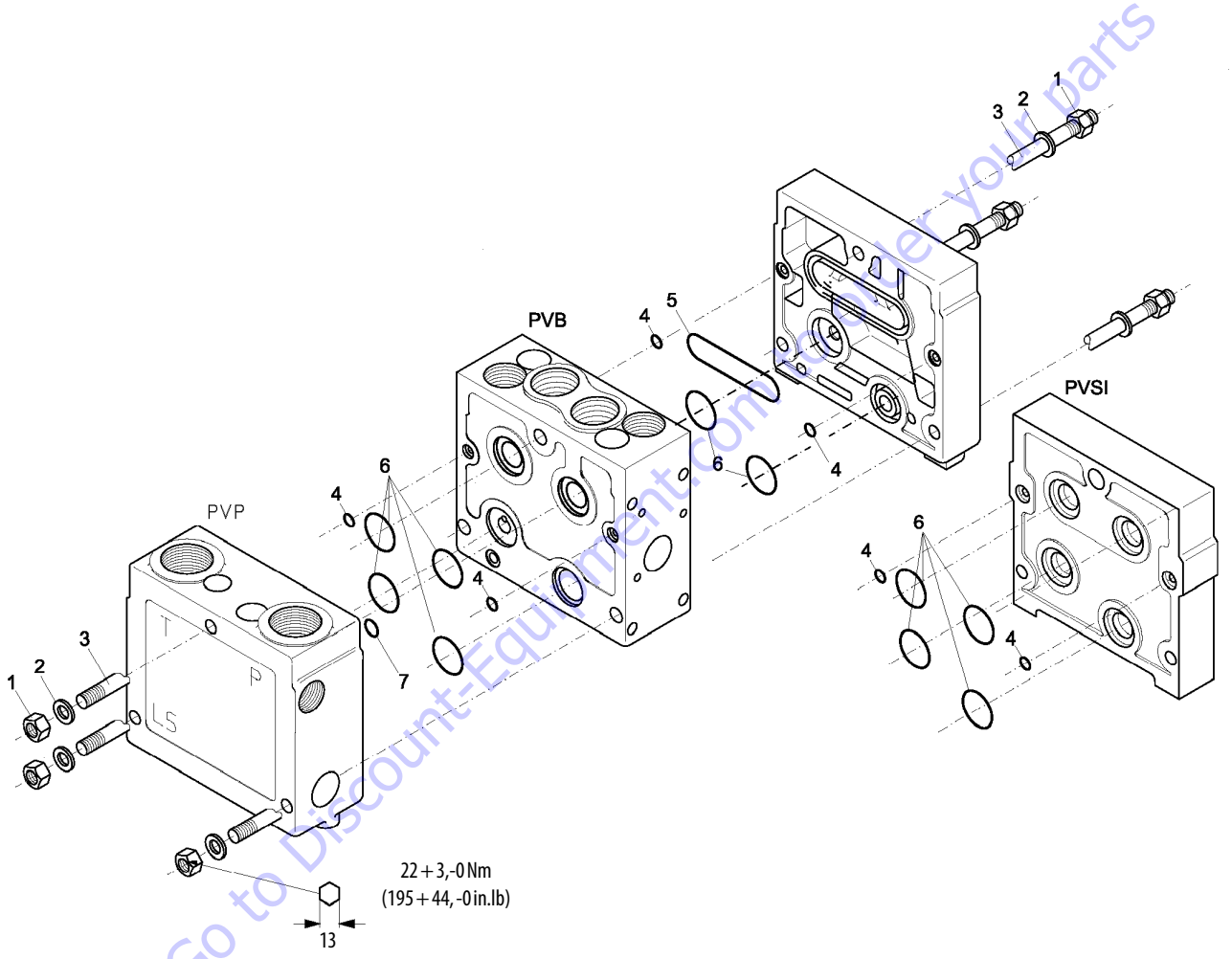
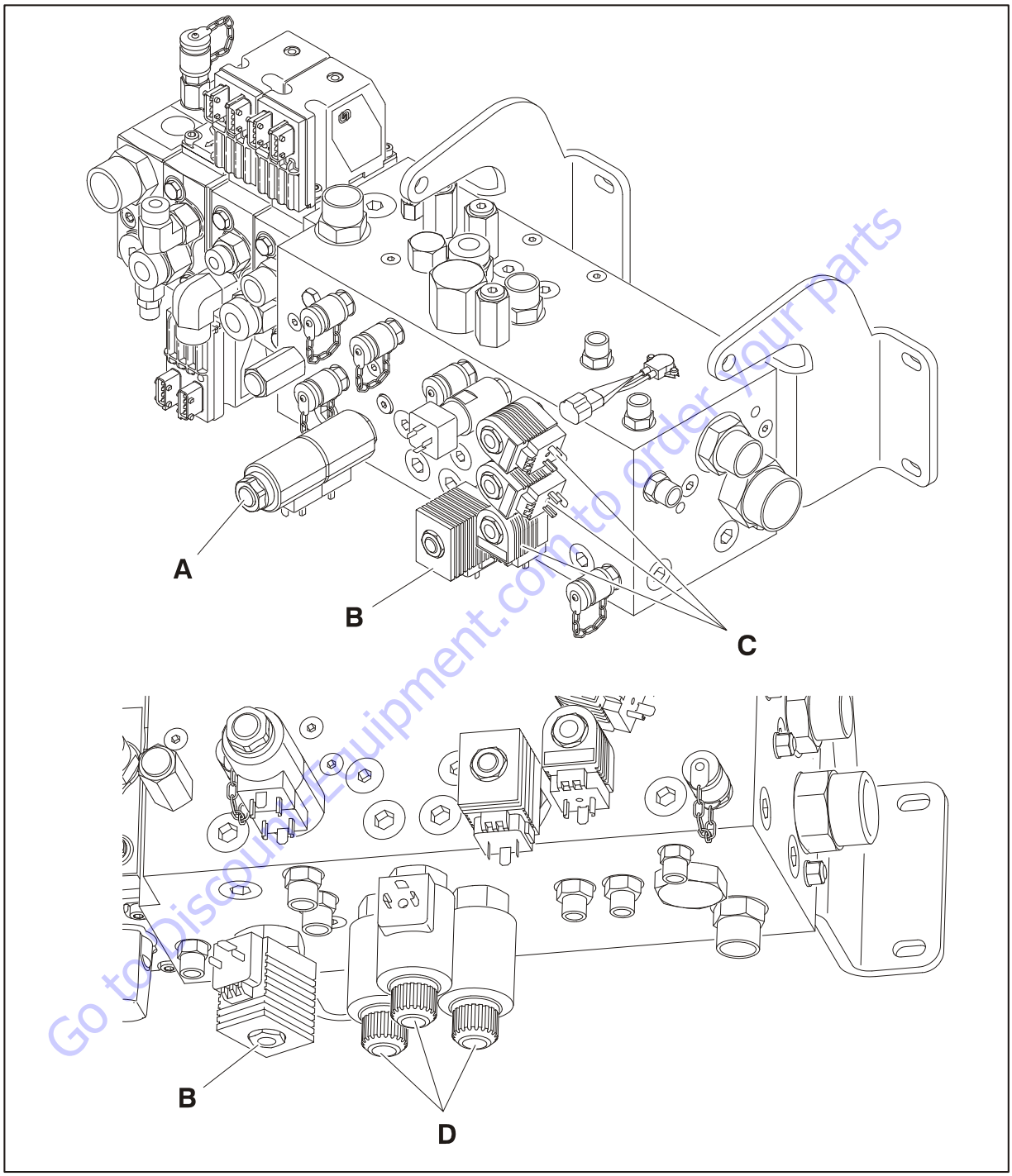


Figure 5-56. PVB Basic Module Torque Values & Tool Size



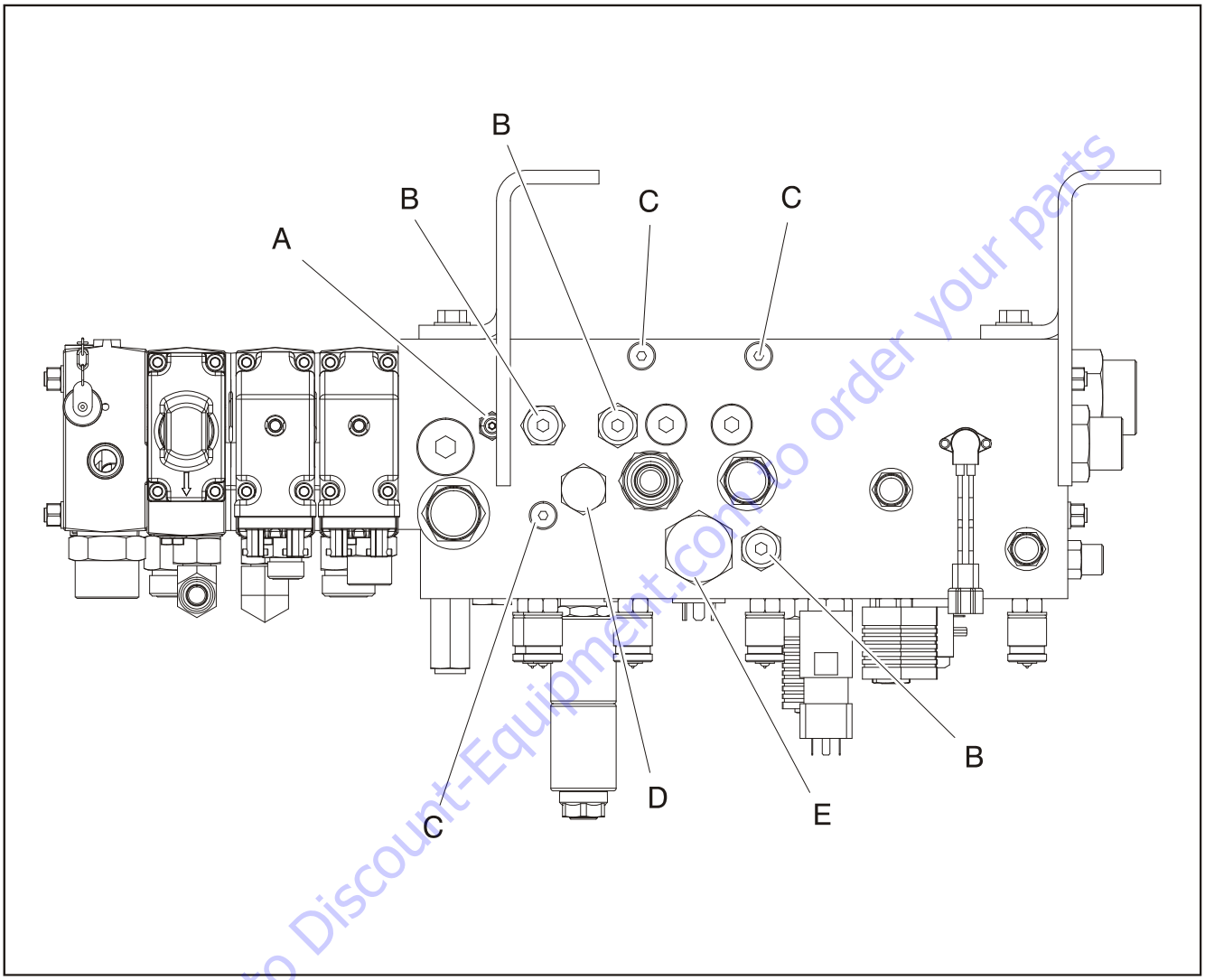
1. Nut
2. Washer
3. Stay Bolt
4. O-ring
5. O-ring
6. O-ring
7. O-ring

Figure 5-57. Assembly Kit & Torque for PVP Section



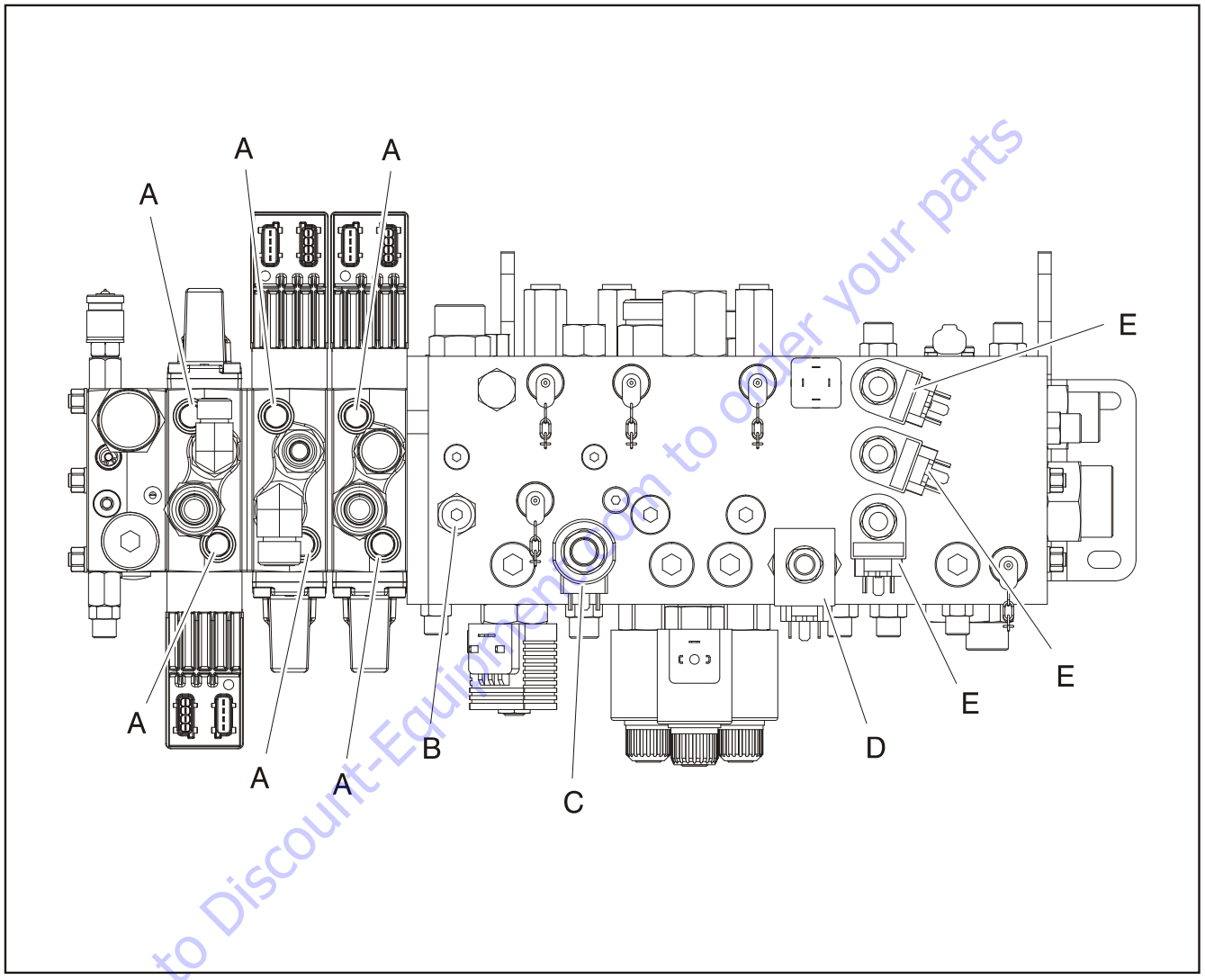
A. 5.2 Ohm ± 5%
B. 7.2 Ohm
C. 8.7 Ohm ± 5%
D. 4.7 Ohm ± 5%

Figure 5-58. Main Valve Ohm Values



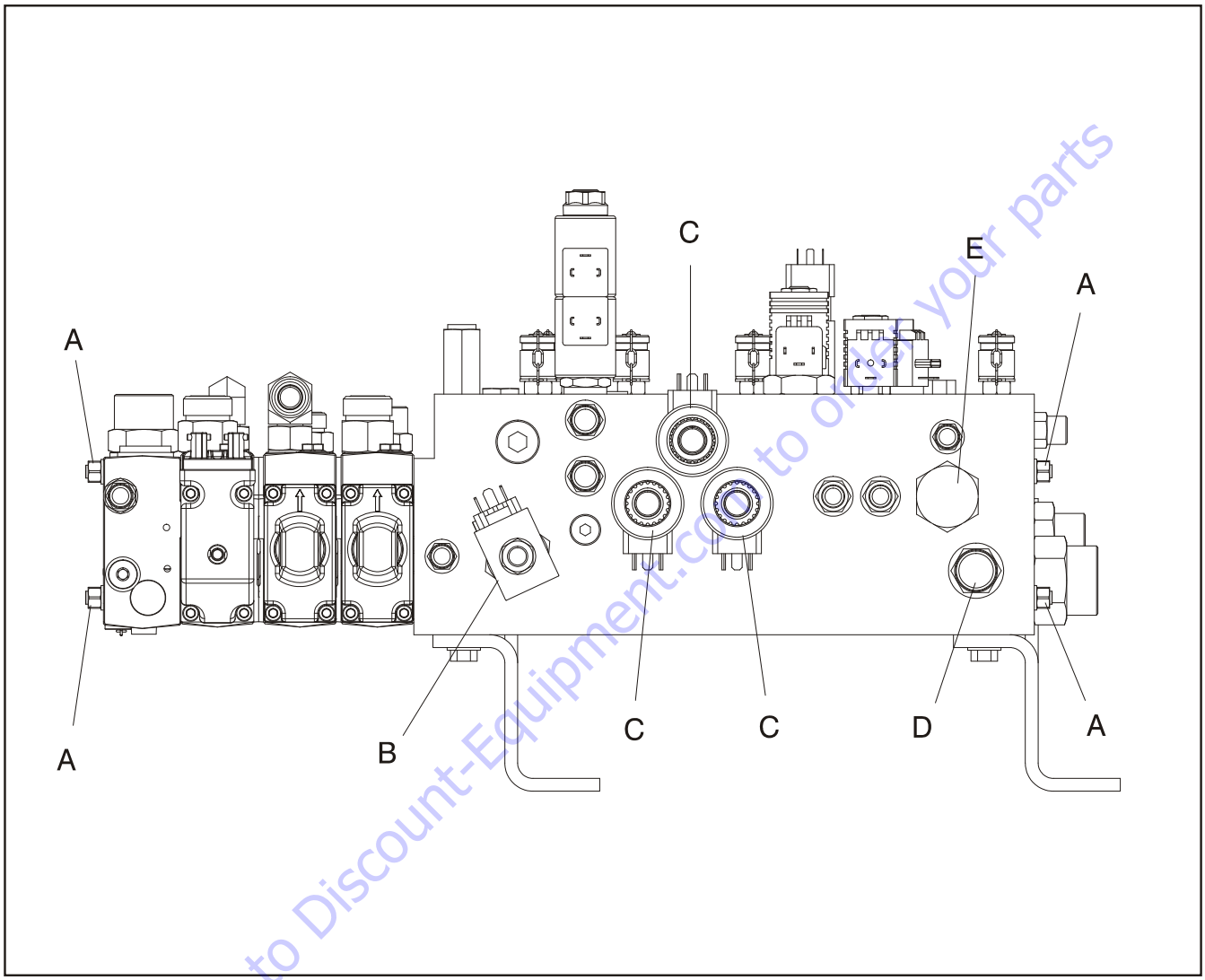
	Ft-Lbs.	Nm
A	14	19
B	20-25	27-34
C	8-10	10-15
D	30-35	41-47
E	90-100	122-136
Coil Nuts	4-6	5-8

Figure 5-59. Main Valve Cartridge Torque Values - Top



	Ft-Lbs.	Nm
A	354 in.lbs.	40
B	20-25	27-34
C	35-40	47-54
D	50	68
E	90-100	122-136
Coil Nuts	4-6	5-8

Figure 5-60. Main Valve Cartridge Torque Values - Front



	Ft-Lbs.	Nm
A	195 in.lbs.	22
B	50	68
C	50-55	68-75
D	8-10	10-15
E	90-100	122-136
Coil Nuts	4-6	5-8

Figure 5-61. Main Valve Cartridge Torque Values - Bottom

5.7 ENABLE VALVES

Removal

1. Make sure the machine is on a firm level surface.
2. Extend the axles until the axle locked light is illuminated.
3. Position the machine with the booms on suitable boom rests.
4. Shut off the engine; remove the key and tag out the machine.
5. Locate and identify the three enable valves on the left side of the machine. Mark the function that the valve controls on the valve, i.e. tower lift, tower tele, main lift.
6. Position a drain pan to catch any hydraulic spills and tag and disconnect the hydraulic hoses going to the three enable valves. Cap or plug all hoses to prevent contamination of the hydraulic system and loss of hydraulic oil.
7. Tag and disconnect the electrical harness from each enable valve solenoid.
8. Remove the existing hardware securing the enable valves to the turntable and remove the three enable valves.

Installation

1. Install the enable valves onto the turntable using the mounting hardware.
2. Connect all hoses and electrical lines as tagged during removal.
3. If coils were removed, reinstall and torque to 5 foot pounds (6.8 Nm) maximum.
4. Check the hydraulic oil level in the tank and replenish as necessary.
5. Remove the tag out from the machine.
6. Proceed to next test procedure.

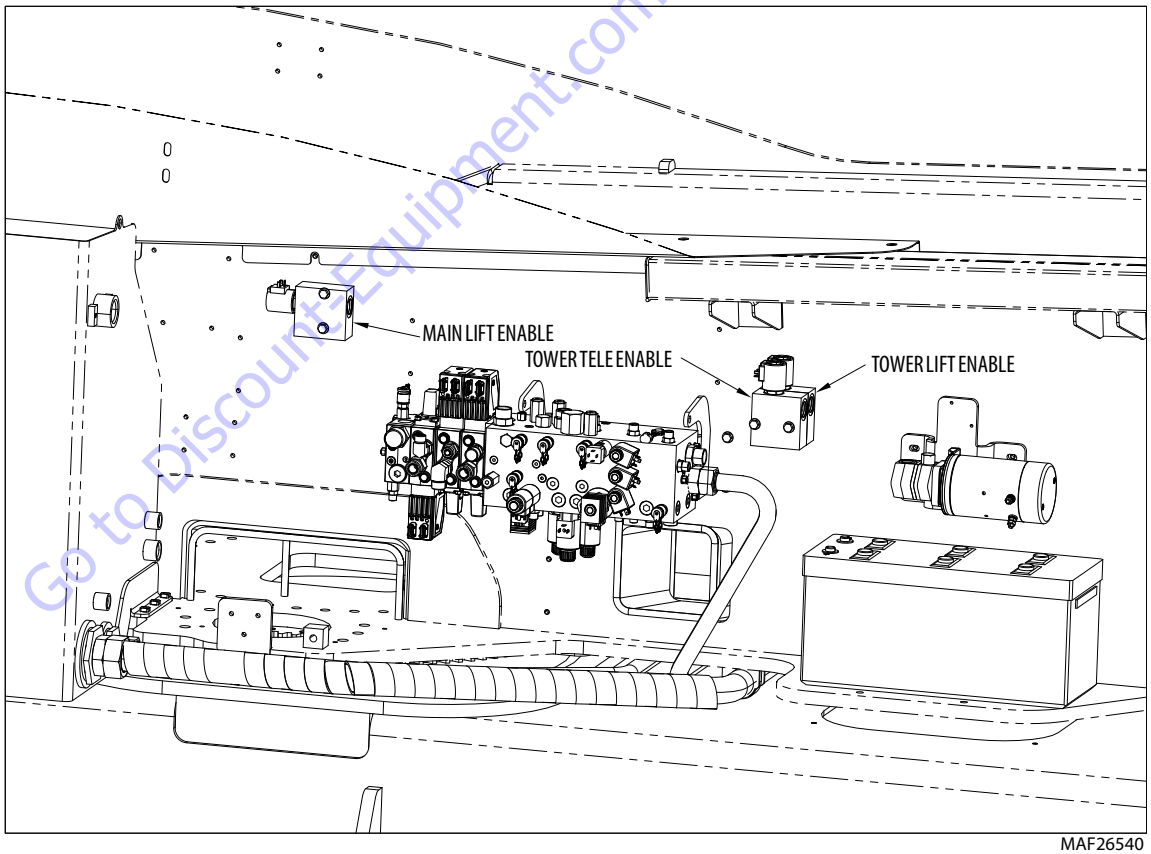


Figure 5-62. Enable Valves

Air Purge Procedure for Non-Calibrated Machines

1. Loosen the hoses on Port #2 (side) of Tower Lift and Tower Telescope enable valves. This is not necessary on Main Lift Enable Valve because the orientation of the valve allows the air to escape.
2. Operate the Main Telescope in until oil appears at Port #2 of both valves.
3. Tighten both hoses.
4. Raise the Main Boom to approximately 10° above horizontal.
5. Operate the Tower Lift for 25 of the following cycles:
   a. Raise the Tower Boom approximately 18″
   b. Pause for approximately 2 seconds.
   c. Lower the Tower Boom to the boom rest.
   d. Pause for approximately 2 seconds.
6. Operate the Tower Telescope for 25 of the following cycles:
   a. Extend the Tower Booms approximately 2′
   b. Pause for approximately 2 seconds
   c. Fully retract the Tower Booms.
   d. Pause for approximately 2 seconds.

Air Purge Procedure for Calibrated Machines

1. Loosen the hoses on Port #2 (side) of Tower Lift and Tower Telescope enable valves. It is not necessary on Main Lift Enable Valve because the orientation of the valve allows the air to escape.
2. Operate the Main Telescope in until oil appears at Port #2 of both valves.
3. Tighten both hoses.
4. Operate Tower Lift up until Tower Booms begins to Telescope.
5. If an ENABLE VALVE STUCK OPEN fault occurs;
   a. Cycle power.
   b. Use Auxiliary Power to raise the Tower Boom until the Tower Telescope starts to move.
6. Under engine power, operate the Tower Lift for 25 of the following cycles:
   a. Raise the Tower Boom approximately 18″.
   b. Pause for approximately 2 seconds.
   c. Lower the Tower Boom 18″.

NOTE: *Do not pause at this reversal. Quickly switch from Tower down to Tower up.*

7. Raise the Tower Boom 18″, then lower it and stop before the boom is on the boom rest.
8. Command Tower Boom up until boom moves.
9. Check for faults.
10. If there are faults, continue cycling as in Step #6 until there are no faults after completing Steps #7 and #8.
11. If there are no faults, position the machine in the stowed position.

5.8 PRESSURE SETTING PROCEDURE

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within ± 5% of specified pressures.

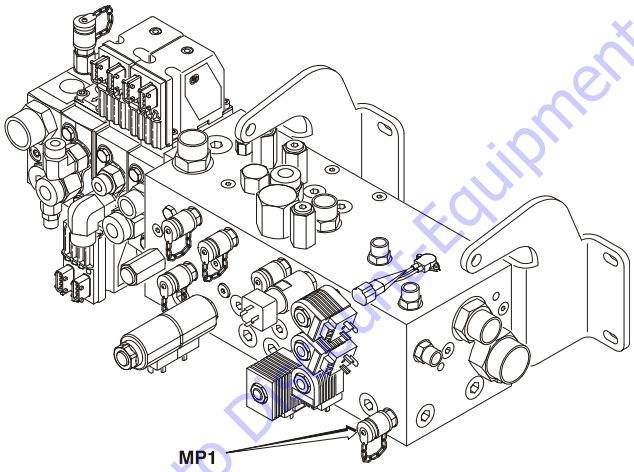
To ensure all pressures are set correctly, the following procedures must be followed in order.

1. All applicable steps in Section 5.11, Drive & Function Pump Start Up must be followed.
2. Set up of the function pump.
3. Adjustments made at the main valve bank.
4. Adjustments made at the platform valve.

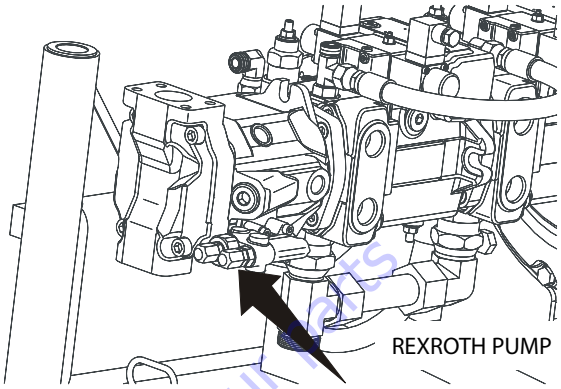
Set Up of the Function Pump

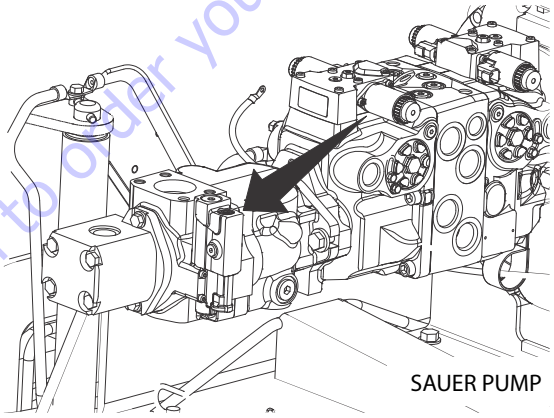
STAND BY PRESSURE OR LOW PRESSURE RELIEF - 450 PSI (31 BAR)

1. Install a low pressure gauge at port MP1 of the main valve block capable of reading 450 psi (31 bar).



2. Start the engine from the ground control. The gauge should read 425-475 psi (29.3-32.75 bar).
3. To make an adjustment to this pressure, go to the engine compartment, locate the function pump. The stand by adjustment is the outside adjustment, closest to the turntable.



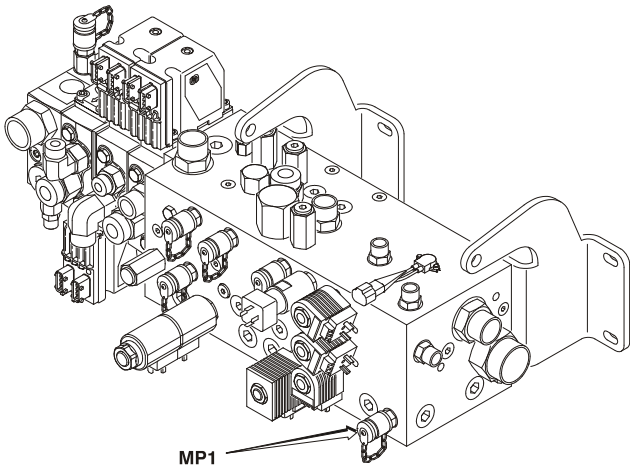


4. To make an adjustment to this pressure on a Rexroth pump, go to the engine compartment and locate the function pump which is the back pump. The high pressure relief adjustment is the adjustment closest to the pump. Using a 17 mm wrench, remove the cover nut. Be careful not to lose the o-ring washer inside the cover nut. Loosen the jam nut at the setscrew with the 17 mm wrench. Using a 3 mm allen wrench, adjust clockwise to increase, or counterclockwise to decrease pressure.

   To make an adjustment to this pressure on a Sauer pump, loosen the 4 mm setscrew towards the engine. Using a 6 mm allen wrench, turn clockwise to increase pressure and counterclockwise to decrease pressure.
5. After adjusting the pressure, tighten the jam nut and the cover nut if applicable.
6. Start the engine and verify the gauge reads 425-475 psi (29.3-32.75 bar).

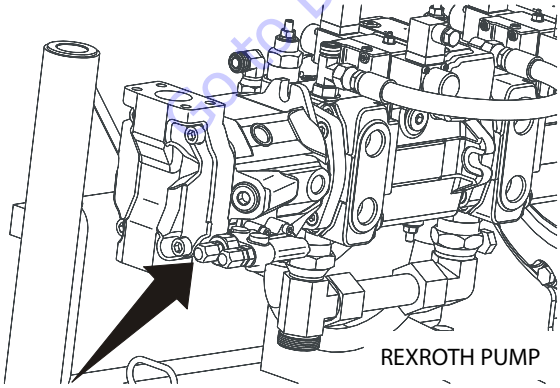
HIGH PRESSURE RELIEF - 3200 PSI (220.6 BAR)

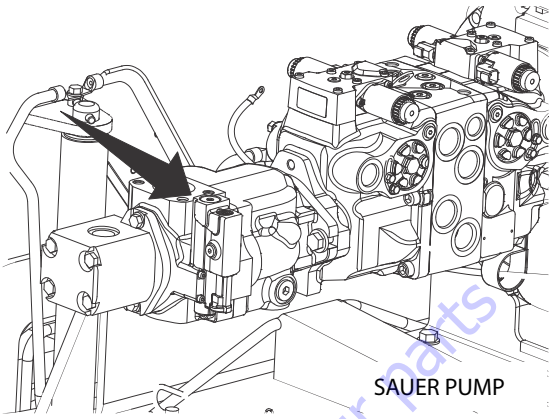
1. Install a high pressure gauge at the MP1 port of the main valve block.



2. Using a screwdriver, remove the Din connector from the telescope proportional flow coil.
3. Activate telescope in. The gauge should read 3200 psi (220.6 bar).
4. To make an adjustment to this pressure on a Rexroth pump, go to the engine compartment and locate the function pump which is the back pump. The high pressure relief adjustment is the adjustment closest to the pump. Using a 17 mm wrench, remove the cover nut. Be careful not to lose the o-ring washer inside the cover nut. Loosen the jam nut at the setscrew with the 17 mm wrench. Using a 3 mm allen wrench, adjust clockwise to increase, or counterclockwise to decrease pressure.

   To make an adjustment to this pressure on a Sauer pump, loosen the 4 mm setscrew towards the engine. Using a 6 mm allen wrench, turn clockwise to increase pressure and counterclockwise to decrease pressure.



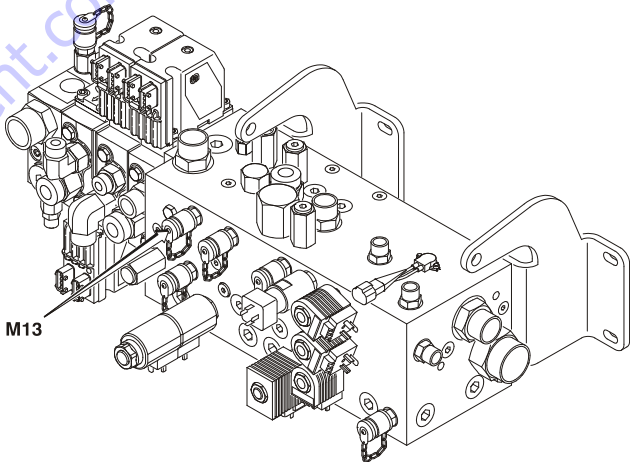


5. After adjusting the pressure, tighten the jam nut and the cover nut if applicable. This is the **maximum** relief pressure for all the functions governed by this pump.

Adjustments made at the Main Valve Bank

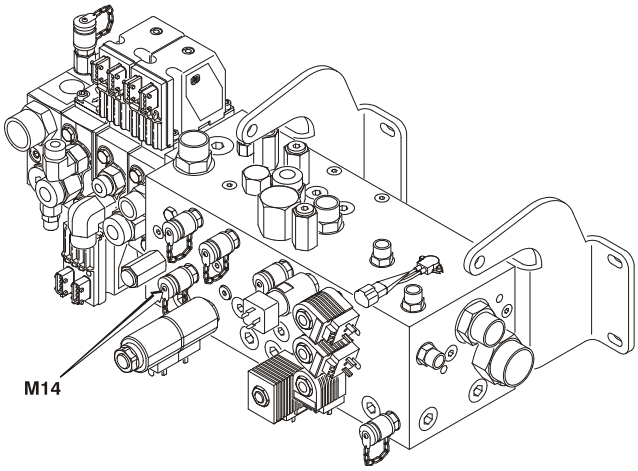
SWING 1500 PSI (103.4 BAR)

1. Install turntable lock pin.
2. Install high pressure gauge at port "M13".



3. Activate swing right.
4. Swing right relief valve is located on top surface of valve directly behind “M13”. The adjustment is below the outer plug. Turn CW to increase pressure.

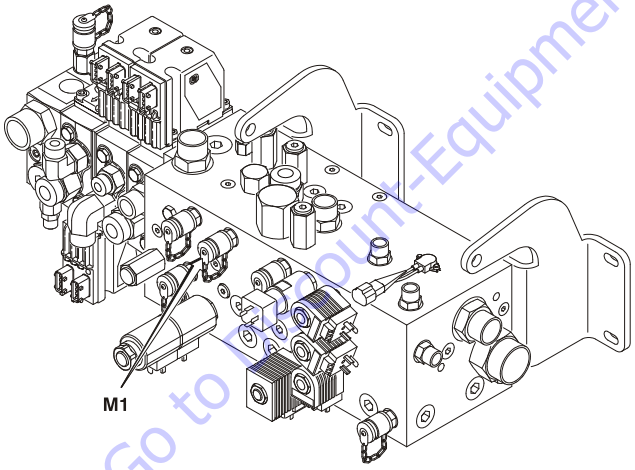
5. Install high pressure gauge at "M14".



6. Activate swing left.
7. Swing left relief is located to the left of "M14". The adjustment is below the outer cap. Turn CW to increase pressure.
8. Remove turntable lock pin.

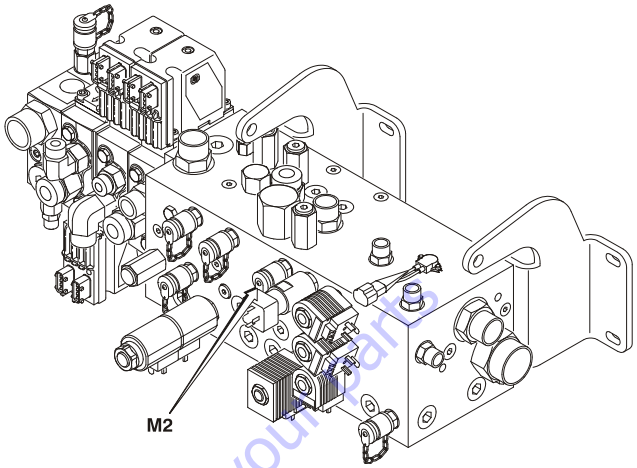
MAIN TELESCOPE 2200 PSI (151.6 BAR)

1. Cap ports 1 and 2.
2. Install high pressure gauge at "M1".



3. Activate main telescope extend.
4. Main telescope extend relief is located on the top surface of the valve directly behind "M1". The adjustment is below the outer cap. Turn CW to increase pressure.

5. Install high pressure relief at "M2".



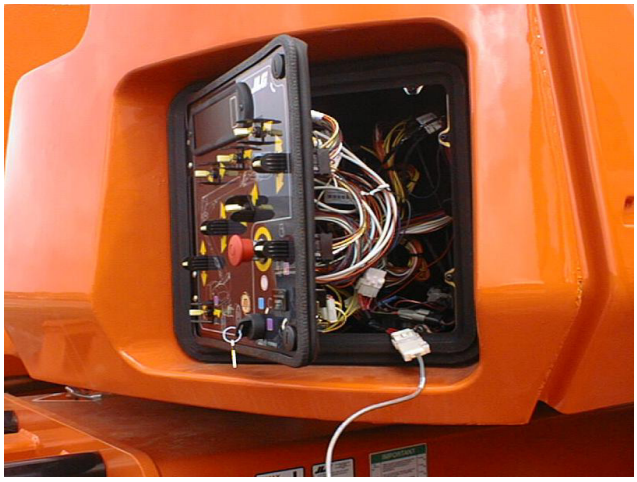
6. Activate main telescope retract.
7. Main telescope retract is on top surface of valve directly behind "M2". The adjustment is below the outer plug. Turn CW to increase pressure.
8. Reconnect hoses.

PVG VALVE (MAIN LIFT, TOWER LIFT, AND TOWER TELE)

Because of an internal shuttle network in the PVG valve, all port pressures can be measured at the "LS" quick connect on the top surface of the valve to the extreme left.

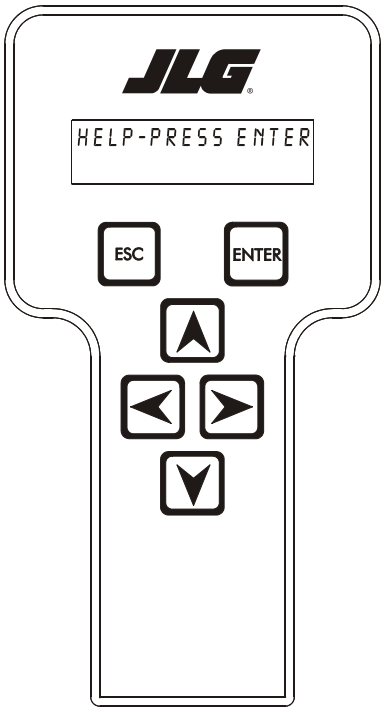
NOTE: *Pressures are not adjustable and can only be monitored. Should the setting be outside of the pressure tolerance the respective shock valve must be replaced.*

1. To check port pressure on PVG, install analyzer and go to access level 1 as follows.
   a. Plug the analyzer into the connector inside the Ground control box.



   b. Pull out the Emergency Stop switch and start the engine.

c. The analyzer screen should read:



d. Use the arrow button to reach ACCESS LEVEL 2. Press the ENTER key.

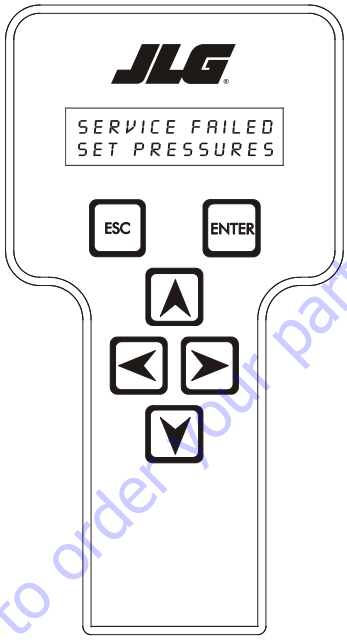
e. Enter the Access Code, 33271 to get into Access Level 1 mode.

NOTE: *The service mode will only be displayed on the analyzer when in access level 1 or 0 in the ground mode and be hidden while in access level 2.*

NOTICE

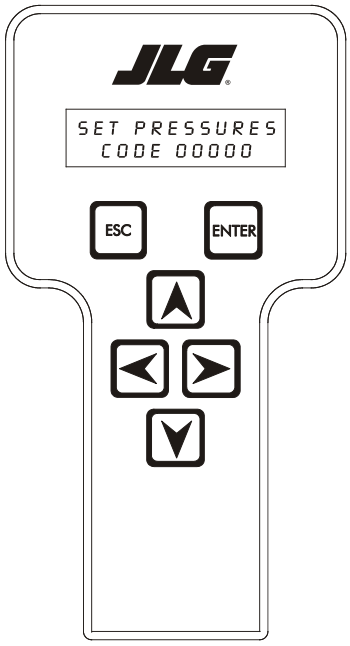
THE SERVICE MODE MENU WILL BE SELECTABLE AT THE TOP LEVEL OF THE ANALYZER MENU STRUCTURE. "SERVICE MODE" WILL BE DISPLAYED ON THE TOP LINE OF THE ANALYZER WITH THE CURRENT SUB-MENU SELECTION ON THE BOTTOM LINE. THE SUB-MENUS WILL SCROLL WITH THE LEFT AND RIGHT ARROW KEYS.

2. In this level, enter the "service mode" menu then scroll left or right to "set pressure" submenu as shown below.

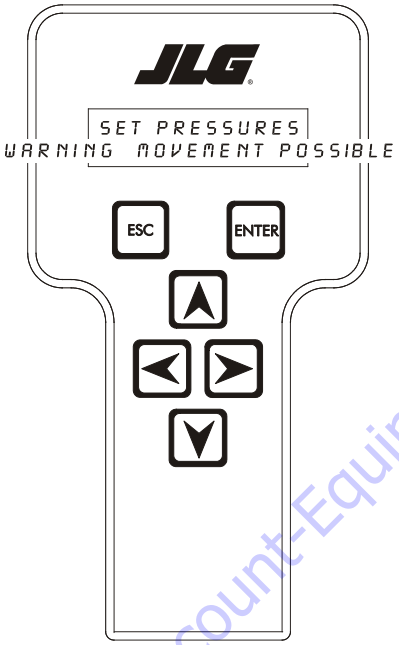


3. Set Pressures - allows function of selected submenu with enable valve closed (to set pressure settings of functions that should not/cannot not be independently operated)

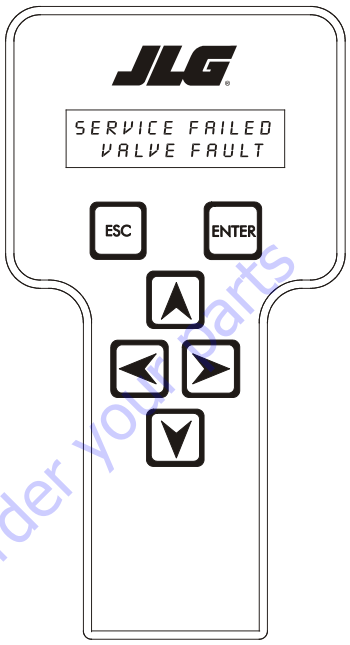
4. When the operator presses the ENTER key, the controller will display "SET PRESSURES" on the top line and "CODE 00000" on the bottom line of the analyzer.



5. When the operator enters access code 146005, "SET PRESSURES" will be displayed on the top line and current sub-menu on the bottom line. The sub-menus will scroll with the left and right arrow keys.
6. Pressure setting sub-menus will include the following:
   - "MAIN LIFT?"
   - "TWR LIFT?"
   - "TWR TELE?"
7. When the operator presses the ENTER key, "SET PRESSURES" will be displayed on the top line of the analyzer and the bottom line will display the following: "WARNING" flashed on a 0.5 hertz rate for 3 cycles followed by the scrolling of "MOVEMENT POSSIBLE". This flashing and scrolling will repeat until the ENTER key is pressed.



8. When the operator pressed the ENTER key, the controller will display "SET PRESSURE" on the top line, "MAIN LIFT" or "TWR LIFT" or "TWR TELE" on the bottom line and will allow operation of the selected submenu function with the enable valve closed. If movement of any of the three functions is detected, the controller will display "SERVICE FAILED" on the top line and "VALVE FAULT" on the bottom line as shown below.



9. Pressing the ESCAPE or the ENTER key once will revert back to the pressure setting sub-menus ("MAIN LIFT", "TWR LIFT", "TWR TELE").
10. Select the PVG function then use the toggle switches at ground control to energize function. Pressure should be:
    - Main Lift UP - 2755 to 3088 psi (190 to 213 Bar)
    - Main Lift DN - 2755 to 3088 psi (190 to 213 Bar)
    - Tower lift UP - 2755 to 3088 psi (190 to 213 Bar)
    - Tower Lift DN - 2755 to 3088 psi (190 to 213 Bar)
    - Tower Tele OUT - 2537 to 2871 psi (175 to 198 Bar)
    - Tower Tele IN - 2537 to 2871 psi (175 to 198 Bar)

Adjustments Made at the Frame Valve Bank

AXLE EXTEND AND RETRACT, FRONT AND REAR - 2500 PSI (172.3 BAR)

1. To extend axles, drive machine back and forth until extended. A machine that cannot be driven must be jacked up.
2. On both the front and rear frame valve banks, install a high pressure gauge on ports MA1 for extend and MA2 for retract. The gauge should read 2500 psi (172.3 Bar) in both directions.
3. The axle extend/retract cylinders are connected hydraulically in parallel. In order to get the correct pressure of the circuit being adjusted, unscrew the solenoid coil from the circuit not being adjusted and pull it away from the valve.
4. Turn clockwise to increase, counterclockwise to decrease.

STEERING, FRONT AND REAR

NOTE: *The following procedure requires 2 people to perform. One is needed for verifying / adjusting pressure readings and wheel spindle alignment the other for operating the steer functions and using the Analyzer from the platform.*

The Analyzer is required to perform the pressure check procedure through access of the calibration menu. The calibration menu will allow for extending and retracting the steer cylinders individually, verifying pressures, and proper steer sensor calibration. Verification of the steer sensor calibration will require one of two types of measuring methods; using a square and ruler or using string as explained in Section 6 - JLG Control System. The purpose of these measuring tools is to assure that the wheel spindle is aligned "straight" with the extended axle weldment.

1. Position machine with front and rear axles fully extended.
2. Install the Analyzer in the platform control box and scroll menu's to Access Level 2 and insert password (33271) to get into Access Level 1.

3. Scroll to the calibration mode. Once in the calibration mode, press "ENTER" and scroll to steer. Once in the steer calibration mode, the Analyzer is going to ask to calibrate the steer sensors, this is going to allow extending and retracting each steer cylinder individually during this process. The JLG control system will ask to calibrate the left front sensor, the left rear sensor, the right front sensor and finally the right rear sensor in that order. During this calibration mode each individual steer cylinder will be extended and retracted to verify correct pressures with the marked MS (Measure Steer) ports on the steer / axle valve that pertains to that steer cylinder. Refer to the Hydraulic Schematic in Section 7 - Schematics.

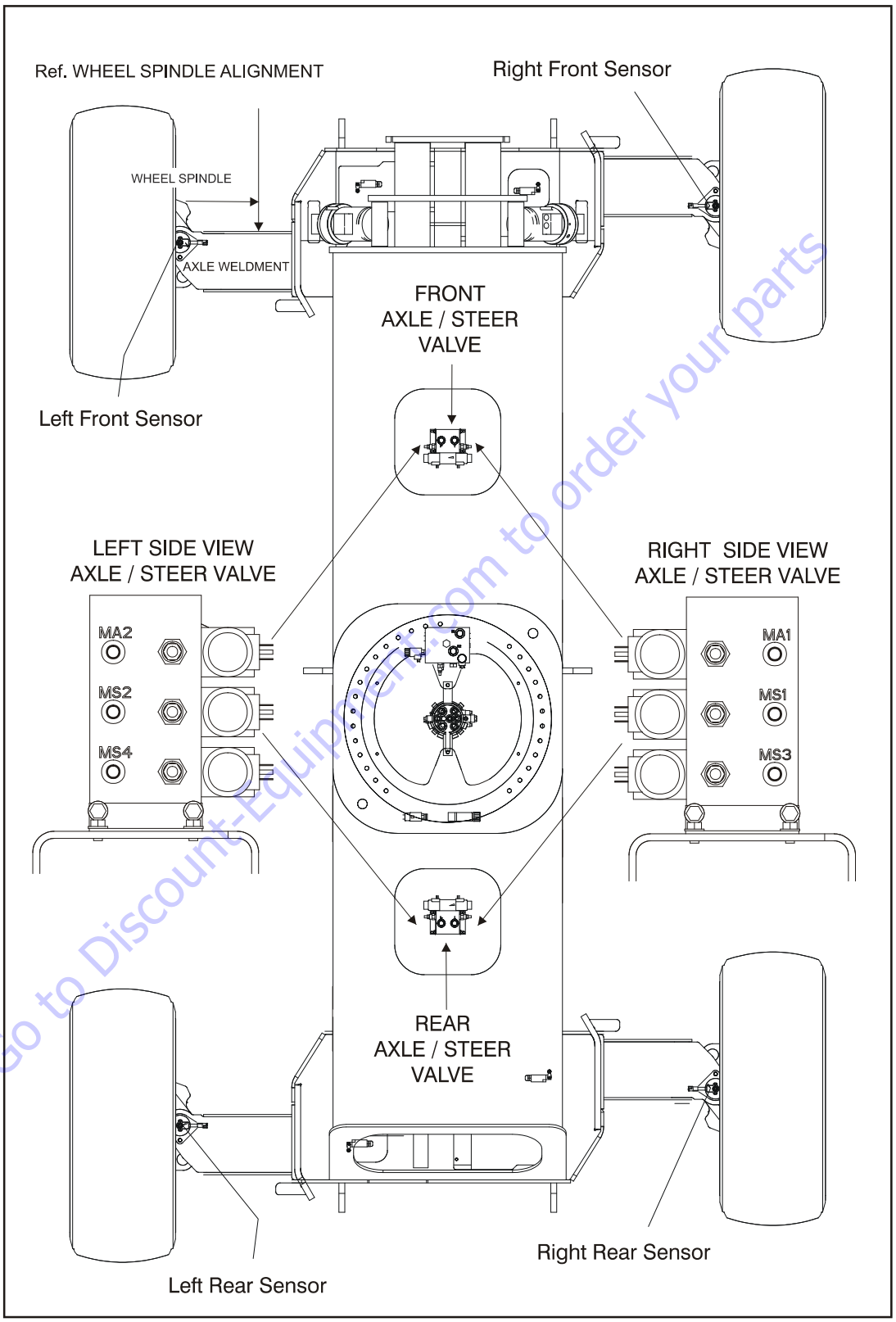
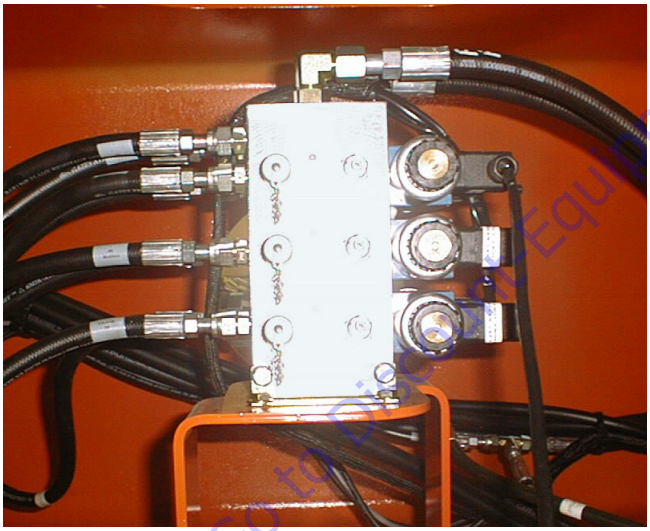


Figure 5-63. Steer Pressure Adjustments

4. Remove the circular covers at the side or square cover at the top to gain access to the axle/steer valves.

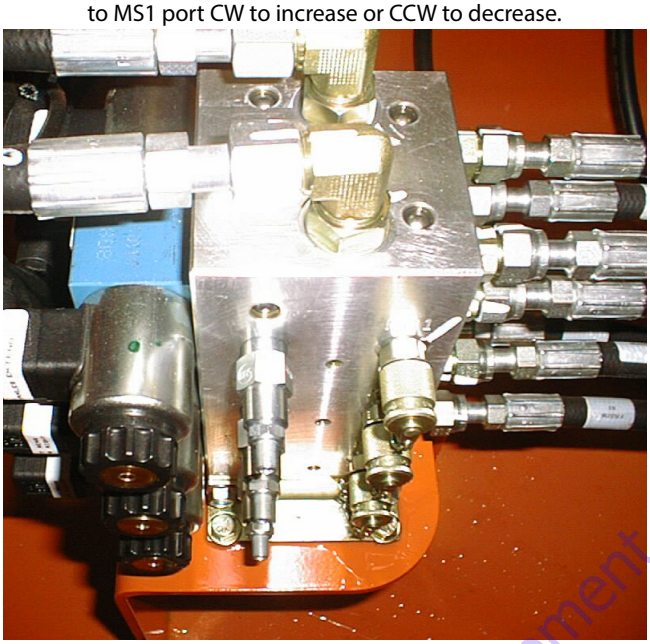
5. Install a pressure gauge at the front axle/steer valve at MS2 port. This should be located on the left side of the valve closest to the left front wheel spindle. Position the steer switch to activate the left front steer cylinder until the rod is in the fully extended position and hold the switch for a few seconds after the rod has been fully extended. The MS2 port should read 2000 psi (138 Bar). If the pressure is not 2000 psi (138 Bar) adjust relief valve mounted next to the MS2 port, CW to increase or CCW to decrease.



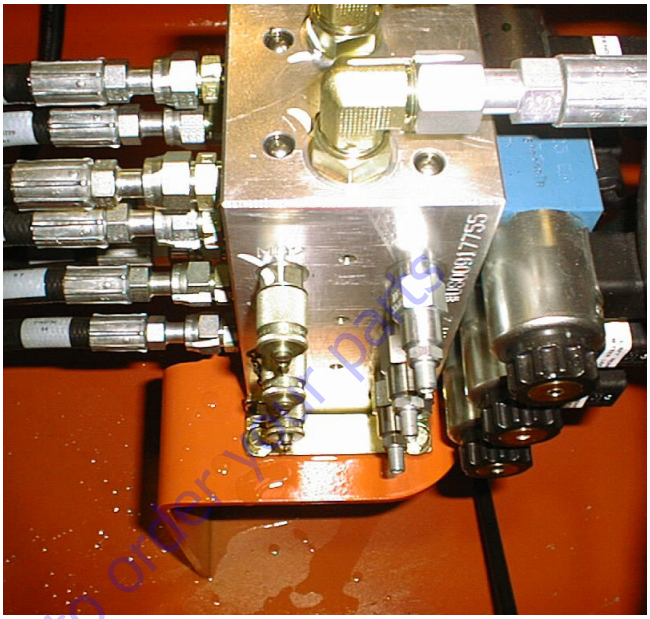
6. Remove the pressure gauge from MS2 port and install on the MS1 port, which is on the right side of the front axle/steer valve, closest to the right front wheel spindle. Position the steer switch to activate the left front steer cylinder until the rod is in the fully retracted position and hold the switch for a few seconds after the rod has stopped. The MS1 port should read 2600 psi (179 Bar). If the pressure is not correct, adjust relief valve next to MS1 port, CW to increase or CCW to decrease.

7. This step involves aligning the left front wheel spindle with the axle weldment. Position the left front wheel spindle “straight” using a square and rule or string for proper alignment (Refer to Section 6 - JLG Control System). Once the left front wheel spindle has been properly measured, press “ENTER” on the Analyzer. This is calibrating data to the JLG Control System that the left front steer sensor is centered.

8. Checking the left rear steer cylinder is identical to the procedure for left front steer cylinder, except now we are checking pressures at the rear axle/steer valve location. Install pressure gauge at MS1 port. This should be located on the left side of the valve closest to the left rear wheel spindle. MS1 port should read 2600 psi (179 Bar) when the left rear steer cylinder is activated with the rod in the fully retracted position. If the pressure is not 2600 psi (179 Bar) adjust relief valve mounted next to MS1 port CW to increase or CCW to decrease.



9. Remove the gauge from MS1 port and install on MS2 port, which is on the right side of the rear axle/steer valve, closest to the right rear wheel spindle. Position the steer switch to activate the left rear steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has been fully extended. The MS2 port should read 2000 psi (179 Bar). If the pressure is not correct, adjust the relief valve mounted next to MS2 port CW to increase or CCW to decrease.



10. The next step is identical to the left front step mentioned above. Make sure the left rear wheel spindle is straight and press “ENTER” to accept the new calibration settings, now press “ESC” (escape) and scroll to the right front steer calibration step.

11. Checking the right front steer cylinder is identical to the procedure laid out for the left front steer cylinder, except the pressures are now checked at MS3 port of the front axle/steer valve. This should be at the right side of the valve closest to the right front wheel spindle. Install the gauge at MS3 port. Position the steer switch to activate the right front steer cylinder until the rod is in the fully retracted position and hold the steer switch for a few seconds after the rod has been fully retracted. If the pressure is not 2600 psi (179 Bar), adjust the relief valve mounted next to the MS3 port CW to increase or CCW to decrease.

12. Remove the gauge from MS3 port and install on MS4 port, which is on the left side of the front axle/steer valve, closest to the left front wheel spindle. Position the steer switch to activate the right front steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has stopped extending. The MS4 port should read 2000 psi (138 Bar). If the pressure is not correct, adjust relief valve mounted next to the MS4 port CW to increase or CCW to decrease.
13. The next step is identical to the left front step mentioned above. Make sure the right front wheel spindle is straight and press "ENTER" to accept the new calibration settings. Scroll over to right rear steer calibration step.
14. Checking the right rear steer cylinder is identical to the procedure laid out for the left rear steer cylinder. Install gauge at MS4 port of the rear axle/steer valve. This should be at the right side of the valve closest to the right rear wheel spindle. Position the steer switch to activate the right rear steer cylinder until the rod is in the fully extended position and hold the steer switch for a few seconds after the rod has stopped extending. The MS4 port should read 2000 psi (138 Bar. If the pressure is not correct, adjust relief valve next to the MS4 port CCW to increase or CCW to decrease.
15. Remove gauge from MS4 port and install on MS3 port, which is on the left side of the rear axle/steer valve, closest to the left rear wheel spindle. Position the steer switch to activate the right rear steer cylinder until the rod is in the fully retracted position and hold the steer switch for a few seconds after the rod stops retracting. If the pressure is not 2600 psi (179 Bar), adjust the relief valve mounted next to the MS3 port CW to increase or CCW to decrease.
16. The next step is identical to the left front step mentioned above, make sure the right rear wheel spindle is straight and press "ENTER" to accept the new calibration settings, now escape out of the calibration menu and remove the Analyzer and pressure gauge.

Adjustments Made at the Platform Valve Bank

PLATFORM LEVEL UP - 3000 PSI (206.8 BAR)

1. Install a high pressure gauge at the gauge port M1.
2. Activate level up to the end of stroke, it should read 3000 psi (206.8 Bar).
3. All the relief valves are located on the same face. The level up relief valve is located closest to the M1 gauge port. Turn clockwise to increase, counterclockwise to decrease.

PLATFORM LEVEL DOWN - 2500 PSI (172.3 BAR)

1. Install a high pressure gauge at gauge port M2.
2. Activate level down to the end of stroke, it should read 2500 psi (172.3 Bar).
3. The level down relief valve is located to the left of the level up relief valve. Turn clockwise to increase, counterclockwise to decrease.

ARTICULATING JIB UP AND DOWN - 2750 PSI (189.6 BAR)

1. Install a high pressure gauge on gauge port M3. The jib relief valve is located below the level down relief valve. Activate jib up or down, it should read 2750 psi (189.6 Bar). Turn clockwise to increase, counterclockwise to decrease.

5.9 DRIVE PUMPS

Troubleshooting Procedure

To aid in troubleshooting, refer also to the pressure measuring port connections for test gauge installation information as shown on the hydraulic circuit diagram. Procedure assumes proper gauges are installed. (Minimum gauges required: (2) 0-6000 psi, (1) 0-3000 psi & (1) 0-1000 psi [{2} 0-415 bar, {1} 0-210 bar & {1} 0-70 bar]). This procedure was written to aid the troubleshooter in following a logical approach to a hydraulic system fault.

1. Transmission does not propel the machine, diesel engine running properly

a. Is there oil in the reservoir?
No - Fill reservoir
Yes - If yes, proceed to step 1.b

b. Is the pump input shaft connected to the engine flex plate or rear of forward pump?
No - Connect pump input shaft
Yes - If yes, proceed to step 1.c

c. Are the hydraulic hoses and tubing connected in accordance with the hydraulic circuit diagram?

No - Correct the hoses/tubing
Yes - If yes, proceed to step 1.d

d. Is the pump direction of rotation correct? (clockwise as looking at the shaft)

No - Fit pump having the correct direction of rotation
Yes - If yes, proceed to step 1.e

e. Are there "O"-rings missing from fittings (as example - suction leak), pinched hoses, broken tubing, etc?

No - Proceed to step 1.f
Yes - Repair damage or fault

f. Are the electrical connectors/wiring intact and secure to the pump control solenoids?
No - Repair damage or fault
Yes - If yes, proceed to step 1.g

g. Does the engine "labor" when attempting drive, are the brakes released?
No - Proceed to step 1.h
Yes - Check brake release circuit, measure pressure at port "MP" on Traction Control manifold

h. Are all four wheel drive planetary reduction gearboxes engaged?
No - Engage wheel drive(s)
Yes - If yes, proceed to step 2.a

2. Transmission does not propel the machine, diesel engine running properly - Charge Pump/Relief Valve

a. Is there any charge pressure at port G or indicated by measuring pressure at Ma and Mb?
No - Proceed to step 2.d
Yes - Proceed to step 2.b

b. Is the charge pressure at least 500 psi while running at high engine speed?
No - Proceed to step 2.c
Yes - Proceed to step 3.a

c. Can the charge pressure be raised by removing dirt/debris from charge relief poppet or by adding or removing shims from the charge pressure relief valve mounted in the second pump of the triple?
No - Proceed to step 2.d
Yes - Adjust pressure to 500 psi +50 psi, -0 psi (34.4 bar +3.4 bar, -0 bar)

NOTE: *The propulsion circuit uses a hot oil flushing valve to obtain brake release pressure. The hot oil flushing valve cartridge (#120) is mounted in the Traction Control Manifold. The flushing valve receives its oil from the "left side" wheel drive pump; the middle pump of the triple. With the engine running and propelling the machine forward or reverse, the "hot oil flushing valve" and the brake release pressure must be adjusted to 475 psi, +25 psi, -0 psi (32.7 bar, +1.7 bar, -0 bar), as set by adjusting pressure relief cartridge (#130). The brake release pressure must be 25 psi less than the charge pump pressure. Measure pressure at port "MP" using a 0-1000 psi (0 - 70 bar) pressure gauge.*

d. Is the transmission pumps suction hose pinched shut?
No - Proceed to step 2e
Yes - Repair damaged hose

e. Is the charge pump suction pressure/vacuum within recommended limits? (0.8 bar absolute or 6.3 inches of mercury)
No - Proceed to step 2.f
Yes - Proceed to step 2.g

f. Is the suction strainer inside the reservoir blocked, clogged, restricted?
No - Proceed to step 2.g
Yes - Repair/replace with a clean suction strainer

g. Is the reservoir air breather blocked or restricted?
No - Proceed to step 2.h
Yes - Clean or replace air breather

h. Remove charge pressure relief valve from the middle pump and inspect. Is it damaged?
No - Refit cartridge and proceed to step 2.i
Yes - Clean & inspect cartridge, poppet, springs, seals to determine cause of damage. Repair or fit a new cartridge and return to step 2.a

i. Remove and inspect charge pump assemblies. Are they damaged?
No - Proceed to step 2.j
Yes - Repair and/or replace damaged components and return to step 2.a

j. Is the charge pump installed for the clockwise rotation?
No - Refit charge pump. Return to step 2.a
Yes - With proper charge pressure and transmission still does not operate, proceed to step 3.a

3. Transmission does not propel the machine, diesel engine running properly - Pump Control: (Insure Generator Drive option is not turned "on")

a. Are the electrical connectors & wiring connected properly to the pump control solenoids?
No - Connect a ammeter in series with solenoid wiring. Is a current of 400 mA to 1060 mA being applied. (Current signal varies with joystick position)
Yes - Proceed to step 3.b

b. Are all four of the two-speed motors, mounted in the wheel drive planetary reduction gearboxes, shifted to maximum displacement (high torque - low speed)?
No - Select maximum displacement
Yes - Proceed to step 3.c

c. Actuate the pump control in both directions. Do the pumps stroke? Do they go to full stroke?
No - Refer to the pump service manual and then proceed to step 3.d
Yes - Operate the transmission

d. Remove stroking orifices in X_1 and X_2. Install pressure gauges in X_1 and X_2 (0-500 psi [0 - 35 bar]). Stroke the pump in both directions. Do the pressures at X_1 and X_2 alternate between 30 & 250 psi (2 & 17 bar)?
No - Remove the EP control module & replace it with a new unit. Repeat step 3.c
Yes - Proceed to step 3.e.

e. Is the pressure at port "R", case pressure, less than 15 psi (1 bar) gauge pressure?
No - Correct problem restricting case drain oil flow (oil cooler blockage, pinched hoses, etc)
Yes - Proceed to step 3.f

f. Stroke pump in both directions, while measuring pressure at Ma & Mb ports of the pump. Does any pressure greater than charge pressure alternate between ports Ma & Mb?
No - Verify that loading the pump will cause system pressure to increase above charge pressure. Proceed to step 3.a
Yes - Proceed to step 3.g

g. Is it possible to adjust high pressure relief valves using 0-6000 psi (0 - 415 bar) gauges to monitor pressure at Ma & Mb? (Refer to relief valve adjustment)
No - Replace high pressure relief valve and return to step 3.c
Yes - Adjust high pressure relief valves to 5000 psi +50 psi, -0 psi (344.7 bar +3.4 bar, -0 bar)

h. Actuate control in both directions. Does transmission operate?
No - Check that minimum displacement stops on the wheel drive motors are adjusted properly, check that the motors stroke between maximum to minimum.
Yes - Operate the transmission

4. Transmission Drive is Sluggish or Erratic

a. Does the "EP" proportional pump control current vary with joystick movement?
No - Rectify the problem - broken wires, electrical connector, open solenoid coil, etc.
Yes - Proceed to step 4.b

b. Are all four (4) brakes fully released?
No - Check brake release pressure and insure each wheel receives correct release pressure.
Yes - Proceed to step 4.c

c. Are the pumps stroking time orifices installed tight and clean?
No - Remove the Plugs in ports X_1 and X_2. Remove orifices with a 3mm allen wrench. Check that orifices are clean & re-install.
Yes - Proceed to step 4.d

d. Is an motor displacement stroking time orifice plugged or is the two-speed shift hose pinched?
Yes - Inspect and clean stroking orifice, check two-speed hose routing

e. Is a flow divider/combiner cartridge stuck in the Traction Control Manifold? Flow divider/combiner cartridge #111 controls the right side wheels, #112 controls the left side wheels. Also check to insure bypass orifices #151 (right side) and #152 (left side are not plugged.

5. Transmission Drives in one direction only

a. Are electrical connections to pump control proportional solenoids correct, intact and without defects?
Yes - Proceed to step 5.b
No - Rectify the problem

b. Check hot oil flushing valve cartridge #120 located in the Traction Control Manifold.
Remove and inspect flushing valve cartridge for stuck spool or damaged cartridge "O"-ring seals & backup rings.

c. Inspect "Make-Up" check valve cartridges, #190.1-190.4, installed in the Traction Control Manifold. Is a cartridge "stuck" open with debris or is an "O"-ring failed?
No - Proceed to step 5.d
Yes - Clean/repair or replace Make-Up check cartridge.

d. Swap high pressure relief valves in the transmission. Does the transmission drive in the other direction?
No - Proceed to step 5.e
Yes - Repair/clean/adjust or replace high pressure relief valve on the non-driving side

e. Replace "EP" control module. Does pump operate properly?
No - Replace or repair pump
Yes - Operate the transmission

6. Transmission Drives in Wrong Direction

a. Check to see if electrical connectors or wiring have been swapped on the pump.

b. Check to determine want end of the machine the boom is swung over.

a. Does pump remain in neutral with electrical connectors removed?
No - proceed to step 7.b
Yes - Check electrical system for signal problem

b. With electrical connectors removed and machines wheels jacked off the ground and engine running, momentarily apply 12 volt DC signal (battery voltage) to a pump control solenoid. Does the pump return to neutral after the 12 volt signal is removed?
No - Apply 12 volts to opposite solenoid & recheck.
No - Replace pump control module, repeat step 7.a
Yes - Possibly dirt was dislodged from control module, re-check thoroughly to determine problem has definitely been resolved.

c. Check mechanical centering of the pumps

8. Transmission Drives at a High Noise Level

a. Are the wheel drive planetary reduction gearboxes filled to the correct level and do they have the proper lubricant?
No - Fill gearbox with correct grade of oil to the prescribed level.
Yes - Proceed to step 8.b

b. Is the engine flex plate and drive coupling correctly installed and aligned with the transmission pump?
No - Install flex plate and bell housing per manufacturer's instructions
Yes - proceed to step 8.c

c. Is a rigid item or object contacting the resilient mounted engine/pump assembly?
No - Proceed to step 8.d
Yes - Insure no item is contacting the unit, transmitting air borne noise.

d. Is the suction pressure/vacuum at the charge pumps inlets within recommended limits?
No - Return to step 1.h
Yes - Proceed to step 8.e

e. Is there air in the hydraulic fluid? This may be indicated by foaming or milky colored oil.
No - Proceed to step 8.f
Yes - De-aerate the oil and inspect system for cause of air induction. Check for loose or missing O-rings on face seal connections.

7. Transmission Does Not Find or Hold Neutral

f. Is a wheel drive hydraulic motor operating at excessive speed?
Yes - Check minimum displacement stop screw

adjustments on the motors. Should be 0.433" or 11mm above the stop screw lock nut. Is one or more motors "stuck" at minimum displacement, check for plugged/blocked two-speed stroking orifice(s).

9. Transmission Operates at a Higher than Normal Temperature

a. Is the reservoir temperature above 195°F (90.5° C)?
No - 195°F (90.5° C) is the upper limit. If temperature is over 195°F (90.5° C), the oil cooler may need to be cleaned.
Yes - Proceed to step 9.c

b. Are the hydraulic motor(s) stalling (wheels not turning) intermittently?
No - Proceed to step 9.c
Yes - Hydraulic fluid is being heated through system pressure relief valves. Shut down system and rectify the cause of motor stall.

c. Does oil temperature remain above 195°F (90.5° C), after cleaning the oil cooler?
No - Operate transmission. Check oil cooler more often.
Yes - Proceed to step 8.a

10. Transmission Operates at a Higher than Normal Temperature

a. Check for differential temperature across the oil cooler. Is there a temperature difference?
No - Check to determine if the bypass check valve (10 psi [0.7 bar] crack pressure) is stuck open. Check to determine if the oil cooler is restricted internally, causing oil flow to pass across the bypass check valve.
Yes - Proceed to step 8.b

NOTE: *Oil cooler flow is received from the transmission pumps cases, max. continuous pump case pressure is 15 psi gauge pressure. Higher pressure will prematurely damage pump shaft seals*

b. Disconnect pump case drain from oil cooler & check flow rate from charge pumps. Is the flow rate 3.8 GPM (14.4 LPM) with diesel idle speed of 1200 rpm?
No - Refer to charge pump removal & inspection procedure

11. Transmission Pump(s) Do Not Develop Maximum Horsepower (Flow & Pressure)

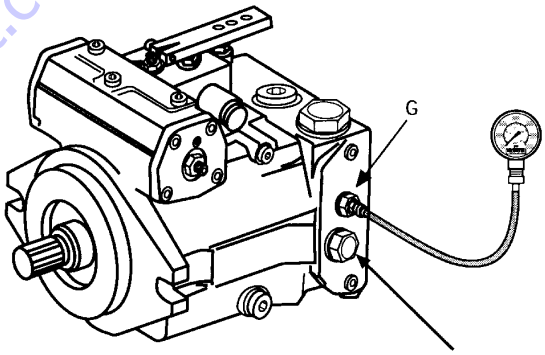
a. Does the charge pump pressure meet specification?
No - Return to step 2.a
Yes - Proceed to step 11.b

b. Does the pump case pressure exceed 15 psi gauge pressure?
No - Proceed to step 11.c
Yes - Check case drain hoses, oil cooler, etc. for pinched or restricted oil flow

c. Are the pump(s) high pressure cross port relief valves adjusted to the required pressure (5000 psi) so they do not bypass prematurely?
No - Inspect/clean/adjust and or replace valve cartridge
Yes - Replace the pump, after blocking the "A" & "B" ports, running the pump and measuring pressure developed at "A" & "B". This must be done to insure that flow & pressure loss in not elsewhere in the system. (motors, swivel coupling, etc)

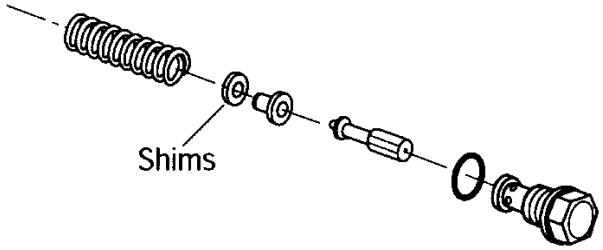
d. Is the diesel engine capable of developing horsepower at design rpm?
Follow recommended troubleshooting procedures to insure the engine is developing full power at specified rpms.

Charge Pressure Relief Valve Adjustment



With a low pressure (0 – 1000 psi [0 - 70 bar]) pressure gauge tee'd into the "G" port or two (2) low pressure gauges installed into "Ma" and "Mb", run pump at engine idle speed. Do not place the pump on stroke – low pressure gauges installed in "Ma" & "Mb" will be damaged! Prior to adjusting pressure, insure charge pressure relief valve is clean of any dirt or debris. The charge pressure relief valve does not wear appreciably over time. If charge pressure was normal and then has decayed, check for other causes of low charge pressure. If pressure is low, remove relief valve and add shim(s). If pressure is high, remove relief valve and take out shim(s).

NOTE: *Shim thickness 1 mm = 56 psi (3.86 bar). Shims are available in 0.3, 0.5, and 1.0 mm thickness.*



Mechanical Centering of Pump

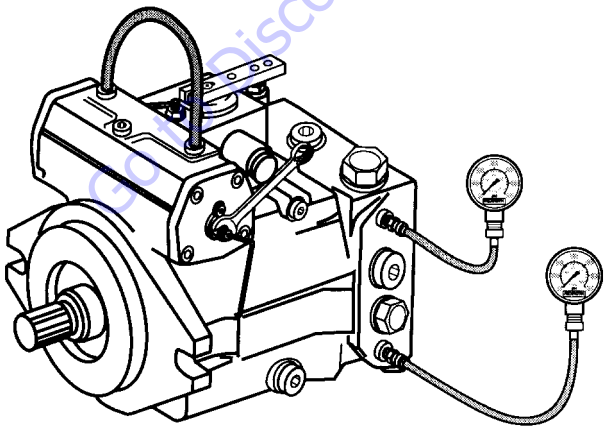
PREPARATION FOR ADJUSTMENT

The control piston has strong centering springs to ensure that once the pump is adjusted for the neutral position it will always return to neutral. If an adjustment is necessary follow the steps listed below.

To ensure there is equal pressure on both sides of the control module during the centering operation, it is necessary to connect the X_1 and X_2 ports together by means of hose or tubing. (No less than a 1/4 inch ID) The port sizes are:

Pump Size	Allen Wrench	Wrench
28	5 mm	17 mm

With pressure gages installed at M_A, and M_B, and with A and B ports blocked (or motor stalled), and with the pump running, loosen the jam nut. Turn the mechanical centering adjusting screw until 1000 psi is read on M_A, or M_B then turn screw opposite direction until 1000 psi is read on other pressure port. Turn the screw back, splitting the distance between the previous two positions. This should be the neutral position. Pressure on M_A, and M_B should be equal.

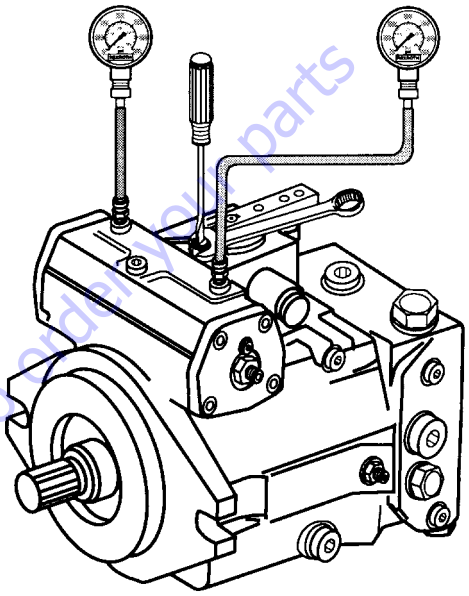


Tighten jam nut, stop the pump drive, remove the hose connecting ports X_1 and X_2.

Hydraulic Centering of Control Modules

PREPARATION FOR ADJUSTMENT

When control modules are exchanged or replaced, it is generally necessary to center the new module. This is done by running the pump with gauges installed at ports X_1, X_2, M_A, and M_B Release the jam nut and turn the adjustment screw on top of the control module valve body.



The adjustment screw is an eccentric, therefore, turning more than 90' in either direction will have no further centering effect, and could cause damage to the eccentric pin.

Pump Size	Tool Required	Wrench
28	Screwdriver	10 mm

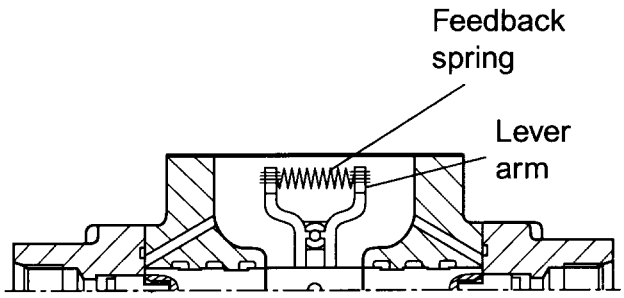
CENTERING THE EP CONTROL MODULE

With no electrical signal to solenoids A and B, (remove both plug-in connectors), the EP control module is correctly adjusted when any or all of the following conditions exist:

1. Approximately, when equal control pressures are obtained at control pressure ports X_1 and X_2.
2. The hydraulic motor does not turn when the brake is released.
3. Charge pressure is registered equally at ports M_A and M_B, when the flow output of the pump is deadheaded against a locked motor or a valve.

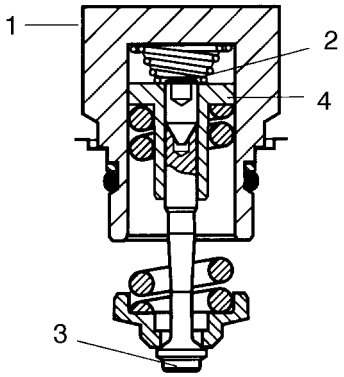
If difficulties are encountered in obtaining neutral position of the HD or EP control modules, check that the ends of the con-

trol spring are correctly located in the grooves near the end of the feedback lever arms.



High Pressure Relief Valve Adjustments

1. Remove relief valve cover from pump (ref. item 1).



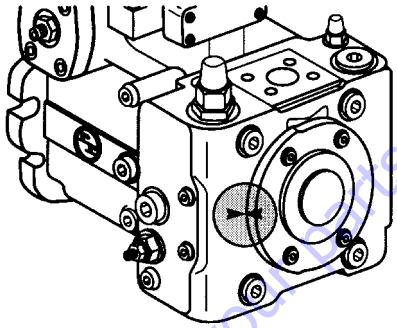
2. Loosen jam screw (ref. item 2).
3. Holding spring loading nut (ref. item 4) rotate valve spindle (ref. item 3). For high range relief valve, one turn equals approximately 630 psi (44 bar). For low range relief valve, one turn equals approximately 377 psi (26 bar).
4. After adjustment is completed torque jam screw (ref. item 4) to 5 ft.lb (7 Nm).
5. Install relief valve assembly into pump, reinstall cover (ref. item 1) to proper torque.

Table 5-35. Torque Specs for Relief Valves into Port Block

Pump Size	Wrench Size	Torque
28	32 mm	66 ft.lb (90 Nm)

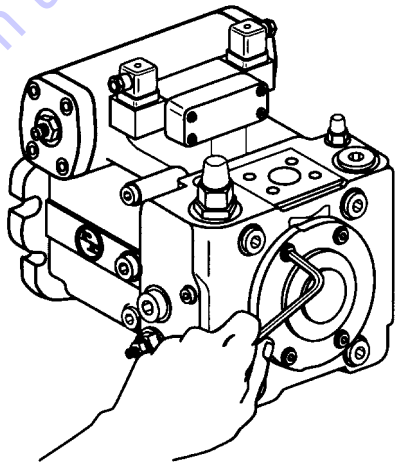
Removal and inspection of charge pump

Before removing capscrews, mark the position of the charge pump housing and separator plate in relation to the port block.



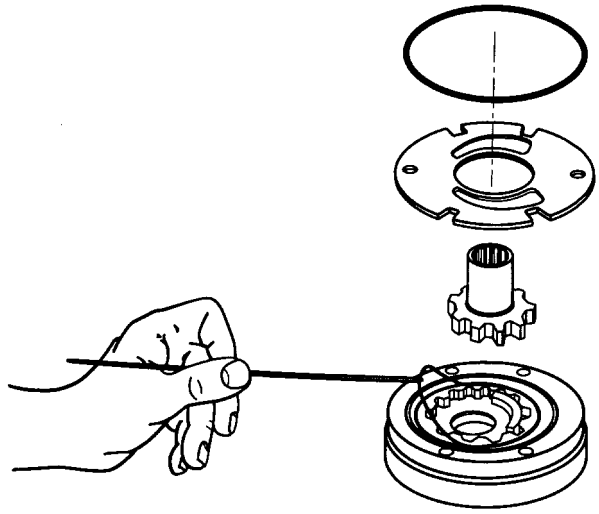
Loosen screws with metric allen wrench.

Pump Size	Allen Wrench
28	8 mm



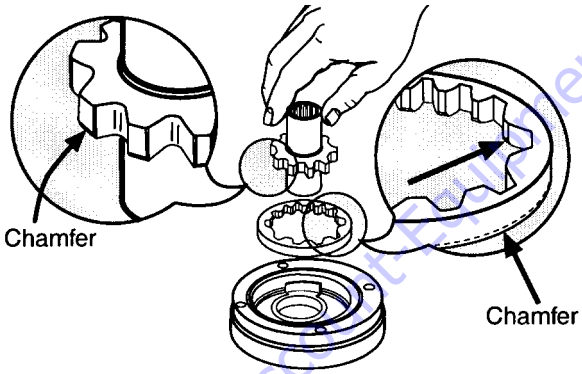
Remove charge pump housing and inspect for wear or damage to gear set and 0-ring seals. Grease 0-rings prior to reas-

sembly. Make sure 0-rings are completely seated in their grooves.



Withdraw pinion shaft and inspect gear teeth and bearing surfaces for abnormal wear.

When reassembling, make sure chamfer (on outer edge of driven gear and drive gear) is installed into housing per illustration.



Torque value for bolts when replacing charge pump.

Pump Size	Torque
28	18 ft.lb (24 Nm)

NOTE: *If serious wear or damage has occurred to one component, the complete charge pump assembly must be replaced because they are matched components.*

Routine Maintenance

The Variable Displacement Hydrostatic Transmission Pumps are relatively maintenance free. Maintenance work is confined to the system, by way of maintaining hydraulic fluid condition, the "life blood" of the machine. Oil monitoring, changes and filter renewal promote system cleanliness. This will prevent premature breakdown and repairs. Under normal application conditions, the following maintenance intervals are suggested:

1. Renewal of Filter Elements

a. After commissioning or re-build.

b. At every 500 operating hours or when filter indicator shows a dirty element.

c. With the suction strainer, the strainer should be renewed as soon as charge pump inlet pressure is less than -3.2 psi, 6.3"Hg or 0.8 bar absolute.

d. Only JLG recommended filter elements are to be used. Paper elements cannot be cleaned; use throwaway cartridges.

2. Hydraulic Fluid Change

a. After 2000 operating hours (1st oil change)

b. Thereafter, every 2000 operating hours or annually, irrespective of operating hours achieved.

c. Oil change should be performed with the system in warm running condition. Before re-filling, the reservoir interior should be inspected and cleaned to remove any sludge.

d. Rags or threaded material must not be used.

e. This machine has been designed & manufactured to operate on an Exxon-Mobil Oil Co. hydraulic fluid, Standard UTTO Fluid, Product #52233-4. Consult JLG Industries prior to introducing any other type of fluid to prevent interaction or possible contamination.

f. The recommended interval between oil changes is based on various factors and should be carried out according to the degree of aging, contamination and water content.

g. Under application conditions with a heavy occurrence of dust or severe temperature fluctuations, the intervals between fluid maintenance should be shortened accordingly.

NOTICE

PRACTICAL EXPERIENCE SHOWS THAT MOST FLUID MAINTENANCE ERRORS OCCUR DURING AN OIL CHANGE DUE TO:

- **Use of an unsuitable hydraulic fluid**
- **Use of oil contaminated due to poor storage practices**
- **Failure to clean the reservoir**
- **Inadequate cleanliness when filling the reservoir (dirty drums, containers, water, etc)**

3. Leakage Inspection

a. After commissioning

b. The complete transmission drive system (pumps, motors, hosing, filters, valves, etc) should be checked for leakage at regular intervals.

c. Leaking joints & connections must only be tightened when pressureless.

4. Cleanliness Inspection

a. The oil tank breather should be regularly cleaned of dirt and dust to prevent clogging. With each cylinder movement, gallons of oil pumped, an equal amount of air exchange occurs across the reservoir breather. A dirty or clogged breather will affect **all** machine functions!

b. The air/oil cooler surfaces and engine radiator should be cleaned at the same time.

c. If hose connections are disassembled, it is imperative that the utmost care be taken that no foreign bodies infiltrate the oil circuit. Catastrophic component failure may occur.

5. Oil Level Inspection

a. Inspect oil level in the reservoir daily.

b. If "topping off" is required, use only the same Standard UTTO Fluid, Product #52233-4.

c. Do Not Mix Fluids.

6. Hydraulic Fluid - The "Life Blood" of the Machine

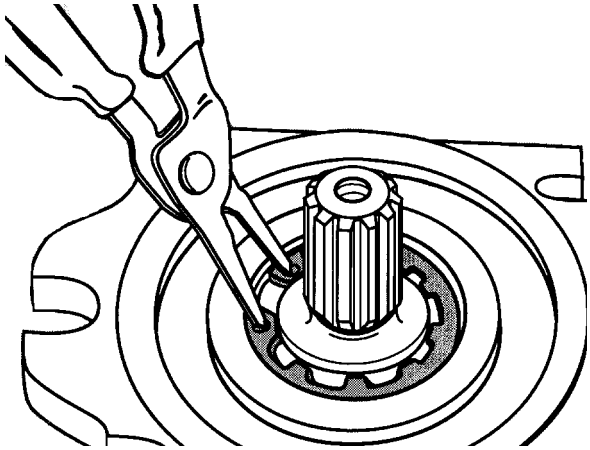
a. The type of hydraulic fluid supplied in the machine from the factory was selected after extensive testing and development. The fluid was selected to perform under "most" applications and conditions. Should this machine be in service for extended time periods at the extremes (hot or cold), JLG should be consulted for assistance in selection of the most suitable fluid type and grade for your application.

b. When operating at temperatures below 0^{o}F, allow a warm-up period, if at all possible, to a temperature of 40^{o}F.

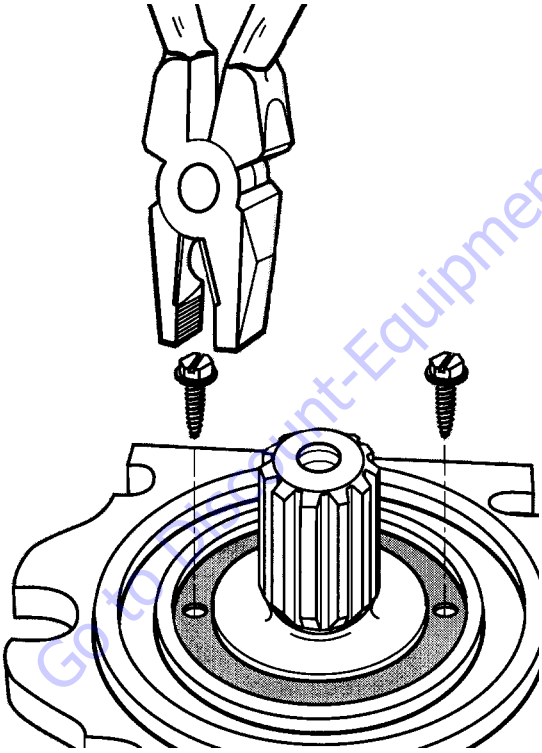
c. When beginning motion of a "cold" machine, operate all functions at reduced speeds until the "cold" oil has circulated out of the drive loop.

Removal and Installation of Shaft Seal

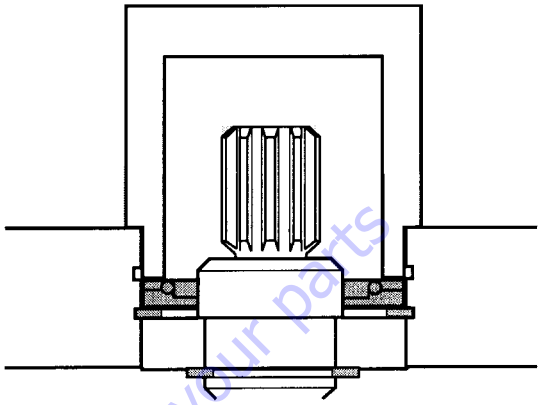
Remove the retaining ring with snap ring pliers.

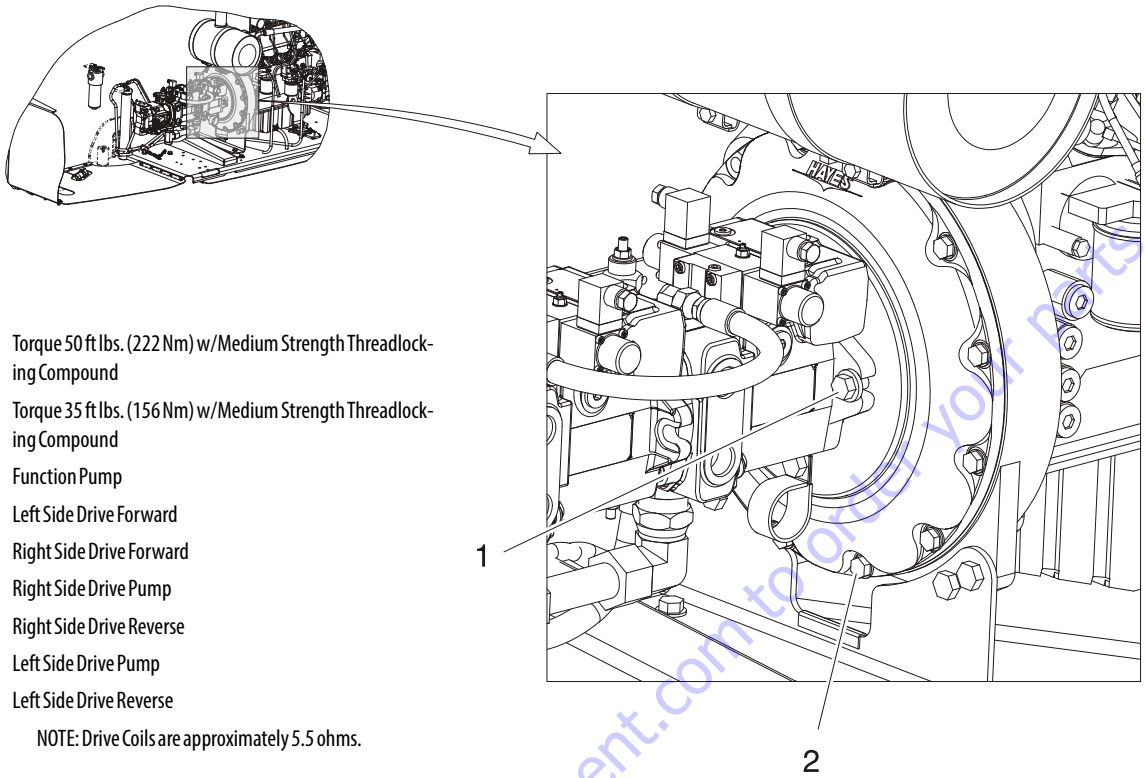


Screw in sheet metal screw into the holes fitted with rubber. Pull out shaft seal with pliers.



Press in shaft seal with bushing to the stop. Then replace snap ring.





1. Torque 50 ft lbs. (222 Nm) w/Medium Strength Threadlocking Compound
2. Torque 35 ft lbs. (156 Nm) w/Medium Strength Threadlocking Compound
3. Function Pump
4. Left Side Drive Forward
5. Right Side Drive Forward
6. Right Side Drive Pump
7. Right Side Drive Reverse
8. Left Side Drive Pump
9. Left Side Drive Reverse

NOTE: Drive Coils are approximately 5.5 ohms.

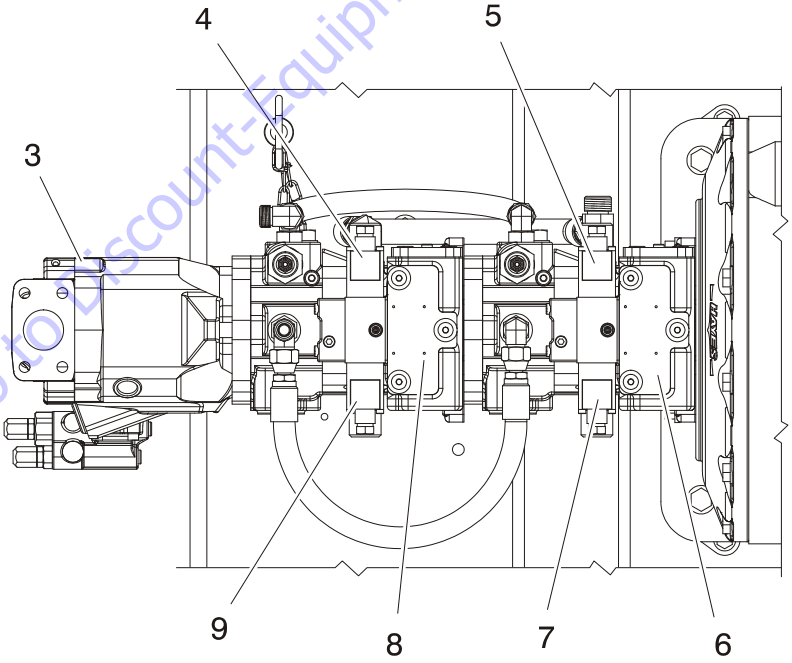


Figure 5-64. Drive & Function Pumps

5.10 FUNCTION PUMP

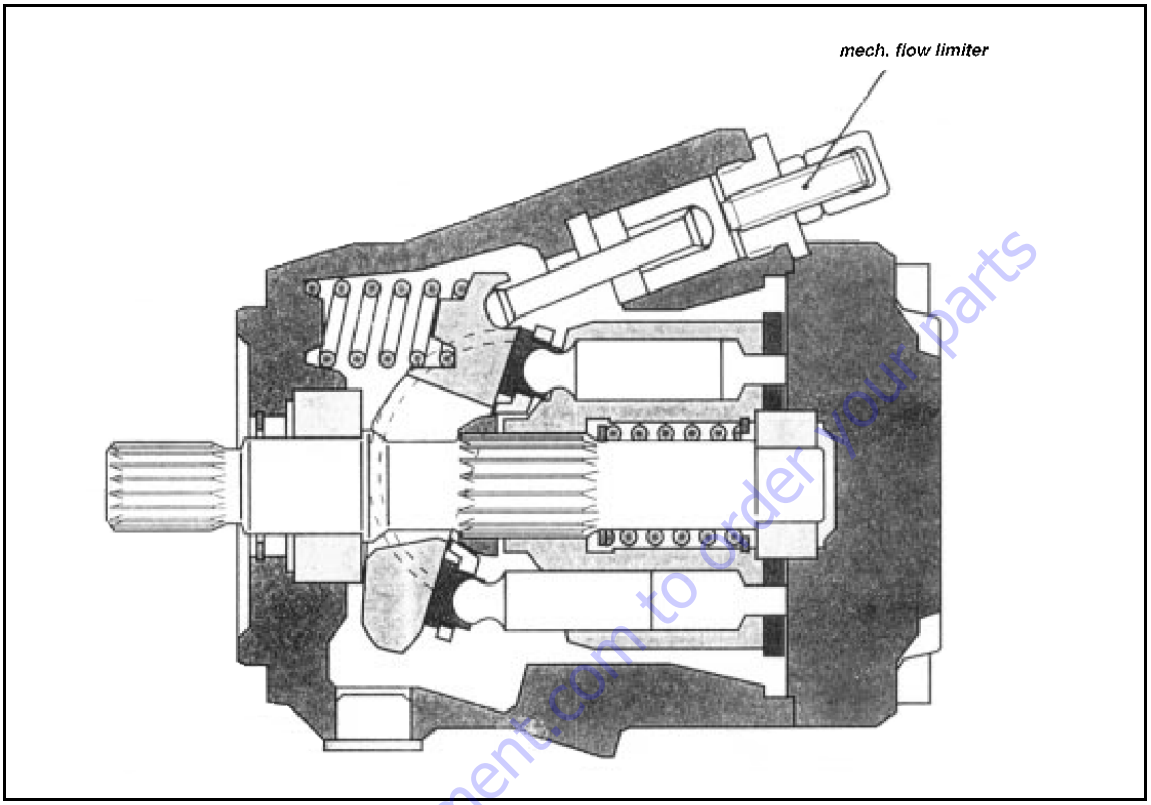
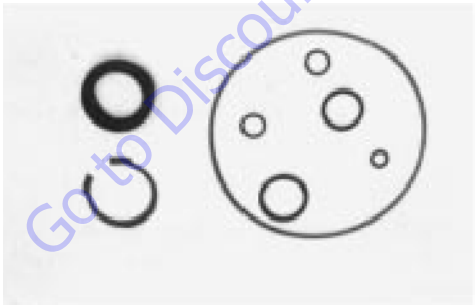


Figure 5-65. Function Pump - Sectional View

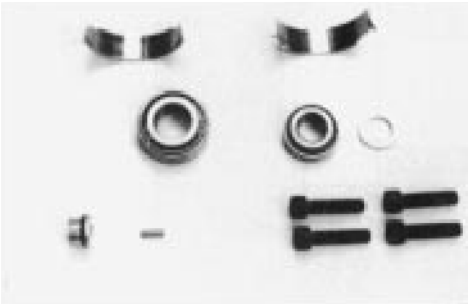
Spare Parts

1. Sealing kit, existing spare parts: shaft sealing ring, o-rings, and a circlip.

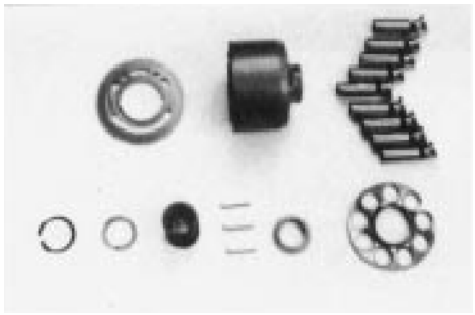


2. Drive Shaft

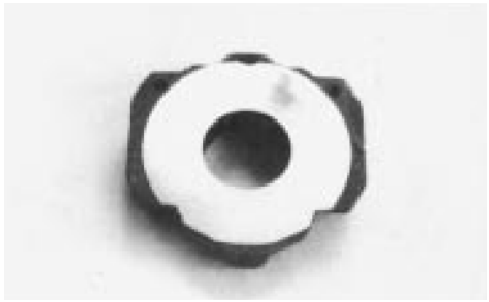
3. Bearing set, miscellaneous parts.



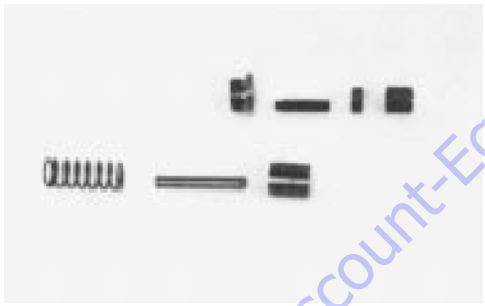
4. Rotary Group complete: 9 pistons, cylinder subassembly, valve plate, retaining plate, and retaining ball.



5. Swash Plate.



6. Parts of the control valve: control piston, piston rod, plug, spring stopper max flow, hex nut, and hex head nut.



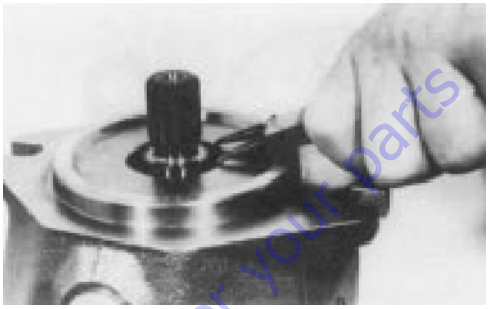
7. DFR pilot valve.

Sealing the Drive Shaft

NOTICE

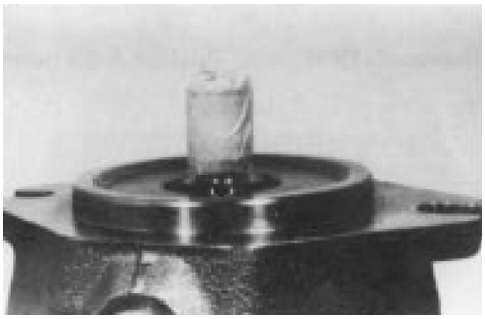
BE VERY CAREFUL SO THE DRIVE SHAFT IS NOT DAMAGED DURING THE REMOVAL OF THE SHAFT SEALING RING.

1. Remove the snap ring.



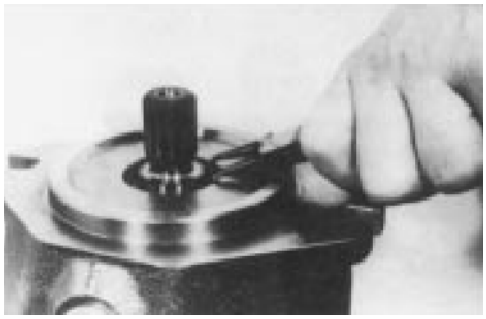
2. Change the shaft seal and check its' sliding surface (drive shaft) and housing. Grease the sealing ring.

3. Be careful while you seal the drive shaft. Use an adhesive tape to prevent the shaft splines from damaging the seal.



4. Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.

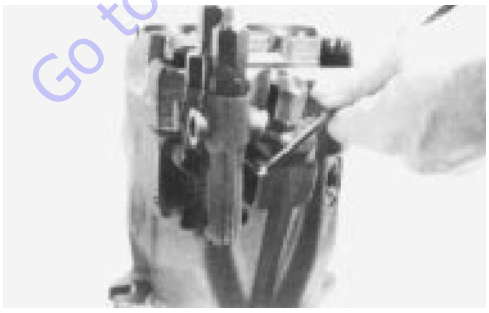
5. Assemble the snap ring.



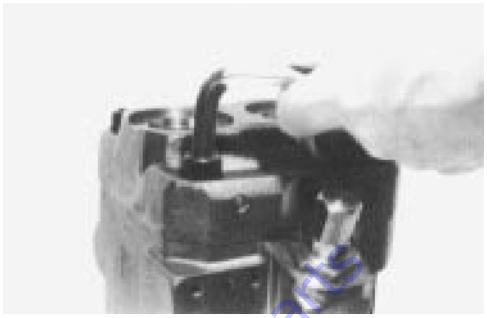
6. Assemble the snap ring in the correct position.

Disassembly and Assembly of the Complete Unit

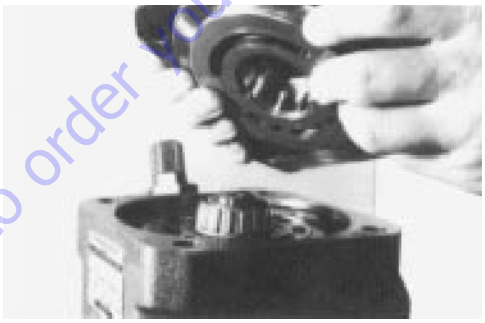
1. Disassemble the pilot valve.



2. Mark the position of the port plate and remove the socket screw of the port plate.



3. Remove the port plate together with the valve plate (hold the valve plate so the plate can't fall down).



4. Remove the o-ring.

5. Disassemble the taper roller bearing (nearby port plate).