

Figure 3-1. Lift Cylinder Bleed Port Location

## 3.2 ALIGNING THE LOAD CELL

Load cell alignment should be checked whenever a major component of the load frame is removed and reinstalled (e.g., the load cell or hydraulic actuator). There are two standard combinations of load cells and actuators. These combinations require different alignment procedures, covered separately in subsection 3.2.1, Rotatable Actuator Rod and subsection 3.2.2, Non-Rotatable Actuator Rod.

### 3.2.1 ROTATABLE ACTUATOR ROD

This procedure applies to actuators with a static force rating of 77 kip (350 kN) or less.

1. Select displacement control for the actuator. Zero any indicated error signal for the actuator control channel. Turn on low hydraulic pressure to the load frame.
2. Adjust the SET POINT control to position the linear actuator rod to the mid-point of its stroke.
3. Refer to the appropriate procedure in section II, Operation, and position the crosshead to where the load cell is at the height (excluding grips) required for the typical specimen being tested. Lock or mechanically clamp the crosshead. Turn off hydraulic pressure.
4. If the space between the load cell and the linear actuator rod top face is 18 in. (457 mm) or less, mount a dial indicator with a magnetic base on the rod face. For a space greater than 18 in. (457 mm), attach an adequately rigid bar to the side of the linear actuator rod to support the dial indicator.
5. Adjust the dial indicator spindle so that the tip contacts the unpainted cylindrical surface of the load cell. Mark this spot on the load cell. Zero the indicator.

6. Rotate the actuator rod one full turn using the spanner wrench while reading the indicator. (If the actuator rod has flats, use a suitable wrench or C-clamp on the flats to rotate it.)
7. If the total indicator reading (TIR is the difference between minimum and maximum indicator readings for 360 degree rotation of the actuator rod) is within the tolerance specified in table 3-1, no adjustment of the load cell is necessary. If the TIR is outside the tolerance, perform steps 8 through 14.

Table 3-1. Load Cell Alignment Tolerances

Load Frame Model		Tolerance (TIR)	
		in.	mm
	311.11	0.0015	0.0381
	311.21	0.002	0.0508
	311.31	0.003	0.0762
	311.41	0.004	0.1016
	311.51	0.004	0.1016
	311.61	0.004	0.1016
	311.71	0.004	0.1016

8. Loosen the cap screws, in the order shown in figure 3-2, to 60% of the torque specified in table 3-2. Loosen the cap screws to 30%, and then 10% of the torque specified. Remove cap screws one at a time. Ensure each cap screw is adequately greased. Replace each cap screw but do not tighten.

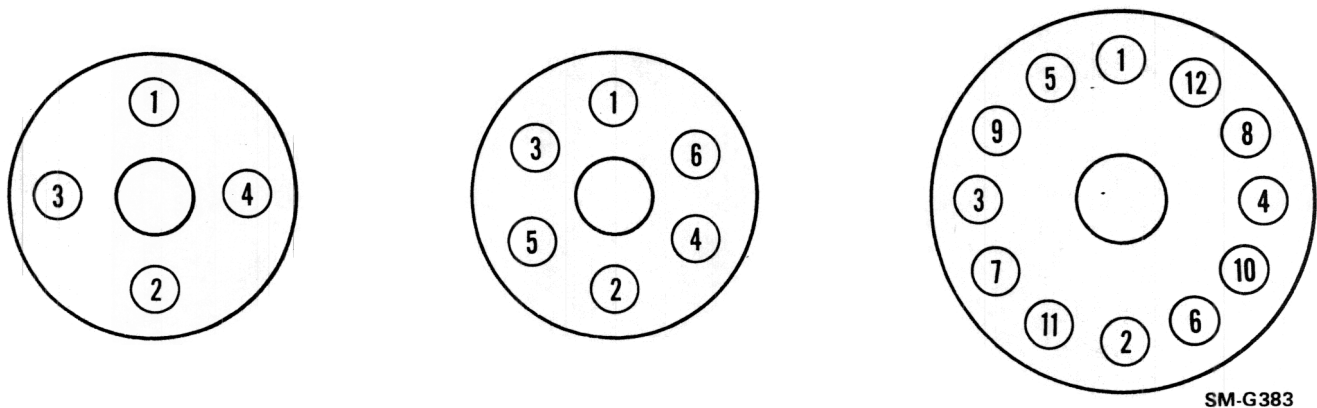


Figure 3-2. Cap Screw Tightening Order

Table 3-2. Cap Screw Torque Requirements

Load Frame Model Number <sup>1</sup>	Cap Screws		Cap Screw Torque	
	Quantity	Size	lbf-ft	N-m
311.11 <sup>2</sup>	4	5/8-11	50	68
311.11 <sup>3</sup>	4	5/8-11	70	95
311.21	4	1-8 UNC-2A	300	406
311.31	6	1-8 UNC-2A	450	610
311.41 <sup>4</sup>	6	1-1/2-6	900	1220
311.41 <sup>5</sup>	6	1-1/2-6	1300	1760
311.51	12	1-1/2-6 UNC-2A	1100	1490

<sup>1</sup> Cap screw specifications for Models 311.61 and 311.71 Load Frames are contained on the drawings and parts lists for the specific unit.

<sup>2</sup> 311.11 with 22 kip (100 kN) load cell.

<sup>3</sup> 311.11 with 55 kip (250 kN) load cell.

<sup>4</sup> 311.41 with 330 kip (1500 kN) load cell.

<sup>5</sup> 311.41 with 550 kip (2500 kN) load cell.

9. Position the load cell laterally with a rubber hammer until the specified TIR or less is achieved (see table 3-1).
10. Tighten the cap screws to 3 lbf-ft (4.1 N-m) torque in the order shown in figure 3-2.
11. Recheck the alignment of the load cell as in steps 5, 6, and 7. If the specified TIR (table 3-1) is met, continue with the procedure. If the specified TIR is not met, repeat step 9.
12. Tighten the cap screws to 10 lbf-ft (13.5 N-m) torque in the order shown in figure 3-2.
13. Repeat step 11
14. Tighten the cap screws in the order shown in figure 3-2, to 30% of the torque specified in table 3-2. Repeat step 11. Tighten the cap screws to 60% of the torque specified. Repeat step 11. Tighten the cap screws to 100% of the torque specified. Repeat step 11.

## NOTE

It may be necessary to loosen the cap screws slightly and retighten them to the specified torque several times before a minimum TIR is achieved.

After completing this procedure, install a dummy specimen and check for a separation gap between the load cell and the crosshead at maximum tensile test load. If a gap occurs, increase the torque on the cap screws in the order shown in figure 3-2 until there is no separation of the load cell from the crosshead. Repeat step 11.

### 3.2.2 NON-ROTATABLE ACTUATOR ROD

This procedure applies to actuators with a static force rating over 77 kip (350 kN).

1. Refer to the appropriate procedure in section II, Operation, and position and lock the crosshead so that the load cell is 1/16 to 1/8 in. (1.6 to 3.2 mm) above the actuator rod face.
2. Using a depth gage at three or four points, approximately equidistant around the load cell, measure the radial distance between the unpainted surface of the load cell and the cylindrical surface of the actuator rod.
3. If the maximum difference (TIR) between the depth gage measurements is within the tolerance specified in table 3-1, no adjustment of the load cell is necessary. If the TIR is outside the tolerance, perform steps 4 through 10.
4. Loosen the cap screws in the order shown in figure 3-2, to 60% of the torque specified in table 3-2. Loosen the cap screws to 30%, and then 10% of the torque specified. Remove cap screws one at a time. Ensure each cap screw is adequately greased. Replace each cap screw but do not tighten.
5. Position the load cell laterally with a rubber hammer until the specified TIR or less is achieved (see table 3-1).
6. Tighten the cap screws to 3 lbf-ft (4.1 N-m) torque in the order shown in figure 3-2.
7. Recheck the alignment of the load cell as in step 2, above. If necessary, repeat step 5.
8. Tighten the cap screws to 10 lbf-ft (13.5 N-m) torque in the same order.
9. Repeat step 7.

10. Tighten the cap screws in the order shown in figure 3-2 to 30% of the torque specified in table 3-2. Repeat step 7. Tighten the cap screws to 60% of the torque specified. Repeat step 7. Tighten the cap screws to 100% of the torque specified. Repeat step 7.

#### NOTE

It may be necessary to loosen the cap screws slightly and retighten them to the specified torque several times before a minimum TIR is achieved.

After completing this procedure, install a dummy specimen and check for a separation gap between the load cell and crosshead at maximum tensile test load. If a gap occurs, increase the torque on the cap screws in the order shown in figure 3-2 until there is no separation of the load cell from the crosshead. Repeat step 7.

#### ADJUSTING THE HYDRAULIC CROSSHEAD LOCKS

The hydraulic locks are adjusted at the factory and should require no field adjustment. However, if the hydraulic locks need adjustment, proceed as follows (refer to the assembly drawings for the location of the crosshead clamp components referenced in this procedure):

1. Remove system hydraulic pressure.
2. Install the shipping collars on diagonally opposite columns directly above and below the crosshead and torque all shipping collar bolts. Refer to section IV, table 4-1 for torque specifications.
3. Turn on console power.
4. Switch the crosshead lock control to UNLOCK.
5. Using a spanner wrench, tighten the clamping piston onto the tie rod until all slack is removed and the clamping piston bottoms into cylinder.
6. Loosen the clamping piston 1/8 turn.
7. Repeat steps 5 and 6 for remaining hydraulic locks.
8. Apply system hydraulic pressure.
9. Switch the crosshead lock control to LOCK.
10. Remove and reinstall the shipping collars for load frame operation. Refer to subsection 4.4.5, Shipping Collar Removal.

## SECTION IV INSTALLATION

This section provides installation instructions for Series 311 Load Frames. MTS Systems Corporation recommends that the procedures in the following subsections be performed in the order given or referenced to minimize the chance of damage to equipment or injury to personnel.

### \*\*\* WARNING \*\*\*

During installation an extremely hazardous situation will exist in which the crosshead can drop unexpectedly, on the columns, if either of the following warnings is ignored.

- Load frames not equipped with hydraulic crosshead lifts:

To position the crosshead, support it using a crane with a capacity equal to or greater than the crosshead weight (listed in table 1-1 or table 1-2) as well as the weight of any load cell or fixture. Remove slack from the crane cable or chain before loosening any of the manual locking bolts on the crosshead face. See full instructions in section II, Operation, before positioning the crosshead.

- Load frames equipped with hydraulic crosshead lifts:

When positioning the crosshead, do not unlock the crosshead or remove the shipping collars unless the lift cylinders have been bled (see Bleeding The Hydraulic Lift Cylinders, subsection 3.1.2). This applies after installation, after hydraulic system maintenance, or if the hydraulic lift actuators did not operate smoothly when last used. See full instructions in section II, Operation, before positioning the crosshead.

### 4.1 UNPACKING

If the load frame is shipped in the horizontal position strapped to a wooden skid, it should be unstrapped and tipped to its upright position before it is moved. Use the following procedure:

1. Carefully cut and remove the straps from around the load frame using an appropriate tool. Some load frames are also bolted to the skid. Remove these bolts if applicable.

**\* WARNING \*\*\***

Use care and ensure adequate ventilation when using any solvent. See any additional warnings and cautions on the solvent container.

2. Some load frame columns are wrapped with protective paper. Remove the paper if applicable. All load frame columns are covered with protective grease (PP2). Remove the grease using grade #1 white kerosene, mineral spirits, or equivalent petroleum-based solvent. Use care and ensure adequate ventilation when using any solvent. Refer to the solvent container for additional warnings and cautions.
3. Series 311 Load Frames are shipped with eye bolts installed in the holes in the top of the crosshead. Verify that the crosshead is properly secured as specified in subsection 4.3.

**\*\*\* WARNING \*\*\***

Ensure that the means of conveyance has a lift capacity equal to or greater than that listed on the **LIFTING AND MOVING INSTRUCTIONS** placard located on the load frame.

4. Attach lifting chain hooks (or equivalent) to all lift point eye bolts or hoist rings. Ensure chain hooks are secure.
5. Block the bottom of the load frame to prevent slipping as the load frame is raised.
6. Slowly lift load frame to vertical position.

#### **4.4 INSPECTION**

Inspect the load frame for evidence of structural damage. Inspect any electrical connectors mounted on the load frame base for damage and cleanliness. If shipped with hydraulic hoses attached, inspect the hoses for evidence of damage and leakage. Inspect the hose connection fittings for damage.

#### **4.3 LIFTING AND MOVING INSTRUCTIONS**

This subsection provides a procedure for lifting and moving the load frame.

**\*\*\* WARNING \*\*\***

Improper lifting or transportation of this device can result in damage to equipment or injury to personnel. Read and comply with the following instructions and refer to the Lifting and Moving Instructions booklet attached to the load frame.

1. Mechanically clamp the crosshead before lifting or moving the load frame. Refer to the appropriate step (A or B) below.
  - A. On crossheads without hydraulic locks, torque all manual locking bolts on the crosshead face. Refer to table 4-1 for torque specifications.
  - B. On crossheads with hydraulic locks, install shipping collars on diagonally opposite columns directly above and below the crosshead and torque all shipping collar bolts. Refer to table 4-1 for torque specifications.

Table 4-1. Manual Locking Nut and Shipping Collar Bolt Torque Specifications

Load Frame Model Number	Manual Locking Nut Torque		Shipping Collar Bolt Torque	
	lbf-ft	N-m	lbf-ft	N-m
311.11	200	272	55	75
311.21	200	272	80	110
311.31	480	651	110	150
311.41	--- <sup>1</sup>	--- <sup>1</sup>	200	270
311.51	--- <sup>1</sup>	--- <sup>1</sup>	680	920
<sup>1</sup> The 311.41 and 311.51 Load Frames are only configured with hydraulic crosshead locks. Therefore, manual locking bolt torque specifications do not apply.				

2. Ensure all devices involved in lifting and moving the load frame are in good working order. Inspect eye bolts or hoist rings, chains, overhead crane, etc, for cracks and damage. Replace as necessary.
3. Ensure all devices involved in lifting and moving the load frame can support the weight of the load frame as shown on the LIFTING AND MOVING INSTRUCTIONS placard located on the load frame. (This weight includes the load frame, load cell, actuator, servovalve(s), manifold(s), grips, etc.)
4. The load frame must be lifted at the designated lift points only. The lift points are located on top of the crosshead and noted by a LIFT POINT placard.
5. If chains will be used to lift and move the load frame, the lifting chains must not exceed a 30° angle from vertical to prevent undesired stress/strain on the eye bolts or hoist rings.
6. Do not apply shock loads when lifting or moving the load frame. Shock loads can cause momentary forces exceeding the actual load frame weight which can result in exceeding the recommended force rating of the lifting devices.



7. Before lifting or moving the load frame, ensure all lifting chain hooks (or equivalent) are securely placed in all lift point eye bolts or hoist rings.
8. Lift load frame only as high as necessary. It is recommended to lift the load frame only a few inches off the ground.
9. Move load frame to desired location and carefully lower into position.

**\*\*\* WARNING \*\*\***

Do not loosen the shipping collars or crosshead manual locking bolts at this time. An extremely hazardous situation will exist if the shipping collars or manual locking bolts are loosened before the means to support the crosshead is provided. If the shipping collars or manual locking bolts are loosened at this time, the crosshead can drop unexpectedly causing equipment damage and/or personal injury. Refer to section II, Operation, subsection 2.2, Positioning the Crosshead, before loosening the shipping collars or manual locking bolts.

## INSTALLATION

Move the load frame to the desired location using the instructions in subsection 4.3.

### LOCATION

Location requirements for the load frame are based primarily upon size, weight, and hydraulic requirements. Floor structure should be checked to ensure that the weight of the load frame can be supported. Ensure safe and adequate access space in all directions around the load frame. Ensure safe and adequate lighting. Ensure easy access for an overhead crane if that method of crosshead positioning will be used. Adequate and appropriate routing for control cables and hoses should be located, paying special attention to conditions which can cause cable or hose damage.

#### 4.4.2 LEVELING THE FRAME

If it is necessary to level the load frame, one or more pieces of shim stock can be placed under one or more of the feet. This operation should be done in conjunction with the vibration isolation pad installation (subsection 4.4.3).

#### 4.4.3 VIBRATION ISOLATION PAD INSTALLATION

Most load frames are supplied with rubber vibration isolation pads that absorb some of the vibration of the load frame, protecting the support floor. These pads must be stacked in the manner shown in figure 4-1, separated by metal dividers, and installed under the four corners of the load frame. Some high-frequency load frames are supplied with optional air bag vibration supports. The air bags should be inflated to between 60 and 100 psi (0.41 and 0.69 MPa).

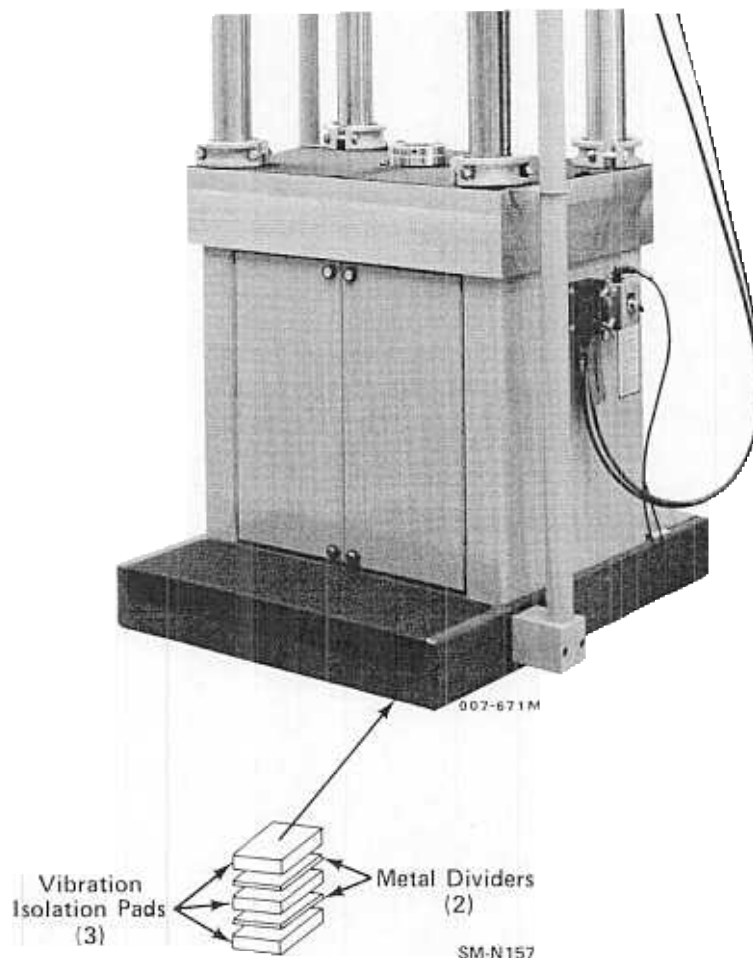


Figure 4-1. Installation of Vibration Isolation Pads

#### 4.4.4 INSTALLATION OF HYDRAULIC HOSES AND ELECTRICAL CONNECTIONS

Connect all applicable hydraulic hoses and all electrical cables. See the applicable system assembly drawing for a complete diagram.

#### 4.4.5 SHIPPING COLLAR REMOVAL

The 311 Load Frames equipped with hydraulic crosshead locks are shipped with collars (see figure 4-2) on the columns to ensure that the crosshead cannot move during shipment. The collars should not be removed unless full hydraulic pressure has been applied to the crosshead, the lift cylinders have been bled, and the crosshead lock control is in the LOCK position. Once the collars are removed, they should be kept rather than discarded. The collars can be reinstalled on the lower portion of the columns. By spacing the collars a few inches below the crosshead and torquing the shipping collar bolts per table 4-1, the collars can be used as stops to limit crosshead travel on the columns should the crosshead fall. Shock protection for the load cell and actuator, as well as some operator protection, are also realized using this method. The shipping collars are also used to mechanically restrain crosshead positioning during some maintenance procedures.

#### CAUTION

If the shipping collars are being used as stops to limit crosshead travel should the crosshead fall, they should be removed before positioning the crosshead. Then reinstalled after the crosshead has been positioned. If the DOWN valve is opened while the crosshead is manually locked, air can be pulled into the lift cylinders. Refer to subsections 2.2.2 and 2.2.3.

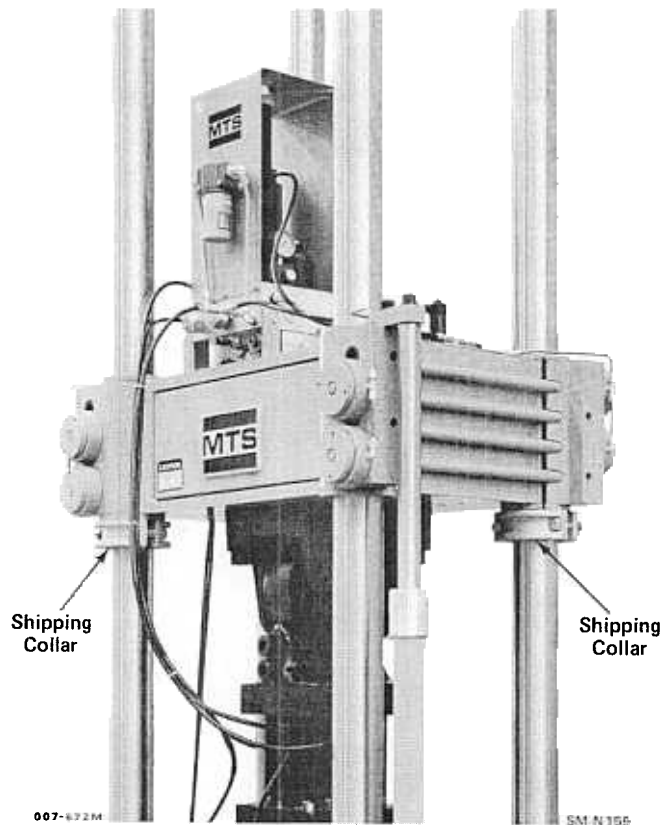
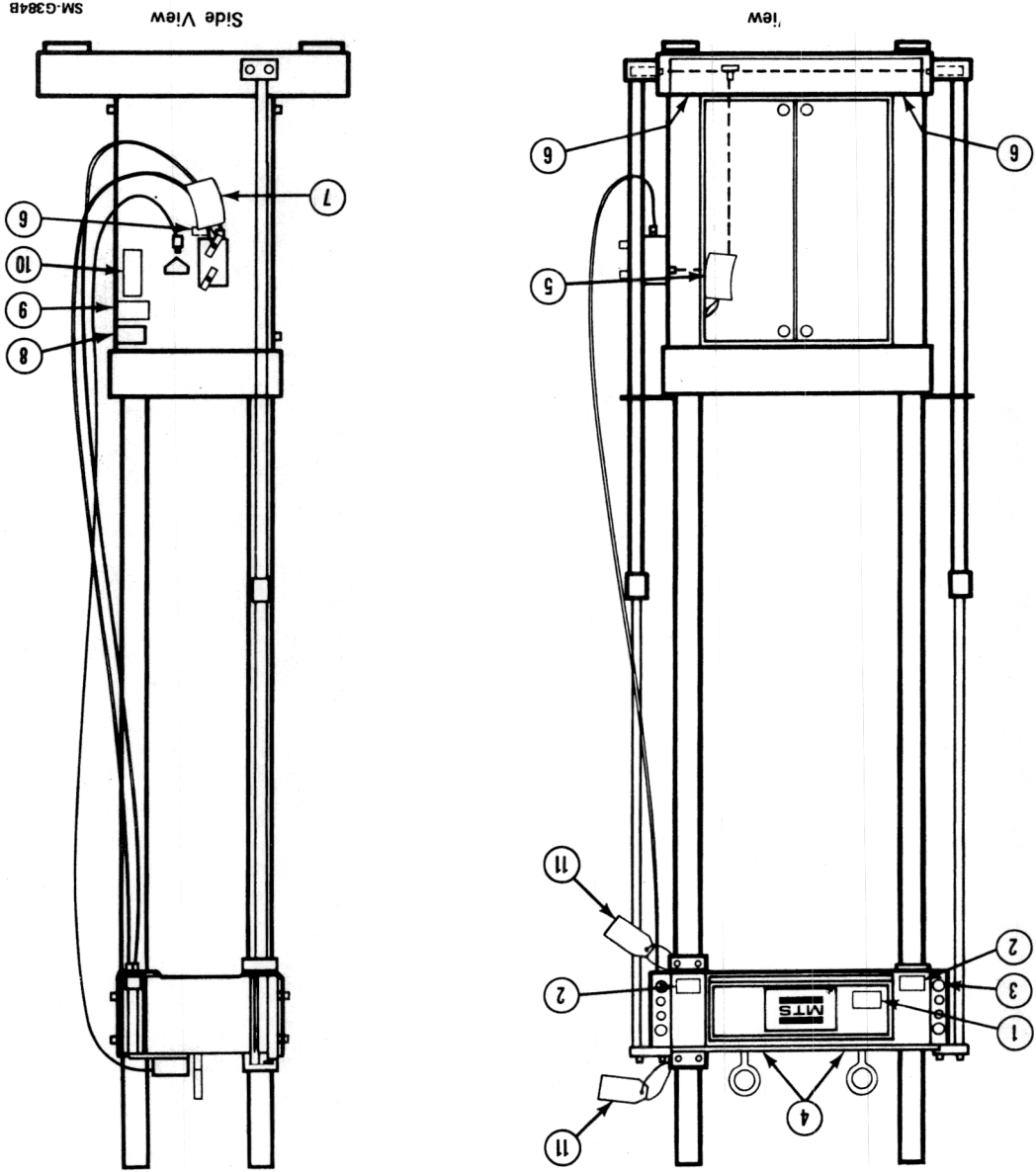


Figure 4-2. Shipping Collars on 311 Load Frame Equipped With Hydraulic Crosshead Locks

# 4. LOAD FRAME PLACARD LOCATION AND IDENTIFICATION

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Figur 4-: Pl and Location or Typ :al 311 Load Frame

SM-G384B

Item	Type	Description
1	CAUTION	<p>POTENTIALLY HAZARDOUS CONDITIONS CAN EXIST IN TESTING AREA WHEN THE SYSTEM IS IN OPERATION</p> <p>... DO NOT LIFT MACHINE BEFORE READING AND COMPLYING WITH LIFTING AND MOVING INSTRUCTIONS. ... READ ALL MANUALS ... USE ADEQUATE EYE PROTECTION ... DON'T TOUCH SPECIMEN OR EQUIPMENT ... KEEP CLEAR OF POTENTIAL CRUSH POINTS</p> <p>Crosshead drop warning:</p> <p>SUPPORT CROSSHEAD BY MEANS OF A CRANE OR SIMILAR DEVICE BEFORE LOOSENING CLAMP BOLTS.</p> <p>Manual locking bolt torque specification.</p> <p>Lift point locator.</p> <p>Lifting and moving instructions booklet.</p> <p>Crosshead drop warning (located on the inside surface of the baseplate support near manifold fittings):</p> <p>IF LIFT CYLINDER LINE IS OPENED, AIR MAY ENTER, CAUSING CROSSHEAD TO DROP WHEN UNLOCKED. BLEED BOTH CYLINDERS BEFORE UNLOCKING CROSSHEAD.</p> <p>Crosshead drop warning tag:</p> <p>BLEED LIFT CYLINDERS BEFORE UNLOCKING CROSSHEAD FOR FIRST TIME OR AFTER MAINTENANCE</p> <p>AIR MAY ENTER CROSSHEAD LIFT CYLINDER DURING SHIPMENT OR WHEN A HYDRAULIC LINE IS OPENED OR DURING PROLONGED SHUTDOWN. IN SUCH CASES, BEFORE UNLOCKING CROSSHEAD BUT AFTER LINES HAVE BEEN FLUSHED:</p>
2	WARNING	
3	Information	
4	Information	
5	Information	
6	WARNING	
7	WARNING	

Table 4-2. Description of Load Frame Placards

Table 4-2. Description of Load Frame Placards (Continued)

Item	Type	Description
8	Information	<p><b>WARNING</b></p> <p>AIR TRAPPED IN LIFT CYLINDER MAY RESULT IN CROSSHEAD DROP.</p> <p>Load frame identification plate. (Model number, serial number, assembly number, revision, and force rating information on this plate are required when contacting MTS Systems Service Department.)</p> <p><b>*** WARNING ***</b></p> <p>POTENTIALLY HAZARDOUS CONDITIONS CAN EXIST IN AND AROUND THIS MACHINE. READ INSTRUCTION MANUALS BEFORE INSTALLING, OPERATING, OR PERFORMING MAINTENANCE.</p> <p>Load frame inspection label.</p>
9	Information	<p>1. ENSURE CROSSHEAD IS MECHANICALLY OR HYDRAULICALLY LOCKED.</p> <p>2. TURN THE SYSTEM ON AND APPLY LOW HYDRAULIC PRESSURE.</p> <p>3. CLOSE THE 'DOWN' VALVE ON THE CROSSHEAD LIFT CONTROL MANIFOLD (TURN CLOCKWISE).</p> <p>4. OPEN THE 'UP' VALVE SLIGHTLY (1/4 TURN COUNTER CLOCKWISE).</p> <p>5. SLOWLY OPEN THE BLEED PORT SCREW USING A HEX KEY WRENCH UNTIL OIL STARTS TO FLOW.</p> <p>6. ALLOW OIL TO FLOW OUT BLEED PORT UNTIL AIR BUBBLES ARE NO LONGER PRESENT.</p> <p>7. TIGHTEN THE BLEED PORT SCREW AND CLOSE THE 'UP' VALVE.</p> <p>8. REPEAT STEPS 4 THROUGH 7 FOR OTHER LIFT CYLINDER.</p>

Item	Type	Description
10	CAUTION	<p>Lifting and Moving Instructions:</p> <ol style="list-style-type: none"> <li>1. LIFT MACHINE ONLY AT DESIGNATED POINTS LOCATED ON TOP OF CROSS-HEAD.</li> <li>2. INSPECT EYE BOLTS OR HOIST RINGS FOR CRACKS OR DAMAGE BEFORE LIFTING. REPLACE AS NECESSARY.</li> <li>3. CROSSHEAD MUST BE MECHANICALLY CLAMPED BEFORE LIFTING MACHINE.</li> <li>A. FOUR COLUMN: INSTALL SHIPPING COLLARS ON COLUMNS DIRECTLY ABOVE AND BELOW CROSSHEAD. TORQUE:</li> <li>B. TWO COLUMN: TORQUE ALL CROSS-HEAD MANUAL LOCKING BOLTS. _____ lbf-ft. _____ N-m</li> <li>4. LIFTING DEVICE MUST BE ABLE TO LIFT MACHINE WEIGHT: _____ lbf-ft. _____ N-m</li> <li>5. LIFTING CHAINS MUST NOT EXCEED 30° ANGLE FROM VERTICAL.</li> <li>6. DO NOT APPLY SHOCK LOADS WHEN LIFTING OR MOVING. MACHINE SHOULD ONLY BE LIFTED AS HIGH AS NECESSARY.</li> <li>7. WHEN MACHINE IS IN POSITION, DO NOT LOOSEN THE SHIPPING COLLARS OR MANUAL LOCKING BOLTS UNTIL A MEANS OF SUPPORT TO THE CROSS-HEAD IS PROVIDED. REFER TO THE LOAD FRAME PRODUCT MANUAL.</li> </ol>

Table 4-2. Description of Load Frame Placards (Continued)

Table 4-2. Description of Load Frame Placards (Continued)

Item	Type	Description
11	WARNING	<p>1. For Lifting and Moving.</p> <p>THE LOAD FRAME CAN DROP OUT OF THE CROSSHEAD AND CAUSE SERIOUS INJURY</p> <p>Do not loosen or remove these collars. Check collar bolt tightness torque by the specifications found in the lifting and moving instruction packet shipped with the unit before attempting to lift the load frame.</p> <p>2. For system startup.</p> <p>THE CROSSHEAD CAN DROP AND CAUSE SERIOUS INJURY</p> <p>Do not loosen or remove these collars until the crosshead has been hydraulically locked and the lift cylinders bled. Refer to the 311 product manual for instructions.</p>