

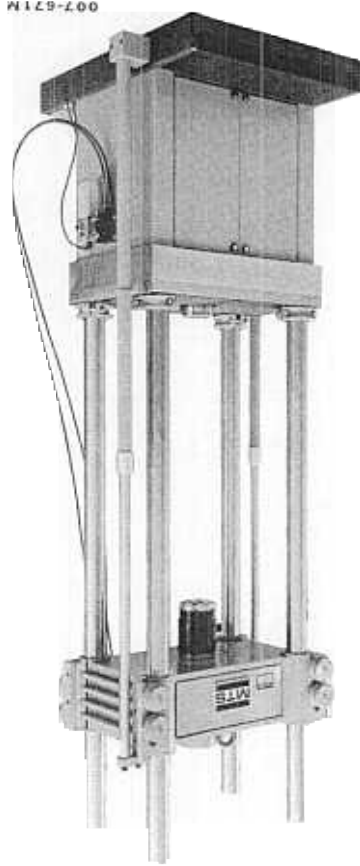
0685

1 11837-05-777

© MTS Systems Corp., 1985



**MTS SYSTEMS CORPORATION**  
BOX 24012, MINNEAPOLIS, MINNESOTA 55424  
TELEPHONE 612-937-4000 TELEEX 29-0521 MTSYSNPE  
FAX 612-937-4515



# SERIES 311 LOAD FRAMES

# TABLE OF CONTENTS

## I. INTRODUCTION

- 1.1 Functional Description 1-2
- 1.2 Specifications 1-2

## II. OPERATION

- 2.1 Specimen Mounting Considerations 2-1
- 2.2 Positioning the Crosshead 2-1
  - 2.2.1 Positioning the Crosshead on Load Frames Equipped With Manual Crosshead Locks and No Hydraulic Lifts 2-2
  - 2.2.2 Positioning the Crosshead on Load Frames Equipped With Manual Locks and With Hydraulic Lifts 2-3
  - 2.2.3 Positioning the Crosshead on Load Frames Equipped With Both Hydraulic Lifts and Locks 2-5

## SERVICE

- 3.1 Maintenance 3-1
  - 3.1.1 Cleaning the Load Frame Columns 3-2
    - 3.1.1.1 Cleaning New Load Frame Columns 3-2
    - 3.1.1.2 Cleaning Operational Load Frame Columns 3-2
  - 3.1.2 Bleeding the Hydraulic Lift Cylinders 3-2
- 3.2 Aligning the Load Cell 3-4
  - 3.2.1 Rotatable Actuator Rod 3-4
  - 3.2.2 Non-Rotatable Actuator Rod 3-7
- 3.3 Adjusting the Hydraulic Crosshead Locks 3-8

## INSTALLATION

- 4.1 Unpacking 4-1
- 4.2 Inspection 4-2
- 4.3 Lifting and Moving Instructions 4-2
- 4.4 Installation 4-4
  - 4.4.1 Location 4-4
  - 4.4.2 Leveling the Frame 4-4
  - 4.4.3 Vibration Isolation Pad Installation 4-5
  - 4.4.4 Installation of Hydraulic Hoses and Electrical Connections 4-5
  - 4.4.5 Shipping Collar Removal 4-6
- 4.5 Load Frame Placard Location and Identification 4-7

## TABLE OF CONTENTS (Continued)

### LIST OF FIGURES

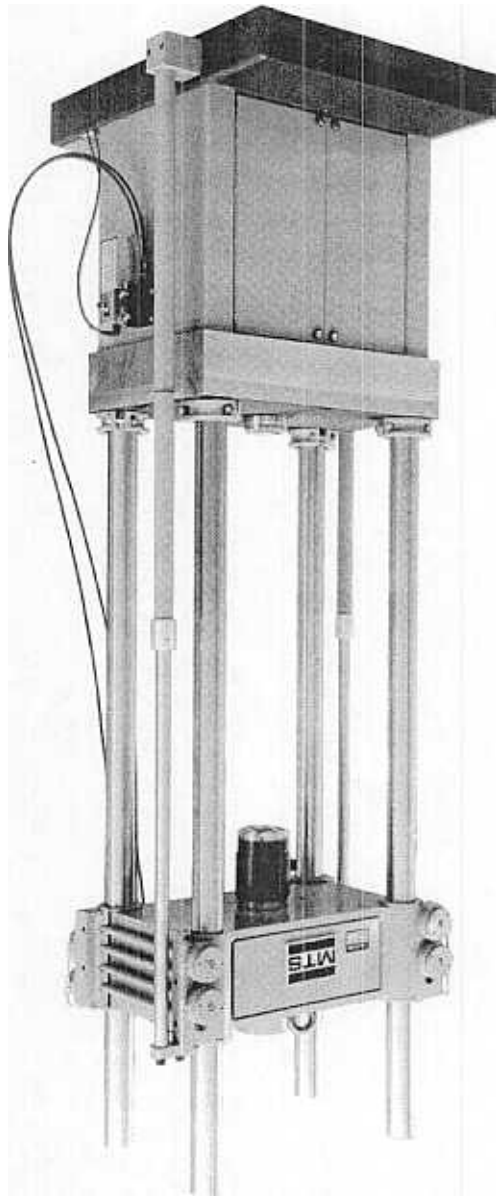
1-1	Typical Series 311.31 Load Frame (Shown with Optional 244 Actuator and 661 Load Cell) 1-1
1-2	Series 311 Load Frame Dimensional Drawing 1-2
2-1	Crosshead Manual Locking Nuts Tightening Order (Maximum Configuration) 2-3
2-2	Controls For Positioning and Locking the Crosshead 2-4
3-1	Lift Cylinder Bleed Port Location 3-4
3-2	Cap Screw Tightening Order 3-5
4-1	Installation of Vibration Isolation Pads 4-5
4-2	Shipping Collars on 311 Load Frame Equipped With Hydraulic Crosshead Locks 4-6
4-3	Placard Location for Typical 311 Load Frame 4-7

### LIST OF TABLES

1-1	Series 311 Load Frames - Dimensions and Weights (U.S. Customary) 1-3
1-2	Series 311 Load Frames - Dimensions and Weights (SI Metric) 1-4
3-1	Load Cell Alignment Tolerances 3-5
3-2	Cap Screw Torque Requirements 3-6
4-1	Manual Locking Nut and Shipping Collar Bolt Torque Specifications 4-3
4-2	Description of Load Frame Placards 4-8

# SECTION I INTRODUCTION

The MTS Series 311 Load Frames (see figure 1-1) are designed to react the forces applied to specimens during high-velocity compression or tension testing and high-frequency fatigue testing. Compatible actuators, load cells, and grips are available from MTS Systems Corporation.



007-671M

Figure 1-1. Typical Series 311.31 Load Frame  
(Shown with Optional 244 Actuator and 661 Load Cell)

## FUNCTIONAL DESCRIPTION

The Series 311 Load Frames consist of four vertical columns that join a movable crosshead and a fixed platen (see figure 1-2). The crosshead is vertically adjustable to accommodate specimens of various lengths. It may be raised or lowered by hydraulic crosshead lifts (optional), or by an overhead hoist. The crosshead, once in position, locks into place to prevent slippage or backlash. It may be locked or unlocked by hydraulically operated crosshead locks (optional), or by manually tightening or loosening the crosshead manual locking nuts.

### 1.2 SPECIFICATIONS

The load frame is free-standing and the weight of the frame is distributed adequately to prevent overloading of most laboratory floors. Isolation pads are provided with the load frame. If more isolation is required, optional air bag vibration isolators are available.

Individual load frames may vary depending on additional options -- special column height, actuator mounted on the crosshead, pit mounting, structural table, etc.

Table 1-1 and table 1-2 lists dimensions and weights of the standard Series 311 Load Frames illustrated in figure 1-2.

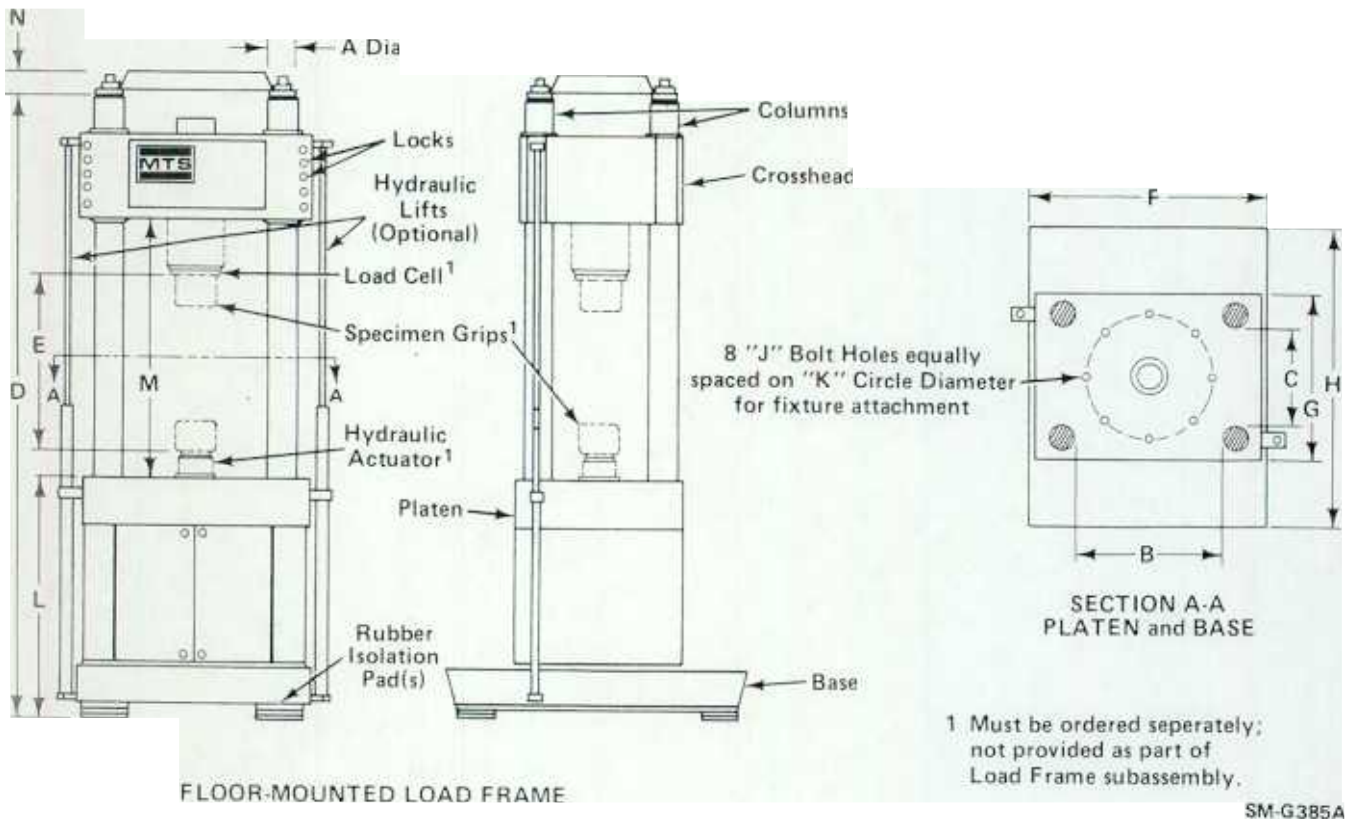


Figure 1-2. Series 311 Load Frame Dimensional Drawing

Table 1-1. Series 311 Load Frames - Dimensions and Weights (U.S. Customary)

Dimensions <sup>1</sup> and Weights	Model 311.11	Model 311.21	Model 311.31	Model 311.41	Model 311.51	Model 311.61	Model 311.71
Force Rating (kip)	55	110	220	550	1100	1650	2200
Column Diameter A	2.5	3	4	6	8	10	12
Column Spacing B	20	24	28	30	36	40	40
Column Spacing C	10	12	16	20	24	30	30
Load Frame Height D (standard)	99	121	151	176	195	___ <sup>2</sup>	___ <sup>2</sup>
Load Frame Height D (maximum)	142	148	190	244	288	___ <sup>2</sup>	___ <sup>2</sup>
Specimen and Grips Spacing E <sup>3</sup>	46	63	81	82	82	___ <sup>2</sup>	___ <sup>2</sup>
Base Length F	28	31.5	38.5	46	60	68	72
Platen Depth G	16.5	20.5	26.5	35.5	43.5	52	56
Base Depth H	28	37	48	60	68	76	80
Bolt Holes J	5/8-11	3/4-10	1-8	1-1/2/6	1-1/2-6	1-1/2-6	1-1/2-6
Circle Diameter K	12.00	14.00	20.00	26.00	32.00	36.00	36.00
Platen Height L	33	37	45	56	49	___ <sup>2</sup>	___ <sup>2</sup>
Maximum Clearance M (standard)	58	74	93	96	___ <sup>2</sup>	___ <sup>2</sup>	___ <sup>2</sup>
Column Frame Height N	1.75	1.75	2.38	3.50	___ <sup>2</sup>	___ <sup>2</sup>	___ <sup>2</sup>
Approximate Crosshead Weight (lb)	400	700	1500	3700	7000	12,000	16,000
Approximate Total Weight <sup>4</sup> (lb)	1900	4500	8000	19,000	36,000	60,000	80,000

<sup>1</sup> Refer to figure 1-2 for dimensional view. All dimensions in this table are in inches except where otherwise noted.

<sup>2</sup> Consult MTS Systems Corporation for information concerning this configuration.

<sup>3</sup> Specimen and grip spacing values are based on the use of a standard fatigue load cell and a 6 in. stroke actuator with piston fully retracted. The dimension must be adjusted to reflect specific actuator and load cell dimensions.

<sup>4</sup> Weight includes typical actuator, load cell, and grips.

Table 1-2. Series 311 Load Frames - Dimensions and Weights (SI Metric)

Dimensions <sup>1</sup> and Weights	Model 311.11	Model 311.21	Model 311.31	Model 311.41	Model 311.51	Model 311.61	Model 311.71
Force Rating (kN)	250	500	1000	2500	5000	7500	10,000
Column Diameter A	63.5	76.2	101.6	152.4	203.2	254.0	304.8
Column Spacing B	508	609	711	762	914	1016	1016
Column Spacing C	254	304	406	508	609	762	762
Load Frame Height D (standard)	2515	3073	3835	4470	4953	___ <sup>2</sup>	___ <sup>2</sup>
Load Frame Height D (maximum)	3606	3759	4826	6200	7300	___ <sup>2</sup>	___ <sup>2</sup>
Specimen and Grips Spacing E <sup>3</sup>	1168	1600	2057	2083	2083	___ <sup>2</sup>	___ <sup>2</sup>
Base Length F	711	800	978	1170	1530	1730	1830
Platen Depth G	419	520	673	900	1100	1320	2030
Base Depth H	710	940	1220	1520	1730	1930	2030
Bolt Holes J <sup>4</sup>	5/8-11	3/4-10	1-8	1-1/2/6	1-1/2-6	1-1/2-6	1-1/2-6
Circle Diameter K	304.8	355.6	508.0	660.4	812.8	914.4	914.4
Platen Height L	838	940	1143	1420	1244	___ <sup>2</sup>	___ <sup>2</sup>
Maximum Clearance M (standard)	1473	1880	2362	2438	___ <sup>2</sup>	___ <sup>2</sup>	___ <sup>2</sup>
Column Frame Height N	45	45	61	89	___ <sup>2</sup>	___ <sup>2</sup>	___ <sup>2</sup>
Approximate Crosshead Weight (kg)	185	320	680	1680	3175	5450	7300
Approximate Total Weight <sup>5</sup> (kg)	900	2000	3500	8500	16,000	27,000	36,000

<sup>1</sup> Refer to figure 1-2 for dimensional view. All dimensions in this table are in mm except where otherwise noted.

<sup>2</sup> Consult MTS Systems Corporation for information concerning this configuration.

<sup>3</sup> Specimen and grip spacing values are based on the use of a standard fatigue load cell and a 6 in. (152.4 mm) stroke actuator with piston fully retracted. The dimension must be adjusted to reflect specific actuator and load cell dimensions.

<sup>4</sup> Metric threads are optional. Thread values listed are U.S. Customary values.

<sup>5</sup> Weight includes typical actuator, load cell, and grips.

## SECTION II OPERATION

Operation instructions for the Series 311 Load Frame cover specimen mounting considerations and positioning of the crosshead. Procedures in this section assume the operator is familiar with all operating aspects of the system electrical controller and interlock restrictions that apply to starting the hydraulic power supply.

### 2.1 SPECIMEN MOUNTING CONSIDERATIONS

Specimen mounting is the most critical and potentially hazardous step in system operation. Careful specimen mounting can minimize potentially hazardous operating conditions, damage to the equipment, and invalid test data. Observe the following precautions when mounting the specimen.

#### CAUTION

Improper operation of the load frame during specimen mounting or test procedures can cause damage to equipment or specimens. Observe the following precautions when mounting a specimen.

1. Whenever possible, turn off the load frame hydraulic power when working near the load frame.
2. Exercise caution in programming to reduce the possibility of specimen buckling both during the test and at specimen failure. Buckling causes damaging side loads to be applied to the load cell.
3. If the specimen will be tested in both tension and compression, reduce backlash to a minimum. This will reduce the possibility of data being invalidated by fixture or specimen shifting.

### 2.2 POSITIONING THE CROSSHEAD

#### CAUTION

The load frame columns must be free of any lubricant (such as oil or grease) to ensure proper operation of the load frame crosshead locks. The crosshead locks are designed to operate with dry and clean column and crosshead bore surfaces. If the columns are oily or greasy, the crosshead can slip during the test resulting in damage to the load cell, fixtures, specimen, etc. Refer to section III for load frame column cleaning information.



There are several configuration possibilities:

- Load frames equipped with manual crosshead locks and no hydraulic lifts,
- Load frames equipped with manual crosshead locks and with hydraulic lifts, and
- Load frames equipped with both hydraulic crosshead locks and lifts.

### 2.2.1 POSITIONING THE CROSSHEAD ON LOAD FRAMES EQUIPPED WITH MANUAL CROSSHEAD LOCKS AND NO HYDRAULIC LIFTS

The height of the crosshead can be changed to accommodate specimens of different lengths. To change the position of the crosshead, proceed as follows:

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

If this warning is ignored, an extremely hazardous situation will exist in which the crosshead can drop unexpectedly on the columns.

To move the crosshead on load frames not equipped with hydraulic lifts, support the crosshead using an overhead 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 the slack from the crane cable or chain before loosening any of the manual locking bolts on the crosshead face.

1. Remove any specimen in the load frame.
2. Support the crosshead by means of a crane or similar device. Refer to above warning.
3. Loosen all manual locking nuts on the crosshead by quarter-turns counterclockwise in the order shown in figure 2-1, to 30% of the specified torque (listed on the plate attached to the crosshead) or less. Then loosen all manual locking nuts the rest of the way.
4. Position the crosshead to the desired height.
5. Ensure that the manual locking nuts are adequately greased. Periodically remove and lubricate the manual locking nuts, one at a time, with a thin coat of grease.
6. Tighten all manual locking nuts in the order shown in figure 2-1 to 15 lbf-ft (20 N-m), then to 90%, and finally to 100% of the torque specified on the plate attached to the crosshead.
7. As the manual locking nuts are successively tightened, those previously tightened will lose clamping force. Repeat the tightening order until all bolts are at the specified torque.

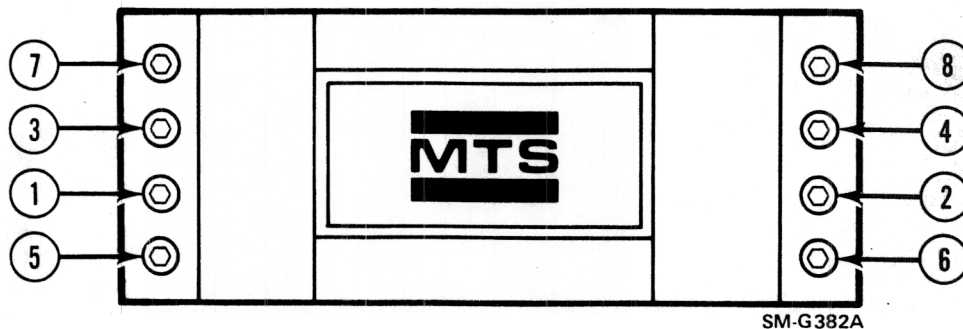


Figure 2-1. Crosshead Manual Locking Nuts Tightening Order (Maximum Configuration)

### 2.2.2 POSITIONING THE CROSSHEAD ON LOAD FRAMES EQUIPPED WITH MANUAL LOCKS AND WITH HYDRAULIC LIFTS

The height of the crosshead can be changed to accommodate specimens of different lengths. To change the crosshead position, proceed as follows:

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

If this warning is ignored, an extremely hazardous situation will exist in which the crosshead can drop unexpectedly on the columns.

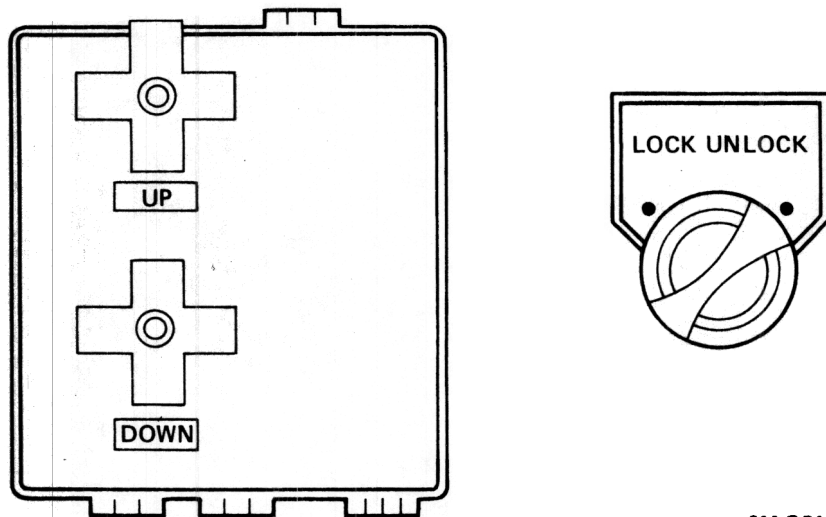
When preparing to move the crosshead, do not unlock the crosshead unless the lift cylinders have been bled (see section III, Service). This applies after installation, after hydraulic system maintenance, or if the hydraulic lift actuators did not operate smoothly when last used. Do not open the DOWN valve when the crosshead is manually locked. This can pull air into the lift actuator cylinders. Apply high pressure before unlocking the crosshead.

1. Remove any specimen in the load frame. Ensure that both the UP and DOWN hand valves (see figure 2-2) on the crosshead lift control manifold are closed (turned fully clockwise).
2. Turn on the system electrical power. Adjust dc error to zero.
3. Reset all active interlocks.
4. Turn on high hydraulic pressure to the system.
5. Open the UP hand valve 1/2 turn, wait 30 seconds, then close the valve.

## CAUTION

If hydraulic pressure is lost when the crosshead is unlocked and one or both of the hand valves are open, the crosshead will fall at a rate determined by the flow restriction of the lift cylinders.

6. Loosen all manual locking nuts on the crosshead by quarter-turns counterclockwise, in the order shown in figure 2-1, to 30% of the specified torque (listed on the plate attached to the crosshead) or less. Then loosen all manual locking nuts all of the way.
7. Open either the UP or DOWN hand valve on the crosshead lift control manifold, depending on which direction the crosshead is to be moved. Counterclockwise rotation of either of these hand valves increases the speed of movement of the crosshead.
8. When the crosshead reaches the desired position, turn the selected hand valve fully clockwise.
9. Tighten all manual locking nuts in the order shown in figure 2-1, to 15 lbf-ft (20 N-m), then to 90%, and finally to 100% of the torque specified on the plate attached to the crosshead.
10. As the manual locking nuts are successively tightened, those previously tightened will lose clamping force. Repeat the tightening order until all bolts are at the specified torque.



SM-G319

Figure 2-2. Controls For Positioning and Locking the Crosshead

### 2.2.3 POSITIONING THE CROSSHEAD ON LOAD FRAMES EQUIPPED WITH BOTH HYDRAULIC LIFTS AND LOCKS

The controls for positioning and locking the crosshead (see figure 2-2) are located on the manifold or manifolds attached to the load frame. The crosshead lock switch is located on a switchbox attached to the load frame. To change the crosshead position, proceed as follows:

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

If this warning is ignored, an extremely hazardous situation will exist in which the crosshead can drop unexpectedly on the columns.

Unlocking the crosshead without high hydraulic pressure, with the control valves open, or with air in the lift cylinders can cause the crosshead to unexpectedly drop down the columns with resulting damage to equipment or injury to personnel. Do not unlock the crosshead unless the lift cylinders have been bled (see section III, Service). This applies after installation, after hydraulic system maintenance, or if the hydraulic lift actuators did not operate smoothly when last used. Do not open the DOWN valve when the crosshead is locked, as this can pull air into the lift cylinders. Apply high pressure before unlocking the crosshead, because low pressure may be unable to support or move the crosshead.

1. Remove any specimen in the load frame. Ensure that both the UP and DOWN hand valves (see figure 2-2) on the crosshead lift control manifold are closed (turned fully clockwise).
2. Turn on the system electrical power. Adjust dc error to zero.
3. Reset all active interlocks.
4. Turn on high hydraulic pressure to the system.
5. Open the UP hand valve 1/2 turn, wait 30 seconds, then close the valve.

#### CAUTION

If hydraulic pressure is lost when the crosshead is unlocked and one or both of the hand valves are open, the crosshead will fall at a rate determined by the flow restriction of the lift cylinders.

6. Switch the crosshead lock control (see figure 2-2) to UNLOCK.

7. Wait at least 30 seconds to allow fluid in the hydraulic locks to return to a zero pressure condition.
8. If shipping collars are secured to the load frame columns (refer to subsection 4.4.5), the shipping collars should be removed before positioning the crosshead.
9. Open either the UP or DOWN hand valve on the crosshead lift control manifold, depending on which direction the crosshead is to be moved. Counterclockwise rotation of either of these valves increases the speed of movement of the crosshead.
10. When the crosshead reaches the desired position, turn the selected hand valve fully clockwise.
11. Switch the crosshead lock control to the LOCK position.
12. Install the shipping collars. Refer to subsection 4.4.5.

## SECTION III SERVICE

This section provides periodic maintenance and load cell alignment instructions for Series 311 Load Frames. Procedures in this section assume the operator is familiar with all operating aspects of the system electrical controller and interlock restrictions that apply to starting the hydraulic power supply. Also contained in this section is information on adjusting the optional hydraulic crosshead locks.

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

During maintenance, 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 subsection 3.1.2, Bleeding The Hydraulic Lift Cylinders). 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.

### 3.1 MAINTENANCE

Maintenance is performed as it is necessary. Each of the following subsections states when maintenance is to be performed.

### 3.1.1. CLEANING THE LOAD FRAME COLUMNS

#### CAUTION

The load frame columns must be free of any lubricant (such as oil or grease) to ensure proper operation of the load frame crosshead locks. The crosshead locks are designed to operate with dry and clean column and crosshead bore surfaces. If the columns are oily or greasy, the crosshead can slip during the test resulting in damage to the load cell, fixtures, specimen, etc.

The load frame columns should be wiped periodically with a clean rag. The frequency of cleaning is determined by environmental conditions. Do not lubricate the columns. They must be clean and dry for proper functioning of the crosshead locks. New load frame columns and operational load frame columns contaminated with any lubricant must be cleaned before attempting any load frame operation. Refer to the appropriate subsection below for column cleaning information.

#### 3.1.1.1 Cleaning New Load Frame Columns

Some load frames 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.

#### 3.1.1.2 Cleaning Operational Load Frame Columns

The possibility of hydraulic oil contamination of the columns usually applies to load frames equipped with a crosshead mounted actuator, hydraulic crosshead locks, or other hydraulic components mounted to the crosshead. If the columns are coated with any lubricant, they must be cleaned before locking the crosshead and performing any test. Proceed as follows:

1. Inspect the felt wipers for lubricant contamination. If contaminated, remove the felt wipers and replace with new felt wipers after the columns are clean. If contaminated wipers are not replaced, they will relubricate the columns whenever the crosshead is repositioned.
2. Wipe the columns with a clean rag dampened with grade #1 white kerosene, mineral spirits, or equivalent petroleum-based solvent to remove any lubricant on the columns. Use care and adequate ventilation when using any solvent. Refer to the solvent container for additional warnings and cautions.
3. Refer to the appropriate procedure in the product manual (subsection 2.2, Positioning the Crosshead), and move the crosshead to expose the column area covered by the crosshead.

4. Clean any lubricant from the newly exposed column area.
5. Repeat steps 3 and 4 until any lubricant buildup in the crosshead bores has been removed.

#### NOTE

If crosshead slippage during testing occurs after performing the above procedure, contact MTS Systems Corporation for additional column and crosshead bore cleaning information.

### 3.1.2 BLEEDING THE HYDRAULIC LIFT CYLINDERS

The hydraulic lift cylinders provide lifting force for positioning the crosshead. If the hydraulic crosshead lift actuators do not operate smoothly, the cylinders must be bled before attempting to use the hydraulic lift option. The customer may wish to include hydraulic lift bleeding in the periodic maintenance schedule. To bleed the hydraulic lift cylinders, proceed as follows:

1. Ensure the crosshead is mechanically or hydraulically locked. Refer to section II, Operation.
2. Ensure both the UP and DOWN hand valves on the crosshead lift control manifold are closed by turning the valves fully clockwise (CW).
3. Turn the system on and apply low hydraulic pressure.
4. Open the UP valve slightly by turning it a quarter turn counterclockwise (CCW).

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

Loosening the bleed port screw further than necessary to permit oil flow can result in the screw being ejected by hydraulic pressure and causing injury to personnel. Complete removal of the bleed valve screw will permit the rapid escape of hydraulic fluid, which can cause injury to personnel. Do not turn the screw further than directed in step 5.

5. Open the bleed port by rotating the screw not more than a half turn CCW using a hex key (see figure 3-1).
6. When hydraulic fluid begins to seep out of the bleed port and air bubbles are no longer present, tighten the screw. Repeat steps 4 and 5 for the other lift cylinder.
7. Remove the hex key. Close the UP valve.