MTS FSE MODULAR TRAINING

Servohydraulic Load Frames

November 7, 2015 rev D

be certain.

Introduction

» This module will cover general principles for load frames. For details see product specific training material or product manuals.

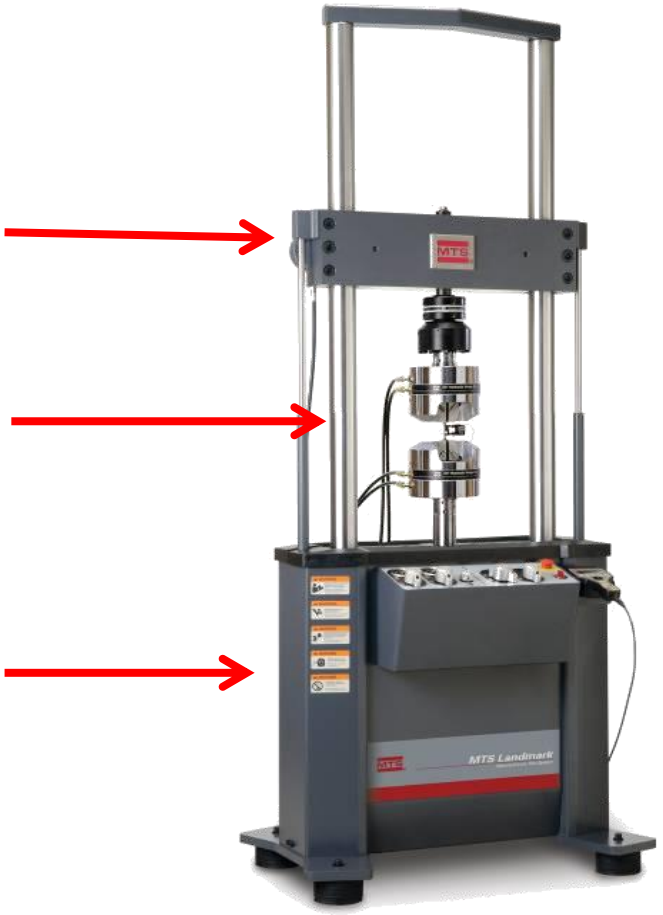
- Introduction
- Operation
- Installation
- Adjustments and Repair
- Reference Information

Load Frame Description

MTS Landmark®

» The servohydraulic load frame is used for performing both dynamic and static testing. The load frame consists of:

- The cross head is where the load cell is mounted and the force is reacted.
- The cross head moves up and down on a set of columns to accommodate different test setups.
- The base is where the actuator and HSM are mounted.



Load Frame Description

- Testing is performed in the test space located between the cross head and the base.
- The actuator applies force to the specimen which is reacted by the crosshead

Load Frame Styles

» The load frame is available both in a floor standing version and a table top version

Floor Standing

Table Top

Crosshead Mounted Actuator

» Some load frames have the actuator mounted in the crosshead and the load cell attached to the base.

Base mounted actuator

Crosshead mounted actuator

Columns

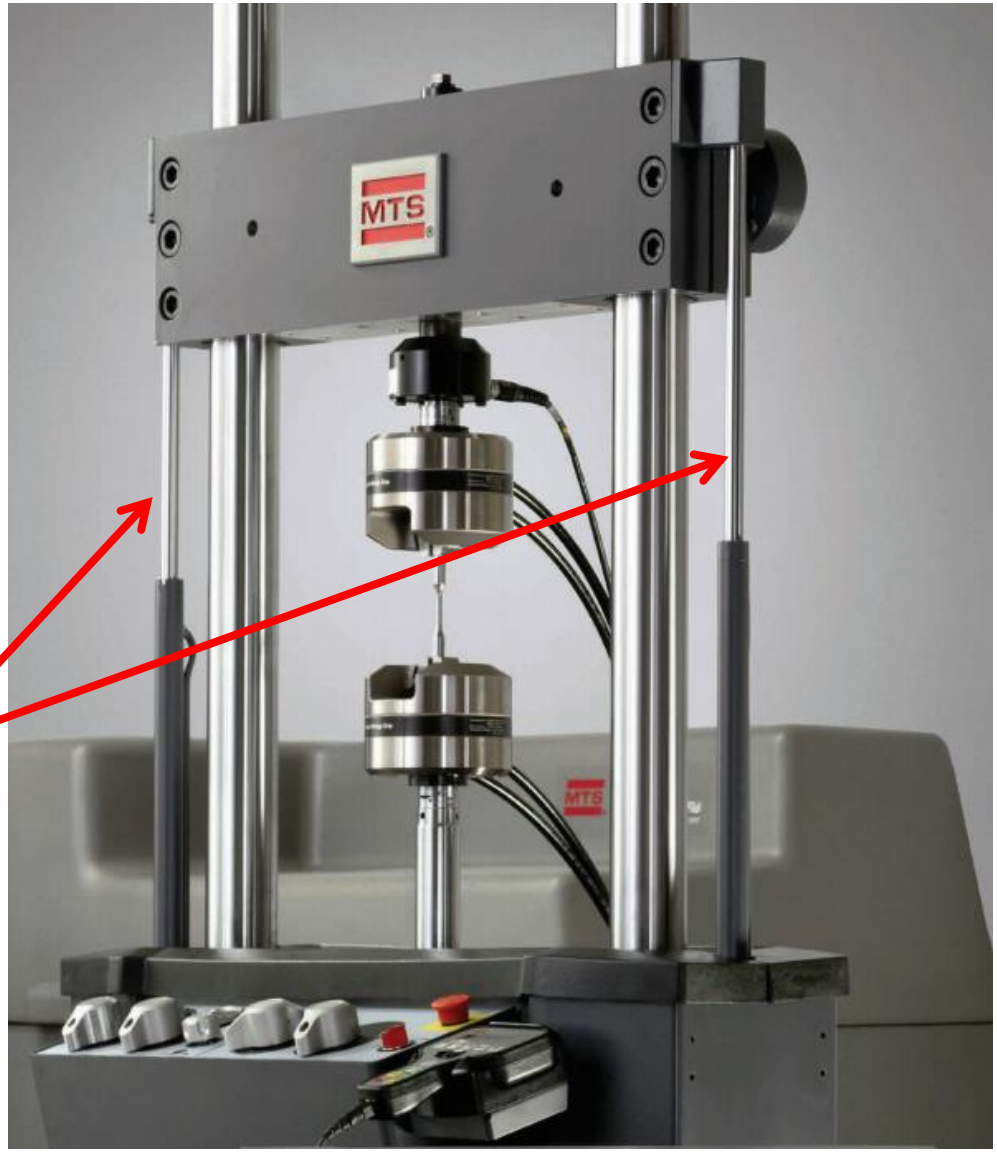
- The number of columns vary from 2 to 4 depending on the force capacity of the system.
- Larger capacity systems have 4 columns

Crosshead Lifts

» The crosshead can be positioned using two different methods

- Manual lift using overhead hoist. No lift cylinders are present

- Hydraulic lift using small hydraulic cylinders as shown in the picture on the right

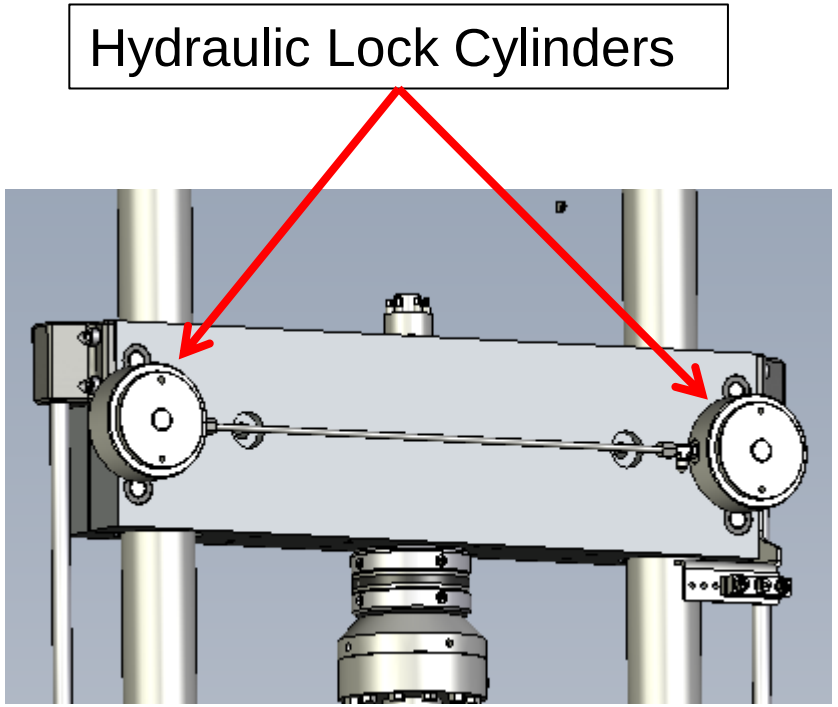


Crosshead Locks

» The crosshead can be locked in position using two different methods

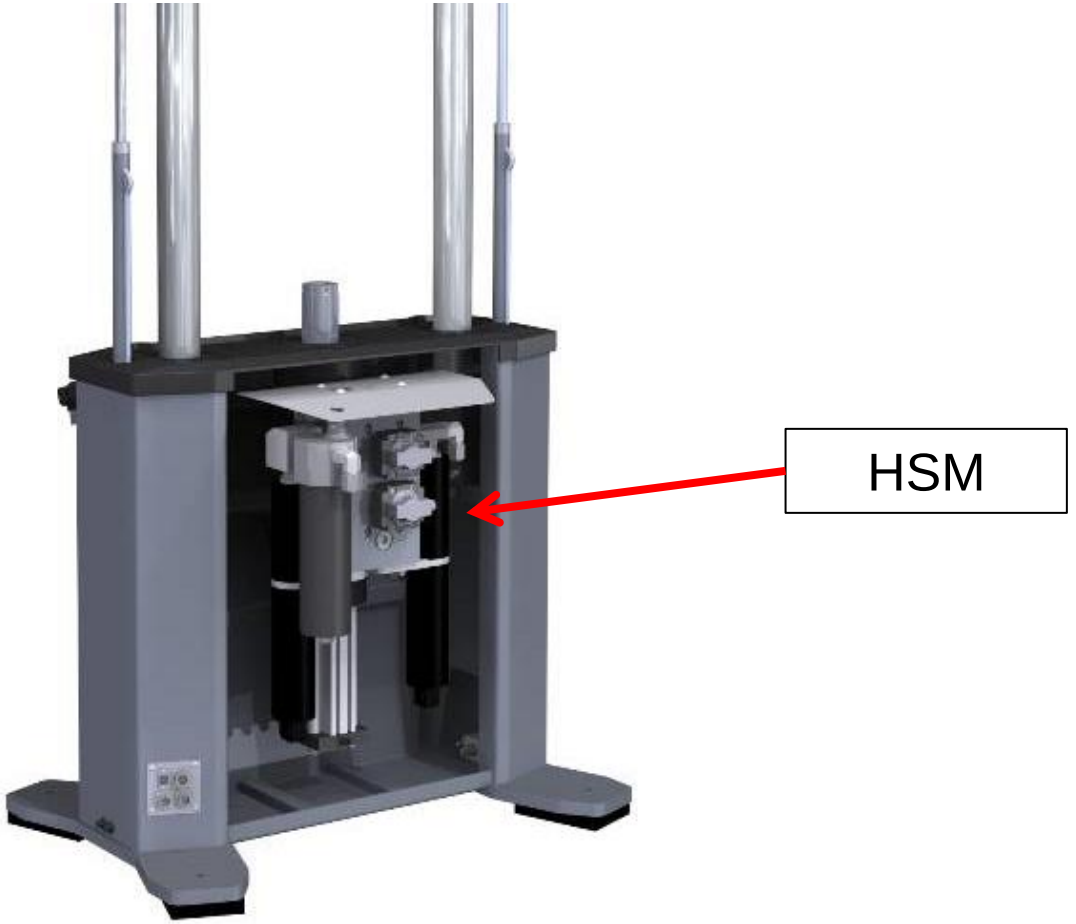
- Manual locking bolts which clamp the crosshead to the column. No lock cylinders are present.

- Hydraulic locking using small hydraulic lock cylinders on the crosshead which are used to clamp the crosshead to the columns.



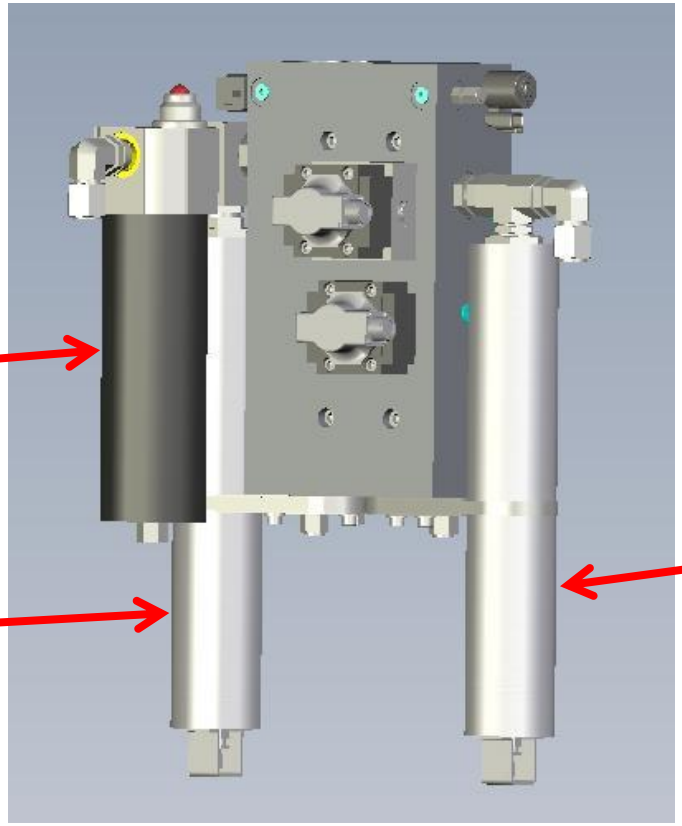
Hydraulic Service Manifold

» Most load frame actuators have a HSM mounted to the directly to the actuator.



Hydraulic Service Manifold

- The hydraulic service manifold typically has both a pressure and return accumulator.
  - For accumulator maintenance see the accumulator module
- A filter is optional



Load Frame Generations

» MTS has manufactured load frames for many years.

312

1967

318A

1984

318B

1994

MTS Landmark®

2007

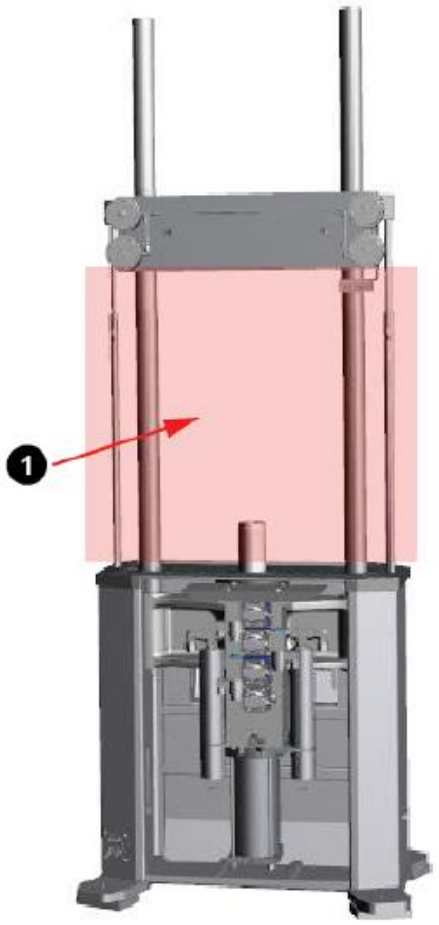
Load Frame Details

» Below is a table which outlines some of the differences between the Load Frame product families.

	312	318A / 380	318B	Landmark
Color	Gray	Brown	Gray / White	Black
Actuator	204	244 / Integral	244 / Integral	Integral
Crosshead Lock Control / Interlock	Electric	Hydraulic	Hydraulic	Hydraulic
Crosshead Lift Cylinder	Single Ended	Single Ended	Single Ended	Double Ended
Velocity Limiting	None	None	Optional	Standard

Crush Zone

- Be aware of the crush zone on any load frame you are working on. Do not put any part of your body in the crush zone with hydraulics applied. Doing this can cause bodily harm.
- The actuator can move rapidly. The area both above and below the actuator are included in the crush zone.
- Lowering the crosshead generates a potential pinch point.
- Gravity will cause the actuator to fall when hydraulic pressure is removed. The falling actuator will create a potential pinch point.



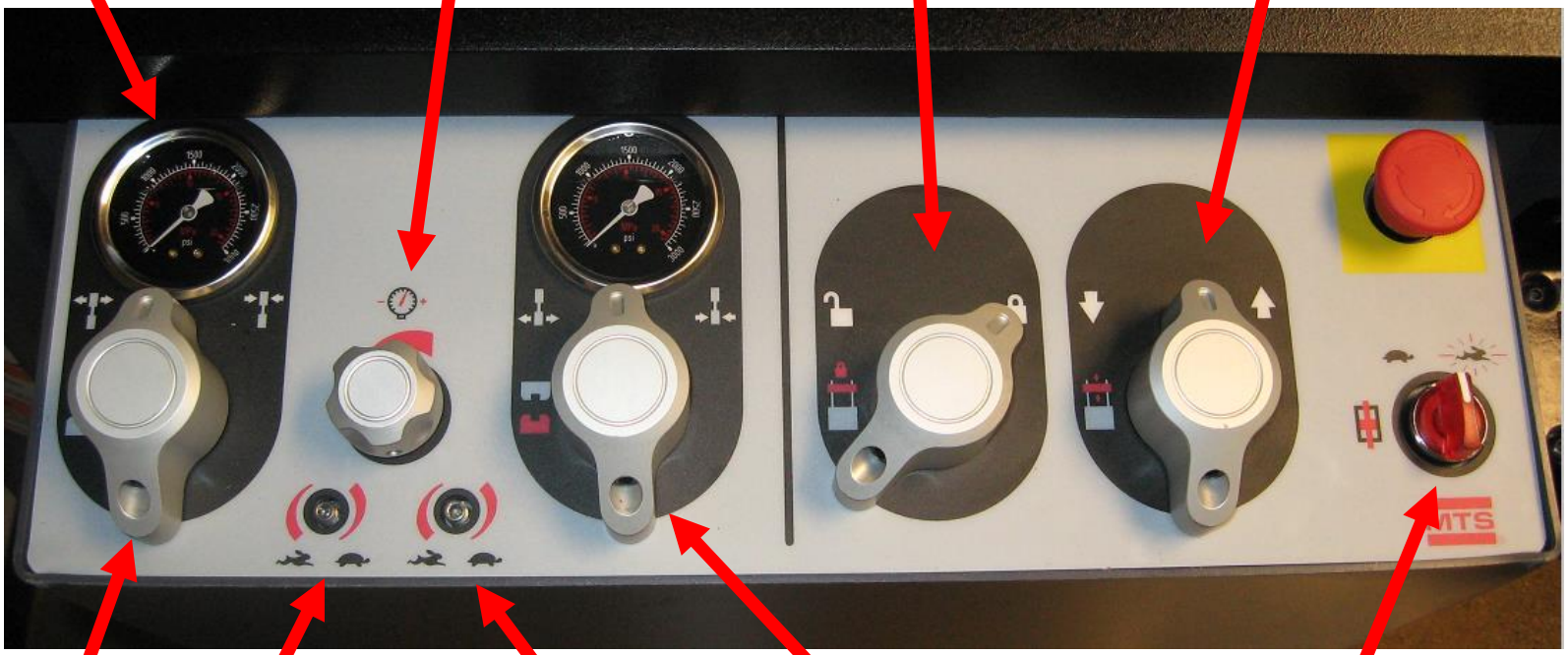
Crush Point Area

Operation

» The following controls are available on load frames. Not all frames have all controls. Some controls are optional. The next page shows a typical operator control layout.

- Emergency Stop
- Crosshead Lock
- Crosshead Lift
- Upper Grip Control
- Lower Grip Control
- Grip Pressure
- Grip Rate
- Velocity Limiting

Landmark - Controls



Operation

» To Raise the crosshead

- Unlock the crosshead
- Use the up / down control to move the crosshead to the desired position
- Lock the crosshead

» When the crosshead is unlocked a program interlock is generated on the controller

- This stops the dynamic program but does not turn off hydraulics
- On late model systems a pressure switch is used to detect the crosshead is unlocked.
- On early model systems an electrical switch is used to detect the crosshead is unlocked.

Installation

- After customer has positioned load frame
  - Ensure isolation pads / air bags are in place and air bags if present are properly inflated
    - Refer to appropriate product manual / drawing for air bag inflation procedure
  - Connect Cables
    - HSM
    - Low Flow power supply if present
    - Transducers
  - Connect Hoses
  - Install Grips and connect grip hoses
  - Verify operation

Connect Cables

» Cable connections between the controller and load frame vary with each system. Typical cable connections are listed below.

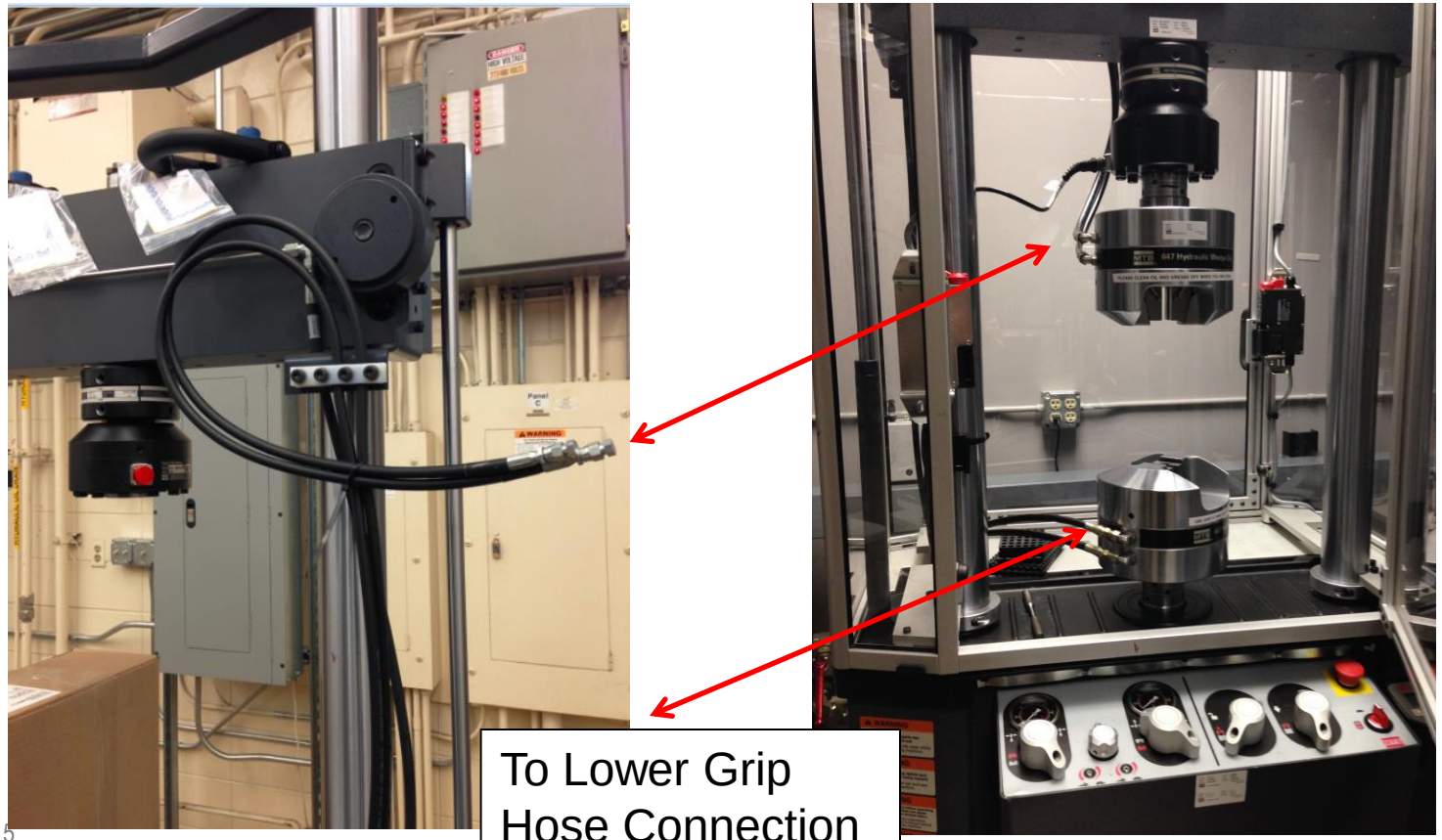
- HSM
- Low Flow Power supply
- LVDT
- Load Cell
- Extensometer
- Ground
- Test area enclosure interlock
- Emergency stop and Load Frame cable

Hose Connections

- There are multiple hoses. The total number of hoses depends on load frame model
  - Pressure
  - Return
  - Actuator drain
    - This is a critical connection. Failure to connect actuator drain will result in damaged low pressure seals. This drain hose is directly attached to the actuator and connected directly to the HPU without the addition of other drain hoses.
  - Lift / Lock control and grip control drain. This is a separate drain hose that is connected near the load frame controls.
  - Pilot pressure and Pilot return. These hoses are only present on systems with a 3 stage valve.

Install Grips and Connect Grip Hoses

» Connect upper and lower grip apply and release hoses



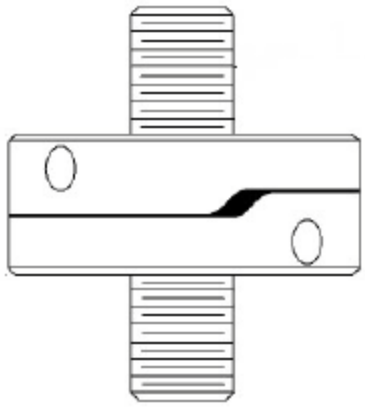
Verify Operation

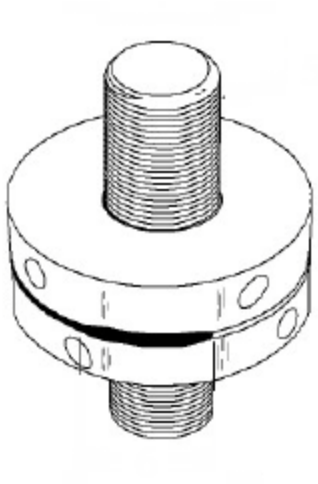
- Once installation is complete, all hoses and cables connected, and hydraulic oil is turned on verify all functions operate correctly.

  - Check for leaks on hoses, actuators, and lifts
  - Operate locks and lifts and verify proper operation
    - Verify program interlock when crosshead unlocked
  - Verify Emergency stop works correctly
  - If grips are present verify each opens and closes correctly
  - Verify actuator controls in displacement control

Pre-Loading Spiral Washers

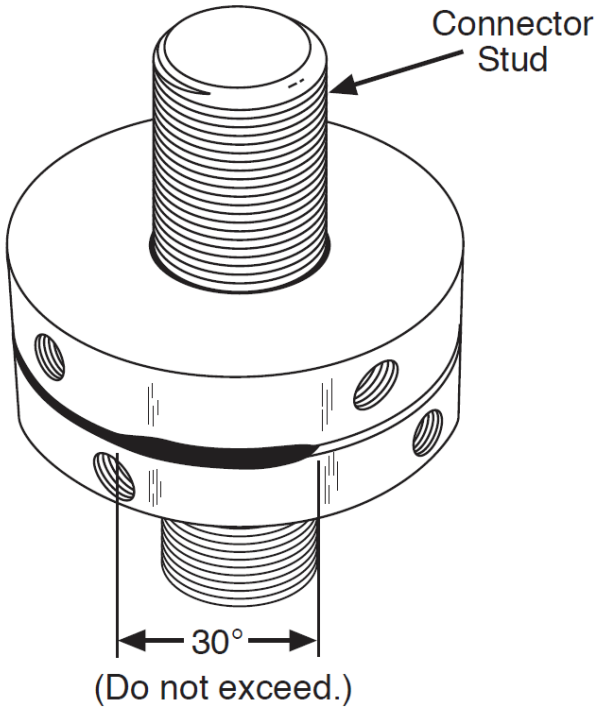
- Assemble grips / fixtures so spiral washers have a small gap as illustrated in left picture below when grips are hand tightened
- Insert a specimen into the grips which can sustain maximum load frame capacity
- Using the hydraulic actuator apply a static load in the tensile direction of at least 10% to 20% greater than expected test loads.
  - Spiral washers preloaded to 110% system capacity at factory when requested





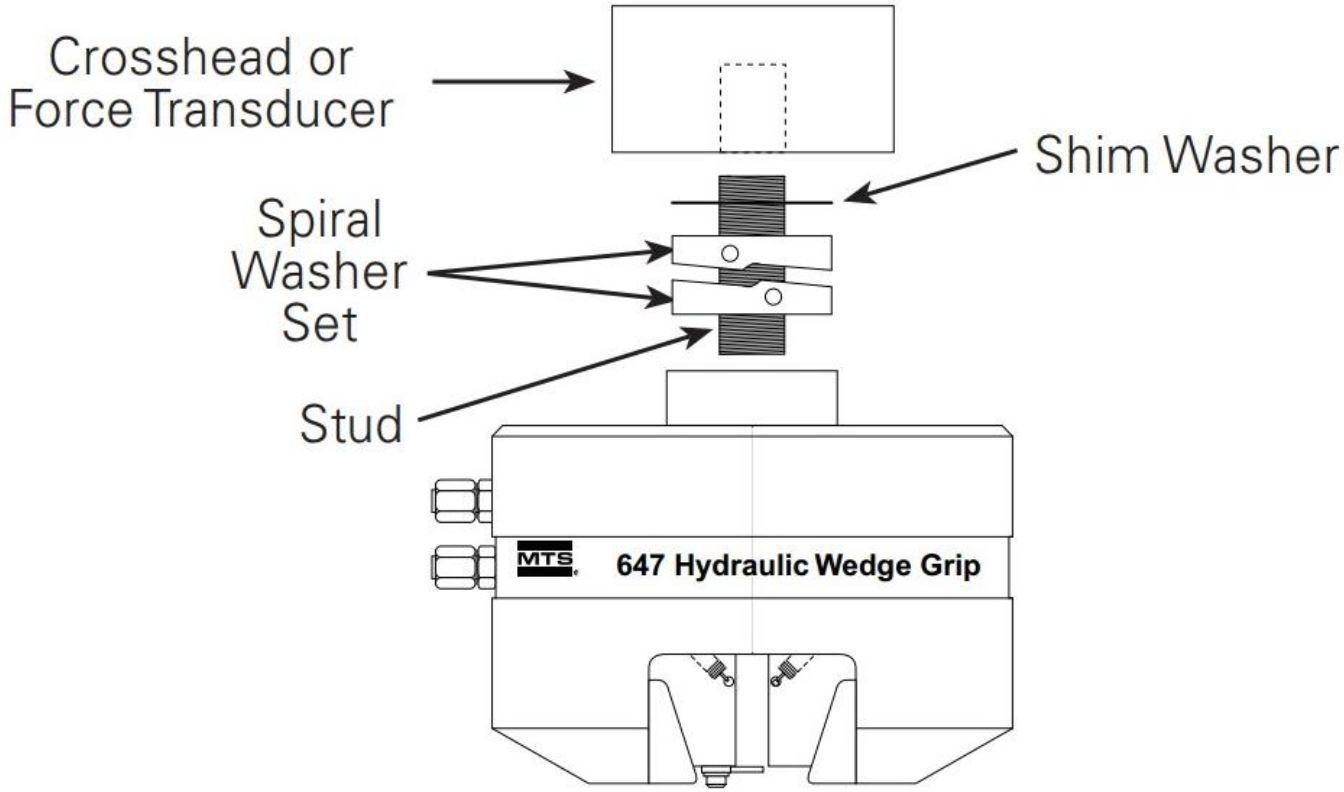
Pre-Loading Spiral Washers

- Using spanner wrenches rotate the two washers in opposite directions until they tighten.
  - Opening cannot exceed 30 degrees. If this happens, decrease initial gap size.
- Reduce force to zero
- Remove specimen



Spiral Washer Shims

» It may be necessary to install a shim to align the upper and lower grip wedges in order to keep the maximum opening of the spiral washers less than 30 degrees.



Spiral Washer Shims

- Kits which contain several thickness shims are available in different sizes to match standard MTS stud diameters.
- The chart on the following page lists shim kit part numbers along with the correct shim thickness and part number to use for common rotational increments.
- Example: If you have a ½" – 20 stud one complete turn is 0.050" travel. If you need to rotate the fixture 90 degrees you would use a 0.012" thickness shim P/N 443665-17

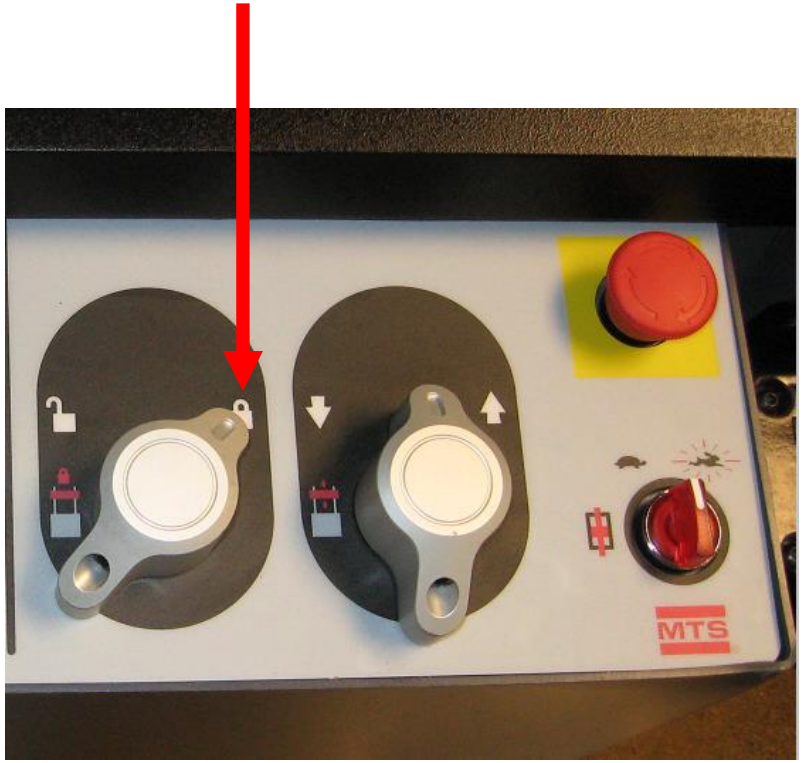
				APROX. ½ TURN (180°)	APROX. ¼ TURN (90°)	APROX. ⅛ TURN (45°)	APROX. 1/16 TURN (22.5°)
PART NUMBER (KIT NUMBER)	REV	THREAD SIZE ACTUATOR (OD)	REF. TRAVEL OF FULL TH'D	SHIM NUMBER THICK. (QTY)	SHIM NUMBER THICK. (QTY)	SHIM NUMBER THICK. (QTY)	SHIM NUMBER THICK. (QTY)
521050-01	B	½" - 20 358 ACT (1.12)	.050"	443665-16 .025 (1)	443665-17 .012 (1)	443665-13 .006 (1)	443665-18 .003 (1)

Shim Kit Part Number Reference

				APROX. ½ TURN (180°)	APROX. ¼ TURN (90°)	APROX. ⅛ TURN (45°)	APROX. 1/16 TURN (22.5°)
PART NUMBER (KIT NUMBER)	REV	THREAD SIZE ACTUATOR (OD)	REF. TRAVEL OF FULL TH'D	SHIM NUMBER THICK. (QTY)	SHIM NUMBER THICK. (QTY)	SHIM NUMBER THICK. (QTY)	SHIM NUMBER THICK. (QTY)
521050-01	B	½" - 20 358 ACT (1.12)	.050"	443665-16 .025 (1)	443665-17 .012 (1)	443665-13 .006 (1)	443665-18 .003 (1)
521050-02	A	M12 x 1.25mm 358 ACT (1.12)	.049"	443665-16 .025 (1)	443665-17 .012 (1)	443665-13 .006 (1)	443665-18 .003 (1)
521050-03	A	½" - 20 318 ACT (1.62)	.050"	443665-19 .025 (1)	443665-20 .012 (1)	443665-07 .006 (1)	443665-21 .003 (1)
521050-04	A	M12 x 1.25mm 318 ACT (1.62)	.049"	443665-19 .025 (1)	443665-20 .012 (1)	443665-07 .006 (1)	443665-21 .003 (1)
521050-05	A	1" - 14 318 ACT (2.62)	.071"	443665-22 .035 (1)	443665-24 .009 (2)	443665-24 .009 (1)	443665-25 .005 (1)
521050-06	A	M27 x 2mm 318 ACT (2.62)	.079"	443665-23 .020 (2)	443665-23 .020 (1)	443665-24 .009 (1)	443665-25 .005 (1)
521050-07	A	1-1/2" - 12 318 ACT (3.62)	.083"	443665-26 .020 (2)	443665-26 .020 (1)	443665-02 .006 (2)	443665-02 .006 (1)
521050-08	A	M36 x 2mm 318 ACT (3.62)	.079"	443665-26 .020 (2)	443665-26 .020 (1)	443665-27 .005 (2)	443665-27 .005 (1)
521050-09	A	2" - 12 318 ACT (4.62)	.083"	443665-28 .020 (2)	443665-28 .020 (1)	443665-15 .010 (1)	443665-29 .005 (1)
521050-10	A	M52 x 2mm 318 ACT (4.62)	.079"	443665-28 .020 (2)	443665-28 .020 (1)	443665-15 .010 (1)	443665-29 .005 (1)
521050-11	A	M76 x 2mm 311 ACT (7.00)	.079"	443665-35 .020 (2)	443665-35 .020 (1)	443665-36 .010 (1)	443665-37 .005 (1)
521050-12	A	M27 x 2mm 311 ACT (3.62)	.079"	443665-47 .020 (2)	443665-47 .020 (1)	443665-48 .009 (1)	443665-49 .005 (1)

Hydraulic Lock Circuit

- When the hydraulic lock control is in the locked position HPU pressure is applied to the hydraulic lock cylinder.
  - 3000 PSI for standard systems
  - If HPU is less than 2000 PSI the crosshead will not lock
- The pressure is maintained in the lock circuit when the HPU is turned off
  - The hose to the lock circuit cannot be removed until the pressure is released



Hydraulic Lock Circuit

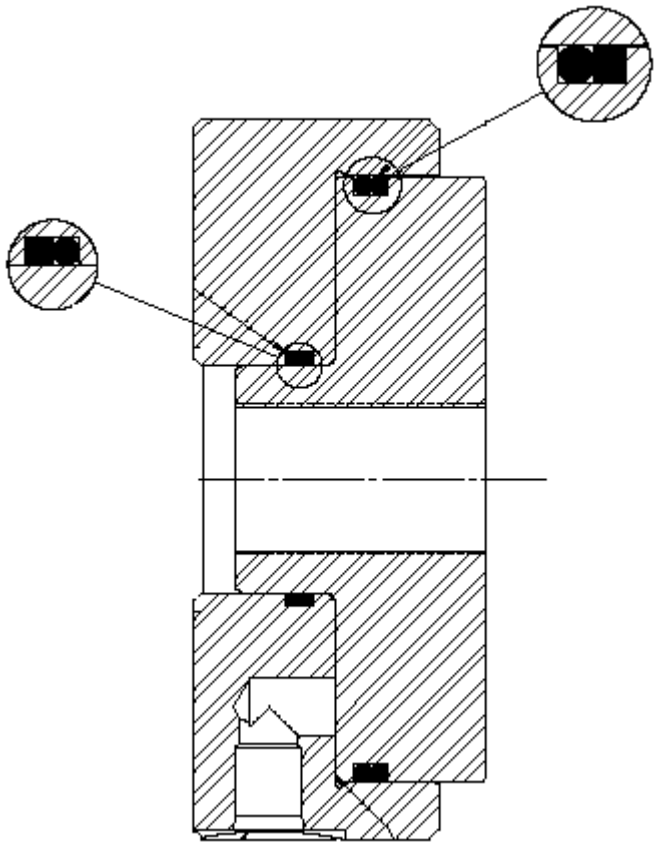
» HPU pressure is required to unlock the crosshead

- Turning the lock control valve to the unlock position with hydraulics off will not discharge the pressure in the hydraulic lock cylinder.

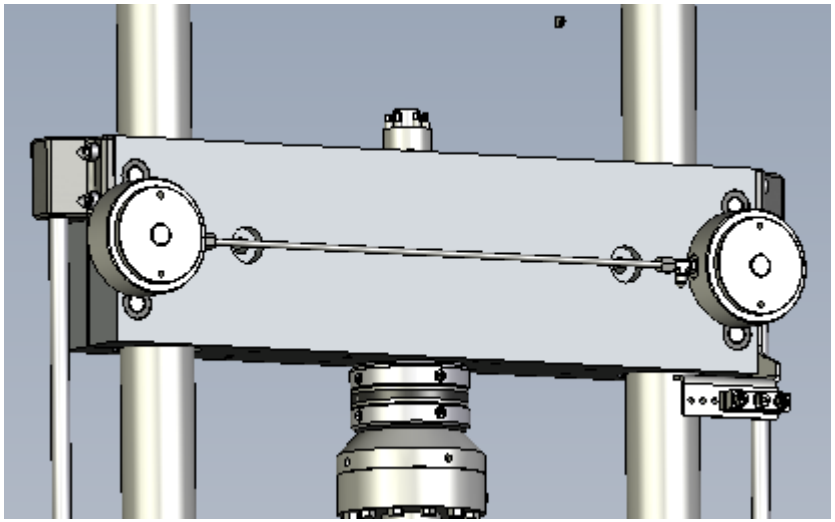
» To discharge pressure prior to removing the hose attached to the lock cylinders

- Tighten manual crosshead locking bolts
- Turn on HPU
- Turn control valve to unlocked position
- Turn off HPU

Lock Cylinders

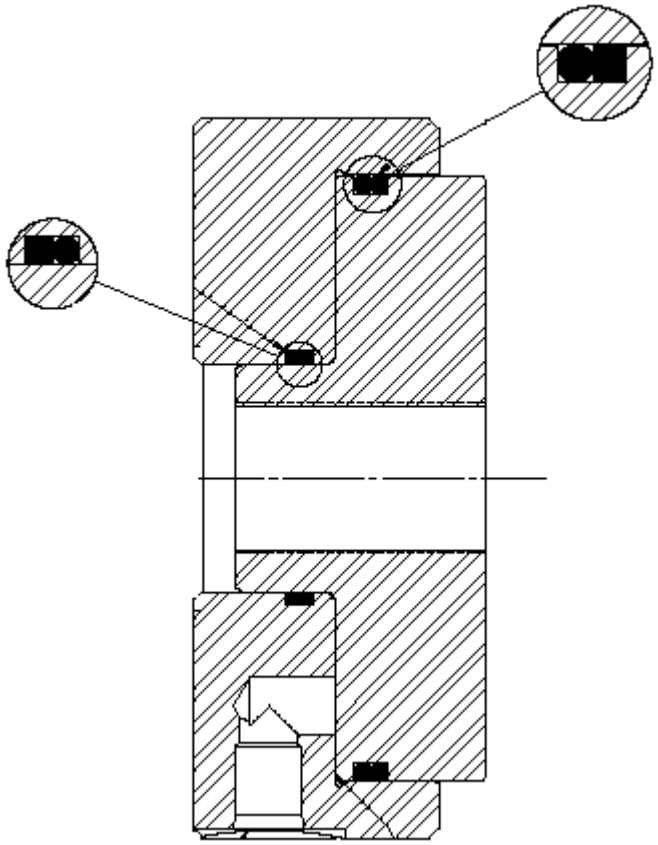


Lock cylinders use O-ring and backup ring.
O-ring installed on pressure side of cylinder.



Lock Cylinders Seal Replacement

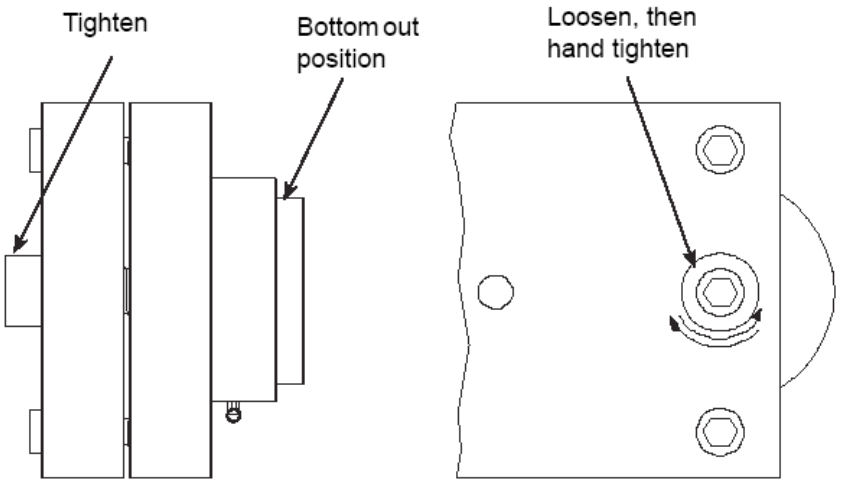
- Ensure crosshead is hydraulically locked using the lock control.
- Turn off hydraulics
- Tighten manual crosshead locking bolts.
- Relieve pressure in hydraulic locks.
- Disassemble lock cylinder.
- Look for any foreign contamination and follow-up as necessary.
- Clean cylinder with lint free rag.
- Replace O-rings and backup rings.
- Reassemble
- Adjust following procedure on next page.
- Unlock manual crosshead lock bolts when complete.



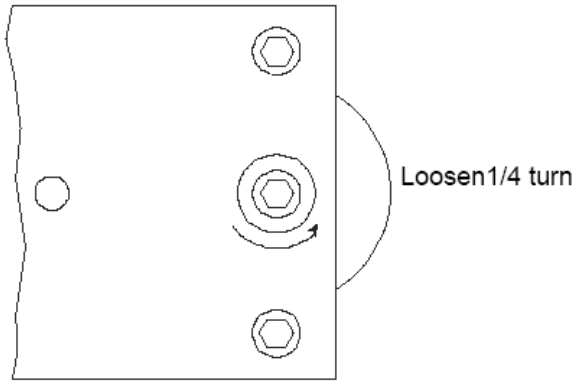
Lock Cylinder Adjustment

- Ensure crosshead is hydraulically locked using the lock control.
- Turn off hydraulics
- Tighten manual crosshead locking bolts.
- Relieve pressure in hydraulic locks.
- Tighten lock cap screw until cylinder bottoms out. Loosen and hand tighten.
- Loosen the lock cap screw ¼ turn.
- Apply hydraulics. Ensure lock control is in lock position.
- Loosen manual crosshead locking bolts.

Tighten each lock's cap screw until its piston bottoms out. Then loosen and hand-tighten each cap screw.

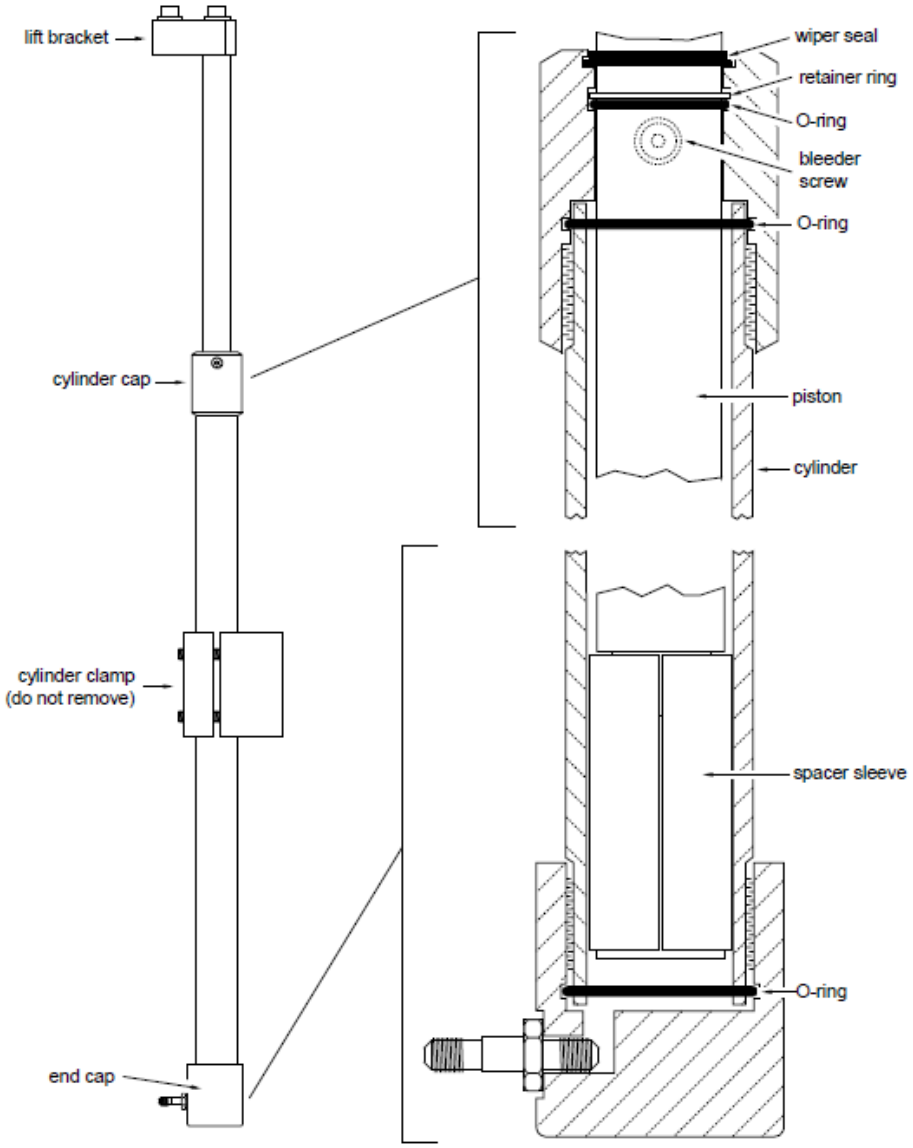


Loosen each of the hydraulic lock cap screws 1/4 turn.



Hydraulic Lift Cylinder Seals

- A typical lift cylinder is shown on the right.
- These cylinders contain a variety of O-rings and wiper seals.
- See product manual for specific model load frame details on the seals.



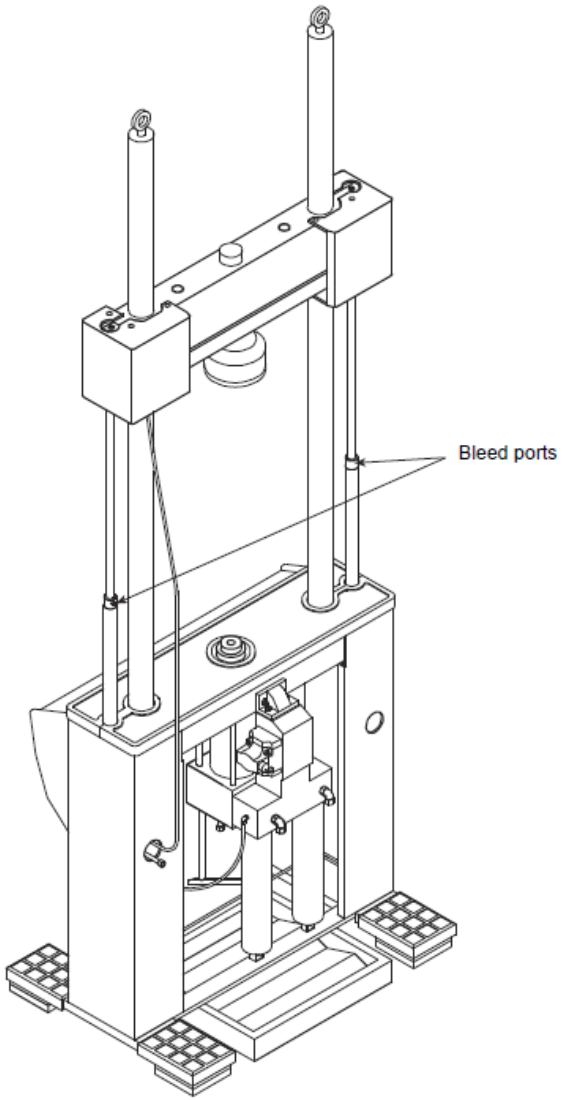
Hydraulic Lift Cylinder Seal Replacement

- Tighten the manual locking bolts
- Turn off hydraulic pressure
- Turn the lift control to the lower position and wait 2 minutes before proceeding to allow pressure to reduce to zero.
- Disconnect lift hose at cylinder
- Replace the end cap O-rings
- Replace the cylinder cap seals
- Reassemble
- Unlock manual locking bolts
- Bleed lift cylinder if bleeder port is present

*Refer to appropriate product manual for detailed instructions.

Hydraulic Lift Cylinder Bleeding

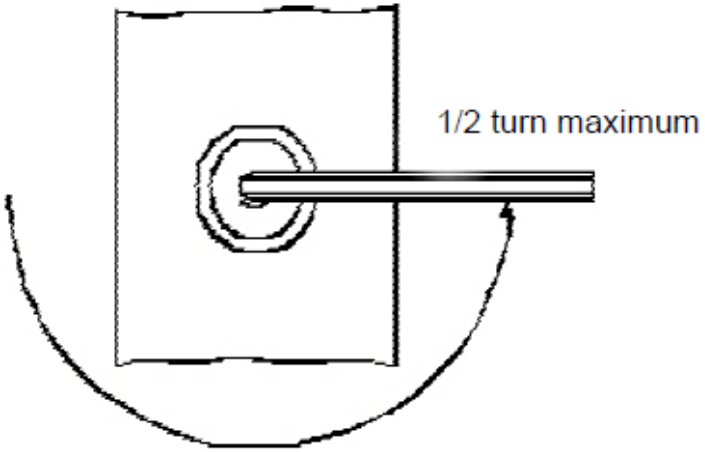
- Some model load frames have lift cylinders which require bleeding.
  - Bleed when movement is not smooth
  - Bleed when the sealed side of the hydraulic system has been opened to air.



Hydraulic Lift Cylinder Bleeding

- Lock Crosshead
- Turn on high pressure
- Unscrew the bleed screw no more than ½ turn
  - Unscrewing the bleed screw all the way can cause the screw to fly out of its port at a high velocity.

Unscrew the bleed port screw no more than 1/2 turn to vent the trapped air.



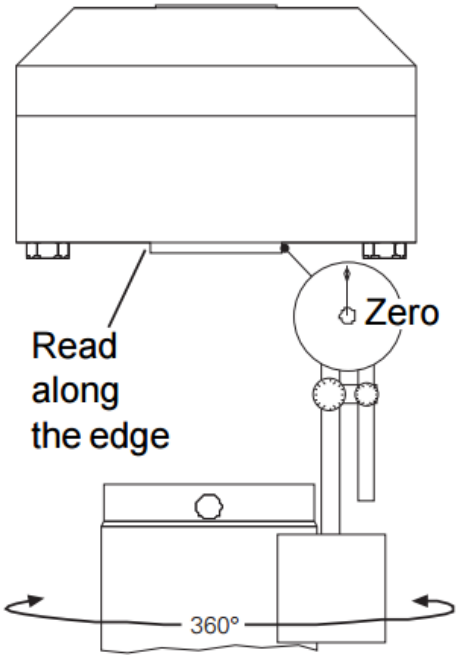
Open to Bleed

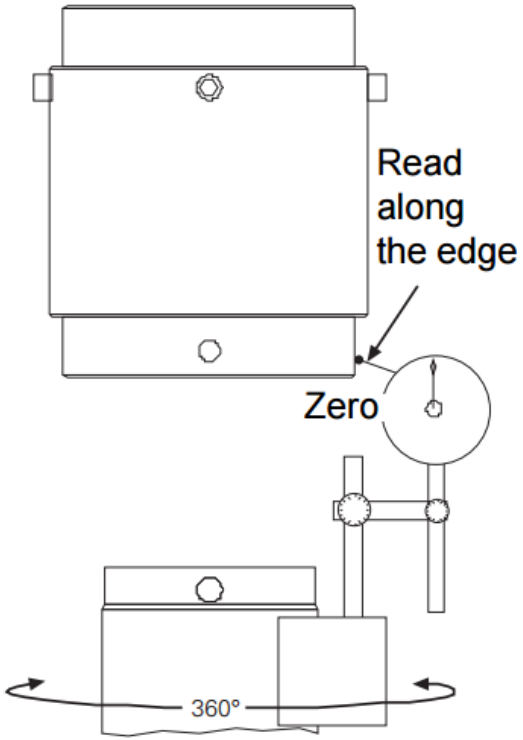
Hydraulic Lift Cylinder Bleeding

- Briefly turn the Lift control to the lift crosshead position to pressurize the lift cylinders. Then return it to the stop crosshead position.
- Shut the port when bubble free oil begins coming out.
  - If necessary, pressurize lift cylinder again briefly if there is still air in the oil
- After bleeding both cylinders exercise the crosshead and verify movement is smooth.

Load Cell Alignment

- To verify the load cell alignment using a dial indicator
  - Attach indicator base to actuator
  - Zero indicator
  - Rotate actuator through 360 degrees and record the maximum and minimum readings





Load Cell Alignment

» The acceptable total indicated runout (TIR) measured using a dial indicator is listed in the table below.

LOAD UNIT RATING	TIR
250 kN (55 kip) or less	>0.038 mm (0.0015 in)
500 kN (100 kip)	0.051 mm (0.0020 in)

» If a precise alignment is required the system must have a 609 alignment fixture. The alignment is performed using a strain gage specimen and 709 alignment software.

Load Cell Attachment

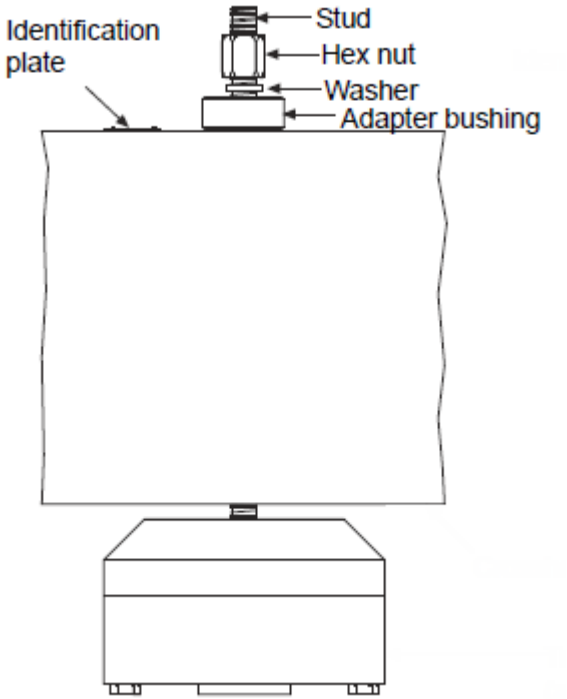
- The load cell is attached using either a standard nut or a “super-nut”.
  - It is important the fastener torque is correct to prevent fatigue of the attachment stud
  - The torque for a single nut is extremely high to achieve correct clamp load
  - The “super-nut” can achieve correct clamp load using a threaded collar with many small jack bolts which have a lower torque requirement

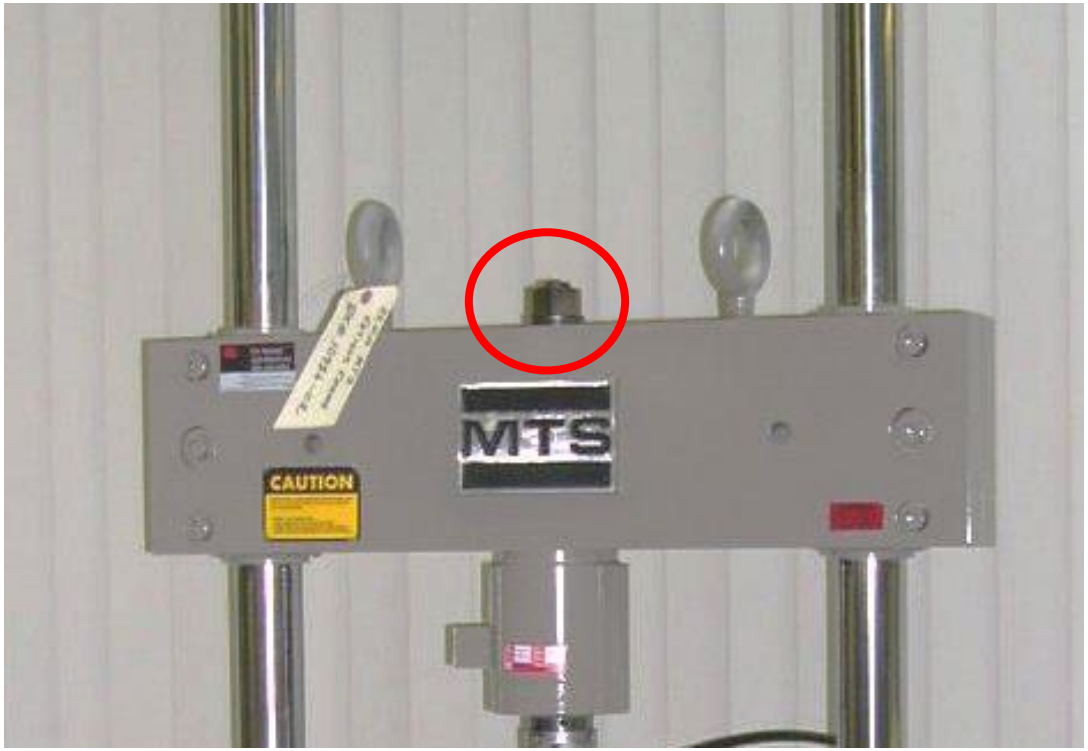
Super Nut

Load Cell Attachment – Single Nut

» If the load cell is attached using a single nut torque to the value shown on the torque value identification plate attached to the crosshead.

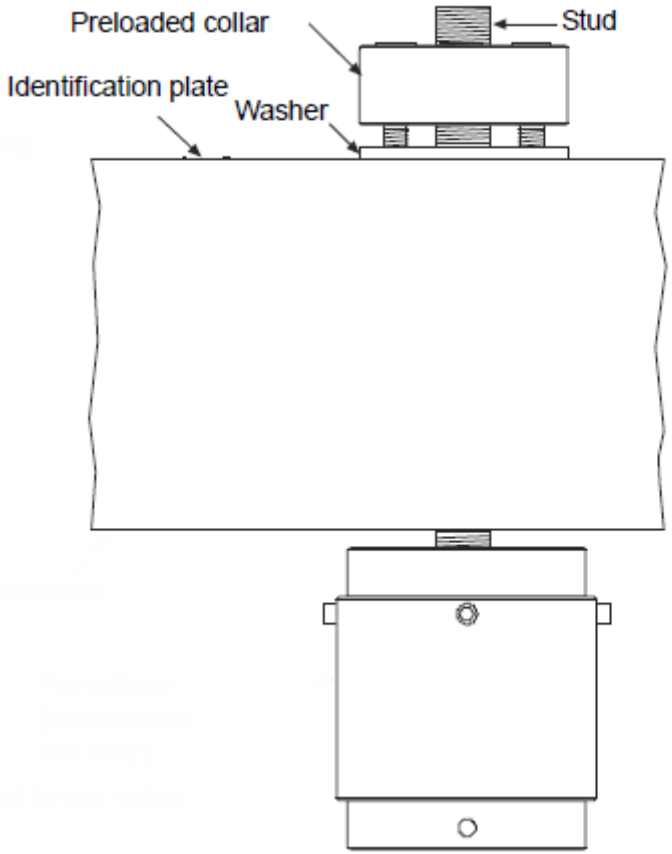
- Typical torque for 100 kN load cell with 1” – 14 threads is: 475 Nm or 350 lbf-ft





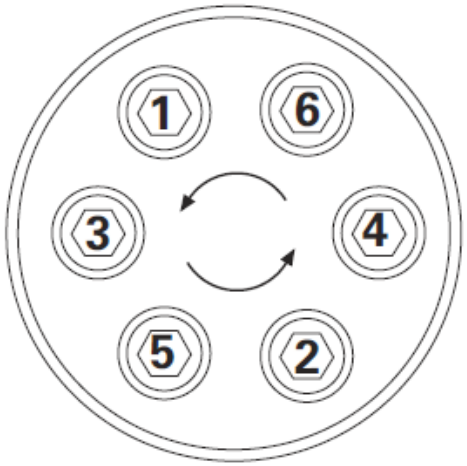
Load Cell Attachment – Preloaded Collar

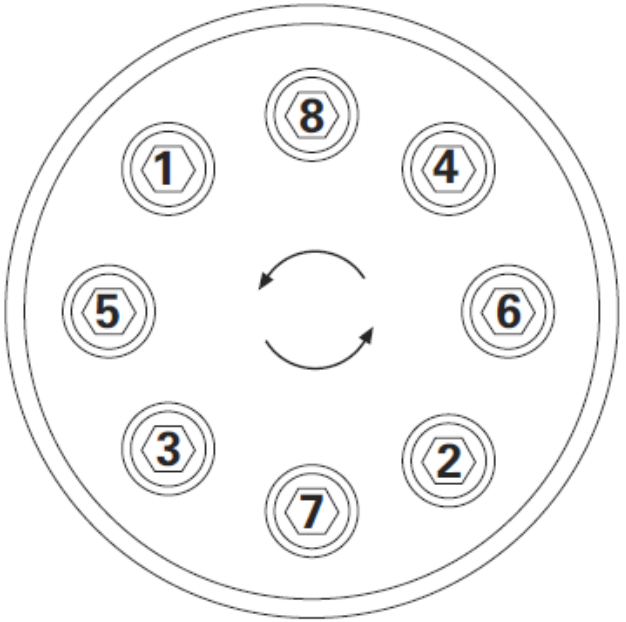
» If the load cell is attached using a preloaded collar with jack bolts incrementally torque each bolt in steps to the proper value.



Preloaded Collar – Torqueing Procedure

» Torque each of the bolts in the sequence shown using the following increments
- 5% of torque
- 50% of torque
- 75% of torque
- 100% of torque
- Repeat 100% torque to verify uniform torque





Routine Maintenance

- A Routine Maintenance chart is available in each product manual.
  - Perform recommended maintenance according to checklist
- See the Servohydraulic load frame Routine Maintenance video for additional details.

Routine Maintenance Overview Checklist

Recommended service to be performed at each running time interval noted

Calendar Time using 8 hour Running Time Rate Per Day	Daily	Weekly	Biweekly				Annually
Running Time-Hours	8	40	80	500	1000	1,500	2,000
Ensure the actuator platen area is clean.	X [4]						
Check all filter indicators.	X						
Ensure all hose, cables, and connectors are attached properly.		X					
Ensure that the crosshead, lifts, and supports are in working order.		X					