



Morehouse
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OPERATION AND INSTRUCTION MANUAL

DEADWEIGHT TENSIOMETER CALIBRATOR 2,000 LBF CAPACITY



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General Description

1- Scope (Introduction):

Following is a complete description of a Deadweight Tensiometer Calibrator, hereafter referred to as the DTC or Calibrator, manufactured by Morehouse Instrument Co., Inc., with a range of 10 to 2,000 lbf for calibrating dynamometers, small load cells, and aircraft cable tensiometers.

The Calibrator is capable of testing all types of dynamometers from 10 to 2,000 lbf, small load cells ranging up to 2,000 lbf, and cable tensiometers, including but not limited to C-5, C-6, C-7, C-8, and C-9 with the range of 10 to 2000 pounds' tension.

2- General:

This Calibrator makes full use of the accuracy of deadweight for applying the required force. The yoke assembly, which is a calibrated weight, supports the weights selected for application and bears directly on the unit under test. There are no lever or hydraulic multipliers, pulleys, or the like between the weight complement and the unit under test. The Calibrator does not use transducers or load cells to simulate deadweight loads. The Calibrator uses actual deadweights for applying the required load in pounds-force (lbf).

For ease of use, the weights contained in the Calibrator's frame are power assisted when being raised and lowered. The weights are raised and lowered using low pressure pneumatic lifts.

2.1- The Calibrator consists of the following two components:

2.1.1- One each Calibrator consisting of an upper frame assembly, lower frame assembly, weights, and yoke assembly.

2.1.2- One each Control Panel with switches to control the application and removal of weights to the unit under test.

3- Performance Requirements:

3.1- The Calibrator has a range of 10 to 2,000 lbf. The yoke assembly, which is 10 lbf, is the minimum force that can be applied.

3.2- The total system accuracy for the Calibrator is better than +/- 0.1% of the applied force from 10 to 2,000 lbf.

3.2.1- A contributing factor to the uncertainty of the Calibrator is the friction between the load rotation limiter, as required by Paragraph 3.8 of the Air Force Purchase Description, PD01MLEPDEB5, 14 Nov 01. The rotation limiter provided with the Calibrator does not cause the system accuracy to exceed +/- 0.1% of the applied force.

3.2.2- Each weight supplied with the Calibrator is adjusted to have an accuracy of better than +/- 0.01% of its nominal value when used in the environmental conditions given in Paragraph 5.4 of the Air Force Purchase Description, PD01MLEPDEB5, 14 Nov 01. The weights are adjusted for force with the following formula, which is given in ASTM specification E74.

$$\text{Force} = ((M * g) / 9.80665) * ((1 - (d / D)))$$

Where: M = Mass of the Weight
g = Acceleration Due to Gravity
d = Air Density
D = Density of Material

For the adjustment of all the weights the following values were used:

g = 9.80665 m/s²
d = 0.0012 Mg/m³
D = 7.92 g/cm³ for stainless steel hand weights and yoke
7.82 g/cm³ for nickel plated steel weights

As evidence of proper adjustment of the weights a Certificate of Calibration is provided for the weights supplied with each Calibrator.

3.3- Repeatability:

Because the applied force bears directly on the unit under test without intervening fixtures, levers, or lever and hydraulic multipliers the repeatability error does not exceed +/- 0.05% for all applied forces within the Calibrator's range of 10 to 2000 lbf.

3.4- Loading Increments:

The Calibrator is capable of applying any force from 10 to 2000 lbf in 1 lbf increments using the following weight complement:

- (1) 1 lbf Hand Weight
- (2) 2 lbf Hand Weights
- (1) 5 lbf Hand Weight
- (1) 10 lbf Yoke Assembly
- (2) 10 lbf Weights
- (1) 20 lbf Weight
- (1) 50 lbf Weight
- (2) 100 lbf Weights
- (1) 200 lbf Weight
- (1) 500 lbf Weight
- (1) 1000 lbf Weight

Each weight contained in the Calibrator, except for the yoke assembly, is individually supported and can be applied or removed in any order. Any weight or combination of weights contained in the Calibrator, except for the yoke assembly which should always be the first weight applied and the last weight removed, can be selected for application or removal without having to apply or remove any of the other weights contained in the Calibrator's frame. This allows application of any force from 10 to 2000 lbf in 10 lbf increments.

The hand weights can be manually applied and removed as needed to the yoke assembly. They are used in conjunction with the weights contained within the Calibrator to provide for applying force in 1 lbf increments.

3.5- Weight Application and Removal:

3.5.1- The weights contained in the Calibrator's frame are applied and removed without manual lifting by the operator. Weights are applied and removed automatically using a system of low pressure pneumatic lifts. The pneumatic lifts are designed to provide gentle and even application of the weights. They operate on low pressure air, approximately 14 psi.

3.5.2- The airflow in and out of the pneumatic lifts is such that the weights will not be applied or removed at a rate exceeding 2 inches per minute. This prevents "shock loads" when weights are applied or removed to the unit under test.

Any weight contained in the Calibrator's frame can be easily applied or removed by simply using the appropriate switch. The switches to control the application and removal of each weight are mounted on the side of the upper frame assembly.

3.6- Weights:

3.6.1- All weights 10 lbf or greater contained in the Calibrator's frame are machined from steel and electroless nickel plated to prevent corrosion.

3.6.2- Each weight is engraved with a unique serial number and its nominal weight value.

3.6.3- A case is provided to protect and store the slotted hand weights when not in use. The case is designed to hold all the hand weights supplied with each Calibrator so they cannot come in contact with each other while in the case.

3.6.4- The Calibrator's lower frame assembly, in which all weights 10 lbf and greater are contained, has steel side covers and plexi-glass panels in the front and rear.

3.7- Control Panel:

The switches used to apply and remove the weights are mounted on the side of the Calibrator's upper frame assembly where they can be easily accessed.

The Calibrator's control allows the selection, application, or removal of any individual weight or combination of weights contained within the Calibrator's frame, except for the yoke assembly, which is a certified weight, and should always be the first weight applied and the last weight removed. Each weight is individually supported and can be applied or removed in any order without having to apply or remove any other weights in the Calibrator. Being able to apply or remove any weight independently of another weight allows great flexibility when selecting weight combinations.

The control also permits weights to be applied or removed incrementally without return to no load.

3.8- Load Rotation Limiter:

The yoke assembly, which is attached to the unit under test and supports the weights that have been applied, will be restricted from rotating. Because the yoke assembly supports the applied weights, preventing rotation of the yoke assembly will steady the load and prevent any of the applied weights from rotating.

3.9- Cabinet Enclosure:

The Calibrator's lower frame assembly, in which all weights 10 lbf and greater are contained, is fully enclosed to keep the weights clean and protected. The lower frame has steel side covers and plexi-glass panels in the front and rear in addition to a steel plate over the top and bottom.

3.10- Calibration:

The Calibrator can be calibrated throughout its entire range, from 10 to 2000 lbf in one lbf increments using a tension type, secondary transfer standard of the appropriate range, stability, and accuracy. To calibrate the system using a secondary transfer, the transfer standard is suspended in the upper frame assembly of the Calibrator and attached to the yoke assembly. Weights are applied to the transfer standard as desired.

Because each weight is individually supported and the Calibrator's control allows the selection, application, or removal of any individual weight or combination of weights contained within the Calibrator's frame the weights can be inter-compared without removing them from the calibrator.

Additionally, the Calibrator can be disassembled allowing the weights, including the yoke assembly, to be removed from the calibrator for calibration.

4- General Requirements:

4.1- Dimensions:

The Calibrator's lower frame assembly, in which all weights 10 lbf and greater are contained, is fully enclosed to keep the weights clean and protected. The lower frame has steel side covers and plexi-glass panels in the front and rear in addition to a steel plate over the top and bottom.

4.1.1- The physical dimensions of the Calibrator are 8 feet 9 inches (105 inches) high and 3 feet (36 inches wide) square.

4.1.2- The Calibrator stands in place and has a beam across the top of the frame to provide a place to attach cables of varying diameters, ranging from 1/16th to 1/2 inch. Only one cable should be attached at a time. The beam is fixed to prevent the cable from rotating.

Any place the cable is to be attached to the Calibrator is designed to accommodate cable diameters ranging from 1/16th to 1/2 inch.

The upper frame of the Calibrator is designed to accommodate cables 60 inches long (+/- 1 inch) with eyebolt holes at each end. The length of the cable should be measured from the centerline of the eyebolt holes.

In use the cable is supported by the top beam and attached to the yoke assembly. The yoke assembly is the first 10 lbf force that will be applied to the cable. Once the cable is in place, and the yoke assembly attached, the operator can select the additional force to be applied to the cable, up to 2000 lbf. As force is applied the cable may stretch and it will be necessary to compensate for the increased length of the cable. This will be accomplished using a hydraulic lifting mechanism. As the cable stretches the operator will use the hydraulic hand pump supplied with the Calibrator to adjust the position of the cable to compensate for its stretch. The hydraulic lifting mechanism is designed to compensate for a minimum of two inches of cable stretch.

The hydraulic lifting mechanism is also used to compensate for variations in cable lengths and is designed to provide for variations in cable length of +/- 1 inch.

This Calibrator requires no electrical power source.

4.3- Pneumatics:

The weights contained in the Calibrator's frame are applied and removed using low pressure pneumatic lifts which operate at approximately 14 psi. The Calibrator is equipped with an air regulator requiring an air supply of clean shop air between 30 and 120 psi.

4.4- Warranty Markings:

Each Calibrator has a warranty label attached to the upper frame.

5- Mechanical and Physical Requirements:

5.1- Commercial Parts:

The Calibrator is constructed from new parts and material consistent with the practices Morehouse uses to manufacture precision laboratory instruments.

5.2- Design and Construction:

The Calibrator is designed and constructed of materials that meet the requirements of the Air Force Directorate of Metrology Purchase Description, PD01MLEPDEB5, 14 Nov 01 and are in accordance with the best commercial practices used by Morehouse to manufacture precision laboratory equipment. The design and manufacture of the Calibrator is based on proven techniques that maximize reliability, maintainability, accuracy, and ease of operation. All parts have the clearances required to insure proper operation so the Calibrator meets the accuracy and load requirements without unnecessary strains, vibration, and overheating.

5.3- Environmental Requirements:

The Calibrator is constructed from new parts and material consistent with the practices Morehouse uses to manufacture precision laboratory instruments.

5.3.1- Operating Temperature:

The Calibrator will operate without loss of performance and within its required accuracy in an ambient temperature of 15 to 35 degrees C. Weights supplied with the Calibrator are adjusted to have a total uncertainty of less than +/- 0.01% of their nominal value when used within the required range of temperature.

5.3.2- Operating Humidity:

The Calibrator will operate without loss of performance and within its required accuracy in an atmosphere of 15 to 70% relative humidity. Weights supplied with the Calibrator are adjusted to have a total uncertainty of less than +/- 0.01% of their nominal value when used within the required range of humidity.

5.5- Safety:

The Calibrator described herein is equipped with safety shields to enclose the working area in the upper frame where the cable is to be placed. There are fixed metal back covers and a hinged metal front cover. The structure of the upper frame completely encloses the sides of the working area.

The front cover is hinged so it can be fully opened to allow easy access to position the cable or unit under test. There is a 24-inch square opening in the front cover positioned to allow easy access to the cable so tensiometers can be clamped to the cable without opening the door.

The back cover is split to provide an opening approximately equal to the height of the window in the front cover. This allows the operator to work from either side of the Calibrator.

6- AFMETCAL/ML-03 Warranty Description dated October 17, 1997

The following are excluded from the Warranty:

6.1- The AFMETCAL/ML-03 warranty states, "Any failed unit returned to a contractor repair center shall be repaired within two weeks (14 calendar days) at no additional cost to the Government."

It is impossible to repair or replace some of the components within this time period. We promise to replace or repair returned parts as quickly and efficiently as possible.

6.2- The AFMETCAL/ML-03 warranty states, "The government shall bear transportation costs for equipment returned to the contractor for repair or replacement. The contractor is responsible for returning the item to the owner and shall bear transportation costs from the repair center to a DOD shipping point. Air freight shall be employed for items shipped over 300 miles unless a faster means is available."

Because some of these Calibrators are being shipped outside the 48 Continental United States it is not possible for Morehouse to assume responsibility for any freight. Additionally, some of the components of the Calibrator are quite large and are not well suited for commercial airfreight.

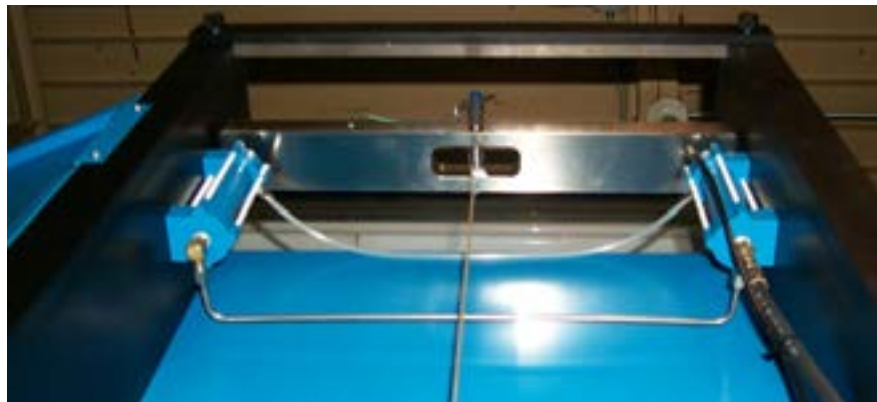
Operating Instructions

1- Open the relief valve of the hand pump and make sure the top beam is fully lowered. After the top beam is fully lowered securely close the relief valve. The relief valve is opened by turning it counter-clockwise and closed by turning it clockwise.



2- Be sure all the weight switches are in the off position. Check the toggle switches on the right side of the upper frame. There is a toggle switch for each weight contained in the calibrator. The weight switches should all be switched to the left for "OFF". When the switches are in the "OFF" position the pneumatic lifts under each weight are fully inflated.

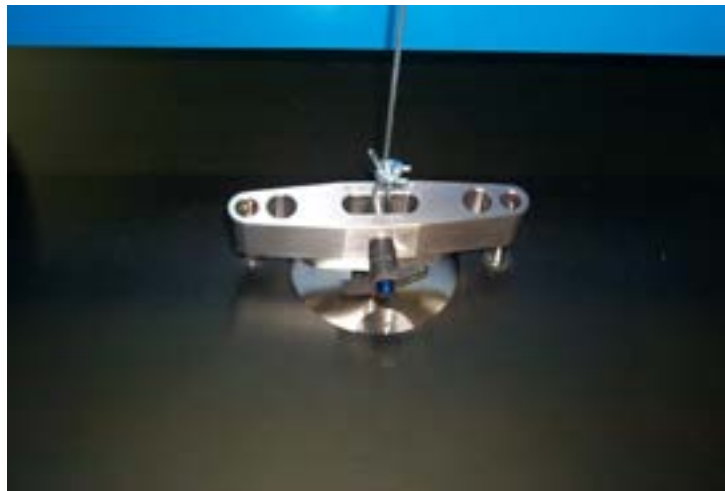
3- Open the front cover and attach the cable to the top beam using the detent pin that is wired to the top beam. Position the cable so it is centered in the opening.



4- Attach the cable to the yoke using the appropriate detent pin. Position the cable so it is centered in the opening. After the cable is in place close the front cover.

The Calibrator is designed to accept cables ranging in length from 59 to 61 inches, measured from the centerline of the eyebolt holes. When attaching cables less than 60 inches, it will be necessary to manually lift the yoke slightly to attach the cable.

Note: The detent pin supplied with the yoke is part of the calibrated weight of the yoke. Do not lose this pin. When not in use always keep the detent pin installed in the yoke as shown in the above photo.



Cable Centered in Yoke

5- Before applying any of the weights contained in the Calibrator use the hand pump to correctly position the yoke. The yoke is raised by pumping the hand pump and lowered by slightly opening the hand pump's relief valve. The relief valve must be fully closed when pumping the hand pump or any weights are being applied.

The hydraulic lifting mechanism has a maximum of 5 inches of travel. Be careful not to go beyond this limit.

The yoke should be positioned so its top is not above the top of the brass section of the anti-rotation pins nor below the bottom of the brass section of the anti-rotation pins. If the top of the yoke is above or below the brass section of the anti-rotation pins its position must be adjusted. It is recommended the top of the upper yoke be positioned so it is approximately 1/8" below the top of the brass section of the anti-rotation pins.

Top of Anti-Rotation Pins



**Highest Yoke Position...Top of Yoke Even with
Top of Anti-Rotation Pins**



**Lowest Yoke Position...
Brass Section of Anti-Rotation Pins Fully Visible**

6- Use the toggle switches on the right side of the upper frame to apply the desired weight or weights. There is a switch for each weight contained in the Calibrator. The weight switches should all be switched to the right for "ON" to apply a weight. The pneumatic lifts under the weights selected for application should be completely deflated.

Remember: The yoke, which weighs 10 lbs, is already attached to the cable, and must be included when determining the total amount of weight applied to the cable.

Be careful not to apply more weight than the cable's load rating as this may damage the cable, or cause it to fail.

7- As weights are applied the position of the yoke in relation to the anti-rotation pins must be checked. The cable may stretch as weights are applied causing the position of the yoke to change. Use the hand pump to keep the yoke in the proper position as described in 5.0 above.

8- The hand weights are slotted and can be applied and removed to the lower yoke as needed. To apply and remove the hand weights the front cover must be opened.



Box for Hand Weights with 1 lbf and 2 lbf Hand Weight Applied to Yoke

9- Before attaching a tensiometer to the cable or taking a reading it is suggested the relief valve be opened slightly momentarily and immediately closed as this will help release any friction between the yoke and the anti-rotation pins.

10- After the calibration is complete remove all the weights by moving the switch for any applied weights back to the "OFF" position. Next, open the relief valve of the hand pump to return the top beam to its lowest position, then remove the cable. When removing the cable detach it from the lower yoke before removing it for the stage beam. After removing the cable be sure the detent pin used with the yoke is installed back in the yoke.

Note: The detent pin supplied with the yoke is part of the calibrated weight of the yoke. Do not lose this pin. When not in use always keep the detent pin installed in the yoke.

Assembly

1- The calibrator is packed in 3 boxes as follows:

1.1- Box #1 contains the "Operation, Assembly, Maintenance, Repair, Calibration, & Parts List Manual", Certificate of Calibration, upper assembly with hand pump and weight control, hand weights with case, (2) side covers, and (2) side cover plexi-glass panels misc. tools, all weight lifter rods, upper yoke section, compression springs for levels 6 thru 9, screws, (2) 10 lbf weights, (1) 20 lbf weight, (1) 50 lbf weight, and (2) 100 lbf weights.



Weights Packed Under
Upper Assembly in Box #1



Contents of Box #1, Showing
Side Covers Packed

1.2- Box #2 contains the weight plates and spacers for levels 6 thru 12, (1) 200 lbf weight, and the spacers for level 13.



Contents of Box #2

1.3- Box #3 contains the 500 lbf weight and weight plate, 1,000 lbf weight and weight plate, feet, and spacers for level 14.



Contents of Box #3

2- The following tools and supplies will be needed for assembly of this Calibrator in addition to the tools provided by Morehouse:

2.1- Phillips Screw Driver

2.2- Adjustable Wrench

2.3- 7/16" Open End Wrench

2.4- 1/2" Allen Wrench

2.5- (4) 4" x 4" x 20" long Wood Blocks

2.6- 60-inch aircraft cable with 2,000 lbf load rating

2.7- Forklift with 2,000 lbf capacity to unload and move shipping crates.

2.8- Overhead crane or other device to safely lift and move up to 1,000 pounds.

3- Remove the top and sides from Box #1. Use caution when opening this box so the contents are not damaged. The side covers and the weight lifter bar/long handled wrench are attached to the side of the shipping box marked **"COVERS ATTACHED TO THIS SIDE – OPEN WITH CAUTION"**. Remove and set aside the plexi-glass panels, tools, weight lifter rods, and compression springs. These will be used a various stages of assembly. Remove the side covers from the plywood and set aside. After these items have been unpacked remove the upper assembly from the box to expose the weights that are packed under the upper assembly.

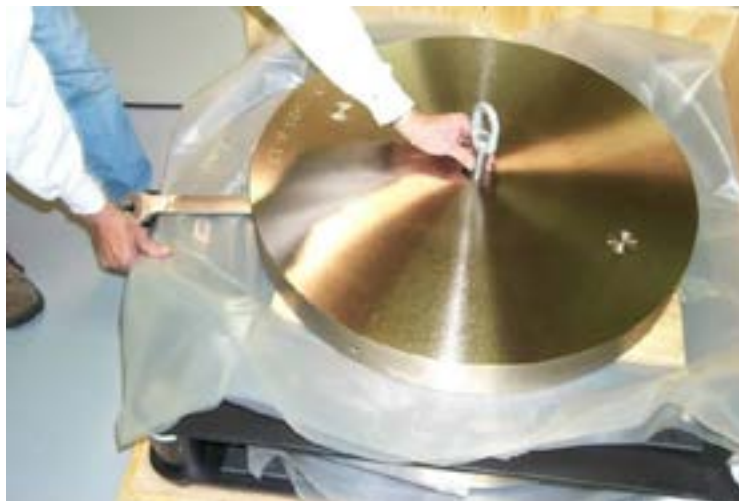
4- Remove the cover from Box #2. First remove the nut from the threaded rod extending above the top of the box. After the nut has been removed, the cover can be lifted off. After the cover is off remove the second nut and then the threaded rod by turning it counter clockwise until it can be removed. Box #2 has the 200 lbf weight on top, weight plates and spacers for levels 6 thru 12, and the spacers for level 13. The spacers for level 13 are on top. The weight plate for level 12 is directly under the 200 lbf weight followed by the spacers for level 12, then the weight plate for level 11 followed by the spacers for level 11, etc. continuing down to the spacers for level 6.

**Remove 2nd Nut
and Threaded Rod**



5- Remove the cover from Box #3. First remove the nut from the threaded rod extending above the top of the box. After the nut has been removed the cover can be lifted off. After the cover is off remove the second nut and then the threaded rod by turning it counter clockwise until it can be removed. Box #3 contains the 500 lbf weight and weight plate, 1,000 lbf weight and weight plate, feet, and spacers for level 14.

6- Lift the exposed 500 lbf weight from the box using the weight lifter bar/long handled wrench, 7/8"-14 lift eye, and 7/8"-14 threaded rod. Slide the weight lifter bar/long handled wrench under the weight. Be careful not to scratch or damage the weight. Attach the 7/8"-14 lift eye to the threaded rod and place it through the hole in the center of the weight and screw it into the weight lifter bar/long handled wrench. After the lift eye is attached to the weight lifter bar/long handled wrench, lift and move the weight onto wood blocks. Be sure the wood blocks are clean so they will not damage the weights. Unthread the lift eye and threaded rod from the weight lifting bar/long handled wrench and remove them from the weight.



Tools Needed:
Weight Lifter/Long Wrench,
7/8"-14 Lift Eye with
7/8"-14 Threaded Rod



Weight Lifted To
Be Put on Wood Blocks

7- Remove the 500 lbf weight plate, number 13, from the box and set aside. The weight plates weigh approximately 150 pounds each and should be manually lifted by two or three people.

8- Lift the exposed 1,000 lbf weight from the box using the weight lifter bar/long handled wrench, 7/8"-14 lift eye, and 7/8"-14 threaded rod. Slide the weight lifter bar/long handled wrench under the weight. Be careful not to scratch or damage the weight. Attach the 7/8"-14 lift eye to the threaded rod and place it through the hole in the center of the weight and screw it into the weight lifter bar/long handled wrench. After the lift eye is attached to the weight lifter bar/long handled wrench, lift and move the weight onto wood blocks. Be sure the wood blocks are clean so they will not damage the weights. Unthread the lift eye and threaded rod from the weight lifting bar/long handled wrench and remove them from the weight.

9- Remove the bottom weight plate, number 14, from the box and place it in position where the Calibrator is to be installed. The bottom weight plate has the foot pads and bottom weight spacers already attached. All weight plates should be positioned so the air supply connection will be on the right as you face the Calibrator. After the bottom weight plate is in position it must be leveled. The foot pad is adjustable to level the Calibrator (See drawing 774000-03).

10- Next move the 1,000 lbf weight from the wood blocks onto the bottom weight plate. Insert the bottom lifter rod, number 14, through the bottom of the weight with the male threads pointing up and attach the 7/8"-14 lift eye to the lifter rod and move the weight into position. Be sure to center the weight on the bottom weight plate when it is placed in position. After the weight and 1,000 lbf lifter have been moved into position remove the 7/8"-14 lift eye. It will be used to install the other weights. When removing the lift eye be sure the 1,000 lbf lifter rod is supported from the bottom so it does not drop on the floor. Place a few drops of Loctite 242 Threadlocker on the exposed thread of the 1,000 lbf lifter. This will help hold the lift rods together and help prevent them from coming loose during normal use.

11- Place the 500 lbf weight plate, number 13, in position on top of the bottom weight spacers. The weight plates weigh approximately 150 pounds each and should be manually lifted by two or three people. All weight plates should be positioned so the air supply connection will be on the right as you face the Calibrator. Position the weight plate so the shoulder of the weight spacer is approximately centered in the hole through each corner of the weight plate. The holes in each corner of the weight plate are larger than the shoulder of the weight spacer. Unscrew the (4) 500 weight spacers, labeled 13, from the Box #2 and screw them onto the bottom spacers. Hand tighten each spacer then loosen 1/4 turn.



Hand Tighten Spacer & Loosen ¼ Turn

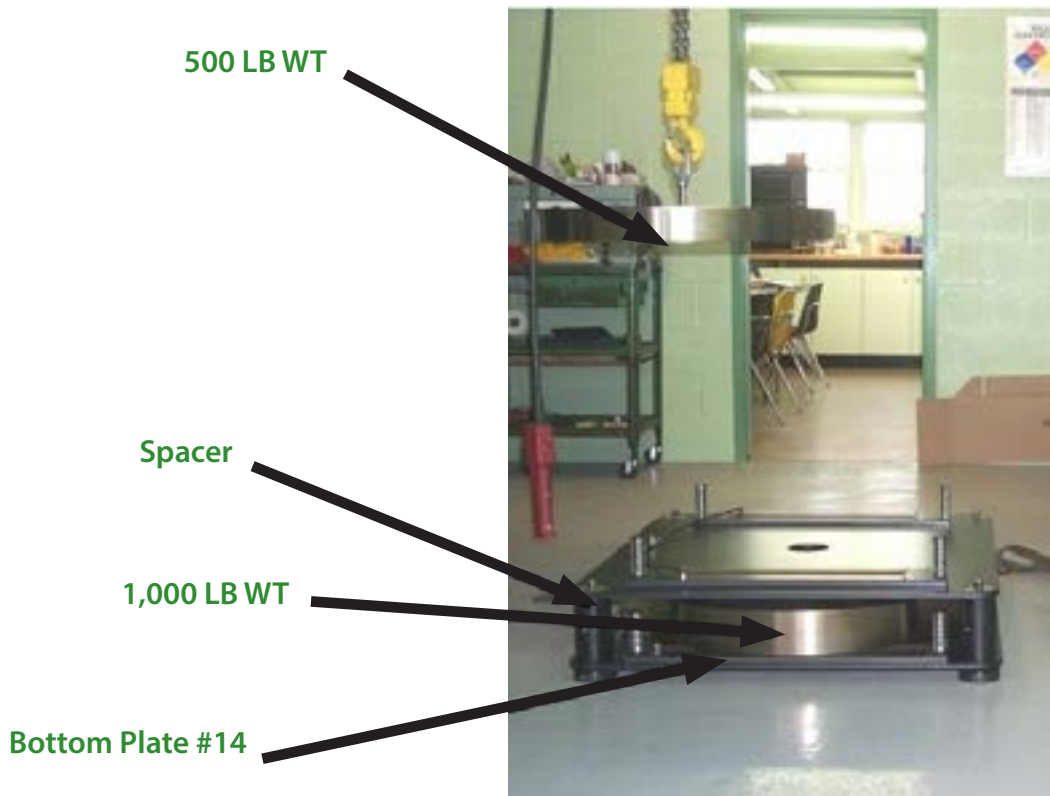
12- Next move the 500 lbf weight from the wood blocks onto its weight plate. Insert the bottom lifter rod, number 13, through the bottom of the weight with the male threads pointing up and attach the 7/8"-14 lift eye to the lifter rod and move the weight into position. Be sure to center the weight on its plate when it is placed in position. After the weight and 500 lbf lifter rod have been moved into position remove the 7/8"-14 to 3/4"-10 Adapter. It will be used to install the other weights. Place a few drops of Loctite 242 Threadlocker of the exposed thread of the 500 lbf lifter. This will help hold the lift rods together and help prevent them from coming loose during normal use.



7/8"-14 Lift Eye Attached to Lift Rod #13



Lifter Rod Placed through the Center Weight Hole



13- Connect the 500 lbf weight lifter rod, number 13, to weight lifter rod on level 14. Screw the weight lifter rods together by turning the wrench fl t located on the weight lifter rod directly above the last weight installed while holding the wrench fl t on the weight lifter rod of the weight directly below. Tighten to approximately 100 to 150 foot pounds of torque. If a torque wrench is not available tightening hand tight and then using the wrenches to tighten an additional quarter turn should approximate the correct torque. The weight lifter bar/long handled wrench is used to hold the wrench fl t of the lower lifter. **Be careful not to cross thread as this will damage the threads on the lifter rods.**

Note: Wrench fl t is held with one hand while the other hand turns & tightens the two lift rods together. A wrench should then be used to tighten lift rods before the next plate is installed.



#13 Lift Rod

14- Lift the 200 lbf weight from the Box #2 using the weight lifter bar/long handled wrench, 7/8"-14 lift eye, and 7/8"-14 threaded rod. Slide the weight lifter bar/long handled wrench under the weight. **Be careful not to scratch or damage the weight.** Attach the 7/8"-14 lift eye to the threaded rod and place it through the hole in the center of the weight and screw it into the weight lifter bar/long handled wrench. After the lift eye is attached to the weight lifter bar/long handled wrench, lift and move the weight onto wood blocks. **Be sure the wood blocks are clean so they will not damage the weights.** Unthread the lift eye and threaded rod from the weight lifting bar/long handled wrench and remove them from the weight.



200 LB WT Lifted

15- Remove the 200 lbf weight plate, number 12, from Box #2 and move it to position on top of the spacers for level 13. The weight plates weigh approximately 150 pounds each and should be manually lifted by two or three people. **All weight plates should be positioned so the air supply connection will be on the right as you face the Calibrator.** Position the weight plate so the shoulder of the weight spacer is approximately centered in the hole through each corner of the weight plate. The holes in each corner of the weight plate are larger than the shoulder of the weight spacer. Next unscrew the (4) 200 lbf weight spacers, labeled 12, from the stack of parts in Box #2 and attach them to the weight spacers on level 13. Hand tighten each spacer then loosen 1/4 turn as it is initially installed.



Plate # 12 Put in Place



200 LB WT Lowered
on to Lifter Pan

16- Next move the 200 lbf weight from the wood blocks onto its weight plate, number 12. Insert the 200 lbf lifter rod, number 12, through the bottom of the weight with the male threads pointing up and attach the 7/8"-14 lift eye to the lifter rod and move the weight into position. Be sure to center the weight on its plate when it is placed in position. **After the weight and 200 lbf lifter rod have been moved into position remove the 7/8"-14 lift eye. It will be used to install the other weights.** Place a few drops of Loctite 242 Threadlocker of the exposed thread of the 200 lbf lifter. This will help hold the lift rods together and help prevent them from coming loose during normal use.

17- Connect the 200 lbf weight lifter rod, number 12, to the weight lifter rod on level 13. Screw the weight lifter rods together by turning the wrench fl t located on the weight lifter rod directly above the last weight installed while holding the wrench fl t on the weight lifter rod of the weight directly below. Tighten to approximately 100 to 150 foot pounds of torque. If a torque wrench is not available tightening hand tight and than using the wrenches to tighten an additional quarter turn should approximate the correct torque. The weight lifter bar/ long handled wrench is used to hold the wrench fl t of the lower lifter. **Be careful not to cross thread as this will damage the threads on the lifter rods.**

18- Remove the 100 lbf weights from Box #1. Move the 100 lbf weights onto wood blocks. **Be sure the wood blocks are clean so they will not damage the weights.** These weights should be able to be moved by one or two people. If they are too heavy to be moved manually they can be moved using the procedure described in 5.0 above. Handle the weights carefully so as not to damage or scratch them.

19- Place the 100 lbf weight plate, number 11, in position on top of the spacers for level 12. **All weight plates should be positioned so the air supply connection will be on the right as you face the Calibrator.** Position the weight plate so the shoulder of the weight spacer is approximately centered in the hole through each corner of the weight plate. The holes in each corner of the weight plate are larger than the shoulder of the weight spacer. Attach the (4) 100 lbf weight spacers, labeled for level 11, to the weight spacers on level 12. Hand tighten each spacer then loosen 1/4 turn as it is initially installed.

20- Remove the 100 lbf weight plate, number 11, from Box #2 and move it to position on top of the spacers for level 12. **The weight plates weigh approximately 150 pounds each and should be manually lifted by two or three people.** All weight plates should be positioned so the air supply connection will be on the right as you face the Calibrator. Next unscrew the (4) 100 lbf weight spacers, labeled 11, from the stack of parts in Box #2 and attach them to the weight spacers on level 12. Hand tighten each spacer then loosen 1/4 turn as it is initially installed.

21- Next move the 100 lbf weight, number -11, from the wood blocks onto its weight plate, number 11. Insert the 100 lbf lifter rod, number 11, through the bottom of the weight with the male threads pointing up. Attach the 7/8"-14 lift eye to the lift rod and move the weight into position. Be sure to center the weight on its plate when it is placed in position. **After the weight and 100 lbf lifter rod have been moved into position remove the 7/8"-14 lift eye. It will be used to install the other weights.** Place a few drops of Loctite 242 Threadlocker on the exposed thread of the lifter rod. This will help hold the lift rods together and help prevent them from coming loose during normal use.

22- Connect the 100 lbf weight lifter rod, number 11, to the weight lifter rod on level 12. Screw the weight lifter rods together by turning the wrench flange located on the weight lifter rod directly above the last weight installed while holding the wrench flange on the weight lifter rod of the weight directly below. Tighten to approximately 100 to 150 foot pounds of torque. If a torque wrench is not available tightening hand tight and then using the wrenches to tighten an additional quarter turn should approximate the correct torque. The weight lifter bar/long handled wrench is used to hold the wrench flange of the lower lifter. **Be careful not to cross thread or as this will damage the threads on the lifter rods.**

23- Repeat steps 20 thru 22 to install the weight plate and spacers for level 10 and the 100 lbf weight, number 10. Position each weight plate so the shoulder of the weight spacer is approximately centered in the hole through each corner of the weight plate. The holes in each corner of each weight plate are larger than the shoulder of the weight spacer.

24- Remove the 50 lbf weight from Box #1. Move the 50 lbf weight onto wood blocks. Be sure the wood blocks are clean so they will not damage the weight. This weight should be able to be moved by one or two people. If it is too heavy to be moved manually, it can be moved using the procedure described in 5.0 above. Handle the weight carefully so as not to damage or scratch it.

25- Repeat steps 20 thru 22 to install the weight plate and spacers for level 9 and the 50 lbf weight. Position each weight plate so the shoulder of the weight spacer is approximately centered in the hole through each corner of the weight plate. The holes in each corner of each weight plate are larger than the shoulder of the weight spacer. Install (4) compression springs over the shoulder screws of the lifter assembly (See Drawing 774000-08) before going to the next step.

26- Remove the 20 lbf weight from Box #1. Move the 20 lbf weight onto wood blocks. **Be sure the wood blocks are clean so they will not damage the weight.** This weight can be moved by one person. Handle the weight carefully so as not to damage or scratch it.

27- Repeat steps 20 thru 22 to install the weight plate

28- Remove the 10 lbf weights from Box #1. Move the 10 lbf weights onto wood blocks. **Be sure the wood blocks are clean so they will not damage the weights.** These weights should be able to be moved by one person. Handle the weights carefully so as not to damage or scratch them.

29- Repeat steps 20 thru 22 to install the weight plate and spacers for level 7 and the 10 lbf weight, number –7. Position each weight plate so the shoulder of the weight spacer is approximately centered in the hole through each corner of the weight plate. The holes in each corner of each weight plate are larger than the shoulder of the weight spacer. Install (4) compression springs over the shoulder screws of the lifter assembly (See Drawing 774000-08) before going to the next step.

30- Repeat steps 20 thru 22 to install the weight plate and the 10 lbf weight, number –6. Position each weight plate so the shoulder of the weight spacer is approximately centered in the hole through each corner of the weight plate. The holes in each corner of each weight plate are larger than the shoulder of the weight spacer. Install (4) compression springs over the shoulder screws of the lifter assembly (See Drawing 774000-08) before going to the next step.



Upper Assembly with Lift Straps



Base of Machine



- 31-** After level 6 is installed attach the (4) top weight spacers, labeled 6, to the spacers on level 7. Hand tighten each spacer then loosen 1/4 turn as it is initially installed.
- 32-** Lift the upper assembly and place it over the spacers that were installed on level 6. After the upper assembly is in place attach it two the spacers on level 6 using (3) $\frac{3}{4}$ "-16 x 1.5" long socket head cap screws and (1) $\frac{3}{4}$ "-16 x 1.25" long fl t socket head cap screw. The $\frac{3}{4}$ "-16 x 1.25" long fl t socket head cap screw is used in the front right corner, as you face the Calibrator, directly under where the hand pump will be attached. After the upper assembly is in place and all screws tightened, attach the hand pump to the top plate.
- 33-** After the upper assembly is attached check to be sure the sides of weight plates, numbers 6 through 13, do not extend beyond the sides of the bottom plate or upper assembly plate. Any weight plate extending beyond the sides of the bottom weight plate or upper assembly plate should be repositioned so its sided do not extend beyond the sides of the bottom weight plate or upper assembly plate. After all weight plates are properly positioned tighten the weight spacers on each level using the spanner wrench which has been provided. Start with the weight spacers on level 14. After all the spacers on level 14 are tight, proceed to level 13, then to level 12, and so on until the spacers on all levels are tight.
- 34-** Attach the upper yoke section to the top lift rod, number 6. First remove the two anti-rotation pins from the upper assembly. Then screw the upper section into the top lift rod, number 6. After the top yoke section is assembled put the anti-rotation pins back in place on the upper assembly.
- 35-** Feed the air lines from the weight control thru the holes in the upper assembly and the holes in the weight plates to each level. Attach each airline to the lifter assemblies on the appropriate level.

Air Lines Feed-Thru



Air Lines Feed-Thru

36- Connect an air supply to the regulators. The regulator has a 1/4-18 female pipe thread. The calibrator requires a clean air supply, must be inert gas, between 30 and 120 psi. With all weights raised the calibrator's compressed air regulator should be set at approximately 14 psi. This setting was made at the factory prior to shipping. However, it may need to be adjusted depending on conditions at the place of installation. Adjust the air pressure as needed in accordance with the instructions in the "Maintenance & Repair" section of this Manual.

37- Set-up the Calibrator, as described in the "Operating Instructions" section of this Manual, with an aircraft cable capable of supporting 2,000 lbf. After the setup has been made, apply all the weights contained in the Calibrator. This will align all the weights. **Be sure to adjust the position of the yoke as needed to compensate for any cable stretch.**

38- With all the weights applied and the yoke properly adjusted, check to be sure there is clearance between the bottom of each weight and the top of the lifter plates. If any of the weights are touching the lifter plates check to be sure all the lifter rods and spacers are completely screwed together.

39- Next apply and remove each weight one at a time. As each weight is applied check to be sure the switch being activated causes the proper weight to apply and remove.

40- The Calibrator is now ready for use

Maintenance & Repair

1- The calibrator should be isolated from vibration. Dust, dirt, and foreign objects should be kept off the weights, yoke assembly, and loading control system.

2- Through normal use the weights in the Calibrator become misaligned. To realign the weights, set-up the Calibrator as described in the "Operating Instructions" section of this Manual with an aircraft cable capable of supporting 2,000 lbf. After the setup has been made, apply all the weights contained in the Calibrator. This will align all the weights. Be sure to adjust the position of the yoke as needed to compensate for any cable stretch.

3- There is an air regulator with pressure gauge supplied with this calibrator. The air regulator requires a supply of clean shop air between 30 and 120 psi.

To protect the calibrator and air regulator from damage that could be caused by a contaminated air supply the regulator has excellent water removal efficiency. The regulator uses a bowl to collect water. The bowl should be drained daily, or as needed, to keep accumulated liquids below the baffle.

With all weights raised the air regulator should be set at approximately 14 psi.

3.1- Before turning on system pressure, turn the regulator adjustment counterclockwise until all load is removed from the regulating spring.

3.2- Turn on system pressure and turn regulator adjustment clockwise until the desired outlet pressure is reached.

3.3- To avoid minor adjustments after making a change in pressure settings always approach the desired pressure from a lower pressure setting. When reducing from a higher to a lower setting, first reduce to a pressure less than that desired, then bring it up to the desired pressure.

4- Tightness of the lift rods should be checked prior to each use. Through normal use the lift rods may become loose. With the weights applied, there should be clearance between the bottom of the weights and the top of the lifter plates. If any of the weights touch the lifter plates, the lift rods will need to be tightened. Check the weight lifter rods on each level. Use the weight lifter bar/long handled lifter wrench to tighten the weight lifter rods to approximately 100 to 150 foot pounds of torque. If a torque wrench is not available, tighten hand tight, then use the wrenches to tighten an additional quarter turn. This should approximate the correct torque. Turn the wrench flange located on the weight lifter rod directly above a weight while holding the wrench flange on the weight lifter rod of the weight directly below. Start at the bottom and work towards the top.

5- An Enerpac P141 Hand Pump is supplied with the Calibrator. The hand pump is used to control the hydraulic lifting mechanism used to compensate for differences and stretch in cables.

5.1- The oil level of the hand pump should be checked monthly, or as needed. Following is the procedure to add oil to the hand pump

5.1.1- Always add oil with cylinders fully retracted.

5.1.2- To add oil first remove the vent /fill cap from the reservoir.

5.1.3- Fill reservoir only to level mark shown on back of pump. Enerpac hydraulic oil is recommended. Air is required in the reservoir to function properly. If the reservoir is completely filled, a vacuum will form and prevent the pump from functioning properly.

5.1.4- Return the vent/fill cap to the reservoir.

5.2- The oil in the hand pump should be changed every 12 months according to the following procedure:

5.2.1- Remove pump from the upper assembly of Calibrator.

5.2.2- Remove vent/fill cap from reservoir.

5.2.3- Tilt pump to drain out old oil.

5.2.4- Fill reservoir only to level shown of back of pump. Enerpac hydraulic oil is recommended.

5.2.4- Return the vent/fill cap to the reservoir and reattach pump to Calibrator's upper assembly.

5.3- Removing air from the hydraulic system will help the cylinder to advance and retract smoothly. Following is the procedure to remove air:

5.3.1- Remove pump from the plate of Calibrator.

5.3.2- Position pump at a higher elevation than the cylinders.

5.3.3- With the relief valve closed operate the pump to fully extend cylinders.

5.3.4- Open release valve to retract cylinder. This will force the trapped air to move into the pump reservoir where it is vented.

5.3.5- Add oil if necessary and repeat above steps as necessary.

Warranty or Repair Contact Information:

Contact information in footer, or Email: info@mhforce.com

Calibration

- 1-** The Calibrator can be calibrated throughout its entire range, from 10 to 2,000 lbf in one pound increments using a tension type, secondary transfer standard of the appropriate range, stability, and accuracy. To calibrate the system, the transfer standard is suspended in the upper frame assembly of the Calibrator, and attached to the yoke assembly. Weights are applied to the transfer standard as desired.
- 2-** Because each weight is individually supported, and the Calibrator's control allows the selection, application, or removal of any individual weight, or combination of weights contained within the Calibrator's frame, the weights can be inter-compared without removing them from the Calibrator.
- 3-** The Calibrator can be disassembled allowing the weights, including the yoke assembly, to be removed from the Calibrator for calibration.

Parts List for 60K lbf Aircraft Scale Calibrator (1-84)

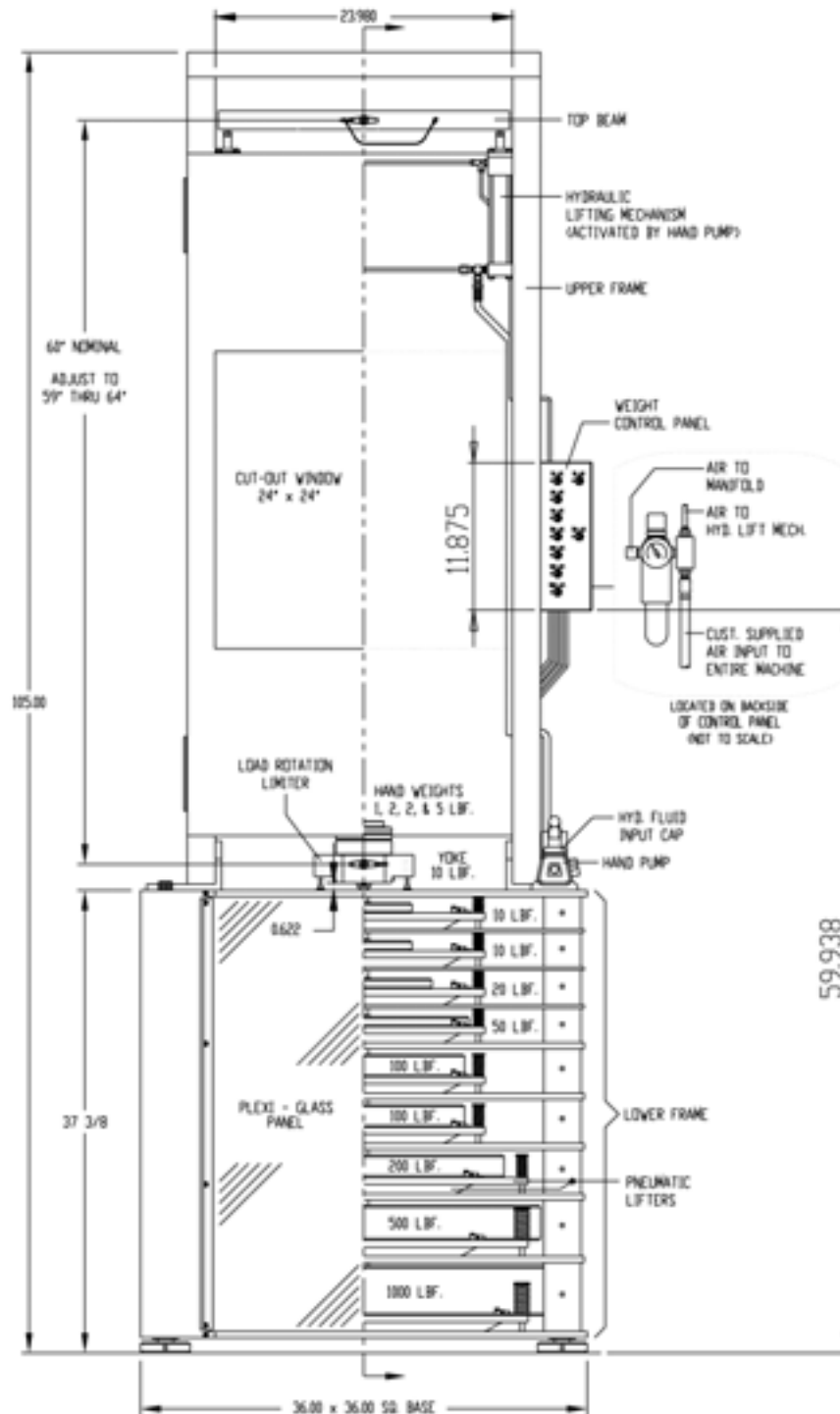
Item	Part No.	Description	Quantity
1	774001	Foot Pad	4
2	774002	Bottom Plate	1
3	774003	Middle Plate	1
4	774004	500 lbf Weight Plate	1
5	774005	200 lbf Weight Plate	1
6	774006	Bottom Weight Spacer	4
7	774007	500 lbf Weight Spacer	4
8	774008	4.0625" Pitch Spacer	12
9	774009	3.0625" Pitch Spacer	12
10	774010	Top Weight Spacer	4
11	774011	50/100 lbf Weight Plate	3
12	774012	10/20 lbf Weight Plate	3
13	774013	Valve Stem for Lifter	18
14	774014	1,000 lbf Lifter Plate	2
15	774015	1,000 lbf Lifter Plate Hose	2
16	774016	4.1875" Lifter Plate Clamp	8
17	774017	500 lbf Lifter Plate	2
18	774018	500 lbf Lifter Plate Hose	2
19	774019	200 lbf Lifter Plate	2
20	774020	200 Lifter Plate Hose	2
21	774021	Small Lifter Plate	12
22	774022	Small Lifter Plate Hose	12
23	774023	2.3125" Lifter Plate Clamp	28
24	774024	Large Lifter Stop	8
25	774025	Small Lifter Stop	12
29	774029	Top Beam	1
31	774031	Yoke	1
40	774040	Upper Frame Door – Front	1
41	774041	Upper Frame Cover – Back	2
42	774042	Lower Frame Side Covers	2
43	774043	Lower Frame Plexi-glass Clamps	4
44	774044	Plexi-glass panels	2
45	774045	Weight Control Pa	1
46	774046	Manifold	1
47	774047	Anti-Rotation Pin	2
48	774048	Spacer Bar	1

Parts List for 60K lbf Aircraft Scale Calibrator (1-84)

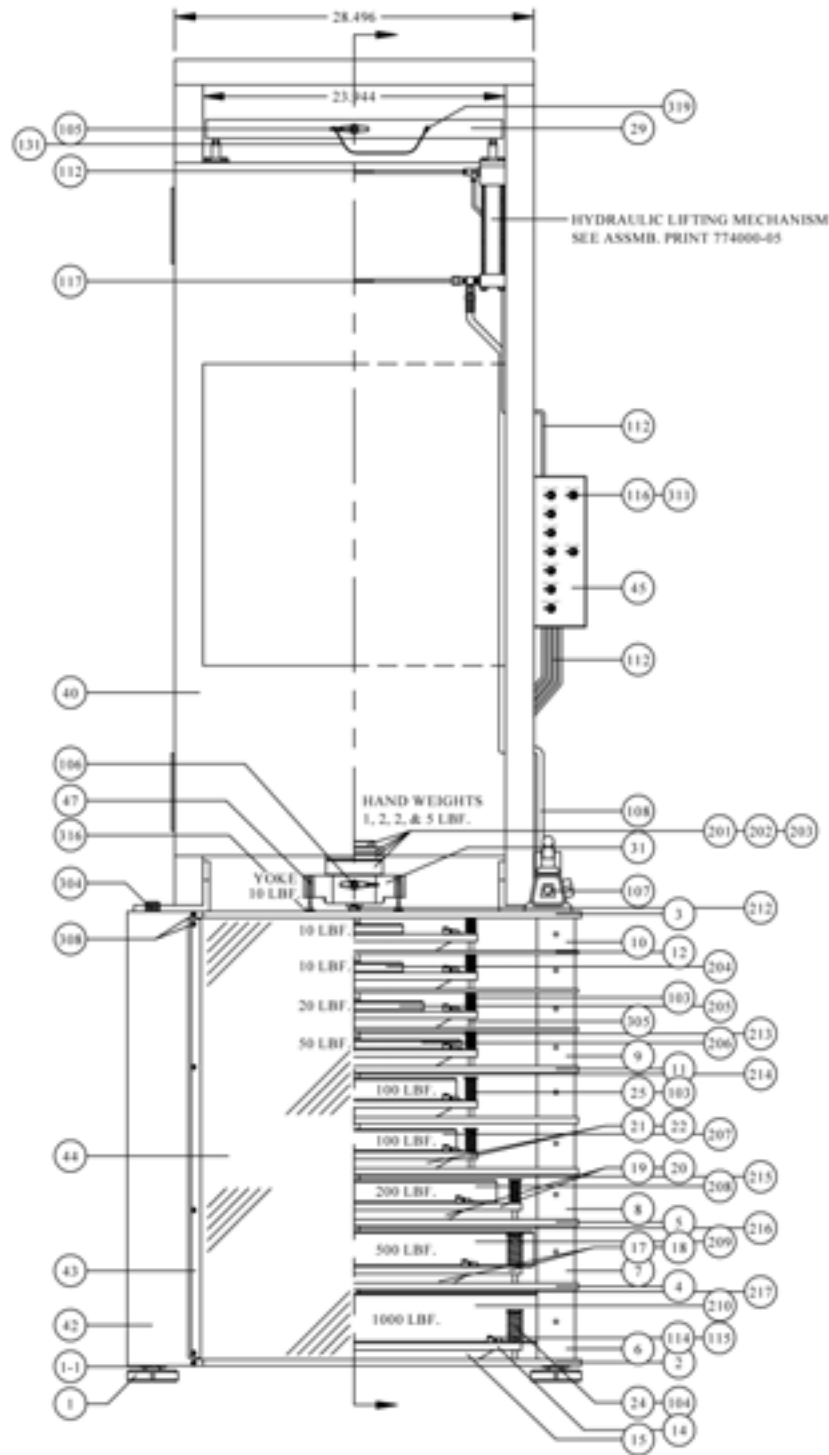
Item	Part No.	Description	Quantity
103		Lee LC-100K-8 Springs	28
104		Lee LHC-162N-3 Springs	8
105		Detent Pin for Top Beam (CL-8-BLPT-3.0)	1
106		Detent Pin for Yoke (CL-8-BLPT-1.5)	1
107		Enerpac Hand Pump P141	1
108		Hydraulic Hose Assembly	1
109		Air Regulator (SMC #NAW2000-NO2-1C)	1
110		Pressure Gauge (SMC #4358509)	1
111		Union Tee	9
112		1/4" PE Black Tubing	1 Roll
114		Connector Barbs	36
115		Swivel L	34
116		Pneumatic Switch	9
117		Hydraulic Tubing – Steel	3
123		1/4"-18 NPT End Cap	1
125		Male Conn	2
126		Branch T (Penn Air T9-444)	1
127		1/4" x 2.5" Pipe Nipple	1
128		1/4" ST Elbow	3
129		Elbow	1
130		Branch T	2
131		Retaining Wire for Detent Pin (21kA12.0 Max)	1
132		Cable Clamps (Keystone 8163)	2
133		Right Side Cylinder (Hana MS4 3ANC 1.50 K09681202)	1
134		Left Side Cylinder (Hana MS4 3ANC 1.50 K09681201)	1
135		Compression Fitting	2
136		Compression Fitting	2
137		Branch T	1
138		Elbow	1
139		Wave Spring	1
140		Retaining Spring	1
143		Magnetic Catch	3

Parts List for 60K lbf Aircraft Scale Calibrator (1-84)

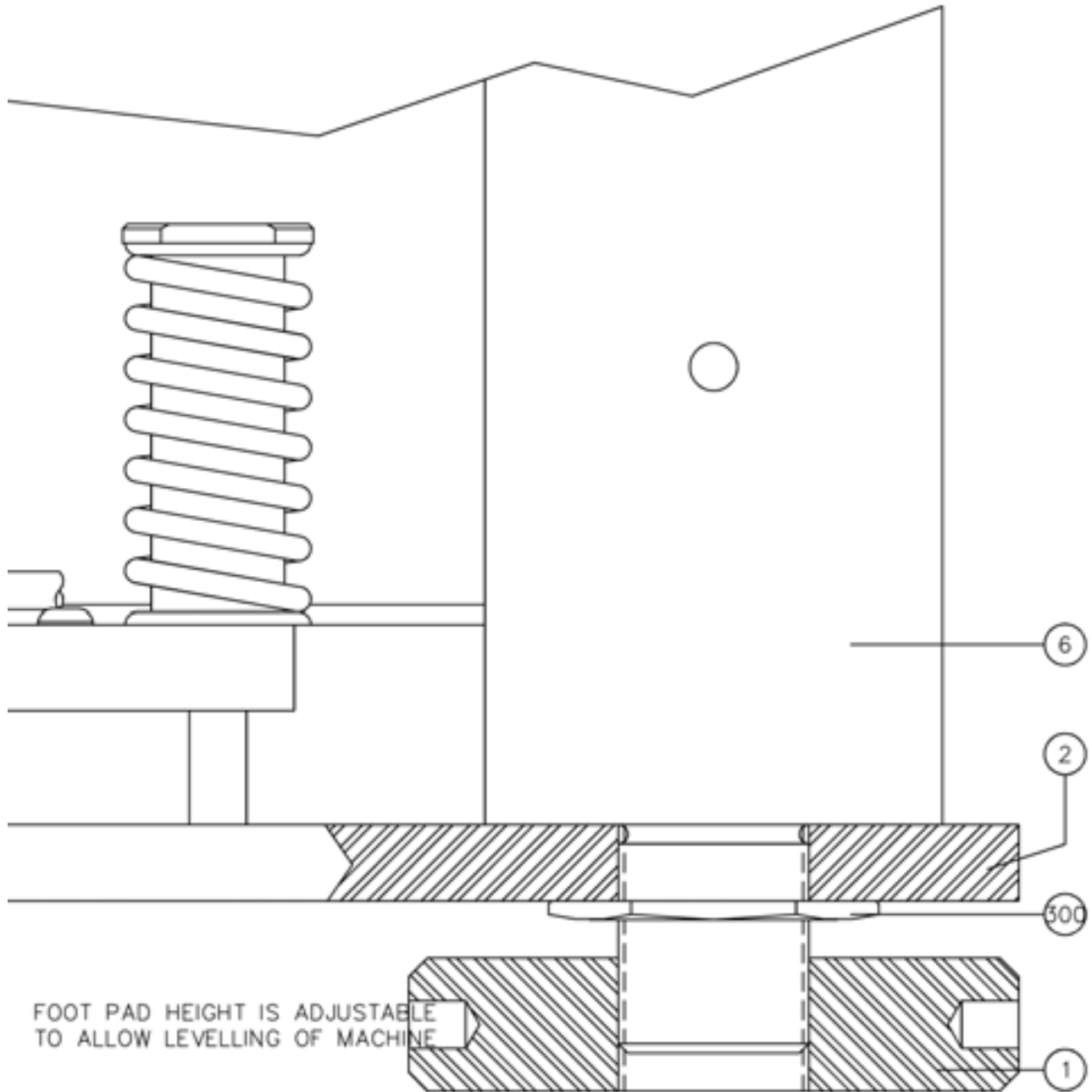
Item	Part No.	Description	Quantity
201	774201	1 lbf Hand Weight	1
202	774202	2 lbf Hand Weight	2
203	774203	5 lbf Hand Weight	1
204	774204	10 lbf Weight	2
205	774205	20 lbf Weight	1
206	774206	50 lbf Weight	1
207	774207	100 lbf Weight	2
208	774208	200 lbf Weight	1
209	774209	500 lbf Weight	1
210	774210	1,000 lbf Weight	1
212	774212	Top Lifter Rod	1
213	774213	3.0625" Pitch Lifter Rod	3
214	774214	3.3125" Pitch Lifter Rod	1
215	774215	4.0625" Pitch Lifter Rod	2
216	774216	4.8125" Pitch Lifter Rod	1
217	774217	Bottom Lifter Rod	1
304		3/4"-16 x 1.5" Socket Hd Cap Screws	3
305		3/8" x 1.5" Socket Hd Shoulder Screws	16
307		3/4"-16 x 1" Flat Socket Hd Screw	1
308		#10-32 x 3/8" Pan Hd Phillips Machine Screws	70
309		1/4"-20 x 3/8" Pan Hd Phillips Machine Screws	4
310		#10-32 x 1/2" Torx Button Hd Cap Screws	80
311		Dress Plate Nuts	9
312		3/8"-16 x 3/4" Socket Hd Cap Screws	2
313		5/16"-24 Hex Jam Nuts	18
316		3/4" OD x 3/8" ID x 1/16" Fiber Washers	2
317		1/4"-20 x 5/16" Hex Hd Bolts	2
318		1/4" SAE Flat Washers	2
319		#6-32 x 1/4" Pan Hd Screws	1



Drawing 774000-01

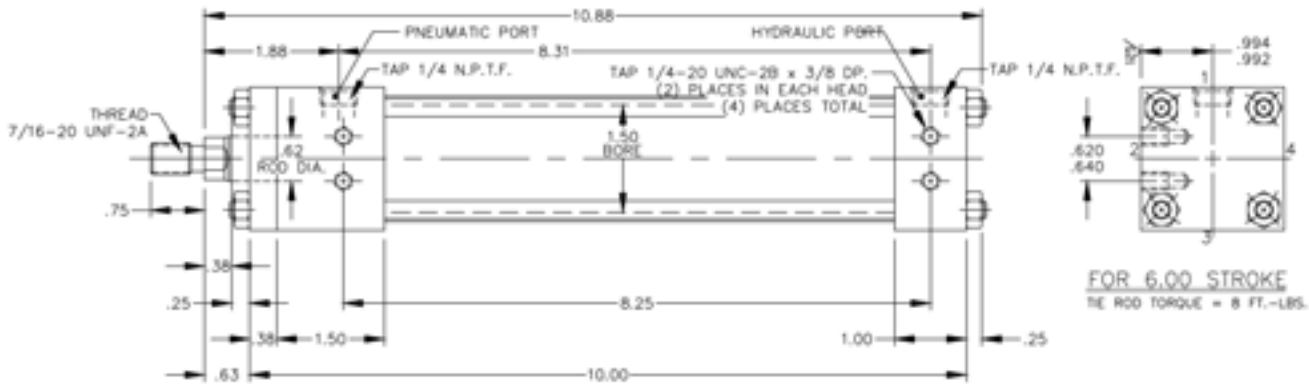


Drawing 774000-02



Drawing 774000-03

RIGHT-SIDE HYDRAULIC PISTON ASSEMBLY - PART NUMBER: 774133



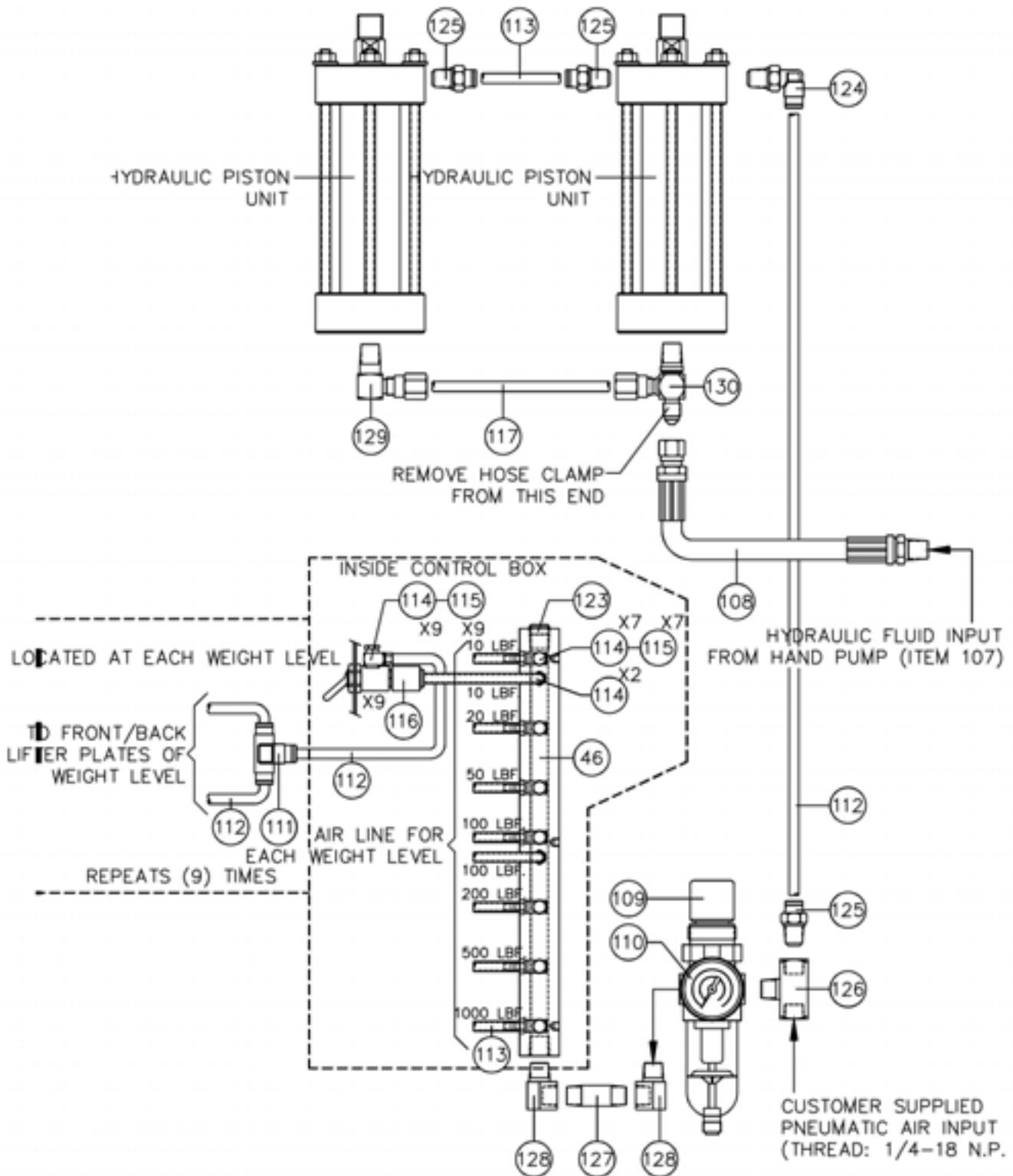
NOTE:

RIGHT-SIDE HYDRAULIC PISTON ASSEMBLY - PART NUMBER: 774133 (HANNA CORP. # K09681201) - 996720 - ALLEGHENY YORK
 LEFT-SIDE HYDRAULIC PISTON ASSEMBLY - PART NUMBER: 774134 (HANNA CORP. # K09681201) 717-266-6617
 LEFT SIDE IS IDENTICAL TO RIGHT-SIDE EXCEPT MOUNTING HOLES ARE A MIRROR IMAGE AND LOCATED ON SIDE 4 INSTEAD OF SIDE 2

ROD SEAL KIT - 706-00046-061 HANNA
 PISTON KIT - 706-00047-011 HANNA

NOTE: BOTH UNITS PNEUMATIC & HYDRAULIC PORTS WILL POINT TO THE REAR OF THE MACHINE WHEN ASSEMBLED TO FRAME

Drawing 774000-05



Drawing 774000-06

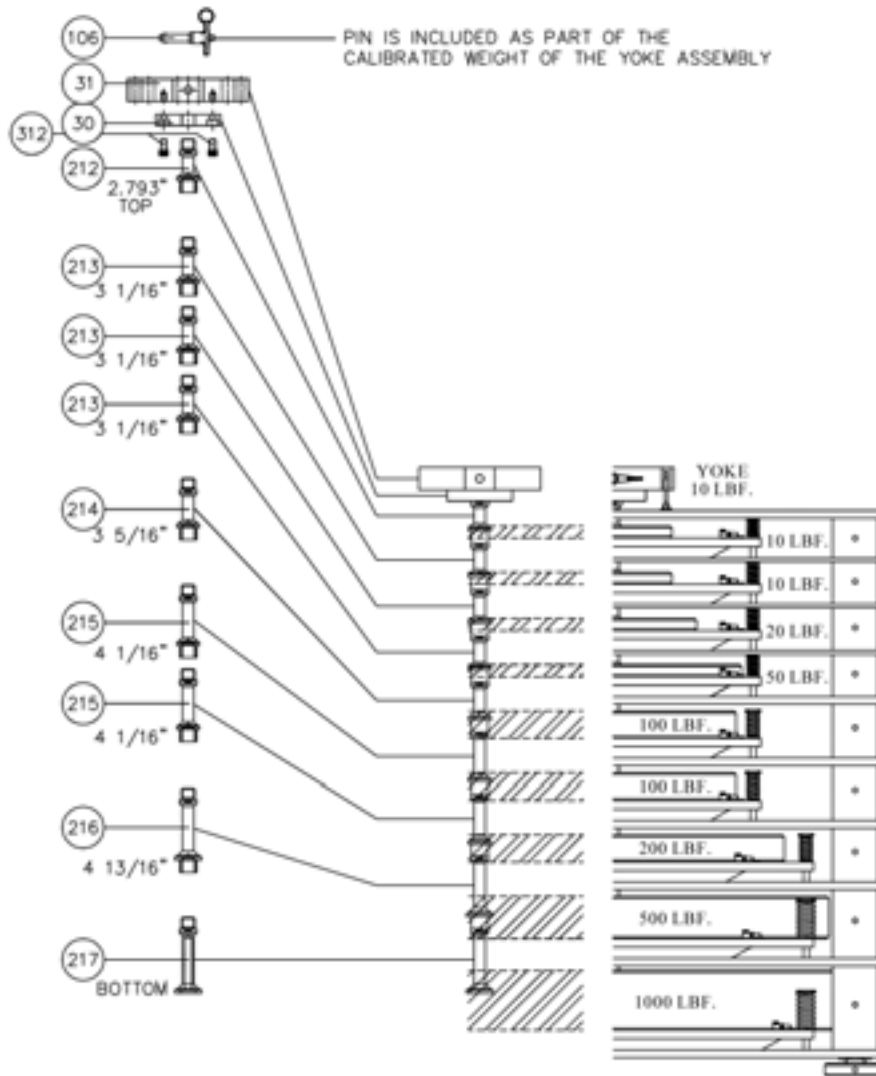
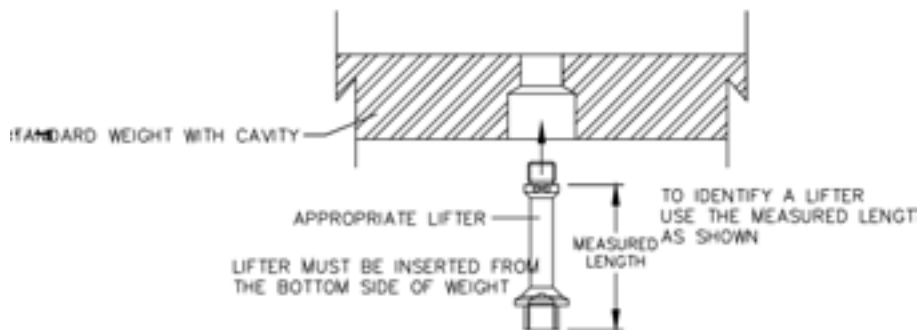
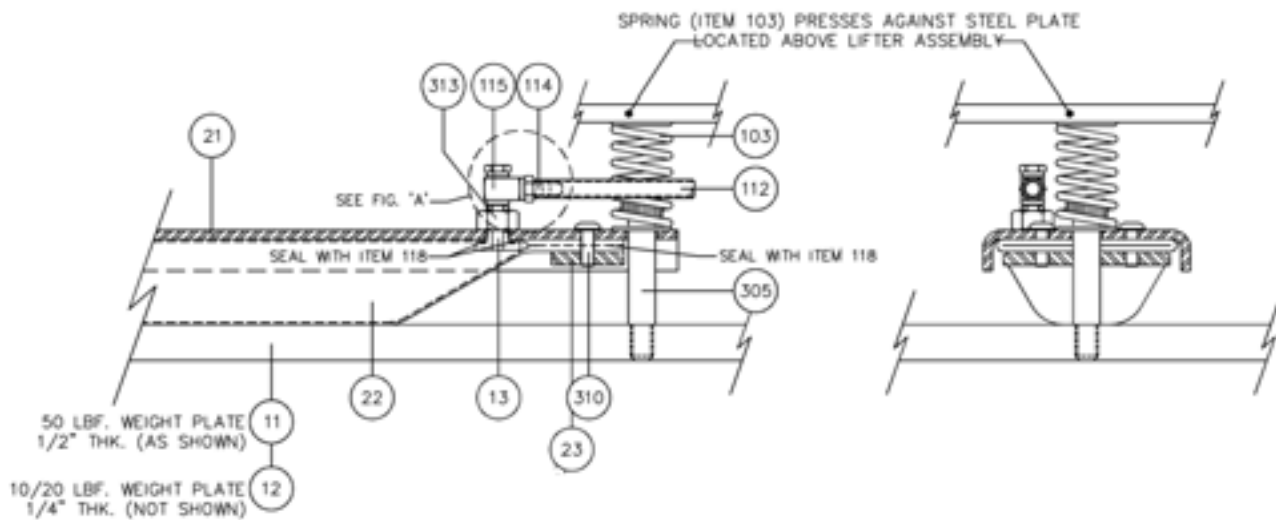
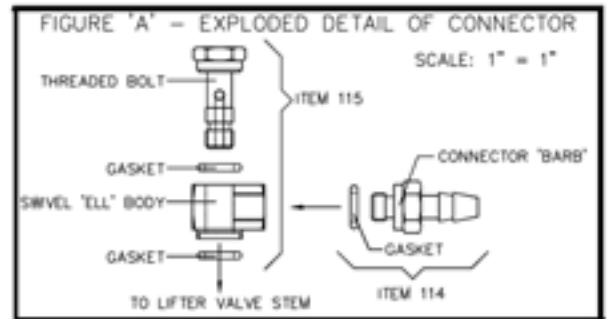


FIGURE 'A' - LIFTER INSERTION



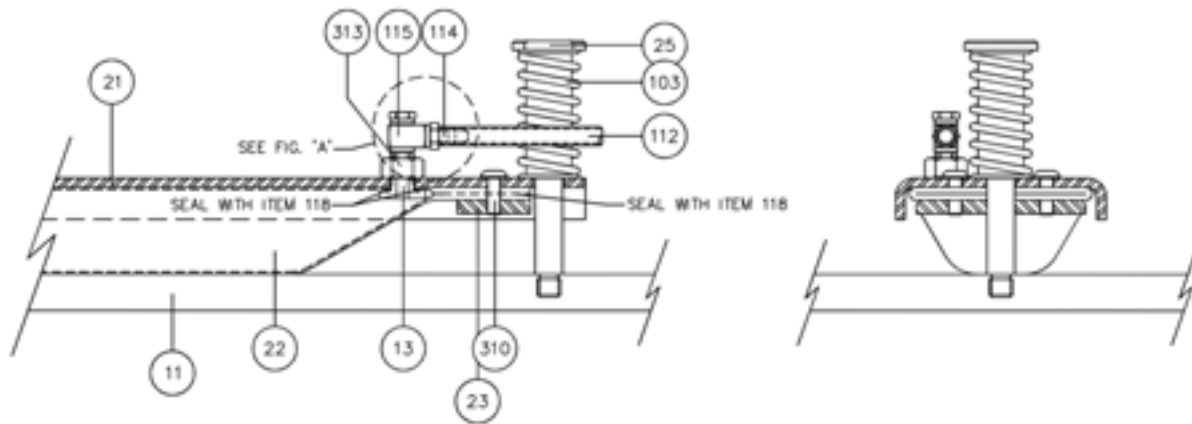
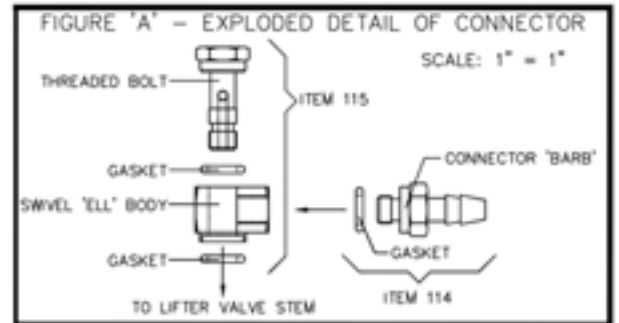
Drawing 774000-07

NOTE: SEAL ENDS OF HOSE (ITEM 22) & SEAL CLAMP SURFACE OF VALVE STEM (ITEM 13) WITH A VULCANIZED RUBBER PRODUCT (ITEM 118)



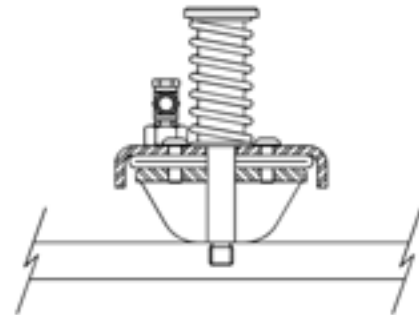
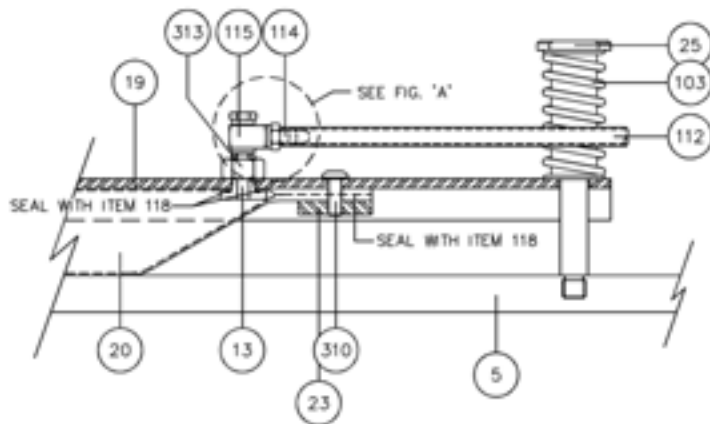
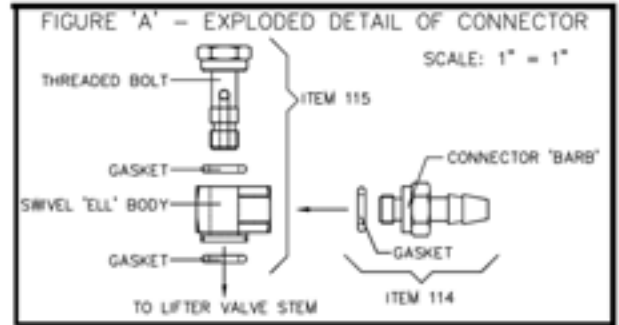
Drawing 774000-08

NOTE: SEAL ENDS OF HOSE (ITEM 22) & SEAL CLAMP SURFACE OF VALVE STEM (ITEM 13) WITH A VULCANIZED RUBBER PRODUCT (ITEM 118)



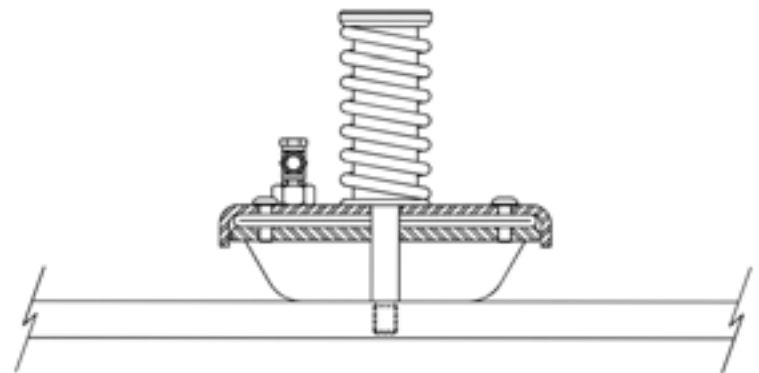
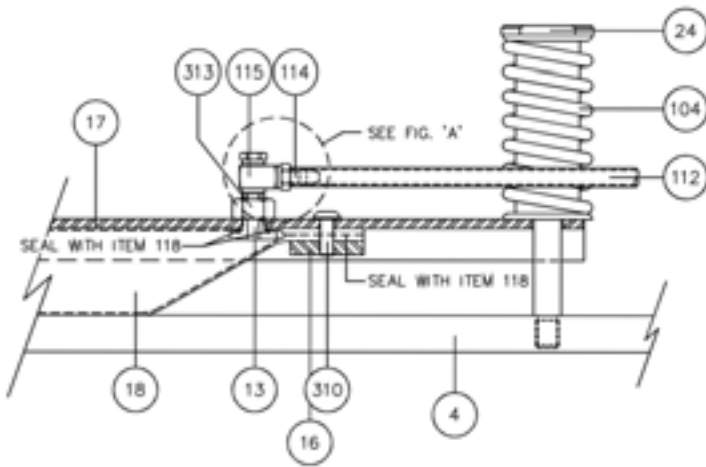
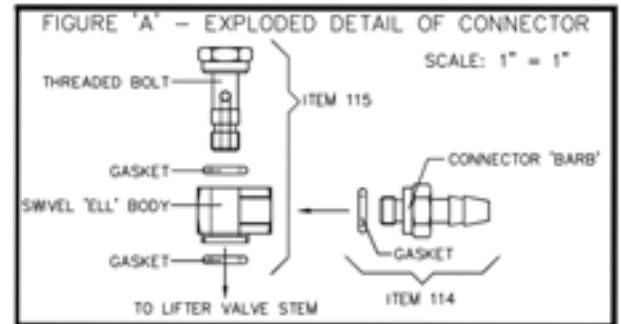
Drawing 774000-09

NOTE: SEAL ENDS OF HOSE (ITEM 20) & SEAL CLAMP SURFACE OF VALVE STEM (ITEM 13) WITH A VULCANIZED RUBBER PRODUCT (ITEM 118)



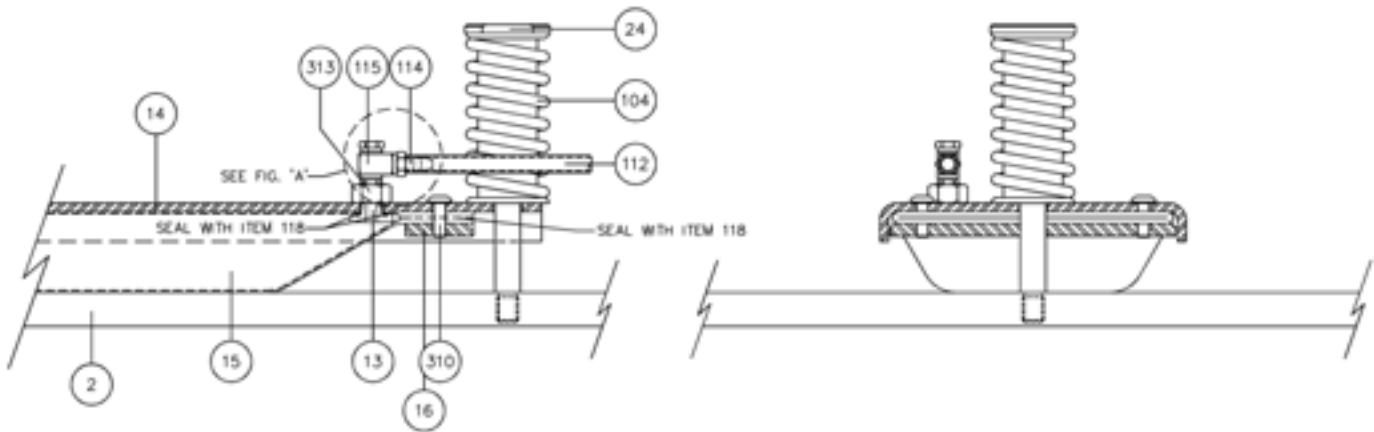
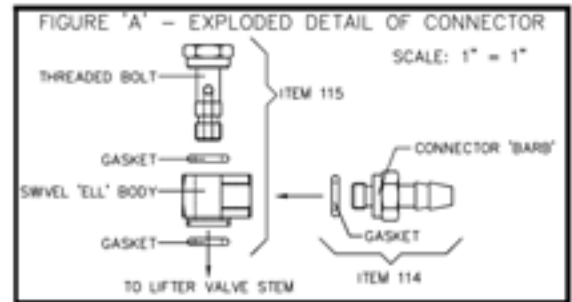
Drawing 774000-10

NOTE: SEAL ENDS OF HOSE (ITEM 18) & SEAL CLAMP SURFACE OF VALVE STEM (ITEM 13) WITH A VULCANIZED RUBBER PRODUCT (ITEM 118)



Drawing 774000-11

NOTE: SEAL ENDS OF HOSE (ITEM 15) & SEAL CLAMP SURFACE OF VALVE STEM (ITEM 13) WITH A VULCANIZED RUBBER PRODUCT (ITEM 118)



Drawing 774000-12