Morehouse
THE FORCE IN CALIBRATION SINCE 1925

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Operation and Instruction Manual

Portable Calibrating Machine

Model: PCM-2MD

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1. Introduction

Morehouse Portable Calibrating Machine Model PCM-2MD is a force calibrating machine designed to calibrate a variety of force measuring instruments in compression or tension modes. The machine is capable of applying force up to 2000 lbf in both loading modes, and provides fine control for the user to apply the test target forces. The machine uses a high precision load cell as reference standard. Furthermore, Portable Calibrating Machine is equipped with a set of automatic alignment features to reduce misalignment errors in force calibration.

Depending on the type and capacity of the instruments needed to be calibrated by the user, various standard load cell capacities can be utilized to cover different ranges. The adjustment and force control on the machine is done manually by the user and the machine does not need any source of electrical power to operate. However, electrical power might be needed to take output reading from standard reference load cell or unit under test, depending on the instrument type.

Morehouse offers two sets of standard adapters which can be ordered to assist with calibration of a variety of force measuring instruments:

1. A set of tension member adapters to mount load cells, force gauges, and other similar instruments into the machine for tension force calibration. It should be noted that in any calibrating machine, a tension force cannot be applied accurately without proper tension adapters.
2. Set of L-Brackets designed specifically for calibrating handheld force gauges in both tension and compression. The L-Bracket kit includes multiple pieces with various mounting patterns and offsets to accommodate a large number of hand-held force gauges available on the market.

In addition to the adapters mentioned above, Morehouse offers several types of custom adapters that could be used in conjunction with the Portable Calibrating Machine such as clevises, rod ends, and compression adaptors.

2. Description

2.1 Components

A standard benchtop calibrator includes the following seperate components:
1. Main loading frame
2. Force standard reference load cell with electronic indicator
3. Compression bearing block
4. Compression ball seat adapter
5. Gray, yellow, and blue/white control springs
6. Custom cut protective case

2.2 Construction

Morehouse Portable Calibrating Machine is manufactured from high quality material and to high quality standards to provide users with a reliable and accurate force calibration system. The calibration force is generated by the means of a mechanical screw jack which applies force in both compression and tension modes. The jack is operated by turning the handwheel in the front side of the machine, and based on the direction of turning the handwheel, compression or tension calibration force is applied.

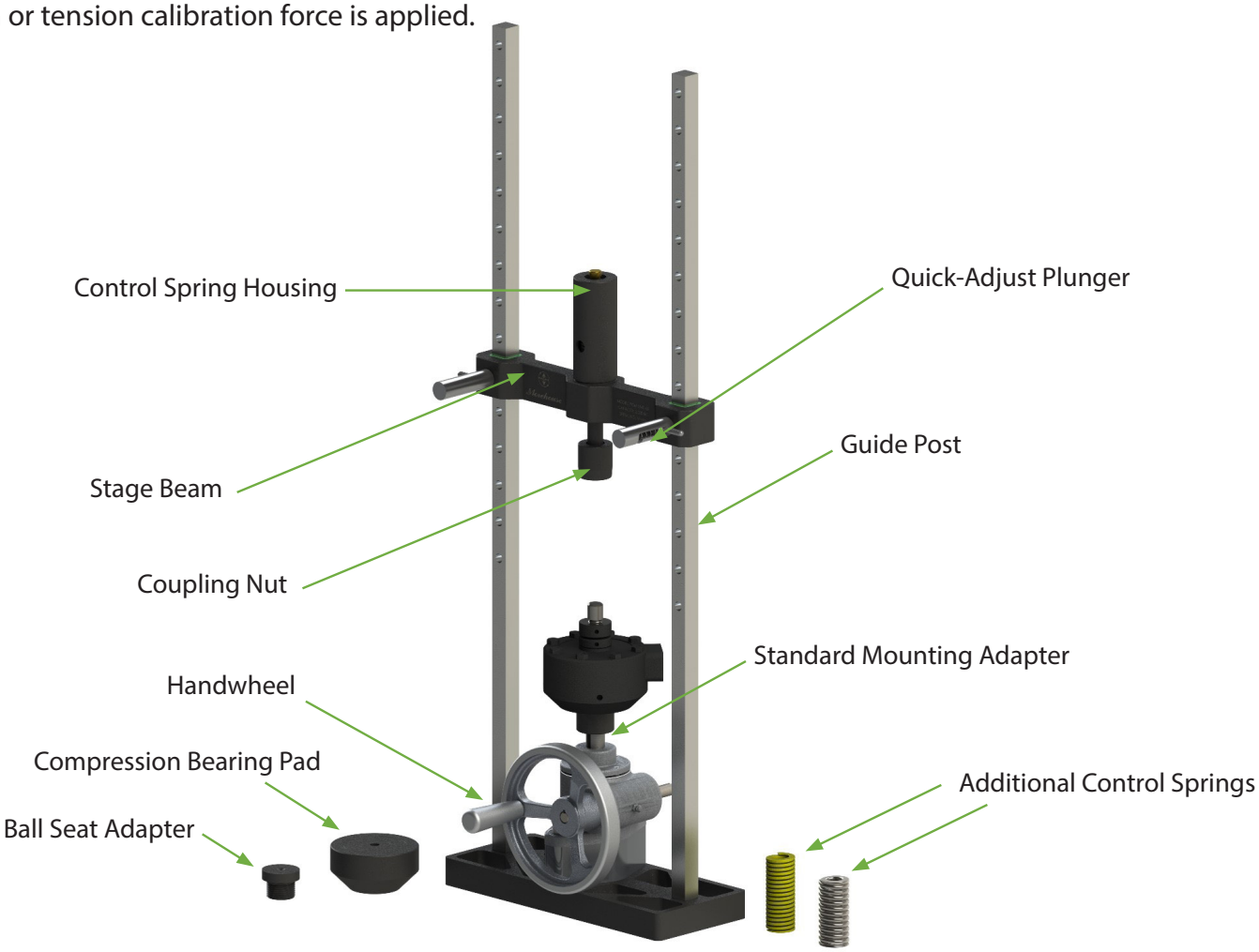

Figure 1: Standard Components of Morhouse Portable Calibrating Machine

The Portable Calibrating Machine is also equipped with a quick-adjust mechanism to change the calibration space based on the size of the equipment. This mechanism adjusts the position of the stage beam quickly, and independent of the loading jack. The stage beam can be repositioned by the user at 1.5 in. intervals when the machine is not under any calibration forces.

By default, Portable Calibrating Machines are assembled for right-hand configuration; meaning that the handwheel is located at the right side of the screw jack when standing in front of the machine. You can switch the machine to left-hand configuration by sliding the stage beam up and off the guide posts, rotating 180°, and sliding it back down onto the guide posts. Then loosen the set screw on the side of the handwheel, and slowly pull the handwheel out, and move the shaft key and handwheel to the other side of the machine, then tighten the set screw.

2.3 Dimensions and Weight

The Morehouse Portable Calibrating Machine weighs 40 lbs. Depending on the load cell standard, accessories, and cases that might be used with the machine, the overall weight may vary. Morehouse supplies the standard Portable Calibrating Machine model in a protective case with wheels which provides portability and contains the machine, load cell system component, and some adapters. Figure 2 presents the overall dimensions of the Portable Calibrating Machine.

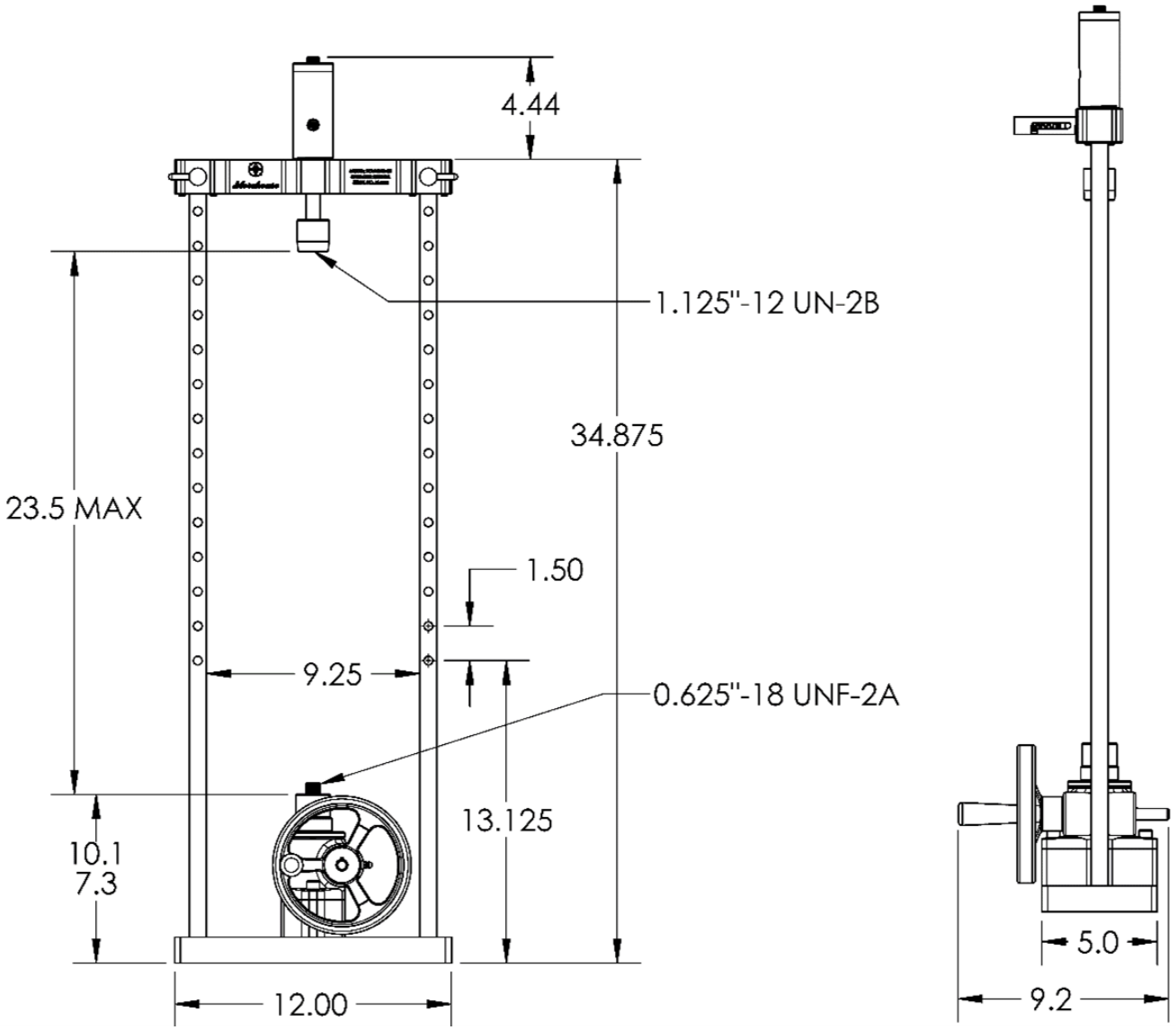

Figure 2: Dimensions of Portable Calibrating Machine (Model: PCM-2MD-02)

3. Operation Instructions

3.1 Installation of Force Standard

The reference standard load cell must be properly installed into the Portable Calibrating Machine prior to doing any calibrations. In general, for each test point, the machine applies the same amount of force to both reference load cell and the unit under test. The readings from the reference standard are used to adjust and control the force in the machine.

In the Portable Calibrating Machine, the reference standard load cell is installed on top of the screw jack. A reference standard mounting adapter is included with each machine. As depicted in Figure 3, this adapter is threaded to the top of the jack. The top side of the adapter with external thread is then used to install the reference standard. By default, the reference standard mounting adapter has an external 0.625"-18 UNF thread on the top side to accommodate a Morehouse Shear Web load cell for capacities 2000 lbf and lower. If a different thread size is needed to mount other types of load cell, consult the Morehouse Sales when placing an order.

When a shear web load cell is calibrated by Morehouse Force Calibration Laboratory, the compression force is applied through the bottom shoulder of the cell (unless otherwise specified by the customer). Therefore, applying the compression load through the bottom thread will cause some errors from the reported calibration values. Make sure that the reference standard load cell is tightened against the mounting adapter before starting a calibration.

IMPORTANT TIP: Standard load cell must be snug-tightened against the mounting adapter before compression calibration. The goal is to have the bottom shoulder of the reference standard in contact with the mounting adapter.

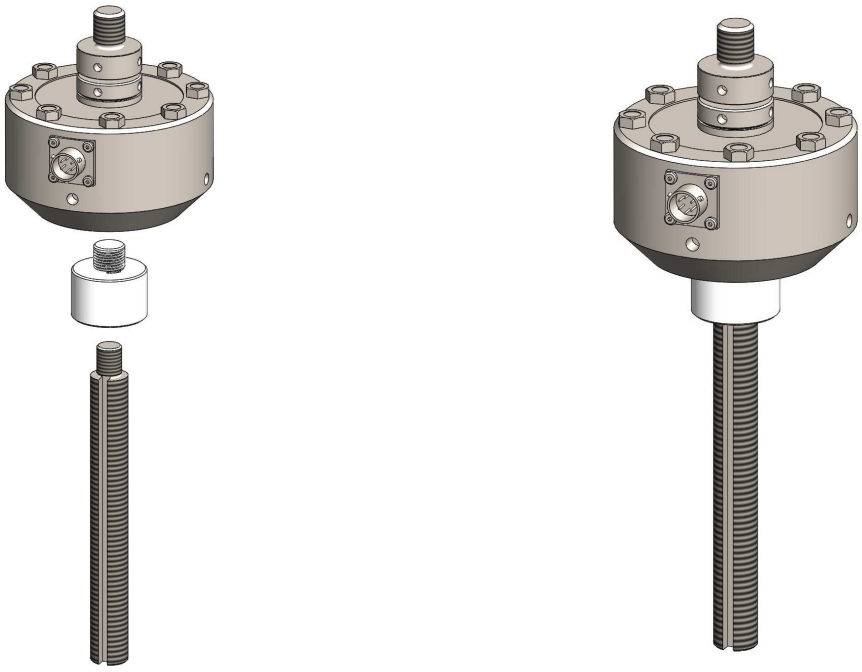

Figure 3: Installation of Reference Load Cell Using the Standard Mounting Adapter

3.2 Compression Setup

A compression bearing block and a ball seat adapter are included with every Portable Calibrating Machine. These adapters can be used to calibrate almost any compression-only force instrument up to 2000 lbf capacity. By default, the compression bearing block is manufactured with an internal 0.625"-18 UNF thread for installing on Morehouse Shear Web standard load cells. If other types of load cells are to be used as the reference statndard, consult the Morehouse Sales team with specific requirements when ordering. To set up the Portable Calibration Machine for a compression-only calibration:

1. Using the front handwheel, lower the jack all the way down
2. Install the compression bearing block on top of the reference standard load cell. Ensure that the thread underneath the bearing block is fully engaged with the threaded rod on the load cell.
3. Install the ball seat adapter to the coupling nut on the upper section of the Portable Calibrating Machine.
4. Place the unit under test on the compression bearing block. The hole at the center of the bearing block can be used with alignment plugs to align the unit under test with the load line accurately. Make sure the unit has an adaptor on top with a load ball of diameter 0.438" or less, and force capacity equal or greater than what will be applied.
5. Release the two latches on the stage beam by pulling the handles out and rotating to the bottom position and move the stage beam up or down to have the top of the unit under test 1.5" or less away from the ball seat adapter. Check that the latches are fully engaged without any gap between the handles and their housing slot. (see Figure 7)
6. Use the screw jack to raise the test setup until the top is about to touch to the ball seat adapter.

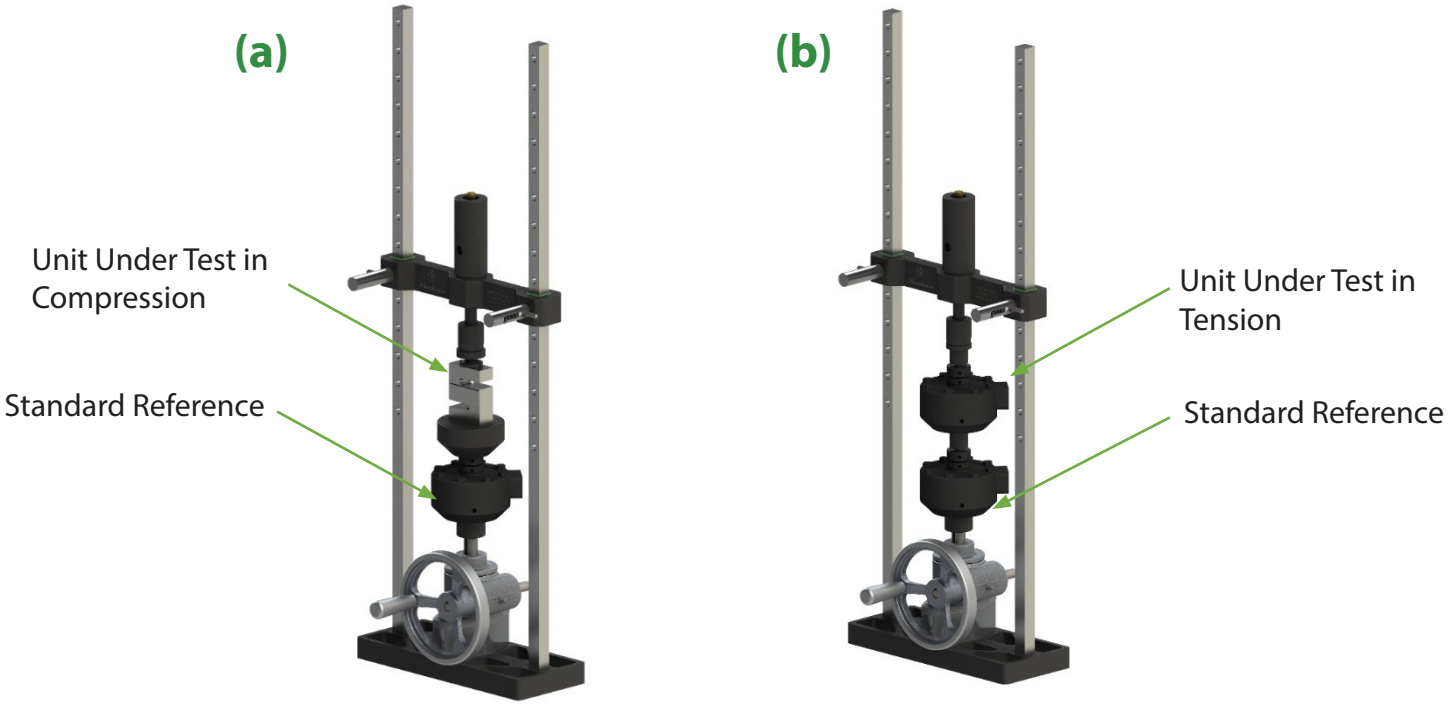

Figure 4: Calibration Setup for: a) Compression-Only Calibration; b) Tension Calibration

3.3 Tension Setup

Before setting up a tension calibration, make sure you have the adapters needed to mount the unit under test and that they are rated for the forces that will be applied. Morehouse manufactures several adapter kits designed for tension calibration in Portable Calibrating Machines. To set up a tension calibration:

1. Using the front hand wheel adjust the height of screw jack so there is about 1" gap between the jack and Standard Mounting Adaptor.
2. The tension unit under test is coupled directly to the top of the load cell using adapters. If the unit under test has an internal threaded hole with 0.625"-18 thread size, it can be directly installed on the threaded stud supplied with Morehouse Shear Web standard load cells.
3. Release the two latches on the stage beam by pulling the handles out and rotating to bottom (see Figure 7) position. Then, move the stage beam up or down to have the top of the unit under test close to the swiveling coupling nut underneath the stage beam. Check the latches to ensure that they are fully engaged without any gap between the handles and their housing slot.
4. The coupling nut has an internal thread of 1.125"-12 UNF thread. Use another adapter to connect the top part of the unit under test to the coupling nut.
5. Use the combination of adjustments provided by the stage beam and screw jack to ensure there is at least 1" but no more than 2.75" gap between the jack and Standard Mounting Adaptor after the initial force is applied.

Some instruments may have special calibration requirements. Check the specifications and calibration instructions of the unit under test before calibration setup to ensure that the right type of adapters and setup is available for calibration.

4. Calibration

4.1 Applying Calibration Forces

After the initial setup, the system is ready for starting the calibration test. Compression or tension force is applied by turning the handwheel clockwise or counter-clockwise, based upon the lefthand or righthand configuration of the machine. Compression force is applied when the jack screw moves up, and tension force is generated when the jack screw moves down. For calibrating digital instruments such as load cells, normally after exercising the instrument, a small contact force is applied and the indicators for both standard and unit under test are tared to zero.

To apply a predetermined amount of force, start turning the handwheel in the appropriate direction while watching the output of the reference load cell. Once a certain amount of force is reached, if the user stops the movement of the jack, the creep in the force instrument and the machine might cause some changes in the force value. However, the user can continuously adjust the position of the mechanical jack to keep the force in the vicinity of the target force. Morehouse offers various types of load cell indicators which can be used to monitor the reference load cell output in ratiometric mV/V, or direct force values in engineering units based on the user's preferences.

The force applied to the calibration setup is generated by the movement of the mechanical screw jack. In other words, the jack converts the rotation applied to the handwheel by the user into unidirectional force. Therefore, the force applied by the jack is dependent on the number of turns on the handwheel with the higher levels of force requiring a higher amount of torque to turn the handwheel. As the applied force increases, the handwheel feels tighter to turn. This is normal as long as the applied force stays within the rated capacity of the machine and control spring used.

4.2 Force Control

Morehouse Portable Calibrating Machine offers an exceptional capability in controlling the calibration force when compared to the other calibration systems commercially available on the market. The machine uses an innovative and simplistic system to achieve this exceptional control capability. Although, capability of controlling the force can change to some extent based on the experience of the user, quality of the force reference standards, and indicator system. Tests have shown that a user can control the calibration force in Portable Calibrating Machine within ±0.001 % of the reference standard capacity, or 0.001 lbf, whichever is greater, when a Morehouse Ultra-Precision Shear Web load cell is used as the standard reference with a high accuracy indicator. For example, if a 1000 lbf Ultra-Precision load cell is used, an experienced user can control the test forces within ±0.01 lbf.

4.3 Changing Control Springs

A special mechanism is designed in the stage beam of Portable Calibrating Machines which helps the calibrator in different aspects such as improving force control and load line alignment. This mechanism is located inside the housing threaded into the top of the stage beam. Included in this mechanism is a die spring, and each machine is supplied with one, two, or three springs with different properties based on the user requirements. The springs are color coded and designed for various loading ranges as follows:

- Gray: 1–2000 lbf compression or tension calibration
- Yellow: 1–750 lbf compression or tension calibration
- White/Blue: 1–250 lbf compression or tension calibration

In general, the gray spring (for up to 2000 lbf loading) can be used for any calibration with test points up to the capacity of the machine. However, if all the test points in a calibration is under 1000 lbf, the yellow spring can be used to gain better control over the applied force. In other words, the spring with lower ratings provide better force control, but with lower capacities. There is a hole cut in the housing that contains the control improvement mechanism through which the color of the existing spring in the machine is visible at all times. The user can identify which spring is already installed into the machine and decide whether or not to change the spring.
To change the spring (Figure 5 and 6):

1. Open the mechanism housing by turning it counter-clockwise.
2. Remove the thumb screw on the top of the loading rod.
3. Remove the nut on top of the loading rod assembly. The nut is hand tightened and should not need a wrench to open. Be aware that once the nut comes out, the loading rod assembly will come apart and fall out of the machine. Hold your hand underneath the coupling nut to keep the assembly in place.
4. Save the alignment bushings on top and at the bottom of the spring. Replace the spring with the desired one. The springs can be installed from either end.
5. Use the alignment bushings while installing the new control spring, and put them in the same order that they came out. Alignment bushings are marked on the side for easier identification.
6. Use the spherical nut to put the assembly together. Ensure the loading rod extends beyond the nut when installed. Tighten the nut until there is no free play between the spring and the alignment bushing. Then back nut off 1/16 of a turn to ensure the spring is not being compressed.
7. Install the thumb screw on top of the loading rod, finger-tight.
8. Put the mechanism housing back on the stage beam by turning it on the beam in clockwise direction. Ensure to have the housing completely threaded in with full engagement. The housing is load bearing in compression and needs to have full engagement, but not tightened beyond hand-tightening.

IMPORTANT TIP: the orientation and placement of the alignment bushings at the top and bottom of the spring are very important. Pay attention to the markings on the bushings to see which one goes on top and which goes to the bottom of the spring. Pay attention to the configuration of the bushings (Figure 6) and how they are assembled with the spring when you are opening the control spring assembly.

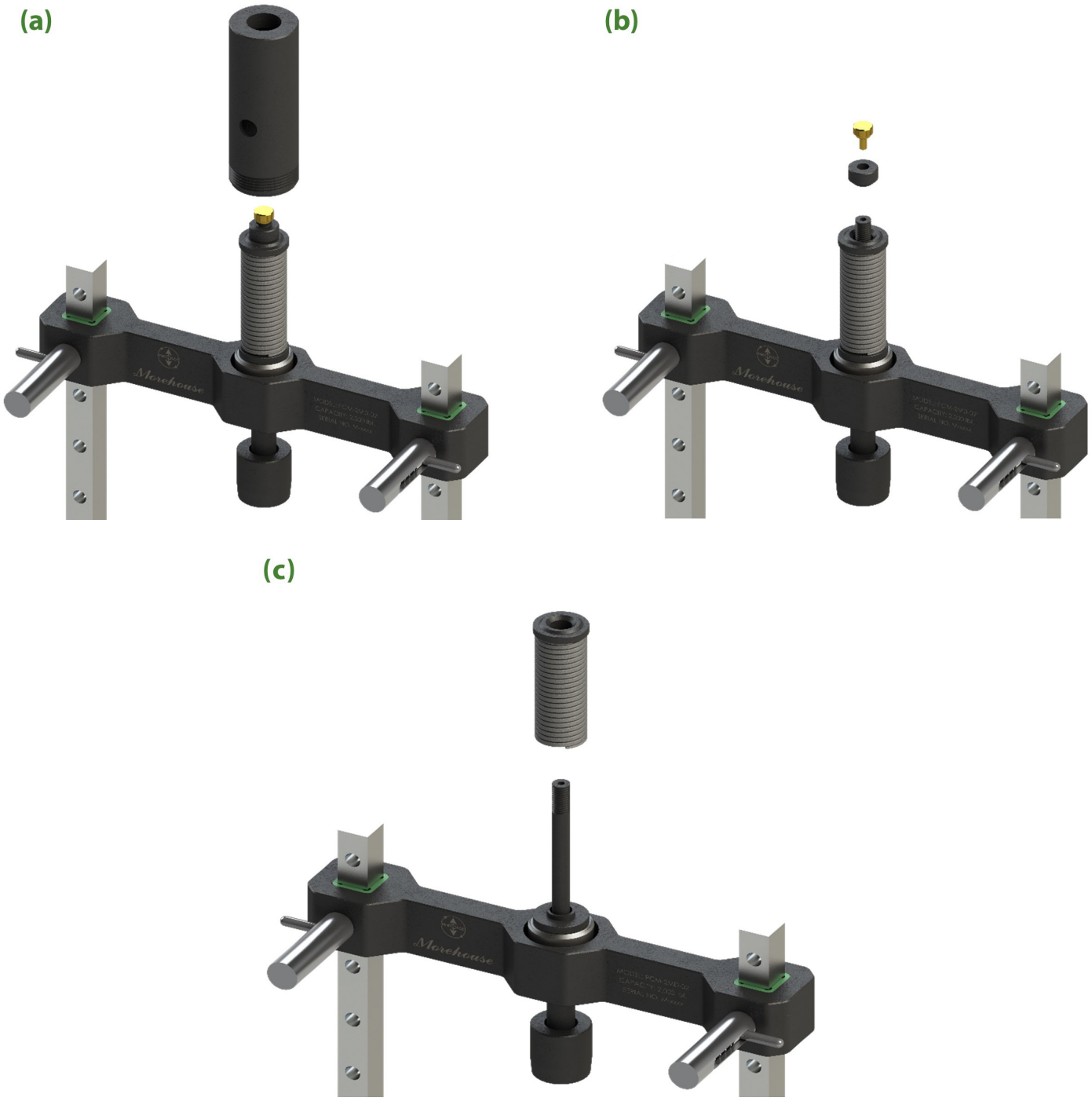

Figure 5: Changing the Control Spring: a) Removing the Housing, b) Removing the Thumb Screw and Spherical Nut; c) Removing the Control Spring

Figure 6: Assembly of the Control Spring Mechanism

5. Maintenance

The mechanical jacks in Morehouse Portable Calibrating Machines are lubricated before leaving the manufacturing plant. For normal operation, jacks should be greased about once per month. Under extended use, grease twice monthly or as conditions dictate. Grease through the fitting on the jack with hand or power operated equipment. Grease with No. 1 Consistency Grease. Do not allow the jack to operate unlubricated. It is the responsibility of the user to maintain sufficient lubrication of the jack and to the lifting screw.

The products listed below are recommended by the lubricant manufacturers to meet the requirements for normal operation. The listing of brand names is solely for the convenience of users of equipment and their lubricant suppliers; it does not constitute any endorsement. Morehouse assumes no responsibilities for quality, performance or availability of any listed products. Total grease capacity for the screw jack used in the Portable Calibrating Machines is about 1.8 oz. or 5 shots.

Table 1: Recommended Lubricants for the Screw Jack	
Company	**Brand Name**
Mobilgrease	XHP 461
Mobilgrease	XHP 221
Shell Oil Company	Retinax HD NLGI 1
Shell Oil Company	Albina SLC 460
Mobil Oil	Mobilith SHC PM 460

The stage beam of the machine is in contact with the guide posts through a set of self-lubricating nylon bushings to avoid jamming in the stage beam slide. In order to keep the slide of the stage beam smooth, the surface area of the guide posts need to stay clean and free of debris. In addition, once the movement of the stage beam is not smooth enough, applying some oil to the nylon bushings and the guide post surfaces will smoothen the slide again.

Upon completion of routine inspection and preventative maintenance procedures, coat all unpainted guide post surfaces with some light machine oil to prevent rusting on these surfaces.

6. Safety

For general guidelines about force calibration safety, refer to the Morehouse Force Measurement Equipment Safety guide. In addition, the following safety practices must be exercised when using a Portable Calibrating Machine. To avoid situations that may cause personal injuries wear eye protection at all times when using a Morehouse Portable Calibrating Machine or any other force calibrating machine.

- Any adapter or accessory you may design, make or purchase for use with a Portable Calibrating Machine, or force measuring instrument, must be of proper design and made from steel of the proper strength to withstand the forces to which it is subjected. It is most important that adapters and accessories be test loaded under safe conditions prior to actual use with an instrument. Equipment should not be used beyond its maximum rated capacity. Failure to use the proper strength material may result in serious injury or death.
- Inspect all parts of the machine regularly to ensure all the components are free of any defects and are assembled properly. Look for any damaged connections or loose bolts. Contact Morehouse with any questions about the assembly of the parts, or for ordering new parts.
- The quick-adjust latches on the stage beam have a critical role in load bearing capability of the Portable Calibrating Machine. Before starting to apply a force, check the latches to ensure that they are completely pushed in, and the holding pin is fully engaged. Figure 8 demonstrates how the engagement of the stage beam latches need to be checked.

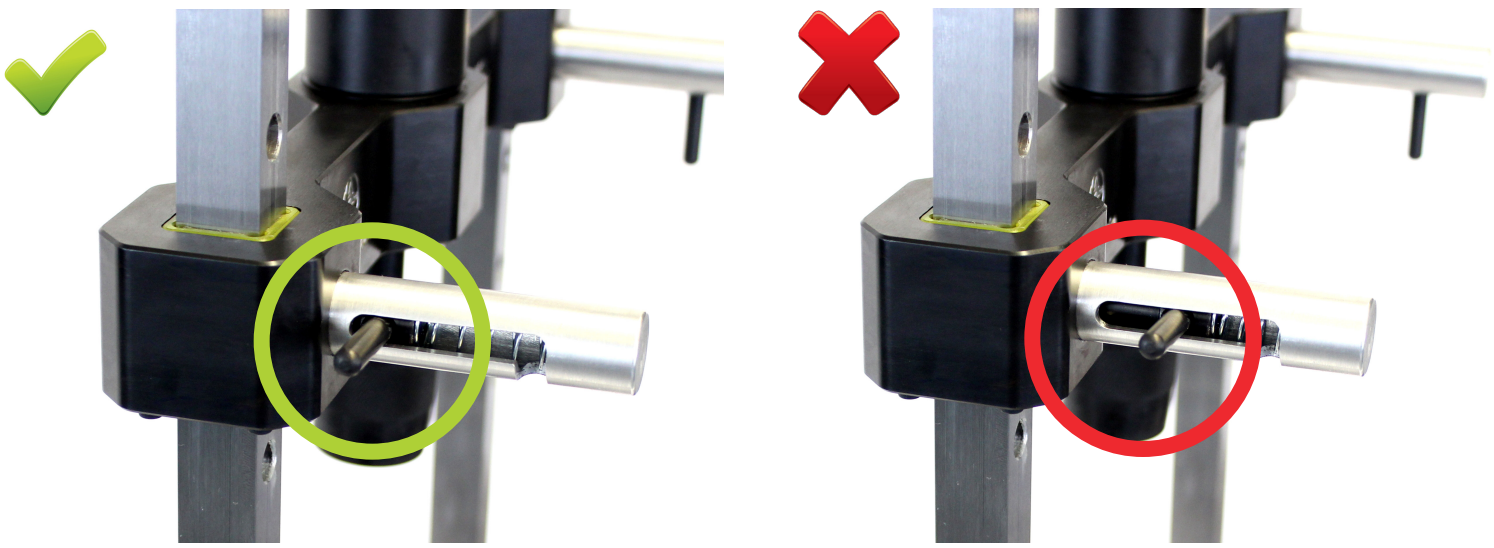

Figure 7: Quick-Change Latch: a) Correct: Fully Engaged, b) Incorrect: Partially Engaged

- The control improvement mechanism on top of the stage beam must be checked regularly and be fully closed before applying any forces. The mechanism's housing cover must be closed and fully threaded into the stage beam before applying forces.
- The spherical nut on top of the control spring and loading rod assembly is also critical in load bearing capability of the machine. Regularly check and ensure that the spherical nut has full thread engagement to the threaded portion of the loading rod before using the machine. Make sure the thumb screw is fully threaded onto the loading rod, as this will keep the spheical nut from working loose during use.
- When applying compression calibration force, due to the movement of the loading rod, the spherical not may move out of the control spring housing. Do not touch the spherical nut when machine is under load.
- When machine is applying force, do not touch the moving parts of the machine such as jack screw, quick-change latches, loading rod, control spring housing, etc.
- Always operate the machine on a flat and level surface with no risk of falling down or losing sight of it. When the machine is under load, prevent any impact or sudden movements to the machine.
- The Portable Calibrating Machine (Model: PCM-2MD) can only be used to generate forces within the rated capacity of the machine. Trying to generate higher forces may cause damage to the machine and result in a dangerous situation for the user. All necessary safety precautions for using manual machinery must be carefully exercised when using Portable Calibrating Machine.
- Read the instruction manual carefully, and ensure that anyone who intends to operate the machine has proper training on safe practices of using Portable Calibrating Machine.

Applying forces to equipment and instruments is inherently dangerous. This document does not, and cannot, foresee all safety considerations in your testing and application environments. It is important to give careful consideration to any application of force.

7. Parts

To order parts and accessories for your Portable Calibrating Machine, contact Morehouse Sales team. Figure 8 and Table 2 demonstrate the parts included in a Portable Calibrating Machine Model PCM-2MD-02.

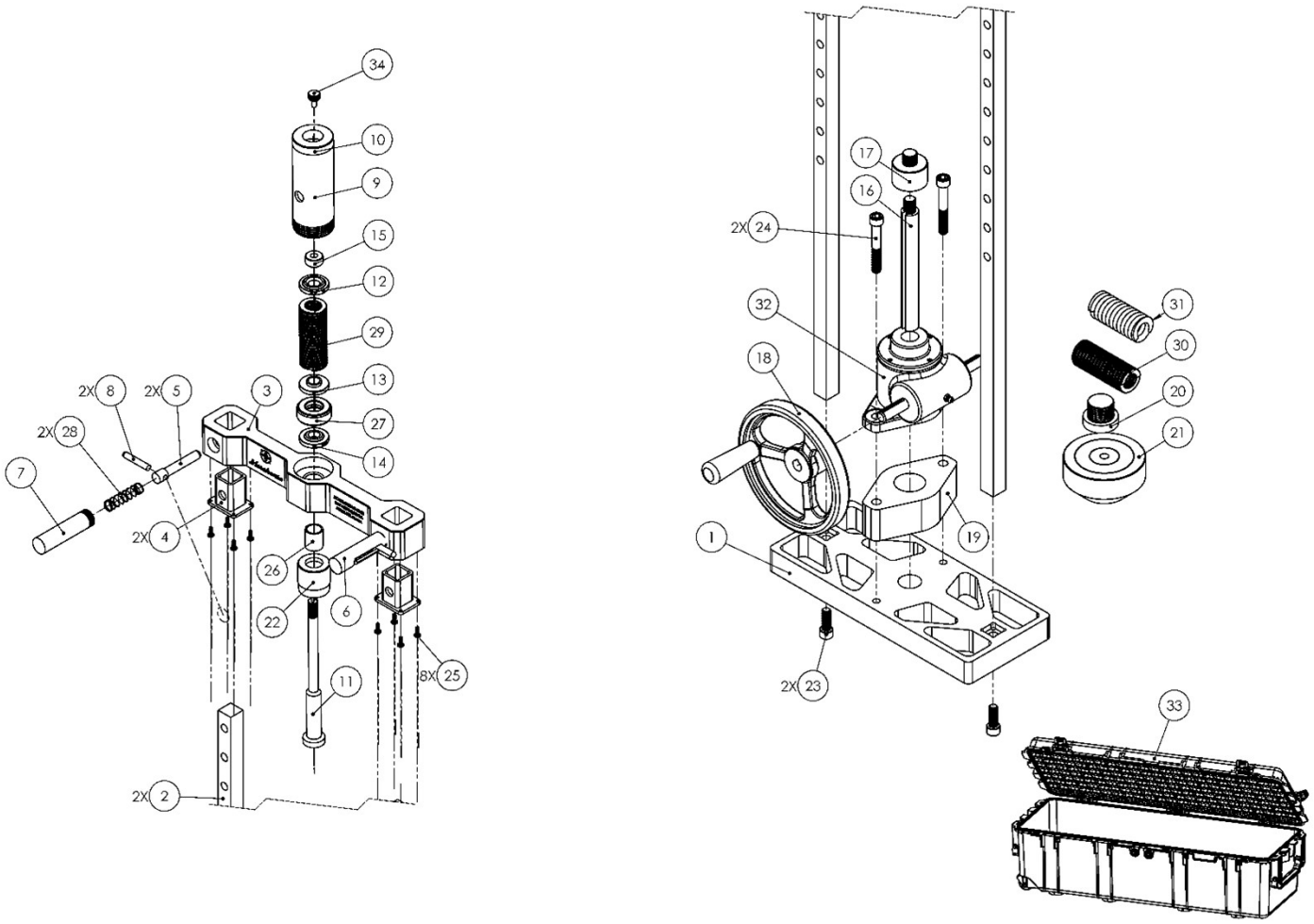

Figure 8: General Assembly of a Portable Calibrating Machine, Model: PCM-2MD-02

Table 2: Parts List for Portable Calibrating Machine, Model: PCM-2MD			
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	PC-2-013-01	BASE PLATE	1
2	PC-2-014-02	GUIDE POST	2
3	PC-2-016-01	STAGE BEAM	1
4	PC-2-022-01	NYLON INSERT	2
5	PC-2-024-01	PLUNGER	2
6	PC-2-026-01	PLUNGER COVER (RIGHT)	1
7	PC-2-027-01	PLUNGER COVER (LEFT)	1
8	PC-2-029-01	PLUNGER HANDLE	2
9	PC-2-036-01	DIE SPRING CYL BOTTOM	1
10	PC-2-037-01	DIE SPRING CYL TOP	1
11	PC-2-038-01	LOADING ROD	1
12	PC-2-040-01	SPRING ALIGN TOP BUSHING	1
13	PC-2-042-01	SPRING ALIGN MIDDLE BUSHING	1
14	PC-2-044-01	SPRING ALIGN BOTTOM BUSHING	1
15	PC-2-046-01	SPHERICAL NUT	1
16	PC-2-052-01	LEAD SCREW	1
17	PC-2-054-01	STANDARD MOUNTING ADAPTER	1
18	PC-2-056-01	HANDWHEEL (6dia.)	1
19	PC-2-060-01	JACK SPACER BLOCK	1
20	PC-2-062-01	COMP BALL SEAT ADAPTER	1
21	PC-2-064-01	COMP BASE PLATE	1
22	TC-12	COUPLING NUT	1
23	ZF-01-009	0.375-16 x 1.000 SOCKET HEAD CAP SCREW	2
24	ZF-01-014	0.375-16 x 2.500 SOCKET HEAD CAP SCREW	2
25	ZF-07-018	#6-32 x 0.375 MACHINE SCREW	8
26	ZM-12-003	OIL EMBEDDED SLEEVE BEARING	1
27	ZM-14-003	THRUST BEARING	1
28	ZM-17-004	SPRING	2
29	ZM-18-001	DIE SPRING	1
30	ZM-18-002	DIE SPRING	1
31	ZM-18-003	DIE SPRING	1
32	ZM-23-001	SCREW JACK HOUSING	1
33	ZM-25-002	PROTECTIVE CASE	1
34	ZZ-0341	THUMB SCREW	1