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Product Guide

Mechanical Tensiometer Calibrator

Morehouse Instrument Company, Inc.
1742 Sixth Ave., York, PA 17403-2675 USA

P: (717) 843-0081
F: (717) 846-4193

info@mhforce.com
www.mhforce.com

Introduction

The Morehouse Mechanical Tensiometer Calibrator (PCM-2MD-T1) is a low-maintenance and user-friendly machine that can calibrate almost any force instrument up to 2,000 lbf capacity. The machine provides a large calibration span that can accommodate calibration setups up to 5 ft. long and 12 in. wide. The system features allow for a quick change of calibration setup to save on calibration time; for instance, the calibration space opening can be changed from 5 feet to 5 inches in seconds.

The Mechanical Tensiometer Calibrator was designed to enable laboratories to calibrate small force instruments with a versatile and economical solution. The machine design addresses several issues relative to calibrating small force instruments, such as:

- Eliminates the need for carrying and stacking hand weights, which many calibration laboratories currently use. Instead, a mechanical jack is utilized to generate calibration forces.
- Fine and stable applied force control allows for low-force instrument calibration while lowering the parasitic effects from hanging weights.
- Lowering the risk of overloading force standard and unit under test by slowly increasing applied force. The issue of overloading force instruments often happens when low-force instruments are placed in higher-capacity force calibrating machines where a slight increase in hydraulic jack pressure can generate more force than the capacity of a small force sensor.
- A large and adjustable calibration area enables one machine to calibrate cable tensiometers and other force instruments, translating into significant initial and upkeep savings for calibration laboratories.
- Providing a two-fixed-point loading configuration for cable tensiometers better replicates the actual testing conditions of cables in the field than the floating load configuration generated by hanging deadweights.
- An all-around shatter-resistant clear safety shield protects the operator against whiplashing cables or broken adapters if a material fails during calibration.
- Provides continuous control over calibration forces. In contrast to the stacking hand weight method, the Mechanical Tensiometer Calibrator provides a continuously applied force, which is helpful when calibrating in different force units.
- The swiveling coupling nut, quick adjustment features, and several optional adapter sets offered by Morehouse make the system adaptable for various force instrument calibrations..

Standard Parts and Dimensions

All Morehouse Mechanical Tensiometer Calibrators are supplied with:

1. Main loading frame, quick-adjust stage beam, and mechanical jack.
2. Clear all-around safety shield.
3. Cable tension clevis set with detent pins.
4. Compression bearing block.
5. Ball seat adapter.
6. Swiveling coupling nut.
7. Clevis mounting adapter.

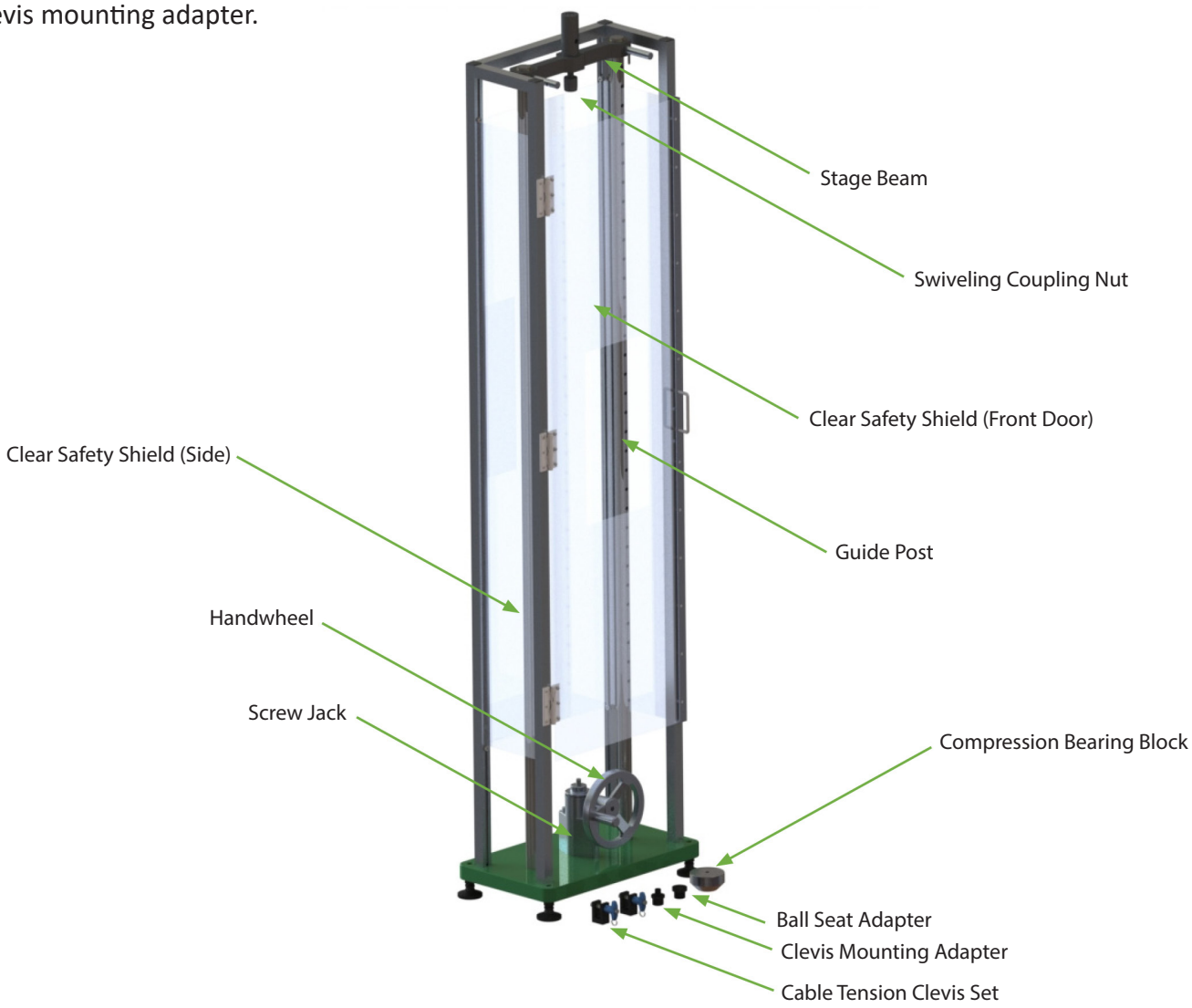

Figure 1: Standard Parts and Adapters Included with Mechanical Tensiometer Calibrator

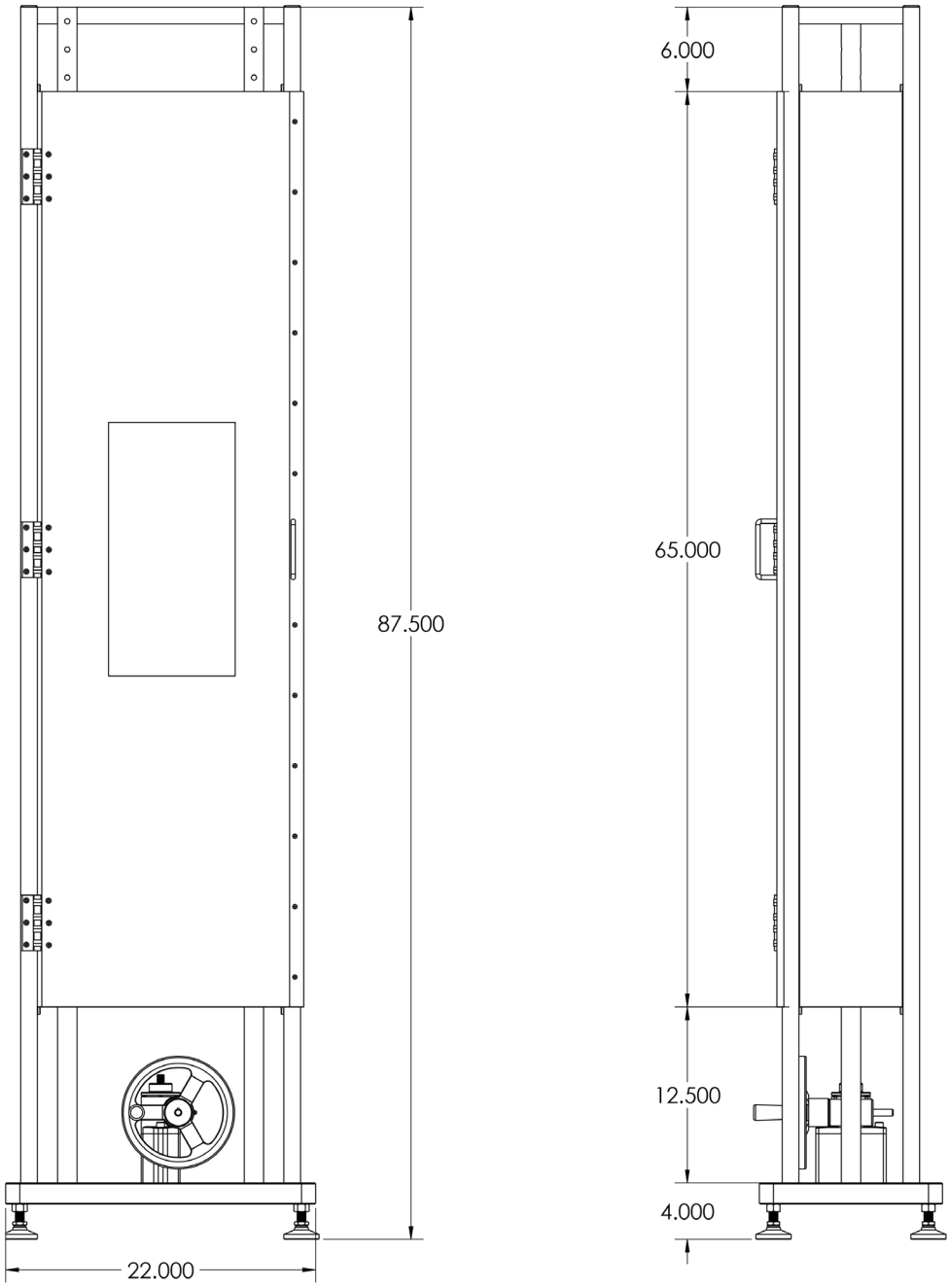

Figure 2: Overall Dimensions of Mechanical Tensiometer Calibrator

Optional Equipment and Accessories

Morehouse offers several types of load cells, adapters, and accessories for the Mechanical Tensiometer Calibrator. This section provides a brief description of some of this equipment. The Morehouse Sales team can be consulted for more information, details, and customizations to these options.

Standard Reference Load Cell

Mechanical Tensiometer Calibrator utilizes a calibrated load cell as the force reference standard to measure the applied calibration force. To use the full potential of the machine, Morehouse Ultra-Precision shear web load cell is recommended as the reference standard. However, other types of load cells can also be used. Morehouse Ultra-Precision load cells are advantageous as force standards for the following reasons:

- Morehouse calibrates Ultra-Precision load cells using primary force standard deadweights accurate to 0.002 % of applied force. This translates into lower uncertainties when the Ultra-Precision load cells calibrate other instruments. This system can typically provide a 0.02 % of applied force uncertainty when used in the Mechanical Tensiometer Calibrator.
- They offer high repeatability, resulting in larger verified force ranges when calibrated to ASTM E74 standard or lower classifications when calibrated to ISO 376 standard.
- More calibration force points can be generated with one load cell, lowering the number of standards needed and saving calibration time by fewer times switching standards.
- Low sensitivity to misalignment and side-loading makes them produce more accurate calibration forces.

Load Cell Indicators

The indicator measures the output from the standard reference load cell. Morehouse offers indicators based on the user's work environment and operational requirements. A High-Accuracy Digital Indicator (HADI) is recommended to capture the calibration force data on a computer screen. HADI is a true 6-wire indicator system that offers stable and accurate readings. HADI can also be supplied with a touchscreen tablet and stand mounted on the machine's base plate for easier readout and data capture, as depicted in Figure 3. For users who would instead use an indicator with a direct display, Morehouse recommends the model 4215 indicator, which offers high stability over time. When standard load cells are returned to the Morehouse laboratory for recalibration, the indicator should also be sent to achieve the best measurement results.

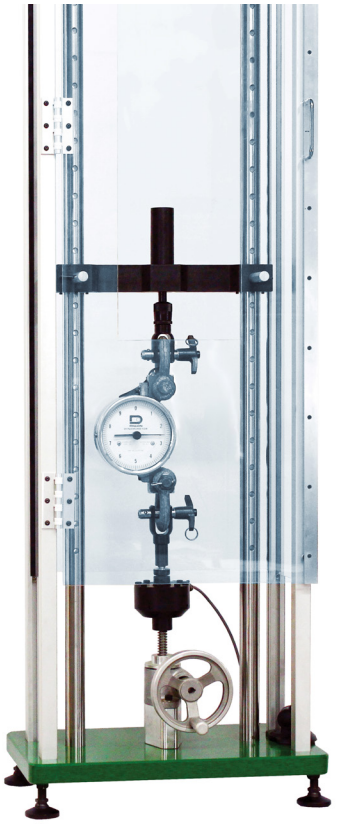

Figure 3: Mechanical Tensiometer Calibrator with Optional Touch-Screen Tablet and Mounted Stand

Tension adapters

Calibrating force instruments in tension often need special adapters to mount the unit under test into the calibrating machine and make a proper calibration setup. To calibrate such instruments in the Mechanical Tensiometer Calibrator, Morehouse offers threaded adapters in standard and custom kits and individually designed for special applications. The Mechanical Tensiometer Calibrator includes a swiveling coupling nut, making changing setups and replacing adapters easier for the operator. In addition, the coupling nut is made with spherical contact points, which help with the alignment of the load line during tension calibration and reduce misalignment errors. Figure 4 shows the standard threaded adapter kit for the Mechanical Tensiometer Calibrator. This kit includes adapters with standard thread sizes commonly found in force instruments with capacities under 2,000 lbf. The kit can be configured for custom applications and metric adapters as well. The standard kit includes two adapters for each thread size to mount the instrument to the coupling nut from one side and the force reference standard with 0.625-18 UNF-2A thread from the other side. Table 1 lists the parts of the standard threaded adapter kit for the Mechanical Tensiometer Calibrator. Figure 5 illustrates a tension calibration setup using two threaded adapters for a canister load cell.

Figure 4: A set of Threaded Adapters for Performing Tension Calibration in Mechanical Tensiometer Calibrator

No.	Part Number	Thread Size	Note
1	TA-PTM(0.250-28)	0.250-28 UNF-2A	**Top Adapters** Connect to the Swiveling Coupling Nut with 1.125-12 UN-2B Thread at the Top of the Machine
2	TA-PTM(0.500-13)	0.500-13 UNC-2A	
3	TA-PTM(0.500-20)	0.500-20 UNF-2A	
4	TA-PTM(0.625-18)	0.625-18 UNF-2A	
5	TA-PTF(0.250-28)	0.250-28 UNF-2B	
6	TA-PTF(0.500-13)	0.500-13 UNC-2B	
7	TA-PTF(0.500-20)	0.500-20 UNF-2B	
8	TA-PTF(0.625-18)	0.625-18 UNF-2B	
9	TA-PBM(0.250-28)	0.250-28 UNF-2A	**Bottom Adapters** Connect to Morehouse Load Cell with 0.625-18 UNF-2A Thread at the Bottom of the Machine
10	TA-PBM(0.500-13)	0.500-13 UNC-2A	
11	TA-PBM(0.500-20)	0.500-20 UNF-2A	
12	TA-PBM(0.625-18)	0.625-18 UNF-2A	
13	TA-PBF(0.250-28)	0.250-28 UNF-2B	
14	TA-PBF(0.500-13)	0.500-13 UNC-2B	
15	TA-PBF(0.500-20)	0.500-20 UNF-2B	
16	TA-PBF(0.625-18)	0.625-18 UNF-2B	

Table 1: Standard Threaded Adapters Kit for Mechanical Tensiometer Calibrator

Figure 5: Tension Calibration Setup Using Threaded Adapters (Safety Shield not Shown)

Compression Adapters

Morehouse Mechanical Tensiometer Calibrator is supplied with a Compression Bearing Block and a Ball Seat Adapter (Figure 1). The two parts are deemed universal adapters needed to calibrate compression-only instruments. However, an additional ball adapter might be needed to be used with the unit under test to achieve the best calibration results. Two commonly used adapters offered by Morehouse are the Load Ball Adapter and Internal Ball Adapter, which are used on instruments with threaded connections to distribute the force onto the measurement instrument better and generate more repeatable calibra-tion data. As demonstrated in Figure 6, these adapters are offered in all standard and metric thread sizes for the capacity range of the Mechanical Tensiometer Calibrator. Figure 7 illustrates a compression cali-bration setup in the Mechanical Tensiometer Calibrator using the included compression bearing block, ball seat adapter, and the optional internal ball adapter for the unit under test.

Compression Ball Adapters

Figure 6: Load Ball Adapter and Internal Ball Adapter

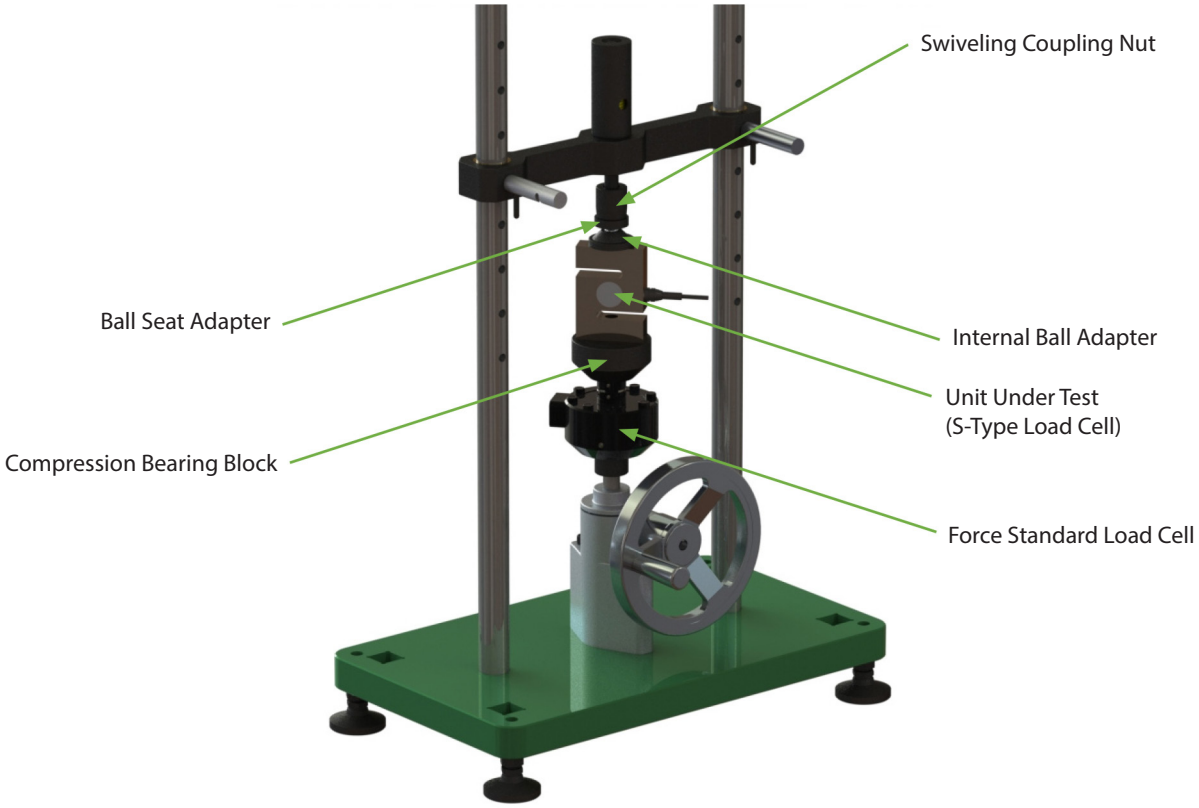

Figure 7: Compression Calibration Setup using Internal Ball Adapter (Safety Shield not Shown)

L-Brackets for Hand-Held Force Gauges

Morehouse Mechanical Tensiometer Calibrator provides a user-friendly solution for calibrating hand-held force gauges. Traditionally, many laboratories use hanging hand weights to calibrate hand-held force gauges. This method is labor-intensive, cumbersome for tension calibration, and often impractical for compression calibration. Morehouse offers L-Bracket adapters, which can be used with a Mechanical Tensiometer Calibrator to calibrate hand-held force gauges in both compression and tension modes without carrying weights. Morehouse also offers a standard L-Bracket Kit, which includes multiple pieces that can be used interchangeably to produce different configurations. This kit consists of:

- Backplates, each manufactured with multiple mounting hole patterns for installing different types of hand-held force gauges
- Base plates with various mounting offsets to mount the hand-held force gauge on the force reference standard and keep the applied force line of the machine aligned with the force gauge
- Threaded adapters to connect the threaded stud of hand-held force gauges to the coupling nut of Mechanical Tensiometer Calibrator

This kit can calibrate several hand-held force gauge models available on the market as listed in Table 2. For calibrating each instrument, a back plate and a base plate are bolted to each other to make the right combination for each specific hand-held force gauge, as shown in Table 2.

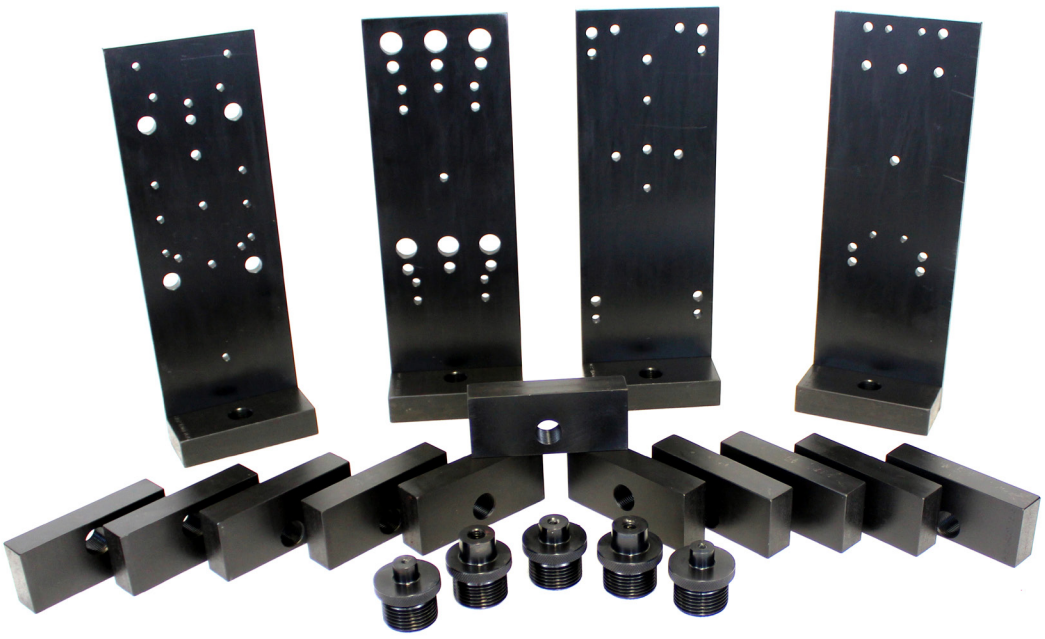

Figure 8: L-Bracket Kit for Calibrating Hand-Held Force Gauges in Mechanical Tensiometer Calibrator

Table 2: List of Handheld Force Gauges which can be Calibrated Using L-Brackets Kit

Manufacturer	Model	L-Bracket Back-Plate	L-Bracket Base Plate Part No.	Threaded Adapter
MOREHOUSE	DFGPP	A	CL-1B-0.5433	M6
AMETEK	D	D	CL-1B-1.1875	#10-32 OR 5/16-18
AMETEK	DFX SERIES	C	CL-1B-0.6850	#10-32 OR 5/16-18
AMETEK	AMETEK III (< 100 LBF)	A	CL-1B-0.7500	#10-32
AMETEK	AMETEK III (> 100 LBF)	D	CL-1B-1.1875	5/16-18
AMETEK	SERIES L	A	CL-1B-0.7812	#10-32
AMETEK	ACCUFORCE CADET SERIES ML	A	CL-1B-0.7812	#10-32 OR 5/16-18
AMETEK	ACCUFORCE III (250 GRAMS / 100 LBS)	A	CL-1B-0.7812	#10-32
AMETEK	ACCUFORCE III (250 LBS / 500 LBS)	D	CL-1B-1.1875	5/16-18
CHATILLON	DFM	B1	CL-1B-0.5000	#10-32
CHATILLON	DFGRS LIGHT DUTY	B1	CL-1B-0.5000	#10-32
CHATILLON	DFGRS HEAVY DUTY	B1	CL-1B-0.5625	5/16-18
CHATILLON	DGGRS	B1	CL-1B-0.5000	#10-32
CHATILLON	DFIS	B1	CL-1B-0.5625	#10-32
CHATILLON	DPPH	B1	CL-1B-0.5625	5/16-18
CHATILLON	DFE	C	CL-1B-0.6850	#10-32 OR 5/16-18
CHATILLON	DFGS	C	CL-1B-0.6850	#10-32
CHATILLON	DPP	C	CL-1B-0.6850	#10-32
CHATILLON	DFX	C	CL-1B-0.6850	#10-32 OR 5/16-18
CHATILLON	DG	D	CL-1B-1.0000	5/16-18
CHATILLON	LG	C	CL-1B-0.6850	#10-32
IMADA	DPS	A	CL-1B-0.4700	#10-32 OR M6
IMADA	DS2	A	CL-1B-0.4700	#10-32 OR M6
IMADA	DST	A	CL-1B-0.4700	#10-32 OR M6
IMADA	ZP	A	CL-1B-0.4700	#10-32 OR M6
IMADA	PS	C	CL-1B-0.6850	#10-32 OR M6
IMADA	FB	C	CL-1B-0.6850	#10-32 OR M6
IMADA	MF	C	CL-1B-0.6850	#10-32 OR M6
IMADA	Z2H-1100	A	CL-1B-0.8500	M10
IMADA	ESH	A	CL-1B-0.9800	M10
IMADA	ZTS/ZTA LOW CAP. (<=220 LBF)	A	CL-1B-0.4700	#10-32 OR M6
IMADA	ZTS/ZTA HIGH CAP. (550 & 1100 LBF)	A	CL-1B-0.9800	M10
MARK 10	BG	A	CL-1B-0.4200	#10-32 OR 5/16-18
MARK 10	EG	A	CL-1B-0.4200	#10-32 OR 5/16-18
MARK 10	MG	A	CL-1B-0.4200	#10-32 OR 5/16-18
MARK 10	SERIES 5 (<= 500 LBF)	A	CL-1B-0.4200	#10-32 OR 5/16-18
SHIMPO	FGE	A	CL-1B-0.5000	M4 OR M6
SHIMPO	FGV	A	CL-1B-0.5000	M4 OR M6
SHIMPO	MF	C	CL-1B-0.7500	M6
SHIMPO	FGV-500/1000HXY	B1	CL-1B-0.9252	M10

Tension Clevises

Due to its large calibration area opening, the Mechanical Tensiometer Calibrator can also calibrate crane scales, dynamometers, and tension links under 2,000 lbf capacity. Clevis adapters are typically used to mount these instruments into a calibrating machine. One of the critical factors that can influence the calibration results of such instruments is the diameter of the pin used to perform the calibration. Most manufacturers specify the pin size they initially supply to calibrate and use the instrument in the field. Once the instrument is sent to a laboratory for recalibration, using a pin with a different diameter than the original pin can change the contact area between the loading apparatus and the instrument and result in calibration errors as high as 2 %, much more than the specified tolerance of the instrument.

Due to the wide variety of crane scale and tension link models available by different manufacturers, a force calibration laboratory would need many different clevis sets for calibrating such instruments. This could impose a high cost on a calibration laboratory and sometimes make low-quantity calibrations cost-prohibitive. Morehouse developed the Adaptable Clevis Kit product line to address this issue, which provides force-calibrating laboratories with a more economical solution to calibrate crane scales, dynamometers, and tension links properly and accurately. These clevis kits were designed and developed for different capacity ranges. Each kit contains one pair of clevises and several pins with different diameters based on the recommended sizes by manufacturers. Each pin is designed in such a way that it fits closely to the common clevis using a bushing. In addition, a detent pin keeps the pin and bushing assembly together and inside the clevis safely during the calibration. In other words, this design utilizes the same set of clevises for different calibrations and saves the laboratories from purchasing different clevises, which are the costliest parts of the set. Figure 9 demonstrates an Adaptable Clevis kit.

Figure 9: Adaptable Clevis Kit with Various Pin Diameter Sizes

The Morehouse 12K Adaptable Clevis Kit is recommended for use with the Mechanical Tensiometer Calibrator. This kit is offered in two different configurations: Basic Kit and Premium Kit. The Premium Kit includes a pair of clevises and 13 pairs of pins. This kit can be used to calibrate more than 190 instrument models available on the market from different manufacturers with capacities lower than 12,000 lbf. To see the full list of the instruments, please refer to the 12 klbf Capacity Adaptable Clevis Kit Datasheet (PD-5904). The kit can be easily used with a Mechanical Tensiometer Calibrator to calibrate equipment with capacities under 2,000 lbf.

Force Control

Morehouse Mechanical Tensiometer Calibrator gives the operator very fine control over the applied force using a simplified and robust mechanical system. Using a high-accuracy reference standard such as a Morehouse Ultra-Precision Shear Web load cell, an experienced operator can control the applied force to the instrument within ±0.001 % of the capacity of the reference standard load cell. For instance, if a 1000 lbf Ultra-Precision load cell is used, the operator can control the applied force to within ±0.001 lbf. Such a fine force control capability is partly provided by the deflection mechanism built into the stage beam of the machine.

The machine is supplied with three different springs which can be used interchangeably to gain the best possible control at different load ranges.

- 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 are 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 always visible. The user can identify which spring is already installed into the machine and decide whether to change the spring. Figure 10 demonstrates the assembly of the control mechanism, and how the user can switch between different springs.

Figure 10: Control Spring Assembly in Mechanical Tensiometer Calibrator

Cable Tensiometer Calibration

Mechanical Tensiometer Calibrator Features

Calibrating a cable tensiometer (tension meter) instrument requires features not entirely provided by commonly used force-calibrating machines. The Morehouse Mechanical Tensiometer Calibrator features the following for calibrating such instruments:

- Safety Shield: Failure of wire ropes during calibration of a tensiometer can impose serious injury threats on calibration technicians. When a cable fails under tensile force, the remaining pieces can move rapidly in a whiplashing manner. To protect the machine operator, the Mechanical Tensiometer Calibrator is offered with a standard safety shield. Moreover, the shield is made of transparent, shatter-proof acrylic material, enabling the operator to monitor the setup during calibration and take readings. A rectangular-shaped opening is also cut in the safety shield for easier access to the cable during calibration and placing/removing tensiometer devices.
- Large Span: To reduce the effect of cable length on the readout of tensiometer devices, calibration of these devices is typically performed on long cables. Based on the quality procedures defined by different organizations, test cables may vary between 3 to 5 feet. This is larger than the setup opening provided by most force-calibrating machines. The Mechanical Tensiometer Calibrator offers adequate space for performing calibrations using cables up to 5 feet, the standard size used by the United States military.
- Large Stroke: Cables show a significant deflection during calibration, which can be higher than the force point stroke provided by most calibrating machines. The screw jack in a Mechanical Tensiometer Calibrator provides 4 inches of force point stroke, which can compensate for cable deflections within the machine's capacity.
- Fixed Points: When cables are tested in the field using a tensiometer, they are typically under tensile force generated during installation. Once the tensiometer is placed on a cable, it increases the cable's tension slightly due to the lateral force of the tensiometer spring. However, when hand weights are used to calibrate a tensiometer, the increase in tensile force does not occur since the cable is only fixed at one point, and the point attached to weights is 'floating.' The Mechanical Tensiometer Calibrator better replicates the actual field conditions compared to the hanging weights method by providing two fixed points at the top and bottom ends of the cable.

Calibration Test Cables

Test cables are needed to calibrate tensiometers. In addition to the test cable's nominal diameter, which is one of the most important factors influencing the tensiometer readout, other properties of the test cable can cause variations in the calibration data, such as:

- Cable construction: 1x7; 1x19; 3x7; 7x7; 7x19.
- Composition: carbon steel zinc coated or stainless steel.
- Jacketed or non-jacketed.
- Stretch under load.

Tensiometer Calibration Procedure

Calibrating a tensiometer (cable tension meter) device in a Mechanical Tensiometer Calibrator involves the following steps:

1. Ensure that the right cable is available with specified size, construction, and other properties as defined by your procedure.
2. Open the safety shield door.
3. Mount the cable tension clevis set in the machine; one on top of the force standard load cell, and another to the swiveling coupling nut using the clevis mounting adapter.
4. Adjust the opening in the machine based on the test cable length by moving the stage beam up or down.
5. Install the cable into the clevises securely using detent pins.
6. Close the safety shield door.
7. With no tension on the test cable, zero reference force standard indicator, place a slight amount of tension on the cable by turning the handwheel counterclockwise. Inspect the setup with the safety shield closed, and ensure all fixtures and adapters are installed securely.
8. Apply less tension to the test cable than the calibration point, approximately 90 % of the target applied force.
9. Using the correct riser for the size of cable in use, attach the tensiometer to the cable at the center of the cable test area (middle 12") through the opening in the safety shield door. Increase the tension to the first point to be tested. Record the reading. Disconnect the tensiometer.
10. Some procedures may also require clamping the tensiometer 4 to 6 inches higher and lower than the first point and taking multiple readings. Adjust the tension to the test point, approaching from below the force value if necessary.
11. Perform Steps 8 through 10 for the remaining calibration points with the same size cable.
12. Completely remove load from the cable, then open the safety shield door to remove the test cable.
13. Perform Steps 4 through 10 for the other cables and risers as necessary.