

# Adapters are Critical

Best measurement practice is talking to the end user and replicating via calibration, how they are using equipment.



*Morehouse*  
THE FORCE IN CALIBRATION SINCE 1925

# What Morehouse does



We are a manufacturing company that produces force calibration equipment and adapters, that are used in industry, to measure force.

We have state-of-the-art force and torque calibration laboratories and offer calibrations at a very high level of accuracy.



# Our Purpose

We create a safer world by helping companies improve their force and torque measurements.



# Outcomes

The participant will be able to

- ▶ Know the right questions to start asking
- ▶ Know what adapters to use to best replicate use
- ▶ Know the interactions of some adapters used for force calibration

# Improve Your Force Measurements

## Agenda

- The Importance of Adapters for Best Force Calibration Results

# Improve Your Force Measurements

## Additional Material

- ▶ Technical Paper on Adapters
- ▶ Technical Paper on Uncertainty Propagation
- ▶ Technical Paper on ASTM E74 and ISO 376
- ▶ Technical Paper on Common Measurement Errors in Weighing
- ▶ PDF version of this presentation
  
- ▶ Website link @ [https://mhforce.com/documentation-tools/?\\_sft\\_support-item-tag=technical-paper](https://mhforce.com/documentation-tools/?_sft_support-item-tag=technical-paper)

# Old Adapters Can Have Issues

- ▶ Service life of force calibration adapters depend on the several factors including design, number of load cycles, and magnitude of each load.
- ▶ Better material manufacturing and quality control processes provide more reliable strength values for design engineers than 20 years ago.

# Old Adapters Can Have Issues



- It is recommended that old adapters be inspected and replaced if they have been used for more than 20 years or 100,000 load cycles (10,000 calibrations)



# The Wrong Tension Adapters



- ▶ If any of these look like tension adapters in your calibration lab, there is a problem.
- ▶ Even straight threaded rod can introduce misalignment issues as they can distort the line of force in non-Morehouse machines.
- ▶ Any machine misalignment of 0.01 degrees can affect the reproducibility of some load cells. Even our spherical adapters can only overcome about 0.1 degree of misalignment.

# Multi - Column Load Cell

Error associated with using a non flat base on a multi-column cell. This is an actual test result we observed on a Revere multi-column cell.



	Non-Flat Base	Flat Base
	Maximum Error	Maximum Error
Force Applied	In Rotation	In Rotation
	LBF	LBF
30000	12	4
150000	136	24
300000	342	68
	% error	% error
30000	0.040%	0.013%
150000	0.091%	0.016%
300000	0.114%	0.023%

# Bottom Plates

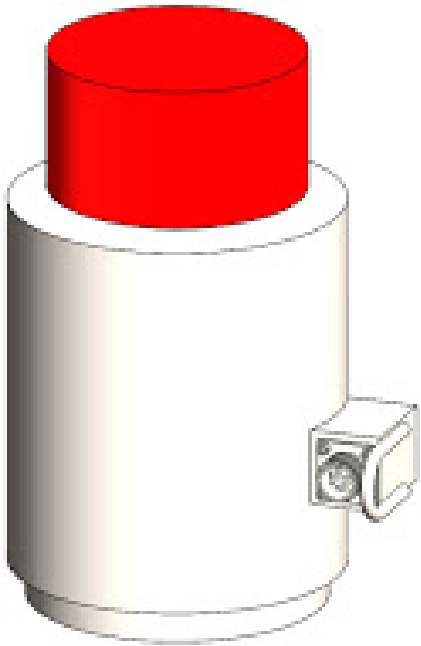


- A flat bottom plate may be needed to improve performance. It is often not recommended the practice to load against the machine surface as it could be uneven, or the base of the load cell could deform the machine surface.
- Pictured left is a Morehouse 60K rod end style load cell with spherical threaded adapter, top compression pad and load cell base plate.



# Top Adapters - Hardness

**Do you have a top block that can be sent with the Force Measuring Device?**

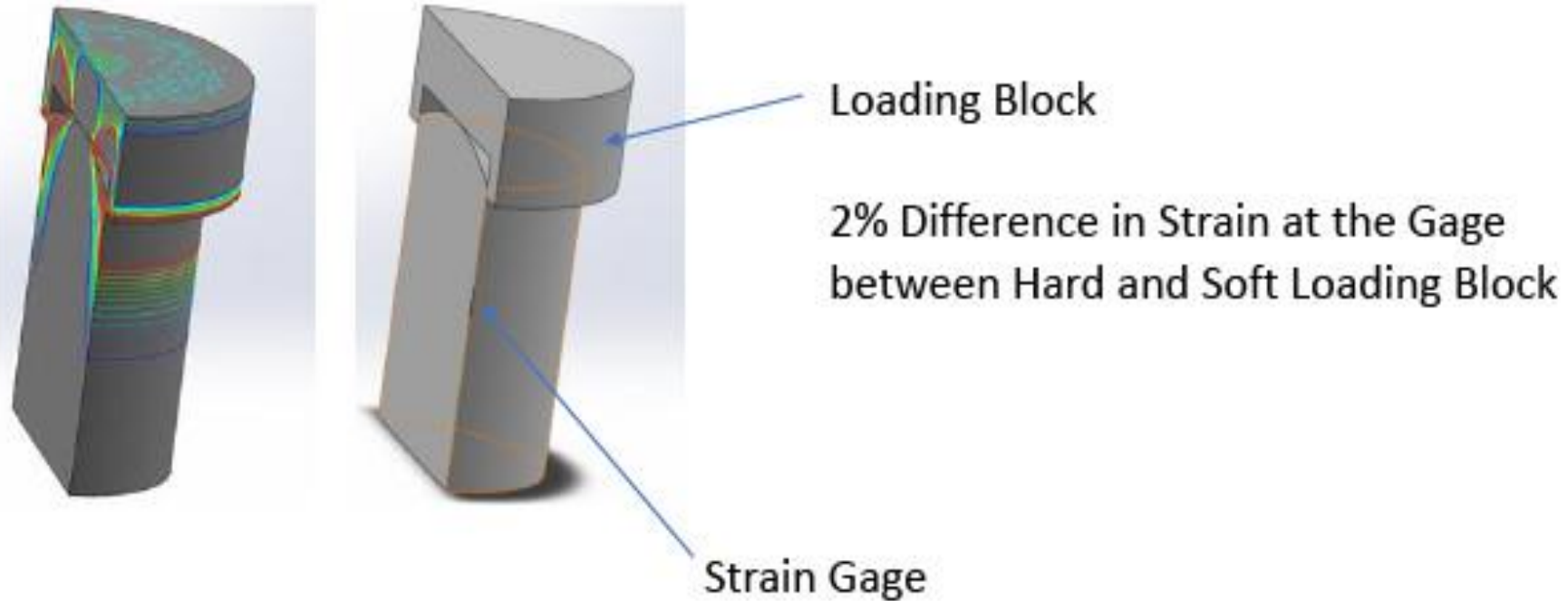


Different hardness of top adapters on column load cells can produce errors as high as 0.3 %.

6/23/2017		6/23/2017		
4340 Top Block		Hardened Top Block		Difference
0	120	0	120	
-48968	-48960	-49120	-49109	-0.307%
-244290	-244308	-244990	-244971	-0.279%
-487279	-487320	-488596	-488570	-0.263%



# Top Adapters - Hardness



Materials with different hardness experience different amounts of lateral deflection under the same amount of load. Therefore, the varying hardness causes different amounts of stress between the block and the load cell. The above analysis shows steel to steel. It gets much worse if we use a softer material

# Flat on Flat Loading

- ▶ Flat on Flat will produce additional errors as the material is never truly flat and side loading occurs.
- ▶ Flat on Flat will not direct the stresses to the gauges



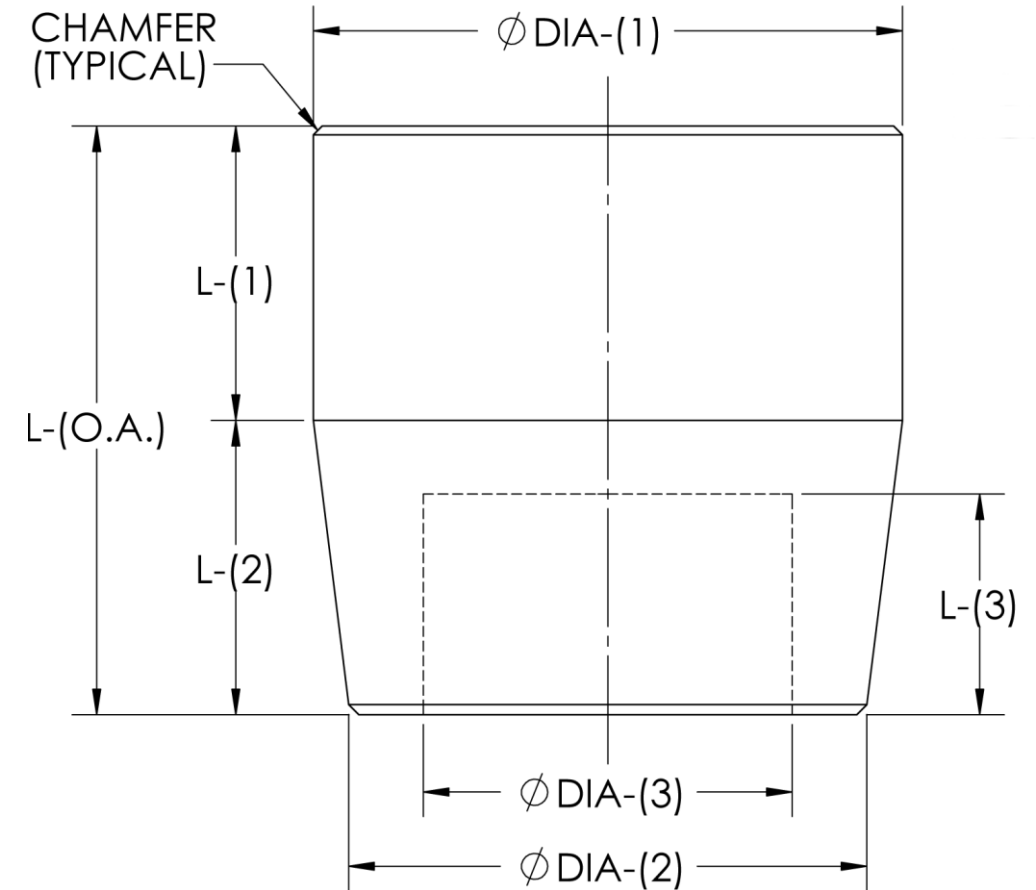
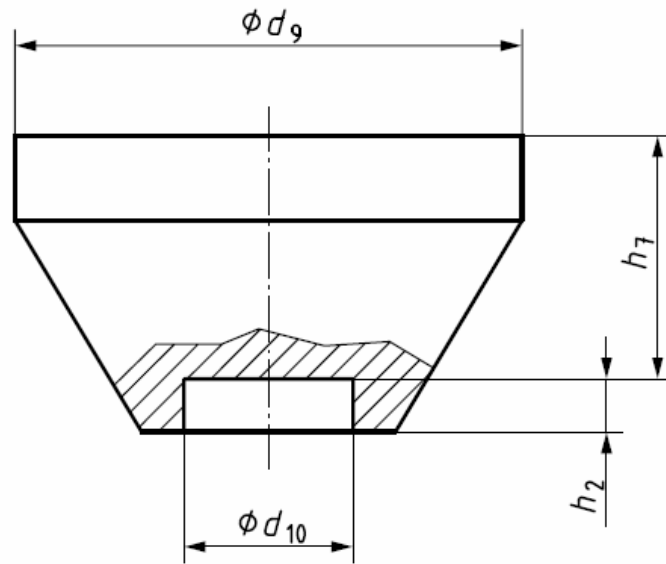
# Morehouse Compression Adapters



- Pictured above is a Morehouse Concrete set with top and bottom adapters (the 600K cell which weighs 25 lbs & with top & bottom adapter weighs less than 40 lbs).

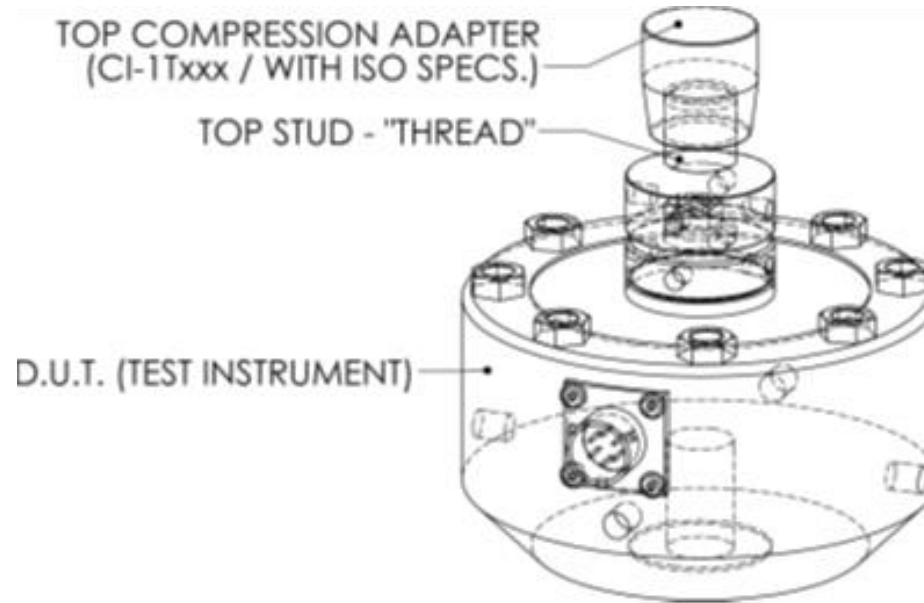
# ISO 376 Compression Adapters

- Compressive force transducers should be fitted with one or two compression pads





# Morehouse Compression Adapters



- Pictured above is an ISO 376 recommended compression adapters

# Thread Versus Shoulder Loading

Is the force device loaded through the top shoulder or thread loaded? If thread loaded, how much engagement?

Morehouse tested the same load cell with two different types of adaptors and recorded the readings with 10,000 LBF applied.



Output was 10,001.5 LB with 1.5" of engagement vs 9942.3 LBF with 0.5" engagement.

**There was a difference of 59.2 LBF on a 10,000 LBF cell.**

The error on this measurement was over 0.5 % on a device expected to be better than 0.025 % (20 times expected).

# Proper Adapters Shear Web cells



Solution - Purchase and lock in an integral adapter

or pick a top adapter and always use and have the force measuring device calibrated with that top adapter. In this example, a spherical load button would be an excellent top adapter for this load cell.

# Asking the Right Questions

Is the force device loaded through the bottom threads?



FORCE APPLIED	LOAD CELL OUTPUT LOADED AGAINST BOTTOM BASE
LBF	
1000	999.0
2000	1998.0
5000	4996.0
7000	6995.0
10000	9994.5
12000	11994.0
15000	14993.5
17000	16993.5
20000	19994.0
22000	21994.0
25000	24994.0

LOAD CELL OUTPUT LOADED AGAINST BOTTOM THREADS
999.0
1998.0
4996.5
6995.5
9995.0
11995.0
14995.0
16995.0
19996.0
21996.5
24997.0



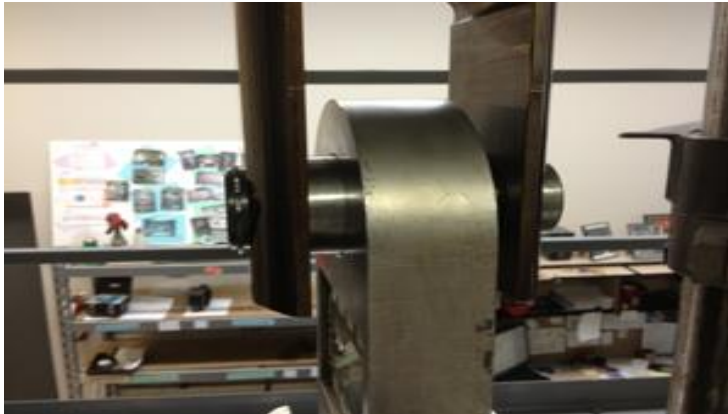
# The Importance of Adapters



Keeping the line of force pure (free from eccentric forces) is key to the calibration of load cells. ASTM E74 does not address the various adapter types, but ISO 376 does.



# Tension Links Pin Diameter

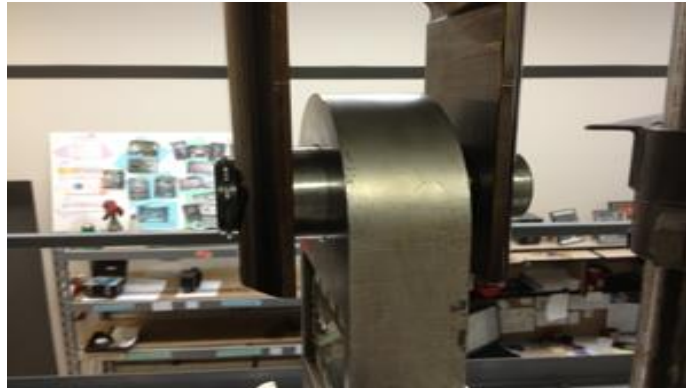


- ▶ Does anyone think the output will vary by using different pin sizes?



# Tension Links Improper Vs Proper Pin Diameter

- Loaded with the proper Pin Diameter to 50,000 LBF



# Tension Links Improper Vs Proper Pin Diameter

- Loaded without the proper Pin Diameter to 50,000 LBF





# Proper Adapters – Tension Links

## Tension Links Improper Vs Proper Pin Diameter

Difference of 860 LBF or 1.72 % error at 50,000 LBF from not using the proper size load pins.



Out of Tolerance

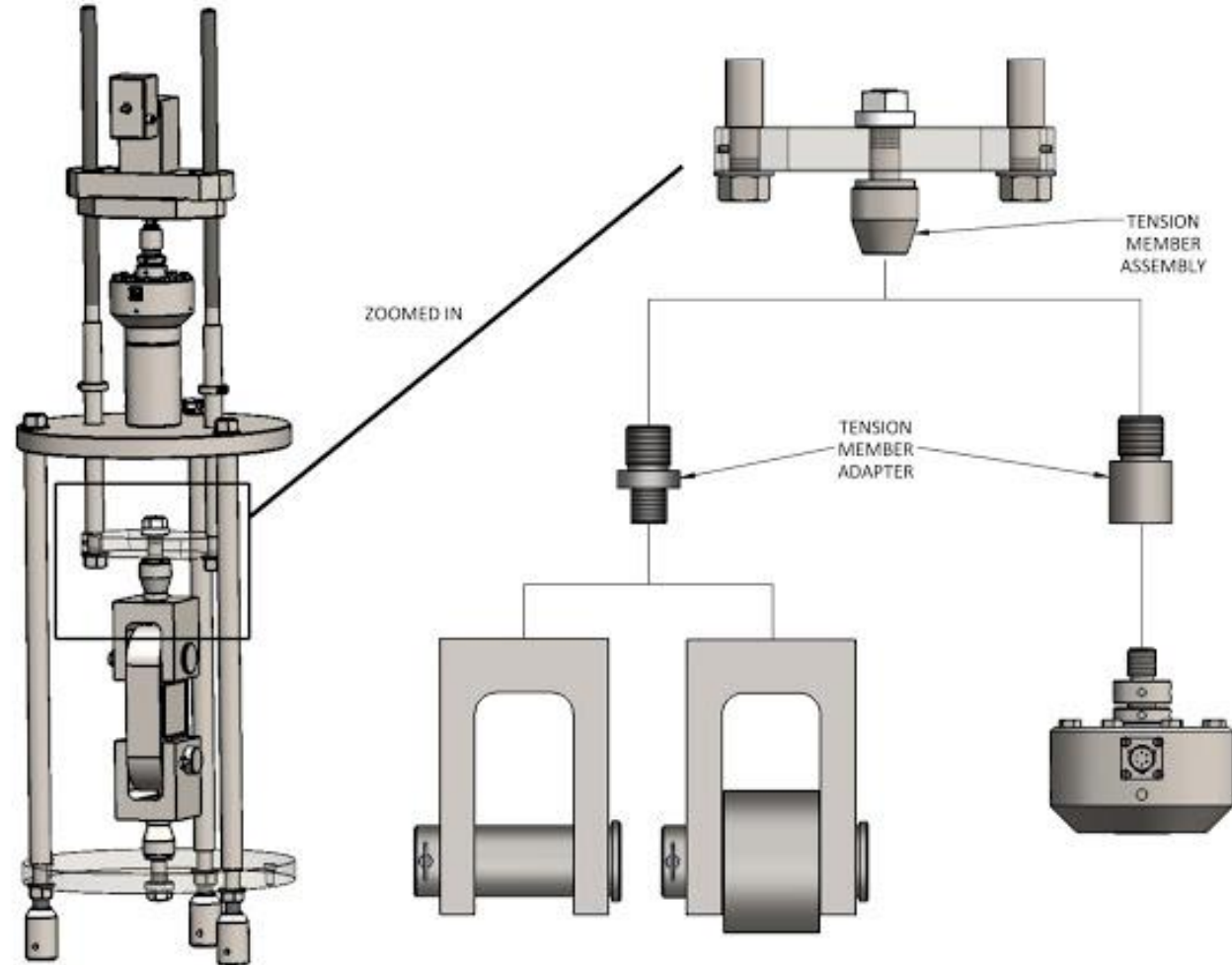
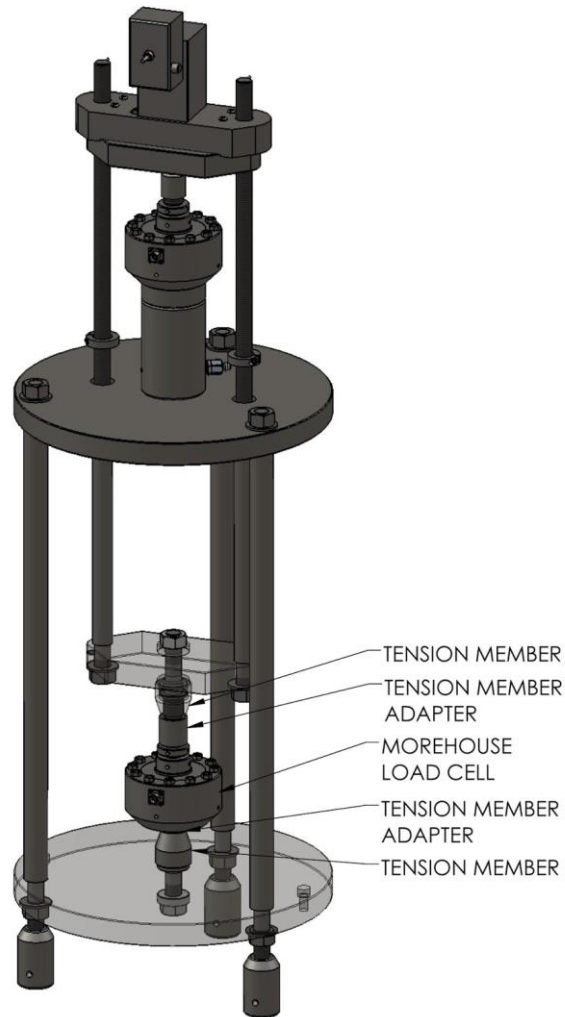
Versus



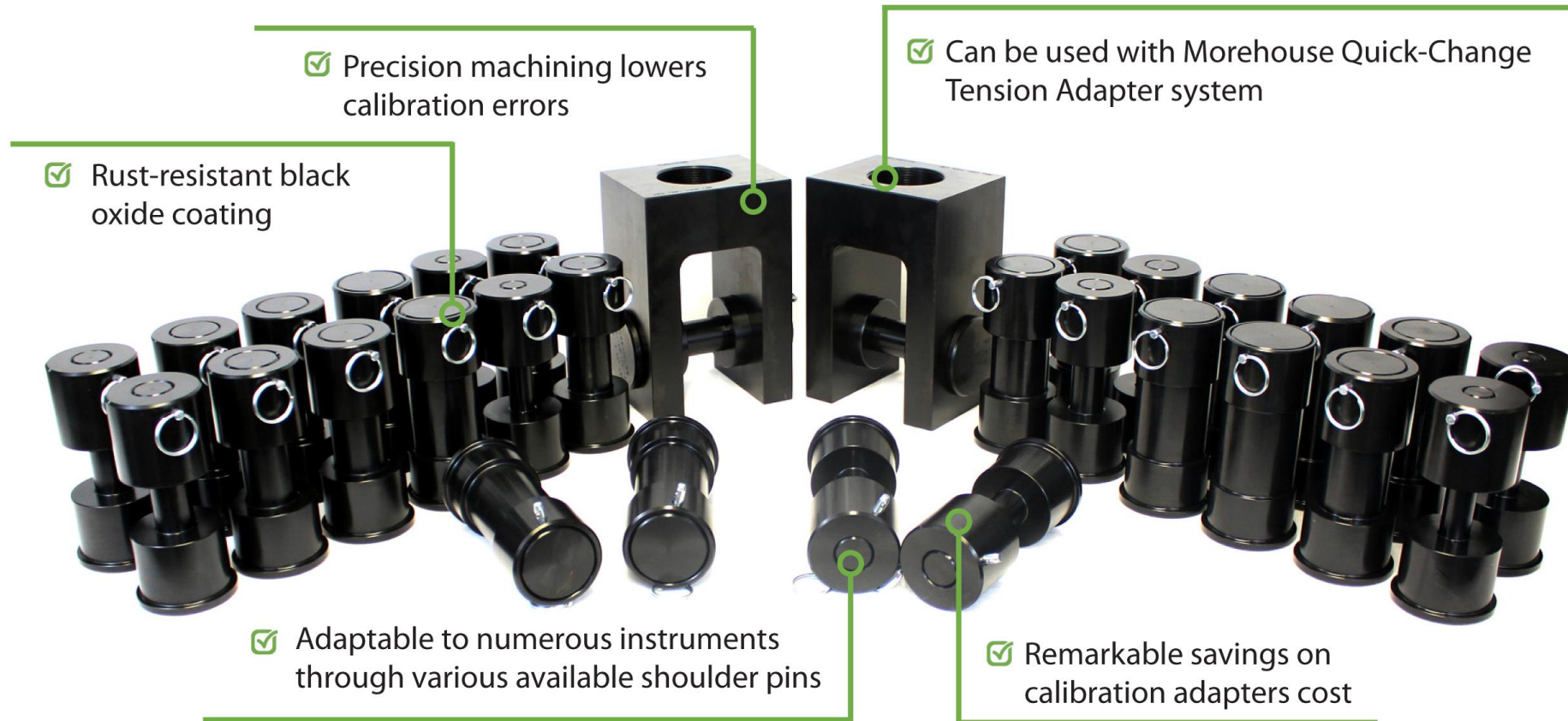
In Tolerance

Note: Tension links of this design seem to exhibit similar problems. If you are unsure, TEST!

# Proper Adapters



# Proper Adapters for Tension Links (U.S. Patent No 11,078,052)



# Proper Adapters for Tension Links

**Dimensions** inches (mm)

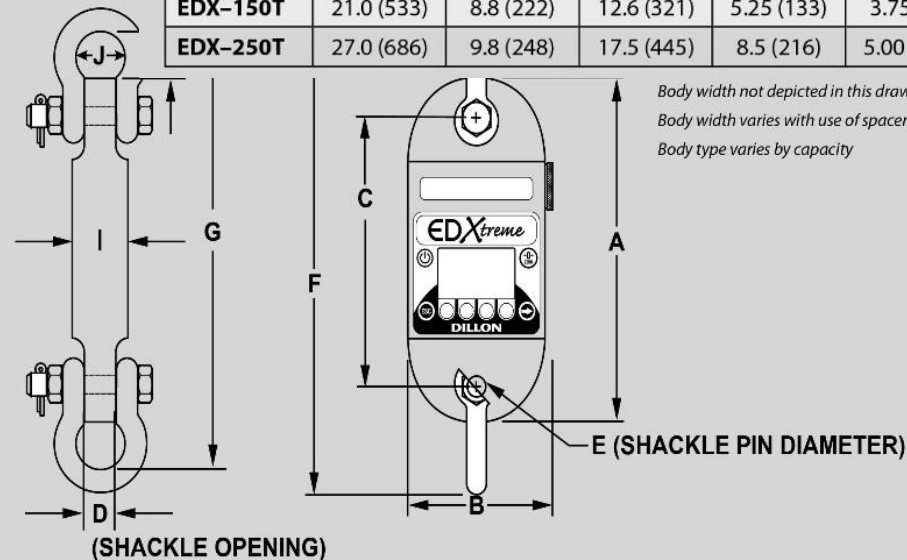
Model	Dimensions inches (mm)
EDX-1T	10.6 (269)
EDX-2T	10.6 (269)
EDX-5T	11.4 (289)
EDX-10T	11.5 (291)
EDX-25T	13.7 (348)
EDX-50T	15.8 (400)
EDX-75T	16.5 (419)
EDX-100T	18.0 (457)
EDX-150T	21.0 (533)
EDX-250T	27.0 (686)

\*Dimensions shown using

**Dimensions** inches (mm)

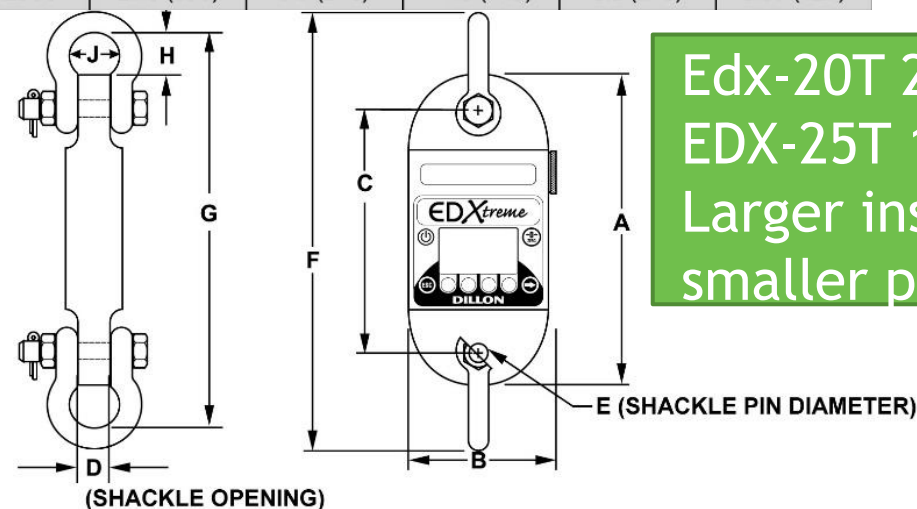
Model	A	B	C	D	E
EDX-1T	10.6 (269)	5.0 (127)	7.8 (198)	1.06 (26)	0.75 (19)
EDX-2T	10.6 (269)	5.0 (127)	7.8 (198)	1.06 (26)	0.75 (19)
EDX-5T	11.4 (289)	5.3 (135)	8.1 (206)	1.38 (35)	1.00 (25)
EDX-10T	11.5 (291)	5.3 (133)	7.9 (201)	1.97 (50)	1.38 (35)
EDX-25T	13.7 (348)	6.0 (152)	9.0 (229)	2.75 (70)	1.97 (50)
EDX-50T	15.8 (400)	6.8 (172)	10.3 (262)	3.88 (99)	2.75 (70)
EDX-75T	16.5 (419)	7.8 (197)	10.3 (262)	3.88 (99)	2.75 (70)
EDX-100T	18.0 (457)	7.8 (197)	11.0 (280)	5.00 (127)	3.25 (83)
EDX-150T	21.0 (533)	8.8 (222)	12.6 (321)	5.25 (133)	3.75 (95)
EDX-250T	27.0 (686)	9.8 (248)	17.5 (445)	8.5 (216)	5.00 (127)

Body width not depicted in this drawing  
Body width varies with use of spacers  
Body type varies by capacity



Model	A	B	C	D	E
EDx-1T	10.6 (269)	5.0 (127)	7.8 (198)	1.06 (26)	0.75 (19)
EDx-2T	10.6 (269)	5.0 (127)	7.8 (198)	1.06 (26)	0.75 (19)
EDx-5T	11.4 (289)	5.3 (135)	8.1 (206)	1.38 (35)	1.00 (25)
EDx-10T	11.5 (291)	5.3 (133)	7.9 (201)	1.97 (50)	1.38 (35)
EDx-20T	13.7 (348)	6.0 (152)	9.0 (229)	2.75 (70)	2.0 (51)
EDx-50T	15.8 (400)	6.8 (172)	10.3 (262)	3.88 (99)	2.75 (70)
EDx-75T	16.5 (419)	7.8 (197)	10.3 (262)	3.88 (99)	2.75 (70)
EDx-100T	18.0 (457)	7.8 (197)	11.0 (280)	5.00 (127)	3.25 (83)
EDx-150T	21.0 (533)	8.8 (222)	12.6 (321)	5.25 (133)	3.75 (95)
EDx-250T	27.0 (686)	9.8 (248)	17.5 (445)	8.5 (216)	5.00 (127)

G	H	J
3.4 (340)	1.36 (34)	1.69 (43)
3.4 (340)	1.36 (34)	1.69 (43)
5.8 (402)	2.17 (56)	2.28 (58)
8.8 (478)	3.67 (93)	3.25 (83)
5.2 (640)	5.7 (146)	5.0 (127)
4.3 (870)	9.3 (235)	7.3 (184)
4.3 (870)	8.9 (225)	7.3 (184)
10.5 (1027)	11.2 (284)	7.8 (200)
16.6 (1159)	12.3 (313)	9.0 (229)
22.8 (1595)	17.9 (454)	13.0 (330)



Edx-20T 2.0-inch pin  
EDX-25T 1.97-inch pin  
Larger instrument takes smaller pin!





**List of Instruments to Calibrate****Instruments which can be calibrated with the Adaptable Clevis Kits and corresponding part numbers**

Common Clevis Part Number: TU-120-001						
Manufacturer	Model	Capacity (lbf)	Pin Needed for Calibration through Instrument Holes	Pin Needed for Calibration through Shackles	Basic Kit (v.1)	Premium Kit (v.1)
Dillon	EDx-20T	50000	TUZ-120-001-11	TP-120-001-01X	✓	✓
Dillon	EDx-25T	55000	TUZ-120-001-24	TP-120-001-01X		✓
Dillon	EDx-50T	100000	TUZ-120-001-10	TP-120-001-01X	✓	✓
Dillon	ED2000 (50000 lbf)	50000	TUZ-120-001-11	TP-120-001-01X	✓	✓
Dillon	ED2000 (100000 lbf)	100000	TUZ-120-001-14	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh; MSI-4260	20000	-	TUZ-120-001-11X	✓	✓
Rice Lake	Port-A-Weigh; MSI-4260	30000	-	TUZ-120-001-11X	✓	✓
Rice Lake	Port-A-Weigh; MSI-4260	50000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh; MSI-4260	70000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh; MSI-4260	100000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-4300	20000	-	TUZ-120-001-11X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-4300	30000	-	TUZ-120-001-11X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-4300	50000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-4300	70000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-4300	100000	-	TP-120-001-01X	✓	✓
Rice Lake	Trans-Weigh; MSI-6260CS	20000	-	TUZ-120-001-11X	✓	✓
Rice Lake	Trans-Weigh; MSI-6260CS	30000	-	TUZ-120-001-11X	✓	✓
Rice Lake	Trans-Weigh; MSI-6260CS	50000	-	TP-120-001-01X	✓	✓
Rice Lake	Trans-Weigh; MSI-6260CS	70000	-	TP-120-001-01X	✓	✓
Rice Lake	Trans-Weigh; MSI-6260CS	100000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-9300	20000	-	TUZ-120-001-11X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-9300	30000	-	TUZ-120-001-11X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-9300	50000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-9300	70000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-9300	100000	-	TP-120-001-01X	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-9300HT †	70000	TUZ-120-001-11 †	TP-120-001-01X †	✓	✓
Rice Lake	Port-A-Weigh Plus; MSI-9300HT †	120000	TUZ-120-001-13 †	TP-120-001-01X †		✓
Rice Lake	Dyna-Link 2; MSI-7300	25000	TUZ-120-001-25	TP-120-001-01X		✓
Rice Lake	Dyna-Link 2; MSI-7300	50000	TUZ-120-001-11	TP-120-001-01X	✓	✓
Rice Lake	Dyna-Link 2; MSI-7300	120000	TUZ-120-001-13	TP-120-001-01X		✓

† Instrument has two different hole sizes. Thus, two pins with two different diameters are required; one for instrument hole and one for shackle.

**Common Clevis Part Number: TU-120-001**

Manufacturer	Model	Capacity (lbf)	Pin Needed for Calibration through Instrument Holes	Pin Needed for Calibration through Shackles	Basic Kit (v.1)	Premium Kit (v.1)
Rice Lake	Dyna-Link 2; MSI-7200	25000	TUZ-120-001-25	TP-120-001-01X		✓
Rice Lake	Dyna-Link 2; MSI-7200	50000	TUZ-120-001-11	TP-120-001-01X	✓	✓
Rice Lake	Dyna-Link 2; MSI-7200	100000	TUZ-120-001-12	TP-120-001-01X		✓
Straightpoint	RLP25T	55000	TUZ-120-001-11	TP-120-001-01X		✓
Straightpoint	RLP35T	77000	TUZ-120-001-12	-		✓
Straightpoint	RLP50T	110000	TUZ-120-001-12	-		✓
Straightpoint	WLP35T	77000	TUZ-120-001-12	-		✓
Straightpoint	WLP50T	110000	TUZ-120-001-12	-		✓
IMES	LE35T	77000	TUZ-120-001-15	-		✓
IMES	LE50T	110000	TUZ-120-001-16	-		✓
Canflex	JCM-25LC	55000	TUZ-120-001-17	-		✓
Canflex	JCM-35LC	77000	TUZ-120-001-18	-		✓
Intercomp	TL8000	25000	TUZ-120-001-25	TP-120-001-01X		✓
Intercomp	TL8000	50000	TUZ-120-001-11	TP-120-001-01X	✓	✓
Intercomp	TL8000	100000	TUZ-120-001-14	TP-120-001-01X	✓	✓
Intercomp	TL8500	25000	TUZ-120-001-25	TP-120-001-01X		✓
Intercomp	TL8500	50000	TUZ-120-001-11	TP-120-001-01X	✓	✓
Intercomp	TL8500	100000	TUZ-120-001-14	-	✓	✓
LSI (Trimble)	GC060	60000	TUZ-120-001-19	-		✓
LSI (Trimble)	GC100	100000	TP-120-001-01	-	✓	✓
Tractel	LLZ2	44000	TUZ-120-001-24	-		✓
Tractel	LLXh	55000	TUZ-120-001-24	-		✓
Tractel	LLXh	110000	TUZ-120-001-20	-		✓
Sensy	5200R (500 kN)	112000	TUZ-120-001-23	-		✓
Sensy	5200-5205 (500 kN)	112000	TUZ-120-001-23	-		✓
Eilon	RON 2300 SHACKLE (80000 lbf)	80000	TUZ-120-001-12	-		✓
Eilon	RON 2300 SHACKLE (100000 lbf)	100000	TUZ-120-001-12	-		✓
Eilon	RON 2501 (80000 lbf)	80000	TUZ-120-001-12	-		✓
Eilon	RON 2501 (100000 lbf)	100000	TUZ-120-001-12	-		✓
Eilon	RON 2000 (80000 lbf)	80000	TUZ-120-001-12	-		✓
Eilon	RON 2000 (100000 lbf)	100000	TUZ-120-001-12	-		✓
Eilon	RON 2125 (80000 lbf)	80000	TUZ-120-001-12	-		✓
Eilon	RON 2125 (100000 lbf)	100000	TUZ-120-001-12	-		✓
Strainert	STL-40 SSX	80000	TUZ-120-001-21	-		✓
Strainert	STL-50 SSX	100000	TUZ-120-001-22	-		✓

### Common Clevis Part Number: TU-120-001

Manufacturer	Model	Capacity (lbf)	Pin Needed for Calibration through Instrument Holes	Pin Needed for Calibration through Shackles	Basic Kit (v.1)	Premium Kit (v.1)
CAS	Caston III	30000	-	TUZ-120-001-11X	✓	✓
CAS	Caston III	40000	-	TUZ-120-001-11X	✓	✓
CAS	Caston III	60000	-	TP-120-001-01X	✓	✓
CAS	Caston III	100000	-	TP-120-001-01X	✓	✓
CAS	Caston III(B)-15THD	33000	-	TUZ-120-001-11X	✓	✓
CAS	Caston III(B)-20THD	44000	-	TUZ-120-001-11X	✓	✓
CAS	Caston III(B)-30THD	66000	-	TP-120-001-01X	✓	✓
CAS	Caston III(B)-50THD	110000	-	TP-120-001-01X	✓	✓
CAS	Caston III(BT)	30000	-	TUZ-120-001-11X	✓	✓
CAS	Caston III(BT)	40000	-	TUZ-120-001-11X	✓	✓
CAS	Caston III(BT)	60000	-	TP-120-001-01X	✓	✓
CAS	Caston III(BT)	100000	-	TP-120-001-01X	✓	✓

\*Parts are designed and manufactured to each instrument's specifications as reported by its manufacturers. For any changes to the standard specifications sheet, the calibration clevis and pins may need to be redesigned.

\*\*Contact Morehouse Sales team for calibrating any instruments which might not be mentioned in the list above.

### Included in the Kits

#### Basic 120K Adaptable Clevis Kit (v.1)

Part Number	Qty.	Description
TU-120-001	2	Clevis
TP-120-001-01X	2	Straight Pin with Roller
TUZ-120-001-10	2	Shoulder Pin
TUZ-120-001-11X	2	Shoulder Pin with Roller
TUZ-120-001-14	2	Shoulder Pin

#### Premium 120K Adaptable Clevis Kit (v.1)

Part Number	Qty.	Description
TU-120-001	2	Clevis
TP-120-001-01X	2	Straight Pin with Roller
TUZ-120-001-10	2	Shoulder Pin
TUZ-120-001-11X	2	Shoulder Pin with Roller
TUZ-120-001-12	2	Shoulder Pin
TUZ-120-001-13	2	Shoulder Pin
TUZ-120-001-14	2	Shoulder Pin
TUZ-120-001-15	2	Shoulder Pin
TUZ-120-001-16	2	Shoulder Pin
TUZ-120-001-17	2	Shoulder Pin
TUZ-120-001-18	2	Shoulder Pin
TUZ-120-001-19	2	Shoulder Pin
TUZ-120-001-20	2	Shoulder Pin
TUZ-120-001-21	2	Shoulder Pin
TUZ-120-001-22	2	Shoulder Pin
TUZ-120-001-23	2	Shoulder Pin
TUZ-120-001-24	2	Shoulder Pin
TUZ-120-001-25	2	Shoulder Pin

# Tension Link Calibration



Anyone think this is a safe adapter?





What do you think was the cause of this?

[Force Safety Blog](#)



# Button Load Cell Calibration

Does this setup look familiar?



Manually Aligned	Data
0 degree	2011
120 degree	1997
240 degree	2018
Average	2008.66667
Standard Deviation	10.6926766
Max Deviation	21
% Error	1.045%

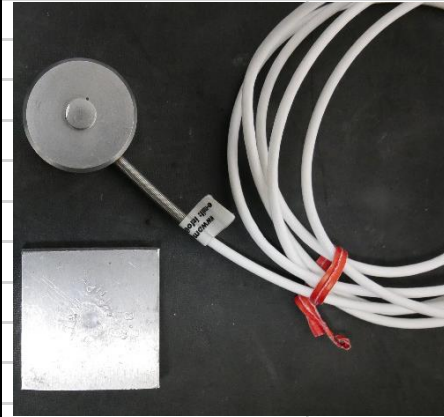


# Button Load Cell Calibration



Button Load Cell Adapters that better aligned the load cell improved the measurement result by 525 %

Standard Setup versus Morehouse Adapters in Morehouse Deadweight



Manually Aligned		Data		Aligned with Adapter		Data	
0 degree		2011		0 degree		2008	
120 degree		1997		120 degree		2006	
240 degree		2018		240 degree		2010	
Average		2008.66667		Average		2008	
Standard Deviation		10.6926766		Standard Deviation		2	
Max Deviation		21		Max Deviation		4	
% Error		1.045%		% Error		0.199%	



**Morehouse**  
THE FORCE IN CALIBRATION SINCE 1925

# Button and Washer Load Cell



- ▶ Above are pictures of button and washer load cell adapters which improve alignment and yield better calibration results

# S-beam



Does anything look different when comparing these two pictures?

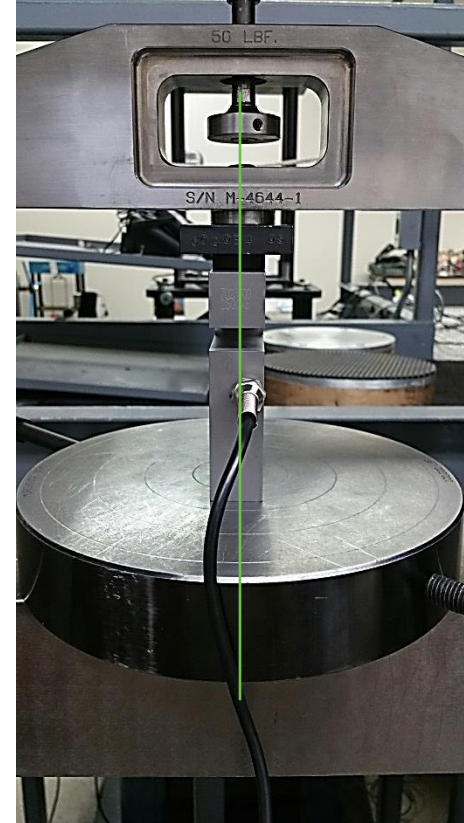


# Misalignment S-Beam

Misalignment Demonstrating 0.752 % error



Output in mV/V  
Aligned in machine  
-1.96732 mV/V



Output in mV/V  
Slightly misaligned in machine  
-1.98211 mV/V

# Misalignment S-Beam

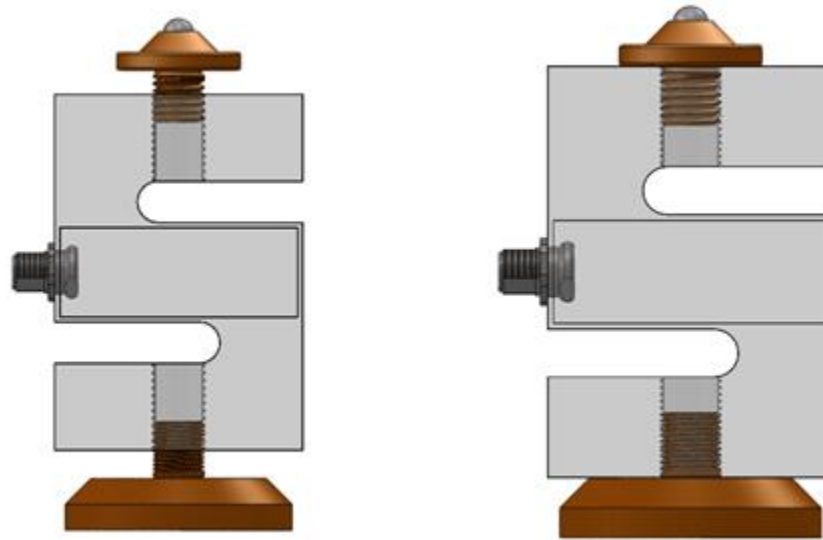
S-BEAM WITH 0.75 % MISALIGNMENT ERROR



S-BEAM	10000 LBF	SERIAL NO	EXAMPLE
%	Force Applied	COMBINED UNCERTAINTY FOR K=2	
2.00%	200	0.89076%	1.782 LBF
10.00%	1000	0.86705%	8.671 LBF
20.00%	2000	0.86630%	17.326 LBF
30.00%	3000	0.86616%	25.985 LBF
40.00%	4000	0.86612%	34.645 LBF
50.00%	5000	0.86609%	43.305 LBF
60.00%	6000	0.86608%	51.965 LBF
70.00%	7000	0.86607%	60.625 LBF
80.00%	8000	0.86607%	69.286 LBF
90.00%	9000	0.86607%	77.946 LBF
100.00%	10000	0.86606%	86.606 LBF



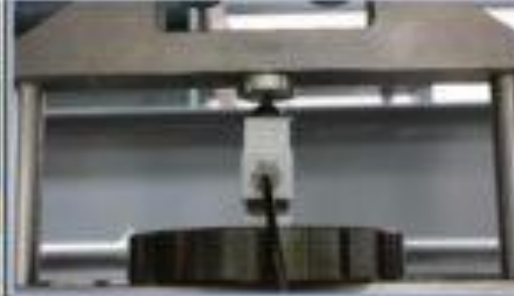

Overall Uncertainty went from about 10 lbf to 86.6 lbf with slight misalignment

# S-beam Loading



S-beam Load Cell with Different Loading Conditions

# S-beam Loading

			
Instrument Reading Thread Loading Loose Both Ends Output in mV/V	Instrument Reading Thread Loading Tight Both Ends Output in mV/V	Instrument Reading Thread Loaded on Top / Flat base Output in mV/V	Instrument Reading Flat on Flat Output in mV/V
1.50136	1.50241	1.50182	1.50721
3.00381	3.00581	3.00459	3.01326
Maximum Difference mV/V	Maximum Difference lbf	Maximum % Difference	Smallest % Difference
0.00585	4.618066191	0.369%	0.029%
0.00945	7.459953077	0.298%	0.025%

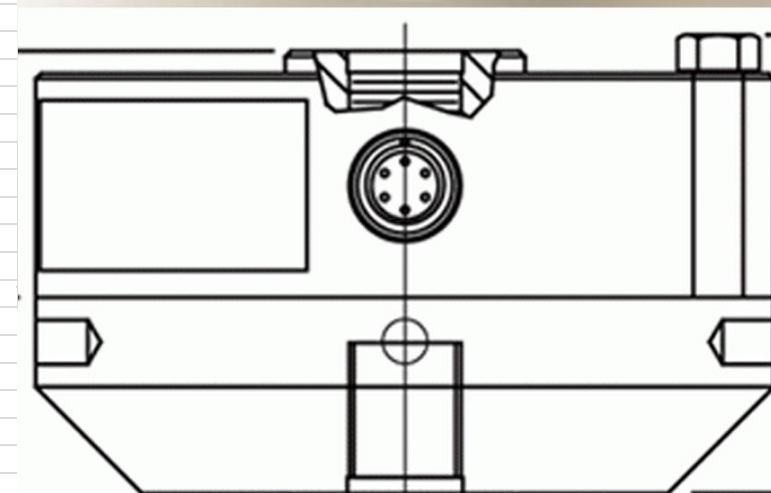
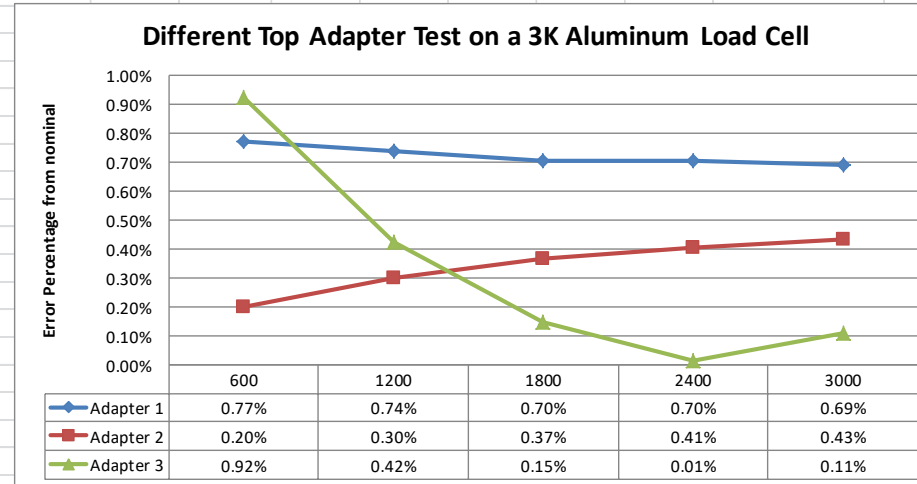
S-Beam example where loading through the threads versus against the base produces up to a 0.369 % difference in output.



# Thread Depth – Shoulder loading Versus Thread Loading ON SHEAR WEB CELLS



Aluminum Load Cell Top Fixture Test						
Force Applied	Adapter 1 Readings	Adapter 2 Readings	Adapter 3 Readings	Max Error Between Adapters	Max % Error	
600	595.4	598.8	605.6	10.2	1.70%	
1200	1191.2	1196.4	1205.1	13.9	1.16%	
1800	1787.4	1793.4	1802.7	15.3	0.85%	
2400	2383.2	2390.3	2399.7	16.5	0.69%	
3000	2979.4	2987.1	2996.7	17.3	0.58%	



Note: This test was done on Aluminum type Shear Web Cell. Steel cells behave much differently. Aluminum cells are usually from 100 LBF - 3,000 LBF

# Shear Web cells



Solution - Purchase and lock in an integral adapter

or pick a top adapter and always use and have the force measuring device calibrated with that top adapter. In this example, a Morehouse spherical load button would be an excellent top adapter for this load cell.

[Link to Adapters](#)

# Loading through the bottom threads in compression



Do you think these loading profiles create a different result?

# Loading through the bottom threads in compression

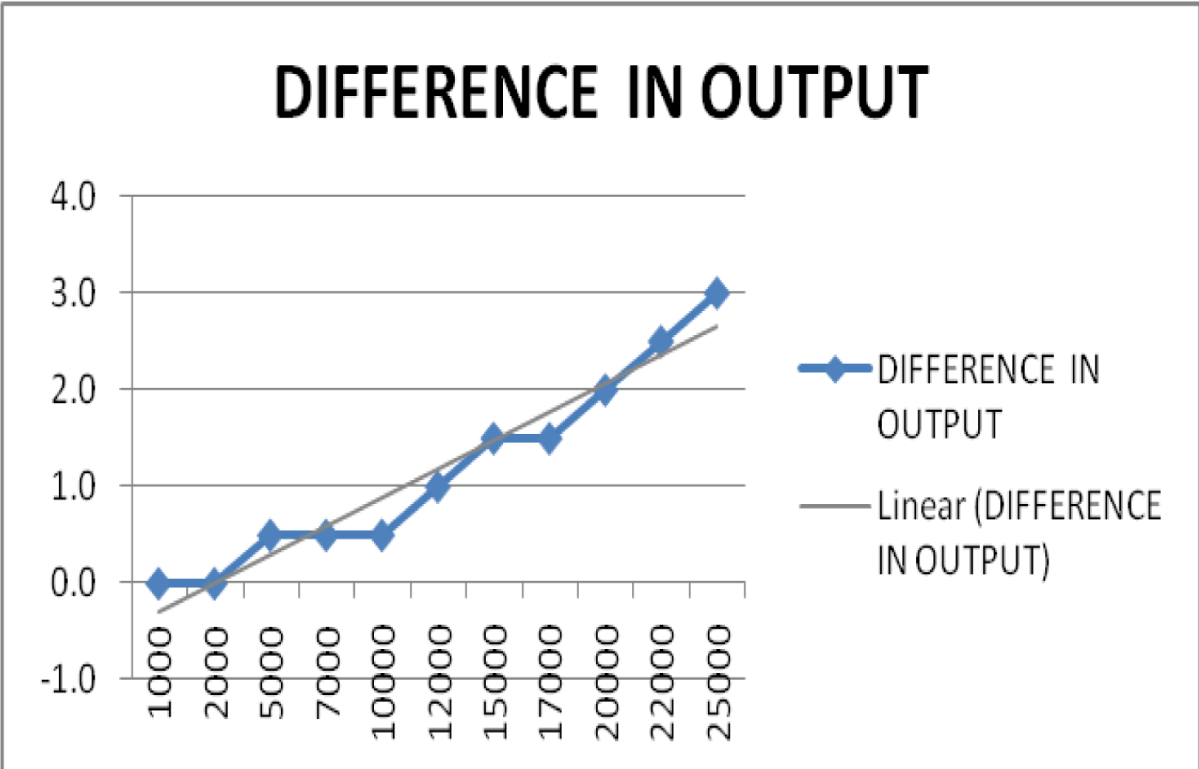


FORCE APPLIED	LOAD CELL OUTPUT LOADED AGAINST BOTTOM BASE	LOAD CELL OUTPUT LOADED AGAINST BOTTOM THREADS
LBF		
1000	999.0	999.0
2000	1998.0	1998.0
5000	4996.0	4996.5
7000	6995.0	6995.5
10000	9994.5	9995.0
12000	11994.0	11995.0
15000	14993.5	14995.0
17000	16993.5	16995.0
20000	19994.0	19996.0
22000	21994.0	21996.5
25000	24994.0	24997.0



# Loading through the bottom threads in compression

FORCE APPLIED LBF	DIFFERENCE IN OUTPUT	% DIFF
1000	0.0	0.000%
2000	0.0	0.000%
5000	0.5	0.010%
7000	0.5	0.007%
10000	0.5	0.005%
12000	1.0	0.008%
15000	1.5	0.010%
17000	1.5	0.009%
20000	2.0	0.010%
22000	2.5	0.011%
25000	3.0	0.012%





# Common Low Force Calibration Problems – Hand-Held Force Gauge

## Stacking Weights Issues

- ▶ Slow and dangerous
- ▶ Ergonomic issue
- ▶ Often not corrected for force (corrections for force must include correcting for gravity, air density, and material density)

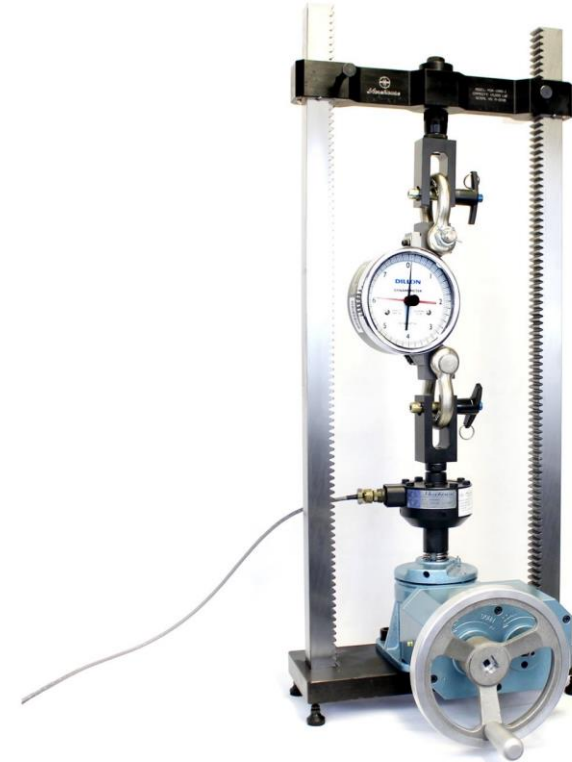




# Common Low Force Calibration Problems – Hand-Held Force Gauge

Not Correcting Mass Weights To Force

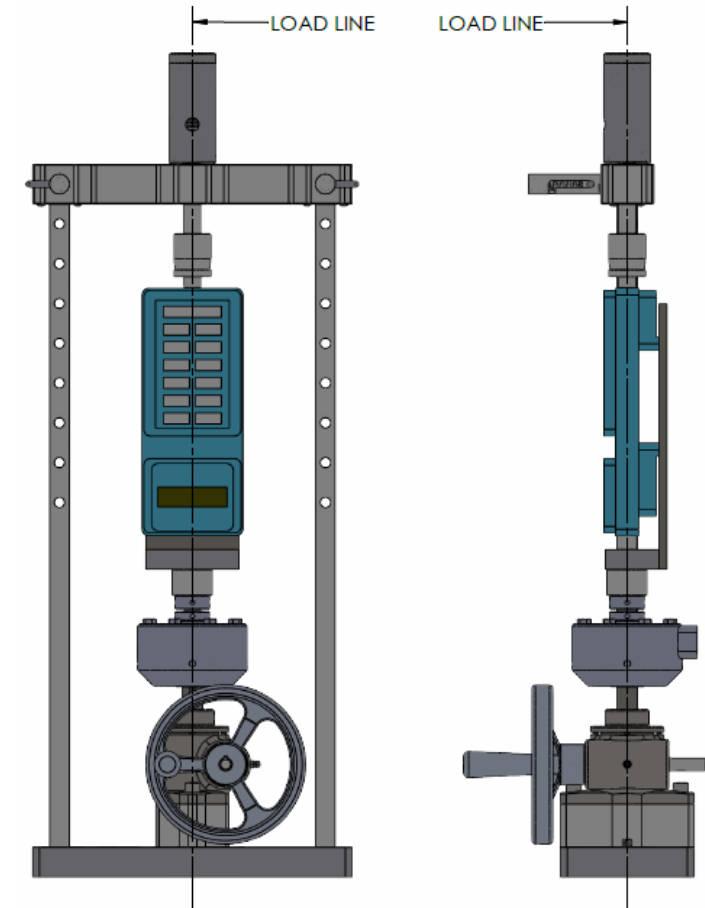
- ▶ [Morehouse Blog on Using Mass Weights](#)
- ▶ Blog shows these errors to be from 0.05 % up to 0.185 %



# Common Low Force Calibration Problems – Hand-Held Force Gauge

## Off Center Loading Issues

- ▶ Most hand-held force gauges require different centering fixtures for alignment - If the line of force is not pure, a large measurement error should be expected



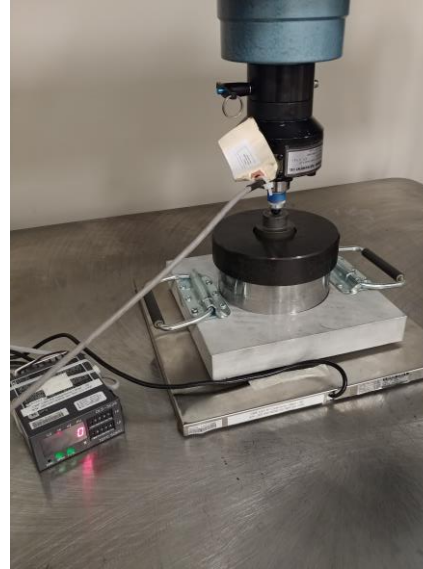
# Adapters for hand-held force gauges



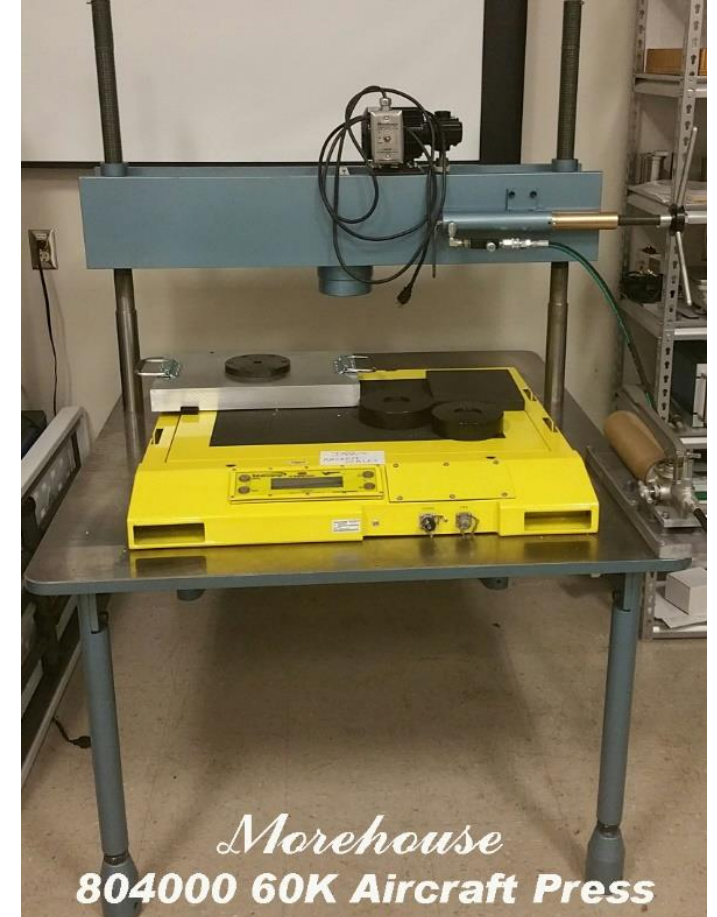
Morehouse L-Bracket kits are available for tension and compression calibration of handheld force gauges. These kits simplify setup and reduce errors with stacking weights. This kit can be used on both the Mechanical Tensiometer and PCM.

[Link to Hand-Held Force Gauge Kit](#)

# Aircraft and Truck Scale Adapters



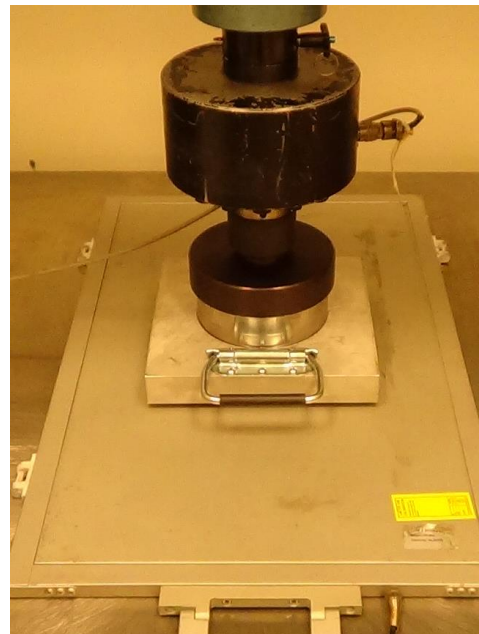
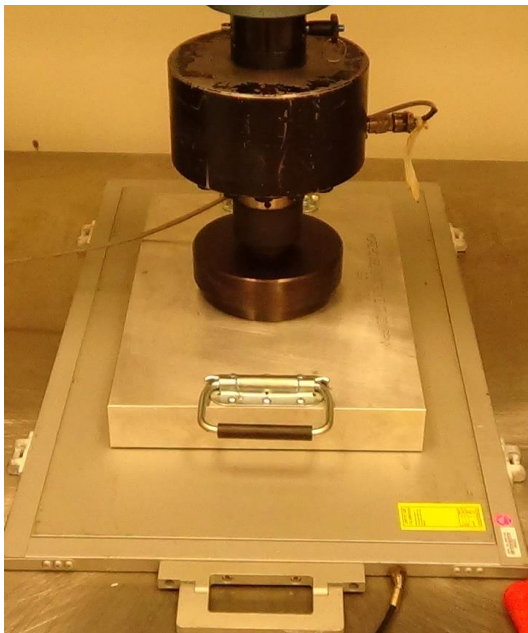
Truck and Aircraft Scales are typically used to weigh trucks and airplanes with the tires sitting on several scales. Any adapter used during calibration should be composed of the same type of rubber and should have the same footprint as the tire to ensure accurate results.





# Aircraft and Truck Scale Adapters

Morehouse has test truck and aircraft scales and there is a large difference in using different size plates

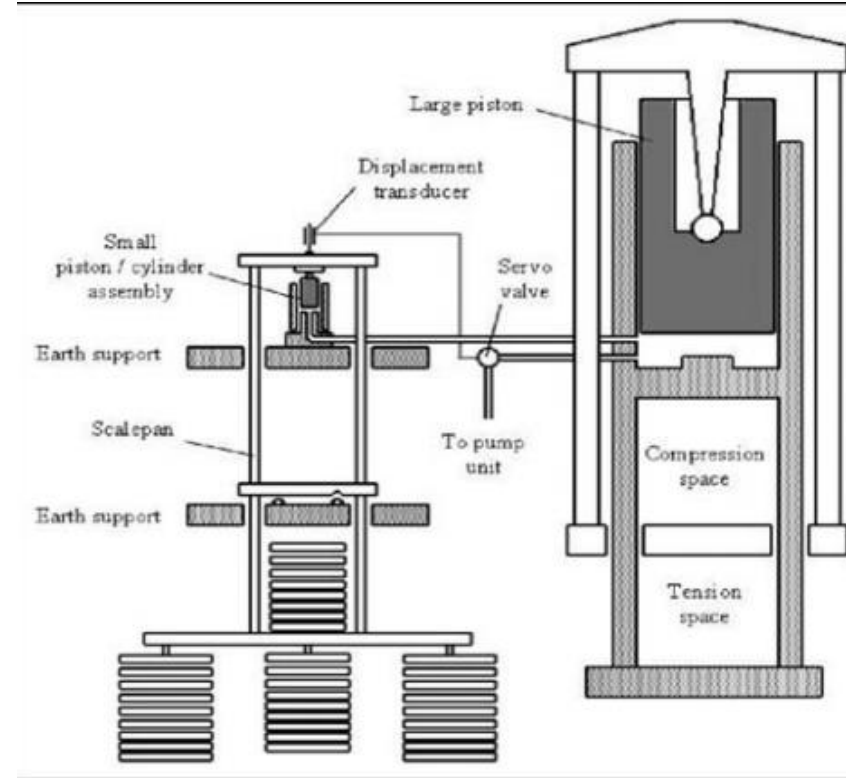
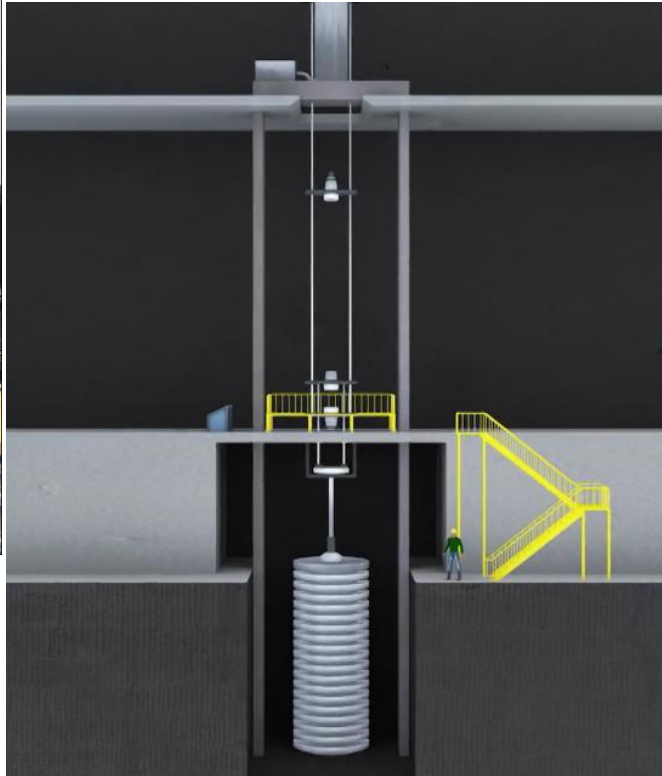
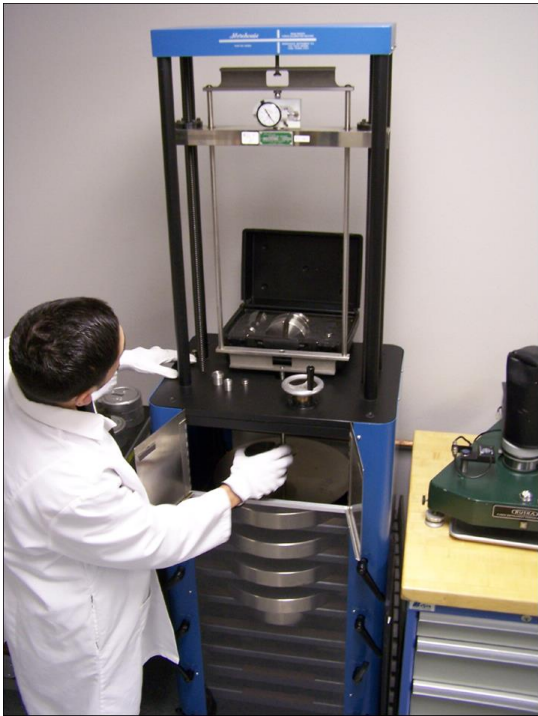


Force Applied lbf	Scale Reading w/ Large pad	Scale Reading w/ Small pad	Diff in lbf	%
0	0	0		
4000	3950	3980	-30	-0.759%
8000	7980	8030	-50	-0.627%
12000	11990	12020	-30	-0.250%
16000	15980	16090	-110	-0.688%
20000	19980	20140	-160	-0.801%
24000	23990	24210	-220	-0.917%
28000	27990	28270	-280	-1.000%
32000	31990	32350	-360	-1.125%
36000	35990	36460	-470	-1.306%
40000	40010	meter saturated		



# The Right Equipment

Replicates Field Use



# The Right Equipment

Replicates Field Use



To Replicate Field Use for ASTM E4 & ISO 7500 Calibrations in These Types of Machines

- The Calibration Laboratory Should Not Perform Compression and Tension Calibration in the Same Setup (Common Practice as it is much quicker)
- They Should use the Customer's Top Blocks and make Separate Compression Setups
- In Compression, they Should Require a Baseplate to Load Against if that is how the load cell is being used.
- For Tension Calibration if the End-User is Calibrating per ISO 7500, They Should Use Adapters Recommended Per the ISO Annex, which would be different than what is shown here

# Summary of Morehouse Common Adapters



✓ Precision machining lowers calibration errors

✓ Can be used with Morehouse Quick-Change Tension Adapter system

✓ Rust-resistant black oxide coating



✓ Adaptable to numerous instruments through various available shoulder pins

✓ Remarkable savings on calibration adapters cost



# The Right Calibration Provider

Morehouse has reference force standards with calibration and measurement capabilities of better than 0.002 % to conduct many tests on adapters and provide solutions that improve measurements for our customer base.

- ▶ The frightening part of this is that not everyone in the industry realize they have these errors.
- ▶ Can you imagine the company making critical measurements using a machine that is not plumb, level, square, rigid, free of torsion, and does not replicate end-use conditions?
- ▶ How about weighing something like a ton of uranium with the wrong pin size using a tension link?

These measurements matter and the errors can be significant!





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