Cable Tensiometers:

Let's Keep the Proper Stress on the Cables, Not Your Nerves

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Cable Tensiometers: Let's Keep the Proper Stress on the Cables, Not Your Nerves

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Abstract

Maintaining precise cable tension is crucial across various industries, including engineering, construction, aerospace, and manufacturing.

Cable tensiometers serve as indispensable instruments for measuring and monitoring this cable tension. However, the calibration of cable tensiometers is riddled with problems.

Clear communication between calibration labs and end users is essential to guarantee that calibrations accurately reflect how equipment is used in real-world situations.

This is especially crucial because different calibration methods can sometimes lead to discrepancies of over 20%, potentially casting doubt on the equipment's functionality.

Abstract

We will delve into three crucial factors that can significantly impact calibration accuracy:

1. Calibration Method: Analysis of various calibration techniques and their influence on results.
2. Cable Length: The impact of different cable lengths used during calibration.
3. Cable Type: How variations in cable types (e.g., GAC vs. SSAC) affect calibration outcomes.

Mechanical Tensiometer

Cable tensiometers are devices used to measure the tension or force in cables, wires, and ropes. They typically feature a load sensor or gauge that provides real-time tension readings.

They are used to check the tension of wire cables (typically used in aircraft rigging and textile manufacturer).

Mechanical Tensiometer
How They Work

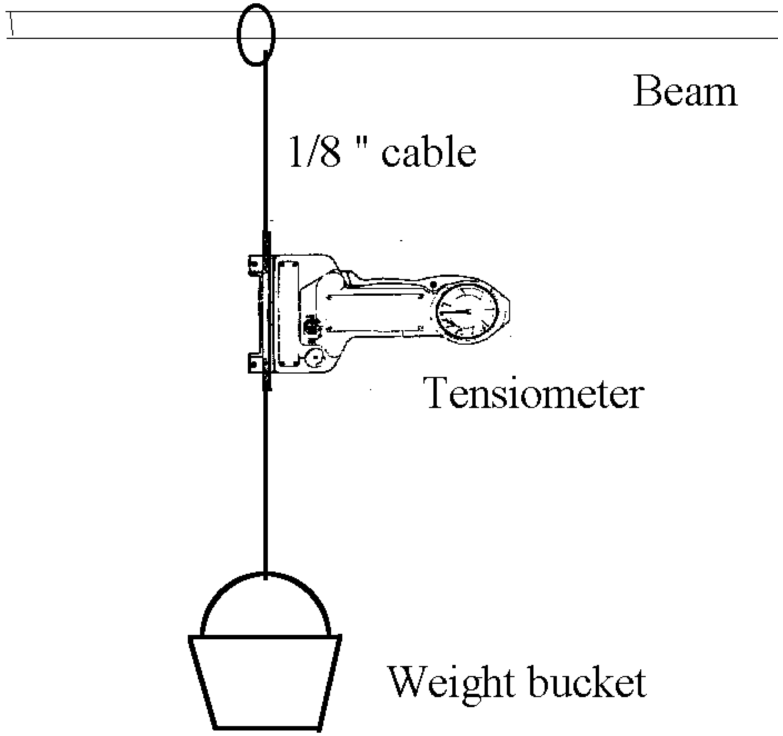
They use a force gauge to react against the cable, via a riser, and display the result, through a gearbox, onto a dial scale. The dial is often just a linear scale numbered 0 through 100, a conversion table is then drawn up to convert the number to a meaningful result in lbf.

Mechanical Tensiometer
How They Work

Calibration is often done by loading to the same force point several times often 6-7.

The tensiometers should be calibrated based on use and other factors. Some common problems to watch for are physical damage, overstretching of the spring(which can happen when the correct riser is not installed for calibration), corrosion, and damaged risers.

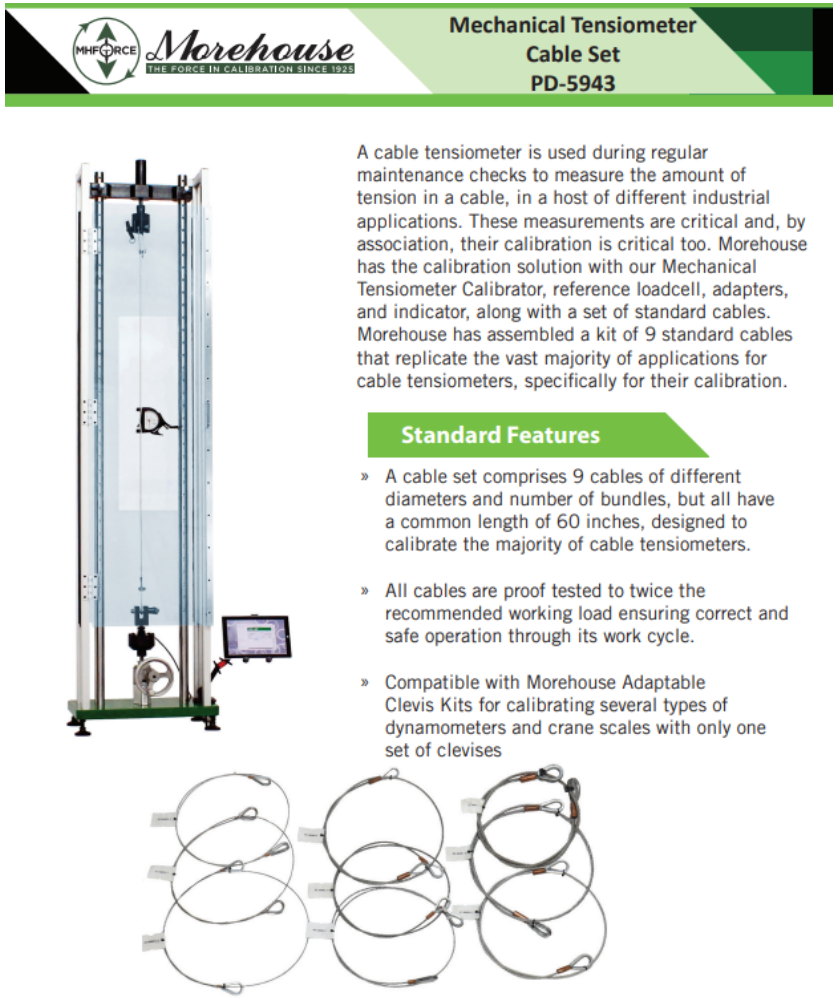
Mechanical Tensiometer



Some calibration procedures may be very questionable. A common method of calibration is fixing one point of the cable and stacking weights, or even filling a bucket with the appropriate amount of weight to generate the force.

Note: Anyone think the bucket method is metrologically sound or would it pass an audit?

Mechanical Tensiometer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Mechanical Tensiometer
Cable Set
PD-5943

A cable tensiometer is used during regular maintenance checks to measure the amount of tension in a cable, in a host of different industrial applications. These measurements are critical and, by association, their calibration is critical too. Morehouse has the calibration solution with our Mechanical Tensiometer Calibrator, reference loadcell, adapters, and indicator, along with a set of standard cables. Morehouse has assembled a kit of 9 standard cables that replicate the vast majority of applications for cable tensiometers, specifically for their calibration.

Standard Features

- A cable set comprises 9 cables of different diameters and number of bundles, but all have a common length of 60 inches, designed to calibrate the majority of cable tensiometers.
- All cables are proof tested to twice the recommended working load ensuring correct and safe operation through its work cycle.
- Compatible with Morehouse Adaptable Clevis Kits for calibrating several types of dynamometers and crane scales with only one set of clevises

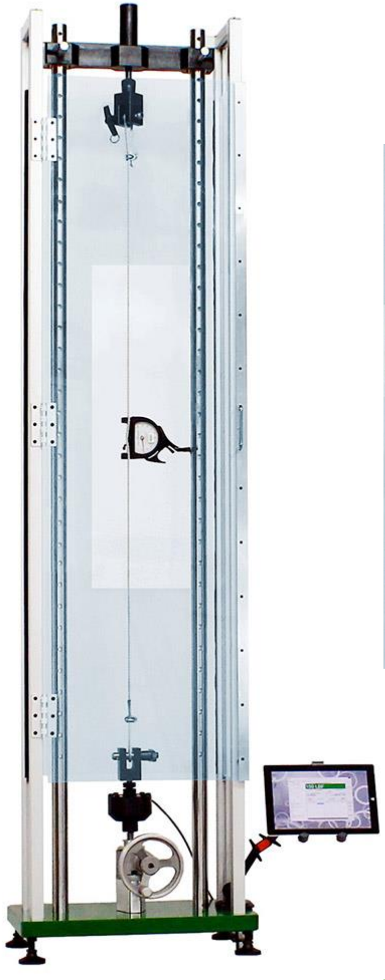
How to Calibrate Cable Tensiometers: The Right Requirements, Equipment, and Process.

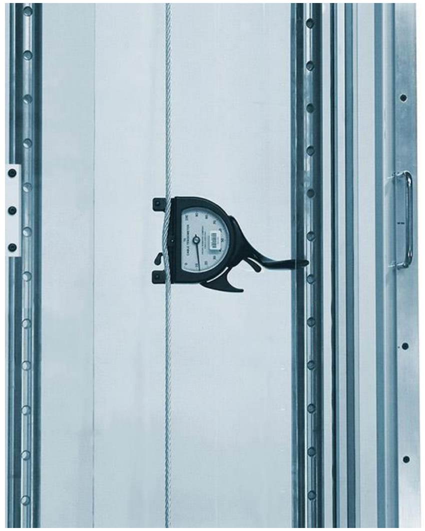
What is needed to accomplish this task? Does cable tensiometer calibration affect the type and length of cable used?

Several variables can influence the readings of the cable tensiometer. The standard variables are.

1. The Method Used for Calibration.
2. The Length of the Cable.
3. The Type of Cable GAC versus SSAC.

Mechanical Tensiometer Used for all Tests Presented





The Expanded Measurement Uncertainty for the Morehouse Cable Tensiometer typically is around 0.05 - 0.1 % of applied forces.

The right equipment may also consist of cables of at least 3 feet or greater free from defects. That means the cable should lie flat and not have any bends or kinks.

Some systems use cables that are 18 – 24 inches, and these shorter cables can lead to different results.

The Machine and Method Used for Calibration

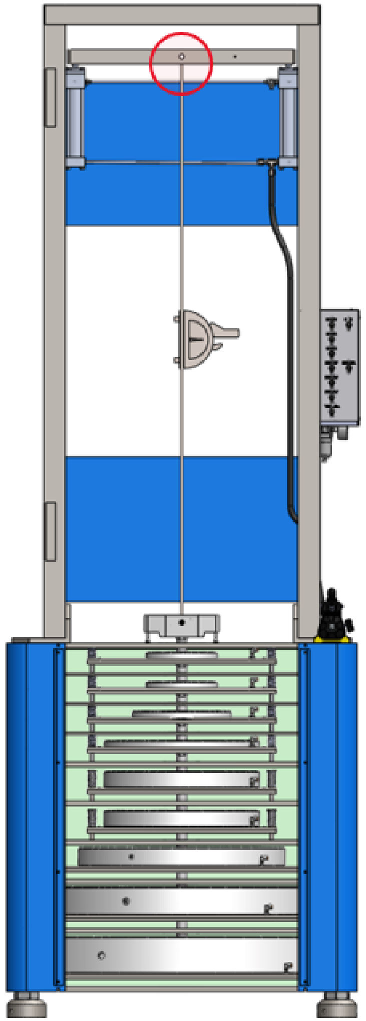
There are two common calibration machines used to calibrate cable tensiometers:

Deadweight calibration with one fixed point: The hanging deadweight avoids introducing additional tension, as clamping the cable does not affect the measured force.

Machine calibration with two fixed points: Clamping the cable in this method shortens the distance between two fixed points, introducing additional tension.

Note: Other machines do exist, and many might not produce the correct results.

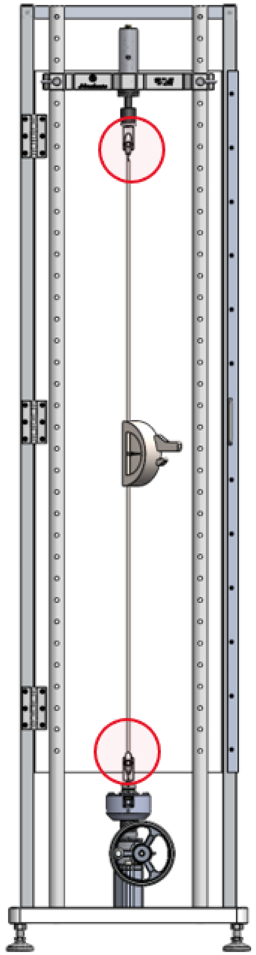
The Machine and Method Used for Calibration



Deadweight calibration with one fixed point: The hanging deadweight avoids introducing additional tension, as clamping the cable does not affect the measured force.

- A fixed point (shown in the red circle) eliminates the need to secure cables to beams and manually hang weights. This design prioritizes safety and simplifies the calibration technician's work. The operator secures the cable and selects desired weights up to 2000 lbf.

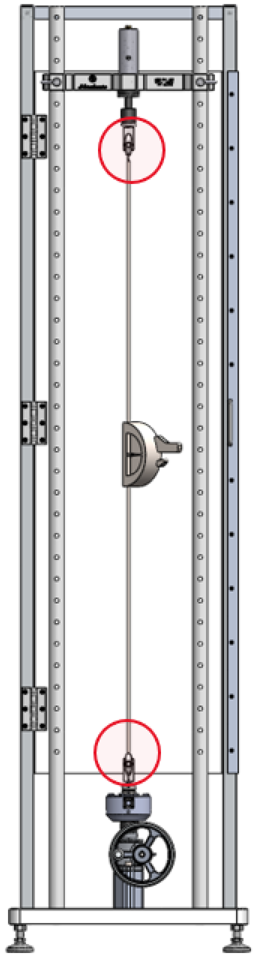
The Machine and Method Used for Calibration



The Morehouse Cable Tensiometer Machine (PCM-2MD-T1), with two fixed points (shown in the red circles), also eliminates the need to secure cables to beams and manually hang weights. One of these points is attached to a more solid fixture in a load cell connected to a jack(bottom), and the other is connected at the top where there is a spring. The spring can either be set up to be very rigid or have some flex.

- A fixed point (shown in the red circle) eliminates the need to secure cables to beams and manually hang weights. This design prioritizes safety and simplifies the calibration technician's work. The operator secures the cable and selects desired weights up to 2000 lbf.

The Machine and Method Used for Calibration



- **Method 1 Clamp the tensiometer and adjust the force.** This method is when the force is applied close to the desired reading, the cable is clamped, and then the force on the cable is adjusted back to the nominal value. In this case, we might load to 460 lbf, clamp the cable, get a reading of 495 lbf, and adjust the force value to 500 lbf. Since we clamp and then adjust to the force value, the results are like using deadweight as we have manually compensated for the increased tension of the tensiometer by decreasing the distance between the two fixed points.

- **Method 2 Clamp tensiometer.** This method is when the force is applied at the desired reading, the cable is clamped, and the value is read. In this scenario, the applied force might be 500 lbf, and when clamped, the value might jump to 528 lbf.

Testing Different Methods Comparison

Method 1 Clamp the tensiometer and then adjust the force.

Method 2 Clamp tensiometer.

Applied	Method 1	Method 2	Diff	% Difference
50	49	63	14	22.22%
250	255	270	15	5.56%
500	510	528	18	3.41%

Differences between the two methods using a digital tensiometer.

The Length of the Cable - Explanation

We can draw an analogy between cables and springs. When subjected to the same force, a longer cable, like a spring with double the length, will experience greater stretching. Consequently, compared to a shorter cable stretched by the same amount, a longer cable may exhibit a smaller relative increase in tension.

$$\frac{F}{e} = \frac{A \cdot E}{L}$$

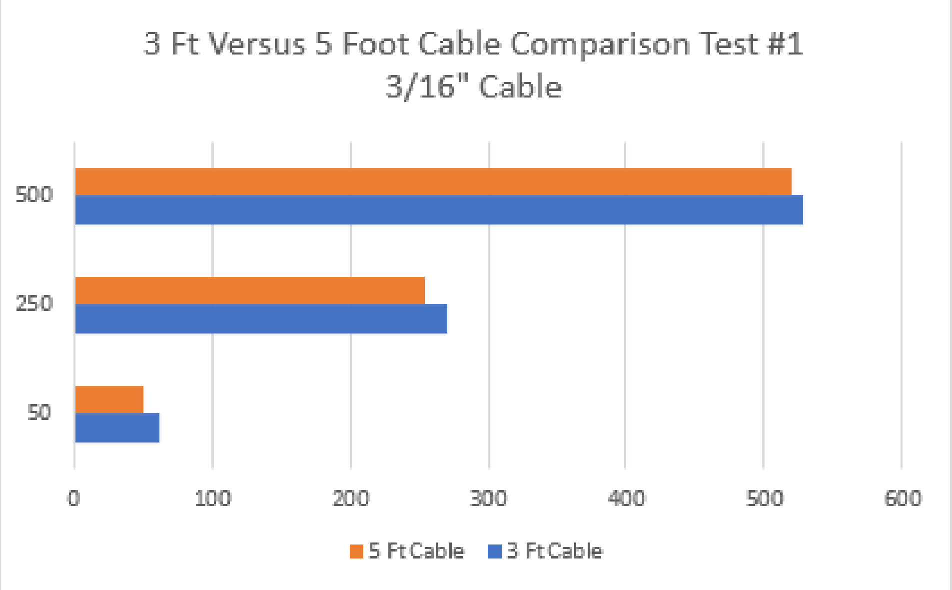
F/e is the spring rate, which is the amount of force (e.g., lbf.) per displacement (e.g., in). So 50lbf/in means if you apply 100 lbf., it will stretch 2 inches. Thinking about the cable, we can see that increasing area increases the spring rate, increasing material stiffness (modulus of elasticity) increases the spring rate, and increasing length decreases the spring rate. A lower spring rate means less change in force (tension) when applying the tensiometer.

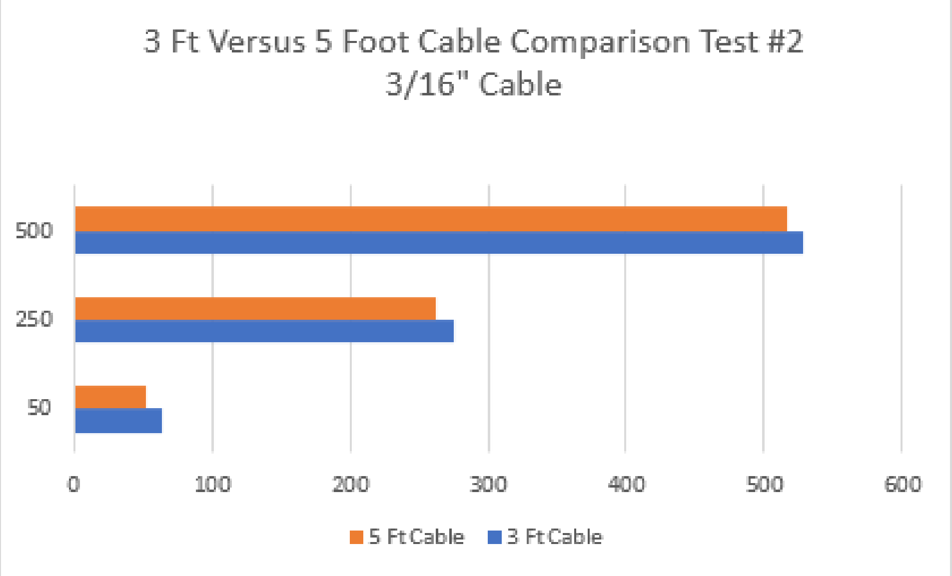
The Length of the Cable

Testing of 3/16" Cables			
Test Point	3 Ft Cable	5 Ft Cable	% Difference
50	63	50	20.42%
250	270	254	5.44%
500	528	519	3.35%

Test Point	3 Ft Cable	5 Ft Cable	% Difference
50	64	52	20.31%
250	275	262	5.93%
500	528	516	2.33%

Note:18-to-24-inch cables are likely to vary even more





Types of Cables GAC versus SSAC

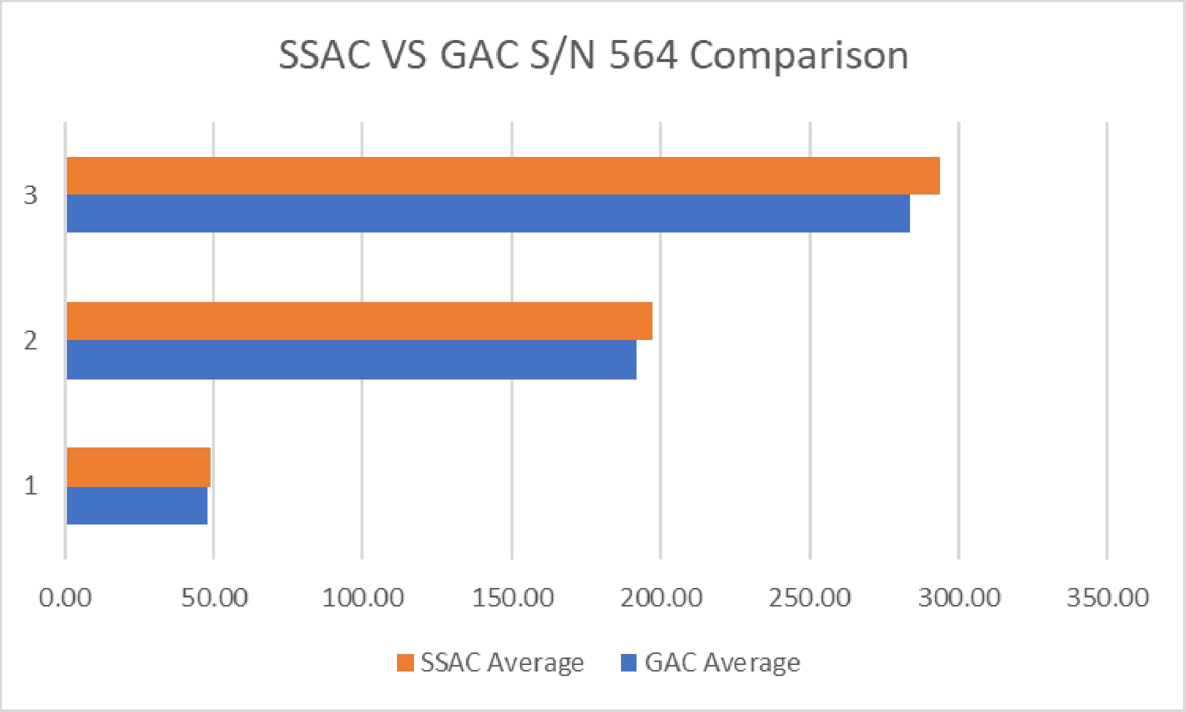
Two 3/32" Cables. The one on the left is a GAC, and the other an SSAC

Two Digital Cable Tensiometers.

We used "Method 1" for the comparison tests with two 3/32-inch cables and two tensiometers with the following specifications below.

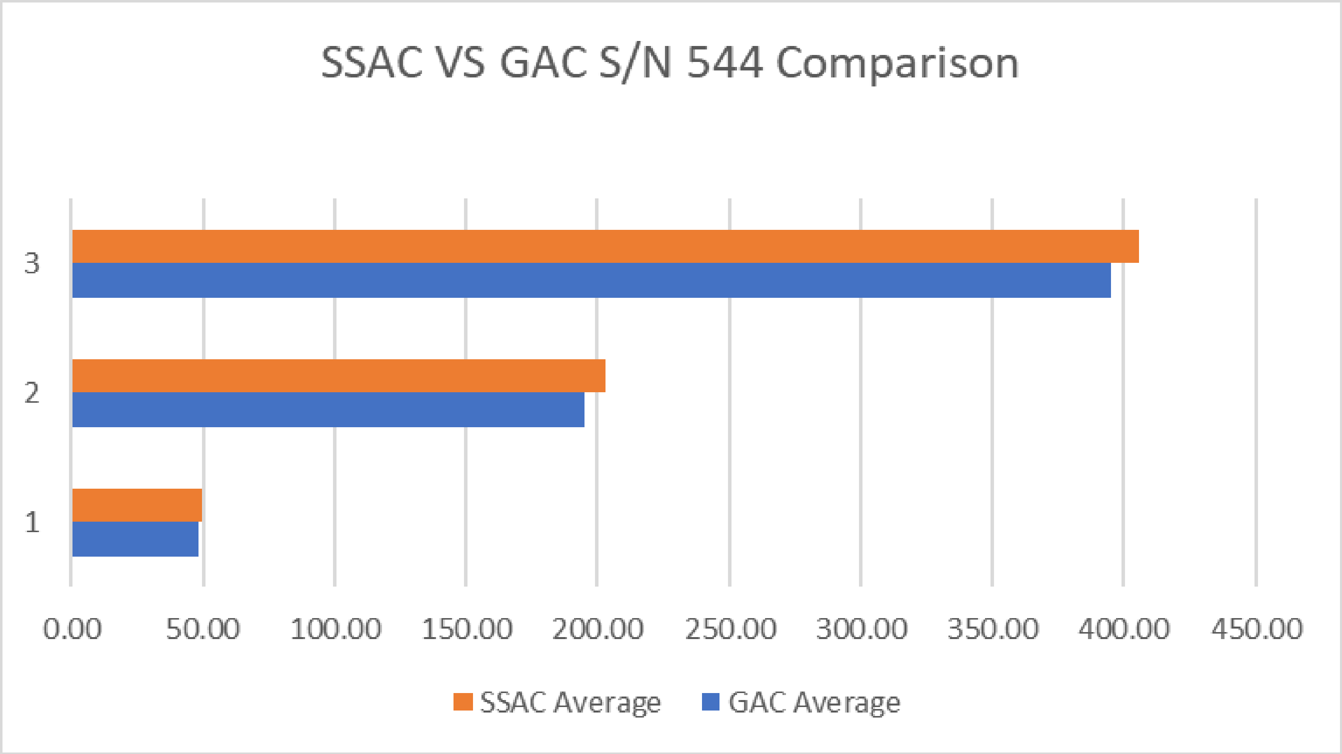
Model #	Range	Performance Specification
CT12A – 3/32	30 - 400 lb.	± 4 Lbs. 30-100 lb. ± 8 Lbs. 101-400 lb.

Types of Cables GAC versus SSAC



Applied Force	GAC Average	SSAC Average	Difference in lb	% Difference
50	47.67	48.67	1.00	2.08%
200	192.00	197.33	5.33	2.74%
300	283.67	293.67	10.00	3.46%

Types of Cables GAC versus SSAC



Applied Force	GAC Average	SSAC Average	Difference in lb	% Difference
50	48.17	49.83	1.67	3.40%
200	195.00	203.17	8.17	4.10%
400	395.33	405.83	10.50	2.62%

How to Calibrate Cable Tensiometers Conclusion

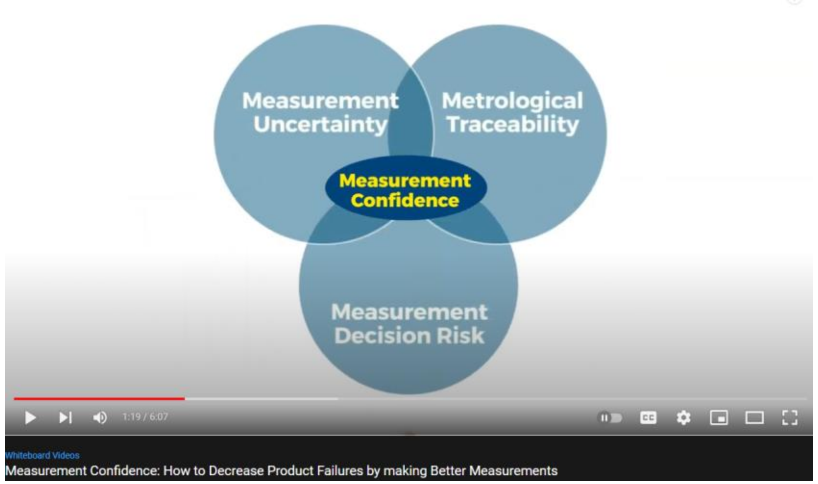
Would you want to be a passenger on that Airplane?

- Calibrating cable tensiometers involves using the right equipment, such as a calibrated load cell and appropriately sized cables and following specific processes to ensure accurate tension measurements for various cable types.

- However, a crucial question remains: which calibration method best reflects the actual end-use conditions for the equipment? Are calibration laboratories actively engaging with their clients to determine the method that best replicates how the equipment is used?

- Failing to do so could result in profound implications. If one method is used on an airplane, a pilot may complain about the rudders being too tight, which can impact the ability of a pilot to turn an airplane.

Want More Information?



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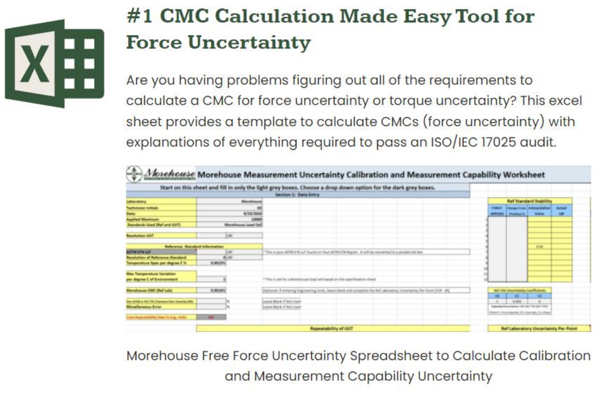

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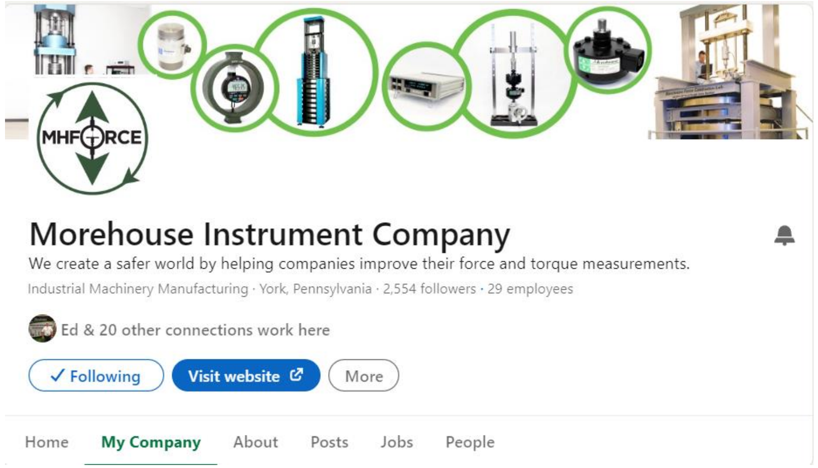

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