WHITE PAPER

Calibration and verification of **Belt Conveyor Scales**

Your company's productivity depends on knowing precisely what is happening in your operations at all times - inputs matching outputs at each process to determine just how well your plant is performing. When it comes to knowing exactly how much solid material is moving throughout your processes, dynamic weighing systems, such as belt scales, deliver the crucial data that you depend on.

But what if that data is inaccurate? What if your weighing systems are not performing to their rated accuracy and capabilities?

Regular calibration is crucial to ensure that your weighing instruments are providing the quality data you need to make production decisions.

This article will highlight both the importance of regular calibrations and also insight into the different calibration types, reviewing their advantages and disadvantages. Then, the article will show you that calibrations do not have to be a massive undertaking, nor do they need to be a significant disruption to your production.

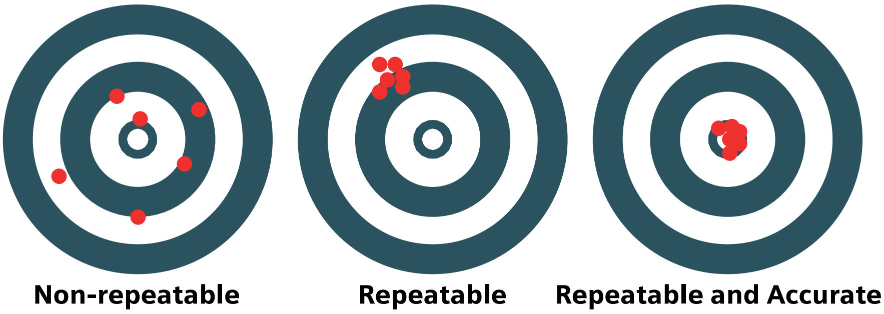
Calibration and Verification of Belt Conveyor Scales
Belt conveyor scales require periodic calibration and verification to assure that the accuracy and repeatability of the system are being maintained within acceptable tolerances. The four methods commonly used to calibrate and verify a belt scale are:

1. Static Test Weight Calibration
2. Roller Test Chain Calibration
3. Electronic Calibration
4. Weighed Material Test Verification

The accuracy of a belt scale system can only be related to the standard used for calibration of the system. Prior to any calibration being performed, however, it's necessary to establish that the belt scale system is repeatable.

Repeatability vs. Accuracy
It is important to understand the difference between repeatability and accuracy. Repeatability refers to the ability to repeat a result multiple times under the same conditions. Accuracy is the ability to repeatedly produce the required result.

To best explain repeatability versus accuracy, let's use an archery analogy.



Consider the following images of archery targets

The target on the left represents performance where none of the shots are repeatable, nor are they accurate. To improve both, adjustments to the equipment and the archer's technique are necessary, with the goal of first improving the repeatability.

On the center target, after some equipment adjustment and technique changes, the archer now has all the shots in a tight grouping, therefore performance is now repeatable, however still not accurate. An additional manual adjustment of the bow's sights will now bring the "repeatable" grouping into center.

On the right target, the archer has now achieved both repeatability and accuracy. To ensure that the results continue to stay repeatable and accurate, the archer will need to maintain the equipment and adjust for day-to-day changes (e.g., weather, wind, etc.) that may cause deviations in performance.

To determine whether the belt scale system is measuring accurately and repeatably, we need to reference its measurement results against another measurement result that is known and trusted. That's why static weights and finally truck material tests are used to verify measurement performance.

To visualize the repeatability and accuracy of a belt scale system, test results can also be plotted on a target graph similar to an archery target. The same target samples above can be used as examples of what a belt scale calibration might look like. After plotting the results of multiple material tests on a target graph on the left, it is clear that the test results are neither accurate nor repeatable.

Adjustments to the belt scale, conveyor equipment, and operation are necessary to improve the repeatability.

Adjustments include:

- Complete an idler alignment
- Inspect and adjust the belt tensioning systems as necessary
- Observe belt tracking and adjust if necessary
- Check loadcell balancing
- Scale location and proximity to feed-points, curved sections, skirting, and training idlers

These adjustments may vary from manufacturer to manufacturer, and it is best to refer to the user manual of the respective belt scale manufacturer for instructions, however, a selection of material from Siemens is available online, including a YouTube video on how to complete an idler alignment (search for "Siemens idler alignment" on YouTube, or access from the Links section following this article).

After making the necessary adjustments, an additional series of material tests are completed and on the center target, results show that the measurement results are now repeatable but still not accurate.

By performing a "Manual Span Adjust" in the belt scale electronics, the repeatable performance can now be centered.

An additional material test or series of tests plotted on the target graph to the right demonstrates the belt scale system is now both repeatable and accurate.

By maintaining the equipment and performing routine zero and span calibrations to compensate for day-to-day changes to the mechanics, material, and weather, you will ensure that the system stays both repeatable and accurate.

But note: accuracy is not achievable without first having a repeatable belt scale system.

Identifying probable causes of poor performance using the System Approach

The belt conveyor scale system consists of four major components

1. Weigh Bridge
2. Speed Sensor
3. Integrator
4. Conveyor

The performance of the belt scale depends on the condition of the conveyor into which it is placed. Conveyor problems that affect belt tensions or belt tracking can have a pronounced effect on the accuracy and repeatability of the belt scale. For these reasons, the belt scale, and the conveyor it is placed into should be considered as a complete weighing system.

Approximately 75% of all belt scale problems that affect accuracy are caused by conveyor irregularities. Using the system approach to solving problems should assure that the optimal accuracy can be obtained from the belt scale weighing system, regardless of the calibration method used.

For a more detailed overview of belt scale system design and installation considerations, there are a few excellent resources referenced in the Links Section following this article, including YouTube videos and an article published by weighing systems experts John Dronette and Tom Pendergras from Siemens USA.

Static Test Weight Calibration

Static test weight calibration is the most used method for calibrating belt scales. Weights are placed on the weighbridge framework to simulate loading. The pounds per foot or kilograms per meter value of the applied weight over the weigh span is entered as the scale test load for calibration purposes.

The advantages of using test weights are:

1. Test weights are compact and easy to handle.
2. Placement of the weights directly upon the weighbridge provides for a repeatable calibration.
3. Test weights are very inexpensive when compared to the cost of test chains or the expense of material testing.

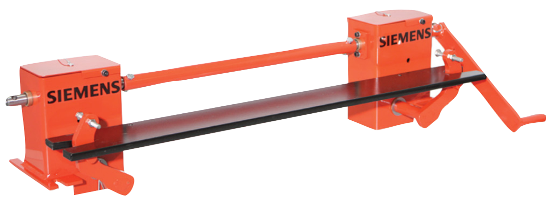
The disadvantage of using test weights is:

1. Provision must be made to store the weights in a reasonably clean and dry area when not in use.
2. Conveyor must be stopped to apply and remove the test weights.

Operators can expect a typical calibration with test weights to take as little as 20 minutes. Total duration is dependant on many factors including the length of the conveyor, the speed of the belt, safety procedures (lockout/tagout), removal of guarding, etc. that are also time consuming to the process. The act of performing the actual calibration may only take a fraction of the total time!

Static test weight calibration via calibration weight management systems

When static weights are used for reference calibration, it's recommended to use dedicated equipment that eliminates the need for time-consuming manual application of the test weights. This equipment also helps to improve calibration procedure safety. These devices allow external application of the calibration weights without removing safety guarding or requiring time consuming lockout/tagout procedures.



The Siemens Milltronics MWL (Milltronics Weight Lifter) is a good example of dedicated weight lifting equipment. It mechanically raises the static weights for resident storage above the belt scale calibration arm, between the belt strands, and allows the operator to lower and apply them safely without having to lean into the conveyor. It is manually operated with a removable crank handle and uses a high mechanical advantage to enable weight up to a total of 340 kg (750 lbs) to be applied by a single operator with very limited effort. With the industry's continued desire to improve safety, these devices are essential to allow effective guarding of dangerous moving conveyor components.

Using a calibration weight management system, operators can expect a typical calibration to take significantly less time than manually applying static test weights.

Roller Test Chain Calibration

Roller test chain calibration is often used to calibrate conveyor belt scales that cannot be material tested. Next to the material test calibration, the test chain calibration offers the highest accuracy. The test chain is secured between the second idler before the scale and the second idler after the scale and rolls upon the surface of the moving conveyor belt to provide dynamic scale loading known weight value for use as a calibration reference.

The advantages of using a test chain are:

1. The test load provided by a roller test chain will cause the surface of the belt to deflect in much the same manner as applied material, however the cross-sectional profile of the test load will be considerably different than a material load.
2. A much greater test load can be applied to high-capacity belt scales because most weighbridge designs can accommodate only a limited number of static test weights.

The disadvantages to the use of test chains are:

1. Roller test chains are expensive. The initial cost for the test chain and its storage device is usually much greater than the cost of the belt scale it is used with.
2. The use of test chains requires provisions to be made for accessibility to the load side of the conveyor belt in the scale area and for the safety of personnel assigned to place, secure, and remove the test chains each time they are used.
3. Test chains should be periodically inspected, lubricated, and repaired to assure continued service. Annual reweighing and measuring to determine the correct pounds per foot value is required to compensate for wear, tear and stretching of the test chain components. This maintenance will add to the overall expense.

The use of test chain calibration is recommended only where a high degree of accuracy (better than 1%) is required in applications that cannot conveniently be material tested.

Test chain calibrations are more involved and will require a greater investment in time. This is largely due to the increased requirements around safe use and handling.

Electronic Calibration
This calibration method uses load cell data to provide a theoretical calculated value for the span counts. Load cell data includes the capacity, sensitivity, excitation voltage of the load-cell(s) as well as idler spacing and inclination of the conveyor. This theoretical span count simulates the signal levels that would be generated by normal loading of the scale.

The advantages of electronic calibration are:

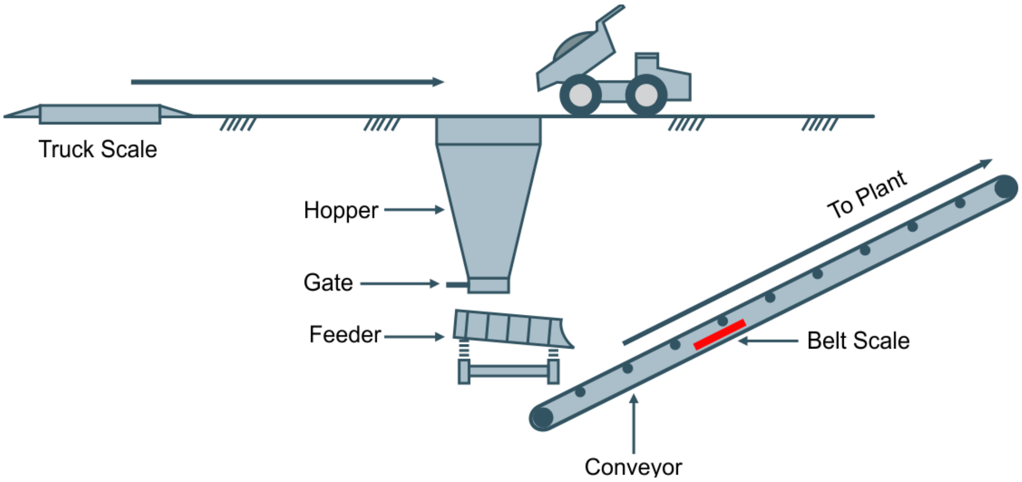
1. Ease of use. There is no need to place test chains or weights upon the scale.
2. Extremely low cost. Only very simple electronic circuitry is used.

The disadvantages of electronic calibration include:

1. Electronic calibration is initiated at the scale integrator. As access to the conveyor and scale weighbridge is not possible, the necessary visual inspections may be neglected. This could result in minor problems not being discovered and corrected until they become major problems.
2. The use of an electronic signal for calibration does not exercise the weighing elements and can mask some linearity and mechanical hysteresis problems that may occur in this area.

The use of electronic calibration is only recommended for applications where the belt scale is inaccessible. It may be the fastest calibration procedure; however, it is the least preferred as it has the highest likelihood of being misused. For these reasons, electronic calibration is the least accepted in industry.

Weighed Material Verification
Calibration verification is accomplished by passing pre-weighed material over the belt scale or by catching and weighing material that has been passed over the belt scale. The weights indicated by the belt scale under test are compared to the reference scale weights. Manual span adjustments are made to the belt scale under test until the weights registered by both scales agree within an acceptable tolerance.



Pre-weighted Material Test

Material testing is the most accurate method of verifying the calibration of a belt scale as the system is tested under the dynamic conditions that occur in normal use.

Material testing is required for belt scales that are to be used as a point-of-sale device for legal trade.

The advantages of weighed material calibration are:

1. Accuracy is proven with the materials normally conveyed and under nominal operating conditions.
2. Calibration is done with a reference scale that is trusted and traceable, ideally one certified by a metrological authority (e.g., Measurement Canada).

The disadvantage of material testing is:

1. High cost. The time, manpower requirements, lost production, and materials handling involved in periodically material testing a belt scale system can result in very high costs.

Material test verification can be a time-consuming procedure, however, it is the only method to prove system accuracy.

Calibration Method	**Advantage**	**Disadvantage**
Test Weight	low cost	conveyor must be stopped to apply and remove weights
	repeatable	does not compensate for belt influence
	no maintenance	
	easy to perform mechanical linearity checks	
Roller Test Chain	most accurate calibration method	Requires considerable storage space
	compensates for belt influence	Heavy and hard to maneuver
Electronic Calibration	No need for additional equipment	Does not detect mechanical hysteresis or non-linearity
	Low cost	Provides the least accuracy when material test not possible
Material Test Verification	Only method to prove accuracy	Time consuming
		Requires process shut down
		Requires coordination with many people

Frequency of Calibration

With belt conveyor scales, changes in belt tension resulting from normal use, maintenance work, or variations of the ambient temperatures have more effect upon zero balance of the belt scale than on span. As a result, zero should be calibrated as often as possible. Zero should be calibrated daily but, if this is not practical, zero calibrations should be done once a week.

Span calibrations should be completed at least monthly to assure continued system accuracy.

If the deviation error is within acceptable tolerances, zero and span calibrations can be performed less frequently. If deviations are not within acceptable tolerances, zero calibrations should be performed more frequently.

Summary

To ensure that performance and accuracy of your belt scale and weigh feeding equipment meets the demands of your operation, the combination of regular zeroing, routine maintenance, and as often as practical, span calibrations are necessary.

All calibration methods - test weight, roller test chain, or electronic calibration - are considered test references. These test references will ensure that the measurement system achieves repeatable performance, however, the system accuracy may vary from 0.25% to 5% if done without material verification.

All test references must be verified with a valid known material test to achieve the specified accuracy of the system, accomplished by performing a Manual Span Adjustment. Once the Manual Span Adjustment has been completed, then the test reference can be used in future to prove the repeatability of an accurate calibration.

These procedures and recommendations do not have to mean constant downtime or production disruptions if carried out as part of the regular maintenance and shut-down scheduling.

For your convenience, we have included a Calibration checklist with this document that you can refer to as part of your regular plant maintenance scheduling or whenever you need to complete a calibration on your belt scale or weigh feeder equipment.

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Links

Siemens

- Weighing webpage
  - https://www.siemens.com/weighing

YouTube

- Installing a belt scale:
  - https://www.youtube.com/watch?v=8EXnV8zM88E
- How to perform an Idler alignment:
  - https://www.youtube.com/watch?v=3GEcxjYtW9Q
- Performing a belt scale zero and span:
  - https://www.youtube.com/watch?v=NRc__UyE5fM&list=PL39558531551E71AF&index=4
- Siemens Milltronics Weight Lifter (MWL)
  - https://www.youtube.com/watch?v=XxG-8gt_-Wjc&list=PL39558531551E71AF&index=7

Siemens belt scale **Calibration Checklist**

Belt Scale

- ☐ Prior to return to service, make sure shipping stops are in the "OFF" (disengaged) position (1)
- ☐ Check that weighbridge and load cells are clean (2)
- ☐ Check that load cells gap is clean. (3) (Use a hacksaw blade to clean out between cover.)
- ☐ Check mV output on each loadcell. Refer to user manual for instructions

Idlers (4)

- ☐ Inspect scale idler, plus two approach and two retreat idlers to verify that they are in good condition and freely rotating.
- ☐ Check bearings on idler rollers to make sure that they are tight and not moving from side to side or up and down.
- ☐ Verify that the approach, scale, and retreat idlers are aligned using a string. Alignment should be within 0.8 mm (1/32"). To be performed annually.
- ☐ Check belt is in good condition. No cuts or tears. Belt should not have a lot of belt splices.
- ☐ Check to make sure that return belt is not hitting the bottom of belt scale when running and at start up.
- ☐ Is there wind blowing on the belt scale or the belt? If so, consider installing a wind shield along scale area.
- ☐ Skirting should not be touching the belt in the scale area - a minimum of two idlers before and two idlers after the scale idler.

Warmup Time

- ☐ Run the conveyor empty for enough time to warm up the belt. 20-30 minutes where possible.

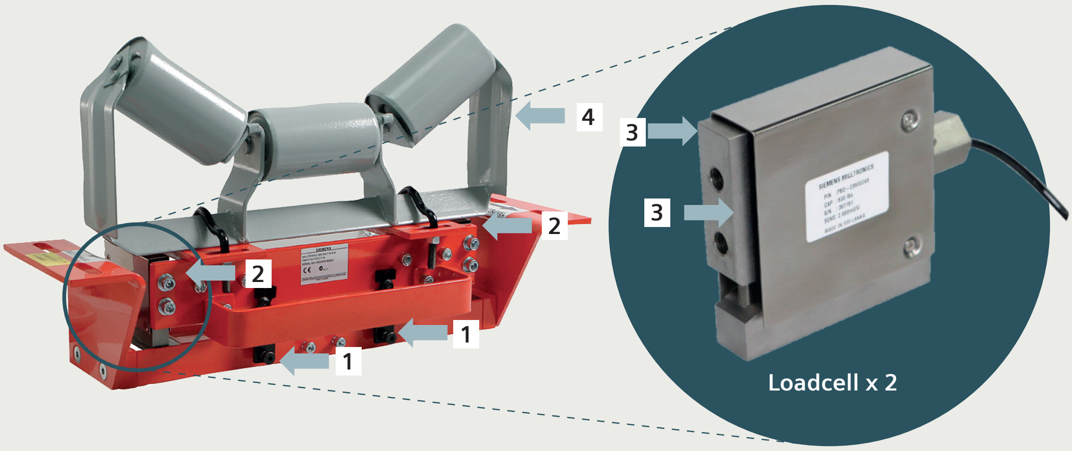
Zero and Span Calibration

- ☐ Perform a minimum of two calibrations, looking for repeatability, prior to making any adjustments. If the two are repeatable to one another, accept the calibration, and perform a third calibration to verify.

Material Test

- ☐ Perform a minimum of two material tests prior to making any adjustments. This will ensure that the material tests were repeatable. If the two are repeatable to one another, perform a manual span adjustment and complete a 3rd material test to verify.

For more information, please download and review our "Belt scale Application Guidelines", available at: https://cache.industry.siemens.com/dl/files/895/109791895/att_1049130/v1/Belt_Scale_Application_Guidelines.pdf



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