

Vehicle Scale Accuracy What You Need to Know

When you consider the cost of your goods and materials, even seemingly small weighing errors can be of considerable value when multiplied by the number of trucks you process each day, week or year. Many business owners have been shocked to learn how many full truckloads worth of goods they are giving away due to permissible scale errors.

Weighing accuracy is critical to protect profitability.

- Accuracy is critical to your business
- A conventional truck scale is not as accurate as you may think
- Legally-acceptable scale error tolerances do not protect you from losses
- Not all scales offer the same level of accuracy



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1 Introduction to Accuracy and Calibration

The accuracy of a truck scale can easily be taken for granted, but accuracy is crucial when buying or selling goods by weight. Profit margins, inventory levels and quality management are all directly affected by the accuracy of the scale. Many business owners are shocked to discover how many full truckloads worth of goods they give away; due to legally acceptable scale errors.

For many years, vehicle scales were designed to meet the minimum legal requirements. Modern technological advances now empower some vehicle scales to achieve a much higher accuracy level. However, most scale manufacturers have been slow to adopt such capabilities since the legal requirements, and even perceptions in the marketplace, have not changed. Nonetheless, for those who wish to benefit, there are now discernible accuracy differences between makes and models of truck scales.

All vehicle scales used for business transactions must be periodically calibrated and adjusted to ensure they weigh within legal accuracy tolerances, as the accuracy of many scales drift outside the specified ranges over time. This also indicates that the amount of error on a scale between calibrations is frequently greater than these legal specifications.

Calibration and Legal Tolerances

In commercial or legal-for-trade applications, scales must be regularly inspected, tested, and recertified by weights and measures authorities. Many scale owners (and even scale providers) assume that these recertifications provide them with sufficient accuracy. In reality, the error tolerances for minimum requirements can be significant. That means even a recently certified scale could still actually be losing money for the owner with every weighment, and the amount of error will typically grow until the next calibration.

Calibration procedures can vary from country to country, however the goal is the same – ensure the scale reading reflects the actual weight applied.

Technician's incrementally add certified test weights to the scale until it reaches a specified percentage of the scale's capacity, defined by the local weights and measures organizations. They then perform the required testing procedures and record the indication of the certified test weights.

This indication is then compared with the specified country tolerance. If the readings fall outside of the allowable tolerance, the scale is adjusted and calibration is performed again, this process continues until the scale performs within specifications.

Even though legal-for-trade scales are periodically calibrated, many factors including the wear of daily operations will be detrimental to the scale's performance. That causes the accuracy of most scales to drift outside of the legal tolerance ranges over time.



2 Determining the Proper Calibration Period

There are many factors that can affect the necessary calibration period required for your vehicle scale.

Government Regulations

Government regulations vary significantly between countries, regions, and/or states. For example, in the United States, one state requires all legal for trade devices to be tested at least once a year by a state Inspector, while another state requires 2 inspections a year. However, yet another state only requires vehicle scale inspections once every 12 years. In Australia, all scales are required to be tested annually at full capacity.

These differing government regulations mean that scale owners need to be aware of their local regulations. It often is not sufficient to rely solely on weights and measurement authority inspections and calibrations. Vehicle scale owners can improve their business performance by being proactive about scale calibrations.



Truck Volume per Day

On conventional scales, the demands of heavy traffic volumes often cause the scale's accuracy to drift outside of tolerance levels faster; putting the business at risk of losing additional profits from inaccuracy. If your vehicle scale experiences a high volume of trucks per day, you should consider increasing the frequency of calibrations. Calibration and adjustments bring the scale's accuracy back to within the legal tolerance level, thus reducing (but not eliminating) the level of loss experienced from scale errors.

Environmental Factors

Environmental conditions will affect the calibration of a truck scale. A few of the most advanced scales can protect and even compensate for these effects, but most scales do not. As temperatures fluctuate, the large scale structure will expand and contract. These subtle changes will adversely impact the calibration of the scale.

Additionally, moisture in all forms creates other challenges. Load cells, cables, and especially junction boxes are prone to problems caused by moisture. If you live in an environment that goes through multiple seasons a year, you should recalibrate your scale as seasons change. Precipitation and humidity should also be considered as any type of moisture is conductive and may cause calibration problems.

Business Impact

Although there is a cost to calibrate a truck scale, these costs are often far offset by the savings from reducing losses due to scale errors. Every weight-based transaction your business processes relies on the ability of the scale to weigh as accurately and consistently as possible. Once they calculate the impacts using real numbers, many business owners are suddenly enthusiastic about calibrating their scale.

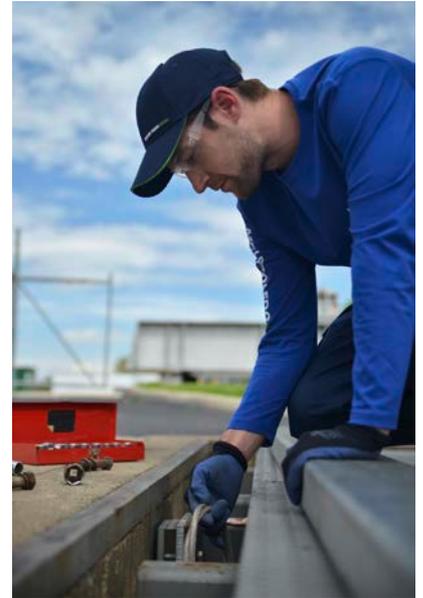
3 Detailed Inspections and Testing

Visual Inspection

Like all industrial equipment, preventative maintenance maximizes the life of the scale, preventing unforeseen breakdowns. After a thorough inspection, a scale condition report notates the status of all critical scale components. This can include:

- Foundation
- Weighbridge
- Load cells
- Cables
- Junction boxes
- Suspension or checking system
- And much more

By noting the detailed health of the scale, the scale owner and service provider can discuss the present and future service needs that will improve the accuracy and increase the life of the equipment.



Eccentricity (Shift) Test

An eccentricity test evaluates the ability of the scale to weigh the same load consistently, regardless of the placement of load on the scale. During the test, certified loads are placed at specific locations on the weighing platform and measurements are recorded.

Error of Indication (Linearity) Test

The error of indication test is conducted to determine how the scale is weighing along a specified range, usually from zero to a certain percentage of the scale's capacity, using certified test weights.

Strain Load Test

The strain load test is used to determine a scale's performance in use; certified test weights are used only as a portion of the applied test load. In some cases, this means that the technicians will place a large (often unknown) load on the scale (such as a truck) and then add the known load of certified test weights. The technicians verify that the weight increases by the correct value with the addition of the test weights. The number of strain load tests will vary by location and inspectors.

Repeatability Test

The repeatability test determines if a known load applied to the scale will indicate the same value each time. For each repeated weighing, the indication value is recorded and compared against the first indication. The number of repeatability tests performed on a scale varies by location and inspector.

4 Evaluating Calibration Readings and Tolerances

Locations have differing specified tolerances that provide a range in which the scale will pass or fail. However, even if the scale passes the test within the tolerance range, it is rare for a conventional scale to perform perfectly at the target (no discernable error). Most of the adjustments made by technicians are done only to bring the scale back to within the tolerance, with a permissible amount of error. Once the readings are within the tolerance range, the scale is allowed to pass.

These ranges exist because conventional scales are tedious to adjust, and only maintain these adjustments for limited periods of time. It has traditionally been considered unfeasible to expect such a large device with a high capacity to weigh "perfectly".



However, the permissible error that remains even after a scale is allowed to "pass" is a disadvantage for the scale owner or operator. Over time, it can add up to significant amount of product and profit losses for a business. Larger tolerances present a larger risk for losses. This is why it is still in the best interest of scale owners to be proactive about scale accuracy.

5 Accuracy Determination

Typically, 60 days after the scale is installed, the scale's accuracy will be verified with tests performed by the local weights and measures authority. Beyond this initial evaluation, these tests usually happen at predetermined intervals, most often once per year.

If the scale's error is beyond the legal tolerance, the weights and measures authority may issue a "yellow tag" or a "red tag" (or equivalent notice). A yellow tag is a warning that gives the scale owner a period of time to have the scale recalibrated by a service provider. The yellow tag allows the scale to be used normally during this time. In contrast, a red tag requires that the scale is closed immediately. It cannot be used until it is recalibrated. Avoiding that situation is another primary reason why a scale owner may wish to calibrate their scale more often than legally required.

6 Making Adjustments to Improve Accuracy

When a scale service provider performs tests and adjustments to your scale, they should provide you with a statement of the "as found" error. This is the error observed in the scale tests prior to any adjustments. They should also provide you with a statement of the "as left" error levels. This is the error remaining after their adjustments have been completed.

By evaluating these readings, you can monitor your scale's behavior to determine how much error is accumulating between calibrations. You can then use this information to calculate the benefit of increased calibration frequency. Based on your cost of goods, number of vehicles weighed per day, and the error typically found in the scale, the cost of a calibration may often be recovered through revenue savings.

Looking at the difference between as-found and as-left readings can also reveal your scale's susceptibility to seasonal factors. By reviewing results from multiple tests done throughout the span of a year or more, you can determine if the scale has larger error numbers during the winter months, for example, or during a busy business season with increased scale use. By strategically scheduling recalibrations during these periods, the business can minimize losses from scale errors.



7 Calibration Procedures, Tools and Documentation

Often overlooked are the procedures, tools and documentation capabilities of calibration service organizations. As most Weights & Measures regulations are not explicit regarding testing procedures and are open for interpretation, it is important that you choose a service provider with expertise in legal metrology and years of experience in implementing and validating their testing procedures and documentation. This will determine whether you receive "just a piece of paper" or consultation and documentation that satisfies requirements but also helps you weigh more accurately and therefore be more profitable.

Variations in calibration procedures are typically associated with a lack of controls over procedures, permitting different outcomes from one calibration to the next and from one technician to the next. These variations can negate the possibility of analyzing a scale's performance over time. Most calibration service providers depend solely on technician training and the technician's memory and discretion regarding calibration procedures. It is also quite challenging for some service organizations to stay current with changes in Weights & Measures regulations and to implement these changes uniformly in a timely manner.



Some of the variations in the quality of calibration documentation occur because various service organizations still depend on handwritten test results on a paper form. This not only means that mistakes can occur in recording weight readings, but that you rely on the legibility of the handwriting. Interpretation of test results also requires calculations that are best done by an automated solution. A handwritten paper form also does not enable a modern and dependable archival system so that calibration reports can be easily retrieved. Finally, handwritten reports mean that it is cumbersome to analyze the performance of your scale historically so you can understand and address adverse trends in performance.

The above mentioned human error elements are resolved through a centrally managed, automated report generation and archival tool. By harmonizing and managing testing procedures, software and calculations centrally, service organizations ensure that you receive the same calibration quality over time, regardless of the technician doing the work. Automated report generation tools also address the data recording and calculations processes. Scale owners and operators also benefit from having the details of the calibration results stored centrally, as the results can be quickly reprinted and historical data can be utilized to analyze the scale performance over time.

When choosing a calibration service organization you should ask several important questions:

1. Ask to see a typical report so you can review the quality of the report and how it is completed
2. Ask how the service provider ensures consistent procedures and results
3. Ask how equipment and reference weights are maintained and calibrated for traceability
4. Ask how your valuable calibration data and reports will be archived and retrieved
5. Ask if the service provider is an expert on various scale technologies so that proper adjustments can be made
6. Ask if your service provider will help you analyze calibration trends to improve accuracy
7. Decide if the service provider's goal is "just a piece of paper" or adding value to your business

8 Maintenance and Reliability

Another goal of the scale owner is to maintain the reliability of the scale. Preventative maintenance performed by a qualified scale technician at appropriate intervals is imperative. In addition, to avoid disruptions from scale downtime, properly maintaining the scale helps maximize its useful life. Regular maintenance also reduces overall ownership costs by minimizing the need for emergency repairs and replacement parts.

Basic vehicle scale maintenance may include lubricating the contact points of components and adjusting the suspension or checking system. Debris should also be removed from locations where buildup can cause the scale deck to bind. Cabling connections will be inspected, and the technician may use service features within the scale operating system to check for inconsistencies.

Your scale supplier may offer you a maintenance program that includes periodic visits from a scale technician who will test and inspect the scale and perform preventative maintenance. Regular maintenance is not a legal requirement, although it may be a condition of the manufacturer's warranty coverage. While this type of maintenance may not be legally required, the largest benefit is protection from costly unplanned downtime.



METTLER TOLEDO
White Paper

9 Load Cell Technologies and Scale Accuracy

Comparing Analog, Hydraulic, Digital, and POWERCELL® Load Cells

The load cell system in your scale may impact your calibration period and accuracy level. The most common load cells found in vehicle scales are Analog, Hydraulic, Digital, and POWERCELL.

Analog Load Cells

Analog load cells have been used in vehicle scales since the 1980s, and have remained relatively unchanged. They are passive devices that measure weight through a minute change in electrical resistance. By modern standards, analog load cells offer limited accuracy. Calibration of analog load cells is done by manually adjusting potentiometers in a junction box. Although they can be calibrated to meet legal-for-trade accuracy standards, they have been shown to easily lose accuracy between calibrations.

Analog load cells are susceptible to many factors that interfere with the accuracy of the scale, such as temperature, moisture, electrical interference, and more. Owners of scales that use analog load cells should consider the benefits of more frequent calibrations. They may also consider upgrading their scale to a more modern load cell system.

Hydraulic Load Cells

Hydraulic load cells are also passive devices, and are more mechanical in nature. Each load cell under the scale compresses a small amount of fluid, which flows through a series of tubes to a large "totalizer" unit, often located near the scale terminal. The totalizer directs the force of the compressed fluid onto a single analog load cell. The reading from this load cell is used by the terminal to display the weight on the scale.

Hydraulic systems are intended to be physically resilient, but they still reflect the limited accuracy of a single analog load cell. Hydraulic systems also face unique challenges, such as maintaining the purity of the hydraulic fluid inside the system. Since they rely on lengthy amounts of plumbing with many connections, leaking fluid is a common source of frustration and inaccuracy in these systems.

Digital Load Cells

Digital load cells transmit information using a digital signal, which is more stable than the small electrical signal transmitted by analog load cells. Some digital load cells can maintain accuracy better than their analog counterparts. However, many digital load cells are still passive devices. Processing of the weight information only occurs once the signals reach the scale terminal. This means that the weight readings from the scale are only as good as the weakest load cell.

Owners of digital load cell systems should evaluate the "as found" and "as left" accuracy levels from past calibrations. If the readings show significant differences, talk to your scale service provider about what can be done to help the scale maintain accuracy better.



POWERCELL® Load Cells

POWERCELL load cells are active devices. They expand on the benefits of digital load cells by incorporating processing capacities at each load cell. By adding various sensors in each load cell, they can compensate for variables that affect weight readings using patented algorithms.

POWERCELL load cells have been shown to maintain their accuracy very well between calibrations. The calibration procedure is also more precise--instead of turning a potentiometer with a screwdriver, POWERCELL calibrations are computed digitally, with infinite coefficients. This means that the scale is much closer to "zero error" than realistically possible with other technologies.

Scale owners who rely on their scales to manage business transactions are often interested in accuracy benefits of POWERCELL load cells. METTLER TOLEDO has successfully converted many makes and models of vehicle scales to POWERCELL load cell systems. Customers note that these converted scales are more accurate, which saves them money.

10 Summary

Vehicle scale accuracy is frequently taken for granted. Legal-for-trade regulations are often not as strict as scale owners assume. Being familiar with the accuracy tolerances in your location can help you make informed decisions. Scale accuracy is influenced by a number of factors. Understanding them can help scale owners determine the best calibration schedule for their scale. Be sure to request accuracy information from your scale service provider and evaluate the information to look for opportunities to improve. This helps minimize business revenue losses from scale errors.

Proper maintenance helps the scale maintain accuracy. It is also critical to the reliability of the scale. Adequately maintaining the scale reduces the overall cost of ownership and maximizes the operational life of the scale.

Calibrations and calibration service providers are not the same; there are broad differences in the quality, results, procedures, tools and value that you receive from vehicle scale calibrations. Calibration determines the accuracy of your scale and accuracy impacts your profitability. Make sure that you carefully choose a calibration partner so that you can leverage this expense to add value and profitability to your business.

The load cell system is the heart of the scale. Understanding the basic differences between types of load cells can also help you understand the nature of the weighing system. Businesses that rely heavily on their scale may benefit from upgrading or converting to a more modern load cell system.

11 Your Qualified Service Provider

Contact METTLER TOLEDO to maximize the return on your investment. Our technicians have the advanced skill set to safeguard the life of your vehicle scales with these comprehensive service offerings:

Upgrading or Converting to POWERCELL® PDX® Load Cells

METTLER TOLEDO offers retrofit hardware to upgrade any existing METTLER TOLEDO vehicle scale, or convert many other makes and models of vehicle scales.



Installation and Start-up

Includes proper installation in the working environment, setup and configuration for optimal operator efficiency, and interface to peripherals, data collection or automation systems.



Calibration Solutions

The value you receive from your vehicle scale depends on its accuracy. METTLER TOLEDO will help you leverage calibrations to be legal and more profitable.



Preventative Maintenance

METTLER TOLEDO provides the right level of periodic preventive maintenance to match equipment utilization, process criticality and equipment lifecycle.



Benefits of METTLER TOLEDO Service:

- Consultation for an optimal service plan to achieve desired business results
- A global network of factory-trained technicians delivering exceptional service
- A field-service force backed by local and global support personnel
- Proprietary service tools to realize and maintain the best performance for your equipment
- Factory maintenance procedures to maximum your return on investment
- Consistent procedures to ensure results that lower costs and increase profitability
- Certification solutions that are compliant with local and global regulations and standards
- Calibration services that are ISO17025 accredited, giving third-party credibility to results

Calibration with MiraCal™

MiraCal™ software ensures that all calibration tests are performed uniformly, eliminating any potential for human error. The computer-generated certificates are easily archived and managed. Have total confidence that your scales are within specification – and that you achieve exceptional business results.