

Truck Scale Buying Guide



Your Next Truck Scale

A Guide to Project Components

METTLER TOLEDO

Preamble

The purpose of this guide is to provide educational information to both new and seasoned truck scale buyers. It is intended to provide more and different information than you find in sales brochures. While brochures typically discuss "who" and "what," this guide answers "how" and "why."

Most content in this guide is intended to be unbiased and universal in nature. However, there are occasional notes that reflect information about METTLER TOLEDO products. Most often, this is to explain how METTLER TOLEDO systems and components work. You should have no trouble distinguishing the universal information from the information that is specific to METTLER TOLEDO.

METTLER TOLEDO is not the only company that makes good truck scales. However, we believe that METTLER TOLEDO products provide exceptional quality and meaningful innovations. Our hope is that this guide will help you judge for yourself.

Publisher

Mettler-Toledo AG
Industrial
Heuwinkelstrasse
CH-8606 Nänikon
Switzerland

Subject to technical changes
© 05/2019 Mettler-Toledo AG

V1.3

Content

Info	Introduction and Terms To Know	4-5
Section 1	How a Truck Scale Works	7-10
Section 2	Scale and Weight Regulations	11-14
Section 3	Basic Scale Choices	15-24
Section 4	Initial Scale Costs and Ongoing Performance	25-34
Section 5	Weighbridge Specifications	35-42
Section 6	Load Cells	43-58
Section 7	Site Planning	59-66
Section 8	Installation and Certification	67-70
Section 9	Maintenance, Service and Warranties	71-76

Introduction

Truck scales are used all over the world. Businesses large and small, as well as transportation agencies, weigh trucks carrying everything from corn and coal to durable goods and solid waste.

The most common use of a truck scale is to determine the weight of bulk goods being bought and sold in truckload-sized quantities. In those cases, information from the scale is a crucial part of the business transaction. The scale functions much like a cash register.

Enforcement agencies use truck scales to check for a truck's compliance with road-going vehicle weight limits. They are also used to monitor intake and output volumes at facilities, such as solid waste processing and recycling centers, construction sites and more.

Most truck scales are located outdoors. That means they must be able to withstand all environmental challenges while working reliably and accurately. Depending on the environment and application, most truck scale owners expect a scale to last 10 to 20 years.

Truck scales are important to the daily operations of many of the facilities that use them. They also have a relatively long useful life. That means that selecting a truck scale is an important decision—one that can benefit (or burden) its owner for decades.

Terms to Know

Beam slab foundation	A scale foundation using concrete beams poured into an excavation
CLC	Concentrated Load Capacity, a rating used by NTEP in the United States to define the maximum capacity for a single group of axles
Compensation (also Digital Compensation)	Typically a digital system that is designed to monitor and control for one or more variables that can affect weighing accuracy
Gross weight	The weight of the loaded truck, meaning the truck and the load combined
Handbook 44	Set of weighing equipment regulations used by NTEP/NIST in the United States
Junction box	One or more boxes, typically located at the scale, which join the cable connections of the load cells with the scale terminal
Legal-for-trade	A term used to describe a scale used for business transactions, which must meet certain performance guidelines
Load cells	The sensory devices used to measure the weight on the scale
Metrology	The scientific study of measurement
Net weight	The weight of the load by itself, minus the weight of the truck. Net weight is often calculated as: gross – tare = net
NIST	See NTEP
NTEP (or NIST)	Weights and measures authority recognized by the United States and others
OIML	Weights and measures authority recognized by many European and Asian countries
Pier foundation	A scale foundation that uses variable depth concrete piers under each of the scale's load bearing points
Pit foundation	A scale foundation that is excavated so that the driving surface is flush with the surrounding ground level
Pitless foundation (also above-ground, or open-sided foundation)	A scale foundation designed to have one or both sides open
Tare weight	The weight of the unloaded truck
Terminal	The scale interface, or control unit
Tread plate	On steel deck scales, the driving surface is often a steel plate with a diamond-tread pattern to benefit traction
Weighbridge	The structure of the scale that the truck drives onto in order to be weighed. Sometimes used to refer to the entire scale.

Section 1

How a Truck Scale Works

Becoming familiar with basic components

Nearly all truck scales have some common components that work together to measure weight. Scale buyers should be familiar with these components to determine the scale that is best equipped for their needs.



Contents

- [1 What Does the Truck Scale Tell Us and Why?](#)
- [2 Main Components of a Truck Scale](#)
- [3 Truck Scale Site Location](#)
- [4 Scale Operation](#)

1 What Does the Truck Scale Tell Us and Why?

For business transactions:

Gross weight: the weight of the loaded truck

Tare weight: the weight of the unloaded truck

Net weight = Gross - Tare

For compliance:

Maximum loading: ensuring that the weight of the entire truck and/or the load on a set of axles is within the legal range for road-going vehicles in a given region

Whether buying goods, selling goods, recording inventory, or checking for compliance, the information from the truck scale is critical. It is used for transaction pricing, profit margins, quality control, inventory management, legal compliance, and more.



This guide is dedicated to helping the user gain this information accurately, reliably, and effectively.

2 Main Components of a Truck Scale

Foundation

A scale may be installed over an excavation, allowing the driving surface to be flush with the ground. It also may be installed in an above-ground configuration with approaches allowing the truck to drive onto, and off, the scale. Either way, permanent installations use a concrete foundation.

Weighbridge

Also known as the scale deck, this is the structure that creates the driving surface for the trucks. The weighbridge is typically composed of modular sections that are placed together to span the desired length. Modules can be made entirely of steel with a steel tread plate as the driving surface. They also can be designed to be filled with concrete, creating a concrete driving surface.

Load Cells

These are the sensors that measure the weight on the scale. Modern scales use load cells as integral structural components. In other words, the weighbridge is supported by the load cells themselves. There are a few different types of load cells. They are typically positioned at the corners of each weighbridge module.

Terminal

Also sometimes referred to as an indicator, the terminal is the control panel for the scale. It displays the weight value to the operator, and often serves as the connection point for other scale peripherals.

Cables

The signal from the load cells must be transmitted to the terminal. In most cases, this is done with cables.

Junction Boxes

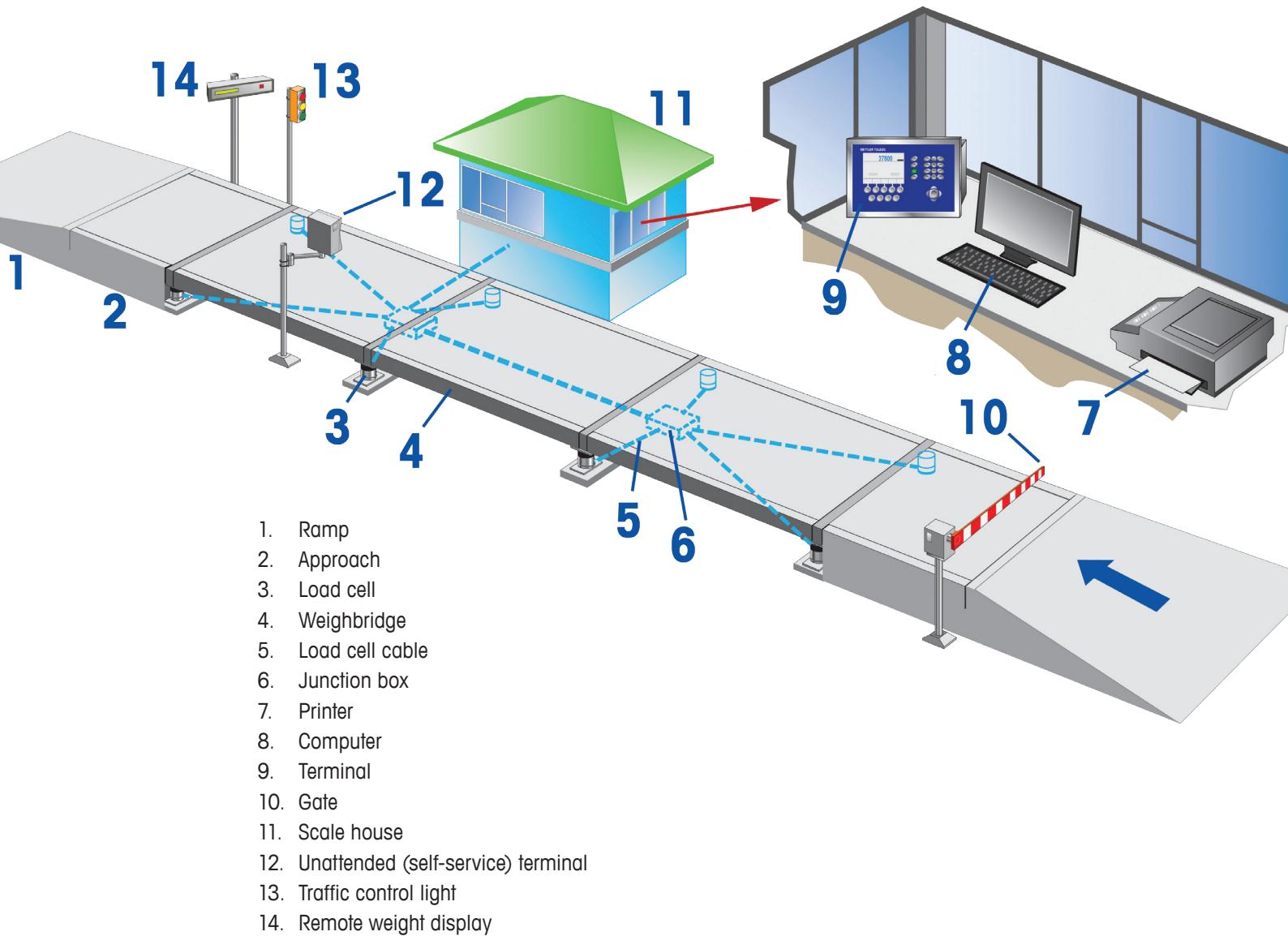
Many scales require numerous junction boxes as connection points for the load cell cables. The junction boxes combine the signals from the load cells and eventually connect to the terminal with a single cable. However, some newer systems no longer require junction boxes.

Accessories

This can include traffic controls, such as gates and lights. Remote weight displays that let the truck driver view the weight are also popular. Special equipment can be incorporated into the scale, such as cameras and radiation sensors. Additionally, some sites take advantage of new automation and self-service capabilities.

Information Management

Handwritten weight tickets have given way to printed forms via integrated printers. Scale software plays an increased role for sites large and small. Software can automate data capture, speeding up weighing times and reducing opportunities for errors.





3 Truck Scale Site Location

The truck scale location should be carefully thought out:

- Does the scale need to handle traffic in one direction or two?
- Does the site provide enough space for trucks to easily maneuver to and from the scale?
- Is there a designated waiting area so that queuing trucks don't block traffic on the roadway?

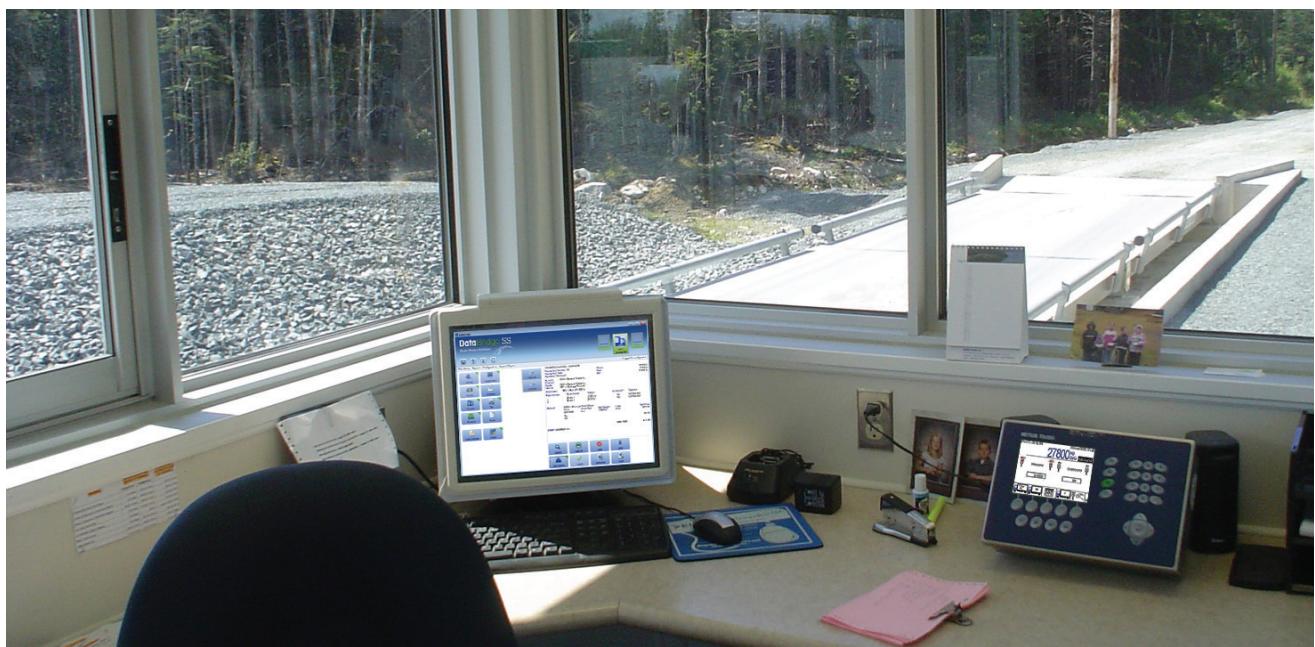
- Is the site level, with adequate load-bearing capacity and resilience through freeze/thaw cycles?
- Does the site offer adequate drainage to handle rainwater and melting ice or snow?
- Does the location offer room to expand by adding another scale if future requirements grow?

These considerations are outlined in more detail in Section 7: Site Planning.

4 Scale Operation

In addition to the scale foundation, the location for the scale often includes a scale house for the scale operator. The operator may keep records by issuing weight tickets, confirming purchase orders and entering material values to inventory. They may also serve as the local dispatcher for trucks via radio interaction with the drivers. Sometimes the scale house is also the entry and exit authority from a security standpoint.

In some applications, scale houses are being replaced by components that allow the truck drivers to process their own transactions. That can streamline operations with high repeatability or limited variables. It can be accomplished through the use of a drive-up kiosk positioned alongside the scale or a walk-up kiosk near the scale.



Section 2

Scale and Weight Regulations

Understanding legal agencies and weighing guidelines

Weight is a universal measurement. Businesses, federal and local agencies, scale manufacturers and more have an interest in ensuring accurate weight information. Regulations for using weight in business transactions, roadway travel laws and equipment verification provide standards with which scale users should be familiar.



Contents

- [1 Road-Going Weight Regulations](#)
- [2 Legal-For-Trade Applications](#)
- [3 Metrology Authorities](#)
- [4 Metrological Regulatory Agencies](#)

1 Road-Going Weight Regulations

Regardless of what your trucks are transporting, regional and/or federal transportation authorities define the maximum allowable weight allowed on public roadways. This is often defined as a maximum allowable weight for a specific configuration of axles. There may also be a maximum overall gross vehicle weight, but sometimes the axle-based regulations stand alone.

Check with the transportation authority in your jurisdiction to find out the legal roadway limits for the type of trucks you will be using. Some sites use their truck scale to load their vehicles with the maximum weights allowable without going over. Overweight trucks can result in steep fines.

Ensure the scale configuration you choose is capable of providing the information you need, especially if you plan to load your trucks close to legal limits. For example, a scale designed to weigh the complete truck may not provide the weights of each axle group unless it is a multi-axle scale. This is explained further in Section 3.

2 Legal-For-Trade Applications

If your scale is to be used in business transactions, your application needs to be "legal for trade." Legal-for-trade applications most often are required to meet a set of federal, local and/or regional requirements. This can include criteria for construction, scale specifications, operation principles and calibration intervals intended to protect business transactions from scale inaccuracy or fraud.

Non-legal-for-trade applications can include scales used exclusively to check for proper axle loading and/or compliance with maximum roadway weight limits. While those are important uses, they are not trade-related applications, and therefore might not be required to meet the same guidelines.



Buying or selling bulk goods by weight means the scale must adhere to legal-for-trade regulations

3 Metrology Authorities

Metrology is defined as the “scientific study of measurement.” Most locations look to a recognized metrology authority for measurement standards to ensure equality in business transactions. When it comes to truck scales, those agencies will provide certifications to equipment and components that meet their performance requirements.

OIML



In many European and Asian countries, the International Organization of Legal Metrology (OIML, www.oiml.org, headquartered in France) provides the standards that measuring devices must meet for commercial applications. That includes vehicle scales and their components, such as load cells.

OIML regularly updates its series of recommendations, guides and other reports and documents. Devices that comply with OIML specifications will carry an OIML classification. For vehicle scale components, such as the weighbridge and load cells, this will define tolerances for their accuracy and capacity, which are verified by standardized testing. For example, OIML document R 60 outlines performance characteristics for load cells.

NIST and NTEP



In the United States, regulations are defined by the National Institute of Standards and Technology (NIST www.nist.gov) Handbook 44, “Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices.” It is most often referred to as Handbook 44 or simply H-44 and is revised annually. H-44 provides the federal specifications for the performance of a truck scale. It also covers the user requirements or tasks that the scale user and owner are to do.

Devices that are intended for commercial applications will carry the National Type Evaluation Program (NTEP) certification issued by the National Conference on Weights and Measures (NCWM). This signifies that the product or component has been tested to conform to the NIST H-44 requirements.

Other Locations

Many other federal and provincial weights and measures (W&M) authorities around the world acknowledge the standards of the aforementioned organizations. Many will accept devices carrying certification from one of those agencies. Your regional weights and measures authority can provide further details regarding the certifications it accepts for commercial vehicle weighing equipment.

Examples:

Canada

The Canadian agency, Measurement Canada, notes that load cells in trade devices must conform with NTEP or OIML regulations.

Source: Bulletin M-25

Australia

The National Measurement Institute (NMI) in Australia performs supplemental testing and certifications for commercial weighbridge load cells based on OIML standards.

Source: NMI R 60

4 Metrological Regulatory Agencies

While the metrology agency may provide certifications for new product designs, ongoing enforcement of measurement standards is left to a local metrological regulatory agency, often known as a department of weights and measures (W&M). These departments conduct annual tests of petrol/gasoline pumps, deli counter scales, truck scales and more.

You will need to contact your local W&M department, as representatives will often need to perform inspections, tests, calibration and certification before your new scale can be used. It can be best to contact them early in the process to ensure you are familiar with their requirements. Inform them that you will be installing a truck scale and ask for all regulations pertaining to the installation and operation of truck scales in your state or province. You will likely be in contact with

them periodically throughout the life of the scale, as they may need to perform regular inspections and tests to recertify the scale.

Depending on your location and business, you may also have to meet the requirements of other regulatory bodies. For example, this may include state and local building code authorities, the Federal Grain Inspection Service, state and federal departments of agriculture, federal customs agencies and departments of transportation. Compile your own list and make sure the appropriate regulations are addressed. Your scale supplier should be able to help you understand which agencies should be involved.



A calibration check can be performed with large test weights that are loaded onto a motorized cart. The technician moves the cart to various points on the scale with different amounts of weight to test for consistent accuracy from the scale.

Section 3

Basic Scale Choices

Decisions every scale buyer must make, and what to know before talking to suppliers

The size, style and configuration of a truck scale can depend on the needs of the purchaser. However, there are also choices that are more subjective. This section discusses some of the fundamental differences that can make one scale different from another.



Contents

- 1 The Scale Project Team
- 2 Deck Construction – Steel vs. Concrete
- 3 Pit Foundation vs. Open-Sided (Pitless) Design
- 4 Portable Truck Scales
- 5 Scale Interface and Data Management
- 6 Unattended Weighing
- 7 Used Vehicle Scales
- 8 Upgrading an Existing Scale

1 The Scale Project Team

Assemble a team for your truck scale project:

- **Internal project team.** This should include the people within your company who handle facilities, operations, traffic, computer systems and finances.
- **Scale supplier.** Get in touch with prospective suppliers early. They can give you good advice and help through the process. They also can recommend experienced people for the other positions. The scale supplier will likely be the one who installs and tests your scale. In some cases, they may perform the initial calibration, unless your local weights and measures guidelines require that it be done by a government agency.
- **General contractor.** A contractor will typically prepare the site by putting in the foundations and approaches, building the roads and parking areas, erecting the scale house and running needed utilities. Get recommendations from scale suppliers and others in your area who have put in a scale over the last few years. In some cases, your scale supplier can provide the general contracting services.
- **Engineer.** Your local government may require that a civil engineer certify the plans for your scale's foundation, and other components. Ask your scale supplier what your location requires.

Talk to prospects for these positions early. Get to know them and select those who can do the best job and with whom you can work most comfortably. Tips on selecting a good scale supplier are included throughout this guide. Once the team members are selected, introduce them to each other and open up the lines of communication.

Evaluating Scale Suppliers

Scale buyers typically narrow their number of prospective suppliers down to two or three. At that point, it can be beneficial to ask the salespeople to take you to visit a nearby site with a scale similar to the model you are considering. Your internal team may wish to accompany you. Ask to see a site that has had its scale for a considerable amount of time. A site visit can provide insight into the true ownership experience.

You may find it helpful to ask specific questions about:

- Maintenance – What standard preventive maintenance is required?
- Unplanned downtime – How much has been experienced? Have they needed to replace any load cells or other components? Were repairs acted upon swiftly by the service provider?
- Calibration – How long does it take?

Eventually, you will review contracts and purchase orders. Read over all the documents before you sign them to make sure you understand their content. The unbundling of services, products and pricing is an art form. Features and services that you think should be standard may be considered extra-cost add-ons by the other party. Ensure that the scope of supply by all players is what you expect. Throughout the quoting process, be certain that all prospective vendors are quoting to similar specifications and capabilities.

Scale Size

The deck of your weighbridge needs to physically accommodate the footprint of the largest truck you plan to weigh. Vehicle sizes can vary throughout the world, but it is a good idea to consider your needs well into the future because a well-made scale can last 10 to 20 years. Consider the possibility of using larger vehicles in the future than you do presently.

Many scale manufacturers will offer standard-sized weighbridges, but will also accept custom dimensions. If you are replacing a pre-existing scale and utilizing an existing foundation, you will need your new scale to fit those dimensions. In those cases, often a scale company representative will visit the site to take measurements before the scale is manufactured.

Length

In applications in which you need to weigh the entire truck, your truck scale must be long enough to hold all the wheels of the longest truck you plan to weigh. That usually means 18 to 24 meters (60 to 80 feet) long for tractor-semitrailers, and up to 30 meters (100 feet) for double trailers. The overall maximum length of over-the-road tractor trailers is typically regulated by regional/state/provincial authorities.

Width

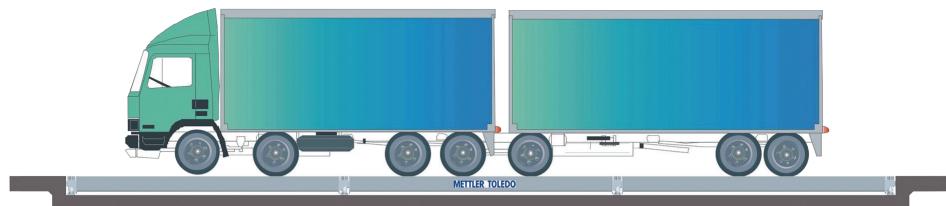
Typical truck scales average 3 to 3.5 meters (10 to 11 feet) in width. A wider scale can make it easier to maneuver the truck onto the scale. A recent trend has been for many customers to choose wider scales than was customary in the past.

Scale Configuration

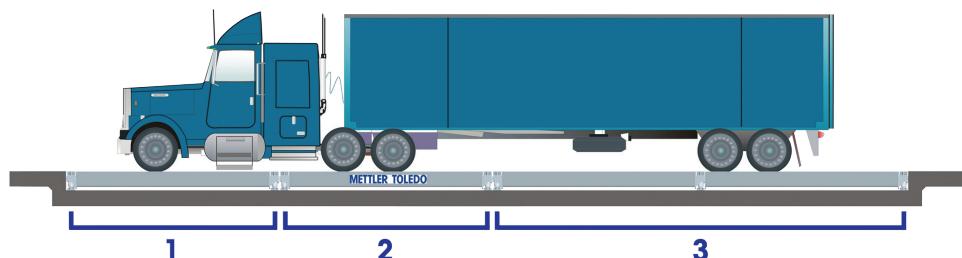
There are three main configurations of scales that can be used to weigh over-the-road vehicles: single-axle scales, full truck scales and multi-axle scales. The style that is best for you depends on the type of weight information you need for your application and legal requirements.



Single-axle scales typically are composed of a single scale module, or platform, large enough to accommodate a single set of truck axles. The main reason that a facility may choose this configuration is cost; these smaller scales cost considerably less than one that accommodates the entire truck. By separately weighing each set of axles, these scales can provide an estimate of the total weight of a truck. However, this method is not accurate enough to be used in legal-for-trade applications (in fact, this method can be off by 450 kg, 1,000 lb, or more). These scales are primarily used to check for compliance with maximum roadway limits.



Full truck scales are weighbridges typically composed of multiple modules, or deck sections, that are connected together in a length long enough to accommodate the entire truck. This is the most common type of truck scale, because most legal-for-trade requirements specify that the entire truck must be weighed at once.



Multi-axle truck scales look much like full truck scales but with one key difference. Instead of interconnected modules and shared load cells, each module or set of modules has its own load cells. This lets these modules or sets of modules operate as separate scales. The scale can provide the full weight of the entire truck and allows the user to see the weight of each axle or group of axles. These scales are more expensive than a full truck scale because they require additional load cells and related hardware. Depending on the type of trucks weighed, they may only be able to provide individual axle weights in one direction of travel due to the lengths and configurations of the modules.

2 Deck Construction – Steel vs. Concrete

The deck is the upper surface of the weighbridge. It's the part over which the truck tires roll. In most scales, you have your choice of steel or concrete deck surfaces. Steel and concrete decks should provide equal weighing performance because both are built to the same design specifications. However, there are some differences that could make one deck type more advantageous for your site or application.

Comparison: Steel Deck vs. Concrete Deck

	Steel	Concrete (site-pour)
Installation time	1 day	~30 days for concrete to cure
Portability	Lighter weight	Much heavier than steel
Traction	Can be slippery when wet	Good traction when wet
Point loading	Not recommended	Suitable
Maintenance	Comparable	Comparable
Service life	Comparable	Comparable
Total project cost	Comparable	Comparable

Steel deck

Steel decks are built in factories and usually welded to an internal system of beams or structural components. Steel deck scales are ready for operation as soon as installation is complete. Because they are fully built in factories, there are few variables to performance.

Most steel decks use a diamond-pattern tread plate as the driving surface. This assists with traction when the scale is wet. Some users prefer the traction of concrete in wet or snowy environments, but in most cases driving traction with a patterned tread plate is comparable to concrete. However, pedestrian traffic may experience better wet traction with a concrete deck as opposed to steel.

Concrete deck

Concrete deck scales are steel structures into which concrete is poured during installation to create the driving surface. The scale supplier builds in all the structural components and reinforcement needed, and the concrete is then typically poured by a third-party contractor based on the scale supplier's specifications. The concrete requires up to 30 days to fully cure before trucks can drive on the scale.

When looking at the cost of a concrete deck scale, be sure to include the cost of the concrete and pouring services. The concrete deck has a much higher static weight than steel, which may also require a more stout foundation, adding to the cost. All things considered, prices between concrete deck scales and steel deck scales can be comparable.

Some manufacturers will offer factory-poured concrete decks. This eliminates the need for curing time on-site. However, these scales can be susceptible to concrete damage during transport. They are also vastly heavier than their unpoured counterparts, making them more expensive to transport – sometimes requiring two trucks as opposed to one. They also may require a larger crane to install. If you consider this option, be sure you are familiar with how this affects the cost of your project.



A steel deck weighbridge is installed



Concrete is poured into the deck of a concrete weighbridge at installation

Overall, a concrete deck can offer advantages, particularly for small truck scales. Because they have about four times the mass of steel, concrete decks are better able to resist the longitudinal forces caused by the truck's drive wheels during acceleration. The concrete deck also provides a uniformly strong surface for trailer-only use in bulk filling applications. The stationary wheels of a trailer can be lowered anywhere on a

concrete deck and find all the support they need for high-point loadings.

Corrosion resistance is a separate consideration. Steel is the better choice for some corrosives, while concrete is preferred for others. Your scale supplier can provide recommendations for your application.

3 Pit Foundation vs. Open-Sided (Pitless) Design

You will need to decide if you want a pit scale or a pitless scale. A pit scale, as the name implies, is built over an excavation, and the surface of the weighing platform is flush with the ground. At one time, all truck scales required deep pits because they needed to house large levers and suspension systems. Today, those mechanical scales are antiquated, making deep pits optional.

Even if a pit is used, the depth requirements are subjective, although the depth of the pit can affect the ease of maintenance and service procedures. This is because a pit that is too shallow can leave little room for service personnel. Be aware, though, that the depth of a pit may be stipulated by local weights and measures authorities in some areas. They may also stipulate the size of manholes.

Pitless, or open-sided scales, are built up from a grade and have a profile of about 28 to 51 centimeters (11 to 20 inches). They may have one or both sides open.

While the choice between a pit or pitless installation is often based on preference, there are a few instances that may require the use of a pit. One is when you don't have enough physical space to build a ramp to the pitless scale's raised-deck surface and still allow enough maneuvering space for the trucks once they exit the scale. Also, some industry safety requirements could make a pit scale more practical, because there is no possibility of the truck driving off the edge of the scale.

Another situation calling for a pit is when you are faced with height restrictions. Let's say, for instance, that your new scale will be used to control a bulk filling process. The overhead filling structures may already be in place and can't be moved. The maximum allowable elevation of the scale's deck is at grade, and the only place to go is down.

However, some sites find that open-sided designs are easier to own for a number of reasons:

- **Access** – Pits can require access points or “man holes” in the weighbridge or scale foundation for maintenance personnel to crawl beneath the scale and inspect critical components. On the other hand, most pitless scales only require the removal of a protective panel to access the scale’s load cells and often don’t require travelling under the scale deck.
- **Drainage** – A pit will require that rain/snow water drainage is considered in its design. Typically this will require the use of a drain and sump pump, which is one more system that will eventually require servicing or replacing. Open-sided scales allow water to escape naturally.
- **Safety** – Depending on the safety requirements of your facility and region, entering a pit for routine service can require special protocols. Because it is often classified as a “confined space,” safety requirements can include the use of harnesses, cable man-lifts, air-quality monitors and more. In some chemical plants, pits can collect heavier-than-air gases, posing a unique danger. Because open-sided scales typically don’t require going under the scale, they can require fewer safety preparations.
- **Other** – Pits have a tendency to collect debris, trash, spilled product and mud. They are difficult to clean, and can become the perfect home for pests and rodents.



A pit-style scale is placed in an excavated foundation, flush with the ground



An open-sided scale design can aid in serviceability



Aggregates sites, for example, may find an open-sided scale easy to clean from spilled product



Some scale owners prefer a pit-style scale

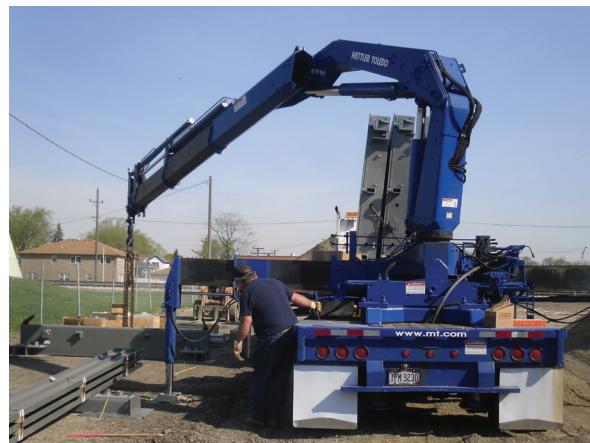
4 Portable Truck Scales

In some situations, you may need to weigh vehicles for a finite period of time. Sites performing construction, logging or on-site materials batching may need a portable truck scale.

Instead of a purpose-built concrete foundation, portable scales make use of a steel frame that typically bolts together in sections. The frame includes mounting locations for the load cells on which the scale deck rests. These scales almost always use a steel deck, as they are much easier to move from one location to another. In most cases, the scale is designed to be partially disassembled for relocation simply by unbolted sections of the frame and deck structure. A crane can then be used to lift the sections as needed.

Portable scales will usually have special guidelines for site preparation – including compacted soil or gravel, or, if possible, concrete. It may be the customer's responsibility to ensure the surface is adequate. The scale approaches, or ramps, may be included with the scale. Often, these must conform to specific regulations defined by the weights and measures authority in your region.

Additionally, weights and measures guidelines in some areas will have special usage requirements for portable scales. For instance, they may require that a portable scale be relocated at certain intervals (6 months, for example).



Piecing together a portable frame truck scale on a prepared compacted soil site



A portable truck scale in Australia

5 Scale Interface and Data Management

Today's scales can take advantage of modern technology to streamline business processes and transactions by collecting the following information:

- Material type
- Price
- Truck weight (tare)
- Net weight
- Customer/Account number
- Purchase contract
- Third-party hauler information
- Driver identification number

- Truck identification number
- Surcharges, fees, taxes
- Material grade
- Material origin

To accomplish this, scale suppliers typically provide three general levels of data management for truck scales. Some features may vary based on manufacturer. They include the scale terminal, basic scale software, and advanced or customized scale software.

Vehicle Scale Indicator/Terminal

- Displays weight value
- Performs simple transactions with gross, tare and net weights
- Stores tare weights to calculate net weights

Optional features

- Calculates simple accumulations, for example, daily tonnage per truck or commodity
- Outputs data to a printer, remote display or other peripheral devices
- Stores limited data and transaction information
- Offers self-diagnostics
- Controls the traffic system
- Operates multiple scales with a single unit



Truck scale terminals are available with a wide range of features and capabilities



Scale software can streamline processes and reduce the need for paperwork

Basic Vehicle Scale Software

- Interfaces with scale terminal for control of scale, traffic lights, loops and gates/barriers
- Provides one-pass, two-pass and multi-pass weighing transactions
- Offers a database with tables to store information about vehicles, products, accounts, etc.
- Configures reports and tickets
- Calculates advanced pricing
- Speeds up transactions with presets and group information
- Imports and exports data

Advanced and/or Customized Vehicle Scale Software

- Controls multiple scales
- Performs advanced transactions: credit checking, vehicle weight checking, product sampling
- Configured for multiple users on a network
- Remotely calculates transactions via web browser
- Synchronizes data among multiple networked sites



Most suppliers offer various solutions within those three categories. METTLER TOLEDO offers multiple terminal options ranging from basic to advanced. It is a similar option with software – METTLER TOLEDO offers the DataBridge™ family of software ranging from standard versions to completely customized offerings. A good supplier partner should listen to your needs and present practical options for effective data management.

DataBridge™ Vehicle Scale Software

Learn more about truck scale software from METTLER TOLEDO at
► www.mt.com/DataBridge

6 Unattended Weighing

A growing number of sites are considering hardware that allows truck drivers to process their own weighing transactions. This capability can be ideal for scales that operate around the clock or that process repetitive transactions. With an unattended driver terminal, you can potentially eliminate the cost of building a scale house next to the scale and employing an on-duty scale operator. Unattended driver terminals commonly offer the following features:



Unattended terminals let drivers process their own weighing transactions

- Card/RFID reader for quickly identifying drivers/vehicles
- Display for prompting drivers to enter data
- Keypad/keyboard or touch screen for entering data
- Ticket printer

Optional features include:

- Wireless networking
- Voice intercom capability (standard or voice-over-IP)
- Camera systems for remote monitoring

If this option seems right for your facility, ask your prospective scale suppliers about their unattended terminals and software programs to run them.



Unattended terminals include various options for automated data capture

7 Used Vehicle Scales

While this guide is intended to address the purchase of a new vehicle scale, there are often second-hand options available as well. The cost savings over a new

scale can be huge, but there are a number of risks and drawbacks that can make this option only viable for a limited few:



Upgrading an existing weighbridge by installing a new load cell system enhances the scale's accuracy and reliability

- **The size of the weighbridge** cannot be modified, as it would harm the structural integrity and void any weights and measures certifications. So a foundation would need to be built to the existing size of the weighbridge, which may not be optimal for the application.
- **The warranty** will be void, with the possible exception of any new components that are installed. See Section 9 for more information about warranties.

- **The condition of the entire system** is subjective, and unless the scale is still installed and operational, it can be impossible to fully test the system.

However, many weighbridges can be modified to accept entirely new load cell systems. For businesses willing to accept the use of a pre-owned weighbridge, this can offer like-new performance at a fraction of the cost of a new scale. This leads us to a related topic: Upgrading an existing scale

8 Upgrading an Existing Scale

Many weighbridges can be made to accept new load cells, even from a different manufacturer, with the use of new conversion mounting hardware. For businesses that have an existing scale, this can offer a great return on investment by eliminating frequent service calls or questionable accuracy on an old scale.

This opportunity began with scale companies offering upgrades to their own installed base of aging scales. Upgrades offer life extension for weighbridges and foundations that are still structurally sound. This has since expanded to companies fitting their load cell systems into competitors' scales. From the customers' standpoint this offers advantages, allowing them to use new technologies while leveraging existing capital equipment.

Because these projects can have many variables, it is best discussed directly with your scale supplier. In some areas, local weights and measures regulations may stipulate whether a truck scale may be upgraded or not.

Here are some general criteria that an existing scale should meet to be considered an acceptable candidate for a load cell system upgrade:

- **Foundation** The scale foundation must be in good condition and structurally sound.
- **Weighbridge** The weighbridge must be evaluated for signs of fatigue, corrosion, cycle history, etc.

- **Checking and/or suspension systems** These components must still be capable of functioning as designed, and deemed appropriate for the requirements of the new load cell system.
- **Accessibility** The existing scale must allow adequate physical access for technicians to remove old components and install new ones where needed.

Video: Truck Scale Upgrades



See a video on truck scale upgrades at
www.mt.com/UpgradeToPDX

Section 4

Initial Scale Costs and Ongoing Performance

What a scale means to your business

An informed truck scale buyer considers more than just the initial purchase price when comparing scale systems. While price is important, it is the accuracy and reliability of the scale that will have a direct impact on the owner's business for decades to come. Selecting a reliable scale can lower many years' worth of maintenance and repair costs. Choosing a highly accurate scale protects against hidden product or profit losses due to scale errors.



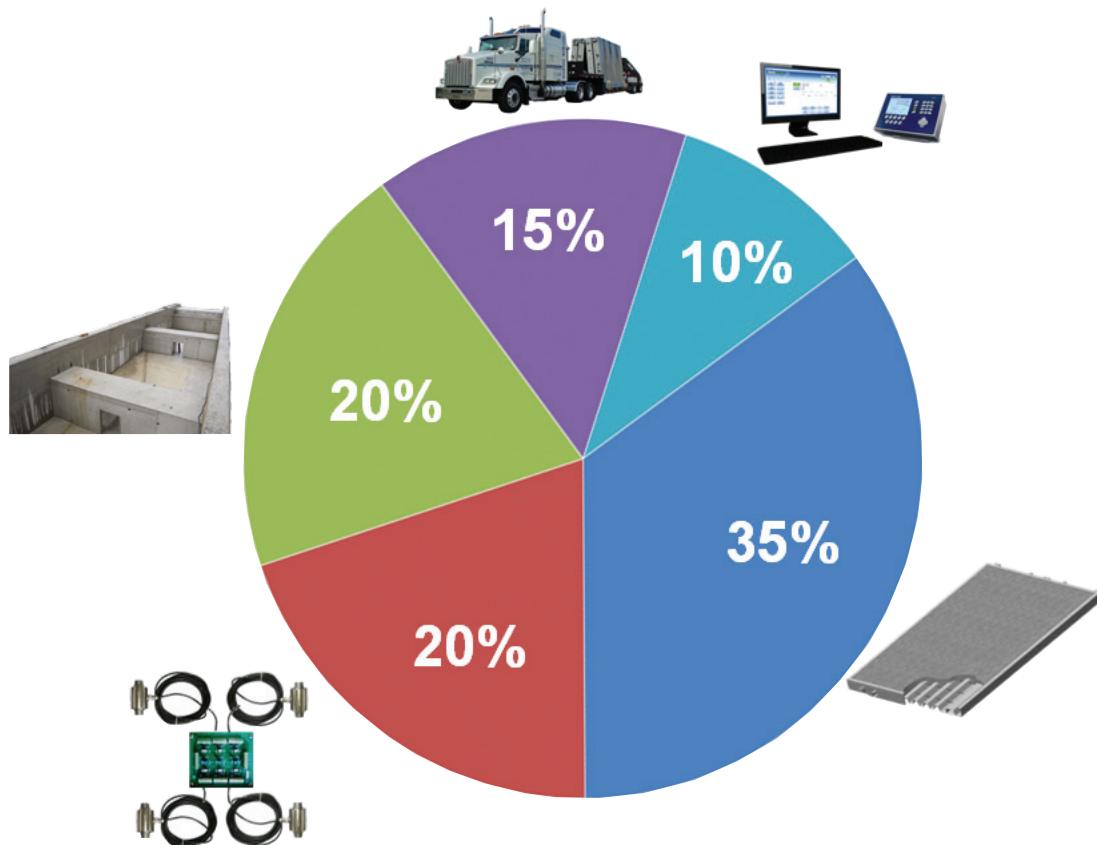
Contents

- 1 Truck Scale Project Costs
- 2 Cost of Ownership
- 3 Reliability
- 4 Accuracy

1 Truck Scale Project Costs

As you familiarize yourself with the various components of a new truck scale installation, you can start to see how each contributes to the total cost of the project. Ask potential suppliers for an itemized quotation. Here, we show an example of the typical costs involved with a full-sized truck scale installation:

35%	Weighbridge
20%	Load cell system
20%	Foundation
15%	Delivery and Installation
10%	Terminal and Software

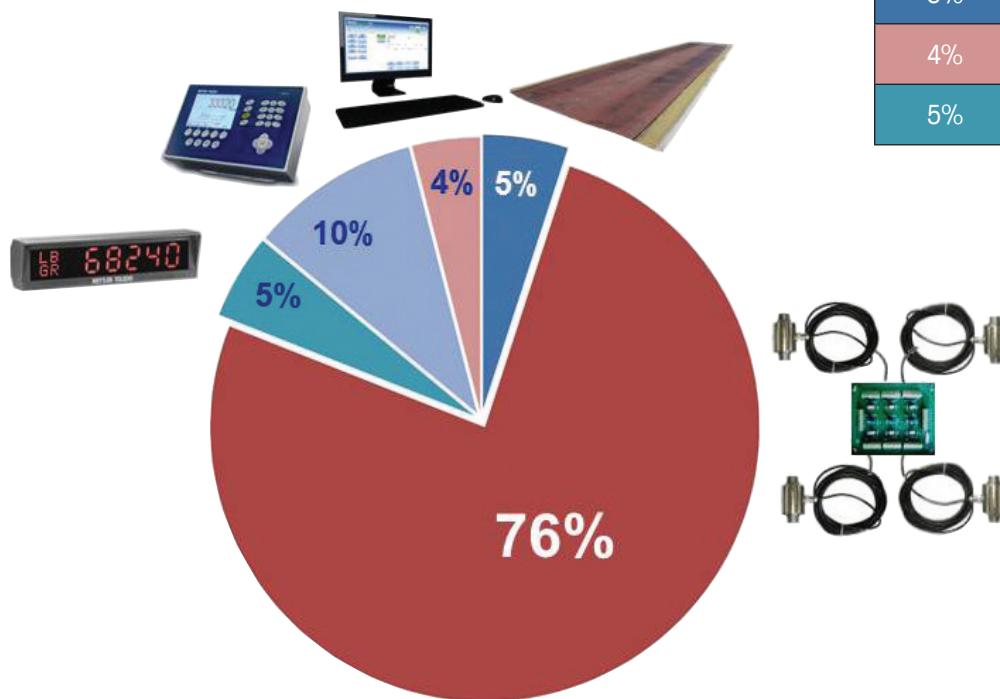


This chart shows how components in an example truck scale purchase are represented in the total cost of the project

2 Cost of Ownership

When comparing different scales, an informed buyer can look at more than just purchase price. Calculating the total cost of ownership over the life of the scale involves factoring in downtime, repair and service costs. Scale downtime has both qualitative and quantitative value. Typically the decision to get a truck scale is based on economics and the value of the products in those trucks. The reasons for having a truck scale come down to the determination of net value:

- 1. Know the value** of the transaction, or the value of the cargo of your incoming or outgoing shipments.
- 2. Verify the value** of incoming shipments. It's good business to double check the accuracy of the shipper's scales. This is also your best opportunity to identify losses, leaks or outright fraud.
- 3. Control inventory.** Your truck scale is the first point of inventory control and an indispensable resource for subsequent bulk measurements for purchasing, materials balancing and auditing.



Costs over the life of the scale

Though many companies focus their sales presentation on the weighbridge, it is typically a low-maintenance item when compared with other parts of the scale. Many truck scale buyers wish to focus sales discussions more on the load cell systems once they learn that older load cell systems have been the main source of ongoing maintenance and repair costs and downtime. Therefore, choosing the right load cell system has the greatest potential to save the owner money over the life of the scale.

- 4. Load the maximum quantity.** You need a truck scale to make sure you're shipping the maximum possible load without exceeding highway weight limits.

If your scale is down, your site loses its ability to perform these functions. That has different meaning for each site, but take the time to consider the value of downtime for your business. It may be more substantial than you think.

Ongoing Ownership Costs

Ownership costs can be related to a situation in which a component has failed, or where the scale requires readjustment or recertification. Some components are more likely to cause those issues than others in conventional scale systems.

Load cell system
10%
5%
4%
5%

3 Reliability



It can be difficult to think about a new scale being unreliable because you don't expect a new piece of equipment to fail. However, truck scales face a number of challenges. Some scales eventually need frequent repairs, while for others this is rare. Because scale downtime can be detrimental to business operations, think about reliability upfront. Designs and features that protect against scale failures can be well worth the initial investment to give you peace of mind later on.

Causes of Scale Downtime

The following list names the most common historical sources of scale repairs across all makes and models. The forthcoming sections of this guide explain many of these components and situations in more detail.

Environmental impacts

- Lightning damage
- Frost-heave, ice damage or debris buildup
- Water damage

Junction boxes and cable connections

- Moisture in a junction box
- Failed connections in a junction box
- Damage to a load cell cable (rodents, accidental severing, etc.)

Load cells

- Moisture ingress damaging internal components
- Physical damage and corrosion
- Physical wear due to misalignment or poor preventive maintenance
- Leaking hydraulic fluid (hydraulic systems)

Calibration or recertification required

- Expired W&M certification
- Change in major components
- Change in location (portable scales)
- Weighbridge misalignment requiring adjustment



Scale failures can result in production delays and idle deliveries, making reliability a key concern

Protection from Environmental Challenges

Flooding and Moisture

Locations that experience rain, snow, ice, and especially flooding should pay special attention to the scale's protections from water damage. Water can cause the weighbridge to corrode, but more often can damage components like load cells and junction boxes.

To prevent damage, load cells can offer hermetic (air-tight) seals thanks to precision manufacturing technologies, such as laser welding. Additionally, load cells and cable connections can carry an Ingress Protection (IP) code rating to note their resistance to the ingress of dust and water. The level of protection is signified with a two-digit number. For example:



A POWERCELL® PDX® load cell undergoing an IP69K test with pressurized spray

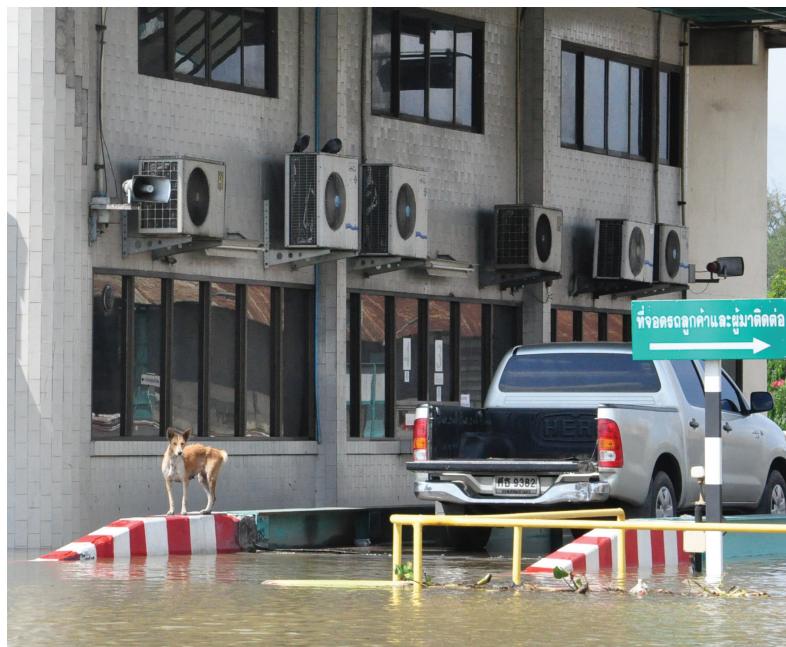
- **IP68**

The number 6 indicates that the enclosure is dust tight, providing complete protection from dust. The number 8 indicates that the component is suitable for continuous immersion in water.

- **IP69K**

This rating indicates that the enclosure is suitable for high-pressure, high-temperature wash-down applications.

However, the components most vulnerable to water or other moisture damage are typically junction boxes. Junction boxes include access panels that are difficult to seal. Junction boxes are discussed in greater detail in section 6.



Heavy flooding submerged this truck scale at a chemical factory in Thailand for weeks. Thanks to superior water protections, the operators were amazed when the scale continued to operate once waters subsided

An extreme situation such as a flood can easily show the value of water protections. A scale with inadequate protection may require the replacement of numerous expensive parts. In other cases, components must be thoroughly dried and serviced before the scale will function again. However, some scales have been designed with conditions like flooding in mind.

With the proper protections, scales have even survived weeks of total submersion with little noticeable effect on performance afterward.

Temperature

Temperature changes can also present challenges to a truck scale. Over time, thermal cycles can cause the scale to require more frequent calibrations and service. Some load cells can experience signal fluctuations due to temperature, causing the scale's accuracy to suffer. This issue is presented in greater detail in section 6.



This truck scale survives the coldest temperatures on Earth at McMurdo Station in Antarctica

Lightning

Passive and Active Systems

Lightning is one of the largest risks for a truck scale owner. If a scale is damaged by a lightning strike, the cost of repairs can be extensive. When you add in the downtime associated with major repairs, the impact on a business can be significant. That is why lightning protection is a hot topic among vehicle scale buyers and manufacturers alike.

Most truck scale providers offer weighing systems with numerous grounding features. A single-point grounding system with surge protectors can be the first line of defense for the scale and scale house. These passive systems offer some level of protection, but how much? Lightning strikes vary in their power, location and more. That can mean that grounding alone offers incomplete protection from the variables associated with lightning strikes.

Active systems are able to re-route the current of a lightning strike away from major components. Some scales are equipped with built-in protective devices, such as gas-filled discharge tubes in the junction boxes (if equipped). Additionally, others offer transient voltage suppressors; those are circuit breakers that react to the heat produced by power surges.

Working together, those features can protect your scale from damage, even from a direct lightning strike. However, testing those systems to ensure they perform as designed can be difficult and expensive. Because of that, few manufacturers test their lightning protection systems.





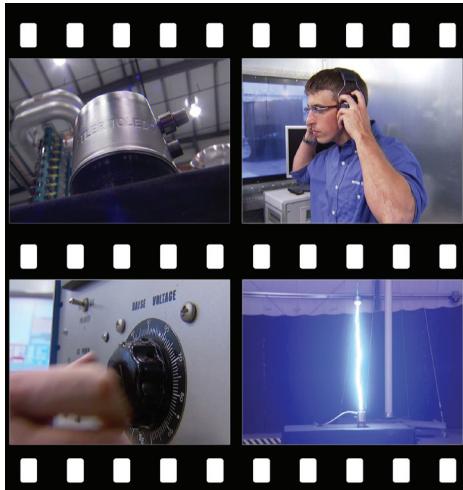
A POWERCELL® PDX® load cell connected to an IND780 terminal during a lightning test

Lightning Protection Validation

The best way to validate a truck scale's lightning protection system is at a lightning laboratory. Lightning labs often are used to test critical aircraft components by shocking them with the same voltage and amperage levels seen in lightning strikes. These labs essentially create man-made lightning.

For example, METTLER TOLEDO has been able to validate the effectiveness of the StrikeShield™ protection on POWERCELL® load cells and scale terminals at such a facility. There, components were hit with 80,000 amperes – twice the current of a typical lightning strike – and protective systems behaved as designed. In this case, the system instantly shuts down, redirects the current of the strike and then reboots.

Video: Lightning protection tests



See a video on how METTLER TOLEDO tests lightning protection systems at
► www.mt.com/LightningTest

Lightning Warranties

Most scale suppliers offer some type of warranty to cover damage from lightning strikes. Many are prorated based on the age of the scale. Ensure that the warranty is in writing and understood by everyone involved. Does the warranty only cover replacement parts? What about travel and labor costs for repairs? Remember that even if a warranty covers replacement of damaged parts, you will still have to deal with the expense of unplanned downtime while the scale is repaired.

Be sure to ask questions about the warranties on scales you are considering. Even the world's best warranty cannot prevent lightning strikes, so it is important to know how your scale will be affected if it is hit.

Business Implications: Delays and Repair Costs

Regardless of the cause, if your scale is down, you have to make a choice. You could continue operations by simply estimating weights (if that is legal for your application). You might be able to send your trucks to another scale depending on how far away it is. Alternately, you can shut down operations until the scale is back in service. Depending on how you use your scale, this situation could mean a large amount of unaccounted-for product, delayed operations, lost revenue and extra expenses.

Calculate the costs of having your scale out of service for two days, one day and one hour. Then, when the time comes, ask each of your prospective scale suppliers to discuss reliability and emergency repairs, especially travel time and the average length of an emergency call all the way through to fully restored service. Ask how long it takes to test and calibrate the scale, along with the recommended interval between tests.

Preventing Unplanned Downtime

Preventive maintenance is strongly encouraged for optimal performance, as is the case with nearly any major equipment. That can include taking the scale offline for prescheduled service at predetermined intervals. This topic is addressed in more detail in section 9.

Failure protection systems are available on some

scales. These monitoring features log the performance of various components and can warn the operator of any inconsistencies typically before the scale faces any crippling errors or failures. The benefit of this warning is the ability to schedule a service call at a convenient time, rather than paying premium rates for emergency service once the scale is no longer operable. This planned downtime is obviously preferable over unplanned downtime.

4 Accuracy

What You Need to Know About Accuracy

- Accuracy affects your business.
- A conventional truck scale may not be as accurate as you think.
- Legal-for-trade scale error tolerances don't protect you from profit losses.
- Not all scales offer the same level of accuracy.

The accuracy of a scale easily can be taken for granted, but if you buy or sell goods with the use of a truck scale, accuracy is critical to your transactions. This includes profit margins, inventory levels, and quality management.

Understanding Legal Error 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 will 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.

The size of the legal accuracy tolerance for your scale depends on your location and whether your region recognizes NIST/NTEP or OIML standards. The tolerance is a function of the percentage of the scale's capacity being utilized, and the size of the scale's weighing increment. Here, the capacity of the scale is the maximum weight value for which the terminal and

load cells are configured, not the physical maximum capacity of the structure. This is an important distinction and one that we will discuss in greater detail later.

NTEP (United States standard)		
1 scale division = 20 lb		
Scale capacity (lb)	Truck weight (lb)	Allowable error (lb)
200 000	40,000 – 50,000	100
	50,000 – 60,000	120
	60,000 – 70,000	140
	70,000 – 80,000	160

- NIST/NTEP Accuracy Tolerance

Handbook 44 outlines a step-based tolerance that increases with every additional 5% of the scale's capacity being utilized.

OIML (Global standard)		
Using C3 load cells		
Scale capacity (kg)	Truck weight (kg)	Allowable error (kg)
60 000	10,000 – 40,000	40
	40,000 – 60,000	60
80 000 (multi-range)	10,000 – 40,000	40
	40,000 – 60,000	60
	60,000 – 80,000	100

- OIML Accuracy Tolerance

There are various accuracy specification levels defined by OIML: C3, C4, and C6 are seen in truck scales. Most truck scale applications are C3 (used in the chart above). A very small percentage of truck scales are C6, which provides a stricter accuracy tolerance.



Product or Profit Loss

When you consider the cost of your goods, 30 kg (80 lb) can be of considerable value when it is multiplied by the volume 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 scale errors.

In the past, scale owners accepted these minimum accuracy tolerances because they reflected the capabilities of past scale technology. For many years, vehicle scales have been designed only to meet the minimum legal requirements. However, some modern scale systems are able to maintain a higher level of accuracy. There are now discernible accuracy features between makes and models of truck scales.

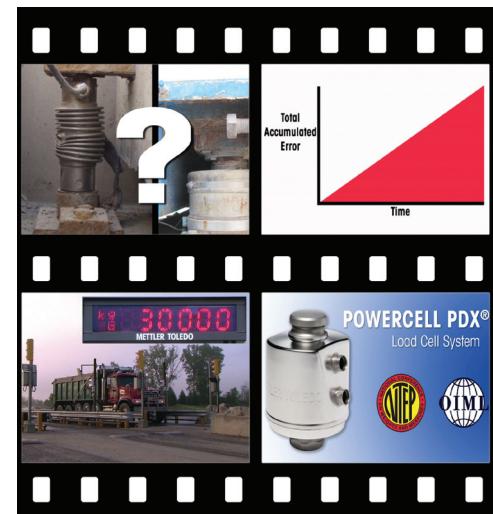
Realize, also, that the scale is periodically recalibrated to be within these tolerances, but the accuracy of many scales will drift outside those ranges over time. That is why periodic recalibrations are needed. It also means that the amount of error on a scale between calibrations can easily be greater than these specifications. But why don't the scale technicians calibrate the scale to zero error? That is because many systems are difficult and time-consuming to fine tune.

In summary, the impact of scale accuracy is extremely important for businesses. Sites processing high volumes of trucks or goods of considerable value (or those planning to do so in the future) should be particularly aware of their scales' accuracy.

Trucks scale error example #1	
Cost of goods	0.10/kg or 0.045/lb
Scale error	30 kg or 67 lb
Trucks per day	50
Days per month	20
Monthly loss from error	3,000

Trucks scale error example #2	
Cost of goods	0.322/kg or 0.145/lb
Scale error	36 kg or 80 lb
Trucks per day	50
Days per month	20
Monthly loss from error	11,500

Video: Truck Scale Accuracy



Run a quick calculation to see what legal errors could be costing you. Then watch a video on how METTLER TOLEDO systems work to ensure accuracy at
▶ www.mt.com/truckload

Section 5

Weighbridge Specifications

Going beyond the sales pitch: Scale designs, ratings, capacities and your choices

The weighbridge, consisting of the scale deck modules, is an important part of the scale. With some fairly basic considerations, you can establish your requirements for a weighbridge that should last many years.

We previously discussed the two basic choices in weighbridge styles – steel deck versus concrete deck, and pit foundations versus above-ground configurations. Beyond those choices are capacity ratings, as well as duty cycle and lifecycle considerations.

Some scale providers focus their sales presentations on the merits of their weighbridge. Keep in mind that, as we discussed in the previous section, **weighbridges are rarely a source of ongoing ownership costs**.

While selecting a weighbridge that meets your needs is important, be cautious of being sold a more expensive model of weighbridge than you really need.



Contents

- 1 Scale Deck Movement
- 2 Weighing Increments
- 3 Scale Capacity
- 4 Lifecycle Testing
- 5 Deflection
- 6 Duty Cycle

1 Scale Deck Movement

Scale deck movement may sound like a bad thing, but most scales are designed to let the deck move a small amount. This is for two main reasons:

- **Prevent binding.** If the scale deck binds on the walls of the foundation, the scale will not weigh accurately.
- **Load transfer.** Most scales are designed to be self-centering, transferring the force of the weight on the scale to the load cells in a vertical manner. If the scale does not transfer the load to the load cells properly, the result can be off-center loading, which causes weighing errors.

Truck scales typically constrain the movement of the deck with the use of bumpers, check rods, or a suspension system. Each type has procedures for regular maintenance to ensure they are adjusted to the proper tolerance. As a scale owner, be sure that those checks are part of your maintenance program. Neglecting those systems not only results in weighing errors, but it also can cause scale components to wear out prematurely.

2 Weighing Increments

Before discussing capacity ratings, we need to explain the weighing increments used by truck scales. This helps the buyer later understand the legally required scale setup formulas used to determine a scale's capacity.

It is important to understand weighing increments and scale divisions (sometimes called scale resolution). Many truck scales weigh in increments of 20 kg in OIML locations and 20 lb in NTEP locations. That is because weights and measures regulations in most areas specify the number of divisions (units of the scale's capacity) a scale must use. For truck scales, often this is 3,000 for OIML and 10,000 for NTEP.

This is determined using the following formula:

Scale capacity / number of divisions = weighing increment size

OIML:

60,000 kg scale capacity / 3,000 scale divisions = **20 kg weighing increment size**

NTEP:

200,000 lb scale capacity / 10,000 scale divisions = **20 lb weighing increment size**

Because the number of divisions is set forth by weights and measures authorities, the relationship

between scale capacity and weighing increment size is fixed. In other words, if the scale's capacity increases, the weighing increment size also must increase.

Why does this matter? With a smaller weighing increment, the scale has a better potential for accuracy because it isn't rounding the weight value in large intervals. The scale terminal typically can be configured to adjust the maximum capacity, but it must follow the legal formula. Some scale companies will mention that their scales can be configured for small increment sizes, citing this as an advantage. However, keep in mind that this may not be acceptable for your application, based on these formulas.



3 Scale Capacity

To discuss your capacity needs, you will need to know how many trucks per day you will be weighing, their types and sizes and the maximum weights. Look at both your current needs and your future needs. The capacity of a vehicle scale can be expressed in multiple ways.

- **Gross Capacity (or Nominal Capacity)** – The total weight that can be evenly distributed over the entire surface of a weighbridge.
- **Concentrated Load Capacity (CLC)** – A declaration of a scale's ability to handle a load utilizing a limited footprint, intended to represent the load applied by a dual tandem axle.
- **Volume of Traffic** – The traffic concentration that a scale is designed to handle.

Let's elaborate on what each of these measures means to the scale buyer.



Gross Capacity

Make sure the gross capacity of your scale exceeds the total weight of the heaviest loaded trucks that you will be weighing. However, be aware of how scale companies discuss gross capacity in sales presentations.

Some scale companies will list very large capacities on their scales to appear superior to their competition. However, remember that if you configure your scale for an extra-large capacity, but you do not actually utilize that capacity, weighing regulations still require that the weight increment size also be increased. This is

undesirable as it increases the need for the terminal to round weights up or down in larger values.

Some salespeople will discuss gross capacity as a correlation to strength. However, gross capacity is determined by formulas that don't truly correspond to strength verification.

How is Gross Capacity Determined?

Gross capacity is not determined in the way some customers might think. The scale company does not test a scale by loading it until it fails. Gross capacity is typically based on a standard weights and measures formula that may take into account the number and capacity of load cells in the scale, the weighing increment size and/or number of divisions, number of scale deck modules and the concentrated load capacity (CLC) rating of the modules.

However, gross capacity is not a true measure of the actual strength of a weighbridge. In the real world, trucks don't distribute their loads evenly over the entire surface of a weighbridge. They concentrate loads on their axles, which is why, in some regions, truck scales may also have a CLC.

Video: Weighbridge Manufacturing



Take a video tour of one of METTLER TOLEDO's vehicle scale manufacturing facilities at

▶ www.mt.com/TruckScaleTour

Concentrated Load Capacity (CLC)

CLC is a specification required by NIST/NTEP, outlined in Handbook 44, applicable to the United States and other regions that recognize these requirements.

Weight limits for road-going vehicles are often expressed as the maximum weight allowed for a dual tandem axle (two axles positioned next to each other in a fixed area of about 2.5 by 1.2 meters, or 8 by 4 feet). CLC is the intended maximum dual tandem axle weight that the scale will support as designated by the scale manufacturer.

How is CLC determined?

The scale manufacturer declares the intended CLC value for a model of scale. That value then is verified with a simple test using flat weights representing the intended maximum value. Those weights are placed at various locations on the scale when it is new. Typically, the scale then is used for a short period of time (30 to 45 days), during which it is required to perform a minimum of about 300 registered weighments. The scale is then tested again to see if the original test results are repeatable in terms of weighing accuracy. If so, the weights and measures organization grants that CLC value to the scale model. That testing does not measure physical stresses or fatigue on the scale structure as it is only checked twice in the first few months of the installation.



Test weights on a truck scale

The CLC rating is frequently misunderstood. It is often cited by salespeople as a sign of the scale's strength. While the CLC test is useful in some ways, it is not a true measure of the "strength" of the scale. Most scale buyers want a "strong" scale because they want the scale to last as long as possible, even with constant use. Unfortunately, this CLC test does not predict a scale's resistance to fatigue, or performance over time. The truth is, even a poorly manufactured scale could pass with a high CLC rating.

How much CLC do I need?

The answer to this question depends somewhat on your location and the maximum legal weight limits defined by your government and/or transportation authority. For example, in the United States, most state transportation regulations limit dual tandem axles to a maximum of **34,000 lb** (15,422 kg). In most cases, you need a CLC that is designed to meet or exceed that value. However, rarely will you encounter a scale option that does not provide an adequate CLC for your area. For a company to offer a scale that doesn't meet local ratings just doesn't make much sense.

Safety factor

A truck scale with a 30-ton CLC rating offers more than 150% of the actual CLC loading the scale will encounter, providing the necessary safety factor for legal roadway weights.



These values reflect the maximum axle loading limits

Common axle group weigh limit (USA)	~20 tons
150% of limit (recommended CLC)	30 tons (60,000 lb)

Let's say you are evaluating two truck scales—one has a CLC rating of 80,000 lb (36,287 kg) and the other has a CLC rating of 100,000 lb (45,359 kg). Both offer more than twice the CLC rating needed to weigh the typical maximum legal dual tandem axle weight for over-the-road trucks in the United States. So is the scale with the higher CLC rating better than the other? No. CLC by itself is a poor means of comparison because it doesn't reflect the scale's quality or performance over time.

Note: In recent years, some scale manufacturers have begun having their scales certified for very large CLC weights so they can use this figure in sales discussions. In reality, many sites have used older truck scales rated at 60,000 or even 45,000 lb CLC for 20 years or more without weighbridge issues. This, combined with the limited nature of the CLC test, makes it easy to see that a higher CLC does not translate to longer scale life.

4 Lifecycle Testing

To evaluate a scale's longevity through years of constant use, lifecycle testing must be performed. A lifecycle test involves repeatedly loading and unloading the structure of the scale to replicate the stresses it will experience over its life. That can involve more than two million dynamic cycles. Though some scale makers will claim that their scales are "designed" to handle two million cycles, few can say that their scales are "tested" to two million cycles. Those physical tests can be expensive and time-consuming, which is why many truck scale makers do not do it.

Ask your prospective scale suppliers about the lifecycle testing they perform. Some salespeople will simply point to the CLC verification and nothing more.

Remember, CLC ratings are only a very small part of the story. The CLC test verifies performance after 300 weighing cycles. That is a small fraction of the total number of weighments a truck scale should be expected to make in its lifetime.



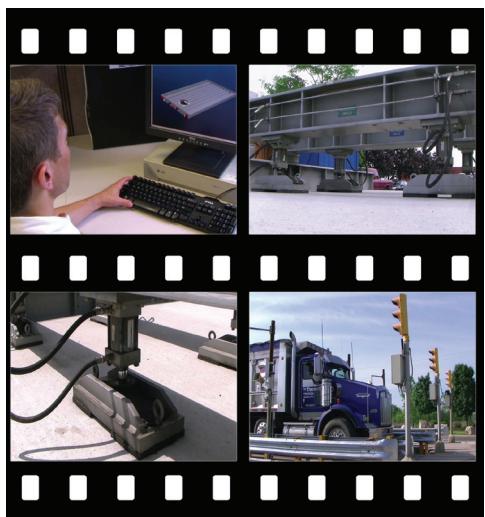
The weighbridge module lifecycle testing machine used by METTLER TOLEDO replicates the forces of trucks driving over the scale.

Video: Lifecycle Testing

METTLER TOLEDO performs lifecycle testing with a specially designed test machine that directly simulates the loading of dual tandem axles. This real-world accelerated-life stress testing uses numerous sensors attached and/or embedded into the structure to provide actual measured stress readings. This data, combined with computer-based finite element analysis, has proven to be an effective means of evaluating a scale's design and construction for durability and longevity.

Watch a video that highlights lifecycle testing at

▶ www.mt.com/weighbridgetesting





5 Deflection

All weighbridges deflect (bend) when a load is placed on them. Many scales will state a deflection ratio as a measure of this movement. So, how does deflection affect a scale?

Scale companies note deflection rates in their materials and use them as a sales message to convince customers that a stiffer weighbridge is an advantage. In reality, all weighbridges deflect, and how much a weighbridge should deflect depends on how it is designed to effectively distribute weight. Because of that, comparing deflection rates between scales with different designs is not an effective evaluation.

The key to the well-designed structure of a truck scale is how well it distributes loads over its surface area. Like CLC, some people misinterpret deflection as a sign of the weighbridge's strength. The stress caused by deflection is not a critical factor as long as the

weighbridge does not have welds or other weak spots in high-stress areas. If the weighbridge is too stiff, the stress of repeated loading can be transferred to weak spots, causing them to fail.

How deflection will affect a scale design is best evaluated by proper lifecycle testing. As we discussed earlier, lifecycle testing will replicate the stresses and potential fatigue a scale will face over time. If the scale is properly designed, even high-stress areas will distribute loads effectively, ensuring a long scale life and accurate weight readings.

When evaluating weighbridges for strength, look for a design that has been thoroughly tested and meets lifecycle expectations for the types of loads you will be weighing. Those tests provide more comprehensive evidence of the effectiveness of a scale's design and manufacturing.

6 Duty Cycle

Not all sites use their truck scale the same way. For an aggregates company, a normal day may see in excess of 100 trucks cross its scale, while a small scrap metal company in the same town may have only 15 or 20 trucks during the same period. Although the scale is equally important to both users as their means of earning income, the aggregates operation will apply five times more traffic to its scale in one day than the scrap metal company.

This is why it is important to consider the number of trucks you plan to weigh when selecting a truck scale. Your scale supplier can help you determine the best model from its product line to meet your capacity needs, as well as the duty cycle you expect. Finding that balance means finding a scale that comfortably satisfies your needs while avoiding investing in a

scale that vastly exceeds them.

It is difficult to cite specifics in terms of duty cycle performance, since weighbridge designs can vary from one manufacturer to another. However, a steel deck weighbridge, for example, may be equipped with thicker steel based on duty cycle needs. Similarly, concrete deck scales may increase the thickness of concrete or the amount of rebar to accommodate an expected heavy cycle.

The following duty examples assume that the site has a single scale for all of its truck traffic. If multiple scales are used at the site, traffic volumes per scale should be considered. The numbers of weighments represent loaded trucks.

	Light Duty	Moderate Duty	Heavy Duty
Example 1	Light volume of traffic with vehicles at or below the legal roadway axle weight limits 0-50 trucks per day	Steady (but not constant) traffic of vehicles at or below legal roadway axle weight limits 50-100 trucks per day	Constant traffic of vehicles at maximum legal roadway axle weight limits 100-350 trucks per day
Example 2	Moderate volume of traffic with vehicles well under the legal roadway axle weight limits 50-100 trucks per day	Constant traffic of vehicles well below the legal roadway axle weight limits 100-350 trucks per day	Light or moderate traffic of vehicles that exceed legal roadway axle weight limits (such as heavy excavation vehicles) 0-50 trucks per day

These examples are for demonstration only. This is not an exhaustive list, nor is it intended to represent strict duty cycle criteria, as ratings can vary between manufacturers.



Consider the amount of truck traffic the site processes when choosing the right truck scale.

Section 6

Load Cells

Understanding the most important components in your scale

Load cells are the heart of any truck scale. They are the sensors that measure the weight of objects on the scale deck. Most truck scales require 6 to 12 load cells. They must work together flawlessly to provide accurate weight readings.

There are a few popular types of load cells currently being sold for use in truck scales. Understanding the differences in their operation and features can help you choose a system that will be accurate and reliable, providing the most value from your investment.

Section 4 presented a brief assessment of the leading causes of ongoing ownership costs in conventional truck scales (downtime, repairs, replacement parts, etc.). The majority of common issues can be traced back to a problematic load cell system.

The load cell system, consisting of the load cells, cables and connections, and possibly junction boxes, presents the most opportunities for a malfunction in your scale. Taking the time to learn where these problems may occur can help you avoid them. Choosing the right load cell system can prevent profit loss, limit downtime and save money on repairs.



Contents

- 1 Evaluating Load Cells
- 2 Types of Load Cells
- 3 Analog Load Cells
- 4 Hydraulic (or Hydrostatic) Load Cells
- 5 Analog/Digital Hybrid Load Cells
- 6 Digital Load Cells
- 7 POWERCELL® Load Cells
- 8 Load Cell Geometry
- 9 Shift / Corner Adjustments
- 10 Junction Boxes
- 11 Replacement Parts

1 Evaluating Load Cells

You have a number of choices when it comes to load cells. Because load cells are the components that most closely affect scale performance, it is worthwhile to understand how they work and the guidelines they must meet.

Do regulations require that they all perform similarly? Most scales are built to comply with the legal-for-trade requirements of Handbook 44, OIML R76, and/or other weights and measures regulations. Does that mean that different types of load cells perform the same because they meet the same guidelines? No.

Load cell performance guidelines in Handbook 44 and OIML R76 include accuracy tolerances, or error thresholds, used for calibrations (see the Accuracy topic in Section 4 for more information). However, the performance standards included in those requirements still reflect the capabilities of mechanical scales, which are now largely antiquated. Mechanical scales have limited capabilities compared to more modern load-

cell technologies. In other words, some load cells are capable of performing significantly better than is minimally required. So, what benefits do newer systems offer the scale buyer?

Truck scale performance and features typically are related to accuracy and reliability.

- **Accuracy.** A system that is designed to establish and maintain a high level of accuracy means that a business can avoid product or profit loss due to weighing errors.
- **Reliability.** A stable and resilient load-cell system means a more reliable scale with less down-time, fewer repair expenses and a lower cost of ownership.

Now, let's briefly discuss the various scale technologies in terms of their accuracy and reliability.

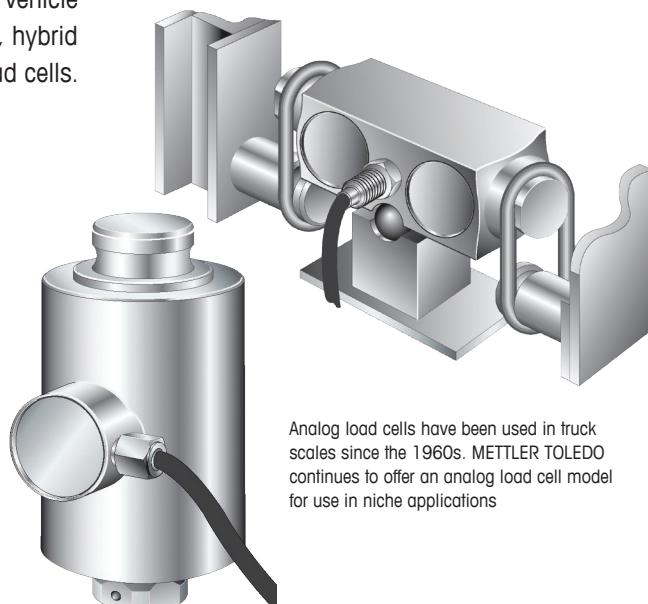
Keep in mind that METTLER TOLEDO has designed, built, sold and/or serviced scales with each of these technologies in the past.

2 Types of Load Cells

There are five predominant types of load cell systems used in vehicle weighing applications: analog load cells, hydraulic load cells, hybrid analog/digital systems, digital load cells and POWERCELL load cells.

Analog

A precision-shaped piece of metal, often steel or stainless steel, that changes its shape slightly as a force (weight) is applied. The change is monitored by electrical strain gauges. The result is an analog voltage signal that varies from the input signal based on the load. The analog signals from all the cells are summed in one or more junction boxes at the scale. The combined signal is then transmitted to the scale house, where it is measured and converted to a digital signal that indicates the weight.



Analog load cells have been used in truck scales since the 1960s. METTLER TOLEDO continues to offer an analog load cell model for use in niche applications



Hydraulic

Hydraulic load cells are hydraulic pistons that compress a reservoir of fluid. The compressed fluid flows through individual hydraulic lines to a mechanism, sometimes called a "totalizer," that is located in or near the scale house. This mechanism then exerts the accumulated force of the combined fluid pressures onto an analog load cell. This load cell generates an electrical signal that indicates the total weight on the scale.

Analog/digital hybrid

Here, analog load cells are connected to a junction box that converts the analog signal to digital. A digital signal is stronger and less susceptible than analog signals to the weighing errors that can occur due to interference from external influences.



Digital

This is a load cell that generates an analog voltage, which is converted into a digital signal within the load cell enclosure. The data from the cells is processed to determine the total weight. Utilizing a digital signal at the load cell and beyond provides advantages because the signal is not susceptible to interference like analog load cell signals.

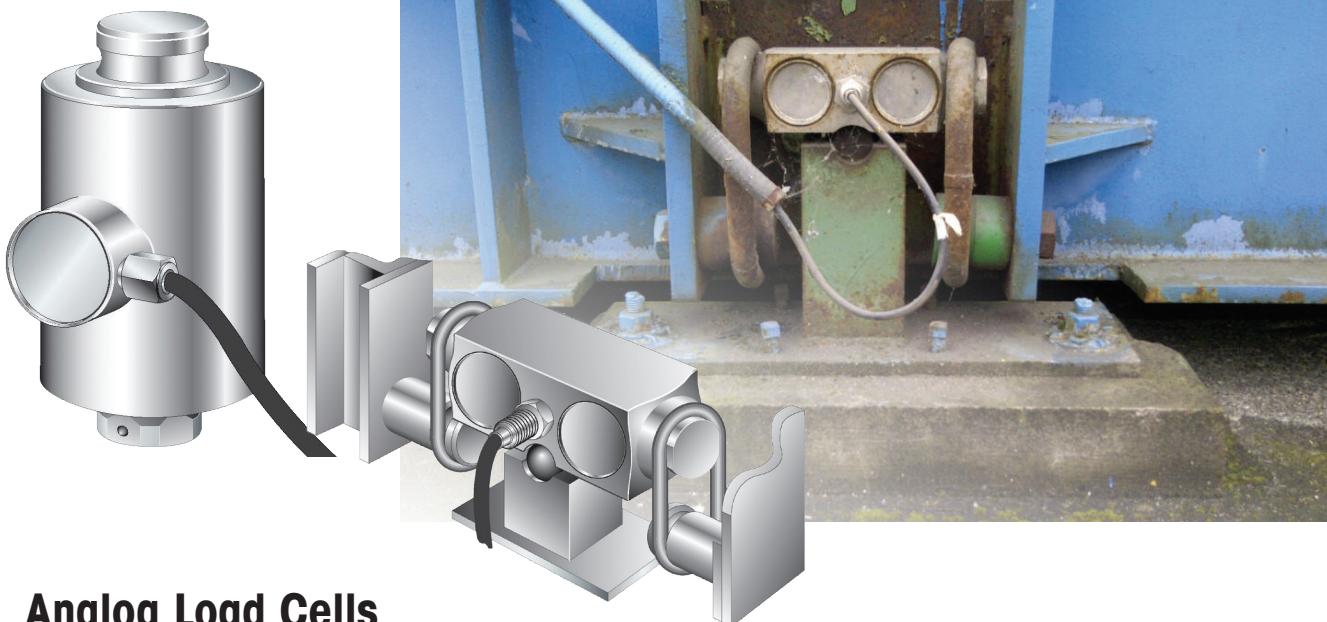


POWERCELL®

These load cells utilize digital electronics and are equipped with signal-processing capabilities at each load cell. The load cell can eliminate errors by monitoring and adjusting the weight measurement based on a number of criteria. This process is called digital compensation. POWERCELL load cells have also introduced features, such as predictive diagnostics, self-monitoring, breach detection and remote diagnostics.

Special note:

Mechanical scales – Before the introduction of electronic components, all vehicle scales were mechanical. Mechanical scale decks were supported by numerous levers and pivot components that transferred the force of the load to a dial indicator. Eventually, a single load cell connected to a terminal replaced those dial indicators. Some of those scales are still in operation today. However, scales supported by multiple load cells have rendered those mechanical systems obsolete. Today's designs require less steel and are more easily installed and maintained. They are also largely more accurate and reliable than their mechanical predecessors. Some surviving mechanical scales can be upgraded to full load cell systems by removing the large lever components and installing mounting points for the load cells to support the deck.



3 Analog Load Cells

Pros	Cons
Low cost	Limited accuracy
Well-known technology – most scale companies offer an analog load cell option	More susceptible to failure, resulting in shorter lifespan than other technologies
	Requires junction boxes which are a common source of problems
	Requires time-consuming manual adjustments for calibrations
	Cannot check the status of individual load cell signals in the system

An analog load cell's performance can be affected by two main elements. One is the nature of the analog output itself; the other is the physical configuration of the load cell. To understand the factors that can affect weighing performance in an analog load cell, you must first understand how analog outputs are generated and used throughout the weighing system. In analog systems, the output of each load cell is simply an electrical voltage that is used to determine the weight measurement. Those voltage levels are very small, making them sensitive to interference and errors.

What is in an analog signal?

An analog load cell signal is simply an electrical voltage. There is no data contained in the signal. The electrical voltage depends on the weight measured by that load cell. When the voltages of all the load cells in the scale are combined, they are used to determine the total weight being read by the entire scale.

How much voltage is in an analog signal? Very little. In fact, that is one of the major drawbacks of analog load cells. The voltages used are so small that it does not take much interference to change the value. Even

the slightest interference that causes a small change in the voltage will create weighing errors.

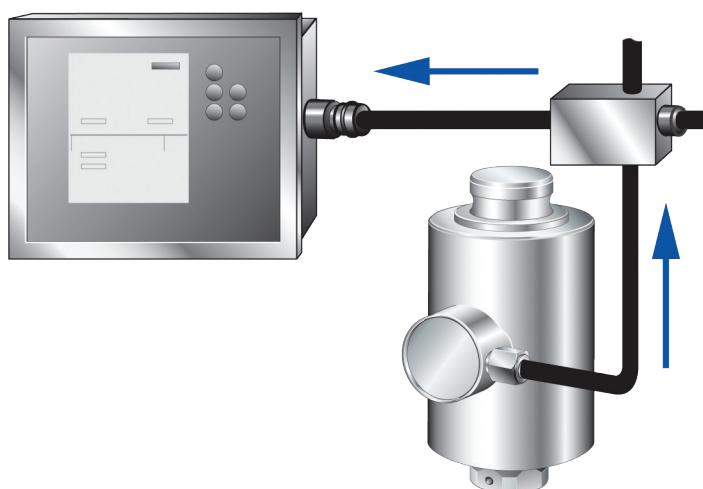
Typical voltage values for a single analog load cell

Weight value	Analog signal voltage
Full capacity range of a single load cell (30 t)	0.03 – 0.04 volt
Average loaded truck weight per load cell (4,000 kg or 9,000 lb)	0.004 volt
One scale division, or weighing increment	0.00002 volt per 20 kg or 0.00001 volt per 20 lb

In other words, on most analog truck scales if the signal from a single load cell has changed by just 0.00002 volt between the load cell and the scale terminal, the weight reading will be wrong by 20 kg or about 44 lb. There are a number of things that can cause these signals to fluctuate by this much or more.

Interference and analog signals

Load cell signals are protected while they are still within the load cell. The housing of most load cells acts as a faraday cage to shield the voltage signal from interference and environmental dangers. However, as the signal leaves the load cell, it is subject to many challenges that can prevent it from making it to the scale terminal exactly as it was produced. Let's follow the analog voltage signal through the scale:



- Load cell to junction box

First, the analog voltage signal will travel through a cable (often around 7.5 meters or 25 feet in length), to reach a junction box. The electrical resistance of this cable can change due to temperature, the quality of the connection, electromagnetic interference from motors, power lines, radios and more.

- Junction box

Next, the voltage signal passes through one or more junction boxes to be combined with signals from other load cells. There, weather seals on access panels often can allow moisture to enter the junction box. Moisture attacks the circuit boards, solder joints and manual wire connections inside. Wet and/or corroded connections can degrade the signal strength by changing the resistance of the circuit.

- Junction box to terminal

Finally, the combined voltage signal travels through another cable to the scale terminal – another 20 meters (65 feet) or more, in length. Once again, the cable itself can degrade the signal due to influential factors that affect its integrity or its electrical resistance. Because that signal includes the combined voltage values from every load cell, any interference there has a compounded effect.

Analog to digital conversion

Once the combined voltage signal arrives at the scale terminal, it is measured and equated with a weight value that can be displayed by the terminal. This process converts the analog signal into a digital signal that represents the weight on the scale. For analog systems, that is the final step in the weight measurement process. A fundamental difference between analog and digital vehicle scales is where the analog to digital conversion takes place. Analog systems perform the conversion once the analog signal finally reaches the scale terminal. Digital systems perform this conversion within each load cell while the original strain gauge signal is still protected from interference. That allows the system to use a binary data signal from the load cells to the terminal. That digital data signal is much more immune to interference.

Troubleshooting

So what happens when a signal from a single analog load cell is wrong due to degradation or other reasons? The resulting bad voltage signal is simply added to the voltage signals from the other analog load cells and sent to the scale house. This creates an erroneous weight reading. If the error is significant, the scale operator may notice it and investigate. However, that may only be likely if a load cell is completely "dead." Otherwise, the scale operator has no way of knowing if the scale could be inaccurate. Because all the load cell signals have been added together, there is no easy way of knowing which of the 6 to 12 cells is causing the problem.



A technician tests load cell cable connections inside a junction box

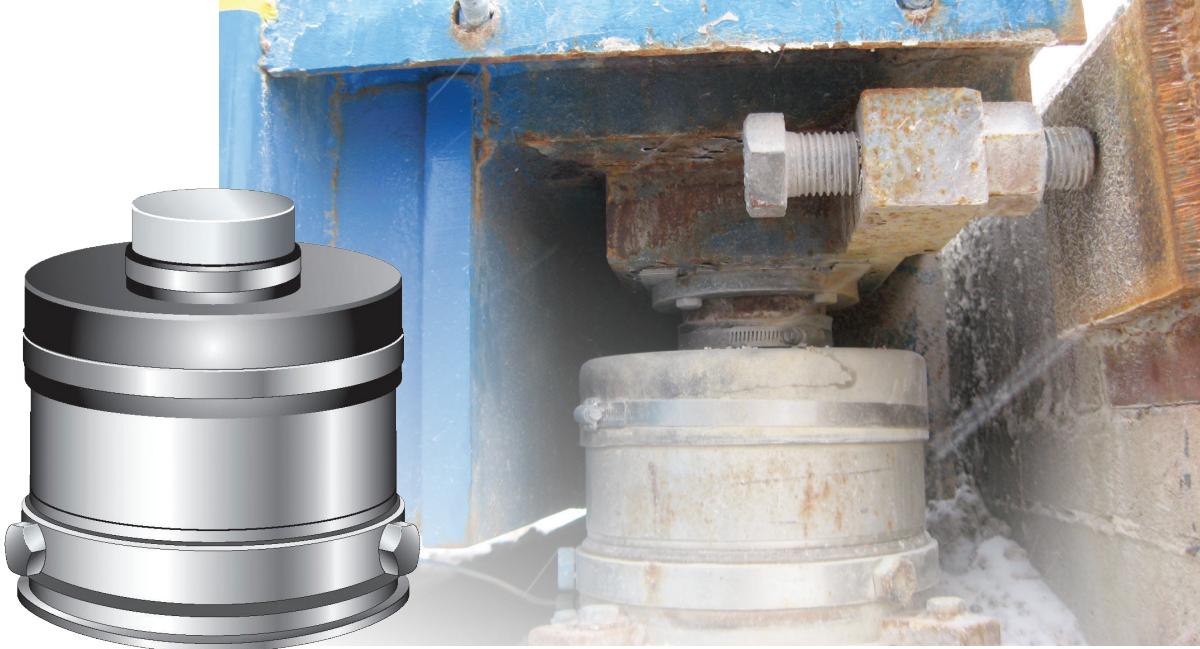
Adjustment and Calibration

Another challenge presented by the small voltage values used in analog systems is scale calibration. To try to ensure that the analog load cells weigh uniformly, each signal travels through a potentiometer in the junction box. During scale calibrations the potentiometers must be manually adjusted by the scale technician. This is a cumbersome and time-consuming process.

Moisture

Because most truck scales are outdoors, all electrical circuits must be protected against moisture. That can be a difficult task, especially for junction boxes, which must be regularly opened by service personnel for troubleshooting. All enclosures must be exceptionally rugged and should ideally be hermetically sealed, or airtight, to protect from corrosion due to moisture in the air. Connections must also be watertight. Cables must be protected against moisture intrusion, abrasion and damage.

The cable from the analog load cell to the junction box is an integral part of the analog load cell circuit. If either fails, both the cable and the load cell must be replaced as a unit in most cases. The cable on most analog load cells cannot be repaired because the load cell signal is calibrated, or tuned, with the original cable. A splice of any kind would alter the signal. Note, too, that where the cable passes through the load cell enclosure provides a potential route for moisture penetration and subsequent corrosion of the circuits inside.



4 Hydraulic (or Hydrostatic) Load Cells

Pros	Cons
Resists moisture well	Higher purchase price than analog systems
May be used in many hazardous areas	Many fluid lines and connections that can leak causing scale errors
Good lightning protection	Mostly mechanical – no modern or advanced features, such as system monitoring or diagnostics

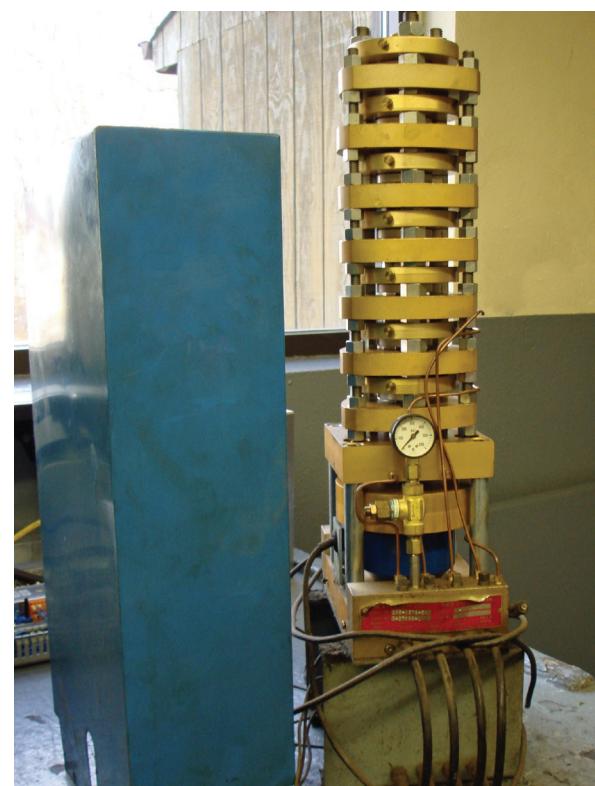
Those load cells are non-electric devices that consist of a piston, base, cylinder and diaphragm. A thin film of fluid is sandwiched between the base and the diaphragm. The piston presses against the diaphragm, resulting in a hydraulic pressure change that pushes fluid through a series of tubes. Each load cell is connected with a separate fluid line to a totalizer unit in the scale house. That can require upwards of 150 meters (500 feet) of fluid lines in a single truck scale.

In the totalizer, the fluid pressure from each cell is combined into a single force that is applied vertically to a single analog load cell. That analog cell is connected to the scale terminal or indicator and calibrated to translate the fluid pressures into the scale's weight value.

Hydraulic load cells have traditionally found favor in hazardous areas where a stray spark or an overheated electrical component could ignite a fire or explosion. But today's low-powered strain-gauge load cells also can provide an approved alternative in most explosive environments.

Hydraulic systems are known for ruggedness in facilities such as solid waste processors. They require specialized maintenance procedures, such as changing fluid and bleeding fluid lines. The load cells at the

scale are not susceptible to radio frequency or electromagnetic interference, although the analog cell in the accumulator could be. Hydraulic systems can also offer resilience to lightning strikes. However, hydraulic load cells and systems face a more low-tech threat that can be hard to overcome – leaks.



The hydraulic load cells are each connected to the large totalizer unit



5 Analog/Digital Hybrid Load Cells (Junction Boxes)

Pros	Cons
Provides more enhanced performance than pure analog systems	Junction boxes are still a common cause of problems
Can support limited system diagnostics to assist in troubleshooting	Not fully digital; still susceptible to signal interference and weighing errors

Another hybrid system uses analog load cells with a digital junction box. The signals from the analog load cells are transmitted to the junction box, where they are summed and converted from analog to a digital

signal. That helps to protect the signal from interference, but only after it has reached the junction box. We will further explain the difference between analog and digital signals in the next few subsections.



6 Digital Load Cells

Pros	Cons
Signal is less prone to interference and weighing errors	Higher purchase price than analog systems
Can offer diagnostics features	Not offered by all scale suppliers
	Proprietary protocols

Digital load cell systems differ from analog systems in three important ways: Signal strength, signal content and data sample rate.

Signal Strength – In a digital load cell, the signals from the strain gauges start as analog electrical voltages. A microprocessor inside the load cell immediately converts them to digital signals. Those digital signals commonly use 2 to 6 volts as their signal range, which is less susceptible to fluctuation than the range of 0.03 volt in an analog cell. In other words, the digital signal is much stronger.

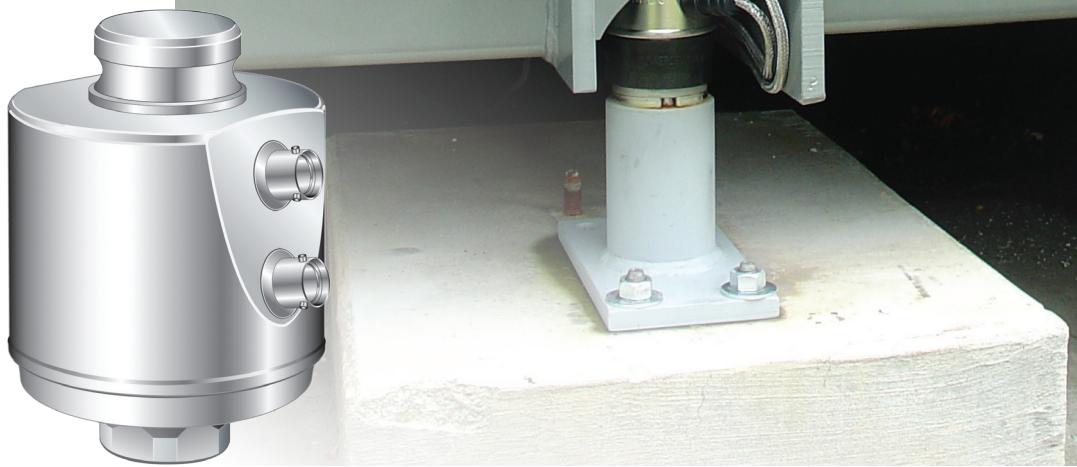
Signal Content – As we mentioned before, analog systems rely on the electrical voltage from the load cell to determine the weight reading. In contrast, digital systems transmit data from each load cell. The signal is composed of binary information (values of zeros and ones) like computers use. Since the binary data is not susceptible to interference from radio frequencies, electromagnetics, temperature and other hazards, the binary data stream is more stable and less prone to weighing errors.

Data Sample Rate – The data rate measures how quickly the load cell can send weight information.

Analog load cells provide weight information continuously in real-time. Digital load cells send weight information in bits, many times per second. For example, many digital load cells have an update rate of 15 updates per second (15 Hz), which is more than adequate for all but a few dynamic vehicle weighing applications.

Some older digital load cells have a slower sample rate, which could create a disadvantage in some operations, such as automated bulk filling. Most modern digital load cells have overcome that drawback. However, sample rates typically are listed on component specifications. If you are operating an automated filling station or an in-motion weighing system, ask your potential suppliers for the rates and compare capabilities.

Diagnostics – Some digital load cell systems offer diagnostic features that can assist with both regular and emergency service. Even though they may be features that only a technician will utilize, the benefit to the owner is shorter maintenance calls and reduced downtime. Diagnostics features can save the scale owner money over the life of the scale.



7 POWERCELL® Load Cells

Pros	Cons
Very low failure rate	Higher initial cost
Numerous innovative features	Proprietary protocols

POWERCELL load cells can be distinguished from the other types of load cells because they can be described as **active** devices, as opposed to **passive** devices. Like digital load cells, POWERCELL load cells use a strain gauge and digital conversion, but each cell can fine-tune the weight information before the final signal leaves the cell. They are also able to transmit additional information in addition to the weight reading, which allows the system to monitor its own health.

On most truck scales, the terminal is the only component with data-processing capabilities. However, the reading on the terminal is only as good as the signals it gets from the load cells. POWERCELL load cell systems rely on the processing capabilities of both the load cells and the terminal, providing capabilities beyond what traditional scale systems can do. They include:

- **Digital compensation**

Proprietary compensation algorithms are built into the microprocessors in each load cell. Each cell is individually programmed during manufacturing based on its own individual characteristics. Once the cells are in use, each cell constantly measures variables, such as temperature, loading history and loading time. The built-in algorithms then neutralize

the effect of those factors on the weight reading. The results are highly consistent and accurate weight measurements, regardless of extreme or changing environmental conditions. That technology has contributed to the success of POWERCELL load cells in the most extreme environments on Earth, from some of the hottest deserts to the cold of Antarctica.

- **Self-monitoring**

These systems constantly measure and log each load cell's performance based on a set of metrics. That establishes a baseline of standard operation. If a load cell provides information that is inconsistent with its performance metrics, the system notifies the user, allowing a technician to further investigate.

- **Simplified service and remote access**

On-board diagnostics allow users and technicians to pinpoint service needs. That makes both routine maintenance and repair procedures much more efficient by eliminating the need to manually test numerous circuits. Some POWERCELL installations are connected to networks that allow them to be accessed securely by a remote technician. In the unlikely event that a load cell needs to be replaced, the procedure is quick and simple.

- **Breach detection**

POWERCELL load cells use a stainless-steel core, shielded by a stainless-steel enclosure that is fully laser welded for a hermetic (airtight) seal. Each load cell is equipped with sensory features that monitor the integrity of the enclosure. Should it be breached, a message is generated at the scale terminal noting the specific cell that is affected. The scale continues to operate normally until the load cell can be replaced at a scheduled time. Ensuring the integrity of the enclosure drastically helps eliminate "hidden" problems that eventually can cause unexpected scale failures.

- **Cables and connections**

POWERCELL load cells use detachable cables with stainless-steel braided sheathing to protect them from physical damage. The cable connects to the load cell with a waterproof glass-to-metal seal (IP68/IP69k rated), but can still be disconnected without the use of any tools. That simplifies service and it means that if either load cell or cable should ever need to be removed or replaced, the procedure is quick and easy.

Special note:

Who manufactures load cells? Many vehicle scale manufacturers worldwide source their load cells from various third-party suppliers. Most will then rebrand the load cells as their own. Although there is nothing fundamentally wrong with this common practice, the load cell system is arguably the most important element of a vehicle scale. The capabilities and features of the load cell system will have a crucial impact on the total cost of ownership and the lifespan of the scale. Look for a scale company that understands the importance of load cell quality and offers a scale that will last.

METTLER TOLEDO is one of only a few vehicle scale manufacturers that designs, manufactures and distributes its own load cells. That has allowed the company to develop new technologies designed to enhance load cell performance and survive demanding applications.

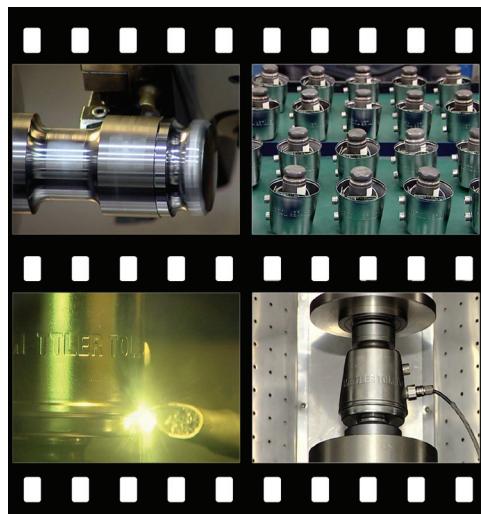
- **Lightning protection**

POWERCELL systems are equipped with the StrikeShield™ lightning protection system. In the event of a lightning strike, dangerous currents are redirected and the terminal safely reboots itself.

- **No junction boxes**

Junction boxes are the known cause of many truck scale problems. Modern POWERCELL systems utilize the CAN-BUS protocol, which has allowed them to eliminate junction boxes from the load-cell networks. This makes the scale more reliable and simplifies service procedures.

All of those advancements aim to make POWERCELL load cells as accurate and reliable as possible. For scale owners, the goal is that this performance will translate to lower operating costs and better profitability.

Video: Load Cell Manufacturing

See a video about how POWERCELL load cells are manufactured at

► www.mt.com/PDXhowitsmade



The original POWERCELL load cell, POWERCELL MTX, and POWERCELL PDX

POWERCELL® Achievements

POWERCELL load cells have been at the forefront of development and achievements in heavy-capacity weighing technology. Since the 1980s, the POWERCELL line has been a breakthrough technology and has been awarded many United States and international patents, including:

- First to convert analog signals to digital within the load cell (US Patent 4,815,547)
- First to perform digital compensation inside hermetically sealed load cells (US Patent 4,804,052)
- First to compensate for hysteresis (loading history) (US Patent 5,308,931)
- First to compensate for creep (loading duration) (US Patent 4,691,290)
- First to eliminate junction boxes (US Patent Pending)
- First anti-rotation feature on column compression load cells (US Patent 4,955,441)
- First load cells equipped with an enclosure breach detection system (US Patent 8,055,456)
- First to use predictive diagnostics (US Patent 6,576,849)

Compensation Algorithms

We mentioned digital compensation in a list of POWERCELL® features. Since being pioneered by METTLER TOLEDO, other manufacturers have tried to develop similar systems. However, there are notable differences between the systems.

• Where does digital compensation occur?

Some load cell systems perform the compensation as a blanket adjustment to all load cell signals together, usually taking place in the junction-box circuitry. **In contrast, METTLER TOLEDO's systems perform compensation in each individual cell.** This mitigates slight differences between the conditions at each load cell.

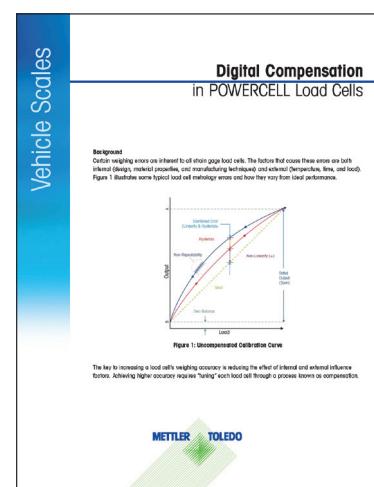
• How are the load cells compensated?

Some manufacturers apply the same compensation coefficients in every load cell produced. The strain gauges in those load cells are precise circuits, but even tiny variations can affect their performance. Raw material variations and machining tolerances in the load cell core also create variances in their response to thermal changes. **That is why METTLER TOLEDO applies a unique compensation to each individual load cell as it is manufactured.** Through complex testing, METTLER TOLEDO adjusts the constants in the algorithms for each POWERCELL® load cell to control even small batch-specific variations.

• What is compensated?

METTLER TOLEDO's current POWERCELL® compensation system adjusts for changes in temperature, load duration, and load history. If you are considering a load cell system that includes compensation features, find out which factors are being compensated.

Ask your scale supplier about the compensation features in the load-cell systems they offer. Those features can make your scale more accurate throughout its entire life.



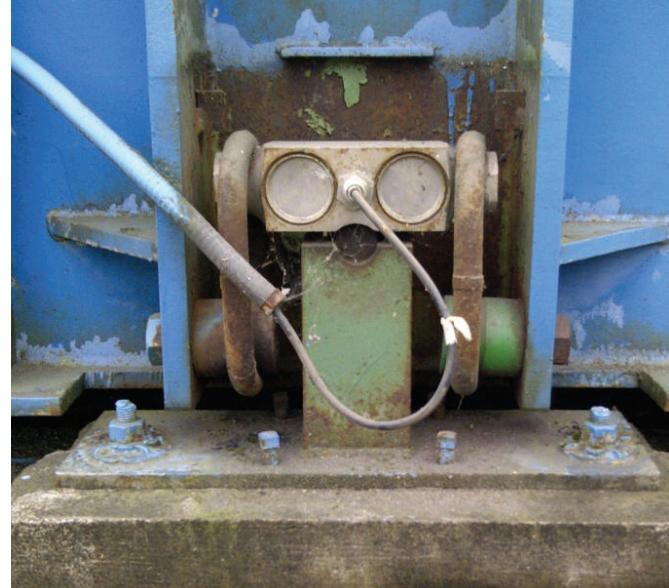
White paper: For more detailed information on digital compensation, download a white paper at

► www.mt.com/POWERCELLcompensation

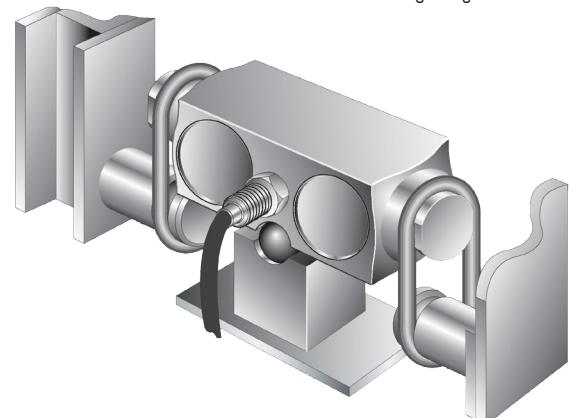
8 Load Cell Geometry

There are two predominant geometries for load cell systems: Compression (vertical) and shear beam (horizontal).

Compression load cells (analog and digital) measure loading with strain gauges on vertical columns running through the center of the load cell. Typically, those load cells are used in a "rocker pin" design, allowing the weighbridge a small amount of free movement within the restraints of a checking system. That checking system can include shock-absorbing bumpers, adjustable bolts and check rods. When adjusted correctly, the system allows just enough movement that the weighbridge and load cells are self-centering. That prevents the scale from binding on the foundation or approaches. That design also limits the opportunities for physical wear to the components. The rocker pin design should also include anti-rotation features so that the load cells cannot rotate in their positions.



Double-ended shear beam load cells are supported in the center and linked to the weighbridge on each end.



If a compression-style load cell has inadequate anti-rotation features, eventually the cable can wrap around the load cell and break.

Shear beam and double-ended shear-beam (including cantilever) load cells also use strain gauges, except they are mounted to a horizontal beam. Single-ended shear beams are fixed on one end and linked to the weighbridge on the other. Double-ended shear beams are typically fixed or supported in the center and linked to the weighbridge on both ends. Either way, those beams typically are linked to a lower mounting point on the weighbridge, creating a suspension system. There, the weighbridge is able to swing slightly in two or more directions. That system is designed to be self-centering, thanks to the gravitational pull downward on the beam ends. However, the links between the beam ends and the scale structure should be regularly inspected for signs of wear.



For example, METTLER TOLEDO's anti-rotation system includes a hexagonal shape in the load cell receivers that prevents the load cell from rotating.

9 Shift / Corner Adjustments

Shift adjustments (or corner adjustments) must be performed when the scale is installed. Those adjustments ensure that the load on the scale will be weighed accurately, regardless of where it is placed on the scale deck. With analog load-cell systems, the procedure is performed by placing large test weights in various locations on the scale deck and making very small manual adjustments to potentiometers in the junction boxes. A qualified technician must manually adjust the potentiometer for each load cell. The procedure can be labor intensive.

Some digital load-cell systems have greatly simplified and improved that procedure. Test weights are still used on the scale deck, but instead of making manual



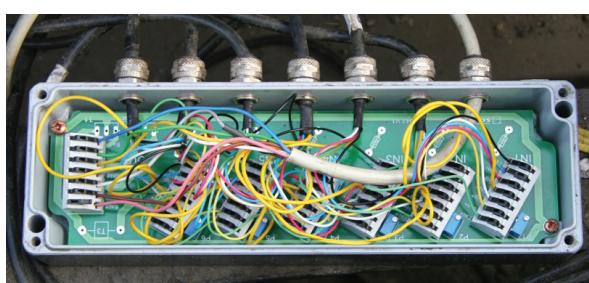
A test weight on scale corner

adjustments, the terminal is equipped with a program to automate the adjustment. Instead of using potentiometers, the adjustment is a function of the data processing. That automated shift/corner adjustment functionality saves time and labor expenses, as well as makes the procedure much less prone to error. In the life of any scale, it is possible that a shift/corner adjustment will need to be made multiple times, making this a helpful feature

10 Junction Boxes

We have mentioned that junction boxes are used with analog load cells, as well as some digital load cells. Junction boxes combine the signals of multiple load cells and then transmit the summed signal. Inside each junction box are manual wire connections that are made when the scale is installed, along with a circuit board that combines the signals and potentiometers for making manual adjustments. A typical truck scale using analog load cells will have 2 to 4 junction boxes.

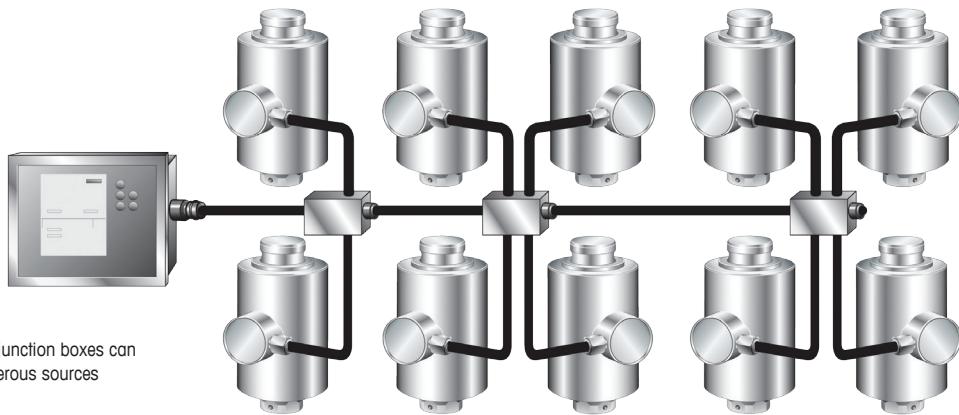
Junction boxes are the leading cause of scale malfunctions and service calls. Typically, it is the result of moisture reaching the electronic components and manual wire connections within the box. Moisture causes corrosion and damages circuit boards.



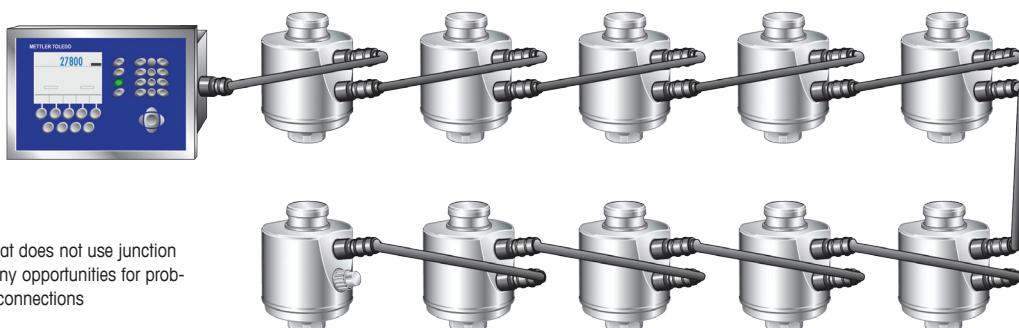
Junction boxes contain circuit boards and many manual wire connections. They are the main cause of truck scale downtime because they are difficult to seal against moisture.

Why not create waterproof junction boxes? Many companies have tried. The reality is that it is impossible to completely seal the boxes from all sources of moisture, including humidity that is naturally in the air. Junction boxes regularly must be opened by service technicians during service procedures. Even if the box stays dry, ongoing temperature fluctuations, condensation and humidity will attack the contents of the junction box.

For many years, analog load cells were considered the industry standard. Junction boxes became accepted despite their troublesome nature. Manufacturers have promoted special junction-box sealing systems to make systems more reliable. Even so, they are still problematic.



A load cell system that uses junction boxes can experience trouble from numerous sources



A load-cell system that does not use junction boxes eliminates many opportunities for problems and has fewer connections

Video: Eliminating Junction Boxes

The vehicle scale experts at METTLER TOLEDO realized that to make a vehicle scale more reliable, the junction boxes had to be eliminated. Since digital load cells output data instead of just a simple voltage, the POWERCELL® designers created a load-cell network that uses the CAN-BUS communication protocol. It is a proven, stable system widely used in automotive applications. It allows the connections among load cells to be made using a cell-to-cell configuration. The result is the POWERCELL® PDX® load cell system – a simplified load cell network that has far fewer cable connections and NO junction boxes.

Eliminate the most common cause of truck scale downtime – junction boxes. Watch the video at

► www.mt.com/NoJunctionBoxes



11 Replacement Parts

When customers first saw the merits of digital load cells versus analog load cells, a hot topic was the compatibility of replacement parts. Digital load cells often have manufacturer-specific programming, meaning digital load cells from company "A" are not compatible with those from company "B." Providers with analog load cells cited this as an advantage for analog, because analog load cells can be somewhat interchangeable.

Indeed, replacing analog load cells can be a common occurrence for a number of reasons. Experiences vary, but analog load cells have an average life of 3

to 5 years. However, advancements in digital load-cell capabilities mean that digital load cells regularly have a longer lifespan than their analog counterparts. That makes parts compatibility less relevant for digital systems because replacement parts are less needed. Even if a replacement component is required, many customers prefer using original manufacturer parts in their scale. Maintaining proper components ensures the advanced features of modern scales (self-monitoring, digital compensation, etc.) remain intact.

Section 7

Site Planning

Ensuring operational efficiency

Most buyers expect their truck scale to last 10 to 20 years, depending on their application. That means that when it comes time to develop a plan for the scale site, it is important to consider your future needs. The layout should be adequate, efficient and able to accommodate growth in your operation.



Contents

- 1 Scale Site Layout
- 2 Site Conditions
- 3 The Foundation
- 4 Locating the Scale House
- 5 Approaches and Ramps
- 6 Peripherals and Accessories
- 7 Hazardous Areas and Materials

1 Scale Site Layout

Let's consider the number of trucks you will be weighing each day. In most cases, each truck will be weighed twice – once loaded and once unloaded.

Small commercial operations typically make 50 to 100 weighments per day. Unless all the trucks arrive at the same time, the requirements for parking and maneuvering will be minimal. One scale should accommodate this volume well, so plan on two-way traffic over it. Make sure there is a bypass around the scale as well.



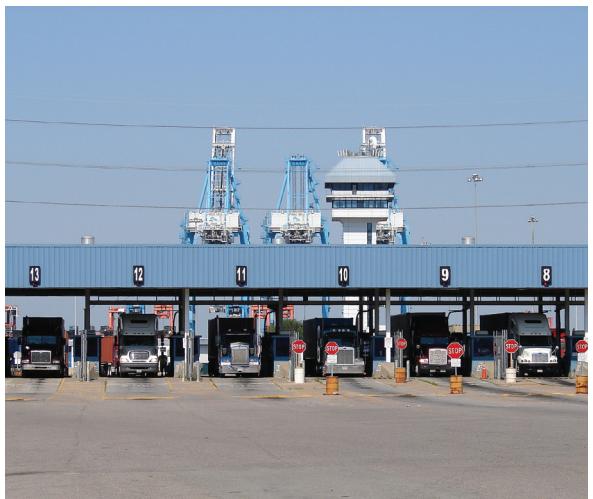
Single scale and scale house

Moderate-volume operations typically make 100 to 200 weighments per day. Those sites should determine when those trucks will be arriving and departing because these sites may need a parking/staging area. The scale queue should not extend onto public streets or highways. Those sites may be able to operate with a single scale and bypass if the traffic flow at peak times is manageable. However, two scales can offer advantages.



Using two scales can offer advantages

High-volume operations typically make more than 200 weighments per day. Planners at these sites should be thinking in terms of traffic patterns (control lights and gates, marked roadways, etc.) not just a parking area. Those sites require two or more scales. If you expect to handle a significantly higher volume of traffic, you should consider more than two scales. For maximum flexibility, the scales should be able to handle loaded or empty trucks from either direction. There should also be a sufficient bypass around the scales.



A sea port processes high volumes of trucks

Layout drawing

Draw a complete plan of the area and think about an average day.

- Where do the trucks go when they arrive?
- Will there be a queue (either or both ways) to use the scale?
- Where do trucks go after being weighed?
- Is there enough maneuvering room between the scale and the loading docks, considering the turning radius of your largest vehicles?
- Do you need a trailer storage area?

Then consider the what-ifs.

- What if a scale is down for maintenance or repair during the day?
- What if you get a heavy snowfall, or a heavy rainfall?
- What if the capacity of the plant is increased?
- What if drivers are forced to wait before they can load or unload?
- What happens during the busy season?

Testing the Location

It can be worthwhile to perform a test of your selected site before breaking ground. That can be done with the help of traffic cones or other markers to signify the intended location of the scale and accessories. If possible, drive a truck through the configuration to check for issues. Ask experienced drivers if you are unsure of the space they need to maneuver.

Housekeeping

The buildup of spilled material, packed debris, frozen snow/ice, road mud, etc., under or around the scale can have a significant impact on its life and performance. That is why many suppliers and customers advocate for an open-sided design that can be regularly cleared of stray material. Locating a water hydrant near the scale can aid in regular cleaning operations, so long as pressurized water spray does not present a problem to the load cells, cables, and/or junction boxes at the scale.

Mining and aggregates facilities in particular have had success installing wheel/truck wash lanes before the scale. With an automatic wash lane for cleaning the trucks before they approach the scale, the amount of dirt, mud and gravel falling off the trucks is greatly reduced. It limits the chances for the debris to interfere with the operation of the scale. It also allows for a more accurate weight reading.



Aerial photos can help you plan for the traffic flow through your site

Filling Applications

Some sites use their scale as a filling tool, where exact amounts of product need to be dispensed into the truck. Those locations may have overhead filling equipment that can limit the vertical space the scale can occupy. Share intentions to use your scale in filling operations with your scale supplier. They may be helpful in suggesting the best configuration and additional scale accessories that can assist these operations.

When estimating the amount of traffic, consider how your operation will use a scale. Is the traffic flow constant, or is it significantly greater at certain times of day or during certain seasons? How long will a truck remain on the scale? Plan your installation to handle the peak periods.



Filling operations may use a truck scale as the primary measurement for dispensing

2 Site Conditions

There are a few site condition considerations that must be accounted for – subsurface obstructions, drainage and soil bearing pressure.

Obstructions

Subsurface obstructions include man-made obstacles, such as water lines, gas lines, power lines, sewers, drains, and old landfills. They have to be moved or avoided. Natural obstacles that must be considered include high water tables, boulders, bedrock and sink holes. If you have any doubt about what's under your site, consider ordering test borings before you start excavation.

Drainage

Every scale located outdoors needs adequate drainage. You do not want excessive storm water or snowmelt flowing over, through, or into your scale. Open-sided scales usually allow water to flow off the foundation naturally. Pit scales, on the other hand, need sufficient drain piping and/or sump pumps.

If your area experiences freezing temperatures, also consider frost heave. Damage to the scale foundation can result from the subsurface around the scale expanding and contracting. Adequate subsurface drainage reduces that risk.

Soil Bearing

The soil at the site needs to be strong enough to support the foundation, the scale and the loads the scale will weigh. That is determined by establishing the soil bearing pressure at the site. Many facilities will have this information on file from construction records when the site was developed. If not, and depending on your area, a civil engineering agency can assess the soil. The soil's strength may have an impact on the design of the foundation to be used. Specific requirements will be noted on your scale company's foundation drawings. These typically range from 7,300 kg/m² to 12,200 kg/m² (1,500 psf to 2,500 psf). If the soil bearing capacity is too low, the foundation design may need to be modified to compensate.

3 The Foundation

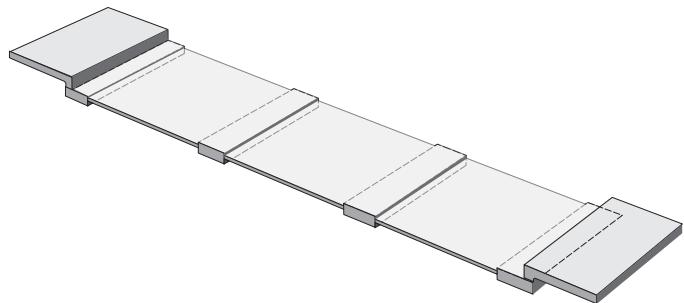
A stable foundation is critical. Any movement or settling may throw your scale out of adjustment and necessitate recalibration, or worse. Continued movement would mean a continuing need for recalibration. Over time, an unstable foundation could move enough to exceed the scale's corrective capacity, in which case you must start all over again and build a new one. The foundation must be designed and installed properly.

Pier Foundation

The least expensive uses variable depth piers. Concrete piers are poured under each of the scale's load-bearing points. The total capacity of the scale determines the footprint of the piers, which are then dug to undisturbed soil below the frost line. The soil must have a minimum bearing capacity of 12,200 kg/m² (2,500 psf). It can be helpful to include a thin wash-out slab poured around the piers to aid in periodic cleaning.

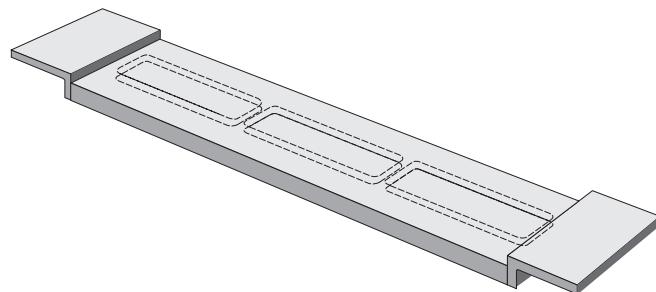
Work closely with your scale supplier. They can advise you on acceptable foundation designs for your locale and they probably have the names of several contractors who have done good foundation work in the past – those who can get it in straight, plumb and level.

There are several types of foundation designs.



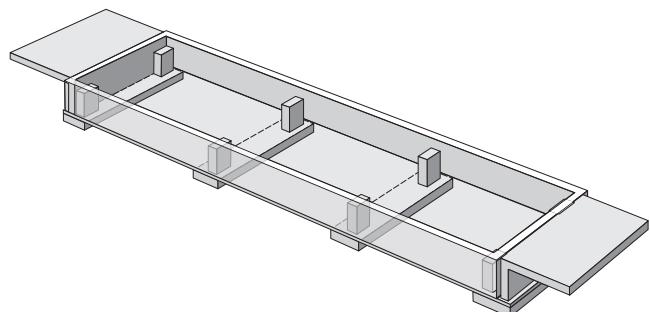
Beam Slab

The beam slab has extra excavations beneath it that create beams of poured concrete for added support. It will typically include beams running the length of the scale along each side, as well as beams running the width of the slab. In combination, those beams make a ladder-bar formation below the visible slab. Minimum bearing capacity is approximately 7,300 kg/m² (1,500 psf). A beam slab foundation is stronger than a pier-style foundation.



Pit Foundation

Pit foundations may be designed to allow service technicians adequate space to access components beneath the weighbridge. The recommended soil bearing capacities are similar to the beam-slab foundation.



4 Locating the Scale House

The scale house is typically near the scale and may contain indicators, printers and other control devices. Data from the scale can be transferred online or in batches as needed to other locations. With the scale house adjacent to the scale, the scale operator can better:

- Monitor traffic
- Communicate with drivers
- Transfer paperwork to drivers
- Make sure the truck is on the scale properly
- Identify the truck and inspect cargo

Ideally, the scale house should be situated so that the operator inside can see the truck to ensure that it is completely and properly on the scale. The driver may not notice if the rearmost axle is not entirely on the scale. Or, some sites with pit scales have had issues with the placement of a truck's tires along the side of the scale. If the tires are not 100% on the scale, the weight reading will be inaccurate. To ensure proper placement of the truck on the scale, some have even used optical sensors along the edges of the scale. Video monitoring and voice intercoms can also work well if you are unable to put the scale house near the scale.



A scale house can serve multiple purposes, including scale operation, transaction processing, and site security

However, a scale house is not a necessity, as discussed in Section 2. Many scale companies now offer unattended terminals for driver self-service. Those terminals often take the form of a drive-up kiosk. That allows the driver to complete a transaction and log data without assistance from a scale operator. They can be advantageous in situations in which 24/7 access is required or when an organization processes repeated similar transactions.

5 Approaches and Ramps

The approach is the part of the scale foundation that the truck drives over just before driving onto the weighbridge, or scale deck. In addition to the approach, the scale may need a ramp where the road transitions to the scale foundation. Guidelines for the approach are defined by the weights and measures authority in some areas.

For example, in the United States, a general recommendation is to make the length of the approach twice the width of the weighbridge. However, specific requirements for approaches often are defined by local authorities depending on the types of trucks you are weighing and the materials they are carrying. There may be a maximum grade (slope) for the approaches and ramps – for example, $\frac{1}{2}$ inch per foot in the United States. Be sure to check the standards for your location.



The scale foundation should include adequate approaches that comply with local regulations

Approach requirements like those are minimums and do not guarantee that every truck can maneuver onto the scale without difficulty. You may need longer approaches if the trucks are coming off a turn and you are installing your scale above ground. Your scale supplier can give you advice on approaches.

A popular recommendation is to have an approach on each end of each scale (required in some areas). That minimizes the lateral forces generated by the trucks driving off. It also gives you the option of two-way traffic over the scale, which is an added measure of flexibility in your traffic pattern.

6 Peripherals and Accessories

Terminals

Your scale will have a control unit, often called a terminal or indicator. They can range from simple to elaborate. Below are some of the advanced features you may consider when choosing a terminal:

- Control more than one scale with a single terminal
- Connect with USB/Ethernet to computers and networks used to interact with scale software, transfer data across company networks and use remote diagnostics
- Connect wireless connectivity with the scale and other accessories
- Automate other scale accessories, such as gates and lights for traffic control
- View data on graphic displays with varying levels of detail
- Store tare/net weights with various memory capacities for transaction logging
- Connect to various compatible ticket printers

The terminal also may serve as the power supply to some or all the load cells. Some will specify how many load cells they are able to support. If the supply power to the terminal is subject to fluctuation in your area, consider using an aftermarket power conditioner.



Modern terminals can include advanced features, such as the METTLER TOLEDO model IND780



With a remote weight display mounted in view of the loader operator, this truck can be filled to the maximum road-going weight limit

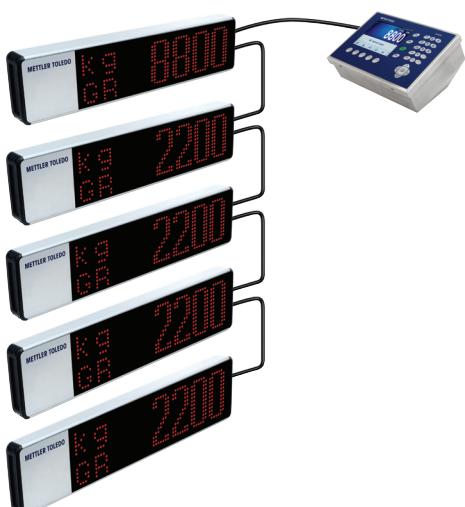
Gates

Some sites place gates at one or both ends of the scale. Whether controlled manually or automated, they can indicate when a vehicle should drive on or off the scale. This can also be accomplished with traffic lights.



Lights

Often a green and red traffic light is placed alongside the scale to control the flow of traffic. They can be controlled manually or automated.



Remote Displays

A remote display is a numerical display unit that indicates the weight on the scale. They are often placed at the front of the scale so the drivers and/or filling operators can see the weight of their truck when it is on the scale.

A roadway weigh station may use multiple remote displays to show drivers the weight of each dual tandem axle, as well as the total gross weight of the truck

Guiderails

Also called guardrails or rubrails, guiderails are an option for most truck scales, although some industries and safety regulations require them. They can be used with pit-style scales to provide guidance to the truck driver approaching the scale. They are more frequently used with above-ground (pitless) scales as a safety device to prevent trucks from driving off the edge of the scale. There are two styles of guiderails.

- **Scale-mounted guardrails** are attached to the weighbridge, by either bolting them to a bracket or welding them to the side of the weighbridge modules. They often can be supplied and installed by the scale supplier.
- **Stand-alone guardrails** are built alongside the scale, but are not attached to the weighbridge. In most cases, guardrails will offer superior protection from driving off the side of the scale. They are not always available directly from the scale supplier. Instead, they may need to be sourced and installed by the contractor preparing the foundation.



Scale-mounted guiderails are attached to the side of the weighbridge modules with bolts or welded brackets



These stand-alone guiderails are planted in the ground alongside the scale to offer added strength and prevent trucks from driving off the side of the scale

7 Hazardous Areas and Materials



Petrochemical facilities often are classified as hazardous areas, meaning truck scales and components must comply with added safety specifications

If you will operate the scale in hazardous areas (flammable or explosive atmospheric concentrations of gases, vapors, mists, dust, fibers or flyings), you will need a scale that has approval (generally from Factory Mutual, Underwriters Laboratories or ATEX) for use in your environment based on its classification. Hazardous area approvals typically are noted on the specifications data for load cells and terminals.

For example, some hazardous area classifications place a limit on the amount of voltage that can be used in equipment. Some regulations require the use of energy-limiting barrier boxes to isolate signals. A good scale supplier should be familiar with these requirements and the types of peripherals that may be used in various areas.

However, the determination of the hazardous area classification is not the responsibility of the scale supplier. The qualified safety officer at the customer site or qualified local industry regulators must make that determination.

Section 8

Installation and Certification

Getting your scale up and running

Once the foundation is complete and has cured (if concrete), the scale can be installed. This process can include activity from various providers in a relatively short period of time. Most of this may be coordinated by the scale provider, but the customer needs to be closely involved to provide on-site support. Knowing what to expect can help you develop a reasonable timeline for your installation.



Contents

- 1 Delivery and Installation
- 2 Testing and Calibration
- 3 Approval and Certification



Transporting the weighbridge modules on a flat trailer is common in some places, although the width of the modules can mean that the truck requires an "oversized load" designation.

1 Delivery and Installation

Some manufacturers deliver and install scales with their own equipment and personnel. Other manufacturers rely to some extent on third parties, which can mean coordinating delivery schedules, crane rentals, concrete companies, etc.

The scale modules typically arrive on a truck trailer once the foundation is prepared. In some cases, they may also travel by rail, or even a standard cargo container (helpful for some remote locations). A crane is then used to lift the modules from their transport vehicle into the scale foundation.



Some manufacturers can offer containerized scales to simplify transporting the scale long distances or to remote areas

The following is a sample timeline for a new scale installation at an unprepared site.

Foundation preparation: ~5 days

- Excavation
- Foundation forming and rebar
- Pouring of foundation concrete



Foundation preparation can take place prior to the scale components arriving on site

Curing of foundation concrete: ~30 days

Scale delivery: Transport time depends on the distance between the scale factory and the customer site.



Specially designed delivery trucks are able to transport the weighbridge modules upright

Installation: 1 to 3 days

- Survey the foundation and mark for baseplate installation
- Install baseplates and fixtures to the foundation
- Place the weighbridge modules (requires a crane and rigging)
- Align and level
- Place load cells into the scale, run cables and add junction boxes (if required)
- Adjust the checking or suspension systems for proper tolerance
- Install the terminal and scale peripherals or software

Concrete deck preparation

(not required for steel deck scales): ~30 days

- Pour concrete into weighbridge modules (1 day)
- Cure concrete (~30 days)

Setup and calibration: 1 day

- Shift adjustment
- Calibrate
- Certify with the local weights and measures department

A complete scale installation project, including foundation preparation and curing, typically can be done in 30 to 60 days.



These scale delivery trucks are equipped with on-board cranes used to lift and place the weighbridge modules into the scale foundation



The weighbridge modules are placed into the foundation



Load cell cables are routed through the scale and attached to the load cells



This scale is nearly ready for concrete to be poured into the deck modules

2 Testing and Calibration

Initial testing and calibration typically is the responsibility of the manufacturer or distributor. The procedure is rather simple. The test team adds incremental weights until they reach the capacity of the scale, taking readings after the addition and the removal of each weight. The readings must fall within a pre-established tolerance. If they do not, the scale is recalibrated and the test is performed again. The calibration/test cycles continue until the scale performs within specifications.

Most legal-for-trade applications require the scale to gain certification of compliance from local weights and measures authorities at certain intervals (annually, semi-annually, etc.). They may witness or play a role in the initial calibration. As the scale owner, you



should ensure that this initial test is coordinated with any required inspection visits from regulatory agencies. That way, you avoid repeating the test if someone who needed to witness the test wasn't notified.

This same type of test/calibration procedure is used throughout the life of the scale for regular scale calibrations and recertifications. Those procedures may be performed by the company that provided the scale or by a third party. Most companies that provide standard testing services are qualified to work on any type of vehicle scale. However, the level of service they provide for maintenance and repairs can vary.

3 Approval and Certification

Any truck scale used in public or private commercial transactions must be inspected and certified by your regional and/or local weights and measures (W&M) department. Local laws typically require you and/or the scale supplier to notify the W&M department when a new scale is installed. That prompts an inspection by a department official to check the installation and test scale accuracy. Typically, that must be done before the scale can be used.

Many manufacturers have their scale designs certified by NTEP, OIML, or other metrology organizations. In some cases, buying a certified scale can simplify your approval process. But some state and local authorities have their own, more stringent, certification processes. You may also have to satisfy the scale requirements of

other regulatory agencies depending on your location and the business you operate. Examples include state and local building code enforcement; the Federal Grain Inspection Service; and state and federal departments of agriculture, customs, departments of transportation and others. An experienced scale supplier knows which agencies are applicable to your project.

Also keep in mind that the scale may need to be re-certified after performing repairs or replacing failed components. For example, replacing a single load cell can require you to pay for your local W&M department to test and recertify your scale. That is just one of the many reasons to properly maintain your scale and become familiar with scale service and warranties.



Section 9

Maintenance, Service and Warranties

Proactive maintenance ensures long scale life

Once your scale is installed, operational and certified for use, you may be ready to consider your truck scale project a success. However, taking the time to develop a scheduled maintenance program while the scale is still new can keep it performing optimally and increase its longevity. This is also the perfect time to utilize the expertise of your scale supplier to discuss plans for service and repairs to your scale – both planned and unplanned. It pays to think about how you will handle service and repairs before you actually need them.



Contents

- 1 Responsibilities of the Scale Owner
- 2 Scheduled Tests and Maintenance
- 3 Inspection and Preventive Maintenance Procedures
- 4 Emergency Service
- 5 Warranties

1 Responsibilities of the Scale Owner

Cleanliness. The scale owner needs to keep the scale clean and free of debris accumulation. The main goal is ensuring that foreign materials do not obstruct the necessary centering movements of the scale modules. Debris can include:

- Spilled goods and material (gravel, corn, scrap metal, etc.)
- Ice and snow
- Standing water (ensure drainage systems are working as intended)
- Mud, dirt and sand

Traffic control. Truck traffic driving on and off the scale should be at a controlled pace. Your scale supplier can provide recommendations for entry and exit speeds based on your application. Most importantly, this ensures the safety of those working nearby, as well as the driver and the truck. Secondly, hard stops and starts on the scale inflict heavy wear on scale components and the foundation. This will lead to inaccurate weights and scale breakdowns that will necessitate more frequent repairs.

Awareness. Scale owners should be aware of how their scale functions and the wear parts that will eventually need to be replaced. For example, the tires on your car will eventually need to be replaced, and most drivers do that before the tires have actually failed. The same can be true for scale components, such as load cell receivers, checking system parts and suspension linkages. Eventually the wear level will necessitate that parts be replaced to prevent a forthcoming failure. Usually the best person to evaluate those situations is a professional scale technician.



Keeping the scale area clean helps prevent weighing errors caused by debris

2 Scheduled Tests and Maintenance

There are two types of ongoing scheduled activities that need to be performed on a legal-for-trade truck scale:

- **Weights and Measures Checks / Calibrations / Recertifications**

In many locations, the scale supplier is permitted to perform the initial calibration and accuracy check on the scale when it is installed. However, typically after 60 days the scale's accuracy will be verified with tests performed by the local weights and measures authority. W&M tests typically happen at predetermined intervals, most often once per year. Those tests are done in one of three ways:

- The W&M agency is equipped to perform those tests and does so with its own truck and technicians
- The tests are performed by a scale service provider but must be witnessed by a W&M agency representative
- The tests are performed by a scale service provider and the scale owner must provide proof of the test and the results to the W&M agency

Your scale supplier can tell you how this is done in your location.

Tip: Remember that standard calibration checks and recalibrations only ensure that the scale's accuracy is within the legal tolerance. They do not ensure that the scale's accuracy is perfect. To monitor your scale's accuracy, ask your service provider to note the scale's accuracy "as found" and "as left." This helps you stay aware of problems with the scale's performance and minimize revenue loss.

- **Manufacturer's Recommended Preventive Maintenance**

Your scale supplier will probably offer you a maintenance program that includes periodic visits from a scale technician who will test and inspect the scale and perform preventive maintenance. While that type of maintenance may not be legally required, to many scale owners, the largest benefit is protection from costly unplanned downtime. This program may or may not cover the W&M requirements, depending on your location. Note that the manufacturer may require preventive maintenance as a condition of the scale's warranty.

Testing the scale

To test the scale, the technician or agency will bring a special truck equipped with certified test weights to the scale site. These weights will be applied to the scale in specific weight intervals and in different locations on the scale deck. The technician will monitor the weight indicated by the scale to check its accuracy and consistency. The technician will provide the customer with a report noting the scale's level of accuracy, as well as findings from the inspection.



What happens if the scale does not pass the Weights and Measures accuracy test?

If the scale's error is beyond the legal tolerance, the W&M agency may issue a yellow tag or a red tag (or something similar). A yellow tag is a warning that gives the scale owner a period of time (often 60 days) 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 reason that a scale owner may wish to be proactive about preventive maintenance.

When discussing a maintenance program, ask the supplier exactly what services are covered. Also ask:

- How often should scales be inspected? How long does it take?
- How much time does a test require?
- How often should we test?
- How difficult is recalibration when we find an error?

Recommended preventive maintenance procedures can vary between the needs of a specific make and model of scale, as well as the application and amount of traffic using the scale. However, a universal recommendation is that, in addition to W&M tests, any truck scale should undergo a thorough service inspection at least once each year.

3 Inspection and Preventive Maintenance Procedures

Procedures may include, but not be limited to, the following:

Weighbridge and Foundation

- Inspect scale approaches for damage
- Check the scale and foundation for any binding between the deck and the foundation
- Inspect the edges of the scale for any foreign objects (stones, etc.)
- Examine the area under the scale for buildup of debris
- Test drain pumps (where applicable) and inspect drainage systems
- Examine the weighbridge for cracks, corrosion, stress patterns, and broken welds
- Inspect deck module couplers for damage
- Examine siderails for damage
- Check for appropriate freedom of motion
- Examine tolerances on suspension/checking system, both side-to-side and front-to-back and adjust as needed

Load Cells

- Raise weighbridge and remove load cells to inspect
- Inspect load cell wear pattern for off-center loading
- Lubricate load cell mating surfaces
- Check load cell mounting plates and tighten as needed
- Inspect load cell cables for damage and secure any loose cables
- Inspect grounding and lightning protection systems, where applicable

Junction Boxes (where applicable)

- Open each junction box to inspect for debris and moisture
- Ensure junction box cable connections are secure
- Inspect junction box seal and replace if needed

Terminal and Operations

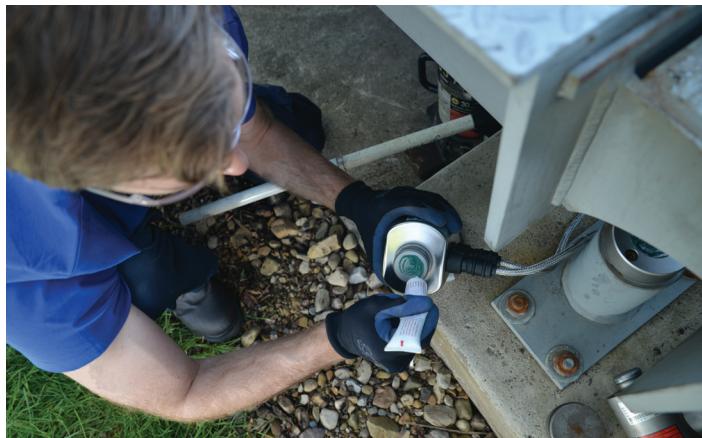
- Check error messages and/or data logs, if so equipped
- Ensure terminal is properly grounded
- Check for appropriate W&M seals
- Perform any system integration tasks as requested by the customer



Inspect the scale checking or suspension system to ensure it is adjusted properly



Periodically check load cells, receivers and other critical parts for wear



Some areas, such as load cell mating surfaces, require periodic lubrication

Who can perform service on my scale?

A reputable company that is qualified to perform scale services can typically do so on any make and model of truck scale. You may wish to gather multiple quotes for maintenance and service programs. Be sure to compare the content of those programs and not just the price. Just as the prices may vary, so too can the

level of service and expertise you receive. Good questions to ask can include:

- Are there fixed rates for service calls?
- Is there a guaranteed response time for service calls?
- What are the technicians' qualifications?
- How do they source common replacement parts?

Special Note:

Be aware that some scale companies generate most of their profit from performing scale service. Those companies may sell customers new scales at a very small profit margin, hoping that they will make their profit on servicing and repairing the scale later. Seeing a very low purchase price, some scale buyers purchase service-prone systems that leave them budgeting large amounts of money each year for service and repairs. That is one of the reasons to look at more than just the initial purchase price when buying a scale.

4 Emergency Service

If your scale is down unexpectedly, your business could be losing money with every hour that you wait for repairs. Ideally, you want a service provider with the right tools, equipment, knowledge, and replacement parts to fix a problem in a single visit.

Additional questions for your potential service supplier:

- What kind of parts inventory do they carry?
- What is the travel time from their location to your scale?
- What sequence of tests does the technician perform when they are faced with a scale that isn't operating properly? How long do they take?

- How long does it take to switch out a common part, e.g., a load cell, a cable or hydraulic line, a printer, etc.?
- Is after-hours service required and available?
- How fast can the manufacturer get parts to the local service organization?
- What equipment does the local organization have, e.g., jacks, test equipment, test trucks, booms and welding equipment?
- Is it possible to perform remote diagnostics rather than traveling to the scale site?



Having a partnership with a reputable industrial scale service team can help any scale owner get the most out of their scales.

5 Warranties

Your scale should come with a manufacturer's warranty. As a customer, this is an area in which you should take time to evaluate options, as warranties can vary considerably. Some manufacturers offer a very limited standard warranty with expanded warranty coverage at an added cost. Take the time to actually read the fine print of the warranty and analyze the following categories.

What does the warranty cover?

Determine the specific level and duration of coverage for the following:

- Types of components covered
- Types of failures covered
- Replacement parts
- On-site labor
- Travel costs for technicians
- Lightning (typically addressed in its own section in the warranty)

There may be certain components that are excluded from the warranty, or that may be covered under their own separate warranty, such as printers.

How long is the warranty?

Some manufacturers prorate their level of coverage as the scale ages. That means their warranty may only cover a percentage of any covered repair after a few years.

How responsive is the manufacturer to warranty coverage?

Does the scale manufacturer have a local sales/service entity or distributor? If not, someone may need to be dispatched from another location. It may be up to you to consider the "what ifs" and determine how responsive you think a company will be in an emergency situation.

In summary, all truck scales will eventually require service. Most scale owners want to have a reliable partner for service and a plan to ensure the scale's performance. The time it takes to develop this plan can be well worth the effort in the resulting peace of mind.



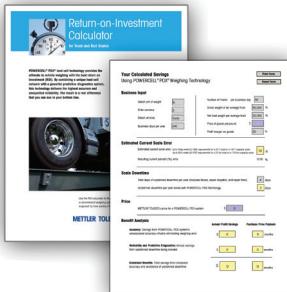
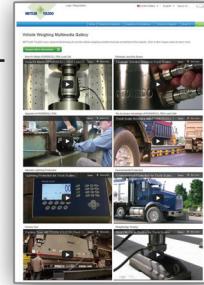
For your Notes

For your Notes

Videos

These two- to three-minute videos highlight the special features, manufacturing processes, and customer value in METTLER TOLEDO vehicle weighing systems.

► www.mt.com/vehicle-videos



Costs and Savings Calculators

These interactive calculators demonstrate how advanced vehicle weighing systems can help businesses save money. Users enter basic information about their business and the form calculates results.

► www.mt.com/PDX-ROI

On-Demand Webinars

METTLER TOLEDO provides an ever-growing collection of informative presentations available online. This includes webinars that specifically address vehicle weighing.

► www.mt.com/webinars



White Papers

White papers provide in-depth information on a specific topic. The METTLER TOLEDO white paper library includes selections dedicated to vehicle weighing.

► www.mt.com/whitepapers

www.mt.com/vehicle

For more information

Mettler-Toledo, LLC
1900 Polaris Parkway
Columbus, Ohio 43240

Subject to technical changes
© 05/2019 Mettler-Toledo, LLC
Printed in USA
MarCom Industrial
44098566