Vehicle Weighing

Truck Scale Weighbridges

Understanding Ratings and Specifications

Truck scale buyers often compare makes and models to find the best scale to meet their needs and provide a long-lasting return on their investment. This publication will help buyers in the United States understand the weighbridge specifications and terms they will encounter, including nominal capacity, concentrated load capacity (CLC), deflection and more.

This publication discusses standards for vehicle scales in the United States.

Some of these concepts are also relevant sales terms for Canada.

Contents

1	Introduction
2	Nominal Capacity and Resolution
3	Concentrated Load Capacity (CLC)
4	CLC and Your Application
5	Larger CLC Ratings... Is There a Benefit?
6	Ownership Costs and the Weighbridge
7	Deflection
8	Steel Content
9	METTLER TOLEDO Weighbridge Evaluations & Performance
10	Summary

METTLER TOLEDO

1 Introduction

Trade-legal vehicle scales in the United States follow standards documented in the National Institute of Standards and Technology (NIST) Handbook 44, as adopted by the National Conference on Weights and Measures. They are evaluated through the National Type Evaluation Program (NTEP). Only two official truck scale capacities are recognized in this program:

- Nominal Capacity and
- Concentrated Load Capacity (CLC).

It is natural to compare these specifications between scales, but buyers can frequently misunderstand these values and how they relate to the use of the scale. It is important to understand what these specifications really mean, and what value they have for the scale owner.

2 Nominal Capacity and Resolution

Contrary to what some may believe, the nominal capacity (sometimes called gross capacity or full scale capacity) is not a statement of the maximum load that the scale is intended to physically support. Nominal capacity is the maximum capacity that can be used when the scale terminal is configured. The scale configuration should be based on the customer's needs and preferences, provided it follows the formula in Handbook 44:

nominal capacity ≤ CLC x (N - 0.5)

where N = the number of sections in the scale (a section is typically a pair of load cells)
where CLC = concentrated load capacity

A common nominal capacity for a truck scale is 200,000 lbs. This is the largest nominal capacity that can still legally use common 20 lb. weighing divisions because the weighing division size, or resolution of the scale, is related to the nominal capacity. Handbook 44 requires the scale resolution to be a maximum of 10,000 divisions (d) of the nominal capacity for vehicle scales. If the scale terminal is configured for a larger capacity, the weighing division also must increase:

nominal capacity / weighing division = # of divisions

Legal Configurations:
Example 1: 120,000 lbs. capacity with 20 lbs. divisions = 6,000 divisions (6,000 d)
Example 2: 200,000 lbs. capacity with 20 lbs. divisions = 10,000 divisions
Example 3: 500,000 lbs. capacity with 50 lbs. divisions = 10,000 divisions

In practice, it is to the scale owner's advantage to use a smaller weighing division (20 lbs.) to minimize round-off errors in each weighment. That means the scale will be configured for a nominal capacity and resolution that is most advantageous to the scale owner.

Comparing truck scales based on their nominal capacity rating is rarely beneficial to the customer.

3 Concentrated Load Capacity (CLC)

The weight of a truck on a scale is concentrated at the points where the truck tires contact the scale surface. Concentrated Load Capacity is a statement of the heaviest dual-tandem axle load that the scale is designed to weigh, as declared by the manufacturer.

Some buyers focus on comparing Concentrated Load Capacity (CLC) ratings when evaluating truck scales. They may believe (and sales representatives may assert) that these ratings are a direct indicator of durability and longevity for the truck scale.

However, buyers should remember that this capacity is declared by the manufacturer based on each manufacturer's own criteria. Their criteria may be rigorous, or it may be severely limited. The declared CLC value is then used as a test parameter in the NTEP evaluation to obtain a certificate of conformance for the device. This evaluation is based entirely on the scale's accuracy performance. No structural metrics (such as stress levels and fatigue life) are included in this evaluation.

Misconceptions in the marketplace have created an incentive for manufacturers to declare increasingly higher CLC values in an effort to appear superior to the competition. This is misleading.

The CLC conformance portion of the NTEP evaluation test is based on an accuracy threshold and not on structural merits that impact the life of the scale. Because of this, many scales are able to gain conformance certificates for inflated CLC values, regardless of structural implications. In other words, a poorly-manufactured scale could gain an NTEP conformance certificate for a large CLC value. However, the CLC value alone is not an adequate indicator of quality, durability or longevity.

NTEP Conformance Evaluation

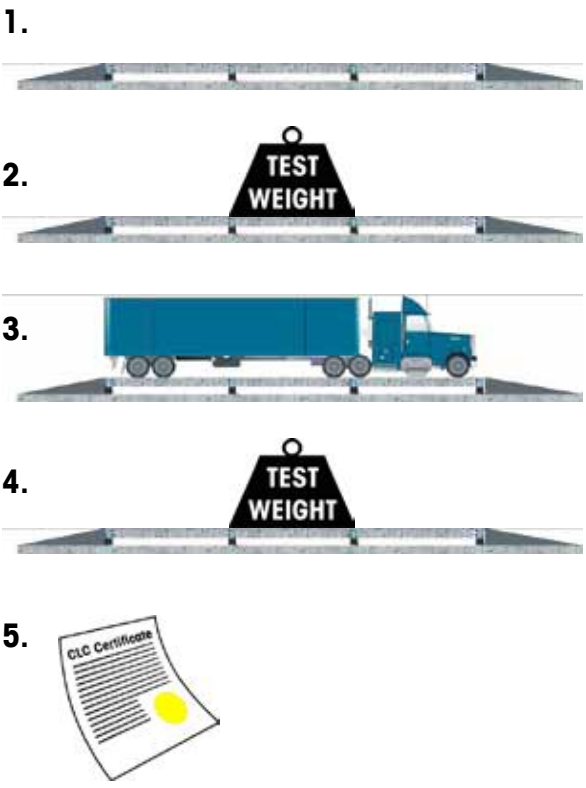
1. The manufacturer declares their intended CLC for their model of scale and a single test scale is installed.

2. Test weights equal to at least 90% of the intended CLC are placed on the scale at various points, and the measurements indicated by the scale are recorded.

3. The scale is put into normal service for a brief period of time not less than 20 days (typically 30-45 days) to register at least 300 weighments.

4. Step #2 is repeated.

5. If the scale weighs within a minimum accuracy tolerance, an NTEP certificate of conformance is issued, validating the CLC value.



Key concepts to remember about CLC ratings:

CLC Loading During Conformance Testing is Limited
NTEP conformance testing includes applying test weights of at least 90% of the declared CLC value to the scale to evaluate weighing accuracy. This happens during only two individual tests that typically take place within a brief 30-45 day interval.

A shortcoming of the CLC loading test is the use of flat-bottom test weights spread across a 4' x 8' area of the scale. Although this is somewhat concentrated weight, the tires of a similarly loaded dual-tandem axle have a smaller contact patch that can exert over 8 times more pressure on the weighbridge surface.

This limited testing alone does not qualify as evidence to support claims of weighbridge durability and longevity. The durability and longevity of the weighbridge relies on the long-term effects of loading stresses and structural fatigue. Those effects cannot be observed through this simple test.

Inflated CLC Ratings Can Create Problems for Buyers
There have been numerous complaints to NTEP committees regarding weighbridge damage from overloaded dual-tandem axles even though the axle loads did not exceed the scale's CLC rating. This is evidence of an inflated CLC value that is used as a selling tactic instead of a meaningful specification. Yet, some manufacturers still feel comfortable listing inflated CLC values because the liklihood of scale use near these limits is very low.

Manufacturers Should Perform Additional Testing
As we have explained, an NTEP certificate of conformance for a stated CLC value confirms that the scale is capable of weighing such a load within legal-for-trade accuracy tolerances. Scale buyers should then ask the manufacturer what additional testing they have completed to validate a lifetime of use at the values they indicate. Buyers should question manufacturers that:

- Cite the CLC conformance certificate alone or
- Rely solely on calculations with no empirical testing.

- A typical CLC loading test uses test weights that do not directly replicate the pressure exerted by the tires of a dual-tandem axle.

- A typical dual-tandem axle configuration, indicating weights experienced when legally loaded.

4 CLC and Your Application

The scale should have a CLC rating that is larger than the dual-tandem axle (DTA) weights of the vehicles being weighed. This rating indicates that the scale is capable of weighing such a load at an accuracy level that is legal for trade.

Throughout the majority of the United States (including all interstate highways), the maximum legal weight for a standard over-the-road DTA configuration is 34,000 lbs. A few states permit off-interstate DTA maximums of 40,000 lbs.

In most applications, the scale should have a CLC rating of at least 40,000 lbs.

5 Larger CLC Ratings... Is There a Benefit?

This is completely dependent on the manufacturer, and whether they have performed credible testing beyond the NTEP evaluation to validate the ongoing physical performance of the scale under these loads.

NTEP evaluations ensure that the scale can accurately measure concentrated loads. It is up to the manufacturer to evaluate the lifespan of the scale under repeated loading.

Based on the NTEP evaluation alone, there is no evidence of a benefit to the customer if a comparable scale offers a higher CLC rating.

If, however, the manufacturer fully validates the scale's performance through a lifetime of use, the buyer gains confidence in the scale's lifespan. For example, METTLER TOLEDO weighbridges undergo an extensive design and evaluation process, including thorough empirical testing that replicates real scale use. The testing includes complete lifecycle confirmation (loading stresses and fatigue performance monitoring through millions of dynamic loading cycles) at a minimum of 60,000 lbs. for standard model truck scales, and up to 100,000 lbs. for heavy-duty model truck scales.

In other words, METTLER TOLEDO truck scales are designed and proven to provide a structural safety capacity amounting to at least 150% of typical maximum legal DTA weights for standard models, and over 200% for heavy-duty models (based on DTA weights of 40,000 lbs.). METTLER TOLEDO offers this recommendation for its own product lines based on a wealth of empirical testing that is far more rigorous than the NTEP evaluation.

While other manufacturers may offer differing recommendations for their own product lines, buyers are advised to ask what criteria the manufacturer has used to arrive at their recommendations.

If a sales person recommends a large CLC without substantiating lifespan performance, the buyer may be listening to a sales tactic instead of meaningful engineering.

6 Ownership Costs and the Weighbridge

While the weighbridge is the largest physical piece of the truck scale, it is not the most critical in terms of the scale's reliability or cost of ownership. Experienced scale owners know that, historically, the majority of scale service calls are related to problematic load cell systems. This is why METTLER TOLEDO developed some of the world's most rugged, accurate and reliable load cells—POWERCELL®—and why some scale makers rarely discuss their load cells. The scale's weighbridge is a relatively low-maintenance component.

Additionally, it should be noted that catastrophic weighbridge failures are rare. Some sales representatives use images of broken scales as a means to continue to focus on CLC values. However, these occurrences are significantly less common than these tactics lead many to believe.

Buyers are advised to thoroughly evaluate the other critical components and hardware in the scale, in addition to the weighbridge.

- The weighbridge is a low-maintenance part of the scale. Weighing components, such as the load cell system, can have a much larger impact on cost of ownership.

7 Deflection

Deflection specifications are not considered in Handbook 44. However, they are frequently seen in the marketplace. All weighbridges deflect (or bend) when a load is applied. Some scale manufacturers publish a calculated deflection ratio to use as a selling point. However, there are a number of concepts for buyers to be aware of regarding deflection ratios and comparing them between two different scales.

First, deflection is typically stated as a "calculated" ratio, observed in a simulation, but not validated through empirical testing. Some manufacturers publish the ratio of deflection at "legal highway loads," which are far less than the CLC value for the scale and can be misleading. It is also typically only stated in terms of longitudinal deflection, although many designs will also experience lateral deflection.

Is deflection inherently negative? It is easy to assume so, but the issue is not that simple.

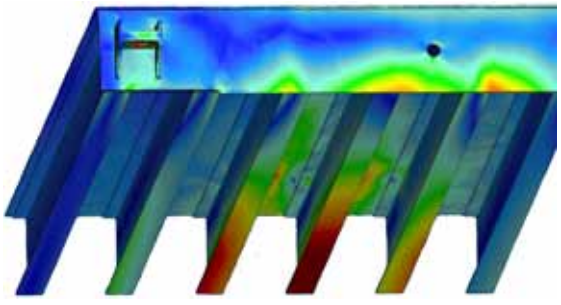
When a weighbridge is loaded, certain parts of the structure will experience more stress than others. If too much stress is experienced in a single area, it can lead to fatigue, and eventually a structural failure.

METTLER TOLEDO weighbridges avoid this by utilizing an orthotropic design that aids in effective distribution of concentrated loads. This reduces the presence of "hot spots" that experience a disproportionate amount of stress. The design also directs the highest stresses to areas of the structure that have no welds, which is beneficial because welds can create discontinuities that could fail under high stress. This helps ensure that the loading stresses during heavy scale use do not fatigue the structure in harmful ways. In other words, the deflection experienced by the structure is not harmful because it is handled effectively and results in stresses below fatigue thresholds.

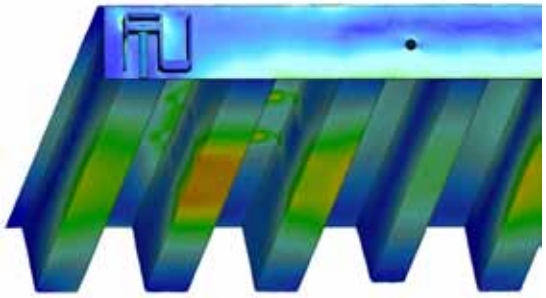
In contrast, some manufacturers insist that a lower deflection ratio is always beneficial to the customer. However, the effects of deflection rely on effective engineering and the unique characteristics of the structure. It cannot be said that a lower deflection ratio (a more rigid weighbridge) is automatically a benefit. This is because, as we have explained, the durability and longevity of the weighbridge relies on structural fatigue, which is not the same as rigidity.

For example, if a weighbridge is extremely rigid, and therefore concentrates loading stresses to a weak part of its structure, that area could be more likely to experience fatigue and eventually fail. In this example, extreme rigidity could be the underlying cause of a problem. So, the effect of weighbridge deflection is a more complex issue than some manufacturers would like buyers to believe.

Finally, manufacturers often calculate their publicized deflection ratio using a scale module that is shorter than those typically sold. A shorter module results in a smaller amount of deflection. However, these ratios are not linear over variable spans of the same structure, making the deflection ratio rather meaningless to the customer.



I-beam weighbridge structure



Orthotropic weighbridge structure

- These models illustrate how deflection experienced by different designs can have different impacts. The I-beam structure experiences less deflection, but results in higher stress levels (shown in red), including high stress on weld joints that can be vulnerable to fatigue. The orthotropic structure experiences more deflection under the same load, but results in lower stress levels. The orthotropic design also directs stress to areas of the structure with no welds, which are less prone to fatigue.

8 Steel Content

Some manufacturers indicate that their weighbridges contain more steel than others. Should it be assumed that this is a benefit? It may sound good on the surface, but more steel does not guarantee more strength. Only empirical testing can sufficiently support such claims.

Many weighbridges on the market today still utilize outdated designs, along with largely manual manufacturing processes, that result in a weighbridge with a heavy shipping weight. However, plenty of these "heavy" weighbridges have been observed to fall short of the operational life promoted by the manufacturer.

The amount of steel in a weighbridge alone is not a meaningful indicator of its quality, durability or longevity.

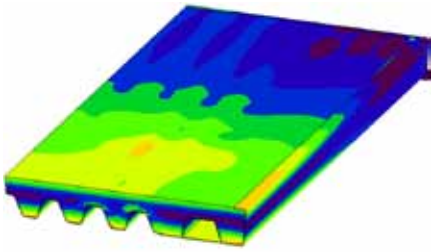
METTLER TOLEDO has nearly 100 years of experience manufacturing vehicle scale weighbridges. For over 30 years, the METTLER TOLEDO orthotropic weighbridge design has been proven in some of the most challenging environments and applications on Earth, with extensive engineering test results to confirm their performance.

- Although the manufacturer boasted of the high steel content in this weighbridge, after just 10 years the treadplate split due to a design with high stress concentrations.

- Most METTLER TOLEDO weighbridges utilize large longitudinal supports, which are frequently used in modern roadway bridges. These ribs are fully welded the entire length of the deckplate using a automated submerged arc welding process that provides completely sealed and lasting construction, even in demanding applications.

9 METTLER TOLEDO Weighbridge Evaluations and Performance

METTLER TOLEDO approaches weighbridge performance with world-class engineering and evaluations.



1. Design Modeling

As an early-adopter of computer-aided design technology, METTLER TOLEDO draws upon decades of experience to ensure that each component meets rigorous design standards.

2. Finite Element Analysis

Each design undergoes extensive Finite Element Analysis (FEA) to determine high and low stress areas under various loading conditions. This includes analyses on individual components, as well as the complete structure.

- The METTLER TOLEDO weighbridge lifecycle test machine (the "Module Masher") dynamically loads the structure in a pattern idential to a dual-tandem axle

3. Stress Level Testing

The purpose-built physical testing machine used by METTLER TOLEDO uses a loading contact pattern that directly replicates tires in an dual-tandem axle configuration. Sensors embedded in the weighbridge structure measure observed loading stress as dynamic loads are applied. These results are used in conjunction with FEA data to make adjustments for enhanced performance.

4. Life-cycle Testing

METTLER TOLEDO uses a specially-built lifecycle testing machine to replicate structural fatigue from decades of use. Running 24 hours a day, the test can exert about 2 million dynamic loading cycles onto the weighbridge over 6 to 8 weeks.

METTLER TOLEDO Weighbridge Lifecycle Testing

METTLER TOLEDO Scale Model	Deck	CLC Rating	Lifecycle Test Value	Total test cycles	Module size tested	Result	Tested at max load for U.S. road-legal axles
VTS100/VTS101	Steel	80,000 lbs.	60,000 lbs.	1,982,200	20' x 11'	Passed	150%
VTS231	Steel	100,000 lbs.	80,000 lbs.	2,075,891	23.5' x 11'	Passed	200%
VTC100/VTC101	Concrete	80,000 lbs.	60,000 lbs.	2,000,000	20' x 11'	Passed	150%
VTC221	Concrete	100,000 lbs.	80,000 lbs.	2,000,300	20' x 11'	Passed	200%

- The total number of cycles target is two million, but includes some variability due to the length of the test (6-8 weeks).

5. Advanced Manufacturing

METTLER TOLEDO combines quality materials, advanced processes, and expert professionals to ensure the quality consistency and strength in every scale. Precise fabrication, advanced welding techniques and automated processes are all part of this high standard.

- METTLER TOLEDO weighbridges are manufactured to extremely high standards with strict quality controls at every step of the process. Here, a special fixture is used to allow the welder to work in an ideal position to place the strongest weld.

6. Superior Components

Many truck scale manufacturers source critical components, such as load cells and terminals from third-party suppliers. METTLER TOLEDO always has been at the forefront of weighing technology, as one of the few manufacturers to build its own truck scale load cells, terminals and software. From basic needs to advanced applications, METTLER TOLEDO offers a complete catalog of innovative answers, including premier POWERCELL® load cells.

7. Legacy and Field Experience

For nearly 100 years, METTLER TOLEDO truck scales have been backed by unparalleled expertise and a reputation for quality as one of the world's largest suppliers of measurement and analytical instruments. METTLER TOLEDO truck scales can be found in the world's most demanding environments—from McMurdo Station, Antarctica, to Death Valley, California.

- The high-quality components found throughout the scale (as shown here in a POWERCELL® PDX® upgrade kit) are a key factor in weighing performance, affecting both accuracy and reliability.

8. Warranty

Most customers look for a truck scale that will last many years. The METTLER TOLEDO warranty is part of the commitment to an ongoing partnership on which customers can depend on.

- METTLER TOLEDO provides one of the most comprehensive warranties in the industry, supported through an extensive network of direct service and authorized distributor service teams throughout the United States.

- METTLER TOLEDO vehicle scales are found throughout the United States and the world. They include innovative features to help them withstand the challenges of any environment.

10 Summary

Some scale manufacturers promote excessive nominal capacity ratings and inflated CLC values as selling points. However, knowledgeable scale buyers can see that the way these values are determined does not adequately support claims of durability and longevity by these ratings alone. Savvy scale buyers realize that inflated capacity ratings actually offer little real-world value. Buyers should be wary of claims that are supported by nominal capacity and CLC ratings alone.

Most manufacturers rely exclusively on computer simulations and a limited NTEP conformance test (which does not include a structural evaluation) as their only indicators of weighbridge performance.

In effect, they are asking the customer to trust them that their scale will perform "as designed," even many years beyond the limited warranty period.

METTLER TOLEDO takes a different approach to weighbridge performance validation.

By performing an unprecedented level of empirical testing and other real-world evaluations, METTLER TOLEDO strives to provide meaningful proof of the durability and long lifespan of the scale structure.

Learn More

METTLER TOLEDO offers a comprehensive *Truck Scale Buying Guide*. The publication includes more than 75 pages of information on vehicle scale technology, helpful photos, illustrations and tips for project management. To request a complimentary copy, visit **www.mt.com/TruckScaleGuide**.

www.mt.com/vehicle

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