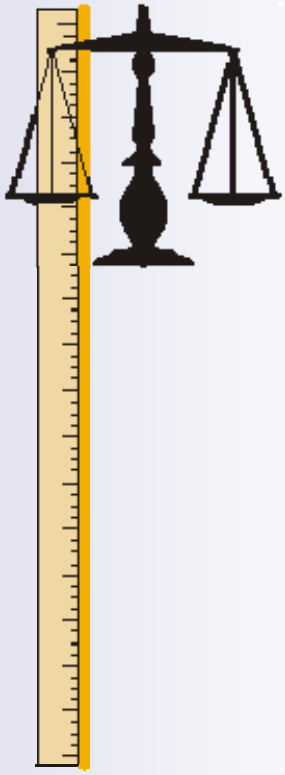
Division of Measurement Standards



Training Module

Nine

Weighing Devices

Training for the Weights and Measures Official

TRAINING FOR THE WEIGHTS AND MEASURES OFFICIAL

CURRICULUM

MODULE 9 - WEIGHING DEVICES

Module 1 - Introduction to Weights and Measures

Module 2 - Laws and Regulations

Module 3 - Enforcement Procedures

Module 4 - Legal Action

Module 5 - Legal Metrology

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Module 8 - Device Type Evaluation

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Module 12 - Petroleum Products

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Module 14 - Service Agencies and Agents

Acknowledgment

Developing a training program for weights and measures officials is a challenging and ambitious project. It requires time, dedication, and expertise from many individuals.

It is impossible to list the names of the many people who contributed to the development of this course. However, gratitude is extended to the following groups whose dedication and commitment made this training module a reality.

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Module Nine
Weighing Devices

Table of Contents

Introduction

Welcome to "Weighing Devices". This is the ninth module in the series "Training for the Weights and Measures Official." Throughout this module you will learn the various terms, definitions, and enforcement tools a field inspector uses in the testing of scales and their components. Completion of this module will not qualify you completely to start testing scales on your own, but it will give you a good foundation upon which you can build - it will prepare you for "hands on" field training with a qualified County or State inspector.

At the end of each segment in this module you will find a series of self-evaluation questions to test your knowledge. Although you are not required to complete the self-evaluation, we encourage you to take a few minutes to read the questions before moving on to the next segment. Answers are provided at the end of the module. If you are unsure of a response, reread the training material and it will give you the information you need.

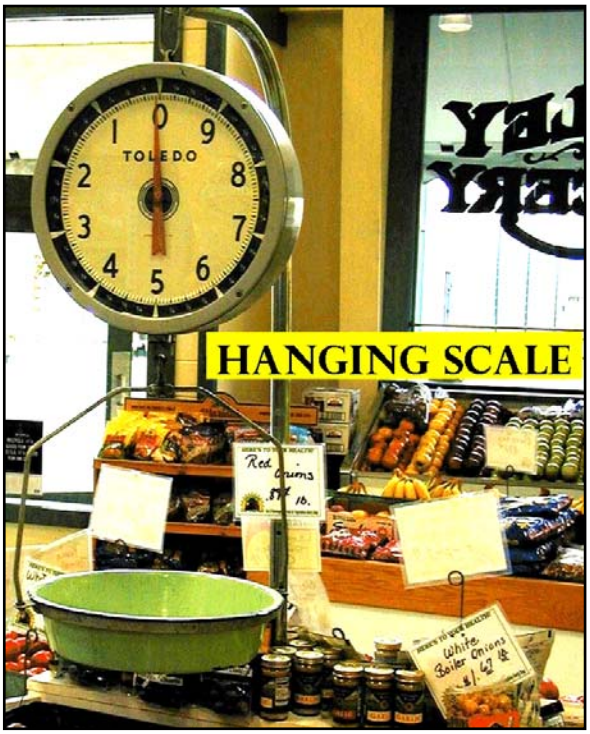
Module Objectives

When you have completed this module you will be able to:

- Understand the difference between commercial and non-commercial, the importance of type approval, and the progression of authority from the Secretary of the Department of Food and Agriculture to the field inspector.
- Know the reference tools such as the California Code of Regulations, Business and Professions Code and the Device Enforcement Program Manual, and how to use those tools in the enforcement of rules and regulations as they apply to scale testing and use.
- Describe the basic construction and use of mechanical weighbeam scales, mechanical dial scales, and electronic digital indicating scales.
- Describe special features of electronic digital indicator scales, including on/off switch, zero-setting mechanisms, and push-button print.

Commercial or Non-Commercial, Type Approval, Accurate, Correct and Authority for Testing Scales

In every commercial transaction involving the weighing of a commodity over a scale, accurate weights and proper weighing practices protect both the buyer and seller. They help ensure equity for buyer and seller and provide purchasers with the means to compare values.



The terms “scale” and “weighing device” encompass all components connected together in a modern weighing “system”. A typical modern system entails multiple sets of marking and identification, and may be covered on multiple type evaluation certificates. Such systems have proliferated because they lend themselves well to customization and modification.

System components or computer software designed to connect into, or receive output as part of a commercial measurement "system" or device, are considered "an accessory used or connected therewith" [see Business and Professions Code Section 12500(a)(b)]. These include, but are not limited to, controllers or controller "software", other metrological software, computer software based "cash registers" integrated in a weighing or measuring system, etc.

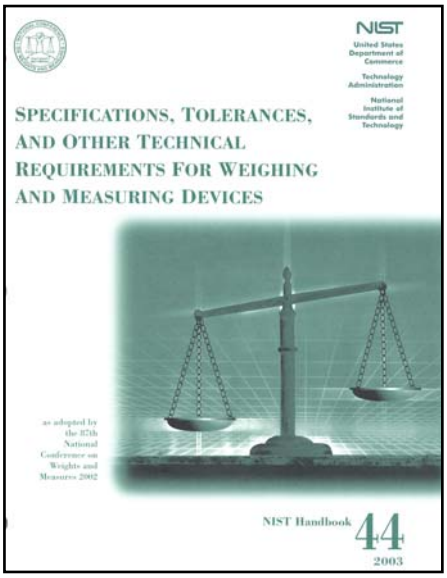
Requirements for stored values, computations, indicated or recorded values, etc., that apply to the "system", will be applied to computer software and hardware controlled components as applicable. An effective weights and measures official will recognize that storage and manipulation of measurement data as well as the display, input, and recording of transaction are all examples of "system" features for which requirements exist in weights and measures regulations.

Weights and measures officials are responsible for testing and sealing or removing from use commercial scales. The user is responsible for their maintenance and accuracy. Businesses may have numerous on-site scales, which may be in use, but are not used in a manner deemed as commercial. An example would be a pre-packaging scale used for filling packages to a pre-determined weight. These scales are non-commercial scales. Packages filled and labeled would be checked by weights and measures officials in the Quantity Control Program by routine package inspection or on the basis of a consumer complaint (***Module 13, Quantity Control***). Most commercial scale transactions occur in the presence of the consumer. When such transactions are not conducted in the presence of the customer, then weighments are documented on weighmaster certificates by a licensed weighmaster (***Module 11, Weighmaster Enforcement***).

Commercial scales are required to be type approved (***Module 8, Device Type Evaluation***). In the field, a scale may be found to be accurate but not correct. An inspector has to have the ability to apply test weights to a given scale to determine its accuracy and also be familiar with its design specifications - as it was designed and approved. Sometimes equipment gets damaged and a scale owner or repair company substitutes parts that are not part of the original design, as it was approved. In other cases, the addition of computer software to an approved device, if not so specified in the original approval, could allow the manipulation of scale weight and permit the facilitation of fraud. These are examples of situations which would prevent a scale from being sealed.

The Secretary of the Department of Food and Agriculture establishes tolerances and specifications for commercial weighing and measuring devices. In doing so, the Division of Measurement Standards adopts, by reference with exceptions, Handbook 44, as created by the National Conference on Weights and Measures (NCWM) and published by the National Institute of Standards and Technology. This model is also

adopted in part or whole by most other states. NCWM is a private, voluntary organization whose membership consists of state and local weights and measures officials, representatives of government agencies that are concerned with weights and measures issues, and representatives of private industry (such as device manufacturers, distributors, and service companies).



Handbook 44 promotes uniformity of weights and measures requirements for devices throughout the country. If a scale manufacturer in Montana had to make slight design changes to comply with each separate state it would be almost impossible for him or her to build a scale. This could also apply to the sale of commodities between states. Imagine the cost of producing a product and confusion that would reign if a manufacturer had to conform to different requirements for every state in which he sold a commodity.

California has some exceptions, exemptions, and modifications to this model, but for the most part is in total alignment with Handbook 44. California Code of Regulations (CCR) Sections 4001, 4002, and 4002.3 identify these differences. Throughout this module Handbook 44 will be referenced only when it is identical to the CCR. Exceptions, exemptions, and modifications will reference the applicable CCR. These regulations are found in Title 4, Division 9 of the California Code of Regulations (Field Reference Manual). The Field Reference Manual has incorporated all of the exceptions to Handbook 44 into the relevant sections. Omitted sections are annotated in the text with the statement “Not Adopted”. Additions to the handbook are denoted by being blocked and shaded.

SELF-EVALUATION QUESTIONS

1. Who is predominantly responsible for the accuracy and maintenance of a commercial scale?

2. What additional requirement must usually be met for scale transactions not conducted in the presence of a customer?

3. Describe a scale used that is non-commercial.

4. Where can the tolerances and specifications for commercial weighing devices be found?

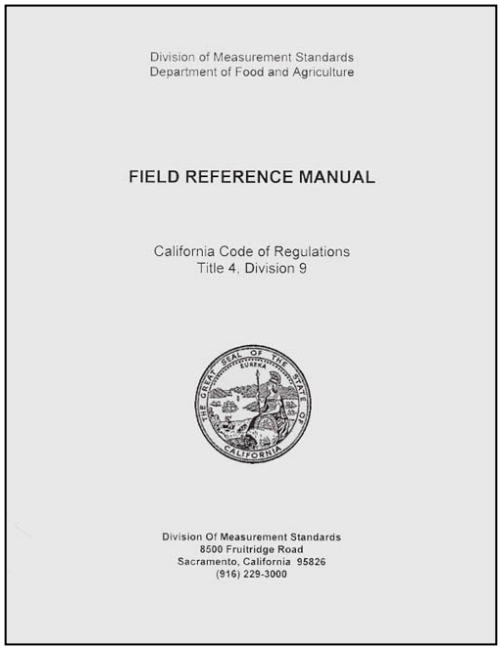
5. Why are the Field Reference Manual and Handbook 44 not identical?

Reference Tools Used by Weights and Measures Officials

Title 4, Division 9 of the California Code of Regulations (CCR) is a comprehensive set of specifications, tolerances, and other technical requirements for weighing and measuring devices. These requirements are organized into a number of codes (a code is a collection of requirements that apply to the same device or set of devices). Section 1.10 pertains to the General Code, Section 2.20-2.22 refers to specific scale types, and Section 2.23 pertains to weights.

The General Code sets the baseline for all types of commercial devices. Rather than repeat the General Code information over for each type of device, Section 1.10 lays it out one time. When retroactive requirements in the regulations are adopted, they are enforceable to all equipment described. When nonretroactive requirements are adopted, they become enforceable to devices first placed into service after the effective date. They are printed in *italic type*.

The CCR introduction explains the system of paragraph designations, and guides you through how to use this resource to obtain criteria, which will enable you to determine suitability, accuracy, and other conformance of a weighing device. The definitions section contained in the CCR will also help introduce terminology and acronyms used by weights and measures officials.


Division of Measurement Standards
Department of Food and Agriculture

FIELD REFERENCE MANUAL

California Code of Regulations
Title 4, Division 9

Division Of Measurement Standards
8500 Fruitridge Road
Sacramento, California 95826
(916) 229-3000

Paragraph Designations

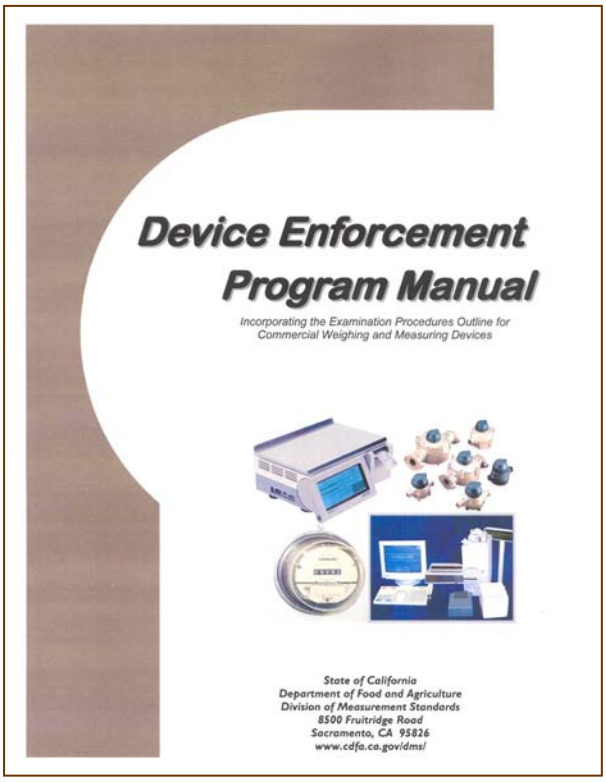
This is the method used to help weights and measures officials and/or industry to quickly find specific parts of the regulations that we need to know about.

G General	A part of the requirement is part of the General Code. As previously discussed, this is a collection of requirements that are generally applicable to all weighing and measuring devices and so are grouped together.
A Application	Tells what types of devices specifically this section applies or does not apply to.
S Specification	Equipment design. Mostly applies to equipment manufacturers.
N Notes	Apply to the official testing of devices. This is the weights and measures official's guide to "how, what, where, when and why" of testing and then sealing a correct device.
T Tolerance	Tolerances are performance requirements. They fix the limit of allowable error or departure from true performance or value.
T.N Tolerances, New Scales Only	Specifies a tolerance that applies to a scale that is marked with an accuracy class. Scales built after January 1, 1986 are required to be marked I, II, III, III L or IIII.
UR User Requirement	Directed particularly to the owner and operator of a device. Apply to the selection, installation, use, and maintenance of devices.
D Definitions of Terms	This section appears in Appendix D to provide the definition of the terms having a special meaning.

The purpose of all these technical requirements is to eliminate from use weighing and other measuring devices that may not be suitable for the application in which they are being used. For instance, the design of weighing elements may not be consistent with the weight range the device is being used at or perhaps the design may not stand up to the forces that will be applied to the device in use. The possibility for that weighing device and its associated equipment to facilitate the perpetuation of fraud must also be evaluated. The manner in which the user may operate the device or the design specifications that the manufacturer must meet may be stated in regulation in order to reduce the possibility for facilitation of fraud.

Device Enforcement Program Manual
(Incorporating the Examination Procedures Outline for Commercial Weighing and Measuring Devices)

This is the real “hands on” or plain English weights and measures guide to testing various types of weighing and measuring devices. Read it. Take it with you when you are going into the field to test a scale. This book has important information including: inspecting a newly installed scale, weight truck calibration, types of indicators, and tolerances. This book also contains Division of Measurement Standards policy letters, notices, and Examination Procedures Outline references. These are included to help the weights and measures official handle issues that come up frequently in the enforcement of rules and regulations.



SELF-EVALUATION QUESTIONS

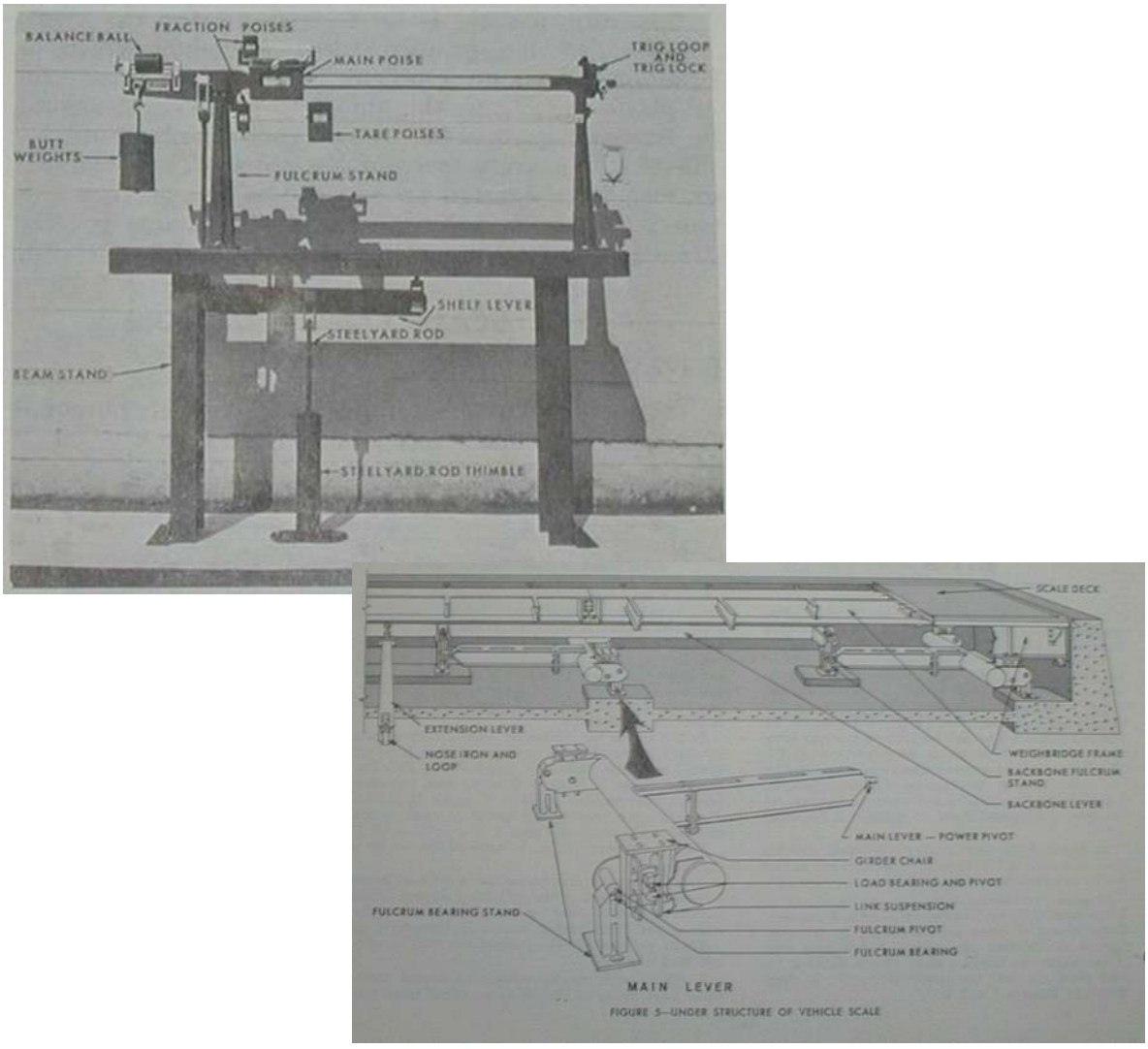
1. What reference material contains a comprehensive set of specifications, tolerances, and other technical requirements for weighing and measuring devices?

2. What is the purpose of the General Code?

3. What does printing in italic type signify about a requirement?

4. Where can you find the Examination Procedures Outline for commercial weighing and measuring devices?

Basic Construction and Use of Various Types of Scales



Basic scale terminology:

Analog type	Load-receiving element	Steelyard rod
Automatic-Indicating scale	Nominal capacity	Tare
Balance indicator	Pivot	Tare mechanism
Beam scale	Poise	Trig loop
Digital type	Reading face	Weighbeam
Graduation	Reading-face capacity	Weighbridge
Indicating element	Recording element	Weighing element
Indicator	Remote indicator	Zero-load balance
Lever	Scale division, value of (d)	Zero-setting mechanism
Load cell		

Definitions are listed in the Glossary section.

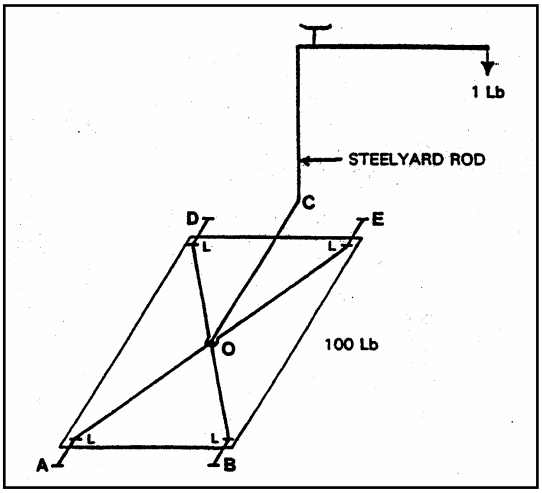
Load-Receiving/Weighing Elements

These consist of a load-receiving element, which on the scales covered in this module are usually a steel or wood platform, and a load-sensing element, which is the mechanism for transmitting the force of the load on the platform to the weight-indicating elements. Examples are systems of levers with pivots and bearings or load-cell systems.

Whether mechanical or electronic, both types of systems have a form of suspension system that supports the platform, the surface upon which the load rests during weighing. The platform itself is often supported by a structure called the weighbridge. Since the weighbridge bears directly upon the load-bearing points of the weighing elements, it is considered to be part of the load-receiving element.

On mechanical scales, a lever system supports the platform and reduces the force from the load on the platform by a precise factor (the lever multiple) and transmits that force to the indicating element. For example, on a livestock scale if we place a one (1) pound weight on the steelyard rod and it took 400 pounds on the weighbeam sliding poise to get the beam to balance, then the scale or lever multiple is 400 to 1. The indicating element balances the force and indicates the weight value.

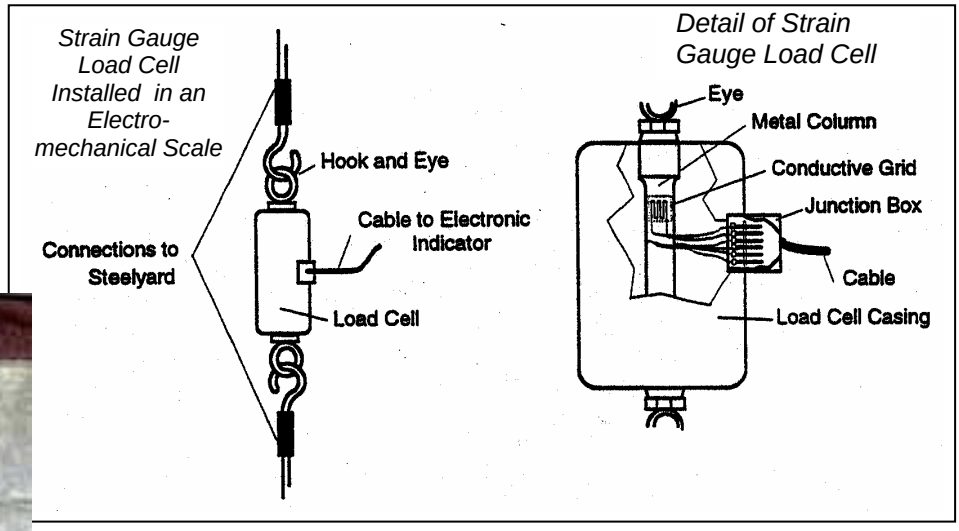
The figure shown below is a diagram of the weighing elements of a typical scale. The weighbridge rests on the four load-bearing points (L). There are actually two platform levers: the long lever, which is shaped like a "Y" (ends A, B and C in the diagram) and the short lever, which is shaped like a "V" (ends D and E in the diagram). The short lever bears on the long lever at "O", so that the force of both platform levers is summed. The long lever in turn transmits the load to the indicating elements, usually through a vertical steelyard rod. The scale may also be equipped with a shelf lever, generally a low-multiple lever which receives the load from the platform lever system via the steelyard rod and transmits its output to the indicating element by means of a beam rod.



Weighing Elements of a Typical Mechanical Scale

One additional feature of mechanical weighing elements should be mentioned, since it provides a means of adjustment that will affect the registered weight. Most lever systems are equipped with nose-irons. A nose-iron is an assembly that can be adjusted to shorten or lengthen the dimension of a lever. This adjustment will increase or decrease the force that is transmitted to the indicating elements. Nose-iron adjustments are made when the scale is calibrated, usually by a service agent or factory representative, but are not done during normal operation.

Electronic weighing elements of scales usually consist of devices called strain gauge load cells (to be distinguished from pneumatic or hydraulic type load cells). These operate on the principle that the resistance of a conductor to electric current varies proportionally with the mechanical stress that is applied to the conductor: compressive stress (pressing or squeezing) decreases resistance and tension (stretching) increases resistance. In a strain gauge load cell, several conductive grids (the strain gauges) are fixed to a column of metal to which the force of the load-receiving element is applied directly. The force is transmitted from the metal column to the strain-gauge. A current of known voltage is supplied to the strain gauges, so that the output voltage of the grid, which is transmitted to the indicating element by cable, can be used as a signal to indicate the force applied to the cell.

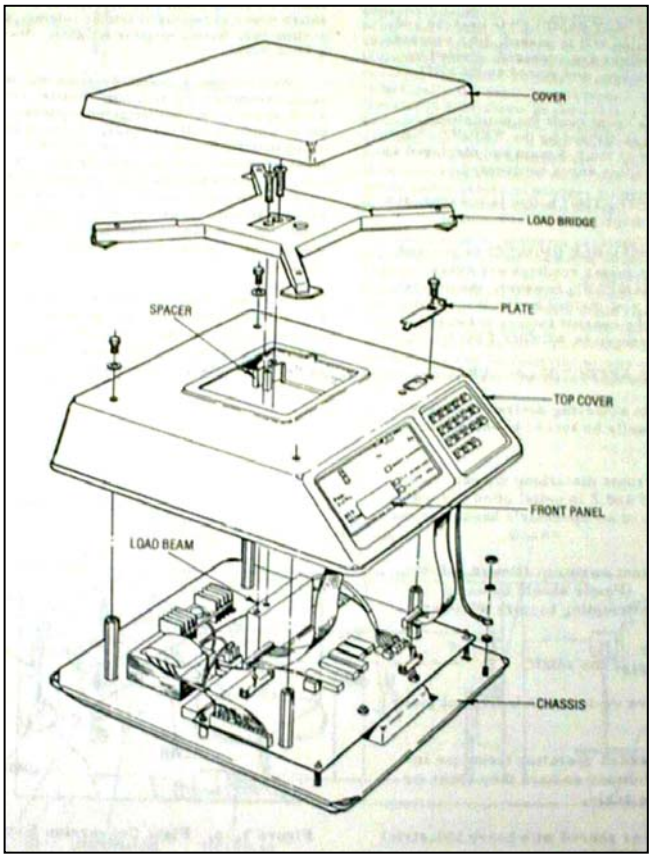


Typical load cell installed in a steel yard rod to a mechanical weighbeam

Some scales are a combination of mechanical systems and electronic systems. These are commonly referred to as levertronic or electromechanical scales. Often a load cell is inserted in the steelyard so that the force from the lever system is transmitted to the load cell. This allows the scale operator, in the event of a power failure, to use the weighbeam as a back up. Weights and measures officials would treat this as two separate scales and test it accordingly.

Other scales are fully-electronic scales. With this type of scale the platform/ weighbridge is supported directly by the load cells. Load cells are positioned at each of the traditional load-bearing points, and the force of the load on the platform is transmitted directly to the load cells.

Electronic Bench Scale



Indicating Elements

Three basic types of indicators are used with scales: weighbeams, dial indicators, and digital electronic indicators. The first two are used exclusively with scales incorporating mechanical weighing elements; digital scales can be used either with fully electronic or electromechanical systems. Thus scales may be classified by the design of their weighing and indicating elements:

- mechanical scales with weighbeams,
- mechanical scales with dials,
- mechanical scales with electronic digital weight indicators (levertronic scales), and
- fully-electronic scale systems.

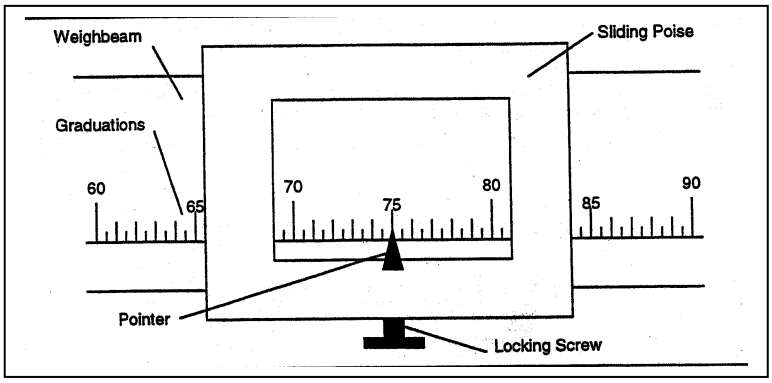
The weighbeam itself is actually both a weighing and indicating element. As the final lever in a mechanical scale (that is, the lever furthest removed from the load-receiving element) the weighbeam is a weighing element.

Typical Weighbeam Assembly

Weighbeams are referred to as non-automatic indicators, because the scale operator must perform action to obtain the measurement: weight must be applied to the power arm of the weighbeam until it balances the load on the deck or receiving element. The load could be balanced by applying counterpoise weights to the tip of the weighbeam. The weight of the load would then be the total counterpoise weight times the lever multiple of the system when the weighbeam is in the balance condition. However, this method could involve the manipulation of a number of relatively small counterpoise weights for any given weighing, plus some computation, and would thus be prone to operator error. A more efficient and secure method

involves balancing the load by moving a sliding poise. A single weight can be used to balance a considerable range of loads. In addition, graduations can be provided on the weighbeam so that the multiplied weight required to balance the load can be read directly, without computation.

Graduated Weighbeam With Sliding Poise



Most weighbeam scales use a combination of both counterpoise weights and a poise. For example, a 1000 lb. x 8 oz. scale might be equipped with a weighbeam that is capable of balancing only 100 lbs. of load on the platform. Counterpoise weights, usually marked to indicate the amount of load which they can balance (for this type of scale, 100 lb., 200 lb. and 500 lb. counterpoise weights would probably be available), are added to the weight hanger until the load is nearly balanced (but not over balanced). The sliding poise is then positioned to make up the difference in the beam achieving a balance condition, and the indicated weight is the sum of the counterpoise weight values plus the reading face value of the poise on the beam.

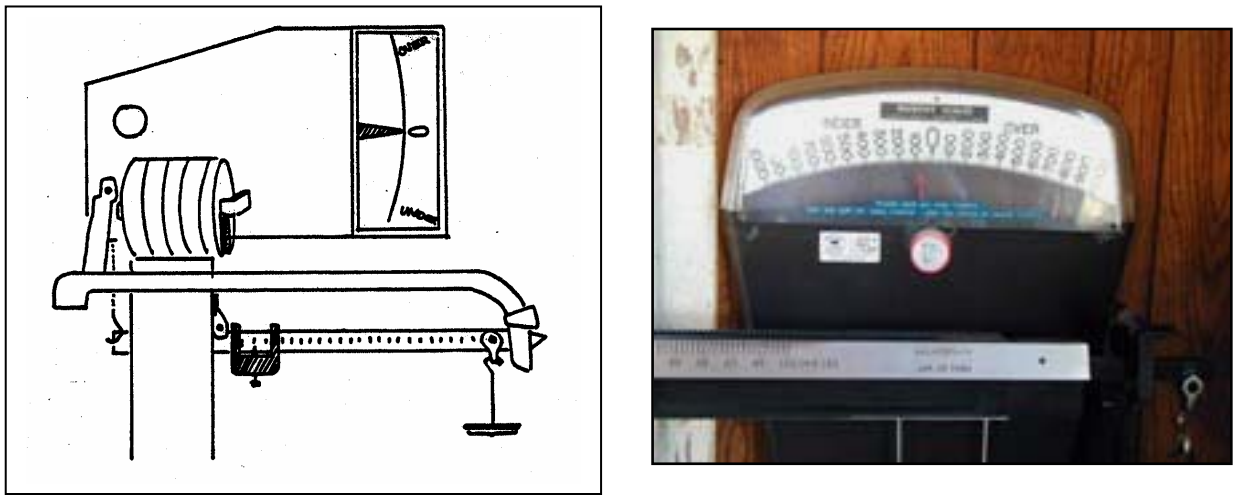
Counterpoise weight with scale ratio (1 lb. weight will balance a 100 lb. load on the scale deck)

The above example shows that a 1 lb. counterpoise weight will balance a 100 lb. load on the scale deck. This is because the scale ratio or multiple is 1:100. It is important to remember that not all scales use the same scale ratios or multiples so care should be taken to ensure counterpoise weights are not exchanged between scales with different multiples. The counterbalance weights and balance ball are used to obtain a balance condition when there is no load on the deck, and are not manipulated during weighing. In fact, all weights used to obtain a zero-load balance should be designed so that they cannot be readily manipulated and so facilitate fraud.

Now let us consider the weighbeam as an indicating element. As said earlier, the balance condition of the scale is indicated when the weighbeam is perfectly horizontal. In fact, when a load is applied to the platform, the tip of the weighbeam will move upward. When the poise is moved to a position that "balances" the load, the weighbeam will oscillate, or move up and down for some period of time before coming to rest. This movement, referred to as the **travel** of the weighbeam, is limited by the **trig loop**. The trig loop is a loop of metal, oval or oblong, through which the tip of the weighbeam passes: when the oscillating beam contacts the top or bottom of the trig loop it comes to a stop, indicating an out-of-balance condition. When the scale is balanced, the weighbeam tip should rest at the center of the trig loop or oscillate above and below the center of the trig loop, touching either limit. When the trig loop is properly adjusted, the oscillating tip of the balanced weighbeam should travel the same distance from the top and bottom limits before changing direction.

Trig Loop with Weighbeam Balance in the Center

The balance condition can always be determined by the operator by observing the travel of the weighbeam tip within the trig loop. However, some weighbeam scales are equipped with **balance indicators,** as shown below. These indicators generally include a dashpot to damp the weighbeam oscillations, and thus provide a quicker indication of the balance condition than observing the trig loop. In the example shown, when the pointer points to the "O" on the indicator scale, the scale is balanced. Another type of balance indicator includes graduations that are numbered to represent weight values by which the scale deviates from balanced condition. Because of the graduations, this latter type of balance indicator must be treated as a dial indicator during field testing by weights and measures officials.



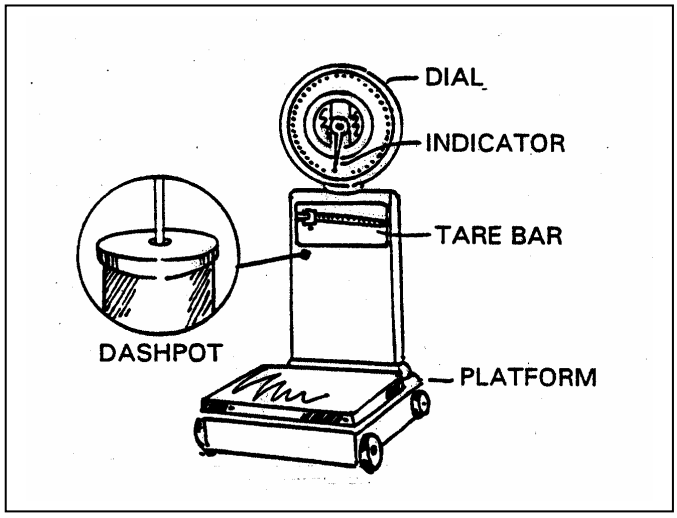
Weighbeam with a Balance Indicator

The following diagram shows the major elements of a typical dial indicator that is used with many older scales. These scales are slowly being replaced with more modern electronic scales. On a dial indicator scale the force of the load, reduced by the lever system, is transmitted by the steelyard rod to a shelf lever, which is enclosed in a cabinet directly below the indicator. The output of the shelf lever, transmitted by a beam rod, actuated the mechanical dial mechanism by the applied load drives the dial hand shaft by means of a rack and pinion. Dashpots are used to reduce oscillation of the indicator, and also to protect the indicator from mechanical shock when the load is applied. As with weighbeam scales, a balance ball is provided on the butt of the shelf lever for adjusting the system to a zero-load balance condition.

This type of scale may also be equipped with one or more weighbeam bars of the following types:

- ***Tare Bar*** – A weighbeam bar intended primarily for use in setting off or balancing the weight of an empty container, vehicle, etc.

- ***Capacity Bar*** – An auxiliary bar provided on an automatic-indicating scale to supplement the capacity of the reading face.



Portable Platform Scale with a Dial

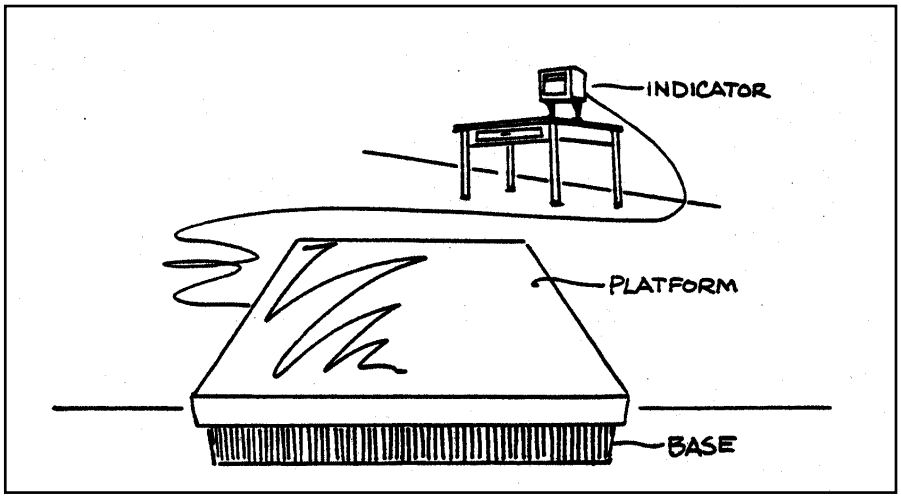
Mechanical scales have been used for over 100 years, while the levertronic and electronic scales only since the development of load cell technology in the 1960's. Most new installations are electronic (those in retail establishments with scanners, for instance) and quite a few are interfaced to computers. Many older mechanical scales have had load cells added to the steelyard rod and now read out electronically.

- The electrical signal produced by the weighing elements (load cells) is transmitted to the indicating elements by cable rather than by a mechanical linkage. This makes it possible to install remote readouts and to interface the scale to other electronic devices, such as computers and printers, which may also be located at remote locations.

- Electronic indicators have processing and memory capabilities, making it possible to enter correction and calibration factors from a control console rather than having to perform mechanical adjustments.

- Two or more electronic scales can be connected to a single indicator, which can display weight registration for each scale.

- Extensive tare capabilities are available, as will be described below.



Electronic Floor Scale with Remote Indicator

Electronic digital indicators display quantities and descriptors in numbers and letters and are far more user friendly than are dials or weighbeams.

Analog or Digital

Most modern day weighing devices are digital, where the numbers advance intermittently. An analog device, on the other hand, is one in which the indicating or recording values are presented as a series of graduations in combination with an indicator such as a sweep hand watch or clock.

Weighbeams generally use a combination of counterpoise weights and a poise to achieve a balance condition, and the counterpoise weights do not, of course, have graduations and an indicator. Indication on the most sensitive element, the beam, employs graduations and is continuous: the indicator passes through an infinite number of intermediate indications between graduations, even if it is not practically possible to read with accuracy to more than one or two subdivisions of the graduated intervals. Many times the beam may be balanced when the pointer is between two graduations. If a particular weighbeam has for example 8 oz. scale divisions**,** depending on the sensitivity of the scale, it may be possible to accurately read the indication to the nearest 4 oz. (0.25 lb.). The value represented by the smallest graduated interval on this device (8 oz.) is the scale division, commonly referred to as “d”.

Most digital indicators have scale divisions ranging from 0.005 lb. to 50 lb. and therefore are only capable of indicating in multiples of those values. The electronic system is designed to "round" values to the nearest increment. For example, if a digital indicator with a scale division of 1 lb. registers a load of 400 lb. and a 0.8 lb. test weight is added to the load, the indicator will register 401 lb., rounding the value to the nearest value that it is capable of displaying.

It might seem from this discussion that analog indicators are more accurate than digital indicators. This is not the case if the scale division is appropriate to the application, both types are equally accurate. However, the difference between the two devices can be significant from the point of view of test procedures. In cases where tolerances are not exact multiples of the scale division, the zone of uncertainty created by the rounding feature of a digital indicator must be taken into account. The following photograph illustrates typical electronic digital indications. The display window will have a liquid crystal or light emitting diode (LED) number and label display. The label would indicate, for example, whether the displayed weight is gross or net. The system might also be programmed to display prompts for the operator in this window.

Electronic Digital Indicator

Electronic Indicator

Some of the most common features of these devices are as follows:

On-Off Switch. This switch controls the power supply. Sometimes it will also perform the system segment check, test all the lights in the digital display, and verify whether each is working. Some on-off switches are designed to shut off power only to the display, thereby keeping the electronic circuitry warmed up.

Zero-Setting Mechanism. This device makes adjustments to maintain the scale in a zero-load balance condition. The semi-automatic zero-setting mechanism requires a single action by the operator. An example is the push-button zero**,** common on electronic scales. The scale may also have an auxiliary center of zero indicator that shows when zero-load balance has been achieved to within one-fourth scale division or less. Push-button zero mechanisms should **not** be used to set tare: since the tare function would not be indicated on the display. This practice could facilitate fraud.

Tare mechanism. A tare mechanism balances the material on the scale platform that is not to be included in the net weight. Two types of tare mechanism are common with scales having electronic digital weight indicators: push-button and keyboard tare. You may also find some scales with thumbwheel or dial tare.

Push-button Tare

An empty container is placed on the scale and the indicator shows its weight. Then the operator presses and releases the tare button and the indicator shows a weight of zero and indicates that the display is net weight. With the same container, now loaded on the scale, the indicator will show only the weight indication for the load - the net weight. In some systems, the gross or tare weight may be stored in memory.

Keyboard Tare

First the weight of the container is determined. This value is entered on a keyboard pad, using the digits 0 – 9, and the tare key on the pad is pressed. On some systems, the tare then shows in the weight display for verification. On other keyboard tare systems, the tare value is displayed on a separate tare display.

Thumbwheel (or Dial) Tare Mechanism

This also requires that the weight of the tare material be determined separately. Then the thumbwheels are turned until each digit in the tare weight is correctly shown in the window or next to the indicator line of the thumbwheels. Once the numbers have been set, this weight value will automatically be subtracted from the gross weight on the platform. (Note: There are probably very few of these scales left in service as they are now antiques.)

These tare taking capabilities are convenient for the operator and minimize the risk of operator error (especially the semi-automatic push-button tare). However, they can be abused. Whatever the tare mechanism, every digital scale must have some means to indicate when tare has been taken. For example, gross and net indications or a lighted legend, such as "Tare Entered".

Point-of-Sale System

Consists of a scale or other device (many times with a scanner), an indicator, a cash register, and a printer. On these systems the tare is quite often automatically subtracted when the operator enters the price look-up (PLU) or code for an item. For example, if green beans are placed in a plastic bag with a tie; and if these generally weigh 0.01 lb.; then the clerk enters the PLU number for green beans. A tare weight of 0.01 lb. is deducted and the consumer pays for the net amount only.

Typical Point-of-Sale System
with Electronic Indicator

- **Clear:** On some systems, tare is automatically cleared when the net load is removed from the platform. However, all scales that have a tare feature should have a manual clear function, so that the tare feature can be cleared even if the transaction is not completed for some reason.

- **Unit Selection:** Some scales are capable of displaying weight values either in inch-pound or metric units. A push-button or similar control is used by the operator to select the unit. In addition to displaying the indicated value in the selected unit, the display must also indicate the unit being displayed (pounds, kilograms or other).

- **Push-button Print:** Depressing this button activates a printer that can record weight values.

Recording Elements

Although not required by the California Code of Regulations, devices that make a permanent, printed record of the transaction are found on many scales. They are actuated by the same signal that produces the digital visual indication, and the two must agree exactly. If tare/gross is stored in "system" memory, the ticket can be printed in a single operation.

SELF-EVALUATION QUESTIONS

1. What is another term for strain gage?

2. A nose-iron adjusts the calibration of the scale by changing a lever ratio. It is an assembly that goes on the end of what?

3. A levertronic scale is what type of weighing system?

4. What kind of indicator is the weighbeam referred to because the scale operator must perform actions to obtain the measurement?

5. What supports the platform upon which the load rests during weighing?

6. What is the value represented by the smallest graduated interval of the scale referred to?

7. The push-button zero, common on electric scales, is an example of what kind of mechanism?

8. The tare setting mechanisms on electronic scales allow you to tare a container so that only what kind of weight is displayed?

9. What is a weighing element integrated with a scanner and electronic cash register with price look-up capability referred to?

Types, Classes and Scale Tolerances

Accuracy Classes of Scales

Weighing devices are divided into accuracy classes according to the number of scale divisions (n) and the value of the scale division (d). There are five classes or types (weighing applications) of scale categories as follows:

I	**Precision laboratory weighing.**
II	**Laboratory weighing, precious metals and gem weighing, grain test scales.**
III	**All commercial weighing not otherwise specified, grain test scales, retail precious metals and semi-precious gem weighing, animal scales, postal scales, scales used to determine laundry charges, and vehicle on-board weighing systems.**
III L	**Vehicle, axle-load, livestock, railway track scales, crane, hopper (other than grain hopper) scales, and vehicle on-board weighing systems.**
IIII	**Wheel-load weighers and portable axle load weighers used for highway weight enforcement (generally the California Highway Patrol).**

The majority of commercial scales tested by weights and measures officials fall into Class III or III L. Scales manufactured after January 1, 1986 are required to be marked with these class designations. There are many older scales in use which were built prior to January 1, 1986 which are not marked. However, we still place those scales into classes based on their use. When we start talking about the application of scale tolerances we look for those class markings as a guide for which set of tolerance tables to use.

Tolerance Determination

Scale tolerance values based on scale divisions or the number of d.

Table 6.
Maintenance Tolerances
(All values in this table are in scale divisions)

Tolerance in Scale Divisions				
	1	2	3	5
Class	Test Load			
I	0 – 50 000	50 001 - 200 000	200 001 +	
II	0 – 5 000	5 001 - 20 000	20 001 +	
III	0 – 500	501 - 2 000	2 001 - 4 000	4 001 +
IIII	0 – 50	51 - 200	201 - 400	401 +
III L	0 – 500	501 - 1 000	(Add 1d for each additional 500d or fraction thereof)	

This table (California Code of Regulations, Scale Code, 2.20) sets tolerance limits for inaccuracy that are allowed for particular devices. "*It is recognized that errorless value or performance of mechanical equipment is unattainable. Tolerances are established, therefore, to fix the range of inaccuracy within which equipment will be approved for commercial use." (*Handbook 44)

Two sets of tolerances are established: acceptance and maintenance tolerances.

- ***Acceptance Tolerance*** is applied to scales that are new or undergoing type evaluation, and are generally one-half of maintenance tolerances.

- ***Maintenance Tolerance*** is that tolerance which allows an additional range of inaccuracy within which a scale will be approved on subsequent tests, permitting an additional amount of deterioration before the scale is placed out of order and requires replacement or repair. In California, maintenance tolerance applies after one commercial use of that scale. Many times new scales are placed into service by licensed service agents and then weights and measures officials arrive to apply field standards and the maintenance tolerance is applied. However, service agents are required to place a correct device into service. This would include adjusting scales as close as practicable to zero error.

Theory of Tolerances

> ***"Tolerance values are so fixed that the permissible errors are sufficiently small that there is no serious injury to either the buyer or the seller of commodities, yet not so small as to make manufacturing or maintenance costs of equipment disproportionately high. Obviously, the manufacturer must know what tolerances his equipment is required to meet, so that he can manufacture economically. His equipment must be good enough to satisfy commercial needs, but should not be subject to such stringent tolerance values as to make it unreasonably costly, complicated, or delicate."*** (Handbook 44)

Tolerances are primarily accuracy criteria for use by weights and measures officials.

On a marked (Class III) 30 lb. capacity computing scale, divide the scale capacity of 30 lbs. by the value of the minimum division, in this case 0.01 lb., and determine the number of divisions as 3000. Looking at Table 6 the maintenance tolerance, or the amount of allowable error, for the test load applied from 0 to 500d is 1 division.

- When applying a test weight of 0.01 lb. to the scale, it would be within maintenance tolerance values if the scale indicated 0.00 to 0.02 lbs.
- When applying 5 lbs. of test weight to this same scale, the scale is within tolerance if it reads anywhere between 4.99 lb. and 5.01 lb.
- With one more "d" or 0.01 lb. of test weight, 501 divisions or 5.01 lbs. to be exact, the allowable error becomes 2d or 0.02 lb.

So with 5.01 lb. of weight on the scale platter, the scale indicator could read anywhere between 4.99 lb. and 5.03 lb. and be within tolerance values.

What if the scale is an older unmarked scale? Then look at Table T.1.1. of the Scale Code (California Code of Regulations 2.20) for the tolerance to apply. This table, for most commercial scales, refers us back to Table 6. All marked (III L) scale tolerances in Table T.1.1. are directed to Table 6. In the previous example, if that 30 lb. x 0.01 lb. scale were unmarked, then looking at Table T.1.1. and the number of "d" is equal to or less than 5000, then the tolerances are found in Table 6. This scale we already determined had only 3000d.

There are other considerations to be made when testing various types of scales. We try to test a scale "as used" with the same amount of test weight or more. We isolate various parts of the scale and its elements to identify any discrepancies that may require the scale to be repaired. Remember our discussion of correct at the very beginning, a scale may indeed be accurate, but it may not be correct. It may be something as small as burnt out LED (light emitting diode) or the numbers in a display on an indicator that would cause a scale to be incorrect.

SELF-EVALUATION QUESTIONS

1. The accuracy classes for commercial weighing devices are based on what criteria?

2. What accuracy class do the majority of commercial scales tested by weights and measures officials fall into?

3. New scale tolerances are set according to accuracy class. What are these based on?

4. Acceptance tolerances are applied to scales that are put into commercial use for the first time and generally what percent of the maintenance tolerance?

5. What are scale tolerances the limits for?

6. In California when does maintenance tolerance apply?

7. What is the accuracy class for a vehicle scale?

8. On a Class III scale, the tolerance is determined by what?

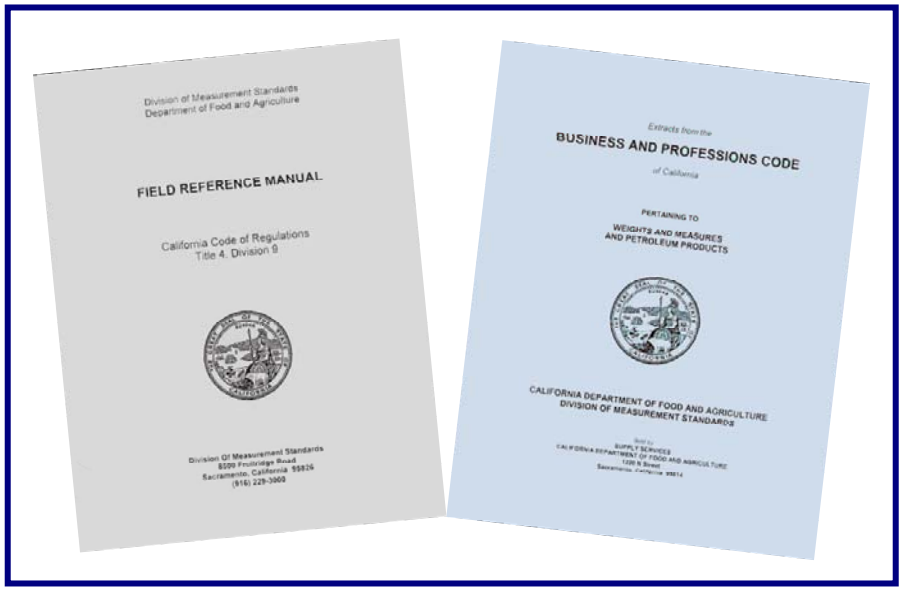
9. What tolerance would apply to a scale that is new and being placed into commercial service for the first time?

Pre-Test Determinations

Previous segments of this module have covered the design, construction, and application of different weighing devices. This segment will discuss the process of examining a device for compliance with design, maintenance, and user requirements to determine if the device can be sealed for commercial service.

Information regarding the requirements a commercial weighing device must meet is contained in the California Code of Regulations (CCR) General Code section (1.10) and the Scales Code section (2.20) under the "specifications" and "user requirements" paragraphs. These paragraphs regulate the design of the weighing device and how the device is to be installed, used, and maintained.

Laws are contained in the Business and Professions (B&P) Code, Division 5, Chapter 5. Other references may be contained in Division of Measurement Standards (DMS) policy letters, notices, and Examination Procedures Outline (EPO) reference letters. These are policies and clarifications to the code which are not regulations.



The best time to ensure a weighing device meets all these requirements is at the time of or prior to the time of installation. The device must be designed and installed in such a way that it is protected from environmental hazards including radio frequency interference. The device must also be installed in accordance with the manufacturer's instructions.

Regulations regarding the placement and visibility of a device along with the ability of an installation to maintain accuracy should be addressed. Compatibility between the different components that make up a weighing system should also be evaluated.

The EPO contains step-by-step inspection procedures for newly installed weighing devices and systems. A weighing device used for commercial purposes must meet all retroactive requirements irrespective of how long it has been in service.

Type Approval

Devices that are being placed into service for the first time and even devices that have been in use and inspected on an annual basis should be checked for non-approved equipment or software. Many times equipment alterations or added software programs that are not approved have been installed subsequent to the last inspection. The type approval or certificate of conformance will state the application the device may be used for, along with available features, options, compatible components, and sealing instructions.

An increasing number of commercial weighing elements and indicators are being interfaced with computers. An interface links weighing systems, indicators, printers, or electronic cash registers to the computer system hardware.

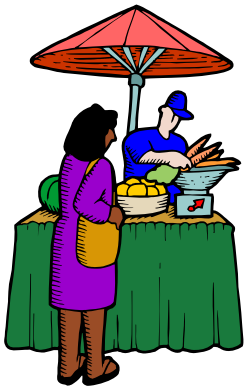
Many of the manipulations that are done by computer software have no effect on weights and measures functions. When the computer software calibrates, displays, computes price, stores weights, calculates extensions, or performs other significant metrological functions typically performed by a self-contained weighing device, then the computer has become an accessory connected with the weighing instrument. These manipulations may affect the metrological or audit trail aspects of a scale system and therefore must be evaluated and approved.

The EPO contains some basic software verification tests to help determine type evaluation compliance. More information may be obtained through the California Type Evaluation Program. If there are regulations covering computer generated features, then it probably requires evaluation.

Suitability

One of the basic requirements of both the Scale Code and the General Code user requirements is that the weighing device be suitable for its application.

An example might be if you were weighing vegetables at a farmer's market, it would be illegal to use a postal weight classifier to determine a weight for charge because the postal weight classifier rounds up according to postal rate instead of by weight. Similarly, you would not use a 1,000 lb. floor scale to weigh your 5 lb. of vegetables because the floor scale, with 1 lb. divisions, was not designed for the sensitivity and accuracy range of 5 lb. The general rule is that a scale cannot be used to weigh a net load of less than 20d.



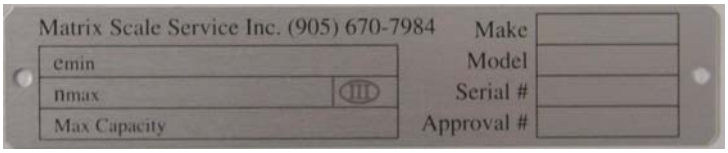
The recommended minimum load for commercial scales is listed in Table 8 of the Scale Code (CCR 2.20). The use of an unsuitable device to weigh light loads is likely to result in relatively large errors.

In addition to the suitability of the device, the device installation and its support must be adequate so level condition and clearance will be maintained and operation and performance will not be adversely affected.

Not only does the device need to be suitable for the application, but the device can only be used in a manner that is indicted by its construction or the manufacturer's use instructions.

Marking Requirements

Required identification includes information needed to verify suitability of the device. The manufacturer and model information will aid you in obtaining the National Type Evaluation Program (NTEP) Certificate of Conformance (CC) or a California Certificate of Approval. On new devices with an NTEP CC, the CC number must also be marked.



Most scales will have the scale capacity, value of the scale division, and accuracy class marked on an identification tag or plate. This information will help determine the correct tolerances to apply during testing.

Additional marking requirements of a weighing device are found in the CCR under the specifications paragraphs of the General Code (1.10) and the Scales Code (2.20).

These marking requirements along with type approvals, laws, regulations, and other references are valuable resources in determining if a weighing device or system is correct.

Inspection vs. Testing

As you can see, the actual testing of a device is only a small portion of the process used in determining if a device can be sealed for commercial use. During the pre-test determinations the device is inspected to determine compliance with design specifications, proper marking requirements, proper installation, and its suitability for its application. Type approval of the device and its components is confirmed and compliance with user requirements is verified. Users must maintain a weighing device in proper operating condition. All these pre-test determination requirements are contained in the Business and Professions Code and the California Code of Regulations.

Inspection is used to include the scope of these pre-test determinations.
Testing is the process to determine the accuracy of the device.

Testing is done to establish whether the performance of the device falls within the applicable tolerances established for that device in regulation. When performance falls within these tolerances, the device is said to be “accurate”.

In order for a device to be sealed for commercial use it must be “correct”. This means that the device, in addition to being accurate, meets all the requirements you inspected for in the pre-test determinations. A correct device as defined in the Business and Professions Code is a weighing instrument, which meets all of the tolerances, specifications, and other technical requirements established by the director for commercial weighing.

Testing and Sealing

Commercial weighing devices must meet performance requirements (tolerances) contained in the CCR. These tolerances are verified during testing of the device.

As you can tell by reviewing the CCR and EPO the range of weighing systems varies greatly. Testing capacities may range from jewelers' scales to railway track scales and may vary from bulk load weighers to electronic cash registers.

Jeweler Scale

Performance tests are conducted with field standard test weights traceable back to the National Institute of Standards and Technology and used in predetermined amounts placed on the load-bearing element. The range of test standards you may be utilizing might range from milligram weights you handle with tweezers to 1,000 lb. blocks you set with a crane.

When testing large capacity scales, the amount of field standard test weights available may be less than the "use" or nominal capacity of the scale. In these instances the inspector may utilize either the "substitution" method of testing or the "strain-load" test method.

> ***Substitution Method*** - The known test weight is applied to the scale and the scale indicator is brought to a readily reproducible balance condition. The known weight is then removed and substituted with material that is available to bring the scale back into the reproducible balance condition when the known weight was applied. The material is left on the scale and the known test weight is placed back on the scale. Tolerances are then applied to the entire amount represented on the scale. This method may only be repeated up to three times to reach the "use" capacity of the scale.

Strain-Load Method - Testing is designed to stress the scale in different operating weight ranges. First, the field test standards are applied to the scale and tolerances are applied. The test standards are removed and an unknown load such as equipment or a loaded grain hopper, preferably in the same weight range as the test standards, is applied to the scale. The unknown load is then balanced out on the scale. The known test load is then added to the scale; however, in the "strain-load" method, tolerances are applied only to the amount of known test weight added.

This application of tolerances to only the known test weight added is the basic difference between "strain-load" testing and the "substitution" method. The "strain-load" method is dependent on the addition of unknown weight only to stress, or load up the scale to the working range of the scale. In the "substitution" method, the material is added in an amount **equaling** the known test load and thereby becomes a known amount.

This is a brief overview of substitution/strain-load testing. The complete test methods for substitution/strain-load testing are contained in EPO No. 4-A.1.

Because of the many different types of weighing systems, testing procedures will vary according to the device being tested. Testing procedures are contained in the Device Enforcement Program Manual and will not be covered here.

It is recommended that you train with qualified county or state officials before proceeding with field-testing. There are numerous safety issues to consider when testing devices such as crane scales, belt conveyor scales and monorail scales. Additional training is needed to operate a heavy capacity truck and boom. Safe handling of the 25 lb. and 50 lb. weights and weight kits should also be covered. Many industrial sites have other hazards relating to chemicals, machinery, etc.

At the conclusion of the test, a correct device will need to be sealed. In addition to the familiar round seal displayed on the device, most devices have provisions for securing the mechanism used by a service agent to make adjustments and calibrations. There are primarily three ways to secure the calibration mechanism and although none will prevent access, they provide evidence of tampering. The traditional method of securing the adjustment mechanism is by using a lead and wire seal.

Security seal

The adjustment mechanism is often covered by a plate held in place with screws, which have holes drilled in the heads.

The service agent or weights and measures official can place a wire through these holes and secure it, with usually a lead seal. The seal is pressed or secured with identifying markings and is what we call a “security or physical seal”.

Another method of physical sealing used where using a lead and wire seal is not feasible is the tamper-resistant pressure sensitive paper seal. This is a paper seal that is applied over an access hole or two halves of a cover and will tear in a predictable pattern if an attempt to remove it is made.

If either of these seals is not intact, the integrity of the device is compromised. It is illegal to use such a device in commerce.

With the advent of computers and communications allowing for electronic configuration, some through modems or access lines, it is sometimes difficult to prevent access to the calibration and parameter functions with the traditional lead and wire or tamper-resistant seals. An electronic “audit trail” is an alternative means of monitoring changes to a device. These may be calibration or configuration parameters (i.e., scale capacity, division size, unit of measure etc.). The “trail” is a minimum of two numbers one of which increases by one, or increments, each time a calibration is made and the other when a configuration value changes. The term for these is “event counter” or “logger”. Basic audit trails do not show what event or change took place only that a calibration was made or configuration changed. Systems that are more sophisticated may have the ability to provide detailed information, such as date, time, user ID, which values were changed, etc.

These event counter values are available and should be recorded during a routine inspection, then, in the event of a consumer complaint or during an investigation, a weights and measures official can compare them to earlier records to determine if there has been unauthorized or unreported access.

Security seals are usually broken when a device is repaired or adjusted; however, whenever a commercial device is repaired or adjusted, the County Sealer must be notified within 24 hours (B&P Code Section 12515). If a service agency repaired or adjusted the device, then the service agency identification must be placed on the device (see ***Module 14, Services Agencies and Agents***).

Enforcement Tools

When a commercial device does not meet the tolerances, specifications, and technical requirements, it cannot be sealed and may need to be removed from service. If any party other than the device owner is adversely affected it must be removed from service by placing a red tag on the device. The level of enforcement may not necessarily be the lowest degree of enforcement. More serious violations may support civil proceedings or criminal citations. This procedure should be discussed with your supervisor so your county's policies may be followed. ***Training Module 3, Enforcement Procedures*** contains an overview of enforcement procedures.

Some counties may allow the use of a device when it is out of tolerance pending repair.

B&P Code § 12501.3	A sealer may permit the use of an unsealed device pending repairs if the device is in error only to the disadvantage of the user and the user is always the seller. Such an unsealed device shall be repaired within 30 days. *Check with your supervisor so you may follow your county procedures.*

When a device is used by a weighmaster to determine entries for a weighmaster certificate, only approved and sealed devices can be used.

B&P Code § 12717	Any weighing, measuring, or counting device which is used by a weighmaster and for which specifications and tolerances have been adopted by the director, shall be approved, tested and sealed in accordance with this division. When a device is used by a weighmaster and is found out of tolerance it must be tagged "out of order" regardless if the error is only to the disadvantage of the user and the user is always the seller.

When a device is found not to be in compliance, a "Notice of Violation" should be issued. The "Notice of Violation" will list the B&P Code violations and also the CCR violations. An explanation or description of the areas that are not in compliance is included and copies are presented to the responsible party for signature. This provides a written acknowledgement that the responsible party is aware of the violations that are present.

B&P Code § 12507	The responsible party should also be aware of the time frame they have to correct the violations and possible action for not correcting the device.
B&P Code § 12508	Removing a sealers tag.
B&P Code § 12510	Using an incorrect device.

STATE OF CALIFORNIA
DEPARTMENT OF FOOD AND AGRICULTURE
DIVISION OF MEASUREMENT STANDARDS

ORIGINAL TO COUNTY
YELLOW TO OWNER OR AGENT
PINK TO STATE

COUNTY

NOTICE OF VIOLATION

BUSINESS NAME | ADDRESS | CITY | ZIP | PHONE

NAME | HOME ADDRESS | CITY | ZIP | PHONE

YOU ARE HEREBY NOTIFIED THAT YOU ARE IN VIOLATION OF SECTION(S)

SECTION(S) (Check Appropriate Boxes) — BUSINESS AND PROFESSIONS CODE OF CALIFORNIA
SECTION(S) — CALIFORNIA CODE OF REGULATIONS
SECTION(S) — PENAL CODE OF CALIFORNIA

DESCRIPTION OF OFFENSE(S)

SIGNATURE OF OWNER OR AGENT OF OWNER | TITLE | DATE | TIME

THESE VIOLATIONS MAY SUBJECT YOU TO PENALTIES AS PROVIDED FOR IN DIVISION 5 OF THE BUSINESS AND PROFESSIONS CODE OF CALIFORNIA OR THE PENAL CODE OF CALIFORNIA.

BY | TITLE | PHONE

40-033 (Rev. 11/01)

One of the responsibilities of a County Sealer is to remove from commercial service incorrect weighing devices. Enforcement may be as simple as pulling the seal off the device so it can no longer be used commercially to issuing an unapproved device tag on scales that do not meet type approval. Scales that are in need of repair may be tagged out of order or may be condemned if they are deemed not susceptible to repair.

An owner of a device may repair his or her own equipment; however, only a County Sealer or a licensed service agent representing a registered service agency may place the device into service or remove a sealer's tag.

Any person who repairs or places a device into service must notify the county sealer so the device may be inspected for compliance.

Refer to ***Training Module 14, Service Agencies and Agents*** for more information and responsibilities of a service agency.

SELF-EVALUATION QUESTIONS

1. When must computer software interfaced with a weighing device be evaluated?

2. What does the Examination Procedures Outline contain?

3. Why is it considered an unsuitable use of a weighing device to weigh a net load under 20d?

4. What identification markings on a weighing device will help you obtain the National Type Approval Certificate of Approval?

5. What is the purpose of a pre-test inspection?

6. Can a device be accurate and not correct? Explain.

7. The many types of testing procedures may be found in what document?

8. Security seals do not prevent tampering so what do they do?

9. Can the owner of a weighing device repair and then use it?

GLOSSARY

A LISTING OF TERMINOLOGY AND ACRONYMS MOST COMMONLY USED BY WEIGHTS AND MEASURES OFFICIALS.

Accurate – A piece of equipment is “accurate” when its performance or value - that is, its indications, its deliveries, its recorded representations, or its capacity or actual value, etc., as determined by tests made with suitable standards - conforms to the standard within the applicable tolerances and other performance requirements. Equipment that fails so to conform is “inaccurate”.

Analog Type – Refers to a system of indication or recording in which values are presented as a series of graduations in combination with an indicator, or in which the most sensitive element of an indicating system moves continuously during the operation of the device.

Applied Load – The force or weight on a load-receiving element of a scale beyond that required to maintain the zero-load balance. Sometimes also called “live load”.

Automatic-Indicating Scale – One of which the weights of applied loads of various magnitudes are automatically indicated throughout all or a portion of the weighing range of the scale.

Balance Ball – A relatively small mass attached to a weighbeam or lever and designed to be moved for the purpose of balancing the scale at zero load. Also called “balance weight”.

Balance Indicator – An accessory designed to magnify the indication and to indicate, by means of the relative positions of an indicator and a fixed reference, whether the weight of the applied load is greater or less than or equal to the weight indication; sometimes graduated in weight units.

Beam Scale – One on which the weights of loads of various magnitudes are indicated solely by means of one or more weighbeam bars either alone or in combination with counterpoise weights.

Commercial – In a restricted sense, pertaining to barter and trade or the purchase of sale of any commodity or service. Tolerances and specifications for commercial weighing devices and their use are developed by the National Conference on Weights and Measures.

Correct – A piece of equipment is “correct” when, in addition to being accurate, it meets all applicable specification requirements. Equipment that fails to meet any of the requirements for correct equipment is “incorrect”.

GLOSSARY

A LISTING OF TERMINOLOGY AND ACRONYMS MOST COMMONLY USED BY WEIGHTS AND MEASURES OFFICIALS.

Counterbalance Weight – One intended for application near the butt of a weighbeam for zero-load balancing purposes.

Counterpoise Weight – An adjusted, removable, (usually) slotted weight, intended to counterpoise an applied load of designated weight value. Sometimes also called “counterweight”

Dashpot – Primarily a damping device, sometimes adjustable. It usually comprises a piston and cylinder, relative motion of which displaces air, oil, or other fluid.

Digital Type – A system of indication or recording of the selector type or one that advances intermittently in which all values are presented digitally or in numbers. In a digital indicating or recording element, or in digital representation, there are no graduations.

Graduation – A defining line or one of the lines defining the subdivisions of a graduated series. The term includes such special forms as raised or indented or scored reference “lines” and special characters such as dots.

Indicating Element – An element incorporated in a weighing or measuring device by means of which its performance relative to quantity or money value is “read” from the device itself as, for example, an index-and-graduated-scale combination, a weighbeam-and-poise combination, a digital indicator, and the like.

Indicator – (1) A device which indicates weight by converting the original weight signal to a form of display, regardless of its location relative to the load-receiving element. (2) Any element of a scale which, by means of its position with reference to a graduation, a series of graduations or another indicator, shows the condition of balance or the weight or value indications of the scale. Sometimes especially in a dial scale, called “hand pointer”.

Lever – In a scale, a part, provided with pivots or flexure plates, for translating external forces.

Lever System – In a compound lever scale, the aggregation of live parts between the load-receiving element and the steelyard rod; sometimes all live parts from the load-receiving element to and including the weighbeam.

GLOSSARY

A LISTING OF TERMINOLOGY AND ACRONYMS MOST COMMONLY USED BY WEIGHTS AND MEASURES OFFICIALS.

Levertronic Scale – A scale in which the indicting and the recording devices can be activated either manually or electronically and which generally has one load cell mounted in the lever system.

Load Cell – The basic weighing element of a load cell scale. The load cell, whether electric, hydraulic, or pneumatic, produces a signal proportional to the load applied.

Load-Receiving Element – That element of a scale which is designed to receive the load to be weighed. For example, platform, deck, rail, hopper, platter, plate, scoop.

Maintenance Tolerance – A tolerance for application under test conditions to a device in service; usually applied to errors “as found”. Sometimes also called “users’ tolerance”.

National Conference on Weights and Measures – An organization of weights and measures officials of states and local jurisdictions which meets annually, sponsored by the National Institute of Standards and Technology for developing model laws and regulations.

National Institute of Standards and Technology – A non-regulatory federal agency whose mission is to develop and promote measurements, standards and technology.

National Type Evaluation Program – Was developed to examine the design, features, operating characteristics, and performance of weighing and measuring devices.

Nominal Capacity – The nominal capacity of a scale is (a) the largest weight indication that can be obtained by the use of all of the reading or recording elements in combination, including the amount represented by any removable weights furnished or ordinarily furnished with the scale, but excluding the amount represented by any extra removable weights not ordinarily furnished with the scale, and excluding also the capacity of any auxiliary weighing attachment not contemplated by the original design of the scale, and excluding any fractional bar with a capacity less than 2-1/2 percent of the sum of the capacities of the remaining reading elements; or (b) the capacity marked on the scale by the manufacturer, whichever is less.

GLOSSARY

A LISTING OF TERMINOLOGY AND ACRONYMS MOST COMMONLY USED BY WEIGHTS AND MEASURES OFFICIALS.

Non-commercial – Not pertaining to barter or trade, or to the purchase or sale of a commodity or service; opposed to “commercial”.

Nose-Iron – A slide-mounted, manually-adjustable pivot assembly for changing the multiple of a lever.

Oscillation – A swinging or varying alternately above and below a mean value.

Output – The signal (voltage, current, pressure, etc.) produced by the load cell. Note: When the output is directly proportional to excitation, the signal must be expressed in terms of volts per volt, volts per ampere, etc., of excitation.

Pivot – That about which something turns or may be supposed to turn; hence, that essential element of a conventional scale lever, designed to transmit external forces through its knife-edge.

Platter – The “platform” of a counter scale. Platters are sometimes identified as “commodity platters” or “weight platters”, according as they are intended for the reception of the commodity to be weighed or the weights which couterpoise the weights of the commodity load.

Poise – A movable weight mounted upon or suspended from a weighbeam bar and used in combination with graduations, and frequently with notches, on the bar to indicate weight values. (A suspended poise is commonly called a “hanging” poise.)

Reading-Face – That portion of an automatic-indicating weighing or measuring device that gives a visible indication of the quantity weighed or measured. A reading face may include an indicator and a series of graduations or may present values digitally, and may also provide money-value indications.

Reading-Face Capacity – The largest weight that may be indicated on the reading face, exclusive of the application of any unit weights, weight ranges, or other elements.

Recording Element – An element incorporated in a weighing or measuring device by means of which its performance relative to quantity or money value is permanently recorded on a tape, ticket, card, or the like, in the form of a printed, stamped, punched, or perforated representation.

GLOSSARY

A LISTING OF TERMINOLOGY AND ACRONYMS MOST COMMONLY USED BY WEIGHTS AND MEASURES OFFICIALS.

Registered Service Agency – The term "registered service agency" means any agency, firm, company, or corporation which, for hire, award, commission, or any other payment of any kind, installs, services, repairs, or reconditions a commercial weighing or measuring device, and is registered with the Secretary of the California Department of Food and Agriculture.

Remote Indicator – A device which duplicates the information derived by the "indicator" and is located remotely. Also called "remote display, repeater, or slave".

Scale Division, Value of (d) – The value of the scale division, expressed in units of mass is the smallest subdivision of the scale for analog indication (d) or the difference between two consecutively indicated or printed values for digital indication or printing.

Seal – (1) The sign, symbol or object placed upon a weighing or measuring device to indicate that it has been inspected and tested by a governmental agency and found to be correct. (2) A device used to prevent disturbances of adjustment.

Security Seal – A lead-and-wire seal, a sufficiently permanent pressure-sensitive seal, or similar device, attached to a weighing or measuring device for protection against or to indicate access to, removal of, or adjustment.

Shelf Lever – That lever nearest in the translation of forces to the weighbeam. When the term applies, the lever is relatively short, is fulcrumed from the shelf, and is parallel to the weighbeam. Sometimes also called "bench lever".

Sliding Poise – A poise which may be slid along a weighbeam, as differentiated from one which is mounted on rollers or is hung from the weghbeam.

Steelyard Rod – The vertical rod which transmits loads to the shelf lever.

Tare – The weight of an empty container or vehicle, or of spools, cores or wrappings, or the allowance or deduction from gross weight made on account thereof. Sometimes also called "light weight", with respect to a container or vehicle.

GLOSSARY

A LISTING OF TERMINOLOGY AND ACRONYMS MOST COMMONLY USED BY WEIGHTS AND MEASURES OFFICIALS.

Tare Mechanism (Tare Bar) – A weighbeam bar intended primarily for use in setting off or balancing the weight of an empty container, vehicle, etc.

Test Load – A load of known weight value applied to a scale for testing purposes.

User Requirement – A requirement dealing with the selection, installation, use, or maintenance of a weighing or measuring device. User requirements are directed primarily to the users of devices.

Weighbeam – An element comprising one or more bars, equipped with movable poises or means for applying counterpoise weights or both.

Weighbridge – The structural frame carried by the main bearings and supporting the load-receiving element in a large capacity scale.

Weighing Element – That portion of a scale that supports the load-receiving element and transmits to the indicating element a signal or force resulting from the load applied to the load-receiving element.

Zero-Load Balance – A correct weight indication or representation of zero when there is no load on the load-receiving element.

Zero-Setting Mechanism – Means provided to attain a zero balance indication with no load on the load-receiving element.

Zone of Uncertainty – The zone between adjacent increments on a digital device in which the value of either of the adjacent increments may be displayed.

BIBLIOGRAPHY AND REFERENCES

Business and Professions Code, Division 5

Division of Measurement Standards, Device Enforcement Program Manual

Division of Measurement Standards, Field Reference Manual (California Code of Regulations, Title 4, Division 9)

National Conference on Weights and Measures, Course Number 203, Module 4, Medium Capacity Inspector's Manual

National Institute of Standards and Technology, Handbook 44, Specifications, Tolerance, and Other Technical Requirements for Weighing and Measuring Devices

National Institute of Standards and Technology, Handbook 130, Uniform Laws and Regulations

Scale Manufacturers Association, Inc., Terms and Definitions for the Weighing Industry, Fourth Edition 1981

SELF-EVALUATION ANSWERS

Segment 1

1. User of the scale.
2. Weighments are documented on weighmaster certificates by a licensed weighmaster.
3. A pre-packaging scale.
4. Field Reference Manual.
5. California has some exceptions, exemptions, and modifications to the handbook.

Segment 2

1. California Code of Regulations.
2. It sets the baseline for all types of commercial devices.
3. The requirement is non-retroactive.
4. The Device Enforcement Program Manual.

Segment 3

1. Load cell.
2. Lever.
3. Electro-mechanical.
4. Non-automatic.
5. The weighbridge.
6. Scale division.
7. Semi-automatic zero-setting mechanism.
8. Net.
9. A point-of-sale system.

Segment 4

1. According to both the number of scale divisions and the value of the scale division.
2. III or III L.
3. Scale divisions or number of d.
4. One-half.
5. Range of inaccuracy within which equipment will be approved for commercial use.
6. After one commercial use.
7. III L.
8. Test load and Table 6.
9. Acceptance.

SELF-EVALUATION ANSWERS

Segment 5

1. When it can manipulate metrological aspects of a transaction.
2. Step-by-step inspection procedures and some basic software verification tests.
3. It is likely to result in relatively large errors.
4. Manufacturer, model, and on new devices the National Type Evaluation Certificate of Conformance number.
5. To determine compliance with specifications, marking, installation and suitability, type approval, and user requirements.
6. Yes, an accurate device meets all tolerances but may not meet specifications. A correct device must meet all tolerances and specifications.
7. The Device Enforcement Program Manual.
8. They leave evidence that tampering may have occurred and that integrity has been compromised.
9. An owner may repair the equipment, but only a registered service agent or sealer may place it back into service.

MORE SELF-EVALUATION QUESTIONS

Following are more self-examination questions, which will test the knowledge you have gained in this module. Answering them is not required but please take a few minutes to read them before you move on to the next module. No answers are provided, but if you are unsure of a response, rereading the training material will give you the information you need.

1. A device attached to a weighing device for protection against or to indicate access to adjustment is:

   (a) An approval seal
   (b) A security seal
   (c) A red tag

2. A requirement dealing with the selection, installation, use, or maintenance of a weighing device is:

   (a) A type approval
   (b) An inspection requirement
   (c) A user requirement

3. When a device's performance, indications and recorded representations conform within the applicable tolerances and other performance requirements, it is:

   (a) Accurate
   (b) Correct
   (c) Usable

4. Any weighing or measuring device commercially used or employed in establishing the size, quantity, or measurement of quantities, things produced for distribution or consumption, purchased, offered or submitted for sale, or in computing any basic charge or payment on the basis of weight or measure is:

   (a) An approved device
   (b) A commercial device
   (c) A correct device

MORE SELF-EVALUATION QUESTIONS

5. If a scale is in place where buying or selling is commonly carried on, the scale is a _____ and subject to examination.

   (a) Non-commercial scale
   (b) In-house scale
   (c) Commercial scale

6. Maintenance tolerances apply to scales that are:

   (a) Already in service
   (b) Just repaired
   (c) All of the above

7. Sensitivity test requirements are contained in the:

   (a) California Code of Regulations
   (b) National Institute of Standards and Technology, Handbook 44
   (c) Device Enforcement Program Manual

8. On scales equipped with a printer, the printed indication must match the indicated representation _____.

   (a) Exactly
   (b) Within tolerance
   (c) Within one division

9. A scale that is interfaced with a scanner, cash register and printer is referred as a:

   (a) Point-of-sale system
   (b) Electronic cash register
   (c) Price look-up system

We would appreciate your taking a few moments to complete our training evaluation feedback form. We welcome your comments and any suggestions you might have regarding Training Module 9. You may E-mail your response to us at DMS@cdfa.ca.gov or mail to Division of Measurement Standards at 6790 Florin Perkins Road, Suite 100, Sacramento CA 95828-1812.

1. Did this module fulfill your expectations?

2. What did you like/dislike about this module?

3. What areas would you like to see improved?

4. What specific changes, if any, would you recommend?

5. How could this module be better organized to make it easier to follow and learn from?

6. Was this module too basic or too advanced for someone with an entry level background in weights and measures?

7. Additional comments or suggestions.