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## Section 2.24. Automatic Weighing Systems

### A. Application

**A.1. General.** – This code applies to devices used to automatically weigh pre-assembled discrete loads or single loads or loose materials in applications where automatic weighing systems<sup>1</sup> are used or employed in the determination of quantities, things, produce, or articles for distribution, for purchase, offered or submitted for sale, for distribution, purchase, or in computing any basic charge or payment for services rendered on the basis of weight, and in packaging plants subject to regulation by the USDA. Some weigh-labelers and checkweighers may also include a scale that is incorporated in a conveyor system that weighs packages in a static or non-automatic weighing mode<sup>2</sup>.

This includes:

- (a) Automatic weigh-labelers;
- (b) Combination automatic and non-automatic weigh-labelers;
- (c) Automatic checkweighers;
- (d) Combination automatic and non-automatic checkweighers; and
- (e) Automatic gravimetric filling machines that weigh discrete loads or single loads of loose materials and determine package and production lot compliance with net content representations.

(Amended 1997 and 2004)

**A.2. Exceptions.** - This code does not apply to:

- (a) Belt-Conveyor Scale Systems;
- (b) Railway Track Scales;
- (c) Monorail Scales;
- (d) Automatic Bulk-Weighing Systems;
- (e) Devices that measure quantity on a time basis;
- (f) Controllers or other auxiliary devices except as they may affect the weighing performance; or

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<sup>1</sup> An automatic weighing system does not require the intervention of an operator during the weighing process. The necessity to give instructions to start a process or to release a load or the function of the instrument (static, dynamic, set-up, etc.) is not relevant in deciding the category of automatic or non-automatic instruments.

(Added 2004)

<sup>2</sup> Prepackaging scales (and other commercial devices) used for putting up packages in advance of sale are acceptable for use in commerce if all appropriate provisions of Handbook 44 are met. Users of such devices must be alert to the legal requirements relating to the declaration of quantity on a package. Such requirements are to the effect that, on the average, the contents of the individual packages of a particular commodity comprising a lot, shipment, or delivery must contain at least the quantity declared on the label. The fact that a scale or other commercial device may overregister, but within established tolerances, and is approved for commercial service is not a legal justification for packages to contain, on the average, less than the labeled quantity.

(Added 2004)

- (g) Automatic gravimetric filling machines and other automatic weighing systems employed in determining the weight of a commodity in a plant or business with a separate quantity control program (e.g., a system of statistical process control) using suitable weighing instruments and measurement standards traceable to national standards to determine production lot compliance with net content representations.<sup>3</sup>

(Added 2004)

**A.3. Additional Code Requirements.** – In addition to the requirements of this code, Automatic Weighing Systems shall meet the requirements of Section 1.10. General Code.

## S. Specifications

### S.1. Design of Indicating and Recording Elements and of Recorded Representations.

#### S.1.1. Zero Indication.

- (a) A weigh-labeler shall be equipped with an indicating or recording element. Additionally, a weigh-labeler equipped with an indicating or recording element shall either indicate or record a zero-balance condition and an out-of-balance condition on both sides of zero.

(Amended 2004)

- (b) An automatic checkweigher may be equipped with an indicating or recording element.
- (c) A zero-balance condition may be indicated by other than a continuous digital zero indication, provided that effective automatic means is provided to inhibit a weighing operation or to return to a continuous digital indication when the device is in an out-of-balance condition.

#### S.1.1.1. Digital Indicating Elements.

- (a) A digital zero indication shall represent a balance condition that is within  $\pm \frac{1}{2}$  scale division.
- (b) A digital indicating device shall either automatically maintain a “center of zero” condition to  $\pm \frac{1}{4}$  scale division or less, or have an auxiliary or supplemental “center-of-zero” indicator that defines a zero-balance condition to  $\pm \frac{1}{4}$  scale division or less.
- (c) Verification of the accuracy of the center of zero indication to  $\pm \frac{1}{4}$  scale division or less during automatic operation is not required on automatic checkweighers.

(Amended 2004)

**S.1.2. Value of Division Units.** – The value of a division  $d$  expressed in a unit of weight shall be equal to:

- (a) 1, 2, or 5; or
- (b) a decimal multiple or submultiple of 1, 2, or 5.

The requirement that the value of the scale division be expressed only as 1, 2, or 5, or a decimal multiple or submultiple of only 1, 2, or 5 does not apply to net weight indications and recorded representations that are calculated from gross and tare weight indications where the scale division of the gross weight is different from the scale division of the tare weight(s) on multi-interval or multiple range scales. For example, a multiple range or multi-interval scale may indicate and record tare weights in a lower weighing range (WR) or weighing segment (WS), gross weights in the higher weighing range or weighing segment, and net weights as follows:

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<sup>3</sup> See NIST Handbook 130, Uniform Laws and Regulations in the Area of Legal Metrology and Engine Fuel Quality, Interpretations and Guidelines, paragraph 2.6.11. Good Quantity Control Practices.

$\begin{array}{r} 55 \text{ kg Gross Weight (WR2 d = 5 kg)} \\ - 4 \text{ kg Tare Weight (WR1 d = 2 kg)} \\ \hline = 51 \text{ kg Net Weight (Mathematically Correct)} \end{array}$ <p>(Amended 2008)</p>	$\begin{array}{r} 10.05 \text{ lb Gross Weight (WS2 d = 0.05 lb)} \\ - 0.06 \text{ lb Tare Weight (WS1 d = 0.02 lb)} \\ \hline = 9.99 \text{ lb Net Weight (Mathematically Correct)} \end{array}$
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**S.1.2.1. Weight Units.** – Except for postal scales, indicating and recording elements for shipping and postal applications, and scales used to print standard pack labels, a device shall indicate weight values using only a single unit of measure.

(Amended 2004)

**S.1.3. Provision for Sealing.**

(a) **Automatic Weighing Systems, Except Automatic Checkweighers.** – A device shall be designed with provision(s) as specified in Table S.1.3. Categories of Device and Methods of Sealing for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity of the device can be made to any electronic mechanism.

(b) **For Automatic Checkweighers.** – Security seals are not required in applications where it would prohibit an authorized user from having access to the calibration functions of a device.

<b>Table S.1.3. Categories of Device and Methods of Sealing</b>	
<b>Categories of Device</b>	<b>Methods of Sealing</b>
<b>Category 1:</b> No Remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
<b>Category 2:</b> Remote configuration capability, but access is controlled by physical hardware.  The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode.	The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters: one for calibration parameters and one for configuration parameters.
<b>Category 3:</b> Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. ( <b>Note:</b> Does not require 1000 changes to be stored for each parameter.)

**S.1.4. Automatic Calibration.** – A device may be fitted with an automatic or a semi-automatic calibration mechanism. This mechanism shall be incorporated inside the device. After sealing, neither the mechanism nor the calibration process shall facilitate fraud.

**S.1.5. Adjustable Components.** – Adjustable components shall be held securely in adjustment and, except for a zero-load balance mechanism, shall be located within the housing of the element.

## S.2. Design of Zero and Tare Mechanisms.

### S.2.1. Zero Load Adjustment.

**S.2.1.1. Automatic Zero-Tracking Mechanism.** – Except for automatic checkweighers, under normal operating conditions the maximum load that can be “rezeroed,” when either placed on or removed from the platform all at once, shall be 1.0 scale division.

Except for an initial zero-setting mechanism, an automatic zero adjustment outside these limits is prohibited.

(Amended 2004 and 2010)

**S.2.1.2. Initial Zero-Setting Mechanism.** – Except for automatic checkweighers, an initial zero-setting mechanism shall not zero a load in excess of 20 % of the maximum capacity of the automatic weighing system unless tests show that the scale meets all applicable tolerances for any amount of initial load compensated by this device within the specified range.

**S.2.2. Tare.** – On any automatic weighing system (except for multi-interval scales or multiple range scales when the value of tare is determined in a lower weighing range or weighing segment) the value of the tare division shall be equal to the value of the scale division. The tare mechanism shall operate only in a backward direction (i.e., in a direction of underregistration) with respect to the zero-load balance condition of the automatic weighing system. A device designed to automatically clear any tare value shall also be designed to prevent the automatic clearing of tare until a complete transaction has been indicated.

(Amended 2008)

**Note:** On a computing automatic weighing system, this requires the input of a unit price, the display of the unit price, and a computed positive total price at a readable equilibrium. Other devices require that a transaction or lot run be completed.

(Note Amended 2004)

## S.3. Verification Scale Interval.

**S.3.1. Multiple Range and Multi-Interval Automatic Weighing System.** – The value of e shall be equal to the value of d.

**S.3.2. Load Cell Verification Interval Value.** – The relationship of the value for the load cell verification scale interval,  $v_{\min}$ , to the scale division d for a specific scale installation shall be:

$$v_{\min} \leq \frac{d}{\sqrt{N}}, \text{ where } N \text{ is the number of load cells in the scale.}$$

**Note:** When the value of the scale division d differs from the verification scale division e for the scale, the value of e must be used in the formula above.

**S.3.3.** – For automatic checkweighers, the value of e shall be specified by the manufacturer and may be larger than d, but in no case can e be more than ten times the value of d.

## S.4. Weight Indicators, Weight Displays, Reports, and Labels.

**S.4.1. Additional Digits in Displays.** – Auxiliary digital displays that provide additional digits for use during performance evaluation may be included on automatic checkweighers. However, in cases where these indications are not valid for determining the actual weight of a package (e.g., only appropriate for use in statistical process control programs by users) they shall be clearly and distinctly differentiated from valid weight displays by indicating them to the user.

For example, the additional digits may be differentiated by color, partially covered by placing crosshatch overlays on the display, or made visible only after the operator presses a button or turns a key to set the device in a mode which enables the additional digits.

**S.4.2. Damping.** – An indicating element equipped with other than automatic recording elements shall be equipped with effective means to permit the recording of weight values only when the indication is stable within plus or minus one scale division. The values recorded shall be within applicable tolerances.

**S.4.3. Over Capacity Indication.** – An indicating or recording element shall not display nor record any values when the scale capacity is exceeded by nine scale divisions.

**S.4.4. Label Printer.** – A device that produces a printed ticket to be used as the label for a package shall print all values digitally and of such size, style of type, and color as to be clear and conspicuous on the label.

**S.4.4.1. Label Printing.** – If an automatic checkweigher prints a label containing weight information that will be used in a commercial transaction, it must conform to all of the requirements specified for weigh-labelers so that the printed ticket meets appropriate requirements.

**S.5. Accuracy Class.**

**S.5.1. Marking.** – Weigh-labelers and automatic checkweighers shall be Class III devices and shall be marked accordingly, except that a weigh-labeler marked Class IIIS may be used in package shipping applications.

(Amended 1997)

**S.6. Parameters for Accuracy Classes.** – The number of divisions for device capacity is designated by the manufacturer and shall comply with parameters shown in Table S.6.

<b>Table S.6. Parameters for Accuracy Classes</b>			
		<b>Number of Divisions (n)</b>	
<b>Class</b>	<b>Value of the Verification Division (e)</b>	<b>Minimum</b>	<b>Maximum</b>
<b>SI Units</b>			
III <sup>1</sup>	0.1 to 2 g inclusive	100	10 000
	equal to or greater than 5 g	500	10 000
<b>Inch-Pound Units</b>			
III	0.0002 lb to 0.005 lb, inclusive	100	10 000
	0.005 oz to 0.125 oz, inclusive	100	10 000
	equal to or greater than 0.01 lb	500	10 000
	equal to or greater than 0.25 oz	500	10 000
IIIS	greater than 0.01 lb	100	1 000
	greater than 0.25 oz	100	1 000

<sup>1</sup>For Class III devices, the value of e is specified by the manufacturer as marked on the device; d shall not be smaller than 0.1 e. e shall be differentiated from d by size, shape, or color.  
(Amended 2004)

**S.7. Marking Requirements.** [See also G-S.1. Identification, G-S.4. Interchange or Reversal of Parts, G-S.6. Marking Operational Controls, Indications, and Features, G-S.7. Lettering, G-UR.2.1.1. Visibility of Identification, and UR.3.3. Special Designs]

**S.7.1. Location of Marking Information.** – Automatic weighing systems which are not permanently attached to an indicating element, and for which the load-receiving element is the only part of the weighing/load-receiving element visible after installation, may have the marking information required in G-S.1. Identification of the General Code and Table S.7.a. Marking Requirements and S.7.b. Notes for Table S.7.a. of the Automatic Weighing Systems Code located in an area that is accessible only through the use of a tool; provided that the information is easily accessible (e.g., the information may appear on the junction box under an access plate). The identification information for these automatic weighing systems shall be located on the weighbridge (load-receiving element) near the point where the signal leaves the weighing element, or beneath the nearest access cover.

Table S.7.a. Marking Requirements					
To Be Marked With ↓	Weighing Equipment				
	Weighing, load-receiving, and indicating element in same housing	Indicating element not permanently attached to weighing and load-receiving element	Weighing and load-receiving element not permanently attached to indicating element	Load cell with CC (10)	Other equipment or device (9)
Manufacturer's ID (1)	x	x	x	x	x
Model Designation (1)	x	x	x	x	x
Serial Number and Prefix (2)	x	x	x	x	x (13)
Certificate of Conformance (CC) Number (16)	x	x	x	x	x (16)
Accuracy Class (14)	x	x (8)	x	x	
Nominal Capacity (3)(15)	x	x	x		
Value of Division, d (3)	x	x			
Value of e (4)	x	x			
Temperature Limits (5)	x	x	x	x	
Special Application (11)	x	x	x		
Maximum Number of Scale Divisions, $n_{max}$ (6)		x (8)	x	x	
Minimum Verification Division, ( $e_{min}$ )			x		
"S" or "M" (7)				x	
Direction of Loading (12)				x	
Minimum Dead Load				x	
Maximum Capacity (Max)	x			x	
Minimum Capacity (Min)	x				
Safe Load Limit				x	
Load Cell Verification Interval ( $v_{min}$ )				x	
Maximum Belt Speed (m/sec or m/min)	x		x		

**Note:** See Table S.7.b. for applicable parenthetical notes.  
(Amended 1999)



**Table S.7.b.**  
**Notes for Table S.7.a.**

1. Manufacturer's identification and model designation. (See G-S.1. Identification)
2. Serial number and prefix. (See G-S.1. Identification)
3. The nominal capacity and value of the automatic weighing system division shall be shown together (e.g., 50 000 x 5 kg, or 30 x 0.01 lb) adjacent to the weight display when the nominal capacity and value of the automatic weighing system division are not immediately apparent. Each division value or weight unit shall be marked on variable-division value or division-unit automatic weighing systems.
4. Required only if different from d.
5. Required only on automatic weighing systems if the temperature range on the NTEP CC is narrower than and within – 10 °C to 40 °C (14 °F to 104 °F).  
(Amended 2007)
6. This value may be stated on load cells in units of 1000; (e.g.,  $n_{\max}$  10 is 10 000 divisions.)
7. Denotes compliance for single or multiple load cell applications.
8. An indicating element not permanently attached to a weighing element shall be clearly and permanently marked with the accuracy Class III, or IIIS and the maximum number of divisions,  $n_{\max}$ .
9. Necessary to the weighing system but having no metrological effect, e.g., auxiliary remote display, keyboard, etc.
10. The markings may be either on the load cell or in an accompanying document; except that, if an accompanying document is provided, the serial number shall appear both on the load cell and in the document. The manufacturer's name or trademark, the model designation, and identifying symbol for the serial number shall also be marked both on the load cell and in any accompanying document.
11. An automatic weighing system designed for a special application rather than general use shall be conspicuously marked with suitable words visible to the operator and customer restricting its use to that application.
12. Required if the direction of loading the load cell is not obvious.
13. Serial number and prefix (See G-S.1. Identification) modules without "intelligence" on a modular system (e.g., printer, keyboard module, cash drawer, and secondary display in a point-of-sale system) are not required to have serial numbers.
14. The accuracy class of a device shall be marked on the device with the appropriate designation.
15. The nominal capacity shall be conspicuously marked on any automatic-indicating or recording automatic weighing system so constructed that the capacity of the indicating or recording element, or elements, is not immediately apparent.
16. Required only if a CC has been issued for the equipment.

**S.7.2. Marking Required on Components of Automatic Weighing Systems.** – The following components of automatic weighing systems shall be marked as specified in Tables S.7.a. Marking Requirements and S.7.b. Notes for Table S.7.2.a.:

- (a) Main elements and components when not contained in a single enclosure for the entire automatic weighing system;
- (b) Load cells for which Certificates of Conformance (CC) have been issued under the National Type Evaluation Program; and
- (c) Other equipment necessary to a weighing system but having no metrological effect on the weighing system.

## N. Notes

### N.1. Test Requirements for Automatic Weighing Systems.

#### N.1.1. Test Pucks and Packages.

- (a) Test pucks and packages shall be:
  - (1) representative of the type, size, and weight ranges to be weighed on a device; and
  - (2) stable while in motion, hence the length and width of a puck or package should be greater than its height.
- (b) For type evaluation the manufacturer shall supply the test pucks or packages for each range of test loads.

(Amended 1997)

**N.1.2. Accuracy of Test Pucks or Packages.** – The error in any test puck or package shall not exceed one-fourth ( $\frac{1}{4}$ ) of the acceptance tolerance. If packages are used to conduct field tests on automatic weighing systems, the package weights shall be determined on a reference scale or balance with an inaccuracy that does not exceed one-fifth ( $\frac{1}{5}$ ) of the smallest tolerance that can be applied to the device under test.

**N.1.3. Verification (Testing) Standards.** – Field standard weights shall comply with requirements of NIST Handbook 105-1 (Class F) or the tolerances expressed in Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied).

**N.1.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility, Field Evaluation.** – An RFI test shall be conducted at a given installation when the presence of RFI has been verified and characterized if those conditions are considered “usual and customary.”

(Added 2004)

**N.1.5. Tests Loads.** – A performance test shall consist of four separate test runs conducted at different test loads according to Table N.1.5. Test Loads.

<b>Table N.1.5. Test Loads</b>
At or near minimum capacity
At or near maximum capacity
At two (2) critical points between minimum and maximum capacity
Test may be conducted at other loads if the device is intended for use at other specific capacities

**N.1.6. Influence Factor Testing.** – Influence factor testing shall be conducted statically.

**N.2. Test Procedures - Weigh-Labelers.** – If the device is designed for use in a non-automatic weighing mode, it shall be tested in the non-automatic mode according to Handbook 44 Section 2.20. Scales Code.

Note: If the device is designed for only automatic weighing, it shall only be tested in the automatic weighing mode.  
(Amended 2004)

**N.2.1. Non-automatic Tests.**

**N.2.1.1. Increasing-Load Test.** – The increasing-load test shall be conducted with the test loads approximately centered on the load-receiving element of the scale.

**N.2.1.2. Decreasing-Load Test.** – The decreasing-load test shall be conducted with the test loads approximately centered on the load-receiving element of the scale.

**N.2.1.3. Shift Test.** – To determine the effect of off-center loading, a test load equal to one-half ( $\frac{1}{2}$ ) maximum capacity shall be placed in the center of each of the four points equidistant between the center and front, left, back, and right edges of the load receiver.

**N.2.1.4. Discrimination Test.** – A discrimination test shall be conducted with the weighing device in equilibrium at zero-load and at maximum test load, and under controlled conditions in which environmental factors are reduced to the extent that they will not affect the results obtained. This test is conducted from just below the lower edge of the zone of uncertainty for increasing-load tests, or from just above the upper edge of the zone of uncertainty for decreasing-load tests.

**N.2.1.5. Zero-Load Balance Change.** – A zero-load balance change test shall be conducted on all automatic weighing systems after the removal of any test load. The zero-load balance should not change by more than the minimum tolerance applicable. (See also G-UR.4.2. Abnormal Performance)

(Amended 2004)

**N.2.2. Automatic Test Procedures.**

**N.2.2.1. Tests Non-automatic.** – If the automatic weighing system is designed to operate non-automatically, and is used in that manner, during normal use operation, it shall be tested non-automatically using mass standards. The device shall not be tested non-automatically if it is used only in the automatic mode.

**N.2.2.2. Automatic Tests.** – The device shall be tested at the normal operating speed using packages. Test runs should be conducted using at least two test loads distributed over its normal weighing range (e.g., near the lowest and highest ranges in which the device is typically operated.) Each test load should be run a minimum of ten consecutive times.

(Amended 2004)

**N.3. Test Procedures - Automatic Checkweigher.**

**N.3.1. Tests Non-automatic.** – If the scale is designed to operate non-automatically during normal user operation, it shall be tested non-automatically according to paragraphs N.2.1.1. Increasing Load Test through N.2.1.5. Zero-Balance Change.

(Amended 2004)

**N.3.2. Automatic Tests.** – The device shall be tested at the highest speed in each weight range using standardized test pucks or packages. Test runs shall be conducted using two test loads. The number of consecutive test weighments shall be as specified in Table N.3.2. Number of Sample Weights per Test for Automatic Checkweighers.

(Amended 2004)

<b>Table N.3.2. Number of Sample Weights per Test for Automatic Checkweighers</b>		
<b>Weighing Range m = mass of test load</b>	<b>Number of Sample Weights per Test</b>	
	<b>Field</b>	<b>Type Evaluation</b>
20 divisions $\leq m \leq 10$ kg 20 divisions $\leq m \leq 22$ lb	30	60
10 kg $< m \leq 25$ kg 22 lb $< m \leq 55$ lb	16	32
25 kg $< m \leq 100$ kg 55 lb $< m \leq 220$ lb	10	20
100 kg (220 lb) $< m$	10	10

## T. Tolerances

### T.1. Principles.

**T.1.1. Design.** – The tolerance for a weighing device is a performance requirement independent of the design principle used.

**T.1.2. Scale Division.** – The tolerance for a weighing device is related to the value of the scale division (d) or the value of the verification scale division (e) and is generally expressed in terms of d or e. The random tolerance for automatic checkweighers is expressed in terms of Maximum Allowable Variance (MAV).

### T.2. Tolerance Application.

**T.2.1. General.** – The tolerance values are positive (+) and negative (–) with the weighing device adjusted to zero at no load. When tare is in use, the tolerance values are applied from the tare zero reference (zero net weight indication); the tolerance values apply to the net weight indication for any possible tare load using certified test loads.

(Amended 2008)

**T.2.2. Type Evaluation Examinations.** – For type evaluation examinations, the tolerance values apply to increasing and decreasing load tests within the temperature and power supply limits specified in T.7. Influence Factors.

(Amended 2004)

**T.2.3. Subsequent Verification Examinations.** – For subsequent verification examinations, the tolerance values apply regardless of the influence factors in effect at the time of the conduct of the examination. (Also see G-N.2. Testing with Nonassociated Equipment)

(Added 2007)

**T.2.4. Multiple Range and Multi-Interval Automatic Weighing System.** – For multiple range and multi-interval devices, the tolerance values are based on the value of the scale division of the range in use.

**T.3. Tolerance Values.**

<b>Table T.3. Class III - Tolerance in Divisions (e)</b>		
<b>Test Load in Divisions</b>	<b>Tolerance in Divisions</b>	
<b>Class III</b>	<b>Acceptance</b>	<b>Maintenance</b>
0 - 500	± 0.5	± 1
501 - 2000	± 1.0	± 2
2001 - 4000	± 1.5	± 3
4001 +	± 2.5	± 5

**T.3.1. Tolerance Values – Class III Weigh-Labeler.** (See Section T.3.2. Class IIIS Weigh-Labelers)

**T.3.1.1. Non-automatic Tests.** – Tolerance values shall be as specified in Table T.3. Class III - Tolerance in Divisions (e).  
(Amended 2004)

**T.3.1.2. Automatic Tests.** – Acceptance tolerance values shall be the same as maintenance tolerance values specified in Table T.3. Class III - Tolerance in Divisions (e).  
(Amended 2004)

**T.3.2. Tolerance Values - Class IIIS Weigh-labelers in Package Shipping Applications.**

(Added 1997)

**T.3.2.1. Non-automatic Tests.** – Tolerance values shall be as specified in Table T.3.2.1. Non-automatic Tolerances for Class IIIS Weigh-labelers.  
(Amended 2004)

**T.3.2.2. Automatic Tests.** – Tolerance values specified in Table T.3.2.2. Automatic Tolerances for Class IIIS Weigh-labelers shall be applied.  
(Amended 2004)

<b>Table T.3.2.1. Non-automatic Tolerances for Class IIIS Weigh-labelers</b>		
<b>Test Load in Divisions</b>	<b>Tolerance in Divisions</b>	
<b>Class IIIS</b>	<b>Acceptance</b>	<b>Maintenance</b>
0 - 50	± 0.5	± 1
51 - 200	± 1.0	± 2
201 - 1000	± 1.5	± 3

(Added 1997) (Amended 2004)

<b>Table T.3.2.2. Automatic Tolerances for Class IIIS Weigh-labelers</b>		
<b>Test Load in Divisions</b>	<b>Tolerance in Divisions</b>	
<b>Class IIIS</b>	<b>Acceptance</b>	<b>Maintenance</b>
0 - 50	± 1.5	± 2
51 - 200	± 2.0	± 3
201 - 1000	± 2.5	± 4

(Added 1997) (Amended 2004)

**T.3.3. Tolerance Values.** – Automatic Checkweighers.

**T.3.3.1. Laboratory Tests for Automatic Checkweighers.**

**T.3.3.1.1. Non-automatic Tests.** – The acceptance tolerance values specified in Table T.3. Class III - Tolerance in Divisions (e), shall be applied.  
(Amended 2004)

**T.3.3.1.2. Automatic Tests.**

- (a) The systematic error for each test run shall be within the acceptance tolerances specified in Table T.3. Class III - Tolerance in Divisions (e) for the test loads specified in Table N.1.5. Test Loads.

(Amended 2004)

- (b) The standard deviation of the results shall not exceed one-ninth ( $1/9$ ) of the MAV for specific package weights (which means that three standard deviations cannot exceed one-third ( $1/3$ ) of the MAV value) as required in the latest edition of NIST Handbook 133. This value does not change regardless of whether acceptance or maintenance tolerances are being applied to the device under test.

(Amended 2004)

- (1) For U.S. Department of Agriculture (USDA) inspected meat and poultry products packaged at a plant subject to inspection by the USDA Food Safety and Inspection Service, use Handbook 133 Table 2-9, U.S. Department of Agriculture, Meat and Poultry, Groups and Lower Limits for Individual Packages;
- (2) for all other packages with a labeled net quantity in terms of weight, use Handbook 133 Table 2-5, Maximum Allowable Variations for Packages Labeled by Weight; or
- (3) for all packages with a labeled net quantity in terms of liquid or dry volume use Handbook 133 Table 2-6, Maximum Allowable Variations for Packages Labeled by Liquid or Dry Volume.

(Amended 2004)

**T.3.3.2. Field Tests for Automatic Checkweighers.**

**T.3.3.2.1. Non-automatic Test.** – The tolerance values shall be as specified in Table T.3. Class III – Tolerance in Divisions (e).

(Amended 2004)

**T.3.3.2.2. Automatic Test.**

- (a) The systematic error requirement is not applied in a field test.
- (b) The standard deviation of the test results shall not exceed one-ninth ( $1/9$ ) of the MAV for specific package weights (which means that three standard deviations cannot exceed one-third ( $1/3$ ) of the MAV value) as required in the latest Edition of NIST Handbook 133. This value does not change regardless of whether acceptance or maintenance tolerances are being applied to the device under test.

(Amended 2004)

- (1) For USDA inspected meat and poultry products packaged at a plant subject to inspection by the USDA Food Safety and Inspection Service, use Handbook 133 Table 2-9, U.S. Department of Agriculture, Meat and Poultry, Groups and Lower Limits for Individual Packages;
- (2) for all other packages with a labeled net quantity in terms of weight, use Handbook 133 Table 2-5, Maximum Allowable Variations for Packages Labeled by Weight; or

- (3) for all packages with a labeled net quantity in terms of liquid or dry volume use Handbook 133 Table 2-6. Maximum Allowable Variations for Packages Labeled by Liquid or Dry Volume.

**T.4. Agreement of Indications.** – In the case of a weighing system equipped with more than one indicating element or indicating element and recording element combination, the difference in the weight value indications of any load shall not be greater than the absolute value of the applicable tolerance for that load, and shall be within tolerance limits.

**T.5. Repeatability.** – The results obtained from several weighings of the same load under reasonably constant test conditions shall agree within the absolute value of the maintenance tolerance for that load, and shall be within applicable tolerances.

(Amended 2004)

**T.6. Discrimination.** – A test load equivalent to 1.4 d shall cause a change in the indicated or recorded value of at least 2.0 d. This requires the zone of uncertainty to be not greater than 0.3 d (See N.2.1.4. Discrimination Test).

(Amended 2004)

**T.7. Influence Factors.** – The following factors are applicable to tests conducted under controlled conditions only.

**T.7.1. Temperature.** – Devices shall satisfy the tolerance requirements under the following temperature conditions:

**T.7.1.1.** – If not specified in the operating instructions or if not marked on the device, the temperature limits shall be: – 10 °C to 40 °C (14 °F to 104 °F).

**T.7.1.2.** – If temperature limits are specified for the device, the range shall be at least 30 °C (54 °F).

**T.7.1.3. Temperature Effect on Zero-Load Balance.** – The zero-load indication shall not vary by more than one division per 5 °C (9 °F) change in temperature.

**T.7.1.4. Operating Temperature.** – The indicating or recording element shall not display nor record any usable values until the operating temperature necessary for accurate weighing and a stable zero balance condition have been attained.

**T.7.2. Electric Power Supply.**

**T.7.2.1. Range of Voltages.**

- (a) Automatic weighing systems that operate using alternating current must perform within the conditions defined in paragraphs T.3. through T.6., inclusive, when tested over the range of – 15 % to + 10 % of the marked nominal line voltage(s) at 60 Hz, or the voltage range marked by the manufacturer, at 60 Hz.
- (b) Automatic weighing systems that operate using DC current must perform within the conditions defined in paragraphs T.3. through T.6., inclusive, when tested over the range from minimum operating voltage<sup>4</sup> to + 20 % of the voltage marked on the instrument (nominal voltage).
- (c) Battery-operated electronic automatic weighing systems with external or plug-in power supply (AC or DC) shall either continue to function correctly or not indicate any weight values if the

---

<sup>4</sup> The minimum operating voltage is defined as the lowest possible operating voltage before the automatic weighing system no longer indicates nor records weight values.

(Added 2004)

voltage is below the manufacturer's specified value, the latter being larger than or equal to the minimum operating voltage.<sup>4</sup>

**Note:** This requirement applies only to metrologically significant voltage supplies.

(Amended 2001)

(Amended 2004)

**T.7.2.2. Power Interruption.** – A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

**T.8. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility.** – The difference between the weight indication with the disturbance and the weight indication without the disturbance (see also N.1.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility, Field Evaluation) shall not exceed one scale division (d) or the equipment shall:

(Amended 2004)

- (a) blank the indication;
- (b) provide an error message; or
- (c) the indication shall be so completely unstable that it could not be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

## **UR. User Requirements**

**UR.1. Selection Requirements.** – Equipment shall be suitable for the service in which it is used with respect to elements of its design, including but not limited to, its capacity, number of scale divisions, value of the scale division or verification scale division, minimum capacity, and computing capability.

**UR.1.1. General.** – Automatic Weighing Systems shall be designated by the manufacturer for that service.

**UR.1.2. Value of the Indicated and Recorded Scale Division.** – The value of the division as recorded shall be the same as the division value indicated.

**UR.2. Installation Requirements.**

**UR.2.1. Protection from Environmental Factors.** – The indicating elements, the lever system or load cells, and the load-receiving element of a permanently installed scale, and the indicating elements of a scale not intended to be permanently installed, shall be adequately protected from environmental factors such as wind, weather, and RFI that may adversely affect the operation or performance of the device.

**UR.2.2. Foundation, Supports, and Clearance.** – The foundation and supports of any scale installed in a fixed location shall be such as to provide strength, rigidity, and permanence of all components, and clearance shall be provided around all live parts to the extent that no contacts may result when the load-receiving element is empty, nor throughout the weighing range of the scale.

**UR.2.3. Entry and Departure from Weighing Area.** – The belt or other conveyance that introduces the weighed load to the weighing zone and that carries the weighed load away from the weighing zone shall be maintained per the manufacturer's recommendations.

**UR.3. Use Requirements.**

**UR.3.1. Minimum Load.** – The minimum load shall be as specified by the manufacturer, but not less than twenty divisions since the use of a device to weigh light loads is likely to result in relatively large errors.



**UR.3.1.1. Minimum Load for Class IIIS Weigh-labelers.** – The minimum load shall be as specified by the manufacturer, but not less than ten divisions since the use of a device to weigh light loads is likely to result in relatively large errors.

(Added 1997)

**UR.3.2. Maximum Load.** – An automatic weighing system shall not be used to weigh a load of more than its maximum capacity.

(Amended 2004)

**UR.3.3. Special Designs.** – An automatic weighing system designed and marked for a special application shall not be used for other than its intended purpose.

**UR.3.4. Use of Manual Gross Weight Entries.** – Manual entries are permitted only when a device or system is generating labels for standard weight packages.

#### **UR.4. Maintenance Requirements.**

**UR.4.1. Balance Condition.** – If an automatic weighing system is equipped with a zero-load display, the zero-load adjustment of an automatic weighing system shall be maintained so that the device indicates or records a zero balance condition.

**UR.4.2. Level Condition.** – If an automatic weighing system is equipped with a level-condition indicator, the automatic weighing system shall be maintained in level.

**UR.4.3. Automatic Weighing System Modification.** – The length or the width of the load-receiving element of an automatic weighing system shall not be increased beyond the manufacturer's design dimension, nor shall the capacity of an automatic weighing system be increased beyond its design capacity by replacing or modifying the original primary indicating or recording element with one of a higher capacity, except when the modification has been approved by competent engineering authority, preferably that of the engineering department of the manufacturer of the automatic weighing system, and by the weights and measures authority having jurisdiction over the automatic weighing system.

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## Section 2.24. Automatic Weighing Systems

### A. Application

**A.1. General.** – This code applies to devices used to automatically weigh pre-assembled discrete loads or single loads or loose materials in applications where automatic weighing systems<sup>1</sup> are used or employed in the determination of quantities, things, produce, or articles for distribution, for purchase, offered or submitted for sale, for distribution, purchase, or in computing any basic charge or payment for services rendered on the basis of weight, and in packaging plants subject to regulation by the USDA. Some weigh-labelers and checkweighers may also include a scale that is incorporated in a conveyor system that weighs packages in a static or non-automatic weighing mode<sup>2</sup>.

This includes:

- (a) Automatic weigh-labelers;
- (b) Combination automatic and non-automatic weigh-labelers;
- (c) Automatic checkweighers;
- (d) Combination automatic and non-automatic checkweighers; and
- (e) Automatic gravimetric filling machines that weigh discrete loads or single loads of loose materials and determine package and production lot compliance with net content representations.

(Amended 1997 and 2004)

**A.2. Exceptions.** - This code does not apply to:

- (a) Belt-Conveyor Scale Systems;
- (b) Railway Track Scales;
- (c) Monorail Scales;
- (d) Automatic Bulk-Weighing Systems;
- (e) Devices that measure quantity on a time basis;
- (f) Controllers or other auxiliary devices except as they may affect the weighing performance; or

---

<sup>1</sup> An automatic weighing system does not require the intervention of an operator during the weighing process. The necessity to give instructions to start a process or to release a load or the function of the instrument (static, dynamic, set-up, etc.) is not relevant in deciding the category of automatic or non-automatic instruments.

(Added 2004)

<sup>2</sup> Prepackaging scales (and other commercial devices) used for putting up packages in advance of sale are acceptable for use in commerce if all appropriate provisions of Handbook 44 are met. Users of such devices must be alert to the legal requirements relating to the declaration of quantity on a package. Such requirements are to the effect that, on the average, the contents of the individual packages of a particular commodity comprising a lot, shipment, or delivery must contain at least the quantity declared on the label. The fact that a scale or other commercial device may overregister, but within established tolerances, and is approved for commercial service is not a legal justification for packages to contain, on the average, less than the labeled quantity.

(Added 2004)

- (g) Automatic gravimetric filling machines and other automatic weighing systems employed in determining the weight of a commodity in a plant or business with a separate quantity control program (e.g., a system of statistical process control) using suitable weighing instruments and measurement standards traceable to national standards to determine production lot compliance with net content representations.<sup>3</sup>

(Added 2004)

**A.3. Additional Code Requirements.** – In addition to the requirements of this code, Automatic Weighing Systems shall meet the requirements of Section 1.10. General Code.

## S. Specifications

### S.1. Design of Indicating and Recording Elements and of Recorded Representations.

#### S.1.1. Zero Indication.

- (a) A weigh-labeler shall be equipped with an indicating or recording element. Additionally, a weigh-labeler equipped with an indicating or recording element shall either indicate or record a zero-balance condition and an out-of-balance condition on both sides of zero.

(Amended 2004)

- (b) An automatic checkweigher may be equipped with an indicating or recording element.
- (c) A zero-balance condition may be indicated by other than a continuous digital zero indication, provided that effective automatic means is provided to inhibit a weighing operation or to return to a continuous digital indication when the device is in an out-of-balance condition.

#### S.1.1.1. Digital Indicating Elements.

- (a) A digital zero indication shall represent a balance condition that is within  $\pm \frac{1}{2}$  scale division.
- (b) A digital indicating device shall either automatically maintain a “center of zero” condition to  $\pm \frac{1}{4}$  scale division or less, or have an auxiliary or supplemental “center-of-zero” indicator that defines a zero-balance condition to  $\pm \frac{1}{4}$  scale division or less.
- (c) Verification of the accuracy of the center of zero indication to  $\pm \frac{1}{4}$  scale division or less during automatic operation is not required on automatic checkweighers.

(Amended 2004)

**S.1.2. Value of Division Units.** – The value of a division  $d$  expressed in a unit of weight shall be equal to:

- (a) 1, 2, or 5; or
- (b) a decimal multiple or submultiple of 1, 2, or 5.

The requirement that the value of the scale division be expressed only as 1, 2, or 5, or a decimal multiple or submultiple of only 1, 2, or 5 does not apply to net weight indications and recorded representations that are calculated from gross and tare weight indications where the scale division of the gross weight is different from the scale division of the tare weight(s) on multi-interval or multiple range scales. For example, a multiple range or multi-interval scale may indicate and record tare weights in a lower weighing range (WR) or weighing segment (WS), gross weights in the higher weighing range or weighing segment, and net weights as follows:

---

<sup>3</sup> See NIST Handbook 130, Uniform Laws and Regulations in the Area of Legal Metrology and Engine Fuel Quality, Interpretations and Guidelines, paragraph 2.6.11. Good Quantity Control Practices.

$\begin{array}{r} 55 \text{ kg Gross Weight (WR2 d = 5 kg)} \\ - 4 \text{ kg Tare Weight (WR1 d = 2 kg)} \\ \hline = 51 \text{ kg Net Weight (Mathematically Correct)} \end{array}$	$\begin{array}{r} 10.05 \text{ lb Gross Weight (WS2 d = 0.05 lb)} \\ - 0.06 \text{ lb Tare Weight (WS1 d = 0.02 lb)} \\ \hline = 9.99 \text{ lb Net Weight (Mathematically Correct)} \end{array}$
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(Amended 2008)

**S.1.2.1. Weight Units.** – Except for postal scales, indicating and recording elements for shipping and postal applications, and scales used to print standard pack labels, a device shall indicate weight values using only a single unit of measure.  
(Amended 2004)

**S.1.3. Provision for Sealing.**

- (a) **Automatic Weighing Systems, Except Automatic Checkweighers.** – A device shall be designed with provision(s) as specified in Table S.1.3. Categories of Device and Methods of Sealing for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity of the device can be made to any electronic mechanism.
- (b) **For Automatic Checkweighers.** – Security seals are not required in applications where it would prohibit an authorized user from having access to the calibration functions of a device.

<b>Table S.1.3. Categories of Device and Methods of Sealing</b>	
<b>Categories of Device</b>	<b>Methods of Sealing</b>
<b>Category 1:</b> No Remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
<b>Category 2:</b> Remote configuration capability, but access is controlled by physical hardware.  The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode.	The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters: one for calibration parameters and one for configuration parameters.
<b>Category 3:</b> Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. ( <b>Note:</b> Does not require 1000 changes to be stored for each parameter.)

**S.1.4. Automatic Calibration.** – A device may be fitted with an automatic or a semi-automatic calibration mechanism. This mechanism shall be incorporated inside the device. After sealing, neither the mechanism nor the calibration process shall facilitate fraud.

**S.1.5. Adjustable Components.** – Adjustable components shall be held securely in adjustment and, except for a zero-load balance mechanism, shall be located within the housing of the element.

## S.2. Design of Zero and Tare Mechanisms.

### S.2.1. Zero Load Adjustment.

**S.2.1.1. Automatic Zero-Tracking Mechanism.** – Except for automatic checkweighers, under normal operating conditions the maximum load that can be “rezeroed,” when either placed on or removed from the platform all at once, shall be 1.0 scale division.

Except for an initial zero-setting mechanism, an automatic zero adjustment outside these limits is prohibited.

(Amended 2004 and 2010)

**S.2.1.2. Initial Zero-Setting Mechanism.** – Except for automatic checkweighers, an initial zero-setting mechanism shall not zero a load in excess of 20 % of the maximum capacity of the automatic weighing system unless tests show that the scale meets all applicable tolerances for any amount of initial load compensated by this device within the specified range.

**S.2.2. Tare.** – On any automatic weighing system (except for multi-interval scales or multiple range scales when the value of tare is determined in a lower weighing range or weighing segment) the value of the tare division shall be equal to the value of the scale division. The tare mechanism shall operate only in a backward direction (i.e., in a direction of underregistration) with respect to the zero-load balance condition of the automatic weighing system. A device designed to automatically clear any tare value shall also be designed to prevent the automatic clearing of tare until a complete transaction has been indicated.

(Amended 2008)

**Note:** On a computing automatic weighing system, this requires the input of a unit price, the display of the unit price, and a computed positive total price at a readable equilibrium. Other devices require that a transaction or lot run be completed.

(Note Amended 2004)

## S.3. Verification Scale Interval.

**S.3.1. Multiple Range and Multi-Interval Automatic Weighing System.** – The value of e shall be equal to the value of d.

**S.3.2. Load Cell Verification Interval Value.** – The relationship of the value for the load cell verification scale interval,  $v_{\min}$ , to the scale division d for a specific scale installation shall be:

$$v_{\min} \leq \frac{d}{\sqrt{N}}, \text{ where } N \text{ is the number of load cells in the scale.}$$

**Note:** When the value of the scale division d differs from the verification scale division e for the scale, the value of e must be used in the formula above.

**S.3.3.** – For automatic checkweighers, the value of e shall be specified by the manufacturer and may be larger than d, but in no case can e be more than ten times the value of d.

## S.4. Weight Indicators, Weight Displays, Reports, and Labels.

**S.4.1. Additional Digits in Displays.** – Auxiliary digital displays that provide additional digits for use during performance evaluation may be included on automatic checkweighers. However, in cases where these indications are not valid for determining the actual weight of a package (e.g., only appropriate for use in statistical process control programs by users) they shall be clearly and distinctly differentiated from valid weight displays by indicating them to the user.



For example, the additional digits may be differentiated by color, partially covered by placing crosshatch overlays on the display, or made visible only after the operator presses a button or turns a key to set the device in a mode which enables the additional digits.

**S.4.2. Damping.** – An indicating element equipped with other than automatic recording elements shall be equipped with effective means to permit the recording of weight values only when the indication is stable within plus or minus one scale division. The values recorded shall be within applicable tolerances.

**S.4.3. Over Capacity Indication.** – An indicating or recording element shall not display nor record any values when the scale capacity is exceeded by nine scale divisions.

**S.4.4. Label Printer.** – A device that produces a printed ticket to be used as the label for a package shall print all values digitally and of such size, style of type, and color as to be clear and conspicuous on the label.

**S.4.4.1. Label Printing.** – If an automatic checkweigher prints a label containing weight information that will be used in a commercial transaction, it must conform to all of the requirements specified for weigh-labelers so that the printed ticket meets appropriate requirements.

**S.5. Accuracy Class.**

**S.5.1. Marking.** – Weigh-labelers and automatic checkweighers shall be Class III devices and shall be marked accordingly, except that a weigh-labeler marked Class IIIS may be used in package shipping applications.

(Amended 1997)

**S.6. Parameters for Accuracy Classes.** – The number of divisions for device capacity is designated by the manufacturer and shall comply with parameters shown in Table S.6.

<b>Table S.6. Parameters for Accuracy Classes</b>			
		<b>Number of Divisions (n)</b>	
<b>Class</b>	<b>Value of the Verification Division (e)</b>	<b>Minimum</b>	<b>Maximum</b>
<b>SI Units</b>			
III	0.1 to 2 g inclusive	100	10 000
	equal to or greater than 5 g	500	10 000
<b>Inch-Pound Units</b>			
III	0.0002 lb to 0.005 lb, inclusive	100	10 000
	0.005 oz to 0.125 oz, inclusive	100	10 000
	equal to or greater than 0.01 lb	500	10 000
	equal to or greater than 0.25 oz	500	10 000
IIIS	greater than 0.01 lb	100	1 000
	greater than 0.25 oz	100	1 000
For Class III devices, the value of e is specified by the manufacturer as marked on the device; d shall not be smaller than 0.1 e. e shall be differentiated from d by size, shape, or color. (Amended 2004)			

**S.7. Marking Requirements.** [See also G-S.1. Identification, G-S.4. Interchange or Reversal of Parts, G-S.6. Marking Operational Controls, Indications, and Features, G-S.7. Lettering, G-UR.2.1.1. Visibility of Identification, and UR.3.3. Special Designs]

**S.7.1. Location of Marking Information.** – Automatic weighing systems which are not permanently attached to an indicating element, and for which the load-receiving element is the only part of the weighing/load-receiving element visible after installation, may have the marking information required in G-S.1. Identification of the General Code and Table S.7.a. Marking Requirements and S.7.b. Notes for Table S.7.a. of the Automatic Weighing Systems Code located in an area that is accessible only through the use of a tool; provided that the information is easily accessible (e.g., the information may appear on the junction box under an access plate). The identification information for these automatic weighing systems shall be located on the weighbridge (load-receiving element) near the point where the signal leaves the weighing element, or beneath the nearest access cover.

Table S.7.a. Marking Requirements					
To Be Marked With ↓	Weighing Equipment				
	Weighing, load-receiving, and indicating element in same housing	Indicating element not permanently attached to weighing and load-receiving element	Weighing and load-receiving element not permanently attached to indicating element	Load cell with CC (10)	Other equipment or device (9)
Manufacturer's ID (1)	x	x	x	x	x
Model Designation (1)	x	x	x	x	x
Serial Number and Prefix (2)	x	x	x	x	x (13)
Certificate of Conformance (CC) Number (16)	x	x	x	x	x (16)
Accuracy Class (14)	x	x (8)	x	x	
Nominal Capacity (3)(15)	x	x	x		
Value of Division, d (3)	x	x			
Value of e (4)	x	x			
Temperature Limits (5)	x	x	x	x	
Special Application (11)	x	x	x		
Maximum Number of Scale Divisions, $n_{max}$ (6)		x (8)	x	x	
Minimum Verification Division, ( $e_{min}$ )			x		
"S" or "M" (7)				x	
Direction of Loading (12)				x	
Minimum Dead Load				x	
Maximum Capacity (Max)	x			x	
Minimum Capacity (Min)	x				
Safe Load Limit				x	
Load Cell Verification Interval ( $v_{min}$ )				x	
Maximum Belt Speed (m/sec or m/min)	x		x		

**Note:** See Table S.7.b. for applicable parenthetical notes.

(Amended 1999)

**Table S.7.b.**  
**Notes for Table S.7.a.**

1. Manufacturer's identification and model designation. (See G-S.1. Identification)
2. Serial number and prefix. (See G-S.1. Identification)
3. The nominal capacity and value of the automatic weighing system division shall be shown together (e.g., 50 000 x 5 kg, or 30 x 0.01 lb) adjacent to the weight display when the nominal capacity and value of the automatic weighing system division are not immediately apparent. Each division value or weight unit shall be marked on variable-division value or division-unit automatic weighing systems.
4. Required only if different from d.
5. Required only on automatic weighing systems if the temperature range on the NTEP CC is narrower than and within – 10 °C to 40 °C (14 °F to 104 °F).  
(Amended 2007)
6. This value may be stated on load cells in units of 1000; (e.g.,  $n_{\max}$  10 is 10 000 divisions.)
7. Denotes compliance for single or multiple load cell applications.
8. An indicating element not permanently attached to a weighing element shall be clearly and permanently marked with the accuracy Class III, or IIIS and the maximum number of divisions,  $n_{\max}$ .
9. Necessary to the weighing system but having no metrological effect, e.g., auxiliary remote display, keyboard, etc.
10. The markings may be either on the load cell or in an accompanying document; except that, if an accompanying document is provided, the serial number shall appear both on the load cell and in the document. The manufacturer's name or trademark, the model designation, and identifying symbol for the serial number shall also be marked both on the load cell and in any accompanying document.
11. An automatic weighing system designed for a special application rather than general use shall be conspicuously marked with suitable words visible to the operator and customer restricting its use to that application.
12. Required if the direction of loading the load cell is not obvious.
13. Serial number and prefix (See G-S.1. Identification) modules without "intelligence" on a modular system (e.g., printer, keyboard module, cash drawer, and secondary display in a point-of-sale system) are not required to have serial numbers.
14. The accuracy class of a device shall be marked on the device with the appropriate designation.
15. The nominal capacity shall be conspicuously marked on any automatic-indicating or recording automatic weighing system so constructed that the capacity of the indicating or recording element, or elements, is not immediately apparent.
16. Required only if a CC has been issued for the equipment.

**S.7.2. Marking Required on Components of Automatic Weighing Systems.** – The following components of automatic weighing systems shall be marked as specified in Tables S.7.a. Marking Requirements and S.7.b. Notes for Table S.7.2.a.:

- (a) Main elements and components when not contained in a single enclosure for the entire automatic weighing system;
- (b) Load cells for which Certificates of Conformance (CC) have been issued under the National Type Evaluation Program; and
- (c) Other equipment necessary to a weighing system but having no metrological effect on the weighing system.

## N. Notes

### N.1. Test Requirements for Automatic Weighing Systems.

#### N.1.1. Test Pucks and Packages.

- (a) Test pucks and packages shall be:
  - (1) representative of the type, size, and weight ranges to be weighed on a device; and
  - (2) stable while in motion, hence the length and width of a puck or package should be greater than its height.
- (b) For type evaluation the manufacturer shall supply the test pucks or packages for each range of test loads.

(Amended 1997)

**N.1.2. Accuracy of Test Pucks or Packages.** – The error in any test puck or package shall not exceed one-fourth ( $\frac{1}{4}$ ) of the acceptance tolerance. If packages are used to conduct field tests on automatic weighing systems, the package weights shall be determined on a reference scale or balance with an inaccuracy that does not exceed one-fifth ( $\frac{1}{5}$ ) of the smallest tolerance that can be applied to the device under test.

**N.1.3. Verification (Testing) Standards.** – Field standard weights shall comply with requirements of NIST Handbook 105-1 (Class F) or the tolerances expressed in Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied).

**N.1.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility, Field Evaluation.** – An RFI test shall be conducted at a given installation when the presence of RFI has been verified and characterized if those conditions are considered “usual and customary.”

(Added 2004)

**N.1.5. Tests Loads.** – A performance test shall consist of four separate test runs conducted at different test loads according to Table N.1.5. Test Loads.

<b>Table N.1.5. Test Loads</b>
At or near minimum capacity
At or near maximum capacity
At two (2) critical points between minimum and maximum capacity
Test may be conducted at other loads if the device is intended for use at other specific capacities

**N.1.6. Influence Factor Testing.** – Influence factor testing shall be conducted statically.

**N.2. Test Procedures - Weigh-Labelers.** – If the device is designed for use in a non-automatic weighing mode, it shall be tested in the non-automatic mode according to Handbook 44 Section 2.20. Scales Code.

Note: If the device is designed for only automatic weighing, it shall only be tested in the automatic weighing mode.  
(Amended 2004)

**N.2.1. Non-automatic Tests.**

**N.2.1.1. Increasing-Load Test.** – The increasing-load test shall be conducted with the test loads approximately centered on the load-receiving element of the scale.

**N.2.1.2. Decreasing-Load Test.** – The decreasing-load test shall be conducted with the test loads approximately centered on the load-receiving element of the scale.

**N.2.1.3. Shift Test.** – To determine the effect of off-center loading, a test load equal to one-half ( $\frac{1}{2}$ ) maximum capacity shall be placed in the center of each of the four points equidistant between the center and front, left, back, and right edges of the load receiver.

**N.2.1.4. Discrimination Test.** – A discrimination test shall be conducted with the weighing device in equilibrium at zero-load and at maximum test load, and under controlled conditions in which environmental factors are reduced to the extent that they will not affect the results obtained. This test is conducted from just below the lower edge of the zone of uncertainty for increasing-load tests, or from just above the upper edge of the zone of uncertainty for decreasing-load tests.

**N.2.1.5. Zero-Load Balance Change.** – A zero-load balance change test shall be conducted on all automatic weighing systems after the removal of any test load. The zero-load balance should not change by more than the minimum tolerance applicable. (See also G-UR.4.2. Abnormal Performance)

(Amended 2004)

**N.2.2. Automatic Test Procedures.**

**N.2.2.1. Tests Non-automatic.** – If the automatic weighing system is designed to operate non-automatically, and is used in that manner, during normal use operation, it shall be tested non-automatically using mass standards. The device shall not be tested non-automatically if it is used only in the automatic mode.

**N.2.2.2. Automatic Tests.** – The device shall be tested at the normal operating speed using packages. Test runs should be conducted using at least two test loads distributed over its normal weighing range (e.g., near the lowest and highest ranges in which the device is typically operated.) Each test load should be run a minimum of ten consecutive times.

(Amended 2004)

**N.3. Test Procedures - Automatic Checkweigher.**

**N.3.1. Tests Non-automatic.** – If the scale is designed to operate non-automatically during normal user operation, it shall be tested non-automatically according to paragraphs N.2.1.1. Increasing Load Test through N.2.1.5. Zero-Balance Change.

(Amended 2004)

**N.3.2. Automatic Tests.** – The device shall be tested at the highest speed in each weight range using standardized test pucks or packages. Test runs shall be conducted using two test loads. The number of consecutive test weighments shall be as specified in Table N.3.2. Number of Sample Weights per Test for Automatic Checkweighers.

(Amended 2004)

<b>Table N.3.2.</b>		
<b>Number of Sample Weights per Test for Automatic Checkweighers</b>		
<b>Weighing Range</b> <b>m = mass of test load</b>	<b>Number of Sample Weights per Test</b>	
	<b>Field</b>	<b>Type Evaluation</b>
20 divisions $\leq m \leq 10$ kg 20 divisions $\leq m \leq 22$ lb	30	60
10 kg $< m \leq 25$ kg 22 lb $< m \leq 55$ lb	16	32
25 kg $< m \leq 100$ kg 55 lb $< m \leq 220$ lb	10	20
100 kg (220 lb) $< m$	10	10

## T. Tolerances

### T.1. Principles.

**T.1.1. Design.** – The tolerance for a weighing device is a performance requirement independent of the design principle used.

**T.1.2. Scale Division.** – The tolerance for a weighing device is related to the value of the scale division (d) or the value of the verification scale division (e) and is generally expressed in terms of d or e. The random tolerance for automatic checkweighers is expressed in terms of Maximum Allowable Variance (MAV).

### T.2. Tolerance Application.

**T.2.1. General.** – The tolerance values are positive (+) and negative (–) with the weighing device adjusted to zero at no load. When tare is in use, the tolerance values are applied from the tare zero reference (zero net weight indication); the tolerance values apply to the net weight indication for any possible tare load using certified test loads.

(Amended 2008)

**T.2.2. Type Evaluation Examinations.** – For type evaluation examinations, the tolerance values apply to increasing and decreasing load tests within the temperature and power supply limits specified in T.7. Influence Factors.

(Amended 2004)

**T.2.3. Subsequent Verification Examinations.** – For subsequent verification examinations, the tolerance values apply regardless of the influence factors in effect at the time of the conduct of the examination. (Also see G-N.2. Testing with Nonassociated Equipment)

(Added 2007)

**T.2.4. Multiple Range and Multi-Interval Automatic Weighing System.** – For multiple range and multi-interval devices, the tolerance values are based on the value of the scale division of the range in use.

**T.3. Tolerance Values.**

<b>Table T.3. Class III - Tolerance in Divisions (e)</b>		
<b>Test Load in Divisions</b>	<b>Tolerance in Divisions</b>	
<b>Class III</b>	<b>Acceptance</b>	<b>Maintenance</b>
0 - 500	± 0.5	± 1
501 - 2000	± 1.0	± 2
2001 - 4000	± 1.5	± 3
4001 +	± 2.5	± 5

**T.3.1. Tolerance Values – Class III Weigh-Labeler.** (See Section T.3.2. Class IIIS Weigh-Labelers)

**T.3.1.1. Non-automatic Tests.** – Tolerance values shall be as specified in Table T.3. Class III - Tolerance in Divisions (e).  
(Amended 2004)

**T.3.1.2. Automatic Tests.** – Acceptance tolerance values shall be the same as maintenance tolerance values specified in Table T.3. Class III - Tolerance in Divisions (e).  
(Amended 2004)

**T.3.2. Tolerance Values - Class IIIS Weigh-labelers in Package Shipping Applications.**

(Added 1997)

**T.3.2.1. Non-automatic Tests.** – Tolerance values shall be as specified in Table T.3.2.1. Non-automatic Tolerances for Class IIIS Weigh-labelers.  
(Amended 2004)

**T.3.2.2. Automatic Tests.** – Tolerance values specified in Table T.3.2.2. Automatic Tolerances for Class IIIS Weigh-labelers shall be applied.  
(Amended 2004)

<b>Table T.3.2.1. Non-automatic Tolerances for Class IIIS Weigh-labelers</b>		
<b>Test Load in Divisions</b>	<b>Tolerance in Divisions</b>	
<b>Class IIIS</b>	<b>Acceptance</b>	<b>Maintenance</b>
0 - 50	± 0.5	± 1
51 - 200	± 1.0	± 2
201 - 1000	± 1.5	± 3

(Added 1997) (Amended 2004)

<b>Table T.3.2.2. Automatic Tolerances for Class IIIS Weigh-labelers</b>		
<b>Test Load in Divisions</b>	<b>Tolerance in Divisions</b>	
<b>Class IIIS</b>	<b>Acceptance</b>	<b>Maintenance</b>
0 - 50	± 1.5	± 2
51 - 200	± 2.0	± 3
201 - 1000	± 2.5	± 4

(Added 1997) (Amended 2004)

**T.3.3. Tolerance Values.** – Automatic Checkweighers.

**T.3.3.1. Laboratory Tests for Automatic Checkweighers.**

**T.3.3.1.1. Non-automatic Tests.** – The acceptance tolerance values specified in Table T.3. Class III - Tolerance in Divisions (e), shall be applied.  
(Amended 2004)

**T.3.3.1.2. Automatic Tests.**

- (a) The systematic error for each test run shall be within the acceptance tolerances specified in Table T.3. Class III - Tolerance in Divisions (e) for the test loads specified in Table N.1.5. Test Loads.

(Amended 2004)

- (b) The standard deviation of the results shall not exceed one-ninth ( $1/9$ ) of the MAV for specific package weights (which means that three standard deviations cannot exceed one-third ( $1/3$ ) of the MAV value) as required in the latest edition of NIST Handbook 133. This value does not change regardless of whether acceptance or maintenance tolerances are being applied to the device under test.

(Amended 2004)

- (1) For U.S. Department of Agriculture (USDA) inspected meat and poultry products packaged at a plant subject to inspection by the USDA Food Safety and Inspection Service, use Handbook 133 Table 2-9, U.S. Department of Agriculture, Meat and Poultry, Groups and Lower Limits for Individual Packages;

- (2) for all other packages with a labeled net quantity in terms of weight, use Handbook 133 Table 2-5, Maximum Allowable Variations for Packages Labeled by Weight; or

- (3) for all packages with a labeled net quantity in terms of liquid or dry volume use Handbook 133 Table 2-6, Maximum Allowable Variations for Packages Labeled by Liquid or Dry Volume.

(Amended 2004)

**T.3.3.2. Field Tests for Automatic Checkweighers.**

**T.3.3.2.1. Non-automatic Test.** – The tolerance values shall be as specified in Table T.3. Class III – Tolerance in Divisions (e).

(Amended 2004)

**T.3.3.2.2. Automatic Test.**

- (a) The systematic error requirement is not applied in a field test.

- (b) The standard deviation of the test results shall not exceed one-ninth ( $1/9$ ) of the MAV for specific package weights (which means that three standard deviations cannot exceed one-third ( $1/3$ ) of the MAV value) as required in the latest Edition of NIST Handbook 133. This value does not change regardless of whether acceptance or maintenance tolerances are being applied to the device under test.

(Amended 2004)

- (1) For USDA inspected meat and poultry products packaged at a plant subject to inspection by the USDA Food Safety and Inspection Service, use Handbook 133 Table 2-9, U.S. Department of Agriculture, Meat and Poultry, Groups and Lower Limits for Individual Packages;

- (2) for all other packages with a labeled net quantity in terms of weight, use Handbook 133 Table 2-5, Maximum Allowable Variations for Packages Labeled by Weight; or



- (3) for all packages with a labeled net quantity in terms of liquid or dry volume use Handbook 133 Table 2-6. Maximum Allowable Variations for Packages Labeled by Liquid or Dry Volume.

**T.4. Agreement of Indications.** – In the case of a weighing system equipped with more than one indicating element or indicating element and recording element combination, the difference in the weight value indications of any load shall not be greater than the absolute value of the applicable tolerance for that load, and shall be within tolerance limits.

**T.5. Repeatability.** – The results obtained from several weighings of the same load under reasonably constant test conditions shall agree within the absolute value of the maintenance tolerance for that load, and shall be within applicable tolerances.

(Amended 2004)

**T.6. Discrimination.** – A test load equivalent to 1.4 d shall cause a change in the indicated or recorded value of at least 2.0 d. This requires the zone of uncertainty to be not greater than 0.3 d (See N.2.1.4. Discrimination Test).

(Amended 2004)

**T.7. Influence Factors.** – The following factors are applicable to tests conducted under controlled conditions only.

**T.7.1. Temperature.** – Devices shall satisfy the tolerance requirements under the following temperature conditions:

**T.7.1.1.** – If not specified in the operating instructions or if not marked on the device, the temperature limits shall be: – 10 °C to 40 °C (14 °F to 104 °F).

**T.7.1.2.** – If temperature limits are specified for the device, the range shall be at least 30 °C (54 °F).

**T.7.1.3. Temperature Effect on Zero-Load Balance.** – The zero-load indication shall not vary by more than one division per 5 °C (9 °F) change in temperature.

**T.7.1.4. Operating Temperature.** – The indicating or recording element shall not display nor record any usable values until the operating temperature necessary for accurate weighing and a stable zero balance condition have been attained.

**T.7.2. Electric Power Supply.**

**T.7.2.1. Range of Voltages.**

- (a) Automatic weighing systems that operate using alternating current must perform within the conditions defined in paragraphs T.3. through T.6., inclusive, when tested over the range of – 15 % to + 10 % of the marked nominal line voltage(s) at 60 Hz, or the voltage range marked by the manufacturer, at 60 Hz.
- (b) Automatic weighing systems that operate using DC current must perform within the conditions defined in paragraphs T.3. through T.6., inclusive, when tested over the range from minimum operating voltage<sup>4</sup> to + 20 % of the voltage marked on the instrument (nominal voltage).
- (c) Battery-operated electronic automatic weighing systems with external or plug-in power supply (AC or DC) shall either continue to function correctly or not indicate any weight values if the

<sup>4</sup> The minimum operating voltage is defined as the lowest possible operating voltage before the automatic weighing system no longer indicates nor records weight values.

(Added 2004)

voltage is below the manufacturer's specified value, the latter being larger than or equal to the minimum operating voltage.<sup>4</sup>

**Note:** This requirement applies only to metrologically significant voltage supplies.

(Amended 2001)

(Amended 2004)

**T.7.2.2. Power Interruption.** – A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

**T.8. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility.** – The difference between the weight indication with the disturbance and the weight indication without the disturbance (see also N.1.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility, Field Evaluation) shall not exceed one scale division (d) or the equipment shall:

(Amended 2004)

- (a) blank the indication;
- (b) provide an error message; or
- (c) the indication shall be so completely unstable that it could not be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

## **UR. User Requirements**

**UR.1. Selection Requirements.** – Equipment shall be suitable for the service in which it is used with respect to elements of its design, including but not limited to, its capacity, number of scale divisions, value of the scale division or verification scale division, minimum capacity, and computing capability.

**UR.1.1. General.** – Automatic Weighing Systems shall be designated by the manufacturer for that service.

**UR.1.2. Value of the Indicated and Recorded Scale Division.** – The value of the division as recorded shall be the same as the division value indicated.

**UR.2. Installation Requirements.**

**UR.2.1. Protection from Environmental Factors.** – The indicating elements, the lever system or load cells, and the load-receiving element of a permanently installed scale, and the indicating elements of a scale not intended to be permanently installed, shall be adequately protected from environmental factors such as wind, weather, and RFI that may adversely affect the operation or performance of the device.

**UR.2.2. Foundation, Supports, and Clearance.** – The foundation and supports of any scale installed in a fixed location shall be such as to provide strength, rigidity, and permanence of all components, and clearance shall be provided around all live parts to the extent that no contacts may result when the load-receiving element is empty, nor throughout the weighing range of the scale.

**UR.2.3. Entry and Departure from Weighing Area.** – The belt or other conveyance that introduces the weighed load to the weighing zone and that carries the weighed load away from the weighing zone shall be maintained per the manufacturer's recommendations.

**UR.3. Use Requirements.**

**UR.3.1. Minimum Load.** – The minimum load shall be as specified by the manufacturer, but not less than twenty divisions since the use of a device to weigh light loads is likely to result in relatively large errors.

**UR.3.1.1. Minimum Load for Class IIIS Weigh-labelers.** – The minimum load shall be as specified by the manufacturer, but not less than ten divisions since the use of a device to weigh light loads is likely to result in relatively large errors.

(Added 1997)

**UR.3.2. Maximum Load.** – An automatic weighing system shall not be used to weigh a load of more than its maximum capacity.

(Amended 2004)

**UR.3.3. Special Designs.** – An automatic weighing system designed and marked for a special application shall not be used for other than its intended purpose.

**UR.3.4. Use of Manual Gross Weight Entries.** – Manual entries are permitted only when a device or system is generating labels for standard weight packages.

#### **UR.4. Maintenance Requirements.**

**UR.4.1. Balance Condition.** – If an automatic weighing system is equipped with a zero-load display, the zero-load adjustment of an automatic weighing system shall be maintained so that the device indicates or records a zero balance condition.

**UR.4.2. Level Condition.** – If an automatic weighing system is equipped with a level-condition indicator, the automatic weighing system shall be maintained in level.

**UR.4.3. Automatic Weighing System Modification.** – The length or the width of the load-receiving element of an automatic weighing system shall not be increased beyond the manufacturer's design dimension, nor shall the capacity of an automatic weighing system be increased beyond its design capacity by replacing or modifying the original primary indicating or recording element with one of a higher capacity, except when the modification has been approved by competent engineering authority, preferably that of the engineering department of the manufacturer of the automatic weighing system, and by the weights and measures authority having jurisdiction over the automatic weighing system.

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