Section 2.24. Automatic Weighing Systems - Tentative Code

This tentative code has only a trial or experimental status and is not intended to be enforced by weights and measures officials. The requirements are designed for study prior to the development and adoption of a final Code for Automatic Weighing Systems. The tentative code is intended to be used by the National Type Evaluation Program for type evaluation of automatic weighing systems. If upgraded to become a permanent code, all requirements, except those for tolerances, will be nonretroactive as of the effective date of the permanent code; tolerance requirements will apply retroactively as of the effective date of the permanent code.
(Tentative Code Added 1995) (Amended 1998)

A. Application

A.1. - This code applies to devices used to weigh or fill packages while the object is in motion. Some weigh-labelers may also include a scale that is incorporated in a conveyor system that weighs packages in a static weighing mode.

This includes:

(a) Weigh-labelers, static and dynamic

(b) Automatic checkweighers
(Amended 1997)

A.2. - 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

A.3. - Also see General Code requirements.

A.4. Type Evaluation. - The National Type Evaluation Program will accept for type evaluation only those devices that comply with all requirements of this code.
(Added 1998)

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. It shall either indicate or record a zero-balance condition and an out-of-balance condition on both sides of zero.

(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 ± ½ scale division.

(b) A digital indicating device shall either automatically maintain a "center of zero" condition to ± ¼ scale division or less, or have an auxiliary or supplemental "center-of-zero" indicator that defines a zero-balance condition to ± ¼ scale division or less.

(c) Verification of the accuracy of the center of zero indication to ± ¼ scale division or less during dynamic operation is not required on automatic checkweighers.

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.

S.1.2.1. Weight Units. - A device shall indicate weight values using only a single unit of measure.

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 field applications where it would prohibit an authorized user from having access to the calibration functions of a device.

Table S.1.3.
Categories of Device and Methods of Sealing

Categories of Device	Method of Sealing
Category 1: No Remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: 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.
Category 3: 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 ten times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: 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-Setting 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.

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 the value of the tare division shall be equal to the value of the 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.

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 a complete weighing operation, including tare, net, and gross weight determination.

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:

$$v_{\min} \leq \frac{d}{\sqrt{N}}$$, where N 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 10 times the value of "d."

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

S.4.1. Weight Units. - An indicating or recording element shall indicate weight values using only a single unit of measure.

S.4.2. 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.4.3. 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.4.4. 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.4.5. 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.4.5.1. 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.

Table S.6.
Parameters for Accuracy Classes

		Number of divisions (n)	
Class	**Value of the verification division (d or e)**	**Minimum**	**Maximum**
SI Units			
III	0.1 to 2g inclusive	100	10 000
	equal to or greater than 5g	500	10 000
INCH-POUND Units			
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	1000
	greater than 0.25 oz	100	1000
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.			

S.7. Marking Requirements. [See also G-S.1., G-S.4., G-S.6., G-S.7., G-U.2.1.1., and UR.3.3.]

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. of the General Code and Table S.7.a. and S.7.b. 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						
Weighing Equipment **To Be Marked With ⇓**	**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 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.)

2. Serial number and prefix. (See G-S.1.)

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 range is other than -10 °C to 40 °C (14 °F to 104 °F).

6. This value may be stated on load cells in units of 1000; (e.g., n: 10 is 10 000 divisions.)

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

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) 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. and S.7.b.:

(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:

(i) representative of the type, size, and weight ranges to be weighed on a device, and

(ii) 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 (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 (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.2. Test Requirements for Automatic Weighing Systems.

N.2.1. Tests Loads. - A performance test shall consist of four separate test runs conducted at different test loads according to Table N.3.2.

N.2.2. Influence Factor Testing. - Influence factor testing shall be conducted statically.

N.3. Test Procedures - Weigh-Labelers. - If the device is designed for use in static weighing, it shall be tested statically using mass standards.

Note: If the device is designed for only dynamic weighing, it shall only be tested dynamically.

N.3.1. Laboratory - Static Tests .

N.3.1.1. 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.3.1.2. 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.3.1.3. Shift Test. - To determine the effect of off-center loading, a test load equal to one-half (½) 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.3.1.4. 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.3.1.5. 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. (Also see G-UR.4.2.)

N.3.1.6. Influence Factor Testing. - Influence factor testing shall be conducted.

N.3.2. Laboratory - Dynamic Tests. - The device shall be tested at the highest speed for each weight range using standardized test pucks or packages. Test runs shall be conducted using four test loads as described in Table N.3.2. Each test load shall be run a minimum of 10 consecutive times.

Table N.3.2. Test Loads
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.3.2.1. Shift Test. - To determine the effect of eccentric loading, for devices without a means to align packages, a test load equal to one-third (1/3) maximum capacity shall be passed over the load receiver or transport belt (1) halfway between the center and front edge, and (2) halfway between the center and back edge.

N.3.3. Field Test Procedures.

N.3.3.1. Static Tests. - If the automatic weighing system is designed to operate statically, and used in that manner, during normal use operation, it shall be tested statically using mass standards. The device shall not be tested statically if it is used only dynamically.

N.3.3.2. Dynamic 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., at the lowest and highest ranges in which the device is typically operated.) Each test load should be run a minimum of 10 consecutive times.

N.4. Test Procedures - Automatic Checkweigher.

N.4.1. Laboratory - Static Tests. - If the scale is designed to operate statically during normal user operation, it shall be tested statically using the applicable weigh-labeler requirements.

N.4.2. Laboratory - Dynamic 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 four test loads. The number of consecutive test weighments shall be as described in Table N.4.2.

Table N.4.2. Number of Sample Weights per Test for Automatic Checkweighers

Weighing Range m = mass of test load	Number of sample weights per test
20 divisions $\leq$ m $\leq$ 10 kg 20 divisions $\leq$ m $\leq$ 22 lb	60
10 kg <m $\leq$ 25 kg 22 lb <m $\leq$ 55 lb	32
25 kg <m $\leq$ 100 kg 55 lb <m $\leq$ 220 lb	20
100 kg (220 lb) < m	10

N.4.3. Field Test Procedures.

N.4.3.1. Static Tests. - If the scale is designed to operate statically during normal user operation, it shall be tested statically according to Sections N.3.1.1. through N.3.1.5.

N.4.3.2. Dynamic Tests. - The device shall be tested dynamically at the highest normal operating speed using packages at two test loads distributed over its normal weighing range. The number of consecutive weighments shall be one-half (½) of those specified in Table N.4.2., but not less than 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; the tolerance values apply to certified test loads only.

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

T.2.3. 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.

Table T.3. Class III - Tolerance in Divisions (d)		
Test Load in Divisions	**Tolerance in Divisions**	
Class III	**Acceptance**	**Maintenance**
0 - 500	± 0.5	± 1
501 - 2000	± 1	± 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. Static Tests. - Tolerance values shall be as specified in Table T.3. Class III - Tolerances in Divisions.

T.3.1.2. Dynamic Tests. - Acceptance tolerance values shall be the same as maintenance tolerance values specified in Table T.3., Class III - Tolerances in Divisions.

T.3.2. Tolerance Values - Class IIIS Weigh-labelers in Package Shipping Applications.
(Added 1997)

T.3.2.1. Static Tests. - Tolerance values shall be as specified in Table T.3.2.1. Static Tolerances for Class IIIS Weigh-labelers.

T.3.2.2. Dynamic Tests. - Tolerance values specified in Table T.3.2.2. Dynamic Tolerances for Class IIIS Weigh-labelers shall be applied.

Table T.3.2.1. Static Tolerance for Class IIIS Weigh-labelers		
Test Load in Divisions	**Tolerance in Divisions**	
Class IIIS	**Acceptance**	**Maintenance**
0 - 50	± 0.5	± 1
51 - 200	± 1	± 2
201 - 1000	± 1.5	± 3

(Added 1997)

Table T.3.2.2. Dynamic Tolerance for Class IIIS Weigh-labelers		
Test Load in Divisions	**Tolerance in Divisions**	
Class IIIS	**Acceptance**	**Maintenance**
0 - 50	± 1.5	± 2
51 - 20	± 2	± 3
201 - 1000	± 2.5	± 4

(Added 1997)

T.3.3. Tolerance Values. - Automatic Checkweighers.

T.3.3.1. Laboratory Tests for Automatic Checkweighers.

T.3.3.1.1. Static Tests. - The acceptance tolerance values specified in Table T.3., Class III-Tolerances in Divisions, shall be applied.

T.3.3.1.2. Dynamic Tests.

(a) The systematic error for each test run must be within the acceptance tolerances for the test load as specified in Table N.3.2.

(b) The standard deviation of the results shall not exceed one-ninth (1/9) of the Maximum Allowable Variation (MAV) for specific package weights (3 standard deviations cannot exceed one-third (1/3) of the MAV value) as required in the 4th 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.

(i) 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, or

(ii) 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.

(iii) 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.3.3.2. Field Tests for Automatic Checkweighers.

T.3.3.2.1. Static Test Tolerances. - The tolerance values shall be as specified in Table T.3., Class III-Tolerances in Divisions.

T.3.3.2.2. Dynamic Test Tolerances. -

(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 Maximum Allowable Variation (MAV) for specific package weights (3 standard deviations cannot exceed one-third (1/3) of the MAV value) as required in the 4th 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.

(i) 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, or

(ii) 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.

(iii) 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 static test conditions shall agree within the absolute value of the maintenance tolerance for that load, and shall be within applicable tolerances.

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.3.1.4.)

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. Barometric Pressure. - The zero indication shall not vary by more than one division for a change in barometric pressure of 1 kPa over the total barometric pressure range of 95 kPa to 105 kPa (28 in to 31 in of Hg).

T.7.3. Electric Power Supply.

T.7.3.1. Power Supply, Voltage and Frequency.

(a) **Alternating Current.** - Weighing devices that operate using alternating current must perform within the conditions defined in paragraphs T.3. through T.7., inclusive, over the line voltage range of 100 V to 130 V or 200 V to 250 V rms as appropriate, and over the frequency range of 59.5 Hz to 60.5 Hz.

Note: This requirement applies only to metrologically significant voltage supplies.
(Amended 2001)

(b) **Battery.** - Battery operated instruments shall not indicate nor record values outside the applicable tolerance limits when battery power output is excessive or deficient.

T.7.3.2. 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 shall not exceed one scale division (d) or the equipment shall:

(a) blank the indication, or

(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 manufacturers recommendations.

UR.3. Use Requirements.

UR.3.1. Minimum Load. - The minimum load shall be as specified by the manufacturer, but not less than 20 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 10 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 the maximum capacity of the automatic weighing system.

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.

D. Definitions

automatic checkweigher. - A dynamic automatic weighing system used to subdivide items of different weights into one or more subgroups, such as identifying packages that have acceptable or unacceptable fill levels. These systems may be used to fill standard packages for compliance with net weight requirements.

automatic weighing system (AWS). - An automatic weighing system is a weighing device that, in combination with other hardware and/or software components, automatically weighs discrete items. Examples include, but are not limited to, weigh-labelers and checkweighers.

package rate. - PPM - Packages per minute.

random error(s). - The sample standard deviation of the error (indicated values) for a number of consecutive automatic weighings of a load, or loads, passed over the load receptor, shall be expressed mathematically as:

$$s = \sqrt{\frac{1}{n-1}\sum\left(x_i - \bar{x}\right)^2} \quad \text{or} \quad s = \sqrt{\frac{1}{n-1}\left(\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n}\right)}$$

where:

x = error of a load indication
n = the number of loads

systematic (average) error $\left(\bar{x}\right)$**. -** The mean value of the error (of indication) for a number of consecutive automatic weighings of a load, or loads, passed over the load receiving element (e.g., weigh-table), shall be expressed mathematically as:

$$\bar{x} = \frac{\sum x}{n}$$

where:

x = error of a load indication
n = the number of loads

test puck. – A metal or plastic object used to simulate a package. Pucks can be made in a variety of dimensions and have different weights to represent a wide range of package sizes. Metal versions may be covered with rubber cushions to eliminate the possibility of damage to weighing and handling equipment. The puck mass is adjusted to specific accuracy so that pucks can be used to conduct performance tests.

weigh-labeler. - An automatic weighing system that determines the weight of a package and prints a label or other document bearing a weight declaration for each discrete item (usually a label also includes unit and total price declarations). Typically, this type of weighing system determines the weight of packages dynamically, but may also include a scale that is incorporated in a conveyor system that weighs packages in a static weighing mode. Weigh-labelers are sometimes used to weigh and label standard and random packages (also called "Prepackaging Scales").