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Field Reference Manual
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FIELD REFERENCE MANUAL - DIVISION 9
Division of Measurement Standards
Department of Food and Agriculture

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I. Committee Agenda

a. The Committee will review issues that have been submitted and selected by majority vote to be included on its agenda. The Committee will only include those issues that have been (1) approved by at least one of the regional associations; or (2) forwarded by other committees, subcommittees, NTETC Sectors, task forces, or work groups, or those issues that meet the criteria in Section H, Exceptions to Policy.

b. The Committee will publish an agenda which identifies the issues to be discussed during the Interim Meetings. This agenda shall be distributed to members approximately 30 days prior to the meetings. The agenda will be provided upon request to all other interested parties. [See NCWM Publication 15, Policy 1.4.6.]
(Amended 1998)

J. Interim Meeting

a. The Committee shall hold public hearings at the Interim Meeting for the purpose of discussing and taking comments on all issues on its agenda.

b. Upon request, the Committee will provide the opportunity for presentations by government officials, industry representatives, consumer groups, or other interested parties during the Interim Meeting. Requests to make presentations must be received by the Committee Chairman or technical advisor at least two weeks prior to the start of the meetings.

K. Interim Meeting Report

a. Issues under consideration by the Committee, and upon which it offers comments or recommendations for Conference action during the Annual Meetings, will be included in the Committee's Interim Reports published in the Annual Meeting, Program and Committee Reports, also called the Announcement Book. [See NCWM Publication 15, Policy 1.4.6.]

b. The Annual Meeting, Program and Committee Reports will be prepared and distributed to Conference members approximately three months prior to the NCWM Annual Meeting.

L. Classifications for Agenda Items

At the Interim Meeting, the Committee can classify items for voting by the NCWM membership (indicated with a "V" after the item number in the agenda or prior to the voting session). The Committee may also decide to carry issues over as "Informational" items for further study, comment, and development (indicated with an "I" after the item number). Items marked "W" in the agenda have been withdrawn from consideration.

M. Developing Items

At the 1998 Annual Meeting, the NCWM established a process for disseminating information on items which may have merit but are insufficiently developed for Committee action. Past practice for handling these items had been to either "carry" them forward as informational items or withdraw them. Conference members felt that carrying undeveloped information items drained NCWM resources, but they also believed that withdrawn items were often prematurely discarded despite the valuable work that had gone into developing the item. The NCWM was also interested in providing a mechanism to inform parties about items that are developing in different localities or in the regional associations.

The NCWM established a new "Developing" designation to allow the Committees to notify the submitter of the item, that, while it may have merit, it may not be adequately developed for action at the national level. The NCWM agreed that "Developing" items should be submitted by the regional associations with a recommendation that they be presented as "D" items on the national agenda. The Committees will present "D" items in list format at the end of their reports and include a point of contact (including the name and telephone number of the submitter) so that interested parties can obtain additional information. No comments will be taken on a "Developing" item, unless the Committee agrees to receive the new information in advance of the hearing. In these cases, the Chairman will announce in advance that an item will be discussed in the session. The use of this "D" designator is seen as an item management tool, as well as a way to keep the membership informed of emerging items.
(Amended 2006)

N. Comments on Interim Reports

a. Weights and measures officials, industry representatives, and all other parties are encouraged to submit written comments on issues in the Committees' Interim Reports.

b. All comments on the Interim Meeting Reports must be submitted to the Committee along with a copy to the Executive Secretary no later than one month preceding the opening of the Annual Meeting.

O. Annual Meeting

a. The Committee will hold a public hearing at the Annual Meeting to discuss issues on its agenda.

b. Those who want to speak on an issue during the public hearings should request time from the Committee Chairman. Time limitations on presentations, the discussion of a

question, or amendments may be imposed by the Committee Chairman. (See NCWM Publication 15, Policy 1.2.3. General Conduct of the Meeting.)

P. Final Committee Reports and Conference Action

a. Following the public hearings, the Committee will prepare its final report for action by the voting membership of the Conference. Prior to the session during which it will be acted on, copies of each final report will be provided for study.

b. The Chairman of the Committee will present the final report of the Committee to the Conference body. A vote will be taken on issues, proposals, or sections in the report as circumstances require. The Conference will vote on the entire final report as presented in accordance with established Conference voting procedures. Parliamentary procedure according to Roberts Rules of Order as amended by NCWM Publication No. 1, Bylaws, will be adhered to in the presentation of and action on Standing Committee reports. (Amended 1998)

Q. System of Paragraph Designation. - In order that technical requirements of a similar nature, or those directed to a single characteristic, may be grouped together in an orderly fashion, and to facilitate the location of individual requirements, the paragraphs of each code are divided into sections. Each section is designated by a letter and a name, and each subsection is given a letter-number designation and a side title.

The letter that appears first in a paragraph designation has a specific meaning, as follows:

G. The letter G is a prefix and indicates that the requirement is part of the General Code.

A. Application. These paragraphs pertain to the application of the requirements of a code.

S. Specification. These paragraphs relate to the design of equipment. Specification paragraphs are directed particularly to manufacturers of devices.

N. Note. These paragraphs apply to the official testing of devices.

T. Tolerance. Tolerances are performance requirements. They fix the limit of allowable error or departure from true performance or value.

Sensitivity. The sensitivity requirements, applicable only to nonautomatic-indicating scales, are performance requirements and are lettered with a T.

UR. User Requirement. These paragraphs are directed particularly to the owner and operator of a device. User requirements apply to the selection, installation, use, and maintenance of devices.

D. Definitions of Terms. A definition section appears in Appendix D to provide the definition of the terms having a special meaning.

The numerical designation after a letter follows the decimal system of paragraph identification that fixes both the relationship and the limitation of the requirements of the paragraph. For example, in the Scales Code, under Specifications, the following numerical designations occur:

S. Specifications

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

S.1.1. Zero Indication.

S.1.1.1. Digital Indicating Elements.
S.1.1.2. No-Load Reference Value.

S.1.2. Value of Scale Division Units.

S.1.2.1. Weight Units.

S.1.3. Graduations.

S.1.3.1. Length.
S.1.3.2. Width.
S.1.3.3. Clear Space Between Graduations.

In this example, Paragraphs S.1.1., S.1.2., and S.1.3. are directed and limited to paragraph S.1., which pertains to the design of indicating and recording elements and of recorded representations. Paragraphs S.1.1.1. and S.1.1.2. are directly related to each other, but are limited to the design of zero indication. Likewise, paragraphs S.1.3.1., S.1.3.2., and S.1.3.3. are directly related to each other, but are limited to the design of graduations.

This Handbook conforms to the concept of primary use of SI (metric) measurements recommended in the Omnibus Trade and Competitiveness Act of 1988 by citing SI metric units before inch-pound units where both units appear together and placing separate sections containing requirements for metric units before corresponding sections containing requirements for customary units. Occasionally, a paragraph or table carries the suffix "M" because the requirement in SI units is shown as a separate statement, rather than combined with the

Sec. 1.10. General Code

G-A. Application

G-A.1. Commercial and Law-Enforcement Equipment. - These specifications, tolerances, and other technical requirements apply as follows:

(a) To commercial weighing and measuring equipment; that is, to weights and measures and weighing and measuring devices commercially used or employed in establishing the size, quantity, extent, area, or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award, or in computing any basic charge or payment for services rendered on the basis of weight or measure.

(b) To any accessory attached to or used in connection with a commercial weighing or measuring device when such accessory is so designed that its operation affects the accuracy of the device.

(c) To weighing and measuring equipment in official use for the enforcement of law or for the collection of statistical information by government agencies.

(These requirements should be used as a guide by the weights and measures official when, upon request, courtesy examinations of noncommercial equipment are made.)

G-A.2. Code Application. - This General Code shall apply to all classes of devices as covered in the specific codes. The specific code requirements supersede General Code requirements in all cases of conflict.
(Amended 1972)

G-A.3. Special and Unclassified Equipment. - Insofar as they are clearly appropriate, the requirements and provisions of the General Code and of specific codes apply to equipment failing, by reason of special design or otherwise, to fall clearly within one of the particular equipment classes for which separate codes have been established. With respect to such equipment, code requirements and provisions shall be applied with due regard to the design, intended purpose, and conditions of use of the equipment.

G-A.4. Metric Equipment. - Employment of the weights and measures of the metric system is lawful throughout the United States. These specifications, tolerances, and other requirements shall not be understood or construed as in any way prohibiting the manufacture, sale, or use of equipment designed to give results in terms of metric units. The specific provisions of these requirements and the principles upon which the requirements are based shall be applied to metric equipment insofar as appropriate and practicable. The tolerances on metric equipment, when not specified herein, shall be equivalent to those specified for similar equipment constructed or graduated in the inch-pound system.

G-A.5. Retroactive Requirements. – "Retroactive" requirements are enforceable with respect to all equipment. Retroactive requirements are printed herein in upright Roman type.

G-A.6. Nonretroactive Requirements. – "Nonretroactive" requirements are enforceable after the effective date for:

(a) devices manufactured within a State after the effective date;

(b) both new and used devices brought into a State after the effective date; and

(c) devices used in noncommercial applications which are placed into commercial use after the effective date.

Nonretroactive requirements are not enforceable with respect to devices that are in commercial service in the State as of the effective date or to new equipment in the stock of a manufacturer or a dealer in the State as of the effective date. *[Nonretroactive requirements are printed in italic type.]*
(Amended 1989)

G-A.7. Effective Enforcement Dates of Code Requirements. - Unless otherwise specified, each new or amended code requirement shall not be subject to enforcement prior to January 1 of the year following the adoption by the National Conference on Weights and Measures and publication by the National Institute of Standards and Technology.

G-S. Specifications

G-S.1. Identification. - All equipment, except weights and separate parts necessary to the measurement process but not having any metrological effect, shall be clearly and permanently marked for the purposes of identification with the following information:

(a) the name, initials, or trademark of the manufacturer or distributor;

(b) a model identifier that positively identifies the pattern or design of the device;

(1) The model identifier shall be prefaced by the word "Model," "Type," or "Pattern." These terms may be followed by the word "Number" or an abbreviation of that word. The abbreviation for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.) The abbreviation for the word "Model" shall be "Mod" or "Mod." Prefix lettering may be initial capitals, all capitals, or all lower case.
[Nonretroactive as of January 1, 2003]

(Added 2000) (Amended 2001, 2004 and 2006)

(c) a nonrepetitive serial number, except for equipment with no moving or electronic component parts and not built-for-purpose, software-based devices;
[Nonretroactive as of January 1, 1968]
(Amended 2003 and 2004)

(1) The serial number shall be prefaced by words, an abbreviation, or a symbol, that clearly identifies the number as the required serial number;
[Nonretroactive as of January 1, 1986]

(2) Abbreviations for the word "Serial" shall, as a minimum, begin with the letter "S," and abbreviations for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., S/N, SN, Ser. No, and S. No).
[Nonretroactive as of January 1, 2001]

(d) the current software version or revision identifer for not built-for-purpose, software-based devices.
[N*onretroactive as of January 1, 2004]*

(1) The version or revision identifier shall be prefaced by words, an abbreviation, or a symbol, that clearly identifies the number as the required version or revision.
[Nonretroactive as of January 1, 2007]
(Added 2006)

(2) Abbreviations for the word "Version" shall, as a minimum, begin with the letter "V" and may be followed by the word "Number." Abbreviations for the word "Revision" shall, as a minimum, begin with the letter "R" and may be followed by the word "Number." The abbreviation for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.).
[Nonretroactive as of January 1, 2007]
(Added 2006)

(e) an NTEP Certificate of Conformance (CC) number or a corresponding CC Addendum Number for devices that have a CC. The CC number or a corresponding CC Addendum Number shall be prefaced by the terms "NTEP CC," "CC," or "Approval." These terms may be followed by the term "Number" or an abbreviation of that word. The abbreviation for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.).
[Nonretroactive as of January 1, 2003]
(Added 2001)

The required information shall be so located that it is readily observable without the necessity of the disassembly of a part requiring the use of any means separate from the device.
(Amended 1985, 1991, 1999, 2000, 2003, 2004 and 2006)

G-S.1.1. Location of Marking Information for Not Built-For-Purpose, Software-Based Devices. *– For not built-for-purpose, software-based devices either:*

(a) The required information in G-S.1 Identification. (a), (b), (d), and (e) shall be permanently marked or continuously displayed on the device; or

(b) The Certificate of Conformance (CC) Number shall be:

(1) permanently marked on the device;

(2) continuously displayed; or

(3) accessible through an easily recognized menu and, if necessary, a submenu. Examples of menu and submenu identification include, but are not limited to, "Help," "System Identification," "G-S.1. Identification," or "Weights and Measures Identification."

Note: *For (b), clear instructions for accessing the information required in G-S.1. (a), (b), and (d) shall be listed on the CC, including information necessary to identify that the software in the device is the same type that was evaluated.*
[Nonretroactive as of January 1, 2004]
(Added 2003) (Amended 2006)

G-S.1.2. Remanufactured Devices and Remanufactured Main Elements.

[NOT ADOPTED]

G-S.2. Facilitation of Fraud. - All equipment and all mechanisms and devices attached thereto or used in connection therewith shall be so constructed, assembled, and installed for use such that they do not facilitate the perpetration of fraud.

G-S.3. Permanence. - All equipment shall be of such materials, design, and construction as to make it probable that, under normal service conditions:

(a) accuracy will be maintained,

(b) operating parts will continue to function as intended, and

(c) adjustments will remain reasonably permanent.

Undue stresses, deflections, or distortions of parts shall not occur to the extent that accuracy or permanence is detrimentally affected.

G-S.4. Interchange or Reversal of Parts. - Parts of a device that may readily be interchanged or reversed in the course of field assembly or of normal usage shall be:

(a) so constructed that their interchange or reversal will not affect the performance of the device, or

(b) so marked as to show their proper positions.

G-S.5. Indicating and Recording Elements.

G-S.5.1. General. - All weighing and measuring devices shall be provided with indicating or recording elements appropriate in design and adequate in amount. Primary indications and recorded representations shall be clear, definite, accurate, and easily read under any conditions of normal operation of the device.

G-S.5.2. Graduations, Indications, and Recorded Representations.

G-S.5.2.1. Analog Indication and Representation. Graduations and a suitable indicator shall be provided in connection with indications designed to advance continuously.

G-S.5.2.2. Digital Indication and Representation. Digital elements shall be so designed that:

(a) All digital values of like value in a system agree with one another.

(b) A digital value coincides with its associated analog value to the nearest minimum graduation.

(c) A digital value "rounds off" to the nearest minimum unit that can be indicated or recorded.

(d) A digital zero indication includes the display of a zero for all places that are displayed to the right of the decimal point and at least one place to the left. When no decimal values are displayed, a zero shall be displayed for each place of the displayed scale division. [Nonretroactive as of January 1, 1986.]
(Amended 1973 and 1985)

G-S.5.2.3. Size and Character. - In any series of graduations, indications, or recorded representations, corresponding graduations and units shall be uniform in size and character. Graduations, indications, or recorded representations that are subordinate to or of a lesser value than others with which they are associated shall be appropriately portrayed or designated.
[Made retroactive as of January 1, 1975.]

G-S.5.2.4. Values. - If graduations, indications, or recorded representations are intended to have specific values, these shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof, uniformly placed with reference to the graduations, indications, or recorded representations and as close thereto as practicable, but not so positioned as to interfere with the accuracy of reading.

G-S.5.2.5. Permanence. - Graduations, indications, or recorded representations and their defining figures, words, and symbols shall be of such character that they will not tend easily to become obliterated or illegible.

G-S.5.3. Values of Graduated Intervals or Increments. In any series of graduations, indications, or recorded representations, the values of the graduated intervals or increments shall be uniform throughout the series.

G-S.5.3.1. On Devices That Indicate or Record in More Than One Unit. - On devices designed to indicate or record in more than one unit of measurement, the values indicated and recorded shall be identified with an appropriate word, symbol, or abbreviation.
(Amended 1978, 1986 and 2006)

G-S.5.4. Repeatability of Indications. - A device shall be capable of repeating, within prescribed tolerances, its indications and recorded representations. This requirement shall be met irrespective of repeated manipulation of any element of the device in a manner approximating normal usage (including displacement of the indicating elements to the full extent allowed by the construction of the device and repeated operation of a locking or relieving mechanism) and of the repeated performance of steps or operations that are embraced in the testing procedure.

G-S.5.5. Money Values, Mathematical Agreement. - Any recorded money value and any digital money-value indication on a computing-type weighing or measuring device used in retail trade shall be in mathematical agreement with its associated quantity representation or indication to the nearest 1 cent of money value. This does not apply to auxiliary digital indications intended for the operator's use only, when these indications are obtained from existing analog customer indications that meet this requirement.
(Amended 1973)

G-S.5.6. Recorded Representations. - Insofar as they are appropriate, the requirements for indicating and recording elements shall also apply also to recorded representations. All recorded values shall be printed digitally.
(Amended 1975 and 2006)

Table 1.
Recorded Representation of Metric Units on Equipment with Limited Character Sets

Name of Unit	International Symbol (common use symbol)	Representation		
		Form I	Form II	
		(double case)	(single case lower)	(single case upper)
Base SI units				
Meter	M	M	m	M
Kilogram	Kg	Kg	kg	KG
Derived SI units				
Newton	N	N	n	N
Pascal	Pa	Pa	pa	PA
Watt	W	W	w	W
Volt	V	V	v	V
degree Celsius	°C	°C	°c	°C
Other units				
liter	l or L	L	l	L
gram	G	G	g	G
metric ton	t	t	tne	TNE
bar	bar	bar	bar	BAR

(Amended 2006)

G-S.5.6.1. Recorded Representation of Metric Units Equipment with Limited Character Sets. - The appropriate defining symbols are shown in Table 1.
(Added 1977)

G-S.5.7. Magnified Graduations and Indications. - All requirements for graduations and indications apply to a series of graduations and an indicator magnified by an optical system or as magnified and projected on a screen.

G-S.6. Marking Operational Controls, Indications, and Features. - *All operational controls, indications, and features, including switches, lights, displays, pushbuttons, and other means, shall be clearly and definitely identified. The use of approved pictograms or symbols shall be acceptable.*
[Nonretroactive as of January 1, 1977.]
(Amended 1978, 1995)

G-S.7. Lettering. - All required markings and instructions shall be distinct and easily readable and shall be of such character that they will not tend to become obliterated or illegible.

G-S.8. Provision for Sealing Electronic Adjustable Components. - *A device shall be designed with provision(s) 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.*
[Nonretroactive as of January 1, 1990.]

A device may be fitted with an automatic or a semiautomatic calibration mechanism. This mechanism shall be incorporated inside the device. After sealing, neither the mechanism nor the calibration process shall facilitate fraud.
(Added 1985) (Amended 1989, 1993)

G-N. Notes

G-N.1. Conflict of Laws and Regulations. - If any particular provisions of these specifications, tolerances, and other requirements are found to conflict with existing State laws, or with existing regulations or local ordinances relating to health, safety, or fire prevention, the enforcement of such provisions shall be suspended until conflicting requirements can be harmonized; and such suspension shall not affect the validity or enforcement of the remaining provisions of these specifications, tolerances, and other requirements.

G-N.2. Testing With Nonassociated Equipment. - Tests to determine conditions, such as radio frequency interference (RFI), that may adversely affect the performance of a device shall be conducted with equipment and under conditions that are usual and customary with respect to the location and use of the device.
(Added 1976)

G-T. Tolerances

G-T.1. Acceptance Tolerances. - Acceptance tolerances shall apply to:

(a) equipment to be put into commercial use for the first time;

Sec. 2.20. Scales

A. Application

A.1. General. - This code applies to all types of weighing devices other than automatic bulk-weighing systems and belt-conveyor scales. The code comprises requirements that are generally applicable to all weighing devices, and specific requirements that are applicable only to certain types of weighing devices.
(Amended 1972 and 1983)

A.2. Wheel-Load Weighers, Portable Axle-Load Weighers, and Axle-Load Scales. - The requirements for wheel-load weighers, portable axle-load weighers, and axle-load scales apply only to such scales in official use for the enforcement of traffic and highway laws or for the collection of statistical information by government agencies.

A.3. Also see General Code requirements.

S. Specifications

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

S.1.1. Zero Indication.

(a) On a scale equipped with indicating or recording elements, provision shall be made to either indicate or record a zero-balance condition.

(b) On an automatic-indicating scale or balance indicator, provision shall be made to indicate or record an out-of-balance condition on both sides of zero.

(c) A zero-balance condition may be indicated by other than a continuous digital zero indication, provided that an effective automatic means is provided to inhibit a weighing operation or to return to a continuous digital indication when the scale is in an out-of-balance condition.
(Added 1987)
(Amended 1987, 1993)

S.1.1.1. Digital Indicating Elements.

(a) A digital zero indication shall represent a balance condition that is within ± 1/2 the value of the scale division.

(b) A digital indicating device shall either automatically maintain a "center-of-zero" condition to ± 1/4 scale division or less, or have an auxiliary or supplemental "center-of-zero" indicator that defines a zero-balance condition to ± 1/4 of a scale division or less.
[Nonretroactive as of January 1, 1993.]
(Amended 1992)

S.1.1.2. No-Load Reference Value. - On a single draft manually operated receiving hopper scale installed below grade, used to receive grain, and utilizing a no-load reference value, provision shall be made to indicate and record the no-load reference value prior to the gross load value.
(Added 1983)

S.1.2. Value of Scale Division Units. *- Except for batching scales and weighing systems used exclusively for weighing in predetermined amounts, the value of a scale 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; or

Examples: Scale divisions may be 10, 20, 50, 100; or 0.01, 0.02, 0.05; or 0.1, 0.2, or 0.5, etc.

(c) a binary submultiple of a specific unit of weight.

Examples: Scale divisions may be 1/2, 1/4, 1/8, 1/16, etc.
[Nonretroactive as of January 1, 1986.]
(Amended 2006)

S.1.2.1. Weight Units. *- Except for postal scales, a digital-indicating scale shall indicate weight values using only a single unit of measure. Weight values shall be presented in a decimal format with the value of the scale division expressed as 1, 2, or 5, or a decimal multiple or submultiple of 1, 2, or 5.*
[Nonretroactive and enforceable as of January 1, 1989.]
(Added 1987)

S.1.2.2. Verification Scale Interval.

S.1.2.2.1. Class I and II Scales and Dynamic Monorail Scales. If $e \neq d$, the verification scale interval "e" shall be determined by the expression:

$$d < e \leq 10\ d$$

If the displayed division (d) is less than the verification division (e), then the verification division shall be less than or equal to 10 times the displayed division.

The value of e must satisfy the relationship, $e = 10^k$ of the unit of measure, where k being a positive or negative whole number or zero. This requirement does not apply to a Class I device with d < 1 mg where e = 1 mg. If e ≠ d, the value of "d" shall be a decimal submultiple of "e," and the ratio shall not be more than 10:1. If e ≠ d, and both "e" and "d" are continuously displayed during normal operation, then "d" shall be differentiated from "e" by size, shape, color, etc., throughout the range of weights displayed as "d." (Added 1999)

S.1.2.2.2. Class III and IIII. The value of "e" is pecified by the manufacturer as marked on the device. Except for dynamic monorail scales, "e" must be less than or equal to "d." (Added 1999)

S.1.2.3. Prescription Scale with a Counting Feature. – A Class I or Class II prescription scale with an operational counting feature shall not calculate a piece weight or total count unless the sample used to determine the individual piece weight meets the following conditions:

(a) minimum individual piece weight is greater than or equal to 3 e; and

(b) minimum sample piece count is greater than or equal to 10 pieces.

(Added 2003)

S.1.3. Graduations.

S.1.3.1. Length. - Graduations shall be so varied in length that they may be conveniently read.

S.1.3.2. Width. - In any series of graduations, the width of a graduation shall in no case be greater than the width of the clear space between graduations. The width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall be not less than 0.2 mm (0.008 in) wide.

S.1.3.3. Clear Space Between Graduations. - The clear space between graduations shall be not less than 0.5 mm (0.02 in) for graduations representing money values, and not less than 0.75 mm (0.03 in) for other graduations. If the graduations are not parallel, the measurement shall be made:

(a) along the line of relative movement between the graduations at the end of the indicator, or

(b) if the indicator is continuous, at the point of widest separation of the graduations.

S.1.4. Indicators.

S.1.4.1. Symmetry. - The index of an indicator shall be of the same shape as the graduations, at least throughout that portion of its length associated with the graduations.

S.1.4.2. Length. - The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case, the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.4.3. Width. - The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

(a) the width of the narrowest graduation, [Nonretroactive as of January 1, 2002.]

(b) the width of the clear space between weight graduations, and

(c) three-fourths of the width of the clear space between money value graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

S.1.4.4. Clearance. - The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.4.5. Parallax. - Parallax effects shall be reduced to the practicable minimum.

S.1.5. Weighbeams.

S.1.5.1. Normal Balance Position. - The normal balance position of the weighbeam of a beam scale shall be horizontal.

S.1.5.2. Travel. - The weighbeam of a beam scale shall have equal travel above and below the horizontal. The total travel of the weighbeam of a beam scale in a trig loop or between other limiting stops near the weighbeam tip shall be not less than the minimum travel shown in Tables 1M and 1. When such limiting stops are not provided, the total travel at the weigh-beam tip shall be not less than 8 percent of the distance from weighbeam fulcrum to the weighbeam tip.

(c) the total price, and

(d) the product class or, in a system equipped with price look-up capability, the product name or code number.

S.1.9. Prepackaing Scales.

S.1.9.1. Value of the Scale Division. - On a pre-packaging scale, the value of the intervals representing weight values shall be uniform throughout the entire reading face. The recorded weight values shall be identical with those on the indicator.

S.1.9.2. Label Printer. - A prepackaging scale or 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.1.10. Adjustable Components. - An adjustable component such as a pendulum, spring, or potentiometer shall be held securely in adjustment and, except for a zero-load balance mechanism, shall be located within the housing of the element.
(Added 1986)

S.1.11. Provision for Sealing.

(a) Except on Class I scales, provision shall be made for applying a security seal in a manner that requires the security seal to be broken before an adjustment can be made to any component affecting the performance of an electronic device.
[Nonretroactive as of January 1, 1979.]

(b) Except on Class I scales, a device shall be designed with provision(s) 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.
[Nonretroactive as of January 1, 1990.]

(c) Except on Class I scales, audit trails shall use the format set forth in Table S.1.11.
[Nonretroactive as of January 1, 1995.]

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.
(Amended 1989, 1991, 1993)

S.1.12. Manual Weight Entries. *- A device when being used for direct sale shall accept an entry of a manual gross or net weight value only when the scale gross or net* weight indication is at zero. Recorded manual weight entries, except those on labels generated for packages of standard weights, shall identify the weight value as a manual weight entry by one of the following terms: "Manual Weight," "Manual Wt," or "MAN WT." The use*

Table S.1.11. 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. *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.)***

[Nonretroactive as of January 1, 1995.]
(Table added 1993)

of a symbol to identify multiple manual weight entries on a single document is permitted, provided that the symbol is defined on the same page on which the manual weight entries appear and the definition of the symbol is automatically printed by the recording element as part of the document.
[Nonretroactive as of January 1, 1993]
*[*Nonretroactive as of January 1, 2005]*
(Added 1992) (Amended 2004)

S.1.13. Vehicle On-Board Weighing Systems: Vehicle in Motion. - When the vehicle is in motion, a vehicle on-board weighing system shall either:

(a) be accurate; or

(b) inhibit the weighing operation.
(Added 1993)

S.2. Design of Balance, Tare, Level, Damping, and Arresting Mechanisms.

S.2.1. Zero-Load Adjustment.

S.2.1.1. General. - A scale shall be equipped with means by which the zero-load balance may be adjusted. Any loose material used for this purpose shall be enclosed so that it cannot shift in position and alter the balance condition of the scale.

S.2.1.2. Scales Used in Direct Sales. - A manual zero-setting mechanism (except on a digital scale with an analog zero-adjustment mechanism with a range of not greater than one scale division) shall be operable or accessible only by a tool outside of and entirely separate from this mechanism, or it shall be enclosed in a cabinet. Except on Class I or II scales, a balance ball shall either meet this requirement or not itself be rotatable.

A semiautomatic zero-setting mechanism shall be operable or accessible only by a tool outside of and separate from this mechanism or it shall be enclosed in a cabinet, or it shall be operable only when the indication is stable within:

(a) plus or minus 3 scale divisions for scales of more than 2 000 kg (5 000 lb) capacity in service prior to January 1, 1981, and for all axle-load, railway track, and vehicle scales; or

(b) plus or minus 1 scale division for all other scales.

S.2.1.3. Scales Equipped With An Automatic Zero-Setting Mechanism (Zero Tracking). -

S.2.1.3.1. Zero-Tracking for Scales Manufactured Between January 1, 1981 and January 1, 2007. *– The maximum load that can be "rezeroed," when either placed on or removed from the platform all at once under normal operating conditions, shall be:*

(a) for bench, counter, and livestock scales: 0.6 scale division;

(b) for vehicle, axle-load, and railway track scales: 3.0 scale divisions; and

(c) for all other scales: 1.0 scale division.
(Amended 2005)

S.2.1.3.2. Zero-Tracking for Scales Manufactured On Or After January 1, 2007. *– The maximum load that can be "rezeroed," when either placed on or removed from the platform all at once under normal operating conditions, shall be:*

(a) for vehicle, axle-load, and railway track scales: 3.0 scale divisions; and

(b) for all other scales: 0.5 scale division.
(Added 2005)

S.2.1.3.3. Means to Disable Zero-Tracking On Class III L Devices. - *Class III L devices equipped with a zero-tracking mechanism shall be designed with a sealable means that would allow zero tracking to be disabled during the inspection and test of the device.*
[Nonretroactive as of January 1, 2001]
(Added 1999) (Amended 2005 and 2006)

S.2.1.4. Monorail Scales. - On a static monorail scale equipped with digital indications, means shall be provided for setting the zero-load balance to within 0.02 percent of scale capacity. On a dynamic monorail weighing system, means shall be provided to automatically maintain these conditions.
(Amended 1999)

S.2.1.5. Initial Zero-Setting Mechanism.

(a) Scales of accuracy Classes I, II, and III may be equipped with an initial zero-setting device.

(b) An initial zero-setting mechanism shall not zero a load in excess of 20 percent of the maximum capacity of the scale unless tests show that the scale meets all applicable tolerances for any amount of initial load compensated by this device within the specified range.
(Added 1990)

S.5.4. Relationship of Load Cell Verification Interval Value to the Scale Division. - *The relationship of the value for the load cell verification scale interval, v_{min}, to the scale division, d, for a specific scale installation using NTEP load cells shall comply with the following formulae where N is the number of load cells in the scale (such as hopper or vehicle scale weighing/load-receiving elements):*

(a) $v_{min} \leq \frac{d^*}{\sqrt{N}}$ *for scales without lever systems; and*

(b) $v_{min} \leq \frac{d^*}{\sqrt{N} \times (\text{scale multiple})}$ *for scales with lever systems.*

*[*When the value of the scale division, d, is different from the verification scale division, e, for the scale, the value of e must be used in the formulae above.]*

This requirement does not apply to complete weighing/ load-receiving scales, which satisfy all the following criteria:

- *The complete weighing/load-receiving element or scale has been evaluated for compliance with T.N.8.1. Temperature under the National Type Evaluation Program (NTEP);*
- *The complete weighing/load-receiving element or scale has received an NTEP Certificate of Conformance; and*
- *The complete weighing/load-receiving element or scale is equipped with an automatic zero-tracking mechanism which cannot be made inoperative in the normal weighing mode. (A test mode which permits the disabling of the automatic zero-tracking mechanism is permissible, provided the scale cannot function normally while in this mode.)*

[Nonretroactive as of January 1, 1994.]
(Added 1993) (Amended 1996 and 2006)

S.6. Marking Requirements. [See also G-S.1., G-S.4., G-S.6., G-S.7., G-UR.2.1.1., and UR.3.4.1.]

S.6.1. Nominal Capacity; Vehicle and Axle-Load Scales. - *For all vehicle and axle-load scales, the marked nominal capacity shall not exceed the concentrated load capacity (CLC) times the quantity of the number of sections in the scale minus 0.5.*

As a formula, this is stated as

nominal capacity $\leq$ *CLC x (N - 0.5)*

where N = the number of sections in the scale.

(See N.1.3.4. and T.N.3.1.)
[Nonretroactive as of January 1, 1989.]

[**Note:** When the device is used in a combination railway track and vehicle weighing application, the above formula shall apply only to the vehicle scale application.]
(Added 1988) (Amended 1999 and 2002)

S.6.2. Location of Marking Information. - Scales that 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 S.6. of the Scales 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 scales 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.
(Added 1989)

S.6.3. Scales, Main Elements, and Components of Scales or Weighing Systems. - Scales, main elements of scales when not contained in a single enclosure for the entire scale, load cells for which Certificates of Conformance (CC) have been issued under the National Type Evaluation Program, and other equipment necessary to a weighing system, but having no metrological effect on the weighing system, shall be marked as specified in Table S.6.3.a. and explained in the accompanying notes (Table S.6.3.b.).
(Added 1990)

S.6.4. Railway Track Scales. - A railway track scale shall be marked with the maximum capacity of each section of the load-receiving element of the scale. Such marking shall be accurately and conspicuously presented on, or adjacent to, the identification or nomenclature plate that is attached to the indicating element of the scale. *The nominal capacity of a scale with more than two sections shall not exceed twice its rated section capacity. The nominal capacity of a two-section scale shall not exceed its rated section capacity.*
[Nonretroactive as of January 1, 2002]
(Amended 1988 and 2001)

S.6.5. Livestock Scales. - A livestock scale manufactured prior to January 1, 1989 or after January 1, 2003 shall be marked with the maximum capacity of each section of the load-receiving element of the scale. Livestock scales manufactured between January 1, 1989 and January 1, 2003 shall be marked with either the Concentrated Load Capacity (CLC) or the Section Capacity. Such marking shall be accurately and conspicuously presented on, or adjacent to the identification or nomenclature plate that is attached to the indicating element of the scale. *The nominal capacity of a scale with more than two sections shall not exceed twice its rated section capacity. The nominal capacity of a two-section scale shall not exceed its rated section capacity**.
*[*Nonretroactive as of January 1, 2003]*

See also Note 14 in Table S.6.3.b.
(Added 2002) (Amended 2003)

S.6.6. Counting Feature, Minimum Individual Piece Weight and Minimum Sample Piece Count. – A Class I or Class II prescription scale with an operational counting feature shall be marked with the minimum individual piece weight and minimum number of pieces used in the sample to establish an individual piece weight.
(Added 2003)

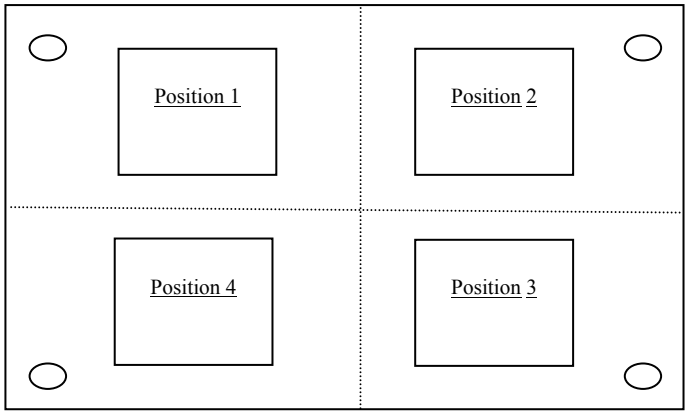
N. Notes

N.1. Test Procedures.

N.1.1. Increasing-Load Test. - The increasing-load test shall be conducted on all scales with the test loads approximately centered on the load-receiving element of the scale, except on a scale having a nominal capacity greater than the total available known test load. When the total test load is less than the nominal capacity, the test load is used to greatest advantage by concentrating it, within prescribed load limits, over the main load supports of the scale.

N.1.2. Decreasing-Load Test (Automatic Indicating Scales). - The decreasing-load test shall be conducted with the test load approximately centered on the load-receiving element of the scale.

(b) A one-half nominal capacity test load centered as nearly as possible, successively at the center of each quarter of the load-receiving element as shown in the diagram below.



⬭ = Load Bearing Point

(Added 2003)

N.1.4. Sensitivity Test. - A sensitivity test shall be conducted on nonautomatic-indicating (weighbeam) scales only, with the weighing device in equilibrium at zero-load and at maximum test load. The test shall be conducted by increasing or decreasing the test load in an amount equal to the applicable value specified in T.2. or T.N.6.

N.1.5. Discrimination Test. *- A discrimination test shall be conducted on all automatic indicating scales with the weighing device in equilibrium at or near zero load and at or near maximum test load, and under controlled conditions in which environmental factors are reduced to the extent that they will not affect the results obtained. For scales equipped with an Automatic Zero-Setting Mechanism (AZSM), the discrimination test may be conducted at a range outside of the AZSM range.*
[Nonretroactive as of January 1, 1986.]
(Added 1985) (Amended 2004)

N.1.5.1. Digital Device. - On a digital device, 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.1.6. RFI Susceptibility Tests, 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 1986)

N.1.7. Ratio Test. - A ratio test shall be conducted on all scales employing counterpoise weights and on nonautomatic-indicating equal-arm scales.

N.1.8. Material Tests. - A material test shall be conducted on all customer-operated bulk weighing systems for recycled materials using bulk material for which the device is used. Insert into the device, in a normal manner, several accurately preweighed samples (free of foreign material) in varying amounts approximating average drafts.

N.1.9. Zero-Load Balance Change. - A zero-load balance change test shall be conducted on all scales 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.) (Renumbered 1988)

N.1.10. Counting Feature Test. – A test of the counting function shall be conducted on all Class I and Class II prescription scales having an active counting feature used in "legal for trade" applications. The test should verify that the scale will not accept a sample with less than either the minimum sample piece count or the minimum sample weight of 30 e. Counting feature accuracy should be verified at a minimum of two test loads. Verification of the count calculations shall be based upon the weight indication of the test load.

Note:

(1) The minimum sample weight is equal to the marked minimum invidiual piece weight times the marked minimum sample piece count.

(2) Test load as used in this section refers to actual calibration test weights selected from an appropriate test weight class.

(Added 2003)

N.1.11. Substitution Test. – In the substitution test procedure, material or objects are substituted for known test weights, or a combination of known test weights and previously quantified material or objects, using the scale under test as a comparator. Additional test weights or other known test loads may be added to the known test load to evaluate higher weight ranges on the scale.
(Added 2003)

N.1.12. Strain-Load Test. – In the strain load test procedure, an unknown quantity of material or objects are used to establish a reference load or tare to which test weights or substitution test loads are added.
(Added 2003)

N.2. Verification (Testing) Standards. - Field standard weights used in verifying weighing devices 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).
(Amended 1986)

TABLE 4. RECOMMENDED[2] MINIMUM TEST WEIGHTS AND TEST LOADS[1]			
Device Capacity (Pounds)	**Recommended[2] minimums (in terms of device capacity)**		**Recommended[2] (where practicable)**
	Test Weights (greater of)	**Test Loads**	
0 to 100	**105%**		
101 to 1,000	**50% or 100 lb**	**105%**	
1,001 to 40,000	**25% or 500 lb**	**50%**	**Test weights to dial face capacity, 1,000d or test load to used capacity, if greater than minimums specified**
40,000 +	**12.5% or 10,000 lb**	**25%**	

[1] The term "test load" means the sum of the combination of field standard test weights and any other applied load used in the conduct of a test using substitution or build-up test methods.

Except for railway track scales, the recommended[2] minimum test of a Class III L scale shall consist of one test from zero to at least 25% of the scale capacity and then one strain load test to at least the used capacity of the device.

Each test is to be conducted using a known test load of at least 25% of scale capacity. This test load may be comprised entirely of test weights or a combination of test weights equal to at least 12.5% of scale capacity and a substitution load.

[2] The word "Recommended" will be deleted from this section as of January 1, 1998. This will make the amounts of test weights and test loads specified in Table 4 mandatory as of January 1, 1998.

N.3. Minimum Test Weights and Test Loads*.

[NOT ADOPTED]

4002.2 Scales (2.20)

(a) Recommended Minimum[2] Test Weights and Test Loads.[1] The recommended[2] minimum test weights and test loads for in-service tests (except railway track scales) are shown in Table 4. [See Table 4 for [1] and [2]]

N.3.1. Minimum Test-Weight Load and Recommended Strain-Load Test for Railway Track Scales.
(Amended 1990)

N.3.1.1. Approval. - The test-weight load shall be not less than 35 000 kg (80 000 lb). A strain-load test conducted up to the used capacity of the weighing system is recommended.
(Added 1990)

N.3.1.2. Interim Approval. - A test-weight load of not less than 13 500 kg (30 000 lb) and a strain-load test up to at least 25 percent of scale capacity may be used to return a scale into service following repairs.
(Added 1990)

Note: The length of time the scale may be used following an interim test is at the discretion of the official with statutory authority.
(Added 1990)

N.3.1.3. Enforcement Action for Inaccuracy. - To take enforcement action on a scale that is found to be inaccurate, a minimum test load of 13 500 kg (30 000 lb) must be used.
(Added 1990)

N.3.2. Field Standard Weight Carts. – Field Standard Weight Carts that comply with the tolerances expressed in Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied) may be included as part of the minimum required test load (see Table 4) for shift tests and other test procedures.
(Added 2004)

T.N.4.4. Shift or Section Tests. - The range of the results obtained during the conduct of a shift test or a section test shall not exceed the absolute value of the maintenance tolerance applicable and each test result shall be within applicable tolerances.
(Added 1986)

T.N.4.5. Time Dependence. – A time dependence test shall be conducted during type evaluation and may be conducted during field verification provided test conditions remain constant.
(Amended 1989 and 2005)

T.N.4.5.1. Time Dependence; Class II, III, and IIII Non-Automatic Weighing Instruments. - A non-automatic weighing instrument of Classes II, III, and IIII shall meet the following requirements at constant test conditions. During type evaluation, this test shall be conducted at 20 °C ± 2 °C (68 °F ± 4 °F):

(a) When any load is kept on an instrument, the difference between the indication obtained immediately after placing the load and the indication observed during the following 30 minutes shall not exceed 0.5 e. However, the difference between the indication obtained at 15 minutes and the indication obtained at 30 minutes shall not exceed 0.2 e.

(b) If the conditions in (a) are not met, the difference between the indication obtained immediately after placing the load on the instrument and the indication observed during the following 4 hours shall not exceed the absolute value of the maximum permissible error at the load applied.

(c) The deviation on returning to zero as soon as the indication has stabilized, after the removal of any load which has remained on the instrument for 30 minutes, shall not exceed 0.5 e.

For a multi-interval instrument, the deviation shall not exceed 0.5 e_1 (where e_1 is the interval of the first partial weighing range or segment of the scale).

On a multiple range instrument, the deviation on returning to zero from Max_i (load in the applicable weighing range) shall not exceed 0.5 e_i (interval of the weighing segment). Furthermore, after returning to zero from any load greater than Max_1 (capacity of the first weighing range) and immediately after switching to the lowest weighing range, the indication near zero shall not vary by more than e_1 (interval of the first weighing range) during the following 5 minutes.
(Added 2005) (Amended 2006)

T.N.4.5.2. Time Dependence; Class III L Non-Automatic Weighing Instruments. - A non-automatic weighing instrument of Class III L shall meet the following requirements:

(a) When any load is kept on an instrument, the difference between the indication obtained immediately after placing the load and the indication observed during the following 30 minutes shall not exceed 1.5 e. However, the difference between the indication obtained at 15 minutes and the indication obtained at 30 minutes shall not exceed 0.6 e.

(b) If the conditions in (a) are not met, the difference between the indication obtained immediately after placing the load on the instrument and the indication observed during the following 4 hours shall not exceed the absolute value of the maximum permissible error at the load applied.

(c) The deviation on returning to zero as soon as the indication has stabilized, after the removal of any load which has remained on the instrument for 30 minutes, shall not exceed one-half of the absolute value of the applicable tolerance for the applied load for Class III L devices.
(Added 2005) (Amended 2006)

T.N.4.6. Time Dependence (Creep) for Load Cells During Type Evaluation. – A load cell (force transducer) marked with an accuracy class shall meet the following requirements at constant test conditions:

(a) **Permissible Variations of Readings**. - With a constant maximum load for the measuring range (D_{max}) between 90% and 100% of maximum capacity (E_{max}), applied to the load cell, the difference between the initial reading and any reading obtained during the next 30 minutes shall not exceed the absolute value of the maximum permissible error (mpe) for the applied load (see Table T.N.4.6.). The difference between the reading obtained at 20 minutes and the reading obtained at 30 minutes shall not exceed 0.15 times the absolute value of the mpe (see Table T.N.4.6.).

(b) **Apportionment Factors**. - The mpe for creep shall be determined from Table T.N.4.6. Maximum Permissible Error (mpe)* for Load Cells During Type Evaluation using the following apportionment factors (p_{LC}):

p_{LC} = 0.7 for load cells marked with S (single load cell applications),
p_{LC} = 1.0 for load cells marked with M (multiple load cell applications), and
p_{LC} = 0.5 for Class III L load cells marked with S or M.
(Added 2005) (Amended 2006)

Table T.N.4.6. Maximum Permissible Error (mpe)* for Load Cells During Type Evaluation			
mpe in Load Cell Verifications Divisions (v) = p_{LC} x Basic Tolerance in v			
Class	p_{LC} x 0.5 v	p_{LC} x 1.0 v	p_{LC} x 1.5 v
I	0 – 50 000 v	50 001 v – 200 000 v	200 001 v +
II	0 – 5 000 v	5 001 v – 20 000 v	20 001 v +
III	0 – 500 v	501 v – 2 000 v	2 001 v +
IIII	0 – 50 v	51 v – 200 v	201 v +
III L	0 – 500 v	501 v – 1 000 v	(Add 0.5 v to the basic tolerance for each additional 500 v or fraction thereof up to a maximum load of 10 000 v)
v represents the load cell verification interval p_{LC} represents the apportionment factors applied to the basic tolerance p_{LC} = 0.7 for load cells marked with S (single load cell applications) p_{LC} = 1.0 for load cells marked with M (multiple load cell applications) p_{LC} = 0.5 for Class III L load cells marked with S or M * mpe = p_{LC} x Basic Tolerance in load cell verifications divisions (v)			

(Table Added 2005) (Amended 2006)

T.N.4.7. Creep Recovery for Load Cells During Type Evaluation. - The difference between the initial reading of the minimum load of the measuring range (D_{min}) and the reading after returning to minimum load subsequent to the maximum load (D_{max}) having been applied for 30 minutes shall not exceed:

(a) 0.5 times the value of the load cell verification interval (0.5 v) for Class I, II, III, and IIII load cells, or

(b) 1.5 times the value of the load cell verification interval (1.5 v) for Class III L load cells.

(Added 2006)

T.N.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.N.6. Sensitivity. - This section is applicable to all non-automatic-indicating scales marked I, II, III, III L, or IIII.

T.N.6.1. Test Load.

(a) The test load for sensitivity for nonautomatic-indicating vehicle, axle-load, livestock, and animal scales shall be 1d for scales equipped with balance indicators, and 2d or 0.2 percent of the scale capacity, whichever is less, for scales not equipped with balance indicators.

(b) For all other nonautomatic-indicating scales, the test load for sensitivity shall be 1d at zero and 2d at maximum test load.

T.N.6.2. Minimum Change of Indications. - The addition or removal of the test load for sensitivity shall cause a minimum permanent change as follows:

(a) for a scale with trig loop but without a balance indicator, the position of the weighbeam shall change from the center to the outer limit of the trig loop;

(b) for a scale with balance indicator, the position of the indicator shall change one division on the graduated scale, the width of the central target area, or the applicable value as shown below, whichever is greater;

Scale of Class I or II: 1 mm (0.04 in),

Scale of Class III or IIII with a maximum capacity of 30 kg (70 lb) or less: 2 mm (0.08 in),

Scale of Class III, III L, or IIII with a maximum capacity of more than 30 kg (70 lb): 5 mm (0.20 in);

(c) for a scale without a trig loop or balance indicator, the position of rest of the weighbeam or lever system shall change from the horizontal or midway between limiting stops to either limit of motion.

(Amended 1987)

T.N.7. Discrimination.

T.N.7.1. Analog Automatic Indicating (i.e., Weighing Device With Dial, Drum, Fan, Etc.). - A test load equivalent to 1.4d shall cause a change in the indication of at least 1.0d. (See N.1.5.)

T.N.7.2. Digital Automatic Indicating. - A test load equivalent to 1.4d shall cause a change in the indicated or recorded value of at least 2.0d. This requires the zone of uncertainty to be not greater than three-tenths of the value of the scale division. (See N.1.5.1.)

T.N.8. Influence Factors. - The following factors are applicable to tests conducted under controlled conditions only, provided that:

(a) types of devices approved prior to January 1, 1986, and manufactured prior to January 1, 1988, need not meet the requirements of this section, and

(b) new types of devices submitted for approval after January 1, 1986, shall comply with the requirements of this section, and

(c) all devices manufactured after January 1, 1988, shall comply with the requirements of this section.
(Amended 1985)

T.N.8.1. Temperature. - Devices shall satisfy the tolerance requirements under the following temperature conditions:

T.N.8.1.1. If not specified in the operating instructions for Class I or II scales, or if not marked on the device for Class III, III L, or IIII scales, the temperature limits shall be:

-10 °C to 40 °C (14 °F to 104 °F)

T.N.8.1.2. If temperature limits are specified for the device, the range shall be at least that specified in Table T.N.8.1.2.

Table T.N.8.1.2.
Temperature Range by Class

Class	Temperature Range
I	5 °C (9 °F)
II	15 °C (27 °F)
III, III L, & IIII	30 °C (54 °F)

T.N.8.1.3. Temperature Effect on Zero-Load Balance. - The zero-load indication shall not vary by more than:

(a) three divisions per 5 °C (9 °F) change in temperature for Class III L devices; or

(b) one division per 5 °C (9 °F) change in temperature for all other devices.
(Amended 1990)

T.N.8.1.4. Operating Temperature. - Except for Class I and II devices, an 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.N.8.2. Barometric Pressure. - Except for Class I scales, the zero indication shall not vary by more than one scale division for a change in barometric pressure of 1 kPa over the total barometric pressure range of 95 kPa to 105 kPa (28 to 31 in of Hg).

T.N.8.3. Electric Power Supply.

T.N.8.3.1. Power Supply, Voltage and Frequency.

(a) Weighing devices that operate using alternating current must perform within the conditions defined in paragraphs T.N.3. through T.N.7., 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.
(Amended 2003 and 2004)

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

T.N.8.3.2. 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.N.9. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility. - The difference between the weight indication due to 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 cannot be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.
(Added 1986)

The tolerance in T.N.9. is to be applied independently of other tolerances. For example, if indications are at allowable basic tolerance error limits when the disturbance occurs, then it is acceptable for the indication to exceed the applicable basic tolerances during the disturbance. [Editors' Note: Following the 1997 NCWM Annual Meeting, the text in this paragraph was revised with concurrence of the S&T Committee to clarify its application.]
(Amended 1997)

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.[4]

[4] Purchasers and users of scales such as railway track, hopper, and vehicle scales should be aware of possible additional requirements for the design and installation of such devices. (Footnote Added 1995)

UR.1.1. General.

(a) For devices marked with a class designation, the typical class or type of device for particular weighing applications is shown in Table 7a.

(b) For devices not marked with a class designation, Table 7b applies.

Table 7a.
Typical Class or Type of Device for Weighing Applications

Class	Weighing Application or Scale Type
I	Precision laboratory weighing
II	Laboratory weighing, precious metals and gem weighing, grain test scales
III	All commercial weighing not otherwise specified, grain test scales, retail precious metals and semi-precious gem weighing, animal scales, postal scales, vehicle on-board weighing systems with a capacity less than or equal to 30 000 lb, and scales used to determine laundry charges
III L	Vehicle scales, vehicle on-board weighing systems with a capacity greater than 30 000 lb, axle-load scales, livestock scales, railway track scales, crane scales, and hopper (other than grain hopper) scales
IIII	Wheel-load weighers and portable axle-load weighers used for highway weight enforcement

Note: A scale with a higher accuracy class than that specified as "typical" may be used.
(Amended 1985, 1986, 1987, 1988, 1992, 1995, 2004 and 2005)

Table 7b.
Applicable to Devices Not Marked With a Class Designation

Scale Type or Design	Maximum Value of d
Retail Food Scales, 50-lb capacity and less	1 ounce
Animal Scales	1 pound
Grain Hopper Scales Capacity up to and incl. 50 000 lb Capacity over 50 000 lb	 10 pounds (but not greater than 0.05 % of capacity) 20 pounds
Crane Scales	not greater than 0.2 % of capacity
Vehicle and Axle-Load Scales Used in Combination Capacity up to and including 200 000 lb Capacity over 200 000 lb	 20 pounds 50 pounds
Railway Track Scales With weighbeam Automatic indicating	 20 pounds 100 pounds
Scales with capacities greater than 500 lb except otherwise specified	0.1 % capacity (but not greater than 50 lb)
Wheel-Load Weighers	.25 % capacity (but not greater than 50 lb)

Note: For scales not specified in this table, G-UR.1.1. and UR.1. apply.
(Added 1985) (Amended 1989)

UR.3.4. Wheel-Load Weighing.

UR.3.4.1. Use in Pairs. - When wheel-load weighers or portable axle-load weighers are to be regularly used in pairs, both weighers of each such pair shall be appropriately marked to identify them as weighers intended to be used in combination.

UR.3.4.2. Level Condition. – A vehicle of which either an axle-load determination or a gross-load determination is being made utilizing wheel-load weighers or portable axle-load weighers, shall be in a reasonably level position at the time of such determination.

UR.3.5. Special Designs. - A scale designed and marked for a special application (such as a prepackaging scale or prescription scale with a counting feature) shall not be used for other than its intended purpose.[4]
(Amended 2003)

UR.3.6. Wet Commodities. - Wet commodities not in watertight containers shall be weighed only on a scale having a pan or platform that will drain properly.
(Amended 1988)

UR.3.7. Minimum Load on a Vehicle Scale.
[NOT ADOPTED]

4002.2. Scales (2.20.)

(b) Minimum Load on a Vehicle Scale. Except for weighments of ferrous metals, cardboard, paper, rags or plastic, and the weighing of vehicles for registration purposes, a vehicle scale shall not be used for weighing net loads less than the value of 20 scale divisions.

[4] Prepackaging scales and prescription scales with a counting feature (and other commercial devices) used for putting up packages in advance of sale are acceptable for use in commerce only 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 prepackaging scale 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. (Amended 2003)

4002.2. Scales (2.20.)

(c) Class III, Class III L and Unmarked Devices Used For Recycling. Except for weighments of ferrous metals, cardboard, paper, rags, or plastic, Class III, Class III L and unmarked devices used in recycling shall not be used for weighing net loads less than the value of 20 scale divisions.

UR.3.8. Minimum Load for Weighing Livestock. - A scale with scale divisions greater than 2 kg (5 lb) shall not be used for weighing net loads smaller than 500d.
(Amended 1989)

UR.3.9. Use of Manual Weight Entries. - Manual gross or net weight entries are permitted for use in the following applications only:

(a) when a point-of-sale system interfaced with a scale is giving credit for a weighed item;

(b) when an item is pre-weighed on a legal for trade scale and marked with the correct net weight;

(c) when a device or system is generating labels for standard weight packages;

(d) when postal scales or weight classifiers are generating manifests for packages to be picked up at a later time; or

(e) when livestock and vehicle scale systems generate weight tickets to correct erroneous tickets.

(Added 1992) (Amended 2000, 2004 and 2006)

UR.3.10. Dynamic Monorail Weighing Systems. – When the value of d is different from the value of e, the commercial transaction must be based on e.
(Added 1999)

UR.3.11. Minimum Count. – A prescription scale with an operational counting feature shall not be used to count a quantity of less than 30 pieces weighing a minimum of 90 e.
(Added 2003) (Amended 2004)

Note: The minimum count as defined in this paragraph refers to the use of the device in the filling of prescriptions and is different from the minimum sample piece count as defined in S.1.2.3. and as required to be marked on the scale by S.6.6.
(Note Added 2004)

UR.3.12. Correct Stored Piece Weight. – For prescription scales with a counting feature, the user is responsible for maintaining the correct stored piece weight. This is especially critical when a medicine has been reformulated or comes from different lots.
(Added 2003)

UR.4. Maintenance Requirements.

UR.4.1. Balance Condition. - The zero-load adjustment of a scale shall be maintained so that, with no load on the load-receiving element and with all load-counter-balancing elements of the scale (such as poises, drop weights, or counterbalance weights) set to zero, the scale shall indicate or record a zero balance condition. A scale not equipped to indicate or record a zero-load balance shall be maintained in balance under any no-load condition.

UR.4.2. Level Condition. - If a scale is equipped with a level-condition indicator, the scale shall be maintained in level.

UR.4.3. Scale Modification. - The dimensions (e.g., length, width, thickness, etc.) of the load receiving element of a scale shall not be changed beyond the manufacturer's specifications, nor shall the capacity of a scale 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 a competent engineering authority, preferably that of the engineering department of the manufacturer of the scale, and by the weights and measures authority having jurisdiction over the scale.
(Amended 1996)

UR.5. Coupled-in-Motion Railroad Weighing Systems.- A coupled-in-motion weighing system placed in service on or after January 1, 1991, should be tested in the manner in which it is operated, with the locomotive either pushing or pulling the cars at the designed speed and in the proper direction. The cars used in the test train should represent the range of gross weights that will be used during the normal operation of the weighing system. Except as provided in N.4.2. and N.4.3.(a), normal operating procedures should be simulated as nearly as practical. Approach conditions for a train length in each direction of the scale site are more critical for a weighing system used for individual car weights than for a unit-train-weights-only facility, and should be considered prior to installation.
(Added 1990) (Amended 1992)

N. Notes

N.1. General. - Belt-conveyor scales are capable of weighing bulk material accurately. (See Tolerances.) However, their performance can be detrimentally affected by the conditions of the installation. (See User Requirements.) The performance of the equipment is not to be determined by averaging the results of the individual tests. The results of all tests shall be within the tolerance limits.
(Amended 2002)

N.1.1. Official Test. - An official test of a belt-conveyor scale system shall include tests specified in N.3.1. Zero Load Tests, N.3.2. Material Tests, and, if applicable, N.3.3. Simulated Load Tests.
(Amended 2006)

N.1.2. Simulated Test. - Simulated loading conditions as recommended by the manufacturer and approved by the official with statutory authority may be used to properly monitor the systems operational performance between official tests, but shall not be used for official certification.
(Amended 1991)

N.2. Conditions of Tests. - A belt-conveyor scale shall be tested after it is installed on the conveyor system with which it is to be used and under such environmental conditions as may normally be expected. Each test shall be conducted with test loads no less than the minimum test load.
(Amended 1986 and 2004)

N.2.1. Initial Verification. – A belt-conveyor scale system shall be tested at the normal use flow rate, 35% of the maximum rated capacity, and an intermediate flow rate between these two points. The system may also be tested at any other rate of flow that may be used at the installation.
(Added 2004)

N.2.2. Subsequent Verification. – Subsequent testing shall include testing at the normal use flow rate and other flow rates used at the installation. The official with statutory authority may determine that testing only at the normal use flow rate is necessary for subsequent verifications if evidence is provided that the system is used to operate:

(a) at no less than 70% of the maximum rated capacity for at least 80% of the time (excluding time that the belt is unloaded), or

(b) with a normal use flow rate that does not vary by more than 10% of the maximum rated capacity.

Example: If a belt-conveyor scale system has a maximum rated capacity of 200 tons per hour (tph), and the normal use flow rate is 150 tph (75% of the maximum rated capacity), no testing at additional flow rates is required provided the flow rates remain above 140 tph for more than 80% of the time. If the same device were operating operating with a normal use flow rate of 130 tph, it is operating at 65% of the maximum rated capacity. In this case, testing at flow rates in addition to the normal use flow rate would be required if the nrmal use flow rate varies by more than 20 tph (10% of the maximum rated capacity).
(Added 2004)

N.2.3. Minimum Test Load. – The minimum test load shall not be less than the largest of the following values.

(a) 800 scale divisions,

(b) the load obtained at maximum flow rate in one revolution of the belt, or

(c) at least 10 minutes of operation.

The official with statutory authority may determine that a smaller minimum totalized load down to 2% of the load totalized in one hour at the maximum flow rate may be used for subsequent tests, provided that:

1. the smaller minimum totalized load is greater than the quantities specified in (a) and (b), and

2. consecutive official testing with the minimum totalized loads described in N.2.3. (a), (b), or (c) and the smaller minimum test load has been conducted that demonstrates the system complies with applicable tolerances for repeatability, acceptance, and maintenance.

(Added 2004)

N.3. Test Procedures.

N.3.1. Zero Load Tests. - A zero-load test shall be conducted to establish that the belt scale system (including the conveyor) is capable of holding a stable, in-service zero.
(Amended 1989 and 2002)

N.3.1.1. Determination of Zero. - A "Zero-Load Test" is a determination of the error in zero, expressed as an internal reference, a percentage of the full-scale capacity, or a change in a totalized load over a whole number of complete belt revolutions. For belt-conveyor scales with electronic integrators, the test must be performed over a period of at least 3 minutes and with a whole number of complete belt revolutions. For belt-conveyor scales with mechanical integrators, the test shall be performed with no less than three complete revolutions or 10 minutes operation, whichever is greater.
(Added 2002)

N.3.1.2. Initial Stable Zero. - The conveyor system shall be run to warm up the belt and the belt scale shall be zero adjusted as required. A series of zero-load tests shall be carried out until three consecutive zero-load tests each indicate an error which does not exceed ± 0.06% of the totalized load at full scale capacity for the duration of the test. No adjustments can be made during the three consecutive zero-load test readings.
(Added 2002) (Amended 2004)

N.3.1.3. Test of Zero Stability. - The conveyor system shall be operated to warm up the belt and the belt scale shall be zero adjusted as required. A series of zero-load tests shall be carried out immediately before the simulated or materials test until the three consecutive zero-load tests each indicate an error which does not exceed ± 0.06% of the totalized load at full scale capacity for the duration of the test. No adjustments can be made during the three consecutive zero-load test readings.
(Added 2002) (Amended 2004)

N.3.1.4. Check For Consistency of the Conveyor Belt Along Its Entire Length. - After a zero-load test with flow rate filtering disabled, the totalizer shall not change more than plus or minus (± 3d) three scale divisions from its initial indication during one complete belt revolution.
(Added 2002) (Amended 2004)

N.3.2. Material Tests. – Material tests should be conducted using actual belt loading conditions. These belt loading conditions shall include, but are not limited to conducting materials tests using different belt loading points, all types and sizes of products weighed on the scale, at least one other belt speed, and in both directions of weighing.

On initial verification, at least 3 individual material tests shall be conducted. On subsequent verifications, at least 2 individual tests shall be conducted. The results of all these tests shall be within the tolerance limits.
(Amended 2005)

Either pass a quantity of pre-weighed material over the belt-conveyor scale in a manner as similar as feasible to actual loading conditions, or weigh all material that has passed over the belt-conveyor scale. Means for weighing the material test load will depend on the capacity of the belt-conveyor scale and availability of a suitable scale for the test. To assure that the test load is accurately weighed and determined, the following precautions shall be observed:
(Amended 2002)

(a) The containers, whether railroad cars, trucks, or boxes, must not leak, and shall not be overloaded to the point that material will be lost.

(b) The actual empty or tare weight of the containers shall be determined at the time of the test. Stenciled tare weight of railway cars or trucks shall not be used. Gross and tare weights shall be determined on the same scale.

(c) When a pre-weighed test load is passed over the scale, the belt loading hopper shall be examined before and after the test to assure that the hopper is empty and that only the material of the test load has passed over the scale.

(d) Where practicable, a reference scale should be tested within 24 hours preceding the determination of the weight of the test load used for a belt-conveyor scale material test.

A reference scale which is not "as found" within maintenance tolerance should have its accuracy re-verified after the belt-conveyor test with a suitable known weight load if the "as found" error of the belt-conveyor scale material test exceeds maintenance tolerance values.

(e) If any suitable known weight load other than a certified test weight load is used for re-verification of the reference scale accuracy, its weight shall be determined on the reference scale after the reference scale certification and before commencing the belt scale material test.

Note: Even if the reference scale is within maintenance tolerance it may require adjusting to be able to meet paragraph N.3.2.1.

(f) The test shall not be conducted if the weight of the test load has been affected by environmental conditions.
(Amended 1986, 1989, 1998, 2000 and 2002)

N.3.2.1. Accuracy of Material. - The quantity of material used to conduct a material test shall be weighed on a reference scale to an accuracy within 0.1 percent. Scales typically used for this purpose include Class III and III L scales or a scale without a class designation as described in Handbook 44, Section 2.20, Table T.1.1.
(Added 1989) (Amended 1991, 1993, 1998 and 2000)

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 and 2006)

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).
(Amended 2004)

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.1.5.1
(Amended 2004)

Table N.1.5. 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

(Amended 2004)

N.1.6. Influence Factor Testing. Influence factor testing shall be conducted statically.
(Amended 2004).

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 (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. (Also see G-UR.4.2.)
(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 10 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 thnrough N.2.1.5. Zero-Balance Change.

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.
(Amended 2004)

Table N.3.2. Number of Sample Weights Per Test for Automatic Checkweighers

Weighing Range m = mass of test load	Number of sample weights per test	
	Field	Type Evaluation
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

(Amended 2004)

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, and power supply limits specified in T.7. Influence Factors.
(Amended 2004)

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.

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

T.3.1.1. Non-Automatic Tests. Tolerance values shall be as specified in Table T.3., Class III - Tolerances in Divisions.
(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 - Tolerances in Divisions.
(Amended 2004)

Table T.3. Class III – Tolerance in Divisions (e)		
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

(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)

Table T.3.2.1. Non-Automatic Tolerances 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) (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 and 2006)

Table T.3.2.2. Automatic Tolerances for Class IIIS Weigh-Labelers		
Test Load in Divisions	Tolerance in Divisions	
Class IIIS	Acceptance	Maintenance
0 - 50	± 1.5	± 2
51 - 200	± 2	± 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, 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 Division (e) for the test loads as specified in Table N.1.5.
(Amended 2004, 2005 and 2006)

(b) The standard deviation of the results shall not exceed one-ninth (1/9) of the Maximum Allowable Variation (MAV) for specific package weights (which means that 3 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 and 2005)

(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, or

(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.

(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 and 2006)

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.
(Amended 2004 and 2005)

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 Maximum Allowable Variation (MAV) for specific package weights (which means that 3 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, 2005 and 2006)

(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, or

(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.

(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 and 2006)

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 constast 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.).
(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.

Sec. 3.30. Liquid-Measuring Devices

A. Application

A.1. - This code applies to:

(a) devices used for the measurement of liquids, including liquid fuels and lubricants, and

(b) wholesale devices used for the measurement and delivery of agri-chemical liquids such as fertilizers, feeds, herbicides, pesticides, insecticides, fungicides, and defoliants.
(Added 1985)

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

(a) meters mounted on vehicle tanks (see Sec. 3.31. Code for Vehicle-Tank Meters),

(b) devices used for dispensing liquefied petroleum gases (see Sec. 3.32. Code for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices),

(c) devices used for dispensing other liquids that do not remain in a liquid state at atmospheric pressures and temperatures,

(d) water meters, or

(e) devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges,

(f) mass flow meters (see Sec. 3.37. Code for Mass Flow Meters).
(Added 1994)

A.3. - In addition to the requirements of this code, liquid-measuring devices shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Indicating and Recording Elements and Recorded Representations.

S.1.1. General. - A liquid-measuring device:

(a) shall be equipped with a primary indicating element, and

(b) may be equipped with a primary recording element.

S.1.2. Units. - A liquid-measuring device shall indicate, and record if the device is equipped to record, its deliveries in liters, gallons, quarts, pints, fluid ounces, or binary-submultiples or decimal subdivisions of the liter or gallon.
(Amended 1987, 1994 and 2006)

S.1.2.1. Retail Motor-Fuel Devices. - Deliveries shall be indicated and recorded, if the device is equipped to record, in liters or gallons and decimal subdivisions or fractional equivalents thereof.
(Added 1979)

S.1.2.2. Agri-Chemical Liquid Devices.

S.1.2.2.1. Liquid Measure. - Deliveries shall be indicated and recorded in liters or gallons and decimal subdivisions or fractional equivalents thereof.

S.1.2.3. Value of Smallest Unit. - The value of the smallest unit of indicated delivery, and recorded delivery if the device is equipped to record, shall not exceed the equivalent of:

(a) 0.5 L (1 pt) on retail devices;

(b) 5 L (1 gal) on wholesale devices.

This requirement does not apply to manually operated devices equipped with stops or stroke-limiting means.
(Amended 1983 and 1986)

S.1.3. Advancement of Indicating and Recording Elements. - It shall not be possible to advance primary indicating and recording elements except by the mechanical operation of the device. Clearing a device by advancing its elements to zero is permitted, but only if:

(a) once started, the advancement movement cannot be stopped until zero is reached, and

(b) in the case of indicating elements only, such elements are automatically obscured until the elements reach the correct zero position.

S.1.4. Graduations.

S.1.4.1. Length. - Graduations shall be varied in length so that they may be conveniently read.

S.1.4.2. Width. - In a series of graduations, the width of:

(a) every graduation shall be at least 0.2 mm (0.008 in) but not greater than the minimum clear interval between graduations, and

(b) main graduations shall be not more than 50 percent greater than the width of subordinate graduations.

S.1.4.3. Clear Interval Between Graduations. - The clear interval between graduations shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

(a) along the line of movement of the tip of the index of the indicator as it passes over the graduations, or

(b) if the indicator extends over the entire length of the graduations, at the point of widest separation of the graduations.

S.1.5. Indicators.

S.1.5.1. Symmetry. - The portion of the index of an indicator associated with the graduations shall be symmetrical with respect to the graduations.

S.1.5.2. Length.

(a) If the indicator and the graduations are in different planes, the index of the indicator shall extend to each graduation with which it is to be used.

(b) If the indicator is in the same plane as the graduations, the distance between the index of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.5.3. Width.

(a) The index of an indicator shall not be wider than the width of the narrowest graduation.
[Nonretroactive as of January 1, 2002]
(Amended 2000)

(b) If the index of an indicator extends over the entire length of a graduation, it shall be of uniform width throughout the portion that coincides with the graduation.

S.1.5.4. Clearance. - If the indicator and the graduations are in different planes, the clearance between the index of an indicator and the plane of the graduations shall be no greater than 1.5 mm (0.06 in).

S.1.5.5. Parallax. - Parallax effects shall be reduced to the practical minimum.

S.1.6. Additional Operating Requirements, Retail Devices (Except Slow Flow Meters).
(Amended 2006)

S.1.6.1. Indication of Delivery. - The device shall automatically show on its face the initial zero condition and the quantity delivered (up to the nominal capacity). However, the following requirements shall apply:

For electronic devices manufactured prior to January 1, 2006, the first 0.03 L (or 0.009 gal) of a delivery and its associated total sales price need not be indicated.

For electronic devices manufactured on or after January 1, 2006, the measurement, indication of delivered quantity, and the indication of total sales price shall be inhibited until the fueling position reaches conditions necessary to ensure that the delivery starts at zero.
[Nonretroactive as of January 1, 2006]
(Added 2005)
(Amended 1982 and 2005)

S.1.6.2. Provisions for Power Loss.

S.1.6.2.1. Transaction Information. - *In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.*
[Nonretroactive as of January 1, 1983.]

S.1.6.2.2. User Information. - *The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.*
[Nonretroactive as of January 1, 1983.]

S.1.6.3. Return to Zero.

(a) The primary indicating elements, and primary recording elements if the device is equipped to record, shall be readily returnable to a definite zero indication. However, a key-lock operated or other self-operated device may be equipped with cumulative indicating or recording elements, provided that it is also equipped with a zero-return indicating element.

(b) It shall not be possible to return primary indicating elements, or primary recording elements beyond the correct zero position.
(Amended 1972)

S.1.6.4. Display of Unit Price and Product Identity.

S.1.6.4.1. Unit Price.

(a) A computing or money-operated device shall be able to display on each face the unit price at which the device is set to compute or to dispense.

(b) Whenever a grade, brand, blend, or mixture is offered for sale from a device at more than one unit price, then all of the unit prices at which that product is offered for sale shall be displayed or shall be capable of being displayed on the dispenser using controls available to the customer prior to the delivery of the product. It is not necessary that all of the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed prior to the delivery of the product. This subsection shall not apply to fleet sales, other contract sales, or truck refueling sales (e.g., sales from dispensers used to refuel trucks).
[Effective and nonretroactive as of January 1, 1991.]
(Amended 1989 and 1997)

S.1.6.4.2. Product Identity.

(a) A device shall be able to conspicuously display on each side the identity of the product being dispensed.

(b) A device designed to dispense more than one grade, brand, blend, or mixture of product also shall be able to display on each side the identity of the grade, brand, blend, or mixture being dispensed.

S.1.6.5. Money-Value Computations.

(a) A computing device shall compute the total sales price at any single-purchase unit price (i.e., excluding fleet sales, other price contract sales, and truck stop dispensers used only to refuel trucks) for which the product being measured is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less.
[Effective and nonretroactive as of January 1, 1991.]

(b) The analog sales price indicated for any delivered quantity shall not differ from a mathematically computed price (quantity x unit price = total sales price) by an amount greater than the value in Table 1.
(Amended 1984, 1989, and 1993)

S.1.6.5.1. Money-Value Divisions, Analog. - The values of the graduated intervals representing money values on a computing type device shall be no greater than those in Table 1.
(Amended 1991)

Table 1.
Money-Value Divisions and
Maximum Allowable Variations for Money-Value
Computations on Mechanical Analog Computers

Unit Price		Money Value Division	Maximum Allowable Variation	
From	To and Including		Design Test	Field Test
0	0.25/liter or $1.00/gallon	1¢	± 1¢	± 1¢
0.25/liter or $1.00/gallon	0.75/liter or $3.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or $3.00/gallon	2.50/liter or $10.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or $3.00/gallon	2.50/liter or $10.00/gallon	5¢	± 2 1/2¢	± 5¢

S.1.6.5.2. Money-Value Divisions, Digital. - A computing type device with digital indications shall comply with the requirements of paragraph G.S.5.5. Money Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.05 liter for devices indicating in metric units and 0.01-gallon intervals for devices indicating in inch-pound units.
(Added 1980)

S.1.6.5.3. Auxiliary Elements. - *If a system is equipped with auxiliary indications, all indicated money value divisions of the auxiliary element shall be identical with those of the primary element.*
[Nonretroactive as of January 1, 1985.]

S.1.6.5.4. Selection of Unit Price. - *Except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), when a product or grade is offered for sale at more than one unit price through a computing device, the selection of the unit price shall be made prior to delivery using controls on the device or other customer-activated controls.* A system shall not permit a change to the unit price during delivery of product.
[Nonretroactive as of January 1, 1991.]
(Added 1989) (Amended 1991, 1992, 1993, and 1996)

S.1.6.5.5. Display of Quantity and Total Price. *- When a delivery is completed, the total price and quantity for that transaction shall be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated by using controls on the device or other customer-activated controls.*
[Nonretroactive as of January 1, 1994.]
(Added 1992) (Amended 1996)

S.1.6.6. Agreement Between Indications. - When a quantity value indicated or recorded by an auxiliary element is a derived or computed value based on data received from a retail motor fuel dispenser, the value may differ from the quantity value displayed on the dispenser, provided the following conditions are met:

(a) all total money values for an individual sale that are indicated or recorded by the system agree, and

(b) within each element, the values indicated or recorded meet the formula (quantity x unit price = total sales price) to the closest cent.
[Nonretroactive as of January 1, 1988.]
(Added 1985) (Amended 1987 and 1988)

S.1.6.7. Recorded Representations. - *Except for fleet sales and other price contract sales, a printed receipt providing the following information shall be available through a built-in or separate recording element for all transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash.*

(a) the total volume of the delivery,

(b) the unit price,

(c) the total computed price, and

(d) the product identity by name, symbol, abbreviation, or code number.

[Nonretroactive as of January 1, 1986.]
(Added 1985) (Amended 1997)

S.1.6.8. Lubricant Devices, Travel of Indicator. – The indicator shall move at least 2.5 cm (1 in) in relation to the graduations, if provided, for a delivery of 0.5 L (1 pt).

S.1.7. Additional Operating Requirements, Wholesale Devices Only.
(Amended 2006)

S.1.7.1. Travel of Indicator. - A wholesale device shall be readily operable to deliver accurately any quantity from 200 L (50 gal) to the capacity of the device. If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a delivery of 4 L (1 gal) shall be not less than 5 mm (0.20 in).
(Amended 1987)

S.1.7.2. Money Values-Mathematical Agreement. - Any digital money-value indication and any recorded money value on a computing-type device shall be in mathematical agreement with its associated quantity indication or representation to within one cent of money value.

S.2. Measuring Elements.

S.2.1. Vapor Elimination.

(a) A liquid-measuring device shall be equipped with a vapor or air eliminator or other automatic means to prevent the passage of vapor and air through the meter.

(b) Vent lines from the air or vapor eliminator shall be made of metal tubing or other rigid material.
(Amended 1975)

S.2.1.1. Vapor Elimination on Loading Rack Metering Systems.

(a) A loading rack metering system shall be equipped with a vapor or air eliminator or other automatic means to prevent the passage of vapor and air through the meter unless the system is designed or operationally controlled by a method, approved by the weights and measures jurisdiction having control over the device, such that air and/or vapor cannot enter the system.

(b) Vent lines from the air or vapor eliminator (if present) shall be made of metal tubing or other rigid material.

(Added 1994)

S.2.2. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or for physically applying a security seal in such a manner that requires the security seal to be broken before an adjustment can be made of:

(a) any measuring or indicating element,

(b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries, and

(c) any metrological parameter that will affect the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

*[Audit trails shall use the format set forth in Table S.2.2.]**
*[*Nonretroactive as of January 1, 1995.]*
(Amended 1991, 1993, 1995, 2003 and 2006)

Table S.2.2. Categories of Device and Methods of Sealing

Category 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 or shall not operate while in this mode.*	*[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.]** *[*Nonretroactive as of January 1, 1996]*
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). *[Nonretroactive as of January 1, 1995.]* *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.* *[Nonretroactive as of January 1, 2001]*	*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.)*

[Nonretroactive as of January 1, 1995.]
(Table added 1993) (Amended 1995, 1998, 1999, 2005 and 2006)

S.2.2.1. Multiple Measuring Elements With a Single Provision for Sealing. *– A change to the adjustment of any measuring element shall be individually identified.*
[Nonretroactive as of January 1, 2005]

Note: Examples of acceptable identification of a change to the adjustment of a measuring element include, but are not limited to:

(a) a broken, missing, or replaced physical seal on an individual measuring element;

(b) a change in a calibration factor for each measuring element;

(c) a display of the date or the number of days since the last calibration event for each measuring element; or

(d) a counter indicating the number of calibration events per measuring element

(Added 2004) (Amended 2006)

S.2.3. Directional Flow Valves. - Valves intended to prevent reversal of flow shall be automatic in operation.

S.2.4. Stop Mechanism.

S.2.4.1. Indication. - The delivery for which the device is set shall be conspicuously indicated.
(Amended 1983)

S.2.4.2. Stroke Limiting Elements. - Stops or other stroke limiting elements subject to direct pressure or impact shall be:

(a) made secure by positive, nonfrictional engagement of these elements; and

(b) adjustable to provide for deliveries within tolerances.

(Amended 1983)

S.2.4.3. Setting. - If two or more stops or other elements may be selectively brought into operation to permit predetermined quantities of deliveries,

(a) the position for the proper setting of each such element shall be accurately defined; and

(b) any inadvertent displacement from the proper setting shall be obstructed.

(Amended 1983)

S.2.5. Zero-Set-Back Interlock, Retail Motor-Fuel Devices. - A device shall be constructed so that:

(a) after a delivery cycle has been completed by moving the starting lever to any position that shuts off the device, an automatic interlock prevents a subsequent delivery until the indicating elements, and recording elements if the device is equipped and activated to record, have been returned to their zero positions;

(b) the discharge nozzle cannot be returned to its designed hanging position (that is, any position where the tip of the nozzle is placed in its designed receptacle and the lock can be inserted) until the starting lever is in its designed shut-off position and the zero-set-back interlock has been engaged; and

(c) in a system with more than one dispenser supplied by a single pump, an effective automatic control valve in each dispenser prevents product from being delivered until the indicating elements on that dispenser are in a correct zero position.

(Amended 1981 and 1985)

S.2.6. Temperature Determination and Wholesale Devices*. - For test purposes, means shall be provided to determine the temperature of the liquid either:*

(a) in the liquid chamber of the meter, or

(b) immediately adjacent to the meter in the meter inlet or discharge line.

[Nonretroactive as of January 1, 1985.]
(Added 1984) (Amended 1986)

S.2.7. Wholesale Devices Equipped with Automatic Temperature Compensators.

S.2.7.1. Automatic Temperature Compensation. A device may be equipped with an automatic means for adjusting the indication and registration of the measured volume of product to the volume at 15°C (60°F).

S.2.7.2. Provision for Deactivating. - On a device equipped with an automatic temperature-compensating mechanism that will indicate or record only in terms of gallons compensated to 15°C (60°F), provision shall be made for deactivating the automatic temperature-compensating mechanism so that the meter can indicate, and record if it is equipped to record, in terms of the uncompensated volume.
(Amended 1972)

S.2.7.3. Provision for Sealing Automatic Temperature Compensating Systems. - Provision shall be made for applying security seals in such a manner that an automatic temperature-compensating system cannot be disconnected and that no adjustment may be made to the system without breaking the seal.

S.2.7.4. Temperature Determination with Automatic Temperature Compensation. - For test purposes, means shall be provided (e.g., thermometer well) to determine the temperature of the liquid either:

(a) in the liquid chamber of the meter, or

(b) immediately adjacent to the meter in the meter inlet or discharge line.

(Amended 1987)

S.2.8. Exhaustion of Supply, Lubricant Devices Other Than Meter Types. - When the level of the supply of lubricant becomes so low as to compromise the accuracy of measurement, the device shall:

(a) become inoperable automatically, or

(b) give a conspicuous and distinct warning.

S.3. Discharge Lines and Valves.

S.3.1. Diversion of Measured Liquid. - No means shall be provided by which any measured liquid can be diverted from the measuring chamber of the meter or its discharge line. Two or more delivery outlets may be installed only if automatic means are provided to ensure that:

(a) liquid can flow from only one outlet at a time, and

(b) the direction of flow for which the mechanism may be set at any time is clearly and conspicuously indicated.

A manually controlled outlet that may be opened for purging or draining the measuring system or for recirculating product in suspension shall be permitted only when the system is measuring food products or agrichemicals. Effective means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system and to inhibit meter indications (or advancement of indications) and recorded representations while the outlet is in operation.
(Amended 1991, 1995, and 1996)

S.3.2. Exceptions. - The provisions of S.3.1. Diversion Prohibited shall not apply to truck refueling devices when diversion of flow to other than the receiving vehicle cannot readily be accomplished and is readily apparent. Allowable deterrents include, but are not limited to, physical barriers to adjacent driveways, visible valves, or lighting systems that indicate which outlets are in operation, and explanatory signs.
(Amended 1982, 1990, 1991 and 2002)

S.3.3. Pump-Discharge Unit. - A pump-discharge unit equipped with a flexible discharge hose shall be of the wet-hose type.

S.3.4. Gravity-Discharge Unit. - On a gravity-discharge unit:

(a) the discharge hose or equivalent pipe shall be of the dry-hose type with no shutoff valve at its outlet end unless the hose or pipe drains to the same level under all conditions of use;

(b) the dry hose shall be sufficiently stiff and only as long as necessary to facilitate drainage;

(c) an automatic vacuum breaker, or equivalent mechanism, shall be incorporated to prevent siphoning and to ensure rapid and complete drainage; and

(d) the inlet end of the hose or outlet pipe shall be high enough to ensure complete drainage.

S.3.5. Discharge Hose, Reinforcement. - A discharge hose shall be reinforced so that the performance of the device is not affected by the expansion or contraction of the hose.

S.3.6. Discharge Valve. - A discharge valve may be installed in the discharge line only if the device is of the wet-hose type. Any other shutoff valve on the discharge side of the meter shall be of the automatic or semi-automatic predetermined-stop type or shall be operable only:

(a) by means of a tool (but not a pin) entirely separate from the device, or

(b) by mutilation of a security seal with which the valve is sealed open.

S.3.7. Antidrain Means. - In a wet-hose pressure-type device, means shall be incorporated to prevent the drainage of the discharge hose.
(Amended 1990)

S.4. Marking Requirements.

S.4.1. Limitation on Use. - The limitations on its use shall be clearly and permanently marked on any device intended to measure accurately only:

(a) products having particular properties; or

(b) under specific installation or operating conditions; or

(c) when used in conjunction with specific accessory equipment.

S.4.2. Air Pressure. - If a device is operated by air pressure, the air pressure gauge shall show by special graduations or other means the maximum and minimum working pressures recommended by the manufacturer.

S.4.3. Wholesale Devices.

S.4.3.1. Discharge Rates. - A wholesale device shall be marked to show its designed maximum and minimum discharge rates. However, the minimum discharge rate shall not exceed 20 percent of the maximum discharge rate.

S.4.3.2. Temperature Compensation. - If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representation shall be clearly and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).

S.4.4. Retail Devices.

S.4.4.1. Discharge Rates. *- On a retail device with a designed maximum discharge rate of 115 L (30 gal) per minute or greater, the maximum and minimum discharge rates shall be marked in accordance with S.4.4.2. The marked minimum discharge rate shall not exceed 20% of the marked maximum discharge rate.*
[Nonretroactive as of January 1, 1985.]
(Added 1984) (Amended 2002 and 2003)

Example: With a marked maximum discharge rate of 230 L/min (60 gpm), the marked minimum discharge rate shall be 45 L/min (12 gpm) or less (e.g., 40 L/min (10 gpm) is acceptable). A marked minimum discharge rate greater than 45 L/min (12 gpm) (e.g., 60 L/min [15 gpm]) is not acceptable.
(Added 2003)

S.4.4.2. Location of Marking Information; Retail Motor-Fuel Dispensers. *– The marking information required in the General Code, Paragraph G-S.1. Identification shall appear as follows:*

(a) within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser;

(b) either internally and/or externally provided the information is permament and easily read; and

(c) on a portion of the device that cannot be readily removed or interchanged (i.e., not on a service access panel).

Note: *The use of a dispenser key or tool to acess internal marking information is permitted for Retail Liquid Measuring Devices.*
[Nonretroactive as of January 1, 2003]
(Added 2002) (Amended 2004 and 2006)

S.5. Totalizers for Retail Motor-Fuel Dispensers. *- Retail motor-fuel dispensers shall be equipped with a nonresettable totalizer for the quantity delivered through the metering device.*
[Nonretroactive as of January 1, 1995.]
(Added 1993) (Amended 1994 and 1997)

N. Notes

N.1. Test Liquid.

N.1.1. Type of Liquid. - The liquid used for testing a liquid-measuring device shall be the type the device is used to measure, or another liquid with the same general physical characteristics.

N.1.2. Labeling. - Following the completion of a successful examination of a wholesale device, the weights and measures official should attach a label or tag indicating the type of liquid used during the test.

N.2. Volume Change. - Care shall be taken to minimize changes in volume of the test liquid due to temperature changes and evaporation losses.

N.3. Test Drafts.

N.3.1. Retail Piston-Type and Visible-Type Devices. – Test drafts shall include the full capacity delivery and each intermediate delivery for which the device is designed.

N.3.2. Slow Flow Meters. - Test drafts shall be equal to at least four times the minimum volume that can be measured and indicated through either a visible indication or an audible signal.

N.3.3. Lubricant Devices. - Test drafts shall be 1 L (1 qt). Additional test drafts may include 0.5 L (1 pt), 4 L (4 qt), and 6 L (6 qt).

N.3.4. Other Retail Devices. - On devices with a designed maximum discharge rate of:

(a) less than 80 L (20 gal) per minute, tests shall include drafts of one or more amounts, including a draft of at least 19 liters (5 gal).

(b) 80 L (20 gal) per minute or greater, tests shall include drafts of one or more amounts, including a draft of at least the amount delivered by the device in one minute at the maximum flow rate of the installation.
(Amended 1984)

N.3.5. Wholesale Devices. - The delivered quantity should be equal to at least the amount delivered by the device in one minute at its maximum discharge rate, and shall in no case be less than 200 L (50 gal).
(Amended 1987 and 1996)

N.4. Testing Procedures.

N.4.1. Normal Tests. - The "normal" test of a device shall be made at the maximum discharge flow rate developed under the conditions of installation. Any additional tests conducted at flow rates down to and including one-half of the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
(Amended 1991)

N.4.1.1. Wholesale Devices Equipped with Automatic Temperature-Compensating Systems.

[NOT ADOPTED]

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2001)

4002.8. Liquid-Measuring Devices. (3.30.)

(a) Wholesale Devices Equipped With Automatic Temperature Compensating Systems. On wholesale devices equipped with automatic temperature compensating systems, normal tests:

(1) shall be conducted with the temperature compensating system connected and operating by comparing the compensated volume indicated or recorded to the actual delivered volume corrected to 60°F, and

(2) may be conducted with the temperature compensating system deactivated by comparing the uncompensated volume indicated or recorded to the actual delivered volume.

The first test shall be performed with the automatic temperature compensating system operating in the "as found" condition.

On devices that indicate or record both the compensated and uncompensated volume for each delivery, the tests in (1) and (2) may be performed as a single test.

N.4.2. Special Tests. - "Special" tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. shall be considered a special test.
(Amended 2005)

N.4.2.1. Slow-Flow Meters. - A "special" test shall be made at a flow rate:

(a) not larger than twice the actual minimum flow rate, and

(b) not smaller than the actual minimum flow rate of the installation.

N.4.2.2. Retail Motor-Fuel Devices.

(a) Devices without a marked minimum flow-rate shall have a "special" test performed at the slower of the following rates:

(1) 19 L (5 gal) per minute, or

(2) the minimum discharge rate at which the device will deliver when equipped with an automatic discharge nozzle set at its slowest setting.

(b) Devices with a marked minimum flow-rate shall have a "special" test performed at or near the marked minimum flow rate.
(Added 1984) (Amended 2005)

N.4.2.3. Other Retail Devices. - "Special" tests of other retail devices shall be made at the slower of the following rates:

(a) 50 percent of the maximum discharge rate developed under the conditions of installation, or

(b) the minimum discharge rate marked on the device.

N.4.2.4. Wholesale Devices. - "Special" tests shall be made to develop the operating characteristics of a measuring system and any special associated or attached elements and accessories. "Special" tests shall include a test at the slower of the following rates:

(a) 20 percent of the marked maximum discharge rate; or

(b) the minimum discharge rate marked on the device.

N.4.3. Money-Value Computation Tests.

N.4.3.1. Laboratory Tests. - When testing the device in the laboratory:

(a) compliance with paragraph S.1.6.5., Money Value Computations, shall be determined by using the cone gear as a reference for the total quantity delivered;

(b) the indicated quantity shall agree with the cone gear representation with the index of the indicator within the width of the graduation; and

(c) the maximum allowable variation of the indicated sales price shall be as shown in Table 1.
(Amended 1984)

N.4.3.2. Field Tests. - In the conduct of field tests to determine compliance with paragraph S.1.6.5., the maximum allowable variation in the indicated sales price shall be as shown in Table 1.
(Added 1982; Amended 1984)

N.5. Temperature Correction on Wholesale Devices. - Corrections shall be made for any changes in volume resulting from the differences in liquid temperatures between time of passage through the meter and time of volumetric determination in the prover. When adjustments are necessary, appropriate petroleum measurement tables should be used.
(Amended 1974)

T. Tolerances

T.1. Application to Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration, whether or not a device is equipped with an automatic temperature compensator.

T.2. Tolerance Values. - Maintenance, Acceptance, and Special Test Tolerances shall be as shown in Table T.2.
(Amended 2002)

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. This tolerance does not apply to the test of the automatic temperature compensating system. See also N.4.1.2.
(Added 1992) (Amended 2001 and 2002)

T.4. Automatic Temperature Compensating Systems. - *The difference between the meter error (expressed as a percentage) for results determined with and without the automatic temperature compensating system activated shall not exceed:*

(a) 0.2 percent for mechanical automatic temperature compensating systems; and

(b) 0.1 percent for electronic automatic temperature compensating systems.

The delivered quantities for each test shall be approximately the same size. The results of each test shall be within the applicable acceptance or maintenance tolerance.
[Nonretroactive as of January 1, 1988.]

Table T.2. Accuracy Classes for Liquid Measuring Devices Covered in NIST Handbook 44 Section 3.30

Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance[1]
0.3	Petroleum products delivered from large capacity (flow rates over 115 L/min (30 gpm))** devices including motor fuel devices, heated products at or greater than 50 °C, asphalt at or below temperatures 50 °C, all other liquids not shown where the typical delivery is over 200 L (50 gal).	0.2 %	0.3 %	0.5 %
0.3A	Asphalt at temperatures greater than 50 °C.	0.3 %	0.3 %	0.5 %
0.5*	Petroleum products delivered from small capacity (at 4 L/min (1 gpm) through 115 L/min (30 gpm))** motor fuel devices, agri-chemical liquids, and all other applications not shown where the typical delivery is $\leq$ 200 L (50 gal).	0.3 %	0.5 %	0.5 %
1.1	Petroleum products and other normal liquids from devices with flow rates** less than 1 gpm and devices designed to deliver less than one gallon.	0.75 %	1.0 %	1.25 %

*For test drafts $\leq$ 40 L or 10 gal, the tolerances specified for Accuracy Class 0.5 in the table above do not apply. For these test drafts, the following applies:

(a) Maintenance tolerances on normal and special tests shall be 20 ml plus 4 ml per indicated liter or 1 in^3 plus 1 in^3 per indicated gallon.

(b) Acceptance tolerances on normal and special tests shall be one-half the maintenance tolerance values.

[1] Special test tolerances are not applicable to retail motor fuel dispensers.

** Flow rate refers to designed or marked maximum flow rate.

(Added 2002) (Amended 2003, 2004 and 2006)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Discharge Hose.

UR.1.1.1. Length. - The length of the discharge hose on a retail motor-fuel device:

(a) shall be measured from its housing or outlet of the discharge line to the inlet of the discharge nozzle;

(b) shall be measured with the hose fully extended if it is coiled or otherwise retained or connected inside a housing; and

(c) shall not exceed 5.5 m (18 ft) unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels.

An unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.
(Amended 1972 and 1987)

UR.1.1.2. Marinas and Airports.

UR.1.1.2.1. Length. - The length of the discharge hose shall be as short as practicable, and shall not exceed 15 m (50 ft) unless it can be demonstrated that a longer hose is essential.

UR.1.1.2.2. Protection. - Discharge hoses exceeding 8 m (26 ft) in length shall be adequately protected from weather and other environmental factors when not in use.
(Made retroactive 1974 and amended 1984)

UR.2. Installation Requirements.

UR.2.1. Manufacturer's Instructions. - A device shall be installed in accordance with the manufacturer's instructions, and the installation shall be sufficiently secure and rigid to maintain this condition.
(Added 1987)

UR.2.2. Discharge Rate. - A device shall be installed so that the actual maximum discharge rate will not exceed the rated maximum discharge rate. Automatic means for flow regulation shall be incorporated in the installation if necessary.

UR.2.3. Suction Head. - A piston-type device shall be installed so that the total effective suction head will not be great enough to cause vaporization of the liquid being dispensed under the highest temperature and lowest barometric pressure likely to occur.

UR.2.4. Diversion of Liquid Flow. - A motor-fuel device equipped with two delivery outlets used exclusively in the fueling of trucks shall be so installed that any diversion of flow to other than the receiving vehicle cannot be readily accomplished and is readily apparent. Allowable deterrents include, but are not limited to, physical barriers to adjacent driveways, visible valves, or lighting systems that indicate which outlets are in operation, and explanatory signs.
(Amended 1991)

UR.2.5. Product Storage Identification.

(a) The fill connection for any petroleum product storage tank or vessel supplying motor-fuel devices shall be permanently, plainly, and visibly marked as to product contained.

(b) When the fill connection device is marked by means of a color code, the color code key shall be conspicuously displayed at the place of business.
(Added 1975 and amended 1976)

UR.3. Use of Device.

UR.3.1. Return of Indicating and Recording Elements to Zero. - On any dispenser used in making retail deliveries, the primary indicating element, and recording element if so equipped, shall be returned to zero before each delivery.

Exceptions to this requirement are totalizers on key-lock-operated or other self-operated dispensers and the primary recording element if the device is equipped to record.

UR.3.2. Unit Price and Product Identity.

(a) The following information shall be conspicuously displayed or posted on the face of a retail dispenser used in direct sale:

(1) except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), all of the unit prices at which the product is offered for sale; and

(2) in the case of a computing type or money-operated type, the unit price at which the dispenser is set to compute.

Provided that the dispenser complies with S.1.6.4.1., it is not necessary that all the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed or posted.

(b) The following information shall be conspicuously displayed or posted on each side of a retail dispenser used in direct sale:

(1) the identity of the product in descriptive commercial terms, and

(2) the identity of the grade, brand, blend, or mixture that a multi-product dispenser is set to deliver. (Amended 1972, 1983, 1987, 1989, 1992, and 1993)

UR.3.3. Computing Device. - Any computing device used in an application where a product or grade is offered for sale at one or more unit prices shall be used only for sales for which the device computes and displays the sales price for the selected transaction.
(Added 1989) (Amended 1992 and 2000)

The following exceptions apply:

(a) Fleet sales and other price contract sales are exempt from this requirement.

(b) A truck stop dispenser used exclusively for refueling trucks is exempt from this requirement provided that:

(1) all purchases of fuel are accompanied by a printed receipt of the transaction containing the applicable price per gallon, the total gallons delivered, and the total price of the sale; and
(Added 1993)

(2) unless a dispenser complies with S.1.6.4.1. (Display of Unit Price), the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.
(Added 1993)
(Amended 2005 and 2006)

UR.3.4. Printed Ticket. - The total price, the total volume of the delivery, and the price per gallon or liter shall be shown, either printed or in clear hand script, on any printed ticket issued by a device and containing any one of these values.
(Amended 2001)

UR.3.5. Steps After Dispensing. - After delivery to a customer from a retail motor-fuel device:

(a) the starting lever shall be returned to its shutoff position and the zero-set-back interlock engaged; and

(b) the discharge nozzle shall be returned to its designed hanging position unless the primary indicating elements, and recording elements if the device is equipped and activated to record, have been returned to a definite zero indication.

UR.3.6. Temperature Compensation, Wholesale.

UR.3.6.1. Automatic.

UR.3.6.1.1. When to be Used. - If a device is equipped with a mechanical automatic temperature compensator, it shall be connected, operable, and in use at all times. An electronic or mechanical automatic temperature compensating system may not be removed, nor may a compensated device be replaced with an uncompensated device, without the written approval of the responsible weights and measures jurisdiction.

[Note: This requirement does not specify the method of sale for product measured through a meter.]
(Amended 1989)

UR.3.6.1.2. Invoices.

(a) A written invoice based on a reading of a device that is equipped with an automatic temperature compensator shall show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).

(b) The invoice issued from an electronic wholesale device equipped with an automatic temperature compensating system shall also indicate: (1) the API gravity, specific gravity or coefficient of expansion for the product; (2) product temperature; and (3) gross reading.
(Amended 1987)

UR.3.6.2. Nonautomatic.

UR.3.6.2.1. Temperature Determination. - If the volume of the product delivered is adjusted to the volume at 15 °C (60 °F), the product temperature shall be taken during the delivery in:

(a) the liquid chamber of the meter, or

(b) the meter inlet or discharge line adjacent to the meter, or

(c) the compartment of the receiving vehicle at the time it is loaded.

UR.3.6.2.2. Invoices. - The accompanying invoice shall indicate that the volume of the product has been adjusted for temperature variations to a volume at 15 °C (60 °F) and shall also state the product temperature used in making the adjustment.

UR.3.6.3. Period of Use. – When fuel is bought or sold on an automatic or nonautomatic temperature-compensated basis, it shall be bought or sold using this method over at least a consecutive 12-month period, unless otherwise agreed to by both the buyer and seller in writing.
(Added 2003)

Sec. 3.31. Vehicle-Tank Meters

A. Application

A.1. - This code applies to meters mounted on vehicle tanks including those used for the measurement and delivery of petroleum products or agri-chemical liquids such as fertilizers, feeds, pesticides, defoliants, and bulk deliveries of water. (Amended 1985 and 1995)

A.2. - This code does not apply to the following devices:

(a) Devices used for dispensing liquefied petroleum gases (for which see Sec. 3.32; Code for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices), or other liquids that do not remain in a liquid state at atmospheric pressures and temperatures.

(b) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.

(c) Vehicle tanks used as measures (for which see Sec. 4.40; Code for Vehicle Tanks Used as Measures).

(d) Mass flow meters (see Sec. 3.37. Code for Mass Flow Meters). (Added 1994)

A.3. - See also Sec. 1.10; General Code requirements.

S. Specifications

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

S.1.1. Primary Elements.

S.1.1.1. General. - A meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element.

[**Note:** Except for systems used solely for the sale of aviation fuel into aircraft and for aircraft-related operations, vehicle-tank meters shall be equipped with a primary recording element as required by paragraph UR.2.2.] (Amended 1993, 2000 and 2006)

S.1.1.2. Units.

(a) A meter shall indicate, and record if the meter is equipped to record, its deliveries in terms of liters (gallons). Fractional parts of the liter (gallon) shall be in terms of either decimal or binary subdivisions.

(b) When it is an industry practice to purchase and sell milk by weight based upon 1.03 kg/L (8.6 lb/gal), the primary indicating element may indicate in kilograms (pounds) and decimal kilograms (pounds). The weight value division shall be a decimal multiple or submultiple of 1, 2, or 5. (See S.5.5.)

S.1.1.3. Value of Smallest Unit. - The value of the smallest unit of indicated delivery, and recorded delivery if the meter is equipped to record, shall not exceed the equivalent of:

(a) 0.5 L (0.1 gal) or 0.5 kg (1 lb) on milk-metering systems,

(b) 0.5 L (0.1 gal) on meters with a rated maximum flow rate of 750 L/min (200 gal/min) or less,

(c) 5 L (1 gal) on meters with a rated maximum flow of 375 L/min (100 gal/min) or more used for jet fuel aviation refueling systems, or (Added 2006)

(d) 5 L (1 gal) on other meters. (Amended 1989, 1994 and 2006)

S.1.1.4. Advancement of Indicating and Recording Elements. - Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the meter. However, a meter may be cleared by advancing its elements to zero, but only if:

(a) the advancing movement, once started, cannot be stopped until zero is reached, or

(b) in the case of indicating elements only, such elements are automatically obscured until the elements reach the correct zero position.

S.1.1.5. Return to Zero. - Primary indicating elements shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of primary indicating elements, and of primary recording elements if these are returnable to zero, beyond their correct zero position.

S.1.2. Graduations.

S.1.2.1. Length. - Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. Width. - In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) wide.

S.1.2.3. Clear Interval Between Graduations. - The clear interval shall be not less than 0.25 mm (0.10 in). If the graduations are not parallel, the measurement shall be made:

(a) along the line of relative movement between the graduations at the end of the indicator, or

(b) if the indicator is continuous, at the point of widest separation of the graduations.
(Amended 1986)

S.1.3. Indicators.

S.1.3.1. Symmetry. - The index of an indicator shall be symmetrical with respect to the graduations at least throughout that portion of its length associated with the graduations.

S.1.3.2. Length. - The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.3.3. Width. - The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

(a) the width of the narrowest graduation, and [*Nonretroactive as of January 1, 2002]*
(Amended 2001)

(b) the width of the minimum clear interval between graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

S.1.3.4. Clearance. - The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.3.5. Parallax. - Parallax effects shall be reduced to the practicable minimum.

S.1.3.6. Travel of Indicator. - If the most sensitive element of the primary indicating element utilizes an indicator and graduations, the relative movement of these parts corresponding to the smallest indicated value shall not be less than 5 mm (0.20 in).

S.1.4. Computing-Type Device.

S.1.4.1. Display of Unit Price. - In a device of the computing type, means shall be provided for displaying, in a manner clear to the operator and an observer, the unit price at which the device is set to compute. The unit price is not required to be displayed continuously.
(Amended 1983 and 2005)

S.1.4.2. Printed Ticket. - If a computing-type device issues a printed ticket which displays the total computed price, the ticket shall also have printed clearly thereon the total quantity of the delivery, the appropriate fraction of the quantity, and the price per unit of quantity.
(Amended 1989)

S.1.4.3. Money-Value Computations. - Money-value computations shall be of the full-computing type in which the money value at a single unit price, or at each of a series of unit prices, shall be computed for every delivery within either the range of measurement of the device or the range of the computing elements, whichever is less. Value graduations shall be supplied and shall be accurately positioned. The value of each graduated interval shall be 1 cent. On electronic devices with digital indications, the total price may be computed on the basis of the quantity indicated when the value of the smallest division indicated is equal to or less than 0.2 L (0.1 gal) or 0.2 kg (1 lb).
(Amended 1979, 1989)

S.1.4.4. Money Values, Mathematical Agreement. - Any digital money-value indication and any recorded money value on a computing-type device shall be in mathematical agreement with its associated quantity indication or representation to within 1 cent of money value.

S.2. Design of Measuring Elements.

S.2.1. Vapor Elimination. - A metering system shall be equipped with an effective vapor or air eliminator or other automatic means to prevent the passage of vapor and air through the meter. Vent lines from the air or vapor eliminator shall be made of metal tubing or some other suitable rigid material.
(Amended 1993)

S.2.2. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail or for physically applying a security seal in such a manner that requires the security seal to be broken before a change or an adjustment or interchange may be made of:

(a) any measuring or indicating element,

(b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries, and

(c) any metrological parameter that will affect the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

*[Audit trails shall use the format set forth in Table S.2.2.]**
*[*Nonretroactive as of January 1, 1995]*
(Amended 2006)

S.2.2.1. Milk-Metering Systems. - Adequate provision shall be made for applying security seals to the adjustment mechanism and the register. The adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

S.2.3. Directional Flow Valves. - Valves intended to prevent reversal of flow shall be automatic in operation. However, on equipment used exclusively for fueling aircraft, such valves may be manual in operation.

S.2.4. Zero-Set-Back Interlock, Vehicle-Tank Meters, Electronic. - *Except for vehicle-mounted metering systems used solely for the delivery of aviation fuel, a device shall be so constructed that after an individual or multiple deliveries at one location have been completed, an automatic interlock system shall engage to prevent a subsequent delivery until the indicating and, if equipped, recording elements have been returned to their zero position. For individual deliveries, if there is no product flow for 3 minutes the transaction must be completed before additional product flow is allowed. The 3-minute timeout shall be a sealable feature on an indicator.*
[Nonretroactive as of January 1, 2006]
(Added 2005)

Table S.2.2. Categories of Device and Methods of Sealing

Category 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 or shall not operate while in this mode.*	*The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.*
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.*	*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.)*

[Nonretroactive as of January 1, 1995]
(Table Added 2006)

S.3. Design of Discharge Lines and Discharge Line Valves. (Not applicable to milk-metering systems.)

S.3.1. Diversion of Measured Liquid. - Except on equipment used exclusively for fueling aircraft, no means shall be provided by which any measured liquid can be diverted from the measuring chamber of the meter or the discharge line therefrom. However, two or more delivery outlets may be installed if means is provided to insure that:

(a) liquid can flow from only one such outlet at one time, and

(b) the direction of flow for which the mechanism may be set at any time is definitely and conspicuously indicated.

S.3.2. Pump-Discharge Unit. - On a pump-discharge unit, the discharge hose shall be of the wet-hose type with a shutoff valve at its outlet end. However, a pump-discharge unit may be equipped also with a dry hose without a shutoff valve at its outlet end, but only if:

(a) the dry hose is as short as practicable, and

(b) there is incorporated in the discharge piping, immediately adjacent to the meter, effective means to insure that liquid can flow through only one of the discharge hoses at any one time and that the meter and the wet hose remain full of liquid at all times.

S.3.3. Gravity-Discharge Unit. - On a gravity-discharge unit, the discharge hose or equivalent pipe shall be of the dry-hose type with no shutoff valve at its outlet end. The dry hose shall be of such stiffness and only of such length as to facilitate its drainage. The inlet end of the hose or of an equivalent outlet pipe shall be of such height as to provide for proper drainage of the hose or pipe. There shall be incorporated an automatic vacuum breaker or equivalent means to prevent siphoning and to insure the rapid and complete drainage.

S.3.4. Discharge Hose. - A discharge hose shall be adequately reinforced.

S.3.5. Discharge Valve. - A discharge valve may be installed in the discharge line only if the device is of the wet-hose type, in which case such valve shall be at the discharge end of the line. Any other shutoff valve on the discharge side of the meter shall be of the automatic or semiautomatic predetermined-stop type or shall be operable only:

(a) by means of a tool (but not a pin) entirely separate from the device, or

(b) by mutilation of a security seal with which the valve is sealed open.

S.3.6. Antidrain Valve. - In a wet-hose, pressure-type device, an effective antidrain valve shall be incorporated in the discharge valve or immediately adjacent thereto. The antidrain valve shall function so as to prevent the drainage of the discharge hose. However, a device used exclusively for fueling and defueling aircraft may be of the pressure type without an antidrain valve.

S.4. Design of Intake Lines (for Milk-Metering Systems).

S.4.1. Diversion of Liquid to be Measured. - No means shall be provided by which any liquid can be diverted from the supply tank to the receiving tank without being measured by the device.

S.4.2. Intake Hose. - The intake hose shall be:

(a) of the dry-hose type;

(b) adequately reinforced;

(c) not more than 6 m (20 ft) in length, unless it can be demonstrated that a longer hose is essential to permit pickups from a supply tank; and

(d) connected to the pump at horizontal or above, to permit complete drainage of the hose.

S.5. Marking Requirements

S.5.1. Limitation of Use. - If a meter is intended to measure accurately only liquids having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the meter.

S.5.2. Discharge Rates. - A meter shall be marked to show its designed maximum and minimum discharge rates. However, the minimum discharge rate shall not exceed 20% of the maximum discharge rate.

Note: See example in Section 3.30. Liquid-Measuring Devices Code, paragraph S.4.4.1.
(Added 2003)

S.5.3. Measuring Components Milk-Metering System. All components that affect the measurement of milk that are disassembled for cleaning purposes shall be clearly and permanently identified with a common serial number.

S.5.4. Flood Volume, Milk-Metering System. - When applicable, the volume of product necessary to flood the system when dry shall be clearly, conspicuously, and permanently marked on the air eliminator.

S.5.5. Conversion Factor. - When the conversion factor of 1.03 kg/L (8.6 lb/gal) is used to convert the volume of milk to weight, the conversion factor shall be clearly marked on the primary indicating element and recorded on the delivery ticket.
(Added 1989)

N. Notes

N.1. Test Liquid.

(a) A measuring system shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics. Following a satisfactory examination, the weights and measures official should attach a seal or tag indicating the product used during the test.
(Amended 1975)

(b) A milk measuring system shall be tested with the type of milk to be measured when the accuracy of the system is affected by the characteristics of milk (e.g., positive displacement meters).
(Amended 1989)

N.2. Evaporation and Volume Change. - Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in 1 minute at its maximum discharge rate, and shall in no case be less than 180 L (50 gal) or 225 kg (500 lb).
(Amended 1989)

N.4. Testing Procedures

N.4.1. Normal Tests. - The "normal" test of a measuring system shall be made at the maximum discharge rate that may be anticipated under the conditions of the installation. Any additional tests conducted at flow rates down to and including one-half of the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
(Amended 1992)

N.4.1.1. Milk Measuring System. - The "normal" test shall include a determination of the effectiveness of the air elimination system.

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as, temperature pressure and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2001)

N.4.2. Special Tests (Except Milk-Measuring Systems). "Special" tests shall be made to develop the operating characteristics of a measuring system and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. and N.4.5. shall be considered a special test. Special test of a measuring system shall be made at a minimum discharge rate of 20% of the marked maximum discharge rate or at the minimum discharge rate marked on the device whichever is less.
(Amended 1978 and 2005)

N.4.3. Antidrain Valve Test. - The effectiveness of the antidrain valve shall be tested after the pump pressure in the measuring system has been released and a valve between the supply tank and the discharge valve is closed.

N.4.4. System Capacity. - The test of a milk-measuring system shall include the verification of the volume of product necessary to flood the system as marked on the air eliminator.

N.4.5. Product Depletion Test. - Except for vehicle-mounted metering systems used solely for the delivery of aviation fuel, the effectiveness of the vapor eliminator or vapor elimination means shall be tested by dispensing product at the normal flow rate until the product supply is depleted and continuing until the lack of fluid causes the meter indication to stop completely for at least 10 seconds. If the meter indication fails to stop completely for at least 10 seconds, continue to operate the system for 3 minutes. Finish the test by switching to another compartment with sufficient product to complete the test on a multi-compartment vehicle or by adding sufficient product to complete the test to a single compartment vehicle. When adding product to a single compartment vehicle, allow appropriate time for any entrapped vapor to disperse before continuing the test. Test drafts shall be of the same size and run at approximately the same flow rate.
(Added 2005)

T. Tolerances

T.1. Application.

T.1.1. To Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Tolerance Values. – Tolerances shall be as shown in Tables 1 and 2.
(Amended 1995, 2002 and 2006)

3.31. Vehicle-Tank Meters

Tolerances, Table 1. Accuracy Classes for Vehicle-Tank Meters					
Accuracy Class	**Application**		**Acceptance Tolerance**	**Maintenance Tolerance**	**Special Test Tolerance**
0.3	Petroleum products including large capacity motor fuel devices (flow rates over 115 L/min (30 gpm))**, heated products at or greater than 50 °C asphalt at or below temperatures 50 °C, all other liquids not shown where the typical delivery is over 200 L (50 gal).		0.15 %	0.3 %	0.45 %
0.3A	Asphalt at temperatures greater than 50 °C.		0.3 %	0.3 %	0.5 %
0.5*	Petroleum products delivered from small capacity (at 4 L/min (1 gpm) through 115 L/min (30 gpm))** motor-fuel devices, agri-chemical liquids, and all other applications not shown.		0.3 %	0.5 %	0.5 %
1.1	Petroleum products and other normal liquids from devices with flow rates** less than 1 gpm and devices designed to deliver less than one gallon.		0.75 %	1.0 %	1.25 %
1.5	Water	Overregistration	1.5 %	1.5 %	1.5 %
		Underregistration	1.5 %	1.5 %	5.0 %

* For 5-gallon and 10-gallon test drafts, the tolerances specified for Accuracy Class 0.5 in the table above do not apply. For these test drafts, the maintenance tolerances on normal and special tests for 5-gallon and 10-gallon test drafts are 6 cubic inches and 11 cubic inches, respectively. Acceptance tolerances on normal and special tests are 3 cubic inches and 5.5 cubic inches.

** Flow rate refers to designed or marked maximum flow rate.

(Added 2002) (Amended 2003)

Table 2. Tolerances for Vehicle-Mounted Milk Meters		
Indication	Maintenance	Acceptance
gallons	gallons	gallons
100	0.5	0.3
200	0.7	0.4
300	0.9	0.5
400	1.1	0.6
500	1.3	0.7
Over 500	Add 0.002 gallon per indicated gallon over 500	Add 0.001 gallon per Indicated gallon over 500

(Added 1989)

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. See also N.4.1.2.
(Added 1992) (Amended 2001 and 2002)

T.4. Product Depletion Test. - The difference between the test result for any normal test and the product depletion test shall not exceed the tolerance shown in Table T.4. Test drafts shall be of the same size and run at approximately the same flow rate.
(Amended 2006)

[**Note:** The result of the product depletion test may fall outside of the applicable test tolerance as specified in Table T.2.]
(Added 2005)

Table T.4. Tolerances for Vehicle-Tank Meters on Product Depletion Tests, Except Milk Meters

Meter Size	Maintenance and Acceptance Tolerances
Up to but not including 50 mm (2 in)	1.70 L (104 in^3)[1]
From 50 mm (2 in) up to but not including 75 mm (3 in)	2.25 L (137 in^3)[1]
75 mm (3 in) or larger	3.75 L (229 in^3)[1]

[1] Based on a test volume of at least the amount specified in N.3.

(Table Added 2005)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Discharge Rate. - A meter shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

UR.1.2. Unit Price. - There shall be displayed on the face of a device of the computing type the unit price at which the device is set to compute.

UR.1.3. Intake Hose. - The intake hose in a milk-metering system shall be installed to permit complete drainage and ensure that all available product is measured following each pickup.

UR.1.4. Liquid Measured. – A vehicle-tank meter shall continue to be used to measure the same liquid or one with the same general physical properties as that used for calibration and weights and measures approval unless the meter is recalibrated with a different product and tested by a registered service agency or a weights and measures official and approved by the weights and measures jurisdiction having statutory authority over the device.
(Added 2003)

UR.2. Use Requirements.

UR.2.1. Return of Indicating and Recording Elements to Zero. - The primary indicating elements (visual), and the primary recording elements, when these are returnable to zero, shall be returned to zero immediately before each delivery is begun and after the pump has been activated and the product to be measured has been supplied to the measuring system.
(Amended 1981)

UR.2.2. Ticket Printer; Customer Ticket.
[NOT ADOPTED]

Section 4002.3. Vehicle-Tank Meters. (3.31.)

UR.2.2. Ticket Printer; Customer Ticket. Vehicle-mounted metering systems shall be equipped with a ticket printer which shall be used for all sales where product is delivered through the meter. A copy of the ticket issued by the device shall be left with the customer at the time of delivery or as otherwise specified by the customer.

[Nonretroactive as of January 1, 1995.]

UR.2.2.1. Exceptions for the Sale of Aviation Fuel. - The provisions of UR.2.2. Ticket Printer; Customer Ticket shall not apply to vehicle-mounted metering systems used solely for the delivery of aviation fuel into aircraft and for aircraft-related operations.
(Added 1999) (Amended 2005)

UR.2.3. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.4. Credit for Flood Volume. - The volume of product necessary to flood the system as marked on the air eliminator shall be individually recorded on the pickup ticket of each seller affected.

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Sec. 3.32. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices[1]

A. Application.

A.1. - This code applies to devices used for the measurement of liquefied petroleum gas and anhydrous ammonia in the liquid state, whether such devices are installed in a permanent location or mounted on a vehicle.

A.2. - Insofar as they are clearly appropriate, the requirements and provisions of the code may be applied to devices used for the measurement of other liquids that do not remain in a liquid state at atmospheric pressures and temperatures.

A.3. - See also Sec. 1.10; General Code requirements.

A.4. - This code does not apply to mass flow meters (see Sec. 3.37. Code for Mass Flow Meters).
(Added 1994)

S. Specifications

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

S.1.1. Primary Elements

S.1.1.1. General. - A device shall be equipped with a primary indicating element and may also be equipped with a primary recording element.

[Note: Vehicle-mounted metering systems shall be equipped with a ticket printer as required by paragraph UR.2.6.]

S.1.1.2. Units. - A device shall indicate, and record if the device is equipped to record, its deliveries in terms of liters, gallons, quarts, pints, or binary-submultiple or decimal subdivisions of the liter or gallon.
(Amended 1987 and 2006)

S.1.1.3. Value of Smallest Unit. - The value of the smallest unit of indicated delivery, and recorded delivery if the device is equipped to record, shall not exceed the equivalent of:

(a) 0.5 L (1 pt) on retail devices, or

(b) 5 L (1 gal) on wholesale devices.
(Amended 1987)

S.1.1.4. Advancement of Indicating and Recording Elements. - Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the device. However, a device may be cleared by advancing its elements to zero, but only if:

(a) the advancing movement, once started, cannot be stopped until zero is reached, or

(b) in the case of indicating elements only, such elements are automatically obscured until the elements reach the correct zero position.

S.1.1.5. Money Values--Mathematical Agreement. Any digital money-value indication and any recorded money value on a computing-type device shall be in mathematical agreement with its associated quantity indication or representation to within one cent of money value; except that a stationary retail computing-type device must compute and indicate to the nearest 1 cent of money value (see Sec. 1.10., G-S.5.5.).
(Amended 1984, 1988)

S.1.1.6. Printed Ticket. - Any printed ticket issued by a device of the computing type on which there is printed the total computed price, shall have printed clearly thereon the total volume of the delivery in terms of liters or gallons, and the appropriate decimal fraction of the liter or gallon, and the corresponding price per liter or gallon.
(Added 1979; Amended 1987)

S.1.2. Graduations.

S.1.2.1. Length. - Graduations shall be so varied in length that they may be conveniently read.

[1]Title amended 1986.

S.1.2.2. Width. - In any series of graduations, the width of a graduation shall in no case be greater then the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) width.

S.1.2.3. Clear Interval Between Graduations. - The clear interval shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

(a) along the line of relative movement between the graduations at the end of the indicator, or

(b) if the indicator is continuous, at the point of widest separation of the graduations.

S.1.3. Indicators.

S.1.3.1. Symmetry. - The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.1.3.2. Length. - The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of graduations, shall be not more than 1.0 mm (0.04 in).

S.1.3.3. Width. - The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

(a) the width of the narrowest graduation, and [*Nonretroactive as of January 1, 2002]* (Amended 2001)

(b) the width of the minimum clear interval between graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

S.1.3.4. Clearance. - The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.3.5. Parallax. - Parallax effects shall be reduced to the practicable minimum.

S.1.4. For Retail Devices Only.

S.1.4.1. Indication of Delivery. - A retail device shall be constructed to show automatically its initial zero condition and the amounts delivered up to the nominal capacity of the device.

S.1.4.2. Return to Zero.

(a) Primary indicating elements shall be readily returnable to a definite zero indication.

(b) Primary recording elements on a stationary retail device shall be readily returnable to a definite zero indication if the device is equipped to record.

(c) Means shall be provided to prevent the return of primary indicating elements, and of primary recording elements if these are returnable to zero, beyond their correct zero position.
(Amended 1990)

S.1.5. For Stationary Retail Devices Only.

S.1.5.1. Display of Unit Price and Product Identity - In a device of the computing type, means shall be provided for displaying on each face of the device the unit price at which the device is set to compute or to deliver as the case may be, and there shall be conspicuously displayed on each side of the device the identity of the product that is being dispensed. If a device is so designed as to dispense more than one grade, brand, blend, or mixture of product, the identity of the grade, brand, blend, or mixture being dispensed shall also be displayed on each face of the device.

S.1.5.2. Money-Value Computations. - A computing device shall compute the total sales price at any single-purchase unit price (excluding fleet sales and other price contract sales) for which the product is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less. The analog money value indication shall not differ from the mathe-matically computed money value (quantity x unit price = sales price), for any delivered quantity, by an amount greater than the values shown in Table 1.
(Amended 1995)

Table 1.
Money-Value Divisions and
Maximum Allowable Variations for Money-Value
Computations on Mechanical Analog Computers

Unit Price		Money Value Division	Maximum Allowable Variation	
From	To and Including		Design Test	Field Test
0	0.25/liter or $1.00/gallon	1¢	± 1¢	± 1¢
0.25/liter or $1.00/gallon	0.75/liter or $3.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or $3.00/gallon	2.50/liter or $10.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or $3.00/gallon	2.50/liter or $10.00/gallon	5¢	± 2-1/2¢	± 5¢

S.1.5.2.1. Money-Value Divisions, Analog. The value of the graduated intervals representing money values on a computing-type device with analog indications shall be as follows:

(a) Not more than 1 cent at all unit prices up to and including $0.25 per liter or $1.00 per gallon.

(b) Not more than 2 cents at unit prices greater than $0.25 per liter or $1.00 per gallon up to and including $0.75 per liter or $3.00 per gallon.

(c) Not more than 5 cents at all unit prices greater than $0.75 per liter or $3.00 per gallon.

(Amended 1984)

S.1.5.2.2. Money-Value Divisions, Digital. - A computing-type device with digital indications shall comply with the requirements of paragraph G-S.5.5., Money Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.01-gallon intervals for devices indicating in inch-pound units and 0.05 liter for devices indicating in metric units.

S.1.5.2.3. Money-Value Divisions, Auxiliary Indications. *- In a system equipped with auxiliary indications, all indicated money-value divisions shall be identical.*
[Nonretroactive as of January 1, 1985.]

S.1.6. For Wholesale Devices Only.

S.1.6.1. Travel of Indicator. - A wholesale device shall be readily operable to deliver accurately any quantity from 180 L (50 gal) to the capacity of the device. If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a delivery of 5 L (1 gal) shall be not less than 5 mm (0.20 in).
(Amended 1987)

S.2. Design of Measuring Elements.

S.2.1. Vapor Elimination. - A device shall be equipped with an effective vapor eliminator or other effective means to prevent the passage of vapor through the meter.

S.2.2. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or for physically applying a security seal in such a manner that requires the security seal to be broken before an adjustment or interchange may be made of:

(a) any measuring or indicating element;

(b) any adjustable element for controlling delivery rate, when such rate tends to affect the accuracy of deliveries, and

(c) any metrological parameter that will affect the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

*[Audit trails shall use the format set forth in Table S.2.2.]**
*[*Nonretroactive as of January 1, 1995]*
(Amended 2006)

Table S.2.2. Categories of Device and Methods of Sealing	
Category 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 or shall not operate while in this mode.*	*The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.*
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.*	*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.)*

[Nonretroactive as of January 1, 1995]
(Table Added 2006)

S.2.3. Directional Flow Valves. - A measuring system shall be equipped with a valve or other effective means, automatic in operation and installed in or adjacent to the measuring element, to prevent reversal of flow of the product being measured.
(Amended 1982).

S.2.4. Maintenance of Liquid State. - A device shall be so designed and installed that the product being measured will remain in a liquid state during the passage through the meter.

S.2.5. Thermometer Well. - For test purposes, means shall be provided to determine the temperature of the liquid either:

(a) in the liquid chamber of the meter, or

(b) in the meter inlet or discharge line and immediately adjacent to the meter.

(Amended 1987)

S.2.6. Automatic Temperature Compensation. [NOT ADOPTED]

4002.4. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices. (3.32.)

(a) Temperature Compensation. All liquefied petroleum gas measuring devices with a manufacturer's maximum rated flow capacity exceeding 20 gallons per minute shall be equipped with automatic means to correct the volume delivered to the volume at 60 °F. The automatic temperature compensator shall be connected, operable and in use at all times.

S.2.6.1. Provision for Deactivating. - On a device equipped with an automatic temperature compensating mechanism that will indicate or record only in terms of liters compensated to 15 °C or gallons to 60 °F, provision shall be made to facilitate the deactivation of the automatic temperature compensating mechanism so that the meter may indicate, and record if it is equipped to record, in terms of the uncompensated volume.
(Amended 1972)

S.2.6.2. Provision for Sealing. - Provision shall be made for applying security seals in such a manner that an automatic temperature compensating system cannot be disconnected and that no adjustment may be made to the system.

S.3. Design of Discharge Lines and Discharge Line Valves.

S.3.1. Diversion of Measured Liquid. - No means shall be provided by which any measured liquid can be diverted from the measuring chamber of the meter or the discharge line therefrom. However, two or more delivery outlets may be permanently installed if means are provided to insure that:

(a) liquid can flow from only one such outlet at one time, and
(b) the direction of flow for which the mechanism may be set at any time is definitely and conspicuously indicated.

In addition, a manually controlled outlet that may be opened for the purpose of emptying a portion of the system to allow for repair and maintenance operations shall be permitted. Effective means shall be provided to prevent the passage of liquid through any such outlet during normal operation of the device and to indicate clearly and unmistakably when the valve controls are so set as to permit passage of liquid through such outlet.
(Amended 1975)

4002.4. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices. (3.32.)

(b) The provisions of Handbook 44, Section 3.32., S.3.1. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices Code shall not apply to equipment located at wholesale loading terminals when used exclusively for the purpose of filling transports utilizing the spray fill, or when the delivery is being made simultaneously to truck and trailer from one meter when the product being delivered into the truck and trailer is being purchased by the same person.

S.3.2. Delivery Hose. - The delivery hose of a retail device shall be of the wet-hose type with a shutoff valve at its outlet end.

S.4. Marking Requirements.

S.4.1. Limitation of Use. - If a device is intended to measure accurately only products having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the device.

S.4.2. Discharge Rates. - A device shall be marked to show its designed maximum and minimum discharge rates. The marked minimum discharge rate shall not exceed:

(a) 20 L (5 gal) per minute for stationary retail devices, or

(b) 20% of the marked maximum discharge rate for other retail devices and for wholesale devices.
(Amended 1987)

Note: See example in Section 3.30. Liquid-Measuring Devices Code, paragraph S.4.4.1.
(Added 2003)

S.4.3. Location of Marking Information; Retail Motor-Fuel Dispensers. - *The marking information required in General Code, Paragraph G-S.1. Identification shall appear as follows:*

(a) within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser;

(b) either internally and/or externally provided the information is permanent and easily read; and

(c) on a portion of the device that cannot be readily removed or interchanged (i.e., not on a service access panel).

Note: The use of a dispenser key or tool to access internal marking information is permitted for retail motor-fuel dispensers.
[Nonretroactive as of January 1, 2003]
(Added 2006)

S.4.4. Temperature Compensation. - If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representation shall be clearly and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).

N. Notes

N.1. Test Liquid. - A device shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics.

N.2. Vaporization and Volume Change. - Care shall be exercised to reduce to a minimum, vaporization and volume changes.

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in 1 minute at its normal discharge rate.
(Amended 1982)

N.4. Testing Procedures.

N.4.1. Normal Tests. - The "normal" test of a device shall be made at the maximum discharge flow rate developed under the conditions of the installation. Any additional tests conducted at flow rates down to and including one-half the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
(Amended 1998)

N.4.1.1. Automatic Temperature Compensation.

[NOT ADOPTED]

4002.4. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices. (3.32.)

(c) Wholesale Devices Equipped With Automatic Temperature Compensating Systems. On wholesale devices equipped with automatic temperature compensating systems, normal tests:

(1) Shall be conducted with the temperature compensating system connected and operating by comparing the compensated volume indicated or recorded to the actual delivered volume corrected to 60 °F; and

(2) May be conducted with the temperature compensating system deactivated, comparing the uncompensated volume indicated or recorded to the actual delivered volume.

The first test shall be performed with the automatic temperature compensating system operating in the "as found" condition. On devices that indicate or record both the compensated and uncompensated volume for each delivery, the tests in (1) and (2) may be performed as a single test.

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as, temperature pressure and flow rate are reduced to the extent that they will not affect the results obtained
(Added 2001)

N.4.2. Special Tests. - "Special" tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. shall be considered a special test.
(Amended 2005)

N.4.2.1. For Motor-Fuel Devices. - A motor-fuel device shall be so tested at a minimum discharge rate of:

(a) 20 L (5 gal) per minute, or

(b) the minimum discharge rate marked on the device, whichever is less.

N.4.2.2. For Other Retail Devices. - A retail device other than a motor-fuel device shall be tested at a minimum discharge rate of:

(a) the minimum discharge rate that can be developed under the conditions of installation, or

(b) the minimum discharge rate marked on the device, whichever is greater.
(Amended 1973)

N.4.2.3. For Wholesale Devices. - A wholesale device shall be so tested at a minimum discharge rate of:

(a) 40 L (10 gal) per minute for a device with a rated maximum discharge less than 180 L (50 gal) per minute.

(b) 20 percent of the marked maximum discharge rate for a device with a rated maximum discharge of 180 L (50 gal) per minute or more, or

(c) the minimum discharge rate marked on the device, whichever is least.
(Amended 1987)

N.4.3. Money-Value Computation Tests.

N.4.3.1. Laboratory Design Evaluation Tests. - In the conduct of laboratory design evaluation tests, compliance with paragraph S.1.5.2. shall be determined by using the cone gear as a reference for the total quantity delivered. The indicated delivered quantity shall agree with the cone gear representation with the index of the indicator within the width of the graduation. The maximum allowable variation of the indicated sales price shall be as shown in Table 1.

N.4.3.2. Field Tests. - In the conduct of field tests to determine compliance with paragraph S.1.5.2. the maximum allowable variation in the indicated sales price shall be as shown in Table 1.
(Added 1984)

N.5. Temperature Correction. - Corrections shall be made for any changes in volume resulting from the differences in liquid temperatures between time of passage through the meter and time of volumetric determination in the test measure.

T. Tolerances

T.1. Application.

T.1.1. To Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration, whether or not a device is equipped with an automatic temperature compensator.

T.2. Tolerance Values. - The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2.
(Amended 1988, 1992 and 2003)

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within applicable tolerance. This tolerance does not apply to the test of the automatic temperature compensating system. See also N.4.1.2.
(Added 1992) (Amended 1997 and 2001)

T.4. Automatic Temperature Compensating Systems. - The difference between the meter error (expressed as a percentage) for results determined with and without the automatic temperature compensating system activated shall not exceed:

(a) 1.0 percent for mechanical automatic temperature compensating systems; and

(b) 0.5 percent for electronic automatic temperature compensating systems.

The delivered quantities for each test shall be approximately the same size. The results of each test shall be within the applicable acceptance or maintenance tolerance.
(Added 1991) (Amended 1992, 1996, and 1997)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Discharge Rate. - A device shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

UR.1.2. Length of Discharge Hose. - The length of the discharge hose on a stationary motor-fuel device shall not exceed 5.5 m (18 ft), measured from the outside of the housing of the device to the inlet end of the discharge nozzle, unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels. Unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.
(Amended 1991)

UR.2. Use Requirements.

UR.2.1. Return of Indication and Recording Elements to Zero. - The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero before each delivery.

Table T.2. Accuracy Classes and Tolerance for LPG and Anhydrous Ammonia Liquid-Measuring Devices

Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
1.0	Anhydrous ammonia, LPG (including vehicle-mounted meters)	0.6%	1.0%	1.0%

(Added 2003) (Amended 2006)

UR.2.2. Condition of Fill of Discharge Hose. - The discharge hose shall be completely filled with liquid before the "zero" condition is established prior to the start of a commercial delivery, whether this condition is established by resetting the primary indicating elements to zero indication or by recording the indications of the primary indicating elements. (Also see UR.2.1.)

UR.2.3. Vapor-Return Line.

[NOT ADOPTED]

4002.4. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices. (3.32.)

(d) Vapor-Return Line. During any metered delivery of liquefied petroleum gas from a supplier's tank to a receiving container, there shall be no vapor-return line from the receiving container to the supplier's tank.

UR.2.4. Temperature Compensation.

UR.2.4.1. Use of Automatic Temperature Compensators. - If a device is equipped with an automatic temperature compensator, this shall be connected, operable, and in use at all times. Such automatic temperature compensator may not be removed, nor may a compensated device be replaced with an uncompensated device, without the written approval of the weights and measures authority having jurisdiction over the device.

UR.2.4.2. Temperature Compensated Sale. - All sales of liquefied petroleum gas in a liquid state, when the quantity is determined by an approved measuring system equipped with a temperature compensating mechanism, or by weight and converted to liters or gallons, or by a calibrated container, shall be in terms of liters at 15 °C or the United States gallon of 231 in^3 at 60 °F.
(Added 1984)

UR.2.4.3. Invoices. - Any invoice based on a reading of a device that is equipped with an automatic temperature compensator or based on a weight converted to gallons, or based on the volume of a calibrated container, shall have shown thereon that the volume delivered has been adjusted to the volume at 15 °C (60 °F).
(Amended 1984)

UR.2.4.4. Automated Temperature-Compensating Systems. - Means for determining the temperature of measured liquid in an automatic temperature-compensating system shall be so designed and located that, in any "usual and customary" use of the system, the resulting indications and/or recorded representations are within applicable tolerances.
(Added 1987)

UR.2.5. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.6. Ticket Printer; Customer Ticket. - Vehicle-mounted metering systems shall be equipped with a ticket printer. The ticket printer shall be used for all sales; a copy of the ticket issued by the device shall be left with the customer at the time of delivery or as otherwise specified by the customer.
(Added 1992) (Amended 2006)

4002.4. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices. (3.32.)

(e) Signs. Any retail liquefied petroleum gas dispenser, with the exception of those mounted on a motor vehicle, shall display a sign showing the price schedule of all transactions. The sign shall be where it is plainly discernable to the customer. All letters, figures or numerals used to express the price schedule shall be at least three-quarters of an inch in height.

Sec. 3.33. Hydrocarbon Gas Vapor-Measuring Devices[1]

A. Application

A.1. - This code applies to devices used for the measurement of hydrocarbon gas in the vapor state, such as propane, propylene, butanes, butylenes, ethane, methane, natural gas and any other hydrocarbon gas/air mix.
(Amended 1984, 1986, 1988, 1991)

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

(a) Liquid-measuring devices used for dispensing liquefied petroleum gases in liquid form (for which see Sec. 3.32; Code for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices).

(b) Natural, liquefied petroleum, and manufactured-gas-vapor meters when these are operated in a public utility system.

(c) Mass flow meters (see Sec. 3.37. Code for Mass Flow Meters).
(Added 1994)

A.3. - See also Sec. 1.10; General Code requirements.

S. Specifications

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

S.1.1. Primary Elements.

S.1.1.1. General. - A device shall be equipped with a primary indicating element and may also be equipped with a primary recording element.

S.1.1.2. Units. - A volume-measuring device shall indicate, and record if equipped to record, its deliveries in terms of cubic meters or cubic feet, or multiple or decimal subdivisions of cubic meters or cubic feet.
(Amended 1972, 1991)

S.1.1.3. Value of Smallest Unit. - Volume-Measuring Devices: The value of the smallest unit of indicated delivery, and recorded delivery if the device is equipped to record, shall not exceed:

(a) 1 m^3 (1 000 dm^3) (100 ft^3) when the maximum rated gas capacity is less than 100 m^3/h (10 000 ft^3/h);

(b) 10 m^3 (1 000 ft^3) when the maximum rated gas capacity is 280 m^3/h (10 000 ft^3/h) up to but not including 1 700 m^3/h (60 000 ft^3/h);

(c) 100 m^3 (10 000 ft^3) when the maximum rated gas capacity is 1 700 m^3/h (60 000 ft^3/h) or more.
(Amended 1972, 1988, 1991)

S.1.1.4. Advancement of Indicating and Recording Elements. - Primary indicating and recording elements shall advance digitally or continuously and be susceptible to advancement only by the mechanical operation of the device.

S.1.1.5. Proving Indicator. - Devices rated less than 280 m^3/h (10 000 ft^3/h) gas capacity shall be equipped with a proving indicator measuring 0.025, 0.05, 0.1, 0.2, or 0.25 m^3 per revolution, (1, 2, 5, or 10 ft^3 per revolution) for testing the meter. Devices with larger capacities shall be equipped as follows:

(a) Devices rated 280 m^3 (10 000 ft^3) up to but not including 1 700 m^3/h (60 000 ft^3/h) gas capacity shall be equipped with a proving indicator measuring not greater than 1 m^3 (100 ft^3) per revolution.

(b) Devices rated 1 700 m^3/h (60 000 ft^3/h) gas capacity or more shall be equipped with a proving indicator measuring not more than 10 m^3 (1 000 ft^3) per revolution.

The test circle of the proving indicator shall be divided into 10 equal parts. Additional subdivisions of one or more of such equal parts may be made.
(Amended 1973 and 1988)

S.1.2. Graduations.

S.1.2.1. Length. - Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. Width. - In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and in no case should it exceed 1.0 mm (0.04 in) for indicating elements and 0.5 mm (0.02 in) for proving circles.

[1] Title changed 1986.

S.1.2.3. Clear Interval Between Graduations. - The clear interval shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

(a) along the line of relative movement between the graduations at the end of the indicator, or

(b) if the indicator is continuous, at the point of widest separation of the graduations.

S.1.3. Indicators.

S.1.3.1. Symmetry. - The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.1.3.2. Length. - The index of an indicator shall reach to the finest graduations with which it is used.

S.1.3.3. Width. - The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

(a) the width of the widest graduation, and

(b) the width of the minimum clear interval between graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

S.1.3.4. Clearance. - The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.3.5. Parallax. - Parallax effects shall be reduced to the practicable minimum.

S.2. Design of Measuring Elements.

S.2.1. Pressure Regulation. - Except when measured as a retail motor fuel, the vapor should be measured at a normal gauge pressure (psig) of:
(Amended 1991)

(a) 2 740 Pa ±685 Pa (11 in of water column [(0.40 psig) ±2.75 in of water column (0.10 psig)] for liquefied petroleum gas vapor; or

(b) 1 744 Pa ±436 Pa [7 in of water column (0.25 psig) ±1.75 in of water column (0.06 psig)] for natural and manufactured gas.

When vapor is measured at a pressure other than what is specified above for the specific product, a volume multiplier shall be applied within the meter or to the billing invoice based on the following equation:

$$VPM = \frac{AAP + GP}{AAP + NGP}$$

Where

VPM = Volume pressure multiplier
AAP = Assumed atmospheric pressure in psia
GP = Gauge pressure in pascal or psig
NGP = Normal gauge pressure in pascal or psig

The assumed atmospheric pressure is to be taken from Tables 2 and 2M.

When liquefied petroleum gas vapor is measured at a pressure of 6 900 Pa (1 psig) or more, the delivery pressure shall be maintained within ±1 725 Pa ±0.25 psig).

Pressure variations due to regulator lock off shall not increase the operating pressure by more than 25%.
(Amended 1980, 1984, 1991)

S.2.2. Provision for Sealing. - Adequate provision shall be made for applying security seals in such a manner that no adjustment or interchange may be made of any measurement element.
(Amended 2006)

S.2.3. Maintenance of Vapor State. - A device shall be so designed and installed that the product being measured will remain in a vapor state during passage through the meter.

S.2.4. Automatic Temperature Compensation. - A device may be equipped with an adjustable automatic means for adjusting the indication and registration of the measured volume of vapor product to the volume at 15 °C (60 °F).

S.3. Design of Discharge Lines

S.3.1. Diversion of Measured Vapor. - No means shall be provided by which any measured vapor can be diverted from the measuring chamber of the meter or the discharge line therefrom.

*indicate and record in uncompensated volume if the mode of operation is clearly indicated, e.g., by a marked annunciator, recorded statement, or other obvious means.**
*[*Nonretroactive as of January 1, 1992.]*
(Amended 1991 and 2002)

S.2.5. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or for physically applying a security seal in such a manner that requires the security seal to be broken before an adjustment or interchange may be made of:

(a) any measuring or indicating element,

(b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries,

(c) any automatic temperature or density compensating system, and

(d) any metrological parameter that will affect the metrological integrity of the device or system.

When applicable, any adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

*[Audit trails shall use the format set forth in Table S.2.5.]**
*[*Nonretroactive as of January 1, 1995]*
(Amended 2006)

S.3. Design of Discharge Lines and Discharge Line Valves.

S.3.1. Diversion of Measured Liquid. - No means shall be provided by which any measured liquid can be diverted from the measuring chamber of the device or the discharge line therefrom, except that a manually controlled outlet that may be opened for purging or draining the measuring system shall be permitted. Effective means shall be provided to prevent the passage of liquid through any such outlet during normal operation of the device and to indicate clearly and unmistakably when the valve controls are so set as to permit passage of liquid through such outlet.

S.3.2. Discharge Hose. - The discharge hose of a measuring system shall be of the completely draining dry-hose type.

Table S.2.5. Categories of Device and Methods of Sealing

Category 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 or shall not operate while in this mode.*	*The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.*
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.*	*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.)*

[Nonretroactive as of January 1, 1995]
(Table Added 2006)

S.4. Level Condition, On-Board Weighing Systems. - Provision shall be made for automatically inhibiting the delivery of a cryogenic liquid when the vehicle is out-of-level beyond the limit required for the performance to be within applicable tolerance.
(Added 1986)

S.5. Marking Requirements.

S.5.1. Limitation of Use. - If a measuring system is intended to measure accurately only liquids having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently marked on the device.

S.5.2. Discharge Rates. - A meter shall be marked to show its designed maximum and minimum discharge rates.

S.5.3. Temperature or Density Compensation. - Devices equipped with an automatic temperature or density compensator, shall be clearly and conspicuously marked on the primary indicating elements, recording elements, and recorded representations to show that the quantity delivered has been adjusted to the conditions specified in S.2.4.

N. Notes

N.1. Test Liquid. - A meter shall be tested with the liquid to be commercially measured except that, in a type evaluation examination, nitrogen may be used.

N.2. Vaporization and Volume Change. - Care shall be exercised to reduce to a minimum vaporization and volume changes. When testing by weight, the weigh tank and transfer systems shall be precooled to liquid temperature prior to the start of the test to avoid the venting of vapor from the vessel being weighed.

N.3. Test Drafts.

N.3.1. Gravimetric Test. - Weight test drafts shall be equal to at least the amount delivered by the device in two minutes at its maximum discharge rate, and shall in no case be less than 907 kg (2 000 lb).

N.3.2. Transfer Standard Test. - When comparing a meter with a calibrated transfer standard, the test draft shall be equal to at least the amount delivered by the device in two minutes at its maximum discharge rate, and shall in no case be less than 180 L (50 gal) or equivalent thereof. When testing uncompensated volumetric meters in a continuous recycle mode, appropriate corrections shall be applied if product conditions are abnormally affected by this test mode.
(Amended 1976)

N.4. Density. - Temperature and pressure of the metered test liquid shall be measured during the test for the determination of density or volume correction factors when applicable. For Liquid Density and Volume Correction Factors (with respect to temperature and pressure) the publications shown in Table N.4. shall apply:
(Amended 1986 and 2004)

N.5. Testing Procedures.

N.5.1. Normal Tests. - The "normal" tests of a device shall be made over a range of discharge rates that may be anticipated under the conditions of installation.

N.5.1.1. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as, temperature pressure and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2001)

N.5.2. Special Tests. - Any test except as set forth in N.5.1. shall be considered a "special" test. Tests shall be conducted, if possible, to evaluate any special elements or accessories attached to or associated with the device. A device shall be tested at a minimum discharge rate of:

(a) 50% of the maximum discharge rate developed under the conditions of installation, or the minimum discharge rate marked on the device, whichever is less, or

(b) the lowest discharge rate practicable under conditions of installation.

Special tests may be conducted to develop any characteristics of the device that are not normally anticipated under the conditions of installation.
(Amended 2005)

N.6. Temperature Correction. - Corrections shall be made for any changes in volume resulting from the differences in liquid temperature between time of passage through the meter and time of volumetric determination of test draft.

N.7. Automatic Temperature or Density Compensation. When a device is equipped with an automatic temperature or density compensator, the compensator shall be tested by comparing the quantity indicated or recorded by the device (with the compensator connected and operating) with the actual delivered quantity corrected to the normal boiling point of the cryogenic product being measured or to the normal temperature and pressure as applicable.

Table N.4. Density or Volume Correction Factors	
Cryogenic Liquid	Publication
Argon	Tegeler, Ch., Span, R., Wagner, W. "A New Equation of State for Argon Covering the Fluid Region for Temperatures from the Melting Line to 700 K at Pressures up to 1000". *Mpa J. Phys. Chem. Ref. Data,* 28(3):779-850, 1999.
Ethylene	Smukala, J., Span, R. Wagner, W. "New Equation of State for Ethylene Covering the Fluid Region for Temperatures from the Melting Line to 450 K at Pressures up to 300 MPA." *J. Phys. Chem. Ref. Data,* 29(5):1053-1122, 2000.
Nitrogen	Span, R., Lemmon, E. W., Jacobsen, R.T., Wagner, W., and Yokozeki, A. "A Reference Thermodynamic Property Formulation for Nitrogen." *J. Phys. Chem. Ref. Data,* Volume 29, Number 6, pp. 1361-1433, 2000.
Oxygen	Schmidt, R., Wagner, W. "A New Form of the Equation of State for Pure Substances and its Application to Oxygen." *Fluid Phase Equilib.,* 19:175-200, 1985.
Hydrogen	"Thermophysical Properties of Fluids. 1. "Argon, Ethlene, Parahydrogen, Nitrogen, Nitrogen Trifluoride, and Oxygen," published in the *Journal of Physical and Chemical Reference Data,* Volume 11, 1982, Supplement No. 1, and published by the American Chemical Society and the American Institute of Physics for the National Institute of Standards and Technology.
Note: A complete database program containing all of the most recent equations for calculating density for various cryogenic liquids is available at www.nist.gov/srd/nist23.htm. There is a fee for download of this database.	

(Added 2004)

T. Tolerances

T.1. Application.

T.1.1. To Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Tolerance Values. – The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2.
(Amended 2003)

T.3. On Tests Using Transfer Standards. - To the basic tolerance values that would otherwise be applied, there shall be added an amount equal to two times the standard deviation of the applicable transfer standard when compared to a basic reference standard.
(Added 1976)

T.4. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. See also N.5.1.1.
(Added 2001)

UR. User Requirements

UR.1. Installation Requirements.

Table T.2. Accuracy Classes and Tolerances for Cryogenic Liquid-Measuring Devices				
Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
2.5	Cryogenic products; liquefied compressed gases other than liquid carbon dioxide	1.5%	2.5%	2.5%

(Added 2003)

UR.1.1. Discharge Rate. - A device shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation.

UR.1.2. Length of Discharge Hose. - The discharge hose shall be of such a length and design as to keep vaporization of the liquid to a minimum.

UR.1.3. Maintenance of Liquid State. - A device shall be so installed and operated that the product being measured shall remain in the liquid state during passage through the meter.

UR.2. Use Requirements.

UR.2.1. Return of Indicating and Recording Elements to Zero. - The primary indicating elements (visual) and the primary recording elements shall be returned to zero immediately before each delivery.

UR.2.2. Condition of Discharge System. - The discharge system, up to the measuring element, shall be pre-cooled to liquid temperatures before a "zero" condition is established prior to the start of a commercial delivery.

UR.2.3. Vapor Return Line. - A vapor return line shall not be used during a metered delivery.
(Amended 1976)

UR.2.4. Drainage of Discharge Line. - On a dry-hose system, upon completion of a delivery, the vendor shall leave the discharge line connected to the receiving container with the valve adjacent to the meter in the closed position and the valve at the discharge line outlet in the open position for a period of at least:

(a) 1 minute for small delivery devices, and

(b) 3 minutes for large delivery devices,

to allow vaporization of some product in the discharge line to force the remainder of the product in the line to flow into the receiving container.
(Amended 1976)

UR.2.5. Conversion Factors. - Established conversion values (see references in N.4.) shall be used whenever metered liquids are to be billed in terms of:

(a) kilograms or pounds based on a meter indication of liters, gallons, cubic meters of gas, or cubic feet of gas; or,

(b) cubic meters or cubic feet of gas based on a meter indication of liters or gallons, kilograms, or pounds; or,

(c) liters or gallons based on a meter indication of kilograms or pounds, cubic meters of gas or cubic feet of gas.

All sales of cryogenic liquids shall be based on either kilograms or pounds, liters or gallons at NBP[1], cubic meters of gas or cubic feet of gas at NTP[1].
(Amended 1986)

UR.2.6. Temperature or Density Compensation.

UR.2.6.1. Use of Automatic Temperature or Density Compensators. - If a device is equipped with an automatic temperature or density compensator, this shall be connected, operable, and in use at all times. Such automatic temperature or density compensator may not be removed, nor may a compensated device be replaced with an uncompensated device, without the written approval of the weights and measures authority having jurisdiction over the device.

UR.2.6.2. Tickets or Invoices. - Any written invoice or printed ticket based on a reading of a device that is equipped with an automatic temperature or density compensator shall have shown thereon that the quantity delivered has been adjusted to the quantity at the NBP of the specific cryogenic product or the equivalent volume of gas at NTP.

UR.2.6.3. Printed Ticket. - Any printed ticket issued by a device of the computing type on which there is printed the total computed price, the total quantity of the delivery, or the price per unit, shall also show the other two values (either printed or in clear script).

UR.2.6.4. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.7. Pressure of Tanks with Volumetric Metering Systems Without Temperature Compensation. - When the saturation pressure of the product in the vendor's tank exceeds 240 kPa (35 psia), a correction shall be applied to the written invoice or printed ticket using the appropriate tables as listed in N.4.; or the saturation pressure shall be reduced to 207 kPa (30 psia) (if this can be safely accomplished) prior to making a delivery.
(Added 1976)

[1] See Definitions section.

Sec. 3.35. Milk Meters

A. Application

A.1. - This code applies to devices used for the measurement of milk; generally applicable to, but not limited to, meters used in dairies, milk processing plants, and cheese factories, to measure incoming bulk milk.

A.2. - See also Sec. 1.10; General Code requirements.

A.3. - This code does not apply to mass flow meters (see Sec. 3.37. Code for Mass Flow Meters).
(Added 1994)

S. Specifications

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

S.1.1. Primary Elements

S.1.1.1. General. - A meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element.

S.1.1.2. Units.

(a) A meter shall indicate, and record if the meter is equipped to record, its deliveries in terms of liters or gallons. Fractional parts of the liter shall be in terms of decimal subdivisions. Fractional parts of the gallon shall be in terms of either decimal or binary subdivisions.

(b) When it is an industry practice to purchase and ell milk by weight based upon 1.03 kg/L (8.6 lb/gal), the primary indicating element may indicate in kilograms or pounds. The weight value division shall be a decimal multiple or submultiple of 1, 2, or 5. Fractional parts of the kilogram or pound shall be in decimal subdivisions. (See S.4.5.)
(Amended 1997)

S.1.1.3. Value of Smallest Unit. - The value of the smallest unit of indicated quantity and recorded quantity, if the meter is equipped to record, shall not exceed the equivalent of:

(a) 0.5 L or 5 kg (1 pt or 1 lb) when measuring quantities less than or equal to 4 000 L or 4 000 kg (1 000 gal or 8 600 lb), or

(b) 5 L or 5 kg (1 gal or 10 lb) when measuring quantities in excess of 4 000 L or 4 000 kg (1 000 gal or 8 600 lb).
(Amended 1989)

S.1.1.4. Advancement of Indicating and Recording Elements. - Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the meter. However, a meter may be cleared by advancing its elements to zero, but only if:

(a) the advancing movement, once started, cannot be stopped until zero is reached, or

(b) in the case of indicating elements only, such elements are automatically obscured until the elements reach the correct zero position.

S.1.1.5. Return to Zero. - Primary indicating elements and primary recording elements, if the device is equipped to record, shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of the primary indicating elements and the primary recording elements, if the device is so equipped, beyond their correct zero position.

S.1.1.6. Indication of Measurement. - A meter shall be constructed to show automatically its initial zero condition and the volume measured up to the nominal capacity of the device.

S.1.2. Graduations.

S.1.2.1. Length. - Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. Width. - In any series of graduations, the width of a graduation shall in no case be greater then the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.2.3. Clear Interval Between Graduations. - The clear interval shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

(a) along the line of relative movement between the graduations at the end of the indicator, or

(b) if the indicator is continuous, at the point of widest separation of the graduations.

S.1.3. Indicators.

S.1.3.1. Symmetry. - The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.1.3.2. Length. - The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of graduations, shall be not more than 1.0 mm (0.04 in).

S.1.3.3. Width. - The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

(a) *the width of the narrowest graduation*,* and *[*Nonretroactive as of January 1, 2002]* (Amended 2001)

(b) the width of the minimum clear interval between graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

S.1.3.4. Clearance. - The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.3.5. Parallax. - Parallax effects shall be reduced to the practicable minimum.

S.1.3.6. Travel of Indicator. - If the most sensitive element of the primary indicating element utilizes an indicator and graduations, the relative movement of these parts corresponding to the smallest indicated value shall be not less than 5 mm (0.20 in).

S.1.4. Computing-Type Devices.

S.1.4.1 Display of Unit Price. - In a device of the computing type, means shall be provided for displaying on the outside of the device, and in close proximity to the display of the total computed price, the price per unit at which the device is set to compute.

S.1.4.2. Printed Ticket. - If a computing-type device issues a printed ticket which displays the total computed price, the ticket also shall have printed clearly thereon the total quantity of the delivery, the appropriate fraction of the quantity, and the price per unit of quantity.
(Amended 1989)

S.1.4.3. Money-Value Computations. - Money-value computations shall be of the full-computing type in which the money value at a single unit price, or at each of a series of unit prices, shall be computed for every delivery within either the range of measurement of the device or the range of the computing elements, whichever is less. Value graduations shall be supplied and shall be accurately positioned. The value of each graduated interval shall be 1 cent.

S.1.4.4. Money Values, Mathematical Agreement. Any digital money-value indication and any recorded money value on a computing-type device shall be in mathematical agreement with its associated quantity indicating or representation to within 1 cent of money value.

S.2. Design of Measuring Elements.

S.2.1. Vapor Elimination. - A metering system shall be equipped with an effective vapor eliminator or other effective means automatic in operation to prevent the passage of vapor and air through the meter. Vent lines from the air (or vapor) eliminator shall be made of metal tubing or some other suitably rigid material.

S.2.2. Maintaining Flooded Condition. - The vent on the vapor eliminator shall be positioned or installed in such a manner that the vapor eliminator cannot easily be emptied between uses.

S.2.3. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or for physically applying a security seal in such a manner that requires the security seal to be broken before an adjustment or interchange may be made of:

(a) any measuring element or indicating element,

(b) any adjustable element for controlling delivery rate, when such rate tends to affect the accuracy of deliveries, and

(c) any metrological parameter that will affect the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

[Audit trails shall use the format set forth in Table S.2.3.] *[*Nonretroactive as of January 1, 1995]*
(Amended 2006)

S.2.4. Directional Flow Valves. - Valves intended to prevent reversal of flow shall be automatic in operation.

S.3. Design of Intake Lines.

S.3.1. Diversion of Liquid to be Measured. - No means shall be provided by which any liquid can be diverted from the supply tank to the receiving tank without being measured by the device. A manually controlled outlet that may be opened for purging or draining the measuring system shall be permitted. Effective means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system.
(Amended 1994)

S.3.2. Intake Hose. - The intake hose shall be:

(a) of the dry-hose type,

(b) adequately reinforced,

(c) not more than 6 m (20 ft) in length unless it can be demonstrated that a longer hose is essential to permit transfer from a supply tank; and

(d) connected to the pump at horizontal or above to permit complete drainage of the hose.
(Amended 1991)

S.4. Marking Requirements.

S.4.1. Limitation of Use. - If a meter is intended to measure accurately only liquids having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the meter.

Table S.2.3. Categories of Device and Methods of Sealing

Category 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 or shall not operate while in this mode.*	*The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.*
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.*	*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.)*

[Nonretroactive as of January 1, 1995]
(Table Added 2006)

S.4.2. Discharge Rates. - A meter shall be marked to show its designed maximum and minimum discharge rates. The marked minimum discharge rate shall not exceed 20% of the marked maximum discharge rate.
(Amended 2003)

Note: See Example in Section 3.30. Liquid-Measuring Devices Code, paragraph S.4.4.1.
(Added 2003)

S.4.3. Measuring Components. - All components that affect the measurement of milk that are disassembled for cleaning purposes shall be clearly and permanently identified with a common serial number.

S.4.4. Flood Volume. - When applicable, the volume of product (to the nearest minimum division of the meter) necessary to flood the system when dry shall be clearly, conspicuously, and permanently marked on the air eliminator.

S.4.5. Conversion Factor. - When the conversion factor of 1.03 kg/L (8.6 lb/gal) is used to convert the volume of milk to weight, the conversion factor shall be clearly marked on the primary indicating element and recorded on the delivery ticket.

N. Notes

N.1. Test Liquid.

(a) A meter shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics. Following a satisfactory examination, the weights and measures official should attach a seal or tag indicating the product used during the test.
(Amended 1989)

(b) A milk measuring system shall be tested with the type of milk to be measured when the accuracy of the system is affected by the characteristics of milk (e.g., positive displacement meters).
(Added 1989)

N.2. Evaporation and Volume Change. - Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

N.2.1. Temperature Correction. - Corrections shall be made for any changes in volume resulting from the differences in liquid temperatures between time of passage through the meter and time of volumetric determination in the test measure. When adjustments are necessary, appropriate tables should be used.

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in one minute at its maximum discharge rate, and shall in no case be less than 400 L or 400 kg (100 gal or 1 000 lb).
(Amended 1989)

N.4. Testing Procedures.

N.4.1. Normal Tests. - The "normal" test of a meter shall be made at the maximum discharge rate that may be anticipated under the conditions of the installation. The "normal" test shall include a determination of the effectiveness of the air elimination system.

N.4.1.1. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2002)

N.4.2. Special Tests. - "Special" tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. shall be considered a special test.
(Amended 2005)

N.4.3. System Capacity. - The test of a milk-metering system shall include the verification of the volume of product necessary to flood the system as marked on the air eliminator.

T. Tolerances

T.1. Application.

T.1.1. To Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Tolerance Values. - Maintenance and acceptance tolerances shall be as shown in Table 1.
(Amended 1989)

T.3. Repeatability – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. See also N.4.1.1.
(Added 2002)

Table 1. Tolerances		
Milk Meters		
Indication	Maintenance	Acceptance
gallons	gallons	gallons
100	0.5	0.3
200	0.7	0.4
300	0.9	0.5
400	1.1	0.6
500	1.3	0.7
Over 500	Add 0.002 gallon per indicated gallon over 500	Add 0.001 gallon per indicated gallon over 500

*Added 1989

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Plumb and Level Condition. - A device installed in a fixed location shall be installed plumb and level, and the installation shall be sufficiently strong and rigid to maintain this condition.

UR.1.2. Discharge Rate. - A meter shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

UR.1.3. Unit Price. - There shall be displayed on the face of a device of the computing type the unit price at which the device is set to compute.

UR.1.4. Intake Hose. - The intake hose shall be so installed as to permit complete drainage and that all available product is measured following each transfer.

UR.2. Use Requirements.

UR.2.1. Return of Indicating and Recording Elements to Zero. - The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero before each transfer.

UR.2.2. Printed Ticket. - Any printed ticket issued by a device of the computing type on which there is printed the total computed price, the total quantity, or the price per unit of quantity, shall also show the other two values (either printed or in clear script).
(Amended 1989)

UR.2.3. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a transfer is begun. If the meter is mounted on a vehicle, in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.4. Credit for Flood Volume. - The volume of product necessary to flood the system as marked on the air eliminator shall be individually recorded on the ticket of each transfer affected.

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Sec. 3.36. Water Meters

A. Application

A.1. This code applies to devices used for the measurement of water; generally applicable to, but not limited to, utilities type meters installed in residences or business establishments and meters installed in batching systems.
(Amended 2002)

A.2. This code does not apply to:

(a) water meters mounted on vehicle tanks (for which see Sec. 3.31. Code for Vehicle Tank Meters).

(b) mass flow meters (see Sec. 3.37. Code for Mass Flow Meters).
(Added 1994)

A.3. See also Sec. 1.10; General Code requirements.

S. Specifications

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

S.1.1. Primary Elements.

S.1.1.1. General. A water meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element. Such elements shall be visible at the point of measurement or be stored in non-volatile and nonresettable memory. The display may be remotely located provided it is readily accessible to the customer.
(Amended 2002)

S.1.1.2. Units. A water meter shall indicate and record, if the device is equipped to record, its deliveries in terms of liters, gallons or cubic feet or binary or decimal subdivisions thereof except batch plant meters, which shall indicate deliveries in terms of liters, gallons or decimal subdivisions of the liter or gallon only.

S.1.1.3. Value of Smallest Unit. The value of the smallest unit of indicated delivery and recorded delivery, if the device is equipped to record, shall not exceed the equivalent of:

(a) 50 L (10 gal) on utility type meters,

(b) 0.2 L (1/10 gal) on batching meters delivering less than 375 L/min (100 gal/min), or

(c) 5 L (1 gal) on batching meters delivering 375 L/min (100 gal/min) or more.

S.1.1.4. Advancement of Indicating and Recording Elements. Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the device.

S.1.1.5. Return to Zero. If the meter is so designed that the primary indicating elements are readily returnable to a definite zero indication, means shall be provided to prevent the return of these elements beyond their correct zero position.

S.1.2. Graduations.

S.1.2.1. Length. Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. Width. In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.2.3. Clear Interval Between Graduations. The clear interval shall not be less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

(a) along the line of relative movement between the graduations at the end of the indicator, or

(b) if the indicator is continuous, at the point of widest separation of the graduations.

S.1.3. Indicators.

S.1.3.1. Symmetry. The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.1.3.2. Length. The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.3.3. Width. The width of the index of an indicator in relation to the series of graduations with which it is used shall not be greater than:

(a) *the width of the narrowest graduation*,* and *[*Nonretroactive as of January 1, 2002]* (Amended 2001)

(b) the width of the minimum clear interval between graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

S.1.3.4. Clearance. The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.3.5. Parallax. Parallax effects shall be reduced to the practicable minimum.

S.2. Design of Measuring Elements.

S.2.1. Provision for Sealing. - Adequate provision shall be made for applying security seals in such a manner that no adjustment or interchange may be made of:

(a) any measurement elements, and

(b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries.

The adjusting mechanism shall be readily accessible for purposes of affixing a security seal.
(Amended 2006)

S.2.2. Batching Meters Only.

S.2.2.1. Air Elimination. Batching meters shall be equipped with an effective air eliminator.

S.2.2.2. Directional Flow Valves. Valves intended to prevent reversal of flow shall be automatic in operation.

S.2.3. Multi-Jet Meter Identification. Multi-jet water meters shall be clearly and permanently marked as such on the device or identified on the Certificate of Conformance.
(Added 2003)

N. Notes

N.1. Test Liquid. A meter shall be tested with water.

N.2. Evaporation and Volume Change. Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes to temperature of the test liquid.

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in 2 minutes and in no case less than the amount delivered by the device in 1 minute at the actual maximum flow rate developed by the installation. The test draft sizes shown in Table N.4.1., shall be followed as closely as possible.
(Amended 2003)

N.4. Testing Procedures.

N.4.1. Normal Tests. The normal test of a meter shall be made at the maximum discharge rate developed by the installation. Meters with maximum gallon per minute ratings higher than the values specified in Table N.4.1. may be tested up to the meter rating, with meter indications no less than those shown.
(Amended 1990, 2002 and 2003)

Table N.4.1. Flow Rate and Draft Size for Water Meters
Normal Tests

Meter Size (inches)	Rate of Flow (gal/min)	Maximum Rate Meter Indication/Test Draft	
		gal	ft^3
Less than 5/8	8	50	5
5/8	15	50	5
3/4	25	50	5
1	40	100	10
1 1/2	80	300	40
2	120	500	40
3	250	500	50
4	350	1 000	100
6	700	1 000	100

(Table Added 2003)

Sec. 3.37. - Mass Flow Meters

A. Application

A.1. Liquids. - This code applies to devices that are designed to dynamically measure the mass, or the mass and density of liquids. It also specifies the relevant examinations and tests that are to be conducted.
(Amended 1997)

A.2. Vapor (Gases). - This code applies to devices that are designed to dynamically measure the mass of hydrocarbon gas in the vapor state. Examples of these products are propane, propylene, butanes, butylenes, ethane, methane, natural gas and any other hydrocarbon gas/air mix.

S. Specifications

S.1. Indicating and Recording Elements.

S.1.1. Indicating Elements. - A measuring assembly shall include an indicating element. Indications shall be clear, definite, accurate, and easily read under normal conditions of operation of the instrument.

S.1.2. Compressed Natural Gas Dispensers. - Except for fleet sales and other price contract sales, a compressed natural gas dispenser used to refuel vehicles shall be of the computing type and shall indicate the quantity, the unit price, and the total price of each delivery. The dispenser shall display the mass measured for each transaction either continuously on an external or internal display accessible during the inspection and test of the dispenser, or display the quantity in mass units by using controls on the device.
(Added 1994)

S.1.3. Units.

S.1.3.1. Units of Measurement. - Deliveries shall be indicated and recorded in grams, kilograms, metric tons, pounds, tons, and/or liters, gallons, quarts, pints and decimal subdivisions thereof. The indication of a delivery shall be on the basis of apparent mass versus a density of 8.0 g/cm^3. The volume indication shall be based on the mass measurement and an automatic means to determine and correct the changes in product density.
(Amended 1993 and 1997)

S.1.3.1.1. Compressed Natural Gas Used as an Engine Fuel. - When compressed natural gas is dispensed as an engine fuel, the delivered quantity shall be indicated in "gasoline liter equivalent (GLE) units" or "gasoline gallon equivalent (GGE) units" (see Definitions).
(Added 1994)

S.1.3.2. Numerical Value of Quantity-Value Divisions. - The value of a scale interval shall be equal to:

(a) 1, 2, or 5, or

(b) a decimal multiple or submultiple of 1, 2, or 5.
(Amended 2006)

S.1.3.3. Maximum Value of Quantity-Value Divisions.

(a) The maximum value of the quantity-value division for liquids shall be not greater than 0.2 percent of the minimum measured quantity.

(b) For dispensers of compressed natural gas used to refuel vehicles, the value of the division for the gasoline liter equivalent shall not exceed 0.01 GLE; the division for gasoline gallon equivalent (GGE) shall not exceed 0.001 GGE. The maximum value of the mass division shall not exceed 0.001 kg or 0.001 lb.
(Amended 1994)

S.1.3.4. Values Defined. - Indicated values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof. A display of "zero" shall be a zero digit for all displayed digits to the right of the decimal mark and at least one to the left.

S.2. Operating Requirements.

S.2.1. Return to Zero. - Except for measuring assemblies in a pipeline:

(a) One indicator and the primary recording elements, if the device is equipped to record, shall be provided with a means for readily returning the indication to zero either automatically or manually.

(b) It shall not be possible to return primary indicating elements, or primary recording elements, beyond the correct zero position.
(Amended 1993)

S.2.2. Indicator Reset Mechanism. - The reset mechanism for the indicating element shall not be operable during a delivery. Once the zeroing operation has begun, it shall not be possible to indicate a value other than the latest measurement, or "zeros" when the zeroing operation has been completed.

S.2.3. Nonresettable Indicator. - An instrument may also be equipped with a nonresettable indicator if the indicated values cannot be construed to be the indicated values of the resettable indicator for a delivered quantity.

S.2.4. Provisions for Power Loss.

S.2.4.1. Transaction Information. - In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.
(Added 1993)

S.2.4.2. User Information. - The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.
(Added 1993)

S.2.5. Display of Unit Price and Product Identity.

S.2.5.1. Unit Price. - A computing or money-operated device shall be able to display on each face the unit price at which the device is set to compute or to dispense.
(Added 1993)

S.2.5.2. Product Identity. - A device shall be able to conspicuously display on each side the identity of the product being dispensed.
(Added 1993)

S.2.5.3. Selection of Unit Price. - *Except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g truck stop dispensers used only to refuel trucks), when a product or grade is offered for sale at more than one uni price through a computing device the selection of the unit price shall be mad prior to delivery using controls on the device or other customer-activated controls. A system shall not permit a change to the unit price during delivery of a product.*
[Nonretroactive as of January 1, 1998]
(Added 1997)

S.2.5.4. Agreement Between Indications. - When a quantity value indicated or recorded by an auxiliary element is a derived or computed value based on data received from a retail motor fuel dispenser, the value may differ from the quantity value displayed on the dispenser, provided the following conditions are met:

(a) all total money values for an individual sale that are indicated or recorded by the system agree; and

(b) within each element the values indicated or recorded meet the formula (quantity x unit price = total sales price) to the closest cent.
[Nonretroactive as of January 1, 1998]
(Added 1997)

S.2.6. Money-Value Computations. - A computing device shall compute the total sales price at any single-purchase unit price (i.e., excluding fleet sales, other price contract sales, and truck stop dispensers used only to refuel trucks) for which the product being measured is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less.
(Added 1993)

S.2.6.1. Auxiliary Elements. - If a system is equipped with auxiliary indications, all indicated money-value and quantity divisions of the auxiliary element shall be identical with those of the primary element.
(Added 1993)

S.2.6.2. Display of Quantity and Total Price. - When a delivery is completed, the total price and quantity for that transaction shall be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated by using controls on the device or other user-activated controls.
(Added 1993)

S.2.7. Recorded Representations, Point-of-Sale Systems. - *The sales information recorded by cash registers when interfaced with a retail motor-fuel dispenser shall contain the following information for products delivered by the dispenser:*

(a) the total volume of the delivery,

(b) the unit price,

(c) the total computed price, and

(d) the product identity by name, symbol, abbreviation, or code number.

[Nonretroactive as of January 1, 1986.]
(Added 1993) (Amended 2000)

S.2.8. Indication of Delivery. - *The device shall automatically show on its face the initial zero condition and the quantity delivered (up to the nominal capacity). However, the first 0.03 L (0.009 gal) of a delivery and its associated total sales price need not be indicated.*
[Nonretroactive as of January 1, 1998]
(Added 1997)

S.3. Measuring Elements and Measuring Systems.

S.3.1. Maximum and Minimum Flow-Rates.

(a) The ratio of the maximum to minimum flow-rates specified by the manufacturer for devices measuring liquified gases shall be 5:1 or greater.

(b) The ratio of the maximum to minimum flow-rates specified by the manufacturer for devices measuring other than liquified gases shall be 10:1 or greater.

S.3.2. Adjustment Means. - An assembly shall be provided with means to change the ratio between the indicated quantity and the quantity of liquid measured by the assembly. A bypass on the measuring assembly shall not be used for these means.

S.3.2.1. Discontinuous Adjusting Means. - When the adjusting means changes the ratio between the indicated quantity and the quantity of measured liquid in a discontinuous manner, the consecutive values of the ratio shall not differ by more than 0.1 percent.

S.3.3. Vapor Elimination. - A liquid-measuring instrument or measuring system shall be equipped with an effective vapor or air eliminator or other effective means, automatic in operation, to prevent the measurement of vapor and air. Vent lines from the air or vapor eliminator shall be made of metal tubing or some other suitable rigid material.
(Amended 1999)

S.3.3.1. Vapor Elimination on Loading Rack Liquid Metering Systems.

(a) A loading rack liquid metering system shall be equipped with a vapor or air eliminator or other automatic means to prevent the passage of vapor and air through the meter unless the system is designed or operationally controlled by a method, approved by the weights and measures jurisdiction having statutory authority over the device, such that neither air nor vapor can enter the system.

(b) Vent lines from the air or vapor eliminator (if present) shall be made of metal tubing or other rigid material.
(Added 1995)

S.3.4. Maintenance of Liquid State. - A liquid-measuring device shall be installed so that the measured product remains in a liquid state during passage through the instrument.

S.3.5. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that no adjustment or interchange may be made of:

(a) any measuring or indicating element;

(b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries;

(c) the zero adjustment mechanism; and

(d) any metrological parameter that will affect the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

*[Audit trails shall use the format set forth in Table S.3.5.]**
*[*Nonretroactive as of January 1, 1995]*
(Amended 1992, 1995 and 2006)

S.3.6. Automatic Density Correction.

(a) An automatic means to determine and correct for changes in product density shall be incorporated in any mass flow metering system that is affected by changes in the density of the product being measured.

(b) Volume-measuring devices with automatic temperature compensation used to measure natural gas as a motor vehicle engine fuel shall be equipped with an automatic means to determine and correct for changes in product density due to changes in the temperature, pressure, and composition of the product.
(Amended 1994, 1997 and 2000)

Table S.3.5. Categories of Device and Methods of Sealing	
Category 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 or shall not operate while in this mode.*	*[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.]* *[* Nonretroactive as of January 1, 1996]*
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). *[Nonretroactive and enforceable as of January 1, 1995]* *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.* *[Nonretroactive as of January 1, 2001]*	*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.)*

[Nonretroactive and enforceable as of January 1, 1995]
(Table Added 1995) (Amended 1998, 1999, 2005 and 2006)

S.3.7. Pressurizing the Discharge Hose. - The discharge hose for compressed natural gas shall automatically pressurize prior to the device beginning to register the delivery.
(Added 1993)

S.3.8. Zero-Set-Back Interlock, Retail Motor-Fuel Devices. - A device shall be constructed so that:

(a) after a delivery cycle has been completed by moving the starting lever to any position that shuts off the device, an automatic interlock prevents a subsequent delivery until the indicating elements, and recording elements if the device is equipped and activated to record, have been returned to their zero positions;
(Added 1993)

(b) the discharge nozzle cannot be returned to its designed hanging position (that is, any position where the tip of the nozzle is placed in its designed receptacle and the lock can be inserted) until the starting lever is in its designed shut-off position and the zero-set-back interlock has been engaged; and

(c) in a system with more than one dispenser supplied by a single pump, an effective automatic control valve in each dispenser prevents product from being delivered until the indicating elements on that dispenser are in a correct zero position.

S.4. Discharge Lines and Valves.

S.4.1. Diversion of Measured Product. - No means shall be provided by which any measured product can be diverted from the measuring instrument. However, two or more delivery outlets may be permanently installed and operated simultaneously, provided that any diversion of flow to other than the intended receiving receptacle cannot be readily accomplished or is readily apparent. Such means include physical barriers, visible valves or indications that make it clear which outlets are in operation, and explanatory signs if deemed necessary.

An outlet that may be opened for purging or draining the measuring system, or for recirculating product if recirculation is required in order to maintain the product in a deliverable state shall be permitted. Effective automatic means shall be provided to prevent the passage of liquid through any such outlet during normal operation of the measuring system and to inhibit meter indications (or advancement of indications) and recorded representations while the outlet is in operation.
(Amended 2002 and 2006)

S.4.2. Pump-Discharge Unit. - A pump-discharge unit for liquids equipped with a flexible discharge hose shall be of the wet-hose type.
(Added 1993)

S.4.3. Directional Flow Valves. - If a reversal of flow could result in errors that exceed the tolerance for the minimum measured quantity, a valve or valves or other effective means, automatic in operation (and equipped with a pressure limiting device, if necessary) to prevent the reversal of flow shall be properly installed in the system. (See N.1.)

S.4.4. Discharge Valves. - A discharge valve may be installed on a discharge line only if the system is a wet-hose type. Any other shut-off valve on the discharge side of the instrument shall be of the automatic or semiautomatic predetermined-stop type or shall be operable only:

- by means of a tool (but not a pin) entirely separate from the device, or
- by means of a security seal with which the valve is sealed open.

S.4.5. Antidrain Means. - In a wet-hose type device, effective means shall be provided to prevent the drainage of the hose between transactions.

S.4.6. Other Valves. - Check valves and closing mechanisms that are not used to define the measured quantity shall have relief valves (if necessary) to dissipate any abnormally high pressure that may arise in the measuring assembly.

S.5. Markings. - A measuring system shall be legibly and indelibly marked with the following information:

(a) pattern approval mark (i.e., type approval number);

(b) name and address of the manufacturer or his trademark and, if required by the weights and measures authority, the manufacturer's identification mark in addition to the trademark;

(c) model identifier or product name selected by the manufacturer;
(Amended 2006)

(d) nonrepetitive serial number;

*(e) the accuracy class of the meter as specified by the manufacturer consistent with Table T.2.;**
(Added 1994)

(f) maximum and minimum flow rates in pounds per unit of time;

(g) maximum working pressure;

(h) applicable range of temperature if other than -10 °C to +50 °C;

(i) minimum measured quantity; and

(j) product limitations, if applicable.

*[*Nonretroactive as of January 1, 1995.]*

***S.5.1. Location of Marking Information; Retail Motor-Fuel Dispensers**. - The marking information required in General Code, Paragraph G-S.1. Identification shall appear as follows:*

(a) within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser;

(b) either internally and/or externally provided the information is permanent and easily read; and

(c) on a portion of the device that cannot be readily removed or interchanged (i.e., not on a service access panel).

Note: *The use of a dispenser key or tool to access internal marking information is permitted for retail liquid-measuring devices.*
[Nonretroactive as of January 1, 2003]
(Added 2006)

S.5.2. Marking of Gasoline Volume Equivalent Conversion Factor. - A device dispensing com-pressed natural gas shall have either the statement "1 Gasoline Liter Equivalent (GLE) is Equal to 0.678 kg of Natural Gas" or "1 Gasoline Gallon Equivalent (GGE) is Equal to 5.660 lb of Natural Gas" permanently and conspicuously marked on the face of the dispenser according to the method of sale used.
(Added 1994) (Amended 2006)

S.6. Printer. - When an assembly is equipped with means for printing the measured quantity, the following conditions apply:

(a) the scale interval shall be the same as that of the indicator;

(b) the value of the printed quantity shall be the same value as the indicated quantity;

(c) a quantity for a delivery (other than an initial reference value) cannot be recorded until the measurement and delivery has been completed;

(d) the printer is returned to zero when the resettable indicator is returned to zero; and

(e) the printed values shall meet the requirements applicable to the indicated values.

S.6.1. Printed Receipt. - Any delivered, printed quantity shall include an identification number, the time and date, and the name of the seller. This information may be printed by the device or preprinted on the ticket.

S.7. Totalizers for Retail Motor-Fuel Devices. *- Retail motor-fuel dispensers shall be equipped with a nonresettable totalizer for the quantity delivered through the metering device.*
[Nonretroactive as of January 1, 1998]
(Added 1997)

N. Notes

N.1. Minimum Measured Quantity. - The minimum measured quantity shall be specified by the manufacturer.

N.2. Test Medium.

N.2.1. Liquid-Measuring Devices. - The device shall be tested with the liquid that the device is intended to measure or another liquid with the same general physical characteristics.

N.2.2. Vapor-Measuring Devices. - The device shall be tested with air or the product to be measured.

N.3. Test Drafts. - The minimum test shall be one test draft at the maximum flow rate of the installation and one test draft at the minimum flow rate. More tests may be performed at these or other flow rates. (See T.3.)

N.4. Minimum Measured Quantity. - The device shall be tested for a delivery equal to the declared minimum measured quantity when the device is likely to be used to make deliveries on the order of the minimum measured quantity.

N.5. Motor Fuel Dispenser. - When a device is intended for use as a liquid motor-fuel dispenser, the type evaluation test shall include a test for accuracy using 5 starts and stops during a delivery to simulate the operation of the automatic shut-off nozzle. This test may be conducted as part of the normal inspection and test of the meter.

N.6. Testing Procedures.

N.6.1. Normal Tests. – The normal test of a meter shall be made at the maximum discharge rate developed by the installation. Any additional tests conducted at flow rates down to and including the rated minimum discharge flow rate shall be considered normal tests.
(Added 1999)

N.6.1.1. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as, temperature pressure and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2001)

N.6.2. Special Tests. – Special tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.6.1. shall be considered a special test. Special tests of a measuring system shall be made to develop operating characteristics of the measuring systems during a split compartment delivery. (See Table T.2.)
(Added 1999) (Amended 2005)

T. Tolerances

T.1. Tolerances, General

(a) The tolerances apply equally to errors of underregistration and errors of overregistration.

(b) The tolerances apply to all products at all temperatures measured at any flow rate within the rated measuring range of the meter.
(Amended 1999)

T.2. Tolerances. - The tolerances for mass flow meters for specific liquids, gases, and applications are listed in Table T.2.
(Amended 1994 and 1999)

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. See also N.6.1.1.
(Amended 1992, 1994 and 2001)

T.4. Type Evaluation Examinations for Liquid-Measuring Devices. - For type evaluation examinations, the tolerance values shall apply under the following conditions:

(a) with any one liquid within the range of liquids,

(b) at any one liquid temperature and pressure within the operating range of the meter, and

(c) at all flow rates within the range of flow rates.
(Added 1993) (Amended 1994)

Table T.2. Accuracy Classes for Mass Flow Meter Applications				
Accuracy Class	Application or Commodity Being Measured	Acceptance Tolerance	Maintenance Tolerance	Special Tolerance
0.3	Loading rack meters, vehicle-tank meters, home heating oil, heated products (except asphalt above 50°C), asphalt 50°C or below, milk and other food products, large capacity motor-fuel dispensers (maximum discharge flow rates greater than 100 L or 25 gallon per minute), all other liquid applications not shown in the table where the minimum delivery is at least 700 kg (1500 lb)	0.2%	0.3%	0.5%
0.3A	Asphalt above 50°C	0.3%	0.3%	0.5%
0.5	Small capacity (retail) motor-fuel dispensers, agri-chemical liquids, all other liquid applications not shown in the table	0.3%	0.5%	0.5%
1.0	Anhydrous ammonia, LP Gas (including vehicle tank meters)	0.6%	1.0%	1.0%
2.0	Compressed natural gas as a motor fuel	1.5%	2.0%	2.0%
2.5	Cryogenic liquid meters, liquefied compressed gases other than LP Gas	1.5%	2.5%	2.5%

(Added 1994) (Amended 1999 and 2001)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Discharge Hose-Length. - *The length of the discharge hose on a retail motor-fuel device shall not exceed 4.6 m (15 ft) unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels.*
[Nonretroactive as of January 1, 1998]
(Added 1997)

UR.1.2. Minimum Measured Quantity.

(a) The minimum measured quantity shall be specified by the manufacturer.

(b) The minimum measured quantity appropriate for a transaction may be specified by the weights and measures authority. A device may have a minimum measured quantity smaller than that specified by the weights and measures authority; however, the device must perform within the performance requirements for the declared minimum measured quantity.

UR.2. Installation Requirements.

UR.2.1. Manufacturer's Instructions. - A device shall be installed in accordance with the manufacturer's instructions, and the installation shall be sufficiently secure and rigid to maintain this condition.
(Added 1997)

UR.2.2. Discharge Rate. - A device shall be installed so that the actual maximum discharge rate will not exceed the rated maximum discharge rate. Automatic means of flow regulation shall be incorporated in the installation if necessary.
(Added 1997)

UR.2.3. Low-Flow Cut-Off Valve. - If a metering system is equipped with a programmable or adjustable "low-flow cut-off" feature:

(a) the low-flow cut-off value shall not be set at flow rates lower than the minimum operating flow rate specified by the manufacturer on the meter; and

(b) the system shall be equipped with flow control valves which prevent the flow of product and stop the indicator from registering product flow whenever the product flow rate is less than the low-flow cut-off value.
(Added 1992)

UR.3. Use of Device.

UR.3.1. Unit Price and Product Identity for Retail Dispensers. - The following information shall be conspicuously displayed or posted on the face of a retail dispenser used in direct sale:

(a) Except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), all of the unit prices at which the product is offered for sale; and
(b) in the case of a computing type or money-operated type, the unit price at which the dispenser is set to compute.

(Added 1993)

UR.3.2. Vapor-Return Line. - During any metered delivery of liquefied petroleum gas and other liquids from a supplier's tank to a receiving container, there shall be no vapor-return line from the receiving container to the supplier's tank:

(a) in the case of any receiving container to which normal deliveries can be made without the use of such vapor-return line, or

(b) in the case of any new receiving container when the ambient temperature is below 90 °F.

(Added 1993)

UR.3.3. Ticket Printer; Customer Ticket. - Vehicle-mounted metering systems shall be equipped with a ticket printer which shall be used for all sales where product is delivered through the meter. A copy of the ticket issued by the device shall be left with the customer at the time of delivery or as otherwise specified by the customer.
(Added 1994) (Amended 2006)

UR.3.4. Printed Ticket. - The total price, the total quantity of the delivery, and the price per unit shall be printed on any ticket issued by a device of the computing type and containing any one of these values.
(Added 1993)

UR.3.5. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.
(Added 1993)

UR.3.6. Steps After Dispensing. - After delivery to a customer from a retail motor-fuel device:

(a) the starting lever shall be returned to its shutoff position and the zero-set-back interlock engaged; and

(b) the discharge nozzle shall be returned to its designed hanging position unless the primary indicating elements, and recording elements, if the device is equipped and activated to record, have been returned to a definite zero indication.

(Added 1993)

UR.3.7. Return of Indicating and Recording Elements to Zero. - The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero immediately before each delivery. Exceptions to this requirement are totalizers on key-lock-operated or other self-operated dispensers and the primary recording element if the device is equipped to record.
(Added 1995) (Amended 1997)

UR.3.8. Return of Product to Storage, Retail Compressed Natural Gas Dispensers. - Provisions at the site shall be made for returning product to storage or disposing of the product in a safe and timely manner during or following testing operations. Such provisions may include return lines, or cylinders adequate in size and number to permit this procedure.
(Added 1998)

Sec. 5.58. Multiple Dimension Measuring Devices

The status of Section 5.58. Multiple Dimension Measuring Devices was changed from "tentative" to "permanent" effective January 1, 2005.

A. Application

A.1. General. This code applies to dimension and volume measuring devices used for determining the dimensions and/or volume of objects for the purpose of calculating freight, storage, or postal charges based on the dimensions and/or volume occupied by the object.

A.2. Insofar as they are clearly applicable, the provisions of this code apply also to devices designed to make multiple measurements automatically to determine a volume for other applications as defined by General Code paragraph G A.1.

A.3. In addition to the requirements of this code, multiple dimension measuring devices shall meet the requirements of Section 1.10. General Code.

A.4. This Code does not apply to:

(a) devices designed to indicate automatically (with or without value-computing capabilities) the length of fabric passed through the measuring elements (see Sec. 5.50. for Fabric-Measuring Devices);

(b) devices designed to indicate automatically the length of cordage, rope, wire, cable, or similar flexible material passed through the measuring elements (see Sec. 5.51. for Wire- and Cordage-Measuring Devices); or

(c) any linear measure, measure of length, or devices used to measure individual dimensions for the purpose of assessing a charge per unit of measurement of the individual dimension (see Sec. 5.52. for Linear Measures).

A.5. Type Evaluation. The National Type Evaluation Program will accept for type evaluation only those devices that comply with all requirements of this code.

S. Specifications

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

S.1.1. Zero or Ready Indication.

(a) Provision shall be made to indicate or record either a zero or ready condition.

(b) A zero or ready condition may be indicated by other than a continuous digital zero indication, provided that an effective automatic means is provided to inhibit a measuring operation when the device is in an out-of-zero or non-ready condition.

S.1.2. Digital Indications. Indicated and recorded values shall be presented digitally.

S.1.3. Negative Values. Except when in the tare mode, negative values shall not be indicated or recorded.

S.1.4. Dimensions Indication. If in normal operation the device indicates or records only volume, a testing mode shall be provided to indicate dimensions for all objects measured.

S.1.5. Value of Dimension/Volume Division Units. The value of a device division "d" expressed in a unit of dimension shall be presented in a decimal format with the value of the division expressed as:

(a) 1, 2, or 5; or

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

(c) a binary submultiple of a specific inch-pound unit of measure.

Examples: device divisions may be 0.01, 0.02, 0.05; 0.1, 0.2, or 0.5; 1, 2, or 5; 10, 20, 50, or 100; 0.5, 0.25, 0.125, 0.0625, etc.

S.1.5.1. For Indirect Sales. In addition to the values specified in S.1.5., the value of the division may be 0.3 inch and 0.4 inch.

S.1.6. Customer Indications and Recorded Representations. Multiple dimension measuring devices or systems must provide information as specified in Table S.1.6. As a minimum, all devices or systems must be able to meet either Clumn 1 or Clumn II in Table S.1.6.
(Amended 2004)

S.1.7. Minimum Lengths. Except for entries of tare, the minimum length to be measured by a device is 12 divisions. The manufacturer may specify a longer minimum length.
(Amended 2006)

S.1.8. Indications Below Minimum and Above Maximum. When objects are smaller than the minimum dimensions identified in paragraph S.1.7. or larger than any of the maximum dimensions plus 9 d, and/or maximum volume marked on the device plus 9 d, or when a combination of dimensions for the object being measured exceeds the measurement capability of the device, the indicating or recording element shall either:
(Amended 2004)

(a) not indicate or record any usable values, or

(b) identify the indicated or recorded representation with an error indication.
(Amended 2006)

S.1.9. Operating Temperature. An indicating or recording element shall not indicate nor record any usable values until the operating temperature necessary for accurate measuring and a stable zero reference or ready condition has been attained.
(Amended 2006)

S.1.10. Adjustable Components. Adjustable components shall be held securely in adjustment and, except for a zeroing mechanism (when applicable), shall be located within the housing of the element.

Tabls S.1.6. Required Information to be Provided by Multiple Dimension Measuring Systems

Information	Column I[1]	Column II[1]		Column III
	Provided by device	Provided by invoice or other means		Provided by invoice or other means as specified in contractual agreement
		Customer present	Customer not present	
1. Device identification[2]	D or P	P	P	P or A
2. Error message (when applicable)	D or P	P	N/A	N/A
3. Hexahedron* dimensions[3]	D or P	P	P	P or A
4. Hexahedron* volume (if used)[3]	D or P	P	P	P or A
5. Actual weight (if used)[3]	D or P	P	P	P or A
6. Tare (if used)[3]	D or P	N/A	N/A	N/A
7. Hexahedron* measurement statement[4]	D or P or M	P	P	P or G

A = AVAILABLE UPON REQUEST BY CUSTOMER[5]

B = DISPLAYED

G = PUBLISHED GUIDELINES OR CONTRACTS

M = MARKED

N/A = NOT APPLICABLE

P = PRINTED OR RECORDED IN A MEMORY DEVICE AND AVAILABLE UPON REQUEST BY CUSTOMER[5]

Notes:

[1] As a minimum all devices or systems must be able to meet either Column I or Column II.

[2] This is only required in systems where more than one device or measuring element is being used.

[3] Some devices or systems may not utilize all of these values; however, as a minimum either hexahedron dimensions or hexahedron volume must be displayed or printed.

[4] This is an explanation that the dimensions and/or volume shown are those of the smallest hexahedron in which the object that was measured may be enclosed rather than those of the object itself.

[5] The information "available upon request by customer" shall be retained by the party having issued the invoice for at least 30 calendar days after the date of invoicing.

* Hexahedron = An object with six rectangular, plane surfaces (sides)

(Amended 2004)

S.1.11. Provision for Sealing.

(a) A device shall be designed with provision(s) 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 measuring element.

(b) Audit trails shall use the format set forth in Table S.1.11.

S.2. Design of Zero and Tare.

S.2.1. Zero or Ready Adjustment. A device shall be equipped with means by which the zero reference or ready condition can be adjusted, or the zero reference or ready condition shall be automatically maintained. The zero reference or ready control circuits shall be interlocked so that their use is prohibited during measurement operations.

S.2.2. Tare. The tare function shall operate only in a backward direction (that is, in a direction of under-registration) with respect to the zero reference or ready condition of the device. The value of the tare division or increment shall be equal to the division of its respective axis on the device. There shall be a clear indication that tare has been taken.

S.3. Systems with Two or More Measuring Elements. A multiple dimension measuring system with a single indicating or recording element, or a combination indicating-recording element, that is coupled to two or more measuring elements with independent measuring systems, shall be provided with means to prohibit the activation of any measuring element (or elements) not in use, and shall be provided with automatic means to indicate clearly and definitely which measuring element is in use.

Note: This requirement does not apply to individual devices that use multiple emitters/sensors within a device in combination to measure objects in the same measurement field. (Amended 2004)

S.4. Marking Requirements. [See also G-S.1., G-S.4., G-S.5.2.5., G-S.6., G-S.7., G-UR.2.1.1., and G-UR.3.1.]

S.4.1. Multiple Dimension Measuring Devices, Main Elements, and Components of Measuring Devices. Multiple dimension measuring devices, main elements of multiple dimension measuring devices when not contained in a single enclosure for the entire dimension/volume measuring device, and other components shall be marked as specified in Table S.4.1.a. and explained in the accompanying notes, Table S.4.1.b.

S.4.2. Location of Marking Information. The required marking information shall be so located that it is readily observable without the necessity of the disassembly of a part requiring the use of any means separate from the device.

Table S.1.11. Categories of Devices and Methods of Sealing for Multiple Dimension Measuring Systems

Categories of Devices	Method of Sealing
Category 1: No remote configuration.	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. 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.)

Table S.4.1.a. Marking Requirements for Multiple Dimension Measuring Systems				
	Multiple Dimension Measuring Equipment			
To be Marked With	Multiple dimension measuring device and indicating element in same housing	Indicating element not permanently attached to multiple dimension measuring element	Multiple dimension measuring element not permanently attached to the indicating element	Other equipment (1)
Manufacturer's ID	X	X	X	X
Model Designation	X	X	X	X
Serial Number and Prefix	X	X	X	X (2)
Certificate of Conformance Number (8)	X	X	X	X (8)
Minimum and Maximum Dimensions for Each Axis (3)	X	X	X	
Value of Measuring Division, d (for each axis and range)	X	X	X	
Temperature Limits (4)	X	X	X	
Minimum & Maximum Speed (5)	X	X	X	
Special Application (6)	X	X	X	
Limitation of Use (7)	X	X	X	

(Amended 2002 and 2006)

Multiple Dimension Measuring Systems Table S.4.1.b.
Notes for Table S.4.1.a.

1. Necessary to the dimension and/or volume measuring system, but having no effect on the measuring value (e.g., auxiliary remote display, keyboard, etc.).

2. Modules without "intelligence" on a modular system (e.g. printer, keyboard module, etc.) are not required to have serial numbers.

3. The minimum and maximum dimensions (using upper or lower case type) shall be marked. For example:

   Length: min _____ max _____
   Width : min _____ max _____
   Height: min _____ max _____

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

5. Multiple dimension measuring devices, which require that the object or device be moved relative to one another, shall be marked with the minimum and maximum speeds at which the device is capable of making measurements that are within the applicable tolerances shall be marked.

6. A device designed for a special application rather than general use shall be conspicuously marked with suitable words visible to the operator and the customer restricting its use to that application.

7. Materials, shapes, structures, combination of object dimensions, speed, or object orientations that are inappropriate for the device or those that are appropriate.

8. Required only if a Certificate of Conformance has been issued for the equipment.

(Amended 2002, 2004 and 2006)

Sec. 5.59. Electronic Livestock, Meat, and Poultry Evaluation Systems and/or Devices - Tentative Code

This tentative code has only a trial or experimental status and is not intended to be enforced. The requirements are designed for study prior to the development and adoption of a final Code for Livestock, Meat, and Poultry Evaluation Systems and/or Devices. Officials wanting to conduct an official examination of a device or system are advised to see paragraph G-A.3. Special and Unclassified Equipment.

A. Application

A.1. This code applies to electronic devices or systems for measuring the composition or quality constituents of live animals, livestock and poultry carcasses, and individual cuts of meat or a combination thereof for the purpose of determining value.

A.2. See also Sec. 1.10; General Code requirements.

A.3. This code does not apply to scales used to weigh live animals, livestock and poultry carcasses, and individual cuts of meat unless the scales are part of an integrated system designed to measure composition or quality constituents. Scales used in integrated systems must also meet NIST Handbook 44 Section 2.20. requirements.

S. Specifications

S.1. Design and Manufacture. - All design and manufacturing specifications shall comply with ASTM Standard F 2342 Standard Specification for Design and Construction of Composition or Quality Constituent Measuring Devices or Systems.

N. Notes

N.1. Method of Test. - Performance tests shall be conducted in accordance with ASTM Standard F 2343 Test Method for Livestock, Meat, and Poultry Evaluation Devices.

N.2. Testing Standards. - American Society for Testing Materials (ASTM) Standard F 2343 requires device or system users to maintain accurate reference standards that meet the tolerance expressed in NIST Handbook 44 Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied**).**

N.3. Verification. - Device or system users are required to verify and document the accuracy of a device or system on each production day as specified by ASTM Standard F 2341 Standard Practice of User Requirements for Livestock, Meat, and Poultry Evaluation Devices or Systems.

N.3.1. Official Tests. - Officials are encouraged to periodically witness the required "in house" verification of accuracy. Officials may also conduct official tests using the on-site testing standards or other appropriate standards belonging to the jurisdiction with statutory authority over the device or system.

T. Tolerances

T.1. Tolerances on Individual Measurements. – Maintenance and acceptance tolerances on an individual measurement shall be as shown in Table T.1.

Table T.1. Tolerances	
Individual linear measurement of a single constituent	± 1 mm (0.039 in)
Measurement of area	± 1.6 cm^2 (0.25 in^2)
For measurements of other constituents	As specified in ASTM Standard F 2343

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Installation. - All devices and systems shall be installed in accordance with manufacturer's instructions.

UR.2. Maintenance of Equipment.

UR.2.1. Maintenance. - All devices and systems shall be continually maintained in an accurate condition and in accordance with the manufacturer's instructions and ASTM Standard F 2341.

UR.3. Use requirements.

UR.3.1. Limitation of Use. - All devices and systems shall be used to make measurements in a manner specified by the manufacturer.

UR.4. Testing Standards. - The user of a commercial device shall make available to the official with statutory authority over the device testing standards that meet the tolerance expressed in Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied). The accuracy of the testing standards shall be verified annually or on a frequency as required by the official with statutory authority and shall be traceable to the appropriate SI standard.

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Definitions

The specific code to which the definition applies is shown in [brackets] at the end of the definition. Definitions for the General Code [1.10] apply to all codes in Handbook 44.

A

absolute value. The absolute value of a number is the magnitude of that number without considering the positive or negative sign. [2.20]

acceptance test. The first official test of a farm milk tank, at a particular location, in which the tank is accepted as correct. This test applies to newly constructed tanks, relocated used tanks, and recalibrated tanks. [4.43]

accurate. A piece of equipment is "accurate" when its performance or value-that is, its indications, its deliveries, its recorded representations, or its capacity or actual value, etc., as determined by tests made with suitable standards-conforms to the standard within the applicable tolerances and other performance requirements. Equipment that fails so to conform is "inaccurate." (Also see "correct.") [1.10]

analog type. A system of indication or recording in which values are presented as a series of graduations in combination with an indicator, or in which the most sensitive element of an indicating system moves continuously during the operation of the device. [1.10]

animal scale. A scale designed for weighing single heads of livestock. [2.20]
(Amended 1987)

apparent mass versus 8.0 g/cm^3. The apparent mass of an object versus 8.0 g/cm^3 is the mass of material of density 8.0 g/cm^3 that produces exactly the same balance reading as the object when the comparison is made in air with a density of 1.2 mg/cm^3 at 20 °C. [3.30, 3.32]

approval seal. A label, tag, stamped or etched impression, or the like, indicating official approval of a device. (Also see "security seal.") [1.10]

atmospheric pressure. The average atmospheric pressure agreed to exist at the meter at various ranges of elevation, irrespective of variations in atmospheric pressure from time to time. [3.33]

audit trail. An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device. [1.10, 2.20, 3.30]
(Added 1993)

automatic bulk weighing system. A weighing system adapted to the automatic weighing of bulk commodities in successive drafts of predetermined amounts, automatically recording the no-load and loaded weight values and accumulating the net weight of each draft. [2.22]

automatic checkweigher. An automatic weighing system that does not require the intervention of an operator during the weighing process and used to subdivide items of different weights into one or more subgroups, such as identifying packages that have acceptable or unacceptable fill levels according to the value of the difference between their weight and a pre-determined set point. These systems may be used to fill standard packages for compliance with net weight requirements. [2.24]
(Added 2004)

automatic gravimetric filling machine (instrument). A filling machine or instrument that fills containers or packages with predetermined and virtually constant mass of product from bulk by automatic weighing, and which comprises essentially an automatic feeding device or devices associated with one or more weighing unit and the appropriate discharge devices. [2.24]
(Added 2004)

automatic hopper scale. One adapted to the automatic weighing of bulk commodity in successive drafts of pre-determined amounts. (This is not an "automatic-indicating scale" defined below.) [2.20]

automatic-indicating scale. One on which the weights of applied loads of various magnitudes are automatically indicated throughout all or a portion of the weighing range of the scale. (A scale that automatically weighs out commodity in predetermined drafts, such as an automatic hopper scale, a packaging scale, and the like, is not an "automatic-indicating" scale.) [2.20]

automatic temperature or density compensation. The use of integrated or ancillary equipment to obtain from the output of a volumetric meter an equivalent mass, or an equivalent liquid volume at a normal temperature of 70 °F and absolute pressure of 14.696 lb/in^2 absolute. [3.34]

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 and that does not require the intervention of an operator during the weighing process. Examples include, but are not limited to, weigh-labelers and checkweighers. [2.24]
(Added 2004)

automatic zero-setting mechanism (zero-tracking mechanism). See "zero-tracking mechanism." [2.20]
(Amended 2005 and 2006)

automatic zero-setting mechanism (belt-conveyor scale). A zero setting device that operates automatically without intervention of the operator after the belt has been running empty. [2.21]
(Added 2002)

auxiliary indicator. Any indicator other than the master weight totalizer that indicates the weight of material determined by the scale. [2.21]

axle-load scale. A scale permanently installed in a fixed location, having a load-receiving element specially adapted to determine the combined load of all wheels (1) on a single axle or (2) on a tandem axle of a highway vehicle. [2.20]

B

badge. A metal plate affixed to the meter by the manufacturer showing the manufacturer's name, serial number and model number of the meter, and its rated capacity. [3.33]

balance, zero-load. See "zero-load balance." [2.20]

balance indicator. A combination of elements, one or both of which will oscillate with respect to the other, for indicating the balance condition of a nonautomatic indicating scale. The combination may consist of two indicating edges, lines, or points, or a single edge, line, or point and a graduated scale. [2.20]

balancing mechanism. A mechanism (including a balance ball) that is designed for adjusting a scale to an accurate zero-load balance condition. [2.20]

base pressure. The absolute pressure used in defining the gas measurement unit to be used, and is the gauge pressure at the meter plus an agreed atmospheric pressure. [3.33]

basic time rate. The charge for time for all intervals except the initial interval. [5.54]

basic tolerances. Basic tolerances are those tolerances on underregistration and on overregistration, or in excess and in deficiency, that are established by a particular code for a particular device under all normal tests, whether maintenance or acceptance. Basic tolerances include minimum tolerance values when these are specified. Special tolerances, identified as such and pertaining to special tests, are not basic tolerances. [1.10]

basic distance rate. The charge for distance for all intervals except the initial interval. [5.54]

batching meter. A device used for the purpose of measuring quantities of water to be used in a batching operation. [3.36]

beam scale. One on which the weights of loads of various magnitudes are indicated solely by means of one or more weighbeam bars either alone or in combination with counterpoise weights. [2.20]

beam. See "weighbeam." [2.20]

bell prover. A calibrated cylindrical metal tank of the annular type with a scale thereon that, in the downward travel in a surrounding tank containing a sealing medium, displaces air through the meter being proved or calibrated. [3.33]

belt-conveyor. An endless moving belt for transporting material from place to place. [2.21]

belt-conveyor scale. A device that employs a weighing element in contact with a belt to sense the weight of the material being conveyed and the speed (travel) of the material, and integrates these values to produce total delivered weight. [2.21]

belt-conveyor scale systems area. The scale area refers to the scale suspension, weigh idlers attached to the scale suspension, 5 approach (-) idlers, and 5 retreat (+) idlers. [2.21]
(Added 2001)

bench scale. See "counter scale." [2.20]

billed weight. The weight used in the computation of the freight, postal, or storage change, whether actual weight or dimensional weight. [5.58]
(Added 2004)

binary submultiples. Fractional parts obtained by successively dividing by the number 2. Thus, one-half, one fourth, one-eighth, one-sixteenth, and so on, are binary submultiples. [1.10]

built-for-purpose device. Any main device or element which was manufactured with the intent that it be used as, or part of, a weighing or measuring device or system. [1.10]
(Added 2003)

C

calibration parameter. Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy, e.g., span adjustments, linearization factors, and coarse zero adjustments. [2.20, 3.30]
(Added 1993)

car-wash timer. A timer used in conjunction with a coin-operated device to measure the time during which car-wash water, cleaning solutions, or waxing solutions are dispensed. [5.55]

center-reading tank. One so designed that the gauge rod or surface gauge, when properly positioned for use, will be approximately in the vertical axis of the tank, centrally positioned with respect to the tank walls. [4.43]

cereal grain and oil seeds. Agricultural commodities including, but not limited to, corn, wheat, oats, barley, flax, rice, sorghum, soybeans, peanuts, dry beans, safflower, sunflower, fescue seed, etc. [5.56]

chart recorder. See analog or digital recorder.
(Amended 2002)

check rate. A rate of flow usually 20 percent of the capacity rate. [3.33]

checkweighing scale. One used to verify predetermined weight within prescribed limits. [2.20]

class of grain. Hard Red Winter Wheat as distinguished from Hard Red Spring Wheat as distinguished from Soft Red Winter Wheat, etc. [5.56]

clear interval between graduations. The distance between adjacent edges of successive graduations in a series of graduations. If the graduations are "staggered," the interval shall be measured, if necessary, between a graduation and an extension of the adjacent graduation. (Also see "minimum clear interval.") [1.10]

cleared. A taximeter is "cleared" when it is inoperative with respect to all fare indication, when no indication of fare or extras is shown and when all parts are in those positions in which they are designed to be when the vehicle on which the taximeter is installed is not engaged by a passenger. [5.54]

cold-tire pressure. The pressure in a tire at ambient temperature. [5.53, 5.54]

computing type or computing type device. A device designed to indicate, in addition to weight or measure, the total money value of product weighed or measured, for one of a series of unit prices. [1.10]

computing scale. One that indicates the money values of amounts of commodity weighed, at predetermined unit prices, throughout all or part of the weighing range of the scale. [2.20]

concave curve. A change in the angle of inclination of a belt conveyor where the center of the curve is above the conveyor. [2.21]

concentrated load capacity (CLC) (also referred to as Dual Tandem Axle Capacity (DTAC). A capacity rating of a vehicle or axle-load scale, specified by the manufacturer, defining the maximum load applied by a group to two axles with a centerline spaced 4 feet apart and an axle width of 8 feet for which the weighbridge is designed. The concentrated load capacity rating is for both test and use. [2.20]
(Added 1988) (Amended 1991, 1994 and 2003)

configuration parameter. Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component, e.g., division value (increment), sensor range, and units of measurement. [2.20, 3.30]
(Added 1993)

consecutive-car test train. A train consisting of cars weighed on a reference scale, then coupled consecutively and run over the coupled-in-motion railway track scale under test. [2.20]
(Added 1990)

construction-material hopper scale. A scale adapted to weighing construction materials such as sand, gravel, cement, and hot oil. [2.20]

contract sale. A sale where a written agreement exists, prior to the point of sale, in which both buyer and seller have accepted pricing conditions of the sale. Examples include, but are not limited to: e-commerce, club sales, or pre-purchase agreements. Any devices used in the determination of quantity must comply with NIST Handbook 44. [3.30, 3.31, 3.37]
(Added 1993) (Amended 2002)

conventional scale. If the use of conversion tables is necessary to obtain a moisture content value, the moisture meter indicating scale is called "conventional scale." The values indicated by the scale are dimensionless. [5.56]

conversion table. Any table, graph, slide rule, or other external device used to determine the moisture content from the value indicated by the moisture meter. [5.56]

correction table. Any table, graph, slide rule, or other external device used to determine the moisture content from the value indicated by the moisture meter when the indicated value is altered by a parameter not automatically corrected for in the moisture meter (for example, temperature or test weight). [5.56]

convex curve. A change in the angle of inclination of a belt conveyor where the center of the curve is below the conveyor. [2.21]

conveyor stringers. Support members for the conveyor on which the scale and idlers are mounted. [2.21]

correct. A piece of equipment is "correct" when, in addition to being accurate, it meets all applicable specification requirements. Equipment that fails to meet any of the requirements for correct equipment is "incorrect." (Also see "accurate.") [1.10]

counter scale. One that, by reason of its size, arrangement of parts, and moderate nominal capacity, is adapted for use on a counter or bench. Sometimes called "bench scale." [2.20]

counterbalance weight. One intended for application near the butt of a weighbeam for zero-load balancing purposes. [2.20]

counterpoise weight. A slotted or "hanger" weight intended for application near the tip of the weighbeam of a scale having a multiple greater than 1. [2.20]

coupled-in-motion railroad weighing system. A device and related installation characteristics consisting of (1) the associated approach trackage, (2) the scale (i.e., the weighing element, the load-receiving element, and the indicating element with its software), and (3) the exit trackage which permit the weighing of railroad cars coupled in motion. [2.20]
(Added 1992)

crane scale. One with a nominal capacity of 5000 pounds or more designed to weigh loads while they are suspended freely from an overhead, trackmounted crane. [2.20]

cryogenic liquid-measuring device. A system including a liquid-measuring element designed to measure and deliver cryogenic liquids in the liquid state. [3.34]
(Amended 1986 and 2003)

cryogenic liquids. Fluids whose normal boiling point is below 120 kelvin (-243 °F). [3.34]

cubic foot, standard. That quantity of gas that occupies a volume of one cubic foot when under a pressure of 14.73 lb/in^2 absolute and at a temperature of 60 °F. [3.33]

cubic foot, metered. That quantity of gas that occupies one cubic foot when under pressure and temperature conditions existing in the meter. [3.33]

cubic-foot bottle. A metal bottle open at the lower end and so supported that it may be easily raised or lowered in a tank that contains a sealing medium. With the level of the sealing medium properly adjusted, the bottle, when lowered, will displace exactly one cubic foot of air upon coming to rest on the bottom of the tank. The marks on the bottle defining the cubic foot are the bottom of the lower neck and the gauge mark that partially surrounds the gauge glass in the upper neck. [3.33]

cubic foot, gas. The amount of a cryogenic liquid in the gaseous state at a temperature of 70 °F and under a pressure of 14.696 lb/in^2 absolute that occupies one cubic foot. (See NTP.) [3.34]

D

"d", dimension division value. The smallest increment that the device displays for any axis and length of object in that axis. [5.58]
(Added 2004)

D_{max} (maximum load of the measuring range). Largest value of a quantity (mass) which is applied to a load cell during test or use. This value shall not be greater than E_{max}. [2.20]
(Added 2005))

D_{min} (minimum load of the measuring range). Smallest value of a quantity (mass) which is applied to a load cell during test or use. This value shall not be less than E_{min}. [2.20]
(Added 2006)

dairy-product-test scale. A scale used in determining the moisture content of butter and/or cheese or in determining the butterfat content of milk, cream, or butter. [2.20]

decimal submultiples. Parts obtained by successively dividing by the number 10. Thus 0.1, 0.01, 0.001, and so on are decimal submultiples. [1.10]
(Added 2006)

decreasing-load test. A test for automatic-indicating scales only, wherein the performance of the scale is tested as the load is reduced. [2.20]
(Amended 1987)

deficiency. See "excess and deficiency." [1.10]

digital type. A system of indication or recording of the selector type or one that advances intermittently in which all values are presented digitally, or in numbers. In a digital indicating or recording element, or in digital representation, there are no graduations. [1.10]

dimensional weight (or dim, weight). A value computed by dividing the object's volume by a conversion factor; it may be used for the calculation of charges when the value is greater than the actual weight. [5.58]
(Added 2004)

direct sale. A sale in which both parties in the transaction are present when the quantity is being determined. An unattended automated or customer-operated weighing or measuring system is considered to represent the device/business owner in transactions involving an unattended device. [1.10]
(Amended 1993)

discharge line. A rigid pipe connected to the outlet of a measuring device. [3.30]
(Added 1987)

discharge hose. A flexible hose connected to the discharge outlet of a measuring device or its discharge line. [3.30]
(Added 1987)

discrimination (of an automatic-indicating scale). The value of the test load on the load-receiving element of the scale that will produce a specified minimum change of the indicated or recorded value on the scale. [2.20]

dispenser. See motor-fuel device. [3.30]

distributed-car test train. A train consisting of cars weighed first on a reference scale, cars coupled consecutively in groups at different locations within the train, then run over the coupled-in-motion railway track scale under test. The groups are typically placed at the front, middle, and rear of the train. [2.20]
(Added 1990)

dry-hose type. A type of device in which it is intended that the discharge hose be completely drained following the mechanical operations involved in each delivery. (See "dry hose.") [3.30, 3.34]

dry hose. A discharge hose intended to be completely drained at the end of each delivery of product. (See "dry-hose type.") [3.30, 3.31]
(Amended 2002)

dynamic monorail weighing system. A weighing system which employs hardware or software to compensate for dynamic effects from the load or the system that do not exist in a static weighing, in order to provide a stable indication. Dynamic factors may include shock or impact loading, system vibrations, oscillations, etc., and can occur even when the load is not moving across the load receiving element. [2.20]
(Added 1999)

E

E_{max} (maximum capacity). Largest value of a quantity (mass) which may be applied to a load cell without exceeding the mpe. [2.20]
(Added 2005)

e_{min} (minimum verification scale division). The smallest scale division for which a weighing element complies with the applicable requirements. [2.20, 2.21, 2.24]
(Added 1997)

E_{min} (minimum dead load). Smallest value of a quantity (mass) which may be applied to a load cell during test or use without exceeding the mpe. [2.20]
(Added 2006)

electronic link. An electronic connection between the weighing/load receiving or other sensing element and indicating element where one recognizes the other and neither can be replaced without calibration. [2.20]
(Added 2001)

element. A portion of a weighing or measuring device or system which performs a specific function and can be separated, evaluated separately, and is subject to specified full or partial error limits.
(Added 2002)

equal-arm scale. A scale having only a single lever with equal arms (that is, with a multiple of 1), equipped with two similar or dissimilar load-receiving elements (pan, plate, platter, scoop, or the like), one intended to receive material being weighed and the other intended to receive weights. There may or may not be a weighbeam. [2.20]

event counter. A nonresettable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable cali-bration or configuration parameters of a device. [2.20, 3.30]
(Added 1993)

event logger. A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter. [2.20, 3.30]
(Added 1993)

excess and deficiency. When an instrument or device is of such a character that it has a value of its own that can be determined, its error is said to be "in excess" or "in deficiency," depending upon whether its actual value is, respectively, greater or less than its nominal value. (See "nominal.") Examples of instruments having errors "in excess" are: a linear measure that is too long; a liquid measure that is too large; and a weight that is "heavy." Examples of instruments having errors "in deficiency" are: a lubricating-oil bottle that is too small; a vehicle tank compartment that is too small; and a weight that is "light." [1.10]

extras. Charges to be paid by a passenger in addition to the fare, including any charge at a flat rate for the transportation of passengers in excess of a stated number and any charge for the transportation of baggage. [5.54]

F

face. That side of a taximeter on which passenger charges are indicated. [5.54]

face. That portion of a computing-type pump or dispenser which the actual computation of price per unit, delivered quantity, and total sale price. In the case of some electronic displays, this may not be an integral part of the pump or dispenser. [3.30]
(Added 1987)

fare. That portion of the charge for the hire of a vehicle that is automatically calculated by a taximeter through the operation of the distance and/or time mechanism. [5.54]

farm milk tank. A unit for measuring milk or other fluid dairy product, comprising a combination of (1) a stationary or portable tank, whether or not equipped with means for cooling its contents, (2) means for reading the level of liquid in the tank, such as a removable gauge rod or a surface gauge, and (3) a chart for converting level-of-liquid readings to volume; or such a unit in which readings are made on gauge rod or surface gauge directly in terms of volume. Each compartment of a subdivided tank shall, for purposes of this code, be construed to be a "farm milk tank." [4.43]

feeding mechanism. The means for depositing material to be weighed on the belt conveyor. [2.21]

fifth wheel. A commercially-available distance-measuring device which, after calibration, is recommended for use as a field transfer standard for testing the accuracy of taximeters and odometers on rented vehicles. [5.53, 5.54]

fifth-wheel test. A distance test similar to a road test, except that the distance traveled by the vehicle under test is determined by a mechanism known as a "fifth-wheel" that is attached to the vehicle and that independently measures and indicates the distance. [5.53, 5.54]

flag. A plate at the end of the lever arm or similar part by which the operating condition of a taximeter is controlled and indicated. [5.54]

fractional bar. A weighbeam bar of relatively small capacity for obtaining indications intermediate between notches or graduations on a main or tare bar. [2.20]

ft^3/h. Cubic feet per hour. [3.33]

G

gasoline gallon equivalent (GGE). Gasoline gallon equivalent (GGE) means 5.660 pounds of natural gas. [3.37] (Added 1994)

gasoline liter equivalent (GLE). Gasoline liter equivalent (GLE) means 0.678 kilograms of natural gas. [3.37] (Added 1994)

gauge pressure. The difference between the pressure at the meter and the atmospheric pressure (psi). [3.33]

gauge rod. A graduated, "dip-stick" type of measuring rod designed to be partially immersed in the liquid and to be read at the point where the liquid surface crosses the rod. [4.43]

gauging. The process of determining and assigning volumetric values to specific graduations on the gauge or gauge rod that serve as the basis for the tank volume chart. [4.43]

graduated interval. The distance from the center of one graduation to the center of the next graduation in a series of graduations. (Also see "value of minimum graduated interval.") [1.10]

graduation. A defining line, or one of the lines defining the subdivisions of a graduated series. The term includes such special forms as raised or indented or scored reference "lines" and special characters such as dots. (Also see "main graduation" and "subordinate graduation.") [1.10]

grain hopper scale. One adapted to the weighing of individual loads of varying amounts of grain. [2.20]

grain moisture meter. Any device indicating either directly or through conversion tables and/or correction tables the moisture content of cereal grains and oil seeds. Also termed "moisture meter." [5.56]

grain sample. That portion of grain or seed taken from a bulk of grain or seed to be bought or sold and used to determine the moisture content of the bulk. [5.56]

grain-test scale. A scale adapted to weighing grain samples used in determining moisture content, dockage, weight per unit volume, etc. [2.20, 5.56]

gravity discharge. A type of device designed for discharge by gravity. [3.30, 3.31 (Amended 2002)]

H

head pulley. The pulley at the discharge end of the belt conveyor. The power drive to drive the belt is generally applied to the head pulley. [2.21]

hired. A taximeter is "hired" when it is operative with respect to all applicable indications of fare or extras. The indications of fare include time and distance where applicable unless qualified by another indication of "Time Not Recording" or an equivalent expression. [5.54]

hopper scale. A scale designed for weighing bulk commodities whose load-receiving element is a tank, box, or hopper mounted on a weighing element. (Also, see "automatic hopper scale," "grain hopper scale," and "construction-material hopper scale.") [2.20]

I

idler space. The center-to-center distance between idler rollers measured parallel to the belt. [2.21]

minimum totalized load. The least amount of weight for which the scale is considered to be performing accurately. [2.21]

minimum tolerances. Minimum tolerances are the smallest tolerance values that can be applied to a scale. Minimum tolerances are determined on the basis of the value of the minimum graduated interval or the nominal or reading face capacity of the scale. (See also definition for basic tolerances.) [2.20]

minimum clear interval. The shortest distance between adjacent graduations when the graduations are not parallel. (Also see "clear interval.") [3.30]

minimum delivery. The least amount of weight that is to be delivered as a single weighment by a belt-conveyor scale system in normal use. [2.21]

moisture content (wet basis). The mass of water in a grain or seed sample (determined by the reference method) divided by the mass of the grain or seed sample expressed as a percentage (%). [5.56]

money-operated type. A device designed to be released for service by the insertion of money, or to be actuated by the insertion of money to make deliveries of product. [1.10]

money drop. An increment of fare indication. The "initial money drop" is the first increment of fare indication following activation of the taximeter. [5.54]

motor-fuel device or motor-fuel dispenser or retail motor- fuel device. A device designed for the measurement and delivery of liquids used as fuel for internal-combustion engines. The term "motor-fuel dispenser" means the same as "motor-fuel device"; the term "retail motor-fuel device" applies to a unique category of device (see definition of "retail device"). [3.30]

motor fuel. Liquid used as fuel for internal-combustion engines. [3.30]

multi-interval scale. A scale having one weighing range which is divided into partial weighing ranges (segments), each with different scale intervals, with each partial weighing range (segment) determined automatically according to the load applied, both on increasing and decreasing loads. [2.20]
(Added 1995) (Amended 2005 and 2006)

multi-jet water meter. A water meter in which the moving element takes the form of a multiblade rotor mounted on a vertical spindle within a cylindrical measuring chamber. The liquid enters the measuring chamber through several tangential orifices around the circumference and leaves the measuring chamber through another set of tangential orifices placed at a different level in the measuring chamber. These meters register by recording the revolutions of a rotor set in motion by the force of flowing water striking the blades. [3.36]
(Added 2003)

multi-revolution scale. An automatic-indicating scale having a nominal capacity that is a multiple of the reading-face capacity and that is achieved by more than one complete revolution of the indicator. [2.20]

multiple cell application load cell. A load cell intended for use in a weighing system which incorporates more than one load cell. A multiple cell application load cell is designated with the letter "M" or the term "Multiple." (See also "single cell application load cell.") [2.20]
(Added 1999)

multiple of a scale. In general, the multiplying power of the entire system of levers or other basic weighing elements. (On a beam scale, the multiple of the scale is the number of pounds on the load-receiving element that will be counterpoised by 1 pound applied to the tip pivot of the weighbeam.) [2.20]

multiple range scale. A scale having two or more weighing ranges with different maximum capacities and different scale intervals for the same load receptor, each range extending from zero to its maximum capacity. [2.20]
(Added 1995)

multiple-tariff taximeter. One that may be set to calculate fares at any one of two or more rates. [5.54]

multiple. An integral multiple; that is, a result obtained by multiplying by a whole number. (Also see "multiple of a scale.") [1.10]

N

natural gas. A gaseous fuel, composed primarily of methane, that is suitable for compression and dispensing into a fuel storage container(s) for use as an engine fuel. [3.37]
(Added 1994)

NBP. Normal boiling point of a cryogenic liquid at 14.696 lb/in^2 absolute. [3.34]

n_{max} (maximum number of scale divisions). The maximum number of scale divisions for which a main element or load cell complies with the applicable requirements. The maximum number of scale divisions permitted for an installation is limited to the lowest n_{max} marked on the scale indicating element, weighing element, or load cell. [2.20, 2.21, 2.24]
(Added 1997)

no-load reference value. A positive weight value indication with no load in the load-receiving element (hopper) of the scale. (Used with automatic bulk-weighing systems and certain single draft, manually-operated receiving hopper scales installed below grade and used to receive grain.) [2.20]

nominal. Refers to "intended" or "named" or "stated," as opposed to "actual." For example, the "nominal" value of something is the value that it is supposed or intended to have, the value that it is claimed or stated to have, or the value by which it is commonly known. Thus, "1-pound weight," "1-gallon measure," "1-yard indication," and "500-pound scale" are statements of nominal values; corresponding actual values may be greater or lesser. (See nominal capacity of a scale.) [1.10]

nominal capacity. The nominal capacity of a scale is (a) the largest weight indication that can be obtained by the use of all of the reading or recording elements in combination, including the amount represented by any removable weights furnished or ordinarily furnished with the scale, but excluding the amount represented by any extra removable weights not ordinarily furnished with the scale, and excluding also the capacity of any auxiliary weighing attachment not contemplated by the original design of the scale, and excluding any fractional bar with a capacity less than 2-1/2 percent of the sum of the capacities of the remaining reading elements, or (b) the capacity marked on the scale by the manufacturer, whichever is less. (Also see "nominal capacity, batching scale"; "nominal capacity, hopper scale.") [2.20]

nominal capacity, batching scale. The nominal capacity of a batching scale is the capacity as marked on the scale by the scale manufacturer, or the sum of the products of the volume of each of the individual hoppers, in terms of cubic feet, times the weight per cubic foot of the heaviest material weighed in each hopper, whichever is less. [2.20]

nominal capacity, hopper scale. The nominal capacity of a hopper scale is the capacity as marked on the scale by the scale manufacturer, or the product of the volume of the hopper in bushels or cubic feet times the maximum weight per bushel or cubic foot, as the case may be, of the commodity normally weighed, whichever is less. [2.20]

non-automatic checkweigher. A weighing instrument that requires the intervention of an operator during the weighing process, used to subdivide items of different weights into one or more subgroups, such as identifying packages that have acceptable or unacceptable fill levels according to the value of the difference between their weight and a pre-determined set point. [2.24]

> **Notes:** Determining the weighing result includes any intelligent action of the operator that affects the result, such as deciding and taking an action when an indication is stable or adjusting the weight of the weighed load.
>
> Deciding that the weighing result is acceptable means making a decision regarding the acceptance of each weighing result on observing the indication or releasing a print out. The weighing process allows the operator to take an action which influences the weighing result in the case where the weighing result is not acceptable.

(Added 2004)

non-automatic weighing instrument. A weighing instrument or system that requires the intervention of an operator during the weighing process to determine the weighing result or to decide that it is acceptable. [2.20, 2.24]

> **Notes:** Determining the weighing result includes any intelligent action of the operator that affects the result, such as deciding and taking an action when an indication is stable or adjusting the weight of the weighed load.
>
> Deciding that the weighing result is acceptable means making a decision regarding the acceptance of each weighing result on observing the indication or releasing a print out. The weighing process allows the operator to take an action which influences the weighing result in the case where the weighing result is not acceptable.

(Added 2004) (Amended 2005)

nonretroactive. "Nonretroactive" requirements are enforceable after the effective date for:

1. devices manufactured within a State after the effective date;
2. both new and used devices brought into a State after the effective date; and
3. devices used in noncommercial applications which are placed into commercial use after the effective date.

Nonretroactive requirements are not enforceable with respect to devices that are in commercial service in the State as of the effective date or to new equipment in the stock of a manufacturer or a dealer in the State as of the effective date. *(Nonretroactive requirements are printed in italic type.)* [1.10]
(Amended 1989)

nose-iron. A slide-mounted, manually-adjustable pivot assembly for changing the multiple of a lever. [2.20]

notes. A section included in each of a number of codes, containing instructions, pertinent directives, and other specific information pertaining to the testing of devices. Notes are primarily directed to weights and measures officials. [1.10]

NTP density and volume correction factor. A correction factor used to adjust the liquid volume of a cryogenic product at the time of measurement to the gas equivalent at NTP. [3.34]

zero-load reference (belt-conveyor scales). A zero-load reference value represents no load on a moving conveyor belt. This value can be either; a number representing the electronic load cell output, a percentage of full scale capacity, or other reference value that accurately represents the no load condition of a moving conveyor belt. The no load reference value can only be updated after the completion of a zero load test. [2.21]
(Added 2002)

zero-setting mechanism. Means provided to attain a zero balance indication with no load on the load-receiving element. Three types of these mechanisms are: [2.20]

> **automatic zero-setting mechanism (zero-tracking).** Automatic means provided to maintain zero balance indication without the intervention of an operator. [2.20]
> (Amended 2005)
>
> **manual zero-setting mechanism.** Nonautomatic means provided to attain a zero balance indication by the direct operation of a control. [2.20]
>
> **semiautomatic zero-setting mechanism.** Automatic means provided to attain a direct zero balance indication requiring a single initiation by an operator. [2.20]

zero-setting mechanism (belt-conveyor scale). A mechanism enabling zero totalization to be obtained over a whole number of belt revolutions. [2.21, 2.23]
(Added 2002)

zero-tracking mechanism. Automatic means provided to maintain zero balance indication without the intervention of an operator. [2.20]
(Added 2005) (Amended 2006)

zone of uncertainty. The zone between adjacent increments on a digital device in which the value of either of the adjacent increments may be displayed. [2.20]

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Units		Apothecaries Drams	Avoirdupois Ounces	Apothecaries or Troy Ounces	Apothecaries or Troy Pounds
1 grain	=	0.016 666 67	0.002 285 714	0.002 083 333	0.000 173 611 1
1 apoth. scruple	=	0.333 333 3	0.045 714 29	0.041 666 67	0.003 472 222
1 pennyweight	=	0.4	0.054 857 14	0.05	0.004 166 667
1 avdp. dram	=	0.455 729 2	0.062 5	0.56 966 15	0.004 747 179
1 apoth. dram	=	1	0.137 142 9	0.125	0.010 416 67
1 avdp. ounce	=	7.291 667	1	0.911 458 3	0.075 954 86
1 apoth. or troy ounce	=	8	1.097 143	1	0.083 333 333
1 apoth. or troy pound	=	96	13.165 71	12	1
1 avdp. pound	=	116.666 7	16	14.583 33	1.215 278
1 milligram	=	0.000 257 206 0	0.000 035 273 96	0.000 032 150 75	0.000 002 679 229
1 gram	=	0.257 206 0	0.035 273 96	0.032 150 75	0.002 679 229
1 kilogram	=	257.206 0	35.273 96	32.150 75	2.679 229

Units		Avoirdupois Pounds	Milligrams	Grams	Kilograms
1 grain	=	0.000 142 857 1	64.798 91	0.064 798 91	0.000 064 798 91
1 apoth. scruple	=	0.002 857 143	1295.978 2	1.295 978 2	0.001 295 978 2
1 pennyweight	=	0.003 428 571	1555.173 84	1.555 173 84	0.001 555 173 84
1 avdp. dram	=	0.003 906 25	1771.845 195 312 5	1.771 845 195 312 5	0.001 771 845 195 312 5
1 apoth. dram	=	0.008 571 429	3887.934 6	3.887 934 6	0.003 887 934 6
1 avdp. ounce	=	0.062 5	28 349.523 125	28.349 523 125	0.028 349 523 125
1 apoth. or troy ounce	=	0.068 571 43	31 103.476 8	31.103 476 8	0.031 103 476 8
1 apoth. or troy pound	=	0.822 857 1	373 241.721 6	373.241 721 6	0.373 241 721 6
1 avdp. pound	=	1	453 592.37	453.592 37	0.453 592 37
1 milligram	=	0.000 002 204 623	1	0.001	0.000 001
1 gram	=	0.002 204 623	1000	1	0.001
1 kilogram	=	2.204 623	1 000 000	1000	1

5. Tables of Equivalents

In these tables it is necessary to differentiate between the "international foot" and the "survey foot" (see Section 2.2.4.); the survey foot is underlined.

When the name of a unit is enclosed in brackets (thus, [1 hand] . . .), this indicates (1) that the unit is not in general current use in the United States, or (2) that the unit is believed to be based on "custom and usage" rather than on formal authoritative definition.

Equivalents involving decimals are, in most instances, rounded off to the third decimal place except where they are exact, in which cases these exact equivalents are so designated. The equivalents of the imprecise units "tablespoon" and "teaspoon" are rounded to the nearest milliliter.

UNITS OF LENGTH

angstrom (Å)[10]	0.1 nanometer (exactly) 0.000 1 micrometer (exactly) 0.000 000 1 millimeter (exactly) 0.000 000 004 inch
1 cable's length	120 fathoms (exactly) 720 <u>feet</u> (exactly) 219 meters
1 centimeter (cm)	0.393 7 inch
1 chain (ch) (Gunter's or surveyors)	66 <u>feet</u> (exactly) 20.116 8 meters
1 decimeter (dm)	3.937 inches
1 dekameter (dam)	32.808 feet
1 fathom	6 <u>feet</u> (exactly) 1.828 8 meters
1 foot (ft)	0.304 8 meter (exactly)
1 furlong (fur)	10 chains (surveyors) (exactly) 660 <u>feet</u> (exactly) 1/8 U.S. statute mile (exactly) 201.168 meters
[1 hand]	4 inches
1 inch (in)	2.54 centimeters (exactly)
1 kilometer (km)	0.621 mile
1 league (land)	3 U.S. statute miles (exactly) 4.828 kilometers
1 link (li) (Gunter's or surveyors)	0.66 <u>foot</u> (exactly) 0.201 168 meter
1 meter (m)	39.37 inches 1.094 yards
1 micrometer	0.001 millimeter (exactly) 0.000 039 37 inch
1 mil	0.001 inch (exactly) 0.025 4 millimeter (exactly)
1 mile (mi) (U.S. statute)[11]	5280 <u>feet</u> survey (exactly) 1.609 kilometers
1 mile (mi) (international)	5280 feet international (exactly)
1 mile (mi) (international nautical)[12]	1.852 kilometers (exactly) 1.151 survey miles

[10] The angstrom is basically defined as 10^{-10} meter.

[11] The term "statute mile" originated with Queen Elizabeth I who changed the definition of the mile from the Roman mile of 5000 feet to the statute mile of 5280 feet. The international mile and the U.S. statute mile differ by about 3 millimeters although both are defined as being equal to 5280 feet. The international mile is based on the international foot (0.3048 meter) whereas the U.S. statute mile is based on the survey foot (1200/3937 meter).

[12] The international nautical mile of 1 852 meters (6 076.115 49 feet) was adopted effective July 1, 1954, for use in the United States. The value formerly used in the United States was 6 080.20 feet = 1 nautical (geographical or sea) mile.

1 millimeter (mm)----------	0.039 37 inch
1 nanometer (mm)----------	0.001 micrometer (exactly) 0.000 000 039 37 inch
1 point (typography)----------	0.013 837 inch (exactly) 1/72 inch (approximately) 0.351 millimeter
1 rod (rd), pole, or perch----------	16 1/2 feet (exactly) 5.029 2 meters
1 yard (yd)----------	0.914 4 meter (exactly)

UNITS OF AREA

1 acre[13]----------	43 560 square feet (exactly) 0.405 hectare
1 are----------	119.599 square yards 0.025 acre
1 hectare----------	2.471 acres
[1 square (building)]----------	100 square feet
1 square centimeter (cm2)-------	0.155 square inch
1 square decimeter (dm^2)--------	15.500 square inches
1 square foot (ft^2)----------	929.030 square centimeters
1 square inch (in^2)----------	6.451 6 square centimeters (exactly)
1 square kilometer (km^2)--------	247.104 acres 0.386 square mile
1 square meter (m^2)----------	1.196 square yards 10.764 square feet
1 square mile (mi^2)----------	258.999 hectares
1 square millimeter (mm^2)------	0.002 square inch
1 square rod (rd^2),---------- sq pole, or sq perch	25.293 square meters
1 square yard (yd^2)----------	0.836 square meter

UNITS OF CAPACITY OR VOLUME

1 barrel (bbl), liquid----------	31 to 42 gallons[14]
1 barrel (bbl), standard for fruits,----- vegetables, and other dry commodities, except cranberries	7056 cubic inches 105 dry quarts 3.281 bushels, struck measure
1 barrel (bbl), standard,---------- cranberry	5 826 cubic inches 86 45/64 dry quarts 2.709 bushels, struck measure
1 bushel (bu) (U.S.)---------- struck measure	2150.42 cubic inches (exactly) 35.239 liters
[1 bushel, heaped (U.S.)]----------	2 747.715 cubic inches 1.278 bushels, struck measure[15]
[1 bushel (bu) (British Imperial)----- (struck measure)]	2219.36 cubic inches 1.032 U.S. bushels, struck measure
1 cord (cd) (firewood)----------	128 cubic feet (exactly)
1 cubic centimeter (cm^3)----------	0.061 cubic inch
1 cubic decimeter (dm^3)----------	61.024 cubic inches
1 cubic foot (ft^3)----------	7.481 gallons 28.316 cubic decimeters

[13] The question is often asked as to the length of a side of an acre of ground. An acre is a unit of area containing 43 560 square feet. It is not necessarily square, or even rectangular. But, if it is square, then the length of a side is equal to $\sqrt{43560\ \text{ft}^2} = 208.710\ \text{ft}$ (not exact)

[14] There are a variety of "barrels" established by law or usage. For example, Federal taxes on fermented liquors are based on a barrel of 31 gallons; many State laws fix the "barrel for liquids" as 31-1/2 gallons; one State fixes a 36-gallon barrel for cistern measurement; Federal law recognizes a 40-gallon barrel for "proof spirits"; by custom, 42 gallons comprise a barrel of crude oil or petroleum products for statistical purposes, and this equivalent is recognized "for liquids" by four States.

[15] Frequently recognized as 1-1/4 bushels, struck measure.

General Tables of Units of Measurement

1 cubic inch (in^3)----------	0.554 fluid ounce 4.433 fluid drams 16.387 cubic centimeters
1 cubic meter (m^3)----------	1.308 cubic yards
1 cubic yard (yd^3)----------	0.765 cubic meter
1 cup, measuring----------	8 fluid ounces (exactly) 237 milliliters 1/2 liquid pint (exactly)
1 dekaliter (daL)----------	2.642 gallons 1.135 pecks
1 dram, fluid (or liquid)---------- (fl dr or ƒ 3) (U.S.)	0.226 cubic inch 1/8 fluid ounce (exactly) 3.697 milliliters 1.041 British fluid drachms
[1 drachm, fluid (fl dr)]---------- (British)]	0.961 U.S. fluid dram 0.217 cubic inch 3.552 milliliters
1 gallon (gal) (U.S.)----------	231 cubic inches (exactly) 3.785 liters 0.833 British gallon 128 U.S. fluid ounces (exactly)
[1 gallon (gal) ---------- (British Imperial)]	277.42 cubic inches 1.201 U.S. gallons 4.546 liters 160 British fluid ounces (exactly)
1 gill (gi)----------	7.219 cubic inches 4 fluid ounces (exactly) 0.118 liter
1 hectoliter (hL)----------	26.418 gallons 2.838 bushels
1 liter (1 cubic decimeter---------- exactly)	1.057 liquid quarts 0.908 dry quart 61.025 cubic inches
1 milliliter (mL)----------	0.271 fluid dram 16.231 minims 0.061 cubic inch
1 ounce, fluid (or liquid)---------- (fl oz or ƒ 3) (U.S.)	1.805 cubic inches 29.573 milliliters 1.041 British fluid ounces
[1 ounce, fluid (fl oz)---------- (British)]	0.961 U.S. fluid ounce 1.734 cubic inches 28.412 milliliters
1 peck (pk)----------	8.810 liters
1 pint (pt), dry----------	33.600 cubic inches 0.551 liter
1 pint (pt), liquid----------	28.875 cubic inches (exactly) 0.473 liter
1 quart (qt), dry (U.S.)----------	67.201 cubic inches 1.101 liters 0.969 British quart
1 quart (qt), liquid (U.S.)----------	57.75 cubic inches (exactly) 0.946 liter 0.833 British quart
[1 quart (qt) (British)]----------	69.354 cubic inches 1.032 U.S. dry quarts 1.201 U.S. liquid quarts
1 tablespoon, measuring----------	3 teaspoons (exactly) 15 milliliters 4 fluid drams 1/2 fluid ounce (exactly)
1 teaspoon, measuring----------	1/3 tablespoon (exactly) 5 milliliters 1-1/3 fluid drams[16]
1 water ton (English)----------	270.91 U.S. gallons 224 British Imperial gallons (exactly)

[16] The equivalent "1 teaspoon = 1-1/3 fluid drams" has been found by the Bureau to correspond more closely with the actual capacities of "measuring" and silver teaspoons than the equivalent "1 teaspoon = 1 fluid dram," which is given by a number of dictionaries.

CHAPTER 4. REGISTRATION OF SERVICE AGENCIES FOR COMMERCIAL WEIGHING AND MEASURING DEVICES

4080. Application. This chapter applies to any person performing duties as a service agency or service agent.

NOTE: Authority cited: Section 12027, Business and Professions Code. Reference: Section 12531, Business and Professions Code.

4081. Registration of Service Agencies and Service Agents Required.

(a) Each service agency shall forward to the Department, with the appropriate registration fee (Business and Professions Code Section 12535), the name and license number of a service agent within 30 days of hiring by the service agency.

(b) The registration of a service agent shall expire upon termination of employment with the service agency.

(c) Each service agency shall notify the Department within 30 days of the termination of a service agent.

NOTE: Authority cited: Section 12027, Business and Professions Code. Reference: Sections 12531 and 12532, Business and Professions Code.

4082. Fees.

(a) Any fee not paid when due, or sent by mail and post-marked five days or more after the due date, is overdue.

(b) To any fee that is overdue and paid within 30 days of the due date, a penalty equal to 30 percent of the amount of the original fee shall be added.

(c) To any fee paid more than 30 days after the due date, a penalty equal to 50 percent of the amount of the original fee shall be added.

NOTE: Authority cited: Section 12027, Business and Professions Code. Reference: Section 12535, Business and Professions Code.

4083. Examinations/Licenses.

(a) **License Application:** Applicants for a service agent license must provide their name, address, and proof of identity by means of a picture identification. At the time of examination, applicants shall pay an examination fee of $35. Applicants renewing an existing license shall also provide the current license number.

(b) **Examination Procedure:** Written examinations will be administered by a county weights and measures office or the Division of Measurement Standards. The examination shall be administered according to instructions issued by the Division of Measurement Standards "Administration of Service Agent Examination" (Est. 8/00), which is incorporated by reference. Applicants will be advised of the results on the day of the examination. The proctor and applicant shall certify under penalty of perjury that the examination was given in accordance with the procedures specified.

(c) **Qualification for a License:** An applicant must receive a minimum score of 70 percent to qualify for a service agent license. Successful applicants will be provided with a service agent license at that time. Except as provided for in subsection (g), such license shall be valid for a period of five years from date of issue.

(d) **Retention and Notification:** Examination information will be retained in the county or state office where administered for a period of five years. County offices will provide to the Division of Measurement Standards within 30 days the names of individuals to whom service agent licenses have been issued.

(e) **Failure and Reexamination:** Applicants failing to receive a passing score may schedule an appointment to be reexamined. The fee specified in subsection (a) shall be paid each time the examination is taken. Reexaminations are subject to all the above conditions.

(f) **Replacement License:** A lost or mutilated license may only be replaced by the Division of Measurement Standards. Before a replacement license is issued, the licensee must provide a written request including the following information: the name as it appeared on the original license, the licensee's signature and current address, and a fee of $10. If a licensee satisfies these requirements, a replacement license will be issued.

(g) **License Renewal:** To maintain a service agent license, applicants may take the examination on or up to 90 days before the expiration date of their current license. Successful applicants will receive a five year extension of the license period.

NOTE: Authority cited: Section 12027, Business and Professions Code. Reference: Section 12540, Business and Professions Code.

4084. Authority for Service Agency to Place a Device into Service. Pursuant to Business and Professions Code Sections 12509 and 12532(d), a service agency may perform any of the following:

(a) place a correct device into service,

(b) remove an "out-of-order" notice to perform the service, and must replace the notice if the device can not be corrected, or

(c) remove an "out-of-order" notice from a corrected device and place it into service.

NOTE: Authority cited: Sections 12027, 12532(b) and 12509, Business and Professions Code. Reference: Sections 12531 and 12532, Business and Professions Code.

4085. Responsibility of a Service Agency.

(a) Each service agency shall be responsible for compliance with the following:

(1) **Repairing or Placing Devices into Service.** - Each service agency shall place into service, upon installation or following repair, a device in such a manner that it meets all the requirements of Division 5 of the California Business and Professions Code and all the requirements of the California Code of Regulations, Title 4, Division 9. Weighing or measuring devices which are not "correct", as defined by Section 12500(c) of the Business and Professions Code, shall not be placed into service.

(2) **Notice to County Sealer of Repairing or Placing of Device into Service by Service Agency. -** Each service agency shall notify the county sealer of the repairing or placing in service of any device. The notice shall be in writing, and transmitted to the county sealer within the 24-hour period following the repair, except as provided by Business and Professions Code Section 12515(b).

The notification shall include the following minimum identifying information;

(i) Name and address of service agency.
(ii) Location of device(s). Name and address, including if available the unique identifier used by the business (e.g., pump or checkstand number).
(iii) Name of service agent.
(iv) Date of adjustment, repair, placing, or replacing into service.
(v) Name of device manufacturer(s).
(vi) Model designation(s) and serial number(s) of the device(s).
(vii) On new installations, the National Institute of Standards and Technology or National Conference on Weights and Measures Certificate of Conformance number(s) for each separately approved component or device, if marked on the component or device.

(3) **Security Seal.** - Service agents shall replace a security seal on any adjustment mechanism where the seal was required to be removed for service, repair, or installation. Before placing a device into service, service agents shall install a security seal on any adjustment mechanism designed to be sealed.

(4) **Identification of Service Agency Work. -** Service agents shall identify their work on each device by applying an adhesive tag or label in a conspicuous location on the device. The adhesive tag or label shall show the name, registration number and business telephone number of the service agency, the license number of the service agent performing the work, and the date. Any security seal required pursuant to Section 12107 of the California Business and Professions Code shall show the registration number of the service agency and the year the security seal was placed on the device.

(5) **Certificate of Accuracy of Standards.** - A service agency shall, on request from a sealer, show a copy of the certification of accuracy for the standards used to place a device into service.

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Sections 12515(a), 12531, 12532(h) and 12533, Business and Professions Code.

4086. Certification of Service Agency Standards. Each service agency shall have its standards certified at the service agency's expense. Standards shall be tested and certified by either the Department or other metrology laboratories traceable to the National Institute of Standards and Technology (NIST). These laboratories include those in county weights and measures programs, industry, and other states that have been approved, certified, or accredited by NIST, or the Department in accordance with criteria established by NIST, or by other appropriate national or international accrediting organizations. The standards shall be certified as often as the Department deems necessary, based upon a review of supporting statistical data resulting from previous certifications, but in no event shall the period of time between certifications exceed 10 years. In the absence of supporting statistical data, standards shall be certified at least every two years.