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# Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

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## Section 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, composition (limited to meat and poultry), constituent values (limited to grain), 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.

(Amended 2008)

- (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 on or after the effective date for devices:

- (a) manufactured within a state after the effective date;
- (b) both new and used, brought into a state after the effective date;
- (c) used in noncommercial applications which are placed into commercial use after the effective date; and

- (d) undergoing type evaluation, including devices that have been modified to the extent that a new NTEP Certificate of Conformance (CC) is required.

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 and 2011)

**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)

- (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)

*(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 identifier for not-built-for-purpose, software-based devices;*

*[Nonretroactive as of January 1, 2004]*

(Added 2003)

*(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 National Type Evaluation Program (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 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.).*

*[Nonretroactive as of January 1, 2003]*

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, 2001, 2003, 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. Devices and Main Elements Remanufactured as of January 1, 2002.** – All devices and main elements remanufactured as of January 1, 2002, shall be clearly and permanently marked for the purposes of identification with the following information:

(a) the name, initials, or trademark of the last remanufacturer or distributor; and

(b) the remanufacturer’s or distributor’s model designation, if different than the original model designation.

(Added 2001) (Amended 2011)

**Note:** Definitions for “manufactured device,” “repaired device,” and “repaired element” are included (along with definitions for “remanufactured device” and “remanufactured element”) in Appendix D, Definitions.

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

(Amended 2007)

**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 and 1986)

**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 to recorded representations. All recorded values shall be printed digitally.

(Amended 1975)

**G-S.5.6.1. Indicated and Recorded Representation of Units.** – Appropriate abbreviations.

- (a) For equipment manufactured on or after January 1, 2008, the appropriate defining symbols are shown in NIST Special Publication SP 811 “Guide for the Use of International System of Units (SI)” and Handbook 44 Appendix C – General Tables of Units of Measurement.

**Note:** SP 811 can be viewed or downloaded at <http://physics.nist.gov/cuu/pdf/sp811.pdf> or by going to <http://www.nist.gov/pml/wmd/index.cfm> and selecting Weights and Measures Publications and the link to Special Publications, Guide for the Use of the International System of Units (SI) (SP 811).

(Added 2007)

- (b) The appropriate defining symbols on equipment manufactured prior to January 1, 2008, with limited character sets are shown in Table 1. Representation of SI Units on Equipment Manufactured Prior to January 1, 2008, with Limited Character Sets.

(Added 1977) (Amended 2007)



<b>Table 1. Representation of SI Units on Equipment Manufactured Prior to January 1, 2008, with Limited Character Sets</b>				
<b>Name of Unit</b>	<b>International Symbol (common use symbol)</b>	<b>Representation</b>		
		<b>Form I</b>	<b>Form II</b>	
		<b>(double case)</b>	<b>(single case lower)</b>	<b>(single case upper)</b>
<b>Base SI Units</b>				
meter	m	m	m	M
kilogram	kg	kg	kg	KG
<b>Derived SI Units</b>				
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
<b>Other Units</b>				
liter	l or L	L	l	L
gram	g	g	g	G
metric ton	t	t	tne	TNE
bar	bar	bar	bar	BAR

(Table Amended 2007)

**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, push buttons, 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 and 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 semi-automatic 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 and 1993)

**G-S.8.1. Multiple Weighing or Measuring Elements that Share a Common Provision for Sealing.** – A change to any metrological parameter (calibration or configuration) of any weighing or measuring element shall be individually identified.

[Nonretroactive as of January 1, 2010]

**Note:** For devices that utilize an electronic form of sealing, in addition to the requirements in G-S.8.1., any appropriate audit trail requirements in an applicable specific device code also apply. Examples of identification of a change to the metrological parameters of a weighing or measuring element include, but are not limited to:

- (1) a broken, missing, or replaced physical seal on an individual weighing, measuring, or indicating element or active junction box;
  - (2) a change in a calibration factor or configuration setting for each weighing or measuring element;
  - (3) a display of the date of calibration or configuration event for each weighing or measuring element; or
  - (4) counters indicating the number of calibration and/or configuration events for each weighing or measuring element.
- (Added 2007)

### **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. 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 equipment:

- (a) to be put into commercial use for the first time;
  - (b) that has been placed in commercial service within the preceding 30 days and is being officially tested for the first time;
  - (c) that has been returned to commercial service following official rejection for failure to conform to performance requirements and is being officially tested for the first time within 30 days after corrective service;
  - (d) that is being officially tested for the first time within 30 days after major reconditioning or overhaul; and
  - (e) undergoing type evaluation.
- (Amended 1989)

**G-T.2. Maintenance Tolerances.** – Maintenance tolerances shall apply to equipment in actual use, except as provided in G-T.1. Acceptance Tolerances.

**G-T.3. Application.** – Tolerances “in excess” and tolerances “in deficiency” shall apply to errors in excess and to errors in deficiency, respectively. Tolerances “on overregistration” and tolerances “on underregistration” shall apply to errors in the direction of overregistration and of underregistration, respectively. (Also see Appendix D, Definitions.)

**G-T.4. For Intermediate Values.** – For a capacity, indication, load, value, etc., intermediate between two capacities, indications, loads, values, etc., listed in a table of tolerances, the tolerances prescribed for the lower capacity, indication, load, value, etc., shall be applied.

## **G-UR. User Requirements**

### **G-UR.1. Selection Requirements.**

**G-UR.1.1. Suitability of Equipment.** – Commercial 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 weighing capacity (for weighing devices), its computing capability (for computing devices), its rate of flow (for liquid-measuring devices), the character, number, size, and location of its indicating or recording elements, and the value of its smallest unit and unit prices.

(Amended 1974)

**G-UR.1.2. Environment.** – Equipment shall be suitable for the environment in which it is used including, but not limited to, the effects of wind, weather, and RFI.

(Added 1976)

**G-UR.1.3. Liquid-Measuring Devices.** – To be suitable for its application, the minimum delivery for liquid-measuring devices shall be no less than 100 divisions, except that the minimum delivery for retail analog devices shall be no less than 10 divisions. Maximum division values and tolerances are stated in the specific codes.

(Added 1995)

### **G-UR.2. Installation Requirements.**

**G-UR.2.1. Installation.** – A device shall be installed in accordance with the manufacturer's instructions, including any instructions marked on the device. A device installed in a fixed location shall be installed so that neither its operation nor its performance will be adversely affected by any characteristic of the foundation, supports, or any other detail of the installation.

**G-UR.2.1.1. Visibility of Identification.** – Equipment shall be installed in such a manner that all required markings are readily observable.

(Added 1978)

**G-UR.2.2. Installation of Indicating or Recording Element.** – A device shall be so installed that there is no obstruction between a primary indicating or recording element and the weighing or measuring element; otherwise there shall be convenient and permanently installed means for direct communication, oral or visual, between an individual located at a primary indicating or recording element and an individual located at the weighing or measuring element. [Also see G-UR.3.3. Position of Equipment.]

**G-UR.2.3. Accessibility for Inspection, Testing, and Sealing Purposes.** – A device shall be located, or such facilities for normal access thereto shall be provided, to permit:

- (a) inspecting and testing the device;
- (b) inspecting and applying security seals to the device; and
- (c) readily bringing the testing equipment of the weights and measures official to the device by customary means and in the amount and size deemed necessary by such official for the proper conduct of the test.

Otherwise, it shall be the responsibility of the device owner or operator to supply such special facilities, including such labor as may be needed to inspect, test, and seal the device, and to transport the testing equipment to and from the device, as required by the weights and measures official.

(Amended 1991)

### **G-UR.3. Use Requirements.**

**G-UR.3.1. Method of Operation.** – Equipment shall be operated only in the manner that is obviously indicated by its construction or that is indicated by instructions on the equipment.

**G-UR.3.2. Associated and Nonassociated Equipment.** – A device shall meet all performance requirements when associated or nonassociated equipment is operated in its usual and customary manner and location.

(Added 1976)

**G-UR.3.3. Position of Equipment.** – A device or system equipped with a primary indicating element and used in direct sales, except for prescription scales, shall be positioned so that its indications may be accurately read and the weighing or measuring operation may be observed from some reasonable “customer” and “operator” position. The permissible distance between the equipment and a reasonable customer and operator position shall be determined in each case upon the basis of the individual circumstances, particularly the size and character of the indicating element.

(Amended 1974 and 1998)

**G-UR.3.4. Responsibility, Money-Operated Devices.** – Money-operated devices, other than parking meters, shall have clearly and conspicuously displayed thereon, or immediately adjacent thereto, adequate information detailing the method for the return of monies paid when the product or service cannot be obtained. This information shall include the name, address, and phone number of the local responsible party for the device. This requirement does not apply to devices at locations where employees are present and responsible for resolving any monetary discrepancies for the customer.

(Amended 1977 and 1993)

### **G-UR.4. Maintenance Requirements.**

**G-UR.4.1. Maintenance of Equipment.** – All equipment in service and all mechanisms and devices attached thereto or used in connection therewith shall be continuously maintained in proper operating condition throughout the period of such service. Equipment in service at a single place of business found to be in error predominantly in a direction favorable to the device user (Also see the Introduction, Section Q) shall not be considered “maintained in a proper operating condition.”

(Amended 1973 and 1991)

**G-UR.4.2. Abnormal Performance.** – Unstable indications or other abnormal equipment performance observed during operation shall be corrected and, if necessary, brought to the attention of competent service personnel.

(Added 1976)

**G-UR.4.3. Use of Adjustments.** – Weighing elements and measuring elements that are adjustable shall be adjusted only to correct those conditions that such elements are designed to control, and shall not be adjusted to compensate for defective or abnormal installation or accessories or for badly worn or otherwise defective parts of the assembly. Any faulty installation conditions shall be corrected, and any defective parts shall be renewed or suitably repaired, before adjustments are undertaken. Whenever equipment is adjusted, the adjustments shall be so made as to bring performance errors as close as practicable to zero value.

**G-UR.4.4. Assistance in Testing Operations.** – If the design, construction, or location of any device is such as to require a testing procedure involving special equipment or accessories or an abnormal amount of labor,

such equipment, accessories, and labor shall be supplied by the owner or operator of the device as required by the weights and measures official.

**G-UR.4.5. Security Seal.** – A security seal shall be appropriately affixed to any adjustment mechanism designed to be sealed.

**G-UR.4.6. Testing Devices at a Central Location.**

- (a) When devices in commercial service require special test facilities, or must be removed from service for testing, or are routinely transported for the purpose of use (e.g., vehicle-mounted devices and devices used in multiple locations), the official with statutory authority may require that the devices be brought to a central location for testing. The dealer or owner of these devices shall provide transportation of the devices to and from the test location.
- (b) When the request for removal and delivery to a central test location involves devices used in submetering (e.g., electric, hydrocarbon vapor, or water meters), the owner or operator shall not interrupt the utility service to the customer or tenant except for the removal and replacement of the device. Provisions shall be made by the owner or operator to minimize inconvenience to the customer or tenant. All replacement or temporary meters shall be tested and sealed by a weights and measures official or bear a current, valid approval seal prior to use.

(Added 1994)

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## Section 3.33. Hydrocarbon Gas Vapor-Measuring Devices<sup>1</sup>

### A. Application

**A.1. General.** – 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, and 1991)

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

- (a) Liquid-measuring devices used for dispensing liquefied petroleum gases in liquid form. (Also see Section 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. (Also see Section 3.37. Code for Mass Flow Meters.) (Added 1994)

**A.3. Additional Code Requirements.** – In addition to the requirements of this code, Hydrocarbon Gas Vapor-Measuring Devices shall meet the requirements of Section 1.10. General Code.

### S. Specifications

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

##### S.1.1. 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 and 1991)

**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:

- (a)  $1 \text{ m}^3$  ( $1000 \text{ dm}^3$ ) ( $100 \text{ ft}^3$ ) when the maximum rated gas capacity is less than  $280 \text{ m}^3/\text{h}$  ( $10\,000 \text{ ft}^3/\text{h}$ );
- (b)  $10 \text{ m}^3$  ( $1000 \text{ ft}^3$ ) when the maximum rated gas capacity is  $280 \text{ m}^3/\text{h}$  ( $10\,000 \text{ ft}^3/\text{h}$ ) up to, but not including,  $1700 \text{ m}^3/\text{h}$  ( $60\,000 \text{ ft}^3/\text{h}$ ); and
- (c)  $100 \text{ m}^3$  ( $10\,000 \text{ ft}^3$ ) when the maximum rated gas capacity is  $1700 \text{ m}^3/\text{h}$  ( $60\,000 \text{ ft}^3/\text{h}$ ) or more.

(Amended 1972, 1988, and 1991)

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<sup>1</sup>Title changed 1986.



**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<sup>3</sup>/h (10 000 ft<sup>3</sup>/h) gas capacity shall be equipped with a proving indicator measuring 0.025, 0.05, 0.1, 0.2, or 0.25 m<sup>3</sup> per revolution, (1, 2, 5, or 10 ft<sup>3</sup> per revolution) for testing the meter. Devices with larger capacities shall be equipped as follows:

- (a) Devices rated 280 m<sup>3</sup> (10 000 ft<sup>3</sup>) up to but not including 1700 m<sup>3</sup>/h (60 000 ft<sup>3</sup>/h) gas capacity shall be equipped with a proving indicator measuring not greater than 1 m<sup>3</sup> (100 ft<sup>3</sup>) per revolution.
- (b) Devices rated 1700 m<sup>3</sup>/h (60 000 ft<sup>3</sup>/h) gas capacity or more shall be equipped with a proving indicator measuring not more than 10 m<sup>3</sup> (1000 ft<sup>3</sup>) per revolution.

The test circle of the proving indicator shall be divided into ten 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.

**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 the:

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

- (b) 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.** – The vapor should be measured at a normal gauge pressure (psig) of:  
(Amended 1991)

- (a) 2740 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) 1744 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 Pa or psia
- GP = Gauge pressure in Pa or psig
- NGP = Normal gauge pressure in Pa 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 6900 Pa (1 psig) or more, the delivery pressure shall be maintained within ± 1725 Pa (± 0.25 psig).

Pressure variations due to regulator lock off shall not increase the operating pressure by more than 25 %.  
(Amended 1980, 1984, and 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.

**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.

## S.4. Marking Requirements.

**S.4.1. Limitations 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 rated gas capacity in cubic meters per hour or cubic feet per hour.

**S.4.3. Temperature Compensation.** – If a device is equipped with an automatic temperature compensator, this shall be indicated on the badge or immediately adjacent to the badge of the device and on the register.

**S.4.4. Badge.** – A badge affixed in a prominent position on the front of the device shall show the manufacturer's name, serial number and model number of the device, and capacity rate of the device for the particular products that it was designed to meter as recommended by the manufacturer.

## N. Notes

**N.1. Test Medium.** – The device shall be tested with air or the product to be measured.

(Amended 1991)

**N.2. Temperature and Volume Change.** – Care should be exercised to reduce to a minimum any volume changes. The temperature of the air, bell-prover oil, and the meters under test should be within 1 °C (2 °F) of one another. The devices should remain in the proving room for at least 16 hours before starting any proving operations to allow the device temperature to approximate the temperature of the proving device.

**N.3. Test Drafts.** – Except for low-flame tests, test drafts shall be at least equal to one complete revolution of the largest capacity proving indicator, and shall in no case be less than 0.05 m<sup>3</sup> or 2 ft<sup>3</sup>. All flow rates shall be controlled by suitable outlet orifices.

(Amended 1973 and 1991)

<b>Table 1.</b>			
<b>Capacity of Low-Flow Test Rate Orifices with Respect to Device Capacity</b>			
<b>Metric Units</b>		<b>Inch-pound Units</b>	
<b>Rated Capacity</b>	<b>Low-Flow Test Rate</b>	<b>Rated Capacity</b>	<b>Low-Flow Test Rate</b>
Up to and including 7 m <sup>3</sup> /h	0.007 m <sup>3</sup> /h	Up to and including 250 ft <sup>3</sup> /h	0.25 ft <sup>3</sup> /h
Over 7 m <sup>3</sup> /h up to and including 14 m <sup>3</sup> /h	0.014 m <sup>3</sup> /h	Over 250 ft <sup>3</sup> /h up to and including 500 ft <sup>3</sup> /h	0.50 ft <sup>3</sup> /h
Over 14 m <sup>3</sup> /h	0.1 % of capacity rate	Over 500 ft <sup>3</sup> /h	0.1 % of capacity rate

**N.4. Test Procedures.** – If a device is equipped with an automatic temperature compensator, the proving device reading shall be corrected to 15 °C (60 °F), using an approved table.

(Amended 1972)

**N.4.1. Normal Tests.** – The normal test of a device shall be made at a rate not to exceed the capacity rate given on the badge of the meter.

(Amended 1988)

**N.4.1.1. Automatic Temperature Compensation.** – If a device is equipped with an automatic temperature compensator, the quantity of the test draft indication of the standard shall be corrected to 15 °C (60 °F).

**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 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. Normal Tests shall be considered a special test.

**N.4.2.1. Slow Test.** – The device shall be tested at a rate not less than 20 % of the marked capacity rate, or (at the check rate) not less than the minimum flow rate if marked on the device, whichever is less.

(Amended 1988)

**N.4.2.2. Low-Flame Test.** – The device shall be tested at an extremely low-flow rate as given in Table 1. The test shall consist of passing air at a pressure of 375 Pa (1.5 in water column) through the meter for not less than 60 minutes. The meter shall continue to advance at the conclusion of the test period.

(Amended 1990 and 1991)

**N.4.2.3. Pressure Regulation Test.** – On devices operating at a pressure of 6900 Pa (1 psig) or more, a pressure regulation test shall be made at both the minimum and maximum use load to determine the proper operation of the regulator and the proper sizing of the piping and dispensing equipment. These tests may include a test of 24 hours during which the pressure is recorded.

(Added 1984)

**N.5. Temperature Correction.** – Corrections shall be made for any changes in volume resulting from the difference in air temperatures between time of passage through the device and time of volumetric determination in the proving device.

**N.6. Frequency of Test.** – A hydrocarbon gas vapor-measuring device shall be tested before installation and allowed to remain in service for 10 years from the time last tested without being retested, unless a test is requested by:

- (a) the purchaser of the product being metered;
- (b) the seller of the product being metered; or
- (c) the weights and measures official.

## T. Tolerances

**T.1. Tolerance Values on Normal Tests and on Special Tests Other Than Low-Flame Tests.** – Maintenance and acceptance tolerances for normal and special tests for hydrocarbon gas vapor-measuring devices shall be as shown in Table T.1. Accuracy Classes and Tolerances for Hydrocarbon Gas Vapor-Measuring Devices.

(Amended 1981 and 2003)

<b>Table T.1. Accuracy Classes and Tolerances for Hydrocarbon Gas Vapor-Measuring Devices</b>				
<b>Accuracy Class</b>	<b>Application</b>	<b>Acceptance Tolerance</b>	<b>Maintenance Tolerance</b>	
3.0	Gases at low pressure (for example, LPG vapor)	<b>Overregistration</b>	1.5 %	1.5 %
		<b>Underregistration</b>	3.0 %	3.0 %

(Added 2003)

**T.2. 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 0.9 % and the results of each test shall be within the applicable tolerance. (See also N.4.1.2. Repeatability Test.)

(Added 2002)

## **UR. User Requirements**

### **UR.1. Installation Requirements.**

**UR.1.1. Capacity Rate.** – A device shall be so installed that the actual maximum flow rate will not exceed the capacity rate except for short durations. 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. Leakage.** – The metering system shall be installed and maintained as a pressure-tight and leak-free system.

### **UR.2. Use Requirements.**

**UR.2.1. Automatic Temperature Compensation.** – A compensated device may not be replaced with an uncompensated device without the written approval of the weights and measures authority having jurisdiction over the device.

**UR.2.2. Invoices.** – A customer purchasing hydrocarbon gas measured by a vapor meter shall receive from the seller an invoice for each billing period. The invoice shall clearly and separately show the following:

- (a) The opening and closing meter readings and the dates of those readings.
- (b) The altitude correction factor.
- (c) The total cubic meters (cubic feet) billed, corrected for elevation.
- (d) The charge per cubic meter (cubic foot) after correction for elevation.
- (e) All periodic charges independent of the measured gas, such as meter charges, meter reading fees, service charges or a minimum charge for a minimum number of cubic meters (cubic feet).
- (f) The total charge for the billing period.

If the vapor meter is equipped with an automatic temperature compensator, or any other means are used to compensate for temperature, the invoice shall show that the volume has been adjusted to the volume at 15 °C (60 °F).

(Amended 1988 and 1991)

**UR.2.3. Correction for Elevation.** – The metered volume of gas shall be corrected for changes in the atmospheric pressure with respect to elevation to the standard pressure of 101.56 kPa (14.73 psia). The appropriate altitude correction factor from Table 2M. Corrections for Altitude, Metric Units or Table 2. Corrections for Altitude, Inch-Pound Units shall be used. (The table is modified from NIST Handbook 117.)

(Amended 1988)

Elevation correction factors (ACF) were obtained by using the following equation:

$$ACF = \frac{GP \text{ of gas} + AAP}{\text{base pressure}}$$

Where:

GP = gauge pressure  
 AAP = assumed atmospheric pressure  
 base pressure = 101.560 kPa = 14.73 psia

2740 Pa = 11 in of water column = 0.397 psig

1744 Pa = 7 in of water column = 0.253 psig

(Added 1988)

**UR.2.4. Valves and Test Tee.** – All gas meter installations shall be provided with a shut-off valve located adjacent to and on the inlet side of the meter. In the case of a single meter installation utilizing a liquefied petroleum gas tank, the tank service valve may be used in lieu of the shut-off valve. All gas meter installations shall be provided with a test tee located adjacent to and on the outlet side of the meter.

[Nonretroactive as of January 1, 1990]

(Added 1989)

**UR.2.5. Use of Auxiliary Heated Vaporizer Systems.** – Automatic temperature compensation shall be used on hydrocarbon gas vapor meters equipped with an auxiliary heated vaporizer system unless there is sufficient length of underground piping to provide gas at a uniform temperature to the meter inlet. When required by weights and measures officials, a thermometer well (appropriately protected against freezing) shall be installed immediately up-stream of the meter.

(Added 1990)

<b>Table 2M. Corrections for Altitude, Metric Units</b>							
<b>Elevation (meters)</b>			<b>Altitude Correction Factor</b>		<b>Assumed Atmospheric Pressure</b>	<b>Assumed Atmospheric Pressure Plus Gauge Pressure</b>	
			<b>2.74 kPa Gauge Pressure</b>	<b>1.74 kPa Gauge Pressure</b>	<b>(kPa)</b>	<b>2.74 kPa Gauge Pressure</b>	<b>1.74 kPa Gauge Pressure</b>
	– 50 to	120	1.02	1.01	100.85	103.59	102.58
above	120 to	300	1.00	0.99	98.82	101.56	100.54
above	300 to	470	0.98	0.97	96.79	99.53	98.51
above	470 to	650	0.96	0.95	94.76	97.50	96.48
above	650 to	830	0.94	0.93	92.73	95.47	94.45
above	830 to	1020	0.92	0.91	90.70	93.44	92.42
above	1020 to	1210	0.90	0.89	88.66	91.40	90.39
above	1210 to	1400	0.88	0.87	86.63	89.37	88.36
above	1400 to	1590	0.86	0.85	84.60	87.34	86.33
above	1590 to	1790	0.84	0.83	82.57	85.31	84.29
above	1790 to	2000	0.82	0.81	80.54	83.28	82.26
above	2000 to	2210	0.80	0.79	78.51	81.25	80.23
above	2210 to	2420	0.78	0.77	76.48	79.22	78.20
above	2420 to	2640	0.76	0.75	74.45	77.19	76.17
above	2640 to	2860	0.74	0.73	72.41	75.15	74.15
above	2860 to	3080	0.72	0.71	70.38	73.12	72.12
above	3080 to	3320	0.70	0.69	68.35	71.09	70.08
above	3320 to	3560	0.68	0.67	66.32	69.06	68.05
above	3560 to	3800	0.66	0.65	64.29	67.03	66.01
above	3800 to	4050	0.64	0.63	62.26	65.00	63.98
above	4050 to	4310	0.62	0.61	60.23	62.97	61.95
above	4310 to	4580	0.60	0.59	58.20	60.94	59.92

Elevation (feet)	Altitude Correction Factor		Assumed Atmospheric Pressure	Assumed Atmospheric Pressure Plus Gauge Pressure		
	11 inch WC	7 inch WC	(psia)	11 inch WC (psia)	7 inch WC (psia)	
	– 150 to 400	1.02	1.01	14.64	15.04	14.89
above	400 to 950	1.00	0.99	14.35	14.74	14.60
above	950 to 1 550	0.98	0.97	14.05	14.45	14.30
above	1 550 to 2 100	0.96	0.95	13.76	14.15	14.01
above	2 100 to 2 700	0.94	0.93	13.46	13.86	13.71
above	2 700 to 3 300	0.92	0.91	13.17	13.56	13.42
above	3 300 to 3 950	0.90	0.89	12.87	13.27	13.12
above	3 950 to 4 550	0.88	0.87	12.58	12.97	12.83
above	4 550 to 5 200	0.86	0.85	12.28	12.68	12.53
above	5 200 to 5 850	0.84	0.83	11.99	12.38	12.24
above	5 850 to 6 500	0.82	0.81	11.69	12.09	11.94
above	6 500 to 7 200	0.80	0.79	11.40	11.79	11.65
above	7 200 to 7 900	0.78	0.77	11.10	11.50	11.35
above	7 900 to 8 600	0.76	0.75	10.81	11.20	11.06
above	8 600 to 9 350	0.74	0.73	10.51	10.91	10.76
above	9 350 to 10 100	0.72	0.71	10.22	10.61	10.47
above	10 100 to 10 850	0.70	0.69	9.92	10.32	10.17
above	10 850 to 11 650	0.68	0.67	9.63	10.03	9.88
above	11 650 to 12 450	0.66	0.65	9.33	9.73	9.58
above	12 450 to 13 250	0.64	0.63	9.04	9.44	9.29
above	13 250 to 14 100	0.62	0.61	8.75	9.14	9.00
above	14 100 to 14 950	0.60	0.59	8.45	8.85	8.70



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## Section 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.

**A.3. Additional Code Requirements.** – In addition to the requirements of this code, Mass Flow Meters shall meet the requirements of Section 1.10. General Code.

### 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  $8.0 \text{ g/cm}^3$ . The volume indication shall be based on the mass measurement and an automatic means to determine and correct for 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.” (Also 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.

**S.1.3.3. Maximum Value of Quantity-Value Divisions.**

- (a) The maximum value of the quantity-value division for liquids shall not be greater than 0.2 % 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 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 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)

**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 liquefied 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 liquefied gases shall be 10:1 or greater.

**S.3.2. Adjustment Means.** – An assembly shall be provided with the 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 %.

**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. Categories of Device and Methods of Sealing]\**

*[\*Nonretroactive as of January 1, 1995]*

(Amended 1992, 1995, and 2006)

<b>Table S.3.5. Categories of Device and Methods of Sealing</b>	
<b>Categories of Device</b>	<b>Methods of Sealing</b>
<p><b>Category 1:</b> <i>No remote configuration capability.</i></p>	<p><i>Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.</i></p>
<p><b>Category 2:</b> <i>Remote configuration capability, but access is controlled by physical hardware.</i></p> <p><i>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.</i></p>	<p><i>[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.]*</i></p> <p><i>[*Nonretroactive as of January 1, 1996]</i></p>
<p><b>Category 3:</b> <i>Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).</i></p> <p><i>[Nonretroactive as of January 1, 1995]</i></p> <p><i>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.</i></p> <p><i>[Nonretroactive as of January 1, 2001]</i></p>	<p><i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)</i></p>

*[Nonretroactive as of January 1, 1995]*

(Table Added 1995) (Amended 1995, 1998, 1999, 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 and 1997)

**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;
- (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.

(Added 1993)

#### **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. (Also see N.1. Minimum Measured Quantity.)

**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 shutoff valve on the discharge side of the instrument 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 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;
- (d) nonrepetitive serial number;
- (e) *the accuracy class of the meter as specified by the manufacturer consistent with Table T.2. Accuracy Classes for Mass Flow Meter Applications Covered in NIST Handbook 44, Section 3.37 Mass Flow Meters;\**  
*[\*Nonretroactive as of January 1, 1995]*  
 (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  $-10\text{ }^{\circ}\text{C}$  to  $+50\text{ }^{\circ}\text{C}$ ;
- (i) minimum measured quantity; and
- (j) product limitations, if applicable.

**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 compressed 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)

**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 pre-printed 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. (Also see T.3. Repeatability.)

**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 five 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. Normal Tests 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. (Also see Table T.2. Accuracy Classes and Tolerances for Mass Flow Meters.)

(Added 1999)

**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. Accuracy Classes and Tolerances for Mass Flow Meters.

(Amended 1994 and 1999)

<b>Table T.2. Accuracy Classes and Tolerances for Mass Flow Meters</b>				
<b>Accuracy Class</b>	<b>Application or Commodity Being Measured</b>	<b>Acceptance Tolerance</b>	<b>Maintenance Tolerance</b>	<b>Special Tolerance</b>
0.3	- Large capacity motor-fuel dispensers (maximum discharge flow rates greater than 100 L/min or 25 gal/min) - Heated products (other than asphalt) at temperatures greater than 50 °C (122 °F) - Asphalt at temperatures equal to or below 50 °C (122 °F) - Loading rack meters - Vehicle-tank meters - Home heating oil - Milk and other food products - 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 at temperatures greater than 50 °C (122 °F)	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 where the minimum delivery is less than 700 kg or 1500 lb	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, 2001, and 2013)

**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 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. (Also see N.6.1.1. Repeatability Tests.)

(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)

## 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)

**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)