

### Section 3

	<b>Page</b>
3.30. Liquid-Measuring Devices .....	3-3
3.31. Vehicle-Tank Meters .....	3-25
3.32. LPG and Anhydrous Ammonia Liquid-Measuring Devices .....	3-37
3.33. Hydrocarbon Gas Vapor-Measuring Devices .....	3-47
3.34. Cryogenic Liquid-Measuring Devices .....	3-57
3.35. Milk Meters .....	3-67
3.36. Water Meters .....	3-75
3.37. Mass Flow Meters .....	3-81
3.38. Carbon Dioxide Liquid-Measuring Devices .....	3-93

**Note:** In this section of Handbook 44, the reference temperature for the temperature compensation of refined petroleum products is shown as "15 °C (60 °F)." Although these values are not exact equivalents, they reflect industry usage when the SI and inch-pound units are used in measurements.

THIS PAGE INTENTIONALLY LEFT BLANK

## Section 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 Section 3.31. Code for Vehicle-Tank Meters),
- (b) devices used for dispensing liquefied petroleum gases (see Section 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,
- (e) devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges, or
- (f) mass flow meters (see Section 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 (0.1 gal) on devices with a maximum rated flow rate of 750 L/min (200 gal/min) or less;
- (b) 5 L (1 gal) on devices with a maximum rated flow of more than 750 L/min (200 gal/min);
- (c) 5 L (1 gal) on meters with a rated maximum flow rate of 375 L/min (100 gal/min) or more used for jet fuel aviation refueling systems.

(Added 2007)

This requirement does not apply to manually operated devices equipped with stops or stroke-limiting means.

(Amended 1983, 1986, and 2007)

**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 % 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).**

**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)

<b>Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers</b>				
<b>Unit Price</b>		<b>Money Value Division</b>	<b>Maximum Allowable Variation</b>	
<b>From</b>	<b>To and including</b>		<b>Design Test</b>	<b>Field Test</b>
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¢	± 2½¢	± 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 L for devices indicating in metric units and 0.01 gal 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 and enforceable 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.** – *Except for aviation refueling applications, 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 and 2007)

**S.1.6.5.6. Display of Quantity and Total Price, Aviation Refueling Applications.**

(a) *The quantity shall be displayed throughout the transaction.*

(b) *The total price shall also be displayed under one of the following conditions:*

i. *The total price can appear on the face of the dispenser or through a controller adjacent to the device.*

- ii. *If a device is designed to continuously compute and display the total price, then the total price shall be computed and displayed throughout the transaction for the quantity delivered.*
- (c) *The total price and quantity shall be displayed for at least 5 minutes or until the next transaction is initiated by using controls on the device or other customer-activated controls.*
- (d) *A printed receipt shall be available and shall include, at a minimum, the total price, quantity, and unit price.*

*[Nonretroactive as of January 1, 2008]*

(Added 2007)

**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.**

**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 1 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 or interchange 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 and enforceable as of January 1, 1995]*

(Amended 1991, 1993, 1995, 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]*

(Added 2004)

**Note 1:** 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 of 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.

(Note 1, Added 2004)

**Note 2:** Paragraph S.2.2.1. Multiple Measuring Elements with a Single Provision for Sealing will be removed in the 2010 Edition of Handbook 44 when General Code paragraph G-S.8.1. Multiple Weighing or Measuring Elements with a Single Provision for Sealing becomes effective.

(Note 2, Added 2007)

<b>Table S.2.2. 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>  <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 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.)</i></p>

*[Nonretroactive as of January 1, 1995]*

(Table Added 1993) (Amended 1995, 1998, 1999, and 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 - Wholesale Devices.** – 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.

[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) automatically become inoperable, 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.

An outlet that may be opened for purging or draining the measuring system or for recirculating, if recirculation is required in order to maintain the product in a deliverable state, shall be permitted only when the system is measuring food products, agri-chemicals, biodiesel, or biodiesel blends. Effective automatic 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, 1996, and 2007)

**S.3.2. Exceptions.** – The provisions of S.3.1. Diversion of Measured Liquid 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 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.3.7. 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 % of the maximum discharge rate.

**S.4.3.2. Temperature Compensation.** – If a device is equipped with an automatic temperature compensation, 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 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.

**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 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 2002) (Amended 2004)

**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)

## 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 L (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 1 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 1 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.** – On wholesale devices equipped with automatic temperature-compensating systems, normal tests shall be conducted:

- (a) by comparing the compensated volume indicated or recorded to the actual delivered volume corrected to 15 °C (60 °F); and

- (b) 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 (a) and (b) may be performed as a single test.

(Amended 1987)

**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.

**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 % 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 % 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. Money-Value Computations, 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. Accuracy Classes for Liquid Measuring Devices Covered in NIST Handbook 44, Section 3.30.



<b>Table T.2. Accuracy Classes for Liquid Measuring Devices Covered in NIST Handbook 44, Section 3.30</b>				
<b>Accuracy Class</b>	<b>Application</b>	<b>Acceptance Tolerance</b>	<b>Maintenance Tolerance</b>	<b>Special Test Tolerance<sup>1</sup></b>
0.3	<ul style="list-style-type: none"> <li>- Petroleum products delivered from large capacity (flow rates greater than 115 L/min or 30 gpm)** devices, including motor-fuel devices</li> <li>- Heated products (other than asphalt) at or greater than 50 °C</li> <li>- Asphalt at or below a temperature of 50 °C</li> <li>- All other liquids not shown in the table where the typical delivery is over 200 L (50 gal)</li> </ul>	0.2 %	0.3 %	0.5 %
0.3A	<ul style="list-style-type: none"> <li>- Asphalt at temperatures greater than 50 °C</li> </ul>	0.3 %	0.3 %	0.5 %
0.5*	<ul style="list-style-type: none"> <li>- Petroleum products delivered from small capacity (at 4 L/min (1 gpm) through 115 L/min or 30 gpm)** motor-fuel devices</li> <li>- Agri-chemical liquids</li> <li>- All other applications not shown in the table where the typical delivery is ≤ 200 L (50 gal)</li> </ul>	0.3 %	0.5 %	0.5 %
1.1	<ul style="list-style-type: none"> <li>- Petroleum products and other normal liquids from devices with flow rates** less than 1 gpm.</li> <li>- Devices designed to deliver less than 1 gal</li> </ul>	0.75 %	1.0 %	1.25 %

\* For test drafts ≤ 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<sup>3</sup> plus 1 in<sup>3</sup> per indicated gallon.

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

<sup>1</sup> Special test tolerances are not applicable to retail motor fuel dispensers.

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

(Added 2002) (Amended 2006)

**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. This tolerance does not apply to the test of the automatic temperature-compensating system. See also N.4.1.2. Repeatability Tests.

(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 % for mechanical automatic temperature-compensating systems; and
- (b) 0.1 % 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]*

(Added 1987) (Amended 1992, 1996, and 2002)

## **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) (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. Display of Unit Price, 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)

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)

**UR.3.4. Printed Ticket.** – The total price, the total volume of the delivery, and the price per liter or gallon shall be shown, either printed by the device 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)

THIS PAGE INTENTIONALLY LEFT BLANK

### Liquid-Measuring Device Code Index

Acceptance.....	16, 17, 18	Money-value divisions .....	6, 7
Adjustable element .....	9	Motor-fuel device .....	17, 18, 19
Advancement .....	4	Nonautomatic .....	20
Agreement.....	7, 8	Normal tests.....	14
Agri-chemical .....	3, 4, 17	Operating requirements .....	5, 8
Antidrain means.....	13	Parallax.....	5
Automatic ....	9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21	Power loss.....	5
Automatic temperature compensation.....	11	Price contract sales .....	6, 7, 8, 19
Automatic temperature compensators.....	11, 13, 20	Primary indicating element.....	3, 5, 13, 19, 20
Automatic temperature-compensating systems.....	11, 14, 17	Printed ticket.....	20
Auxiliary elements.....	7	Product identity .....	6, 8, 19
Blend.....	6, 19	Pump-discharge unit.....	12
Clear interval.....	4	Quantity .....	5, 6, 8, 14, 16
Clearance .....	5	Recording element.....	3, 4, 5, 8, 11, 13, 19, 20
Computing device .....	6, 7, 19	Repeatability.....	15, 17
Directional flow valves .....	10	Retail devices.....	5, 13, 14, 15
Discharge hose.....	12, 13, 18	Retail motor-fuel device .....	3, 11, 15, 18, 20
Discharge lines.....	12	Retail motor-fuel dispensers .....	14
Discharge rate .....	13, 14, 15, 18	Seal .....	9, 10, 11, 12
Diversion.....	18	Sealing .....	9, 10, 11
Dry-hose .....	12	Security.....	9, 11, 12
Fleet sales.....	6, 7, 8, 19	Slow flow meters.....	5, 14, 15
Grade.....	6, 7, 19	Special tests .....	15
Graduations.....	4, 5, 8, 13	Stop mechanism.....	10
Gravity-discharge unit .....	12	Temperature compensation.....	11, 13
Index of an indicator .....	4, 5	Temperature compensators .....	11, 13, 20
Indicating element.....	4, 5, 11	Temperature correction.....	16
Indicators .....	4	Temperature determination.....	11, 20
Installation requirements.....	18	Temperature-compensating systems.....	11, 14, 17
Interlock.....	11	Test drafts .....	14, 15, 17
Invoices.....	20	Tolerances.....	10, 16
Key-lock .....	5, 19	Total price.....	7, 19, 20
Lubricant devices.....	8, 12, 14	Totalizers .....	14, 19
Maintenance.....	16, 17, 18	Truck refueling .....	6, 7, 12, 19
Marking requirements.....	13	Unit price .....	5, 6, 7, 8, 19, 20
Mass.....	3	User information.....	5
Mass flow meters .....	3	Valves.....	10, 12, 18
Measuring element.....	9	Vapor elimination .....	9
Money value computation.....	16	Wet-hose.....	12, 13
Money value divisions .....	7	Wholesale devices .....	3, 8, 11, 13, 14, 15, 16, 20
Money values-mathematical agreement.....	8	Zero-set-back interlock.....	11, 20
Money-value computation .....	6, 16		

THIS PAGE INTENTIONALLY LEFT BLANK