

## Sec. 3.3X. Hydrogen Gas Meters

### A. Application

**A.1.** This code applies to devices that are designed to dynamically measure the mass of hydrogen gas in the vapor state used as a vehicle fuel.

**A.2.** This code does not apply to devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.

**A.3. Type Evaluation.** - The National Type Evaluation Program will accept for type evaluation only those devices that comply with all requirements of this code.

**A.4.** In addition to the requirements of this code, hydrogen gas 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. Hydrogen Gas Dispensers.** - A hydrogen gas dispenser used to refuel vehicles shall be of the computing type and shall indicate the mass, 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.

#### S.1.3. Units. -

**S.1.3.1. Units of Measurement.** - Deliveries shall be indicated and recorded in grams or kilograms or pounds and decimal subdivisions thereof. The indication of a delivery shall be on the basis of apparent mass versus a density of 8.0 g/cm<sup>3</sup>.

**S.1.3.2. Numerical Value of Quantity-Value Divisions.** - The value of a scale interval shall be equal to:

- 1, 2, or 5, or
- a decimal multiple or submultiple of 1, 2, or 5.

**S.1.3.3. Maximum Value of Quantity-Value Divisions.** - The maximum value of the quantity-value division shall be not greater than 0.2 % of the minimum measured quantity.

**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.

- (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.

**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.

**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.

**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.

**S.2.5.2. Product Identity.** - A device shall be able to conspicuously display on each side the identity of the product being dispensed.

**S.2.5.3. Selection of Unit Price.** - When a product 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.

**S.2.5.4. Agreement Between Indications.** - All quantity, unit price, and total price indications within a measuring system shall agree for each transaction.

**S.2.6. Money-Value Computations.** - A computing device shall compute the total sales price at any single-purchase unit price 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.

**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.

**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.

**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 mass of the delivery,
- (b) the unit price,
- (c) the total computed price, and
- (d) the product identity by name, symbol, abbreviation, or code number.

**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).

**S.3. Design of Measuring Elements and Measuring Systems.**

**S.3.1. Maximum and Minimum Flow-Rates.** - The ratio of the maximum to minimum flow-rates specified by the manufacturer for devices measuring gases shall be 10:1 or greater.

**S.3.2. Adjustment Means.** - An adjustment means to change the accuracy of the measuring instrument. A bypass on the measuring assembly shall not be used for these means.

**S.3.2.1. Discontinuous Adjusting Means.** - When the accuracy adjusting means changes in a discontinuous manner, the consecutive values of the ratio shall not differ by more than 0.1 %.

**S.3.3. 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.3.4. 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 may be made of:

- (a) each individual measurement element;
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries;  
or
- (c) the zero adjustment mechanism.

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.3.4.

**S.3.5. Automatic Density Correction.**

- (a) An automatic means to determine and correct for changes in product density shall be incorporated in any hydrogen gas metering system that is affected by changes in the density of the product being measured.
- (b) Mass-measuring devices with automatic temperature compensation used to measure hydrogen 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.

**S.3.6. Pressurizing the Discharge Hose.** - The discharge hose for hydrogen gas shall automatically pressurize prior to the device beginning to register the delivery.

<b>Table S.3.4. Categories of Device and Methods of Sealing</b>	
<b>Categories of Device</b>	<b>Method of Sealing</b>
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).  The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)

**S.3.7. 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.

**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.

**S.4.2. Directional Flow Valves.** - If a reversal of flow could result in errors that exceed the tolerance for the minimum measured quantity, a valve or valves or other effective means, automatic in operation (and equipped with a pressure limiting device, if necessary) to prevent the reversal of flow shall be properly installed in the system. (See N.1.)

**S.4.3. 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 conspicuously, 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 designation 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.;
- (f) maximum and minimum flow rates in pounds per unit of time;
- (g) maximum working pressure;
- (h) applicable range of temperature if other than -10 °C to +50 °C;
- (i) minimum measured quantity; and
- (j) product limitations, if applicable.

**S.6. Printer.** - When an assembly is equipped with means for printing the measured quantity, the printed information must agree with the indications on the dispenser for the transaction and the printed values shall be clearly defined.

**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 each separate metering device.

## N. Notes

**N.1. Minimum Measured Quantity.** - The minimum measured quantity shall be specified by the manufacturer.

**N.2. Test Medium.** - The device shall be tested with hydrogen gas.

**N.3. Test Drafts.** - The minimum test shall be one test draft at the maximum flow rate of the installation and one test draft at the minimum flow rate. More tests may be performed at these or other flow rates. (See T.3.)

**N.4. Minimum Measured Quantity.** - The device shall be tested for a delivery equal to the declared minimum measured quantity when the device is likely to be used to make deliveries on the order of the minimum measured quantity.

**N.5. Motor Fuel Dispenser.** - When a device is intended for use as a 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.

**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.

**N.6.2. Special Tests.** - Special tests to develop the operating characteristics of a meter and any special elements and accessories attached to or associated with the device, shall be made as circumstances require. Any test except as set forth in N.6.1. shall be considered a special test. Special test of a measuring system shall be made to develop operating characteristics of the measuring systems during a split compartment delivery. (See Table T.2.)

**N.7. Density.** Temperature and pressure of metered hydrogen gas shall be measured during the test for the determination of density or volume correction factors when applicable. For the thermophysical properties of hydrogen the following publications shall apply: NBS Technical Note 1079 "Tables of Industrial Gas Container Contents and Density for Oxygen, Argon, Nitrogen, Helium, and Hydrogen," or available on-line "NIST Chemistry WebBook" at <http://webbook.nist.gov/chemistry/fluid>, or for a wider range of data available for purchase on-line NIST Standard Reference Database 12 "NIST Thermodynamic and Transport Properties of Pure Fluids."

## 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.

**T.2. Tolerances.** - The tolerances for hydrogen gas meters are listed in Table T.2.

<b>Table T.2. Accuracy Classes for Hydrogen Gas Meter Applications</b>				
<b>Accuracy Class</b>	<b>Application or Commodity Being Measured</b>	<b>Acceptance Tolerance</b>	<b>Maintenance Tolerance</b>	<b>Special Tolerance</b>
2.0	Compressed natural gas as a motor fuel and hydrogen gas	1.5 %	2.0 %	2.0 %

**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. See also N.6.1.1.

**T.4. Type Evaluation Examinations for Devices.** - For type evaluation examinations, the tolerance values shall apply under the following conditions:

- (a) at any temperature and pressure within the operating range of the meter, and
- (b) at all flow rates within the range of flow rates.

### **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.

**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.

**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.

**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.

**UR.3. Use of Device.**

**UR.3.1. Unit Price and Product Identity for Retail Dispensers.** - In the case of a computing type or money-operated type, the unit price at which the dispenser is set to compute shall be conspicuously displayed or posted on the face of a retail dispenser used in direct sale.

**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.

**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.

**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.

**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.

**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.

**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.

**UR.3.8. Return of Product to Storage, Retail Hydrogen 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.

**UR.3.9. Conversion Factors.** - Established conversion values (see references in N.6) shall be used whenever metered hydrogen gas is billed. All sales shall be based on grams or kilograms or pounds.

**NOTE: Current NIST Handbook 44 definitions that will need to be modified to correspond with the proposed new code for hydrogen gas meters.**

## Appendix D

### Definitions

The specific code to which the definition applies is shown in [brackets] at the end of the definition. Definitions for the General Code [1.10] apply to all codes in Handbook 44.

#### A

**audit trail.** An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device. [1.10, 2.20, 2.21, 2.24, 3.30, 3.37, 3.3X, 5.56(a)]

**automatic temperature or density compensation.** The use of integrated or ancillary equipment to obtain from the output of a volumetric meter an equivalent mass, or an equivalent liquid volume at the assigned reference temperature below and a pressure of 14.696 lb/in<sup>2</sup> absolute.

Cryogenic liquids, Hydrogen gas – 21 °C (70 °F) [3.34, 3.3X]

Hydrocarbon gas vapor – 15 °C (60 °F) [3.33]

Liquid carbon dioxide – 21 °C (70 °F) [3.38]

Liquefied petroleum gas (LPG) and Anhydrous ammonia – 15 °C (60 °F) [3.32]

Petroleum liquid fuels and lubricants – 15 °C (60 °F) [3.30]

#### C

**calibration parameter.** Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy, e.g., span adjustments, linearization factors, and coarse zero adjustments. [2.20, 2.21, 2.24, 3.30, 3.37, 3.3X, 5.56(a)]

#### D

**discharge hose.** A flexible hose connected to the discharge outlet of a measuring device or its discharge line. [3.30, 3.31, 3.32, 3.34, 3.37, 3.38, 3.3X]

**discharge line.** A rigid pipe connected to the outlet of a measuring device. [3.30, 3.31, 3.32, 3.34, 3.37, 3.3X]

#### E

**event counter.** A nonresettable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable calibration or configuration parameters of a device. [2.20, 2.21, 3.30, 3.37, 3.3X, 5.54, 5.56(a), 5.56(b), 5.57]

**event logger.** A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter. [2.20, 2.21, 3.30, 3.37, 3.3X, 5.54, 5.56(a), 5.56(b), 5.57]

#### M

**motor-fuel device** or **motor-fuel dispenser** or **retail motor-fuel device**. A device designed for the measurement and delivery of ~~liquids~~ products used as fuel for internal-combustion engines. The term "motor-fuel dispenser" means the same as "motor-fuel device"; the term "retail motor-fuel device" applies to a unique category of device (see definition of "retail device").[3.30, 3.32, 3.37, 3.3X]

## P

**point-of-sale system**. An assembly of elements including a weighing or measuring element, an indicating element, and a recording element (and may also be equipped with a "scanner") used to complete a direct sales transaction.[2.20, 3.30, 3.32, 3.37, 3.3X]

## R

**remote configuration capability**. The ability to adjust a weighing or measuring device or change its sealable parameters from or through some other device that is not itself necessary to the operation of the weighing or measuring device or is not a permanent part of that device. [2.20, 2.21, 2.24, 3.30, 3.37, 3.3X, 5.56(a)]

**retail device**. A measuring device primarily used to measure product for the purpose of sale to the end user. [3.30, 3.32, 3.37, 3.3X]

## W

**wet hose**. A discharge hose intended to be full of product at all times. (See "wet-hose type.")[3.30, 3.31, 3.38, 3.3X]

**wet-hose type**. A type of device designed to be operated with the discharge hose full of product at all times. (See "wet hose.")[3.30, 3.32, 3.34, 3.37, 3.38, 3.3X]