

Section 3.31. Vehicle-Tank Meters

A. Application

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

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

- (a) Devices used for dispensing liquefied petroleum gases (see Sec. 3.32; Code for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices), or other liquids that do not remain in a liquid state at atmospheric pressures and temperatures.
- (b) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.
- (c) Vehicle tanks used as measures (see Sec. 4.40; Code for Vehicle Tanks Used as Measures).
- (d) Mass flow meters (see Sec. 3.37. Code for Mass Flow Meters). (Added 1994)

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

S. Specifications

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

S.1.1. Primary Elements.

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

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

S.1.1.2. Units. -

- (a) A meter shall indicate, and record if the meter is equipped to record, its deliveries in terms of liters or gallons. Fractional parts of the liter or gallon shall be in terms of either decimal or binary subdivisions.
- (b) When it is an industry practice to purchase and sell milk by weight based upon 1.03 kg/L (8.6 lb/gal), the primary indicating element may indicate in kilograms or pounds and decimal kilograms or pounds. The weight value division shall be a decimal multiple or submultiple of 1, 2, or 5. (See S.5.5.)

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

- (a) 0.5 L (0.1 gal) or 0.5 kg (1 lb) on milk-metering systems,
- (b) 0.5 L (0.1 gal) on meters with a rated maximum flow rate of 750 L/min (200 gal/min) or less,
- (c) 5 L (1 gal) on meters with a rated maximum flow of 375 L/min (100 gal/min) or more used for jet fuel aviation refueling systems, or (Added 2006)

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

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

- (a) the advancing movement, once started, cannot be stopped until zero is reached, or
- (b) in the case of indicating elements only, such elements are automatically obscured until the elements reach the correct zero position.

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

S.1.2. Graduations.

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

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

S.1.2.3. Clear Interval Between Graduations. - The clear interval shall be not less than 2.5 mm (0.10 in). If the graduations are not parallel, the measurement shall be made:

- (a) along the line of relative movement between the graduations at the end of the indicator, or
 - (b) if the indicator is continuous, at the point of widest separation of the graduations.
- (Amended 1986)

S.1.3. Indicators.

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

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

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

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

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

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

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

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

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

S.1.4. Computing-Type Device.

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

(Amended 1983 and 2005)

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

(Amended 1989)

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

(Amended 1979 and 1989)

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

S.2. Design of Measuring Elements.

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

(Amended 1993)

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

- (a) any measuring or indicating element,
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries, and
- (c) any metrological parameter that will affect the metrological integrity of the device or system.

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

*[Audit trails shall use the format set forth in Table S.2.2.]**

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

(Amended 2006)

Table S.2.2. Categories of Device and Methods of Sealing	
Category of Device	Method of Sealing
<i>Category 1: No remote configuration capability.</i>	<i>Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.</i>
<i>Category 2: Remote configuration capability, but access is controlled by physical hardware.</i> <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>	<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>Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).</i> <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>	<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>

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

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

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

[Nonretroactive as of January 1, 2006]
(Added 2005)

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

(Not applicable to milk-metering systems.)

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

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

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

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

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

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

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

- (a) by means of a tool (but not a pin) entirely separate from the device, or
- (b) by mutilation of a security seal with which the valve is sealed open.

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

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

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

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

- (a) of the dry-hose type;
- (b) adequately reinforced;
- (c) not more than 6 m (20 ft) in length, unless it can be demonstrated that a longer hose is essential to permit pickups from a supply tank; and
- (d) connected to the pump at horizontal or above, to permit complete drainage of the hose.

S.5. Marking Requirements

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

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

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

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

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

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

N. Notes

N.1. Test Liquid.

- (a) A measuring system shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics. Following a satisfactory examination, the weights and measures official should attach a seal or tag indicating the product used during the test.
(Amended 1975)
- (b) A milk measuring system shall be tested with the type of milk to be measured when the accuracy of the system is affected by the characteristics of milk (e.g., positive displacement meters).
(Part (b) Added 1989)

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

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

N.4. Testing Procedures

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

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

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

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

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

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

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

(Added 2005)

T. Tolerances

T.1. Application.

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

T.2. Tolerance Values. - Tolerances shall be as shown in Tables 1 and 2.
(Amended 1995)

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

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

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

(Added 2002)

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

(Added 1989)

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

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

[**Note:** The result of the product depletion test may fall outside of the applicable test tolerance as specified in Table 1.]

Table T.4. Tolerances for Vehicle-Tank Meters on Product Depletion Tests, Except Milk Meters	
Meter Size	Maintenance and Acceptance Tolerances
Up to, but not including, 50 mm (2 in)	1.70 L (104 in ³) ¹
From 50 mm (2 in) up to, but not including, 75 mm (3 in)	2.25 L (137 in ³) ¹
75 mm (3 in) or larger	3.75 L (229 in ³) ¹
¹ Based on a test volume of at least the amount specified in N.3.	

(Table Added 2005)

UR. User Requirements

UR.1. Installation Requirements.

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

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

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

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

UR.2. Use Requirements.

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

UR.2.2. Ticket Printer; Customer Ticket. - 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 1993) (Amended 1994)

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

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

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