

**Appendix B, 2020 Measuring Sector Meeting  
Highlighted references to the term ‘retail motor fuel’  
and other variations of the term**

**National Type Evaluation Program  
Liquid Measuring Devices – Technical Policy**

**A. Type Evaluation Test Location, Installations Criteria and Certificate of Conformance Information**

The manufacturer has the choice of submitting a meter or liquid measuring device to one of the following for National Type Evaluation Program (NTEP) evaluation:

- A government laboratory
- A field test
- A manufacturer's laboratory

A laboratory test alone may not be sufficient basis on which to issue a Certificate of Conformance (CC.) The policies on product families, meter sizes, and flow rates listed on a CC apply regardless of where the meter is tested. Additional testing may be required based on these policies.

**Site Requirements - General**

Site requirements for tests to add new sizes to an existing CC:

For tests of a meter size not previously covered on the CC (through testing or through the guidelines outlined for meter sizes paragraph E), the installation selected for test must achieve at least 80% of the meter's rated maximum flow rate.

Site requirements to add new products to an existing CC:

11. If the size of meter selected for test was previously tested under the CC with another product, then there are no minimum requirements with respect to the flow rates to be achieved in the installation selected for testing.
12. If the size of meter selected for test was covered based on the guidelines outlined for meter sizes not previously tested under the CC with another product, then the installation selected for test must achieve at least 40% of the meter's rated maximum flow rate; otherwise, the site is inappropriate for type evaluation.

To recognize that the maximum discharge flow rate developed by the measuring system will vary with each system, NTEP accepts a maximum discharge rate developed by a system as low as 50% of the rated maximum flow rate of the device. If the maximum flow rate achieved during and NTEP evaluation is less than 50% of the maximum flow rate marked on the device, NTEP will limit the maximum flow rate listed on the CC to 200% of the maximum flow rate achieved during the evaluation.

The CC should include the following information:

- Approved ranges and parameters (flow rates, viscosity / specific gravity, product family or families, sizes of meter, minimum measured quantity)
- Accuracy Class
- Application (stationary, vehicle mounted, etc.)
- Multi-point calibration (if applicable)
- Special restrictions (if applicable)
- Operating instructions required to test or inspect the device
- Conditions of testing (lab, field, manufacturer facility, etc.), test equipment used and other devices used in the system under test

**B. Tolerance Application**

**General**

The tolerance applied during type evaluation will be listed on the Certificate of Conformance (CC) along with the product family or families covered under the CC for all metering devices.

A manufacturer must specify the application and consequently, the tolerance to be applied, at the time a device is submitted for evaluation. NTEP will not shift the device applications based on the results of the type evaluation because the number of devices tested are not enough to assess the performance for tighter tolerances.

If a meter is tested to the tighter tolerances for "Other Liquids" for a given product family, it can be used with that same product family in applications which would fall under "Other Liquids" OR "Agri-chemicals" because the tolerance for agri-chemical applications is larger. If, however, the meter is tested using the "Agri-chemicals" tolerance, the meter is restricted to use in agri-chemical applications until additional testing is performed.

#### **Normal Test Tolerances**

For the purposes of calculating tolerances, normal tests conducted in an NTEP evaluation may be performed at any flow rate down to:

$[50\% \text{ of the rated maximum flow rate} + \text{the rated minimum flow rate}] / 2$

For example: For a meter with a rated maximum flow rate of 60 gallons/minute (gpm) and a minimum flow rate of 12 gpm, the maximum discharge rate developed in an actual installation may be as low as 30 gpm. Therefore, for NTEP tests, calculate the "breakpoint" between normal and special tests as:

$[(50\% \times 60) + 12] / 2 = 21$

Thus, in the example, NTEP test runs at flow rates between 60 and 21 gpm are considered normal tests.

### **C. Product Categories and Families for Meters**

When submitting a meter for evaluation, the manufacturer must specify the product categor(y)(ies) and/or famil(y)(ies) and critical parameters for which the meter is being submitted.

#### **Product Category**

A group of products that share similar characteristics.

*Note: Under certain Test Requirements, product coverage is indicated by reference to the "Product Category," while under other Test Requirements, product coverage is indicated by "Product Family."*

#### **Product Family**

A group of products, sometimes including multiple Product Categories, which share a common Test Requirement.

*Note: Coverage of different products by a certificate may be indicated using references to either "Product Categories" or "Product Families," as indicated in the Test Requirement for that Product Family.*

The product family and the specific product subgroup covered by the Certificate are to be identified on page one (1) of the Certificate of Conformance. More detailed information, including the typical product types found in the subgroup, is to be included in the application section of the Certificate.

Mass Meter Product Category and Test Requirements			Magnetic Flow Meter Product Category and Test Requirements			Positive Displacement Flow Meter Product Category and Test Requirements		Turbine Flow Meter Product Category and Test Requirements	
<b>Test B</b> To cover a range of the following products, test with one product having a low specific gravity and test with a second product having a high specific gravity. The Certificate of Conformance will cover all products in all product categories listed in the table under Test B within the specific gravity range tested. • Test B does not apply to product categories of liquefied gases, compressed liquids, cryogenic liquids or heated products.  <i>Note: Product categories under Test B were formerly referred to collectively as "Normal Liquids."</i>			<b>Test F</b> To cover a range of the following products, test with one product having a specified conductivity. The Certificate of Conformance will cover all products with conductivity equal to or above the conductivity of the tested liquid. • Test F does not apply to product categories of potable water, non-potable water, tap water, water mixes of alcohols and glycols, fertilizers, suspension fertilizers, liquid feeds, clear liquid fertilizers, chemicals or crop chemicals A, B, C, or D. • Test F does not apply to product categories of liquefied gases, or compressed liquids.			<b>Test C</b> To cover a range of products within each product category, test with one product having a low viscosity and test with a second product having a high viscosity within each category. The Certificate of Conformance will cover all products in the product category within the viscosity range tested.  <b>Product Category:</b> Alcohols, Glycols and Water Mixes Thereof (Alc Gly)		<b>Test E</b> To cover a range of products within each product category, test with one product having a low kinematic viscosity and test with a second product having a high kinematic viscosity within each category. The Certificate of Conformance will cover all products in the product category within the kinematic viscosity range tested. <sup>1</sup>  <b>Product Category:</b> Alcohols, Glycols and Water Mixes Thereof (Alc Gly)	
Typical Products	Specific Gravity <sup>2</sup> (60 °F)	Product Category	Typical Products	Conductivity (micro-siemens/centimeter)	Product Category	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Typical Products	Reference Kinematic Viscosity <sup>1</sup> (60 °F) centistokes (cSt)
Butanol	0.81	Alc Gly	Butanol		Alc Gly	Butanol	3.34	Butanol	4.13
Ethanol	0.79	Alc Gly	Ethanol	0.0013	Alc Gly	Ethanol	1.29	Ethanol	1.64
Ethylene Glycol	1.19	Alc Gly	Ethylene Glycol		Alc Gly	Ethylene Glycol	25.5	Ethylene Glycol	21.5
Isobutyl	0.81	Alc Gly	Isobutyl	0.02	Alc Gly	Isobutyl	4.54	Isobutyl	5.62
Isopropyl	0.79	Alc Gly	Isopropyl	3.5	Alc Gly	Isopropyl	2.78	Isopropyl	3.53
Methanol	0.80	Alc Gly	Methanol	0.44	Alc Gly	Methanol	0.64	Methanol	0.80
Propylene Glycol	1.04	Alc Gly	Propylene Glycol		Alc Gly	Propylene Glycol	54	Propylene Glycol	52
Banvel	0.7 – 1.2	CC-A	6 Oil (#5, #6)		FL&O	<b>Test C</b> <b>Product Category:</b> Crop Chemicals (Type A) (CC-A)		<b>Test E</b> <b>Product Category:</b> Compressed Liquids, Fuels and Refrigerants NH <sub>3</sub> (Comp liq)	
Herbicides	0.7 – 1.2	CC-A	Asphalt		FL&O	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Typical Products	Reference Kinematic Viscosity <sup>1</sup> (60 °F) centistokes (cSt)
Paraquat	0.7 – 1.2	CC-A	Avgas		FL&O	Banvel	4 – 400	Anhydrous Ammonia	0.31

<sup>1</sup> Viscosity (dynamic) is measured in centipoise. Kinematic viscosity is measured in centistokes. Source for some of the viscosity value information is the Industry Canada – Measurement Canada "Liquid Products Group, Bulletin V-16-E (rev.1), August 3, 1999."  
 centistokes (10<sup>-6</sup> m<sup>2</sup>/s) = centipoise (10<sup>-3</sup> kg/m·s) ÷ density (kg/m<sup>3</sup>) OR centistokes (cSt) = 1.002 × centipoise (cP) ÷ density (SG)

<sup>2</sup> The specific gravity of a liquid is the ratio of its density to that of water at standard conditions, usually 4 °C (or 40 °F) and 1 atmosphere. The density of water at standard conditions is approximately 1000 kg/m<sup>3</sup> (or 998 kg/m<sup>3</sup>). The specific gravity of a gas is the ratio of its density to that of air at standard conditions, usually 4 °C (or 40 °F) and 1 atmosphere.

Mass Meter Product Category and Test Requirements			Magnetic Flow Meter Product Category and Test Requirements			Positive Displacement Flow Meter Product Category and Test Requirements		Turbine Flow Meter Product Category and Test Requirements	
Typical Products	Specific Gravity <sup>2</sup> (60 °F)	Product Category	Typical Products	Conductivity (micro- siemens/centimeter)	Product Category	<b>Test C</b>  Product Category: Crop Chemicals (Type A) (CC-A) continued		<b>Test E</b>  Product Category: Compressed Liquids, Fuels and Refrigerants NH <sub>3</sub> (Comp liq) continued	
						Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Typical Products	Reference Kinematic Viscosity <sup>1</sup> (60 °F) centistokes (cSt)
Prowl	0.7 – 1.2	CC-A	Biodiesel above B20		FL&O				
Round-up	0.7 – 1.2	CC-A	Bunker Oil		FL&O	Herbicides	4 – 400	Butane	0.32
Touchdown	0.7 – 1.2	CC-A	Cooking Oils		FL&O	Paraquat	4 – 400	Ethane	
Treflan	0.7 – 1.2	CC-A	Corn Oil		FL&O	Prowl	4 – 400	Freon 11	0.21
Adjuvants	0.7 – 1.2	CC-B	Crude Oil		FL&O	Round-up	4 – 400	Freon 12	0.27
Fumigants	0.7 – 1.2	CC-B	Diesel Fuel <sup>3</sup>		FL&O	Touchdown	4 – 400	Freon 22	1.46
Fungicides	0.7 – 1.2	CC-B	Fuel Oil (#1, #2, #3, #4)	0	FL&O	Treflan	4 – 400	Propane	0.195
Insecticides	0.7 – 1.2	CC-B	Gasoline <sup>4</sup>		FL&O	<b>Test C</b>  Product Category: Crop Chemicals (Type B) (CC-B)		<b>Test E</b>  Product Category: Fuels, Lubricants, Industrial and Food Grade Liquid oils (FL&O)	
Fungicides	1 – 1.2	CC-C	Jet A		FL&O	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Typical Products	Reference Kinematic Viscosity <sup>1</sup> (60 °F) centistokes (cSt)
Micronutrients	0.9 – 1.65	CC-D	Jet A-1		FL&O	Adjuvants	0.7 – 100	6 Oil (#5, #6)	73 – 14,500
Hydrochloric Acid	1.1	Chem	Jet B		FL&O	Fumigants	0.7 – 100	Asphalt	
Phosphoric Acid	1.87	Chem	JP4		FL&O	Fungicides	0.7 – 100	Avgas	
Sulfuric Acid	1.83	Chem	JP5		FL&O	Insecticides	0.7 – 100	Biodiesel above B20	11.8
3-10-30	0.9 – 1.65	Fert	JP7 and JP8		FL&O	<b>Test C</b>  Product Category: Crop Chemicals (Type C) (CC-C)		Bunker Oil	11,300
4-4-27	0.9 – 1.65	Fert	Kerosene		FL&O	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Cooking Oils	10.8
9-18-9	1.32	Fert	Light Oil		FL&O	Fungicides	20 – 900	Corn Oil	4.4
10-34-0	1.39	Fert	Lubricating Oils		FL&O	<b>Test C</b>  Product Category: Crop Chemicals (Type D) (CC-D)		Crude Oil	3 – 2260
20% Aqua-Ammonia	0.89	Fert	Olive Oil		FL&O	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Diesel Fuel <sup>3</sup>	12
28%, 30% or 32%	1.28 – 1.32	Fert	Peanut Oil		FL&O	Micronutrients	20 – 1000	Fuel Oil (#1, #2, #3, #4)	9 – 98

<sup>3</sup> Diesel fuel blends (biodiesel with up to 20% vegetable or animal fat/oil.)

<sup>4</sup> Gasoline includes oxygenated fuel blends with up to 15% oxygenate.

Mass Meter Product Category and Test Requirements			Magnetic Flow Meter Product Category and Test Requirements			Positive Displacement Flow Meter Product Category and Test Requirements		Turbine Flow Meter Product Category and Test Requirements	
Typical Products	Specific Gravity <sup>2</sup> (60 °F)	Product Category	Typical Products	Conductivity (micro-siemens/centimeter)	Product Category	<u>Test C</u> <b>Product Category:</b> Chemicals (Chem)		<u>Test E</u> <b>Product Category:</b> Fuels, Lubricants, Industrial and Food Grade Liquid oils (FL&O) continued	
						Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Typical Products	Reference Kinematic Viscosity <sup>1</sup> (60 °F) centistokes (cSt)
Ammonia Nitrate	1.16 – 1.37	Fert	SAE Grades		FL&O				
Clear Liquid Fertilizer	1.17 – 1.44	Fert	Soy Oil	0	FL&O	Hydrochloric Acid	0.80 – 1.0	Gasoline <sup>4</sup>	0.39
Nitrogen Solution	1.17 – 1.44	Fert	Spindle Oil		FL&O	Phosphoric Acid	161	Jet A	
N-P-K Solutions	1.2 – 1.4	Fert	Sunflower Oil		FL&O	Sulfuric Acid	1.49	Jet A-1	1.8
Urea	1.3	Fert	Vegetable Oil	0	FL&O	<u>Test C</u> <b>Product Category:</b> Compressed Liquids, Fuels and Refrigerants (Comp liq)		Jet B	
Diesel exhaust fluid	1.08 – 1.18	DEF	Asphalt		Heated	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	JP4	1.34
6 Oil (#5, #6)	0.9	FL&O							
Asphalt		FL&O	Bunker C		Heated	Anhydrous Ammonia	0.188	JP5	2.56
Avgas		FL&O	Carbon Tetra-Chloride		Solv Cl	Butane	0.19	JP7 and JP8	2.4
Biodiesel above B20	0.86	FL&O	Methylene-Chloride		Solv Cl	Ethane		Kerosene	2.6
Bunker Oil	0.99	FL&O	Perchloro-Ethylene		Solv Cl	Freon 11	0.313	Light Oil	15.7
Cooking Oils	0.92	FL&O	Trichloro-Ethylene		Solv Cl	Freon 12	0.359	Lubricating Oils	22 – 1250
Corn Oil	0.91	FL&O	Acetates		Solv Gen	Freon 22	1.99	Olive Oil	127
Crude Oil	0.79 – 0.97	FL&O	Acetone	.02	Solv Gen	Propane	0.098	Peanut Oil	11 – 122
Diesel Fuel <sup>3</sup>	0.84	FL&O	Ethylacetate	0.00001	Solv Gen	<u>Test C</u> <b>Product Category:</b> Clear Liquid Fertilizers (Fert) and DEF		SAE Grades	214 – 4037
Fuel Oil (#1, #2, #3, #4)	0.9	FL&O	Hexane	0	Solv Gen	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Soy Oil	97.6
Gasoline <sup>4</sup>	0.72	FL&O	MEK	0.1	Solv Gen	9-18-0		Spindle Oil	
Jet A		FL&O	Toluene	0	Solv Gen	10-34-0	48	Sunflower Oil	97.1
Jet A-1	0.76	FL&O	Xylene	0	Solv Gen	20% Aqua-Ammonia	1.1 – 1.3	Vegetable Oil	145
Jet B		FL&O	Deionized		Water	28%, 30% or 32%	31 – 110	<u>Test E</u> <b>Product Category:</b> Solvents General (Solv Gen)	
JP4	0.76	FL&O	Demineralized		Water	Ammonia Nitrate	11.22	Typical Products	Reference Kinematic Viscosity <sup>1</sup> (60 °F) centistokes (cSt)
JP5	0.76	FL&O				Clear Liquid Fertilizer	31 – 110	Acetates	0.47

Mass Meter Product Category and Test Requirements			Magnetic Flow Meter Product Category and Test Requirements			Positive Displacement Flow Meter Product Category and Test Requirements		Turbine Flow Meter Product Category and Test Requirements	
JP7 and JP8	0.76	FL&O				Nitrogen Solution	31 – 110	Acetone	0.43
<b>Typical Products</b>	<b>Specific Gravity<sup>2</sup> (60 °F)</b>	<b>Product Category</b>	<b>Test D</b> To obtain coverage for a product category, test with one product in the product category. The Certificate of Conformance will cover all products in the category. <ul style="list-style-type: none"> <li>Test D does not apply to product categories of pure alcohols, pure glycol, pure water, solvents chlorinated, solvents general, fuels, lubricants, industrial and food grade liquid oils.</li> <li>Test D does not apply to product categories of liquefied gases, compressed liquids or heated products.</li> </ul>			<b>Test C</b> <b>Product Category:</b> Clear Liquid Fertilizers (Fert) and DEF continued		<b>Test E</b> <b>Product Category:</b> Solvents General (Solv Gen) continued	
Kerosene	0.75	FL&O	<b>Typical Products</b>	<b>Conductivity (micro-siemens/centimeter)</b>	<b>Product Category</b>	<b>Typical Products</b>	<b>Reference Viscosity<sup>1</sup> (60 °F) centipoise (cP)</b>	<b>Typical Products</b>	<b>Reference Kinematic Viscosity<sup>1</sup> (60 °F) centistokes (cSt)</b>
Light Oil	0.86	FL&O	Water Mixes of Alcohols and Glycols		Alc Gly	N-P-K Solution		Ethylacetate	1.42
Lubricating Oils	0.80 – 0.90	FL&O	Banvel		CC-A	Urea	1.7 – 1.9	Hexane	0.52
Olive Oil	0.92	FL&O	Herbicides		CC-A	Diesel exhaust fluid	1.2 – 1.7		
						<b>Test C</b> <b>Product Category:</b> Fuels, Lubricants, Industrial and Food Grade Liquid Oils (FL&O)		MEK	0.56
Peanut Oil	0.9 – 1.0	FL&O	Paraquat		CC-A	<b>Typical Products</b>	<b>Reference Viscosity<sup>1</sup> (60 °F) centipoise (cP)</b>	Toluene	0.71
SAE Grades	0.9	FL&O	Prowl		CC-A	6 Oil (#5, #6)	66 – 13,000	Xylene	0.97
Soy Oil	0.93	FL&O	Round-up		CC-A	Asphalt	100 – 5000	<b>Test A</b> The following products must be individually tested and noted on the Certificate of Conformance.	
Spindle Oil		FL&O	Touchdown		CC-A	Avgas	1.5 – 6	<b>Typical Products</b>	<b>Product Category</b>
Sunflower Oil	0.93	FL&O	Treflan		CC-A	Biodiesel above B20	10.12	Banvel	CC-A
Vegetable Oil	0.92	FL&O	Adjuvants		CC-B	Bunker Oil	11,200	Herbicides	CC-A
Liquid Molasses	1.25	Liq Feed	Fumigants		CC-B	Cooking Oils	9.93	Paraquat	CC-A
Molasses Plus Phos Acid and/or Urea (TreaChle)	1.1 – 1.3	Liq Feed	Fungicides		CC-B	Corn Oil	4	Prowl	CC-A
Carbon Tetra-Chloride	1.6	Solv Cl	Insecticides		CC-B	Crude Oil	3-1783	Round-up	CC-A
Methylene-Chloride	1.34	Solv Cl	Fungicides		CC-C	Diesel Fuel <sup>3</sup>	10	Touchdown	CC-A
Perchloro-Ethylene	1.6	Solv Cl	Micronutrients		CC-D	Fuel Oil (#1, #2, #3, #4)	8 to 88	Treflan	CC-A

Mass Meter Product Category and Test Requirements			Magnetic Flow Meter Product Category and Test Requirements			Positive Displacement Flow Meter Product Category and Test Requirements		Turbine Flow Meter Product Category and Test Requirements	
Trichloro-Ethylene	1.47	Solv Cl	Hydrochloric Acid	395000	Chem	Gasoline <sup>4</sup>	0.28	Adjuvants	CC-B
Acetates	0.93	Solv Gen	Phosphoric Acid	56600	Chem	Jet A	1.5 – 6	Fumigants	CC-B
Typical Products	Specific Gravity <sup>2</sup> (60 °F)	Product Category	Typical Products	Conductivity (micro-siemens/centimeter)	Product Category	<b>Test C</b> <b>Product Category:</b> Fuels, Lubricants, Industrial and Food Grade Liquid Oils (FL&O) continued		Typical Products	Product Category
Acetone	0.8	Solv Gen	Sulfuric Acid	209000	Chem	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Fungicides	CC-C
Ethylacetate	0.96	Solv Gen	9-18-0		Fert	Jet A-1	1.36	Insecticides	CC-B
Hexane	0.66	Solv Gen	10-34-0		Fert	Jet B	1.5 – 6	Fungicides	CC-C
MEK	0.81	Solv Gen	20% Aqua-Ammonia		Fert	JP4	1.02	Micronutrients	CC-D
Toluene	0.87	Solv Gen	28%, 30% or 32%		Fert	JP5	1.94	Hydrochloric Acid	Chem
Xylene	0.89	Solv Gen	Ammonia Nitrate		Fert	JP7 and JP8	1.82	Phosphoric Acid	Chem
Beverages	1.0	Water	Clear Liquid Fertilizer		Fert	Kerosene	1.94	Sulfuric Acid	Chem
Deionized	1.0	Water	Nitrogen Solution		Fert	Light Oil	13.47	NH <sub>3</sub>	Comp Liq
Demineralized	1.0	Water	N-P-K Solutions		Fert	Lubricating Oils	20 – 1000	20% Aqua-Ammonia	Fert
Juices	1.0	Water	Urea	5000	Fert	Olive Oil	116.8	28%, 30% or 32%	Fert
Milk	1.0	Water	Diesel exhaust fluid	2000 -5000	DEF	Peanut Oil	11 – 110	9-18-0	Fert
			Liquid Molasses	300	Liq Feed				
Nonpotable	1.0	Water	Molasses Plus Phos Acid and/or Urea (TreaChle)		Liq Feed	SAE Grades	192 – 3626	10-34-0	Fert
Potable	1.0	Water	3-10-30		Sus Fert	Spindle Oil		Ammonia Nitrate	Fert
Tap Water	1.0	Water	4-4-27		Sus Fert	Soy Oil	90.6	Clear Liquid Fertilizer	Fert
<b>Test D</b> To obtain coverage for each of the following product categories, test with one product in each product category. The Certificate of Conformance will cover the products in the product category in which a product was tested.			Beverages		Water	Sunflower Oil	90.1	Nitrogen Solution	Fert
Typical Products	Specific Gravity <sup>2</sup> (60 °F)	Product Category	Juices		Water	Vegetable Oil	133	N-P-K Solutions	Fert

Mass Meter			Magnetic Flow Meter			Positive Displacement Flow Meter Product		Turbine Flow Meter			
Product Category and Test Requirements			Product Category and Test Requirements			Category and Test Requirements		Product Category and Test Requirements			
Compressed Natural Gas (CNG)	0.6 – 0.8 (1=Air)	Comp gas	Nonpotable	72 <sup>5</sup>	Water			Urea	Fert		
Anhydrous Ammonia	0.61	Comp liq	Potable	72 <sup>5</sup>	Water			Diesel exhaust fluid	DEF		
Butane	0.595	Comp liq	Tap Water	72 <sup>5</sup>	Water			Bicep	Flow		
								Broadstrike	Flow		
Typical Products	Specific Gravity <sup>2</sup> (60 °F)	Product Category				Test C		Typical Products	Product Category		
						Product Category: Flowables (Flow)					
Ethane		Comp liq				Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Doubleplay	Flow		
Freon 11	1.49	Comp liq				Bicep	20 – 900	Dual	Flow		
Freon 12	1.33	Comp liq				Broadstrike	20 – 900	Guardsman	Flow		
Freon 22	1.37	Comp liq				Doubleplay	20 – 900	Harness	Flow		
Propane	0.504	Comp liq				Dual	20 – 900	Marksman	Flow		
Liquefied Natural Gas		Cryo LNG				Guardsman	20 – 900	Topnotch	Flow		
Liquefied Oxygen	0.66	Cryo LNG				Harness	20 – 900	Asphalt	Heated		
Nitrogen	0.31	Cryo LNG				Marksman	20 – 900	Bunker C	Heated		
Asphalt		Heated				Topnotch	20 – 900	Liquid Molasses	Liq Feed		
Bunker C	1.1	Heated				Test C		Product Category: Heated (Heated)		Molasses plus Phos Acid and/or Urea (TreaChle)	Liq Feed
Test A The following products must be individually tested and noted on the Certificate of Conformance.						Typical Products		Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)		Carbon Tetra-Chloride	Solv Cl
Typical Products	Specific Gravity <sup>2</sup> (60 °F)	Product Category				Asphalt		100 – 5000		Methylene-Chloride	Solv Cl
Compressed Hydrogen Gas (H or H2)	0.07 (1=Air)	Comp H2				Bunker C		11,200		Perchloro-Ethylene	Solv Cl
Liquid Carbon Dioxide	1.12 (-40 °F)	Liq CO2				Test C		Product Category: Liquid Feed (Liq Feed)		Trichloro-Ethylene	Solv Cl
						Typical Products		Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)		3-10-30	Sus Fert
						Liquid Molasses		8640		4-4-27	Sus Fert

<sup>5</sup> This data point is suspected to be lower than that of normal tap water supplied for residential consumption.



Mass Meter Product Category and Test Requirements	Magnetic Flow Meter Product Category and Test Requirements	Positive Displacement Flow Meter Product Category and Test Requirements		Turbine Flow Meter Product Category and Test Requirements	
		Molasses Plus Phos Acid and/or Urea (TreaChle)	2882	Compressed Hydrogen Gas (H or H2)	Comp H2
				Liquid Carbon Dioxide	Liq CO2

	<b>Test C</b> <b>Product Category:</b> Solvents Chlorinated (Solv Cl)		<b>Test D</b> To obtain coverage for a product category, test with one product in the product category. The Certificate of Conformance will cover all products in the category.	
	<b>Typical Products</b>	<b>Reference Viscosity<sup>1</sup> (60 °F) centipoise (cP)</b>	<b>Typical Products</b>	<b>Product Category</b>
	Carbon Tetra-Chloride	0.99	Liquefied Natural Gas	Cryo LNG
	<b>Test C</b> <b>Product Category:</b> Solvents Chlorinated (Solv Cl) continued		Liquefied Oxygen	Cryo LNG
	<b>Typical Products</b>	<b>Reference Viscosity<sup>1</sup> (60 °F) centipoise (cP)</b>	Nitrogen	Cry LNG
	Methylene-Chloride	0.46	Beverages	Water
	Perchloro-Ethylene	1	Deionized	Water
	Trichloro-Ethylene	0.6	Demineralized	Water
	<b>Test C</b> <b>Product Category:</b> Solvents General (Solv Gen)		Juices	Water
	<b>Typical Products</b>	<b>Reference Viscosity<sup>1</sup> (60 °F) centipoise (cP)</b>	Milk	Water
	Acetates	0.44	Nonpotable	Water
	Acetone	0.34	Potable	Water
	Ethylacetate	1.36	Tap Water	Water
	Hexane	0.34		
	MEK	0.45		
	Toluene	0.62		
	Xylene	0.86		
	<b>Test C</b> <b>Product Category:</b> Suspension Fertilizers (Sus Fert)			
	<b>Typical Products</b>	<b>Reference Viscosity<sup>1</sup> (60 °F) centipoise (cP)</b>		
	3-10-30	100 – 1000		

Mass Meter Product Category and Test Requirements	Magnetic Flow Meter Product Category and Test Requirements	Positive Displacement Flow Meter Product Category and Test Requirements		Turbine Flow Meter Product Category and Test Requirements
		4-4-27	20 – 215	

<b>Test D</b> To obtain coverage for a product category, test with one product in the product category. The Certificate of Conformance will cover all products in the category.	
<b>Product Category:</b> Water (Water)	
Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)
Beverages	1.0
Deionized	1.0
Demineralized	1.0
Juices	1.0
Milk	1.0
Nonpotable	1.0
Potable	1.0
<b>Test D</b> <b>Product Category:</b> Water (Water) continued	
Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)
Tap Water	1.0
<b>Test A</b> The following products must be individually tested and noted on the Certificate of Conformance.	
<b>Product Category:</b> Cryogenic Liquids and Liquefied Natural Gas (Cryo LNG)	
Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)
Liquefied Natural Gas	
Liquefied Oxygen	0.038
Nitrogen	1.07
<b>Test A</b>	

Mass Meter Product Category and Test Requirements	Magnetic Flow Meter Product Category and Test Requirements	Positive Displacement Flow Meter Product Category and Test Requirements	Turbine Flow Meter Product Category and Test Requirements				
		<div>The following products must be individually tested and noted on the Certificate of Conformance.</div> <div>Product Category: Compressed Hydrogen Gas (Comp H2)</div> <table><tr><th>Typical Products</th><th>Reference Viscosity<sup>1</sup> (60 °F) centipoise (cP)</th></tr><tr><td>Compressed Hydrogen Gas (H or H2)</td><td>0.0097</td></tr></table>	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Compressed Hydrogen Gas (H or H2)	0.0097	
Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)						
Compressed Hydrogen Gas (H or H2)	0.0097						
		<div>Test A</div> <div>The following products must be individually tested and noted on the Certificate of Conformance.</div> <div>Product Category: Liquid Carbon Dioxide (Liq CO2)</div> <table><tr><th>Typical Products</th><th>Reference Viscosity<sup>1</sup> (60 °F) centipoise (cP)</th></tr><tr><td>Liquid Carbon Dioxide</td><td>0.194</td></tr></table>	Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)	Liquid Carbon Dioxide	0.194	
Typical Products	Reference Viscosity <sup>1</sup> (60 °F) centipoise (cP)						
Liquid Carbon Dioxide	0.194						

Product Category Table – Category Abbreviations

Abbreviation	Product Category	Abbreviation	Product Category
Alc Gly	Alcohols, Glycols and Water Mixes Thereof	Fert	Fertilizers
CC-A	Crop Chemicals (Type A)	FL&O	Fuels, Lubricants, Industrial and Food Grade Liquid Oils
CC-B	Crop Chemicals (Type B)	Flow	Flowables
CC-C	Crop Chemicals (Type C)	Heated	Heated Products (Above 50 °C)
CC-D	Crop Chemicals (Type D)	Liq Feed	Liquid Feeds
Chem	Chemicals	Liq CO2	Liquid Carbon Dioxide
Comp gas	Compressed Gases	Solv Chl	Solvents Chlorinated
Comp H2	Compressed Hydrogen Gas	Solv Gen	Solvents General
Comp liq	Compressed Liquids (Fuels and Refrigerants, NH <sub>3</sub> )	Sus Fert	Suspension Fertilizers
Cryo LNG	Cryogenic Liquids and Liquefied Natural Gas	Water	Water
DEF	Diesel Exhaust Fluid		

*Note: The Typical Products listed in this table are not limiting or all-inclusive; there may be other products and product trade names, which fall into a product family. Water and a product such as stoddard solvent or mineral spirits may be used as test products in the fuels, lubricants, industrial, and food- grade liquid oils product family.*

## **D. Additional Criteria for Product Families for Mass Flow Meters**

When two liquids of different densities are tested the Certificate of Conformance (CC) for the mass flow meter will cover approved liquids with a specific gravity range from 0.1 above the highest specific gravity tested to 0.1 below the lowest specific gravity tested. The specific gravity range within the product group can be expanded by conducting an NTEP test with a liquid of higher or lower specific gravity than is covered on the existing CC.

Multi-product applications (that is, applications in which the meter will be used without a change to zero or calibration to dispense different products which vary in specific gravity by more than 0.1) must include a multi-product test. The multi-product initial test will be performed on the meter without a change to zero or calibration using multiple products having a difference in specific gravity of at least 0.2. For devices which will be used to dispense multiple products having a specific gravity range greater than 0.2, the multi-product testing must be performed over the anticipated range before multi-product applications will be included on the CC. For the multi-product testing, throughput testing will be performed on one or a combination of the products; testing for the subsequent test will be conducted on both products without a change to zero or calibration. The CC for a mass flow meter will cover multi-product applications where the specific gravity of a single product, or multiple products, varies by the amount tested throughout the entire approved specific gravity range of the meter.

Example: Where a meter has been tested and a certificate issued for multi-product with one liquid having a specific gravity of 0.7 and another liquid having a specific gravity of 1.0 and the meter is subsequently tested to expand the range with a liquid having a specific gravity of 1.6 the allowed variation of densities covered by the CC will be from 0.7 through 1.6. Multi-product testing requirements do not apply to meters used to dispense a product such as propane in which the density varies in normal operation.

## **E. Meter Sizes to be Included on a Certificate of Conformance (CC)**

Based upon the test of a meter (or meters), meters larger and smaller than the meter(s) tested and meeting the following criteria may be covered by the CC:

1. Meter sizes with rated maximum flow rates of 50% to 200% of the rated maximum flow rate of the meter tested; and
2. Meter sizes with rated minimum flow rates of 50% to 200% of the rated minimum flow rate of the meter tested.
3. The maximum flow rate achieved in an installation is considered to be 80% of the maximum flow rate to be listed on the CC.

## F. New Product Applications for Meters

### Meter Sizes Covered with Adding a New Product

CC Covers	Test	Tolerances Class <i>NIST Handbook 44</i>	Product Family <i>NCWM Pub 14</i>	New CC Covers	Example (to be added)
Application for New CC	1 meter	Any Accuracy Class (Tolerance)	Any Product Family	Policy E.	
Range of Sizes	1 meter	Same or New Accuracy Class with Greater Tolerance	Same Product Family	Current Range of Sizes + Policy E.	
Range of Sizes	1 meter	New Accuracy Class with Smaller Tolerance	Same Product Family	Policy E.	
Range of Sizes	1 meter	Any Accuracy Class	New Product Family	Policy E.	
Range of Sizes with Two (2) or More Accuracy Classes <u>And</u> <sup>6</sup> Two (2) or More Product Families	1 meter	Any Accuracy Class	Any Product Family	Current Range of Sizes + Policy E.	

If the product being added is from a family of products that has been previously subjected to the permanence test, then the requirement for a permanence test may be waived provided the initial test of the product being added meets the following conditions:

- b. The results of the initial test were not questionable; and
- c. Multi-point calibration may not be used to add the new product.

## G. Range of Data Points

The number and types of tests to be run on devices covered under this checklist are specified in the Checklist and Test Procedures section and the Field Evaluation and Permanence Tests for Metering Systems section of this checklist. However, if the NTEP laboratory feels that there is a performance or other *NIST Handbook 44* related problem and provides reasons to support this belief, the laboratory is given the latitude to require additional testing.

A measuring element may use factory-established linearization curves to establish the minimum flow range (5:1, 10:1, or as required), providing the linearization programming is installed during manufacturing and the programming cannot be altered after leaving the factory.

Auxiliary equipment (e.g., indicator or register) with programmable multi-point calibration that alters the output signal from the measuring element to extend the flow range of the system beyond the measuring element's required minimum flow range may be used and the auxiliary device's multi-point calibration will be noted on the Certificate of Conformance and must be marked on the meter.

## H. Listing of Stacked Sales for Electronic Cash Registers Interfaced with **Retail Motor Fuel Dispensers**

If an electronic cash register (ECR) interfaced with **retail motor fuel** dispensers can be programmed to accept stacked, completed sales, then the Certificate of Conformance (CC) must indicate that this option is permitted only when the ECR is provided with an uninterruptible power supply or other means of recalling stacked sales information in the event of a power failure. If the cash register is equipped with the stacked sales option, but the option is not programmable, then the CC must limit the use of the ECR to applications in which an uninterruptible power supply or other means of recalling stacked sales information in the event of a power failure is provided.

<sup>6</sup> For Mass Flow Meter with two (2) or more Accuracy Classes or two (2) or more Product Families.

## I. Guidelines for Requiring Serial Numbers on Devices

A serial number is required on equipment in the following circumstances:

1. **Separate Device:** A device is capable of operating as a weighing or measuring device without interfacing with or connecting to other components.
2. **Separate Main Element:** Primary indicating elements must be marked. The device is a major element in the weighing or measuring system, which means, it is metrologically significant to the operation and/or performance of the system and interfaces with different compatible main elements. Examples: Indicating Elements, Meter Registers and Meter Measuring Elements (Vehicle-Tank Meters and Loading-Rack Meters.)
3. **Component:** The device is a component in a system, may be used in different models of devices, and is sufficiently complex to warrant a separate evaluation and a separate Certificate of Conformance (CC) (e.g., load cells and vapor recovery nozzles.) Such a device may or may not be placed into an enclosure with other components of the system. When installed in an enclosure, the complete device must be marked with a serial number and the one serial number will suffice for the entire collection of components. If not placed in an enclosure with other components, the component must be marked with a serial number.

### Examples

#### Retail Motor Fuel Dispensers:

- Whole unit requires a serial number.
- Indicating elements do not require a serial number unless it is a replacement kit with a CC.
- Measuring element does not require a separate serial number.
- The measuring element is metrologically significant because it affects the operation of the system as a whole; however, it is always enclosed in a housing, which has a serial number for the whole device.

*Note: A conventional nozzle on a retail motor fuel dispenser is not a sufficiently complex device to warrant a separate type evaluation or a serial number. The nozzle does not affect the accuracy of the delivery. A separate requirement addresses the anti-drain valve. A vapor recovery nozzle does warrant a separate evaluation because it is a complex device and has the potential to affect the accuracy of the device during the normal operation of the device. One model of vapor recovery nozzle can be used on many models of dispensers. Thus, it is reasonable to require a vapor recovery nozzle to be marked with a serial number.*

#### Vehicle-Tank Meter:

- A serial number is required on the meter; it is a major component of the system because it is required for the system to operate.
- A serial number is required on the indicating elements.

## J. Vapor Recovery Option

If a retail motor fuel dispenser includes a vapor recovery option, the following statement will be included on the Certificate of Conformance: "No NTEP testing has been performed on the device equipped with vapor recovery option or equipment to determine compliance with air resources board requirements."

## K. Policy on Remanufactured and Repaired Devices

Refer to the Section M, Policy on Remanufactured and Repaired Devices in the *NCWM Publication 14 Administrative Policy*.

## L. Cash Acceptors – Marketing

Certificates of Conformance will cover the use of the cash acceptor option at both attended and unattended stations. Cash acceptors, which are used at unattended locations, must meet the marking requirements of paragraph G-UR.3.4. Responsibility, Money-Operated Devices shall have clearly and conspicuously displayed on the device or immediately adjacent to the device information detailing the return of monies paid when the product cannot be obtained.

## M. Customer Display on Vehicle-Tank Meters

Paragraph G-UR.3.3. requires the primary indicating element to be visible from a reasonable customer position. Many electronic vehicle-mounted metering/controlling systems on which transaction information is displayed are mounted inside the cab of the delivery vehicle. This location is not considered visible from a reasonable customer position. Some systems provide a remote customer display as a standard feature, and some do not. The application section of any Certificate of Conformance issued to a vehicle-mounted metering/controlling system must limit the system to installations where a customer indicator is provided and located in a reasonable customer position (e.g., at the meter on the rear of the vehicle.)

## **N. Compact Provers**

Provers other than volumetric neck-type are permitted for use in performing both field and laboratory portions of an NTEP test. If the policy of the weights and measures jurisdiction with authority over a device undergoing type evaluation does not recognize the use of compact provers for official tests, it is recommended that the weights and measures jurisdiction perform an official test following the completion of the NTEP permanence test.

## **O. Loading Rack Meter Controllers with Blending Capabilities**

In addition to the Common and General Code Criteria and applicable sections of the Wholesale and Loading Rack Meters and other Checklists, the following applies to tests of Loading Rack Meter Controllers with Blending Capabilities:

1. For NTEP testing, it is acceptable for the sum of the total quantity printed/displayed for each component of the blend to be different from the total quantity delivered due to intermediate rounding of each component. For example, if the quantity for each component has a higher internal resolution than that displayed, the displayed/printed quantity will be a rounded value. If each component of the blend is rounded in this way, the sum of the components may be different (due to rounding) than the actual quantity delivered by the system.
2. No mathematical correction is permitted to account for growth or shrinkage due to blending of product.

## **P. Turbine Meters with both Vertical and Horizontal Orientation**

In addition to the Common General Code Criteria, Common Specific Code Criteria, and the Field Evaluation and Permanence Tests, the following applies to tests of turbine meters designed for use in both vertical and horizontal orientations, and/or in both directions of flow due to the effect on meter performance.

For NTEP testing of a meter that may be installed in multiple orientations (e.g., horizontal, vertical, or other), at least one meter must be tested in each orientation. For meters that are designed as “bi-directional,” at least one meter must be tested in both directions of flow.

Limitations in orientation or direction of flow must be addressed as follows:

- Direction of flow (e.g., bi-directional or uni-directional) must be marked on the meter as well as listed in the Certificate of Conformance.
- Limitations regarding the orientation (e.g., horizontal or vertical) must be specified in the Certificate of Conformance; however, these limitations are not required to be marked on the meter.
- In the case of a meter approved for use in other than a horizontal orientation, limitations regarding the upward/downward flow must be specified in the Certificate of Conformance; however, these limitations are not required to be marked on the meter.

## **Q. New Certificate of Conformance (CC) for Mass Flow Meter Indicating Only in Units of Volume or Adding Volume Measurement to Existing Mass Flow Meter CC**

The NTEP laboratory must test a mass flow meter with products as outlined in the family of products table to include volume units of measurement on a mass flow meter CC. This policy applies regardless of whether or not the meter is covered by an existing CC for mass units. It would result in re-testing products in the volume mode that were previously tested in the mass mode.

Testing for a mass flow meter indicating only in units of volume or to add volumetric units to a MFM CC can be done volumetrically using volumetric test procedures used for other volumetric meters or gravimetrically using gravimetric test procedures outlined in *NCWM Publication 14* and the minimum test criteria (kinds and number of tests) outlined for mass flow meters. The volume indication of the meter shall be based on the mass measurement and an automatic means to determine and correct for changes in product density. The method used to determine product density for gravimetric tests will

be reviewed by NTEP on a case-by-case basis to allow the manufacturer flexibility in determining density for various product types and applications. Testing will not result in an approval of the density indication feature on the CC. *Note: To add volume units, the test of only one meter size is required to cover the whole family of meter sizes listed on the original CC.* Only an initial test is required for each new product. A subsequent permanence test is not required. The CC for a meter tested with only one measurement unit will cover only that unit of measure and will be noted in the application section of the CC.

## **R. Vehicle-Mounted and Stationary Applications of Meters and Registers**

If a meter or register is successfully tested in a vehicle-mounted application, both vehicle-mounted and stationary applications can be covered on the resulting NTEP Certificate of Conformance (CC) without additional testing in a stationary application provided all other suitability criteria have been met (e.g. flow rates.) If a meter or register evaluation has only been conducted in a stationary application, testing must also be conducted on the meter or register in a vehicle-mounted application in order to cover both applications on the NTEP CC.

## **S. Changing the Device Category for Devices Sealed with an Audit Trail**

If a manufacturer with a Certificate of Conformance (CC) for a device that uses an audit trail to meet the sealing requirements wants to change the device category for the audit trail, the CC for the device must be amended and the device will be subject to at least a partial initial evaluation. Performance testing is not required. Based on results of the initial evaluation, NTEP may determine that further evaluation is required.

## **T. Testing Required to Interface Indicators and Measuring Elements with Individual Certificate of Conformance's (CC) That Were Not Previously Tested Together**

Additional testing by an NTEP Participating Laboratory is not required if an electronic indicator is interfaced to a measuring element provided all of the following are true:

- a. The communication means for the input to the electronic indicator (pulse, frequency, serial, etc.) has been previously tested with a measuring element listed on a CC.
- b. The communication means for the output of the measuring element (pulse, frequency, serial, etc.) has been previously tested with an electronic indicator listed on a CC.
- c. The communication means to be used for the electronic indicator input is the same as the communication means to be used for the measuring element output (pulse-pulse, frequency-frequency, serial-serial, etc.) and both devices are being used within the current parameters listed on their respective CCs.
- d. The devices are communicating with each other and the system into which they are installed can be accurately calibrated.
- e. If required, *NIST Handbook 44* compliant tickets can be printed.

*Note: NTEP may require Initial or Complete evaluation of new technologies or applications.*

## **U. Evaluating Electronic Indicators Submitted Separate from a Measuring Element**

When evaluating electronic indicators submitted separate from a measuring element, simulated inputs (e.g. meter pulse, temperature, pressure, density, communications, etc.) may be used as follows:

1. For the initial testing of the indicator.
2. For software changes to a device with an existing CC.



## V. List of Price and Quantity Markings on Retail Motor Fuel Dispensers (RMFDs)

### List of Price and Quantity Markings on RMFDs (Does Not Apply to Receipt Format)

Total Sale Acceptable	Unit Price Acceptable	Delivered Quantity Acceptable
Total Sale \$ 000.00 Total \$ 000.00 This Sale \$ 000.00 Purchase \$ 000.00 Total Purchase \$ 000.00 Sale \$ 000.00	Unit Price \$ 0.000 Price Per Gallon \$ 0.000 Price/Gallon \$ 0.000 Price Per Liter \$ 0.000 Price/Liter \$ 0.000 Price Per GGE \$ 0.000 (CNG Only) Price/GGE \$ 0.000 (CNG Only) Price Per GLE \$ 0.000 (CNG Only) Price/GLE \$ 0.000 (CNG Only) Price Per kg \$0.00 (Hydrogen Only) Price/kg \$ 0.00 (Hydrogen Only) Price Per Unit \$ 0.000 Price/Unit \$ 0.000	Gallons Gal Liters L or l GGE (CNG Only) GLE (CNG Only) kg (Hydrogen Only)
Total Sale Unacceptable	Unit Price Unacceptable	Delivered Quantity Unacceptable
\$ 000.00	Price Per Vol Price/Vol \$/G \$0.000 \$/Gal \$0.000 \$/Liter \$0.000 \$/L \$0.000 \$/l \$0.000 Price Per kg \$ 0.000 (Hydrogen Only) Price/kg \$ 0.000 (Hydrogen Only)	G Unit Volume Vol k KG

## W. Relative Error

$$\text{Percent Error} = [(\text{Indicated} - \text{Actual}) / \text{Actual}] \times 100$$

Where "Actual" = the amount delivered corrected for appropriate influence factors.



# National Type Evaluation Program

## Liquid Measuring Devices – Checklists and Test Procedures

### Introduction

This checklist contains criteria that are common to the codes, which apply to **retail motor fuel** devices, wholesale meters, and LP gas meters. The checklist is designed so that the user can determine and record the conformance of the device with the elements of the checklist in a logical sequence. It is suggested that the user copy the checklist to serve as worksheets, and thus, preserve the original for reference. Unless specifically requested to do so, the applicant is not required to submit a completed checklist to National Type Evaluation Program (NTEP) prior to the evaluation; however, the applicant is urged to carefully review the checklist prior to submission to ensure that the device meets the requirements of the checklist. In most cases, the results of evaluation for each element can be recorded by checking the appropriate response. In some cases, the user is required to record values, results, or comments. In those cases, space is provided.

This checklist is a guide for conducting prototype examinations to determine compliance with the requirements of *NIST Handbook 44*. These criteria shall apply only to type evaluation examinations, not on a retroactive basis to devices currently in service. The General Code requirements apply to all classes of devices. The specific code requirements supersede General Code requirements in all cases of conflict.

### 1. General

#### Code Reference: G-S.1. Identification

Virtually all weighing and measuring equipment must be clearly and permanently marked with, or display, the manufacturer's name or trademark, model designation, and serial number. Service station dispensers, consoles, cash registers interfaced with dispensers, retrofit computing registers, and customer card-activated terminals must all have these markings. As a practical matter, some equipment need not have a serial number. "Satellite" modules in a modular system (e.g., keyboard module and cash drawer) need not have serial numbers because they do not have any "intelligence." A serial number is required in the following circumstances:

#### Separate Device

A device is capable of operating as a weighing or measuring device without interfacing with or connecting to other components.

#### Separate Main Element

Primary indicating elements must be marked. The device is a major element in the weighing or measuring system, which means, it is metrologically significant to the operation and/or performance of the system and interfaces with different compatible main elements. Examples include the following: indicating elements, weighing elements, meter registers, meter measuring elements (vehicle tank meters and loading rack meters.)

#### Component

The device is a component in a system, may be used in different models of devices, and is sufficiently complex to warrant a separate evaluation and a separate CC (e.g., load cells and vapor recovery nozzles.) Such a device may or may not be placed into an enclosure with other components of the system. When installed in an enclosure, the complete device must be marked with a serial number, and the one serial number will suffice for the entire collection of components. If not placed in an enclosure with other components, the component must be marked with a serial number.

The following are examples of the application of these criteria:

#### **Retail Motor Fuel Dispensers:**

- Whole unit requires a serial number.
- Indicating elements do not require a separate serial number.
- Measuring element does not require a separate serial number.
- The measuring element is metrologically significant because it affects the operation of the system as a whole; however, it is always enclosed in a housing, which has a S/N for the whole device.

*Note: A conventional nozzle on a retail motor fuel dispenser is not a sufficiently complex device to warrant a special type evaluation or a serial number. The nozzle does not affect the accuracy of the delivery. A separate requirement addresses the anti-drain valve. A vapor recovery nozzle does warrant a separate evaluation because it is a complex device, and it does have the potential to affect the accuracy of the device during the normal operation of the device. One model of vapor recovery nozzle can be used on many models of dispensers. The proper operation of a vapor recovery nozzle and system is "important" as defined by federal regulations. Thus, it is reasonable to require a vapor recovery nozzle to be marked with a serial number.*

#### **Vehicle Tank Meters**

- Serial number is required on the meter; it is a major component of the system since it is required for the system to operate.
- Serial number is required on the indicating elements.

#### **Markings:**

Equipment must be marked on a surface that is an integral part of the device, and the marking must be visible after installation. If the required information is not positioned in a visible location after installation, a duplicate, permanent identification badge must be located in a visible location after installation. A removable cover is an acceptable location for the required information only if a permanent ID badge is located elsewhere on the device.

The information may be on a metal or plastic plate that is attached with pop rivets, adhesive, or other means, but removable bolts or screws are not permitted. A foil or vinyl badge may be used provided that it is able to survive wear and tear, remains legible, and is difficult to remove. The printing on a foil badge must be easily readable and not easily obliterated by rubbing with a relatively soft object (e.g., the wood of a pencil.)

Location of the information:

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All equipment shall be clearly and permanently marked on an exterior surface that is visible after installation with the following information (prefix lettering may be initial capitals, all capitals, or all lower case):

#### **Code Reference: G-S.1. (a)**

- 1.4. The name, initials, or trademark of the manufacturer or distributor. ☐ Yes ☐ No ☐ N/A

#### **Code Reference: G-S.1. (b)**

- 1.5. A model identifier that positively identifies the pattern or design of the device. The model identifier shall be prefaced by the word "Model," "Type," or "Pattern." These terms may be followed by the word "Number" or an abbreviation of that word. ☐ Yes ☐ No ☐ N/A
- 1.5.1. The abbreviation for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.) ☐ Yes ☐ No ☐ N/A
- 1.5.2. The abbreviation for the word "Model" shall be "Mod" or "Mod." Prefix lettering may be initial capitals, all capitals, or all lower case. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.1. (c)**

- 1.6. Except for equipment with no moving or electronic component parts and software, a non-repetitive serial number. ☐ Yes ☐ No ☐ N/A
- 1.6.1. The serial number shall be prefaced by the words "Serial Number" or an abbreviation, or a symbol, that clearly identifies the number as the required serial number. ☐ Yes ☐ No ☐ N/A
- 1.6.2. Abbreviations for the word "Serial" shall, as a minimum, begin with the letter "S," and abbreviations for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., S/N, SN, Ser. No, and S No.) ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.1. (d)**

- 1.7. Not built-for-purpose, software based devices shall be marked with the following. ☐ Yes ☐ No ☐ N/A  
Note: Effective January 1, 2022, this will apply to all software-based devices (or equipment).
- 1.7.1. the current software version or revision identifier designation. ☐ Yes ☐ No ☐ N/A
- 1.7.2. The version or revision identifier shall be prefaced by the word "Version" or "Revision" as appropriate and either word may be followed by the word "Number." ☐ Yes ☐ No ☐ N/A

If the equipment is capable of displaying the version or revision identifier but is unable to meet the formatting requirement, through the NTEP type evaluation process, other options may be deemed acceptable and described in the CC.

If this option is used, describe the option below:

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- 1.7.3. The version or revision identifier shall be continuously displayed or be accessible via the display. Instructions for displaying the version or revision identifier shall be described in the CC. As an alternative, permanently marking the version or revision identifier shall be acceptable providing the device does not always have an integral interface to communicate the version or revision identifier. ☐ Yes ☐ No ☐ N/A

If this option is used, describe the option below:

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- 1.7.4. Abbreviations for the word "Version" shall, as a minimum, begin with the letter "V." Abbreviations for the word "Revision" shall, as a minimum, begin with the letter "R." The abbreviations for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.). Prefix lettering may be initial capitals, all capitals, or all lowercase. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.1. (e)**

- 1.8. An NTEP Certificate of Conformance (CC) Number or a corresponding CC addendum number for devices that have (or will have) a CC. ☐ Yes ☐ No ☐ N/A

- 1.8.1. The number shall be prefaced by the terms "NTEP CC," "CC," or "Approval." These terms may be followed by the word "Number" or an abbreviation for the word "Number." ☐ Yes ☐ No ☐ N/A

- 1.8.2. The abbreviation for the word "Number" shall as a minimum begin with the letter "N" (e.g., No or No.) ☐ Yes ☐ No ☐ N/A

The device must have an area, either on the identification plate or on the device itself, suitable for the application of the Certificate of Conformance Number. If the area for the CC number is not part of an identification plate, then note its intended location below and how it will be applied. ☐ Yes ☐ No ☐ N/A

Location of CC Number if not located with the identification information:

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#### Permanence of Lettering:

The following test procedure shall be used to determine the permanence of the identification markings. The lettering for the markings is subjected to the following tests to simulated accelerated wear. The markings are then compared with a typical set of labels exhibiting various degrees of wear, graded from minimal effect (7) to excessive unacceptable wear (1).

Attempts are made to remove the marked information whether on a badge (plate) or on the device itself, using the following means.

1. Rub over one letter of the marking at least 20 times using an ink eraser in the same manner and force as one would normally exert while erasing an inscription written with a ball point pen.

*Note: For consistency of application, all NTEP labs are to use Eberhard Faber ink eraser type #110 (no longer commercially available); the Papermate Black Pearl; or the Papermate Union 110.*

2. Clean the marking or badge with the following cleaners presumed to be "readily available."
  - a. Disinfecting cleaning liquid and a damp cloth.
  - b. "Soft" household cleaning powder and a damp cloth.
  - c. Window cleaning fluids and a damp cloth.

*Note: For consistency of application, NTEP labs use "409," Bon Ami, and Windex brands of products for tests in parts 2a., b., and c., respectively.)*

Marking information remains legible after following the above procedures: ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.1.1. Location of Marking Information for Not Built-for-Purpose, Software-Based Devices**

1.9. For not built-for-purpose, software-based devices the following shall apply:

- |          |                                                                                                                                                                                                                                                            |                              |                             |                              |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|
| 1.9.1.   | The required information in G-S.1 Identification. (a), (b), (d), and (e) shall be permanently marked or continuously displayed on the device. <b>OR</b>                                                                                                    | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.9.2.   | The Certificate of Conformance Number shall be:                                                                                                                                                                                                            | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.9.2.1. | Permanently marked on the device. <b>OR</b>                                                                                                                                                                                                                | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.9.2.2. | Continuously displayed. <b>OR</b>                                                                                                                                                                                                                          | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.9.2.3. | Accessible through an easily recognized menu and, if necessary, a submenu. Examples of menu and submenu identification include, but are not limited to "Help," "System Identification," "G S.1. Identification," or "Weights and Measures Identification." | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |

*Note: For (1.6.2.), clear instructions for accessing the information required in G-S.1. (a), (b), and (d) shall be listed on the CC, including information necessary to identify that the software in the device is the same type that was evaluated.*

- |       |                                                              |                              |                             |                              |
|-------|--------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|
| 1.10. | The identification badge must be visible after installation. | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.11. | The identification badge must be permanent.                  | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |

**Code Reference: G-S.2. Facilitation of Fraud**

This applies to all metering systems, including retail **fuel** dispensers that are controlled from a remote location, vehicle tank meters, and LP gas meters. An exception is permitted if the unit price can be changed at a retail **fuel** dispenser only through the use of a key to gain access to the unit price mechanism, (e.g., mechanical computing registers.) Such action would be obvious to a consumer and would inhibit changing the unit price during a delivery.

This requirement addresses the process of changing the unit price or unit prices set in a metering system, but not the selection of a unit price from prices among several posted on a **retail motor fuel** dispensing system. Specific criteria for selecting unit prices for **retail motor fuel** dispensers are given in the **retail motor fuel** section of the checklist.

- |       |                                                                                                                                                                             |                              |                             |                              |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|
| 1.12. | The system shall prevent a change of unit price during a delivery or, in the case of a retail <b>fuel</b> dispenser, while the operating mechanism is in the "on" position. | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|

**Authorization of Stacked Sales**

Service station consoles, which are capable of stacking prepaid sales, shall not be capable of automatically authorizing a stacked sale immediately upon completing the previous transaction. The console operator cannot maintain adequate control over a console with automatic authorization capability. To avoid facilitation of fraud, the console operator must maintain control over the transaction process until the customer who has paid for a prepaid, stacked sale is ready to begin dispensing the product.

For the operator to maintain control over the transaction, the operator should be required to perform some step or operation, which would give final authorization to the stacked sale after the previous sale has been completed. For example, if the operator must press an "authorization" key before the subsequent stacked transaction can begin, the operator can maintain control over the transaction. The operator would not press the authorization key to authorize a stacked sale if the customer waiting at the dispenser is not the customer who paid for the stacked sale.

- |       |                                                                                                                                                                    |                              |                             |                              |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|
| 1.13. | A service station console shall not be capable of automatically authorizing a sale immediately upon the completion of the previous transaction for that dispenser. | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|

**Code Reference: G-S.3. Permanence**

- 1.14. Equipment shall be of such materials, design, and construction that, under normal service conditions:

- |                                                                |                              |                             |                              |
|----------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|
| 1.14.1. Accuracy will be maintained.                           | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.14.2. Operating parts will continue to function as intended. | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.14.3. Adjustments will remain reasonably permanent.          | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |

**Code Reference: G-S.4. Interchange or Reversal of Parts**

If a metering system has parts that interchange or reverse in normal field assembly, the system shall either be constructed so that reversal will not affect the accuracy of the system or the parts must be marked to indicate their proper position. For most metering devices, this applies only to the reversal of connectors or cables to peripheral devices.

- 1.15. If a metering system has any parts that may be interchange or reverse in normal field assembly, the parts must either be:

- |                                                                             |                              |                             |                              |
|-----------------------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|
| 1.15.1. Constructed so that reversal will not affect performance. <b>OR</b> | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.15.2. Marked or keyed to indicate the proper position.                    | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |

**Code Reference: G-S.5.1. and G-S.5.2.2. Indicating and Recording Elements**

Several requirements of a general nature facilitate the reading and interpretation of displayed values. Each display for quantity or total price must be appropriate in design and have sufficient capacity for particular applications to be suitable for the application. For example, retail **fuel** dispensers capable of indicating to 99.999 liters or gallons or \$99.99 are appropriate for automobiles at today's prices, but that are unsuitable for **fueling** trucks where deliveries may regularly exceed 100 liters or gallons and \$100. Metering devices must be capable of indicating the maximum quantity and money values that can normally be expected in a particular application.

- |                                                                                                                                                                                   |                              |                             |                              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------|------------------------------|
| 1.16. The maximum money value and quantity indications and unit prices are appropriate for the intended use.                                                                      | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.17. The indications must be clear, definite, and accurate.                                                                                                                      | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.18. The indications must be easily read under normal operating conditions.                                                                                                      | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.19. Totalizer values must be accurate to the nearest minimum interval with decimal points displayed or subordinate digits adequately differentiated from others, if applicable. | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.20. Symbols for decimal points shall clearly identify the decimal position. (Generally acceptable symbols are dots, small commas, or x.)                                        | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.21. The zero indication must consist of at least the following minimum indications as appropriate:                                                                              | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.21.1. One digit to the left and all digits to the right of a decimal point.                                                                                                     | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.21.2. If a decimal point is not used, at least one active decade plus any constant zeros.                                                                                       | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |
| 1.21.3. A fixed or constant zero cannot appear after a decimal point, (e.g., all decades to the right of a decimal point must be active).*                                        | <input type="checkbox"/> Yes | <input type="checkbox"/> No | <input type="checkbox"/> N/A |

\*A fixed zero may appear after a decimal point on a receipt and/or console if the system is unable to distinguish if the digit is fixed or active.



## 2. Graduations, Indications and Recorded Representations

### Code Reference: G-S.5.2.1. Analog

- 2.1. An analog device must have graduations and a suitable indicator to provide an accurate indication of quantity and money values. ☐ Yes ☐ No ☐ N/A

### Code Reference: G-S.5.2.3. Size and Character

Digits used for comparable values must be uniform in size and character, but subordinate values may be displayed in different and less prominent digits than more significant values may be displayed. The latter more likely occurs on analog devices. In digital indications, the digits are usually uniform throughout a particular display. The size of digits differs for different quantities. For example, the quantity and unit price digits may be smaller than the total price digits.

- 2.2. Corresponding graduations shall be uniform in size and character. ☐ Yes ☐ No ☐ N/A
- 2.3. Subordinate graduations, indications, and recorded representations shall be appropriately portrayed or designated. ☐ Yes ☐ No ☐ N/A

### Code Reference: G-S.5.2.4. Values Defined

- 2.4. Values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations and uniformly placed so that they do not interfere with the accuracy of the reading. ☐ Yes ☐ No ☐ N/A

### Code Reference: G-S.5.2.5. Permanence

- 2.5. Graduations, indications, or recorded representations and their defining figures, words, and symbols shall be of such character that they will not easily become obliterated or illegible. ☐ Yes ☐ No ☐ N/A

### Code Reference: G-S.5.3. and G-S.5.3.1. Values of Graduated Intervals or Increments

- 2.6. Graduations, digital and analog indications and recorded representations shall be uniform in size, character, and value throughout any series. Graduations must have a regular pattern, and the increments must be consistent. Quantity values shall be defined by the specific unit of measure in use. ☐ Yes ☐ No ☐ N/A
- 2.7. Graduations and indications shall be uniform throughout any series. ☐ Yes ☐ No ☐ N/A
- 2.8. Quantity values shall be identified by the unit of measure. ☐ Yes ☐ No ☐ N/A

### Code Reference: G-S.5.4. Repeatability of Indications

The quantity measured by a device shall be repeatable within tolerance for the same indication. One condition that may create a problem is that the value of the quantity division may be large relative to the tolerance. A delivery must be within tolerance wherever the delivery is stopped within the nominal indication of the test draft. Meters that may be at the tolerance limit may be out of tolerance at an extreme limit of the nominal quantity indication.

- 2.9. When a digital indicator is tested, the delivered quantity shall be within tolerance at any point within the quantity-value division for the test draft. ☐ Yes ☐ No ☐ N/A

### Code Reference: G-S.5.6. Recorded Representations

- 2.10. All recorded values shall be digital. *See also G-UR.3.3.* ☐ Yes ☐ No ☐ N/A
- 2.11. In applications where recorded representations are required, the customer may be given the option of not receiving the recorded representation. ☐ Yes ☐ No ☐ N/A
- 2.12. For systems equipped with the capability of issuing an electronic receipt, ticket, or other recorded representations, the customer may be given the option to receive any required information electronically ☐ Yes ☐ No ☐ N/A

(e.g., via cell phone, computer, etc.) in lieu of or in addition to a hard copy.

The electronic copy is provided:

2.12.1 In lieu of a hard copy of the recorded representation.

☐ Yes ☐ No ☐ N/A

2.12.2. In addition to a hard copy of the recorded representation.

☐ Yes ☐ No ☐ N/A

Describe the options provided:

2.12.3. Via Cell phone.

☐ Yes ☐ No ☐ N/A

2.12.4. Computer.

☐ Yes ☐ No ☐ N/A

2.12.5. Other (describe).

☐ Yes ☐ No ☐ N/A

#### **Code Reference: G-S.5.7. Magnified Graduations and Indications**

- 2.13. Magnified indications shall conform to all requirements for graduations and indications. ☐ Yes ☐ No ☐ N/A

#### **Code Reference: G-S.6. Marking, Operational Controls, Indications and Features**

All operational controls, indications, and features shall be clearly and definitely identified. Non-functional keys and annunciators shall not be marked because their marking implies that the key or annunciator is functional and should be inspected or tested by the enforcement official. Keys and operator controls that are visible to a customer in a direct sale transaction shall be marked with words or symbols to the extent that they can aid the customer to understand and make the transaction. Keys that are visible only to the console operator need to be marked only to the extent that a trained operator can understand the function of each key.

- 2.14. All operational controls, indications, and features including switches, lights, displays, and push-buttons shall be clearly and definitely identified. The use of approved pictograms or symbols shall be acceptable. ☐ Yes ☐ No ☐ N/A
- 2.15. All dual function (multi-function) keys or controls shall be marked to clearly identify all functions. ☐ Yes ☐ No ☐ N/A
- 2.16. Non-functional controls and annunciators shall not be marked. ☐ Yes ☐ No ☐ N/A

#### **Code Reference: G-S.7. Lettering, Readability**

- 2.17. Required markings and instructions shall be permanent and easy to read. ☐ Yes ☐ No ☐ N/A

#### **Code Reference: G-S.8. Sealing Electronic Adjustable Components; and Provision for Sealing Adjustable Components; Provision of metrological Data Change or Audit Trail and G-S.9. Metrologically Significant Software Updates.**

*Note: Also reference specific code requirements for sealing and audit trails including Liquid Measuring Devices Code paragraph S.2.2., Mass Flow Meters Code paragraph S.3.5, and other applicable specific code requirements.*

- 2.18. Electronic adjustable components that affect the performance of a device shall provide for an approved means of security (e.g. data change audit trail) or for physically applying a security seal. This includes components such as the mechanical adjustment mechanism of meters; the electronic calibration factor and automatic temperature compensator for electronic meter registers; selection of pressure or density correction capability and correction values; and pulser setting and gallon/liter conversion switches when they may accidentally or intentionally be used to perpetrate fraud; and software updates that change the metrologically significant software. ☐ Yes ☐ No ☐ N/A

Appendix A provides the philosophy and list of sealable parameters that apply to provision for sealing all liquid measuring devices.

An electronic data audit trail is a means of allowing a weights and measures inspector to review how many times any electronic adjustment, which affects the accuracy of a weight or measurement, has been changed since the previous inspection. The information contained in the audit trail shall consist of an accumulative and non-destructible number (even if a power failure occurs) which increments each time any of the adjustments that are required to be sealed have been changed. The electronic data audit trail information shall be capable of being recalled by the official on the main display of the device.

As a minimum, devices, which use an audit trail to provide security for sealable parameters shall satisfy the following criteria and shall use the format, set forth in Appendix A, Minimum Requirements for Audit Trails for Liquid Measuring Devices.

### Sealing - General

In addition to satisfying the physical security sealing requirement; the presence of a physical seal shall clearly indicate that the setup or configuration mode (any mode permitting access to any or all sealable parameters based upon the application of the Philosophy for Sealing in *NCWM Publication 14*) of the device cannot be accessed without additional actions (e.g., removal of a jumper, pressing a key or switch, etc.) only possible after the removal of the seal.

If the use of a physical seal is the only approved method of sealing,; it shall not be possible to apply the physical seal with the device in the setup or configuration mode (any mode permitting access to any or all sealable parameters based upon the application of the Philosophy for Sealing in *NCWM Publication 14*) unless the device has a clear indication that the device is in this mode. See the list of acceptable and unacceptable indications below.

#### Applicable for Devices Using a Physical Seal

Technologist: _____	Remarks: _____
Control Number: _____	_____
Date: _____	_____
Time: _____	_____
Temp.: (°C) _____	_____
RH (%): _____	_____

#### Mechanism Used to Enter Calibration / Configuration:

Jumper	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Push-button (memory switch)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Toggle / Slide Switch	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Other (describe in remarks)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Meets Requirements	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A


#### Mechanism Effective Upon Exit of Calibration / Configuration in Approved Mode (when mechanism is properly set according to manufactures specifications)

Jumper	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Push-button (memory switch)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Toggle / Slide Switch	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Other (describe in remarks)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Meets Requirements	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A

*Note: Means of entering and exiting the calibration/configuration access mode shall be listed on the NTEP CC.*

#### Indications Representing That the Device is Configured with the Setup or Configuration Mode Enabled (i.e., any mode permitting access to any or all sealable parameters)

This list is not limiting or all-inclusive; other indications or pictograms may be acceptable.

Acceptable Clear Indications	Indications NOT Acceptably Clear
<ul style="list-style-type: none"> <li>Unusable quantity indications Example: <b>C100.05E</b></li> <li>“not <b>HB 44</b>” annunciator</li> <li>“CAL” annunciator (single or mixed case)</li> <li>“Set-up” annunciator (single or mixed case)</li> <li>“Config” annunciator (single or mixed case)</li> <li></li> </ul>	<ul style="list-style-type: none"> <li><b>C 100.05 gal</b></li> <li>Any digit in the quantity differentiated by size, shape, or color</li> <li>Quantities w/o units Example: <b>100.05</b></li> <li>Flashing quantity value</li> <li>Quantity with no annunciators displayed</li> <li>Quantity all annunciators displayed</li> </ul>

**Category 1 Devices (Devices with No Remote Configuration Capability):**

- 2.19. The device is sealed with a physical seal or it has an audit trail with two event counters (one for calibration, the second for configuration.) ☐ Yes ☐ No ☐ N/A
- 2.20. A physical seal must be applied without exposing electronics. ☐ Yes ☐ No ☐ N/A
- 2.21. Event counters are non-resettable and have a capacity of at least 000 to 999. ☐ Yes ☐ No ☐ N/A
- 2.22. Event counters increment appropriately. ☐ Yes ☐ No ☐ N/A
- 2.23. The audit trail information must be capable of being retained in memory for at least 30 days while the device is without power, or must be retained in nonvolatile memory. ☐ Yes ☐ No ☐ N/A
- 2.24. Accessing the audit trail information for review shall be separate from the calibration mode. ☐ Yes ☐ No ☐ N/A
- 2.25. Accessing the audit trail information must not affect the normal operation of the device. ☐ Yes ☐ No ☐ N/A
- 2.26. Accessing the audit trail information shall not require removal of any additional parts other than normal requirements to inspect the integrity of a physical security seal. (e.g., a key to open a locked panel may be required.) ☐ Yes ☐ No ☐ N/A

**Category 2 Devices (Devices with Remote Configuration Capability but Controlled by Hardware):**

- 2.27. The physical hardware enabling access for remote communication must be on-site. ☐ Yes ☐ No ☐ N/A
- 2.28. The physical hardware must be sealable with a security seal. **OR** ☐ Yes ☐ No ☐ N/A
- 2.29. The device must be equipped with at least two event counters: one for calibration, the second for configuration parameters: ☐ Yes ☐ No ☐ N/A
- 2.29.1. Calibration parameters event counter. ☐ Yes ☐ No ☐ N/A
- 2.29.2. Configuration parameters event counter. ☐ Yes ☐ No ☐ N/A
- 2.30. Adequate provision must be made to apply a physical seal without exposing electronics. ☐ Yes ☐ No ☐ N/A
- 2.31. Event counters are non-resettable and have a capacity of at least 000 to 999. ☐ Yes ☐ No ☐ N/A
- 2.32. Event counters increment appropriately. ☐ Yes ☐ No ☐ N/A
- 2.33. Event counters may be located either: ☐ Yes ☐ No ☐ N/A
- 2.33.1. At the individual measuring device. **OR** ☐ Yes ☐ No ☐ N/A
- 2.33.2. At the system controller ☐ Yes ☐ No ☐ N/A
- 2.34. If the counters are located at 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. ☐ Yes ☐ No ☐ N/A
- 2.35. An adequate number (see table below) of event counters must be available to monitor the calibration and configuration parameters of each individual device. ☐ Yes ☐ No ☐ N/A

**Minimum Number of Counters Required**

	<b>Minimum Counter(s) Required for Devices Equipped with Event Counters</b>	<b>Minimum Event Counter(s) at System Controller</b>
Only one type of parameter accessible (calibration or configuration.)	One (1) Event Counter	One (1) event counter for each separately controlled device, or one (1) event counter, if changes are made simultaneously.
Both calibration and configuration parameters accessible.	Two (2) Event Counters	Two (2) event counters for each separately controlled device, or two (2) or more event counters if changes are made to all controlled devices simultaneously.

**Category 3 Devices (Devices with Unlimited Remote Configuration Capability):**

Category 3 devices have virtually unlimited access to sealable parameters or access is controlled through a password.

- 2.36. For devices manufactured after January 1, 2001, the device must either:
- 2.36.1. Clearly indicate when it is in the remote configuration mode. **OR** ☐ Yes ☐ No ☐ N/A
- 2.36.2. The device shall not operate while in the remote configuration mode. ☐ Yes ☐ No ☐ N/A
- 2.37. The device is equipped with an event logger. ☐ Yes ☐ No ☐ N/A
- 2.38. The event logger automatically retains the identification of the parameter changed, the date and time of the change, and the new value of the parameter. ☐ Yes ☐ No ☐ N/A
- 2.39. Event counters are non-resettable and have a capacity of at least 000 to 999. ☐ Yes ☐ No ☐ N/A
- 2.40. The system is designed to attach a printer, which can print the contents of the audit trail. In addition to the hard copy, the information may also be made available electronically. ☐ Yes ☐ No ☐ N/A
- 2.41. The audit trail information must be capable of being retained in memory for at least 30 days while the device is without power or must be retained in nonvolatile memory. ☐ Yes ☐ No ☐ N/A
- 2.42. The event logger must 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. ☐ Yes ☐ No ☐ N/A
- 2.43. The event logger drops the oldest event when the memory capacity is full and a new entry is saved. ☐ Yes ☐ No ☐ N/A
- 2.43.1. Describe the method used to seal the device or access the audit trail information:

---



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**Code Reference: G-UR.1.1. Suitability of Equipment**

A device must be properly designed and have sufficient capacity to be suitable to use in a particular application. A device must measure the appropriate characteristics of a commodity to accurately determine the quantity, have the necessary components (e.g. vapor eliminator) to eliminate factors that may cause measurement errors during normal use, have sufficient capacity to indicate the quantity measured and the associated total price if it is a computing device. The meter must have the proper flow rate capacity to operate over the actual flow rates for the application, and the device must have a quantity division appropriate for the application. Some specific requirements for device characteristics are given in the specific codes for particular devices.

- 2.44. The equipment is suitable for its intended application. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-UR.1.2. Environment**

- 2.45. Equipment shall be suitable for use in the environment in which it will be used. ☐ Yes ☐ No ☐ N/A  
Suitability with respect to environment includes the effects of wind, weather, temperature variations, and radio frequency interference. A device must work and remain accurate under its actual conditions of use.

**Code Reference: G-UR.3.3. Position of Equipment**

Paragraph G-UR.3.3. requires that the primary indicating element be visible from a reasonable customer position. Many electronic vehicle-mounted metering/controlling systems on which transaction information is displayed are mounted inside the cab of the delivery vehicle. This location is not considered visible from a reasonable customer position. Some systems provide a remote customer display as a standard feature and some do not. The application section of any Certificate of Conformance issued to a vehicle-mounted metering/controlling system must limit the system to installations where a customer indicator is provided and located in a reasonable customer position (e.g., at the meter on the rear of the vehicle.)

## National Type Evaluation Program

### Liquid Measuring Devices – Checklists and Test Procedures for Common Specific Code Requirements

#### 3. Indicating Elements, Recording Elements and Recorded Representations

##### Code Reference: S.1.1. Primary Elements – General

- 3.1. A device shall be equipped with a primary indicating element. ☐ Yes ☐ No ☐ N/A
- 3.2. Is the device equipped with a primary recording element? ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.3. Advancement of Indicating and Recording Elements

Primary indicating and recording elements may advance only as a result of the mechanical operation of the device. However, during the process of re-setting the indicating and recording elements to zero, the elements may advance to zero provided that once the advancing movement is started, it cannot be stopped until zero is reached, in the case of indicating elements, the indications are automatically obscured during the reset process until the correct zero position is reached.

- 3.3. Indicating and recording elements shall advance only by the mechanical operation of the device (except for clearing the device to zero.) ☐ Yes ☐ No ☐ N/A
- 3.4. If the indicating and recording elements advance to zero during the reset operation, the advancing movement cannot be stopped until zero is reached, or in the case of indicating elements only, the elements shall automatically be obscured until the elements reach the correct zero position. ☐ Yes ☐ No ☐ N/A

#### 4. Graduations

##### Code Reference: S.1.4.1. Length

- 4.1. Graduations shall vary in length such that they may be conveniently read. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.4.2. and S.1.4.3. Width, Clear Interval between Graduations

For the purpose of visibility and ease of reading, several requirements exist for the length and width of graduations and the clear space between graduations. Although main graduations are permitted to be wider than subordinate graduations, it is recommended that all graduations be of uniform width. The clear interval between graduations must be at least 1.0 mm (0.04 in.) If the graduations are not parallel, then the clear interval is measured at specified points depending upon the type of indicator that is used. The points of measurement are (a) along the line of movement between the graduations and the end of the indicator, or (b) if the indicator extends over the entire length of the graduations measure at the point of widest separation of the graduations.

- 4.2. Graduations shall be at least 0.2 mm (0.008 in) wide. ☐ Yes ☐ No ☐ N/A
- 4.3. The clear interval between graduations shall be at least 1.0 mm (0.04 in.) ☐ Yes ☐ No ☐ N/A
- 4.4. Graduations shall not be wider than the clear interval between the graduations. ☐ Yes ☐ No ☐ N/A
- 4.5. Main graduations shall not be more than 50% wider than subordinate graduations. ☐ Yes ☐ No ☐ N/A

## 5. Indicators

To facilitate reading values indicated on analog indicating elements, the index of the indicator must have a shape, length, and width that promotes the accurate reading of values. The index must be properly positioned to reduce reading errors.

### Code Reference: S.1.5.1. Symmetry

- 5.1. The index shall be symmetrical with respect to the graduations. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.1.5.2. Length

- 5.2. The index shall reach to the finest graduations with which it is used unless the indicator and graduations are in the same plane. ☐ Yes ☐ No ☐ N/A
- 5.3. If the indicator and graduations are in the same plane, the distance between the end of the indicator and the ends of the graduations shall not exceed 1.0 mm (0.04 in.) ☐ Yes ☐ No ☐ N/A

### Code Reference: S.1.5.3. Width

- 5.4. Width of the index of an indicator:
- 5.4.1. The width of the index shall not exceed the width of narrowest graduation. This requirement applies to liquid measuring devices covered in *NIST Handbook 44* Section 3.30. Liquid Measuring Devices. ☐ Yes ☐ No ☐ N/A
- 5.5. The width of the index shall not exceed the width of the clear interval between graduations. ☐ Yes ☐ No ☐ N/A
- 5.6. If the index extends along the entire length of a graduation, the portion of the index that overlays the graduation shall be of constant width throughout the length of the graduation. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.1.5.4. Clearance

- 5.7. The clearance between the index and the graduations shall not exceed 1.5 mm (0.06 inch.) ☐ Yes ☐ No ☐ N/A

### Code Reference: S.1.5.5. Parallax

- 5.8. Parallax effects shall be reduced to practicable minimum. ☐ Yes ☐ No ☐ N/A

## 6. Measuring Elements

### Code Reference: S.2.1. Air/Vapor Elimination (LPG S.2.1.)

If air/vapor enters a measuring system or the product changes into the vapor state as it passes through the system, then the system must be equipped with an effective air/vapor eliminator or other automatic means to prevent the air/vapor from passing through the meter. To prevent the vapor eliminator vent lines from being pinched closed and re-opened without being detected, the vent lines shall be made of appropriate non-collapsible material. If the system is designed such that air/vapor will not enter the system, then an air/vapor eliminator is not required. One example is when a product is being pumped from the bottom of a tank and a low-level detector in the tank shuts off the pump before the liquid level gets to the point where air could enter the system.

- 6.1. The metering system is equipped with an effective air/vapor eliminator. ☐ Yes ☐ No ☐ N/A
- 6.2. Other effective, automatic means are provided to prevent air/vapor from passing through the system. Describe the means provided and list this information on the Certificate of Conformance. ☐ Yes ☐ No ☐ N/A
- 
- 6.3. The vent lines are made of appropriate non-collapsible material to prevent the lines from being pinched closed and re-opened without being detected. ☐ Yes ☐ No ☐ N/A



## National Type Evaluation Program

### Liquid Measuring Devices – Checklists and Test Procedures for **Retail Motor Fuel** Dispensers

#### 7. Indicating and Recording Elements

##### Code Reference: G-S.5.1. and G-UR.1.1. General

Indicating elements must be appropriately designed and adequate in amount. Specifically, a device must have sufficient display capacity to indicate the quantities and total prices, if it applies in the normal encountered specific application. Electronic devices shall either have sufficient display capacity to indicate the normal quantities and money values or automatically stop the delivery before exceeding the display capacity of either the quantity or total price. Analog indicating elements are required to have sufficient display capacity, or the device is not suitable for the application. This consideration may apply when evaluating a system that may be used in either a truck stop or an automobile service station.

- 7.1. Analog dispensers shall have adequate display capacity for the application. ☐ Yes ☐ No ☐ N/A
- 7.2. An electronic digital indicating element shall either:
- 7.2.1. Have adequate display capacity for the application. **OR** ☐ Yes ☐ No ☐ N/A
- 7.2.2. Automatically stop the delivery before exceeding the maximum quantity or maximum total price that can be indicated. ☐ Yes ☐ No ☐ N/A

##### Code Reference: G-S.5.2.2. Digital Indication and Representation; S.1.6.6. Agreement Between Indications

Basic operating requirements for devices are that:

- All digital values of like value in a system shall agree.
- A digital value shall agree with its analog representation to the nearest minimum graduation.
- Digital values shall round off to the nearest digital division that can be indicated or recorded.
- When a digital zero display is provided, the zero indication shall consist of at least one digit to the left and all digits to the right of the decimal point.

Due to limitations of some of the technologies used to transmit information from dispensers to service station consoles, some exceptions to these rules have been given to the indications on **retail motor fuel** dispensers and service station consoles. Exact agreement of digital quantity values is not required if only total price information is sent from the dispenser to the console. In these cases, the console calculates the quantity from the unit price set in the console. Consequently, the quantity indicated on the console may not agree exactly with the quantity indicated on the dispenser. However, if the console prints a customer receipt, then the quantity times unit price must equal the total price on both the dispenser and the printed receipt. In 2012, provisions were added to allow systems to apply post-delivery discounts. In cases where a system applies a post-delivery discount(s) to a fuel's unit price through an auxiliary element, the exception mentioned above does not apply and, therefore, the total volume quantity of the delivery shall be in agreement between all elements in the system. *See LMD Code S.1.6.6.*

Previously, the service station console was considered an auxiliary indication and did not have to satisfy the mathematical agreement requirement for money values (G-S.5.5.) A non-retroactive requirement effective January 1, 1988 requires all service station consoles installed after January 1, 1988 (not just new models) to satisfy the mathematical agreement of money values requirement (S.1.6.6.) The money value indication prior to the application of any post-delivery discount for dispensers and consoles must agree for all installations, both old and new.

For those systems consisting of a console and dispensers and equipped with pre-set volume, the dispenser must deliver at least the pre-set volume; it cannot deliver less. For example, if the console sends only the money equivalent of the pre-set volume to the dispenser, the dispenser shall deliver at least the pre-set volume. It may not stop at the first quantity amount that results in mathematical agreement with the money value equivalent of the pre-set volume if the quantity indication is less than the pre-set volume. Similarly, if a money value is pre-set, the dispenser is not properly designed if it always stops at the lowest quantity value that provides mathematical agreement with the pre-set money value.

Tests for agreement of digital values shall be performed in the post pay, prepay money, and pre-set volume modes. Agreement should be checked at several unit prices including the maximum unit price and with the dispenser operating at its maximum flow rate.

- 7.3. All total sale money value indications in a computing system are primary indications and must agree prior to the application of any post-delivery discount. ☐ Yes ☐ No ☐ N/A
- 7.4. Digital volume indications in a non-computing system must agree or "round off" to the nearest minimum unit that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A
- 7.5. Manual quantity entries in invoice billing systems must be identified as such. ☐ Yes ☐ No ☐ N/A
- 7.6. When delivery from a computing device is based upon a pre-set volume, the quantity indicated on the dispenser and any auxiliary device must be equal to or greater than the pre-set volume and the dispenser and remote console must comply with G-S.5.5. Money Values, Mathematical Agreement. ☐ Yes ☐ No ☐ N/A
- 7.7. The quantity, unit price, and total price indications on the console shall be in mathematical agreement prior to the application of any post-delivery discount.. ☐ Yes ☐ No ☐ N/A
- 7.8. The following applies when a quantity value indicated or recorded by an auxiliary element such as a console, ticket printer, or remote customer display, is a derived or computed value based on data received from a **retail motor fuel** dispenser. When a system applies a post-delivery discount(s) to a fuel's unit price through an auxiliary element, the total volume of the delivery shall be in agreement between all elements in the system. ☐ Yes ☐ No ☐ N/A
- 7.8.1. In systems that do not apply a post-delivery discount the quantity values indicated or recorded on a console, electronic cash register, or other auxiliary indicating or recording element may differ, however, for all systems: ☐ Yes ☐ No ☐ N/A
- 7.8.1.1. All indicated or recorded total money values for an individual sale shall agree. **AND** ☐ Yes ☐ No ☐ N/A
- 7.8.1.2. The indicated or recorded quantity, unit price, and total sales price values shall be in mathematical agreement to the closest cent (e.g., within each element, the values indicated or recorded must meet the formula [quantity x unit price = total sales price] to the closest cent.) ☐ Yes ☐ No ☐ N/A
- Examples: \$1.5549 rounds to \$1.55  
\$1.5551 rounds to \$1.56  
\$1.5550 rounds to either \$1.55 or \$1.56
- 7.9. The printed ticket and dispenser must comply with G.S.5.5. Money Values, Mathematical Agreement to the nearest cent (unit price x volume = total sale  $\pm$  0.5 cent.) ☐ Yes ☐ No ☐ N/A
- 7.10. Digital values agree with their associated analog value to the nearest minimum graduation. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.5. Digital Money Values, Mathematical Agreement**

Any recorded money value and any digital money value indication on a primary indicator must agree mathematically with its associated quantity (volume) representation or indication to the nearest one cent.

**Formula: Unit Price x Indicated Volume = Total Sale ± 0.5 cent**

7.11. Check mathematical agreement of all primary indications (e.g., dispenser, console, printer) under the following conditions:

- |                                                                                                                                                         |                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 7.11.1. At various flow rates, including maximum and minimum.                                                                                           | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 7.11.2. Snapping nozzle on and off several times during delivery. Check mathematical agreement each time flow is halted.                                | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 7.11.3. At several unit prices including the low prices and the maximum pricing capability of the computer and when operating at the maximum flow rate. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 7.11.4. Turn the dispenser off during delivery with nozzle open.                                                                                        | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |

**Code Reference: G-S.5.1. Indicating and Recording Elements/General****Discount Pricing**

*NIST Handbook 44* requires that, except for dispensers used for fleet sales, other price contract sales, 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 through the deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions.

Should the customer elect to use another method of payment following completion of delivery, the console may be used to recalculate the total price — provided the dispenser complies with all applicable *NIST Handbook 44* requirements. For example, the customer selects the credit card unit price on the dispenser and dispenses product at that unit price. However, the customer discovers that he forgot his credit card and decides to pay cash. In this case, the console might be used to calculate the total price at the cash unit price. In keeping with the intent of National Conference on Weights and Measures action in 1989 to require dispensers to calculate at all unit prices for which a product is offered for sale, it is anticipated that the console would be required to recalculate the new total price using the formula (quantity x unit price = total price.)

Except for fleet sales and other contract sales, a receipt providing the total volume, unit price, total computed price and product identity 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. (Code Reference S.1.6.7). The recorded and displayed total fuel price on the receipt and dispenser, respectively, shall agree.

**Selectable Unit Price Capability**

Selectable unit price capability is a design feature that permits the customer to select the unit price for a particular transaction at the time of sale. A dispenser may then allow the unit price for a delivery to be selected from two or more unit prices through the deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions.

If the customer selects the unit price at the dispenser (e.g., cash or credit price), the selection may be made at any time prior to the start of product flow. The dispenser operating handle may be on when the selection is made. A system shall not permit a change to the unit price during delivery of product.

After a transaction is completed, the unit price displayed at the dispenser may be changed to a base unit price. However, the quantity and total price must be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated. Any display of quantity, unit price, and total price that does not mathematically agree occurs between transactions. This is permitted (in response to demands of device users) because the displayed values between "transactions" are not "significant" relative to the actual delivery process (transaction.)

The displayed unit price may revert to the base unit price immediately after the completion of a transaction, defined as the time the delivery has been terminated and payment has been settled. The payment may be automatic if the delivery is to a pre-paid amount. If the sale is prepaid, the delivery is considered terminated after the "handle" is in the off position or after the nozzle has been returned to the designed hanging position. This will allow the customer adequate time to observe that the prepaid amount has been reached. If the delivery stops short or overruns a prepaid amount, settling the payment means that money is either refunded or collected from the customer and the transaction is "cashed out" by the console operator.

In the case of invoice billing systems, such as card-lock or key-lock systems which compute the total sale price, it is considered not appropriate for the displayed unit price to revert to the base unit price immediately following a transaction. Because a receipt for the transaction may not be available, the customer must be allowed an adequate period of time following

the delivery to record the transaction information. The transaction unit price must be displayed for at least 30 seconds, and the total price and the quantity must be displayed for at least 5 minutes following the completion of the delivery or the start of the next transaction. The delivery is considered complete after the "handle" is off or the nozzle has been returned to its designed hanging position.

- 7.12. A dispenser may be equipped with means for selecting more than one unit price, provided that the selected unit price cannot be changed after the initial flow begins. ☐ Yes ☐ No ☐ N/A
- 7.13. The selected unit price must be made clearly evident on the dispenser. ☐ Yes ☐ No ☐ N/A
- 7.14. Once selected the unit price cannot be changed by the operator at the console prior to or during the delivery. ☐ Yes ☐ No ☐ N/A
- 7.15. The selected unit price displayed at the dispenser prior to the delivery of product must be continuously displayed at the conclusion of the delivery by moving the operating mechanism to the "off" position, until the start of the next transaction by:
- 7.15.1. Movement of the operating mechanism to the "on" position. **OR** ☐ Yes ☐ No ☐ N/A
- 7.15.2. "Authorization/Approval" by the console operator, whichever occurs first. ☐ Yes ☐ No ☐ N/A
- 7.16. 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 (e.g., customer-activated) controls. ☐ Yes ☐ No ☐ N/A
- 7.17. In a system where a base unit price is automatically displayed on the dispenser after the completion of a transaction (e.g., product is dispensed and payment is settled), the dispenser may display the values for quantity, unit price, and total price that do not result in a mathematically correct equation. That is provided when the total price value displayed is divided by the quantity value displayed, the result is a unit price that is "posted" for a particular kind of transaction. ☐ Yes ☐ No ☐ N/A

Means shall be provided to the customer to determine the initial cash value of the card and the remaining cash value prior to and after each transaction.

**Code Reference: S.1.6.5.2. Money-Value Divisions, Digital**

- 7.18. A computing type device with digital indications shall comply with the requirements of paragraph G-S.5.5. Money Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.05-liter intervals for devices indicating in metric units or 0.01-gallon intervals for devices indicating in inch-pound units. ☐ Yes ☐ No ☐ N/A

*Note: At least four decimal places in cents must be carried to determine the proper round off of money values.*

**Code Reference: S.1.2. Primary Elements/Units**

- 7.19. 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. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.2.3. Value of Smallest Unit**

- 7.20. The value of the quantity division shall not exceed the equivalent of 0.5 L (0.1 gal) on retail devices with a flow rate of 750 L/min (200 gal/min) or less. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.6.1. Indication of Delivery**

- 7.21. Retail devices shall automatically show their initial zero condition and amount delivered up to the nominal capacity of the device. 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 the delivery starts at zero. ☐ Yes ☐ No ☐ N/A
- 7.22. 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. ☐ Yes ☐ No ☐ N/A

**Test Method Steps:**

1. Set unit price on dispenser.
2. Pressurize system.
3. Turn the dispenser off.
4. Create void in dispenser hydraulics by opening the fuel nozzle to provide a zero internal pressure. Then close the fuel nozzle.
5. Activate the dispenser and let the system reset (for example, showing "8"s and then zero, running through a segment check, or using another method of resetting the system).
6. With the nozzle closed, watch the main sales display for advancement of total sales and total volume for at least 5 seconds and no more than 10 seconds.
7. No advancement constitutes a passing test.
8. Advancement constitutes a failed test.
9. Replace the fuel nozzle and turn off the dispenser.
10. Repeat this test 2 more times. *Note: The evaluator must be aware that a time delay for this feature may be incorporated.*
11. Device passes test.

☐ Yes ☐ No ☐ N/A
**Code Reference: S.1.6.2.1. and S.1.6.2.2. Provisions for Power Loss**

Even if power fails during a delivery, it is still necessary to correctly complete all transactions in progress at the time of the power failure. Quantity and total sales price information shall be recallable for at least 15 minutes after the power failure. The information may be recalled at the dispenser or at the console if the console indications are accessible to the customer. Operator information, such as fuel and money value totals, shall be retained in memory during a power failure. The operator information is not required to be recallable during the power failure, but shall be recallable after power is restored. Test to determine if the indications are accurate when the delivery is continued after a power failure.

*Note: For remote controllers (e.g., cash register, console, etc.) which have the capability to retain information pertaining to a transaction (e.g., stacked completed sales.) If the information cannot be recalled at the dispenser following a power outage, means (e.g., uninterruptible power supply or other means) must be provided to enable the transaction information to be recalled and verified for at least 15 minutes following a power outage.*

- |                                                                                                                                                                   |                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 7.23. The quantity and total sales price shall be recallable for 15 minutes after the power failure.                                                              | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 7.24. The quantity and total sales price values shall be correct if the power fails between deliveries.                                                           | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 7.25. The quantity and total sales price values shall be correct if the delivery is continued after a power failure.                                              | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 7.26. The operator's information shall be retained in memory during a power failure.                                                                              | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 7.27. Remote controllers which stack completed sales must have a means to enable the transaction information to be recalled and verified for at least 15 minutes. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |

**Code Reference: S.1.6.3. Return to Zero**

The primary indicating and recording elements of a retail device shall readily return to a definite zero indication. Key-lock and other self-operated devices must have a zero-return indicating element, but they are not required to have the recording element return to zero. These devices may be equipped with cumulative recording elements. The primary indicating and recording elements shall not go beyond their correct zero position. Primary indicating elements shall not be resettable to zero during delivery.

- |                                                         |                                                                                       |
|---------------------------------------------------------|---------------------------------------------------------------------------------------|
| 7.28. Does the device have a primary recording element? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
|---------------------------------------------------------|---------------------------------------------------------------------------------------|

- 7.29. The indicating and recording elements of a retail device shall readily returnable to a definite zero indication. ☐ Yes ☐ No ☐ N/A
- 7.30. Key-lock and self-operated devices shall have an indicating element that return to zero. ☐ Yes ☐ No ☐ N/A
- 7.31. Does the device have: ☐ Yes ☐ No ☐ N/A
- 7.31.1. A cumulative indicating element? ☐ Yes ☐ No ☐ N/A
- 7.31.2. A cumulative recording element? ☐ Yes ☐ No ☐ N/A
- 7.32. Primary indicating and recording elements shall not go beyond their correct zero position. ☐ Yes ☐ No ☐ N/A
- 7.33. Primary indicating elements shall not be resettable to zero a during delivery. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.6.4.1. Display of Unit Price**

A computing or money-operated device shall have a means on the face of the device for displaying the unit price at which it is set to compute or deliver. If a grade, brand, blend, or mixture is offered for sale at more than one unit price from a device, 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. The unit price shall be expressed as a decimal value in dollars.

- 7.34. Means shall be provided to display the unit price on the face of the device. ☐ Yes ☐ No ☐ N/A
- 7.35. If a grade, brand, blend, or mixture is offered for sale at more than one unit price from a device, then all of the unit prices at which that product is offered for sale: ☐ Yes ☐ No ☐ N/A
- 7.35.1. Shall be displayed prior to the delivery of the product. **OR** ☐ Yes ☐ No ☐ N/A
- 7.35.2. Shall be capable of being displayed on the dispenser through the deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions. ☐ Yes ☐ No ☐ N/A

*Note: It is not necessary to simultaneously display all of the unit prices for all grades, brands, blends, or mixtures provided the dispenser complies with this section, S.1.6.4.1.*

***Note: For a system that offers post-delivery discounts on fuel sales, display of pre-delivery unit price information is exempt from 7.38, provided the system complies with S.1.6.8.***

The unit prices for each product and price level may be:

- a. Displayed simultaneously for all products.
- b. Displayed simultaneously for each product separately.; or
- c. Displayed individually in a unit-price display only if controls permit the customer to sequence the display through the unit prices for each and every product.

*Note: Section 7.38.2 shall not apply to fleet sales, other contract sales, or truck refueling sales (e.g. sales from dispensers used to refuel trucks.)*

- 7.36. The unit price shall be expressed in dollars and decimals of dollars using a dollar sign. A common fraction shall not appear in the unit price, (e.g., \$1.299 not \$1.29 9/10). ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.6.4.2. Display of Product Identity**

- 7.37. Means shall be provided to post the identity of the product grade, brand, blend, or mixture or dispensed product. ☐ Yes ☐ No ☐ N/A



**Code Reference: S.1.6.5.5. Display of Quantity and Total Price**

- 7.38. Except for aviation refueling applications, when a delivery is completed on a computing device, 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. ☐ Yes ☐ No ☐ N/A

*Note: The displayed unit price may revert to a base unit price immediately after the completion of a transaction, defined as the time the delivery has been terminated and payment has been settled. Any display of quantity, unit price, and total price that does not mathematically agree occurs between transactions and is permitted (in response to demands of device users) because the displayed values between "transactions" are not "significant" relative to the actual delivery process (transaction.)*

**Code Reference: S.1.6.5.4. Selection of Unit Price**

- 7.39. Except for dispensers used exclusively for 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:

- 7.39.1. Prior to delivery using controls on the device. **OR** ☐ Yes ☐ No ☐ N/A
- 7.39.2. Through deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions. ☐ Yes ☐ No ☐ N/A

*Note: This requirement does not apply to devices for which the Certificate of Conformance is limited to installations where the devices are used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks.)*

- 7.40. A system shall not permit a change to the unit price during delivery of product. ☐ Yes ☐ No ☐ N/A

**Code References: S.1.6.7. Recorded Representations; and S.1.6.8. Recorded Representations for Transaction Where a Post-Delivery Discount(s) is Provided.**

Except for fleet sales and other price contract sales, for transactions conducted with point-of-sale systems or devices activated by credit cards, debit cards, or cash, a printed receipt containing information about the transaction shall be available to the customer as outlined in the following items. A printed receipt must always be available to the customer upon request and printing of the receipt may be initiated at the option of the customer. In addition, some systems may be equipped with the capability to issue an electronic receipt; for those systems, the customer may be given the option to receive the receipt electronically (e.g., via cell phone, computer, etc.). See also NCWM Publication 14, Code Reference: G-S.5.6. Recorded Representations.

Device capabilities: ☐ Printed Receipt ☐ Electronic Receipt

- 7.41. The system must provide a receipt to be made available to the customer at the completion of the transaction through either:
- 7.44.1. a built-in recording element **OR** ☐ Yes ☐ No ☐ N/A
- 7.44.2. a separate recording element that is part of the system ☐ Yes ☐ No ☐ N/A
- 7.42. Except for transactions where a post-delivery discount is provided, the customer receipt must contain the following information:
- 7.42.1. the total volume of the delivery; ☐ Yes ☐ No ☐ N/A
- 7.42.2. the unit price; ☐ Yes ☐ No ☐ N/A
- 7.42.3. the total computed price; ☐ Yes ☐ No ☐ N/A
- 7.42.4. the product identity by name, symbol, abbreviation, or code number; and ☐ Yes ☐ No ☐ N/A
- 7.42.5. the dispenser designation by either and alpha or numerical description (effective as of January 1, 2021). ☐ Yes ☐ No ☐ N/A
- 7.43. Where a post-delivery discount(s) is applied, the sales receipt must provide:

- 7.43.1. the product identity by name, symbol, abbreviation, or code number; ☐ Yes ☐ No ☐ N/A
- 7.43.2. the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s); ☐ Yes ☐ No ☐ N/A
- 7.43.3. an itemization of the post-delivery discounts to the unit price; ☐ Yes ☐ No ☐ N/A
- 7.43.4. the final total price of each fuel sale after all post-delivery discounts are applied; and ☐ Yes ☐ No ☐ N/A
- 7.43.5. the dispenser designation by either and alpha or numerical description (effective as of January 1, 2021). ☐ Yes ☐ No ☐ N/A

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

- 7.44. a. The quantity shall be displayed throughout the transaction. ☐ Yes ☐ No ☐ N/A
- 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 calculate and display the total price, it shall be displayed for the quantity delivered throughout the transaction.
- 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.

## 8. Computing

A retail computing device shall be capable of computing total sale prices for all unit prices and for all deliveries within the range of measurement or computing capacity. The maximum value of the money-value division and the maximum variation of indicated total sale price from the mathematically computed total sale price are specified for analog devices. Because analog dispensers may have different money-value divisions depending upon the unit price, the service station console must update in the same money-value division to maintain agreement of total sale price values. The maximum quantity-value divisions for digital devices are prescribed.

**Code Reference: S.1.6.5. Money-Value Computations**

- 8.1. A retail computing device shall compute total sale prices for all quantities and unit prices within the range of its quantity and computing capacities. ☐ Yes ☐ No ☐ N/A

*Notes: For dispensers which are not capable of complying with the requirements of UR.3.2., UR.3.3., and S.1.6.5., the Certificate of Conformance must be limited to single-tier pricing applications. This requirement does not apply to devices for which the Certificate of Conformance is limited to installations where the devices are used for fleet sales, other price contract sales, and truck stop dispensers used only to refuel trucks.*

- 8.2. Analog money value indications on each side of a device shall not differ from the mathematically computed money value (Quantity x Unit Price = Sales Price), for any delivered quantity, by an amount greater than the values shown in the following table: ☐ Yes ☐ No ☐ N/A

Unit Price		Money Value Division	Maximum Allowable Variation	
From	To and Including		Design Test	Field Test
0	0.25/liter or \$1.00/gallon	1¢	± 1¢	± 1¢
0.25/liter or \$1.00/gallon	0.75/liter or \$3.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or \$3.00/gallon	2.50/liter or \$10.00/gallon	1¢, 2¢ or 5¢	± 1¢ ± 2.5¢	± 2¢ ± 5¢

See NIST Handbook 44 N.4.3. for Test Procedures



- 8.3. Total prices indicated on the two sides of an analog register shall agree within one-half of the money value division. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.6.5.1. Analog Money-Value Divisions**

Analog money-value divisions shall be as follows:

- 8.4. Not more than 1 cent at all unit prices up to and including \$0.25 per liter or \$1.00 per gallon. ☐ Yes ☐ No ☐ N/A
- 8.5. Not more than 2 cents at all unit prices greater than \$0.25 per liter or \$1.00 per gallon up to and including \$0.75 per liter or \$3.00 per gallon. ☐ Yes ☐ No ☐ N/A
- 8.6. Not more than 5 cents at all unit prices greater than \$0.75 per liter or \$3.00 per gallon. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.6.5.2. Digital Money-Value Divisions**

- 8.7. Digital quantity and total price indications shall agree to the nearest cent. ☐ Yes ☐ No ☐ N/A
- 8.8. Total price indications shall be based on quantity-value divisions that are less than or equal to 0.05 liters or 0.01 gallons. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.6.5.3. Money-Value Divisions, Auxiliary Indications**

- 8.9. Money value divisions on devices such as remote consoles and printers shall be the same as on the dispenser. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.6.9. Travel of Indicator on Lubricant Devices**

- 8.10. If the most sensitive element of the indicating system of a lubricant device uses an indicator and graduations, the relative movement of these parts shall be at least 2.5 cm (1 in) per 0.5 L (1 pt) of delivery. ☐ Yes ☐ No ☐ N/A

## 9. Measuring Elements

**Code Reference: S.2.2. Provision for Sealing**

Measuring elements shall be designed with adequate provisions to prevent changes from being made to the measuring element or the flow rate control (if the flow rate control affects the accuracy of deliveries) without evidence of the change being made. These provisions can be an approved means of security (e.g., data change audit trail) or physically applying a security seal which must be broken before adjustments can be made. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal.

- 9.1. A measuring element shall have provisions for either:
- 9.1.1. Applying a physical security seal. **OR** ☐ Yes ☐ No ☐ N/A
  - 9.1.2. An approved means of security (e.g., data change audit trail) so that no changes may be made to its adjustable components. ☐ Yes ☐ No ☐ N/A
- 9.2. Any adjustable element controlling the delivery rate shall provide for sealing or other approved means of security (e.g., data audit trail) if the flow rate affects the accuracy of deliveries. ☐ Yes ☐ No ☐ N/A
- 9.3. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal. ☐ Yes ☐ No ☐ N/A
- 9.4. Audit trails shall use the format set forth in the Common and General Code Criteria section of this checklist (Code Reference G-S.8) and in Appendix A, Philosophy for Sealing, and Appendix B, Requirements for Metrological Audit Trails. ☐ Yes ☐ No ☐ N/A
- 9.5. **Retail motor fuel** dispensers with remote configuration capabilities shall be sealed according to Appendix A, Philosophy for Sealing, and Appendix B, Requirements for ☐ Yes ☐ No ☐ N/A

Metrological Audit Trails (Table S.2.2.) and under the "Common and General Code Criteria" section of this checklist.

**Code Reference: G-S.8.1. Multiple Weighing or Measuring Elements that Share a Common Provision for Sealing**

9.6. A change to the adjustment of any measuring element shall be individually identified. ☐ Yes ☐ No ☐ N/A

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

- a. A broken, missing, or replaced physical seal on an individual measuring element.
- b. A change in a calibration factor for each measuring element.
- c. Display of the date of or the number of days since the last calibration event for each measuring element.
- d. A counter indicating the number of calibration events per measuring element.

**Code Reference: S.2.3. Directional Flow Valves**

9.7. Values intended to prevent the reversal of flow shall be automatic in operation. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.4. Stop Mechanism**

If a device is hand-operated via a crank, the device is likely to have "stops" or tabs designed to stop the cranking operation at the point representing the nominal quantity to be delivered in one cycle. The stops must be held securely in place and marked with the nominal quantity represented by one cycle of the cranking process.

9.8. Stops must be held securely in position. ☐ Yes ☐ No ☐ N/A

9.9. Each stop shall be marked with the nominal quantity to be delivered by cranking to each stop. ☐ Yes ☐ No ☐ N/A

9.10. Stops shall be adjustable so deliveries will be within tolerance. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5. Zero-Set-Back Interlock**

The zero-set-back interlock on a dispenser is critical to prevent fraudulent practices. A **retail motor fuel** device shall have an effective automatic interlock such that once the dispenser shuts off, it cannot be restarted without resetting the indicating element to zero. This requirement also applies to the recording element if one is present. The dispenser shall be designed so that the starting lever must be in the shut-off position and the interlock engaged before the discharge nozzle can be returned to its designed hanging position. If a single pump supplies more than one dispenser, then each dispenser shall have an automatic control valve that prevents product from being delivered by a dispenser until its indications have been set to zero.

9.11. After the device is turned off by moving the lever that stops the flow, a subsequent delivery shall be prevented until the indicators (and recording element if present) have returned to their correct zero positions. ☐ Yes ☐ No ☐ N/A

9.12. The starting lever shall be in shut off position and zero-set-back interlock engaged before the nozzle can 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. ☐ Yes ☐ No ☐ N/A

9.13. If more than one dispenser is connected to a single pump, an automatic control valve shall prevent fuel from being delivered until the indicating elements have been returned to their correct zero position and engaged. ☐ Yes ☐ No ☐ N/A

9.14. The use of the interlock shall be effective under all conditions when any control on the console, except a system emergency shut-off, is operating and after any momentary power failure. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.8. Lubricant Devices, Supply Exhaustion**

A lubricant device that is not a meter type shall become inoperable or give a conspicuous and distinct warning when the level of the supply of lubricant becomes so low that it may affect the accuracy of the measurement.

**10. Discharge Lines and Discharge Line Valves****Code Reference: S.3.1. Diversion of Measured Liquid**

This paragraph does not apply to devices that comply with Paragraph S.3.2.

To prevent fraudulent practices, no means for which any measured liquid can be diverted from the measuring chamber or the discharge line of a device shall be available.

A device may have two or more delivery outlets if there are automatic means to insure that:

- a. Liquid can flow from only one outlet at a time. and
  - b. The direction of liquid flow is definitely and conspicuously indicated.
- 10.1. Except as identified above, it shall not be possible to divert measured liquid from the measuring chamber or the discharge line of the device. ☐ Yes ☐ No ☐ N/A
  - 10.2. Two or more delivery outlets may be installed if there are automatic means to ensure that liquid can flow from only one outlet at a time, and the direction of flow for which the mechanism may be set at any time is definitely and conspicuously indicated. ☐ Yes ☐ No ☐ N/A
  - 10.3. Except as identified above, 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. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.2. Exceptions**

If suitable means are provided to prevent the diversion of liquid flow to other than the receiving vehicle, devices that are specifically installed for fueling trucks are exempt from the provisions of S.3.1. and may have two outlets operating simultaneously.

- 10.4. For devices that are specifically installed for fueling trucks, two outlets may be operated simultaneously only if suitable means are provided to ensure that diversion of flow to other than the receiving vehicle cannot readily be accomplished and is readily apparent. Such means include, but are not limited to, physical barriers to adjacent driveways, visible valves or lighting systems indicating which outlets are in operation, and explanatory signs. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.3. Pump-Discharge Unit**

- 10.5. If a pump-discharge unit is equipped with a flexible discharge hose, it shall be a wet-hose type. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.5. Discharge Hose**

- 10.6. A discharge hose shall be adequately reinforced. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.6. Discharge Valve**

- 10.7. A discharge valve may be installed in the discharge line only if the device is of the wet-hose type. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.7. Antidrain Valve**

- 10.8. A wet-hose, pressure-type device shall have an effective anti-drain valve incorporated in the discharge valve or adjacent thereto. ☐ Yes ☐ No ☐ N/A

## 11. Marking

### Code Reference: S.4.1.1. Marking Requirements; Limitation on Use

- 11.1. If a device is intended to accurately measure only products having particular properties or under specific installation or operating conditions or when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the device. A meter may be used to measure both gasoline and diesel fuel at different times provided the meter is tested and adjusted with the product to be measured before it is used commercially. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.4.4. Marking Requirements For Retail Devices Only

- 11.2. On a retail device with a designed maximum discharge rate of 115 L/min (30 gpm) or greater, the maximum and minimum discharge rates shall be marked in accordance with *NIST Handbook 44* S.4.4.2. The minimum rate shall not exceed 20% of the maximum discharge rate. ☐ Yes ☐ No ☐ N/A

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.

### Code Reference: S.4.4.2. Location of Marking Information

- 11.3. The required marking information in the General Code, paragraph G-S.1. shall be located as follows:
- 11.3.1. Shall be within 24 to 60 inches from the base of the dispenser. ☐ Yes ☐ No ☐ N/A
  - 11.3.2. May be internal and/or external provided the information is permanent and easily read. ☐ Yes ☐ No ☐ N/A
  - 11.3.3. Shall be on a portion of the device that cannot be readily removed or interchanged ( e.g., not on a service access panel.) ☐ Yes ☐ No ☐ N/A

*Note: The use of a dispenser key or tool to access internal marking information is permitted.*

## 12. Totalizers

### Code Reference: S.5.1. Totalizers for **Retail Motor Fuel** Dispensers

- 12.1. **Retail motor fuel** dispensers shall be equipped with a non-resettable totalizer for the quantity delivered through the metering device. ☐ Yes ☐ No ☐ N/A

## 13. User Requirements

### Code Reference: UR.1.1. Length of Discharge Hose

- 13.1. The length of a discharge hose shall not exceed 5.5 m (18 ft), but marinas and airports may have hoses up to 15 m (50 ft) long. ☐ Yes ☐ No ☐ N/A
- 13.2. If the length of a discharge hose in a marina or airport exceeds 8 m (26 ft), it shall be adequately protected from environmental factors. ☐ Yes ☐ No ☐ N/A

### Code Reference: UR.3. Use of Device

*Note: For dispensers which are not capable of complying with the requirements of UR.3.2., UR.3.3., and S.1.6.5., the Certificate of Conformance must be limited to single-tier pricing applications.*

## 14. Installation Requirements

### Code Reference: UR.2.1. Installation

- 14.1. A device shall be installed according to the manufacturer's instructions, and the installation shall be sufficiently secure and rigid to maintain this condition. ☐ Yes ☐ No ☐ N/A

### Code Reference: UR.2.2. Discharge Rate

- 14.2. Actual maximum discharge rate shall not exceed the rated maximum discharge rate. ☐ Yes ☐ No ☐ N/A



## National Type Evaluation Program

### Liquid Measuring Devices – Checklists and Test Procedures for Cash-Activated **Retail Motor Fuel** Dispensers

The following criteria and test procedures apply to cash-activated **retail motor fuel** dispensers. Tests using various denominations of bills accepted by the cash acceptor should be performed.

Certificates of Conformance will cover the use of the cash acceptor option at both attended and unattended stations. Cash Acceptors which are used at unattended locations must meet the marking requirements of paragraph G-UR.3.4. Responsibility, Money-Operated Devices shall be clearly and conspicuously displayed on the device or immediately adjacent to the device information detailing the return of monies paid when the product cannot be obtained.

#### 15. Code Reference: S.1.6.2. Provisions for Power Loss

Even if power is interrupted during a delivery, it is still necessary to correctly complete all transactions in progress at the time of the power interruption. 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, sales price, or amount of money already inserted into the cash acceptor) shall be determinable for at least 15 minutes at the dispenser or at the console or journal printer if the console or journal printer is accessible to the customer.

All portions of the transaction must be accounted for in order to complete the transaction. This information would include the following: (1) the total amount of money that was inserted into the device prior to the power interruption, (2) the amount of product already dispensed (which should be available from the dispenser and which must comply with the requirements of S.1.6.2., (3) and any bill that has been inserted but has not yet been recognized by the cash acceptor.

*Note: For bills that have not yet been drawn into the cash acceptor to the point that the bill is no longer visible, it is assumed that the information on the bill denomination can be obtained from visual examination.*

Various methods may be used to recall specific portions of the transaction depending on how the basic system operates. For example, systems that can print a record of the amount fed into the machine as each bill is fed into the device maintain an ongoing record of bills recognized by the system. Other systems may not print a receipt until the end of the transaction, so the information is recalled on a journal printer accessible to the customer or can be recalled on the cash acceptor display.

Check to see what happens when the power is interrupted at different points of the transaction. Note what occurs at the points where power is interrupted, what information is provided to the customer on the receipt, audibly and visually in the form of instructions or error messages. Because systems may be installed with separate power lines to the console, card reader, and dispenser may be installed, tests should be run with power interruptions to different parts of the system to evaluate the potential for accidental or intentional errors. The appropriate device response depends upon when the power loss occurs during the delivery sequence.

- 15.1. Systems with Battery Back-up or Uninterruptible Power Supply or Equivalent - Some ☐ Yes ☐ No ☐ N/A  
 systems are equipped with a battery back-up or an uninterruptible power supply (or equivalent) which allows a transaction to continue in the event of a power loss. For such systems, the transaction in progress at the time of a power interrupted must continue as if no power interruption had occurred (or comply with the requirements for systems not equipped with a battery back-up.) That is, all bills (including bills being fed into the device at the time of the power loss) must be correctly accounted for, and the quantity and total sale amounts must be mathematically correct. Check these systems by interrupting power at several points in the transaction to ensure that all information (total price, quantity, mathematical agreement, and total dollar amount inserted by the customer) is accounted for correctly.

**All Other Systems:** To check the operation of systems not equipped with a battery backup, uninterruptible power supply, or equivalent, interrupt power as described below. As noted earlier, if separate power lines supply different components in the system, interrupt power to different parts of the system.

- 15.2. When one or more bills has been accepted and registered by the device, but product has not yet been dispensed, at least one of the following criteria must be met to ensure that this information can be recalled in the event of a power interruption:
- 15.2.1. The denomination of the bill must be printed by the printer on the device as the device recognizes the bill. (The printed receipt must be available to the customer.) ☐ Yes ☐ No ☐ N/A
  - 15.2.2. The denomination of each bill must be printed by a journal or other printer accessible to the customer as each bill is recognized by the device. ☐ Yes ☐ No ☐ N/A
  - 15.2.3. The running total display must be capable of being recalled for at least 15 minutes. ☐ Yes ☐ No ☐ N/A
  - 15.2.4. Means provided to enable the customer to retrieve the money inserted into the device (e.g., a button which can be used during a power interruption to eject the money inserted by the customer.) ☐ Yes ☐ No ☐ N/A
  - 15.2.5. Other means used to provide a visual or printed record of the total amount of money accepted by the device. ☐ Yes ☐ No ☐ N/A
- 15.3. There is a brief period of time during which a bill has been accepted by the cash acceptor but has not yet been recognized by the device. The following criteria must be met to ensure that this information can be recalled in the event of a power failure.
- 15.3.1. Means provided to enable the attendant or customer to retrieve the bill (for example, a button which can be used during a power interruption to eject the bill or if the cash acceptor box can be removed by the attendant and the bill retrieved.) ☐ Yes ☐ No ☐ N/A

*Note: There may be a space of time in which a bill can be caught partially in and out of the cash acceptor during a power interruption. In such a case, if the denomination of the bill is visible to the customer and attendant, this is sufficient to provide information about the bill being fed into the device at the time of the power interruption. The cash acceptor must comply with the other applicable items noted above.*

It is expected that the **retail motor fuel** dispenser will comply with S.1.6.2. and the information on the product already dispensed can be recalled through this portion of the system.

- 15.4. Power should be interrupted at different points in the transaction to determine that all transaction information can be recalled in the event of a power interruption including combinations of the following:
- 15.4.1. After one bill has been inserted. ☐ Yes ☐ No ☐ N/A
  - 15.4.2. After several bills have been inserted. ☐ Yes ☐ No ☐ N/A
  - 15.4.3. While a bill is being inserted. ☐ Yes ☐ No ☐ N/A
  - 15.4.4. After a bill has been inserted but not yet recognized. ☐ Yes ☐ No ☐ N/A
  - 15.4.5. After a bill(s) has been inserted and recognized, but the on/off handle is still in the "off" position. ☐ Yes ☐ No ☐ N/A
  - 15.4.6. After a bill(s) has been inserted and recognized, the on/off handle is in the "on" position, but no product has been dispensed. ☐ Yes ☐ No ☐ N/A
  - 15.4.7. After a bill(s) has been inserted and recognized, the on/off handle is in the "on" position, and product is being dispensed. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.1. Indicating and Recording Elements, General; S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided**

- 15.5. Total Money Display - A running display showing the amount of money fed into the machine must be provided. It is not necessary for this information to be displayed once the customer initiates delivery. ☐ Yes ☐ No ☐ N/A



- 15.6. Printed Receipt - A printed receipt must be available to the customer from the device at the completion of the transaction. The issuance of the receipt may be initiated at the option of the customer. ☐ Yes ☐ No ☐ N/A

15.6.1. The customer receipt must contain the following information:

- 15.6.1.1. The identity (codes may be used) of the product purchased, the quantity purchased, the unit price, and the total price. ☐ Yes ☐ No ☐ N/A

Because the customer must be provided with the option of receiving a receipt, the system must not accept cash if sufficient paper is not available to complete the transaction.

- 15.6.1.2. Where a post-delivery discount(s) is applied, the sales receipt must provide: ☐ Yes ☐ No ☐ N/A

- 15.6.1.2.1. the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s); ☐ Yes ☐ No ☐ N/A

- 15.6.1.2.2. an itemization of the post-delivery discounts to the unit price; and ☐ Yes ☐ No ☐ N/A

- 15.6.1.2.3. the final total price of each fuel sale after all post-delivery discounts are applied. ☐ Yes ☐ No ☐ N/A

*See LMD Code S.1.6.8.*

☐ Yes ☐ No ☐ N/A

- 15.7. The cash acceptor must not initiate a cash transaction if either of the following conditions is true: ☐ Yes ☐ No ☐ N/A

- 15.7.1. No paper is in the receipt printer of the cash acceptor. ☐ Yes ☐ No ☐ N/A

- 15.7.2. Insufficient paper is available to complete a transaction. ☐ Yes ☐ No ☐ N/A

#### **Code Reference: G-S.6. Marking Operational Controls, Indications, and Features**

- 15.8. Instructions must be marked on the device to inform the customer how to operate the cash acceptor. ☐ Yes ☐ No ☐ N/A

#### **Code Reference: G-S.2. Facilitation of Fraud**

- 15.9. Means must be provided for the customer to cancel the transaction at any point.

- 15.9.1. The customer has inserted cash, but has not yet dispensed product. If the customer cancels the transaction by pressing the cancel key (or equivalent key(s)) or by lowering the on/off handle, the device must either:

- 15.9.1.1. Be equipped with means for the customer to retrieve the cash inserted from the device. **AND** ☐ Yes ☐ No ☐ N/A

Automatically issue a printed receipt indicating the amount tendered and the amount returned. **OR**

- 15.9.1.2. Display instructions (such as "sale terminated, see attendant," "sale terminated, get receipt" or similar wording) for the customer to see the attendant. **AND** ☐ Yes ☐ No ☐ N/A

Automatically issue a printed receipt showing the amount of cash inserted by the customer, a statement indicating that the sale was terminated, and instructions for the customer to see the attendant.

- 15.9.2. The customer has inserted cash and has started dispensing product. If the customer cancels or discontinues the transaction by pressing the cancel key (or equivalent key(s)) or lowering the on/off handle before reaching the total money inserted into the device, the device must:

- 15.9.2.1. Display instructions for the customer to obtain the receipt and to see the attendant. ☐ Yes ☐ No ☐ N/A

- 15.9.2.2. Automatically issue a printed receipt showing the amount of cash inserted, the amount dispensed, the balance due to the customer, a statement indicating that the sale was terminated, and instructions for the customer to see the attendant. ☐ Yes ☐ No ☐ N/A

*Note: It is acceptable for different messages to be used. This depends upon whether the transaction is terminated by use of the cancel key, (e.g., "sale terminated, get receipt" or "sale terminated, see attendant") or by lowering the on/off handle, (e.g., "change due, see attendant.")*

**Code References: S.1.6.7. Recorded Representations; and S.1.6.8. Recorded Representations for Transaction Where a Post-Delivery Discount(s) is Provided.**

Except for fleet sales and other price contract sales, for transactions conducted with point-of-sale systems or devices activated by credit cards, debit cards, or cash, a printed receipt containing information about the transaction shall be available to the customer as outlined in the following items. A printed receipt must always be available to the customer upon request and printing of the receipt may be initiated at the option of the customer. In addition, some systems may be equipped with the capability to issue an electronic receipt; for those systems, the customer may be given the option to receive the receipt electronically (e.g., via cell phone, computer, etc.). See also NCWM Publication 14, Code Reference: G-S.5.6. Recorded Representations.

Device capabilities: ☐ Printed Receipt ☐ Electronic Receipt

- 15.10. The system must provide a receipt to be made available to the customer at the completion of the transaction through either:
- 15.10.1. a built-in recording element OR ☐ Yes ☐ No ☐ N/A
- 15.10.2. a separate recording element that is part of the system ☐ Yes ☐ No ☐ N/A
- 15.11. Except for transactions where a post-delivery discount is provided, the customer receipt must contain the following information:
- 15.11.1. the total volume of the delivery; ☐ Yes ☐ No ☐ N/A
- 15.11.2. the unit price; ☐ Yes ☐ No ☐ N/A
- 15.11.3. the total computed price; ☐ Yes ☐ No ☐ N/A
- 15.11.4. the product identity by name, symbol, abbreviation, or code number; and ☐ Yes ☐ No ☐ N/A
- 15.11.5. the dispenser designation by either and alpha or numerical description (effective as of January 1, 2021). ☐ Yes ☐ No ☐ N/A
- 15.12. Where a post-delivery discount(s) is applied, the sales receipt must provide:
- 15.12.1. the product identity by name, symbol, abbreviation, or code number; ☐ Yes ☐ No ☐ N/A
- 15.12.2. the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s); ☐ Yes ☐ No ☐ N/A
- 15.12.3. an itemization of the post-delivery discounts to the unit price; ☐ Yes ☐ No ☐ N/A
- 15.12.4. the final total price of each fuel sale after all post-delivery discounts are applied; and ☐ Yes ☐ No ☐ N/A
- 15.12.5. the dispenser designation by either and alpha or numerical description (effective as of January 1, 2021). ☐ Yes ☐ No ☐ N/A
- 15.13. The unit of measure shall be clearly defined. Acceptable symbols for units are: Gallon Gal, of G for gallons and Liter, l or L for liters. Upper or lower case is optional except that a lower case "l" must not resemble a "1" (numeral one), (e.g. a script "l" is an acceptable symbol for liters.) ☐ Yes ☐ No ☐ N/A
- The unit of measure may be defined with either the quantity value, (e.g., 10 000 GAL) or with the unit price, (e.g., \$1.119/Gal), not necessarily both.
- 15.14. Acceptable designations of the unit price are: "@" as a prefix to the unit price value, an upper or lower case "X" or slash between the quantity and unit price, \$/G, PPG

(price per gallon), PPL (price per liter), UP (unit price), P/G, price/Vol, PPU (price per unit), DOL/GAL.

- 15.15. The total fuel price must be clearly distinguished from other information in the fuel transaction. To identify the total fuel sale price, use one of the following methods:
  - 15.15.1. Decimal point in the proper dollar position, (e.g., XX.XX.) If a dollar sign is not used, there must be at least one offset column of the least significant digit in recorded information, other than the sale price.
  - 15.15.2. The words gas, diesel, or other product designation may be used with the word "SALE" (e.g., "FUEL SALE" or "GAS SALE") or the product identification followed by the sale price, (e.g., GAS 20.00.)



## National Type Evaluation Program

### Liquid Measuring Devices – Checklists and Test Procedures for Wholesale and Loading Rack Meters

#### 16. Indicating and Recording Elements

##### Code Reference: G-S.5.1. and G-UR.1.1. General

Indicating elements must be appropriate in design and adequate in amount. Specifically, a device must have sufficient display capacity to indicate the quantities and total prices, if applicable that are normally encountered in the intended application. Electronic devices shall either have sufficient display capacity to indicate the normal quantities and money values or automatically stop the delivery before exceeding the display capacity of either the quantity or total price. Analog indicating elements must have sufficient display capacity for the device to be suitable for the application.

- |                                                                                                                             |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 16.1. Analog dispensers shall have adequate display capacity for the application.                                           | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.2. An electronic digital indicating element shall either:                                                                | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.2.1. Have adequate display capacity for the application.                                                                 | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.2.2. Automatically stop the delivery before exceeding the maximum quantity or maximum total price that can be indicated. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |

##### Code Reference: G-S.5.2.2. Digital Indication and Representation

- |                                                                                                                                                                        |                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 16.3. Basic operating requirements for devices:                                                                                                                        |                                                                                       |
| 16.3.1. All digital values of like value in a system shall agree.                                                                                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.3.2. A digital value shall agree with its analog representation to the nearest minimum graduation.                                                                  | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.3.3. Digital values shall round off to the nearest digital division that can be indicated or recorded.                                                              | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.3.4. When a digital zero display is provided, the zero indication shall consist of at least one digit to the left and all digits to the right of the decimal point. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |

Agreement of indications shall be checked for several deliveries. The totalizer shall be checked for accuracy and agreement with individual deliveries and with other totalizers in the system. Indications may disagree if digital indications receive quantity pulses from a non-resettable pulser.

- |                                                                                                                                 |                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 16.3.4.1. All digital values of like values in a system agree with one another.                                                 | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.3.4.2. Digital values coincide with associated analog values to the nearest minimum graduation.                              | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.3.4.3. Digital values "round off" to the nearest minimum unit that can be indicated or recorded.                             | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 16.3.4.4. The device totalizer shall agree with the total of the individual deliveries and with other totalizers in the system. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |

##### Code Reference: S.1.2. Units

- |                                                                                                                                                                                    |                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 16.4. The device shall indicate and record if it is equipped to record its deliveries in terms of gallons, cubic meters, or liters and decimal or binary submultiples of a gallon. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|

##### Code Reference: S.1.2.3. Value of Smallest Unit

- |                                                                                          |                                                                                       |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 16.5. The value of the smallest quantity division shall not exceed 4 liters or 1 gallon. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|

##### Code Reference: S.1.7.1. Travel of Indicator

- 16.6. A wholesale device shall accurately deliver any quantity from 50 gallons to the capacity of the device. ☐ Yes ☐ No ☐ N/A
- 16.7. If the most sensitive element of the indicating system uses an indicator and graduations, the relative movement of these parts corresponding to a delivery of 4 liters or 1 gallon must be no less than 5 mm (0.20 in.) ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.7.2. Money Values - Mathematical Agreement**

- 16.8. Any digital money value indication and any recorded money value on a computing-type device must be in mathematical agreement with its associated quantity indication or representation to within one cent of money value. (Quantity X Unit Price = Sale Price  $\pm$  1 cent.) ☐ Yes ☐ No ☐ N/A

*Note: At least four decimal places in cents must be carried to determine the proper round off of money values.*

## 17. Measuring Elements

**Code Reference: S.2.1.1. Air/Vapor Elimination on Loading Rack Metering Systems**

A loading rack measuring system shall be equipped with an effective air/vapor eliminator or other automatic means to prevent the passage of air/vapor through the meter. This is unless the system is designed or operationally controlled by a means such that air or vapor cannot enter the system. (Several guidelines, not intended to be all-inclusive for evaluation of a loading rack metering system in which an air eliminator is not needed were adopted by NCWM in July of 1995).

- 17.1. The metering system is equipped with an effective air/vapor eliminator. ☐ Yes ☐ No ☐ N/A
- 17.2. Other effective, automatic means are provided to prevent air/vapor from passing through the system. Describe the means provided and list this information on the Certificate of Conformance:
- 
- 
- 17.3. Vent lines from the air/vapor eliminator shall be made of appropriate non-collapsible material to prevent the lines from being pinched closed and re-opened without being detected. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.2. Provision for Sealing**

Measuring elements shall be designed with provision for an approved means of security, (e.g., data change audit trail or physically applying security seals) such that an adjustment to the measuring element or the flow rate control (if the flow rate affects the accuracy of deliveries) cannot be made without breaking the security seal. The adjusting mechanism shall be readily accessible for the purposes of affixing a security seal.

- 17.4. A measuring element shall provide for either:
- 17.4.1. Applying a physical security seal. **OR** ☐ Yes ☐ No ☐ N/A
- 17.4.2. An approved means of security, (e.g., data change audit trail) so that no change may be made to its adjustable component. ☐ Yes ☐ No ☐ N/A
- 17.5. Any adjustable element controlling the delivery rate shall provide for sealing or other approved means of security (e.g., data change audit trail) if the flow rate affects the accuracy of deliveries. ☐ Yes ☐ No ☐ N/A
- 17.6. When applicable, the adjusting mechanism shall be readily accessible for the purpose of affixing a security seal. ☐ Yes ☐ No ☐ N/A
- 17.7. Audit trails shall use the format set forth in the Common and General Code Criteria Section of this checklist (Code Reference G-S.8) and in Appendix A, Audit Trail checklist for Liquid measuring Devices. [Non-reactive as of 1/1/95]. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.3. Directional Flow Valves**

- 17.8. Values intended to prevent the reversal of flow shall be automatic in operation. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.7.2. Provision for Deactivation - Automatic Temperature Compensator**

- 17.9. If a device is equipped with only a net indicating and/or recording element (volume compensated at 15 °C (60 °F)), provision must be made to facilitate the deactivation of the automatic temperature-compensating mechanism so the meter will indicate and/or record the uncompensated volume. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.7.3. Provision for Sealing - Automatic Temperature Compensation**

- 17.10. Automatic temperature compensators must provide for applying security seals to prevent undetected adjustment or disconnection of the compensating system. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.7.4. Thermometer Well**

- 17.11. If a device is equipped with an automatic compensating system, the device shall have a thermometer well either in the liquid chamber of the meter or in the meter inlet or discharge line immediately adjacent to the meter. ☐ Yes ☐ No ☐ N/A

**18. Discharge Lines and Discharge Line Valves****Code Reference: S.3.1. Diversion of Measured Liquid**

- 18.1. No means shall be provided to allow any measured liquid to be diverted from the measuring chamber. ☐ Yes ☐ No ☐ N/A
- 18.2. A manually controlled outlet that may be opened for purging or draining the measuring system or for recirculating product in suspension shall be permitted only when the system is measuring food products or agri-chemicals. Effective means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system and to inhibit meter indications (or advancement of indications) and recorded representations while the outlet is in operation. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.1. Diversion of Measured Liquid**

- 18.3. If the pump-discharge unit is equipped with a flexible discharge hose, it must be a wet-hose type. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.4. Gravity-Discharge Unit**

It is critical to accurate measurement that the gravity-discharge system be designed to drain repeatedly to the same point or condition.

- 18.4. The discharge hose or pipe must be a dry-hose type with no shut-off valve at its outlet end. It may have a shut-off valve at or near the outlet end if the line drains to the same level under all anticipated conditions of product discharge. ☐ Yes ☐ No ☐ N/A
- 18.5. A dry-hose must be stiff enough to facilitate its drainage and no longer than necessary for drainage. ☐ Yes ☐ No ☐ N/A
- 18.6. The inlet end of the hose or pipe must be high enough to provide for proper drainage. ☐ Yes ☐ No ☐ N/A
- 18.7. The system must provide an automatic vacuum breaker or equivalent means for preventing siphoning and ensuring rapid and complete drainage. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.5. Discharge Hose**

- 18.8. A discharge hose shall be adequately reinforced. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.6. Discharge Valve**

- 18.9. A discharge valve may be installed in the discharge line only if the device is of the wet-hose type. ☐ Yes ☐ No ☐ N/A
- 18.10. Any other shut-off valve on the discharge side of the meter must be of the automatic or semiautomatic pre-determined stop type or shall operate only: ☐ Yes ☐ No ☐ N/A
- 18.10.1. By means of a tool (not a pin) entirely separate from the device. ☐ Yes ☐ No ☐ N/A
- 18.10.2. By mutilation of a security seal with which the valve is sealed open. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.7. Anti-drain Valve**

- 18.11. A wet-hose, pressure-type device shall have an effective anti-drain valve incorporated in the discharge valve or adjacent to it. ☐ Yes ☐ No ☐ N/A

**19. Marking****Code Reference: S.4. Marking Requirements**

- 19.1. If a device is intended to accurately measure only products that have particular properties or are under specific installation or operating conditions, or when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently marked on the device. Wholesale devices shall be marked with their designed maximum and minimum discharge rates. If a device is equipped with an automatic temperature-compensating system, the primary indicating and recording elements, and recorded representation shall be clearly and conspicuously marked to show that the volume has been adjusted to 15 °C (60 °F.) A meter may be used to measure both gasoline and diesel fuel at different times provided that the meter is tested and adjusted with the product to be measured before it is used commercially. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.1. Limitation on Use**

- 19.2. Any limitations of use shall be clearly and permanently marked on the device. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.2. Air Pressure**

- 19.3. If the device operates using air pressure, the air pressure gauge must show the maximum and minimum working pressures recommended by the manufacturer. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.3.1. Discharge Rates**

- 19.4. The designed maximum and minimum discharge rates must be marked on the device. The minimum rate shall not exceed 20% of maximum rate. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.3.2. Temperature Compensation**

- 19.5. If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representations shall be clearly and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C (60 °F.) ☐ Yes ☐ No ☐ N/A



## National Type Evaluation Program

### Liquid Measuring Devices – Checklists and Test Procedures for Specific Criteria for Vehicle Tank Meters

#### 20. Indicating and Recording Elements

##### Code Reference: G-S.5.1. General/Tax Computation

Digital electronic vehicle tank meters frequently have the capability to compute the taxes applicable to the sale of fuel oil and gasoline. There may be more than one tax on a delivery. Unless the round-off method for a tax to be applied to a sale is specified, the dollar amount of each tax is to be computed separately, rounded to the nearest cent, and then summed to obtain the total price of the sale. A vehicle-tank-meter register must demonstrate that it is capable of rounding the tax money values to the nearest cent (even if the jurisdiction in which the test is conducted specifies another form of round off) because most jurisdictions require round-off to the nearest cent.

- 20.1. Each tax shall be computed separately, rounded to the nearest cent, and summed to obtain the total price of the sale. ☐ Yes ☐ No ☐ N/A

#### 21. Digital

##### Code Reference: G-S.5.2.2. Digital Indication and Representation

##### 21.1. Basic operating requirements for devices:

- 21.1.1. All digital values of like value in a system shall agree. ☐ Yes ☐ No ☐ N/A
- 21.1.2. A digital value shall agree with its analog representation to the nearest minimum graduation. ☐ Yes ☐ No ☐ N/A
- 21.1.3. Digital values shall round off to the nearest digital division that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A
- 21.1.4. When a digital zero display is provided, the zero indication shall consist of at least one digit to the left and all digits to the right of the decimal point. ☐ Yes ☐ No ☐ N/A

Agreement of indications shall be checked for several deliveries. The totalizer shall be checked for accuracy and agreement with individual deliveries and with other totalizers in the system. Indications may disagree if digital indications receive quantity pulses from a non-resettable pulser.

- 21.2. All digital values of like values in a system agree with one another. ☐ Yes ☐ No ☐ N/A
- 21.3. Digital values coincide with associated analog values to the nearest minimum graduation. ☐ Yes ☐ No ☐ N/A
- 21.4. Digital values "round off" to the nearest minimum unit that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A
- 21.5. The device totalizer shall agree with the total of the individual deliveries and with other totalizers in the system. ☐ Yes ☐ No ☐ N/A

#### 22. Primary Elements

##### Code Reference: S.1.1.2. (a) Units

- 22.1. If the device is equipped to record, it shall indicate and record its deliveries in terms of gallons and decimal or binary subdivisions except as noted in S.1.1.2.(b) and S.1.1.2.(c) below. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.1.2. (b) Units for Meters Used to Sell Milk**

- 22.2. 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 pounds. Fractional parts of the pound shall be in decimal subdivisions. ☐ Yes ☐ No ☐ N/A

- 22.3. The weight value division shall be a decimal multiple or submultiples of 1, 2, or 5. ☐ Yes ☐ No ☐ N/A

*Note: The mass shall be expressed as apparent mass versus 8.0 g/cm<sup>3</sup>.*

**Code Reference: S.1.1.3. Value of Smallest Unit**

If the meter is equipped to record, the value of the smallest unit of indicated delivery and recorded delivery shall not exceed the equivalent of:

- 22.4. 0.5 L (0.1 gal) or 0.5 kg (1 lb) on milk-metering systems. ☐ Yes ☐ No ☐ N/A

- 22.5. 0.5 L (0.1 gal) on meters with a rated maximum flow rate of 750 L/min (200 gal/min) or less. ☐ Yes ☐ No ☐ N/A

- 22.6. 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** ☐ Yes ☐ No ☐ N/A

- 22.7. 5 L (1 gal) on other meters. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.1.5. Return to Zero**

The primary indicating elements on a vehicle tank meter must be returnable to zero before a delivery. If the register has a printer, it is not required that the printer be returnable to zero. If it is returnable to zero, then neither the indicating nor the recording element shall go beyond their correct zero position. Due to the manner in which vehicle tank meters are operated, the outlet side of the meter shall be automatically or manually pressurized before the indicating and recording elements are set to zero. Primary indicating elements shall not be resettable to zero during a delivery.

- 22.8. Primary indicating elements shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of the primary indicating or recording elements beyond their correct zero position. ☐ Yes ☐ No ☐ N/A

- 22.9. Automatic or manual means shall be provided to assure that the system on the outlet side of the meter is pressurized before recording an initial zero condition as required by UR.2.1. ☐ Yes ☐ No ☐ N/A

- 22.10. A printer shall be so designed that the recording of zero shall reflect the actual initial condition of the meter prior to deliver. ☐ Yes ☐ No ☐ N/A

- 22.11. Primary indicating elements shall not be resettable to zero during a delivery. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.6. Travel of Indicator**

- 22.12. If the most sensitive element of the indicating system uses an indicator and graduations, the relative movement of these parts corresponding to the smallest indicated value must be no less than 5 mm (0.2 in.) ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5. Automatic Temperature Compensation for Refined Petroleum Products**

- 22.13. 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 for liters or the volume at (60 °F) for gallons and decimal subdivisions or fractional equivalents thereof where not prohibited by state law. ☐ Yes ☐ No ☐ N/A

- 22.14. On a device equipped with an automatic temperature-compensating mechanism that will indicate or record only in terms of liters (gallons) compensated to 15 °C (60 °F), provision shall be made for deactivating the automatic temperature-compensating mechanism so the meter can indicate and record, if it is equipped to record, in terms of the uncompensated volume. ☐ Yes ☐ No ☐ N/A

- 22.15. A device equipped with automatic temperature compensation shall indicate or record, ☐ Yes ☐ No ☐ N/A if equipped to record, both the gross (uncompensated) and net (compensated) volume for testing purposes. It is not necessary that both net and gross volume be displayed simultaneously.

## 23. Computing Type Devices

### Code Reference: S.1.4. Computing-Type Device

If a vehicle tank meter can compute the total sales price of a delivery, then the unit price at which the meter is set to compute must be displayed on the outside of the device. The unit price must be displayed in a manner that is clear to both the operator and an observer. The primary indicating element must be visible from a reasonable customer position. Many electronic vehicle-mounted metering/controlling systems on which transaction information is displayed are mounted inside the cab of the delivery vehicle. This location is not considered visible from a reasonable customer position. Some systems provide a remote customer display as a standard feature and some do not. The application section of any Certificate of Conformance issued to a vehicle-mounted metering/controlling system must limit the system to installations where a customer indicator is provided and located in a reasonable customer position (e.g., at the meter on the rear of the vehicle.) The printed ticket must state the quantity delivered and the unit price if the total price is printed on the ticket.

A computing-type meter shall compute the total sale price for all unit prices and quantities for all deliveries. The money value division for analog meters shall be one cent, and the graduations shall be accurately positioned; however, the accuracy of the total price is not specified. On devices with digital indications, the total price shall be computed on the basis of a quantity-value division of 0.2 L (0.1 gal) or less. The total price indication on a digital device shall be accurate to within one cent.

### Code Reference: S.1.4.1. Display of Unit Price

- 23.1. Means must be provided to display the unit price at which the device is set to compute in proximity to the total computed price display. (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.) ☐ Yes ☐ No ☐ N/A
- 23.2. The unit price shall be expressed in dollars and decimals of dollars using a dollar sign. A common fraction shall not appear in the unit price (e.g., \$1.299 not \$1.29 9/10.) ☐ Yes ☐ No ☐ N/A

### Code Reference: S.1.4.2. Printed Ticket

- 23.3. Any printed ticket with the total computed price indicated must also have clearly printed the total quantity delivered in terms of liters, gallons or kilograms, pounds and the appropriate fraction, and the unit price. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.1.4.3. Money Value Computations

- 23.4. The device shall be of the full computing type. ☐ Yes ☐ No ☐ N/A
- 23.5. Money-value graduations shall be supplied and accurately positioned. ☐ Yes ☐ No ☐ N/A
- 23.6. The value of each graduated interval shall be one cent. ☐ Yes ☐ No ☐ N/A
- 23.7. 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.) ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.4.4. Money Values - Mathematical Agreement**

Any digital money value indication and any recorded money value on a computing type device must mathematically agree with its associated quantity indication or representation to within one cent of money value (Quantity X Unit Price = Sale Price  $\pm$  1 Cent.) Check mathematical agreement:

- 23.8. At various flow rates, including the maximum and minimum. ☐ Yes ☐ No ☐ N/A
- 23.9. At several unit prices including low prices and the maximum pricing capability of the computer. ☐ Yes ☐ No ☐ N/A

*Note: At least four decimal places in cents must be carried to determine the proper round off of money values.*

**24. Measuring Element****Code Reference: S.2.2. Provision for Sealing**

Measuring elements shall be designed with a provision for sealing such that an adjustment to the measuring element or the flow rate control (if the flow rate affects the accuracy of deliveries) cannot be made without breaking the security seal. These provisions can be an approved means of security (e.g., data change audit trail) or physically applying a security seal which must be broken before adjustments can be made. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal.

- 24.1. A measuring element shall have provision for sealing its adjustable components. ☐ Yes ☐ No ☐ N/A
- 24.2. Any adjustable element controlling the delivery rate shall provide for sealing if the flow rate affects the accuracy of deliveries. ☐ Yes ☐ No ☐ N/A
- 24.3. The adjusting mechanism shall be readily accessible to affix a security seal. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.4. Zero-Set-Back Interlock**

- 24.4. Except for vehicle-mounted metering systems used solely for the delivery of aviation fuel, a device shall be so constructed that after 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. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5.4. Provision for Sealing Automatic Temperature-Compensating Systems**

- 24.5. 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 an automatic temperature compensating system cannot be disconnected and no adjustment may be made to the system. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5.5. Temperature Determination with Automatic Temperature Compensation**

- 24.6. For test purposes, means shall be provided (e.g., thermometer well) to determine the temperature of the liquid either:
- 24.6.1. In the liquid chamber of the meter. **OR** ☐ Yes ☐ No ☐ N/A
- 24.6.2. Immediately adjacent to the meter in the meter inlet or discharge line. ☐ Yes ☐ No ☐ N/A

## 25. Discharge Lines and Discharge Valves

### Code Reference: S.3.1. Diversion of Measured Liquid

No means shall be provided by which any measured liquid can be diverted from the measuring chamber or from the discharge line. However, two or more delivery outlets may be installed if means are provided to ensure that liquid can flow from only one outlet at a time and the setting for the direction of flow is conspicuously and definitely indicated. This paragraph does not apply to the following:

- 1) Equipment used exclusively for fueling aircraft.
- 2) Multiple-product, single-discharge hose metering systems that are equipped with systems designed to flush the discharge hose, provided the flushing system complies with the provisions of paragraph S.3.1.1. Means for Clearing the Discharge Hose.

- 25.1. Is the equipment used only to fuel aircraft? ☐ Yes ☐ No ☐ N/A  
If "yes" skip to next Code Reference.
- 25.2. Is the application for the metering system intended to be for multiple-product, single-discharge hose metering systems that will include systems designed to flush the discharge hose? ☐ Yes ☐ No ☐ N/A  
If "yes" skip to next Code Reference.
- 25.3. It shall not be possible to divert measured liquid from the measuring chamber or the discharge line. ☐ Yes ☐ No ☐ N/A
- 25.4. If two or more delivery outlets are installed, then liquid shall flow from only one outlet at a time and the direction of flow shall be conspicuously indicated. ☐ Yes ☐ No ☐ N/A

### Code Reference S3.1.1. Means for Clearing the Discharge Hose

Metering systems may be equipped with a system specifically designed to facilitate clearing of the discharge hose prior to delivery to avoid product contamination. In such systems, a valve to temporarily divert product from the measuring chamber of the meter to a storage tank shall be installed only under specific conditions. For metering systems which are interfaced with such flushing systems, the provisions paragraph S.3.1.1. Means for Clearing the Discharge Hose must be satisfied. This must be specified on the CC when this option is listed.

If the system under evaluation is equipped with such a flush system, verify that the interface with the metering system operates properly; does not affect the operation of the metering system; and does not facilitate fraud.

Verify the metering system and flush system meets the following conditions:

- (a) the discharge hose remains of the wet hose type; ☐ Yes ☐ No ☐ N/A
- (b) the valve and associated piping are approved by the weights and measures authority having jurisdiction over the device prior to commercial use; ☐ Yes ☐ No ☐ N/A
- (c) the valve is permanently marked with its purpose (e.g., flush valve); ☐ Yes ☐ No ☐ N/A
- (d) the valve is installed in a conspicuous manner and as far from the hose reel as practical; ☐ Yes ☐ No ☐ N/A
- (e) the system clearly and automatically indicates the direction of product flow during operation of the flush system; ☐ Yes ☐ No ☐ N/A
- (f) clear means, such as an indicator light or audible alarm, is used to identify when the valve is in use; and ☐ Yes ☐ No ☐ N/A
- (g) no hoses or piping are connected to the inlet when it is not in use. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.3.2. Pump-Discharge Unit

- 25.5. A pump-discharge unit must have wet-hose type discharge hose with the shut-off valve at outlet end. ☐ Yes ☐ No ☐ N/A
- 25.6. A pump-discharge unit may also have dry-hose type without a shut-off valve at the outlet end if:
- 25.6.1. The dry-hose is as short as practicable. **AND** ☐ Yes ☐ No ☐ N/A
  - 25.6.2. An effective means in the discharge piping immediately adjacent to the meter permits flow through only one of the discharge hoses at any one time, and the meter and wet-hose remain full of liquid at all times. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.3. Gravity-Discharge Unit**

It is critical to accurate measurement that a gravity-discharge system be designed to drain repeatedly to the same point or condition.

- 25.7. The discharge hose or pipe must be a dry-hose type with no shut-off valve at its outlet end. ☐ Yes ☐ No ☐ N/A
- 25.8. A dry hose must be stiff enough to facilitate its drainage and no longer than necessary for drainage. ☐ Yes ☐ No ☐ N/A
- 25.9. The inlet end of the hose or pipe must be high enough to provide for proper drainage. ☐ Yes ☐ No ☐ N/A
- 25.10. The system must provide an automatic vacuum breaker or equivalent means for preventing siphoning and ensuring rapid and complete drainage. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.4. Discharge Hose**

- 25.11. The discharge hose must be adequately reinforced. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.5. Discharge Valve**

- 25.12. A discharge valve may be installed in the discharge line only if the device is of the wet-hose type in which case the valve must be at the discharge end of the line. ☐ Yes ☐ No ☐ N/A
- 25.13. Any other shut-off valve on the discharge side of the meter must be of the automatic or semiautomatic predetermined stop type or shall be operable only: ☐ Yes ☐ No ☐ N/A
- 25.13.1. By means of a tool (not a pin) entirely separate from the device. **OR** ☐ Yes ☐ No ☐ N/A
- 25.13.2. By mutilation of a security seal with which the valve is sealed open. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.6. Anti-drain Valve**

- 25.14. A wet-hose, pressure-type device shall have an effective anti-drain valve incorporated in the discharge valve or adjacent thereto to prevent drainage of the discharge hose. Devices used only for fueling and de-fueling aircraft may be of the pressure-type without an anti-drain valve. ☐ Yes ☐ No ☐ N/A

**26. Marking Requirements****Code Reference: S.5. Marking Requirements**

If a device is intended to accurately measure only products with the following: having particular properties, under specific installation, operating conditions, or when used in conjunction with specific accessory equipment. These limitations shall be clearly and permanently marked on the device. Wholesale devices shall be marked with their designed maximum and minimum discharge rates.

**Code Reference: S.5.1. Limitation of Use**

- 26.1. Any limitations of use shall be clearly and permanently marked on the device. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.5.2. Discharge Rates**

- 26.2. The designed maximum and minimum discharge rates must be marked on the device. ☐ Yes ☐ No ☐ N/A  
The minimum rate shall not exceed 20% of maximum rate.

**Code Reference: S.5.5. Conversion Factor**

- 26.3. When the conversion factor of 8.6 pounds per gallon 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. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.5.6. Temperature Compensation for Refined Petroleum Products**

- 26.4. If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representations shall be clearly ☐ Yes ☐ No ☐ N/A

and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C for liters or the volume at 60 °F for gallons and decimal subdivisions or fractional equivalents thereof.





## National Type Evaluation Program

### Liquid Measuring Devices – Checklists and Test Procedures for Liquefied Petroleum Gas (LPG) Liquid Measuring Devices

#### 27. General – LPG Liquid Measuring Devices

##### Code Reference: G-S.5.1. and G-UR.1.1. General

Indicating elements must be appropriately designed and adequate in amount. Specifically, if applicable, a device must have sufficient display capacity to indicate the quantities and total prices normally encountered in the specific application. Electronic devices shall either have sufficient display capacity to indicate the normal quantities and money values or automatically stop the delivery before exceeding the display capacity for the device to be suitable for the application.

- 27.1. Analog dispensers shall have adequate display capacity for the application. ☐ Yes ☐ No ☐ N/A
- 27.2. An electronic digital indicating element shall either: ☐ Yes ☐ No ☐ N/A
- 27.2.1. Have adequate display capacity for the application. ☐ Yes ☐ No ☐ N/A
- 27.2.2. Automatically stop the delivery before exceeding the maximum quantity or maximum total price that can be indicated. ☐ Yes ☐ No ☐ N/A

##### Code Reference: G-S.5.2.2. Digital Indication and Representation

- 27.3. All digital values of like values in a system agree with one another. ☐ Yes ☐ No ☐ N/A
- 27.4. Digital values coincide with associated analog values to the nearest minimum graduation. ☐ Yes ☐ No ☐ N/A
- 27.5. Digital values "round off" to the nearest minimum unit that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A
- 27.6. The device totalizer shall agree with the total of the individual deliveries and with other totalizers in the system. ☐ Yes ☐ No ☐ N/A
- 27.7. All total sale money value indications in a computing system are primary indications and must agree prior to the application of any post-delivery discount. ☐ Yes ☐ No ☐ N/A
- 27.8. Digital volume indications in a non-computing system must agree or "round off" to the nearest minimum unit that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A
- 27.9. Manual quantity entries in invoice billing systems must be identified as such. ☐ Yes ☐ No ☐ N/A

##### For Stationary retail devices:

- 27.10. When delivery from a stationary retail computing device is based upon a pre-set volume, the quantity indicated on the dispenser and any auxiliary device must be equal to or greater than the pre-set volume and the dispenser and remote console must comply with G-S.5.5. Money Values, Mathematical Agreement. ☐ Yes ☐ No ☐ N/A
- 27.11. The quantity, unit price, and total price indications on the console shall be in mathematical agreement prior to the application of any post-delivery discount. ☐ Yes ☐ No ☐ N/A
- 27.12. The following applies when a quantity value indicated or recorded by an auxiliary element such as a console, ticket printer, or remote customer display, is a derived or computed value based on data received from a retail motor fuel dispenser. When a system applies a post-delivery discount(s) to a fuel's unit price through an auxiliary ☐ Yes ☐ No ☐ N/A

element, the total volume of the delivery shall be in agreement between all elements in the system.

27.12.1. In systems that do not apply a post-delivery discount the quantity values indicated or recorded on a console, electronic cash register, or other auxiliary indicating or recording element may differ, however, for all systems: ☐ Yes ☐ No ☐ N/A

27.12.1.1. All indicated or recorded total money values for an individual sale shall agree. AND ☐ Yes ☐ No ☐ N/A

27.12.1.2. The indicated or recorded quantity, unit price, and total sales price values shall be in mathematical agreement to the closest cent (e.g., within each element, the values indicated or recorded must meet the formula [quantity x unit price = total sales price] to the closest cent.) ☐ Yes ☐ No ☐ N/A

Examples: \$1.5549 rounds to \$1.55

\$1.5551 rounds to \$1.56

\$1.5550 rounds to either \$1.55 or \$1.56

27.13. The printed ticket and dispenser must comply with G.S.5.5. Money Values, Mathematical Agreement to the nearest cent (unit price x volume = total sale  $\pm$  0.5 cent.) ☐ Yes ☐ No ☐ N/A

27.14. Digital values agree with their associated analog value to the nearest minimum graduation. ☐ Yes ☐ No ☐ N/A

#### Code Reference: S.1.1.2. Units

27.15. The device shall indicate, and record if equipped to record, its deliveries in terms of gallons, cubic meters, or liters and decimal or binary-submultiples of a gallon. ☐ Yes ☐ No ☐ N/A

#### Code Reference: S.1.1.3. Value of Smallest Unit

27.16. The value of the smallest quantity division shall not exceed:

27.16.1. 0.5 L (1 pt) on retail devices. **OR** ☐ Yes ☐ No ☐ N/A

27.16.2. 5 L (1 gal) on wholesale devices. ☐ Yes ☐ No ☐ N/A

#### Code Reference: S.1.1.5. Money Values - Mathematical Agreement

Any recorded money value and any digital money value indication on a primary indicator must be in mathematical agreement with its associated quantity (volume) representation or indication to:

27.17. The nearest one cent for a **motor fuel** device. ☐ Yes ☐ No ☐ N/A

27.18. Within one cent for all other Liquefied Petroleum Gas liquid meters. ☐ Yes ☐ No ☐ N/A

#### Code Reference: S.1.1.6. Printed Ticket

Any printed ticket with the total computed price must also have clearly printed the total volume delivered in terms of gallons, cubic meters, or liters, and the appropriate fractions, and unit price.

*Note: Vehicle-mounted metering systems must be equipped with a ticket printer. If the device submitted for type evaluation is equipped with a ticket printer, this should be listed as a standard feature. If the device submitted is not equipped with a ticket printer, the application section of the Certificate of Conformance must indicate that the device is suitable for installation only in applications where an appropriate and compatible ticket printer is provided. (Code Reference UR.2.6., Ticket Printer)*

**Code Reference: S.1.4. For Retail Devices Only**

Retail Liquefied Petroleum Gas (LPG) devices are used for single deliveries of liquefied petroleum gas for domestic or non-resale use. A retail device may be mounted on a vehicle for home deliveries or it may be stationary, used primarily as a **motor fuel** dispenser or for filling LPG cylinders. The requirements of Section S.1.4. apply to both stationary and vehicle-mounted retail devices, but additional specifications are given in Section S.1.5. for stationary retail devices.

**Code Reference: S.1.4.1. Indication of Delivery**

- 27.19. A retail device shall automatically show on its face the initial zero condition and the quantity delivered up to normal capacity of the device. ☐ Yes ☐ No ☐ N/A
- 27.20. 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. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.4.2. Return to Zero**

The primary indicating element on any retail device shall be returnable to zero before a delivery. However, unless the retail device is a **retail motor fuel** device (or a stationary retail device), the recording element need not be returnable to zero before a delivery. Consequently, a vehicle-mounted Liquefied Petroleum Gas retail meter is not required to have a recording element that is returnable to zero before a delivery. Primary indicating elements shall not be resettable to zero during a delivery.

- 27.21. Is the device equipped with a recording element? ☐ Yes ☐ No ☐ N/A
- 27.22. The primary indicating element shall be capable of being reset to zero before a delivery. ☐ Yes ☐ No ☐ N/A
- 27.23. If the device is a **retail motor fuel** device and includes a printer, it shall be possible to reset the printer to zero before a delivery. ☐ Yes ☐ No ☐ N/A
- 27.24. Indicating and recording elements shall not go beyond their correct zero position. ☐ Yes ☐ No ☐ N/A
- 27.25. Primary indicating elements shall not be resettable to zero during a delivery. ☐ Yes ☐ No ☐ N/A

## 28. Stationary Retail Devices

**Code Reference: S.1.5.1. Display of Unit Price and Product Identity**

A computing or money-operated device shall display on each face the unit price at which it is set to compute or deliver, expressed as a decimal value in dollars. Means shall be provided to display on each side of the device the identity of the product grade, blend, or mixture of product being dispensed.

Except for dispensers intended to be limited for use exclusively for fleet sales and other price contract sales, all of the unit prices at which that product is offered for sale shall meet the following conditions:

- (1) For a system that applies a discount prior to the delivery, all unit prices shall be displayed or shall be capable of being displayed on the dispenser through a deliberate action of the purchaser prior to the delivery of the product. It is not necessary that all of the unit prices be simultaneously displayed prior to the delivery of the product.
- (2) For a system that offers post-delivery discounts on fuel sales, display of pre-delivery unit price information is exempt from (1) above, provided the system complies with S.1.5.5. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided.

Note: When a product is offered at more than one unit price, display of the unit price information may be through the deliberate action of the customer: 1) using controls on the device; 2) through the customer's use of personal or vehicle-mounted electronic equipment communicating with the system; or 3) verbal instructions by the customer.

- 28.1. Means shall be provided to display the unit price on each face of the device. ☐ Yes ☐ No ☐ N/A
- 28.2. The unit price shall be expressed in dollars and decimals of dollars using a dollar sign. A common fraction shall not appear in the unit price, (e.g., \$1.299 not \$1.29 9/10.) ☐ Yes ☐ No ☐ N/A
- 28.3. The unit price cannot be changed while the dispenser is activated. ☐ Yes ☐ No ☐ N/A
- 28.4. Means shall be provided to display on each side of the device the product identity, grade, brand, blend, or mixture of product being dispensed. ☐ Yes ☐ No ☐ N/A
- 28.5. If a grade, brand, blend, or mixture is offered for sale at more than one unit price from a device, then all of the unit prices at which that product is offered for sale:
- 28.5.1. Shall be displayed prior to the delivery of the product. OR ☐ Yes ☐ No ☐ N/A
- 28.5.2. Shall be capable of being displayed on the dispenser through the deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions. ☐ Yes ☐ No ☐ N/A

*Note: It is not necessary to simultaneously display all of the unit prices for all grades, brands, blends, or mixtures provided the dispenser complies with this section, S.1.5.1.*

*Note: For a system that offers post-delivery discounts on fuel sales, display of pre-delivery unit price information is exempt from 28.5, provided the system complies with S.1.5.5. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided.*

28.6. The unit prices for each product and price level may be:

- 28.6.1. Displayed simultaneously for all products. ☐ Yes ☐ No ☐ N/A
- 28.6.2. Displayed simultaneously for each product separately.; or ☐ Yes ☐ No ☐ N/A
- 28.6.3. Displayed individually in a unit-price display only if controls permit the customer to sequence the display through the unit prices for each and every product. ☐ Yes ☐ No ☐ N/A

*Note: Section 28.5 shall not apply to fleet sales, other contract sales, or truck refueling sales (e.g. sales from dispensers used to refuel trucks.)*

#### **Code Reference: S.1.5.2. Money-Value Computations**

A computing device shall compute the total sales price at any single-purchase unit price (excluding fleet sales and other price contract sales) for which the product is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less. The analog money value indication shall not differ from the mathematically computed money value (quantity x unit price = sales price) for any delivered quantity by an amount greater than the values shown in Table 1 on the next page. The maximum value of the money-value division and the maximum variation of indicated total sale price from the mathematically computed total sale price are specified for analog devices.

- 28.7. A retail computing device shall compute total sale prices for all quantities and unit prices within the range of its quantity and computing capacities. ☐ Yes ☐ No ☐ N/A
- 28.7.1. For any delivered quantity, analog money value indications on each side of a device shall not differ by an amount greater than the values shown in Table 1 from the mathematically computed money value (Quantity x Unit Price = Sales Price.) ☐ Yes ☐ No ☐ N/A
- 28.7.2. Total prices indicated on the two sides of an analog register shall agree within one-half of the money value division. *See NIST Handbook 44 N.4.3. for Test Procedures.* ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.5.2.1. Analog Money-Value Divisions**

28.8. Analog money-value divisions shall be as follows:

28.8.1. Not more than 1 cent at all unit prices up to and including \$0.25 per liter or \$1.00 per gallon. ☐ Yes ☐ No ☐ N/A

28.8.2. Not more than 2 cents at all unit prices greater than \$1.00 up to and including \$0.75 per liter or \$3.00 per gallon. ☐ Yes ☐ No ☐ N/A

**Table 1.**

**Money-Value Divisions and Maximum Allowable Variations  
for Money-Value Computations on Mechanical Analog Computers**

Unit Price		Money Value Division	Maximum Allowable Variation	
From	To and Including		Design Test	Field Test
0	0.25/liter or \$1.00/gallon	1¢	± 1¢	± 1¢
0.25/liter or \$1.00/gallon	0.75/liter or \$3.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or \$3.00/gallon	2.50/liter or \$10.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or \$3.00/gallon	2.50/liter or \$10.00/gallon	5¢	± 2 ½¢	± 5¢

28.9. Not more than 5 cents at all unit prices greater than \$0.75 per liter or \$3.00 per gallon. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.5.2.2. Digital Money-Value Divisions**

28.10. Digital quantity and total price indications shall agree to the nearest cent. ☐ Yes ☐ No ☐ N/A

28.11. Total price indications shall be based on quantity-value divisions that are less than or equal to 0.05 L (0.01 gal.) ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.5.2.3. Money-Value Divisions, Auxiliary Indications**

28.12. Money value divisions on devices such as remote consoles and printers shall be the same as on the dispenser. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.5.4. Recorded Representations; and S.1.5.5. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided.**

Except for fleet sales and other price contract sales, for transactions conducted with point-of-sale systems or devices activated by credit cards, debit cards, or cash, a printed receipt containing information about the transaction shall be available to the customer as outlined in the following items. A printed receipt must always be available to the customer upon request and printing of the receipt may be initiated at the option of the customer. In addition, some systems may be equipped with the capability to issue an electronic receipt; for those systems, the customer may be given the option to receive the receipt electronically (e.g., via cell phone, computer, etc.). See also NCWM Publication 14, Code Reference: G-S.5.6. Recorded Representations.

Device capabilities: ☐ Printed Receipt ☐ Electronic Receipt

28.13. The system must provide a receipt to be made available to the customer at the completion of the transaction through either:

28.13.1. a built-in recording element OR ☐ Yes ☐ No ☐ N/A

28.13.2. a separate recording element that is part of the system ☐ Yes ☐ No ☐ N/A

28.14. Except for transactions where a post-delivery discount is provided, the customer receipt must contain the following information: ☐ Yes ☐ No ☐ N/A

28.14.1. The total volume of the delivery; ☐ Yes ☐ No ☐ N/A

- 28.14.2. The unit price; ☐ Yes ☐ No ☐ N/A
- 28.14.3. The total computed price; and ☐ Yes ☐ No ☐ N/A
- 28.14.4. The product identity by name, symbol, abbreviation, or code number. ☐ Yes ☐ No ☐ N/A
- 28.15. Where a post-delivery discount(s) is applied, the sales receipt must provide: ☐ Yes ☐ No ☐ N/A
- 28.15.1. the product identity by name, symbol, abbreviation, or code number; ☐ Yes ☐ No ☐ N/A
- 28.15.2. the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s); ☐ Yes ☐ No ☐ N/A
- 28.15.3. an itemization of the post-delivery discounts to the unit price; and ☐ Yes ☐ No ☐ N/A
- 28.15.4. the final total price of each fuel sale after all post-delivery discounts are applied. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.5.6. Provisions for Power Loss**

Even if power fails during a delivery, it is still necessary to correctly complete all transactions in progress at the time of the power failure. Quantity and total sales price information shall be recallable for at least 15 minutes after the power failure. The information may be recalled at the dispenser or at the console if the console indications are accessible to the customer. Operator information, such as fuel and money value totals, shall be retained in memory during a power failure. The operator information is not required to be recallable during the power failure, but shall be recallable after power is restored. Test to determine if the indications are accurate when the delivery is continued after a power failure.

*Note: For remote controllers (e.g., cash register, console, etc.) which have the capability to retain information pertaining to a transaction (e.g., stacked completed sales.) If the information cannot be recalled at the dispenser following a power outage, means (e.g., uninterruptible power supply or other means) must be provided to enable the transaction information to be recalled and verified for at least 15 minutes following a power outage.*

- 28.16. The quantity and total sales price shall be recallable for 15 minutes after the power failure. ☐ Yes ☐ No ☐ N/A
- 28.17. The quantity and total sales price values shall be correct if the power fails between deliveries. ☐ Yes ☐ No ☐ N/A
- 28.18. The quantity and total sales price values shall be correct if the delivery is continued after a power failure. ☐ Yes ☐ No ☐ N/A
- 28.19. The operator's information shall be retained in memory during a power failure. ☐ Yes ☐ No ☐ N/A
- 28.20. Remote controllers which stack completed sales must have a means to enable the transaction information to be recalled and verified for at least 15 minutes. ☐ Yes ☐ No ☐ N/A

In addition to the above criteria for power, loss, the following applies to evaluations of Cash-Activated LPG **Retail Motor-Fuel** Dispensers:

In addition to the above checklist complete those portions of Section 15. of LMD Checklist, Checklists and Test Procedures for Cash-Activated **Retail Motor-Fuel** Dispensers which relate to provisions for power loss.

**Code Reference: S.1.5.7. Totalizers for **Retail Motor-Fuel** Dispensers.**

- 28.21. **Retail motor fuel** dispensers shall be equipped with a non-resettable totalizer for the quantity delivered through the metering device. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.6.1. Travel of Indicator**

- 28.22. A wholesale device shall accurately deliver any quantity from 180 L (50 gal) to the capacity of the device. ☐ Yes ☐ No ☐ N/A

- 28.23. If the most sensitive element of the indicating system uses an indicator and graduations, the relative movement of these parts corresponding to a delivery of 5 kg (10 lb) or 5 L (1 gal) must be no less than 5 mm (0.20 in.) ☐ Yes ☐ No ☐ N/A

## 29. Measuring Elements

### Code Reference: S.2.2. Provision for Sealing

Measuring elements shall be designed with a provision for sealing such that an adjustment to the measuring element or the flow rate control (if the flow rate affects the accuracy of deliveries) cannot be made without breaking the security seal. These provisions can be an approved means of security (e.g., data change audit trail) or physically applying a security seal which must be broken before adjustments can be made. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal.

- 29.1. A measuring element shall provide for sealing its adjustable components. ☐ Yes ☐ No ☐ N/A
- 29.2. Any adjustable element controlling the delivery rate shall provide for sealing if the flow rate affects the accuracy of deliveries. ☐ Yes ☐ No ☐ N/A
- 29.3. The adjusting mechanism shall be readily accessible to affix a security seal. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.2.3. Directional Flow Valves

Valves intended to prevent the reversal of flow shall be automatic in operation.

### Code Reference: S.2.4. Maintenance of Liquid State

- 29.4. Because Liquefied Petroleum Gas liquid is susceptible to cavitations and is measured under pressure, a device shall be designed and installed so that the product will remain in liquid state while passing through the meter. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.2.5. Zero-Set-Back Interlock

The zero-set-back interlock on a dispenser is critical to prevent fraudulent practices. A **retail motor fuel** device shall have an effective automatic interlock such that once the dispenser shuts off, it cannot be restarted without resetting the indicating element to zero. This requirement also applies to the recording element if one is present. The dispenser shall be designed so that the starting lever must be in the shut-off position and the interlock engaged before the discharge nozzle can be returned to its designed hanging position. If a single pump supplies more than one dispenser, then each dispenser shall have an automatic control valve that prevents product from being delivered by a dispenser until its indications have been set to zero.

- 29.5. After the device is turned off by moving the lever that stops the flow, a subsequent delivery shall be prevented until the indicators (and recording element if present) have returned to their correct zero positions. ☐ Yes ☐ No ☐ N/A
- 29.6. The starting lever shall be in shut off position and zero-set-back interlock engaged before the nozzle can 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. ☐ Yes ☐ No ☐ N/A
- 29.7. If more than one dispenser is connected to a single pump, an automatic control valve shall prevent fuel from being delivered until the indicating elements have been returned to their correct zero position and engaged. ☐ Yes ☐ No ☐ N/A
- 29.8. The use of the interlock shall be effective under all conditions when any control on the console, except a system emergency shut-off, is operating and after any momentary power failure. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.2.5. Thermometer Well

- 29.9. For test purposes, means shall be provided for inserting a thermometer in the meter chamber or immediately adjacent to the meter. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.2.6. Automatic Temperature Compensator

- 29.10. An Liquefied Petroleum Gas meter may be equipped with an automatic temperature compensator. If so equipped, the meter shall be provided with a means for automatically adjusting the indication and registration of the measured volume of the product to the volume at 15 °C (60 °F.) ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.6.1. Provision for Deactivation**

- 29.11. If a device is equipped with only a net indicating and/or recording element (volume compensated to 15 °C (60 °F)) provisions must be made to facilitate the deactivation of the automatic temperature-compensating mechanism so that the meter will indicate and/or record the uncompensated volume. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.6.2. Provision for Sealing**

- 29.12. Automatic temperature compensators must provide for applying security seals to prevent undetected adjustment or disconnection of the compensating system. ☐ Yes ☐ No ☐ N/A

### 30. Discharge Lines and Discharge Line Valves

**Code Reference: S.3.1. Design of Discharge Lines and Discharge Line Valves**

To deter fraudulent practices, it shall not be possible to divert measured liquid from the measuring chamber or the discharge line of a device. The following exceptions to this requirement are permitted.

- 30.1. A device may have two or more delivery outlets if there are automatic means to ensure that:
- 30.1.1. Liquid can flow from only one outlet at a time. **AND** ☐ Yes ☐ No ☐ N/A
  - 30.1.2. The direction of liquid flow is definitely and conspicuously indicated. ☐ Yes ☐ No ☐ N/A
- 30.2. A manually controlled outlet may be opened to empty a portion of the system to allow for repair and maintenance operations. ☐ Yes ☐ No ☐ N/A
- 30.3. Except as identified above, it shall not be possible to divert measured liquid from the measuring chamber or the discharge line of the device. ☐ Yes ☐ No ☐ N/A
- 30.4. Two or more delivery outlets may be installed if there are automatic means to ensure that liquid can flow from only one outlet at a time and the direction of flow for which the mechanism may be set at any time is definitely and conspicuously indicated. ☐ Yes ☐ No ☐ N/A
- 30.5. If the device is equipped with a manually-controlled valve to empty a portion of the system, the passage of liquid through the outlet during normal operation shall be prevented. The device shall clearly indicate whenever the valve controls are set to allow liquid through the valve. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.2. Delivery Hose**

- 30.6. The delivery hose of a retail device shall be of the wet-hose type with a shut-off valve at its outlet end. ☐ Yes ☐ No ☐ N/A

### 31. Marking

**Code Reference: S.4. Marking Requirements**

- 31.1. If a device is intended to accurately measure only products having particular properties, or under specific installation or operating conditions, or when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently marked on the device. Devices shall be marked with their designed maximum and minimum discharge rates. If the device is equipped with an automatic temperature-compensating system, the primary indicating and recording elements, and recorded representation shall be clearly and conspicuously marked to show that the volume has been adjusted to 15 °C (60 °F.) ☐ Yes ☐ No ☐ N/A



**Code Reference: S.4.1. Limitation of Use**

31.2. Any limitations for use shall be clearly and permanently marked on the device. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.2. Discharge Rates**

31.3. Maximum and minimum discharge rates must be marked on the device. The marked minimum shall not exceed 20 liters (5 gal) per minute on motor fuel devices or 20% of the maximum rate for other devices. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.3. Location of Marking Information; Retail Motor Fuel Dispenser**

31.4. The marking information required in the General Code, Paragraph G S.1. Identification shall appear as follows:

31.4.1. Within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser. ☐ Yes ☐ No ☐ N/A

31.4.2. Either internally and/or externally provided the information is permanent and easily read. AND ☐ Yes ☐ No ☐ N/A

31.4.3. On a portion of the device that cannot be readily removed or interchanged (e.g., not on a service access panel.) ☐ Yes ☐ No ☐ N/A

*Note: The use of a dispenser key or tool to access internal marking information is permitted for retail liquid measuring devices. [Non-retroactive as of January 1, 2003] (Added 2006)*

**Code Reference: S.4.4. Temperature Compensation**

31.5. If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representations shall be clearly and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C (60 °F.) ☐ Yes ☐ No ☐ N/A



## National Type Evaluation Program

### Liquid Measuring Devices – Checklists and Test Procedures for Mass Flow Meters

#### 32. Indicating and Recording Elements

##### Code Reference: S.2.8., G-S.5.1. and G-UR.1.1. General

Indicating elements must be appropriately designed and adequate in amount. If applicable specifically, a device must have sufficient display capacity to indicate the quantities and total prices that are normally encountered in the specific application. Electronic devices shall have either sufficient display capacity to indicate the normal quantities and money values or automatically stop the delivery before exceeding the display capacity of either the quantity or total price.

- 32.1. The device shall automatically show on its face the initial zero condition; however, the first 0.03 L (0.009 gal.) of a delivery and its associated total sales price does not need to be indicated. ☐ Yes ☐ No ☐ N/A
- 32.2. The device shall automatically show on its face the quantity delivered up to the nominal capacity. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.7. Totalizers for **Retail Motor Fuel** Devices

- 32.3. **Retail motor fuel** dispensers shall be equipped with an non-resettable totalizer. ☐ Yes ☐ No ☐ N/A

##### Code Reference: G-S.5.2.2. and G-S.5.2.3. Digital Indication and Representation

Basic operating requirements for devices are that:

- All digital values of like value in a system shall agree.
- A digital value shall agree with its analog representation to the nearest minimum graduation.
- Digital values shall round off to the nearest digital division that can be indicated or recorded.
- When a digital zero display is provided, the zero indication shall consist of at least one digit to the left and all digits to the right of the decimal point.

Due to limitations of some of the technologies used to transmit information from dispensers to service station consoles, some exceptions to these rules have been given to the indications on **retail motor fuel** dispensers and service station consoles. Exact agreement of digital quantity values is not required if only total price information is sent from the dispenser to the console. In these cases, the console calculates the quantity from the unit price set in the console. Consequently, the quantity indicated on the console may not exactly agree with the quantity indicated on the dispenser. However, if the console prints a customer receipt, then the quantity times unit price must equal the total price on both the dispenser and the printed receipt.

Previously, the service station console was considered an auxiliary indication and did not have to satisfy the mathematical agreement requirement for money values (G-S.5.5.) The money value indication for dispensers and consoles must agree for all installations, both old and new.

For those systems consisting of a console, dispensers, and equipped with pre-set volume, the dispenser must deliver at least the pre-set volume; it cannot deliver less. For example, if the console sends only the money equivalent of the pre-set volume to the dispenser, the dispenser shall deliver at least the pre-set volume. It may not stop at the first quantity amount that results in mathematical agreement with the money value equivalent of the pre-set volume if the quantity indication is less than the pre-set volume. Similarly, if a money value is pre-set, the dispenser is not properly designed if it always stops at the lowest quantity value that provides mathematical agreement with the pre-set money value.

Tests for agreement of digital values shall be performed in the post-pay, prepay money, and pre-set volume models. Agreement should be checked at several unit prices including the maximum unit price and with the dispenser operating at its maximum flow rate.

- 32.4. All total sale money value indications in a computing system are primary indications and must agree. ☐ Yes ☐ No ☐ N/A
- 32.5. Digital volume indications in a non-computing system must agree or "round off" to the nearest minimum unit that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A
- 32.6. Manual quantity entries in invoice billing systems must be identified as such. ☐ Yes ☐ No ☐ N/A
- 32.7. When delivery from a computing device is based upon a pre-set volume, the quantity indicated on the dispenser and any auxiliary device must be equal to or greater than the pre-set volume and the dispenser and remote console must comply with G-S.5.5. Money Values, Mathematical Agreement. ☐ Yes ☐ No ☐ N/A
- 32.8. Ticket printers and remote customer read-outs used in conjunction with retail dispensers may print or display a volume that is not in exact agreement with the dispenser or remote console, but the total sale amounts must agree. The printed ticket and dispenser must comply with G.S.5.5. Money Values, Mathematical Agreement to the nearest cent (unit price x volume = total sale  $\pm$  0.5 cent.) ☐ Yes ☐ No ☐ N/A
- 32.9. Digital values agree with their associated analog value to the nearest minimum graduation. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.5. Digital Money Values, Mathematical Agreement**

Any recorded money value and any digital money value indication on a primary indicator must mathematically agree with its associated quantity (volume) representation or indication to the nearest one cent.

**Formula: Unit Price x Indicated Volume = Total Sale  $\pm$  0.5 cent**

Check mathematical agreement of all primary indications (e.g., dispenser, console, printer) under the following conditions:

- 32.10. At various flow rates, including maximum and minimum. ☐ Yes ☐ No ☐ N/A
- 32.11. After shutting off the dispenser by turning lever or button to 'off' position while pumping gas into cylinder. ☐ Yes ☐ No ☐ N/A
- 32.12. At several unit prices including the low prices and the maximum pricing capability of the computer and when operating at the maximum flow rate. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.1. Indicating and Recording Elements**

After a transaction is completed, the unit price displayed at the dispenser may be changed to a base unit price. Any display of quantity, unit price, and total price that does not mathematically agree occurs between transactions. This is permitted (in response to demands of device users) because the displayed values between "transactions" are not "significant" relative to the actual delivery process (transaction.)

The displayed unit price may revert to the base unit price immediately after the completion of a transaction. This is defined as the time the delivery has been terminated and payment has been settled. The payment may be automatic if the delivery is to a prepaid amount. If the sale is prepaid, the delivery is considered terminated after the "handle" is in the off position or after the nozzle has been returned to the designed hanging position. This allows the customer adequate time to observe that the prepaid amount has been reached. If the delivery stops short or overruns a prepaid amount, settling the payment means that money is either refunded or collected from the customer and the transaction is "cashed out" by the console operator.

In the case of invoice billing systems such as card-lock or key-lock systems which compute the total sale price, it is not considered appropriate for the displayed unit price to revert to the base unit price immediately following a transaction. Because a receipt for the transaction may not be available, the customer must be allowed an adequate period of time following the delivery to record the transaction information. All information for a transaction, including the transaction unit price, must be displayed for at least 30 seconds following the completion of the delivery and the total price and the quantity must be displayed for at least 5 minutes following the completion of the delivery or the start of the next transaction. The delivery is considered complete after the "handle" is off or the nozzle has been returned to its designed hanging position.

- 32.13. In a system where a base unit price is automatically displayed on the dispenser after the completion of a transaction (e.g., product is dispensed and payment is settled), the dispenser may display the values for quantity, unit price, and total price that do not result in a mathematically correct equation, provided that when the total price value displayed is divided by the quantity value displayed, the result is a unit price that is "posted" for a particular kind of transaction. ☐ Yes ☐ No ☐ N/A

*Note: The mass shall be expressed as apparent mass versus a density of 8.0 g/cm<sup>3</sup>.*

**Code Reference: S.1.3. Units for Mass Flow Meters**

- 32.14. The primary indicating element may indicate in pounds. Fractional parts of the pound shall be expressed in decimal subdivisions. ☐ Yes ☐ No ☐ N/A

**Credit Card or Debit Card-Activated Retail Motor Fuel Dispenser**

On card-activated retail motor fuel dispensers, the customer authorizes the dispenser by inserting the card or swiping the card through a slot. On credit card transactions, the customer is typically billed through the same methods as have been used for credit transactions handled through a station attendant. On debit card transactions, payment is made directly from the purchaser's account by electronic funds transfer.

- 32.15. A receipt must be available to the customer at the completion of the transaction. The customer may request a receipt. ☐ Yes ☐ No ☐ N/A
- 32.16. The customer receipt must contain the following information: ☐ Yes ☐ No ☐ N/A
- Identity (codes may be used) of the Product Purchased
  - Quantity Purchased
  - Unit Price
  - Total Price
- 32.17. Cash Value Card: A cash value card initially encoded with the purchase price, authorizing a customer to purchase products up to the current cash value of the card. The value of the card decreases in amounts equal to individual transactions. ☐ Yes ☐ No ☐ N/A
- Means shall be provided to the customer to determine the initial cash value of the card and the remaining cash value prior to and after each transaction.
- 32.18. Invoice Billing: Invoice billing is a process in which customers are billed for one or more transactions at the end of a billing period.
- 32.18.1. For computing systems, quantity, unit price, and total price shall be recorded and shall agree with the indications on the dispenser. ☐ Yes ☐ No ☐ N/A
- 32.18.2. All displayed transaction information must be shown for at least 30 seconds after the completion of a delivery or the start of the next transaction. The delivery is considered complete after the "handle" is off or after the nozzle has been returned to its designed hanging position. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.2. Compressed Natural Gas and Liquefied Natural Gas Dispensers — Mass Flow Meters**

- 32.19. Except for fleet sales and other price contract sales, a compressed or liquefied natural gas dispenser used to refuel vehicles, shall be of the computing type and shall indicate the quantity, the unit price, and the total price of each delivery. ☐ Yes ☐ No ☐ N/A
- 32.20. The mass measured for each transaction shall be displayed on the dispenser either continuously on an external display or on an internal display accessible during the inspection and test of the dispenser, or it shall display the quantity in mass units by using controls on the device. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.1.1. Compressed Natural Gas Used as an Engine Fuel - Mass Flow Meters**

- 32.21. When compressed natural gas is dispensed as an engine fuel, the delivered quantity shall be indicated in "gasoline gallon equivalent units (GGE) " or "diesel gallon equivalent units (DGE)," or in mass. "See NIST Handbook 44 definitions below." ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.1.2. Liquefied Natural Gas Used as an Engine Fuel - Mass Flow Meters**

- 32.22. When liquefied natural gas is dispensed as an engine fuel, the delivered quantity shall ☐ Yes ☐ No ☐ N/A be indicated in diesel gallon equivalent units (DGE) or in mass. See NIST Handbook 44 definitions below.

Diesel Gallon Equivalent (DGE). – Diesel gallon equivalent (DGE) means 6.384 pounds of compressed natural gas or 6.059 pounds of liquefied natural gas. [3.37]  
(Added 2016)

**Gasoline Gallon Equivalent (GGE)**

Gasoline gallon equivalent (GGE) means 5.660 pounds of natural gas. [3.37] (Added 1994)

- 32.23. An electronic digital indicating element shall either:

32.23.1. Have adequate display capacity for the application. **OR** ☐ Yes ☐ No ☐ N/A

32.23.2. Automatically stop the delivery before exceeding the maximum quantity or maximum total price that can be indicated. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.3. Money-Value Divisions, Digital**

- 32.24. The maximum value of the quantity-value division for liquids shall not be greater than 0.2% of the minimum measured quantity. ☐ Yes ☐ No ☐ N/A

32.24.1. A computing type device with digital indications shall comply with the requirements of paragraph G-S.5.5. Money Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.01 gasoline liter equivalent (GLE) for devices indicating in metric units or 0.001 gasoline gallons equivalent intervals for devices indicating in inch-pound units. The maximum value of the mass division shall not exceed 0.001 kg or 0.001 lb. ☐ Yes ☐ No ☐ N/A

*Note: At least four decimal places in cents must be carried to determine the proper round off of money values.*

**Code Reference: S.1.3.1. Units of Measurement**

- 32.25. The primary indicating element may indicate in grams, kilograms, metric tons, pounds, tons, liters, gallons, quarts, and/or pints. Fractional parts of each unit must be expressed in decimal subdivisions. ☐ Yes ☐ No ☐ N/A

*Note: The mass shall be expressed as apparent mass versus a density of 8.0 g/cm<sup>3</sup>.*

- 32.26. Volume indications may be based upon mass measurements as long as an automatic means to determine and correct for changes in product density is included in the system. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.3. Value of Smallest Unit**

- 32.27. The value of the quantity division shall not exceed the equivalent of 0.001 units mass and 0.01 GLE or 0.001 GGE. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.4.1. and S.2.4.2. Provisions for Power Loss**

Even if power fails during a delivery, it is still necessary to correctly complete all transactions in progress at the time of the power failure. Quantity and total sales price information shall be recallable for at least 15 minutes after the power failure. The information may be recalled at the dispenser or at the console if the console indications are accessible to the customer. Operator information, such as fuel and money value totals, shall be retained in memory during a power failure. The operator information is not required to be recallable during the power failure, but shall be recallable after power is restored. Test to determine if the indications are accurate when the delivery is continued after a power failure.

- 32.28. The quantity and total sales price shall be recallable for 15 minutes after the power failure. ☐ Yes ☐ No ☐ N/A
- 32.29. The quantity and total sales price values shall be correct if the power fails between deliveries. ☐ Yes ☐ No ☐ N/A
- 32.30. The quantity and total sales price values shall be correct if the delivery is continued after a power failure. ☐ Yes ☐ No ☐ N/A
- 32.31. The operator's information shall be retained in memory during a power failure. ☐ Yes ☐ No ☐ N/A

**Code Reference: UR.3.8. and S.2.1. Return to Zero**

The primary indicating and recording elements of a retail device shall be readily returnable to a definite zero indication. Key-lock and other self-operated devices must have a zero-return indicating element, but are not required to have the recording element return to zero. These devices may be equipped with cumulative recording elements. The primary indicating and recording elements shall not go beyond their correct zero position.

- 32.32. Does the device have a primary recording element. ☐ Yes ☐ No ☐ N/A
- 32.33. The indicating and recording elements of a retail device shall be readily returnable to a definite zero indication. ☐ Yes ☐ No ☐ N/A
- 32.34. Key-lock and self-operated devices shall have an indicating element that returns to zero. ☐ Yes ☐ No ☐ N/A
- 32.35. Does the device have:
- 32.35.1. A cumulative indicating element? ☐ Yes ☐ No ☐ N/A
- 32.35.2. A cumulative recording element? ☐ Yes ☐ No ☐ N/A
- 32.36. Primary indicating and recording elements shall not go beyond their correct zero position. ☐ Yes ☐ No ☐ N/A
- 32.37. Does the device return to zero after each delivery if the device is not key-lock or self operated? ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5.1. Display of Unit Price**

A computing or money-operated device shall have a means for displaying on each face of the device the unit price at which it is set to compute or deliver. The unit price shall be expressed as a decimal value in dollars.

- 32.38. Means shall be provided to display the unit price on the face of the device. ☐ Yes ☐ No ☐ N/A
- 32.39. The unit price shall be expressed in dollars and decimals of dollars using a dollar sign. A common fraction shall not appear in the unit price; e.g., \$1.199 not \$1.29 9/10. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5.2. Display of Product Identity**

- 32.40. Means shall be provided to post the identity of the dispensed product. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5.3. Selection of Unit Price**

- 32.41. Unless the dispenser is used exclusively for fleet sales or other contract sales, means shall be available to select the unit price prior to delivering product using customer-activated controls. ☐ Yes ☐ No ☐ N/A
- 32.42. The dispenser shall not permit a change to the unit price during the delivery of a product. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.6.2. Display of Quantity and Total Price**

When a delivery is completed on a computing device, 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 customer uses controls on the device or other user-activated controls to initiate the next transaction.

*Note: The displayed unit price may revert to a base unit price immediately after the completion of a transaction, defined as the time the delivery has been terminated and payment has been*

*settled. Any display of quantity, unit price, and total price that is not in mathematical agreement occurs between transactions and is permitted (in response to demands of device users) because the displayed values between "transactions" are not "significant" relative to the actual delivery process (transaction.)*

### 33. Computing

A retail computing device shall be capable of computing total sale prices for all unit prices and for all deliveries within the range of measurement or computing capacity. The maximum value of the money-value division and the maximum variation of indicated total sale price from the mathematically computed total sale price are specified for analog devices. Because analog dispensers may have different money-value divisions depending upon the unit price, the service station console must update in the same money-value division to maintain agreement of total sale price values. The maximum quantity-value divisions for digital devices are prescribed.

#### Code Reference: S.2.6. Money-Value Computations

- 33.1. A retail computing device shall compute total sale prices for all quantities and unit prices within the range of its quantity and computing capacities. ☐ Yes ☐ No ☐ N/A

*Note: This requirement does not apply to devices for which the Certificate of Conformance is limited to installations where the devices are used for fleet sales, other price contract sales, and truck stop dispensers used only to refuel trucks.*

#### Code Reference: G-S.5.5. Digital Money-Value Divisions

- 33.2. Digital quantity and total price indications shall agree to the nearest cent. ☐ Yes ☐ No ☐ N/A
- 33.3. Total price indications shall be based on quantity-value divisions that are less than or equal to 0.01 gasoline liters equivalent or 0.001 gasoline gallons equivalent. ☐ Yes ☐ No ☐ N/A

#### Code Reference: S.2.6.1. Money-Value Divisions, Auxiliary Indications

- 33.4. Money value divisions on devices such as remote consoles and printers shall be the same as on the dispenser. ☐ Yes ☐ No ☐ N/A

*Note: This requirement does not apply to devices for which the Certificate of Conformance is limited to installations where the devices are used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks.)*

#### Code Reference: S.2.5.4. Agreement between Indications

- 33.5. The quantity values indicated on a console and a dispenser may differ, however:
- 33.5.1. All indicated or recorded total money values for an individual sale shall agree. **AND** ☐ Yes ☐ No ☐ N/A
- 33.5.2. The indicated or recorded quantity of each element, unit price, and total sales price values shall meet the formula (quantity x unit price = total sales price) to the closest one cent. ☐ Yes ☐ No ☐ N/A

### 34. Measuring Elements

#### Code Reference: S.3.3. Air/Vapor Elimination

If air/vapor enters a measuring system or the product changes into the vapor state as it passes through the system, then the system must be equipped with an effective air/vapor eliminator or other automatic means to prevent the air/vapor from being measured by the meter. To prevent air/vapor eliminator vent lines from being pinched close and re-opened without being detected, the vent lines shall be made of appropriate non-collapsible material. If the system is designed such that air/vapor will not enter the system, then an air/vapor eliminator is not required. One example is when a product is being pumped from the bottom of a tank and a low-level detector in the tank shuts off the pump before the liquid level gets to the point where air could enter the system.

- 34.1. A mass flow metering system shall be equipped with a vapor or air eliminator or other automatic means to prevent the measurement of vapor or air by the meter. ☐ Yes ☐ No ☐ N/A



- 34.2. Other effective, automatic means are provided to prevent air/vapor from passing through or being measured by the system. Describe the means provided and list this information on the Certificate of Conformance: ☐ Yes ☐ No ☐ N/A
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- 34.3. Vent lines from the air/vapor eliminator shall be made of appropriate non-collapsible material to prevent the lines from being pinched closed and re-opened without being detected. ☐ Yes ☐ No ☐ N/A

#### Code Reference: S.3.5. Provision for Sealing

Measuring elements shall be designed with adequate provisions to prevent changes from being made to the measuring element or the flow rate control (if the flow rate control affects the accuracy of deliveries) without evidence of the change being made. These provisions can be an approved means of security (e.g., data change audit trail) or physically applying a security seal which must be broken before adjustments can be made. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal.

- 34.4. A measuring element shall have provisions for either:

34.4.1. Applying a physical security seal. **OR** ☐ Yes ☐ No ☐ N/A

34.4.2. An approved means of security (e.g., data change audit trail) so that no changes may be made to its adjustable components. ☐ Yes ☐ No ☐ N/A

- 34.5. Any adjustable element controlling the delivery rate shall provide for sealing or other approved means of security (e.g., data audit trail) if the flow rate affects the accuracy of deliveries. ☐ Yes ☐ No ☐ N/A

- 34.6. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal. ☐ Yes ☐ No ☐ N/A

- 34.7. Audit trails shall use the format set forth in the Common and General Code Criteria section of this checklist (Code Reference G-S.8) and in Appendix A, Audit Trail Checklist for Liquid measuring Devices. [Non-retroactive and enforceable as of January 1, 1995] ☐ Yes ☐ No ☐ N/A

- 34.8. Adequate provision must be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that an adjustment on any device that affects the measurement result cannot be made without breaking the security seal. Provision shall be made for the zero adjustment mechanism to meet this requirement. ☐ Yes ☐ No ☐ N/A

*Note: See also Common General Code Criteria Code Reference G-S.8 and Appendix A for audit trail criteria.*

- 34.9. **Retail motor fuel** dispensers with remote configuration capabilities shall be sealed as specified in Table S.3.5. and according to Appendix A, Audit Trail Checklist for Liquid measuring Devices and under the "Common and General Code Criteria" sections of this checklist. ☐ Yes ☐ No ☐ N/A

#### Code Reference: S.3.6. Mass Flow Meters Only

- 34.10. An automatic means to determine and correct for changes in product density due to changes in temperature, pressure, and composition, shall be incorporated in any mass flow metering system that is affected by changes in the density of the product being measured. ☐ Yes ☐ No ☐ N/A

#### Code Reference: S.3.8. Zero-Set-Back Interlock

The zero-set-back interlock on a dispenser is critical to prevent fraudulent practices. A **retail motor fuel** device shall have an effective automatic interlock such that once the dispenser is shut off, it cannot be restarted without resetting the indicating element to zero. This requirement also

applies to the recording element if one is present. The dispenser shall be designed so that the starting mechanism must be in the shut-off position and the interlock engaged before the discharge nozzle can be returned to its designed hanging position. If a single pump supplies more than one dispenser, then each dispenser shall have an automatic control valve that prevents product from being delivered by a dispenser until its indications have been set to zero.

- 34.11. After the device is turned off by movement of the mechanism that stops the flow, a subsequent delivery shall be prevented until the indicators (and recording element if present) have returned to their correct zero positions. ☐ Yes ☐ No ☐ N/A
- 34.12. The starting mechanism shall be in shut off position and zero-set-bank interlock engaged before the nozzle can 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. ☐ Yes ☐ No ☐ N/A
- 34.13. If more than one dispenser is connected to a single compressor station, an automatic control valve shall prevent fuel from being delivered until the indicating elements have been returned to their correct zero position and engaged. ☐ Yes ☐ No ☐ N/A
- 34.14. Use of the interlock shall be effective under all conditions when any control on the console, except a system emergency shut-off, is operated and after any momentary power failure. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.3. Directional Flow Valves**

- 34.15. Valves intended to prevent the reversal of flow shall be automatic in operation. ☐ Yes ☐ No ☐ N/A

## 35. Discharge Lines and Discharge Line Valves

**Code Reference: S.4.1. Diversion of Measured Product**

To prevent fraudulent practices, it shall not be possible to divert measured product from the measuring chamber or the discharge line of a device.

A device may have two or more delivery outlets if there are automatic means to insure that:

- a. Product can flow from only one outlet at a time. **AND**
- b. The direction of product flow is definitely and conspicuously indicated.

- 35.1. Except as identified above, it shall not be possible to divert measured product from the measuring chamber or the discharge line of the device. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.7. Pressurizing the Discharge Hose**

- 35.2. The discharge hose for compressed natural gas shall automatically pressurize prior to the advancement of the register. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.4. Discharge Valve**

- 35.3. A discharge valve installed in the discharge side of the instrument shall be of the automatic or semi-automatic predetermined-stop type or shall be operable only:

- 35.3.1. By means of a tool (but not by a pin) entirely separate from the device. **OR** ☐ Yes ☐ No ☐ N/A
- 35.3.2. By means of a security seal with which the valve is sealed open. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.4.5. Anti-drain Valve**

- 35.4. There shall be effective means provided to prevent hose drainage between transactions or: ☐ Yes ☐ No ☐ N/A
- 35.4.1. The device shall automatically correct for loss of product in the hose before a subsequent delivery. ☐ Yes ☐ No ☐ N/A
  - 35.4.2. If the hose is designed to be bled back to the storage tank, then there shall be automatic means to correct for these conditions so that the customer is not charged for the hose fill or portion of product not received. ☐ Yes ☐ No ☐ N/A

## 36. Marking

### Code Reference: S.5. Marking Requirements

36.1. The dispenser shall have the following information on the identification plate:

- |                                                                                                                                                                                         |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 36.1.1. Pattern approval mark (e.g., type approval number)                                                                                                                              | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.2. Name and address of the manufacturer or his trademark and, required by the weights and measures authority, the manufacturer's identification mark in addition to the trademark. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.3. Model designation or product name selected by the manufacturer.                                                                                                                 | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.4. Non-repetitive serial number.                                                                                                                                                   | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.5. Accuracy class of the meter as specified by the manufacturer consistent with Table T.2.                                                                                         | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.6. Maximum and minimum flow rates in pounds per unit of time.                                                                                                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.7. Maximum working pressure.                                                                                                                                                       | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.8. Applicable temperature range if other than - 10 °C to +50 °C.                                                                                                                   | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.9. Minimum measured quantity (MMQ.)                                                                                                                                                | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.1.10. Product limitations if applicable.                                                                                                                                             | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |

### Code Reference: S.5.1. Location of Marking Information; **Retail Motor Fuel** Dispensers

36.2. The marking information required in the General Code, Paragraph G S.1. Identification shall appear as follows:

- |                                                                                                                          |                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 36.2.1. Within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser.                                           | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.2.2. Either internally and/or externally provided the information is permanent and easily read. <b>AND</b>            | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 36.2.3. On a portion of the device that cannot be readily removed or interchanged (e.g., not on a service access panel.) | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |

*Note: The use of a dispenser key or tool to access internal marking information is permitted for retail liquid measuring devices. [Non-retroactive as of January 1, 2003] (Added 2006)*

### Code Reference: S.5.2. Marking of Equivalent Conversion Factors for Compressed Natural Gas

- |                                                                                                                                                                                                                                                                                                                                                       |                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 36.3. A device dispensing compressed natural gas shall have either the statement "1 Gasoline Gallon Equivalent (GGE) means 5.660 lb of Compressed Natural Gas" or "1 Diesel Gallon Equivalent (DGE) means 6.384 lb of Compressed Natural Gas" permanently and conspicuously marked on the face of the dispenser according to the method of sale used. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|

### Code Reference: S.5.3. Marking of Equivalent Conversion Factors for Liquefied Natural Gas

- |                                                                                                                                                                                                                                                             |                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 36.4. A device dispensing liquefied natural gas shall have the statement "1 Diesel Gallon Equivalent (DGE) means 6.059 lb of Liquefied Natural Gas" permanently and conspicuously marked on the face of the dispenser according to the method of sale used. | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|

### Code Reference: S.6. Printer

36.5. When an assembly is equipped with means for printing the measured quantity, the following conditions apply:

- |                                                                                                                                                                                                                             |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| (a) the scale interval shall be the same as that of the indicator;                                                                                                                                                          | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| (b) the value of the printed quantity shall be the same value as the indicated quantity, <u>except that after January 1, 2021 the printed quantity shall also include mass value if mass is not the indicated quantity;</u> | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |

- (c) a quantity for a delivery (other than an initial reference value) cannot be recorded until the measurement and delivery has been completed; ☐ Yes ☐ No ☐ N/A
- (d) the printer is returned to zero when the resettable indicator is returned to zero; and ☐ Yes ☐ No ☐ N/A
- (e) the printed values shall meet the requirements applicable to the indicated values. ☐ Yes ☐ No ☐ N/A

### 37. Installation Requirements

#### Code Reference: UR.2. Low-Flow Cut-Off Valve

- 37.1. The low-flow cut-off valve shall not be set at flow rates lower than the minimum operating flow rate specified by the manufacturer. The system shall be equipped with a flow control valve, which prevents the flow of product and stops the indicator from registering whenever the product flow rate is less than the low-flow cut-off. ☐ Yes ☐ No ☐ N/A

## National Type Evaluation Program

### Liquid Measuring Devices – Additional Checklists and Test Procedures for Card-Activated **Retail Motor Fuel** Dispensers

#### 38. Card-Activated **Retail Motor Fuel** Dispensers

On card-activated **retail motor fuel** dispensers, the customer authorizes the dispenser by inserting the card or swiping the card through a slot. On credit card transactions, the customer is typically billed through the same methods as have been used for credit transactions handled through a station attendant. On debit card transactions, payment is made directly from the purchaser's account by electronic funds transfer.

##### Code Reference: G-S.5.1. Indicating and Recording Elements

- 38.1. Cash Value Card - A cash value card that is initially encoded with the purchase price, authorizing a customer to purchase products up to the current cash value of the card. The value of the card is decreased in amounts equal to individual transactions.. ☐ Yes ☐ No ☐ N/A

Means shall be provided to the customer to determine the initial cash value of the card and the remaining cash value prior to and after each transaction

- 38.2. Invoice Billing - Invoice billing is a process in which customers are billed for one or more transactions at the end of a billing period. ☐ Yes ☐ No ☐ N/A

- 38.2.1. For computing systems, the date, quantity, unit price, and total price shall be recorded and shall agree with the indications on the dispenser. ☐ Yes ☐ No ☐ N/A

- 38.2.2. When non-computing analog dispensers are used and the billing is on the basis of individual quantities for each transaction (non-cumulative), the value of the smallest unit of displayed quantity for each transaction shall be not greater than 0.1 gallon providing the "pulser" and the recorded quantity used for billing are each equal to or less than 0.01 gallon. ☐ Yes ☐ No ☐ N/A

- 38.2.3. All displayed transaction information must be shown for at least 30 seconds after completing a delivery or starting the next transaction. The delivery is considered complete after the "handle" is off or after the nozzle has been returned to its designed hanging position. ☐ Yes ☐ No ☐ N/A

##### Code Reference: G-S.2. Facilitation of Fraud

There is great concern regarding the potential for accidental or intentional fraud when card-activated systems are used in service stations, especially because bank-card-activated systems give direct access to bank accounts.

A card-activated system shall authorize the dispensing of product for not more than two minutes of the time between authorization and "handle on" at the dispenser. Additionally, once a device has been authorized, it must de-authorize within two minutes if not activated. It shall properly record transactions on the appropriate card account.

When a card-activated system is subjected to power loss of greater than 10 seconds, the dispenser shall deauthorize. Because systems may be installed with separate power lines to the console, card reader, and dispenser, to different parts of the system should be tested with power failures to evaluate the potential for accidental or intentional errors. The appropriate device response depends upon when the power loss occurs during the delivery sequence.

- 38.3. The dispenser must de-authorize in not more than two minutes if the pump "handle" is not turned on. ☐ Yes ☐ No ☐ N/A

- 38.4. The dispenser must be de-authorized in not more than two minutes if not activated. ☐ Yes ☐ No ☐ N/A

- 38.5. If the time limit to de-authorize a dispenser is programmable, it shall not accept an entry greater than two minutes. ☐ Yes ☐ No ☐ N/A

38.6. When a power loss greater than 10 seconds occurs after the pump "handle" is on, the dispenser must de-authorize. ☐ Yes ☐ No ☐ N/A

38.7. When there is a loss of power, but the pump "handle" is not on, the dispenser must de-authorize in not more than three minutes. ☐ Yes ☐ No ☐ N/A

**Code References: S.1.6.7. Recorded Representations; and S.1.6.8. Recorded Representations for Transaction Where a Post-Delivery Discount(s) is Provided.**

Except for fleet sales and other price contract sales, for transactions conducted with point-of-sale systems or devices activated by credit cards, debit cards, or cash, a printed receipt containing information about the transaction shall be available to the customer as outlined in the following items. A printed receipt must always be available to the customer upon request and printing of the receipt may be initiated at the option of the customer. In addition, some systems may be equipped with the capability to issue an electronic receipt; for those systems, the customer may be given the option to receive the receipt electronically (e.g., via cell phone, computer, etc.). See also NCWM Publication 14, Code Reference: G-S.5.6. Recorded Representations.

Device capabilities: ☐ Printed Receipt ☐ Electronic Receipt

38.8. The system must provide a receipt to be made available to the customer at the completion of the transaction through either:

38.8.1. a built-in recording element OR ☐ Yes ☐ No ☐ N/A

38.8.2. a separate recording element that is part of the system ☐ Yes ☐ No ☐ N/A

38.9. Except for transactions where a post-delivery discount is provided, the customer receipt must contain the following information:

38.9.1. the total volume of the delivery; ☐ Yes ☐ No ☐ N/A

38.9.2. the unit price; ☐ Yes ☐ No ☐ N/A

38.9.3. the total computed price; ☐ Yes ☐ No ☐ N/A

38.9.4. the product identity by name, symbol, abbreviation, or code number; and ☐ Yes ☐ No ☐ N/A

38.9.5. the dispenser designation by either and alpha or numerical description (effective as of January 1, 2021). ☐ Yes ☐ No ☐ N/A

38.10. Where a post-delivery discount(s) is applied, the sales receipt must provide:

38.10.1. the product identity by name, symbol, abbreviation, or code number; ☐ Yes ☐ No ☐ N/A

38.10.2. the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s); ☐ Yes ☐ No ☐ N/A

38.10.3. an itemization of the post-delivery discounts to the unit price; ☐ Yes ☐ No ☐ N/A

38.10.4. the final total price of each fuel sale after all post-delivery discounts are applied; and ☐ Yes ☐ No ☐ N/A

38.10.5. the dispenser designation by either and alpha or numerical description (effective as of January 1, 2021). ☐ Yes ☐ No ☐ N/A

## 39. Test Methods

39.1. Authorize the dispenser and, with the pump "handle" on, interrupt power to any part (or all) of the system. The pump should de-authorize immediately. Specifically:

39.1.1. Authorize with a card and turn the "handle" on. Power down briefly then restore power. Try to dispense product, the dispenser must not dispense since the power failure should have de-authorized the dispenser. ☐ Yes ☐ No ☐ N/A

39.2. Authorize the dispenser using a card (leaving handle off), wait more than two minutes, and try to start the dispenser. It should not start because the authorization should have timed out. Specifically:

39.2.1. Authorize with a card, but do not turn the "handle" on. Power down for more than two minutes, and then restore power. Try to dispense product, the dispenser should have "timed-out" and not dispense. ☐ Yes ☐ No ☐ N/A

39.2.2. Authorize and dispense with card #1. Allow the system to time out and de-authorize (if it does.) Do not turn off the "handle." Authorize and dispense with card #2. The transactions shall be properly recorded for each card. ☐ Yes ☐ No ☐ N/A

*Note: A mechanical register may accumulate the two deliveries, but the printed record must not have accumulated values.*

39.2.3. Authorize with card #1. Turn the "handle" on, then off. Authorize with card #2. Dispense product and complete the delivery. Check the printed receipt to verify that the delivery has been properly charged to card #2. ☐ Yes ☐ No ☐ N/A

39.2.4. Turn the dispenser "handle" on and use a card to authorize the dispenser. Turn the "handle" off, then on. Try to deliver product: the dispenser must not dispense. ☐ Yes ☐ No ☐ N/A

**For Multi-hose Dispensers:**

39.2.5. Turn the dispenser "handle" on and use a card to authorize the dispenser. Turn the "handle" off. After a period of 15 seconds, turn the "handle" on. Try to deliver product; the dispenser must not dispense. ☐ Yes ☐ No ☐ N/A

39.2.6. Authorize with card #1 (do not turn the "handle" on) and interrupt power for at least 10 seconds. This should de-authorize the dispenser. Resupply power, turn "handle" on, and try to dispense. The dispenser shall not deliver product. ☐ Yes ☐ No ☐ N/A

39.2.7. Authorize with card #1, turn the "handle" on, and then interrupt power. This should de-authorize the dispenser. Resupply power and authorize the dispenser with card #2, then complete a delivery. Verify that the transaction is charged to card #2. ☐ Yes ☐ No ☐ N/A

39.2.8. Authorize a dispenser with card #1, but do not turn the dispenser "handle" on. Try to authorize the same dispenser with card #2, it should not be accepted until after the two minute time-out. ☐ Yes ☐ No ☐ N/A

39.3. Attempt to override or confuse the card system by: varying the length of time the card is in the slot, e.g., vary the "swipe" times, and pushing all other keys on the keypad during each step of the authorization process. ☐ Yes ☐ No ☐ N/A





**National Type Evaluation Program**  
**Liquid Measuring Devices – Additional Checklists and Test Procedures**  
**for Milk Meters**

**40. Additional Checklists and Test Procedures for Milk Meters**

**Code Reference: S.3.1. Diversion of Liquid to be Measured -- Milk Meters Code (Milk Meters Code Reference)**

There will be no means provided by which any liquid can be diverted from the supply tank to the receiving tank without being measured by the device. A manually controlled outlet that may be opened for purging or draining the measuring system shall be permitted. Effective means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system.



**National Type Evaluation Program**  
**Liquid Measuring Devices – Additional Checklists and Test Procedures**  
**for Interfacing Components**

**41. Additional Checklists and Test Procedures for Interfacing Components**

When examining the interface between Electronic Indicator and a Measuring Element, the following must be considered:

- |                                                                                                                                                      |                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 41.1. Does the electronic indicator have a CC?                                                                                                       | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 41.2. Is the electronic indicator being used within the application limits of the CC?                                                                | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 41.3. Does the measuring element have a CC?                                                                                                          | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 41.4. Is the measuring element being used within the application limits of the CC?                                                                   | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 41.5. Can the system into which both devices are installed be accurately calibrated?                                                                 | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 41.6. Can a ticket (if required) be properly printed?                                                                                                | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |
| 41.7. Are interfaces, other than mechanical or pulse interfaces (e.g. 4-20 mA or frequency interfaces), being used as defined by the appropriate CC? | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |



## National Type Evaluation Program

### Liquid Measuring Devices – Additional Checklists and Test Procedures for Water Meters

*Note: Refer to Section L. Field Evaluation and Permanence Tests for Utility Type Water Meters for test procedures specific to utility type water meters.*

#### 42. Indicating and Recording Element

##### Code Reference: S.1.1.1. General

- 42.1. A water meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element. Such elements shall be visible at the point of measurement or be stored in non-volatile and non-resettable memory. The display may be remotely located provided it is readily accessible to the customer. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.1.2. Units

- 42.2. A water meter shall indicate and record, if the device is equipped to record, its deliveries in terms of liters, gallons or cubic feet or binary or decimal subdivisions thereof except batch plant meters, which shall indicate deliveries in terms of liters, gallons or decimal subdivisions of the liter or gallon only. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.1.3. Value of the Smallest Unit

- 42.3. 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:
- 42.3.1. 50 L (10 gal or 1 ft<sup>3</sup>) on utility type meters, sizes 1 in and smaller, **OR** ☐ Yes ☐ No ☐ N/A
  - 42.3.2. 500 L (100 gal or 10 ft<sup>3</sup>) on utility type meters, sizes 1-1/2 in and 2 in, **OR** ☐ Yes ☐ No ☐ N/A
  - 42.3.3. 0.2 L (1/10 gal or 1/100 ft<sup>3</sup>) on batching meters delivering less than 375 L/min (100 gal/min or 13 ft<sup>3</sup>/min), **OR** ☐ Yes ☐ No ☐ N/A
  - 42.3.4. 5 L (1 gal or 1/10 ft<sup>3</sup>) on batching meters delivering 375 L/min (100 gal/min or 13 ft<sup>3</sup>/min) or more. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.1.4. Advanced of Indicating and Recording Elements

- 42.4. Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the device. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.1.5. Return to Zero

- 42.5. If the meter is so designed that the primary indicating elements are readily returnable to a definite zero indication, means shall be provided to prevent the return of these elements beyond their correct zero position. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.2.1. Graduation Length

- 42.6. Graduations shall be so varied in length that they may be conveniently read. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.2.2. Graduation Width

- 42.7. In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.2.3. Clear Interval Between Graduations**

42.8. The clear interval shall not be less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

- 42.8.1. along the line of relative movement between the graduations at the end of the indicator, **OR** ☐ Yes ☐ No ☐ N/A
- 42.8.2. if the indicator is continuous, at the point of widest separation of the graduations. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.1. Indicator Summary**

42.9. 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. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.2. Indicator Length**

42.10. 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). ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.3. Indicator Width**

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

- 42.11.1. the width of the widest graduation, **AND** ☐ Yes ☐ No ☐ N/A
- 42.11.2. the width of the minimum clear interval between graduations. ☐ Yes ☐ No ☐ N/A

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.

**Code Reference: S.1.3.4. Clearance**

42.12. The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in). ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.6. Parallax**

42.13. Parallax effects shall be reduced to the practicable minimum. ☐ Yes ☐ No ☐ N/A

**43. Measuring Elements****Code Reference: S.2.1. Provision for Sealing**

Measuring elements shall be designed with adequate provisions to prevent changes from being made to the measuring element or the flow rate control (if the flow rate control affects the accuracy of deliveries) without evidence of the change being made. These provisions can be an approved means of security (e.g., data change audit trail) or physically applying a security seal which must be broken before adjustments can be made. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal.

43.1. A measuring element shall have provisions for either:

- 43.1.1. Applying a physical security seal. **OR** ☐ Yes ☐ No ☐ N/A
- 43.1.2. An approved means of security (e.g., data change audit trail) so that no changes may be made to its adjustable components. ☐ Yes ☐ No ☐ N/A

- 43.2. Any adjustable element controlling the delivery rate shall provide for sealing or other approved means of security (e.g., data audit trail) if the flow rate affects the accuracy of deliveries. ☐ Yes ☐ No ☐ N/A
- 43.3. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal. ☐ Yes ☐ No ☐ N/A
- 43.4. Audit trails shall use the format set forth in the Common and General Code Criteria section of this checklist (Code Reference G-S.8) and in Appendix A, Philosophy for Sealing, and Appendix B, Requirements for Metrological Audit Trails. ☐ Yes ☐ No ☐ N/A
- 43.5. Water meters with remote configuration capabilities shall be sealed according to Appendix A, Philosophy for Sealing, and Appendix B, Requirements for Metrological Audit Trails (Table S.2.2.) and under the "Common and General Code Criteria" section of this checklist. ☐ Yes ☐ No ☐ N/A
- 43.6. A change to the adjustment of any measuring element shall be individually identified. ☐ Yes ☐ No ☐ N/A

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

- a. A broken, missing, or replaced physical seal on an individual measuring element.
- b. A change in a calibration factor for each measuring element.
- c. Display of the date of or the number of days since the last calibration event for each measuring element.
- d. A counter indicating the number of calibration events per measuring element.

## 44. Batching Meters Only

### Code Reference: S.2.2.1. Air/Vapor Elimination, Batching Measuring Systems

If air/vapor enters a measuring system or the product changes into the vapor state as it passes through the system, then the system must be equipped with an effective air/vapor eliminator or other automatic means to prevent the air/vapor from being measured by the meter. To prevent vapor eliminator vent lines from being pinched closed and re-opened without being detected, the vent lines shall be made of appropriate non-collapsible material. If the system is designed such that air/vapor will not enter the system, then an air/vapor eliminator is not required. One example is when a product is being pumped from the bottom of a tank and a low-level detector in the tank shuts off the pump before the liquid level gets to the point where air could enter the system.

44.1. The metering system is equipped with an effective air/vapor eliminator. ☐ Yes ☐ No ☐ N/A

44.2. Other effective, automatic means are provided to prevent air/vapor from passing through the system. Describe the means provided and list this information on the Certificate of Conformance:

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44.3. Vent lines from the air or vapor air/vapor eliminator (if present) shall be made of appropriate non-collapsible material to prevent the lines from being pinched closed and re-opened without being detected. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.2.2.2. Directional Flow Valves

44.4. Valves intended to prevent reversal of flow shall be automatic in operation. ☐ Yes ☐ No ☐ N/A

## 45. Multi-jet Meter Indication

### Code Reference: S.2.3. Multi-jet Meter Indication

45.1. Multi-jet water meters shall be clearly and permanently marked as such on the device or identified on the Certificate of Approval. ☐ Yes ☐ No ☐ N/A



## National Type Evaluation Program

### Liquid Measuring Devices – Additional Checklists and Test Procedures for Hydrogen Gas – Measuring Devices

*Note: Refer to Section I. Field Evaluation and Permanence Tests for Mass Flow Meters (All topics with the exception of “Testing for Volume Units Only or to Add Volume Units to Existing Certificates”) for test procedures.*

#### 46. Indicating and Recording Elements and Recorded Representations

##### Code Reference: S.1.1. Indicating Elements

- 46.1. A device shall be equipped with a primary indicating element that continuously displays measurement results relative to quantity and total price. ☐ Yes ☐ No ☐ N/A
- 46.2. Is the device equipped with a primary recording element? ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.2. **Vehicle Fuel** Dispensers

- 46.3. Dispensers used to fuel vehicles shall be of the computing type and shall indicate the mass, the unit price, and the total price of each delivery. ☐ Yes ☐ No ☐ N/A

##### Code Reference: S.1.1. Indicating Elements and S.2. Operating Requirements

Primary indicating and recording elements may advance only as a result of the operation of the device. However, means shall be provided for readily returning the device to zero. Once the zeroing operation has begun, it shall not be possible to return primary indicating elements or primary recording elements beyond the correct zero position. It shall not be possible to indicate a value other than the latest measurement, or "zeros" when the zeroing operation has been completed.

- 46.4. Indicating and recording elements shall advance only by the operation of the device (except for clearing the device to zero). ☐ Yes ☐ No ☐ N/A
- 46.5. During the reset operation, it shall not be possible to return primary indicating elements or primary recording elements to any value other than zero. ☐ Yes ☐ No ☐ N/A
- 46.6. During the reset operation, it shall not be possible to indicate a value other than the latest measurement, or "zeros" when the zeroing operation has been completed. ☐ Yes ☐ No ☐ N/A

##### Code Reference: G-S.5.1. Indicating and Recording Elements – General

Indicating elements must be appropriately designed and adequate in amount. Specifically, a device must have sufficient display capacity to indicate the quantities and total prices, if it applies in the normal encountered specific application. Electronic devices shall either have sufficient display capacity to indicate the normal quantities and money values or automatically stop the delivery before exceeding the display capacity of either the quantity or total price. This consideration may apply when evaluating a system that may be used in either a truck stop or an automobile service station.

- 46.7. An electronic digital indicating element shall either:
- 46.7.1. Have adequate display capacity for the application, **OR** ☐ Yes ☐ No ☐ N/A
- 46.7.2. Automatically stop the delivery before exceeding the maximum quantity or maximum total price that can be indicated. ☐ Yes ☐ No ☐ N/A

##### Code Reference: G-S.7. Lettering

- 46.8. All required markings and instructions shall be distinct and easily readable and shall be of such character that they will not tend to become obliterated or illegible. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.2.4. and S.1.3.4. Values Defined**

- 46.9. Values shall be adequately defined by a sufficient number of figures, words, or combinations to include a zero display for all displayed digits to the right of the decimal mark and at least one to the left. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.2.2. Digital Indication and Representation and S.2.4.4. Agreement Between Indications**

Basic operating requirements for devices are that:

- All digital values of like value in a system shall agree.
- Digital values shall round off to the nearest digital division that can be indicated or recorded.
- When a digital zero display is provided, the zero indication shall consist of at least one digit to the left and all digits to the right of the decimal point.

For those systems consisting of a console and dispensers and equipped with pre-set quantity, the dispenser must deliver at least the pre-set quantity; it cannot deliver less. For example, if the console sends only the money equivalent of the pre-set quantity to the dispenser, the dispenser shall deliver at least the pre-set quantity. It may not stop at the first quantity amount that will result in mathematical agreement with the money value equivalent of the pre-set quantity if the quantity indication is less than the pre-set quantity. Similarly, if a money value is pre-set, the dispenser is not properly designed if it always stops at the lowest quantity value that provides mathematical agreement with the pre-set money value.

Tests for agreement of digital values shall be performed in the post pay, prepay money, pre-set quantity modes, and power loss. Agreement should be checked at several unit prices including the maximum unit price and with the dispenser operating at its maximum flow rate.

- 46.10. Digital quantity indications must agree. ☐ Yes ☐ No ☐ N/A
- 46.11. Manual quantity entries in invoice billing systems must be identified as such. ☐ Yes ☐ No ☐ N/A
- 46.12. When delivery from a computing device is based upon a pre-set quantity, the quantity indicated on the dispenser and any auxiliary device must be equal to or greater than the pre-set quantity at the conclusion of the transaction. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.5. Money Values, Mathematical Agreement**

- 46.13. All total sale money value indications in a computing system are primary indications and must agree. ☐ Yes ☐ No ☐ N/A
- 46.14. Any recorded money-value and any digital money-value indication on a computing – type measuring device used in retail trade shall be in mathematical agreement with its associated quantity representation or indication to the nearest 1 cent of money value. (e.g., within each element, the values indicated or recorded must meet the formula) ☐ Yes ☐ No ☐ N/A
- 46.15. The printed ticket and dispenser money values shall be in mathematical agreement to the nearest cent. ☐ Yes ☐ No ☐ N/A
- 46.16. The quantity, unit price, and total price indications on the console shall be in mathematical agreement with the dispenser and printed ticket. ☐ Yes ☐ No ☐ N/A

46.17. The following applies when a quantity value indicated or recorded by an auxiliary element such as a console, ticket printer, or remote customer display, is a derived or computed value based on data received from a **retail vehicle** fuel dispenser.

46.17.1. The quantity values indicated or recorded on a console, electronic cash register, or other auxiliary indicating or recording element may differ, however:

46.17.1.1. All indicated or recorded total money values for an individual sale shall agree, **AND** ☐ Yes ☐ No ☐ N/A

46.17.1.2. The indicated or recorded quantity, unit price, and total sales price values shall be in mathematical agreement. ☐ Yes ☐ No ☐ N/A

[Quantity x Unit price = Total sales price] to the closest cent.

**Examples:**

\$4.5549 rounds to \$4.55

\$4.5551 rounds to \$4.56

\$4.5550 rounds to either \$4.55 or \$4.56

**Code Reference: G-S.2.5.1. Auxiliary Elements**

Money value divisions on auxiliary elements such as remote consoles and printers shall be the same as on the primary element. Any recorded money value and any digital money value indication on a primary indicator must agree mathematically with its associated quantity representation or indication.

**Formula: Unit Price x Indicated quantity = Total Sale**

46.18. Check mathematical agreement of all primary indications (e.g., dispenser, console, printer) under the following conditions:

46.18.1. At various flow rates, including maximum and minimum. ☐ Yes ☐ No ☐ N/A

46.18.2. Closing and reopening the nozzle outlet valve several times during delivery. Check mathematical agreement each time flow is halted. ☐ Yes ☐ No ☐ N/A

46.18.3. At several unit prices including the low prices and the maximum pricing capability of the computer and when operating at the maximum flow rate. ☐ Yes ☐ No ☐ N/A

46.18.4. Turn the dispenser off during delivery with nozzle outlet valve open. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.1. Indicating and Recording Elements / General**

**Discount Pricing**

*NIST Handbook 44* requires that, 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.

Should the customer elect to use another method of payment following completion of delivery, the console may be used to recalculate the total price – provided the dispenser complies with all applicable *NIST Handbook 44* requirements. For example, the customer selects the credit card unit price on the dispenser and dispenses product at that unit price. However, the customer discovers that he forgot his credit card and decides to pay cash. In this case, the console might be used to calculate the total price at the cash unit price. In keeping with the intent of National Conference on Weights and Measures action in 1989 to require dispensers to calculate at all unit prices for which a product is offered for sale, it is anticipated that the console would be required to recalculate the new total price using the formula (quantity x unit price = total price). A receipt providing the total quantity, unit price, total computed price, and product identity 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 (Code Reference S.2.6. Recorded Representations, Point of Sale Systems) as the transaction was completed. The recorded and displayed total quantity on the receipt and dispenser, respectively, shall agree.

**Selectable Unit Price Capability**

Selectable unit price capability is a design feature that permits the customer to select the unit price for a particular transaction at the time of sale. A dispenser may then allow the unit price for a delivery to be selected from two or more unit prices.

If the customer selects the unit price at the dispenser (e.g., cash or credit price), the selection may be made at any time prior to the start of product flow. The dispenser operating "control" may be activated when the selection is made. A system shall not permit a change to the unit price during delivery of product.

*Note: The term "control" generically refers to the handle, flapper, start button, on/off switch, or other mechanism used to activate or deactivate the dispenser.*

**Code Reference: S.2.5.2. Display of Quantity and Total Price**

After a transaction is completed, the unit price displayed at the dispenser may be changed to a base unit price. However, the quantity and total price must be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated. Any display of quantity, unit price, and total price that does not mathematically agree occurs between transactions. This is permitted (in response to demands of device users) because the displayed values between "transactions" are not "significant" relative to the actual delivery process (transaction.)

The displayed unit price may revert to the base unit price immediately after the completion of a transaction, defined as the time the delivery has been terminated and payment has been settled. The payment may be automatic if the delivery is to a pre-paid amount. If the sale is prepaid, the delivery is considered terminated after the "control" is in the off position or after the nozzle has been returned to the designed hanging position. This will allow the customer adequate time to observe that the prepaid amount has been reached. If the delivery stops short or overruns a prepaid amount, settling the payment means that money is either refunded or collected from the customer and the transaction is "cashed out" by the console operator.

In the case of invoice billing systems, such as card-lock or key-lock systems which compute the total sale price, it is considered not appropriate for the displayed unit price to revert to the base unit price immediately following a transaction. Because a receipt for the transaction may not be available, the customer must be allowed an adequate period of time following the delivery to record the transaction information. The transaction unit price must be displayed for at least 30 seconds, and the total price and the quantity must be displayed for at least 5 minutes following the completion of the delivery or the start of the next transaction. The delivery is considered complete after the "control" is off or the nozzle has been returned to its designed hanging position.

**Code Reference: S.2.4.1. Unit Price and S.2.4.3. Selection of Unit Price**

- 46.19. The selected unit price must be made clearly evident on the dispenser. ☐ Yes ☐ No ☐ N/A
- 46.20. A dispenser may be equipped with means for selecting more than one unit price, provided that the selected unit price cannot be changed after the initial flow begins. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5.2. Display of Quantity and Total Price**

- 46.21. The selected unit price displayed at the dispenser prior to the delivery of product must be continuously displayed at the conclusion of the delivery, after automatic termination by the dispenser or after manual termination by the customer using the controls at the device, until the start of the next transaction by whichever occurs first:
- 46.21.1. Customer initiation of the delivery using the controls at the device, **OR** ☐ Yes ☐ No ☐ N/A
- 46.21.2. "Authorization/Approval" by the console operator. ☐ Yes ☐ No ☐ N/A
- 46.22. 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 (e.g., customer-activated) controls. ☐ Yes ☐ No ☐ N/A
- 46.23. In a system where a base unit price is automatically displayed on the dispenser after the completion of a transaction (e.g., product is dispensed and payment is settled), the dispenser may display the values for quantity, unit price, and total price that do not result in a mathematically correct equation. That is provided when the total price value displayed is divided by the quantity value displayed, the result is a unit price that is "posted" for a particular kind of transaction. ☐ Yes ☐ No ☐ N/A

**Credit Card - or Debit Card – Activated Retail Vehicle Fuel Dispenser**

On card-activated retail vehicle fuel dispensers, the customer authorizes the dispenser by inserting the card or swiping the card through a slot. On credit card transactions, the customer is typically billed through the same methods as have been used for credit transactions handled through a station attendant. On debit card transactions, payment is made directly from the purchaser's account by electronic funds transfer.

- 46.24. A receipt must be available to the customer at the completion of the transaction. The issuance of the receipt may be initiated at the option of the customer. ☐ Yes ☐ No ☐ N/A
- 46.25. The customer receipt must contain the following information:
- 46.25.1. The identity (codes may be used) of the product purchased, the quantity purchased, the unit price, and the total price. ☐ Yes ☐ No ☐ N/A
- 46.26. Cash Value Card - A cash value card that is initially encoded with the purchase price, authorizing a customer to purchase products up to the current cash value of the card. The value of the card is decreased in amounts equal to individual transactions. Means shall be provided to the customer to determine the initial cash value of the card and the remaining cash value prior to and after each transaction. ☐ Yes ☐ No ☐ N/A
- 46.27. Invoice Billing - Invoice billing is a process in which customers are billed for one or more transactions at the end of a billing period.
- 46.27.1. The date, quantity, unit price, and total price shall be recorded and shall agree with the indications on the dispenser. ☐ Yes ☐ No ☐ N/A
- 46.27.2. All displayed transaction information must be shown for at least 30 seconds after completing a delivery or starting the next transaction. The delivery is considered complete after the "control" is off or after the nozzle has been returned to its designed hanging position. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.1. Primary Elements / Units**

- 46.28. A hydrogen gas-measuring device shall indicate, and record if the device is equipped to record, its deliveries in kilograms or decimal multiples or submultiples of the kilogram. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.3.2. Numerical Value of Quantity-Divisions and S.1.3.3.****Maximum Value of Quantity-Value Divisions**

- 46.29. The value of the scale division for the indicating and recording element must be in values of 1, 2, or 5 and uniform throughout the series. The maximum value of the quantity-value division shall not be greater than 0.5 % of the minimum measured quantity. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.1.4. Value of Smallest Unit**

- 46.30. The value of the quantity division shall not exceed the equivalent of 0.001 kg on devices with a marked maximum flow rate of 30 kg/min or less. ☐ Yes ☐ No ☐ N/A
- 46.31. The value of the quantity division shall not exceed the equivalent of 0.01 kg on devices with a marked maximum flow rate greater than 30 kg/min. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.7.; Indication of Delivery and S.3.5. Pressurizing the Discharge Hose**

- 46.32. Retail devices shall automatically show their initial zero condition and amount delivered up to the nominal capacity of the device. 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 the delivery starts at zero. ☐ Yes ☐ No ☐ N/A

**Test Method:**

1. Remove nozzle from dispenser and connect to test cylinder. Test cylinder initial pressure should not be greater than 2.5 MPa (360 psig) and should not be less than 2 MPa (290 psi) to simulate an actual delivery.
2. Turn nozzle valve from "OFF" to "FILL" position.
3. Empty discharge hose.
4. Turn nozzle valve to "OFF" position
5. Activate dispenser.

46.33. Dispenser indications shall not advance.

☐ Yes ☐ No ☐ N/A**Code Reference: S.2.3. Provisions for Power Loss and S.2.3.1. Transaction Information**

Even if power fails during a delivery, it is still necessary to correctly complete all transactions in progress at the time of the power failure. Quantity and total sales price information shall be recallable for at least 15 minutes after the power failure. The information may be recalled at the dispenser or at the console if the console indications are accessible to the customer. Operator information, such as fuel and money value totals, shall be retained in memory during a power failure. The operator information is not required to be recallable during the power failure, but shall be recallable after power is restored. Test to determine if the indications are accurate when the delivery is continued after a power failure.

*Note: For remote controllers (e.g., cash register, console, etc.) which have the capability to retain information pertaining to a transaction (e.g., stacked completed sales.) If the information cannot be recalled at the dispenser following a power outage, means (e.g., uninterruptible power supply or other means) must be provided to enable the transaction information to be recalled and verified for at least 15 minutes following a power outage.*

**Code Reference: S.2.3.2. User Information**

- 46.34. The quantity and total sales price shall be recallable for 15 minutes after the power failure. ☐ Yes ☐ No ☐ N/A
- 46.35. The quantity and total sales price values shall be correct if the power fails between deliveries. ☐ Yes ☐ No ☐ N/A
- 46.36. The quantity and total sales price values shall be correct if the delivery is continued after a power failure. ☐ Yes ☐ No ☐ N/A
- 46.37. The operator's information shall be retained in memory during a power failure. ☐ Yes ☐ No ☐ N/A
- 46.38. Remote controllers which stack completed sales must have a means to enable the transaction information to be recalled and verified for at least 15 minutes. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.1. Return to Zero**

The primary indicating and recording elements of a retail device shall readily return to a definite zero indication. Key-lock and other self-operated devices must have a zero-return indicating element, but they are not required to have the recording element return to zero. These devices may be equipped with cumulative recording elements. The primary indicating and recording elements shall not go beyond their correct zero position.

- 46.39. Does the device have a primary recording element? ☐ Yes ☐ No ☐ N/A
- 46.40. The indicating and recording elements of a retail device shall be readily returnable to a definite zero indication. ☐ Yes ☐ No ☐ N/A
- 46.41. Key-lock and self-operated devices shall have an indicating element that return to zero. ☐ Yes ☐ No ☐ N/A
- 46.42. Does the device have:
- 46.42.1. a cumulative indicating element? ☐ Yes ☐ No ☐ N/A
- 46.42.2. a cumulative recording element? ☐ Yes ☐ No ☐ N/A

- 46.43. Primary indicating and recording elements shall not go beyond their correct zero position. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.4. Display of Unit Price and Product Identity**

A computing or money-operated device shall have a means on the face of the device for displaying the unit price at which it is set to compute or deliver and for posting the product identity. When a product is offered for sale at more than one unit price from a device, 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. The unit price shall be expressed as a decimal value in dollars.

**Code Reference: S.2.4.1. Unit Price, S.2.4.2. Product Identity and**

**S.2.4.3. Selection of Unit Price**

- 46.44. Means shall be provided to display the unit price on each face of the device. ☐ Yes ☐ No ☐ N/A
- 46.45. Means shall be provided to post on each side of the device the identity of the dispensed product. ☐ Yes ☐ No ☐ N/A
- 46.46. When a product is offered for sale at more than one unit price from a device, then all of the unit prices at which that product is offered for sale:
- 46.46.1. Shall be displayed prior to the delivery of the product, **OR** ☐ Yes ☐ No ☐ N/A
- 46.46.2. Shall be capable of being displayed on the dispenser using controls available to the customer. ☐ Yes ☐ No ☐ N/A
- 46.46.3. A system shall not permit a change to the unit price during delivery of product. ☐ Yes ☐ No ☐ N/A

*Note: It is not necessary to simultaneously display all of the unit prices, provided the dispenser complies with NIST Handbook 44 section S.2.4.1.*

- a. The unit prices for each product and price level may be:
- b. Displayed simultaneously for all products,
- c. Displayed simultaneously for each product separately, **OR**
- d. Displayed individually in a unit-price display only if controls permit the customer to sequence the display through the unit prices for each and every product.

- 46.47. The unit price shall be expressed in dollars and decimals of dollars using a dollar sign. A common fraction shall not appear in the unit price, (e.g., \$4.29 not \$4 29/100). ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.5.2. Display of Quantity and Total Price**

- 46.48. When a delivery is completed on a computing device, 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. ☐ Yes ☐ No ☐ N/A

*Note: The displayed unit price may revert to a base unit price immediately after the completion of a transaction, defined as the time the delivery has been terminated and payment has been settled. Any display of quantity, unit price, and total price that does not mathematically agree occurs between transactions and is permitted (in response to demands of device users) because the displayed values between "transactions" are not "significant" relative to the actual delivery process (transaction.)*

## 47. Computing

### Code Reference: S.2.5. Money-Value Computations

A hydrogen gas dispenser used to fuel vehicles shall be capable of computing total sale prices for all unit prices and for all deliveries within the range of measurement or computing capacity.

- 47.1. A retail computing device shall compute total sale prices for all quantities and unit prices within the range of its quantity and computing capacities. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.2.4.4. Agreement between Indications

- 47.2. All quantity, unit price, and total price indications shall agree. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.2.5.1. Auxiliary Elements

- 47.3. All indicated money value divisions and quantity value divisions on auxiliary elements shall be identical with those of the primary element. ☐ Yes ☐ No ☐ N/A

## 48. Recorded Representations, Point of Sale Systems, and Printed Receipt

A printed receipt shall be available through a built-in or separate recording element for transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash. The printed receipt shall contain the following information for products delivered by the dispenser.

### Code Reference: S.2.6. Recorded Representations, Point of Sale Systems

- 48.1. A printed receipt shall be available for devices activated by debit cards, credit cards, and/or cash. The printed receipt:
- 48.1.1. Shall contain the total mass of the delivery. ☐ Yes ☐ No ☐ N/A
  - 48.1.2. Shall contain the unit price. ☐ Yes ☐ No ☐ N/A
  - 48.1.3. Shall contain the total computed price. **AND** ☐ Yes ☐ No ☐ N/A
  - 48.1.4. Shall contain the product identity by name, symbol, abbreviation, or code number. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.6. Printer

- 48.2. Printed information must agree with the indications on the dispenser.
- 48.2.1. Printed values shall be clearly defined. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.6.1. Printed Receipt

- 48.3. Any delivered, printed quantity
- 48.3.1. Shall include an identification number. **AND** ☐ Yes ☐ No ☐ N/A
  - 48.3.2. Shall include the time and date. **AND** ☐ Yes ☐ No ☐ N/A
  - 48.3.3. Shall include the name of the seller. ☐ Yes ☐ No ☐ N/A

## 49. Design of Measuring Elements and Measuring Systems

### Code Reference: S.3.1. Maximum and Minimum Flow-Rates

- 49.1. The ratio of the maximum to minimum flow-rates for devices measuring gases shall be 10:1 or greater. ☐ Yes ☐ No ☐ N/A



**Code Reference: S.3.2. Adjustment Means**

49.2. Means shall be provided to change the ratio between the indicated quantity and the quantity of gas measured by the assembly.

49.2.1. A bypass on the measuring assembly shall not be used for these means. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.2.1. Discontinuous Adjustment Means**

49.3. When the adjusting means changes the ratio between the indicated quantity and the quantity of measured gas in a discontinuous manner, the consecutive values of the ratio shall not differ by more than 0.1%. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.3. Provision for Sealing**

Measuring elements shall be designed with adequate provisions to prevent changes from being made to the measuring element or the flow rate control (if the flow rate control affects the accuracy of deliveries) without evidence of the change being made. These provisions can be an approved means of security (e.g., data change audit trail) or physically applying a security seal which must be broken before adjustments can be made. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal.

49.4. A measuring element shall have provisions for either:

49.4.1. Applying a physical security seal. **OR** ☐ Yes ☐ No ☐ N/A

49.4.2. An approved means of security (e.g., data change audit trail) so that no changes may be made to its adjustable components. ☐ Yes ☐ No ☐ N/A

49.5. Any adjustable element controlling the delivery rate shall provide for sealing or other approved means of security (e.g., data audit trail) if the flow rate affects the accuracy of deliveries. ☐ Yes ☐ No ☐ N/A

49.6. When applicable, the adjusting mechanism shall be readily accessible for the purposes of affixing a security seal. ☐ Yes ☐ No ☐ N/A

49.7. Audit trails shall use the format set forth in the Common and General Code Criteria section of this checklist (Code Reference G-S.8 LMD-23) and in Appendix A, Philosophy for Sealing. ☐ Yes ☐ No ☐ N/A

49.8. **Retail vehicle fuel** dispensers with remote configuration capabilities shall be sealed according to Table S.3.3. of NIST HB 44 Section 3.39 Hydrogen Gas-Measuring Devices – Tentative Code and according to Appendix A, Philosophy for Sealing. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.4. Automatic Density Correction**

49.9. An automatic means to determine and correct for changes in product density due to changes in temperature, pressure, and composition, shall be incorporated in any hydrogen gas-measuring system that is affected by changes in the density of the product being measured. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.3.6. Zero-Set-Back Interlock, **Retail Vehicle Fuel** Devices**

The zero-set-back interlock on a dispenser is critical to prevent fraudulent practices. A **retail vehicle fuel** device shall have an effective automatic interlock such that once the dispenser shuts off, it cannot be restarted without resetting the indicating element to zero. This requirement also applies to the recording element if one is present. The dispenser shall be designed so that the starting lever must be in the shut-off position and the interlock engaged before the discharge nozzle can be returned to its designed hanging position. If a single pump supplies more than one dispenser, then each dispenser shall have an automatic control valve that prevents product from being delivered by a dispenser until its indications have been set to zero.

49.10. After the device is turned off by moving the lever that stops the flow, a subsequent delivery shall be prevented until the indicators (and recording element if present) have returned to their correct zero positions. ☐ Yes ☐ No ☐ N/A

- 49.11. The starting lever shall be in shut off position and zero-set-back interlock engaged before the nozzle can 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. ☐ Yes ☐ No ☐ N/A
- 49.12. If more than one dispenser is connected to a single source, an automatic control valve shall prevent fuel from being delivered until the indicating elements have been returned to their correct zero position and engaged. ☐ Yes ☐ No ☐ N/A
- 49.13. The use of the interlock shall be effective under all conditions when any control on the console, except a system emergency shut-off, is operating and after any momentary power failure. ☐ Yes ☐ No ☐ N/A

## 50. Discharge Lines and Valves

### Code Reference: S.4.1. Diversion of Measured Product

- 50.1. No means shall be provided by which any measured product can be diverted from the measuring device. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.4.2. Directional Flow Valves

- 50.1.1. Valves intended to prevent the reversal of flow shall be automatic in operation. ☐ Yes ☐ No ☐ N/A

### Code Reference: S.4.3. Other Valves

- 50.1.2. 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. ☐ Yes ☐ No ☐ N/A

## 51. Markings

### Code Reference: S.5. Marking Requirements

- 51.1. A measuring system shall be conspicuously, legibly, and indelibly marked with:
- 51.1.1. Pattern approval mark (e.g., type approval number). ☐ Yes ☐ No ☐ N/A
- 51.1.2. Name and address of the manufacturer or his trademark and, required by the weights and measures authority, the manufacturer's identification mark in addition to the trademark. ☐ Yes ☐ No ☐ N/A
- 51.1.3. Model designation or product name selected by the manufacturer. ☐ Yes ☐ No ☐ N/A
- 51.1.4. Non-repetitive serial number. ☐ Yes ☐ No ☐ N/A
- 51.1.5. Accuracy class of the meter as specified by the manufacturer consistent with Table T.2. Accuracy Classes and Tolerances for Hydrogen Gas-Measuring Devices. ☐ Yes ☐ No ☐ N/A
- 51.1.6. Maximum and minimum flow rates in kilograms per unit of time. ☐ Yes ☐ No ☐ N/A
- 51.1.7. Maximum working pressure/ ☐ Yes ☐ No ☐ N/A
- 51.1.8. Applicable temperature range if other than - 10 °C to +50 °C. ☐ Yes ☐ No ☐ N/A
- 51.1.9. Minimum measured quantity (MMQ). ☐ Yes ☐ No ☐ N/A
- 51.1.10. Product limitations (such as fuel quality) if applicable. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.5.1. Location of Marking Information; Retail Vehicle Fuel Dispensers**

51.2. The marking information required in the General Code, Paragraph G-S.1. Identification shall appear as follows:

- 51.2.1. Within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser. ☐ Yes ☐ No ☐ N/A
- 51.2.2. Either internally and/or externally provided the information is permanent and easily read and accessible. **AND** ☐ Yes ☐ No ☐ N/A
- 51.2.3. On a portion of the device that cannot be readily removed or interchanged (e.g., not on a service access panel). ☐ Yes ☐ No ☐ N/A

*Note: The use of a dispenser key or tool to access internal marking information is permitted for retail hydrogen-measuring devices.*

**52. Totalizers****Code Reference: S.7. Totalizers for Retail Vehicle Fuel Dispensers**

- 52.1. **Vehicle fuel** dispensers shall be equipped with a non-resettable totalizer for the quantity delivered through each separate measuring device. ☐ Yes ☐ No ☐ N/A

**53. Minimum Measured Quantity****Code Reference: S.8. MMQ**

- 53.1. The minimum measured quantity shall satisfy the conditions of use of the measuring system as follows: ☐ Yes ☐ No ☐ N/A
- 53.1.1. An MMQ not exceeding 0.5 kg for measuring systems with maximum flow rate less than or equal to 4 kg/min. **OR** ☐ Yes ☐ No ☐ N/A
- 53.1.2. An MMQ not exceeding 1.0 kg for measuring systems with maximum flow rate greater than 4 kg/min but not greater than 12 kg/min. ☐ Yes ☐ No ☐ N/A

**54. Card-Activated Hydrogen Gas-Measuring Devices****Code Reference: G-S.2. Facilitation of Fraud**

There is great concern regarding the potential for accidental or intentional fraud when card-activated systems are used in service stations, especially because bank-card-activated systems give direct access to bank accounts. The following criteria and test procedures apply to card-activated **retail vehicle fuel** dispensers.

A card-activated system shall authorize the dispensing of product for not more than two minutes of the time between authorization and “control” on at the dispenser. It shall properly record transactions on the appropriate card account.

When a card-activated system is subjected to power loss of greater than 10 seconds, the dispenser shall deauthorize. Because systems may be installed with separate power lines to the console, card reader, and dispenser, the different parts of the system should be tested with power failures to evaluate the potential for accidental or intentional errors. The appropriate device response depends upon when the power loss occurs during the delivery sequence.

*Note: The term "control" generically refers to the handle, flapper, start button, on/off switch, or other mechanism used to activate or deactivate the dispenser.*

- 54.1. The dispenser must de-authorize in not more than two minutes if the pump "control" is not turned on. ☐ Yes ☐ No ☐ N/A
- 54.2. If the time limit to deactivate a dispenser is programmable, it shall not accept an entry greater than two minutes. ☐ Yes ☐ No ☐ N/A
- 54.3. When a power loss greater than 10 seconds occurs after the pump "control" is on, the dispenser must de-authorize. ☐ Yes ☐ No ☐ N/A

- 54.4. When there is a loss of power, but the dispenser "control" is not on, the dispenser must de-authorize in not more than two minutes. ☐ Yes ☐ No ☐ N/A

## 55. Test Methods for Card-Activated **Retail Vehicle Fuel** Dispensers

- 55.1. Authorize the dispenser and, with the pump "control" on, interrupt power to any part (or all) of the system. The pump should de-authorize immediately.
- 55.1.1. Authorize with a card and turn the "control" on. Power down briefly, then restore power. Try to dispense product: the dispenser must not dispense because the power failure should have de-authorized the dispenser. ☐ Yes ☐ No ☐ N/A
- 55.2. Authorize the dispenser using a card (leaving control off); wait more than two minutes, and try to start the dispenser. It should not start because the authorization should have timed out.
- 55.2.1. Authorize with a card, but do not turn the "control" on. Power down for more than two minutes, and then restore power. Try to dispense product; the dispenser should have "timed-out" and not dispense. ☐ Yes ☐ No ☐ N/A
- 55.2.2. Authorize and dispense with card #1. Allow the system to time out and de-authorize (if it does). Do not turn off the "control." Authorize and dispense with card #2. The transactions shall be properly recorded for each card. ☐ Yes ☐ No ☐ N/A
- 55.2.3. Authorize with card #1. Turn the "control" on, then off. Authorize with card #2. Dispense product and complete the delivery. Check the printed receipt to verify that the delivery has been properly charged to card #2 ☐ Yes ☐ No ☐ N/A
- 55.2.4. Turn the dispenser "control" on, and use a card to authorize the dispenser. Turn the "control" off. After a period of 15 seconds, turn the "control" on. Try to deliver product; the dispenser must not dispense. ☐ Yes ☐ No ☐ N/A
- 55.2.5. Authorize with card #1 (do not turn the "control" on) and interrupt power for at least 10 seconds. This should de-authorize the dispenser. Resupply power; turn the "control" on; try to dispense. The dispenser shall not deliver product. ☐ Yes ☐ No ☐ N/A
- 55.2.6. Authorize with card #1 (turn the "control" on) and interrupt power for at least 10 seconds. This should de-authorize the dispenser. Resupply power; turn the "control" on; try to dispense. The dispenser shall not deliver product. ☐ Yes ☐ No ☐ N/A
- Note: This test is not required if the device under test complies with paragraph 10.1.*
- 55.2.7. Authorize a dispenser with card #1, but do not turn the dispenser "control" on. Try to authorize the same dispenser with card #2; it should not be accepted until after the two minute time-out. ☐ Yes ☐ No ☐ N/A
- 55.3. Attempt to override or confuse the card system by varying the length of time the card is in the slot, (e.g., vary the "swipe" times) and pushing all other keys on the keypad during each step of the authorization process. ☐ Yes ☐ No ☐ N/A

## 56. Cash Activated Hydrogen Gas-Measuring Devices

The following criteria and test procedures apply to cash-activated **retail vehicle fuel** dispensers. Tests using various denominations of bills accepted by the cash acceptor should be performed.

Certificates of Conformance will cover the use of the cash acceptor option at both attended and unattended stations. Cash Acceptors which are used at unattended locations must meet the marking requirements of paragraph G-UR.3.4. Responsibility, Money-Operated Devices shall be clearly and conspicuously displayed on the device or immediately adjacent to the device information detailing the return of monies paid when the product cannot be obtained.

Even if power is interrupted during a delivery, it is still necessary to correctly complete all transactions in progress at the time of the power interruption. 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, sales price, or amount of money already inserted into the cash acceptor) shall be determinable for at least 15 minutes at the dispenser or at the console or journal printer if the console or journal printer is accessible to the customer.

All portions of the transaction must be accounted for in order to complete the transaction. This information includes the following: (1) the total amount of money that was inserted into the device prior to the power interruption, (2) the amount of product already dispensed (which should be available from the dispenser and which must comply with the requirements of S.2.3. Provision for Power Loss, (3) and any bill that has been inserted but has not yet been recognized by the cash acceptor.

Note: For bills that have not yet been drawn into the cash acceptor to the point that the bill is no longer visible, it is assumed that the information on the bill denomination can be obtained from visual examination.

Various methods may be used to recall specific portions of the transaction depending on how the basic system operates. For example, systems that can print a record of the amount fed into the machine as each bill is fed into the device maintain an ongoing record of bills recognized by the system. Other systems may not print a receipt until the end of the transaction, so the information is recalled on a journal printer accessible to the customer or can be recalled on the cash acceptor display.

Check to see what happens when the power is interrupted at different points of the transaction. Note what occurs at the points where power is interrupted, what information is provided to the customer on the receipt, audibly and visually in the form of instructions or error messages. Because systems may be installed with separate power lines to the console, card reader, and dispenser may be installed, tests should be run with power interruptions to different parts of the system to evaluate the potential for accidental or intentional errors. The appropriate device response depends upon when the power loss occurs during the delivery sequence.

### Code Reference: S.2.3. Provisions for Power Loss

- 56.1. Systems with Battery Back-up or Uninterruptible Power Supply or Equivalent - Some ☐ Yes ☐ No ☐ N/A  
 systems are equipped with a battery back-up or an uninterruptible power supply (or equivalent) which allows a transaction to continue in the event of a power loss. For such systems, the transaction in progress at the time of a power interrupt must continue as if no power interruption had occurred (or comply with the requirements for systems not equipped with a battery back-up.) That is, all bills (including bills being fed into the device at the time of the power loss) must be correctly accounted for, and the quantity and total sale amounts must be mathematically correct. Check these systems by interrupting power at several points in the transaction to ensure that all information (total price, quantity, mathematical agreement, and total dollar amount inserted by the customer) is accounted for correctly.

### All Other Systems:

To check the operation of systems not equipped with a battery backup, uninterruptible power supply, or equivalent, interrupt power as described below. As noted earlier, if separate power lines supply different components in the system, interrupt power to different parts of the system.

- 56.2. When one or more bills has been accepted and registered by the device, but product has not yet been dispensed, at least one of the following criteria must be met to ensure that this information can be recalled in the event of a power interruption:
- 56.2.1. The denomination of the bill must be printed by the printer on the device as the device recognizes the bill. (The printed receipt must be available to the customer.) ☐ Yes ☐ No ☐ N/A
  - 56.2.2. The denomination of each bill must be printed by a journal or other printer accessible to the customer as each bill is recognized by the device. ☐ Yes ☐ No ☐ N/A
  - 56.2.3. The running total display must be capable of being recalled for at least 15 minutes. ☐ Yes ☐ No ☐ N/A
  - 56.2.4. Means provided to enable the customer to retrieve the money inserted into the device (e.g., a button which can be used during a power interruption to eject the money inserted by the customer.) ☐ Yes ☐ No ☐ N/A
  - 56.2.5. Other means used to provide a visual or printed record of the total amount of money accepted by the device. ☐ Yes ☐ No ☐ N/A
- 56.3. There is a brief period of time during which a bill has been accepted by the cash acceptor but has not yet been recognized by the device. The following criteria must be met to ensure that this information can be recalled in the event of a power failure.

- 56.3.1. Means provided to enable the attendant or customer to retrieve the bill (for example, a button which can be used during a power interruption to eject the bill or if the cash acceptor box can be removed by the attendant and the bill retrieved.) ☐ Yes ☐ No ☐ N/A

*Note: There may be a space of time in which a bill can be caught partially in and out of the cash acceptor during a power interruption. In such a case, if the denomination of the bill is visible to the customer and attendant, this is sufficient to provide information about the bill being fed into the device at the time of the power interruption. The cash acceptor must comply with the other applicable items noted above.*

*It is expected that the **retail vehicle fuel** dispenser will comply with paragraph S.2.3. Provision for Power Loss; and the information on the product already dispensed can be recalled through this portion of the system.*

- 56.4. Power should be interrupted at different points in the transaction to determine that all transaction information can be recalled in the event of a power interruption including combinations of the following:

- 56.4.1. After one bill has been inserted. ☐ Yes ☐ No ☐ N/A
- 56.4.2. After several bills have been inserted. ☐ Yes ☐ No ☐ N/A
- 56.4.3. While a bill is being inserted. ☐ Yes ☐ No ☐ N/A
- 56.4.4. After a bill has been inserted but not yet recognized. ☐ Yes ☐ No ☐ N/A
- 56.4.5. After a bill(s) has been inserted and recognized, but the on/off control is still in the "off" position. ☐ Yes ☐ No ☐ N/A
- 56.4.6. After a bill(s) has been inserted and recognized, the on/off control is in the "on" position, but no product has been dispensed. ☐ Yes ☐ No ☐ N/A
- 56.4.7. After a bill(s) has been inserted and recognized, the on/off control is in the "on" position, and product is being dispensed. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.5.1. Indicating and Recording Elements, General**

- 56.5. A running display showing the amount of money fed into the machine must be provided. It is not necessary for this information to be displayed once the customer initiates delivery. ☐ Yes ☐ No ☐ N/A

**Code Reference: S.2.6. Record Representation, Point of Sale Systems**

- 56.6. A printed receipt must be available to the customer from the device at the completion of the transaction. The issuance of the receipt may be initiated at the option of the customer. ☐ Yes ☐ No ☐ N/A
- 56.7. The customer receipt must contain the following information:
- 56.7.1. The identity (codes may be used) of the product purchased, the quantity purchased, the unit price, and the total price. ☐ Yes ☐ No ☐ N/A
- Because the customer must be provided with the option of receiving a receipt, at unattended devices the system must not accept cash if sufficient paper is not available to complete the transaction.
- 56.8. The cash acceptor must not initiate a cash transaction if either of the following conditions is true:
- 56.8.1. No paper is in the receipt printer of the cash acceptor. ☐ Yes ☐ No ☐ N/A
- 56.8.2. Insufficient paper is available to complete a transaction. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.6. Marking Operational Controls, Indications, and Features**

- 56.9. Instructions must be marked on the device to inform the customer how to operate the cash acceptor. ☐ Yes ☐ No ☐ N/A

**Code Reference: G-S.2. Facilitation of Fraud**

- 56.10. Means must be provided for the customer to cancel the transaction at any point.

- 56.10.1. The customer has inserted cash, but has not yet dispensed product. If the customer cancels the transaction by pressing the cancel key (or equivalent key(s)) or by lowering the on/off control, the device must either:

- 56.10.1.1. Be equipped with means for the customer to retrieve the cash inserted from the device. **AND** ☐ Yes ☐ No ☐ N/A

- 56.10.1.2. Automatically issue a printed receipt indicating the amount tendered and the amount returned. **OR** ☐ Yes ☐ No ☐ N/A

- 56.10.1.3. Display instructions (such as "sale terminated, see attendant," "sale terminated, get receipt" or similar wording) for the customer to see the attendant. **AND** ☐ Yes ☐ No ☐ N/A

- 56.10.1.4. Automatically issue a printed receipt showing the amount of cash inserted by the customer, a statement indicating that the sale was terminated, and instructions for the customer to see the attendant. ☐ Yes ☐ No ☐ N/A

- 56.10.2. The customer has inserted cash and has started dispensing product. If the customer cancels or discontinues the transaction by pressing the cancel key (or equivalent key(s)) or lowering the on/off control before reaching the total money inserted into the device, the device must:

- 56.10.2.1. Display instructions for the customer to obtain the receipt and to see the attendant. ☐ Yes ☐ No ☐ N/A

- 56.10.2.2. Automatically issue a printed receipt showing the amount of cash inserted, the amount dispensed, the balance due to the customer, a statement indicating that the sale was terminated, and instructions for the customer to see the attendant. ☐ Yes ☐ No ☐ N/A

*Note: It is acceptable for different messages to be used. This depends upon whether the transaction is terminated by use of the cancel key, (e.g., "sale terminated, get receipt" or "sale terminated, see attendant") or by lowering the on/off "control" (e.g., "change due, see attendant").*





## **National Type Evaluation Program**

### **Liquid Measuring Devices – Laboratory / Field Evaluation and Permanence Tests for Metering Systems**

#### **Laboratory or Field Evaluation**

When evaluating electronic indicators submitted separate from a measuring element, simulated inputs (e.g. meter pulse, temperature, pressure, density, communications, etc.) may be used as follows:

- For the initial testing of the indicator.
- For software changes to a device with an existing CC.

Measuring systems, devices, and elements whose performance may change with use over time are generally subject to field evaluation and permanence tests.

The following types of devices and elements are subject to initial field or laboratory evaluation:

- Electronic Indicating Elements
- Consoles
- Recording Elements
- Electronic Cash Registers
- Data Processing Units

Field examination is conducted between 20 and before 30 days of use in a normal installation. During this interval, the device must perform and function correctly and not be serviced. Permanence tests are conducted on equipment such as a complete measuring system or only a measuring element (meter.)

The permanence test is not required in either new evaluations or updating a CC for the electronic devices listed above in stationary installations. The permanence test for mobile electronic devices may be waived by NTEP for updating a CC.

#### **Compatibility Test**

Similar devices that were individually tested for a similar application can be "mixed and matched" without additional testing, if the system functions properly during the initial test. For example, NTEP can determine the compatibility of an approved console interfaced with an approved **retail motor fuel** dispenser during a type evaluation when both components are previously approved in like applications. If devices are to be used in dissimilar applications, then additional NTEP testing is required.

#### **Permanence Test Procedures for Meters**

##### **A. Field Evaluation and Permanence Test of New-Design Meters In **Retail Motor Fuel** Dispensers**

All new-design meters are subject to a permanence test. If a meter is the same as one in a previously tested dispenser, a permanence test is not required. NTEP National Type Evaluation Program reserves the right to require a permanence test based on the result of the initial examination.

#### **Initial Examination**

1. All meters of the new type installed at the type evaluation location are subject to examination. At least two meters must be tested.
2. At least one meter will be chosen for throughput testing on each of two major products (e.g., unleaded gasoline and diesel fuel.) The minimum number of tests for each of these two meters will include the following:
  - Five tests at the fast flow rate
  - Three tests at a midrange flow rate
  - Five tests at the slow flow rate

At least five tests at both the fast and slow flow rates and three midrange flow rate tests will be run on each of these two meters. Only one test at each flow rate need be run on any remaining meters. If both products are not available for the type

evaluation, the test may be performed using one product and a Provisional Certificate of Conformance may be issued for the one product. The test using the other product may be performed at a later date to result in a full Certificate of Conformance.

12. All meters must perform within acceptance tolerance.
13. **Repeatability** - When consecutive multiple tests are conducted at approximately the same flow rate, the range of the test results for the flow rate shall not exceed 40% of the absolute value of the maintenance tolerance.

#### Subsequent Examination

Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates to be included on the Certificate of Conformance (CC) must be within the applicable tolerances. Extended flow range testing performed at the manufacturer's discretion may be included on the CC provided the results are within the acceptable tolerances.

1. The examination will be conducted as applicable:
  - No sooner than 20 days for electronic changes of metrological significance.
  - 20,000 gallons for throughput testing for mechanical changes of metrological significance.
2. Five tests at both fast and slow flow rates, and three midrange flow rate tests, will be made on the throughput meters. Only one test at each flow rate needs to be performed on any remaining meters.
3. **Repeatability** - When consecutive multiple tests are conducted at approximately the same flow rate, the range of the test results for the flow rate shall not exceed 40% of the absolute value of the maintenance tolerance.

### B. Field Evaluation Test of Previously Evaluated Components in **Retail Motor Fuel** Dispensers Using Different Previously Evaluated Meters

#### Different Previously Evaluated Meter

Previously evaluated dispensers using a previously type evaluated meter and indicator (register) will be subject to a initial test. Based on the test results of the initial test, National Type Evaluation Program (NTEP) may require a permanence test.

#### Non-metrological Changes

A technical administrative review shall be conducted to issue a new Certificate of Conformance (CC) or amend an existing CC for previously evaluated devices because of non metrological changes. Based on the results of the technical administrative review, NTEP may require additional tests.

### C. Field Evaluation and Permanence Test for Vehicle-Tank Meters (Except for LPG, Cryogenic and CO2 Meters)

The following tests are considered to be appropriate for vehicle-tank metering systems:

- Four test drafts at each of five flow rates.
- One vapor or air eliminator (product depletion) test.

*Note: 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. (Code reference N.4.1.)*

Only one meter is required for the initial test, and after the test, the meter will be placed into service for the permanence test. The minimum throughput criterion for these meters is the maximum rated flow in units per minute x 2000.

Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates to be included on the Certificate of Conformance (CC) must be within the applicable tolerances. Extended flow range testing performed at the manufacturer's discretion may be included on the CC provided the results are within the acceptable tolerances.

#### Tests of Automatic Temperature Compensating Systems (Code Reference T.2.1.)

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.

**Repeatability on Vehicle-Tank Meters (Code Reference T. 3.)**

When multiple tests are conducted at approximately the same flow rate, 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.

Tests for repeatability shall 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.

**Code Reference: N.4.2. Special Tests (except Milk-Measuring Systems), N.4.5. Product Depletion Test, and T.4. Product Depletion Test****Product Depletion Test**

Except for devices used exclusively for the delivery of aircraft fuel, before vehicle mounted applications are listed on a National Type Evaluation Program Certificate of Conformance, the meter must pass a product depletion test. This policy applies to all meter technologies (e.g. Coriolis mass flow meters, turbine meters and positive displacement meters) even if the meter will never be installed on trucks with more than a single compartment. The permanence test still applies including the throughput and a duration of at least 20 days. Ideally, this test should be performed with a multiple-compartment vehicle; however, a single compartment vehicle may be used to simulate the product depletion test by running the tank empty, to simulate the product depletion.

**Purpose**

A product depletion test verifies the proper operation of air elimination means when the storage tank for the product being measured is pumped dry. This test is necessary for meters that may drain a tank completely, such as a vehicle tank meter.

**Test Procedure****For a Multi-compartment Tank:**

1. Begin the test from a compartment (ideally the largest compartment) containing an amount of fuel equal to or less than one-half the nominal capacity of the prover being used. Operate the meter at the normal full flow rate until the compartment is empty. There are several methods for determining that the compartment is empty. There may be a significant change in the sound of the pump. There may be visual evidence that the compartment is run dry. The meter may stop entirely or may begin to move in jumps (pause, resume running, then pause, then run again.)
2. Continue the test until the meter indication stops entirely for at least 10 seconds. If the meter stops for 10 seconds or more, proceed to step 3. If the meter indication fails to stop entirely for a period of 10 seconds, continue to operate the system for 3 minutes.
3. Close the valve from the empty compartment, and, if top filling, then close the nozzle or valve at the end of the delivery hose. Open the valve from another compartment containing the same product. Carefully open the valve at the end of the delivery hose. Pockets of vapor or air may cause product to splash out of the prover. The test results may not be valid if product is splashed out of the prover. Appropriate eye protection is required, but caution is still necessary.
4. Continue delivering product at the normal full flow rate until the liquid level in the prover reaches the nominal capacity of the prover.
5. Close the delivery nozzle or valve, stop the meter, allow any foam to settle, then read the prover sight gauge as quickly as practical.
6. Compare the meter indication with the actual delivered volume in the prover.
7. Calculate the meter error, apply Product Depletion test tolerance, and determine whether or not the meter error is acceptable.

**Test Procedure:****For a Single-compartment Tank:**

The test of a single-compartment tank is easier to accomplish if there is a quick-connect hose coupling between the compartment valve and the pump that supplies product to the meter. If the system does not have a quick-connect coupling between the compartment and the meter, an additional source of sufficient product at the test site is required.

**Without a Quick-connect Coupling:**

1. Begin the test with the compartment containing an amount of fuel equal to or less than one-half the nominal capacity of the prover being used. Operate the meter at the normal full flow rate until the supply tank is empty. There are several methods for determining that the tank is empty. There may be a significant change in the sound of the pump. Someone may visually watch for the tank to run dry. The meter may stop entirely or may begin to move in jumps (pause, resume running, then pause, then run again.)
2. Continue the test until the meter indication stops entirely for at least 10 seconds. If the meter stops for at least 10 seconds, proceed to step 3. If the meter indication fails to stop entirely for at least 10 seconds, continue to operate the system for 3 minutes.
3. Close the compartment valve and the delivery nozzle or valve if top filling. Stop the pump and load sufficient product from the alternate source into the supply compartment for the meter being tested. Allow the product to stand in the compartment for a brief time to allow entrained vapor or air to escape.
4. Open the compartment valve and restart the pump without resetting the meter to zero. Carefully open the nozzle or valve at the end of the delivery hose. Pockets of vapor or air may cause product to splash out of the prover. The test results may not be valid if product is splashed out of the prover. Appropriate eye protection is required, but caution is still necessary.
5. Continue delivering product at the normal full flow rate until the liquid level in the prover reaches the nominal capacity of the prover.
6. Close the delivery nozzle or valve, stop the meter, allow any foam to settle, then read the prover sight gauge as quickly as practical.
7. Compare the meter indication with the actual delivered volume in the prover.
8. Calculate the meter error, apply Product Depletion test tolerance, and determine whether or not the meter error is acceptable.

**With a Quick-connect Coupling:**

1. During a normal full flow test run, close the compartment valve at approximately one-half of the nominal prover capacity. Then slowly and carefully disconnect the quick-connect coupling allowing the pump to drain the supply line.
2. Continue the test until the meter indication stops entirely for at least 10 seconds. If the meter fails to stop entirely for at least 10 seconds, continue to operate the system for 3 minutes.
3. If the meter stops for at least 10 second or after 3 minutes, close the delivery nozzle or valve at the end of the delivery hose if top filling.
4. Reconnect the quick-connect coupling and open the compartment valve.
5. Carefully open the nozzle or valve at the end of the delivery hose. Pockets of vapor or air may cause product to splash out of the prover. The test results may not be valid if product is splashed out of the prover. Appropriate eye protection is required, but caution is still necessary.
6. Continue delivering product at the normal full flow rate until the liquid level in the prover reaches the prover's nominal capacity.
7. Close the delivery nozzle or valve, stop the meter, allow any foam to settle, then read the prover sight gauge as quickly as practical.
8. Compare the meter indication with the actual delivered volume in the prover.
9. Calculate the meter error, apply Product Depletion test tolerance, and determine whether or not the meter error is acceptable.

## D. Initial Evaluation and Permanence Tests for Wholesale Positive Displacement (PD) Meters

The following tests are considered to be appropriate for metering systems on Wholesale PD Meters:

1. Four test drafts at each of five flow rates.
  - 1.1. "Special" tests shall include a test at or slightly above the slower of the following rates:
    - 1.1.1. 20% of the marked maximum discharge rate; or,
    - 1.1.2. The minimum discharge rate marked on the device.

In no case shall the test be performed at a flow rate less than the minimum discharge rate marked on the device.
2. Only one meter is required for the initial test, after which the meter will be reevaluated for permanence. The minimum throughput criterion for these meters is the maximum rated flow in units per minute x 2000.
3. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates to be included on the Certificate of Conformance (CC) must be within the applicable tolerances. Extended flow range testing performed at the manufacturer's discretion may be included on the CC provided the results are within the acceptable tolerances.

### Tests of Automatic Temperature Compensating Systems on Wholesale Meters (Code Reference T.2.3.4.)

The difference between the meter error for results determined with and without the automatic temperature compensating system activated shall not exceed:

1. 0.2% of the test draft for mechanical automatic temperature compensating systems. AND
2. 0.1% of the test draft for electronic automatic temperature compensating systems.

The results of each test shall be within the applicable "acceptance" or maintenance tolerance.

### Repeatability on Wholesale Meters (Code Reference T.2.3.3.)

When multiple tests are conducted at approximately the same flow rate, 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.

Tests for repeatability shall 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.

## E. Field Evaluation and Permanence Test for LPG and Cryogenic Meters

The following tests are considered to be appropriate for metering systems on LPG and cryogenic meters:

1. Four test drafts at each of five flow rates.

Only one meter is required for the initial test, after which the meter will be placed into service for the permanence test. The minimum throughput criterion for these meters is the maximum rated flow in units per minute x 2000.

Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates to be included on the Certificate of Conformance (CC) must be within the applicable tolerances. Extended flow range testing performed at the manufacturer's discretion may be included on the CC provided the results are within the acceptable tolerances.

### Repeatability on LPG & NH<sub>3</sub> Meters (Code Reference T.3.)

When multiple tests are conducted at approximately the same flow rate, the range of the test results for the flow rate shall not exceed 40% of the absolute value of the absolute value of the maintenance tolerance and the results of each test shall be within acceptance tolerance. This tolerance does not apply to the test of the automatic temperature compensating system.

Tests for repeatability shall 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.

*Note: Stable temperature and pressure indications are necessary during the entire repeatability test to achieve good test results.*

**For multiple drafts to determine repeatability, the following conditions shall be maintained;**

1. The range of flow rates shall not exceed 5% of the first test draft.
2. The range of temperatures at the meter shall not exceed 1 °C (2 °F.)
3. The range of pressure shall not exceed 68.95 Kpa, or 10 PSI.
4. The temperature difference between the meter and the prover shall not exceed 1o C (2 °F.)

If these conditions cannot be met, repeatability tolerances shall not be applied. Repeatability tests must include at least three consecutive test drafts.

**Tests of Automatic Temperature Compensating Systems - LPG & NH<sub>3</sub> Meters**

The difference between the meter error for results determined with and without the automatic temperature-compensating system activated shall not exceed:

1. 0.5% of the test draft for mechanical automatic temperature compensating systems. AND
2. 0.25% of the test draft for electronic automatic temperature compensating systems.

The results of each test shall be within the applicable "acceptance" or maintenance tolerance.

**F. Field Evaluation and Permanence Test for LPG Vapor Meters**

The following tests are to be run on an LPG vapor meter as part of the permanence test:

1. Three tests at the maximum discharge rate.
2. Three slow-flow tests.
3. One low-flame test.

Only one meter will be required for the initial test, after which the meter must have air or product passed through it as part of the permanence test. The amount of air or product shall be at least the maximum flow rate times 1000. California weights and measures performs this test in approximately 60 days. Although it is longer than the usual 30-day test, this is considered appropriate because these meters are usually tested only every ten years.

Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates to be included on the Certificate of Conformance (CC) must be within the applicable tolerances. Extended flow range testing performed at the manufacturer's discretion may be included on the CC provided the results are within the acceptable tolerances.

**G. Repeatability on Milk Meters (Code Reference N.4.1.1. and T.3.)**

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.

Tests for repeatability shall 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.

**H. Field Evaluation and Permanence Test for Turbine Meters**

1. The following tests are considered to be appropriate for turbine meters:

Meters tested in a laboratory environment will be tested four times at each of five different flow rates, using varsol or water for both the initial and the follow-up evaluation to establish "baseline" data for the meter's performance. A Certificate of Conformance (CC) may be issued for the product(s) tested in the laboratory; however, additional products will not be included until testing is completed with these products. After a "baseline" is obtained, products can be included on the CC by performing three tests at each of four different flow rates in the field for both the initial and follow-up evaluation. If a meter is tested in the field without first determining a "baseline," the meter must undergo four tests at each of five different flow rates; these criteria apply for both the initial and follow-up test."

2. At least one meter is required for each product type for the initial test.
3. If the meter is to be used with products other than gasoline and diesel fuel, the manufacturer must also submit data to indicate meter performance over the range of viscosity of products to be used with the meter.

4. To indicate meter performance over the temperature range in which the meter is anticipated to be used, data must also be submitted.
5. Following the initial test, the meters will be placed into service for the permanence test. The minimum throughput criterion for these meters is the maximum rated flow in units per minute x 2000.
6. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates to be included on the Certificate of Conformance (CC) must be within the applicable tolerances. Extended flow range testing performed at the manufacturers' discretion may be included on the CC provided the results are within the acceptable tolerances. Following evaluation of test data and analysis of the data presented by the manufacturer for meter performance over temperature and viscosity ranges, the evaluating laboratory may require additional testing prior to issuing a CC for the meter.

## **I. Field Evaluation and Permanence Tests for Mass Flow Meters**

The following tests are considered to be appropriate for mass flow meters:

### **Type Evaluation**

The gravimetric test method shall be used for type evaluation for meters indicating only in units of mass and may be used for meters indicating in units of volume. Meters indicating in only units of volume may be tested using a volumetric standard. Alternatively, field standard, mass meters (master meters) may be used for type evaluation for meters indicating in either mass or volume units, provided that the master meter indicates in the appropriate units and is a traceable reference standard in compliance with all the requirements of this policy.

### **Test Data**

Meters tested in a laboratory environment will be tested four times at each of five different flow rates. Use the product available in the laboratory for both the initial and the follow-up evaluation to establish "baseline" data for the meter's performance. A Certificate of Conformance (CC) may be issued for the product(s) tested in the laboratory; however, additional products will not be included until testing is completed with these products. After a "baseline" is obtained, products can be included on the CC by performing three tests at each of four different flow rates in the field for both the initial and follow-up evaluation. If a meter is tested in the field without first determining a "baseline," the meter must undergo four tests at each of five different flow rates; these criteria apply for both the initial and follow-up test.

Following the initial test, the meters will be placed into service for the permanence test. The minimum throughput criterion recommended for these meters is 60 days, or 2000 x maximum rated flow in units per minute. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates to be included on the certificate of conformance must be within the applicable tolerances. Extended flow range testing performed at the manufacturer's discretion may be included on the certificate of conformance provided the results are within the acceptable tolerances.

### **Gravimetric Standard**

As a general guideline for the gravimetric standard, the value of the scale division should not be larger than one-tenth of the tolerance times the smallest test draft. The combined error of the standard used for testing measuring instruments shall not exceed 20% of the maximum permissible error to be applied. Using known weight (field standard), determine the error present in the weighing instrument over the weighing range that will be used in the test. The inherent error, if present, is to be factored out of the measurement. The scale will then be used as a field standard.

The reference scale used in the gravimetric test must be tested immediately prior to testing the mass flow meter. The test should be conducted no earlier than one day prior to the test of the mass flow meter. For example, the laboratory may arrive at the site and conduct the test of the reference scale on the first day and then return the second day to begin testing of the mass flow meter. If at all possible, the reference scale should not be used for other purposes during the testing of the mass flow meter. However, it is recognized that this is not always practical since the scale will often be used at the site for other purposes. If the evaluating laboratory has reason to believe that scale performance has changed (e.g., erratic readings, observed abuse of the scale, etc.) during the conduct of the mass flow meter test, testing of the reference scale should be repeated. If scale performance has changed, any meter tests that have already been performed must be repeated.

If necessary, the reference scale should also be tested after the test of the mass flow meter is completed; this includes testing after completing the series of initial tests in the permanence test and also after completing the series of subsequent tests in a permanence test.

Under no circumstances is the laboratory to accept test results from a prior scale inspection or test. The evaluating laboratory must witness the test of the reference scale, and the test must be conducted at the same time as the testing of the mass flow meter. Accuracy tests of the scale must be conducted with certified, traceable test weights. On the subsequent test of a meter after the permanence period, the reference scale must be retested; scale test results obtained during the initial test of the meter are not sufficient.

Remember that the reference scale serves as your test standard for the mass flow meter test, and you are to make error corrections to your mass flow meter test results based upon the test you perform on the reference scale. Therefore, it is essential to ensure that the standard is correct at all times during the test and to determine the exact errors in the scale in the range of weights where the mass flow meter will be tested.

#### **The Sequence of Testing is To Occur as Follows:**

1. Test the reference scale and note the errors in the weight ranges where the meter test will be conducted.
2. Perform initial tests of the mass flow meter.
3. If necessary, test the reference scale to determine that scale performance has not significantly changed.
4. Subject the meter to throughput during the permanence test.
5. Test the reference scale and note errors in the weight ranges where the meter test will be conducted.
6. Perform the subsequent tests of the mass flow meter.
7. If necessary, test the reference scale to determine that scale performance has not significantly changed. It is preferable to have a scale that is dedicated to only NTEP weighing during the evaluation of the meter. The scale shall be reverified if it is used for purposes other than evaluation weighing, or if the maximum time between the initial test and the permanence test exceeds five days.

#### **Additional Considerations:**

1. The reference scale should be adjusted to have errors as close to zero as practicable.
2. When weighing individual test drafts, the beginning weight (tare) and ending weight (gross) must both be corrected for scale error at that load range in order to determine the correct net weight for the run.
3. All scale readings should be made using error weights to 0.1 d or using expanded resolution if available. The scale should repeat successive readings of the same load within 0.5 scale divisions. An NTEP approved scale is not required.
4. If reasonably stable readings using error weights cannot be achieved due to wind or other environmental factors, testing should be suspended until such time that stable readings can be achieved.
5. The NTEP Laboratory and the applicant may consider setting the scale up and calibrating with a smaller division or using an expanded resolution mode if available. If the scale is set up and calibrated with a smaller division and the resulting total number of divisions for the scale exceeds the  $n_{\max}$  allowed for the device, the use of the scale will be restricted to the type evaluation weighings only.
6. To conduct the mass flow meter tests, position the test vessel completely on the scale and in the same position for all weighments.
7. When "semi" tractor/trailer tankers are used, the maximum gross load can be reduced by uncoupling the tractor and weighing only the trailer.
8. The driver should be out of the truck and the engine off whenever weighments are made.
9. The scale shall be within 5 miles of the meter evaluation site unless it is possible to determine fuel consumption and make appropriate corrections for the fuel consumed.

*Notes: Measurement Canada requires that the minimum scale division not exceed one fifth of the limit of error for the test draft. Test criteria are being developed for an abbreviated follow-up test.*

#### **Test Drafts with a Gravimetric Standard**

All test drafts shall meet the following criteria:

The minimum quantity for any test draft shall be equal to or greater than the amount delivered in one minute at the flow rate being tested, and any test draft shall be equal to or greater than ten times the division size of the available reference scale(s) divided by the applicable draft tolerance in percent for the device under test. As a formula:

Minimum draft size  $\geq 10$  (scale "d") / Applicable Draft Tolerance for one minutes flow



For example: With a scale division of 0.1 lb (or 1 lb with 10:1 expanded resolution or by using error weights) and an applicable tolerance of 0.2%, the minimum draft must be equal to or greater than 500 lb.

With a scale division of 0.5 lb (or 5 lb with 10:1 expanded resolution / error weights) and an applicable tolerance of 0.3%, the minimum draft must be equal to or greater than 1667 lb.

### **Field Standard Meter (Master Meter) Qualification**

Prior to using the field standard meter for field evaluation testing, traceability of the field standard meter (master meter) measurements shall be established and documented in one of the two ways described here:

- Calibration in the units (mass or volume) by an independent laboratory that is accredited to ISO17025 standards by a recognized notified body (e.g., NVLAP, A2LA). The documentation of the scope of accreditation of the lab must indicate that the uncertainty of the calibrated master meter measurements, in the units to be tested, is less than or equal to 1/3 of the tolerance allowed for the device that is to be tested. The lab used to calibrate the master meter shall maintain and provide on demand the documentation that will include the following:
  - The date and time of the most recent calibration,
  - the metrological traceability chain linking the master meter calibration to NIST standards,
  - the uncertainty of the calibrated master meter stated in the Scope of Accreditation over the entire flow range,
  - the measurement procedures and fluid(s) used to calibrate the master meter,
  - the Certificate of Accreditation to ISO 17025 as proof of the technical competence of the lab and its personnel,
  - the master meter calibration test results realized in SI units,
  - the periodic calibration verification schedule and the calibration history of the master meter,
  - the measurement assurance program data for the lab,
  - A statement of compliance with NCWM Publication 14 on the master meter test reports.
- Calibration of a master meter by a lab that is not accredited to ISO17025 may be performed, so long as the calibration is witnessed by the evaluator. In cases where the evaluator witnesses the calibration of the master meter in a lab that is not ISO17025 accredited, the evaluator must also witness the verification of the gravimetric scales with mass standards traceable to NIST prior to the use of that scale(s) to calibrate the master meter. The uncertainty of the calibration should be documented and approved by the evaluator as being less than or equal to 1/3 of the tolerance that is to be tested. The following documentation of the master meter traceability should be included in the report filed by the evaluator:
  - The date and time of the witnessed calibration,
  - the metrological traceability chain linking the master meter to NIST standards,
  - the uncertainty analysis of the calibrated master meter over the entire flow range,
  - the measurement procedures and fluid(s) used to calibrate the field standard meter,
  - the observed technical competence of the lab and its personnel,
  - the field standard meter calibration test results realized in SI units.

When the master meter type has been shown through testing against traceable standards to have the same calibration configuration values between the master meter calibration fluid and the fluid for the test meter, testing may be done using the test fluid without adjustment to the master meter.

At the discretion of the evaluator, calibration verification of the master meter may be required following field evaluation testing. The decision whether to require post-testing calibration verification of the master meter should be based on:

- The time that has passed since the most recent calibration of the field standard meter
- The past history performance and stability documented for the field standard meter
- The data collected during the field evaluation (e.g., irregular or unusually close to allowed tolerance)

### **Test Drafts with a Field Standard Meter (Master Meter)**

All test drafts shall meet the following criteria:

The minimum quantity for any test draft shall be equal to or greater than the amount delivered in one minute at the flow rate being tested, and any test draft shall be equal to or greater than ten times the MMQ of the master meter.

MMQ testing may be performed with master meters with smaller quantities than required above, provided that MMQ of the master meter is equal to or less than the MMQ of the device being evaluated.

### Testing for Volume Units Only or to Add Volume Units to Existing Certificates

In order to add volumetric indications to an existing NTEP Certificate of Conformance (CC) for a meter which already covers mass indications for a meter, the following criteria relative to meter sizes to be covered on the CC must be met:

- At least one meter size must be tested in the volumetric mode.
- If the meter size(s) selected for testing is not already covered on the existing CC, then the request is treated as a submission to add a new meter size (e.g., a permanence test is required and testing must be performed in both the mass and the volume modes of operation.)

*Note: During an evaluation of a meter to add volume unit to an existing certificate the tolerance specified in the mass flow meters code is to be applied to both the initial and the final tests. No adjustments may be made to the meter during this period. This tolerance is to be applied even if different liquid temperatures and pressures exist between the initial and final tests. During the evaluation of a meter for volume units only for a product specific application where a separate product specific NIST Handbook 44 code exists; e.g., LPG, cryogenic liquids, CO<sub>2</sub>, etc., the appropriate NIST Handbook 44 section for the intended application will be applied.*

Determination of performance relative to repeatability, accuracy, and linearity should be performed using accepted statistical methodology. Reference documents include: 1) SAMA Standard PMC 20.1-1973, Process Measurement and Control Terminology; 2) ANSI/ASME MFC-2M-1983, Measurement Uncertainty for Fluid Flow in Closed Conduits; and 3) ANSI/ASME MFC-1M-1979, Glossary of Terms Used in the Measurement of Fluid Flow in Pipes.

### Repeatability for Mass Flow Meters (Mass Flow Meters Code Reference T.3.)

When multiples tests are conducted at approximately the same flow rate, the range of the test results for the flow rate shall not exceed:

1. 0.2% for retail liquid **motor fuel** devices. AND
2. 40% of the applicable tolerance for all other devices listed in Table T.2. of the Mass Flow Meters Code.

*Note: The normal test of a mass flow metering system shall be made at the maximum discharge rate developed under the conditions of the installation. Any additional tests conducted at flow rates down to and including the rated minimum discharge flow rate shall be considered normal tests. (Code reference N.6.) Special test tolerances shall apply to tests such as a split compartment test conducted to develop operating characteristic of the measuring systems.*

### Testing for Multi-Product Applications

Multi-product applications (that is, applications in which the meter will be used without a change to zero or calibration to dispense different products which vary in specific gravity by more than 0.1) must include a multi-product test. The multi-product initial test will be performed on the meter without a change to zero or calibration using multiple products having a difference in specific gravity of at least 0.2. For devices which will be used to dispense multiple products having a specific gravity range greater than 0.2, the multi-product testing must be performed over the anticipated range before multi-product applications will be included on the CC. For the multi-product testing, throughput testing will be performed on one or a combination of the products; testing for the subsequent test will be conducted on both products without a change to zero or calibration. The CC for a mass flow meter will cover multi-product applications where the specific gravity of a single product, or multiple products, varies by the amount tested throughout the entire approved specific gravity range of the meter.

Example: Where a meter has been tested and a certificate issued for multi-product with one liquid having a specific gravity of 0.7 and another liquid having a specific gravity of 1.0 and the meter is subsequently tested to expand the range with a liquid having a specific gravity of 1.6 the allowed variation of densities covered by the CC will be from 0.7 through 1.6. Multi-product testing requirements do not apply to meters used to dispense a product such as propane in which the density varies in normal operation.

#### **Additional Considerations for Testing Mass Flow Meters Dispensing Compressed Natural Gas (CNG)**

1. Ideally, the device should be tested over a temperature range. Because this is not possible to easily regulate in the field, to observe any effects of temperature changes test early in the day and then again later in the day.

*Note: The evaluating laboratory should attempt to test at as wide a temperature range as possible; however, it is recognized that this may not always be possible and, in some cases, little or no variation in temperature will be experienced.*

2. The magnitude of the draft (and, therefore, the time required for delivery) may impact upon the test results. For very small drafts, the start and stop effects can become significant and may result in large variability. Because CNG stations are presently few and far between in some areas, it is anticipated that these devices will be heavily used to "top off" tanks. Consequently, the minimum measured quantity declared for the device can be significant. It is desirable to have at least some tests run at or near the minimum measured quantity.
3. In setting up the arrangements for testing, the resolution of the scale relative to the test draft must be considered and "rounding error" of the scale must be kept to an acceptably small level. As a general guideline, the value of the scale division should not exceed one-tenth of the tolerance applied to the device. Either a high-resolution scale is needed; error weights should be used; or a larger test draft selected. A combination of these approaches may be used. The total error of the field standard must be limited to less than one-third of the tolerance. Therefore, the scale must be thoroughly tested; the repeatability of the scale verified; and corrections made to the results of the meter test to correct for any errors determined during the scale test.
4. The repeatability of the test results must be within 40% of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerances.

Tests for repeatability shall 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.

5. Repeat tests should be run over a range of flows or, because the device may operate at only one flow in the field installation, over a range of quantities.
6. The typical tank size being filled by the device will be 7-10 kg (16-20 lb.) A very large tank size may be 20 kg (40 lb) if a vehicle is equipped with two tanks. The average amount dispensed will probably be around 4 kg (8 lb).
7. Because the zero changes with temperature, the zero must be sealable as noted in the Mass Flow Meters Code in *NIST Handbook 44*. CNG meters must indicate on the basis of mass, with the computation of total sale based on mass units. Supplemental units may be used in addition to the mass units; however, these must be clearly identified as supplementary units. It is suggested that conversion charts be provided to explain to the consumer how the conversion factor for the supplemental units is derived.

#### **The Following Tests are Considered Appropriate for CNG Dispensers:**

1. Normal Test (Code References S.3.7., N.4., N.6.1., T.2. and T.3.)

#### **Computer Jump:**

- Remove nozzle from dispenser and connect to test cylinder. (Test cylinder pressure should not be greater than 200 psi to simulate an actual delivery.)
- Turn nozzle valve from "OFF" position to "FILL" position.
- Empty discharge hose.
- Turn nozzle valve to "OFF" position.
- Activate dispenser.
- Observe dispenser indications, if computer jump occurs, take appropriate action.

*Note: A test cylinder is not necessary for the computer jump test on dispensers equipped with an autovent system. To test, turn dispenser on and observe the indication display for computer jump when the dispenser shuts off.*

**Minimum Test Drafts are as Follows:**

- Place empty test cylinder on the scale.
- Access mass display of the dispenser.
- Tare weight of the test cylinder, chocks and stand.
- Connect the nozzle to the test cylinder.
- Fill the test cylinder to 1/3 capacity full at maximum flow rate.
- Disconnect the nozzle from the test cylinder.
- Compare mass display to scale indication.
- Determine dispenser error. (Code Reference T.2.)
- Leave product in test cylinder.
- Tare the weight of the test cylinder, chocks and stand.
- Connect the nozzle to the test cylinder.
- Begin the fill operation with product in the cylinder; fill cylinder to 2/3 capacity at maximum flow rate.
- Disconnect the nozzle from the test cylinder.
- Compare mass display to scale indication.
- Determine dispenser error. (Code Reference T.2.)
- Tare the weight of the test cylinder, chocks, and stand.
- Connect the nozzle to the test cylinder.
- Begin the fill operation with product in the cylinder; fill cylinder to capacity at maximum flow rate.
- Disconnect the nozzle from the test cylinder.
- Compare mass display to scale indication.
- Determine dispenser error. (Code Reference T.2.)
- Return product to owner/operator of dispenser. (Code Reference UR.3.8.)
- Place empty test cylinder on scale (scale may be supported by chocks and stand.)
- Tare the weight of the test cylinder, chocks, and stand.
- Connect the nozzle to the test cylinder.
- Fill test cylinder to capacity at maximum flow rate.
- Disconnect the nozzle from the test cylinder.
- Compare mass display to scale indication.
- Determine dispenser error. (Code Reference T.2.)
- Return product to owner/operator of dispenser.
- Repeating previous tests. (Code Reference T.3.(a))
- Applicable tolerance for multiple tests at the same flow rate.
- Return product to owner/operator of dispenser.
- If the meter minimum measured quantity (MMQ) is less than the smallest test draft, conduct a test at the MMQ value. (Code Reference N.4.)

*Note: If 300 divisions (d) or 2.27 kilograms (5 pounds) is greater than 1/3 of the test cylinder capacity, then the test cylinder should be emptied to accommodate a delivery of at least 300 d or 2.27 kilograms (5 pounds) otherwise a larger tank is necessary.*

2. Check effectiveness of zero-setback interlock. (Code References S.3.8., UR3.6. and UR.3.7.
  - No subsequent delivery until indicating and recording element returned to zero.
  - After delivery is complete the dispenser starting lever (mechanism) is shutoff, interlock engaged, and discharge nozzle is in the designed hanging position. Note: This does not apply to nozzle control.
  - Remove nozzle from hanging position.
  - Reset computer to zero and turn on dispenser.
  - Attempt to return the nozzle to its designed hanging position, carefully remove nozzle and connect it to the test tank and open valve. Move the dispenser starting lever (mechanism) to "ON" position and attempt to dispense product. Note: This does not apply to nozzle control.
  - Product should not flow without resetting the indications to zero.
3. Check operation of low-flow cut-off valve . (Code Reference UR.2.3.)
  - Valve shall not be set lower than the minimum flow rate.
  - Valve stops registration when flow is below the low-flow cut-off value.
  - Connect nozzle to empty test tank and dispense product. Slowly throttle down on the valve on the test tank to the minimum attainable flow rate. Product delivery should not occur below the mass flow meter minimum flow rate.
4. Power loss test. (Code References S.2.4.1. and S.2.4.2.)
  - Transaction in progress at power loss, information shall be retainable for 15 minutes.
  - Device memory shall retain quantity of product and sales price during power loss.
  - Security seal--apply wire security seal to secure adjusting mechanism (if applicable.)
  - (Code References G-UR.4.5. and S.3.5.)
  - Note on the official report the number of gasoline gallon equivalents of product dispensed during the test.
  - After all equipment at a location has been tested, review results to determine compliance with equipment maintenance and use of adjustments. (Code Reference G-UR.4.1. and G-UR.4.3.)

## J. Testing of Lubricating Oil Meters

Lubricating oil meters are to be tested as follows using a specially designed small volume prover for small meters or using gravimetric test methods for all sizes of meters.

Avoid recirculating product during the testing process; recirculation can cause aeration of the product and create changes in product temperature. The Certificate of Conformance is to specify that effective, automatic means must be provided in the installation to prevent the introduction of air/vapor into the meter or, in the case of a mass flow meter, prevent the air/vapor from being measured.

### **Specially Designed Volumetric Prover**

Because lubricating oils tend to be viscous, testing with a volumetric neck-type prover can yield erratic results. The excessive clingage of the product to the sides of the prover makes consistent draining difficult. Consequently, testing of lubricating oil meters is to be performed using a prover, which is specially designed for this type of testing. This type of prover is designed to consistently remove most of the product clinging to the sides of the prover each time the prover is emptied, thus yielding more consistent results.

### **Gravimetric Test methods**

Gravimetric testing is to be performed using the following equipment and test procedures:

*Note: The inch-pound values listed in this test procedure are given only to illustrate how this procedure would be used with inch-pound units. The inch-pound values are not equivalents of the metric values listed in all cases; in some cases the inch-pound value is a value of similar magnitude to the metric value listed.*

#### **Equipment:**

1. Graduated flask conforming to *NIST Handbook 105-2*, 2 L (1 gal), to contain with neck graduation to 1 mL (1 fl dr) or smaller increments.
2. Thermometer.
3. Pipette.

- Small capacity scale sufficient to weigh 2 L (1 gal) of test liquid plus the flask and sensitive to 1 g (0.002 lb) or less.
- Platform or portable scale conforming to all requirements of *NIST Handbook 44*. The scale must have sufficient capacity to weigh the gross load of the receiving vessel and at least as much product as will pass through the meter in one minute at the normal flow rate. The scale should be sensitive to 0.03% or less of the total net weight of the product in the receiving vessel.
- Sufficient test weights to verify each scale up through the gross loads to be applied to each. (Errors at each test load should be recorded for later reference.)

### Pretest Determinations

- Decide on test logistics such as necessary plumbing, location of test, product supply and handling, communications and scheduling with company representatives.
- Determining the Coefficient of Expansion - When testing temperature compensated meters, the weight per volume must be corrected back to 15 °C (60 °F.) When testing non-compensated meters, the weight per volume must also be adjusted to the temperature of the metered liquid. This will require knowledge about the coefficient of expansion for the product or products to be metered commercially. If the coefficient of expansion is not known, it can usually be estimated by reading the volume change in a graduated flask at two temperatures, preferably 11.1 °C (20 °F) or greater in difference. Care must be taken to ensure that air bubbles are not present within the liquid when making volume determinations. For volatile fluids, care should be exercised to ensure that some of the volume change is not due to evaporation. This can be monitored by weighing or guarded against by sealing the flask during cooling. Expansion and contraction of the glassware is generally insignificant for glassware conforming to *NIST Handbook 105-2* specifications.

In the examples listed below, calculate the coefficient of expansion for the liquid. Suppose a sample of liquid was taken at the time of test and had a temperature of 27 °C and was cooled to 14 °C with the volumes listed in the table below. (If working in inch-pound units, consider a different example in which a sample of liquid was taken at the time of test and had a temperature of 81 °F and was cooled to 58 °F, with the volumes listed in the table below.) Then, the coefficient of expansion is calculated as illustrated.

### Examples of Determining Coefficient of Expansion

Metric	Inch-Pound
at 27 °C the volume = 3.785 L and 44 mL = 3829 mL	at 81 °F the volume = 1 gallon + 1.5 fl dr = 1025.5 fl dr
at 14 °C the volume = 3782 mL	at 58 °F the volume = 1023 fl dr
Calculation of the coefficient of expansion:	Calculation of the coefficient of expansion:
$C_e = \frac{(V_i - V_e)}{(T_i - T_e)(V_i)} = \frac{(3829\text{mL} - 3782\text{mL})}{(27^\circ\text{C} - 14^\circ\text{C})(3829\text{mL})}$	$C_e = \frac{(V_i - V_e)}{(T_i - T_e)(V_i)} = \frac{(1025.5\text{ fl dr} - 1023\text{ fl dr})}{(81^\circ\text{F} - 58^\circ\text{F})(1025.5\text{ fl dr})}$
$C_e = 0.000944/^\circ\text{C}$	$C_e = 0.000106/^\circ\text{F}$

- Test both scales throughout the range of use. Record scale errors for each test load near the loads for which the scales will be used; these errors will be used for later reference.
- Obtain a sample of the product to be metered. Weigh the empty graduated flask or set the tare with the flask on the smaller scale. After all entrapped air has settled out, adjust the level of the product in the flask to the 2-liter (1-gallon) graduation. Determine and record the net weight,  $W_o$ , correcting for any errors previously identified at the gross load on the scale.
- Immediately after weighing, take the temperature of the product in the graduate at or near the center of the flask, not in the neck of the flask.

For temperature compensated meters measuring petroleum products (other product types may have a reference temperature different from 15 °C or 60 °F), estimate the weight per volume at 15 °C (60 °F) as follows:

$$\text{Metric: } W_c = (C_e * (T_o - 15^\circ C + 1) * W_o$$

$$\text{Inch-Pound: } W_c = (C_e * (T_o - 60^\circ F + 1) * W_o$$

Where:

$W_c$  = Weight per volume corrected to 15 °C for SI units or 60 °F for inch-pound units

$C_e$  = Cubical coefficient of expansion

$T_o$  = Observed temperature of product in graduate

$W_o$  = Observed weight per volume of product in graduate

Examples of how this formula is applied are listed below, using the coefficients of expansion calculated in Pretest Determination Number 2.

#### Temperature-Compensated Meters — Estimating the Weight per Volume

Metric	Inch-Pound
Weight of 2 L = 1.734 kg = 0.867 kg/L	
$W_o = 0.867 \text{ kg/L}$	$W_o = 7.235 \text{ lb/gal}$
$T_o = 27^\circ \text{C}$	$T_o = 83^\circ$
$C_e = 0.000944/^\circ \text{C}$	$C_e = 0.000106/^\circ \text{F}$
$W_c = [0.000944/^\circ \text{C} * (27^\circ \text{C} - 15^\circ \text{C}) + 1] * 0.867 \text{ kg/L}$	$W_c = [0.000106/^\circ \text{F} * (83^\circ \text{F} - 60^\circ \text{F}) + 1] * 7.235 \text{ lb/gal}$
$= [0.000944/^\circ \text{C} * (+ 12) + 1] * 0.867 \text{ kg/L}$	$= [0.000106/^\circ \text{F} * (+ 23) + 1] * 7.235 \text{ lb/gal}$
$= [+ 0.011328 + 1] * 0.867 \text{ kg/L}$	$= [+ 0.002438 + 1] * 7.235 \text{ lb/gal}$
$= (1.011328) * 0.867 \text{ kg/L} = 0.877 \text{ kg/L}$	$= (1.002438) * 7.235 \text{ lb/gal} = 7.253 \text{ lb/gal}$

For non-compensated meters, record the weight per volume,  $W_o$  and the temperature for later reference. Errors in the scale will require correction of the observed net weight.

#### Testing

- On the large capacity scale, set or record the tare of the receiving vessel. Deliver the product into the receiving vessel as required by the test. Stop the product delivery and record the indicated volume, flow rate, and all other pertinent information. Determine the net weight of the delivery. Errors in the scale will require correction of the observed weights.
- a. For temperature compensated meters measuring petroleum products (other product types may have a reference temperature different from 15 °C or 60 °F), divide the net weight by the weight per volume corrected to 15 °C (60 °F) as determined in "Pretest Determinations, Step #4" to obtain the quantity delivered.
- b. For non-compensated meters, immediately record the temperature of the delivered product near the center of the volume of the receiving vessel. Determine the quantity delivered as follows:

$$W_d = (1 + (T_r - T_m) * C_e) * W_o$$

Where:

$T_r$  = Reference temperature of unit volume sample

$T_m$  = Temperature of the product during metering

$C_e$  = Coefficient of expansion

$W_o$  = Reference weight per volume (pretest step 4)

$W_d$  = Weight per volume at delivery temperature

Divide the net weight of the delivery by  $W_d$  to obtain the quantity delivered.

Examples of determining the quantity delivered for non-temperature compensated meters are listed below, using the coefficients of expansion determined in Pretest Determinations Number 2.

#### Non-Compensated Meters — Examples of Determining Quantity Delivered

Metric	Inch-Pound
The one-liter sample net weight was 0.87089 kg/L at 22.8 °C	The one-gallon sample net weight was 7.268 lb at 73 °F
The coefficient of expansion was found to be 0.000944/°C	The coefficient of expansion was found to be 0.000106/°F
The product temperature during the metering was 29.3 °C	The product temperature during the metering was 84.8 °F
$W_d = [1 + ([22.8\text{ °C} - 29.3\text{ °C}] * (0.000944/\text{°C}))] * 0.87089\text{ kg/L}$	$W_d = [1 + ([73\text{ °F} - 84.8\text{ °F}] * (0.000106/\text{°F}))] * 7.268\text{ lb/gal}$
$= [1 + (-6.5\text{ °C} * 0.000944/\text{°C})] * 0.87089\text{ kg/L}$	$= [1 + (-11.8\text{ °F} * 0.000106/\text{°F})] * 7.268\text{ lb/gal}$
$W_d = [1 - 0.006136] * 0.87089\text{ kg/L} = 0.865\text{ kg/L}$	$W_d = [1 - 0.0012508] * 7.268\text{ lb/gal} = 7.259\text{ lb/gal}$

*Note: When a single meter is used to deliver various products with a range of viscosities or densities, performance tests should be made at least with the products of the extreme densities or viscosities. It should also be noted that air elimination becomes much more critical with viscous liquids.*

## K. Testing of Hot Oil Meters

### Lubricating Oil Meters are to be Tested Using One of the Following Test Methods

1. Gravimetrically **OR**
2. Mechanical displacement prover (such as a ball type prover)

In special cases, a master meter may be used. The decision to use a master meter will be made by the National Conference on Weights and Measures on a case-by-case basis. In cases where the master meter is considered acceptable, the master meter must be tested gravimetrically prior to the type evaluation test to verify its accuracy and performance.

## L. Laboratory Evaluation and Permanence Tests for Utility Type Water Meters

All new-design meters are subject to a permanence test. NTEP reserves the right to require a permanence test based on the results of the initial examination.

### Initial Examination

1. All meters of the new type installed at the type evaluation location are subject to evaluation. At least three meters of the same model must be tested.
2. At least three meters will be chosen for throughput testing on water. The minimum number of tests to be conducted for each of these meters will include the following:
  - Three tests at the maximum flow rate
  - Three tests at the intermediate flow rate



- Three tests at the minimum flow rate
3. All meters must perform within acceptance tolerance.
  4. Repeatability - When three or more consecutive tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed repeatability tolerance.

#### Subsequent Examination

1. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates are to be included on the certificate of conformance provided the results are within the applicable tolerances.
2. The examination will be conducted as applicable:
  - 200,000 gallons for throughput testing for mechanical changes of metrological significance
  - Flow rates during throughput testing are not to exceed the normal flow rate from HB 44 or a stated maximum continuous flow rate from the manufacturer, if it is greater than the normal flow rate.
3. Three tests at maximum, intermediate and minimum flow rate will be made on the throughput meters. Only one test at each flow rate needs to be performed on any remaining meters.
4. Repeatability – When three or more consecutive tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed repeatability tolerance.

### M. Initial Evaluation and Permanence Tests for Magnetic Flow Meters and Ultrasonic Meters (Other Than Vehicle-Mounted and **Retail-Motor-Fuel** Applications)

The following tests are considered to be appropriate for magnetic flow meters and ultrasonic metering systems:

1. For wholesale devices, four test drafts at each of five flow rates.
  - 1.2. “Special” tests shall include a test at or slightly above the slower of the following rates:
    - 1.2.1. 20% of the marked maximum discharge rate; or,
    - 1.2.2. The minimum discharge rate marked on the device.
2. For retail devices:
  - 2.1 The minimum number of tests for the meter will include the following:
    - Five tests at the fast flow rate
    - Three tests at a midrange flow rate
    - Five tests at the slow flow rate
3. The meters must perform within acceptance tolerance.
4. Repeatability - Tests for repeatability shall 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.  
 The range of the test results for the flow rate shall not exceed 40% of the absolute value of the maintenance tolerance. 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.
5. In no case shall testing be performed at a flow rate less than the minimum discharge rate marked on the device.
6. Only one meter is required for the initial test, after which the meter will be reevaluated for permanence. The minimum throughput criterion for these meters is the maximum rated flow in units per minute x 2000.
7. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates to be included on the Certificate of Conformance (CC) must be within the applicable tolerances. Extended flow range testing performed at the manufacturer's discretion may be included on the CC provided the results are within the acceptable tolerances.



## Appendix A

### Philosophy for Sealing

#### Typical Features to Be Sealed

##### Minimum Requirements for Audit Trails for Liquid Measuring Devices

The need to seal some features depends upon:

- The ease with which the feature or the selection of the feature can be used to facilitate fraud. **AND**
- The likelihood that using the feature will result in fraud not being detected.

Features or functions such as setting the unit prices on gasoline dispensers and maintaining unit prices in price look-up codes stored in memory, which are routinely used by the operator as part of device operation, are not sealable parameters and shall not be sealed.

If a parameter (or set of parameters) selection would result in performance that would be obviously in error, such as the selection of parameters for different countries, then, it is not necessary to seal the selection of these features.

If individual device characteristics are selectable from a "menu" or a series of programming steps, then access to the "programming mode" must be sealable.

*Note: If an audit trail is the only means of security, then the audit trail shall update only after at least one sealable parameter has been changed. Simply accessing the sealable parameters via a menu shall not update the audit trail.*

The current language in *NIST Handbook 44*, paragraph G-S.8. states: "A device shall be designed with provision(s) for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity of the device can be made to any electronic mechanism." Thus, for parameters protected by physical means of security, once a physical security seal is applied to the device, it should not be possible to make a metrological change to those parameters without breaking that seal. Likewise, for parameters protected by electronic means of security, it should not be possible to make a metrological change to those parameters without that change being reflected in the audit trail. Since this philosophy addresses provisions for protecting access to any metrological adjustment, the philosophy should be applied consistently to all electronic device types.

If a device must undergo a physical act, such as cutting a wire and physically repairing the cut to reactivate the parameter, this physical repair process would then be considered an acceptable way to select parameters without requiring a physical seal or an audit trail.

### Typical Features and Parameters to Be Sealed

The following provides examples of configuration and calibration parameters that are to be sealed. The examples are provided for guidance and are not intended to cover all possible parameters.

#### Calibration Parameters:

Calibration parameters are those parameters whose values are expected to change as a result of accuracy adjustments. Examples include the following:

1. Measuring element adjustments where linearity corrections are used (e.g., flow rate 1 and meter factor 1, flow rate 2 and meter factor 2, etc.)
2. Mass flow meter adjustments for zero adjustments (not simply setting the display to zero) and span settings.

#### Configuration Parameters:

Configuration parameters are those parameters where the values are expected to be entered once only and not changed after all initial installation settings have been made. Examples include the following:

1. Octane or other blend setting ratios (optional in Canada at this time.)
2. Temperature, pressure, density, and other sensor settings for zero, span, and offset values.
3. Measurement units (in Canada, only if not displayed or printed on the primary register.)
4. Temperature compensation table, liquid coefficient of expansion, or compressibility factors or tables.

5. Liquid density setting (in Canada, only if not displayed or printed on the primary register) and allowable liquid density input range.
6. Vapor pressures of liquids if used in calculations to establish the quantity.
7. Meter or sensor temperature compensation factors.
8. False or missing pulse limits for dual pulse systems (Canada only.)
9. On/off status of automatic temperature, pressure, or density correction.
10. Automatic or manual data input for sensors.
11. Dual pulse checking feature status on or off.
12. Flow control settings (optional in Canada.)
13. Filtering constants.
14. Software updates that change the metrologically significant software.

#### Liquid Measuring Device Features and Parameters

Typical Features or Parameters to be Sealed	Typical Features or Parameters <u>NOT</u> Required to be Sealed
<ul style="list-style-type: none"> <li>• Measuring Element Adjustment (both mechanical and electronic)</li> <li>• Linearity Correction Values</li> <li>• Measurement Units (e.g., gallons to liters)</li> <li>• Octane Blend Setting for <b>Retail Motor Fuel</b> Dispensers</li> <li>• Any Tables or Settings Accessed by the Software or Manually Entered to Establish the Quantity (e.g., specific gravity, pressure, etc.)</li> <li>• Density Ranges</li> <li>• Pulsers</li> <li>• Single Pick-up (magnetic or reluctance)</li> <li>• Temperature Probes and Temperature Offsets in Software</li> <li>• Pressure and Density Sensors and Transducers</li> <li>• Flow Control Settings (e.g., flow rates for slow-flow start, quantity for slow-flow start and stop)</li> <li>• Temperature Compensating Systems (on/off)</li> <li>• Differential Pressure Valves</li> <li>• As a point of clarification, the flow control settings referenced above are those controls typically incorporated into the installations of large-capacity meters (wholesale meters.) The reference does not include the point at which <b>retail motor fuel</b> dispensers slow product flow during a prepaid transaction to enable the dispenser to stop at the preset amount.</li> <li>• <b>Software updates that change the metrologically significant software.</b></li> </ul>	<ul style="list-style-type: none"> <li>• Analog-to-Digital Converters</li> <li>• Quantity Division Value (display resolution)</li> <li>• Double Pulse Counting</li> <li>• Communications</li> </ul>

*Note: The above examples of adjustments, parameters, and features to be sealed are to be considered "typical" or "normal." This list may not be all inclusive. Some parameters other than those listed, which affect the metrological performance of the device, must be sealed. If listed parameters or other parameters, which may affect the metrological function of the device, are not sealed, the manufacturer must demonstrate that all settings comply with the most stringent requirements for the application of the device (e.g., the parameter does not affect compliance with NIST Handbook 44.)*

## Appendix B

### Requirements for Metrological Audit Trails

#### Scope

This discussion lists the requirements for the acceptable forms of metrological audit trail which are recognized by the National Conference on Weights and Measures (NCWM) as providing acceptable security for commercial weighing and measuring devices. The criteria adopted by the NCWM in July 1993 further define the minimum forms of metrological audit trail that would be acceptable under the General Code paragraph G-S.8. Provisions for Sealing Electronic Adjustment Components.

Remote configuration capability of commercial weighing and measuring devices was a major consideration in developing the criteria ultimately adopted by the NCWM. Weights and measures officials are concerned that using such new features might lead to increased fraudulent use of devices unless new, more appropriate means of sealing are also implemented.

The following specifications are based upon requirements adopted by the NCWM July 1993. These requirements are intended to be incorporated into *NCWM Publication 14*.

#### Definitions

The following definitions apply to the discussion of metrological audit trails. Those definitions, which were added to *NIST Handbook 44* as a result of NCWM action in July 1993, are indicated by italicized type.

#### Adjustment Mode

An operational mode of a device, which enables the user to adjust sealable parameters, including changes to configuration parameters.

#### Adjustment

A change in the value of any of a device's sealable calibration parameters or sealable configuration parameters.

#### Audit Trail

An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device. (The term addresses all forms of audit trail described in this paper.)

#### 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.)

#### Configuration Parameter

Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component, (e.g., division value (increment), sensor range, and units of measurement.)

#### Enabling/Inhibiting Sealable Hardware

Physically sealable hardware, such as a two-position switch, located on a remotely configurable device, that enables and inhibits the capability to receive adjustment values or changes to sealable configuration parameters from a remote device.

#### Event

An action in which one or more changes are made to configuration parameters or adjustments are made to one value (or values for a set of values) for a calibration parameter (e.g., adjustments for a set of calibration factors to linearize device output), while in the adjustment mode. If no adjustment is made, then there is no event. In the case of a centralized audit trail, the same values for the same parameter sent to multiple devices shall be considered to be the same event. In the case of a centralized event logger, the event logger must identify both the device and the parameter that was changed.

**Event Counter**

A non-resettable 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.

*Note: An event counter shall have a capacity of at least 1000 values [e.g., 000 to 999].*

**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.

**Physical Seal**

A physical means, such as lead and wire, used to seal a device to detect access to those adjustable features that are required to be sealed.

**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.

**Remote Device**

A device that (1) is not required for the measurement operation of the primary device or computing the transaction information in one or more of the available operating modes for commercial measurements or (2) is not a permanent part of the primary device. A remote device has the ability to adjust another device or change its sealable configurable parameters.

**Remotely Configurable Device**

Any weighing or measuring device with remote configuration capability that permits sealable configuration or calibration parameter values to be deleted, appended to, modified, or substituted in whole or in part by downloading over any type of communications link from another device, such as a geographically local or remote console or computer, whether or not the secondary apparatus is part of the network connecting the devices.

**Seal**

As a verb, to seal a device is to make a device secure so that access to adjustments and other sealable parameters will be detectable.

**Sealable Parameters**

Calibration and configuration parameters that are required to be sealed.

**Unrestricted Access to Sealable Parameters**

Unrestricted access means that a physical security seal is not present, so that access to the sealable parameters is available from a remote device at any time at the request of an authorized operator subject to the operating status of the receiving device.

**Categories of Device: Three Forms of Audit Trail**

Three forms of the audit trail have been established; the form of audit trail acceptable for a device depends on the capability to adjust the device or change sealable parameters. The form that applies to a particular device depends upon the availability of remote configuration capability and, if so, whether or not there is virtually unrestricted access to the configuration or calibration parameters of the device. Three categories of device are listed below with the category designation numbered to correspond to the capability and ease of changing sealable parameters from a remote device.

**Category 1.**

A device that does not have remote configuration capability.

These devices may be sealed with either a physical security seal or an audit trail. If an audit trail is used, then the minimum form of audit trail must be provided (see next page.)

**Category 2.**

If a device has remote configuration capability, but the activation of the remote configuration capability is through physical hardware (such as a switch) that can be sealed with a physical seal, then the device may be sealed using a physical seal or the minimum form of the audit trail.

Because the event logger (see category 3 below) requires significant memory and many device manufacturers want to provide remote configuration capability for at least some of the sealable parameters, a "hybrid" form of audit trail was established. Restricted access to the hardware inhibiting and activating the remote configuration capability eliminates the need for the event logger as the form of audit trail for this category of device.

The second category of device specifies that, when the device is in the remote configuration mode, there must be a clear and continuous indication to that effect. The objective is that the device shall not be (erroneously) sealed with the remote communication capability operational. The clear and continuous indication is intended to reduce this possibility. A "clear and continuous indication" that the device is in the remote configuration mode must be of such a nature that it discourages the use of the device for normal transactions when in this mode. This may be a partial obscuring of the numbers, an alternating display message, or some other obvious indication. The lighting of an annunciator is not sufficient. If values can be printed when in the configuration mode, the system shall record a message to indicate that the system is in the configuration mode.

**Category 3.**

A device that allows virtually unrestricted access to configuration parameters or calibration parameters, or has remote configuration or calibration capability, must have an event logger as its minimum form of the audit trail. All devices with remote configuration capability manufactured after January 2005 must comply with the sealing requirements of Category 3.

An event logger contains detailed information on the parameters that have been changed and documents the new parameter values. An event logger requires a significant amount of memory; however, it is anticipated that any device to which unrestricted access is given, will be part of sophisticated measurement process that will have considerable memory available. A centralized audit trail may be used, but additional criteria apply.

**Liquid Measuring Devices Code: S.2.2. 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. Any measurement element. OR
- d. Any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries. When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.
- e. Audit trails shall use the format set forth in Table S.2.2. [Non-retroactive and enforceable as of January 1, 1995.] (Amended 1991, 1993, 1995, and 2015)

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

Categories of Device	Method of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters; one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware.  Device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.] [Non-retroactive as of January 1, 1996.]
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 on demand through the device or through another on-site device. The information may also be available electronically. 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.  <i>Note: Does not require 1000 changes to be stored for each parameter.</i>

**Minimum Form of the Audit Trail**

The minimum form of the audit trail shall consist of two event counters: one for configuration parameters and one for the adjustment (calibration) parameters (000 to 999 for each counter.)

The maximum number of values or parameters that must be retained in event logger memory is 1000. (This limit may not apply to centralized event loggers. See the section titled "Centralized Event Loggers" for details.)

The octane blend settings for a retail motor fuel dispenser are considered to be configuration parameters.

**Event Loggers: Acceptable Form of Audit Trail for Category 3 Devices**

1. The event logger is the minimum form of audit trail for Category 3 devices (those that have unrestricted remote access to the configuration or calibration parameters.) The event logger shall contain the following information:

Event Counter	Date and Time	Parameter ID	New Value
---------------	---------------	--------------	-----------

2. This information shall be automatically entered into the event logger by the device. In the case of centralized event loggers, the parameter identification shall include the device identification to which the event applies. Additional relevant information is permitted, (e.g., the identification of the person who made the adjustment or the old value of the parameter that was changed.)
3. The date and time shall be presented in understandable format. The date shall include month, day, and year. The time shall include the hour and minutes.
4. A hard-copy print-out of the contents of the event logger shall be available upon demand from the device or an associated device on the site of the device installation. The display or printing of the event logger contents shall exclude other information, such as transaction data, operator inventory records, or shift totals.



5. An event logger shall have a capacity of at least 10 times the number of sealable parameters; however, it is not required to retain more than 1000 events for all parameters combined. This limit applies to devices for which the event logger is dedicated to a single device. See the section titled "Centralized Event Loggers."

### **Centralized Event Logger**

Remote configuration will be used most frequently when several devices interface with a host computer or other host device. A centralized event logger may be used when several "satellite" devices interface with a host device. The following criteria must be satisfied if a centralized event logger is to be used:

1. If electronic parameters monitored by the event logger are changed at the device, rather than through the device containing the centralized audit trail. The changes shall be transferred to and maintained in the centralized audit trail. It shall not be possible to circumvent the unit containing the audit trail. For example, if the audit trail unit is disconnected or inhibited, the attached network devices shall be inoperable and impossible to adjust electronically when in the network configuration. Mechanical adjustments are not expected to be monitored by the event logger since there will probably not be an electrical connection from the mechanical adjustment to the event logger. Sealable mechanical adjustments must be secured by a physical security seal.
2. If the same values for change to a parameter (e.g., the division value for the device) are sent from the host device to several satellite devices, this shall be represented as one event in the logger. If changes are made to individual devices rather than to all attached devices, the event logger shall identify both the parameter and the device that was changed. Identification may be by individual devices, groups of devices, or designated as all devices.
3. If a device can be installed in a stand-alone operation, it must have the minimum form of audit trail when installed in the stand-alone mode.
4. A system shall be capable of providing, upon demand, a hard copy of the event logger information. The printer requirement is a user requirement, not a device specification.
5. If a centralized audit trail is used for a large number of devices on a network, the logger capacity of 1000 events may not be sufficient.

### **General Requirements for Metrological Audit Trails**

When an audit trail is the form of security, minimum forms of audit trail are specified for different categories of devices. The following general requirements for metrological audit trails must be satisfied as part of all three minimum forms of audit trail.

1. The adjustment mode shall address only sealable parameters in order to avoid entering the adjustment mode to access non-sealable parameters that must be routinely changed as part of the normal use of the device. Because the audit trail requirements are intended to satisfy the weights and measures requirements of the U.S. and Canada, any parameters required to be sealed in one country, but not the other, may be included in the adjustment mode and still comply with this requirement. Manufacturers should consult with the weights and measures authority to discuss those parameters that may be questionable as to whether or not the parameter must be sealed. Manufacturers may choose to incorporate the capability to set a software "switch" that determines whether or not a parameter is sealable. If this is done, then the software switches (that determine whether or not a parameter is sealable) shall be sealable.
2. For all Category 2 devices and for Category 3 devices manufactured after January 2005: When a remotely configurable device is in the remote configuration mode, that is, capable of receiving changes to sealable parameters, the device shall either:
  - a. Not indicate or record (if equipped with a printer.) OR
  - b. Provide a clear and continuous indication that it is in remote configuration mode. Any printed ticket or receipt shall include a message with each ticket or receipt that the device is in the calibration mode.

A "clear and continuous indication" that the device is in the remote configuration mode must be of such a nature that it discourages the use of the device for normal transactions when in this mode. This may be a partial obscuring of the numbers, an alternating display message, or some other obvious indication. The lighting of an annunciator is not sufficient. If values can be printed when in the configuration mode, the system shall record a message to indicate that the system is in the configuration mode.

3. An event counter shall have a capacity of at least 1000 values (e.g., 000 to 999.)
  - a. The event counter for calibration parameters shall increment only when a change is made to at least one sealable calibration parameter during an event (during the time when in the adjustment mode); the counter shall increment only once regardless of the number of changes made while in the adjustment mode. When the calibration mode is entered, but no changes are made, this does not constitute an event and the counter must not increment.
  - b. The event counter for configuration parameters shall increment only when a change is made to at least one sealable configuration parameter during an event (during the time when in the configuration mode.) The counter shall increment only once regardless of the number of changes made while in the configuration mode. When the configuration mode is entered, but no changes are made, this does not constitute an event and the counter must not increment.
  - c. In the case of the event logger, the event counter will increment once for each change to a sealable parameter since each new value must be retained in the event logger.

*Note: The criteria in items 3(a) and 3(b) specify the minimum requirements for event counters. A device may have a separate event counter for each sealable parameter; in this case, the corresponding event counter must increment once each time its sealable parameter is changed.*

4. When the storage memory of the event logger has been filled to capacity, any new event shall cause the oldest event to be deleted. The event counter used in the event logger shall continue to increment to its capacity, although the event logger may retain fewer records than the count capacity of the event counter. The event counter provides the necessary information to indicate the number of records that have been overwritten in the event logger as new information overwrites the old records.
5. The audit trail data shall be:
  - a. Stored in non-volatile memory and shall be retained for at least 30 days if power is removed from the device. **AND**
  - b. Protected from unauthorized erasure, substitution, or modification.
6. Access to the audit trail information for the purpose of viewing or printing the contents must be "convenient" for the enforcement official.
  - a. Accessing the audit trail information for review shall be separate from the calibration mode so there is no possibility for the weights and measures official to change or corrupt the device configuration or the contents of the audit trail.
  - b. Accessing the audit trail information shall not affect the normal operation of a device before or after accessing the information.
  - c. A key (for a panel lock) may be required to gain access to the means to view the contents of the audit trail. Access may be through the supervisor's mode of operation of the device.
  - d. Accessing the audit trail information shall not require the removal of any additional parts other than normal requirements to inspect the integrity of a physical seal.
7. The displayed or printed form of the audit trail information shall be readily interpretable by the inspector.
8. The information from an event logger shall be displayed or printed in order from the most recent event to the oldest event. If a device is not capable of displaying all the information for a single event on one line or at one time, the information shall be displayed in blocks of information which are readily understandable.