Appendix C

National Type Evaluation Technical Committee (NTETC) Measuring Sector Meeting Summary

October 21 - 22, 2011
Norfolk, Virginia

INTRODUCTION

The charge of the NTETC Measuring Sector (herein after referred to as "Sector") is to provide appropriate type evaluation criteria based on specifications, tolerances and technical requirements of NIST Handbook 44, *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*, Sections 1.10. General Code and all portions of Section 3 including codes for Liquid Measuring Devices, Vehicle Tanks Meters, Liquid Petroleum Gas and Anhydrous Ammonia Measuring Devices, Cryogenic Liquid Measuring Devices, Milk Meters, Water Meters, Mass Flow Meters, and Carbon Dioxide Liquid Measuring Devices. The Sector's recommendations are presented to the National Type Evaluation Program (NTEP) Committee each January for approval and inclusion in NCWM Publication 14, *Technical Policy, Checklists, and Test Procedures* for national type evaluation.

The Sector is also called upon occasionally for technical expertise in addressing difficult NIST Handbook 44 issues on the agenda of National Conference on Weights and Measures (NCWM) Specifications and Tolerances (S&T) Committee. Sector membership includes industry, NTEP laboratory representatives, technical advisors, and the NTEP Administrator. Meetings are held annually, or as needed and are open to all NCWM members and other registered parties.

Suggested revisions are shown in **bold face print** by ~~**striking out**~~ information to be deleted and **underlining** information to be added. Requirements that are proposed to be nonretroactive are printed in ***bold faced italics***.
Note: It is policy to use metric units of measurement in publications; however, recommendations received by NCWM technical committees and regional weights and measures associations have been printed in this publication as submitted. Therefore, the report may contain references to inch-pound units.

Table A
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Table B
Glossary of Acronyms and Terms

Acronym	Term	Acronym	Term
AWWA	American Water Works Association	NTEP	National Type Evaluation Program
CC	Certificate of Conformance	NTETC	National Type Evaluation Technical Committee
CIML	International Committee of Legal Metrology	OIML	International Organization of Legal Metrology
CNG	Compressed Natural Gas	OWM	Office of Weights and Measures
CTEP	California Type Evaluation Program	RMFD	Retail Motor Fuel Dispensers
DEF	Diesel Exhaust Fluid	S&T	Specifications and Tolerances Committee
LMD	Liquid Measuring Devices	SWMA	Southern Weights and Measures Association
NCWM	National Conference on Weights and Measures	USNWG	U.S. National Work Group
NIST	National Institute of Standards and Technology	VTM	Vehicle Tank Meter

Details of All Items
(In order by Reference Key)

CARRY-OVER ITEMS

1. Add Testing Criteria to NTEP Policy U Evaluating Electronic Indicators Submitted Separate from a Measuring Element

Source:
California NTEP Lab – Carryover from 2007-2010 NTETC Measuring Sector Agendas

Background/Discussion:
At its 2007 NTETC Measuring Sector Meeting, the Sector heard that Section U. of the NTEP Technical Policy in NCWM Publication 14 allows for testing an indicator separate from a measuring element. However, specific test criteria had not been developed for this section. The Sector heard a recommendation to develop and add specific criteria for testing an indicator separate from a measuring element for this section. From 2007 to 2010, the California NTEP laboratory worked to develop a checklist, but had received limited input on the drafts. At the 2010 NTETC Measuring Sector Meeting, Mr. Reiswig, California Division of Measurement Standards, presented a list of the areas of the draft checklist that specifically needed further attention and review. The Sector reviewed these items and agreed that Mr. Reiswig should continue developing the checklist for Electronic Indicators Submitted Separate from a Measuring Element.

The Sector identified five points that require further development and input from industry in order to finalize the checklist. The Sector also identified a list of people who might be able to provide additional input. The Sector agreed that Mr. Reiswig should forward the latest draft of the checklist along with the five areas requiring specific attention to the people listed in the original work group and to the list of possible contacts identified by the Sector. Mr. Reiswig should ask for their assistance in reviewing and commenting on the checklist, noting that input on the five areas would be of particular help.

The Sector heard a report from Mr. Ingram, California Division of Measurement Standards, on the status of the checklist. Mr. Ingram reported that Mr. Reiswig has changed positions within California Department of Food and Agriculture and that Mr. Ingram would represent the State of California at the 2011 NTETC Measuring Sector Meeting. Mr. Ingram noted that not much additional input had been received and the checklist has not changed since the Sector had last seen it in March of 2010 because of such limited feedback. Mr. Frailer, Maryland Department of Agriculture asked if the checklist had been used in California, to which Mr. Ingram replied that some of the checklist tests had been applied on systems with temperature compensation in California. Mr. Ingram recommended that the work group be re-formed to complete the draft checklist initiated by Mr. Reiswig and also the associated changes to reflect the use of simulated pulses proposed in NCWM Publication 14, Technical Policy T. Testing Required for Electronic Indicators Used with Measuring Elements.

Mr. Miller, FMC Technologies Measurement Solutions, Inc., inquired if the National Institute of Standards and Technology (NIST), Office of Weights and Measures (OWM) would be able to complete the work. Ms. Butcher, NIST, OWM, pointed out that, while NIST, OWM is certainly willing to assist in advancing the work along, the checklist is at a stage where what is most needed is careful consideration by the stakeholders that would be most affected by the checklist. Several industry members suggested that a deadline for comments should be set to facilitate moving the item forward on a predictable timeline. Mr. Keilty, Chair noted that there are several sections in the current draft that are highlighted. Mr. Ingram explained that these represent sections where Mr. Reiswig still had open questions or concerns about the applicability and validity of those items. Mr. Keilty stated that he did not see any problems with anything he had seen so far, but that he did not believe the checklist would be ready to be incorporated into NCWM Publication 14 until the highlighted areas had been reviewed and validated by the stakeholders.

Mr. Keilty pointed out that the Sector had agreed at its 2010 NTETC Measuring Sector Meeting that the item had merit and should remain on the agenda. Mr. Miller commented that testing of electronic indicators is currently done, but that the checklist is needed to establish uniformity in how and what tests are applied in these cases. He stated that he believed the Sector would need someone to drive the issue in order to complete the checklist and volunteered to lead a work group. Two NTEP laboratory representatives volunteered to review and comment on the final product of the work group.

The Sector then discussed the scope of work needed to complete the checklist, noting that all the sections left highlighted by Mr. Reiswig should be resolved. Mr. Katalinic, North Carolina Department of Agriculture, commented that the work group should also address the five specific points that the Sector had listed during the 2010 NTETC Measuring Sector Meeting. The Sector revisited these points and made some clarifications to them, as noted in the decision below.

Mr. Keilty proposed a timeline with the first review in one to two months to allow the laboratories time to review the results and comment such that exact language would be ready for inclusion in NCWM Publication 14 before NCWM Interim Meeting in January.

Conclusion:
The Sector agreed that additional work is needed to finalize the checklist. Mr. Miller, FMC Technologies Measurement Solutions, Inc., volunteered to serve as Chair of the work group and Mr. Buttler, NIST, OWM will assist as needed and monitor progress of work.

Electronic Indicators Checklist Work Group members are: (*Established at the October 21 - 22, 2011, NTETC Measuring Sector Meeting)*

Chair:
Mr. Rich Miller, FMC Technologies Measurement Solutions, Inc.

Members:

- Mr. Dmitri Karimov, Liquid Controls
- Mr. Michael Keilty, Endress + Hauser Flowtec AG USA

Review and Comment:

- Mr. Michael Keilty, Endress + Hauser Flowtec AG USA
- Mr. Allen Katalinic, North Carolina Department of Agriculture

NIST Technical Advisor

- Mr. Marc Buttler, NIST, OWM

The work group is asked to address the highlighted sections of the draft checklist along with the following points and submit the finished checklist to the two laboratory representatives listed above for review and comment.

1. A minimum of 10 000 pulses must be collected. To ensure that there will be a change in the displayed indication for each pulse received, the electronic indication should be scaled such that the value of the smallest indicated division should equate to less than or equal to the value associated with one input pulse.

2. It is important to validate whether ± 1 pulse is an appropriate tolerance, taking into consideration applicable International Organization of Legal Metrology (OIML) requirements.

3. The number of different temperature inputs and API gravity values that would need to be tested to adequately verify the temperature compensation function of an electronic indicator must be determined. Spot checking of three random tables at three different temperatures would be adequate to verify an indicator's temperature compensation feature is functioning properly.

4. The work group should add a step in the checklist for checking multi-point calibration along with associated guidance. This guidance should emphasize the necessity of working with the manufacturer of each device in order to set up tests to properly check multipoint calibration using simulated pulses.

5. Addressing various different input signal formats including pulses, analog, and digital communication will be challenging. Analog (4 - 20 mA) input devices are to be excluded from the scope at this time. The work group is asked to address pulse (frequency) signals in the final version of the checklist and is asked to consider whether or not to also include digital communications.

Appendix A contains the draft checklist. Below are the proposed revisions to Technical Policy T.

Many different kinds of electronic indicators are available for liquid measurement. Gas pumps, vehicle tank meters, and wholesale meters are common applications used. In some cases, the same indicator can be used in multiple applications. Below are some guidelines and test procedures to be incorporated into Publication 14 to allow the manufactures to pretest to and to make uniform the testing for the NTEP labs for this technology.

T. Testing required for Electronic Indicators used with Measuring Elements.
If the indicator and measuring element are built into the system as a whole device then they are approved as a system and listed as a single device on the certificate.

If the indicator or measuring element are separable and can be used with other approved and compatible equipment then the following needs to be considered:
If the Electronic Indicator and Measuring Element both have a CC then the two do not need evaluation provided new features that would have a metrological effect have not been added to the existing equipment. Even though they both have a CC they still need compatibility verification i.e. approved and compatible. This can be verified at the local level of compliance.

If neither the Electronic Indicator or Measuring Element do not have a CC then full testing will be performed as per Pub 14 permanence testing for Electronic Indicating Element (20 - 30 days of significant use) and Measuring Element (through put).

If the Electronic Indicator does not have a CC but the Measuring Element has a CC then the Register will go through the 20 - 30 day permanence test.

If the Electronic Indicator has a CC but the Measuring Element does not then the measuring element will go through the associated through put as per the permanence for that particular technology.

Upon verification of the local authority, the NTEP lab may allow the local authority to conduct one phase of the evaluation, at the NTEP labs direction and control.

Testing considerations for the electronic indicator:

1. Multi-point Calibration:

Some of the newer indicators have the optional single point or multi-point calibration. Multi-point calibration associates multiple meter calibration factors with different flow rates. Meter field testing at the local level is usually at the maximum and minimum flow ratings of the meter. Without the ability to print or view the multi-point parameters a meter could be calibrated with an intentional erroneous factor and could go undetected. The only other way would be to test at random flow rates and depending on the number of calibration points fraud could still be undetected; i.e., a meter factor that would allow an out of tolerance error for a delivery flow rate other than customary test flow rates.

Some manufactures have provided a method for weights and measures to view or print the calibration information without having to break any seals. This viewing or printing capability should be incorporated into NCWM Publication 14 (maybe NIST Handbook 44 too?) as a tool for W/M to be able to detect the possibility of fraud on these systems. It would also allow for manufactures to be aware of this and build this into their systems that have multi-point calibration.

2. **Tests for temperature compensation:**

   a. **Temperature test at cold temperature and verify correction.**

   b. **Temperature test at hot temperature.**

   c. **Temperature test at field site temperature.**

   d. **List temperature range tested and type of probe tested on certificate.**

3. **Tests for pulser/encoder rotation speed:**

   a. **Induce pulses and/or frequency at maximum to determine limitations of device.**

   b. **Induce pulses and/or frequency at minimum to determine limitations of device.**

   c. **List limitations on certificate.**

4. **Tests for power failure: Indicators are capable of operating on different voltages. May want to consider weighing device testing for electronic indicators and information listed on certificate.**

   a. **Test through AC voltage range**

   b. **Test through DC voltage range**

   c. **Power failure**

5. **Tests for computation, if capable.**

   a. **Test below $.999/gal.**

   b. **Test above $1.00/gal.**

   c. **Test above $2.00/gal.**

   d. **Test at maximum unit price capability.**

6. **Tests for agreement of indications between indicator and totalizer if a totalizer is provided.**

2. Development of Water Meters Checklist

Source:
Mr. Noel, Neptune Technology Group, Inc. – Carryover from 2010 Measuring Sector Agenda

Background/Discussion:
At its 2010 NTETC Measuring Sector Meeting, the Sector heard that utility type water meter manufacturers are receiving requests for NTEP Certificate of Conformance (CCs) from State weights and measures jurisdictions.

There is no NTEP checklist for utility-type water meters. However, utility-type water meters covered by NIST Handbook 44, Section 3.36. are evaluated under the California Type Evaluation Program (CTEP).
During the 2010 NTETC Measuring Sector Meeting, the Sector agreed to establish a work group to further develop the draft NTEP checklist. The Water Meters Checklist Development Work Group consisted of the following members:

- Mr. Andre Noel, Neptune Technology Group, Inc.
- Mr. Dan Reiswig, California Division of Measurement Standards

In developing the checklist, the work group was asked to:

1. Identify areas in NIST Handbook 44 Section 3.36. Water Meters Code where changes might be appropriate to update the criteria to reflect current technology and practices. For example, more specific audit trail criteria may need to be added to the Water Meters Code.
2. Forward any proposed changes to NIST Handbook 44 to NCWM S&T Committee via the established NCWM process by preparing and submitting NCWM Form 15 to the regional weights and measures associations and NTETC Measuring Sector.
3. Consider any differences between American Water Works Association (AWWA) standards and NIST Handbook 44 and consider recommendations for aligning the two documents where that makes sense.
4. Copy the NTETC Measuring Sector Chair, Mr. Keilty, and NIST Technical Advisor, Mr. Buttler, on communications to the work group.
5. Copy the U.S. point of contact for OIML R 49, Mr. Richter, NIST, OWM, with any proposed drafts.
6. Distribute a subsequent draft for review by the Sector by the January 2011 NCWM Interim Meeting.
7. Distribute a final draft for review by the Sector at least a month prior to the fall 2011 NTETC Measuring Sector meeting.

At its 2011 NTETC Measuring Sector Meeting, the Sector heard a report from Mr. Noel, Neptune Technology Group, Inc., on the progress of the checklist and status of action items from the 2010 NTETC Measuring Sector Meeting. Mr. Noel reported that multiple manufacturers who are all members of AWWA had compared AWWA and NIST Handbook 44 standards. Based on that review, this work group has developed and submitted a proposal to modify NIST Handbook 44 to further harmonize the two standards. Mr. Noel stated that the work group believes there will always be some differences, but manufacturers are committed to working with state and county weights and measures officials to identify and gradually eliminate differences. On October 11, 2011, Mr. Noel forwarded a draft Water Meters Checklist to Mr. Buttler, NIST Technical Advisor, who coordinated posting of the document as attachment #6 to the 2011 NTETC Measuring Sector Agenda. Mr. Buttler reported that he also forwarded the draft checklist to Mr. Richter, NIST, OWM, who is the U.S. point of contact for OIML R 49.

Mr. Noel explained that only the content beginning on page 13 of the draft Water Meter Checklist would need to be included if it was decided to incorporate the checklist into the Liquid Measuring Devices (LMD) section of NCWM Publication 14. The rest of the information on the first 12 pages would only be needed if the Water Meter Checklist were to be added as a completely separate section.

Ms. Butcher, NIST, OWM, requested an explanation of the rationale behind the statement in the proposed permanence test requirements that “Flow rates during throughput testing are not to exceed 50 % of the manufacturer’s rated maximum flow rate.” Mr. Noel responded that it was related to California laboratory testing criteria and that AWWA standards state that, for permanence, continuous flow should be half of its maximum. Ms. Butcher stated that the requirement did not seem logical as compared to test site selection criteria for other meters because it implies that the meter will not pass if it has been run from 50 % to 100 % of the stated limit. In assessing

the suitability of a given site for permanence testing, NTEP typically considers whether or not flow rates that can be achieved at a site are reflective of the range requested on the CC. For example, given a meter with a rated minimum flow of 20 gpm and maximum flow of 100 gpm, if a company picked a site that never got above 30 gpm, one might question whether or not the site would be adequate to demonstrate sustained performance over the rated flow range. Mr. Noel explained that the meter could still be tested for performance within tolerance up to the maximum rate; it was only the flow rate during the accumulation of the required throughput that was intended to be limited to 50 % of maximum rated flow. He also pointed out that throughput flow rates for other device types undergoing type evaluation are typically under the control of the equipment owner and that there is no stated requirement about the flow rate at which the throughput must be accumulated. He further noted that water meters are somewhat unique in that throughput during type evaluation is often under the control of a state laboratory. This difference is cited as the reason that a statement about the throughput flow rate is even necessary. The Sector went on to discuss whether to add a note identifying AWWA as the source of the 50 % constraint on permanence throughput flow rate and decided, if captured in the NTETC Measuring Sector Summary it isn't necessary to add a note to NCWM Publication 14.

The Sector discussed the application of the special tolerance for water meters. It was noted that the far right column of Table T.1. of Section 3.36. Water Meters in NIST Handbook 44 is labeled as "Tolerance for Special Tests Conducted at the Minimum Flow Rate." Mr. Noel explained that the application of the special tolerance only at the minimum flow rate for water meters is in harmony with AWWA standards. It was also noted that for LMD there is a difference between the calculation stated in NCWM Publication 14 Technical Policy B. Tolerance Application for the lowest flow rate for a normal test ([50 % of the rated maximum flow rate + the rated minimum flow rate]/2) and the calculation stated in NIST Handbook 44 Section 3.30. Liquid-Measuring Devices paragraph N.4.1. Normal Tests. for the lowest flow rate considered to be a normal test (flow rates below one-half of the sum of the maximum discharge flow rate and the rated minimum discharge flow rate). Mr. Buttler, NIST Technical Advisor, noted that, according to item 1.B) in the 1998 NTETC Measuring Sector Summary, the addition of the 50 % multiplier to the maximum rated flow rate in the calculation in NCWM Publication 14 is intentional. The purpose of the more restrictive criteria is to demonstrate during type approval testing that a device of the same type will comply with NIST Handbook 44 in the most conservative case wherein the maximum discharge rate of the device in a given application may be as low as 50 % of the device's rated maximum flow rate.

The Sector noted that there exist differences between the criteria stated under the heading Normal Test Tolerances in Technical Policy B. Tolerance Application from the LMD section of NCWM Publication 14 and the requirements in NIST Handbook 44. Certain sections of the code in NIST Handbook 44 define the criteria for applying normal test tolerances differently than Technical Policy B. Two examples were discussed. The first example was in Section 3.36. Water Meters where the heading "Tolerance for Special Tests Conducted at the Minimum Flow Rate" appears in the farthest right column of Table T.1. Accuracy Classes and Tolerances for Water Meters. The second example was in Section 3.37. Mass Flow Meters where the criteria for Normal Tests in N.6.1. includes "Any additional tests conducted at flow rates down to and including the rated minimum discharge flow rate." The Sector agreed that Technical Policy B. in NCWM Publication 14 must be revised to acknowledge these and any other exceptions in NIST Handbook 44.

Conclusion:
The Sector modified the draft checklist in order to incorporate it into the LMD section in NCWM Publication 14. The four checklist items in the draft under the heading Additional Checklist and Test Procedures for Water Meters were renumbered as items 44 through 47 so that they could be appended after the highest number item (43) currently in the LMD checklist. The Sector also agreed to propose Paragraph L. Laboratory Evaluation and Permanence Tests for Utility Type Water Meters as originally presented. All other information in the draft Water Meter Checklist was removed, as it is redundant to content already contained in the LMD section of NCWM Publication 14. This was done to prepare the proposal as an addendum to the LMD section instead of as a separate stand-alone checklist.
The Sector unanimously agreed to recommend the modified proposal as shown in Appendix B to the NTEP Committee for incorporation into NCWM Publication 14 as checklist items 44 through 47. The proposed language for Paragraph L. Laboratory and Permanence Tests for Utility Type Water Meters is below:

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 multiple 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 the following values:**

   a. **0.6 percent for tests conducted at Normal Flow Rates**

   b. **2.0 percent for tests conducted at Intermediate Flow Rates**

   c. **4.0 percent for tests conducted at Minimum Flow Rates**

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 50 % of the manufacturers rated maximum 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 multiple 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 the following values:**

   a. **0.6 percent for tests conducted at Normal Flow Rates**

   b. **2.0 percent for tests conducted at Intermediate Flow Rates**

To acknowledge the exceptions between NIST Handbook 44 and the method of applying normal test tolerances stated in Technical Policy B. Tolerance Application, the Sector also unanimously agreed to send a proposal to amend Technical Policy B. such that the text under the heading of "Normal Test Tolerances" would read as follows:

"For the purpose of calculating tolerances, **unless otherwise specified in Publication 14 (e.g. utility-type water meters and mass flow meters)**, normal tests conducted in an NTEP evaluation may be performed at any flow rate down to:" […with the rest of the existing content remaining unchanged].

3. Development of Hydrogen Gas-Measuring Devices Checklist

Source:
NIST, OWM - Carryover from 2010 Measuring Sector Agenda

Background/Discussion:
At the July 2010 NCWM Annual Meeting, NCWM members voted to add a tentative code for commercial hydrogen gas-measuring devices to NIST Handbook 44. Since the majority of states require an NTEP CC for commercial weighing and measuring devices, offering NTEP CCs for these devices would facilitate the acceptance of these devices in the commercial marketplace and assist states in their assessment of these devices.
At its 2010 NTETC Measuring Sector Meeting, the Sector established a work group to develop a draft Hydrogen Gas-Measuring Devices Checklist for the Sector to consider. The Hydrogen Gas-Measuring Devices Checklist Work Group consists of the following members:

Work Group Chair: Mr. Michael Keilty, Endress + Hauser Flowtec AG USA

- Mr. Dennis Beattie, Measurement Canada
- Mr. Mike Gallo, CLEANFUEL USA
- Mr. Norman Ingram, California Division of Measurement Standards
- Mr. Dan Reiswig, California Division of Measurement Standards
- Mr. John Roach, California Division of Measurement Standards
- Mr. Van Thompson, California Division of Measurement Standards
- Ms. Juana Williams, NIST, OWM
- Mr. Marc Buttler, NIST, OWM

Following the Measuring Sector meeting, the work group held a series of seven teleconferences from March through September and completed their task to develop a draft checklist. The U.S. National Work Group (USNWG) for the development of Commercial Hydrogen Measurement Standards reviewed the checklist during September and October.

Mr. Keilty, Endress + Hauser Flowtec AG USA, reported that the work group had completed its work on the draft checklist for Hydrogen Gas-Measuring Devices and requested that the Sector forward the draft to the NTEP Committee with a recommendation to add it to NCWM Publication 14. The checklist is needed in order to respond to pending requests for NTEP evaluation and CC's on hydrogen gas-measuring devices. Some members of the Sector asked whether NTEP can issue a CC for hydrogen measuring devices while NIST Handbook 44, Section 3.39. Hydrogen Gas-Measuring Devices has "Tentative Code" status. Mr. Truex, NTEP Administrator, responded that any NTEP CC issued under a tentative code is provisional, but is still an official CC. The only difference being that when the status of the code is changed from tentative to permanent, a device covered by a provisional CC may need to undergo additional evaluation to demonstrate compliance with any additional requirements that may have been added to the code. If no additional requirements are added when the tentative status of the code is changed, then any existing provisional certificates would automatically be upgraded to full certificates.

Mr. Truex asked if the checklist should be added to the LMD section of NCWM Publication 14 or as a new, separate section. Mr. Buttler, NIST Technical Advisor, recommended locating the new checklist in the LMD section of NCWM Publication 14; this proposal was based on the observation that the Compressed Natural Gas (CNG) checklist is located in the Mass Flow Meter portion of the LMD checklist now and it would be best to keep these similar entities together. Mr. Truex agreed.

The Sector discussed how to address the need for guidance on permanence testing and field evaluation methods. Mr. Ingram, California Division of Measurement Standards, Mr. Buttler, NIST, OWM, and Mr. Keilty, Endress + Hauser Flowtec AG USA, recommended referencing the existing Section I. Field Evaluation and Permanence Tests for Mass Flow Meters to leverage the existing information developed for CNG meters in order to address this need for hydrogen gas-measuring devices. After reviewing Section I, the Sector agreed that all the information was pertinent and appropriate to hydrogen with the exception of the sub-section on "Testing for Volume Units Only or to Add Volume Units to Existing Certificates." The Sector agreed to reference Section I. for hydrogen gas-measuring devices until other guidelines specific to hydrogen are developed.

Mr. Truex, NTEP Administrator, stated that there are stakeholders that have an immediate need for the checklist and that he supports adding it in the LMD section and the addition of the reference to Section I. of the field evaluation and permanence tests.

Conclusion:
The Sector unanimously agreed to send a proposal to the NTEP Committee to include new checklist items in the LMD Checklists and Test Procedures as shown in Appendix C to this summary. The Sector further agreed to include the following note, as also shown in Appendix C, to the beginning of the checklist:

> "Refer to Section I. Field Evaluation and Permanence Test for Mass Flow Meters (All topics with the exception of "Testing for Volume Units Only or to Add Volume Units to Existing Certificate") for test procedures."

Mr. Buttler, NIST Technical Advisor, noted that in anticipation that the Water Meter checklist from Agenda Item 2 is adopted as items 44-47 in the LMD section of NCWM Publication 14, Mr. Keilty, Endress + Hauser Flowtec AG USA, and Mr. Buttler have updated the numbering shown in Appendix C to reflect the item range from 48 to 58.

NEW ITEMS

4. Product Families Table – Include Water on Existing NTEP CC's

Source:
Mr. Karimov, Liquid Controls

Background/Discussion:
Mr. Karimov, Liquid Controls, noted that flow meters are approved to very tight tolerances on aggressive liquids such as acids, alcohols, glycols and their mixtures with water and liquid fertilizers. Many of these liquids are water-based such as liquid fertilizers and glycol/water mixtures. Water is a significantly less aggressive fluid and has a higher NIST Handbook 44 tolerance than other liquids.

A note at the end of the Product Families Table in NCWM Publication 14 allows water to be used as a test product in the fuels product family. Despite this, NCWM Publication 14 requires separate tests on water in order to add water to the NTEP CC for PD and turbine meters.

The Sector was asked to consider adding the following note at the bottom of the Product Families Table of NCWM Publication 14. This note would allow the "water" family (or specific liquids from the water family) to be added to an NTEP CC without additional testing based on approvals for certain other products:

> **The water family (in its entirety or partially) can be included on an NTEP CC based on an approved product or range of products with similar metrological characteristics (specific gravity, conductivity, and**

viscosity – as applicable to the relevant meter technology) unless materials constituting the measuring element are known to deteriorate in contact with water.

Mr. Karimov, Liquid Controls, explained that he has submitted this item to address applications where his customers would like the ability to measure large quantities of water (using larger meters than standard utility meters) and he does not feel that a device type that is already approved on other similar products should be required to undergo evaluation with water in order to be approved for water.

Mr. Ingram, California Division of Measurement Standards, stated that California has tested devices using water as a test medium. Mr. Keilty, Endress + Hauser Flowtec AG USA, added that mass meters are also often tested using water.

Mr. Oppermann, Weights and Measures Consulting, LLC pointed out that OIML R 117 is for fluids other than potable water and asked why the OIML standard for potable water R 49 is held separate from other codes. Ms. Butcher, NIST, OWM, explained that the Water Meters Code in NIST Handbook 44 was developed to address utility-type and batching meters, but is not limited to those types of water meters. She went on to point out that the LMD Code in NIST Handbook 44 specifically excludes water meters. Mr. Frailer, Maryland Department of Agriculture, added that, unlike the LMD Code, the Vehicle Tank Meter (VTM) Code and the Mass Flow Meters Code do not exclude water. Requirements already exist for devices that measure water and fall under those codes. Mr. Buttler, NIST Technical Advisor, mentioned that water is defined as a separate product category in NCWM Publication 14 Technical Policy C. Product Families for Meters.

The Sector discussed various different fluids, comparing properties and tolerances.

Mr. Karimov, Liquid Controls, described a case where a device has approval for use as a VTM delivering Diesel Exhaust Fluid (DEF), which is a water based solution. He would like to add stationary water meter approval for that device with no further testing. Mr. Karimov pointed out that there are two issues preventing this expanded approval. The first issue is the need for further testing to add water; he feels this additional testing is unnecessary because the device has already been demonstrated to perform on DEF, which is largely composed of water. Mr. Karimov hopes to address this issue with the note he proposes to add to NCWM Publication 14. The second issue involves the exclusion of water meters from the Application Section of the LMD Code. Even though the tolerances in the Water Meters Code are larger than those in the LMD Code, a meter that has already been tested for applications covered by the LMD Code must still meet the specific flow rate range requirements defined by meter size in the Notes Section of the Water Meters Code to receive approval in stationary water applications.

Mr. Karimov, Liquid Controls, pointed out that a note in NCWM Publication 14 Product Families Table states that "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." Given this note, he asked why devices tested on these types of products would not also be approved for water without having to specifically test with water. Mr. Buttler, NIST Technical Advisor, had researched the origin of the note, tracing it back to the 2005 NTETC Measuring Sector Meeting. During that meeting, there were multiple proposals developed for a Product Families Table, and a work group was formed that developed the table overnight, including this note. There is no clear discussion in the Sector summary for that year on the note. Mr. Buttler contacted Mr. Suiter, Richard Suiter Consulting, and the NIST Technical Advisor at that time, and learned that the intent was to recognize that water and Stoddard solvent were being used commonly in industry to eliminate the danger of testing with hazardous fluids and to permit the use of water as a substitute test medium in those instances. Mr. Keilty asked the Sector if the note should be removed because of the confusion it causes. Mr. Miller, FMC Technologies Measurement Solutions, Inc., disagreed, stating that this would disallow the common practice to use safe fluids in the laboratory. All agreed to keep the note.

Mr. Keilty, Endress + Hauser Flowtec AG USA, pointed out that it is very common to perform testing on water in a controlled environment before testing in field applications to add new products to an approval. It was unclear to him why Mr. Karimov, Liquid Controls, would want approval for water without testing on water. Mr. Karimov replied that the reason he has proposed this new note is to give the NTEP Measuring Laboratories legal authority to make a judgment call on whether to allow water approval on a device based on the performance of the device on other fluids.

There was discussion about the metrological impacts of differences in materials of meter construction compared to the metrological impacts of changing fluid product material. Mr. Andre Noel, Neptune Technology Group, Inc., asked if it is necessary to change calibration from DEF to water. Mr. Karimov, Liquid Controls, replied that the calibration must be changed from application to application. Mr. Allen Katalinic, North Carolina Department of Agriculture, pointed out that water expands when it freezes, unlike some other products. There was further discussion about how different types of water have different potential effects on permanence testing results. Mr. Noel suggested that the proposed note should apply to potable and tap water only because of the increased potential for material compatibility issues with distilled and deionized water. Mr. Karimov proposed that the NTEP Measuring Laboratories should have legal authority to decide whether certain water products could be included without testing based on the lab's understanding of the metrological and material compatibility of the meter and the types of water involved in an evaluation. Mr. Noel stated that when the requirements are left open, different manufacturers may receive different approval for the same testing.

Mr. Noel, Neptune Technology Group, Inc., pointed out that different products, such as milk, have different system requirements. Ms. Butcher, NIST, OWM, agreed that there are other code requirements specific to milk and noted that, in the case of adding fluids that have code requirements that were not examined during previous type evaluations, compliance of the device with the new code requirements would have to be evaluated. Ms. Butcher added that when a meter application is covered by two different codes, the evaluating laboratory must evaluate the device by applying all the requirements from both codes. Product family categories already indicate by their groupings what products have similar metrological characteristics and code requirements. Mr. Karimov, Liquid Controls, replied that he believes the groupings are imperfect now.

Ms. Butcher, NIST, OWM, requested a clarification in terms of the intended quantity or magnitude of the word "similar" as it appears in the proposed note. Mr. Karimov, Liquid Controls, replied that "similar" is intended to mean that the value of the critical characteristic property for the meter technology (e.g., viscosity for PD meters) for the proposed type of water would need to be identical to, or within the range of the physical property values of previously tested and approved products.

Conclusion:
Mr. Keilty, Endress + Hauser Flowtec AG USA, confirmed with the Sector that there had been sufficient discussion on the item and called for a vote. Mr. Karimov, Liquid Controls, requested that the wording of the proposed note be amended to include "- as determined by NTEP" in the parenthetical qualifying term for "water family." The vote was, thus, on a proposal to add a note to the end of the Product Families Table that would apply to all technologies as follows:

> **The water family (in its entirety or partially – as determined by NTEP) can be included on an NTEP CC based on an approved product or range of products with similar metrological characteristics (specific gravity, conductivity, and viscosity - as applicable to the relevant meter technology) unless materials constituting the measuring element are known to deteriorate in contact with water.**

The results of the vote are as follows:

- In favor: 9
- Opposed: 3
- Abstain: 1
- Note: Two of the three laboratories were opposed to the item.

The item and the voting results will be forwarded to the NTEP Committee. Mr. Truex, NTEP Administrator, informed the Sector that the NTEP Committee typically does not view voting results as consensus when a majority of the laboratories do not support an item.

5. Product Families Table – Change Test Requirements for Turbine Meters from Test A to Test E

Source:
Dmitri Karimov, Liquid Controls

Background/Discussion:
In the Product Families Table of NCWM Publication 14, turbine meters require testing on individual products with some exceptions. This approach, which was appropriate many years ago when turbine meters were first entering the custody transfer arena, has become outdated in the opinion of the submitter. Turbine meters have been tested extensively under NTEP. Turbine meters need at least to have product tests match those of PD meters because turbine meter influence factors are similar to those of PD meters.

The Sector was asked to consider replacing Test A with Test E for turbine meters and to merge the products under turbine meters into product category groups similar to those of PD meters.

Mr. Karimov, Liquid Controls, explained that the reason he has submitted this item is that his company expects to see demand for turbine meters in a growing number of different applications and on different products requiring NTEP approval.

The NTEP laboratories were not ready to agree that Test A should be eliminated for turbine meters on all products and asked what specific details were being proposed. They pointed out that the different product categories were originally created for a reason and wanted to know what has changed and what specific product categories needed to be reviewed. Mr. Karimov, Liquid Controls, stated that the immediate focus should be on combining chlorinated solvents and fertilizer groups.

The manufacturers in the room were asked if they offer turbine meters. Mr. Rich Miller, FMC Technologies Measurement Solutions, Inc., said his company only sells turbine meters in petroleum applications. Mr. Andre Noel, Neptune Technology Group, Inc., said that his company only sells turbine meters in water applications. Mr. Karimov, Liquid Controls, said that his company sells turbine meters in a wide range of applications on various fluids. He mentioned that they use turbine meters on acids, DEF, and alcohols, and believes that this experience has shown that turbine meters can be approved for ranges of viscosities, the way that PD meters are now. Ms. Butcher, NIST, OWM, asked if data could be provided that shows how the meter behaves going from one end of a range to another; Mr. Karimov replied they do not have data they could provide.

There followed discussion about the basic nature of turbine meters with Mr. Karimov, Liquid Controls, asserting that turbine meters are affected by viscosity. Mr. Keilty, Endress + Hauser Flowtec AG USA, and Mr. Noel, Neptune Technology Group, Inc., both said that turbine meters are velocity meters. Mr. Miller, FMC Technologies Measurement Solutions, Inc., disagreed and stated that turbine meters are inference devices. Mr. Beattie, Measurement Canada, explained that Canada uses kinematic viscosity when working with turbine meters because the Reynolds number is too difficult to work with.

When turbine meters were first included in the Product Families Table, there was not as much experience with the technology in weights and measures applications. Mr. Karimov, Liquid Controls, stated that, at first, turbine meters needed to be tested with every product because they were so new to weights and measures. He asserted that, in the intervening years, much has been learned and demonstrated about their performance. He explained that there are more different product families for turbine meters than are needed and pointed to chlorinated solvents as an example. Mr. Jerry Butler, North Carolina Department of Agriculture agreed that if we have proof now, we should move forward and update the table.

The Sector reviewed the history of work done on turbine meters over the course of the NTETC Measuring Sector and NTEP. Mr. Henry Oppermann, Weights and Measures Consulting, LLC, recalled that the Sector was first formed in 1984, just prior to NTEP. Mr. Keilty, Endress + Flowtec AG USA, said that the primary focus of the Sector at that time was PD meter approvals. Mr. Keilty recalled that there had been a turbine meter work group in 1994 led by Mr. Alston, Daniel Flow Products Inc. Ms. Butcher, NIST, OWM, added that Dr. Mattingly, NIST, OWM, had provided input based on NIST's research on turbine meters to the Sector that addressed influence factors related to flow profile, installation, flow direction, and orientation.

Mr. Karimov, Liquid Controls, proposed combining families into the following new groupings:

- Chlorinated solvents – one category
- Chemicals – one category
- Fertilizers – one category

Mr. Frailer, Maryland Department of Agriculture, stated that the scope of the change, as it was originally proposed, was too broad and that it was not possible to clearly understand the reduction in scope that was being proposed in the discussion without seeing how it would appear in the Product Families Table. The laboratories all agreed that they would need to see a detailed draft with the specific proposed groupings clearly depicted and all the pertinent product property data included in order for them to be able to fully understand what they were being asked to agree to. Mr. Karimov, Liquid Controls, agreed to prepare a draft table for the next sector meeting and requested assistance from NCWM and NIST in providing a file format of the current table that would allow him to make the appropriate markings for the draft.

Conclusion:
The Sector agreed to carry this item over to the NTETC Measuring Sector's 2012 Meeting. This will allow time for Mr. Karimov, Liquid Controls, to prepare a detailed proposal using the format of the current Product Families Table. Mr. Karimov, Liquid Controls, will rework the table and send it to interested stakeholders for review and comment prior to the next sector meeting. Stakeholders were identified as all the NTEP Measuring Laboratories, Mr. Miller, FMC Technologies Measurement Solutions, Inc., and Mr. McAllister, Daniel Measurement. Mr. Karimov will include in the draft all property data for each product that is included in the recommended set of changes so that the Sector will have a clear view of how the products in the proposed groupings compare. The table will be updated prior to the release of the agenda for the next NTETC Measuring Sector Meeting to incorporate the input received back from the stakeholders identified. Mr. Buttler, NIST Technical Advisor, will ask Ms. Hier, NCWM Project Coordinator, to provide Mr. Karimov with the current table in a format that he will be able to modify to reflect his proposal. Mr. Buttler will also aid Mr. Karimov as needed in preparation of the draft.

6. Product Families Table – Consolidate Product Categories for PD and Turbine Meters

Source:
Dmitri Karimov, Liquid Controls

Background/Discussion:
NCWM Publication 14 has too many agri-chemical products categories for PD and turbine meters that were created many years ago and are outdated. This item relates to a parallel proposal to match PD and turbine product categories.

The Sector was asked to consider a proposal to consolidate most of the agri-chemical product categories for PD and turbine meters into the following two groups:

- All solvents, glycols and alcohols, and chemicals in one group
- All crop chemicals (A, B, C, and D), fertilizers, and flowables in one group

As an alternative proposal, the Sector was asked to consider adding the following note to the bottom of the Product Families Table or somewhere else in the LMD-Technical Policy:

If a meter is approved for a product of low viscosity in one product family or category and the same meter is approved for a product of high viscosity in another product family or category, the meter will be approved for this viscosity range in both product families/categories.

Mr. Dmitri Karimov, Liquid Controls, explained to the Sector that the main difference between this agenda item and the proposal presented in Agenda Item 5 was that this one includes both PD meters and turbine meters. Based on the discussion and status of Agenda Item 5, Mr. Karimov proposed limiting the scope of this item to PD meters only. Mr. Keilty, Endress + Hauser Flowtec AG USA, asked Mr. Karimov, Liquid Controls, if he would consider developing a draft table with the changes proposed, similar to what was agreed to for Agenda Item 5. Before committing to that effort, Mr. Karimov wanted to know if the labs would consider the change. Mr. Ingram, California Division of Measurement Standards, said he would be willing to consider a proposal. Mr. Frailer, Maryland Department of Agriculture, added that he would want to know why the changes were being proposed. Mr. Karimov cited as an example that fungicides and insecticides are all water-based solutions. Mr. Frailer noted that there are four different categories for crop chemicals and that he would consider combining them if they are all in fact similar. Mr. Katalinic, North Carolina Department of Agriculture, added that Round Up is not a suspension. Mr. Butler, North Carolina Department of Agriculture said that PD meters have been around since the 1950's and noted that the chemical products have not changed that much since then. Mr. Miller, FMC Technologies Measurement Solutions, Inc., stated that the Sector had been working on the format for the Product Families Table with the agreement that there would be no changes to content as part of that project. Since that project was completed in 2010, the Sector can move forward with these types of proposals to change the substance of the table.
Mr. Keilty, Endress + Hauser Flowtec AG USA, asked Mr. Karimov, Liquid Controls, to describe the alternative proposal in the recommendation above. Mr. Karimov explained that the intent of his alternate proposal is to establish a policy that defines a single approved viscosity range for a meter rather than separate approved viscosity ranges for that meter by each product family. Under this proposed policy, the limits of the range of approved viscosities for a meter would be determined by the highest viscosity and the lowest viscosity products tested, regardless of the product families those two products fall within. Furthermore, this single approved viscosity range would apply to all products in all the product families for which the meter has been approved, regardless of the range of the viscosities of the products in each family that had actually been tested during evaluations. Mr. Karimov stated that it is his intent that the scope of the alternative proposal should still include both PD and turbine meters despite his earlier request to exclude turbine meters from the primary proposal. Mr. Karimov noted that his proposal does not have any impact on multi-product approvals.

Mr. Truex, NTEP Administrator, asked Mr. Karimov, Liquid Controls, if there is any data available to support the validity of the alternative proposal. Mr. Karimov replied that he could not provide such data. Mr. Truex expressed concern about the proposal since there is no data to support it. Mr. Frailer, Maryland Department of Agriculture, added that it is important to remember that there are other similarities between products in the same family to consider in addition to just viscosity.

Mr. Miller, FMC Technologies Measurement Solutions, Inc., asked for clarification on how the proposal would impact permanence testing requirements. Mr. Karimov, Liquid Controls, said his intent was that it would still be necessary to do permanence testing on one product from each category. He described an example where a permanence test would be conducted using a high viscosity product from one family and a second permanence test would be conducted using a low viscosity product from another family; these tests would allow the full range of viscosity to be included for both families.

Mr. Keilty, Endress + Hauser Flowtec AG USA, recapped the two proposals in Agenda Item 6:

- The primary proposal suggests consolidating the solvents, glycols and alcohols, and chemicals into one group and consolidating all crop chemicals A, B, C, and D into another group.

- The alternative proposal is to add a note to the bottom of the Product Families Table or elsewhere in the Technical Policy describing the application of viscosity ranges across families.

Mr. Butler, North Carolina Department of Agriculture reminded the Sector that the product families were separate for a reason. He gave a hypothetical example wherein a CC would include approval of a meter model family for a wide range of viscosities based on testing that included a high viscosity product (e.g., molasses) tested on a smaller meter size (and, therefore, tested at lower flow rates), and a low viscosity product tested on a larger meter size (and, therefore, tested at higher flow rates). The concern would be that the entire family of meters would have coverage for the full range of viscosities across all approved families despite the fact that no testing with high viscosity product at higher flow rates and on larger meters was done. Mr. Butler's comments highlighted the concern that the flow profile, velocity, and other fluid flow characteristics of different products can vary significantly through different sized meters and at different flow rates. The current product family groupings help to ensure that an appropriate amount of testing is done to understand the effects of these variations. Mr. Karimov, Liquid Controls, responded that each meter model (size) should be tested on both high and low viscosity products over the range of approved flow rates for that meter model. He proposed to address the concern by adding the word "model" to the note to ensure that a wide range of viscosities is to be tested on each meter size that is selected for testing to adequately represent performance of the full range of sizes for that meter model family.

Mr. Ingram, California Division of Measurement Standards, interpreted the proposal as basically combining all the families into one and agreed with the other labs that the product families are currently separate for a reason. Mr. Beattie, Measurement Canada, added that, with the manufacturers taking responsibility for any variation in materials of construction, incorporating the proposed change would make manufacturers fully responsible for all variations of both meter and fluid product materials and stated that he is not comfortable with that idea. Mr. Butler, North Carolina Department of Agriculture asked if a change in the meter material would mean a change in the model number. Mr. Keilty, Endress + Hauser Flowtec AG USA, replied that was not necessarily true and it would depend on how manufacturers define their model structures.

Mr. Karimov, Liquid Controls, requested that the sector vote on the alternative proposal to add a note regarding the expanded application of tested viscosity ranges across families. Mr. Buttler, NIST Technical Advisor, asked for clarification as to whether mass flow meters and specific gravity would also be included in the scope of the proposed policy. Mr. Karimov said these are not intended to be included in the proposal and he believes that would need to be developed and submitted by someone with an interest in mass flow meter policy.

Conclusion:
Mr. Karimov, Liquid Controls, withdrew the primary proposal and plans to incorporate it into the draft changes to the Product Families Table that will be developed for Agenda Item 5 that was carried over to 2012.

The Sector voted on the alternative proposal to add a note to the LMD Technical Policy, which was modified to include the qualifiers "PD or turbine" and "model" as shown below.

If a PD or turbine meter is approved for a product of low viscosity in one product family or category and the same model meter is approved for a product of high viscosity in another product family or category, the meter will be approved for this viscosity range in both product families/categories.

The results of the vote are as follows:

- Approve: 7
- Oppose: 5
- Abstain: 0
- Note: All three labs and NIST were opposed to the item as it was framed for the vote. The item and the voting results will be forwarded to the NTEP Committee.

7. Add Metrological Sealing Checklist to Measuring Devices NCWM Publication 14

Source:
NTEP Measuring Laboratories

Background/Discussion:
At its 2011 NTETC Measuring Sector Meeting, the NTEP Measuring Laboratories agreed that a sealing table checklist that is modeled after the example in NCWM Publication 14, Digital Electronic Scales checklist, Section 10 should be added to NCWM Publication 14.

The Sector was asked to consider forming a work group to develop a sealing checklist to add to the Measuring Devices NCWM Publication 14 that is modeled on the example from NCWM Publication 14, Digital Electronic Scales checklist, Section 10.

Mr. Truex, NTEP Administrator, summarized the development of this item. The S&T Committee has determined that adding this information to the type-evaluation checklists in NCWM Publication 14 is the appropriate resolution to an item that has been on the S&T Committee agenda for several years. The original concern was raised in recognition that there were some weighing devices in service that could be left in a calibration mode while sealed. The S&T Committee determined that appropriate requirements already exist in NIST Handbook 44, and that clarification of the interpretation of these requirements in the NTEP checklists would help to ensure the requirements are more uniformly interpreted and applied. Mr. Truex supported the decision of the S&T Committee and recommended the Sector move this item forward.

Mr. Keilty, Endress + Hauser Flowtec AG USA, asked where the proposed sealing checklist would be located in NCWM Publication 14 Ms. Butcher, NIST, OWM, suggested that it appear under code reference G-S.8.1.
Mr. Truex, NTEP Administrator, explained that all the highlighted text, including the two tables would be ready to add to the LMD checklist under item 2.16 if any language related to “weight” and “weighing devices” and units were revised to include references appropriate to measuring devices. The Sector reviewed the proposal and agreed that the item would be suitable for measuring devices if the following changes were made in the table of examples at the end:

- Change each instance of “lb” to “gal”
- Change each instance of “weight” to “quantity” and “weights” to “quantities”

Mr. Truex, NTEP Administrator, noted that these terms are just provided in the tables as examples and that the references are not meant to be all-inclusive. Mr. Miller, FMC Technologies Measurement Solutions, Inc., added that PTB in Germany would require an asterisk in front if the value was a not-legal-for-trade value. Referring to the fourth item in the right column of the second table, Mr. Johnson, Gilbarco, Inc., asked why a flashing value would not be acceptable as an indication representing that a device is configured with the setup or configuration mode enabled. Mr. Johnson added that retail motor-fuel dispensers have been using a flashing display value for 30 years to signify a non-valid indication. He further noted that many of these devices use a display that only has numeric capability, making it impossible to use letter codes as shown in the first example of an acceptable indication shown in the second table. Mr. Truex responded that flashing zeros or dashes would be acceptable, but a flashing value would not be acceptable if it was flashing at a rate that would still make the value usable. He added that if the value could be sent to the console and that value could be used, then that could also be a problem.

Conclusion:
The Digital Electronic Scales sealing checklist item was reviewed and revised by the Sector during the meeting to make it suitable for measuring devices. The Sector unanimously agreed to forward a proposal to the NTEP Committee to include the revised checklist item shown in Appendix D under item 2.16. in the LMD checklist.

8. Product Families Table – Categorization of Liquid CO_2

Source:
NTEP Measuring Laboratories

Background/Discussion:
Liquid CO_2 does not appear in the Product Families Table in Technical Policy C. of the LMD checklist. Therefore, it is difficult to determine whether liquid CO_2 would fall into the compressed liquid category, or the cryogenic liquid category, or a new category of liquid. Without a clearly defined product category, it cannot be determined what tests are required to include liquid CO_2 on an NTEP CC. This item was originally introduced in 2008. At that time, the Sector had agreed to table the issue until the reorganization of the Product Families Table was completed and more data was available to suggest the best approach for including liquid CO_2 in the Product Families Table and for defining the test criteria. The Sector has not received additional data, however the issue remains that the categorization of liquid CO_2 is undefined. In the absence of data to support any other categorization and in recognition of the unique properties of liquid CO_2, the most conservative approach would be to add liquid CO_2 to the Product Families Table with Test A status; this will require it to be tested individually in order to be added to an NTEP CC.

The Sector was asked to consider adding liquid CO_2 to the Product Families Table with Test A status (which requires testing with each product) to eliminate the current ambiguous status of liquid CO_2.

Mr. Buttler, NIST Technical Advisor, explained that liquid CO_2 does not qualify as a cryogenic liquid because the boiling point (− 70 °F) is considerably higher than the maximum boiling point for cryogenic liquids (− 243 °F) defined in NIST Handbook 44.

The NTEP Measuring Laboratories were asked about their experience with liquid CO_2. Only California has evaluated devices measuring liquid CO_2 in commercial applications. California has issued CTEP approval, but there has never been an NTEP approval on a metering device on liquid CO_2 to the Sector's knowledge. The Sector agreed that, in the absence of data or experience to support a less conservative approach, liquid CO_2 should be added to the Product Families Table as a Test A fluid for all technologies so that the ambiguity would be resolved. Mr. Keilty, Endress + Hauser Flowtec AG USA, commented that magnetic flow meters do not measure liquid CO_2.

Conclusion:
The Sector unanimously agreed to propose adding a separate product category for liquid CO_2 and including liquid CO_2 as a Test A product for Mass Flow Meters, Positive Displacement Meters, and Turbine Meters.

9. Product Families Table – Add Hydrogen (Compressed Gas)

Source:
USNWG for the Development of Commercial Hydrogen Measurement Standards

Background/Discussion:
Section 3.39 Hydrogen Gas-Measuring Devices – Tentative Code was added to NIST Handbook 44 in 2011. There is no mention of hydrogen in the Product Families Table in Technical Policy C. Hydrogen should be added to the Product Families Table in Technical Policy C. to provide clarity as to the Test Requirements, Coverage, Product Category, and Typical Properties.

The Sector was asked to consider adding hydrogen to the checklist for all meter types that measure compressed gases. Because of the unique properties of compressed hydrogen gas, the NTEP Measuring Laboratories recommend that Test A, which requires individual testing, be specified for hydrogen gas.

Mr. Buttler, NIST Technical Advisor, explained that the USNWG requested this item to clarify the testing requirements for hydrogen gas-measuring device type evaluations.

Mr. Karimov, Liquid Controls, requested that hydrogen be added for PD and turbine meters, as well as mass flow meters. Mr. Cooper, Tuthill Transfer Systems, agreed, offering that this would avoid the need to revisit the issue later. Mr. Keilty, Chair, cautioned the Sector about adding blanket statements that include technologies which are not being considered in practice. Mr. Beattie, Measurement Canada, reminded the Sector that the table is not all inclusive; products that do not appear in the table can still be approved.

Conclusion:
The Sector voted on a proposal to add hydrogen to the table for mass flow meters, PD meters, and turbine meters as a Test A fluid as shown in Appendix E to this summary. The results of the vote are as follows:

- Approve: 11
- Opposed: 1
- Abstain: 2
- Note: All 3 labs and NIST approved the item as it was framed for the vote. The item and the voting results will be forwarded to the NTEP committee.

10. Add Units for Compressed Gases to Technical Policy V. List of Price and Quantity Markings on Retail Motor Fuel Dispensers (RMFDs)

Source:
Hydrogen Checklist Work Group

Background/Discussion:
Section 3.39. Hydrogen Gas-Measuring Devices – Tentative Code was added to NIST Handbook 44 in 2011. NCWM Publication 14, LMD Technical Policy V. List of Price and Quantity Markings on RMFDs does not include units for CNG or hydrogen compressed gas in the list of Acceptable Delivered Quantity representations.

The Sector was asked to consider adding "kg," "GGE," and "GLE" to the list of "Delivered Quantity Acceptable" in the top right corner of the Table in Technical Policy V. as acceptable quantity units for CNG and hydrogen RMFDs. The Hydrogen Checklist Work Group noted that the units relating to the compressed gaseous fuels CNG and hydrogen were missing from the table in NCWM Publication 14 Technical Policy V. Mr. Keilty, Endress + Hauser Flowtec AG USA, said that the proposed change should prevent confusion during type evaluation of compressed gas dispensers. Mr. Ingram, California Division of Measurement Standards, noted that the hydrogen gas method of sale regulation in NIST Handbook 130 has a provision that limits the resolution of the unit price to whole cents.

Conclusion:
The Sector reviewed the proposal and identified additional changes that further improved the clarity of the policy. The Sector unanimously agreed to propose the changes to Technical Policy V. List of Price and Quantity Markings on Retail Motor Fuel Dispensers (RMFDs) in NCWM Publication 14 as shown below:

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**

11. Certificate of Conformance Parameters for Measuring Devices

Source:
Mr. Marc Buttler, NIST Technical Advisor

Background:
NCWM Publication 14, *Administrative Policy P*. CC lists several options for typical information to be included on an NTEP CC; however, there is no guidance on the minimum information that is to be included in a CC, such as the sealing category and product photographs. Identifying the minimum components to be included on every CC would provide better guidance for NTEP Measuring Laboratories, improve consistency of CC's, and promote easier interpretation by field inspectors.

Mr. Buttler, NIST Technical Advisor, clarified that the intent of the item was to provide guidance for new CC content and not to be applied retroactively to modify existing NTEP CCs.

Mr. Truex, NTEP Administrator, told the Sector that the NTEP CC process is able to effectively ensure that the minimum needed information is contained on all new CC's issued. The necessary content is being effectively captured by virtue of the CC application form. Mr. Truex stated that CC content is dealt with administratively and that there is no need to change NCWM Publication 14.

Conclusion:
The Sector agreed that the need to include the minimum necessary information in all new CC's can be effectively addressed administratively by NCWM. Consequently, the Sector agreed that the proposed change is unnecessary and withdrew the item.

12. Test for Mathematical Agreement of Card Reader after Power Loss

Source:
Mr. Reiswig, California Division of Measurement Standards

Background/Discussion:
During development of the draft checklist for Hydrogen Gas-Measuring Devices, a gap was identified for CNG Card-Activated Retail Motor Fuel Dispensers. NTEP evaluators have found cases where there is not mathematical agreement between the total quantity, the unit price, and the total price when executing the "Power Loss" test (item 16.1) in the LMD NCWM Publication 14, Section 16. Test Methods for Card-Activated Retail Motor Fuel Dispensers. This test is designed to ensure that the device will not dispense any fuel after a power interruption without reauthorization of the card-activated device. The test does not currently call for any check of the mathematical agreement.

The Sector was asked to consider the addition of a procedure to 16.1 of the checklist to verify mathematical agreement after a power loss shut down of an RMFD as shown below:

16.1. 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:

16.1.1. Authorize with a card and turn the "handle" on. Power down briefly, then restore power. Try to dispense product: the dispenser must not dispense because the power failure should have de-authorized the dispenser.

16.1.2. The dispenser must maintain mathematical agreement between the computed money value and the quantity (Quantity × Unit Price = Sales Price) at the point in time that de-authorization occurred.

After reviewing the proposal, the Sector was uncertain as to where within the checklist the addition should be made. The Sector asked Mr. Ingram, California Division of Measurement Standards, Mr. Buttler, NIST Technical Advisor, and Mr. Keilty, Chair, to review NCWM Publication 14 and the hydrogen draft checklist during the lunch break and share their recommendation for the proposed location(s) for the item. After their review, this group reported to the Sector that they found instances already in place in NCWM Publication 14 that appear to be sufficient to address the concern raised by the originator.

Conclusion:
The Sector agreed that provision for verifying mathematical agreement following a power loss is already covered in other sections of NCWM Publication 14, including the LMD Checklists and Test Procedures for Retail Motor-Fuel Dispensers, the LMD Checklists and Test Procedures for Mass Flow Meters, and the newly proposed draft LMD Additional Checklists and Test Procedures for Hydrogen Gas-Measuring Devices. There are references at multiple points in each checklist that would address mathematical agreement. Consequently, the Sector agreed that the proposed change is unnecessary and withdrew the item.

13. Device Marking for Electronic Linearization for Meters

Source:
NTEP Measuring Laboratories

Background/Discussion:
During the 2010 NTETC Measuring Sector Meeting, the Sector considered the item "Electronic Linearization for Positive Displacement Meters" and agreed to recommend that the second paragraph of Technical Policy G be replaced with the following:

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 manufacturer.

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 CC and must be marked on the meter.

The requirements for marking flow rate limitations on devices was discussed at the spring 2011 NTEP Measuring Laboratories Meeting in relation to this change, and it was determined that additional clarification is needed regarding the marking requirement that is referenced in NCWM Publication 14, Section G. For example, if a device can have its range expanded by the addition of an optional auxiliary approved device that has multi-point calibration, how is this device to be marked, and do both ranges need to be marked on the device in case the auxiliary device is ever replaced or removed?

The Sector was asked to clarify how the multi-point calibration is to be marked on the meter and add specific guidance to the LMD checklist Section 11. Marking; "Code Reference: S.4.1.1. Marking Requirements; Limitation on Use." The Sector was asked to consider adding the example below or to offer other alternatives to clarify range of use limitations of a meter with and without an auxiliary multi-point indicator.

	Without Aux Multi-Point Indicator	**With Aux Multi-Point Indicator**
Min Flow	20 GPM	10 GPM
Max Flow	100 GPM	100 GPM

The Sector reviewed Technical Policy G and discussed how it allows an auxiliary device to be used to extend the flow range of a system beyond the measuring element's minimum flow range. Mr. Buttler, NIST Technical Advisor, and Ms. Butcher, NIST, OWM, noted two main concerns to be addressed by this proposal:

1. Technical Policy G requires that "the auxiliary device's multi-point calibration will be noted on the CC and must be marked on the meter." However, there is no guidance or example of acceptable marking.

2. When a CC lists different approved flow rate ranges depending on whether an auxiliary device is used to extend the approved flow rate range, how can the flow rate range marking on the device ensure that all the information needed by a field inspector is available when the auxiliary device can be added or removed without changing the marking on the measuring element?

Mr. Buttler, NIST Technical Advisor, illustrated these concerns further by describing a hypothetical example of a device that was marked with an extended range because it was originally installed with an auxiliary multi-point calibration device. If the auxiliary device were ever to fail or be removed and not be replaced, then the marking on the meter would reflect an incorrect approved flow rate range.

Mr. Frailer, Maryland Department of Agriculture, added another example of an inspector examining a device in service that was marked for the range that the device would be approved for if it was not using an auxiliary device (e.g., 20 GPM MIN FLOW). If the inspector found the device to be operating using an auxiliary device in the extended range approved for that system when using that auxiliary device (e.g., down to 10 gpm), the inspector would still fail the device in this case because of the disagreement between the marked range and the operating range.

Mr. Karimov, Liquid Controls, asked whether turbine meters were excluded. Mr. Buttler, NIST Technical Advisor, explained that Technical Policy G applies to all technologies.

Several sector members could see the need for greater clarity and discussed the best location within NCWM Publication 14 to make sure that the information would be clear and not overlooked during type evaluation. No clear location was identified. Mr. Cooper, Tuthill Transfer Systems, shared the history of the original item with the Sector and mentioned that the original item submitted by Mr. Cooper did not include any intent to affect marking requirements.

Conclusion:
The Sector was unable to reach a consensus for guidance on how the policy for marking meters with an extended flow range is to be applied. Consequently, the Sector withdrew the item, and the NTEP Measurement Laboratories will decide how each meter must be marked on a case-by-case basis.

14. Product Families Table - Restore Notation "(Above 50 °C)" to the Heated Products Category Definition

Source:
NTEP Measuring Laboratories

Background/Discussion:
The NTEP Measuring Laboratories noted that the newly revised Product Families Table in NCWM Publication 14 Technical Policy C. is missing the statement "(Above 50 °C)" to qualify the "Heated Products" category. This statement had appeared in prior versions of the Product Families Table and the Sector had not discussed deleting the statement. Consequently, it appears that the statement was inadvertently omitted when the table was reorganized.
The Sector is asked to consider that NIST Handbook 44 currently lists "Asphalt at temperatures greater than 50 °C" in the Tolerances Table under Accuracy Class 0.3A, with an Acceptance Tolerance of 0.3 %. The table also specifies "Heated Products (other than asphalt) at or greater than 50 °C" under Accuracy Class 0.3, with an Acceptance Tolerance of 0.2 %. NIST Handbook 44 does not include a specific definition for "Heated Products" in the Definitions section.

The Sector was asked to consider restoring the term "(Above 50 °C)" to the "Heated Products" category abbreviations as shown below to clarify the temperature range that defines "Heated Products".

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	Solv Chl	Solvents Chlorinated
Comp gas	Compressed Gases	Solv Gen	Solvents General
Comp liq	Compressed Liquids (Fuels and Refrigerants, NH3)	Sus Fert	Suspension Fertilizers
Cryo LNG	Cryogenic Liquids and Liquefied Natural Gas	Water	Water

Mr. Buttler, NIST Technical Advisor, explained that the omission of the note appears to have been an oversight that occurred when the new table format was added to NCWM Publication 14 in 2011.

Mr. Buttler described the associated concern about heated products and the Product Families Table. Because heated asphalt and other heated products all fall together in the category of "Heated Products," but have different tolerances in NIST Handbook 44, there was a concern that a device might be approved for a family by testing with the less stringent tolerance. The Sector discussed the concern further and agreed that the issue is effectively addressed by LMD Technical Policy B. Tolerance Application, which provides an example wherein a meter tested using only the "agri chemical" tolerance is restricted from use in applications with tighter tolerances until additional testing is performed. Ms. Butcher, NIST, OWM, pointed out that the Technical Policy B was added because companies were applying for one application and associated tolerance, but if their equipment performed within tighter tolerances, they wanted to also add applications with tighter tolerances to the CC. This provision is intended to emphasize that applicants must specify the application and tolerance for the approvals they seek at the time a device is submitted for evaluation.

The Sector noted two issues in NIST Handbook 44 related to heated products:

- There exists an inconsistency in the Accuracy Classes and Tolerance Tables in the LMD Code and in the VTM Code in NIST Handbook 44 between the temperature range defined for heated asphalt and the temperature range defined for other heated products. Heated asphalt is defined as "greater than 50 ºC," whereas other heated products are defined as "at or greater than 50 ºC."

- The description for "Heated products" in the Mass Flow Meters Code Table T.2 Accuracy Class 0.3 in NIST Handbook 44 is incomplete compared with the description from the LMD Code, which reads "Heated products (other than asphalt) at or greater than 50 ºC."

Conclusion:
The Sector unanimously agreed to propose the addition of the statement "(Above 50 °C)" to the "Heated Products" abbreviation as originally proposed.
Mr. Buttler, NIST Technical Advisor, will investigate and address the two NIST Handbook 44 issues that were identified:

- Inconsistency between the temperature ranges for heated asphalt and for other heated products in the LMD Code and the VTM Code.

- Incomplete description for "Heated products" in the Mass Flow Meters Code

15. Next Meeting

The Sector agreed to recommend to NCWM that its next meeting be held in conjunction with the 2012 Southern Weights and Measures Association (SWMA) Annual Meeting. However, because the Sector must be mindful of meeting publication deadlines for NCWM Publication 15, the Sector noted that this decision may need to be revisited once a date and location has been selected for the 2012 SWMA meeting.

ADDITIONAL ITEMS

The NTETC Measuring Sector was asked to provide input on the following measuring-related issues on its agenda if time permitted during the NTETC Measuring Sector Meeting. In the interest of brevity, the narrative for each item is abbreviated to the extent practical. Full descriptions of NCWM S&T Committee items can be found in the S&T Committee's list of carryover items and its 2011 Interim and Final Reports.

16. Section 3.31. Vehicle-Tank Meters; Paragraph T.4. Product Depletion Test

Source:
Northeast Weights and Measures Association. This item was originally part of the 2010 NCWM Publication 16 Agenda Item 360-3 – Developing Items Part 3.31., Vehicle-Tank Meters - Item 1.

Purpose:
Modify the VTM code to base the product depletion test tolerances on the meter's maximum flow rate (a required marking on all meters), rather than the meter size (a required marking for meters manufactured beginning in 2009). This will enable more consistent application of the tolerances for older meters, which are not required to be marked with the meter size and address an unintentional gap which allows an unreasonably large tolerance for smaller meters.

Item Under Consideration:
The S&T Committee is considering two options for modifications to Paragraph T.4. and Table T.4. The committee is asking for feedback on both of these proposals and is particularly interested in data from manufacturers and weights and measures jurisdictions that would illustrate the impact of these proposals on smaller meters.

Option 1 Summary:
Option 1 proposes to modify Paragraph T.4. and Table T.4. to define product depletion test tolerances based on the maximum flow rate marked on the meter, instead of the meter size and to provide corresponding examples. The proposed tolerance is equal to 0.5 % of the volume delivered in one minute at the marked maximum flow rate.

Option 2 Summary:
Option 2 proposes a wider tolerance than Option 1 for meters rated 100 gpm or lower. As with Option 1, Option 2 proposes to modify Paragraph T.4. and Table T.4. to define product depletion test tolerances based on the maximum flow rate marked on the meter, instead of the meter size and provide corresponding examples. The proposed tolerances in Option 2 are equal to 0.6 % of the volume delivered in one minute at the marked maximum flow rate for meters rated 100 gpm or lower, and 0.5 % of the volume delivered in one minute at the marked maximum flow rate for meters rated above 100 gpm.

Background/Discussion:
At the 2011 NCWM Annual Meeting, the S&T Committee reiterated its need for data to evaluate the impact of any proposed tolerances changes, noting that, to date, no data has been submitted to the committee.

The Committee asked that the following test data be submitted to assist the committee in making this assessment:

- make and model of the meter;
- marked maximum flow rate of the meter;
- actual delivery rate during the normal test;
- error (in cubic inches or percent) for the normal test;
- actual delivery rate during the product depletion test;
- error (in cubic inches or percent) for the product depletion test; and
- type of test (e.g., routine or follow-up).

For information on submitting data, please contact Ms. Butcher, S&T Committee NIST Technical Advisor, at (301) 975-2196 or tina.butcher@nist.gov. The committee also plans to distribute a request on NIST, OWM's Weights and Measures Directors' list serve for jurisdictions to submit data.

Mr. Karimov, Liquid Controls, speaking on behalf of the Meter Manufactures Association (MMA), indicated that the MMA continues to be concerned about the impact of any proposed changes on smaller meter sizes, particularly meter sizes that are less than 1½ inches.

The Committee was looking forward to receiving additional proposals and requested data by November 1, 2011, so that the information can be considered at the 2012 NCWM Interim Meeting, and the item can remain on the Committee's agenda.

Conclusion:
The Sector discussed this issue briefly. They heard an overview of an alternate proposal from Mr. Karimov, Liquid Controls, and Mr. Cooper, Tuthill Transfer Systems, with input from Mr. Miller, FMC Technologies Measurement Solutions, Inc. The Sector did not take a position on this issue.

Mr. Buttler, NIST Technical Advisor, noted the alternate proposal discussed during the sector meeting was formally submitted by the MMA to the S&T Committee on November 3, 2011, after the sector meeting. This proposal is provided below:

Meter Manufacturers Association Proposed Option
T.4. Product Depletion Test. – The difference between the test result for any normal test and the product depletion test shall not exceed:

- eight-tenths (0.8 %) of the volume delivered in one minute at the maximum flow rate marked on the meter for meters marked with a maximum flow rate of 227 Lpm (60 gpm) or less;

- six-tenths (0.6 %) of the volume delivered in one minute at the maximum flow rate marked on the meter for meters marked with a maximum a flow rate of greater than 227 Lpm (60 gpm) and equal or less than 379 Lpm (100 gpm);

- five-tenths (0.5 %) of the volume delivered in one minute at the maximum flow rate marked on the meter for meters marked with a maximum flow rate of greater than 379 Lpm (100 gpm).

Table T.4.
Tolerances for Typical Vehicle-Tank Meters on Product Depletion Tests, Except Milk Meters

Marked Maximum Flow Rate	Maintenance and Acceptance Tolerances	Marked Maximum Flow Rate	Maintenance and Acceptance Tolerances
114 Lpm	0.91 L	30 gpm	0.24 gal (55.4 in^3)
227 Lpm	1.82 L	60 gpm	0.48 gal (110.9 in^3)
379 Lpm	2.27 L	100 gpm	0.60 gal (138.6 in^3)
757 Lpm	3.79 L	200 gpm	1.0 gal (231 in^3)

Refer to T.4. for meters with maximum flow rates not listed.
Based on a test draft volume of a least the amount specified in N.3. Test Drafts.

Summary of the MMA Option:
The MMA Option is similar to Options 1 and 2, but proposes a wider tolerance than both Option 1 and Option 2 for meters rated 60 gpm or lower. As in Options 1 and 2, the MMA Option is to modify Paragraph T.4. and Table T.4. to define product depletion test tolerances based on the maximum flow rate marked on the meter, instead of the meter size and to provide corresponding examples. The proposed tolerances in the MMA Option are equal to 0.8 % of the volume delivered in one minute at the marked maximum flow rate for meters rated 60 gpm or lower, 0.6 % of the volume delivered in one minute at the marked maximum flow rate for meters rated between 60 gpm and 100 gpm (including 100 gpm), and 0.5 % of the volume delivered in one minute at the marked maximum flow rate for meters rated above 100 gpm.

17. OIML B 3 Basic Certificate System for OIML Type Evaluation of Measuring Instruments and OIML B 10 Framework for a MAA on OIML Type Evaluations

Source:
Dr. Ehrlich, NIST, OWM

Background/Discussion:
Voting was scheduled to take place on October 14 on the standards for the MAA and OIML type evaluation certificate system standards at the 46th International Committee of Legal Metrology (CIML) meeting in Prague, Czech Republic. The Committee Drafts for both B 3 and B 10 were provided to the Sector for information purposes.

Conclusion:
Mr. Buttler, NIST Technical Advisor, reported the outcome of the October 14 CIML voting. Both items passed and were forwarded to International Bureau of Legal Metrology for publication. Mr. Truex, NTEP Administrator, asked the Sector if any members had MAA Certificates, to which none responded. The Sector took no further action on this item.

18. G-S.1. Marking (Software)

Sources:
2010 Carryover Item 310-3. This item originated from the NTETC Software Sector and first appeared on the S&T Committee's 2007 Agenda as Developing Item Part 1, Item 1.

Background/Discussion:
The NTETC Software Sector has continued to collect information and concerns of stakeholders on this item.
During the 2011 NCWM Annual Meeting, the S&T Committee heard a recommendation from NIST, OWM that this item should be changed to Developing in order to provide the NTETC Software Sector additional time to more fully develop the item based on the following points:

1. The current proposal is not developed enough for consideration by the S&T Committee. Based on the diversity of comments that continue to be heard on this issue, NIST, OWM believes the item is not close to a NCWM vote and that considerable work still needs to be done to develop the item.

2. NIST, OWM interprets the current proposal as requiring that software be marked with a non-repetitive serial number. However, it is not the intent of the NTETC Software Sector to require such marking. Thus, it is believed that the language must be revised to resolve this issue and assure the intended interpretation is clear.

3. The draft of the March 2011 NTETC Software Sector Summary reported that several members envision G-S.1. being developed further to the extent that G-S.1.1. may not be needed.

There was a position posted on NCWM 2011 Online Position Forum by Mr. Johnson, Gilbarco, Inc., opposing the item as written and sharing the following comments:

> Gilbarco, Inc. does not support the current proposed language. Our pumps and dispensers have a numeric display capable of displaying 6 digits. It is not currently possible to display the version identifier or an abbreviation or symbol that identifies the version number as required in (d) (1) and (2). It is not possible to access the software version using "one or, at most, two levels of access" as noted in section G-S.1.1 (3). We do not currently offer a menu based system and do not offer functions such as "Metrology," "System Identification" or "Help." We do not have the ability not offer icons or symbols. Meeting the new marking requirements will be costly to the customer. We can currently display the software version number (i.e., Software Version number 01.8.30 would be shown on the main display as 01830 by using controls on the device). The software version will also be displayed during the power up cycle. Recommend the status be changed to Informational.

After considering all the comments received, the S&T Committee agreed to change the status of this item to Developing because the item lacks enough information for full consideration and a full proposal had yet to be developed.

This item was included on the NTETC Measuring Sector's Agenda to keep sector members informed of the item and to allow for sector comment, discussion, and input to the S&T Committee.

Conclusion:
The Sector discussed the item briefly. Mr. Truex, NTEP Administrator, shared that there is still much work to be done on this item. The NTETC Measuring Sector had no specific recommendations for the NTETC Software Sector to consider.

19. Interpretation of VTM Code 3.31., Paragraph S.2.4., with Regard to Individual vs. Multiple Deliveries

Source:
NTEP Measuring Laboratories and Ms. Butcher, NIST, OWM

Background/Discussion:
NIST, OWM received an inquiry from a regulatory official regarding the application of the VTM Code Paragraph S.2.4. Zero-Set-Back Interlock. The regulator reported receiving a complaint from a buyer who received a receipt for an individual delivery that was labeled "multiple delivery." This discussion revealed that the code is not clear regarding how the zero-set-back interlock and 3-minute timeout are to function relative to both "individual" and "multiple" deliveries. There currently is no requirement for a delivery to be designated as "individual" or "multiple." However, the NTEP Measurement Laboratories agreed that such a provision would be beneficial to field officials in identifying improper use of the device. The laboratories also discussed how paragraph S.2.4. is currently being implemented and agreed there may be confusion on how the current language applies.

NIST, OWM requests input from the Sector on the development of a proposal to help clarify how S.2.4. was intended to apply and on the concept of requiring the type (i.e., "individual" or "multiple") of delivery to be automatically identified. Modifications to paragraph S.2.4. might include an addition of a new user requirement that explains how the operator is to control and/or document "individual" vs. "multiple" delivery status. The proposal might also clearly explain if and how the 3-minute timeout is to function depending on the "individual" vs. "multiple" status.

Conclusion:
The Sector discussed the issue briefly. Ms. Butcher, NIST, OWM, explained that the item was to engage stakeholders interested in seeking a solution to the issue that meets inspectors' and consumers' needs, but is not burdensome to manufacturers or users. The issue was raised when a ticket appeared with "multiple delivery" printed on it and it could not be explained what this means. She noted that the item is still developing and there is no specific proposal to consider at this point. Mr. Miller, FMC Technologies Measurement Solutions, Inc., and Mr. Karimov, Liquid Controls, expressed interest in providing input on the item as it is being developed.

ACTION ITEMS TABLE

NTETC Measuring Sector Meeting
October 21-22, 2011, Norfolk, Virginia

Agenda Item	Title	Task	Responsible Person(s)	Due Date
1	Add Testing Criteria to NCMW Publication 14, NTEP Policy U. Evaluating Electronic Indicators Submitted Separate from a Measuring Element	Finalize the checklist, addressing all highlighted areas and the five open issues	• Work Group	1/3/12
		Forward finalized checklist to Mike Frailer and Allen Katalinic for review	• Rich Miller, FMC Technologies Measurement Solutions, Inc. • Marc Buttler, NIST Technical Advisor	1/4/12
		Review finalized checklist and provide comments to Rich Miller and Marc Buttler	• Mike Frailer, MD • Allen Katalinic, NC	1/17/12
		Incorporate laboratory comments prior to 2012 NCWM Interim Meeting	• Rich Miller, FMC • Marc Buttler, NIST Technical Advisor	1/22/12
2	Development of Water Meters Checklist	Submit recommendation to modify NCWM Publication 14 to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11
3	Development of Hydrogen Gas-Measuring Devices Checklist	Update numbering to reflect 48-58 and forward version with Item I. reference to Marc Buttler	• Michael Keilty, Endress + Hauser Flowtec AG USA	Complete
		Submit recommendation to modify NCWM Publication 14 to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11
4	Product Families Table - Include Water on Existing NTEP CC's	Submit recommendation and voting results to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11
5	Product Families Table – Change Test Requirements for Turbine Meters from Test A to Test E	• Update table with specific proposal and numbers • Incorporate stakeholder input from labs, Rich Miller	• Dmitri Karimov, Liquid Controls	Next Sector Meeting
		Provide Dmitri Karimov with workable table	• Marc Buttler, NIST Technical Advisor • Lindsay Hier, NCWM Project Coordinator	Complete
6	Product Families Table – Consolidate Product Categories for PD and Turbine Meters	Submit recommendation and voting results to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11

Agenda Item	Title	Task	Responsible Person(s)	Due Date
7	Add Metrological Sealing Checklist to Measuring Devices NCWM Publication 14	Update Scale checklist item example as agreed to in the sector meeting	• Technical Advisor, Marc Buttler	Complete
		Submit recommendation to modify NCWM Publication 14 to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11
8	Product Families Table – Categorization of Liquid CO_2	Submit recommendation to modify NCWM Publication 14 to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11
9	Product Families Table – Add Hydrogen (Compressed Gas)	Submit recommendation and voting results to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11
10	Add Units for Compressed Gases to Technical Policy V. List of Price and Quantity Markings on Retail Motor Fuel Dispensers (RMFDs	Submit recommendation to modify NCWM Publication 14 to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11
14	Product Family Table - Restore notation "(Above 50 °C)" to the heated products category definition	Submit recommendation to modify NCWM Publication 14 to NTEP Committee	• Marc Buttler, NIST Technical Advisor	12/1/11
		Address the two NIST Handbook 44 issues related to heated products that were identified	• Marc Buttler, NIST Technical Advisor	Prior to fall 2012 Regional Association meetings
15	Next Meeting	Identify location and time of next SWMA Meeting and propose location to NTEP Committee	• Chair • NTEP Administrator • NIST Technical Advisor	2012 Interim Meeting

Carry Over Actions from 2010 Measuring Sector				
	Hydrogen Gas-Measuring Devices Checklist	Monitor USNWG progress on developing test procedures. Begin development of type evaluation test procedures when USNWG completes test procedures work.	Hydrogen Meters Checklist Sub-Group	Ongoing

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Appendix A

Draft National Type Evaluation Program
Evaluating Digital Indicators – Checklists and Test Procedures

Introduction

This checklist is used for Technical Policy U. Evaluating Electronic Digital Indicators submitted separate from a measuring element. This section is intended for lab testing only. Is permanence necessary?

1. Identification

Code Reference: G-S.1. Identification

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

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

1.2. 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. The abbreviation for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.) The abbreviation for the word "Model" shall be "Mod" or "Mod." Prefix lettering may be initial capitals, all capitals, or all lower case. ☐ Yes ☐ No ☐ N/A

1.3. Except for not-built-for-purpose, software-based devices, a norepetitive serial number. 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. 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

1.4. For not built-for-purpose, software based devices the current software version or revision designation. 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." The 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.) ☐ Yes ☐ No ☐ N/A

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

1.5. An NTEP Certificate of Conformance (CC) Number or a corresponding CC addendum number for devices that have (or will have) a CC. 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." 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.

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

_____

_____

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

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

1.6.1. The required information in G-S.1 Identification. (a), (b), (d), and (e) shall be permanently marked or continuously displayed on the device. **OR** ☐ Yes ☐ No ☐ N/A

1.6.2. The Certificate of Conformance (CC) Number shall be:

1.6.2.1. Permanently marked on the device. **OR** ☐ Yes ☐ No ☐ N/A

1.6.2.2. Continuously displayed. **OR** ☐ Yes ☐ No ☐ N/A

1.6.2.3. 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." ☐ Yes ☐ No ☐ N/A

Note: 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.

1.7. The identification badge must be visible after installation. ☐ Yes ☐ No ☐ N/A

1.8. The identification badge must be permanent. ☐ Yes ☐ No ☐ N/A

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

This applies to all metering system indicators installed at a fixed location or vehicle tank meter applications and controlled remotely or within the device itself. This requirement addresses the process of changing the unit price or unit prices set in a metering system.

1.9. The system shall prevent a change of unit price during a delivery. ☐ Yes ☐ No ☐ N/A

Code Reference: G-S.3. Permanence <u>How would this be conducted or not?</u>

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

1.10.1. Accuracy will be maintained. ☐ Yes ☐ No ☐ N/A

1.10.2. Operating parts will continue to function as intended. ☐ Yes ☐ No ☐ N/A

1.10.3. Adjustments will remain reasonably permanent. ☐ Yes ☐ No ☐ N/A

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

If a metering system has parts that may be interchanged or reversed 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 of cables to peripheral devices.

1.11. If a metering system has any parts that may be interchanged or reversed in normal field assembly, the parts must either be:

- 1.11.1. Constructed so that reversal will not affect performance. ☐ Yes ☐ No ☐ N/A
- 1.11.2. Marked or keyed to indicate their proper positions. Multiple cable connections but not interchangeable due to different plug styles. ☐ Yes ☐ No ☐ N/A
- 1.11.3. Cables are connected but are not removable without breaking a seal and opening housing. ☐ Yes ☐ No ☐ N/A

2. Indications and Recorded Representations Look at Different Codes

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

Several general requirements 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. Metering devices must be capable of indicating the maximum quantity and money values that can normally be expected in a particular application.

2.1. Minimum quantity value indications:

- 2.1.1. Display is capable of 1.0 ☐ Yes ☐ No ☐ N/A
- 2.1.2. Display is capable of 01 ☐ Yes ☐ No ☐ N/A
- 2.1.3. Display is capable of 0.01 ☐ Yes ☐ No ☐ N/A
- 2.1.4. Display is capable of 0.001 ☐ Yes ☐ No ☐ N/A
- 2.1.5. Display is capable of other: ☐ Yes ☐ No ☐ N/A

_____

2.2. Money value is properly displayed

2.3. The indications must be clear, definite and accurate: ☐ Yes ☐ No ☐ N/A

- 2.3.1. Values must be clear, definite and accurate. ☐ Yes ☐ No ☐ N/A
- 2.3.2. Unit of measure is programmable Gallon, Liter, Pound. ☐ Yes ☐ No ☐ N/A
- 2.3.3. Unit of measure is applied by permanent marking on indicator housing. ☐ Yes ☐ No ☐ N/A

2.4. The indications must be easily read under normal operating conditions. ☐ Yes ☐ No ☐ N/A

2.5. Symbols for decimal points shall clearly identify the decimal position. (Generally acceptable symbols are dots, small commas, or x.) ☐ Yes ☐ No ☐ N/A

2.6. The zero indication must consist of at least the following minimum indications as appropriate:

- 2.6.1. One digit to the left and all digits to the right of a decimal point. ☐ Yes ☐ No ☐ N/A
- 2.6.2. If a decimal point is not used, at least one active decade must be displayed. ☐ Yes ☐ No ☐ N/A

2.7. Totalizer values must be accurate to the nearest minimum interval with decimal points displayed or subordinate digits adequately differentiated from others, if applicable. ☐ Yes ☐ No ☐ N/A

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

2.8. Basic operating requirements for devices:

2.8.1. All digital values of like value in a system shall agree with one another. ☐ Yes ☐ No ☐ N/A

2.8.2. A digital value coincides with its associated analog value to the nearest minimum graduation. ☐ Yes ☐ No ☐ N/A

2.8.3. Digital values shall round off to the nearest minimum unit that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A

2.8.4. 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

2.9. 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.

2.9.1. All digital values of like value in a system agree with one another. ☐ Yes ☐ No ☐ N/A

2.9.2. Digital values coincide with associated analog values to the nearest minimum graduation. ☐ Yes ☐ No ☐ N/A

2.9.3. Digital values "round off" to the nearest minimum unit that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A

2.9.4. The device totalizer shall agree with the total of the individual deliveries and with other totalizers in the system. ☐ 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. The latter more likely occurs on analog devices. In digital indications, the digits are usually of uniform size throughout a particular display. The size of digits may differ for different quantities, for example, the quantity and unit price digits may be smaller than the total price digits.

2.10. Delete this line, nothing here.

2.11. Indications and recorded representations shall be appropriately portrayed or designated. ☐ Yes ☐ No ☐ N/A

Code Reference: G-S.5.2.4. Values Defined

2.12. Values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations, which are 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

2.13. Indications, or recorded representations and their defining figures, words, and symbols shall be of such character that they will not tend to 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

2.14. Digital indications and recorded representations shall be uniform in size, character, and value throughout any series. Quantity values shall be defined by the specific unit of measure in use. ☐ Yes ☐ No ☐ N/A

2.15. Indications shall be uniform throughout any series. ☐ Yes ☐ No ☐ N/A

2.16. 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.

2.17. 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

2.18. All recorded values shall be digital. *See also G-UR.3.3.* ☐ Yes ☐ No ☐ N/A

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

2.19. ~~Magnified indications shall conform to all requirements for graduations and indications.~~ Do not think this is needed and intend on removing this section. ~~☐ Yes ☐ No ☐ N/A~~

Code Reference: G-S.5.6. Marking, Operational Controls, Indications and Features

All operational controls, indications, and features shall be clearly and definitely identified. Nonfunctional 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 be understood by the customer and aid in understanding 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.

2.20. All operational controls, indications, and features including switches, lights, displays, and push buttons shall be clearly and definitely identified. ☐ Yes ☐ No ☐ N/A

2.21. All dual function (multi-function) keys or controls shall be marked to clearly identify all functions. ☐ Yes ☐ No ☐ N/A

2.22. Non-functional controls and annunciators shall not be marked. ☐ Yes ☐ No ☐ N/A

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

2.23. Required markings and instructions shall be permanent and easily read. ☐ Yes ☐ No ☐ N/A

Code Reference: G-S.8. Sealing Electronic Adjustable Components and Provision for Sealing of Adjustable Components or Audit Trail

2.24. 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. These components include the following: ☐ Yes ☐ No ☐ N/A

1. mechanical adjustment mechanism for meters,
2. the electronic calibration factor and automatic temperature compensator for electronic meter registers,
3. selection of pressure for density correction capability and correction values, and
4. pulser setting and gallon/liter conversion switches when they may accidentally or intentionally be used to perpetrate fraud.

The following philosophy and list of sealable parameters applies 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 volume measurement has been changed. The information contained in the audit trail shall consist of a cumulative and non-destructible number (even if a power failure occurs) which increments each time any of the adjustments 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 of the checklist for Liquid-Measuring Devices.

Philosophy for Sealing

Typical Features to Be Sealed

Principles for Determining Features to Be Sealed

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 which the operator routinely uses as part of device operation, such as setting the unit prices on dispensers and maintaining unit prices in price look-up codes stored in memory, 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.

If a physical act, such as cutting a wire is required to change a parameter setting and physically repairing the cut is required to reactivate the parameter, then this physical repair process would 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 whose values are expected to be entered only once and not changed after all initial installation settings are made. Examples include the following.

1. Octane or other blend setting ratios (optional in Canada at this time.)
3. Temperature, pressure, density, and other sensor settings for zero, span, and offset values.
4. Measurement units (in Canada, only if not displayed or printed on the primary register.)
5. Temperature compensation table, liquid coefficient of expansion, or compressibility factors or tables.
6. Liquid density setting (in Canada, only if not displayed or printed on the primary register) and allowable liquid density input range.
7. Vapor pressures of liquids if used in calculations to establish the quantity.
8. Meter or sensor temperature compensation factors.
9. False or missing pulse limits for dual pulse systems (Canada only.)
10. On/off status of automatic temperature, pressure, or density correction.
11. Automatic or manual data input for sensors.
12. Dual pulse checking feature status on or off.
13. Flow control settings (optional in Canada.)
14. Filtering constants.

Liquid Measuring Device Features and Parameters

Typical Features or Parameters to be Sealed	**Typical Features or Parameters <u>NOT</u> Required to be Sealed**
• Measuring Element Adjustment (both mechanical and electronic) • Linearity Correction Values • Measurement Units (e.g., gallons to liters) • Octane Blend Setting for Retail Motor Fuel Dispensers • Any Tables or Settings Accessed by the Software or Manually Entered to Establish the Quantity (e.g., specific gravity, pressure, etc.) • Density Ranges • Pulsers • Single Pick-up (magnetic or reluctance) • Temperature Probes and Temperature Offsets in Software • Pressure and Density Sensors and Transducers • Flow Control Settings (e.g., flow rates for slow-flow start, quantity for slow-flow start and stop) • Temperature Compensating Systems (on/off) • Differential Pressure Valves • 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 retail motor fuel dispensers slow product flow during a prepaid transaction to enable the dispenser to stop at the preset amount.	• Analog-to-Digital Converters • Quantity Division Value (display resolution) • Double Pulse Counting • Communications

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).

Category 1 Devices (Devices with <u>No</u> Remote Configuration Capability):

- Required markings and instructions shall be permanent and easily read. ☐ Yes ☐ No ☐ N/A
- 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
- A physical seal must be applied without exposing electronics. ☐ Yes ☐ No ☐ N/A
- Event counters are non-resettable and have a capacity of at least 000 to 999. ☐ Yes ☐ No ☐ N/A
- Event counters increment appropriately. ☐ Yes ☐ No ☐ N/A
- The audit trail information must be capable of being retained in memory for at least 30 days while the device is without power. ☐ Yes ☐ No ☐ N/A
- Accessing the audit trail information for review shall be separate from the calibration mode. ☐ Yes ☐ No ☐ N/A
- Accessing the audit trail information must not affect the normal operation of the device. ☐ Yes ☐ No ☐ N/A

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

- The physical hardware enabling access for remote communication must be on- site. ☐ Yes ☐ No ☐ N/A
- The physical hardware must be sealable with a security seal, **OR** ☐ Yes ☐ No ☐ N/A
- The device must be equipped with at least two event counters: one for calibration, the second for configuration parameters. ☐ Yes ☐ No ☐ N/A
  - Calibration parameters event counter
  - Configuration parameters event counter
- Adequate provision must be made to apply a physical seal without exposing electronics. ☐ Yes ☐ No ☐ N/A
- Event counters are non-resettable and have a capacity of at least 000 to 999. ☐ Yes ☐ No ☐ N/A
- Event counters increment appropriately. ☐ Yes ☐ No ☐ N/A
- Event counters may be located either: ☐ Yes ☐ No ☐ N/A
  - at the individual measuring device or
  - at the system controller
- 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
- 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
- The device must either: ☐ Yes ☐ No ☐ N/A
  - clearly indicate when it is in the remote configuration mode, **OR**
  - the device shall not operate while in the remote configuration mode.
- If capable of printing in the calibration mode, it must print a message that it is in the calibration mode. ☐ Yes ☐ No ☐ N/A
- The audit trail information must be capable of being retained in memory for at least 30 days while the device is without power. ☐ Yes ☐ No ☐ N/A
- The audit trail information must be readily accessible and easily read. ☐ Yes ☐ No ☐ N/A

Minimum Number of Counters Required

	Minimum Counter(s) Required for Devices Equipped with Event Counters	Minimum Event Counter(s) at System Controller
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 though a password.

- For devices manufactured after January 1, 2001, the device must either: ☐ Yes ☐ No ☐ N/A
  - clearly indicate when it is in the remote configuration mode, or
  - the device shall not operate while in the remote configuration mode
- The device is equipped with an event logger ☐ Yes ☐ No ☐ N/A
- 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
- Event counters are non-resettable and have a capacity of at least 000 to 999. ☐ Yes ☐ No ☐ N/A
- The system is designed to attach a printer, which can print the contents of the audit trail. ☐ Yes ☐ No ☐ N/A
- The audit trail information must be capable of being retained in memory for at least 30 days while the device is without power. ☐ Yes ☐ No ☐ N/A
- 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
- The event logger drops the oldest event when the memory capacity is full and a new entry is saved. ☐ Yes ☐ No ☐ N/A
  - Describe the method used to seal the device or access the audit trail information. Is this used?

_____

_____

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. Remove?

2.25. The equipment is suitable for its intended application. Remove? ☐ Yes ☐ No ☐ N/A

2.26. Equipment shall be suitable for use in the environment in which it will be used. 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. Unless specific tests are developed this has no meaning! ☐ Yes ☐ No ☐ N/A

Simulator Tests:

All tests shall have a minimum of 10,000 pulses applied to the device for each test. Test with a minimum of two API/Density settings. Is this appropriate for all indicator technologies PD, Mass, Mag, etc?

Product:	**Meter Factor:**	**K Factor:**	
1	Test with liquid temperature between 55 – 65 degrees F at the manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
2	Test with liquid temperature between 55 – 65 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
3	Test with liquid temperature below 35 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
4	Test with liquid temperature below 35 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
5	Test with liquid temperature above 100 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity: Temperature:	☐ Yes ☐ No ☐ N/A
6	Test with liquid temperature above 100 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity: This way OR? Temperature:	☐ Yes ☐ No ☐ N/A
7	Test with liquid temperature between 55 – 65 degrees F at the manufactures rated maximum frequency/pulse rate.	API Gravity/Density: This way? Temperature:	☐ Yes ☐ No ☐ N/A
8	Test with liquid temperature between 55 – 65 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
9	Test with liquid temperature below 35 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
10	Test with liquid temperature below 35 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
11	Test with liquid temperature above 100 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
12	Test with liquid temperature above 100 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
13		API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
14		API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A

15		API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
Product:	**Meter Factor:**	**K Factor:**	
1	Test with liquid temperature between 55 – 65 degrees F at the manufactures rated maximum frequency/pulse rate.	API Gravity: Temperature:	☐ Yes ☐ No ☐ N/A
2	Test with liquid temperature between 55 – 65 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity: Temperature:	☐ Yes ☐ No ☐ N/A
3	Test with liquid temperature below 35 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity: Temperature:	☐ Yes ☐ No ☐ N/A
4	Test with liquid temperature below 35 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity: Temperature:	☐ Yes ☐ No ☐ N/A
5	Test with liquid temperature above 100 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity: Temperature:	☐ Yes ☐ No ☐ N/A
6	Test with liquid temperature above 100 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity: Temperature:	☐ Yes ☐ No ☐ N/A
7	Test with liquid temperature between 55 – 65 degrees F at the manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
8	Test with liquid temperature between 55 – 65 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
9	Test with liquid temperature below 35 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
10	Test with liquid temperature below 35 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
11	Test with liquid temperature above 100 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
12	Test with liquid temperature above 100 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
13		API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
14		API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
15		API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
16		API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A
17		API Gravity/Density: Temperature:	☐ Yes ☐ No ☐ N/A

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Appendix B
Draft 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.

44. Indicating and Recording Element

Code Reference: S.1.1.1. General

44.1. 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

44.2. 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

44.3. 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:

44.3.1. 50 L (10 gal or 1 ft^3) on utility type meters, sizes 1 in and smaller, **OR** ☐ Yes ☐ No ☐ N/A

44.3.2. 500 L (100 gal or 10 ft^3) on utility type meters, sizes 1½ in and 2 in, **OR** ☐ Yes ☐ No ☐ N/A

44.3.3. 0.2L ($^1/_{10}$ gal or $^1/_{100}$ ft^3) on batching meters delivering less than 375 L/min (100 gal/min or 13 ft^3/min), **OR** ☐ Yes ☐ No ☐ N/A

44.3.4. 5 L (1 gal or $^1/_{10}$ ft^3) on batching meters delivering 375 L/min (100 gal/min or 13 ft^3/min) or more. ☐ Yes ☐ No ☐ N/A

Code Reference: S.1.1.4. Advanced of Indicating and Recording Elements

44.4. 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

44.5. 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

44.6. 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

44.7. 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

44.8. 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:

44.8.1. along the line of relative movement between the graduations at the end of the indicator, **OR** ☐ Yes ☐ No ☐ N/A

44.8.2. 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

44.9. 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

44.10. 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

44.11. 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:

44.11.1. the width of the widest graduation, **AND** ☐ Yes ☐ No ☐ N/A

44.11.2. 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

44.12. 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

44.13. Parallax effects shall be reduced to the practicable minimum. ☐ Yes ☐ No ☐ N/A

45. Measuring Elements

Code Reference: S.2.1. Provision for Sealing

45.1. Adequate provision shall be made for applying security seals in such a manner that no adjustment or interchange may be made of:

44.13.1. any measurement elements, **AND** ☐ Yes ☐ No ☐ N/A

44.13.2. any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries. ☐ Yes ☐ No ☐ N/A

The adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

46. Batching Meters Only

Code Reference: S.2.2.1. Air Elimination

46.1. Batching meters shall be equipped with an effective air eliminator. ☐ Yes ☐ No ☐ N/A

Code Reference: S.2.2.2. Directional Flow Valves

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

47. Multi-jet Meter Indication

Code Reference: S.2.3. Multi-jet Meter Indication

47.3. 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

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Appendix C

Draft 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.

48. Indicating and Recording Elements and Recorded Representations

Code Reference: S.1.1. Indicating Elements

48.1. 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

48.2. Is the device equipped with a primary recording element? ☐ Yes ☐ No ☐ N/A

Code Reference: S.1.2. Vehicle Fuel Dispensers

48.3. 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.

48.4. Indicating and recording elements shall advance only by the operation of the device (except for clearing the device to zero). ☐ Yes ☐ No ☐ N/A

48.5. 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

48.6. 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.

48.7. An electronic digital indicating element shall either:

48.7.1. Have adequate display capacity for the application, OR ☐ Yes ☐ No ☐ N/A

48.7.2. Automatically stop the delivery before exceeding the maximum ☐ Yes ☐ No ☐ N/A

quantity or maximum total price that can be indicated.

Code Reference: G-S.7. Lettering

48.8. 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

48.9. 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.

48.10. Digital quantity indications must agree. ☐ Yes ☐ No ☐ N/A

48.11. Manual quantity entries in invoice billing systems must be identified as such. ☐ Yes ☐ No ☐ N/A

48.12. 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

48.13. All total sale money value indications in a computing system are primary indications and must agree. ☐ Yes ☐ No ☐ N/A

48.14. 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

48.15. The **printed ticket** and dispenser money values shall be in mathematical agreement to the nearest cent. ☐ Yes ☐ No ☐ N/A

48.16. The quantity, unit price, and total price indications on the **console** shall be in ☐ Yes ☐ No ☐ N/A

mathematical agreement with the dispenser and printed ticket.

48.17. 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.

48.17.1. The quantity values indicated or recorded on a console, electronic cash register, or other auxiliary indicating or recording element may differ, however:

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

48.17.1.2. 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

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

48.18.1. At various flow rates, including maximum and minimum. ☐ Yes ☐ No ☐ N/A

48.18.2. Closing and reopening the nozzle outlet valve several times during delivery. Check mathematical agreement each time flow is halted. ☐ Yes ☐ No ☐ N/A

48.18.3. 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

48.18.4. 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 five 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 five 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

48.19. The selected unit price must be made clearly evident on the dispenser. ☐ Yes ☐ No ☐ N/A

48.20. 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

48.21. 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:

48.21.1. Customer initiation of the delivery using the controls at the device, **OR** ☐ Yes ☐ No ☐ N/A

48.21.2. "Authorization/Approval" by the console operator. ☐ Yes ☐ No ☐ N/A

48.22. 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

48.23. 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.

48.24. 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

48.25. The customer receipt must contain the following information:

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

48.26. **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. ☐ 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.

48.27. **Invoice Billing** - Invoice billing is a process in which customers are billed for one or more transactions at the end of a billing period.

48.27.1. The date, quantity, unit price, and total price shall be recorded and shall agree with the indications on the dispenser. ☐ Yes ☐ No ☐ N/A

48.27.2. 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

48.28. 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

48.29. 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

48.30. 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

48.31. 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

48.32. 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.

48.1. 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

48.2. The quantity and total sales price shall be recallable for 15 minutes after the power failure. ☐ Yes ☐ No ☐ N/A

48.3. The quantity and total sales price values shall be correct if the power fails between deliveries. ☐ Yes ☐ No ☐ N/A

48.4. The quantity and total sales price values shall be correct if the delivery is continued after a power failure. ☐ Yes ☐ No ☐ N/A

48.5. The operator's information shall be retained in memory during a power failure. ☐ Yes ☐ No ☐ N/A

48.6. 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.

48.7. Does the device have a primary recording element? ☐ Yes ☐ No ☐ N/A

48.8. The indicating and recording elements of a retail device shall be readily returnable to a definite zero indication. ☐ Yes ☐ No ☐ N/A

48.9. Key-lock and self-operated devices shall have an indicating element that return to zero. ☐ Yes ☐ No ☐ N/A

48.10. Does the device have:

48.10.1. A cumulative indicating element? ☐ Yes ☐ No ☐ N/A

48.10.2. A cumulative recording element? ☐ Yes ☐ No ☐ N/A

48.11. 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

48.12. Means shall be provided to display the unit price on each face of the device. ☐ Yes ☐ No ☐ N/A

48.13. Means shall be provided to post on each side of the device the identity of the dispensed product. ☐ Yes ☐ No ☐ N/A

48.14. 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:

48.14.1. Shall be displayed prior to the delivery of the product, OR ☐ Yes ☐ No ☐ N/A

48.14.2. Shall be capable of being displayed on the dispenser using controls available to the customer. ☐ Yes ☐ No ☐ N/A

48.14.3. 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.

48.15. 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

48.16. 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.)

49. 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.

49.1. 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

48.17. All quantity, unit price, and total price indications shall agree. ☐ Yes ☐ No ☐ N/A

Code Reference: S.2.5.1. Auxiliary Elements

48.18. 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

50. 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

50.1. A printed receipt shall be available for devices activated by debit cards, credit cards, and/or cash. The printed receipt:

- 50.1.1. Shall contain the total mass of the delivery; ☐ Yes ☐ No ☐ N/A
- 50.1.2. Shall contain the unit price; ☐ Yes ☐ No ☐ N/A
- 50.1.3. Shall contain the total computed price; and, ☐ Yes ☐ No ☐ N/A
- 50.1.4. Shall contain the product identity by name, symbol, abbreviation, or code number. ☐ Yes ☐ No ☐ N/A

Code Reference: S.6. Printer

50.2. Printed information must agree with the indications on the dispenser.

- 50.2.1. Printed values shall be clearly defined. ☐ Yes ☐ No ☐ N/A

Code Reference: S.6.1. Printed Receipt

50.3. Any delivered, printed quantity:

- 50.3.1. Shall include an identification number, and; ☐ Yes ☐ No ☐ N/A
- 50.3.2. Shall include the time and date, and; ☐ Yes ☐ No ☐ N/A
- 50.3.3. Shall include the name of the seller. ☐ Yes ☐ No ☐ N/A

51. Design of Measuring Elements and Measuring Systems

Code Reference: S.3.1. Maximum and Minimum Flow-Rates

51.1. 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

51.2. Means shall be provided to change the ratio between the indicated quantity and the quantity of gas measured by the assembly.

- 51.2.1. 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

51.3. 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.

51.4. A measuring element shall have provisions for either:

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

51.4.2. 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

51.5. 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

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

51.7. 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

51.8. 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

51.9. 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.

51.10. 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

51.11. 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

51.12. 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

51.13. 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

52. Discharge Lines and Valves

Code Reference: S.4.1. Diversion of Measured Product

52.1. 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

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

Code Reference: S.4.3. Other Valves

52.3. 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

53. Markings

Code Reference: S.5. Marking Requirements

53.1. A measuring system shall be conspicuously, legibly, and indelibly marked with:

53.1.1. Pattern approval mark (e.g., type approval number); ☐ Yes ☐ No ☐ N/A

53.1.2. 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

53.1.3. Model designation or product name selected by the manufacturer; ☐ Yes ☐ No ☐ N/A

53.1.4. Non-repetitive serial number; ☐ Yes ☐ No ☐ N/A

53.1.5. 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

53.1.6. Maximum and minimum flow rates in kilograms per unit of time; ☐ Yes ☐ No ☐ N/A

53.1.7. Maximum working pressure; ☐ Yes ☐ No ☐ N/A

53.1.8. Applicable temperature range if other than – 10 °C to + 50 °C; ☐ Yes ☐ No ☐ N/A

53.1.9. Minimum measured quantity (MMQ.); ☐ Yes ☐ No ☐ N/A

53.1.10. 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

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

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

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

53.2.3. 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.

54. Totalizers

Code Reference: S.7. Totalizers for Retail Vehicle Fuel Dispensers

54.1. Vehicle fuel dispensers shall be equipped with a non-resettable totalizer for the quantity delivered through each separate measuring device. ☐ Yes ☐ No ☐ N/A

55. Minimum Measured Quantity

Code Reference: S.8. MMQ

55.1. The minimum measured quantity shall satisfy the conditions of use of the measuring system as follows:

55.1.1. 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

55.1.2. 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

56. 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 three 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 de-authorize. 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.

56.1. The dispenser must de-authorize in not more than three minutes if the pump "control" is not turned on. ☐ Yes ☐ No ☐ N/A

56.2. If the time limit to deactivate a dispenser is programmable, it shall not accept an entry greater than three minutes. ☐ Yes ☐ No ☐ N/A

56.3. When a power loss greater than 10 seconds occurs after the pump "control" is on, the dispenser must de-authorize. ☐ Yes ☐ No ☐ N/A

56.4. When there is a loss of power, but the dispenser "control" is not on, the dispenser must de-authorize in not more than three minutes. ☐ Yes ☐ No ☐ N/A

57. Test Methods for Card-Activated Retail Vehicle Fuel Dispensers

57.1. 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.

57.1.1. 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

57.2. Authorize the dispenser using a card (leaving control off); wait more than three minutes, and try to start the dispenser. It should not start because the authorization should have timed out. ☐ Yes ☐ No ☐ N/A

57.2.1. Authorize with a card, but do not turn the "control" on. Power down for more than three minutes, and then restore power. Try to dispense product; the dispenser should have "timed-out" and not dispense. ☐ Yes ☐ No ☐ N/A

57.2.2. 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

57.2.3. 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

57.2.4. 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

57.2.5. 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

57.2.6. 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.

48.18.1. 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 3 minute time-out. ☐ Yes ☐ No ☐ N/A

57.3. 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

58. 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

58.1. Systems with Battery Back-up or Uninterruptible Power Supply or Equivalent - Some 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. ☐ Yes ☐ No ☐ N/A

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.

58.2. 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:

58.2.1. 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

58.2.2. 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

58.2.3. The running total display must be capable of being recalled for at least 15 minutes. ☐ Yes ☐ No ☐ N/A

58.2.4. 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

58.2.5. Other means used to provide a visual or printed record of the total amount of money accepted by the device. ☐ Yes ☐ No ☐ N/A

58.3. 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.

58.3.1. 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.

58.4. 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:

58.4.1. After one bill has been inserted. ☐ Yes ☐ No ☐ N/A

58.4.2. After several bills have been inserted ☐ Yes ☐ No ☐ N/A

58.4.3. While a bill is being inserted. ☐ Yes ☐ No ☐ N/A

58.4.4. After a bill has been inserted but not yet recognized. ☐ Yes ☐ No ☐ N/A

58.4.5. After a bill(s) has been inserted and recognized, but the on/off control is still in the "off" position. ☐ Yes ☐ No ☐ N/A

58.4.6. 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

58.4.7. 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

58.5. 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

58.6. 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

58.6.1. The customer receipt must contain the following information: ☐ Yes ☐ No ☐ N/A

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

58.6.3. 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.

58.7. The cash acceptor must not initiate a cash transaction if either of the following conditions is true:

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

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

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

2.1. 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

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

58.8.1. 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:

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

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

58.8.1.3. 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

58.8.1.4. 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.

58.8.2. 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:

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

58.8.2.2. 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").

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Appendix D

Draft NCWM Publication 14, Liquid Measuring Devices 2.16.

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	☐ Yes	☐ No	☐ N/A
Push-button (memory switch)	☐ Yes	☐ No	☐ N/A
Toggle/Slide Switch	☐ Yes	☐ No	☐ N/A
Other (describe in remarks)	☐ Yes	☐ No	☐ N/A
Meets Requirements	☐ Yes	☐ No	☐ N/A

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

Jumper	☐ Yes	☐ No	☐ N/A
Push-button (memory switch)	☐ Yes	☐ No	☐ N/A
Toggle/Slide Switch	☐ Yes	☐ No	☐ N/A
Other (describe in remarks)	☐ Yes	☐ No	☐ N/A
Meets Requirements	☐ Yes	☐ No	☐ 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 may be acceptable.

Acceptable Clear Indications	Indications NOT Acceptably Clear
Unusable quantity indications Example: C100.05E	C 100.05 gal
"not NIST Handbook 44" annunciator	Any digit in the quantity differentiated by size, shape, or color
"CAL" Annunciator (single or mixed case)	Quantities w/o units Example:100.05
"Set-up" Annunciator (single or mixed case)	Flashing Quantity Value
"Config" Annunciator (single or mixed case)	Quantity with No Annunciators Displayed
	Quantity All Annunciators Displayed

Mass Meter
Product Category and Test Requirements

Test 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.

Note: Product categories under Test B were formerly referred to collectively as "Normal Liquids."

Typical Products	Specific Gravity[2] (60 °F)	Product Category
Butanol	0.81	Alc Gly
Ethanol	0.79	Alc Gly
Ethylene Glycol	1.19	Alc Gly
Isobutyl	0.81	Alc Gly
Isopropyl	0.79	Alc Gly
Methanol	0.80	Alc Gly
Propylene Glycol	1.04	Alc Gly
Banvel	0.7 – 1.2	CC-A
Herbicides	0.7 – 1.2	CC-A
Paraquat	0.7 – 1.2	CC-A

Magnetic Flow Meter
Product Category and Test Requirements

Test F
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.

Typical Products	Conductivity (micro-siemens/centimeter)	Product Category
Butanol		Alc Gly
Ethanol	0.0013	Alc Gly
Ethylene Glycol		Alc Gly
Isobutyl	0.02	Alc Gly
Isopropyl	3.5	Alc Gly
Methanol	0.44	Alc Gly
Propylene Glycol		Alc Gly
6 Oil (#5, #6)		FL&O
Asphalt		FL&O
Avgas		FL&O

Positive Displacement Flow Meter Product Category and Test Requirements

Test C
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.

Product Category:
Alcohols, Glycols and Water Mixes Thereof (Alc Gly)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Butanol	3.34
Ethanol	1.29
Ethylene Glycol	25.5
Isobutyl	4.54
Isopropyl	2.78
Methanol	0.64
Propylene Glycol	54

Test C
Product Category:
Crop Chemicals (Type A) (CC-A)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Banvel	4 – 400

Turbine Flow Meter
Product Category and Test Requirements

Test E
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.[1]

Product Category:
Alcohols, Glycols and Water Mixes Thereof (Alc Gly)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Butanol	3.34
Ethanol	1.29
Ethylene Glycol	25.5
Isobutyl	4.54
Isopropyl	2.78
Methanol	0.64
Propylene Glycol	54

Test E
Product Category:
Compressed Liquids, Fuels and Refrigerants
NH_3 (Comp liq)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Anhydrous Ammonia	0.188

[1] Kinematic viscosity is measured in centistokes. Source for some of the viscosity value information is in the Industry Canada – Measurement Canada "Liquid Products Group, Bulletin V-16-E (rev.1), August 3, 1999."

$$\text{Centistokes } (m^2/s) = \frac{\text{Centipoise } (kg/m\ s)}{\text{density } (kg/m^3)}$$

[2] 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^3 (or 998 kg/m^3). 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[2] (60 °F)**	**Product Category**	**Typical Products**	**Conductivity (micro-siemens/centimeter)**	**Product Category**	**Test C** **Product Category:** Crop Chemicals (Type A) (CC-A) continued		**Test E** **Product Category:** Compressed Liquids, Fuels and Refrigerants NH_3 (Comp liq) continued	
Prowl	0.7 – 1.2	CC-A	Biodiesel above B20		FL&O	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**
Round-up	0.7 – 1.2	CC-A	Bunker Oil		FL&O	Herbicides	4 – 400	Butane	0.19
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	0.313
Adjuvants	0.7 – 1.2	CC-B	Crude Oil		FL&O	Round-up	4 – 400	Freon 12	0.359
Fumigants	0.7 – 1.2	CC-B	Diesel Fuel[3]		FL&O	Touchdown	4 – 400	Freon 22	1.99
Fungicides	0.7 – 1.2	CC-B	Fuel Oil (#1, #2, #3, #4)	0	FL&O	Treflan	4 – 400	Propane	0.098
Insecticides	0.7 – 1.2	CC-B	Gasoline[4]		FL&O	**Test C** **Product Category:** Crop Chemicals (Type B) (CC-B)		**Test E** **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[1] (60 °F) Centipoise (cP)**	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**
Micronutrients	0.9 – 1.65	CC-D	Jet A-1		FL&O	Adjuvants	0.7 – 100	6 Oil (#5, #6)	66 – 13,000
Hydrochloric Acid	1.1	Chem	Jet B		FL&O	Fumigants	0.7 – 100	Asphalt	100 – 5000
Phosphoric Acid	1.87	Chem	JP4		FL&O	Fungicides	0.7 – 100	Avgas	1.5 – 6
Sulfuric Acid	1.83	Chem	JP5		FL&O	Insecticides	0.7 – 100	Biodiesel above B20	10.12
3-10-30	0.9 – 1.65	Fert	JP7 and JP8		FL&O	**Test C** **Product Category:** Crop Chemicals (Type C) (CC-C)		Bunker Oil	11,200
4-4-27	0.9 – 1.65	Fert	Kerosene		FL&O	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	Cooking Oils	9.93
9-18-9	1.32	Fert	Light Oil		FL&O	Fungicides	20 – 900	Corn Oil	4
10-34-0	1.39	Fert	Lubricating Oils		FL&O	**Test C** **Product Category:** Crop Chemicals (Type D) (CC-D)		Crude Oil	3 – 1783
20% Aqua-Ammonia	0.89	Fert	Olive Oil		FL&O	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	Diesel Fuel[3]	10
28%, 30% or 32%	1.28 – 1.32	Fert	Peanut Oil		FL&O	Micronutrients	20 – 1000	Fuel Oil (#1, #2, #3, #4)	8 – 88

[3] Diesel fuel blends (biodiesel with up to 20% vegetable or animal fat/oil.)
[4] Gasoline includes oxygenated fuel blends with up to 15% oxygenate.

Mass Meter Product Category and Test Requirements

Typical Products	Specific Gravity[2] (60 °F)	Product Category
Ammonia Nitrate	1.16 – 1.37	Fert
Clear Liquid Fertilizer	1.17 – 1.44	Fert
Nitrogen Solution	1.17 – 1.44	Fert
N-P-K Solutions	1.2 – 1.4	Fert
Urea	1.89	Fert
6 Oil (#5, #6)	0.9	FL&O
Asphalt		FL&O
Avgas		FL&O
Biodiesel above B20	0.86	FL&O
Bunker Oil	0.99	FL&O
Cooking Oils	0.92	FL&O
Corn Oil	0.91	FL&O
Crude Oil	0.79 – 0.97	FL&O
Diesel Fuel[3]	0.84	FL&O
Fuel Oil (#1, #2, #3, #4)	0.9	FL&O
Gasoline[4]	0.72	FL&O
Jet A		FL&O
Jet A-1	0.76	FL&O
Jet B		FL&O
JP4	0.76	FL&O
JP5	0.76	FL&O
JP7 and JP8	0.76	FL&O

Magnetic Flow Meter Product Category and Test Requirements

Typical Products	Conductivity (micro-siemens/centimeter)	Product Category
SAE Grades		FL&O
Soy Oil	0	FL&O
Spindle Oil		FL&O
Sunflower Oil		FL&O
Vegetable Oil	0	FL&O
Asphalt		Heated
Bunker C		Heated
Carbon Tetra-Chloride		Solv Cl
Methylene-Chloride		Solv Cl
Perchloro-Ethylene		Solv Cl
Trichloro-Ethylene		Solv Cl
Acetates		Solv Gen
Acetone	.02	Solv Gen
Ethylacetate	0.00001	Solv Gen
Hexane	0	Solv Gen
MEK	0.1	Solv Gen
Toluene	0	Solv Gen
Xylene	0	Solv Gen
Deionized		Water
Demineralized		Water

Positive Displacement Flow Meter Product Category and Test Requirements

Test C
Product Category: Chemicals (Chem)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Hydrochloric Acid	0.80 – 1. 0
Phosphoric Acid	161
Sulfuric Acid	1.49

Test C
Product Category: Compressed Liquids, Fuels and Refrigerants (Comp liq)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Anhydrous Ammonia	0.188
Butane	0.19
Ethane	
Freon 11	0.313
Freon 12	0.359
Freon 22	1.99
Propane	0.098

Test C
Product Category: Clear Liquid Fertilizers (Fert)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
9-18-0	
10-34-0	48
20% Aqua-Ammonia	1.1 – 1.3
28%, 30% or 32%	31 – 110
Ammonia Nitrate	11.22
Clear Liquid Fertilizer	31 – 110
Nitrogen Solution	31 – 110

Turbine Flow Meter Product Category and Test Requirements

Test E
Product Category: Fuels, Lubricants, Industrial and Food Grade Liquid oils (FL&O) continued

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Gasoline[4]	0.28
Jet A	1.5 – 6
Jet A-1	1.36
Jet B	1.5 – 6
JP4	1.02
JP5	1.94
JP7 and JP8	1.82
Kerosene	1.94
Light Oil	13.47
Lubricating Oils	20 – 1000
Olive Oil	116.8
Peanut Oil	11 – 110
SAE Grades	192 – 3626
Soy Oil	90.6
Spindle Oil	
Sunflower Oil	90.1
Vegetable Oil	133

Test E
Product Category: Solvents General (Solv Gen)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Acetates	0.44
Acetone	0.34

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[2] (60 °F)**	**Product Category**	**Test D** 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. • 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. • Test D does not apply to product categories of liquefied gases, compressed liquids or heated products.			**Test C Product Category:** Clear Liquid Fertilizers (Fert) continued		**Test E Product Category:** Solvents General (Solv Gen) continued	
Kerosene	0.75	FL&O	**Typical Products**	**Conductivity (micro-siemens/centimeter)**	**Product Category**	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**
Light Oil	0.86	FL&O	Water Mixes of Alcohols and Glycols		Alc Gly	N-P-K Solution		Ethylacetate	1.36
Lubricating Oils	0.80 – 0.90	FL&O	Banvel		CC-A	Urea	1	Hexane	0.34
Olive Oil	0.92	FL&O	Herbicides		CC-A	**Test C Product Category:** Fuels, Lubricants, Industrial and Food Grade Liquid Oils (FL&O)		MEK	0.45
Peanut Oil	0.9 – 1.0	FL&O	Paraquat		CC-A	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	Toluene	0.62
SAE Grades	0.9	FL&O	Prowl		CC-A	6 Oil (#5, #6)	66 – 13,000	Xylene	0.86
Soy Oil	0.93	FL&O	Round-up		CC-A	Asphalt	100 – 5000	**Test A** 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	**Typical Products**	**Product Category**
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[3]	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
Trichloro-Ethylene	1.47	Solv Cl	Hydrochloric Acid	395000	Chem	Gasoline[4]	0.28	Adjuvants	CC-B
Acetates	0.93	Solv Gen	Phosphoric Acid	56600	Chem	Jet A	1.5 – 6	Fumigants	CC-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**	
Typical Products	**Specific Gravity[2] (60 °F)**	**Product Category**	**Typical Products**	**Conductivity (micro-siemens/centimeter)**	**Product Category**	**Test C** **Product Category:** 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[1] (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_3	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	Liquid Molasses	300	Liq Feed	Peanut Oil	11 – 110	9-18-0	Fert
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
Test D 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[2] (60 °F)**	**Product Category**	Juices		Water	Vegetable Oil	133	N-P-K Solutions	Fert
Compressed Natural Gas (CNG)	0.6 – 0.8 (1=Air)	Comp gas	Nonpotable	72[5]	Water			Urea	Fert
Anhydrous Ammonia	0.61	Comp liq	Potable	72[5]	Water			Bicep	Flow
Butane	0.595	Comp liq	Tap Water	72[5]	Water			Broadstrike	Flow

[5] 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

Typical Products	Specific Gravity[2] (60 °F)	Product Category
Ethane		Comp liq
Freon 11	1.49	Comp liq
Freon 12	1.33	Comp liq
Freon 22	1.37	Comp liq
Propane	0.504	Comp liq
Liquefied Natural Gas		Cryo LNG
Liquefied Oxygen	0.66	Cryo LNG
Nitrogen	0.31	Cryo LNG
Asphalt		Heated
Bunker C	1.1	Heated

Test A
The following products must be individually tested and noted on the Certificate of Conformance.

Typical Products	Specific Gravity[2] (60 °F)	Product Category
Compressed Hydrogen Gas (H or H2)	0.07 (1=Air)	CompH2

Magnetic Flow Meter
Product Category and Test Requirements

Positive Displacement Flow Meter Product
Category and Test Requirements

Test C
Product Category:
Flowables (Flow)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Bicep	20 – 900
Broadstrike	20 – 900
Doubleplay	20 – 900
Dual	20 – 900
Guardsman	20 – 900
Harness	20 – 900
Marksman	20 – 900
Topnotch	20 – 900

Test C
Product Category:
Heated (Heated)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Asphalt	100 – 5000
Bunker C	11,200

Test C
Product Category:
Liquid Feed (Liq Feed)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Liquid Molasses	8640
Molasses Plus Phos Acid and/or Urea (TreaChle)	2882

Test C
Product Category:
Solvents Chlorinated (Solv Cl)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Carbon Tetra-Chloride	0.99

Turbine Flow Meter
Product Category and Test Requirements

Typical Products	Product Category
Doubleplay	Flow
Dual	Flow
Guardsman	Flow
Harness	Flow
Marksman	Flow
Topnotch	Flow
Asphalt	Heated
Bunker C	Heated
Liquid Molasses	Liq Feed
Molasses plus Phos Acid and/or Urea (TreaChle)	Liq Feed
Carbon Tetra-Chloride	Solv Cl
Methylene-Chloride	Solv Cl
Perchloro-Ethylene	Solv Cl
Trichloro-Ethylene	Solv Cl
3-10-30	Sus Fert
4-4-27	Sus Fert
Compressed Hydrogen Gas (H or H2)	Comp H2

Test D
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.

Typical Products	Product Category
Liquefied Natural Gas	Cryo LNG
Liquefied Oxygen	Cryo LNG

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

Test C
Product Category:
Solvents Chlorinated (Solv Cl) continued

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Methylene-Chloride	0.46
Perchloro-Ethylene	1
Trichloro-Ethylene	0.6

Test C
Product Category:
Solvents General (Solv Gen)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Acetates	0.44
Acetone	0.34
Ethylacetate	1.36
Hexane	0.34
MEK	0.45
Toluene	0.62
Xylene	0.86

Test C
Product Category:
Suspension Fertilizers (Sus Fert)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
3-10-30	100 – 1000
4-4-27	20 – 215

Test D
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.

Product Category:
Water (Water)

Typical Products	Reference Viscosity[1] (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

Typical Products	Product Category
Nitrogen	Cry LNG
Beverages	Water
Deionized	Water
Demineralized	Water
Juices	Water
Milk	Water
Nonpotable	Water
Potable	Water
Tap Water	Water

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

Test D

Product Category:
Water (Water) continued

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Tap Water	1.0

Test A
The following products must be individually tested and noted on the Certificate of Conformance.

Product Category:
Cryogenic Liquids and Liquefied Natural Gas (Cryo LNG)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Liquefied Natural Gas	
Liquefied Oxygen	0.038
Nitrogen	1.07

Test A
The following products must be individually tested and noted on the Certificate of Conformance.

Product Category:
Compressed Hydrogen Gas (Comp H2)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
Compressed Hydrogen Gas (H or H2)	0.0097

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
CC-D	Crop Chemicals (Type D)	Liq Feed	Liquid Feeds
Chem	Chemicals	Solv Chl	Solvents Chlorinated
Comp gas	Compressed Gases	Solv Gen	Solvents General
Comp H2	Compressed Hydrogen Gas	Sus Fert	Suspension Fertilizers
Comp liq	Compressed Liquids (Fuels and Refrigerants, NH_3)	Water	Water
Cryo LNG	Cryogenic Liquids and Liquefied Natural Gas		

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.