National Type Evaluation Program (NTEP)
Measuring Sector

Annual Meeting
October 9-10, 2013 Charleston, WV

Meeting Summary

Appendices:

Appendix A: Electronic Indicators Checklist Draft [Agenda Item 1]
Appendix B: Proposed Permanence Criteria for Markings, LMD Checklist [Agenda Item 2]
Appendix C: NCWM S&T Committee Item 330-3, 2013 Annual Report, Excerpt [Agenda Item 3]
Appendix D: Product Families Table, Units for Viscosity [Agenda Item 4a]
Appendix E: Receipt Requirements - Card Activated RMFDs [Agenda Item 4b]
Appendix F: Receipt Requirements - Cash Activated RMFDs [Agenda Item 4c]
Appendix G: Receipt Requirements - ECRs Interfaced with RMFDs [Agenda Item 4e]

Glossary of Acronyms			
CC	Certificate of Conformance	OIML	International Organization of Legal Metrology
DMS	Division of Measurement Standards	OWM	Office of Weights and Measures (NIST)
ECR	Electronic Cash Register	PD	Positive Displacement
HB 44	NIST Handbook 44 "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices"	Pub 14	NCWM Publication 14
LMD	Liquid Measuring Devices	RMFD	Retail Motor-Fuel Dispenser
mA	milliamp	SI	International System of Units
NCWM	National Conference on Weights and Measures	S&T	Specifications and Tolerances
NIST	National Institute of Standards and Technology	VTM	Vehicle Tank Meter
NTEP	National Type Evaluation Program	W&M	Weights and Measures
NTETC	National Type Evaluation Technical Committee		
This glossary is meant to assist the reader in the identification of acronyms used in this agenda and does not imply that these terms are used solely to identify these organizations or technical topics.			

Technical Advisor's Note: I was unable to attend the Sector meeting due to a Federal Government shutdown. I want to extend thanks to Sector Chairman, Mike Keilty, and Sector Member, Paul Glowacki, for providing notes from the meeting and enabling me to prepare this summary.

Carry-over Items:

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

Source: California NTEP Lab

Background: At its 2007 meeting, the Measuring Sector heard that Technical Policy U in Pub 14 allows for testing an indicator separate from a measuring element. However, specific test criteria had not been developed for this practice. The Sector heard a recommendation to develop and add specific criteria for testing an indicator separate from a measuring element.

From 2007 to 2010, the California NTEP laboratory worked to develop a checklist, but had received limited input on the drafts. At the 2009 Sector meeting, Dan Reiswig provided an update to the Sector on progress to develop criteria for separate electronic indicators. He reported that the draft checklist provided to the Sector follows the general format of Pub 14 and the main test procedures are at the end of the document. At the 2010 Sector meeting, Mr. Reiswig presented a list of the areas of the checklist that specifically needed further attention and review. Attachments 1 and 2 to the Sector's 2010 Meeting Agenda, submitted by Mr. Reiswig, contain the draft checklist and proposed revisions to Technical Policy T.

At its 2011 meeting, the Sector agreed that additional work is needed to finalize the checklist. Mr. Rich Miller (FMC) volunteered to serve as Chair of the Work Group and Sector Technical Advisor, Mr. Marc Buttler (NIST OWM), will assist as needed and monitor progress of work. Work Group members are listed below:

Electronic Indicators Checklist Work Group	
Chair:	Rich Miller, FMC
Members:	Dmitri Karimov, Liquid Controls
	Mike Keilty, Endress + Hauser
Review & Comment:	Mike Frailer, MD W&M
	Allen Katalinic, NC DMS
Technical Advisor:	Marc Buttler, NIST OWM
Established at the October 21-22, 2011 Measuring Sector Meeting *Technical Advisor's Note, August 2013: Mr. Michael Frailer, MD W&M retired June 2013. Mrs. Tina Butcher, NIST, OWM has replaced Marc Buttler, as NIST Technical Advisor.*	

The Work Group was asked to address the highlighted sections in the draft checklist from Dan Reiswig (Attachment 1 to the Sector's 2011 Meeting Agenda) along with the five points below and submit the finished checklist to the two lab 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 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 multipoint 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.

Also at that meeting, Mr. Miller reported that FMC had a new electronic indicator with frequency input (serial communication was not part of the scope) nearing release and anticipated submitting it for evaluation by the end of 2012. He proposed using the evaluation, applying both the current standards and proposed checklist, to help refine the checklist and CA volunteered to serve as the evaluating laboratory. The Sector agreed with this proposal. During that meeting, Mr. Jack Kiefert volunteered to join the work group.

At the 2012 Sector meeting, FMC reported that, due to a heavy backlog, the CA laboratory was not available to conduct an evaluation prior to the end of January 2013. However, plans are in place for the NC laboratory to conduct an evaluation sometime in December 2012. The Sector agreed to maintain the item on its agenda to allow this work to be completed.

In August 2013, Work Group Chairman, Rich Miller, informed the Technical Advisor that the NC laboratory conducted an evaluation on FMC's new indicator. During the evaluation, Mr. Miller and the NC laboratory evaluators reviewed the checklist and identified some suggested areas for revision.

Discussion: The Sector heard an update on the Work Group's progress.

During the meeting, John Roach (CA) recommended retaining Checklist Item 2.24 under Code Reference G-S.5.7., noting that this requirement is specified in NIST HB 44 and Jim Truex (NTEP Director) and Dmitri Karimov (LC) agreed that the item should not be stricken. The Sector also discussed the merits of conducting permanence tests on electronics. The following additional general questions and comments were made regarding permanence tests, including suggestions that the permanence criteria section in the proposed checklist needs additional work:

- Pub 14 specifies a 20-day permanence test on electronics (e.g., digital indicators) specified in Pub 14. Additionally, Pub 14 specifies 20- and 30- day permanence tests specified for various types of Liquid-Measuring Devices.

- For indicators that will be used in vehicle-mounted installations, vehicle-mounted permanence tests are needed.

- There is a general feeling amongst Sector members present that permanence testing is not needed for electronics unless the electronics are used in a vehicle-mounted application.

- Software updates would not necessarily require a permanence test. Note that California uses a 20-day permanence test in their evaluations of new equipment. Canada requires a permanence test on initial evaluations, but not for updates to software.

- This document only addresses electronic indicators with frequency input and, thus, does not apply to indictors such as those for mass flow meters.

- The five points listed in Dan Reiswig's proposal may not adequately be covered in the checklist and should be reviewed.

- Will the test evaluate the form of pulse scaling? How will "edge counting" and "threshold levels" be addressed?

John Roach noted that he conducts two or three evaluations of electronic indicators per year and he requires permanence tests; however, he has not used the draft checklist. Sector members present noted that the work group primarily consisted of Rich Miller (FMC) and Allen Katalinic (NC). The draft checklist was not distributed nor reviewed outside of the workgroup and Mr. Katalinic has additional comments on the most recent draft. The Sector Chairman proposed that the work group continue its work for another year, giving consideration to the Sector's discussion and comments and bring the checklist back to the Sector at its next meeting.

Decision: The Sector concluded that additional work is needed on the checklist and agreed in a vote as follows to carry this item over to its next meeting:

> **Proposal:** Carry this item over to the next Sector meeting and ask that the sub-group continue its work and consider the points raised in the Sector's discussion of this item.
>
> **Yes:** 8
> **No:** 0
> **Result:** Passed

The Sector proposed no changes to Pub 14.

New Items:

2. Permanence of Markings, LMD Checklist

Source: NTEP Measuring Labs

Recommendation: Modify Section 1. General in the Liquid Measuring Devices Checklist as shown in Appendix B to this summary to include specific procedures for evaluating the permanence of marking

Background: At the spring 2013 NTEP Laboratory meeting, the measuring labs noted that the checklist for Digital Electronic Scales of Pub 14 provides detailed information about how to test the permanence of markings on the device. The labs propose replicating this language in the LMD checklist to add clarity for manufacturers and NTEP evaluators.

Discussion: Jim Truex, NTEP Director, explained the proposed revisions and noted that these revisions are not new procedures; the NTEP laboratories have conducted the tests shown in Appendix B to this summary on weighing and other device types for many years. The intent was not to impose more stringent requirements, but to ensure that the permanence criteria are uniformly applied; as such, the tests should be consistent regardless of the type of device. Without specific guidelines, the application of the permanence criteria is left to the judgment of individual evaluators and can lead to unintentional inconsistencies. Mr. Truex also noted that the language in proposed Sections 1.8 and 1.9 is new, but not controversial. John Roach (CA) noted that these procedures are used for all tests in CA and pointed out the need to ensure consistency among evaluations. Sector members asked about corresponding Canadian methods and Dennis Beattie (Measurement Canada) noted that Canada's methods are similar and have been for some time.

Mike Keilty (Endress + Hauser) commented that the use of "wood of a pencil" seems excessive and suggested deleting the reference. Mr. Truex noted that this criterion is already part of NCWM Publication 14; the current proposal is not to modify current permanence test requirements, but such a proposal could be considered as part of a future proposal. Henry Oppermann (W&M Consulting) explained that the reference to the wood pencil was to prevent the use of a harsher material such as a knife or screwdriver blade.

Several Sector members expressed concern that the changes outlined in the Appendix B to this summary propose changes that address all aspects of permanence criteria for markings, not just the criteria for the permanence of lettering. For example, proposed changes include additions of criteria for the "Permanence of Attachment of Badge" and title heading for the "Location and Visibility of the Marking Information." Rich Tucker (RL Tucker Consulting) also noted that requirements for permanence of the label are addressed in specific checklist sections and suggested that these requirements should be addressed only in the specific sections of the checklist to avoid possible conflicts.

Sector members expressed concerns that the changes to the checklist format and content to mirror corresponding permanence criteria in the weighing checklists are too extensive. The Sector considered taking time during or immediately after the meeting to review the proposal and suggest alternate changes; however, there was a feeling

that there was not sufficient time to do this. Consequently, the Sector agreed to limit its consideration of the proposed changes to only address permanence of lettering.

- **Decision:** After considering proposed changes to include specific criteria for determining permanence of marking information, the Sector agreed to make only the following changes. The Sector did not accept any other changes recommended in the original proposal; the original proposal is included in Appendix B to this summary for reference.Under Section 1. General, Code Reference G-S.1. Identification, delete the second and third paragraphs that currently appear after the example for "Vehicle Tank Meters" as follows:

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

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

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

  ~~Location of the information:~~

- Add the following heading and text after the heading of "Required Markings" prior current checklist item 1.1:

  Required Markings:

  Permanence of Marking Information:

  "Permanent" markings address two aspects: (1) if the markings are on a plate or badge, then the marking badge must be "permanently" attached to the device, and (2) the printed information will withstand wear and cleaning.

  The identification marking must be permanent, able to survive normal wear and tear, and remain legible. If located on a metal or plastic plate or badge, it must be attached with pop rivets or adhesive, or equivalent permanent means; removable bolts or screws are not permitted. A foil badge is permitted provided that it is durable, is able to survive wear and tear, remains legible, is difficult to remove, and exhibits obvious evidence of an attempt to remove the marking or badge. The printing on a foil badge must be easily readable and not easily obliterated by rubbing with a relatively soft object (e.g., the wood of a pencil).

  Location of the information:

  Permanence of Lettering:

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

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

- Rub over one letter of the marking at least 20 times using an ink eraser in the same manner and force as one would normally exert while erasing an inscription written with a ball point pen.
- *Note: For consistency of application, all NTEP labs are to use Eberhard Faber ink eraser type #110 (no longer commercially available); the Papermate Black Pearl; or the Papermate Union 110.*
- Clean the marking or badge with the following cleaners presumed to be "readily available."

Marking information remains legible after following the above procedures using:

1.1	Disinfecting cleaning liquid and a damp cloth.	☐ Yes	☐ No	☐ N/A
1.2	"Soft" household cleaning powder and a damp cloth.	☐ Yes	☐ No	☐ N/A
1.3	Window cleaning fluids and a damp cloth.	☐ Yes	☐ No	☐ N/A

Note: For consistency of application, NTEP labs use "409," Bon Ami, and Windex brands of products for tests in parts 1.1, 1.2, and 1.3 respectively.

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

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

[Renumber subsequent paragraphs.]

3. N.4.2.4. Wholesale Devices, 2013 NCWM S&T Committee Item 330-3

Source: NCWM S&T Committee

Recommendation: At the 2013 NCWM Annual Meeting, the S&T Committee requested assistance and input from the NTEP Measuring Sector on a proposal recommending changes to the requirements for special tests of wholesale meters. The Sector is asked to consider the proposals currently under consideration by the S&T Committee and to provide suggestions on how the Committee might best address the concerns expressed. Appendix C to this summary includes an excerpt from the 2013 S&T Committee's Annual Report with full details of the item. An abbreviated synopsis of the item is included below in the "Background" information.

Background: At the 2013 NCWM Interim and Annual Meetings, the S&T Committee considered a proposal under Item 330-3 on its agenda to modify the requirements for special tests of wholesale meters. The purpose of the proposal is to better align the special test requirements in NIST Handbook 44 with the current testing procedures, measuring practices, and technology changes while maintaining the integrity of the special test.

The "Item Under Consideration" as currently shown on S&T Committee's agenda is as follows:

Amend paragraph N.4.2.4. as follows:

N.4.2.4. Wholesale Devices. - "Special" tests shall be made to develop the operating characteristics of a measuring system and any special associated or attached elements and accessories.

N.4.2.4.1. Special Test, Type Evaluation. - "Special" tests shall **be made during type evaluation** ~~**include a test**~~ at the slower of the following rates:

(a) 20 % of the marked maximum discharge rate; or

(b) The minimum discharge rate marked on the device.

Add a new paragraph N.4.2.4.2. as follows:

N.4.2.4.2. Special Test, Field Evaluation. - "Special" tests shall be made during field tests at or near the minimum discharge flow rate developed under the conditions of installation, but not less than the minimum discharge rate marked on the device.

In its deliberations of this item, the S&T Committee heard from the submitter, Mr. Constantine Cotsoradis, Flint Hills Resources, who noted that the current language in NIST Handbook 44 is very restrictive. Even in systems where the flow can be reduced, it is difficult to set the flow and maintain it at the target flow rate over the course of an entire test.

During the 2013 NCWM Interim Meeting, the S&T Committee heard comments expressing concern that, without a test conducted near the minimum flow rate marked on the device, an official or device owner cannot adequately assess the condition of the meter and determine if the device is being properly maintained. The official also needs to be able to verify performance at other flow rates within the range of the meter.

At the 2013 NCWM Annual Meeting The Committee heard similar comments along with comments from NIST OWM regarding the purpose of the special test. The Committee heard additional comments suggesting that details of testing might be better addressed in the NIST Examination Procedure Outlines. The Committee heard additional comments suggesting that details of testing might best be addressed in the NIST Examination Procedure Outlines. Mr. Dmitri Karimov, speaking on behalf of the MMA, expressed concern about testing at flow rates which create pressures exceeding the rated pressure of the meter.

The Committee received the following alternate proposal from Mr. Randy Jennings, TN through the NCWM Online Comment Forum:

N.4.2.4.1. Special Test, Type Evaluation. - "Special" tests shall include a test at the slower of the following rates:

a. **Approximately** 20 % of the marked maximum discharge rate; or
b. The **approximate** minimum discharge rate marked on the device.

At the 2013 Annual Meeting, the Committee received the following alternate proposal from the submitter of the item; this proposal was also supported by Mr. Jennings.

N.4.2.4.2. Special Test, Field Evaluation. – A "Special" test shall be made during field tests at or near the minimum discharge flow rate developed under the conditions of installation, but not less than the minimum discharge rate marked on the device. Additional "Special" tests may be conducted at flow rates down to and including the maximum discharge rate marked on the device.

Given the wide range of questions and concerns raised about the most appropriate way to address this issue, Mr. Michael Keilty (Endress + Hauser), chairman of the NTEP Measuring Sector, recommended that the item be moved to an information status. He suggested asking the Sector to review this issue and provide suggestions to the Committee on how to best address special tests on wholesale devices. This suggestion was supported by several other NCWM members as well as the S&T Committee.

Discussion: Dmitri Karimov (LC), speaking on behalf of the MMA, summarized the item as presented by the submitter of the item. He noted that the design of many loading-rack metering systems is such that flow rate is automatically controlled; the user is not able to adjust the flow rate to the minimum flow rate marked on the meter. He also noted that the MMA has concerns that, if additional back pressure is created by artificially reducing the flow rate, system pressures may exceed the pressure ratings of the meter. Mike Keilty noted that the Vehicle-Tank Meters Code and the Liquid-Measuring Devices Code both have "special test" tolerances which would apply to tests conducted at lower flow rates; the Mass Flow Meters Code does not have "special test" tolerances.

Dennis Beattie (Measurement Canada) commented that their officials require the owner to reprogram the system to deliver at lower flow rates so that performance can be verified at lower flow rates during official testing of the meter. Several commented that this might be difficult to do for smaller metering systems such as retail motor-fuel dispensers. The group also discussed how this requirement might apply to retail devices and how it would apply to wholesale devices.

The Sector also discussed the alternate proposal presented by Randy Jennings (TN). Some members were concerned about the use of the word "maximum" and questioned whether or not this was intended to refer to a "miminum." Concern was also expressed that the use of the word "approximate" could be problematic and may lead to inconsistent application.

Henry Oppermann (Weights & Measures Consulting) noted that weights and measures officials and service companies need to be able to conduct tests at lower flow rates as a means to assess the condition of the meter. This allows officials to ensure that the meter is being maintained properly and allows service personnel to assess how best to service equipment. Allen Katalinic (NC) provided a specific example in which an operator was consistently operating the system at lower flow rates, emphasizing the need to test the system at lower flow rates.

Mr. Oppermann noted that the proposed language does not appear to require any test at lower flow rates and the group concurred with his interpretation. Given the importance of conducting tests over a range of flow rates, including tests at lower flow rates, Mr. Oppermann suggested that the Sector advise the S&T Committee that the Sector does not support the proposal. This motion was seconded by Jerry Butler (NC) and supported by the Sector.

Decision: The Sector considered the proposals presented to the S&T Committee under its 2013 Agenda Item 330-3 for modifying the requirements under LMD Code Paragraph N.4.2.4. Wholesale Devices that apply to "Special Tests." The Sector recognized the need to conduct tests at lower flow rates as a means to verify performance of the meter across its flow range and ensure proper maintenance by the device owner. The Sector does not concur with the language in either proposal being considered by the S&T Committee and agreed to forward this position to the S&T Committee.

4. Corrections/Editorial for 2014 Pub 14

Source: NTEP Administrator

Background and Discussion: Several changes that were recommended by the 2013 Measuring Sector and approved by the NCWM NTEP Committee were not correctly implemented in the 2013 Pub 14. These proposed changes are outlined in the following subitems. During the Sector meeting, NTEP Director, Jim Truex, noted that these items were recommended and approved by the NTEP Committee and the proposed agenda items are an accurate description of those changes. He also noted that Appendices D, E, F, and G did not get posted with the meeting agenda and he circulated a copy of the first day of the Sector meeting.

a. Product Families Table, NTEP Technical Policy C – Units Correction

Recommendation: Modify Technical Policy C. Product Categories and Families for Meters to correct the viscosity units for turbine meters as shown in Appendix D to this summary.

Background: At its 2012 meeting, the Sector agreed to make changes correcting the unit labeling of all references to kinematic viscosity under the turbine meter columns of the Product Families Table in Technical Policy C to centistokes (cSt). Several changes that were recommended by the 2013 Measuring Sector and approved by the NCWM NTEP Committee were not correctly implemented in the 2013 Pub 14. This item is included to correct these inadvertent omissions.

Discussion/Decision: The Sector reviewed the proposed changes in Appendix D and accepted the changes by consensus without additional comments.

b. LMD Checklist References for Card Activated Retail Motor-Fuel Dispensers

Recommendation: Consolidate references to "credit- or debit-card activated" retail motor-fuel dispensers in the "Checklist and Test Procedures for Retail Motor-Fuel Dispensers" and correct references to printed receipt requirements to reflect NIST Handbook 44 language by making the following modifications:

- Delete Sections 7.18 through 7.21 and move this text (with some minor modifications to reflect current NIST Handbook 44 language) to "LMD – Additional Checklists and Test Procedures for Card-Activated Retail Motor-Fuel Dispensers" Section 40. Card-Activated Retail Motor-Fuel Dispensers.

  - Move the preamble to Sections 7.18 through 7.21. to the beginning of the "NTEP LMD Additional Checklists and Test Procedures for Card-Activated Retail Motor-Fuel Dispensers."

  - Create a new "Code Reference G-S.5.1. Indicating and Recording Elements" under "NTEP LMD Additional Checklists and Test Procedures for Card-Activated Retail Motor-Fuel Dispensers," and move the text currently in Sections 7.20 and 7.21 to this new code reference.

  - Create a new Code Reference heading for LMD Code paragraphs S.1.6.7. Recorded Representation and S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided and insert text from 7.18 through 7.19., modified to reflect current NIST Handbook 44 language in this new reference.

- Delete Section 15. Card Activated Retail Motor-Fuel Dispensers, which is redundant to "LMD – Additional Checklists and Test Procedures for Card-Activated Retail Motor-Fuel Dispensers" Section 40.1 through 40.4

- Delete Section 16. Test Methods for Card-Activated Retail Motor-Fuel Dispensers, which is redundant to"LMD – Additional Checklists and Test Procedures for Card-Activated Retail Motor-Fuel Dispensers" Section 41., Test Methods

Attachment E to the Sector's agenda outlined specific proposed changes to the checklist.

Discussion: The Sector reviewed proposed changes in Attachment E to the Sector's agenda. The Sector discussed changes in checklist item section 40 in detail.

Decision: The Sector concurred with the proposed changes in the document, with the exception to the proposed checklist item 40.8; the Sector also noted duplication in the paragraph numbering with two items being numbered 40.8. The Sector was concerned with inclusion of the "Yes," "No," and "N/A" checkboxes. The Sector agreed to strike the first item numbered "40.8;" however, the Sector agreed to

retain the text in that item asking for a designation of the option(s) available for providing a receipt and incorporate that text into the previous checklist item 40.7.

Appendix E to this meeting summary shows the final version of the proposed changes, including the revisions described above in section 40 that were adopted by the Sector.

c. LMD Checklist – Checklist and Test Procedures for Cash-Activated RMFDs

Recommendation: Add the following new section at the end of Publication 14 LMD Checklist, Checklist and Test Procedures for Cash-Activated RMFDs to include references to receipt requirements for LMD Code paragraph S.1.6.7. as shown in Attachment F to the Sector's meeting agenda.

Background: In reviewing the references to printed receipt requirements in the LMD and associated checklists, the technical advisor noted that there are no references to the requirements for printed receipts in the section of the Checklist addressing Cash-Activated Dispensers. The proposed changes will make this section consistent with the sections on card-activated RMFDs and for ECRs interfaced with RMFDs.

Discussion: The Sector reviewed proposed changes in Attachment F to the Sector's agenda. The Sector discussed changes in checklist item section 17 in detail.

Decision: The Sector concurred with all changes except for the proposed checklist item 17.11 which asked for a designation of the type(s) of receipts provided, similar to the item described in agenda item (c) above. The Sector was concerned with inclusion of the "Yes," "No," and "N/A" checkboxes. The Sector agreed to retain the text asking for a designation of the option(s) available for providing a receipt by moving this text to item 17.10. The Sector agreed to strike the remainder of item 17.11 and renumber subsequent checklist items.

Appendix F to this meeting summary shows the final version of the proposed changes adopted by the Sector, including the revisions to section 17 described above.

d. LMD Checklist – Post-Delivery Discounts – Formatting Change

Recommendation: Modify Publication 14 LMD checklist Code Reference S.1.6.8. as follows to create separate checklist items for each piece of information required on the receipt and to include specific checklist line items for systems that are capable of providing electronic receipts.

Code Reference: S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided

7.44. Except for fleet sales and other price contract sales, w~~W~~here a post-delivery discount(s) is(are) applied, the sales receipt must provide: ☐ Yes ☐ No ☐ N/A

~~the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s);~~

~~an itemization of the post-delivery discounts to the unit price; and~~

~~the final total price of each fuel sale after all post-delivery discounts are applied~~

7.44.1. the product identity by name, symbol, abbreviation, or code number;

7.44.~~1~~2. the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s); ☐ Yes ☐ No ☐ N/A

7.44.~~2~~3. an itemization of the post-delivery discounts to the unit price; and ☐ Yes ☐ No ☐ N/A

7.44.~~3~~4. the final total price of each fuel sale after all post-delivery discounts are applied. ☐ Yes ☐ No ☐ N/A

7.44.5. For systems that are capable of generating electronic receipts, the customer must be given the alternative option of receiving a hard copy receipt in lieu of or in addition to the electronic receipt. ☐ Yes ☐ No ☐ N/A

Indicate the option(s) available:
☐ Hard Copy or Electronic
☐ Hard Copy and Electronic

Background: The proposed change would assist NTEP laboratories in identify specific areas to be evaluated as part of reviewing the requirements for a receipt specified in NIST Handbook 44 LMD Code paragraph S.1.6.8. These changes also make this checklist item consistent with LMD Checklist Item 7.19.2.

Discussion: The Sector reviewed the recommendation above and concurred with all but section 7.44.5. which asked for a designation of the type(s) of receipts provided, similar to the item described in agenda items (b and c) above. The Sector was concerned with inclusion of the "Yes," "No," and "N/A" checkboxes. The Sector agreed to retain the text asking for a designation of the option(s) available for providing a receipt by moving this text to immediately follow item 7.44.4. The Sector agreed to strike the remainder of item 7.44.5.

Decision: The Sector agreed to recommend the following changes for inclusion in Pub 14:

Code Reference: S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided

7.44. Except for fleet sales and other price contract sales, w~~W~~here a post-delivery discount(s) is(are) applied, the sales receipt must provide: ~~☐ Yes ☐ No ☐ N/A~~

~~the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s);~~

~~an itemization of the post-delivery discounts to the unit price; and~~

~~the final total price of each fuel sale after all post-delivery discounts are applied~~

7.44.1. the product identity by name, symbol, abbreviation, or code number;

7.44.~~1~~2. the total quantity, unit price, and total computed price that were displayed on the dispenser at the end of the delivery prior to any post-delivery discount(s); ☐ Yes ☐ No ☐ N/A

7.44.~~2~~3. an itemization of the post-delivery discounts to the unit price; and ☐ Yes ☐ No ☐ N/A

7.44.~~3~~4. the final total price of each fuel sale after all post-delivery discounts are applied. ☐ Yes ☐ No ☐ N/A

Indicate the option(s) available for providing a receipt:

☐ Hard Copy or Electronic

☐ Hard Copy and Electronic

e. ECRs Interfaced with RMFDs Checklist, Section 3. Recorded Representations

Recommendation: Modify the ECRs Interfaced with RMFDs checklist to:

- Make changes to the preamble and other text to be consistent with corresponding requirements for card- and cash-activated RMFDs;
- Add specific references to receipt requirements specified by LMD Code paragraph S.1.6.7, including the option of an electronic receipt;
- Create individual numbered checklist items for each of the three sub-bullets under the requirements for post-delivery discount receipts as specified in LMD Code paragraph S.1.6.8.; and
- Reorganize the order of items by moving the references to paragraph S.1.6.8. to follow those for S.1.6.7.

Specific proposed changes are outlined in Attachment G.

Background: The proposed changes are to ensure consistency with corresponding changes in corresponding sections of the LMD checklist for RMFDs.

Discussion: The Sector reviewed proposed changes in Attachment G to the Sector's agenda. The Sector discussed changes in checklist item section 3.2 in detail.

Decision: The Sector concurred with all changes except for the proposed checklist item 3.2, which asked for a designation of the type(s) of receipts provided, similar to the item described in agenda items (b), (c), and (d) above. The Sector was concerned with inclusion of the "Yes," "No," and "N/A" checkboxes. The Sector agreed to retain the text asking for a designation of the option(s) available for providing a receipt by moving this text to item 3.1. The Sector agreed to strike the remainder of item 3.2 and renumber subsequent checklist items.

Appendix G to this meeting summary shows the final version of the proposed changes adopted by the Sector, including the revisions to section 3 described above.

5. Product Families Table Addition - Dimethylether (DME)

Source: John Roach (CA NTEP Laboratory)

Background: NTEP has received requests to evaluate metering systems for Dimethylether (DME), which is not currently referenced in the Product Families Table of NCWM Publication 14. The CA NTEP laboratory reports the following regarding this product:

- DME seems to have similar characteristics of propane.
- CA has one client that has an LPG (propane) RMFD which is approved for several different PD meters. PD meters are viscosity sensitive in cP centipoise.
- Pub. 14 states that Propane is 0.098 cP at 60 degrees F.

- DME is not currently referenced in the Pub. 14 and it should be added
- This product may be very popular.
- CA DMS chemists note that DME is being used in other counties for fuel and cooking. You can fill a propane container just like propane with DME.
- The submitting manufacturer provided the following data regarding DME along with relative values for Commercial Propane:
    - Liquid specific gravity at 60 deg = 0.66 Propane = 0.510
    - Vapor specific gravity @ 60F = 1.59 Propane = 1.5
    - Centipose viscosity @ 60F = 0.15 Propane = 0.11

Because this is the first NTEP evaluation of this product and this will set a precedent for how to address this product with regard to any resulting Certificate and its associated coverage, the CA NTEP laboratory wants to ensure that adequate testing is conducted. The CA Laboratory has informed the applicant that testing will need to be conducted with DME as well as LPG product unless the Measuring Sector and NTEP Committee determine otherwise. However, the question has been posed of whether or not the testing with both products is necessary.

Recommendation: The CA NTEP laboratory has asked that the Measuring Sector review the properties of this product; determine where it best fits within the Product Families Table of NCWM Publication 14; identify required testing parameters; and provide any additional guidelines for evaluating laboratories and manufacturers regarding the NTEP evaluation of meters used in this application.

Discussion: John Roach (CA) introduced the item and summarized the intent of the recommendation, noting that he is attempting to get clarification on the criteria based upon questions raised by a dispenser manufacturer. Jim Truex (NTEP Director) noted that the NTEP laboratories are not comfortable with adding DME to the "compressed gases" category since this would allow the product to be included on a Certificate that covers this category without testing the meter with DME. Dennis Beattie (Measurement Canada) noted that compatibility of materials is a concern and Mike Keilty (Endress + Hauser) and Dmitri Karimov (LC) gave examples of materials that are and are not compatible with DME.

Mr. Roach asked the Sector to consider whether a test is needed on a meter delivering DME in addition to testing with another product(s) in the compressed gases category. He also asked whether testing could be run on the same meter with a different meter factor. He noted that he believes a permanence test should be conducted.

Though acknowledging that the chemical properties of DME appear similar to propane, Sector members present did not have in-depth experience with DME nor specific data to illustrate similarity of meter performance with the two products.

Henry Oppermann (Weights & Measures Consulting) noted that there are three facets of this issue that need to be addressed and the Sector agreed with this analysis of the issues to be addressed:

(1) Conducting type evaluation on a dispenser metering DME to gain a type approval for DME only;
(2) Conducting tests on a dispenser using DME and then using propane to obtain type approval on both products. Submitting this data to the Measuring Sector in an effort to possibly obtain broader coverage of different types of meters by getting a change to the product families criteria.
(3) Considering the need to re-open the discussion to further define the product families criteria by identifying the important product characteristics that defines the product category for each meter type. The material compatibility of the meters should not be a W&M issue; the manufacturer must ensure that the materials are appropriate for each product measured by the meter.

Decision: The Sector considered whether or not DME can be added to a Certificate that has been issued to a meter based on testing conducted with commercial propane. The Sector acknowledged that the properties of DME may be similar to that of commercial propane; however, the Sector agreed that, if a Certificate has been issued based on testing with propane, additional testing is needed with DME in order to add DME to the Certificate. If a meter is only tested with DME, then the resulting Certificate will apply only to DME. If data is provided from NTEP testing of a meter using both propane and DME, the Sector is amenable to further considering whether or not it might be appropriate to include the chemical DME in the "Compressed Liquids" category of the Product Families Table. However, the Sector does not plan to undertake an effort to collect such data.

Additional Items as Time Allows:

If time permits, the NCWM S&T Committee and the NTEP Software Sector would appreciate input from the Measuring Sector on the measuring-related issues that are outlined in the remaining agenda items below. A copy of any regional association modifications or positions will be provided to the Sector when these are made available by the regions.

6. Appendix D – Definitions: Remote Configuration Capability, NCWM S&T Committee Item 360-7

Source:
2013 NCWM S&T Committee (2012 Grain Analyzer Sector Meeting Summary)

Background / Discussion:
At its 2012 meeting, the Grain Analyzer Sector agreed to forward a proposal to amend the definition of "remote configuration capability" in NIST Handbook 44 to the S&T Committee for consideration. The following changes were proposed:

> **remote configuration capability. –** The ability to adjust a weighing or measuring device or change its sealable parameters from or through some other device that ~~**is not**~~ **may or may not** itself **be** necessary to the operation of the weighing or measuring device or ~~**is not**~~ **may or may not be** a permanent part of that device.[2.20, 2.21, 2.24, 3.30, 3.37, 5.56(a)]
>
> (Added 1993, **Amended 20XX**)

The Sector noted in their proposal that removable digital storage devices containing the latest grain calibrations can be used in grain moisture meters (GMMs) as either data transfer devices that are not necessary to the operation of the GMM or as data storage devices which are necessary to the operation of the GMM. If removable data storage devices are necessary to the operation of the device, they are not covered by the current definition of remote configuration capability.

A USB flash drive is most likely to be used as a data transfer device. In a typical data transfer application, the USB flash drive is first connected to a computer with access to the GMM manufacturer's web site to download the latest grain calibrations that are then stored in the USB flash drive. The USB flash drive is removed from the computer and plugged into a USB port on the GMM. The GMM is put into remote configuration mode to copy the new grain calibration data into the GMM's internal memory. When the GMM has been returned to normal operating (measuring) mode the USB flash drive can be removed from the GMM.
Although a Secure Digital (SD) memory card could also be used as a data transfer device it is more likely to be used as a data storage device. In a typical "data storage device" application, the SD memory card stores the grain calibrations used on the GMM. The SD memory card must be plugged into an SD memory card connector on a GMM circuit card for the GMM to operate in measuring mode. To install new grain calibrations the GMM must be turned "off" or put into a mode in which the SD memory card can be safely removed. The SD memory card can either be replaced with an SD memory card that has been programmed with the new grain calibrations or the original SD memory card can be re-programmed with the new grain calibrations in much the same way as that described in the preceding paragraph to copy new grain calibrations into a USB flash drive. In either case, the SD memory card containing the new calibrations must be installed in the GMM for the GMM to operate in measuring mode. In that regard, the SD memory card (although removable) can be considered a permanent part of the GMM in that the GMM cannot operate without it.

Note: In the above example SD memory card could be any removable flash memory card such as the Secure Digital Standard-Capacity, the Secure Digital High-Capacity, the Secure Digital Extended-Capacity, and the Secure Digital Input/Output, which combines input/output functions with data storage. These come in three form factors: the original size, the mini size, and the micro size. A Memory Stick is a removable flash memory card format, launched by Sony in 1998, and is also used in general to describe the whole family of Memory Sticks. In addition to the original Memory Stick, this family includes the Memory Stick PRO, the Memory Stick Duo, the Memory Stick PRO Duo, the Memory Stick Micro, and the Memory Stick PRO-HG.

During its Open Hearings at the 2013 NCWM Interim Meeting, the Committee heard comments from Ms. Juana Williams (NIST OWM). OWM suggested the Committee consider this item as a Developing item to allow other Sectors to discuss how a change to the definition may affect other device types of similar design and to consider changes if needed. OWM recognizes that the current definition for "remote configuration capability" may not address those grain moisture meters (GMMs) which can only be operated with a removable data storage device, containing, among other things, the grain calibrations intended for use with the GMM, inserted in the device (as was described by the Grain Analyzer Sector). As such, OWM noted that current sealing requirements were developed at a time when such technology likely didn't exist, nor could be envisioned, and are based on the current definition of remote configuration capability. Because the current definition was never intended to apply to this "next generation" technology, OWM suggested that those charged with further development of this item may wish to revisit the five philosophies of sealing and consider whether a new paragraph, completely separate from current sealing requirements, might be appropriate and a better option, than the one currently proposed. The five philosophies of sealing are included in the 1992 Report of the 77th National Conference on Weights and Measures (Report of the Specifications and Tolerances Committee). Another option, preferred over the changes currently proposed, would be to add a separate statement to the current definition of "remote configuration capability" to address removable storage devices. For example, the following sentence might be considered as an addition to the current definition for "remote configuration capability:"

> **Devices which are programmed using removable media (such as SD cards, flash drives, etc.) that may or may not be required to remain with the device during normal operation are also considered to be remotely configured devices.**

The Committee also heard comments from Dmitri Karimov (LC), speaking on behalf of the MMA, who made two points: (1) Flow computers may already have these capabilities, thus it may be more appropriate to consider adding requirements to the General Code so that the requirements will be uniformly applied to all device types; and (2) the Committee should look ahead and consider other capabilities that may or already have emerged such as wireless communication and configuration.

The Committee acknowledged the comments indicating that the current definition of "remote configuration capability" was developed at a time when certain technologies, such as blue tooth, SD storage devices, flash drives, etc., didn't exist. The Committee recognized that it may be difficult to modify the existing definition and associated requirements to be flexible enough to address emerging and future technologies without having a significant (and possibly detrimental impact) on existing devices. Consequently, rather than modifying the current definition, the Committee concluded that a better approach might be to develop an entirely separate set of security requirements that would apply to emerging technologies. The Committee believes that additional work is needed to develop proposed definition(s) and associated requirements and decided to designate the item as Developmental. The Committee requests other Sectors review the Grain Sector's proposed modification to the definition as well as OWM's suggestions and provide input.

During the 2013 NTEP Laboratory Meeting, the NTEP evaluators were asked if they were aware of or had observed during any of their evaluations of a weighing or measuring device, one which required some form of memory card or data storage device be installed in order for the device to be operational in the measuring or weighing mode. A weighing representative from Measurement Canada reported that he had observed scales having flash drives (some of which were micro in size) that are sealed via physical seal that contain calibration information and possibly even the operating system stored on a card, which must remain in the device in order for the device to be operational. The US NTEP evaluators (i.e., on both the weighing and measuring side) reported they had no knowledge of such technology being used in devices they had evaluated, but they also acknowledged that it could have been present without them noticing it during the evaluation process.

At the 2013 NCWM Annual meeting, OWM reiterated comments it made at the 2013 Interim meeting suggesting that it may be appropriate to develop separate requirements to address new and future technologies which can be remotely configured with removable media. OWM indicated it plans to develop draft language and request input from the various sectors at their upcoming meetings. Two additional comments were made in support of possibly including requirements in the General Code of NIST Handbook 44 to address newer and emerging technologies.

Additional background information relative to this item can be found in *2013 NCWM Publication 16* at:

http://www.ncwm.net/resources/dyn/files/1025938z8fff0401/_fn/2013_ST_Pub16.pdf

Recommendation:
The Sector is asked to identify the various types of removable storage media (e.g., USB flash drives, SD memory cards, etc.) currently in use with measuring equipment and explain the functionality of that media. OWM anticipates possibly using the information provided by the Sector to develop some draft proposals to amend NIST Handbook 44 to adequately address the security of the metrological significant parameters of devices using such media. Members of the Sector may wish to review *NCWM Publication 14 LMD Technical Policy, Checklists, and Technical Procedures, Appendix B Requirements for Metrological Audit Trails* prior to the Sector meeting to refresh their understanding of the various acceptable means of providing security.

Discussion: Sector Chairman, Mike Keilty (Endress and Hauser) introduced the item and described Endress and Hauser's process for storing significant parameters in removable media which is part of the device and under physical security. The ensuing discussion centered largely around the definitions of the various types of devices and how removable media might be used with them. John Roach (CA) noted that a removable memory stick or memory card is covered by the current definition of "remote configuration" and NTEP Director, Jim Truex, noted that this view is consistent with that of NIST OWM. The Sector agrees that the current language in HB44 addresses devices that can be adjusted using these types of removable media.

Decision: The Sector does not support the language "may or may not be necessary" because this phrase changes the category of what is considered "remote configuration capability." The Sector agreed that, if the card (or other removable device) needs to be a part of the measuring device for normal operation, then the card is effectively part of the device; in that case, the measuring device is a Category 1. If the card is only used for configuration or calibration and is not necessary for the operation of the measuring device, the measuring device is a Category 2. The Sector discussed whether or not additional guidance might be needed on what is covered by each sealing category; however, concluded that the definitions are adequate as currently written.

7. Identification of Certified Software

Source: NTEP Software Sector

Background: This item originated as an attempt to answer the question "How does the field inspector know that the software running in the device is the same software evaluated and approved by the lab?" In previous meetings it was shown that the international community has addressed this issue (both WELMEC and OIML).

At the 2012 NTETC Software Sector Meeting, there was some discussion as to where the terminology regarding inextricably linking the software version or revision to the software itself belonged. The Sector recommended adding the following to *NCWM Publication 14* and forward to NTETC Weighing, Measuring, Grain Analyzer Sectors for feedback:

Identification of Certified Software:

Note: Manufacturers may choose to separate metrologically significant software from non-metrologically significant software. Separation would allow the revision of the non-metrological portion without the need for further evaluation. In addition, non-metrologically significant software may be updated on devices without breaking a seal, if so designed. Separation of software requires that all software modules (programs, subroutines, objects etc.) that perform metrologically significant functions or that contain metrologically significant data domains form the metrologically significant software part of a measuring instrument (device or sub-assembly). If the separation of the software is not possible or needed, then the software is metrologically significant as a whole. The conformity requirement applies to all parts and parts shall be marked according to Section G-S-X.X.

The manufacturer must describe and possibly demonstrate how the version or revision identifier is directly and inseparably linked to the metrologically significant software. Where the version revision identifier is comprised of more than one part, the manufacturer shall describe which portion represents the metrological significant software and which does not.

Recommendation: The Software Sector is requesting feedback on the following language developed by the Software Sector in 2012 for possible future inclusion into NCWM Publication 14 Weighing Devices, DES pages 22-23, Section 3. Additional Marking Requirements – Not Built-for-Purpose Software-Based Devices:

Identification of Certified Software:

Note: Manufacturers may choose to separate metrologically significant software from non-metrologically significant software. Separation would allow the revision of the non-metrological portion without the need for further evaluation. In addition, non-metrologically significant software may be updated on devices without breaking a seal, if so designed. Separation of software requires that all software modules (programs, subroutines, objects etc.) that perform metrologically significant functions or that contain metrologically significant data domains form the metrologically significant software part of a measuring instrument (device or sub-assembly). If the separation of the software is not possible or needed, then the software is metrologically significant as a whole. The conformity requirement applies to all parts and parts shall be marked according to Section G-S-X.X.

The manufacturer must describe and possibly demonstrate how the version or revision identifier is directly and inseparably linked to the metrologically significant software. Where the version revision identifier is comprised of more than one part, the manufacturer shall describe which portion represents the metrological significant software and which does not.

Discussion: Sector Chairman, Mike Keilty (Endress and Hauser), introduced the item and NTEP Director, Jim Truex, provided additional details on the item. Mr. Truex noted that the Grain Analyzers Sector looked at the proposal and agreed to consider the proposal at greater length. Grain analyzer manufacturers also agreed to take the item to their software experts for additional input band bring any recommendations back to the Sector. Mr. Truex reported that the Weighing Sector proposed adding the two paragraphs, with the exception of the last sentence of paragraph 1. Mr. Truex noted that, in the LMD checklist, the language might be considered for addition to checklist item 1.6. He also commented that questions have been raised by inspectors about how to find software that has a newer revision number that the software found in the device that the inspector is examining. While the Software Sector includes representatives from four state weights and measures programs, there are no field inspectors on the Sector.

Mr. Keilty noted that the first paragraph in the recommendation appears permissive, whereas the second appears to be a requirement. He also stated that he would like the opportunity to further consider the proposed language and to take it to his company's software engineers for review and input. Paul Glowacki (Murray Equipment) indicated he would like to do the same. Gordon Johnson (Gilbarco) commented that Gilbarco's software is not written in this way and some commented that there may be differences in firmware versus software.

Dennis Beattie (Measurement Canada) commented that it is difficult for the Software Sector to anticipate future devices given the approaches used in developing software today. He noted there is a need for the Sector to focus on future and cutting edge technology rather than be overly concerned about how potential changes might affect existing equipment. He reported that the WELMEC standards requires manufacturers to explain the numbering schemes used in their equipment, and the numbering scheme is to be identified on the type approval certificate.

Decision: After considerable discussion of the proposed changes, the Measuring Sector rejected the recommendation to include the proposed changes in Pub 14. Measuring Sector manufacturers asked for additional time to consider the proposal and carry it back to their respective companies' software engineers for input. The Sector agreed to carry this item over to its next meeting to allow the manufacturers time to study this issue and bring back alternative(s) to consider.

8. Software Protection/Security

Source:
NTEP Software Sector

Background
The Sector agreed that *NIST Handbook 44* already has audit trail and physical seal, but these may need to be enhanced.

From the WELMEC Document:

Protection against accidental or unintentional changes

Metrologically significant software and measurement data shall be protected against accidental or unintentional changes.

Specifying Notes:

Possible reasons for accidental changes and faults are: unpredictable physical influences, effects caused by user functions and residual defects of the software even though state of the art of development techniques have been applied.

This requirement includes consideration of:

a) Physical influences: Stored measurement data shall be protected against corruption or deletion when a fault occurs or, alternatively, the fault shall be detectable.

b) User functions: Confirmation shall be demanded before deleting or changing data.

c) Software defects: Appropriate measures shall be taken to protect data from unintentional changes that could occur through incorrect program design or programming errors, e.g. plausibility checks.

Required Documentation:

The documentation should show the measures that have been taken to protect the software and data against unintentional changes.

Example of an Acceptable Solution:

- The accidental modification of software and measurement data may be checked by calculating a checksum over the relevant parts, comparing it with the nominal value and stopping if anything has been modified.
- Measurement data are not deleted without prior authorization, e.g. a dialogue statement or window asking for confirmation of deletion.
- For fault detection see also Extension I.

The Sector continued to develop a proposed checklist for *NCWM Publication 14*. The numbering will still need to be added. This is based roughly on R 76 – 2 checklist and discussions beginning as early as the October 2007 NTETC Software Sector Meeting. The information requested by this checklist is currently voluntary, however, it is recommended that applicants comply with these requests or provide specific information as to why they may not be able to comply. Based on this information, the checklist may be amended to better fit with NTEP's need for information and the applicant's ability to comply.

The California, Maryland and Ohio laboratories agreed to use this check list on one of the next devices they have in the lab and report back to the Sector on what the problems may be. In February 2011, the North Carolina laboratory was also given a copy of the check list to try.

1. Devices with ~~Embedded~~ Software ~~TYPE P (aka built for purpose)~~

1.1. Declaration of the manufacturer that the software is used in a fixed hardware and software environment. **AND**	☐ Yes ☐ No ☐ N/A
1.2. Cannot be modified or uploaded by any means after securing/verification.	☐ Yes ☐ No ☐ N/A
Note: It is acceptable to break the "seal" and load new software, audit trail is also a sufficient seal.	
1.3 The software documentation contains:	
1.3.1. Description of all functions, designating those that are considered metrologically significant.	☐ Yes ☐ No ☐ N/A
1.3.2. Description of the securing means (evidence of an intervention).	☐ Yes ☐ No ☐ N/A
1.3.3. Software Identification, including version / revision	☐ Yes ☐ No ☐ N/A
1.3.4. Description how to check the actual software identification.	☐ Yes ☐ No ☐ N/A
1.4. The software identification is:	
1.4.1. Clearly assigned to the metrologically significant software and functions.	☐ Yes ☐ No ☐ N/A

1.4.2. Description how to check the actual software identification. ☐ Yes ☐ No ☐ N/A

1.4.3. Provided by the device as documented. ☐ Yes ☐ No ☐ N/A

1.4.4. Directly linked to the software itself. ☐ Yes ☐ No ☐ N/A

2. ~~Personal Computers, Instruments with PC Components, and Other Instruments, Devices, Modules, and Elements with Programmable or~~ Loadable Metrologically Significant Software ~~TYPE U (aka not built for purpose)~~

2.1. The metrologically significant software is:

2.1.1. Documented with all relevant (see below for list of documents) information. ☐ Yes ☐ No ☐ N/A

2.1.2. Protected against accidental or intentional changes. ☐ Yes ☐ No ☐ N/A

2.2. Evidence of intervention (such as, changes, uploads, circumvention) is available until the next verification / inspection (e.g., physical seal, Checksum, Cyclical Redundancy Check (CRC), audit trail, etc. means of security). ☐ Yes ☐ No ☐ N/A

3. Software with ~~Closed Shell (~~no access to the operating system and/or programs possible for the user~~)~~

3.1. Check whether there is a complete set of commands (e.g., function keys or commands via external interfaces) supplied and accompanied by short descriptions. ☐ Yes ☐ No ☐ N/A

3.2. Check whether the manufacturer has submitted a written declaration of the completeness of the set of commands. ☐ Yes ☐ No ☐ N/A

4. Operating System and / or Program(s) Accessible for the User

4.1 Check whether a checksum or equivalent signature is generated over the machine code of the metrologically significant software (program module(s) subject to legal control Weights and Measures jurisdiction and type-specific parameters). ☐ Yes ☐ No ☐ N/A

4.2 Check whether the metrologically significant software will detect and act upon any unauthorized alteration of the metrologically significant software using simple software tools (e.g., text editor). ☐ Yes ☐ No ☐ N/A

5. Software Interface(s)

5.1 Verify the manufacturer has documented:

5.1.1. The program modules of the metrologically significant software are defined and separated. ☐ Yes ☐ No ☐ N/A

5.1.2. The protective software interface itself is part of the metrologically significant software. ☐ Yes ☐ No ☐ N/A

5.1.3. The functions of the metrologically significant software that can be accessed via the protective software interface. ☐ Yes ☐ No ☐ N/A

5.1.4. The parameters that may be exchanged via the protective software interface are defined. ☐ Yes ☐ No ☐ N/A

5.1.5. The description of the functions and parameters are conclusive and complete. ☐ Yes ☐ No ☐ N/A

5.1.6. There are software interface instructions for the third party (external) application programmer. ☐ Yes ☐ No ☐ N/A

The Maryland laboratory had particular questions regarding 3.1 and 5.1. The information for 3.1 could be acquired from an operator's manual, a training video, or in-person training. The items in 5.1 were confusing to the evaluators. The terminology is familiar to software developers, but not necessarily others. It was indicated that manufacturers were typically quick to return the filled out questionnaire, but he didn't know how his laboratory was supposed to verify that it was true. Generally, the laboratories wouldn't be expected to verify things to that level. For example, if the manufacturer states that a checksum is used to ensure integrity, the laboratories wouldn't be expected to evaluate the algorithm used.

The intent was to see whether the manufacturer had at least considered these issues, not for evaluators to become software engineers. Perhaps a glossary or descriptive paragraphs might be added to assist the evaluators for if the manufacturer has questions for the evaluators.

OIML makes use of supplementary documents to explain the checklist they use. Below are links:
http://www.oiml.org/publications/D/D031-e08.pdf
http://www.welmec.org/latest/guides/72.html
http://www.welmec.org/fileadmin/user_files/publications/2-3.pdf

WELMEC document 2.3 is the original source for our checklist, but it's been significantly revised and simplified. Mr. Payne, Maryland Department of Agriculture, is going to review the other documents and come up with some suggestions for the checklist. Mr. Roach, California Division of Measurement Standards, is going to begin using the checklist. The international viewpoint is that any device running an operating system is considered to be Type U. Mr. Roach mentioned that they're having lots of problems with "skimmers" stealing PIN's. Is there some way they can detect this?

Mr. Lewis, Rice Lake Weighing Systems, Inc., mentioned that he liked Measurement Canada's website. When answering similar questions, different pages would appear, based on answers to those questions:
http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00573.html

At the 2011 NTETC Software Sector Meeting, the laboratories were polled to obtain any feedback on the use of the checklist. Maryland attempted to use this checklist a few times. They had some difficulty obtaining answers from the manufacturers because the individual(s) interacting with the Maryland evaluator didn't always have the required information on hand. More experience in using the checklist will help determine what needs to be revised.
It was suggested that the checklist could be sent to manufacturers for their feedback as well, with the stipulation that it a completely voluntary exercise and purely informational at this point. The laboratories will coordinate with willing manufacturers to obtain feedback.
Work is ongoing on this item with the intent that it eventually will be incorporated as a checklist in *NCWM Publication 14*; again the laboratories are requested to try utilizing this checklist for any evaluations on software-based electronic devices.

The checklist has been reviewed with an eye to making its terminology clearer to laboratories. Some examples and clarifications have been added as shown in the discussion section of this item. The revised checklist will be distributed to the laboratories for additional review. Maryland and California laboratories agreed to use the checklist on a trial basis.

Over the past year, attempts to use the current checklist did not meet with many difficulties. The checklists were given to the manufacturers to fill out, and that seemed to work rather well. Minor modifications (in red above) were made to clarify certain confusing areas or eliminate redundancy.

Recommendation: The Software Sector is recommending that each NTETC Sector consider adding the proposed software checklist (shown in the table above) to their respective and appropriate NCWM Publication 14 device checklists. Thus, the MS was asked to consider whether or not it is appropriate to add the proposed software checklist to Publication 14, and if so, to which of the checklists within Pub 14 Liquid Measuring Devices it is be included (for example, LMD General, RMFD, ECR-LMD, etc.).

Discussion: Jim Truex (NTEP Director) introduced the item and noted that the Software Sector made this recommendation in March 2013. He reported that the Grain Analyzer Sector rejected the proposal as did the Weighing Sector. A concern on the part of the other Sectors was that this criteria could not be applied to older devices and the issue of establishing non-retroactive requirements needs to be addressed. The Sectors also noted that the proposed language is not supported by corresponding requirements in HB44. A question was raised about Checklist Item 1.2, which implies that it is not permissible to load any metrological or non-metrological software without breaking a seal. Additionally, some terms such as "fixed software" and "software environment" were not defined and there was confusion about other terminology. There was general lack of understanding of the proposed requirements and many present were unable to see the direction in which the proposed changes were heading.

Gordon Johnson (Gilbarco) questioned whether or not there are concerns about the need for evaluator training. Dennis Beattie (Measurement Canada) pointed out that these requirements are a very small subset of the WELMEC requirements referenced. He also suggested that the issue of retroactivity be addressed first; he noted that Measurement Canada is working on a non-retroactive bulletin that will be based on WELMEC 7.2 and the manufacturer will be required to demonstrate that the device minimizes the ability for fraud. Mr. Truex stated that NTEP does not plan to go forward with software testing and evaluation directly.

John Roach (CA DMS) and Allen Katalinic (NC) suggested that the Sector consider taking a small step of putting something into Pub 14 as a starting point. Although the Sector discussed this item at length, the Sector was unable to reach agreement on any proposed language and noted that many present did not feel they had the expertise to speak on the issue of software attributes.

Decision: After considerable discussion and debate on the proposed changes, the Measuring Sector rejected the recommendation to include the proposed changes in Pub 14. Measuring Sector manufacturers were unable to add any contributions during the meeting that would lead to agreement to include the proposed changes in Pub 14, citing a lack of expertise to make an informed proposal or decision. However, the manufacturers committed to the task of taking this issue to their companies' software engineers to flesh out the proposal. The Sector agreed to carry this item over to its next meeting to allow the manufacturers time to study this issue and bring back alternative(s) to consider.

9. Software Maintenance and Reconfiguration

Source:
NTEP Software Sector

Background:
After the software is completed, what do the manufacturers use to secure their software? The following items were reviewed by the Sector. *Note that agenda Item 3 also contains information on Verified and Traced updates and Software Log.*

1. Verify that the update process is documented (OK)
2. For traced updates, installed Software is authenticated and checked for integrity
   Technical means shall be employed to guarantee the authenticity of the loaded software (i.e. that it originates from the owner of the type approval certificate). This can be accomplished (e.g. by cryptographic means like signing). The signature is checked during loading. If the loaded software fails this test, the instrument shall discard it and either use the previous version of the software **or become inoperative**.
   Technical means shall be employed to guarantee the integrity of the loaded software i.e. that it has not been inadmissibly changed before loading. This can be accomplished e.g. by adding a checksum or hash code of the loaded software and verifying it during the loading procedure. If the loaded software fails this test, the instrument shall discard it and either use the previous version of the software **or become inoperative**.
   Examples are not limiting or exclusive.
3. Verify that the sealing requirements are met
   The Sector asked, What sealing requirements are we talking about?
   This item is **only** addressing the **software update**, it can be either verified or traced. It is possible that there are two different security means, one for protecting software updates (software log) and one for protecting the other

metrological parameters (Category I II or III method of sealing). Some examples provided by the Sector members include but are not limited to:
Physical Seal, software log
Category III method of sealing can contain both means of security

4. Verify that if the upgrade process fails, the device is inoperable or the original software is restored

The question before the group is, Can this be made mandatory?
The manufacturer shall ensure by appropriate technical means (e.g. an audit trail) that traced updates of metrologically significant software are adequately traceable within the instrument for subsequent verification and surveillance or inspection. This requirement enables inspection authorities, which are responsible for the metrological surveillance of legally controlled instruments, to back-trace traced updates of metrologically significant software over an adequate period of time (that depends on national legislation). The statement in italics will need to be reworded to comply with US weights and measures requirements.

The Sector **agreed** that the two definitions below for Verified update and Traced update were acceptable.

Verified Update
A verified update is the process of installing new software where the security is broken and the device must be re-verified. Checking for authenticity and integrity is the responsibility of the owner/user.

Traced Update
A traced update is the process of installing new software where the software is automatically checked for authenticity and integrity, and the update is recorded in a software update log or audit trail.

Note: It's possible that the Philosophy of Sealing section of NCWM Publication 14 may already address the above IF the definitions of Verified and Traced Updates (and the statement below) were to be added. The contrary argument was that it may be better to be explicit).

Use of a Category 3 audit trail is required for a Traced Update. A log entry representing a traced software update shall include the software identification of the newly installed version.

The Sector recommended consolidating the definitions with the above statement thus:

Verified Update
A verified update is the process of installing new software where the security is broken and the device must be re-verified. Checking for authenticity and integrity is the responsibility of the owner/user.

Traced Update
A traced update is the process of installing new software where the software is automatically checked for authenticity and integrity, and the update is recorded in a ~~**software update log or**~~ Category 3 audit trail. The audit trail entry shall include the software identification of the newly installed version.

In 2012, the Sector recommended that as a first step, the following be added to *NCWM Publication 14*:

The updating of metrologically significant software, including software that checks the authenticity and integrity of the updates, shall be considered a sealable event.

Mr. Truex, NTEP Administrator, indicated his opinion that the above sentence is unnecessary since it's self-evident. It was agreed by the group however to ask the other sectors for feedback on the value of this addition.
Though the Sector is currently considering only the single sentence be incorporated into *NCWM Publication 14* for the time being, ultimately, the Sector may wish to advance the remaining language of the original item submission.

Discussion:
The Sector had no information indicating that the other Sectors had yet been approached for feedback on the value of the addition of the proposed sentence.

Recommendation:
The Software Sector is requesting each of the NTETC Sectors review and provide feedback on the following draft language it developed for consideration of adding it to NCWM Publication 14:

The updating of metrologically significant software, including software that checks the authenticity and integrity of the updates, shall be considered a sealable event.

Should the MS agree this language is appropriate, it might then consider where within Publication 14 Liquid-Measuring Devices this sentence should be inserted. The Sector might consider including it in the appropriate sealing sections of Publication 14 relating to audit trails. For example:

- LMD Checklist:
  - General, Section 2. Graduations, Indications and Recorded Representations, Code Reference G-S.8.
  - RMFDs, Section 9. Measuring Elements, Code Reference S.2.2. Provision for Sealing and Code Reference: S.2.2.1. Multiple Measuring Devices with a Single Provision for Sealing
  - Wholesale & Loading Rack Meters, Section 19. Measuring Elements, Code Reference S.2.2. Provision for Sealing and Code Reference: S.2.7.3. Provision for Sealing - Automatic Temperature Compensation
  - Vehicle-Tank Meters, Section 26. Measuring Elements, Code Reference S.2.2. Provision for Sealing and Code Reference: S.2.6.2. Provision for Sealing
  - LPG & NH3 Meters, Section 31. Measuring Elements, Code Reference S.2.2. Provision for Sealing
  - Mass Flow Meters, Section 36. Measuring Elements, Code Reference: S.3.5. Provision for Sealing
  - Water Meters Checklist, Section 45 Measuring Elements, Code Reference: S.2.1. Provision for Sealing
  - Hydrogen Gas Measuring Devices, Section 51. Design of Measuring Elements and Measuring Systems, Code Reference: S.3.3. Provision for Sealing
  - LMD Checklist Appendix B Requirements for Metrological Audit Trails

- ECR-LMD Checklist
  - Section 4. Provisions for Sealing, Code Reference: G-S.8. Provision for Sealing Electronic Adjustable Components

The Software Sector is also requesting feedback from the other NTETC Sectors regarding whether or not additional language such as the following is needed in Publication 14 to make clear that an existing audit trail should be protected during a software update. In the background information provided for this item, it was noted that the Software Sector noted that this does already seem to be addressed in the Requirements for Metrological Audit Trails in Publication 14.

1. The audit trail data shall be:

3.5.1.1.1. Stored in non-volatile memory and shall be retained for at least 30 days if power is removed from the device. **AND**

3.5.1.1.2. Protected from unauthorized erasure, substitution, or modification.

Discussion: Jim Truex (NTEP Director) described feedback from the Weighing Sector and Grain Sectors in their discussions of this item. Dennis Beattie (Measurement Canada) noted that the software described in the recommendation policies the authenticity of the existing software in an electronic weighing or measuring system. This software would be separate from audit trail information and the event of a change in software would be considered a metrologically significant event. In discussing this item, some members noted that there are no HB 44 requirements to support the language proposed for inclusion in Pub 14.

Decision: The Measuring Sector rejected the recommendation to include the proposed changes in Pub 14. Measuring Sector manufacturers were unable to add any contributions during the meeting that would lead to agreement to include the proposed changes in Pub 14; however, they committed to the task of taking this issue to their companies' software engineers to flesh out the proposal. The Sector agreed to carry this item over to its next meeting to allow the manufacturers time to study this issue and bring back alternative(s) to consider.

10. LNG Metering Applications

Source: Michael Keilty, Endress + Hauser, Chairman, NTEP Measuring Sector

Background: The number of LNG dispensing applications is growing in the U.S. NIST Handbook 44 does not specifically address this application and many questions have come up regarding the requirements for metering devices at both retail level and also for large capacity and wholesale applications. Likewise, there are many questions about the appropriate testing procedures and criteria for these applications. Questions about this application have arisen within OIML R-117 discussions and Canada has a draft regulation for dispensing LNG already developed. NIST has begun reviewing proposed approaches for addressing LNG within NIST Handbook 44; however, does not have any specific proposals for consideration at this point.

Recommendation: While there is no specific recommendation for the Sector to consider, the Sector is asked to provide input on how to best address this product in NIST Handbook 44 and NCWM Publication 14 as well as for suggestions on proposed testing criteria. Additional information may be provided by Mr. Keilty at the Sector Meeting.

Discussion: Mr. Keilty introduced this item and noted related work taking place as part of an OIML project on OIML R117-2. Dennis Beattie (Measurement Canada) described some changes that Canada plans to propose to R117-1 relative to LNG, although he noted that these changes will not be considered until R117-1 is open for revision. Mr. Beattie described examples of a dispensing system for LNG and the group discussed various aspects of these measuring systems, including the use of vapor return lines as opposed to venting. John Roach (CA DMS) reported some challenges in selecting an appropriate reference scale for use in testing these systems, noting that platform scales are not generally practical and hanging scales have seemed to work best. Mr. Roach also noted that, of the LNG systems tested under NTEP, LNG was used as the test produce in one of the systems where a vapor recovery system was used; the other three used liquid nitrogen and the liquid nitrogen was vented. He reported that draft sizes were varied and a tolerance of 1.5% was applied. He also noted that one manufacturer wanted to use a turbine meter in the testing; in this case, he believes testing needs to be conducted at additional flow rates.

Decision: This item was included on the Sector's agenda for information purposes only and to allow the Sector to discuss some aspects of testing LNG systems. Consequently, the Sector made no decisions on this item.

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? If new evaluation (yes) if updating existing CC (no)

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. Name, initials, or trademark of the manufacturer. **Yes ☐ No ☐ N/A ☐**

1.2. A model designation that positively identifies the pattern or design. The Model designation shall be prefaced by the word "Model", "Type", or "Pattern". These terms may be followed by the term "Number" or an abbreviation of that word. The abbreviation for the word "Number" shall, at a minimum, begin with the letter "N" (e.g., No or No.) The abbreviation for the word "Model" shall be "Mod" or "Mod.". **Yes ☐ No ☐ N/A ☐**

1.3. Except for not built-for-purpose, software-based devices, a nonrepetitive serial number. The serial number shall be prefaced by words, 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". The abbreviation 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. The NTEP Certificate of Conformance (CC) Number or a corresponding CC addendum number for devices that 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 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. Ex. May be part of W&M display screen, using the requirements of section 1.6.2
Location of CC Number if not located with the identification:

_____

_____

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

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

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

- permanently marked on the device; or
- continuously displayed; or
- 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."

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

AK- This is not a lab issue, this is a field requirement due to the fact that the equipment is being lab evaluated, the evaluator will not see the end use installation.

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.
Other item fall under facilitation of fraud, needs more input
Example if Cat 3 device verify passwords and audit trail is correct….

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

AK- This is not a lab issue, this is a field requirement due to the fact that the equipment is being lab evaluated, the evaluator will not see the end use installation.

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.

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

1.13. Constructed so that reversal will not affect performance, **Yes ☐ No ☐ N/A ☐**

1.14 Marked or keyed to indicate their proper positions. May have multiple cable connections but not interchangeable due to different plug styles, or; **Yes ☐ No ☐ N/A ☐**

1.15. Cables are connected but are not removable without breaking a seal and opening housing. (Note: may need HB 44 requirement to cover this) **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	**Yes ☐ No ☐ N/A ☐**
2.1.2.	Display is capable of 0.1	**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 (fill in blank): needs comment section	

2.2. **Money value display. .**

2.2.1.	a. Money value is properly displayed and verify rounding b. Verify the presents of currency symbol **i.e. dollar sign "$" or "Dollars"** **Yes ☐ No ☐ N/A ☐**	**Yes ☐ No ☐ N/A ☐**

3.2. **The indications must be clear, definite, and accurate.**

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

2.3.	The indications must be easily read under normal operating conditions.	**Yes ☐ No ☐ N/A ☐**
2.4.	Symbols for decimal points shall clearly identify the decimal position. (Generally acceptable symbols are dots, small commas, or x.)	**Yes ☐ No ☐ N/A ☐**
2.5.	**The zero indication must consist of at least the following minimum indications as appropriate:**	
2.5.1.	One digit to the left and all digits to the right of a decimal point.	**Yes ☐ No ☐ N/A ☐**
2.5.2.	If a decimal point is not used, at least one active decade must be displayed.	**Yes ☐ No ☐ N/A ☐**
2.6.	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

Basic operating requirements for devices:

2.7.	All digital values of like value in a system shall agree with one another.	**Yes ☐ No ☐ N/A ☐**
2.8.	A digital value coincides with its associated analog value to the nearest minimum graduation.	**Yes ☐ No ☐ N/A ☐**
2.9.	Digital values shall round off to the nearest minimum unit that can be indicated or recorded.	**Yes ☐ No ☐ N/A ☐**
2.10.	When a digital zero display is provided, the zero indication shall consist of at least one digit to the left and all digits to the right of the decimal point.	**Yes ☐ No ☐ N/A ☐**

Agreement of indications shall be checked for several deliveries. The totalizer shall be checked for accuracy and agreement with individual deliveries and with other totalizers in the system.

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

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

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

2.14. 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.

2.15. **Yes ☐ No ☐ N/A ☐**

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

Code Reference: G-S.5.2.4. Values Defined

2.17. 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

2.18. 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. What permanence quantities should be verified for electronic devices with graphical displays? **Yes ☐ No ☐ N/A ☐**

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

2.19. 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 ☐**

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

2.21. 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.

2.22. 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

2.23. 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**~~

~~2.24. Magnified indications shall conform to all requirements for graduations and indications.~~

Code Reference: G-S.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.

2.25.	All operational controls, indications, and features including switches, lights, displays, and push buttons shall be clearly and definitely identified.	**Yes** ☐ **No** ☐ **N/A** ☐
2.26.	All dual function (multi-function) keys or controls shall be marked to clearly identify all functions.	**Yes** ☐ **No** ☐ **N/A** ☐
2.27.	Non-functional controls and annunciators shall not be marked (in the graphical display example they would be dimmed etc.)	**Yes** ☐ **No** ☐ **N/A** ☐

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

2.28.	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 Trial

2.29.	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: (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	**Yes** ☐ **No** ☐ **N/A** ☐

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 the use of 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
2. Temperature, pressure, density, and other sensor settings for zero, span, and offset values
3. Measurement units 4. Temperature compensation table, liquid coefficient of expansion, or compressibility factors or tables
5. Liquid density setting and allowable liquid density input range
6. Vapor pressures of liquids if used in calculations to establish the quantity
7. Meter or sensor temperature compensation factors
8. 9. On/off status of automatic temperature, pressure, or density correction
10. Automatic or manual data input for sensors
11. 12.
13. Filtering constants

Liquid-Measuring Device Features and Parameters	
Typical Features or Parameters to be Sealed	**Typical Features or Parameters Not Required to be Sealed**
Measuring element adjustment (both mechanical and electronic)	Analog-to-digital converters
Linearity correction values	Quantity division value (display resolution)
Measurement units (e.g., gallons to liters)	Double pulse counting
Octane blend setting for retail motor-fuel dispensers	Communications
Any tables or settings accessed by the software or manually entered to establish the quantity (e.g., specific gravity, pressure, etc.)	
Density ranges	
~~Pulsers~~	
~~Signal pick-up (magnetic or reluctance)~~	
Temperature probes and temperature offsets in software (S.2.5.4 VT)	
~~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.	

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 (i.e., the parameter does not affect compliance with Handbook 44).

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

- 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 ☐**
- Accessing the audit trail information shall not require removal of any additional parts other than normal requirements to inspect the integrity of a physical security seal. (e.g., a key to open a locked panel may be required). **Yes ☐ No ☐ N/A ☐**

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

- 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
- Verify that all metrological relevant parameters are logged to Event Counter (S.2.2) **Yes ☐ No ☐ N/A ☐**

  Yes ☐ No ☐ N/A ☐
  - Adequate provision must be made to apply a physical seal without exposing electronics.
- 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 Counters 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.

- , 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 ☐**
- Verify that all metrological relevant parameters are logged to Audit trail (S.2.2) **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 nonresettable and have a capacity of at least 000 to 999. **Yes ☐ No ☐ N/A ☐**
- The system is designed to attach a printer, or other communications device (i.e. Ethernet, Serial Communications, USB, Wi-Fi, Bluetooth etc) which will allow an interface to a printer or allow for the creation of a digital copy (file) for future reference **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.

_____

_____

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

A register / indicator must be properly designed and have sufficient capacity to be suitable to use in a particular application. A register / indicator must measure the appropriate characteristics of a commodity to accurately determine the quantity, , have sufficient capacity to indicate the quantity measured and the associated total price if it is a computing device. The register/ indicator must have the proper capacity to operate over the actual frequency range for the application, and the device must have a quantity division appropriate for the application.

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

.	Compliance to this requirement is determined by the permanence test. Unless specific tests are developed this has no meaning! AK_ RM - Agreed	

2.26.	**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? AK RM – Yes as this is a check list for a register / indicator it shall be compatible for all measurement technologies.** **Notes, items that need to be added to table / Checklist:** **a. Information needs to be added to capture different K-Factor values** **b. All API tables to be included on certificate shall be verified** **c. Verify extreme endpoints and a center point of each table** **d.**

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 ☐**

1. General

Code Reference: G-S.1. Identification

Virtually all weighing and measuring equipment must be clearly and permanently marked with, or display, the manufacturer's name or trademark, model designation, and serial number. Service station dispensers, consoles, cash registers interfaced with dispensers, retrofit computing registers, and customer card-activated terminals must all have these markings.

Marking of Serial Number:

As a practical matter, some equipment need not have a serial number. "Satellite" modules in a modular system (e.g., keyboard module and cash drawer) need not have serial numbers because they do not have any "intelligence." A serial number is required in the following circumstances:

Separate Device

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

Separate Main Element

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

Component

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

The following are examples of the application of these criteria:

Retail Motor Fuel Dispensers:

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

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

Vehicle Tank Meters

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

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

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

Location of the information:

_____

_____

Required Markings:

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

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 equipment with no moving or electronic component parts and not built for purpose, software-based devices, a non-repetitive 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 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

Location and Visibility of Marking Information:

Required information shall be clearly and permanently marked on an exterior surface that is visible after installation as follows:

1.5. Equipment must be marked on a surface that is an integral part of the device. ☐ Yes ☐ No ☐ N/A

Location of Marking Information:_____

1.6. Markings must be visible after installation. If the required information is not positioned in a visible location after installation, a duplicate, permanent identification badge must be located in a visible location after installation. A removable cover is an acceptable location for the required information only if a permanent ID badge is located elsewhere on the device. ☐ Yes ☐ No ☐ N/A

Permanence of Marking Information:

"Permanent" markings address two aspects: (1) if the markings are on a plate or badge, then the marking badge must be "permanently" attached to the device, and (2) the printed information will withstand wear and cleaning.

The identification marking must be permanent, able to survive normal wear and tear, and remain legible. If located on a metal or plastic plate or badge, it must be attached with pop rivets or adhesive, or equivalent permanent means; removable bolts or screws are not permitted. A foil badge is permitted provided that it is durable, is able to survive wear and tear, remains legible, is difficult to remove, and exhibits obvious evidence of an attempt to remove the marking or badge. The printing on a foil badge must be easily readable and not easily obliterated by rubbing with a relatively soft object (e.g., the wood of a pencil).

Permanence of Attachment of Badge:

1.7. Attempt to remove the badge by pulling it off or prying off a metal badge that is attached using only adhesive; removal must be "difficult" at all temperatures. If the badge can be removed, it must show obvious evidence that the badge was removed. Acceptable indications are destruction of the badge by tearing, permanent and extensive wrinkling, or repeated exposure of the word "VOID" upon removal of the badge. ☐ Yes ☐ No ☐ N/A

If required markings are behind a door or panel, the manufacturer is encouraged to put a label on the outside of the device that explains where the ID information is located.

1.8. If the information required by G-S.1. is placed on a badge or plate, the badge or plate must be permanently attached to the device. See criteria above for permanence of Attachment of Badge. ☐ Yes ☐ No ☐ N/A

1.9. If the markings for other than device identification required by G-S.1. is placed on badge or decal, then the badge or decal must be durable (difficult to remove at all temperatures.) ☐ Yes ☐ No ☐ N/A

Permanence of Lettering:

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

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

- Rub over one letter of the marking at least 20 times using an ink eraser in the same manner and force as one would normally exert while erasing an inscription written with a ball point pen.
- *Note: For consistency of application, all NTEP labs use Eberhard Faber ink eraser type #110*
- Clean the marking or badge with the following cleaners presumed to be "readily available."

Marking information remains legible after following the above procedures using:

1.10. Disinfecting cleaning liquid and a damp cloth. ☐ Yes ☐ No ☐ N/A

1.11. "Soft" household cleaning powder and a damp cloth. ☐ Yes ☐ No ☐ N/A

1.12. Window cleaning fluids and a damp cloth. ☐ Yes ☐ No ☐ N/A

Note: For consistency of application, NTEP labs use "409," Bon Ami, and Windex brands of products for tests in parts 1.8, 1.9, and 1.10 respectively.

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

1.13. 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.

1.13.1. 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

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

1.14.1. 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

1.14.2. The Certificate of Conformance Number shall be:

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

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

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

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

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

Excerpt from NCWM Specifications & Tolerances Committee 2013 Annual Report

330-3 I N.4.2.4. Wholesale Devices

(The status of this item was changed from Voting to Informational)

Source:
Flint Hills Resources (2013)

Purpose:
To better align wholesale meter testing with current testing procedures, measuring practices and technology changes while maintaining the integrity of the special test.

Item Under Consideration:
Amend paragraph N.4.2.4. as follows:

N.4.2.4. Wholesale Devices. - "Special" tests shall be made to develop the operating characteristics of a measuring system and any special associated or attached elements and accessories.

N.4.2.4.1. Special Test, Type Evaluation. - "Special" tests shall **be made during type evaluation** ~~**include a test**~~ at the slower of the following rates:

(a) 20 % of the marked maximum discharge rate; or

(b) The minimum discharge rate marked on the device.

Add a new paragraph N.4.2.4.2. as follows:

N.4.2.4.2. Special Test, Field Evaluation. - "Special" tests shall be made during field tests at or near the minimum discharge flow rate developed under the conditions of installation, but not less than the minimum discharge rate marked on the device.

Background / Discussion:
This proposal is intended to clarify that conducting a slow flow test to the marked minimum discharge rate is required for type evaluation and testing to the minimum discharge flow rate developed under the conditions of installation for routine field inspections is appropriate. It would:

1) Remove the rigidity of the current language and provide for flexibility and efficiency while maintaining the requirement to test at different flow rates to determine the accuracy of a measuring system;

2) Differentiate between testing for type evaluation and field verification;

3) Reflect changes in field testing procedures, technology, and industry practices; and

4) Improve meter performance by establishing a meter factor for the slowest preset flow rate.

The current language is very rigid and does not take field installation conditions into consideration. It may not be possible or practicable to achieve the marked minimum discharge rate during field tests without changes to upstream equipment (valves, pumps, etc.), changing the flow computer programmed presets, or changing the idling of other fueling bays during testing.

The Code does not allow for any deviation from the **"**shall**"** test at the marked minimum discharge rate. Current loading rack systems generally do not have a discharge nozzle or other physical means downstream of the meter to control or restrict the flow rate. Today, most rely on pumps and valves upstream of the meter and preprogrammed flow rates for specific products with an assigned meter factor for each flow rate and product. The proposed change would still allow for testing at the marked minimum discharge rate when there is a discharge nozzle or other physical means in use downstream of the meter to restrict flow, but would recognize the need to vary from the marked minimum discharge rate for systems not so equipped.

The submitter notes that it is more productive to verify that the system is operating properly when used in its intended manner and set-up rather than alter the system for test-purposes and then return it to its "as-used condition." Adjusting the system to flow at the marked minimum discharge rate by making changes to the system when that flow rate is not used introduces variables into the system not normally seen and adds little to no value.

Even if the system can achieve the marked minimum discharge rate (for example, through the use of a discharge nozzle), it is not always practical or possible to hit it exactly when testing. The variables involved with proving while multiple bays are operating at a loading rack can make achieving the target flow rate difficult. It is not really necessary to test exactly at the marked minimum flow rate to develop the operating characteristics of a meter. However, NIST Handbook 44 offers no room for deviation. Today, a wholesale meter tested "near," but not exactly "at," the marked minimum discharge rate is not being tested in accordance with the requirements of NIST Handbook 44. This problem may never be an issue, but it might (the history regarding the change to NIST Handbook 44 Introduction section illustrates why the language in the handbook must match the application of it in the field). Amending the current language as proposed will remove this risk, however, slight.

In the LMD Code, retail motor-fuel devices with a marked minimum flow rate are tested "at or near the marked minimum flow rate," but are not required to be tested at exactly the marked minimum. If this is acceptable for a retail motor-fuel dispenser then it should be acceptable for a wholesale meter. The proposal would make testing more uniform and consistent among different, but similar device types.

The purpose of this proposal is not to do away with a special test, but to make the test more reasonable. The proposal would allow the integrity of the test process to be maintained while providing both industry technicians and weights and measures officials the flexibility to test the meter in a manner that is more reflective of actual field testing and device use. It is designed to test meters not at the *design* flow rate, but at the flow rate at which they are actually used. It does not preclude a weights and measures inspector from testing at the marked minimum flow rate; it just removes the mandate to conduct it at that flow rate

The submitter points out the following supporting arguments:

- The marked minimum and maximum discharge rates are design parameters, not operational parameters.
- The Mass Flow Meters Code does not require testing at the marked minimum discharge rate. It requires, at a minimum, that one test be conducted at the minimum flow rate of the installation.
- The principle of testing as used and not to the design parameters is present in other codes and testing. It exists for scales since scales are not required to be tested to their design parameters; they are only tested as set up and used. A scale may be rated at a capacity range of 100,000 – 200,000 pounds and a scale division of 20 or 50 pounds, but it will only be tested based on its conditions of installation regardless of how it could be used.
- NIST Handbook 44 does not require that a measuring system be tested at the marked maximum discharge rate because it recognizes the measuring system may not be able to achieve the marked maximum discharge rate due to the conditions of installation.
- There is no regulation requiring a meter to be able to discharge at its marked minimum discharge flow rate; the marked minimum discharge flow rate is a design parameter not a use requirement.
- Not all tests in the test notes section are required to be conducted in the field as is noted in NIST Handbook 44 Introduction Section S. Using the Handbook, which states: "Since some sections are designed to be applied to tests performed under laboratory conditions, it would be impractical or unrealistic to apply them to field tests. Not all tests described in the "Notes" section of the handbook are required to be performed in the field as an official test." Based on this section, it could be argued that a "special" test is not even required; however, the submitter believes that the special test has value and is not seeking to eliminate the test entirely.

The proposal doesn't specify the exact flow rate, but requires a test at the minimum flow rate based on the system and the establishment of a meter factor at that flow rate. The added flexibility and establishment of a meter factor during the test is important for both industry technicians and weights and measures officials.

The proposed change is similar to the recommended tests described in API Manual of Petroleum Measurement Standards (MPMS) Chapter 6.2 Loading Rack Metering Systems - "When using electronic presets with multiple flow rate configurations, the establishment of multiple meter factors may be required. This is particularly true when low flow start-up and shutdown sequences are employed to prevent system shock and static electricity generation (see API RP 2003)."

A potential argument in opposition to the proposal is that, even if the system is not being used at the marked minimum discharge rate at the time of test, it could be used later; thus, it is important to not only test as found, but as it could be used. While there is some merit to this argument, it is not consistently applied since many systems are tested as found, not as they *could be* used. There is also no incentive for a fuel terminal to not test their system as used. Further, the current practice is to set a calibration factor for all flow rates, so it is unlikely that the system would be changed after testing without additional testing and establishment of a calibration factor.

Based on comments received at its 2012 Interim Meeting, the CWMA amended the original proposal to reflect language that was applicable to field practices and current with technology. The language was also amended to maintain special tests as a requirement during type evaluation, but optional for other examinations. CWMA supported the item as amended and forwarded the item to NCWM, recommending it as a Voting Item. The proposal submitted by the CWMA is as follows:

N.4.2.4. Wholesale Devices. - "Special" tests shall be made **during type evaluation** to develop the operating characteristics of a measuring system and any special associated or attached elements and accessories. "Special" tests shall include a test at the slower of the following rates:

(a) 20 % of the marked maximum discharge rate; or

(b) The minimum discharge rate marked on the device.

N.4.2.5. Wholesale Devices; Other Tests. – Other tests may be made during field tests at or near the minimum discharge flow rate developed under the conditions of installation for all wholesale devices.

(a) For devices equipped with electronic preset flow rates, tests may be conducted at any electronic preset flow rate used, including the slowest flow rate, when multiple flow rate configurations are used to deliver product.

(b) "Normal" applicable tolerances shall apply to tests conducted.

U.R.3.6.4 Wholesale Devices; Electronic Preset Flow Rates - A meter factor shall be established for all electronic preset flow rates used to deliver product.

At the 2013 NCWM Interim Meeting, the Committee heard comments from Mr. Ross Andersen (retired NY) who suggested that, if the concern is that there is not enough flexibility in the reference to "20% of the marked maximum," the focus should be placed on modifying this reference rather than making other proposed changes. He provided alternative language for the Committee to consider. The Committee also received written and verbal comments from NIST OWM noting that the proposed language would not consider any test conducted at lower flow rates to be 'normal" tests and, therefore, such tests would be required to meet "normal" test tolerances.

OWM commented that it is important to verify the performance of a meter over the range of flow rates for which it is designed to operate. The "normal" test (as described in N.4.1. Normal Tests.) combined with a "slow flow" test (as described in N.4.2.4. Wholesale Devices.) allows an inspector or serviceperson to verify the performance of a meter over the range in which it is typically used under the conditions of its installation. For positive displacement meters

with single point calibration, the results of both tests can be used to determine whether or not a particular meter is providing accurate measurement over the complete range of operating speeds associated with its installation and whether the meter is in good operating condition. Product discharge rates are affected by installation particulars, (e.g., the diameter of the piping, pump speed, etc.,) and these can be changed after installation, thus affecting meter performance. For these reasons, OWM recommends the slow flow test remain a required part of an official test as was originally intended by the original submitter of this item. As a general rule, OWM recommends that test procedures considered part of an official examination of a commercial weighing or measuring device not be made elective because, as such, they create the potential for inconsistent enforcement of legal requirements amongst weights and measures jurisdictions.

The proposed new paragraph N.4.2.5. Wholesale Devices; Other Tests. allows for a test at the minimum discharge rate marked on the device but would have the effect of eliminating the application of the "Special Test" tolerance, which currently applies to the results of a test conducted at flow rates below a certain point. Since the test would no longer be considered a "Special Test," basic tolerances (i.e., 0.3 % maintenance and 0.2% acceptance) would apply and these tolerances are more stringent than the current "Special Test" tolerance of 0.5 % specified in NIST Handbook 44. OWM is concerned about the impact this change may have on existing in-service wholesale equipment that might currently be able to comply with the "Special Test" tolerance, but may not be able to comply if that tolerance were tightened. For example, in instances where the minimum discharge flow rate developed under the conditions of installation (i.e., the test condition specified in proposed new paragraph N.4.2.5.Wholesale Devices; Other Tests.) for a wholesale device already in service, is equivalent to the lesser of the two rates specified in N.4.2.4., the flow rate for the test, whether applying proposed paragraph N.4.2.5. or existing paragraph N.4.2.4., would be the same, yet a more stringent tolerance would apply under proposed paragraph N.4.2.5.

An additional concern is that if the parameters of the test were changed from those currently specified in (a) and (b) of paragraph N.4.2.4. to the proposed "at or near the minimum discharge flow rate developed under the conditions of installation" the change would provide device owners the latitude of being able to try and extend the service life of a meter by compensating for badly worn or otherwise defective parts simply by increasing the minimum flow rate of product through it. Although such action would constitute a violation of G-UR.4.3. Use of Adjustments, it might be very difficult for officials to recognize and enforce.

For these reasons, OWM proposed alternate language (which combines elements of the original proposal and the CWMA alternative) as a means to provide more flexibility in conducting special tests, while retaining the original intent of the special test as a tool for verifying the condition of the meter.

OWM also commented that additional work is needed to develop minimum testing requirements for equipment with multi-point calibration capability to ensure consistency in inspection and testing of these systems.

Mr. Henry Oppermann (Weights and Measures Consulting) echoed OWM's concerns regarding the need to conduct special tests as a means to assess the condition of the meter. He acknowledged that the current language in NIST Handbook 44 may not provide the same flexibility that is provided for other meter types (for which tests can be "at or near" the marked minimum); however, he expressed concern about backing off of a proper test for what appears to be primarily convenience. Mr. Constantine Cotsoradis (Flint Hills Resources) pointed out that, with many current systems, there frequently is not a way to restrict the flow rate. Mr. Richard Suiter (Richard Suiter Consulting) further commented that the location where flow is restricted (e.g., before vs. after the meter) during special tests can also affect the results of testing, and this should be considered in constructing the final language (and associated test procedures) for any proposed change.

Mr. Dmitri Karimov (Liquid Controls Corporation, LLC), speaking on behalf of the MMA, noted that the proposal has the effect of (1) providing some flexibility in establishing a flow rate near the marked minimum flow rate rather than at the minimum; (2) changing the tolerances that would apply to tests conducted at slower flow rates; and (3) specifying the establishment of meter factors for preset flow rates. Of these three facets, MMA only supports the first. He noted that some registers may use different types of calibration factors and addressing these variations in a single paragraph would be difficult. He further noted that, if changes are made to the test conditions in the LMD Code, similar changes should be made to other measuring codes as needed to ensure consistency.

Ms. Julie Quinn (MN) noted that MN believes that it is necessary to conduct testing at every flow rate where the device is configured; however, the factors at these various points do not need to be different.

The Committee acknowledged the comments in support of maintaining the requirement for conducting special tests during routine field inspections, but modifying paragraph N.4.2.4. to provide for some flexibility in the rate at which a special test is conducted. In recognition of limitations which may prevent some systems from being tested exactly at the marked minimum flow rate, the Committee agreed that modification to the language to be more consistent with other measuring devices is appropriate. Based on the support heard for the language proposed by OWM with respect to N.4.2.4.1. Special Test, Type Evaluation and N.4.2.4.2.Special Tests, Field Evaluation, the Committee agreed to recommend this alternative language as shown in the Item Under Consideration above for a vote.

In reviewing the remaining portion of the proposed changes, the Committee noted the considerable debate regarding the inclusion of the User Requirement regarding the establishment of meter factors for preset flow rates. Based on this opposition, the Committee considered splitting this proposal into two items: one item to address the proposed changes to the Notes and a second item to address the proposed changes to the User Requirements. However, there was very limited support for the proposed changes to the User Requirement. Thus, the Committee decided to eliminate the proposed paragraph U.R.3.6.4 Wholesale Devices; Electronic Preset Flow Rates from the Item Under Consideration.

At their 2013 Annual Meetings, NEWMA and the CWMA supported the item as a Voting Item and commented that they believe the concerns stated by OWM and others at the NCWM Interim meeting have been sufficiently addressed by the NCWM S&T Committee.

Two Government representatives indicated a position of support on the NCWM Online Position Forum. Another Government representative, Mr. Randy Jennings (TN) indicated opposition to the proposal and, noting that the item appeared on only one regional weights and measures association agenda, expressed concern that the item requires more vetting. Mr. Jennings expressed concern about the phrase "developed under the conditions of the installation," and noted that this may be interpreted to mean that, if a system can be installed to run at maximum flow rates other than "start-up" and "shut-down," then an official cannot request that the system be "chocked" to reduce the flow. He further commented that the reduced flow test has always been effective in detecting and diagnosing wear in the meter. He also noted that Tennessee has a valve on its prover that can be used to reduce the flow rate during a slow flow test. Mr. Jennings proposed the following alternative changes to paragraph N.4.2.4.1. Special Test, Type Evaluation which would make the current requirement less restrictive, yet achieve a compromise to help all stakeholders:

> **N.4.2.4.1. Special Test, Type Evaluation. - "**Special" tests shall include a test at the slower of the following rates:
>
> a. **Approximately** 20 % of the marked maximum discharge rate; or
> b. The **approximate** minimum discharge rate marked on the device.

During its Open Hearings at the 2013 Annual Meeting, the Committee received a proposed modification to the Item Under Consideration by the original submitter Mr. Cotsoradis. In addition to the other changes proposed in the Item Under Consideration, Mr. Cotsoradis proposed replacing the new paragraph N.4.2.4.2. with the following:

> **N.4.2.4.2. Special Test, Field Evaluation. – A "Special" test shall be made during field tests at or near the minimum discharge flow rate developed under the conditions of installation, but not less than the minimum discharge rate marked on the device. Additional "Special" tests may be conducted at flow rates down to and including the maximum discharge rate marked on the device.**

Mr. Jennings supported this proposed modification by Mr. Cotsoradis.

Mr. Cotsoradis further noted that the current language in NIST Handbook 44 is very restrictive. Even in systems where the flow can be reduced, it is difficult to set the flow and maintain it at the target flow rate over the course of an entire test.

OWM noted that, according to the 1949 NCWM S&T Committee Report, requirements to conduct "Special Tests" were established in 1949. The report states that "Special" tests are not defined in detail except that such tests shall include tests at specified minimum discharge rates; other details of "Special" tests are left to the judgment of the official. The primary purpose of the "Special" test is to determine the condition of the meter and determine whether or not the user is maintaining the equipment in proper operating condition. As noted in comments during the 2013 Interim Meeting, the results of a "Special" test, conducted at a slow flow rate, when compared with the result of a "Normal" test can indicate the condition of the meter. In general, the greater the difference between meter errors observed for the "Normal" and "Special" test, the stronger the indication that the meter is in need of reconditioning. It is questionable whether or not two tests conducted at flow rates that are not appreciably different will provide adequate information about the condition of a meter. If the features of a particular installation do not permit testing at the slower rates as currently required in paragraph N.4.2.4.Wholesale Devices, paragraph G-UR.4.4. Assistance in Testing Operations may be applied to facilitate a proper test. OWM also pointed out that when this requirement was first added the dominant meter technology was positive displacement meters. Since that time a number of different technologies have been developed and it may be necessary to reassess what minimum testing is necessary. OWM also noted that in training provided by NIST on testing of these systems, OWM recommends running tests at slightly above the targeted flow rate; this helps to prevent the flow rate from dropping below the meter's marked minimum flow rate and, thus, helps to ensure a fair test of the metering system. OWM also reiterated comments it made during the 2013 Interim Meeting concerning the need to develop testing requirements for equipment with multi-point calibration capability.

Mr. Andersen suggested that the specifics of what testing is required would best be addressed in the NIST EPOs. Mr. Karimov expressed concern about testing at flow rates which create pressures exceeding the rated pressure of the meter. The Committee heard additional comments from conference members expressing confusion over what minimum testing should be required.

Mr. Michael Keilty (Endress + Hauser), chairman of the NTEP Measuring Sector, recommended that the item be moved to an information status. He suggested asking the Sector to review this issue and provide suggestions to the Committee on how to best address special tests on wholesale devices. This suggestion was supported by several other NCWM members.

The Committee agreed to ask the Measuring Sector to review and provide suggestions on this issue. Consequently, it changed the status of this item from "Voting" to "Information" to allow for additional input from the Sector and other interested parties.

Additional letters, presentations and data may have been part of the Committee's consideration. Please refer to http://ncwm.net/meetings/annual/publication-16 to review these documents.

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

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

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)

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 Kinematic Viscosity[1] (60 °F) centistokes (cSt)
Butanol	4.13
Ethanol	1.64
Ethylene Glycol	21.5
Isobutyl	5.62
Isopropyl	3.53
Methanol	0.80
Propylene Glycol	52

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

Typical Products	Reference Kinematic Viscosity[1] (60 °F) centistokes (cSt)

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

[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**	
Paraquat	0.7 – 1.2	CC-A	Avgas		FL&O	Banvel	4 – 400	Anhydrous Ammonia	0.31
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 Kinematic Viscosity[1] (60 °F) centistokes (cSt)**
Round-up	0.7 – 1.2	CC-A	Bunker Oil		FL&O	Herbicides	4 – 400	Butane	0.32
Touchdown	0.7 – 1.2	CC-A	Cooking Oils		FL&O	Paraquat	4 – 400	Ethane	
Treflan	0.7 – 1.2	CC-A	Corn Oil		FL&O	Prowl	4 – 400	Freon 11	0.21
Adjuvants	0.7 – 1.2	CC-B	Crude Oil		FL&O	Round-up	4 – 400	Freon 12	0.27
Fumigants	0.7 – 1.2	CC-B	Diesel Fuel[3]		FL&O	Touchdown	4 – 400	Freon 22	1.46
Fungicides	0.7 – 1.2	CC-B	Fuel Oil (#1, #2, #3, #4)	0	FL&O	Treflan	4 – 400	Propane	0.195
Insecticides	0.7 – 1.2	CC-B	Gasoline[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 Kinematic Viscosity[1] (60 °F) centistokes (cSt)**
Micronutrients	0.9 – 1.65	CC-D	Jet A-1		FL&O	Adjuvants	0.7 – 100	6 Oil (#5, #6)	73 – 14,500
Hydrochloric Acid	1.1	Chem	Jet B		FL&O	Fumigants	0.7 – 100	Asphalt	
Phosphoric Acid	1.87	Chem	JP4		FL&O	Fungicides	0.7 – 100	Avgas	
Sulfuric Acid	1.83	Chem	JP5		FL&O	Insecticides	0.7 – 100	Biodiesel above B20	11.8
3-10-30	0.9 – 1.65	Fert	JP7 and JP8		FL&O	**Test C Product Category:** Crop Chemicals (Type C) (CC-C)		Bunker Oil	11,300
4-4-27	0.9 – 1.65	Fert	Kerosene		FL&O	**Typical Products**	**Reference Viscosity[1] (60 °F) centipoise (cP)**	Cooking Oils	10.8
9-18-9	1.32	Fert	Light Oil		FL&O	Fungicides	20 – 900	Corn Oil	4.4
10-34-0	1.39	Fert	Lubricating Oils		FL&O	**Test C Product Category:** Crop Chemicals (Type D) (CC-D)		Crude Oil	3 – 2260
20% Aqua-Ammonia	0.89	Fert	Olive Oil		FL&O	**Typical Products**	**Reference Viscosity[1] (60 °F) centipoise (cP)**	Diesel Fuel[3]	12

[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			**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**	
28%, 30% or 32%	1.28 – 1.32	Fert	Peanut Oil		FL&O	Micronutrients	20 – 1000	Fuel Oil (#1, #2, #3, #4)	9 – 98

Typical Products	**Specific Gravity[2] (60 °F)**	**Product Category**	**Typical Products**	**Conductivity (micro-siemens/centimeter)**	**Product Category**	**Test C Product Category:** Chemicals (Chem)		**Test E Product Category:** Fuels, Lubricants, Industrial and Food Grade Liquid oils (FL&O) continued	
Ammonia Nitrate	1.16 – 1.37	Fert	SAE Grades		FL&O	Typical Products	**Reference Viscosity[1] (60 °F) centipoise (cP)**	**Typical Products**	**Reference Kinematic Viscosity[1] (60 °F) centistokes (cSt)**
Clear Liquid Fertilizer	1.17 – 1.44	Fert	Soy Oil	0	FL&O	Hydrochloric Acid	0.80 – 1. 0	Gasoline[4]	0.39
Nitrogen Solution	1.17 – 1.44	Fert	Spindle Oil		FL&O	Phosphoric Acid	161	Jet A	
N-P-K Solutions	1.2 – 1.4	Fert	Sunflower Oil		FL&O	Sulfuric Acid	1.49	Jet A-1	1.8
Urea	1.89	Fert	Vegetable Oil	0	FL&O	**Test C Product Category:** Compressed Liquids, Fuels and Refrigerants (Comp liq)		Jet B	
6 Oil (#5, #6)	0.9	FL&O	Asphalt		Heated	**Typical Products**	**Reference Viscosity[1] (60 °F) centipoise (cP)**	JP4	1.34
Asphalt		FL&O	Bunker C		Heated	Anhydrous Ammonia	0.188	JP5	2.56
Avgas		FL&O	Carbon Tetra-Chloride		Solv Cl	Butane	0.19	JP7 and JP8	2.4
Biodiesel above B20	0.86	FL&O	Methylene-Chloride		Solv Cl	Ethane		Kerosene	2.6
Bunker Oil	0.99	FL&O	Perchloro-Ethylene		Solv Cl	Freon 11	0.313	Light Oil	15.7
Cooking Oils	0.92	FL&O	Trichloro-Ethylene		Solv Cl	Freon 12	0.359	Lubricating Oils	22 – 1250
Corn Oil	0.91	FL&O	Acetates		Solv Gen	Freon 22	1.99	Olive Oil	127
Crude Oil	0.79 – 0.97	FL&O	Acetone	.02	Solv Gen	Propane	0.098	Peanut Oil	11 – 122
Diesel Fuel[3]	0.84	FL&O	Ethylacetate	0.00001	Solv Gen	**Test C Product Category:** Clear Liquid Fertilizers (Fert)		SAE Grades	214 – 4037
Fuel Oil (#1, #2, #3, #4)	0.9	FL&O	Hexane	0	Solv Gen	**Typical Products**	**Reference Viscosity[1] (60 °F) centipoise (cP)**	Soy Oil	97.6
Gasoline[4]	0.72	FL&O	MEK	0.1	Solv Gen	9-18-0		Spindle Oil	
Jet A		FL&O	Toluene	0	Solv Gen	10-34-0	48	Sunflower Oil	97.1
Jet A-1	0.76	FL&O	Xylene	0	Solv Gen	20% Aqua-Ammonia	1.1 – 1.3	Vegetable Oil	145
Jet B		FL&O	Deionized		Water	28%, 30% or	31 – 110	**Test E**	

Mass Meter
Product Category and Test Requirements

JP4	0.76	FL&O
JP5	0.76	FL&O
JP7 and JP8	0.76	FL&O

Typical Products	**Specific Gravity[2] (60 °F)**	**Product Category**
Kerosene	0.75	FL&O
Light Oil	0.86	FL&O
Lubricating Oils	0.80 – 0.90	FL&O
Olive Oil	0.92	FL&O
Peanut Oil	0.9 – 1.0	FL&O
SAE Grades	0.9	FL&O
Soy Oil	0.93	FL&O
Spindle Oil		FL&O
Sunflower Oil	0.93	FL&O
Vegetable Oil	0.92	FL&O
Liquid Molasses	1.25	Liq Feed
Molasses Plus Phos Acid	1.1 – 1.3	Liq Feed

Magnetic Flow Meter
Product Category and Test Requirements

Demineralized		Water

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.

Typical Products	**Conductivity (micro-siemens/centimeter)**	**Product Category**
Water Mixes of Alcohols and Glycols		Alc Gly
Banvel		CC-A
Herbicides		CC-A
Paraquat		CC-A
Prowl		CC-A
Round-up		CC-A
Touchdown		CC-A
Treflan		CC-A
Adjuvants		CC-B
Fumigants		CC-B
Fungicides		CC-B

Positive Displacement Flow Meter Product Category and Test Requirements

32%	
Ammonia Nitrate	11.22
Clear Liquid Fertilizer	31 – 110
Nitrogen Solution	31 – 110

Test C
Product Category:
Clear Liquid Fertilizers (Fert) continued

Typical Products	**Reference Viscosity[1] (60 °F) centipoise (cP)**
N-P-K Solution	
Urea	1

Test C
Product Category:
Fuels, Lubricants, Industrial and Food Grade Liquid Oils (FL&O)

Typical Products	**Reference Viscosity[1] (60 °F) centipoise (cP)**
6 Oil (#5, #6)	66 – 13,000
Asphalt	100 – 5000
Avgas	1.5 – 6
Biodiesel above B20	10.12
Bunker Oil	11,200
Cooking Oils	9.93
Corn Oil	4

Turbine Flow Meter
Product Category and Test Requirements

Product Category:
Solvents General (Solv Gen)

Typical Products	**Reference Kinematic Viscosity[1] (60 °F) centistokes (cSt)**
Acetates	0.47
Acetone	0.43

Test E
Product Category:
Solvents General (Solv Gen) continued

Typical Products	**Reference Kinematic Viscosity[1] (60 °F) centistokes (cSt)**
Ethylacetate	1.42
Hexane	0.52
MEK	0.56
Toluene	0.71
Xylene	0.97

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

Typical Products	**Product Category**
Banvel	CC-A
Herbicides	CC-A
Paraquat	CC-A
Prowl	CC-A

Mass Meter Product Category and Test Requirements			**Magnetic Flow Meter Product Category and Test Requirements**			**Positive Displacement Flow Meter Product Category and Test Requirements**		**Turbine Flow Meter Product Category and Test Requirements**	
and/or Urea (TreaChle)									
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
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			Beverages		Water	Sunflower Oil	90.1	Nitrogen Solution	Fert

Mass Meter
Product Category and Test Requirements

each product category. The Certificate of Conformance will cover the products in the product category in which a product was tested.

Typical Products	Specific Gravity[2] (60 °F)	Product Category
Compressed Natural Gas (CNG)	0.6 – 0.8 (1=Air)	Comp gas
Anhydrous Ammonia	0.61	Comp liq
Butane	0.595	Comp liq
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	0.07 (1=Air)	Comp H2

Magnetic Flow Meter
Product Category and Test Requirements

Juices		Water
Nonpotable	72[5]	Water
Potable	72[5]	Water
Tap Water	72[5]	Water

Positive Displacement Flow Meter Product Category and Test Requirements

Vegetable Oil	133

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

Turbine Flow Meter
Product Category and Test Requirements

N-P-K Solutions	Fert
Urea	Fert
Bicep	Flow
Broadstrike	Flow

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

[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			**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**	
(H or H2)							
Liquid Carbon Dioxide	1.12 (-40 °F)	Liq CO2		**Test C** **Product Category:** Liquid Feed (Liq Feed)		Trichloro-Ethylene	Solv Cl
				Typical Products	**Reference Viscosity[1] (60 °F) centipoise (cP)**	3-10-30	Sus Fert
				Liquid Molasses	8640	4-4-27	Sus Fert
				Molasses Plus Phos Acid and/or Urea (TreaChle)	2882	Compressed Hydrogen Gas (H or H2)	Comp H2
						Liquid Carbon Dioxide	Liq CO2

	Test C **Product Category:** Solvents Chlorinated (Solv Cl)		**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	**Reference Viscosity[1] (60 °F) centipoise (cP)**	**Typical Products**	**Product Category**
	Carbon Tetra-Chloride	0.99	Liquefied Natural Gas	Cryo LNG
	Test C **Product Category:** Solvents Chlorinated (Solv Cl) continued		Liquefied Oxygen	Cryo LNG
	Typical Products	**Reference Viscosity[1] (60 °F) centipoise (cP)**	Nitrogen	Cry LNG
	Methylene-Chloride	0.46	Beverages	Water
	Perchloro-Ethylene	1	Deionized	Water
	Trichloro-Ethylene	0.6	Demineralized	Water
	Test C **Product Category:** Solvents General (Solv Gen)		Juices	Water
	Typical Products	**Reference Viscosity[1] (60 °F) centipoise (cP)**	Milk	Water
	Acetates	0.44	Nonpotable	Water
	Acetone	0.34	Potable	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**	
		Ethylacetate	1.36	Tap Water	Water
		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		
		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)**		

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**
		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	
		Test A The following products must be individually tested and noted on the Certificate of Conformance.		
		Product Category: Liquid Carbon Dioxide (Liq CO2)		
		Typical Products	**Reference Viscosity[1] (60 °F) centipoise (cP)**	
		Liquid Carbon Dioxide	0.194	

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 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."*			**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.			**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.		**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.[6]	
						Product Category: Alcohols, Glycols and Water Mixes Thereof (Alc Gly)		**Product Category:** Alcohols, Glycols and Water Mixes Thereof (Alc Gly)	
Typical Products	**Specific Gravity[7] (60 °F)**	**Product Category**	**Typical Products**	**Conductivity (micro-siemens/centimeter)**	**Product Category**	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	**Typical Products**	**Reference Kinematic Viscosity[1] (60 °F) Centistokes (cSt)**
Butanol	0.81	Alc Gly	Butanol		Alc Gly	Butanol	3.34	Butanol	3.34
Ethanol	0.79	Alc Gly	Ethanol	0.0013	Alc Gly	Ethanol	1.29	Ethanol	1.29
Ethylene Glycol	1.19	Alc Gly	Ethylene Glycol		Alc Gly	Ethylene Glycol	25.5	Ethylene Glycol	25.5
Isobutyl	0.81	Alc Gly	Isobutyl	0.02	Alc Gly	Isobutyl	4.54	Isobutyl	4.54
Isopropyl	0.79	Alc Gly	Isopropyl	3.5	Alc Gly	Isopropyl	2.78	Isopropyl	2.78
Methanol	0.80	Alc Gly	Methanol	0.44	Alc Gly	Methanol	0.64	Methanol	0.64
Propylene Glycol	1.04	Alc Gly	Propylene Glycol		Alc Gly	Propylene Glycol	54	Propylene Glycol	54
Banvel	0.7 – 1.2	CC-A	6 Oil (#5, #6)		FL&O	**Test C** **Product Category:** Crop Chemicals (Type A) (CC-A)		**Test E** **Product Category:** Compressed Liquids, Fuels and Refrigerants NH_3 (Comp liq)	
Herbicides	0.7 – 1.2	CC-A	Asphalt		FL&O	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**

[6] 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."

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

[7] 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**	
Paraquat	0.7 – 1.2	CC-A	Avgas		FL&O	Banvel	4 – 400	Anhydrous Ammonia	0.188
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[8]		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[9]		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

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

Mass Meter Product Category and Test Requirements			Magnetic Flow Meter Product Category and Test Requirements			Positive Displacement Flow Meter Product Category and Test Requirements		Turbine Flow Meter Product Category and Test Requirements	
Typical Products	**Specific Gravity[2] (60 °F)**	**Product Category**	**Typical Products**	**Conductivity (micro-siemens/centimeter)**	**Product Category**	**Test C** **Product Category:** Chemicals (Chem)		**Test E** **Product Category:** Fuels, Lubricants, Industrial and Food Grade Liquid oils (FL&O) continued	
Ammonia Nitrate	1.16 – 1.37	Fert	SAE Grades		FL&O	Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**
Clear Liquid Fertilizer	1.17 – 1.44	Fert	Soy Oil	0	FL&O	Hydrochloric Acid	0.80 – 1. 0	Gasoline[4]	0.28
Nitrogen Solution	1.17 – 1.44	Fert	Spindle Oil		FL&O	Phosphoric Acid	161	Jet A	1.5 – 6
N-P-K Solutions	1.2 – 1.4	Fert	Sunflower Oil		FL&O	Sulfuric Acid	1.49	Jet A-1	1.36
Urea	1.89	Fert	Vegetable Oil	0	FL&O	**Test C** **Product Category:** Compressed Liquids, Fuels and Refrigerants (Comp liq)		Jet B	1.5 – 6
6 Oil (#5, #6)	0.9	FL&O	Asphalt		Heated	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	JP4	1.02
Asphalt		FL&O	Bunker C		Heated	Anhydrous Ammonia	0.188	JP5	1.94
Avgas		FL&O	Carbon Tetra-Chloride		Solv Cl	Butane	0.19	JP7 and JP8	1.82
Biodiesel above B20	0.86	FL&O	Methylene-Chloride		Solv Cl	Ethane		Kerosene	1.94
Bunker Oil	0.99	FL&O	Perchloro-Ethylene		Solv Cl	Freon 11	0.313	Light Oil	13.47
Cooking Oils	0.92	FL&O	Trichloro-Ethylene		Solv Cl	Freon 12	0.359	Lubricating Oils	20 – 1000
Corn Oil	0.91	FL&O	Acetates		Solv Gen	Freon 22	1.99	Olive Oil	116.8
Crude Oil	0.79 – 0.97	FL&O	Acetone	.02	Solv Gen	Propane	0.098	Peanut Oil	11 – 110
Diesel Fuel[3]	0.84	FL&O	Ethylacetate	0.00001	Solv Gen	**Test C** **Product Category:** Clear Liquid Fertilizers (Fert)		SAE Grades	192 – 3626
Fuel Oil (#1, #2, #3, #4)	0.9	FL&O	Hexane	0	Solv Gen	**Typical Products**	**Reference Viscosity[1] (60 °F) Centipoise (cP)**	Soy Oil	90.6
Gasoline[4]	0.72	FL&O	MEK	0.1	Solv Gen	9-18-0		Spindle Oil	
Jet A		FL&O	Toluene	0	Solv Gen	10-34-0	48	Sunflower Oil	90.1
Jet A-1	0.76	FL&O	Xylene	0	Solv Gen	20% Aqua-Ammonia	1.1 – 1.3	Vegetable Oil	133
Jet B		FL&O	Deionized		Water	28%, 30% or 32%	31 – 110	**Test E** **Product Category:** Solvents General (Solv Gen)	

Mass Meter Product Category and Test Requirements		
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		
Demineralized		Water

Positive Displacement Flow Meter Product Category and Test Requirements	
Ammonia Nitrate	11.22
Clear Liquid Fertilizer	31 – 110
Nitrogen Solution	31 – 110

Turbine Flow Meter Product Category and Test Requirements	
Typical Products	**Reference Viscosity[1] (60 °F) Centipoise (cP)**
Acetates	0.44
Acetone	0.34

Typical Products	Specific Gravity[2] (60 °F)	Product Category
Kerosene	0.75	FL&O
Light Oil	0.86	FL&O
Lubricating Oils	0.80 – 0.90	FL&O
Olive Oil	0.92	FL&O
Peanut Oil	0.9 – 1.0	FL&O
SAE Grades	0.9	FL&O
Soy Oil	0.93	FL&O
Spindle Oil		FL&O
Sunflower Oil	0.93	FL&O
Vegetable Oil	0.92	FL&O
Liquid Molasses	1.25	Liq Feed
Molasses Plus Phos Acid and/or Urea (TreaChle)	1.1 – 1.3	Liq Feed

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.

Typical Products	Conductivity (micro-siemens/centimeter)	Product Category
Water Mixes of Alcohols and Glycols		Alc Gly
Banvel		CC-A
Herbicides		CC-A
Paraquat		CC-A
Prowl		CC-A
Round-up		CC-A
Touchdown		CC-A
Treflan		CC-A
Adjuvants		CC-B
Fumigants		CC-B
Fungicides		CC-B

Test C

Product Category:
Clear Liquid Fertilizers (Fert) continued

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
N-P-K Solution	
Urea	1

Test C

Product Category:
Fuels, Lubricants, Industrial and Food Grade Liquid Oils (FL&O)

Typical Products	Reference Viscosity[1] (60 °F) Centipoise (cP)
6 Oil (#5, #6)	66 – 13,000
Asphalt	100 – 5000
Avgas	1.5 – 6
Biodiesel above B20	10.12
Bunker Oil	11,200
Cooking Oils	9.93
Corn Oil	4

Test E

Product Category:
Solvents General (Solv Gen) continued

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

Test A

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

Typical Products	Product Category
Banvel	CC-A
Herbicides	CC-A
Paraquat	CC-A
Prowl	CC-A

Mass Meter Product Category and Test Requirements			**Magnetic Flow Meter Product Category and Test Requirements**			**Positive Displacement Flow Meter Product Category and Test Requirements**		**Turbine Flow Meter Product Category and Test Requirements**	
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
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			Beverages		Water	Sunflower Oil	90.1	Nitrogen Solution	Fert

Mass Meter
Product Category and Test Requirements

product category in which a product was tested.

Typical Products	Specific Gravity[2] (60 °F)	Product Category
Compressed Natural Gas (CNG)	0.6 – 0.8 (1=Air)	Comp gas
Anhydrous Ammonia	0.61	Comp liq
Butane	0.595	Comp liq
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)	Comp H2
Liquid Carbon	1.12	Liq CO2

Magnetic Flow Meter
Product Category and Test Requirements

Juices		Water
Nonpotable	72[10]	Water
Potable	72[5]	Water
Tap Water	72[5]	Water

Positive Displacement Flow Meter Product Category and Test Requirements

Vegetable Oil	133

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

Turbine Flow Meter
Product Category and Test Requirements

N-P-K Solutions	Fert
Urea	Fert
Bicep	Flow
Broadstrike	Flow
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-	Solv Cl

[10] 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		
Dioxide	(-40 °F)	

Magnetic Flow Meter Product Category and Test Requirements

Positive Displacement Flow Meter Product Category and Test Requirements	
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

Turbine Flow Meter Product Category and Test Requirements	
Ethylene	
3-10-30	Sus Fert
4-4-27	Sus Fert
Compressed Hydrogen Gas (H or H2)	Comp H2
Liquid Carbon Dioxide	Liq CO2

Test C **Product Category:** Solvents Chlorinated (Solv Cl)	
Typical Products	**Reference Viscosity[1] (60 °F) Centipoise (cP)**
Carbon Tetra-Chloride	0.99

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

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
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~~
		~~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~~	
		~~**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~~	~~0.038~~	

~~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~~
		~~Oxygen~~		
		~~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~~	
		~~**Test A**~~ ~~The following products must be individually tested and noted on the Certificate of Conformance.~~		
		~~**Product Category:**~~ ~~Liquid Carbon Dioxide (Liq CO2)~~		
		~~**Typical Products**~~	~~**Reference Viscosity[1] (60 °F) Centipoise (cP)**~~	
		~~Liquid Carbon Dioxide~~	~~0.194~~	

Product Category Table – Category Abbreviations

Abbreviation	Product Category	Abbreviation	Product Category
Alc Gly	**Alcohols, Glycols and Water Mixes Thereof**	**Fert**	**Fertilizers**
CC-A	**Crop Chemicals (Type A)**	**FL&O**	**Fuels, Lubricants, Industrial and Food Grade Liquid Oils**
CC-B	**Crop Chemicals (Type B)**	**Flow**	**Flowables**
CC-C	**Crop Chemicals (Type C)**	**Heated**	**Heated Products (Above 50 °C)**
CC-D	**Crop Chemicals (Type D)**	**Liq Feed**	**Liquid Feeds**
Chem	**Chemicals**	**Liq CO2**	**Liquid Carbon Dioxide**
Comp gas	**Compressed Gases**	**Solv Chl**	**Solvents Chlorinated**
Comp H2	**Compressed Hydrogen Gas**	**Solv Gen**	**Solvents General**
Comp liq	**Compressed Liquids (Fuels and Refrigerants, NH_3)**	**Sus Fert**	**Suspension Fertilizers**
Cryo LNG	**Cryogenic Liquids and Liquefied Natural Gas**	**Water**	**Water**

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.