Appendix D

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

October 5 - 6, 2012
Louisville, Kentucky

INTRODUCTION

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

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

Suggested revisions are shown in **bold face print** by ~~**striking out**~~ information to be deleted and **underlining** information to be added. Requirements that are proposed to be nonretroactive are printed in ***bold-faced italics***.

Note: It is policy to use metric units of measurement in publications; however, recommendations received by NCWM technical committees and regional weights and measures associations have been printed in this publication as submitted. Therefore, the report may contain references to inch-pound units.

Table A
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APPENDICES:

Table B
Glossary of Acronyms and Terms

Acronym	Term	Acronym	Term
CC	Certificate of Conformance	NTEP	National Type Evaluation Program
DMS	Division of Measurement Standards	NTETC	National Type Evaluation Technical Committee
ECR	Electronic Cash Register	OIML	International Organization of Legal Metrology
GPM	Gallons Per Minute	OWM	Office of Weights and Measures (NIST)
HB 44	NIST Handbook 44 *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*	PD	Positive Displacement
L&R	Laws and Regulations	Pub 14	NCWM Publication 14
LMD	Liquid Measuring Devices	RMFD	Retail Motor-Fuel Dispenser
mA	milliamp	SI	International System of Units
MMA	Meter Manufacturer's Association	VTM	Vehicle Tank Meter
NCWM	National Conference on Weights and Measures	W&M	Weights and Measures
NIST	National Institute of Standards and Technology		
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.			

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, Mr. Dan Reiswig (CA DMS) provided an update to the Sector on the progress of the project. He presented a draft checklist, noting that the checklist follows the general format of NCWM Publication 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. Appendices A and B, submitted by Mr. Reiswig, contain the draft checklist and proposed revisions to Technical Policy T.

At the conclusion of 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. Sector Technical Advisor, Mr. Marc Buttler (NIST OWM), will assist as needed and monitor progress of work.

Discussion:
Mr. Miller reported that a new electronic indicating device is very close to being released by FMC. FMC would like to use the normal NTEP evaluation of this device as an opportunity to help complete the new checklist. Results from a "bench test trial" using the draft checklist will be used by the Work Group and brought back to the Sector.

Mr. Miller understands that, once the checklist has been adopted in NCWM Publication 14, an indicator will not require a permanence test beyond the initial laboratory bench testing for approval in stationary applications because there is no wear on an electronic indicator that results from product flow as there is with a measuring element. However, since the checklist has not yet been completed by the Sector, Mr. Miller is planning for the device to undergo both the bench test trial of the new checklist and a full field evaluation, including a full permanence test on a vehicle.

Mr. Miller expects the new FMC device will be submitted for NTEP evaluation for a vehicle-mounted approval by the end of 2012. This device receives a pulse input representing the measured quantity. Serial communication from the measuring device is not within the scope of the proposed evaluation.

It was proposed by FMC that the bench testing could be conducted at the ISO 17025 accredited FMC Lab in Erie, Pennsylvania, in December. The truck on which the device will be mounted for field-testing and permanence evaluation is also located in Erie.

Final details regarding assignment of the project to one of the NTEP labs and timing will need to be decided at the time the device is submitted. However, because all the work on the checklist to date has originated from California, the Sector, with the concurrence of the NTEP Director, agreed that the CA DMS NTEP Lab would be the preferred lab for the trial as long as there are no scheduling issues.

Decision:
The Sector agreed to carry the item over to the Sector's next meeting based on the recommendation from the Work Group to allow for completion and trial of the checklist. Mr. Jack Kiefert (Honeywell Enraf) has volunteered to join the group.

Work Group members as revised at the Sector's 2012 meeting are listed below:

Electronic Indicators Checklist Work Group	
Chair:	Rich Miller, FMC
Members:	Dmitri Karimov, Liquid Controls
	Mike Keilty, Endress and Hauser
	Jack Kiefert, Honeywell Enraf
Review & Comment:	Mike Frailer, Maryland Weights and Measures
	Allen Katalinic, North Carolina Division of Measurement Services
Technical Advisor:	Marc Buttler, NIST, OWM, Office of Weights and Measures

Appendices A and B to this summary contain the draft checklist and proposed revisions to Technical Policy T. submitted by Mr. Reiswig. The Work Group was asked to address the highlighted sections in the draft checklist. The Work Group was also asked to address the five points below and then 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. It has been proposed that spot-checking of three random tables at three different temperatures would be adequate to verify that an indicator's temperature compensation feature is functioning properly.**

4) **A step for checking multipoint calibration along with associated guidance should be developed and added to the checklist. 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. A nalog (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.**

2. Product Families Table - Include Water on Existing NTEP CC's

Source:
Dmitri Karimov, Liquid Controls

Background:
Flow meters are approved to very tight tolerances on aggressive liquids such as acids, alcohols, glycol/water mixtures, and liquid fertilizers. Many of these liquids, including glycol/water mixtures and some liquid fertilizers, are water-based. Water is a less aggressive fluid and has a wider NIST Handbook 44 tolerance than these liquids.

A note at the end of the Product Families Table in NCWM Publication 14 allows water to be used as a test product in the "Fuels, Lubricants, and Industrial and Food-grade Liquid Oils" product family.

Despite these points, NCWM Publication 14 requires separate tests with water in order to add water to an existing PD or turbine meter NTEP CC which was issued based on tests with other products in the "Fuels, Lubricants, and Industrial and Food-grade Liquid Oils" product family.

At the conclusion of its 2011 meeting: The Sector voted on a proposal to add a note to the end of the Product Families Table that would apply to all technologies as follows:

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

The proposal and the results of the vote shown below were forwarded to the NTEP Committee.

In favor: 9
Opposed: 3
Abstained: 1

Note: Two of the three labs were opposed to the item.

On January 21, 2012, the NTEP Committee returned this item to the Sector for further consideration, noting that because the majority of the NTEP labs did not concur with the proposal, the conclusion did not represent a consensus among all segments of the membership.

Discussion:
At its 2012 meeting, the Sector reviewed and discussed each of the five points that were noted as unresolved issues in the 2011 summary:

Issue 1: The proposal to leave the decision of whether to add water to a CC without any additional testing up to the judgment of the NTEP labs on a case-by-case basis caused concern among some Sector members. The labs and some manufacturers were concerned that such ambiguity in NTEP policy could lead to unintentional inconsistency and less predictable outcomes during type evaluations.

The Sector discussed how, in order to replace testing with their judgment alone as the means of verifying suitability and metrological integrity of a meter with a new product family, the NTEP labs would need to invest in developing material compatibility expertise that would extend beyond what is justified by their primary mission.

Issue 2: A concern was raised about the application of the LMD Code and the Water Meters Code in NIST Handbook 44. Paragraph A.2.(d) of the LMD Code specifically excludes water meters. T his exclusion requires a meter that already has a CC under the LMD Code to meet a potentially different set of requirements found in the Water Meters Code in order to add water to the CC. For example, a 3" size PD meter that is already approved under the LMD Code with a maximum discharge rate of 300 gpm would be required by paragraph S.4.4.1. in the LMD Code (Section 3.30.) to have a minimum discharge rate not to exceed 20 % of the marked maximum discharge rate, or 60 gpm. Therefore, the meter could be approved for use in applications other than water with a flow rate range from 60 gpm to 300 gpm. However, to comply with paragraph N.4.2. "Special Tests" in the Water Meters Code (Section 3.36.), the device would need to be able to pass special tests at 20 gpm, as shown in Table N.4.2.a.; this flow rate is three times smaller than what would normally be permitted by the LMD Code to be the smallest minimum rated discharge rate.

The Sector discussed emerging commercial water-measuring applications, such as Water-For-Injection (WFI), where the value of the water has been increased by industrial processes and larger quantities are measured. In these applications, a device other than a traditional utility water meter is generally preferred. With the emergence of new water-measuring applications, manufacturers question whether the requirements for traditional utility and batching applications, especially those that restrict flow rate ranges by meter size, should still apply to all applications that measure water of every type. It is possible that paragraph G-A.3. "Special and Unclassified Equipment" in NIST Handbook 44 may apply to some emerging applications that do not clearly fit the standard utility and batching applications that the Water Meters Code is intended to address. The Sector noted that there are already exceptions in the Water Meters Code that exclude mass flow meters and meters mounted on vehicle tanks. In both of these cases, meters must meet more stringent requirements, but are afforded greater flexibility of flow rate ranges than those that are allowed in the Water Meters Code.

More information is needed about the specific parameters of emerging water-measuring applications that do not fit clearly into the range of applications that are intended to be addressed by the Water Meters Code in order to develop a proposal to update NIST Handbook 44 for these applications. It is not yet clear from what is currently known whether it would be more appropriate to expand the scope of the Water Meters Code to address new applications or to modify the exception to water meters in the LMD Code to allow for certain types of water-measuring applications. In either case, the nature of the new applications must be well understood in order to justify a proposal to change NIST Handbook 44.

Issue 3: The Sector understands that any amount of testing will require some resources, and an effort is made to avoid policies that are not essential to assuring metrological integrity that might impose unreasonable burdens on manufacturers. However, several manufacturers stated that they often test on water and did not understand how testing with water could be viewed as an unreasonable burden.

The Sector discussed whether it would create a burden for some devices to require testing with water if the device is difficult to test on water because of questionable material compatibility. The Sector concluded that testing with water is even more important for devices which are marginally compatible with water or for which the compatibility with water is not well understood because the device was not originally intended to measure water.

Issue 4: There were concerns raised that water has been grouped separately in the product families table in the past for a reason, and that different types of water can affect measuring devices differently.

It was proposed to revise the Product Families Table, but a detailed proposal has not yet been developed.

Issue 5: A concern was raised that the word "similar" as used in the proposed language needed to be defined in more detail. During the 2011 Sector meeting, a definition for "similar" was proposed by one manufacturer as describing a group of two or more fluids that share the same value of the single critical property that applies to the device technology of concern (i.e., dynamic viscosity for PD meters, kinematic viscosity for turbine meters, specific gravity for mass flow meters, and conductivity for magnetic flow meters). This definition of similar fluids did not offer any explanation as to the reason that there are multiple product families in the Product Families Table which are similar as far as the critical property, but nevertheless have been defined as separate families ever since the adoption of the original version of the table.

The Sector agreed that some of the different product families were created to match meters made with different materials of construction. However, no one could say with certainty whether or not there are additional fluid product properties beyond the critical property for the device in question that affect the metrological integrity and durability of different measuring device types.

The submitter proposed withdrawing the item in recognition that there is no consensus support for the item as it is currently presented. Mr. Dmitri Karimov (Liquid Controls) plans to develop and submit a new item that will replace the current Agenda Items 2, 3, and 4.

Decision: The Sector agreed to Withdraw the item and anticipates Mr. Karimov will introduce a new item that combines Items 2, 3, and 4 from the 2012 Sector Agenda and which includes a detailed draft in the format of the Product Families Table.

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

Source:
Dmitri Karimov, Liquid Controls

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

Discussion:
Mr. Karimov suggested Withdrawing the item until such time as a more detailed proposal that includes a draft of the changes to the Product Families Table can be completed. The Sector agreed that much of the discussion pertaining to Agenda Item 2 also applied to this item.

Decision:
The Sector agreed to Withdraw the item and anticipates Mr. Karimov will introduce a new item that combines Items 2, 3, and 4 from the 2012 Sector Agenda and which includes a detailed draft in the format of the Product Families Table.

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

Source:
Dmitri Karimov, Liquid Controls

Background:
The submitter believes that NCWM Publication 14 (Pub 14) has too many agri-chemical products categories for PD and turbine meters that were created many years ago and are outdated. Note that this item relates to the proposal in Agenda Item 3 to match PD and turbine product categories.

At the conclusion of its 2011 meeting: The Sector voted on a proposal to add a note, as shown below, to the LMD Technical Policy.

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

The proposal and the results of the vote shown below were forwarded to the NTEP Committee.

Approve: 7
Oppose: 5
Abstain: 0

Note: All three labs and NIST were opposed to the item as it was framed for the vote.

On January 21, 2012, the NTEP Committee returned the item to the Sector for further consideration noting that because the NTEP labs and NIST did not concur with the proposal, the conclusion did not represent a consensus among all segments of the membership.

Discussion:
The Sector discussed the responses of the NTEP Committee to the voting results of Agenda Items 2 and 4. Even though an overall majority of the Sector members had voted in favor of both items, the NTEP Committee could not regard the proposals as representing consensus recommendations since a majority of one of the membership segments voted against each item. Because the NTEP Committee regards the input and participation from each segment of the Sector membership as critical, the committee regards such cases as a strong indication that an item needs further development.

Mr. Henry Oppermann (Weights and Measures Consulting) suggested that aligning proposals with OIML standards is often helpful in avoiding gaps in understanding between public and private sector members of the Sector. Mr. Dennis Beattie (Measurement Canada) mentioned that Canada is also attempting to address the organization of product fluid properties and meter materials of construction for the purpose of determining appropriate testing requirements for type evaluation.

The submitter proposed withdrawing the item in recognition that there is no consensus support for the item as it is currently presented. Mr. Karimov plans to develop and submit a new item that will replace the current Agenda Items 2, 3, and 4.

Mr. Buttler mentioned that he is available to provide technical guidance to Mr. Karimov in developing the draft proposal. However, industry must develop the item to ensure that the interests of industry are reflected by the proposal. Mr. Karimov commented that he would focus primarily on the test requirements for turbine meters in the new proposal.

The NTEP labs noted that a reference tool similar to the Product Families table is needed to capture the critical properties for each individual fluid. Because the Product Families Table is not all-inclusive and only provides information on the typical range of critical property values for each product family, the values for individual products must be determined by some other means. The Sector noted that the Product Families Table does not currently include all fluid products sold commercially and agreed that such a tool would be useful to aid field inspectors in enforcement and NTEP labs during type evaluation. However, the Sector also noted that it would be cumbersome to maintain the increasing volume of data that would be needed to achieve this.

Decision:
The Sector agreed to Withdraw the item and anticipates Mr. Karimov will introduce a new item that combines Items 2, 3, and 4 from the 2012 Sector Agenda and which includes a detailed draft in the format of the Product Families Table.

The Sector requested that the Technical Advisor, Mr. Buttler, provide assistance by researching historical records for any information listing the various fluid product properties that were considered when the product families for PD and turbine meters were first drafted by Mr. Mel Hankel of Liquid Controls for the original Product Families Table proposal.

Technical Advisor's Note: Mr. Buttler located information from the NIST file on the 1991 Measuring Sector meeting and attached the information to this summary as Appendices C and D.

Appendix C is a scanned image of a detailed letter from Mel Hankel to NIST that describes the interrelations between meter materials of construction and fluid product properties that formed the basis of the original proposal to streamline NTEP type testing by grouping fluids together into families. Appendix D is a technical paper from Smith Meter Inc. that includes additional technical information about interactions between meters and fluids with varying properties.

Appendices C and D identify the following fluid properties as properties that were considered during the creation of the original Product Families Table:

- ***Viscosity***
- ***Specific Gravity***
- ***Percent of Abrasive Solids***
- ***Lubricity Service Factor***
- ***Typical Flow Rate Range Ratio***
- ***Corrosiveness***
- ***Vapor Pressure***
- ***Homogeneity***
- ***Solids (Particulate) Content***
- ***Typical Temperature Ranges***
- ***Typical Pressure Ranges***
- ***Boundary Layer Thickening***
- ***Deposits (e.g., paraffin)***

The 1991 discussion also noted that, at the time, Liquid Controls was producing 15 PD meter classes using various different materials of construction to address the anticipated range of these various fluid properties.

One additional fluid property was the subject of discussion in the 1991 Sector meeting. Entrained vapor/air resulting from agitation of fluids (e.g., fertilizers) was discussed at length with respect to the impact on effectiveness of the vapor/air elimination means of some measuring systems. Multiple fluid properties (e.g.,

viscosity and surface tension) will determine how entrained vapor/air will be dispersed in an agitated fluid and how quickly and effectively the entrained vapor/air can be eliminated.

The information from the 1991 Measuring Sector archive, Appendices C and D, in combination with more recent data from industry regarding the effects of various fluid properties on the latest metering technologies should be helpful to Mr. Karimov in developing the new proposal referenced above. If it can be shown which of the properties from the list above are the key characteristics for each of the currently defined product families, this understanding could then help to justify the specific details of a reorganization and consolidation of the Product Families Table.

NEW ITEMS:

5. Pictograms for "Setup or Configuration Mode Enabled"

Source:
NTEP Measuring Labs

Background:
At the spring 2012 meeting of the NTEP measuring labs, the labs agreed that pictogram  is clear and acceptable indication of the status of the setup or configuration mode while sealing a device. To clarify acceptability of pictograms such as these, it is proposed that an example be added under the heading of Acceptable Clear Indications to the list of indications representing that the device is configured with the setup or configuration mode enabled.

Recommendation:
The Sector was asked to consider adding a pictogram to the sealing checklist table under examples of Acceptable Clear Indications that a device has the setup or configuration mode enabled as shown in the lower left corner of the figure below.

Indications representing that the device is configured with the setup or configuration mode enabled (i.e., any mode permitting access to any or all sealable parameters) This list is not limiting or all-inclusive; other indications may be acceptable.	
Acceptable Clear Indications	**Indications NOT Acceptably Clear**
Unusable quantity indications Example: C100.05E	C 100.05 gal
"not **HB 44**" annunciator	Any digit in the quantity differentiated by size, shape, or color
"CAL" annunciator (single or mixed case)	Quantities w/o units Example. 100.05
"Set-up" annunciator	Flashing quantity value

Indications representing that the device is configured with the setup or configuration mode enabled (i.e., any mode permitting access to any or all sealable parameters) This list is not limiting or all-inclusive; other indications may be acceptable.	
Acceptable Clear Indications	**Indications NOT Acceptably Clear**
(single or mixed case)	
"Config" annunciator (single or mixed case)	Quantity with no annunciators displayed
	Quantity all annunciators displayed

It was also recommended that the Sector consider adding an accompanying checklist table to show examples of optional indications that a device is in the sealed mode or has setup or configuration mode disabled. Indication of this mode is currently neither required nor prohibited in NIST Handbook 44.

Indications (optional) representing that the device is configured with the setup or configuration mode disabled (i.e., no access to any or all sealable parameters) This list is not limiting or all-inclusive; other indications may be acceptable.
Acceptable Clear Indications


Discussion:
The Technical Advisor summarized the two parts of the proposal:

- the addition of a pictogram example to the exiting table of indications representing that the device is configured with the setup or configuration mode enabled, and
- the addition of a second table to show examples of indications representing that the device is configured with the setup or configuration mode **disabled.**

The Sector first discussed the existing table of indications representing that the device is configured with the setup or configuration mode enabled. The Sector noted that NCWM Publication 14 does not now prohibit the use of pictograms. The Sector agreed that adding examples of acceptable pictograms could avoid confusion as to whether pictograms are acceptable and would provide manufacturers that are submitting new devices with the pictogram options that have been reviewed previously and determined to be clear indications.

The Sector noted that the location of the title of the table as it appears in the proposal was inside the top cell of the table, and that this was in contrast to the location of the title of the table as separate text above the table where it currently appears in NCWM Publication 14. It was proposed that the table title and the note indicating that the list is not all-inclusive should remain as separate text above the table. The Sector agreed to keep the title and the note above the table to remain consistent with the way that other similar tables appear in NCWM Publication 14.

The Sector discussed the requirement found in Table S.2.2. "Categories of Device and Methods of Sealing" from the LMD Code in NIST Handbook 44 that applies to Category 2 and Category 3 devices:

> *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.*

The Sector noted that there is no corresponding specific requirement in NIST Handbook 44 for a device to indicate when the remote configuration mode is **not** enabled. The Sector's interpretation of this is that, although it is permitted for a device to indicate when the remote configuration mode is not enabled, it is only required for the device to indicate when the remote configuration mode is enabled. A concern was raised about adding examples of indications that are permitted but are not required. The Sector ultimately decided not to add the additional table that was proposed which would have listed the optional indications representing that the device is configured with the setup or configuration mode disabled.

Decision: The Sector unanimously agreed to propose adding the pictogram example and the additional wording to the note under the title of the existing table as shown underlined below. The Sector also decided not to include the new additional table that had been proposed to show optional indications representing that the device is configured with the setup or configuration mode "disabled."

The title, note, and table should appear with the revisions as shown here:

> **Indications Representing That the Device is Configured with the Setup or Configuration Mode Enabled (i.e., any mode permitting access to any or all sealable parameters)**
>
> This list is not limiting or all-inclusive; other indications or pictograms may be acceptable.

Acceptable Clear Indications	Indications NOT Acceptably Clear
• Unusable quantity indications Example: C100.05E • "not **HB 44**" annunciator • "CAL" annunciator (single or mixed case) • "Set-up" annunciator (single or mixed case) • "Config" annunciator (single or mixed case) • 	• C 100.05 gal • Any digit in the quantity differentiated by size, shape, or color • Quantities w/o units Example: 100.05 • Flashing quantity value • Quantity with no annunciators displayed • Quantity all annunciators displayed

6. Utility Water Meter Repeatability Tolerances

Source:
NTEP Measuring Labs

Background:
The new Section L "Laboratory Evaluation and Permanence Tests for Utility Type Water Meters" that was added to NCWM Publication 14 in 2012 includes repeatability tolerance values for utility-type meters. At the spring 2012 meeting of the NTEP measuring labs, the labs recommended that these tolerance values be removed from NCWM Publication 14. Tolerance values are published in NCWM Handbook 44, and it is standard practice to refer to NIST Handbook 44 as the sole location of all tolerance values.

Recommendation:
The Sector was asked to consider removing the tolerance values for utility-type water meters from NCWM Publication 14 as shown below.

L. Laboratory Evaluation and Permanence Tests for Utility Type Water Meters

All new-design meters are subject to a permanence test. NTEP reserves the right to require a permanence test based on the results of the initial examination.

Initial Examination

1. All meters of the new type installed at the type evaluation location are subject to evaluation. At least three meters of the same model must be tested.
2. At least three meters will be chosen for throughput testing on water. The minimum number of tests to be conducted for each of these meters will include the following:
   - Three tests at the maximum flow rate
   - Three tests at the intermediate flow rate
   - Three tests at the minimum flow rate
3. All meters must perform within acceptance tolerance.
4. Repeatability – When multiple tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed repeatability tolerance. ~~the following values:~~
   1. ~~**0.6 percent for tests conducted at Normal Flow Rates**~~
   2. ~~**2.0 percent for tests conducted at Intermediate Flow Rates**~~
   3. ~~**4.0 percent for tests conducted at Minimum Flow Rates**~~

Subsequent Examination

1. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates are to be included on the certificate of conformance provided the results are within the applicable tolerances.
2. The examination will be conducted as applicable:
   - 200 000 gallons for throughput testing for mechanical changes of metrological significance
   - Flow rates during throughput testing are not to exceed 50 % of the manufacturers rated maximum flow rate
3. Three tests at maximum, intermediate and minimum flow rate will be made on the throughput meters. Only one test at each flow rate needs to be performed on any remaining meters.
4. Repeatability – When multiple tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed **repeatability tolerance.** ~~**the following values:**~~
   1. ~~**0.6 percent for tests conducted at Normal Flow Rates**~~
   2. ~~**2.0 percent for tests conducted at Intermediate Flow Rates**~~
   3. ~~**4.0 percent for tests conducted at Minimum Flow Rates**~~

Discussion:
The Sector discussed the item and agreed that the convention in NCWM Publication 14 of not listing tolerance values, but rather referring directly to NIST Handbook 44 for tolerance values should apply for water meters as well.

Technical Advisor's Note: Clarifications that repeatability tests are three or more consecutive tests were added as an editorial change to reflect paragraph N.4.1.1. "Repeatability Tests" in the HB 44 Water Meters Code."

Decision:
The Sector unanimously agreed to propose removing the tolerance values for utility-type water meters from NCWM Publication 14 as shown below.

L. Laboratory Evaluation and Permanence Tests for Utility Type Water Meters

All new-design meters are subject to a permanence test. NTEP reserves the right to require a permanence test based on the results of the initial examination.

Initial Examination

1. All meters of the new type installed at the type evaluation location are subject to evaluation. At least three meters of the same model must be tested.
2. At least three meters will be chosen for throughput testing on water. The minimum number of tests to be conducted for each of these meters will include the following:
   - Three tests at the maximum flow rate
   - Three tests at the intermediate flow rate
   - Three tests at the minimum flow rate
3. All meters must perform within acceptance tolerance.
4. Repeatability – When ~~multiple~~ three or more consecutive tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed **repeatability tolerance.** ~~**the following values:**~~
   ~~**1. 0.6 percent for tests conducted at Normal Flow Rates**~~
   ~~**2. 2.0 percent for tests conducted at Intermediate Flow Rates**~~
   ~~**3. 4.0 percent for tests conducted at Minimum Flow Rates**~~

Subsequent Examination

1. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates are to be included on the certificate of conformance provided the results are within the applicable tolerances.
2. The examination will be conducted as applicable:
   - 200 000 gallons for throughput testing for mechanical changes of metrological significance
   - Flow rates during throughput testing are not to exceed 50 % of the manufacturers rated maximum flow rate
3. Three tests at maximum, intermediate and minimum flow rate will be made on the throughput meters. Only one test at each flow rate needs to be performed on any remaining meters.
4. Repeatability – When ~~multiple~~ three or more consecutive tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed **repeatability tolerance.** ~~**the following values:**~~
   ~~**1. 0.6 percent for tests conducted at Normal Flow Rates**~~
   ~~**2. 2.0 percent for tests conducted at Intermediate Flow Rates**~~
   ~~**3. 4.0 percent for tests conducted at Minimum Flow Rates**~~

7. Water Meters Permanence Flow Rates

Source:
NTEP Measuring Labs

Background:
The new Section L "Laboratory Evaluation and Permanence Tests for Utility Type Water Meters" that was added to NCWM Publication 14 in 2012 includes a restriction preventing throughput flow rates to 50 % of maximum rated flow rate and below. The NTEP labs report that past laboratory throughput testing of water meters has been run with flow rates near the maximum rated flow rate. Water meters in service are often found that are nearly continuously subjected to flow at close to the maximum rated flow rate. The labs feel it is important to be able to conduct testing under the conditions in which the meters will be used.

Recommendation:
The Sector was asked to consider removing the restriction in Section L that prevents throughput flow rates above 50 % of maximum rated flow rate as shown below.

Subsequent Examination

1. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates are to be included on the certificate of conformance provided the results are within the applicable tolerances.
2. The examination will be conducted as applicable:
   - 200 000 gallons for throughput testing for mechanical changes of metrological significance
   - ~~Flow rates during throughput testing are not to exceed 50 % of the manufacturers rated maximum flow rate~~
3. Three tests at maximum, intermediate, and minimum flow rate will be made on the throughput meters. Only one test at each flow rate needs to be performed on any remaining meters.
4. Repeatability – When multiple tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed repeatability tolerance.

Discussion:
The Sector revisited the question of what limit, if any, is appropriate to place on the throughput flow rate during permanence testing of utility type water meters. Mr. John Roach (CA DMS NTEP Lab) said that the water meter testing in California regularly runs throughput flow rates on $^{5}/_{8}$-inch meters at 15 gpm. He also mentioned that utility type water meters of similar size would often run continuously at this same high flow rate while in service. Sector members agreed that, for a permanence test to be valid, the meter should be allowed to run throughput at a flow rate similar to that at which a meter of the type is expected to see in service.

Mr. Andre Noel (Neptune Technology Group, Inc.) explained that there appears to be confusion when referring to the "manufacturer's rated maximum flow rate" resulting from a difference in nomenclature between NCWM Publication 14; the ANSI/AWWA C700 "AWWA Standards for Cold-Water Meters"; and the Water Meters Code (Section 3.36.) in NIST Handbook 44. In the AWWA standard, the "recommended maximum rate for <u>continuous</u> operations" for cold-water meters is limited to 50 % of the "safe maximum operating capacity" flow rate. AWWA C700 describes the "safe maximum operating capacity" as the maximum rate of flow that water should be passed through the meter. AWWA adds that the maximum rate should extend only for short periods of time and at infrequent intervals, and that maximum flow could be destructive if continuous.

Mr. Noel further explained that the flow rates for normal tests listed in Table N.4.1. in the Water Meters Code in NIST Handbook 44 are lower than the "safe maximum operating capacity" flow rate values in AWWA C700. The limit on the throughput of "50 % of the manufacturer's rated flow rate" currently stated in Section L of NCWM Publication 14 was intended to prevent continuous throughput flow at "safe maximum operating capacity" flow rates and thus avoid the potential destructive effects of continuous flow at those rates.

Since neither the "manufacturer's rated flow rate" from NCWM Publication 14 nor the "safe maximum operating capacity" from the AWWA standard are terms that are currently referenced or defined in NIST Handbook 44, the Sector agreed to reword the description of the throughput flow rate limit in Section L of NCWM Publication 14 using terms referenced in NIST Handbook 44 and AWWA C700. Mr. Noel and other Sector members agreed that the throughput flow rates for water meters should be allowed to run at 100 % of the normal test flow rates in the NIST Handbook44 Water Meters Code Table N.4.1. or up to the manufacturer's recommended maximum rate for continuous operations, if that is higher. Mr. Roach confirmed that these flow rates represent the testing practices that are currently in place in California and are also reflective of normal continuous use conditions for utility type water meters.

Decision:
The Sector unanimously agreed to propose revisions to the wording of the "Subsequent Examination" steps in Section L of NCWM Publication 14 as shown below to resolve the nomenclature differences between NCWM Publication 14 and AWWA C700.

Subsequent Examination

1. Following the period of use, the tests listed above are to be repeated. All results within the range of flow rates are to be included on the certificate of conformance provided the results are within the applicable tolerances.
2. The examination will be conducted as applicable:
   - 200 000 gallons for throughput testing for mechanical changes of metrological significance
   - Flow rates during throughput testing are not to exceed **the normal flow rate from HB 44 or a stated maximum continuous flow rate from the manufacturer, if it is greater than the normal flow rate.** ~~**50% of the manufacturers rated maximum flow rate**~~
3. Three tests at maximum, intermediate and minimum flow rate will be made on the throughput meters. Only one test at each flow rate needs to be performed on any remaining meters.
4. Repeatability – When multiple tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed **repeatability tolerance.** ~~**the following values:**~~
   ~~**1. 0.6 percent for tests conducted at Normal Flow Rates**~~
   ~~**2. 2.0 percent for tests conducted at Intermediate Flow Rates**~~
   ~~**3. 4.0 percent for tests conducted at Minimum Flow Rates**~~

8. Clarify Scope of Technical Policy R (VTM and Stationary) - Applicability to both Meters and Registers

Source:
NIST OWM

Background:
At their April 2000 meeting, the NTEP laboratories agreed that if a meter is successfully tested in a vehicle-mounted application, the resulting CC could cover both vehicle-mounted and stationary applications without additional testing in a stationary application. The labs forwarded a proposal to the Measuring Sector to add a new paragraph to the Technical Policy for Liquid-Measuring Devices, and this resulted in the addition of Technical Policy R "Vehicle-Mounted and Stationary Applications of the Meter" to Pub 14.

Since it was originally developed, Technical Policy R has referred only to "the meter." NIST has received inquiries from industry requesting clarification on whether the scope of Technical Policy R is intended to include registers. Discussion notes from the 2000 Measuring Sector meeting confirm that the proposal was originally based on recognition that the vehicle-mounted application is the worst case of the two scenarios. There is no mention of any intention to exclude registers from the scope of this conclusion.

Recommendation:
The Sector was asked to consider clarifying Technical Policy R to include registers within the scope as shown in the decision below.

Discussion:
The Sector discussed the item and all agreed that the scope of Technical Policy R was intended to include both meters and registers. Several suggestions were offered to clarify the language that was initially proposed. However, after some discussion, all agreed to leave the original language of the proposal intact..

Decision:
The Sector unanimously agreed to propose the change as it appears below.

R. Vehicle-Mounted and Stationary Applications of ~~the~~ Meters and Registers

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

must also be conducted on the meter or register in a vehicle-mounted application in order to cover both applications on the NTEP CC.

9. Product Families Table - Correct the Units for the Turbine Meter's Critical Parameter of Kinematic Viscosity to Centistokes (cSt) in the Product Families Table

Source:
Marc Buttler, NIST OWM

Background:
In 2010, the Measuring Sector recommended a new format to reorganize the Product Families Table of Technical Policy C. The NTEP Committee approved the new format of the table and it was published in the 2011 edition of NCWM Publication 14.

The Sector had been working to develop the new format since 2006, but limited the scope of these discussions to revising the format and not the content of the table. See the 2006 – 2010 Measuring Sector Meeting Summaries for details.

The way in which viscosity units were presented in the older format of the table led to an error in how the content was translated to the new format. Viscosity units for both PD and turbine meters had previously been combined in the old format in a single column labeled "Viscosity (Centipoise Centistokes)." The correct unit for the critical parameter of "kinematic viscosity" that applies to turbine meters is centistokes (cSt). The correct unit for the critical parameter of "dynamic viscosity" that applies to PD meters is centipoise (cP). Dynamic viscosity is commonly referred to as either just "viscosity" or sometimes "absolute viscosity."

The relationship between centistokes and centipoise is shown in the following equations:

$$\text{centistokes } (10^{-6}\ m^2/s) = \text{centipoise } (10^{-3}\ kg/m{\cdot}s) \div \text{density } (kg/m^3)$$

OR

$$\text{centistokes (cSt)} = 1.002 \times \text{centipoise (cP)} \div \text{density (SG)} \qquad [\text{Where 1 SG} = 998\ kg/m^3]$$

In the Product Families Table, Test E, which has always been reserved exclusively for turbine meters, specifies kinematic viscosity as the correct critical parameter for turbine meters.

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.

Furthermore, the approved range of kinematic viscosity in active turbine meter CCs is identified using units of centistokes as the critical parameter.

Recommendation:
The Sector was asked to consider 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) as shown in the example below. A complete markup with all changes to the table was provided (Appendix E). In addition to the corrections of the unit labels, the markup also included updated kinematic viscosity values for each product that were computed from the dynamic viscosity and density values found for each product elsewhere throughout the table. The conversions between units of centipoise and centistokes in Footnote 1 of the table were also clarified in the Attachment 3 markup.

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) ~~Centipoise (cP)~~ Centistokes (cSt)**

Discussion: Mr. Buttler (NIST, OWM) reviewed how the error in units of viscosity occurred during the translation of the Product Families Table into the new format. Mr. Buttler also explained how the corrected values for kinematic viscosity for turbine meters in the proposed table shown in Appendix E were derived from other values already in the table. Values for dynamic viscosity in centipoise from the PD meter column of the table and SG values from the mass meter column were used in the formula stated above and in the footnote below the table to compute the kinematic viscosity values in the turbine meter column. Correcting the units to kinematic viscosity for turbine meters is essential to preserve the technical accuracy of the table, as well as the accuracy of active CCs that already state kinematic viscosity ranges for approved turbine meters in units of centistokes (e.g., CC 04-097A3).

Decision:
The Sector unanimously agreed to propose the changes as shown in Appendix E.

10. Post-Delivery Discounts and Electronic Receipts

Source:
2012 NCWM S&T Committee Item 330-1 (Unit Price Posting and Selection Requirements)

Background:
At the 2012 NCWM Annual Meeting, S&T Item 330-1 was approved to update specifications in NIST Handbook 44 to address current marketing methods for offering pricing discounts beyond simple cash/credit pricing and to establish a framework for "post-delivery" discounts offered after the delivery of fuel is complete.

Recommendation:
The Sector was asked to update the LMD and ECR-RMFD checklists to reflect the new requirements relating to post-delivery discounts and availability of electronic receipts.

Draft copies of Appendix F (LMD checklist) and Appendix G (ECR-RMFD checklist) were provided by the technical advisor. Revisions were proposed to portions of the checklists that reference the following paragraphs in the NIST Handbook 44 LMD Code (Section 3.30.):

- S.1.6.4.1. Unit Price
- S.1.6.5.4. Selection of Unit Price
- S.1.6.6. Agreement Between Indications
- S.1.6.7. Recorded Representations
- UR.3.2. Unit Price and Product Identity

Discussion:
The Technical Advisor, Mr. Buttler, presented first drafts of Appendices F and G to the Sector and explained that they were draft revisions to the NCWM Publication 14 LMD and ECR checklists which were developed in response to new LMD unit price posting and selection options and requirements adopted by the S&T Committee at the 2012 NCWM Annual Meeting for inclusion in NIST HandbookB 44. Because of the short window of time between the finalization of the new requirements and Measuring Sector meeting, there was no opportunity for review of the drafts by any Sector members prior to the Measuring Sector meeting. Mr. Buttler explained that the Retail Motor-Fuel Dispensers Price Posting and Computing Capability (RMFD PPCC) Task Group, which had been responsible for developing the new options and requirements, was asked by the S&T Committee to continue their work by developing examples and interpretations that would aid weights and measures officials and industry in interpreting and applying the requirements, and the Measuring Sector in updating the LMD and ECR checklists. However, that follow-up task is not yet complete and the Task Group has not yet set a target date for completion.

The NTEP Director, Mr. Jim Truex (NCWM), explained that in this situation, some urgent action was warranted to address the anticipated need for NTEP labs to be prepared for applications involving devices that would comply with some or all of the new options and requirements that were adopted. He asserted that these additional options were now going to be allowed in NIST Handbook44. Thus, the Measuring Sector and the NTEP labs could not afford to wait for delivery of the examples and interpretations by the RMFD PPCC Task Group, and must instead take some immediate action to establish interpretations and guidelines for use in type evaluation.

The Sector discussed the situation and agreed to do whatever was possible to complete the minimum updates to the checklists that would be needed to meet immediate needs in the short term without waiting for the anticipated deliverables from the RMFD PPCC Task Group. Furthermore, the Sector realized that additional revisions to the checklists might be required in the future in order to make use of the deliverables from the Task Group once they are provided.

Mr. Jerry Buttler (North Carolina NTEP Lab) raised a question about stacked sales, "Will the console be able to retain all the necessary dispenser information long enough when there is a long delay between the fuel delivery and the customer action that qualifies for a post-delivery discount?" This scenario seems likely, as it is anticipated that shopping and purchasing items inside a convenience store is one likely action that would trigger a post-delivery discount. The Sector discussed this and concluded that the requirements for stacked sales and for what must appear on the receipt when a post-delivery discount is applied would apply to these systems. Furthermore, the Sector concluded that design and use for compliance with these requirements must be addressed by the manufacturers and users/owners of these devices and systems if post-delivery discounts are to be offered. However, the further concern was raised as to whether the checklists fully address the need to assure that long delays in completing stacked sales do not present problems for some devices and systems.

Mr. Chris Willeke (Bright Solutions, LLC) raised a concern that, for tax reporting purposes, the International Fuel Tax Association (IFTA) may require that the net unit price of the fuel be stated by trucking operations for all purchases. The concern was based on the potential scenario where a receipt from a fuel sale would include all the information required in the new NIST Handbook 44 paragraph S.1.6.8. "Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided," including the: total quantity, unit price, and total computed price shown at the dispenser prior to the post-delivery discount; an itemization of the post-delivery discounts to the unit price; and the final total computed price of the fuel sale. However, because the receipt is not required to include the final computed **unit** price paid for the fuel that includes all post-delivery discounts, it would require truck operators to do a substantial amount of additional calculations to compute the values when preparing tax reports. Mr. Rich Tucker (RL Tucker Consulting LLC) asked if the post-delivery discounts applied to the unit price would need to be reported or would the unit price at the pump be reported, since the discount would be applied after the fuel was delivered. Mr. Willeke consulted with some of his staff and later confirmed that the report that truck operators must submit does not require the unit price, only the net total computed price for the fuel. Learning this, the Sector agreed that the issue was resolved, since the net total computed price for the fuel is required to appear on the receipt.

After the above discussion, the group of volunteers listed below agreed to reconvene following the first day of the Sector meeting to work on the checklist drafts:

Jerry Butler, NC NTEP Lab
Marc Buttler, NIST OWM Technical Advisor
Mike Frailer, MD NTEP Lab
Gordon Johnson, Gilbarco, Inc.
Henry Oppermann, W&M Consulting
Jim Truex, NCWM NTEP Director
Rich Tucker, RL Tucker Consulting LLC

During the evening session, Mr. Oppermann suggested that the order in which certain checklist items and code references appear in the LMD checklist needed to be reorganized in order to place these items in the correct section of the checklist and to ensure they are applied to all the intended types of devices. The Task Group relocated the code reference S.1.6.5.4. "Selection of Unit Price" and its associated checklist items from Section 8 "Computing" to Section 7 "Indicating and Recording Elements" in order to locate the checklist items that are related to the selection of unit price together with the code reference S.1.6.4.1. "Display of Unit Price" and its associated checklist items. The code reference S.1.6.8. "Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided" and its associated checklist items needed to be located in multiple locations to ensure that the checklist items are applied to general retail motor fuel dispensers, card-activated devices, and cash-activated devices, when appropriate.

The volunteers successfully completed their review and presented their results as shown in Appendices F and G the next day.

Decision:
The Sector reviewed the revised proposals and unanimously agreed to propose them as shown in Appendices F and G to the NTEP Committee for inclusion in NCWM Publication 14.

11. NCWM Pub 14, NTEP Administrative Policy Revision

Source:
NTEP

Background:
NCWM is working to revise Pub 14, Administrative Policy to put it in a more logical order and more understandable form. The purpose is not to change the intent of the document, rather to realign and clarify sections as necessary.

Discussion:
Mr. Truex explained that the purpose of the proposed revision of the Administrative Policy of NCWM Publication 14 was to streamline the document and to address aspects of the current version that some people had found confusing. He further explained that the proposal was not intended to change the meaning of any aspect of the policy, only to reorganize and clarify. Since the Administrative Policy section of NCWM Publication 14 is not the responsibility of any specific Sector to maintain, the modified draft version has been distributed widely to the members of all NTETC Sectors. Mr. Truex reported that all other Sectors have reviewed the draft and reported no major problems. Mr. Oppermann also reported having reviewed the draft and indicated his support.

Mr. Truex requested that all recommendations and concerns from individuals, if there are any, be provided directly to him prior to the 2013 NCWM Interim Meeting, if possible.

Decision:
The Sector members agreed to provide any comments on the proposed revisions to the Administrative Policy of NCWM Publication 14 directly to Mr. Truex.

ADDITIONAL ITEMS AS TIME ALLOWS:

The Measuring Sector was asked to provide input on the following measuring-related issues on its agenda if time permitted during the Sector Meeting. In the interest of brevity, the narrative for each item is abbreviated to the extent practical. Full descriptions of NCWM S&T Committee items can be found in the S&T Committee's list of carryover items and its 2012 Final Reports.

12. Windshield Washer Fluid Vending Units

Source:
Chris Willeke, Bright Solutions

Background:
A manufacturer seeking preliminary guidance on requirements for windshield washer fluid vending units asked for input on the application of NIST Handbook 44 and NCWM Publication 14 to these devices. Specific language for NCWM Publication 14 and NIST Handbook 44 have not yet been developed.

Recommendation:
The Sector was asked to consider the application and recommend the most appropriate path to address the following issues for windshield washer fluid vending devices:

- Determine the appropriate code section from NIST Handbook 44 that applies to this application and whether any changes or additions to either NIST Handbook 44 and/or NCWM Publication 14 are required.

- Determine what changes or additions to either NIST Handbook 44 and/or NCWM Publication 14 are appropriate to recognize the proposed method of dispensing without an indication of the total quantity delivered and with a time-out function. The submitter suggests using language that can be found in the California Type Evaluation Program (CTEP) standards for testing and certifying water vending units as a starting point. However, these standards do not address specifications or testing of the time-out function.

Discussion:
Mr. Michael Keilty (Endress and Hauser) explained that this item is not a NCWM Publication 14 issue, but a manufacturer is seeking input from the sector on how the code would apply for an NTEP evaluation. The Sector did not object to hearing the item.

Mr. Chris Willeke (Bright Solutions, LLC) explained the system's functioning and answered questions from other Sector members about how the device functions. The system is designed primarily to be installed on the island in fueling stations near the motor-fuel dispensers. It delivers discrete pre-authorized quantities of windshield washer fluid through a hose and nozzle that is intended to be used by customers to fill the reservoir in their vehicle during fueling stops. The device is capable of meeting a 0.75 % tolerance and typically discharges product at a flow rate close to 1 gpm.

As part of his presentation, Mr. Willeke shared a system diagram that included a totalizer and a Point of Sale (POS) display. Mr. Willeke explained that the totalizer does not return to zero or display the indications of total quantity, unit price, or computed price for each transaction that would be required to comply with the LMD Code. There is a discharge valve on the nozzle that is controlled by the customer. The POS system is used solely to purchase and pre-authorize the delivery of a discrete pre-set amount (e.g., 1 gal). However, if the customer does not allow the full amount to be delivered through the discharge valve within a certain time limit, the device is automatically reset and the quantity that remains undelivered is forfeited by the customer. Mr. Willeke also confirmed that there is no indication of the amount that was forfeited. The time limit is measured from the time the transaction is first authorized and cannot otherwise be controlled by the customer.

Mr. Willeke noted that the State of Wisconsin required this device to have an NTEP CC before it could be placed into commercial service. Mr. Willeke suggests that similar devices are in service now in some jurisdictions to vend water. The main difference between these devices and the proposed method is that water vending machines are designed to always deliver the full quantity of what was purchased into an empty container of known volume. Because water vending machines always dispense the full amount that was purchased, the selected preset amount can serve as the indication of the quantity that was delivered. Water vending machines have no customer-controlled nozzle, so there is no need for a time-out function that resets the transaction, possibly retaining an undisclosed amount of undelivered product. However, no standards or test methods exist in NIST Handbook 44 or NCWM Publication 14 that could be employed to ensure that the time-out function of the windshield washer vending machine, as it is described, is operating as intended and not in a way that could facilitate fraud.

The NTEP labs were uncertain what code could be applied for NTEP evaluation because of some of the unique characteristics of the device. The CA DMS NTEP Lab described CTEP approval of water vending machines as the example of equipment that is perhaps most similar to the windshield washer fluid vending machine. Mr. John Roach (CA DMS NTEP Lab) explained that CA borrows from the Water Meters Code for tolerance values when they evaluate water vending machines for CTEP approval because there is no national code that would apply to these devices.

The Sector members made comparisons between the system that was described by Mr. Willeke and other commercial devices, including timing devices used in air compressors for filling tires, water vending machines, DEF dispensers, and slow flow liquid-measuring devices used to sell fuel additives. At the end of the discussion, the consensus was that the way that this system currently functions does not comply with any existing set of requirements in NIST Handbook 44. Many members of the Sector expressed opinions that the device would need to be modified to comply with the LMD Code in order to seek NTEP approval.

Mr. Dennis Beattie (Measurement Canada) questioned whether the LMD Code could be applied to the device because of paragraph A.2.(e), which states:

> **A.2. Exceptions.** – This code does not apply to:
>
> **:**
> **:**
> **:**
>
> (e) devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges;

This would potentially be true, unless a customer decided to purchase more than the initial discrete amount, in which case the total customer charges would be incrementally increased based on the measurement of the device each time it reached the pre-authorized quantity and stopped until more was purchased.

Mr. Truex offered an opinion that this is a method of sale issue. He added that the fuel additive device that was discussed earlier has a working display to comply with the LMD Code. Mr. Truex confirmed that there are no NTEP CCs on water vending machines. Mr. Truex suggested that this metering device does not clearly fit into any code in HB 44 and suggested contacting the NIST L&R experts for guidance. He stated that the recommendation Mr. Willeke received from WI to apply for an NTEP CC may have been incorrect and he will discuss the issue with Wisconsin Weights and Measures.

Decision:
There was no decision to be made by the Sector on this issue. The manufacturer expressed his gratitude to the Sector for considering the question of how to seek NTEP approval.

13. Hot Water Meters

Source:
Michael Dick, Norgas Metering Technologies, Inc.

Purpose:
Include provisions for type evaluation and NTEP certification of hot water meters.

Recommendation:
Neither NCWM Publication 14 nor NIST Handbook 44 specifically address water temperature in the sections related to water meters. The Sector was asked to consider whether specific testing requirements or other information are needed in NCWM Publication 14 and/or NIST Handbook 44 to support NTEP evaluation, testing, and certification of hot water meters that are designed to operate continuously in the range from 80 °F to 140 °F.

Background:
Submeter applications exist where individual tenants share a common water heating system. To accommodate accurate measurement of the hot water consumed by each tenant, NTEP certified meters capable of measuring the water after it has been heated (in the range from 80 °F to 140 °F) are needed.

The submitter is developing a proposal to establish requirements for these devices and has asked the Sector for preliminary guidance. Specific language for NCWM Publication 14 and NIST Handbook 44 has not yet been developed. The item was withdrawn by the submitter prior to the meeting; however, the Sector chose to discuss the item and determine if anyone else wanted to address the item.

Discussion:
Mr. Roach explained that California issues CTEP CCs which specifically identify "hot water" meters and "cold water" meters on the CC. CTEP requirements for hot water meters reference the AWWA handbook.

Mr. Truex explained that the original submitter of this item was requesting a "hot water" meter designation on an NTEP CC. He further explained that NTEP cannot issue a CC for a "hot water meter" since NIST Handbook 44 does not include a definition or requirements for "hot water meters." The Water Meters Code in NIST Handbook 44 currently imposes no specific temperature restrictions on ordinary water meters beyond the limitations stated by the manufacturer. The individual was satisfied when NTEP agreed to include water temperatures that were used during testing under the "test conditions" section of an NTEP certificate that recognizes the device as an ordinary water meter as defined in Section 3.36. of NIST Handbook 44. Mr. Truex added that the temperature information would NOT appear on page 1 of the CC because stating this information on page 1 would imply something that has no basis in NIST Handbook 44.

The Sector went on to discuss whether there is a general need for NIST Handbook 44 to recognize hot water meters separately and with a different set of requirements than standard "cold" water meters. Mr. Ralph Richter (NIST, OWM) shared that OIML R 49 "Water meters intended for the metering of cold potable water and hot water" includes hot water meters and cold-water meters together. Mr. Andre Noel (Neptune Technology Group, Inc.) pointed out that some meters may be made of materials that are compatible with cold water, but not with hot water. Mr. Noel volunteered to raise this question with other water meter manufacturers to determine if any manufacturers are interested in developing this item as a proposal to the NCWM S&T Committee.

Decision:
The Sector agreed to carry over the item in the Additional Items as Time Allows Section to allow the water meter manufactures to determine whether it will merit further development.

14. Section 3.31. Vehicle-Tank Meters; Paragraph T.4. Product Depletion Test *(S&T Carryover Agenda Item)*

Source:
2012 NCWM S&T Agenda. Original source is the Northeast Weights and Measures Association (NEWMA).

Background:
The S&T Committee has been considering a proposal to modify the VTM Code to base the product depletion test tolerances on the meter's maximum flow rate (a required marking on all meters), rather than the meter size (a required marking for meters manufactured beginning in 2009). This will enable more consistent application of the tolerances for older meters, which are not required to be marked with the meter size, and address an unintentional gap that allows an unreasonably large tolerance for smaller meters.

From 2009 to 2011, the Committee repeatedly requested data to support or oppose the various proposals under consideration with little success. At the 2011 Annual Meeting, the Committee reiterated its need for data to evaluate the impact of any proposed tolerances changes. Following that meeting, NIST Technical Advisor, Ms. Tina Butcher, on behalf of the Committee, distributed a request on NIST OWM Directors' list serve asking weights and measures jurisdictions to submit data.

At the 2012 NCWM Interim Meeting, the Committee reiterated its position that tolerances for the product depletion test of a VTM should be based on the marked maximum flow rate of the meter rather than meter size. The Committee considered the three options for modifying NIST Handbook 44, including two options presented in its Interim Agenda and a third option submitted by the MMA prior to the meeting. A summary of the three options is outlined in the following table. A second table illustrating examples of tolerances for common meter sizes and maximum flow rates is also included.

Summary of Product Depletion Tolerance Options Considered		
	Marked Maximum Flow Rate or Meter Size	**Tolerance (% of Marked Max Flow Rate)**
Current	Up to but not including 2 in	104 in^3
	2 in up to but not including 3 in	137 in^3
	3 in and larger	229 in^3
Option 1:	All Maximum Flow Rates	0.5 %
Option 2:	Marked Max ≤ 100 gpm	0.6 %
	Marked Max > 100 gpm	0.5 %
Option 3:	Marked Max ≤ 60 gpm	0.8 %
	Marked Max > 60 gpm up to and including 100 gpm	0.6 %
	Marked Max > 100 gpm	0.5 %

Examples of Tolerance Options for Different Meter Sizes/Flow Rates					
Size	**Marked Maximum Flow Rate (gpm)**	**Current Tolerance**	**Option 1 (0.5 % max)**	**Option 2 (0.6 % max) (0.5 % max)**	**Option 3 (0.8 % max) (0.6 % max) (0.5 % max)**
1-1/2 in	60 gpm	104 in^3	69 in^3	83 in^3	111 in^3
2 in	100 gpm	137 in^3	115 in^3	139 in^3	139 in^3
2 in	150 gpm	137 in^3	173 in^3	173 in^3	173 in^3
3 in	150 gpm	229 in^3	173 in^3	173 in^3	173 in^3
3 in	200 gpm	229 in^3	231 in^3	231 in^3	231 in^3
3 in	300 gpm	229 in^3	346 in^3	346 in^3	346 in^3
3 in	350 gpm	229 in^3	404 in^3	404 in^3	404 in^3

During its Open Hearings at the 2012 Interim Meeting, the Committee heard support for Option 3 from members of the MMA. The Committee also heard a comment from Mr. Ross Andersen, who submitted the original proposal. Mr. Andersen pointed out that the tolerances in Option 1 were the same as those that apply prior to modifying the tolerance to be based on meter size.

S&T Technical Advisor, Mrs. Tina Butcher, NIST OWM, reported that the Committee received product depletion test data from nine state and county weights and measures jurisdictions. Mrs. Butcher distributed a summary to the Committee as shown in the following two tables. Mrs. Butcher noted that assumptions were made about meter size in some instances where meter size and/or maximum flow rate were not both provided. The first table summarizes the number of meters tested along with a comparison of the number that failed the current and proposed tolerances; the data includes a breakdown of meters in three different flow rate categories.

Summary of Product Depletion Test Data Submitted by State and County Weights and Measures Jurisdictions As of 1/20/12						
	Total Meters	**Failed Current Tolerance**	**Failed Option 1**	**Failed Option 2**	**Failed MMA**	**Marked Max**
Jurisdiction #1	67	0	2	1	1	---
	1	0	1	1	1	60 gpm
	53	0	1	0	0	100 gpm
	12	0	0	0	0	> 100 gpm
	1	0	0	0	0	??
Jurisdiction #2	9	0	0	0	0	No Data
Jurisdiction #3	288	21	33	22	20	---
	28	1	5	3	1	60 gpm
	228	17	25	16	16	100 gpm
	32	3	3	3	3	> 100 gpm
Jurisdiction #4	196	7	18	9	6	---
	14	0	3	3	0	60 gpm
	153	5	14	5	5	100 gpm
	29	2	1	1	1	> 100 gpm
Jurisdiction #5	134	7	12	7	7	---
	10	2	3	2	2	60 gpm
	72	4	8	4	4	100 gpm
	52	1	1	1	1	> 100 gpm
Jurisdiction #6	200	20	29	20	20	---
	0	0	0	0	0	60 gpm
	178	16	25	16	16	100 gpm
	22	4	4	4	4	> 100 gpm
Jurisdiction #7	196	13	14	13	13	---
	0	0	0	0	0	60 gpm
	150	11	12	11	11	100 gpm
	46	2	2	2	2	> 100 gpm
Jurisdiction #8	761	0	7	1	0	---

Summary of Product Depletion Test Data Submitted by State and County Weights and Measures Jurisdictions As of 1/20/12						
	Total Meters	**Failed Current Tolerance**	**Failed Option 1**	**Failed Option 2**	**Failed MMA**	**Marked Max**
	103	0	1	1	0	60 gpm
	629	0	6	0	0	100 gpm
	29	0	0	0	0	> 100 gpm
Jurisdiction #9	71	26	26	20	20	No Data

The second table provides a summary showing these totals for all jurisdictions combined.

	Total Meters	**Failed Current Tolerance**	**Failed Option 1**	**Failed Option 2**	**Failed Option 3**	**Marked Max**
Summary of All Jurisdictions	156	3	13	10	4	**60 gpm**
	1463	53	91	52	52	**100 gpm**
	222	12	11	11	11	**>100 gpm**
	81	26	26	20	20	**No Info**
Totals	**1922**	**94**	**141**	**93**	**87**	

At the 2012 NCWM Annual Meeting Open Hearings, Mr. Dmitri Karimov (Liquid Controls) speaking on behalf of the Meter Manufacturers Association, commented that, while MMA is aware that the Committee did not support MMA's proposed "Option 3," the MMA supports "Option 2" recommended by the Committee.

The Committee wishes to express its sincere appreciation to those jurisdictions that submitted data. The Committee discussed the data received and the summaries prepared by NIST OWM. The Committee recognizes that the data collected was not obtained under controlled conditions or as part of a structured survey or study; however, the data has been extremely valuable to the Committee in assessing the relative impact of the three options proposed. After discussing the comments and reviewing the summary of the data prepared by NIST OWM, the Committee agreed that Option 2 represents a reasonable compromise between the original proposal and the MMA's proposal (designated Option 3 in the tables above). The Committee acknowledged that this item has included multiple proposals up to this point and it is important for the Committee to designate a single option for consideration by the NCWM in order that this item can progress. Consequently, the Committee is deleting the other options and presenting Option 2 for consideration. Because this item has included multiple proposals up to this point, the Committee decided to designate this item as an Information Item and is asking for input on the proposal as shown in the Item Under Consideration prior to moving the item forward as a Voting Item.

The Committee asks the regional weights and measures associations and industry for input regarding whether or not the proposed changes are ready for adoption in the next NCWM cycle.

Discussion:
Members of the MMA who were present at the Sector meeting shared that, although they still recommend "Option 3" as it was proposed to the S&T Committee, the MMA understands the deliberations of the S&T Committee and reluctantly supports the item moving forward as Option 2. The meter manufacturers in the MMA have discussed the latest position of the S&T Committee and agree they can "live with" and will support Option 2 in order to move the item forward.

The MMA's reluctance to support Option 2 was based on a concern that the tolerances in Option 2 are still too tight on smaller meters and they had offered "Option 3" to resolve this concern. The MMA believes that the failures of the smaller meter sizes in the data are mainly measuring system failures, not meter failures.

Decision:
The Measuring Sector discussed this item and learned that the MMA is supporting the item. The Sector, therefore, recommends that the S&T Committee move the item forward as a Voting Item using the language as described in Option 2.

NEXT MEETING:

The Sector discussed the time and location of the next meeting and all agreed to continue to keep the meeting in association with the SWMA. A proposal to hold the Sector meeting following the SWMA was discussed, but the Sector decided to keep the meeting prior to the SWMA, because the time following the SWMA is not available for some members.

Technical Advisor's Note: Since the Sector meeting, Mr. Keilty has received information that the 2013 SWMA Annual Meeting is scheduled to take place from October 7 - 9, 2013, in Charleston, West Virginia, at the Embassy Suites Hotel. The Measuring Sector Meeting is likely to be scheduled on October 4 - 5, 2013, in that location.

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Appendix D – Sub-appendix A

Agenda Item 1

Checklist for Testing Electronic Digital Indicators with Simulated Pulses October 3, 2009

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?

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.

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.

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

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

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

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

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

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

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

1.10. Accuracy will be maintained. **Yes ☐ No ☐ N/A ☐**

1.11. Operating parts will continue to function as intended, **Yes ☐ No ☐ N/A ☐**

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

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

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

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. Multiple cable connections but not interchangeable due to different plug styles. **Yes ☐ No ☐ N/A ☐**

1.15. Cables are connected but are not removable without breaking a seal and opening housing. **Yes ☐ No ☐ N/A ☐**

2. Indications, and Recorded Representations Look at different codes

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

Several general requirements facilitate the reading and interpretation of displayed values. Each display for quantity or total price must be appropriate in design and have sufficient capacity for particular applications to be suitable for the application. Metering devices must be capable of indicating the maximum quantity and money values that can normally be expected in a particular application.

2.1. **Minimum quantity value indications.**

2.1.1.	Display is capable of 1.0	**Yes ☐ No ☐ N/A ☐**
2.1.2.	Display is capable of 01	**Yes ☐ No ☐ N/A ☐**
2.1.3.	Display is capable of 0.01	**Yes ☐ No ☐ N/A ☐**
2.1.4.	Display is capable of 0.001	**Yes ☐ No ☐ N/A ☐**
2.1.5.	Display is capable of other (fill in blank):	**Yes ☐ No ☐ N/A ☐**

2.2. **Money value display**

2.2.1.	Money value is properly displayed	**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. **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.~~ Do not think this is needed and intend on removing this section. **Yes ☐ No ☐ N/A ☐**

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

All operational controls, indications, and features shall be clearly and definitely identified. 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. **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 (4) pulser setting and gallon/liter conversion switches when they may accidentally or intentionally be used to perpetrate fraud. **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 (optional in Canada at this time)
2. Temperature, pressure, density, and other sensor settings for zero, span, and offset values
3. Measurement units (in Canada, only if not displayed or printed on the primary register)
4. Temperature compensation table, liquid coefficient of expansion, or compressibility factors or tables
5. Liquid density setting (in Canada, only if not displayed or printed on the primary register) and allowable liquid density input range
6. Vapor pressures of liquids if used in calculations to establish the quantity
7. Meter or sensor temperature compensation factors
8. False or missing pulse limits for dual pulse systems (Canada only)
9. On/off status of automatic temperature, pressure, or density correction
10. Automatic or manual data input for sensors
11. Dual pulse checking feature status on or off
12. Flow control settings (optional in Canada)
13. Filtering constants

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	
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
- Adequate provision must be made to apply a physical seal without exposing electronics. **Yes ☐ No ☐ N/A ☐**
- Event counters are non-resettable and have a capacity of at least 000 to 999. **Yes ☐ No ☐ N/A ☐**
- Event counters increment appropriately. **Yes ☐ No ☐ N/A ☐**
- Event counters may be located either: **Yes ☐ No ☐ N/A ☐**
  - at the individual measuring device or
  - at the system controller
- If the counters are located at the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device. **Yes ☐ No ☐ N/A ☐**
- An adequate number (see table below) of event counters must be available to monitor the calibration and configuration parameters of each individual device. **Yes ☐ No ☐ N/A ☐**
- The device must either: **Yes ☐ No ☐ N/A ☐**
  -clearly indicate when it is in the remote configuration mode or
  -the device shall not operate while in the remote configuration mode.
- If capable of printing in the calibration mode, it must print a message that it is in the calibration mode. **Yes ☐ No ☐ N/A ☐**
- The audit trail information must be capable of being retained in memory for at least 30 days while the device is without power. **Yes ☐ No ☐ N/A ☐**
- The audit trail information must be readily accessible and easily read. **Yes ☐ No ☐ N/A ☐**

Minimum Number of Counters Required		
	Minimum 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.

- For devices manufactured after January 1, 2001, the device must either: **Yes ☐ No ☐ N/A ☐**
  - Clearly indicate when it is in the remote configuration mode, or
  - The device shall not operate while in the remote configuration mode
- The device is equipped with an event logger **Yes ☐ No ☐ N/A ☐**
- The event logger automatically retains the identification of the parameter changed, the date and time of the change, and the new value of the parameter. **Yes ☐ No ☐ N/A ☐**
- Event counters are nonresettable and have a capacity of at least 000 to 999. **Yes ☐ No ☐ N/A ☐**
- The system is designed to attach a printer, which can print the contents of the audit trail. **Yes ☐ No ☐ N/A ☐**
- The audit trail information must be capable of being retained in memory for at least 30 days while the device is without power. **Yes ☐ No ☐ N/A ☐**
- The event logger must have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. **Yes ☐ No ☐ N/A ☐**
- The event logger drops the oldest event when the memory capacity is full and a new entry is saved. **Yes ☐ No ☐ N/A ☐**
- Describe the method used to seal the device or access the audit trail information. Is this used?

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

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

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

2.25. Equipment shall be suitable for use in the environment in which it will be used. Suitability with respect to environment includes the effects of wind, weather, temperature variations, and radio frequency interference. A device must work and remain accurate under its actual conditions of use. Unless specific tests are developed this has no meaning! **Yes ☐ No ☐ N/A ☐**

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?**

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	API Gravity/Density:		**Yes ☐ No ☐ N/A ☐**

Product:		**Meter Factor:**	**K Factor:**	
	at manufactures rated minimum frequency/pulse rate.	Temperature:		
11	Test with liquid temperature above 100 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:		**Yes ☐ No ☐ N/A ☐**
12	Test with liquid temperature above 100 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:		**Yes ☐ No ☐ N/A ☐**
13		API Gravity/Density: Temperature:		**Yes ☐ No ☐ N/A ☐**
14		API Gravity/Density: Temperature:		**Yes ☐ No ☐ N/A ☐**
15		API Gravity/Density: Temperature:		**Yes ☐ No ☐ N/A ☐**
16		API Gravity/Density: Temperature:		**Yes ☐ No ☐ N/A ☐**
17		API Gravity/Density: Temperature:		**Yes ☐ No ☐ N/A ☐**

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

Product:		**Meter Factor:**	**K Factor:**	
10	Test with liquid temperature below 35 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:		**Yes** ☐ **No** ☐ **N/A** ☐
11	Test with liquid temperature above 100 degrees F at manufactures rated maximum frequency/pulse rate.	API Gravity/Density: Temperature:		**Yes** ☐ **No** ☐ **N/A** ☐
12	Test with liquid temperature above 100 degrees F at manufactures rated minimum frequency/pulse rate.	API Gravity/Density: Temperature:		**Yes** ☐ **No** ☐ **N/A** ☐
13		API Gravity/Density: Temperature:		**Yes** ☐ **No** ☐ **N/A** ☐
14		API Gravity/Density: Temperature:		**Yes** ☐ **No** ☐ **N/A** ☐
15		API Gravity/Density: Temperature:		**Yes** ☐ **No** ☐ **N/A** ☐
16		API Gravity/Density: Temperature:		**Yes** ☐ **No** ☐ **N/A** ☐
17		API Gravity/Density: Temperature:		**Yes** ☐ **No** ☐ **N/A** ☐

Appendix D – Sub-appendix B

Draft Measuring Element vs. Register Evaluation Criteria (Technical Policy T)

Agenda Item 1

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

T. Testing required for Electronic Indicators used with Measuring Elements.

If the indicator and measuring element are built into the system as a whole device then they are approved as a system and listed as a single device on the certificate.

If the indicator or measuring element are separable and can be used with other approved and compatible equipment then the following needs to be considered:

If the Electronic Indicator and Measuring Element both have a CC then the two do not need evaluation provided new features that would have a metrological effect have not been added to the existing equipment. Even though they both have a CC they still need compatibility verification i.e. approved and compatible. This can be verified at the local level of compliance.

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

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

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

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

Testing considerations for the electronic indicator:

1) Multi-point Calibration: Some of the newer indicators have the optional single point or multi-point calibration. Multi-point calibration associates multiple meter calibration factors with different flow rates. Meter field testing at the local level is usually at the maximum and minimum flow ratings of the meter. Without the ability to print or view the multi-point parameters a meter could be calibrated with an intentional erroneous factor and could go undetected. The only other way would be to test at random flow rates and depending on the number of calibration points fraud could still be undetected; i.e. a meter factor that would allow an out of tolerance error for a delivery flow rate other than customary test flow rates. Some manufactures have provided a method for weights and measures to view or print the calibration information without having to break any seals. This viewing or printing capability should be incorporated into Pub 14 (maybe HB44 too?) as a tool for W/M to be able to detect the possibility of fraud on these systems. It would also allow for manufactures to be aware of this and build this into their systems that have multi-point calibration.
2) Tests for temperature compensation:
   a) Temperature test at cold temperature and verify correction.
   b) Temperature test at hot temperature.
   c) Temperature test at field site temperature.

   List temperature range tested and type of probe tested on certificate.
3) Tests for pulser/encoder rotation speed:
   a) Induce pulses and/or frequency at maximum to determine limitations of device.
   b) Induce pulses and/or frequency at minimum to determine limitations of device.

   List limitations on certificate.
4) Tests for power failure: Indicators are capable of operating on different voltages. May want to consider weighing device testing for electronic indicators and information listed on certificate.
   a) Test through AC voltage range
   b) Test through DC voltage range
   c) Power failure
5) Tests for computation, if capable.
   a) Test below $.999/gal.
   b) Test above $1.00/gal.
   c) Test above $2.00/gal.
   d) Test at maximum unit price capability.
6) Tests for agreement of indications between indicator and totalizer if a totalizer is provided.

Appendix D – Sub-appendix C

1991 Product Families Table Proposal – Liquid Controls

(Agenda Items 2-4)

Attachment for
Agenda Item II
Oct, 1991

Liquid CONTROLS CORPORATION

LIQUID LC CONTROLS

WACKER PARK
NORTH CHICAGO, IL 60064-3702
TEL: 708 689-2400 FAX: 708 689-8090

September 23, 1991

Mr. Henry Opperman
National Institute of Stds & Tech
Administration 101 Rm A617
Gaithersburg, MD 20899

Subject: Meter Approvals - Proposed NTEP Program for Type Approval Testing of Meters for Liquids other than Petroleum Products

Dear Henry:

As a result of our meeting on August 7, 1991 in which we discussed means for testing meters for Type Approval on liquids other than refined petroleum, I have prepared a proposal which outlines an approach that will, I believe, validate the acceptability of positive displacement meters for a large variety of liquid types and applications while holding costs and use of labor at a practical level.

Please review this and pass it along to the National Type Evaluation Technical Committee (NTETC) for discussion and action.

Your support and assistance on this matter will be greatly appreciated.

Yours truly,

Mel Hankel

Melvin C. Hankel
Manager of Engineering
Product Support Group

xc: N. Alston, NTETC Chairman
R. L. Wipple, NIST
Royal Wollberg, LC

September 23, 1991

Proposal to NTEP:

Program for Approval of Meters on Liquids other than Petroleum Products.

Subject: Type Evaluation and Approval of Positive Displacement Meters for Liquids other than Refined Petroleum Products

The use of positive displacement meters for the accurate measurement of petroleum products throughout the entire petroleum distribution system has had a long history of success.

These meters or variants of them, with minor variations of materials of construction in some cases, have the demonstrated ability to handle a wide spectrum of liquids in other areas of industry and commerce as well. Some of these applications are not familiar to many people. Therefore the ability to judge their effectiveness, especially when submitted for weights & measures type evaluation and approval for use in trade, is a cause for concern.

The response is generally to require that insitu accuracy and permanence tests be run at a field test site. This approach is cautious and conservative, but also costly to the equipment manufacturer and wasteful of Weights & Measures officials time. Indirectly, it tends to discourage use of efficient handling of liquids by meter measurement systems in many commercial areas because of protracted approval costs.

September 23, 1991

There are hundreds, even thousands, of liquids that are suitable for meter measurement. What is proposed herewith is a workable, reliable approach for evaluation that will yield results that will validate the capability of the meter on a range of liquids and conserve valuable time and labor in the process.

This approach is dependent on two general concepts:

a) The classification of meters by materials of construction b)

The classification of liquids into families or groups

Materials of Construction

Classification of meters by materials of construction is as noted earlier in this proposal a means to adapt the meter to the liquid environment in which it will be used. Matters of corrosion, lubricity, and the like are dealt with by the manufacturer in order to optimize the construction for the intended service. For a given meter manufacturer, meter measuring elements in design, size, and shape are unchanged, but the materials are selected to make the unit function effectively in the liquid group in which it will be used.

Liquid Controls Corporation has developed 15 classes that give optimum performance in the various liquid groups at an effective cost level. (Refer to Appendix A for a listing of these classes.) The number and make up of the classes may vary from manufacturer to manufacturer.

Liquid Groups or Families

It is possible to classify and group liquids in a number of ways including for example the broad general groups of:

Inorganic Liquids (usually water based solutions of acids, bases, or their salts - liquids that are likely to be corrosive in varying degrees due to their dissociation or ionization in water).

or

Organic Liquids (usually non-dissociated non-ionized homogenous and non-corrosive).

However, for practical reasons in matching not only chemical characteristics, but also physical characteristics such as viscosity, vapor pressure, whether clear and homogenous, specific gravity, whether or not they contain solid particulate matter, etc. another method of classifying is desirable.

A practical classification method that has worked well in the past in the industrial metering arena uses the following Families:

Water

Hydrocarbons/Petroleum Products

Alcohols, Glycols, and water mixtures thereof

Solvents (General) Solvents

(Chlorinated) Compressed

Liquified Gases

LPG

NH_3

September 23, 1991

Agricultural Liquids

Liquid Feeds

Clear Liquid Fertilizers

Suspension Fertilizers

Herbicides

Chemicals

These are groups of liquids that have a high degree of commonality in chemical and physical properties and are therefore similar in metering characteristics.

Appendix B is a chart showing the Liquid Families along with lists of examples of the various groups and their key parameters that influence meterability. These examples cover the range of properties within a group, but the list is not inclusive of all liquids in a given group in most cases.

Appendix B also includes a chart matching meter class materials of construction with the various Liquid Families for optimum compatibility.

In view of the above, it is our specific recommendation that the following approach be used for the testing, evaluation, and approval of meters in the numerous application areas possible. We feel that this will enable expanded use in trade of a very efficient method of moving and handling liquids without undue approval cost to the manufacture nor undue use of the limited Weights and Measures labor resources:

September 23, 1991

A. Application would be made and a meter would be submitted for approval on a specific family of liquids.

From the list of liquids, constituting the family(s), two liquids representative of the high and low of the key parameters would be selected for use in the test. If the meter successfully performed on tests of accuracy and permanence on the two extreme liquids it would be approved for use on all liquids in that family(s).

B. If meters of a given class of construction successfully passed all evaluation criteria, meters of a higher grade of construction would also be granted approval if so requested at the time of application by the manufacture if the design and size of the devices were the same. An example of this might be:

If a meter of ferrous construction were submitted and approved then the same device constructed of stainless steel could likewise be approved without retesting if so requested by the manufacturer.

C. For a given Meter Class having a range of sizes or capacities (such as 1112", 2", 3", 4" and 6"), if the middle unit of these (e.g. 3") were submitted for type evaluation and passed all requirements of accuracy and permanence, then the entire series of meters would be approved if so requested by the manufacturer at the time of submittal. D. For a smaller range of size or capacity, meters one size smaller and one size larger than the meter submitted for actual approval test would be also approved upon completion of successful test of the submitted unit if the manufacturer so requested this at the time of submittal.

September 23, 1991

This is predicated on the fact that the design of the meter is identical in all respects only scaled down or up in size for capacity.

An example of this might be:

If a 2" meter were submitted for approval, upon successful completion of testing the next smaller size, 1 1/2" meter, and the next larger size, 3" meter, would likewise be given approval.

This proposal is submitted as a request to develop and establish testing policy guidelines that will enable approvals sought under NTEP to have a standardized set of procedures and requirements that are practical in terms of costs and manpower utilization.

In conclusion, in view of recent efforts to assure competitive relationships in world trade, the requirements developed for NTEP approvals of meters should be no more severe or restricting than those required by international regulatory bodies (e.g. ECC in Europe and OIML).

Melvin C. Hankel
Mgr. of Engr. Support Group
Liquid Controls Corporation

Appendix A

METER CLASSES AND MATERIALS OF CONSTRUCTION

CLASS 1
Aluminum 356-T6
NiResist II or Ryton
Sintered Iron
Stainless Steel
BunaN

CLASS 2
Aluminum 356-T6
NiResist II or Ryton
Stainless Steel
BunaN

CLASS 3
Aluminum 356-T6
Ni-Resist II
Stainless Steel
BunaN

CLASS 4
Aluminum 356-T6
Carbon
17-4PH Stainless
316 Stainless/Hard Chrome
BunaN

CLASS 7
Cast Iron
NiResist II
Carbon

CLASS 8
316 Stainless Steel
Carbon or Teflon
Teflon

CLASS 10
Aluminum 356-T6
Stainless Steel/Hardchrome
NiResist/Carbon
BunaN

CLASS 12
Aluminum 356-T6
Stainless Steei/Hardchrome
NiResist/Carbon
Teflon/Buna N

CLASS 14
Aluminum 356-T6
NiResist II
316 Stainless/Hardchrome
Sintered Iron
Viton or Teflon

CLASS 15
Aluminum 356-T6
316 Stainless/Hardchrome
Teflon
17-4 PH
BunaN

CLASS 16
Aluminum 356-T6
NiResist/Carbon
Sintered Iron
Buna Nor Teflon

CLASS 20
Brass
Carbon
17-4PH
Buna N or Teflon

CLASS 27
Cast Iron
NiResist Il/Teflon
Stainless Steel
Viton or Teflon

CLASS 30
Aluminum 356-T6
Teflon
316 Stainless/Hardchrome
Stainless Steel
Viton

CLASS 37
Cast Iron
NiResist II
Sintered Iron
Viton or Teflon
Stainless Steel

APPENDIX B -LIQUID COMMODITY (LIQUID FAMILY) GROUPS (AND KEY PHYSICAL PROPERTIES

LIQUID FAMILIES

CONSTRAINT	PETROLEUM PRODUCTS	SOLVENTS GENERAL	SOLVENTS CHLORINATED	ALCOHOLS GLYCOLS & WATER MIXES THERE OF	COMPRESSED LIQUIFIED GASES		WATER	AGRICULTURAL LIQUIDS					CHEMICALS
					LPG	NH3		FERTILIZERS CLEAR LIQUID N-P-K	FERTILIZERS NITROGEN SOLUTIONS	FERTILIZERS SUSPEN-SIONS	HERBICIDES	LIQUID FEEDS	
EXAMPLES OF LIQUID WITHIN FAMILIES (PARTIAL LISTING)	Diesel Fuel Distillate Gasoline Fuel Oil Mineral Spirits Oil Bunker Oil Lube Oil Crude Oil Asphalt Etc.	Acetates Acetone Esters Ethylacetate Hexane MEK Naphtha Toluene Xylene Etc.	Carbon Tetra-Chloride Methylene-Chloride Perchloro-Ethylene Trichloro-Ethylene Etc.	Ethanol Methanol Butanol Isopropyl Isobutyl Ethylene Glycol Propylene Glycol Etc.	Propane Butane Freon 11 Freon 12 Freon 22 Etc.	Anhydrous-Ammonia	Tap Water Deionized Demineral-ized Potable	10-34-0 4-10-10 9-18-9 Etc.	20% Aqua-Ammonia 28%,30% or 32% Nitrogen Solution Urea Ammonia-Nitrate Etc.	3-10-30 4-4-27 Etc	Atrex Atrazine Bicep Bladex Dual Eptan Eradicane Lorox Princep Round-up Sencor Sutan Treflon Etc	Liquid-Molasses Molasses + Phos-Acid and/or Urea Etc.	Surfuric-Acid Hydrochloric-Acid Phosphoric-Acid Etc.
VISCOSITY SSU CP	25 to 1 Million	2 to 35 0.3 to 7	2 to 35 0.3 to 7	2 to 35 0.3 to 7	.5 to 3 .1 to .5	.5 .1	5 1.0	50 to 150 10 to 30	30 to 100 10 to 30	100 to 1000 20 to 200	100 to 3500 20 to 700	50 to 250,000 10 to 50,000	75
SP.GR.	.68 to 1.1	.6 to 1.6	.6 to 1.6	.6 to 1.6	.5 to .65	.56 to .68	1.0	1.0 to 1.3	1.0 to 1.35	1.0 to 1.65	.9 to 1.2	1.2 to 1.5	1.1 to 1.85
% OF ABRASIVE SOLIDS	None	None	None	None	None	None	None	None	None	4%	3%	4%	None
LUBRICITY SERVICE FACTOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.8	0.8	1.0
RANGE	10:1	10:1	10:1	10:1	5:1	5:1	10:1	10:1	10:1	8:1	8:1	8:1	10:1
CLASS													
1	X												
2	X												
3													
4							X						
7	X	X	X	X									
8	X	X	X	X			X	X	X		X	X	X
10					X								
12						X							
14												X	
15									X		X		
16		X		X									
20							X						
27								X	X		X		
30											X		
37	X							X		X		X	

Appendix D/ Sub-appendix D

1991 PD Meters TP 101D – Smith Meter Inc.

(Agenda Item 2-4)

Smith Meter Inc.
A Moorco Company

MOORCO®

Technical Paper 101D

Positive Displacement Liquid Meters

Christopher B. Laird

Introduction

This paper will examine positive displacement (P.D.) meters for liquid measurement. The emphasis will be on providing a basic understanding of the factors influencing its design and performance. Although the focus will be on petroleum liquids, these factors can be applied to other applications and other liquids as well.

History

P.D. meters have existed for over a century. Many of the designs were developed from either pumps or compressors. By the late 1930's, P.D. meters were being used extensively for precise measurement of petroleum liquids on tank trucks, bulk loading terminals, and small pipelines. With the construction of large pipelines and large ship loading facilities in the 1950's and 1960's, P.D. meters were developed which could measure flow rates over 10,000 barrels per hour. Most will agree that since its perfection in the 1950's, there exists no more accurate means of petroleum measurement than the P.D. meter. It has become the "Standard of Measurement" for the liquid petroleum industry.

Types of Meters

In general, all types of fluid flow meters can be classified as either Inference or Direct type meters.

Inference

Inference meters infer volumetric flow rate by measuring some dynamic property of the flow stream. Turbine meters fall into this category.

Other examples of Inference meters are orifice plates, flow nozzles, venturis, and pilot tubes, all of which infer flow rate from differential pressure measurements. Other types of meters infer flow rate from the measurement of mechanical force, magnetic resonance, flow area, electromagnetic force, speed of sound, vortex shredding, drag, swirl, impellor speed, etc.

One basic assumption of all Inference meters is that the effective flow cross-sectional area at the meter sense point remains constant between meter provings. If this effective flow area changes due to erosion, corrosion, deposits, boundary layer thickening, cavitation, obstructions, etc., the volume registration will change even though volumetric flow rate remains constant.

Direct

P.D. meters are of the Direct type since they measure volumetric flow directly by continuously separating (isolating) the flow stream into discrete volumetric segments and counting them.

Within the last few years, another interesting meter has emerged. It is the vibrating tube mass meter, and it responds directly to mass flow; and, therefore, is of the Direct type.

Design and Construction

The three basic groups of components or subassemblies that make up a P.D. meter are the: External Housing, Internal Measuring Element, and Accessory Drive Train.

External Housing

The external housing is basically a pressure vessel with inlet and outlet connections. P.D. meters are commonly built with inlet and outlet connections from 1/4" to 16" for pressures to 1,440 psi (600 lb ANSI) and flow rates to 12,500 BPH. External housing materials typically are carbon steel, cast iron, ductile iron, aluminum, bronze, or stainless steel.

Meters may be of single or double case construction. In single case construction, the external housing serves both as a pressure vessel and as the measuring element housing; whereas with double case construction, the external housing is strictly a pressure vessel. Small meters of materials other than carbon steel are normally single case. Meters over 6" in size almost always use carbon steel double case construction.

The advantages of double case construction are: (1) piping stress is not transmitted to the measuring element; (2) the measuring element can be easily removed for service or line flushing on start-up; and (3) the differential pressure across the measuring element walls is minimal, thus eliminating the possibility of measuring element dimensional changes due to system pressure variations.

Internal Measuring Element

As previously mentioned, P.D. meters measure volumetric flow by continuously separating the flow stream into discrete volumetric segments and counting them. Some of the most common P.D. meters measuring element principles are illustrated in Figure 1. The measuring element also serves as a hydraulic motor, absorbing energy from the flow stream to produce the torque necessary to overcome internal friction and drive the counter and other accessory loads.

Accessory Drive Train

The accessory drive train, a typical example of which is shown in Figure 2, consists of three basic elements; Gear Train, Rotary Shaft Seal (Packing Gland), and Calibrator (Adjustor).

1. **Gear Train**

   The gear ratio of the gear train is chosen to convert the fixed volume per revolution of the measuring element to some nominally convenient volume per revolution of the counter input shaft. For example, a 4" Smith P.D. Meter measuring element has a nominal 2.0 Gal/Rev. A typical counter input shaft speed

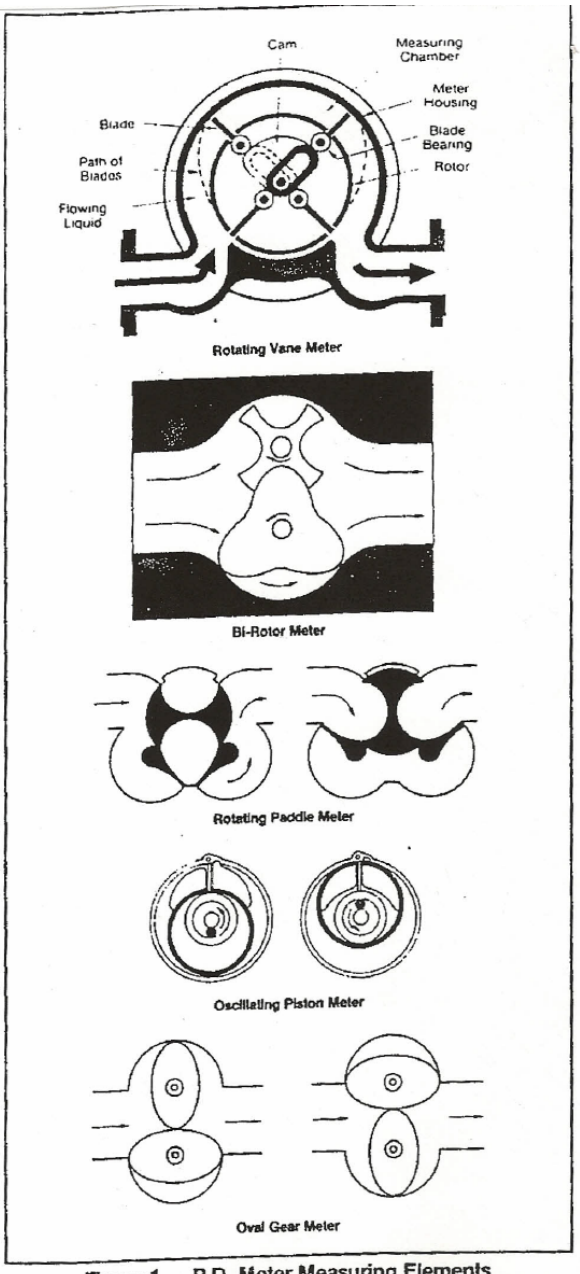

Figure 1 — P.D. Meter Measuring Elements

utilized is 5 Gal/Rev. Thus, a nominal 5:2 reduction gear ratio is used for the meter gear train.

2. **Rotary Shaft Seal**

A rotary shaft seal is required where the counter drive train penetrates the meter pressure vessel. It is normally designed into a module or gland for easy access, since it is a wear item which must be serviced when leakage occurs.

Smith's high presure (275 psi and up) meters utilize an externally lubricated packing gland to isolate the dynamic shaft seal from the product, thereby increasing packing gland life. The external lubricant (typically glycerin or silicone grease) must be chemically compatible and immiscible with the product being metered.

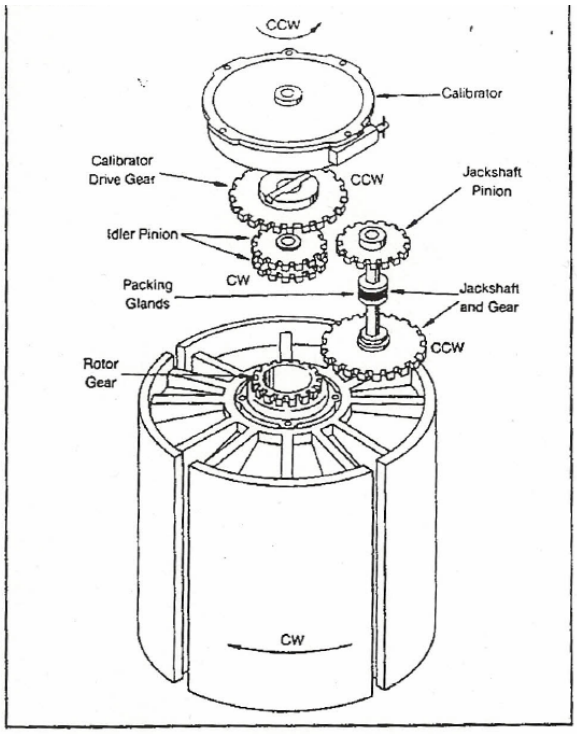

Figure 2 — Typical Counter Drive Train

Some P.D. meters have a magnetic drive coupling instead of a packing gland to eliminate the need for frequent servicing of a dynamic shaft seal.

The primary factors affecting rotary shaft seal life are the seal's compatibility with the liquid and the abrasive contamination of the liquid.

3. **Calibrator (Adjustor)**

A meter calibrator is a device for adjusting in fine increments the meter's counter drive train to register the true volume that has passed through the meter. Without a calibrator, a meter can typically only be geared to register true volumetric throughput within about 0.5 - 1.0%. This is due to manufacturing variations in the measuring element and the relatively coarse gear ratio increments available in a normal meter gear train.

Thus, a calibrator is necessary whenever the mechanical counter on the meter must register actual volume throughput. If a "meter factor" (ratio of actual/registered volume) is to be applied to registered volume, a common practice with pipeline meters, then nominal 100% meter gearing and no calibrator or a "dummy calibrator" is typically used.

Characteristics of a good meter calibrator are:

- Ability to drive a high torque load.
- Long service life.
- Fine adjustment range.
- Adequate adjustment range.
- Low repair or replacement cost.
- Minimal cyclic speed variation of the output shaft.

No available meter calibrator rates superior in all of these categories. However, the commonly used clutch type calibrator probably has a superior rating for all except minimal cyclic speed variation.

Since the clutch calibrator can only add revolutions to its input shaft, it is necessary that the gear train be biased slightly to under-register the throughput volume. Thus, when a 4" Smith P.D. Meter is said to have "96% 5:1 gallon gearing," the nominal gear ratio to the calibrator is only 96% of 5 U.S. gallons per revolution (4.8 U.S. gallons/rev). The calibrator must be adjusted to the overall gear ratio to the counter or other accessories by approximately 4%.

The clutch calibrator incorporates a double overriding clutch mechanism which acts to increase the drive ratio, e.g., 96 revolutions in 100 revolutions out. This is accomplished by increasing the speed of the input shaft through one-half of each output shaft revolution. That is, through the first half revolution, the input and output shafts travel at the same speed; however, during the second half revolution, the output shaft speeds above (overrides) the input shaft (upper graph of Figure 3). This produces cyclical speed variations in the output shaft. The amount of speed variation is proportional to the amount of calibration being applied.

Cyclic speed variation from a calibrator causes no registration error when the volume delivered is a whole number multiple of the volume per calibrator output shaft revolution. For example, a meter geared 5 gallons per calibrator output shaft revolution would have no registration error if the volume delivered were an exact multiple of 5 (e.g., 15, 605, 1,000, etc.) gallons. Since the volume of a tank or can type prover vessel is normally such a whole number multiple of the meter's volume per revolution, meter calibration is generally unaffected by cyclic speed variation from a calibrator.

However, the volume between detector switches on a pipe (displacement type) prover is normally not exactly a whole number multiple of the meter volume per revolution. Thus, cyclic speed variation from the calibrator can cause nonrepeatability in consecutive pipe prover type meter calibration tests.

Since the nonrepeatability is strictly random, statistical averaging of the results from several consecutive tests will produce an accurate meter factor.

In order to understand why cyclic speed variations from the calibrator can cause nonrepeatability when proving the meter, the operation of the calibrator must be closely examined. The lower graph in Figure 3 shows how the calibrator output shaft alternates in error between +4% or -4%.

If the meter were proved on only one-half (1/2) revolution of the calibrator (2-1/2 gallons on a 96% 5:1 gallon geared meter), then the repeatability error would be ±4% as shown by Case A.

If the meter were proved on one revolution (or whole revolutions) of the calibrator then there would be no repeatability error as shown by Case B.

$$\text{Repeatability Error (\%)} = \frac{(1 - \text{Nom. Meter Gearing})}{(2 \times \text{Revs. of Calibration Output Shaft})}$$

For a meter having nominal 99% 5:1 gallon gearing, an approximate 500 gallon calibration run would have a negligible (1%/200 = 0.005%) repeatability error. However, if the meter were geared 96% 1:1 barrel (one barrel per rev.), the maximum possible error on the above calibration run would be substantial (4%/2(500/42) = 0.17%). Thus, to minimize nonrepeatability of calibration runs when a cyclic output calibrator is to be used on a meter to be calibrated with a pipe prover, the meter should be geared for minimum calibrator correction

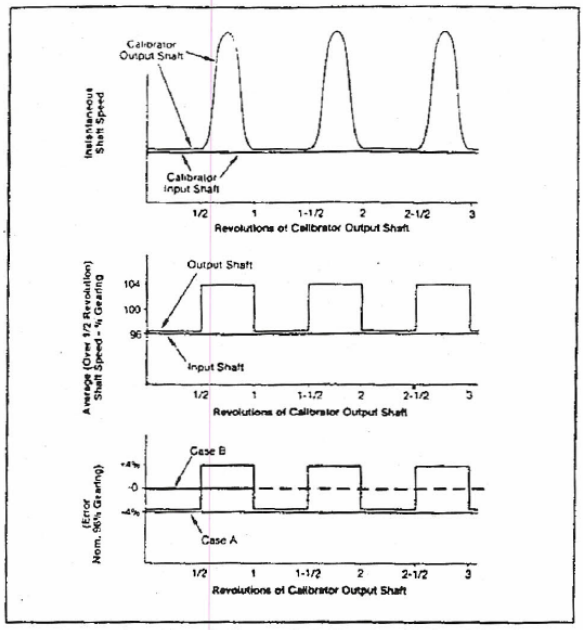

Figure 3 — Revolutions of Calibrator Output Shaft

(e.g., 99%) and maximum calibrator output shaft revolutions (smallest possible units of measure).

Cyclic speed variation can come from other sources. As liquid flows through the meter at a steady rate, the measuring element rotates. This rotation is carried through the drive train to eventually turn a counter, pulse transmitter, etc. It is logical to expect that if the liquid flow rate is constant, then the rotational speed of the output shaft must also be constant. This is not necessarily the case. As mentioned previously, a clutch calibrator will induce a cyclic speed variation in the output shaft.

However, even if a "dummy" calibrator is used, there will be small cyclic speed variation in the output shaft. Unlike the calibrator, this speed variation does not repeat (cycle) on each revolution of the shaft. It may not repeat for several revolutions. This is the result of rotor runout, gear runout, and drive couplings, and even though the speed variation is small, it can cause nonrepeatability when the meter is being proved using small volume displacement provers.

These secondary sources of cyclic speed variation are peculiar to each individual meter and, therefore, cannot be accurately predicted. In some cases, they may act to cancel each other or they may add to each other. If the nonrepeatability which is caused by these factors is excessive, then larger groups of proving runs can be taken and the repeatability of consecutive groups can be evaluated.

Accuracy Theory

The factors affecting the performance of P.D. meters can be described in terms of their effect on the volume displacement per rotor revolution or the slippage through the clearances of the measuring element.

Volume Displacement

The volume displaced by the measuring element is affected by: temperature, pressure, viscosity, wear, and deposits.

1. **Temperature**

   Increasing temperature causes the measuring chamber volume to expand at the cubical expansion coefficient of its metal parts. When dissimilar metals are used (e.g., aluminum blades in a cast iron measuring element), the clearance between the dissimilar metal parts (e.g., blade tip clearance) changes with temperature, affecting displacement volume. This temperature effect is typically about 0.02% for a 10° F fluid temperature change.

2. **Pressure**

   A substantial change in operating pressure will affect displacement volume in a single case meter, but not in a double case meter (where the pressure differential across the walls of the measuring chamber is nil). This effect varies with meter design. However, as a guideline, where operating pressure changes of over 20 psi are expected, the use of either a double case meter or a pressure adjusted meter factor should be considered.

3. **Viscosity**

   As the viscosity of the liquid increases, it tends to cling to the surfaces of the measuring chamber. This clingage has the effect of reducing the displacement volume. This reduction ends when the film can no longer build because of the wiping action of the parts forming the measuring chamber.

4. **Wear**

   Wear can have the effect of increasing the displacement of the rotating vane meter. As the cam or blade bearing becomes worn, the blade is allowed to move closer to the inner surface of the measuring chamber and, therefore, displaces more volume.

5. **Deposits**

   Deposits such as paraffin on measuring chamber surfaces will reduce displacement volume up to a point where clearances become nil. Then, meter performance should remain very constant as long as the deposit remains in place.

   However, if the paraffin has a melting point near the operating temperature of the meter, then the formation or melting can cause significant shifts in meter performance.

Slippage

All P.D. meters have some clearances between moving and stationary surfaces, with differential pressure across the clearances. Thus, there will always be some fluid that bypasses the measuring chamber by "slipping" through these clearances.

Figure 4 shows a typical clearance and the following equation relating the factors affecting slippage.

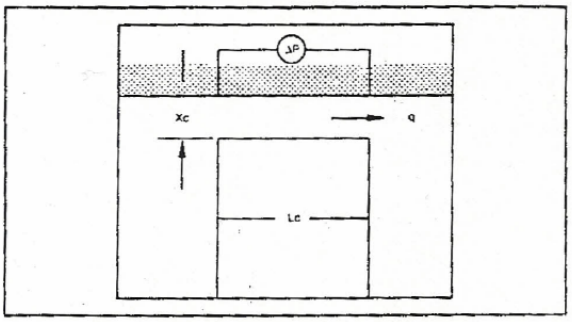

Figure 4 — Typical P.D. Meter Clearance

$$q = K \frac{Xc^3}{\mu Lc} \Delta P$$

If % bypass (q/Q x 100) remained constant, the counter gear train could be adjusted to compensate for it. However, this relationship does not remain constant under normal operating conditions because of the following factors:

1. **Viscosity**

   Figure 5 is a typical illustration of how the accuracy curve shifts with changing viscosity.

   It is interesting to note that the rangeability of a P.D. meter increases dramatically with increasing viscosity. An approximate "rule of thumb" is that a meter's rangeability for a given meter factor shift, as well as meter factor shift for a given rangeability, changes in direct proportion to the change in fluid absolute viscosity (e.g., centipoise, but not necessarily SSU). For example, a P.D. meter should have about the same linearity accuracy between 5% and 100% of maximum rated flow (rangeability of 20:1) on a 4 cP viscosity fluid as it has between 10% and 100% of maximum rated flow (rangeability of 10:1) on a 2 cP viscosity fluid. In other words, halving the viscosity also halves the rangeability.

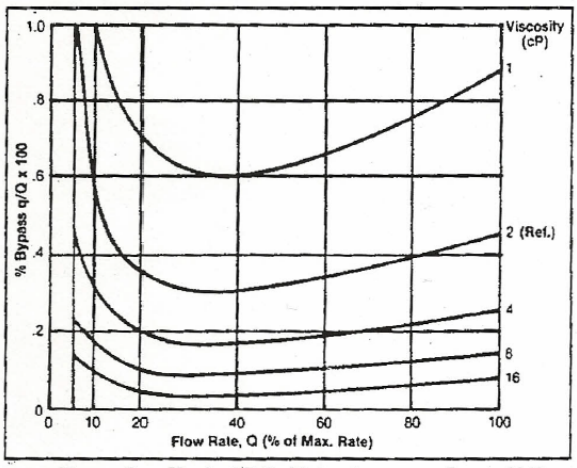

Figure 5 — Typical P.D. Meter Accuracy Curve Shift with Viscosity

It is also interesting to note in Figure 5 the relative shift in % bypass (or meter factor) with viscosity. At viscosities greater than 16 cP, the change in meter factor with changing viscosity and flow rate is negligible for this meter between 10% and 100% of maximum rated flow. In general, from an accuracy viewpoint at least, P.D. meters are the ideal flow meter for fluid viscosities greater than about 4 cP (No. 2 Fuel Oil or 40° API gravity crude oil). The accuracy and rangeability of Inference type flow meters (e.g., turbine meters), in general, decrease at higher viscosities, opposite to that of P.D. meters.

The viscosity of most liquids is related to the temperature. Figure 6 shows several relationships. For example, the viscosity of kerosene changes from 2 6 cP to 1.3 cP between 40°F and 100°F, respectively

2. **Clearances**

   Figure 7 is a typical illustration of how the accuracy curve can shift with a relatively small change in average measuring element clearances (X_C). This shift is due to the cubing of this term in the basic bypass equation (Equation 2).

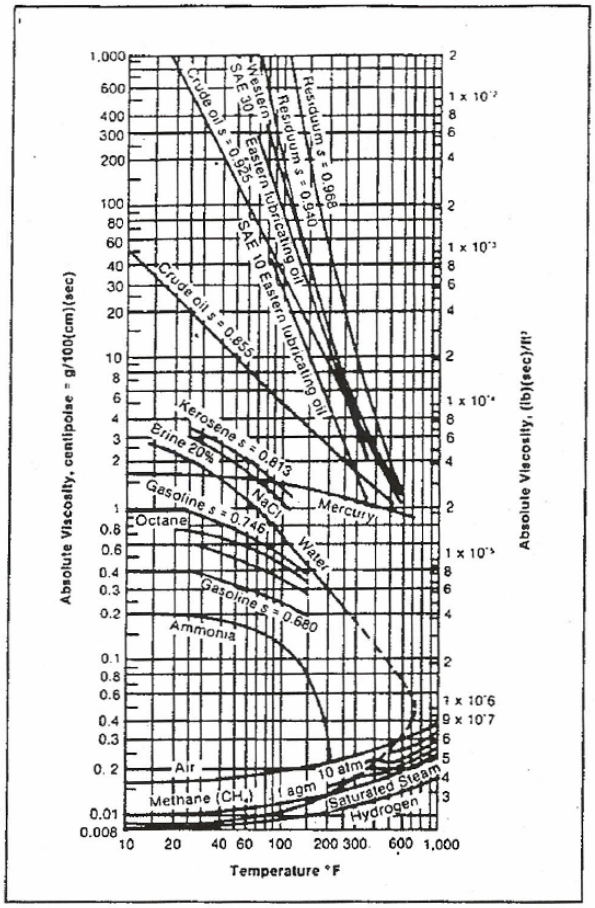

Figure 6 — Values of Absolute Viscosity

From an economical manufacturing viewpoint, because of the buildup of manufacturing tolerances in the various components of the measuring element of a P.D. meter, it is virtually impossible for all P.D. meters of the same design to have exactly the same clearance dimensions. Thus, any two apparently identical P.D. meters can exhibit significantly different shifts in meter factor even though the service would appear to be identical. Certainly the tighter the meter clearances, the less the slippage and the lower the meter factor shift. However, a meter with extremely tight clearances will have reduced service time before inevitable bearing wear causes these same clearances to close up altogether, subsequently resulting in increased mechanical friction and possible severe meter element damage.

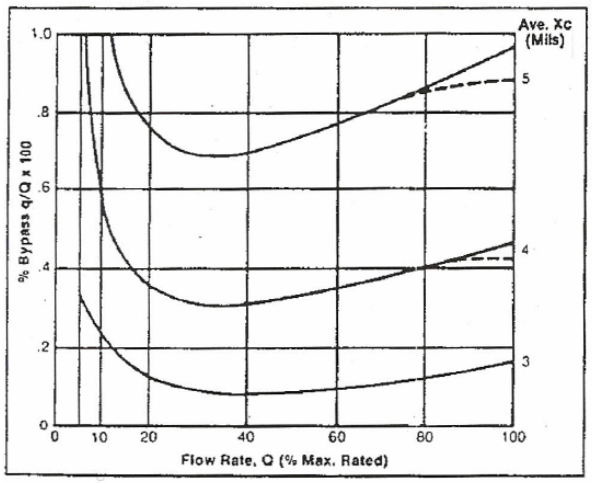

Figure 7 — Typical P.D. Meter Accuracy Curve Shift with Clearance Width

3. **Friction**

Figure 8 shows how the accuracy curve is shifted due to change in mechanical friction. When mechanical friction increases, more pressure differential is required to produce the torque to drive the meter, and therefore, bypass through the clearances is greater. Meters with relatively high mechanical friction may actually show better linearity over a narrow range (e.g., 2:1).

Accuracy Maintenance

In general, if liquid and operating properties (e.g., viscosity, flow rate, temperature) remain constant, there are only two basic types of meter malfunctions that can cause an abnormal shift in meter factor: excessive meter clearances, or excessive mechanical friction.

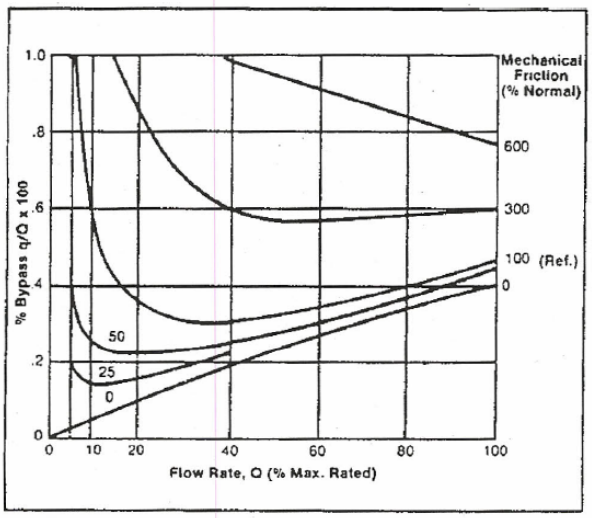

Figure 8 — Typical P.D. Meter Accuracy Curve Shift with Mechanical Friction

Observing the shift in meter factor at low and high flow rates, from earlier calibration runs, particularly on light viscosity (<10 cP) liquids, can provide a clue as to which of these two possible malfunctions is the cause of the problem. In both cases, the meter factor will increase. However, in comparing Figures 7 and 8, one observes that excessive meter clearances result in a greater increase in meter factor at high flow (e.g., 100%) than at low flow (e.g., 20%), whereas the opposite is true for excessive mechanical friction. If the latter is thus indicated, it is advisable to first check the torque required to drive the accessory stack. It is not uncommon for corrosion, abrasion, or foreign matter in a meter stack to cause its required drive torque to increase significantly.

Loss of rotor end clearance is another common cause of meter factor shift in horizontal meters. This has the compounding effect of increasing slippage through the upper rotor end clearances and increasing slippage through all clearances due to the high friction load.

Figure 8 shows another interesting phenomenon for very low mechanical friction. Notice the hypothetical 0% mechanical friction curve has more slippage at 100% of flow rate than at others. This is due to hydraulic pressure drop as liquid passes through the meter.

Conclusion

For optimum metering accuracy, it is important for the P.D. meter user to have a basic understanding of how various design and operating conditions can affect P.D. meter performance. This paper should provide that basic understanding.

The P.D. meter design characteristics important to good meter accuracy are:

- Low pressure differential across measuring element clearances.
- Large clearance length L_C.
- Small clearance width, X_C.

The low pressure differential across meter clearances is the main reason for the good accuracy characteristics of the Smith P.D. Meter. This is primarily the result of the following basic design characteristics of the Smith P.D. Meter:

1. At high flow rates, most of the pressure drop across the meter occurs in the inlet and outlet nozzles and not directly across the measuring element.
2. At low flow (less than 10%), the main cause of pressure drop is the energy expended to overcome internal friction (turn the meter) and the accessory torque load. In the Smith meter, this pressure drop is low because of the use of low friction ball bearings, the relatively large extended blade area normal to the flow stream, and the relatively large moment arm of the extended blade.

The operating condition variations having the greatest effect on the gross meter factor of a P.D. meter are: flow rate, fluid, viscosity, and fluid temperature.

P.D. meters, in general, provide better accuracy than velocity type meters (e.g., turbine meters) for applications where fluid viscosity exceeds about 4 cP (e.g., No. 2 Oil). Fluid viscosity may change due to temperature variations with the same fluid or due to a change of fluids. The insensitivity of the P.D. meter's meter factor to changes in operating conditions increases with increasing fluid viscosity. The opposite is true for velocity type meters.

For flow rates greater than about 4,000 BPH (10" P.D. meter), the cost of P.D. meters normally substantially exceeds the cost of alternative measurement methods (e.g., turbine meters).

However, this extra cost can be quickly offset by the superior accuracy obtainable from the P.D. meter. For example, a 16" P.D. meter operating at its maximum flow rate registers over $200,000 worth of liquid per hour. An increase in accuracy of only 0.02%, would pay for itself at the rate of nearly $1,000 per day.

References

1. Streeter, Victor L.: "Handbook of Fluid Dynamics," McGraw-Hill, New York, 1961.
2. Streeter, Victor L.: "Fluid Mechanics," 2nd Edition, McGraw-Hill, New York, 1958.

Acknowledgement

Much of the material presented here is contained in Smith Meter Inc. Technical Paper 101B, written by Philip D. Baker.

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Appendix D/Sub-appendix E

Technical Policy C – Product Families Table – Centistoke Correction –

(Agenda Item 9)

C. Product Categories and Families for Meters

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

Product Category

A group of products that share similar characteristics.

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

Product Family

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

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

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

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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	Reference Viscosity[1]

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	Reference Kinematic

[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**	
						Products	**(60 °F) centipoise (cP)**	**Products**	**Viscosity[1] (60 °F) centistokes (cSt)**
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		FL&O	**Test C**		Crude Oil	3 – 2260

[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**	
			Oils			**Product Category:** Crop Chemicals (Type D) (CC-D)			
20% Aqua-Ammonia	0.89	Fert	Olive Oil		FL&O	**Typical Products**	**Reference Viscosity[1] (60 °F) centipoise (cP)**	Diesel Fuel[3]	12
28%, 30% or 32%	1.28 – 1.32	Fert	Peanut Oil		FL&O	Micronutrients	20 – 1000	Fuel Oil (#1, #2, #3, #4)	9 – 98

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

Mass Meter Product Category and Test Requirements		
Jet A-1	0.76	FL&O
Jet B		FL&O
JP4	0.76	FL&O
JP5	0.76	FL&O
JP7 and JP8	0.76	FL&O
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		
Xylene	0	Solv Gen
Deionized		Water
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	
20% Aqua-Ammonia	1.1 – 1.3
28%, 30% or 32%	31 – 110
Ammonia Nitrate	11.22
Clear Liquid Fertilizer	31 – 110
Nitrogen Solution	31 – 110
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	
Vegetable Oil	145
Test E **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 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

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

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

Typical Products	Specific Gravity[2] (60 °F)	Product Category
Compressed Hydrogen Gas (H or H2)	0.07 (1=Air)	Comp H2
Liquid Carbon Dioxide	1.12 (-40 °F)	Liq CO2

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

Test C
Product Category:

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
Trichloro-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

Positive Displacement Flow Meter Product Category and Test Requirements

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

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
MEK	0.45
Toluene	0.62

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**
		Xylene	0.86	
		<u>Test C</u> **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	
		<u>Test D</u> 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	
		<u>Test D</u> **Product Category:** Water (Water) continued		
		Typical Products	**Reference Viscosity[1] (60 °F) centipoise (cP)**	
		Tap Water	1.0	
		<u>Test A</u> 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]**	

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
		(60 °F) centipoise (cP) Liquefied Natural Gas: Liquefied Oxygen: 0.038 Nitrogen: 1.07 **Test A** The following products must be individually tested and noted on the Certificate of Conformance. **Product Category:** Compressed Hydrogen Gas (Comp H2) **Typical Products** / **Reference Viscosity[1] (60 °F) centipoise (cP)** Compressed Hydrogen Gas (H or H2): 0.0097	
		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.

Appendix D/Sub-appendix F

National Type Evaluation Program
Liquid Measuring Devices – Checklists and Test Procedures for Retail Motor Fuel Dispensers

(Agenda Item 10)

7. Indicating and Recording Elements

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

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

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

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

Basic operating requirements for devices are that:

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

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

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

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

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

7.3. All total sale money value indications in a computing system are primary indications and must agree prior to the application of any post-delivery discount. ☐ Yes ☐ No ☐ N/A

7.4. Digital volume indications in a non-computing system must agree or "round off" to the nearest minimum unit that can be indicated or recorded. ☐ Yes ☐ No ☐ N/A

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

7.6. When delivery from a computing device is based upon a pre-set volume, the quantity indicated on the dispenser and any auxiliary device must be equal to or greater than the pre-set volume and the dispenser and remote console must comply with G-S.5.5. Money Values, Mathematical Agreement. ☐ Yes ☐ No ☐ N/A

7.7. The quantity, unit price, and total price indications on the console shall be in mathematical agreement prior to the application of any post-delivery discount. ☐ Yes ☐ No ☐ N/A

7.8. The following applies when a quantity value indicated or recorded by an auxiliary element such as a console, ticket printer, or remote customer display, is a derived or computed value based on data received from a retail motor fuel dispenser. When a system applies a post-delivery discount(s) to a fuel's unit price through an auxiliary element, the total volume of the delivery shall be in agreement between all elements in the system.

7.8.1. In systems that do not apply a post-delivery discount, the quantity values indicated or recorded on a console, electronic cash register, or other auxiliary indicating or recording element may differ, however, for all systems:

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

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

Examples: $1.5549 rounds to $1.55
$1.5551 rounds to $1.56
$1.5550 rounds to either $1.55 or $1.56

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

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

Code Reference: G-S.5.5. Digital Money Values, Mathematical Agreement
Any recorded money value and any digital money value indication on a primary indicator must agree mathematically with its associated quantity (volume) representation or indication to the nearest one cent.

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

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

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

7.11.2. Snapping nozzle on and off several times during delivery. Check mathematical agreement each time flow is halted. ☐ Yes ☐ No ☐ N/A

7.11.3. At several unit prices including the low prices and the maximum pricing capability of the computer and when operating at the maximum flow rate. ☐ Yes ☐ No ☐ N/A

7.11.4. Turn the dispenser off during delivery with nozzle open. ☐ Yes ☐ No ☐ N/A

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

Discount Pricing
NIST Handbook 44 requires that, except for dispensers used for fleet sales, other price contract sales, truck refueling (e.g., truck stop dispensers used only to refuel trucks), when a product or grade is offered for sale at more than one unit price through a computing device, the selection of the unit price shall be made prior to delivery using controls on the device or through the deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions.

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

Except for fleet sales and other contract sales, a receipt providing the total volume, unit price, total computed price and product identity shall be available through a built-in or separate recording element for all transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash. (Code Reference S.1.6.7) The recorded and displayed total fuel price on the receipt and dispenser, respectively, shall agree.

Selectable Unit Price Capability
Selectable unit price capability is a design feature that permits the customer to select the unit price for a particular transaction at the time of sale. A dispenser may then allow the unit price for a delivery to be

selected from two or more unit prices through the deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions.

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

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

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

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

7.12. A dispenser may be equipped with means for selecting more than one unit price, provided that the selected unit price cannot be changed after the initial flow begins. ☐ Yes ☐ No ☐ N/A

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

7.14. Once selected the unit price cannot be changed by the operator at the console prior to or during the delivery. ☐ Yes ☐ No ☐ N/A

7.15. The selected unit price displayed at the dispenser prior to the delivery of product must be continuously displayed at the conclusion of the delivery by moving the operating mechanism to the "off" position, until the start of the next transaction by:

7.15.1. Movement of the operating mechanism to the "on" position. **OR** ☐ Yes ☐ No ☐ N/A

7.15.2. "Authorization/Approval" by the console operator, whichever occurs first. ☐ Yes ☐ No ☐ N/A

7.16. When a delivery is completed, the total price and quantity for that transaction shall be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated by using controls on the device or other user-activated (e.g., customer-activated) controls. ☐ Yes ☐ No ☐ N/A

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

for a particular kind of transaction.

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

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

7.18. A receipt must be available to the customer at the completion of the transaction. The issuance of the receipt may be initiated at the option of the customer. ☐ Yes ☐ No ☐ N/A

7.19. The customer receipt must contain the following information:

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

7.19.2. Where a post-delivery discount(s) is applied, the sales receipt must provide:

- 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.

See LMD Code S.1.6.8.

7.20. Cash Value Card - A cash value card that is initially encoded with the purchase price, authorizing a customer to purchase products up to the current cash value of the card. The value of the card is decreased in amounts equal to individual transactions. ☐ Yes ☐ No ☐ N/A

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

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

7.21.1. For computing systems, the date, quantity, unit price, and total price shall be recorded and shall agree with the indications on the dispenser. ☐ Yes ☐ No ☐ N/A

7.21.2. When non-computing analog dispensers are used and the billing is on the basis of individual quantities for each transaction (non-cumulative), the value of the smallest unit of displayed quantity for each transaction shall be not greater than 0.1 gallon providing the "pulser" and the recorded quantity used for billing are each equal to or less than 0.01 gallon. ☐ Yes ☐ No ☐ N/A

7.21.3. All displayed transaction information must be shown for at least 30 seconds after completing a delivery or starting the next transaction. The delivery is considered complete after the "handle" is off or after the nozzle has been returned to its designed hanging position. ☐ Yes ☐ No ☐ N/A

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

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

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

Code Reference: S.1.2. Primary Elements/Units

7.23. A liquid measuring device shall indicate, and record if the device is equipped to record, its deliveries in liters, gallons, quarts, pints, fluid ounces, or binary-submultiples or decimal subdivisions of the liter or gallon. ☐ Yes ☐ No ☐ N/A

Code Reference: S.1.2.3. Value of Smallest Unit

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

Code Reference: S.1.6.1. Indication of Delivery

7.25. Retail devices shall automatically show their initial zero condition and amount delivered up to the nominal capacity of the device. For electronic devices manufactured on or after January 1, 2006, the measurement, indication of delivered quantity, and the indication of total sales price shall be inhibited until the fueling position reaches conditions necessary to ensure the delivery starts at zero. ☐ Yes ☐ No ☐ N/A

7.26. For electronic devices manufactured prior to January 1, 2006, the first 0.03 L (or 0.009 gal) of a delivery and its associated total sales price need not be indicated. ☐ Yes ☐ No ☐ N/A

Test Method Steps:

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

Code Reference: S.1.6.2.1. and S.1.6.2.2. Provisions for Power Loss

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

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

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

Code Reference: S.1.6.3. Return to Zero

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

7.32.	Does the device have a primary recording element?	☐ Yes ☐ No ☐ N/A
7.33.	The indicating and recording elements of a retail device shall readily returnable to a definite zero indication.	☐ Yes ☐ No ☐ N/A
7.34.	Key-lock and self-operated devices shall have an indicating element that return to zero.	☐ Yes ☐ No ☐ N/A
7.35.	Does the device have:	
7.35.1.	A cumulative indicating element?	☐ Yes ☐ No ☐ N/A
7.35.2.	A cumulative recording element?	☐ Yes ☐ No ☐ N/A
7.36.	Primary indicating and recording elements shall not go beyond their correct zero position.	☐ Yes ☐ No ☐ N/A

Code Reference: S.1.6.4.1. Display of Unit Price

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

from a device, then all of the unit prices at which that product is offered for sale shall be displayed or shall be capable of being displayed on the dispenser using controls available to the customer prior to the delivery of the product. The unit price shall be expressed as a decimal value in dollars.

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

7.38. If a grade, brand, blend, or mixture is offered for sale at more than one unit price from a device, then all of the unit prices at which that product is offered for sale:

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

7.38.2. Shall be capable of being displayed on the dispenser through the deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions. ☐ Yes ☐ No ☐ N/A

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

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

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

a. Displayed simultaneously for all products.

b. Displayed simultaneously for each product separately.; or

c. Displayed individually in a unit-price display only if controls permit the customer to sequence the display through the unit prices for each and every product.

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

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

Code Reference: S.1.6.4.2. Display of Product Identity

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

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

7.41. Except for aviation refueling applications, when a delivery is completed on a computing device, the total price and quantity for that transaction shall be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated by using controls on the device or other customer-activated controls. ☐ Yes ☐ No ☐ N/A

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

Code Reference: S.1.6.5.4. Selection of Unit Price

7.42. Except for dispensers used exclusively for truck refueling (e.g., truck stop dispensers used only to refuel trucks), when a product or grade is offered for sale at more than one unit price through a computing device, the selection of the unit price shall be made:

7.42.1. Prior to delivery using controls on the device. **OR** ☐ Yes ☐ No ☐ N/A

7.42.2. Through deliberate action of the purchaser using: 1) controls on the device; 2) personal or vehicle mounted electronic equipment communicating with the system; or 3) verbal instructions. ☐ Yes ☐ No ☐ N/A

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

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

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

7.44. Where a post-delivery discount(s) is 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.

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

7.45. a. The quantity shall be displayed throughout the transaction. ☐ Yes ☐ No ☐ N/A

b. The total price shall also be displayed under one of the following conditions:

i. The total price can appear on the face of the dispenser or through a controller adjacent to the device.

ii. If a device is designed to continuously calculate and display the total price, it shall be displayed for the quantity delivered throughout the transaction.

c. The total price and quantity shall be displayed for at least 5 minutes or until the next transaction is initiated by using controls on the device or other customer activated controls.

d. A printed receipt shall be available and shall include, at a minimum, the total price, quantity, and unit price.

8. Computing

A retail computing device shall be capable of computing total sale prices for all unit prices and for all deliveries within the range of measurement or computing capacity. The maximum value of the money-value division and the maximum variation of indicated total sale price from the mathematically computed total sale price are specified for analog devices. Because analog dispensers may have different money-value divisions

depending upon the unit price, the service station console must update in the same money-value division to maintain agreement of total sale price values. The maximum quantity-value divisions for digital devices are prescribed.

Code Reference: S.1.6.5. Money-Value Computations

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

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

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

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

See NIST Handbook 44 N.4.3. for Test Procedures

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

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

Analog money-value divisions shall be as follows:

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

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

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

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

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

8.8. Total price indications shall be based on quantity-value divisions that are less than or equal to 0.05 liters or 0.01 gallons. ☐ Yes ☐ No ☐ N/A

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

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

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

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

9. Measuring Elements

Code Reference: S.2.2. Provision for Sealing

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

9.1. A measuring element shall have provisions for either:

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

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

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

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

9.4. Audit trails shall use the format set forth in the Common and General Code Criteria section of this checklist (Code Reference G-S.8) and in Appendix A, Audit Trail Checklist for Liquid Measuring Devices. ☐ Yes ☐ No ☐ N/A

9.5. Retail motor fuel dispensers with remote configuration capabilities shall be sealed according to Table S.2.2. in Appendix A, Minimum Requirements for Audit Trails for Liquid Measuring Devices and under the "Common and General Code Criteria" section of this checklist. ☐ Yes ☐ No ☐ N/A

Code Reference: S.2.2.1. Multiple Measuring Devices with a Single Provision for Sealing

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

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

a. A broken, missing, or replaced physical seal on an individual measuring element.

b. A change in a calibration factor for each measuring element.

c. Display of the date of or the number of days since the last calibration event for each measuring element.

d. A counter indicating the number of calibration events per measuring element.

Note: S.2.2.1. will be removed in the 2010 edition of NIST Handbook 44 when General Code paragraph G S.8.1. Multiple Weighing or Measuring Elements with a Single Provision for Sealing becomes effective.

Code Reference: S.2.3. Directional Flow Valves

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

Code Reference: S.2.4. Stop Mechanism

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

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

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

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

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

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

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

9.12. The starting lever shall be in shut off position and zero-set-back interlock engaged before the nozzle can be returned to its designed hanging position. That is any position where the tip of the nozzle is placed in its designed receptacle and the lock can be inserted. ☐ Yes ☐ No ☐ N/A

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

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

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

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

10. Discharge Lines and Discharge Line Valves

Code Reference: S.3.1. Diversion of Measured Liquid

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

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

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

a. Liquid can flow from only one outlet at a time. and

b. The direction of liquid flow is definitely and conspicuously indicated.

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

10.2. Two or more delivery outlets may be installed if there are automatic means to ensure that liquid can flow from only one outlet at a time, and the direction of flow for which the mechanism may be set at any time is definitely and conspicuously indicated. ☐ Yes ☐ No ☐ N/A

10.3. Except as identified above, an outlet that may be opened for purging or draining the measuring system or for recirculating, if recirculation is required in order to maintain the product in a deliverable state, shall be permitted only when the system is measuring food products, agri chemicals, biodiesel, or biodiesel blends. Effective automatic means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system and to inhibit meter indications (or advancement of indications) and recorded representations while the outlet is in operation. ☐ Yes ☐ No ☐ N/A

Code Reference: S.3.2. Exceptions

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

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

Code Reference: S.3.3. Pump-Discharge Unit

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

Code Reference: S.3.5. Discharge Hose

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

Code Reference: S.3.6. Discharge Valve

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

Code Reference: S.3.7. Antidrain Valve

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

11. Marking

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

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

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

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

Example: With a marked maximum discharge rate of 230 L/min (60 gpm), the marked minimum discharge rate shall be 45 L/min (12 gpm) or less (e.g., 40 L/min (10 gpm) is acceptable.) A marked minimum discharge rate greater than 45 L/min (12 gpm) (e.g., 60 L/min (15 gpm)) is not acceptable.

Code Reference: S.4.4.2. Location of Marking Information

11.3. The required marking information in the General Code, paragraph G-S.1. shall be located as follows:

11.3.1. Shall be within 24 to 60 inches from the base of the dispenser. ☐ Yes ☐ No ☐ N/A

11.3.2. May be internal and/or external provided the information is permanent and easily read. ☐ Yes ☐ No ☐ N/A

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

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

12. Totalizers

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

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

13. User Requirements

Code Reference: UR.1.1. Length of Discharge Hose

13.1. The length of a discharge hose shall not exceed 5.5 m (18 ft), but marinas and airports may have hoses up to 15 m (50 ft) long. ☐ Yes ☐ No ☐ N/A

13.2. If the length of a discharge hose in a marina or airport exceeds 8 m (26 ft), it shall be adequately protected from environmental factors. ☐ Yes ☐ No ☐ N/A

Code Reference: UR.3. Use of Device

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

14. Installation Requirements

Code Reference: UR.2.1. Installation

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

Code Reference: UR.2.2. Discharge Rate

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

15. Card-Activated Retail Motor Fuel Dispensers

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

Accidental or intentional fraud causes great concern when customers use card-activated systems in service stations, bank-card-activated systems directly access bank accounts. The following criteria and test procedures apply to card-activated retail motor fuel dispensers.

A card-activated system shall authorize the dispensing of product for not more than three minutes for the time between authorization and "handle on" at the dispenser. It shall properly record transactions on the appropriate card account.

When a card-activated system is subjected to power loss of greater than 10 seconds, the dispenser shall de-authorize. Because systems may be installed with separate power lines to the console, card reader, and dispenser, tests should be run with power failures to different parts of the system to evaluate the potential for accidental or intentional errors. The appropriate device response depends when the power loss occurs during the delivery sequence.

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

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

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

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

16. Test Methods for Card-Activated Retail Motor Fuel Dispensers

16.1. Authorize the dispenser and, with the pump "handle" on, interrupt power to any part (or all) of the system. The pump should deauthorize immediately. Specifically:

16.1.1. Authorize with a card and turn the "handle" on. Power down briefly, then restore power. Try to dispense product: the dispenser must not dispense because the power failure should have de-authorized the dispenser. ☐ Yes ☐ No ☐ N/A

16.2. Authorize the dispenser using a card (leaving handle off); wait more than three minutes, and try to start the dispenser. It should not start because the

authorization should have timed out. Specifically:

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

16.2.2. Authorize and dispense with card #1. Allow the system to time out and de-authorize (if it does). Do not turn off the "handle." Authorize and dispense with card #2. The transactions shall be properly recorded for each card. ☐ Yes ☐ No ☐ N/A

Note: A mechanical register may accumulate the two deliveries, but the printed record must not have accumulated values.

16.2.3. Authorize with card #1. Turn the "handle" on, then off. Authorize with card #2. Dispense product and complete the delivery. Check the printed receipt to verify that the delivery has been properly charged to card #2. ☐ Yes ☐ No ☐ N/A

16.2.4. Turn the dispenser "handle" on, and use a card to authorize the dispenser. Turn the "handle" off. After a period of 15 seconds, turn the "handle" on. Try to deliver product; the dispenser must not dispense. ☐ Yes ☐ No ☐ N/A

16.2.5. Authorize with card #1 (do not turn the "handle" on) and interrupt power for at least 10 seconds. This should de-authorize the dispenser. Resupply power; turn the "handle" on; try to dispense. The dispenser shall not deliver product. ☐ Yes ☐ No ☐ N/A

Note: The term "handle" generically refers to the handle, flapper, start button, on/off switch, or other mechanism used to activate or deactivate the dispenser.

16.2.6. Authorize with card #1; turn the "handle" on, and then interrupt power. This should de-authorize the dispenser. Resupply power and authorize the dispenser with card #2. Then, complete a delivery. Verify that the transaction is charged to card #2. ☐ Yes ☐ No ☐ N/A

Note: This test is not required if the device under test complies with paragraph 16.1.

16.2.7. Authorize a dispenser with card #1, but do not turn the dispenser "handle" on. Try to authorize the same dispenser with card #2; it should not be accepted until after the 3 minute time-out. ☐ Yes ☐ No ☐ N/A

16.3. Attempt to override or confuse the card system by varying the length of time the card is in the slot, (e.g., vary the "swipe" times) and pushing all other keys on the keypad during each step of the authorization process. ☐ Yes ☐ No ☐ N/A

National Type Evaluation Program
Liquid Measuring Devices – Checklists and Test Procedures for Cash-Activated Retail Motor Fuel Dispensers

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

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

17. Code Reference: S.1.6.2. Provisions for Power Loss

Even if power is interrupted during a delivery, it is still necessary to correctly complete all transactions in progress at the time of the power interruption. In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, sales price, or amount of money already inserted into the cash acceptor) shall be determinable for at least 15 minutes at the dispenser or at the console or journal printer if the console or journal printer is accessible to the customer.

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

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

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

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

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

Check these systems by interrupting power at several points in the transaction to ensure that all information (total price, quantity, mathematical agreement, and total dollar amount inserted by the customer) is accounted for correctly.

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

17.2. When one or more bills has been accepted and registered by the device, but product has not yet been dispensed, at least one of the following criteria must be met to ensure that this information can be recalled in the event of a power interruption:

17.2.1. The denomination of the bill must be printed by the printer on the device as the device recognizes the bill. (The printed receipt must be available to the customer.) ☐ Yes ☐ No ☐ N/A

17.2.2. The denomination of each bill must be printed by a journal or other printer accessible to the customer as each bill is recognized by the device. ☐ Yes ☐ No ☐ N/A

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

17.2.4. Means provided to enable the customer to retrieve the money inserted into the device (e.g., a button which can be used during a power interruption to eject the money inserted by the customer.) ☐ Yes ☐ No ☐ N/A

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

17.3. There is a brief period of time during which a bill has been accepted by the cash acceptor but has not yet been recognized by the device. The following criteria must be met to ensure that this information can be recalled in the event of a power failure. ☐ Yes ☐ No ☐ N/A

17.3.1. Means provided to enable the attendant or customer to retrieve the bill (for example, a button which can be used during a power interruption to eject the bill or if the cash acceptor box can be removed by the attendant and the bill retrieved.) ☐ Yes ☐ No ☐ N/A

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

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

17.4. Power should be interrupted at different points in the transaction to determine that all transaction information can be recalled in the event of a power interruption including combinations of the following:

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

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

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

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

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

17.4.6. After a bill(s) has been inserted and recognized, the on/off handle is in the "on" position, but no product has been dispensed. ☐ Yes ☐ No ☐ N/A

17.4.7. After a bill(s) has been inserted and recognized, the on/off handle is in the "on" position, and product is being dispensed. ☐ Yes ☐ No ☐ N/A

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

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

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

17.6.1. The customer receipt must contain the following information:

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

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

17.6.1.2. Where a post-delivery discount(s) is 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.
See LMD Code S.1.6.8.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix D/Sub-appendix G

National Type Evaluation Program

Post Delivery Discount Revisions – Publication 14
Electronic Cash Register Interfaced with Retail Motor Fuel Dispensers

(Agenda Item 10)

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Appendix G- Post-Delivery Discount revisions-Publication_14_ECR_Interfaced_with_RMFD_DRAFT revised 10-6-12

National Conference on Weights and Measures

National Type Evaluation Program

Electronic Cash Register Interfaced with Retail Motor Fuel Dispensers

Technical Policy • Checklists • Test Procedures

NCWM

Publication 14

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We also acknowledge the NTEP Committee for its careful assessment of the recommendations presented by the sector, commenting and revising when necessary, and approving the recommendations for inclusion in these checklists.

These contributions from so many people have resulted in a reference book that will help device manufacturers to design devices in compliance with *NIST Handbook 44* and promote uniform procedures and assessment by type evaluation by the laboratories. This is a goal of NTEP.

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Amendments

Electronic Cash Register Interfaced with Retail Motor Fuel Dispensers

Section Number	Amendment	Page	Source
Document	Please note that the NTEP Measuring Devices publication has been thoroughly reviewed by NCWM staff. Changes have been made, but none are to change intent of the policies, checklists or test procedures, thus considered editorial. Issues or concerns should be brought to the attention of NCWM staff.	Document	Editorial

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Checklists and Test Procedures

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National Type Evaluation Program
Electronic Cash Register Interfaced with Retail Motor Fuel Dispenser
Checklists and Test Procedures

Introduction

This checklist is intended for use when conducting general evaluations of new electronic cash registers (ECR) that are to interface with retail motor fuel dispensers. It is assumed that the dispenser was previously evaluated, if not, the Liquid Measuring Device checklist must be applied to the dispenser sale system. The ECR must interface with a dispenser to perform this evaluation. Specific criteria that apply to service station control consoles are in the checklist for retail motor fuel dispensers and must be applied if the cash register also serves as the service station controller. As a minimum, two dispensers from different manufacturers, each of which includes all of the features to be listed on the ECR Certificate of Conformance (CC), must be evaluated with the ECR in order to have the statement "equivalent and compatible equipment" appear on the CC.

This checklist is designed in a logical sequence for the user to determine and record the conformance of the device with the elements of *NIST Handbook 44*. The user should make copies of the checklist to serve as worksheets and preserve the original for reference. In most cases, the results of evaluation for each element can be recorded by checking the appropriate response. In some cases, the user is required to record values, results, or comments. In those cases, space is provided.

Identification

Code Reference: G-S.1. General
Each cash register must comply with the appropriate *NIST Handbook 44* identification requirements.

All equipment, except weights and separate parts necessary to the measurement process but not having any metrological effect, shall be clearly and permanently marked for the purposes of identification with the following information (prefix lettering may be initial capitals, all capitals, or all lower case.)

Location of the information:

_____

_____

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,	☐ Yes ☐ No ☐ N/A

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.)

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

1.5. An NTEP Certificate of Conformance (CC) Number or a corresponding CC addendum number for devices that have (or will have) a CC. The number shall be prefaced by the terms "NTEP CC," "CC," or "Approval." These terms may be followed by the word "Number" or an abbreviation for the word "Number." The abbreviation for the word "Number" shall as a minimum begin with the letter "N" (e.g., No or No.) ☐ Yes ☐ No ☐ N/A

The device must have an area, either on the identification plate or on the device itself, suitable for the application of the Certificate of Conformance Number. If the area for the CC number is not part of an identification plate, then note its intended location below and how it will be applied.

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

_____

_____

1.6. The required information shall be so located that it is readily observable without the necessity of the disassembly of a part requiring the use of any means separate from the device. ☐ Yes ☐ No ☐ N/A

1.7. The device must be marked with a unique serial number to identify the electronic element that controls the system. A remote display is not required to have a serial number because it usually does not have any electronics to analyze the signal received from the measuring element. Similarly, other elements of a system, (e.g., a printer, keyboard, cash drawer etc.) which cannot be operated as stand-alone units or are not intended to interface in a system of other models are not required to have a serial number. ☐ Yes ☐ No ☐ N/A

1.8. The marking must be visible after installation. ☐ Yes ☐ No ☐ N/A

1.9. Equipment is to be marked on a surface that is an integral part of the chassis, which is visible after installation. If the required information is located on the back of the device, the same information must also appear on the side, front, or top. It may be installed on the housing only if the housing can be fitted with a security seal. The bottom of a device is not an acceptable surface. ☐ Yes ☐ No ☐ N/A

1.10. The marking must be permanent. It may be a metal or plastic plate attached with pop rivets, adhesive, or other means. Removable bolts or screws are not permitted. A foil plate may be used provided it is destroyed in any attempt to remove it. Additionally, the printing on a foil plate must be easily read and not easily obliterated by rubbing with a relatively soft object (e.g., the wood of a pencil.) ☐ Yes ☐ No ☐ N/A

Note: A location under a cover or inside a panel door is acceptable. Visibility may be achieved by placing a duplicate serial number badge on the front, side, or top of the ECR. This badge may contain only the serial number if the other information is visible elsewhere on the ECR.

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

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

1.1.1. 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

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

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

1.1.2.2. Continuously displayed. OR ☐ Yes ☐ No ☐ N/A

1.1.2.3. 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 (1.11.2.), 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.

Indicating and Recording Elements

Code Reference: G-S.5.1. Price Look-up Codes (PLUs)

2.1. PLUs must operate only with appropriate information, (e.g., if a PLU activates a dispenser transaction, a volume input is required before a price is computed and recorded.) ☐ Yes ☐ No ☐ N/A

2.2. Other PLUs must not interact with dispenser information. ☐ Yes ☐ No ☐ N/A

2.3. Manual volume entries are permitted. They must be clearly identified on the receipt as a manual entry by the terms "Manual Fuel Sale." ☐ Yes ☐ No ☐ N/A

Note: All uppercase or a combination of upper and lower case letters are permitted provided the evaluating laboratory finds the resulting text to be clear and legible.

2.4. Incorrect entries shall be signaled by an audio and/or visual signal. ☐ Yes ☐ No ☐ N/A

2.5. A dispenser verification display (e.g., segment test) shall not be recorded by the ECR. ☐ Yes ☐ No ☐ N/A

Code Reference: S.1.6.2. Provision for Power Loss

2.6. Power Interruptions. First test with a power failure to the ECR alone. Then a power failure to the dispenser alone. Finally, a power failure to both components simultaneously. When power interruption occurs, the register must do one of the following:

2.6.1. Continue to function and perform correctly either automatically or manually. ☐ Yes ☐ No ☐ N/A

2.6.2. The transaction is halted and can be continued when power returns. ☐ Yes ☐ No ☐ N/A

Note: The ECR may continue to function while power is interrupted, (e.g., the ECR is equipped with an uninterruptible power supply.) Alternatively, the ECR may cease operation when power is interrupted and may resume the transaction in process at the time of the power failure when power is returned. Either alternative is acceptable provided that the ECR continues to function and perform correctly. There are no requirements to indicate when a power failure or interruption has occurred.

2.7. Provisions for Power Loss.

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

2.7.1. Remote controllers which stack completed sales must have a means to enable the transaction information to be recalled and verified for at least 15 minutes. ☐ Yes ☐ No ☐ N/A

Note: The criteria for power loss to a fuel dispenser are given in the retail motor fuel dispenser checklist.

2.8. An ECR shall be able to record all quantities, unit prices, and total prices up to the capacity of the dispenser. When the capacity of the quantity or total price is exceeded and the display "rolls over," the ECR shall not record the "rolled over" value but shall either record the correct total volume and total price or give an error indication. ☐ Yes ☐ No ☐ N/A

2.9. A cash register shall not print the values from a dispenser until the delivery has been completed and dispenser turned off. ☐ Yes ☐ No ☐ N/A

Items not measured or weighed may be split-priced according to general marketing practices. Acceptable price extensions will depend on individual State policies. Normally, the single item price will be the multiple item price divided by the number of items and rounded up to the next high cent. If the single item price is different from the price that would be computed as described, the price per item must be posted at the display. *See FPLA value comparison considerations and the Model Unit Pricing Regulation.* Suggested multiple item prices for test procedures are 3/$1.00 and 7/$1.00. The single item prices may be recorded as $.34, $.34, $.32 or $.34, $.33, $.33 and $.15, $.15, $.15, $.15., $.15, $.15, $.10 or $.15, $.14, $.14, $.15, $.14, $.14, $.14, respectively.

2.10. Price calculations for multiple-item-priced commodities shall be correctly computed as described above for:

2.10.1. Prices entered via PLUs. ☐ Yes ☐ No ☐ N/A

2.10.1. Prices entered through the keyboard. ☐ Yes ☐ No ☐ N/A

3. Recorded Representations

Code Reference: G-S.5.1., S.1.6.7., and S.1.6.8.

A sales receipt showing the quantity, unit price, total price, and product identity for each fuel delivery in a transaction is required for point-of-sale systems. A printed receipt must always be available to the customer upon request. In addition, systems may be equipped with the capability to issue an electronic receipt. The customer may be given the option to receive the receipt electronically (e.g., via cell phone, computer, etc.).

Various forms (or representations) of sales receipt formats are acceptable provided they are clear and understandable. Guidelines are provided to assist manufacturers and weights and measures officials in determining the acceptability of formats. Symbols other than those given below may be acceptable, but they will be reviewed on a case-by-case basis. More descriptive symbols and terms are acceptable.

3.1. The unit of measure shall be clearly defined. Acceptable symbols for units are: Gallon Gal, of G for gallons and Liter, l or L for liters. Upper or lower case is optional except that a lower case "l" must not resemble a "1" (numeral one), (e.g. a script "l" is an acceptable symbol for liters.) ☐ Yes ☐ No ☐ N/A

The unit of measure may be defined with either the quantity value, (e.g., 10 000 GAL) or with the unit price, (e.g., $1.119/Gal), not necessarily both.

3.2. Acceptable designations of the unit price are: "@" as a prefix to the unit price value, an upper or lower case "X" or slash between the quantity and unit price, $/G, PPG (price per gallon), PPL (price per liter), UP (unit price), P/G, price/Vol, PPU (price per unit), DOL/GAL. ☐ Yes ☐ No ☐ N/A

3.3. The total fuel price must be clearly distinguished from other information in the fuel transaction. To identify the total fuel sale price, use one of the following methods:

3.3.1. Decimal point in the proper dollar position, (e.g., XX.XX.) If a dollar sign is not used, there must be at least one offset column of the least significant digit in recorded information, other than the sale price. ☐ Yes ☐ No ☐ N/A

3.3.2. The words gas, diesel, or other product designation may be used with the word "SALE" (e.g., "FUEL SALE" or "GAS SALE") or the product identification followed by the sale price, (e.g., GAS 20.00.) ☐ Yes ☐ No ☐ N/A

3.4. Each fuel delivery in a transaction for a single customer must be recorded separately. ☐ Yes ☐ No ☐ N/A

3.5. Where a post-delivery discount(s) is 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. *See LMD Code S.1.6.8.*

3.6. When a service station cash register/console is capable of recording sales transactions of other products, the fuel transaction must be clearly distinguished from the other transactions. A "product class" must be associated with the fuel transaction as well as the other transactions. In terms of format, the fuel transactions may be separated (blocked-off) from other transactions by blank lines or by at least one offset column between the sales price and the other recorded information. ☐ Yes ☐ No ☐ N/A

3.7. The product identity for fuel need only distinguish it from other items. The product name, code number (similar to a price look-up code), or hose or pump number are acceptable designations of product identify. *See LMD Code S.1.6.4.* ☐ Yes ☐ No ☐ N/A

Example 1		Example 2	
Meat	3.89	Meat	3.89
Soda	2.99	Soda	2.99
Gas 5.080 G @ 1.000	5.08	Gas 4.080 G @ 1.000	4.08
Cig	1.00		

Note: NIST Handbook 44 does not require that product identification, date, and change due be printed on a ticket or a cash register receipt. These requirements apply to recorded representations resulting from a final sale, not to deposit slips for prepay transactions, etc.

3.8. The quantity representation of an item sold by count must be expressed in whole units. An expression of count with a decimal point and trailing zeroes, (e.g., 2.00 items) is acceptable provided that fractions of a whole unit cannot be expressed. ☐ Yes ☐ No ☐ N/A

4. Provisions for Sealing

Code Reference: G-S.8. Provision for Sealing Electronic Adjustable Components

Remote controllers, which have the capabilities to electronically adjust components that affect the performance of a device, shall have provisions for approved means of security. *See LMD - Appendix A - Philosophy for Sealing, Typical Features to be Sealed.*

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Appendix D/Sub-appendix H Action Items Table
October 5-6, 2012
NTETC Measuring Sector Meeting

Agenda Item	Title	Task	Responsible Person(s)	Due Date
1	**Add Testing Criteria to NTEP Policy U "Evaluating electronic indicators submitted separate from a measuring element"**	Finalize the checklist, addressing all highlighted areas and the five open	Work group	1/3/13
		Forward finalized checklist to Mike Frailer and Allen Katalinic for review.	Rich Miller, FMC; Technical Advisor, Marc Buttler	1/4/13
		Review finalized checklist and provide comments to Rich Miller and	Mike Frailer, MD; Allen Katalinic, NC	1/18/13
		Incorporate laboratory comments prior to 2013 NCWM Interim Meeting.	Rich Miller, FMC; Technical Advisor, Marc Buttler	1/23/13
2-4	**Product Families Table**	Research historical records for any information listing the various fluid product properties that were considered when the product families for PD and turbine meters were first drafted by Mel Hankel of Liquid Controls for the original Product	Technical Advisor, Marc Buttler	Completed 10/10/12
		Draft a specific proposal to update the Product Families Table for turbine and PD meters including the latest values for dynamic and kinematic viscosity if needed. Incorporate stakeholder input from labs, Rich	Dmitri Karimov, Liquid Controls	Next Sector meeting
5-9	**See Summary**	Submit recommendation to modify NCWM Publication 14 to NTEP Committee.	Technical Advisor, Marc Buttler	11/30/12
10	**Post-Delivery Discounts and Electronic Receipts**	Send advance draft copies of LMD and ECR checklist changes to Gordon Johnson and John Roach.	Technical Advisor, Marc Buttler	Completed 10/9/12
11	**NCWM Pub 14, NTEP Administrative Policy Revision**	Send all comments on the NCWM Pub 14, NTEP Administrative Policy draft revision to Jim Truex.	Sector members	Prior to 2013 NCWM Interim Meeting
12	**Windshield Washer Fluid Vending Units**	Discuss the issue with WI W&M.	Jim Truex, NCWM	TBD
13	**Hot Water Meters**	Discuss the merit of the item with water meter manufacturers.	Andre Noel, Neptune	Next Sector meeting
	Next Meeting	Identify location and time of next SWMA Meeting and propose location to NTEP Committee	Chair, NTEP Director, Technical Advisor	Completed 10/10/12

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National Conference on Weights and Measures / National Type Evaluation Program

Measuring Sector Attendee List Final

October 5-6, 2012 – Louisville, KY

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