300 INTRODUCTION

The S&T Committee (hereinafter referred to as the “Committee”) submits this Committee Interim Report for consideration by National Conference on Weights and Measures (NCWM). This report contains the items discussed and actions proposed by the Committee during its Interim Meeting in Albuquerque, New Mexico, January 19-22, 2014. The report will address the following items in Table A during the Annual Meeting. Table A identifies the agenda items by reference key, title of item, and page number and addresses the appendices by appendix designations and page number. The acronyms for organizations and technical terms used throughout the report are identified in Table B. The headings and subjects apply to NIST Handbook 44 Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, 2014 Edition. The first three digits of an item’s reference key are assigned from the Subject Series List. The status of each item contained in the report is designated as one of the following: (D) Developing Item: the Committee determined the item has merit; however, the item was returned to the submitter or other designated party for further development before any action can be taken at the national level; (I) Informational Item: the item is under consideration by the Committee but not proposed for Voting; (V) Voting Item: the Committee is making recommendations requiring a vote by the active members of NCWM; (W) Withdrawn Item: the item has been removed from consideration by the Committee.

Some Voting Items are considered individually, others may be grouped in a consent calendar. Consent calendar items are Voting Items that the Committee has assembled as a single Voting Item during their deliberation after the Open Hearings on the assumption that the items are without opposition and will not require discussion. The Voting Items that have been grouped into consent calendar items will be listed on the addendum sheets. Prior to adoption of the consent calendar, the Committee will entertain any requests from the floor to remove specific items from the consent calendar to be discussed and voted upon individually.

Committees may change the status designation of agenda items (Developing, Informational, Voting, and Withdrawn) up until the time that the report is adopted, except that items which are marked Developing, Informational or Withdrawn cannot be changed to Voting Status. Any change from the Committee Interim Report (as contained in this publication) or from what appears on the addendum sheets will be explained to the attendees prior to a motion and will be acted upon by the active members of NCWM prior to calling for the vote.

An “Item Under Consideration” is a statement of proposal and not necessarily a recommendation of the Committee. 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. Additional letters, presentations, and data may have been part of the Committee’s consideration. Please refer to www.ncwm.net/meetings/annual/publication-16 to review these documents.

All sessions are open to registered attendees of the conference. If the Committee must discuss any issue that involves proprietary information or other confidential material; that portion of the session dealing with the special issue may be closed provided that (1) the Chairman or, in his absence, the Chairman-Elect approves; (2) the Executive Director is notified; and (3) an announcement of the closed meeting is posted on or near the door to the meeting session and at the registration desk. If at all possible, the posting will be done at least a day prior to the planned closed session.

Note: The policy of NIST and NCWM is to use metric units of measurement in all of their 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.
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310  HANDBOOK 44 - GENERAL CODE

310-1  D  G-S.1. Identification. – (Software)

Source:
This item originated from the NTEP Software Sector and first appeared on NCWM S&T Committee’s 2007 agenda as Developing Item Part 1, Item 1. and in 2010 as Item 310-3.

Purpose:
Provide marking requirements that enable field verification of the appropriate version or revision for metrological software, including methods other than “permanently marked,” for providing the required information.

Item Under Consideration:
Amend NIST Handbook 44: G-S.1. Identification and G-S.1.1. Location of Marking Information for Not-Built-For-Purpose, Software-Based Devices as follows:

G-S.1. Identification. – 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:

(a) the name, initials, or trademark of the manufacturer or distributor;

(b) a model identifier that positively identifies the pattern or design of the device;

1. The model identifier shall be prefixed 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 lowercase.
[Nonretroactive as of January 1, 2003]
(Added 2000) (Amended 2001)

(c) a nonrepetitive serial number, except for equipment with no moving or electronic component parts and not-built-for-purpose software-based software devices.
[Nonretroactive as of January 1, 1968]
(Amended 2003)

1. The serial number shall be prefaced by words, an abbreviation, or a symbol, that clearly identifies the number as the required serial number.
[Nonretroactive as of January 1, 1986]

2. Abbreviations for the word “Serial” shall, as a minimum, begin with the letter “S,” and abbreviations for the word “Number” shall, as a minimum, begin with the letter “N” (e.g., S/N, SN, Ser. No., and S. No.).
[Nonretroactive as of January 1, 2001]

(d) the current software version or revision identifier for not-built-for-purpose software-based electronic devices, which shall be directly linked to the software itself.
[Nonretroactive as of January 1, 2004]
(Added 2003) **(Amended 20XX)**

(1) **The version or revision identifier shall be prefaced by words, an abbreviation, or a symbol, that clearly identifies the number as the required version or revision.**
[Nonretroactive as of January 1, 2007]
(Added 2006)

(2) **Abbreviations for the word “Version” shall, as a minimum, begin with the letter “V” and may be followed by the word “Number.” Abbreviations for the word “Revision” shall, as a minimum, begin with the letter “R” and may be followed by the word “Number.” The abbreviation for the word “Number” shall, as a minimum, begin with the letter “N” (e.g., No or No.).**
[Nonretroactive as of January 1, 2007]
(Added 2006)

(3) **The version or revision identifier shall be accessible via the display. Instructions for displaying the version or revision identifier shall be described in the CC. As an exception, permanently marking the version or revision identifier shall be acceptable under the following conditions:**

(a) **The user interface does not have any control capability to activate the indication of the version or revision identifier on the display, or the display does not technically allow the version or revision identifier to be shown (analog indicating device or electromechanical counter) or**

(b) **the device does not have an interface to communicate the version or revision identifier.**

(c) an **National Type Evaluation Program (NTEP) Certificate of Conformance (CC) number or a corresponding CC Addendum Number for devices that have a CC.**

(1) **The CC Number or a corresponding CC Addendum Number shall be prefaced by the terms “NTEP CC,” “CC,” or “Approval.” 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.).**
[Nonretroactive as of January 1, 2003]

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. (Amended 1985, 1991, 1999, 2000, 2001, 2003, **and 2006 and 201X**)

**G-S.1.1. Location of Marking Information for Not-Built-For-Purpose All Software-Based Devices.** – For **not-built-for-purpose** software-based devices, either:

(a) **The required information in G-S.1. Identification. (a), (b), (d), and (e) shall be permanently marked or continuously displayed on the device; or**

(b) **The CC Number shall be:**

(1) permanently marked on the device;

(2) continuously displayed; or

(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.”
**Background / Discussion:**

Among other tasks, the NTEP Software Sector was charged by the NCWM Board of Directors to recommend NIST Handbook 44 specifications and requirements for software incorporated into weighing and measuring devices, which may include tools used for software identification. During its October 2007 meeting, the Sector discussed the value and merits of required markings for software, including possible differences in some types of software-based devices and methods of marking requirements. After hearing several proposals, the Sector agreed to the following technical requirements applicable to the marking of software:

1. The NTEP CC Number must be continuously displayed or hard-marked;
2. The version must be software-generated and shall not be hard-marked;
3. The version is required for embedded (Type P) software;
4. Printing the required identification information can be an option;
5. Command or operator action can be considered as an option in lieu of a continuous display of the required information; and
6. Devices with Type P (embedded) software must display or hard-mark the device make, model, and serial number to comply with G S.1. Identification.

In 2008, the Software Sector developed and submitted a proposal to the NCWM S&T Committee to modify G-S.1. and associated paragraphs to reflect these technical requirements. Between 2008 and 2011, this item appeared on the S&T Committee’s main agenda and the Committee and the Sector received numerous comments and suggestions relative to the proposal. The Sector developed and presented several alternatives based on feedback from weights and measures officials and manufacturers. Among the key points and concerns raised during discussions over this period were how to address the following:

(a) **Limited Character Sets and Space.** – How to address devices that have limited character sets or restricted space for marking.

(b) **Built-for-Purpose vs. Not-Built-for-Purpose.** - Whether or not these should be treated differently.

(c) **Ease of Access.** – Ease of accessing marking information in the field.
   - Complexity of locating the marking information
   - Use of menus for accessing the marking information electronically
   - Limits on the number of levels required to access information electronically
   - Possibility of single, uniform method of access

(d) **Hard Marking vs. Electronic.** – Whether or not some information should be required to be hard marked on the device.

(e) **Continuous Display.** – Whether or not required markings must be continuously displayed.

(f) **Abbreviations and Icons.** – Establishment of unique abbreviations, identifiers, and icons and how to codify those.

(g) **Certificate of Conformance Information.** – How to facilitate correlation of software version information to a CC, including the use of possible icons.

Further details on the alternatives considered can be found in the Committee’s Final Reports from 2008 to 2012.
2013 NCWM Interim Meeting: No comments were received relative to this item during the Open Hearings. In considering the item, the S&T Committee questioned whether or not the Software Sector was still actively working the item. It was reported that the Software Sector believed they had developed the item as much as possible, yet the different stakeholders affected by the proposal could not agree on the changes that the Sector had proposed. Based upon that update, the Committee agreed to add to its report a request that the Software Sector work with the Weighing Sector and Measuring Sector to identify which portions of the proposal need to be modified in order that they might be accepted by the entire community. The Committee acknowledged the efforts of the Software Sector and stated that it looked forward to being able to consider a proposal that addresses both the identification of software and how it may be accessed.

Just prior to the 2013 NCWM Annual Meeting, the Software Sector forwarded a modified version of the proposed changes to paragraph G-S.1., which the Sector agreed to during its March 2013 meeting. The modified language, which is now included in Item Under Consideration, includes slight modifications to the previous proposal in an effort to address concerns received from other sectors and interested parties.

With regard to the revised proposal, the Sector reported the following:

- That the new language in G-S.1.1 reflects the Sector’s consensus on the following positions:
  - The software version/revision should, with very few exceptions, be accessible via the user interface.
  - The means by which the software version is accessed must be described in the Certificate of Conformance (CC).
- After removing the “and inseparably” terminology from the proposal, the concerns on the possibility of controversy were reduced.
- The Sector’s opinion on the interpretation of “directly linked” is that it means you can’t change the version/revision without changing the software.
- It may be desirable to evaluate options that would lead to fully eliminating G-S.1.1. The Sector recognized that this would be a more invasive modification to the existing Handbook and perhaps should be delayed until the first step of addressing software in all devices (not just standalone) was accomplished.

In comments provided to the Committee, the Software Sector indicated that they considered the item sufficiently developed. The Sector noted that since the 2012 meeting, it had tried to promote this item using several means to attempt to address the concerns of other interested parties. For example, a presentation was generated and shared with the SMA at its 2012 meeting. Additionally, most of the regional weights and measures associations had access to this information prior to their meetings, since the proposal was posted on the NCWM website. Unfortunately, based on the comments from the fall 2012 regional association meetings, some regional associations were not aware that this information had been made available. The Sector also noted that they may want to consider more direct methods for sharing information with other groups, such as designating a representative to address the regional groups or other sectors at their meetings. An additional option would be to provide a presentation at the the NCWM Annual Meeting.

At the 2013 NCWM Annual Meeting a state director suggested that consideration be given to changing the status of the item to informational. In considering this suggestion, the Committee agreed that the change might be appropriate; however, decided instead to seek input from the NTEP Sectors and industry associations before making that decision. Consequently, the Committee requested that the sectors and industry associations review the Software Sector’s latest proposal at their next meetings. (See the Committee’s 2013 Final Report for details.)

At the 2014 NCWM Interim Meeting the SMA commented that it continues to support the work of the Software Sector and encourages communications with the other device sectors.

NIST OWM raised two concerns relating to the most recent changes proposed by the Software Sector to subparagraph G-S.1. (d) and offered some suggestions relative to those concerns as follows:

1. Deleting the words “for not-built-for-purpose software-based electronic devices” creates the implication that all equipment manufactured as of January 1, 2004, except weights and separate parts necessary to the measurement process but not having any metrological effect, would be required to be permanently marked with a current software version or revision identifier. OWM questioned whether or not it was the Software
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The Sector’s intent to require a software version or revision identifier be marked on equipment that is not electronic. If not the intent, OWM suggested that the Sector consider adding additional text to better clarify the type of equipment intended to be addressed by this proposed change and offered the following additional text for consideration:

(d) the current software version or revision identifier for software-based electronic devices, which shall be directly linked to the software itself;

2. The proposed changes would require a current software version or revision identifier be marked on both built-for-purpose and not-built-for-purpose software-based equipment manufactured as of January 1, 2004. If it is the intent of the Sector to require that a current software version or revision identifier be marked on built-for-purpose software-based equipment, then the Sector might consider proposing that such a requirement be non-retroactive considering the time and cost involved in updating equipment already in service.

OWM also provided the following additional feedback on the Software Sector’s proposed changes to paragraphs G-S.1. and G-S.1.1.:

• It is not clear what equipment would be affected by the proposed changes to G-S.1. (c). By proposing that the word “software” be added, is the exception intended to apply to the software itself or to equipment in which the software is installed?
• In the proposed additions to G-S.1. (d)(3)(a), it is not clear what is meant by the phrase “or the display does not technically allow the version or revision identifier to be shown.” The examples “analog indicating device” and “electromechanical counter” are confusing. OWM doesn’t believe these examples provide enough information to lead one to conclude that the intent is to address such things as numeric-only displays. For example, numeric-only displays that don’t have the capability of displaying abbreviations for “version” or “revision” as noted in earlier comments originating from the Sector.
• OWM recommends adding some examples to clarify the types of devices described in paragraph G-S.1. (d)(3)(b).
• OWM agrees with the Software Sector’s assertion that it may be possible to eventually eliminate G-S.1.1.

The Committee is concerned that this item has remained on S&T’s agenda for a long time with little progress. The Committee appreciates the efforts of the Software Sector and recognizes the difficulty in developing a proposal that meets the needs of multiple groups. The Committee agreed to maintain the item on its agenda to allow the Sector to finalize work on this issue; however, if no progress is made in the next year, the Committee plans to withdraw the item from its agenda. The Committee notes that this would not preclude the Sector from resubmitting the item at some point in the future when additional work has been done or the item has been fully developed.

NTEP Sector Meeting Comments:
2013 NTEP Weighing Sector Meeting (August 2013): The Weighing Sector reviewed the March 2013 proposal from the Software Sector. There were no comments except that one Sector member questioned whether or not a nonrepetitive serial number is needed for software. The example provided was two software applications running on a single PC that was interfaced with two weighing elements. In this example, how would an inspector know which weighing system he/she is evaluating? The Sector discussed this concern and agreed to forward it to the Software Sector and the S&T Committee for consideration.

2013 Grain Analyzer Sector (August 2013) and NTEP Measuring Sector (October 2013): The Grain Analyzer Sector and the Measuring Sector did not consider the Software Sector’s most recent draft update to amend G-S.1. and G-S.1.1. during their meetings.

Regional Association Comments:
CWMA recommended this item remain as a Developing Item and be sent back to the Software Sector to write a definition for software-based devices.

WWMA agrees this item has merit, but it needs further development. The WWMA recognized the importance of this item at their 2011 and 2012 Regional meetings but agreed further development is needed by the Software
Sector. The WWMA also acknowledged that three regions recommended the item remain Developing. WWMA looks forward to hearing the results of the Weighing and Software Sector’s joint meeting and recommended that this item remain as a Developing Item.

NEWMA recognized that the Committee asked at the 2013 NCWM Annual Meeting for input from the NTEP Sectors and industry on this item. NEWMA anticipates some new developments that may move this item forward. NEWMA recommended that the item remain as a Developing Item.

SWMA received a presentation by Mr. Doug Bliss (Mettler Toledo) on behalf of the Software Sector. The Committee considered recommending this as a Voting Item due to the length of time it has been on the agenda, but comments received indicated that progress would be made in the next year and, with this information, the Committee recommends it be maintained as a Developing Item.

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

310-2 V G-S.5.6. Recorded Representations

Source:
Liquid Controls (2014)

Purpose:
Address the issue of receipt (printed, electronic, and optional).

Item Under Consideration:
Amend NIST Handbook 44 General Code as follows:

G-S.5. Indicating and Recording Elements.

G-S.5.6. Recorded Representations. – Insofar as they are appropriate, the requirements for indicating and recording elements shall also apply to recorded representations. All recorded values shall be printed digitally. In applications where recorded representations are required, the customer may be given the option of not receiving the recorded representation. For systems equipped with the capability of issuing an electronic receipt, ticket, or other recorded representation, the customer may be given the option to receive any required information electronically (e.g., via cell phone, computer, etc.) in lieu of or in addition to a hard copy.

(Amended 1975)

Background / Discussion:
At the 2013 NCWM Annual Meeting, members expressed support for including requirements to address the use of electronic receipts in the General Code rather than in individual device codes. Including requirements in the General Code would eliminate confusion and inconsistency, consolidate provisions from individual codes, and confine future updates to a single code.

The concept of providing receipts electronically is incorporated in certain provisions of the Liquid Measuring Devices Code. Similar provisions are needed in other specific HB44 codes. Inserting a single provision in the General Code to address the use of electronic receipts will be more efficient than proposing changes to multiple individual codes and will eliminate inconsistencies among sections.

Some concerns have been raised that recognition of electronic receipts could lead to the elimination of printed receipts, particularly for customers who have limited access to the internet, smart phones, etc. However, the proposal is written to ensure that the printed receipt remains an option for the customer.
A summary of the proposed changes is as follows:

- If a receipt is required, allow the customer to decline the option of receiving any type of receipt.
- Add an option of electronic receipt as long as the system has the capability of generating electronic receipts.
- If a receipt is desired, allow customer to select between printed and electronic receipt; or both.
- Remove references to electronic receipts from the Liquid Measuring Devices Code as they will be redundant.

See Item 330-5 for related background and discussions. See also Item 330-1 for a related proposal.

At the 2014 NCWM Interim Meeting Mr. Steve Langford (Cardinal Scale Manufacturing), speaking on behalf of the SMA, stated that the SMA could see no harm in giving the consumer the option of not receiving the recorded representation or receiving the recorded representation in alternative forms. The SMA supported the item as written.

OWM noted that weighing and measuring equipment that has the capability of issuing an electronic receipt exists, yet the information contained on the receipt is not required by NIST Handbook 44. For example, nowhere in NIST Handbook 44 is it required that a printed ticket from a scale that is not part of a POS system contain certain information. For this reason, OWM finds the use of the word “the” immediately preceding the word “required” in the second sentence of the proposal somewhat confusing and recommended replacing the word “the” with the word “any” so that the sentence reads as follows:

For systems equipped with the capability of issuing an electronic receipt, ticket, or other recorded representation, the customer may be given the option to receive the any required information electronically (e.g., via cell phone, computer, etc.) in lieu of or in addition to a hard copy.

OWM also noted that Item 330-1 includes a corresponding proposal. Should the Committee decide to advance Items 310-2 and 330-1, the Committee should give consideration to consolidating them into a single item for NCWM action. See also Items 331-1 LPG Code Modifications (UR.2.8.) and 332-2 (S.1.5.3. Recorded Representations, Point-of-Sale Systems, LPG Code) which may also be impacted by action on 310-2.

Ms. Fran Elson-Houston (Ohio and Chair of the Task Group (TG) on RMFD Price Posting and Computing Capability) stated that the TG on RMFD Price Posting and Computing Capability supports this item. Mr. Gordon Johnson (Gilbarco, Inc.) also supported the item. Mr. Michael Keilty (Endress & Hauser Flowtec AG USA) commented that an electronic failure would lead to consumers being unable to receive a receipt.

The Committee agreed with OWM’s assessment that not all weighing and measuring equipment equipped with the capability of issuing an electronic receipt, ticket or recorded representation is explicitly required to provide certain information on the receipt or ticket. For example, NIST Handbook 44 does not require any of the information that typically gets recorded onto a printed ticket generated from a stand-alone small capacity computing scale used in a direct sale application. Handbook 44 does require any information that is provided on the receipt or ticket of such a scale to be accurate and clearly identified. For this reason, the Committee concluded that the use of the word “the” in the second sentence of the proposal may lead to confusion and agreed to replace that word with the word “any” as suggested by OWM and shown in the “Item Under Consideration.” The Committee acknowledged that there are potential overlaps with this item and Items 330-1, 330-5B, 332-1, and 332-2, which could lead to potential conflicts if this item is adopted. The Committee plans to address any conflict which might arise by modifying those items prior to presenting them for a vote. The Committee’s plans are described in each item.

**Regional Associations Comments:**
CWMA supports this item and forwarded it to NCWM, recommending it as a Voting Item.

SWMA did not receive any comments opposing this item. The SWMA believes the item has merit and should be considered by the NCWM S&T Committee.

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

320-1 W S.2.1.6. Combined Zero-Tare (“0/T”) Key

Source: California Division of Measurement Standards (2014)

Purpose: Allow a combined “zero/tare” feature under specified conditions.

Item Under Consideration: Amend NIST Handbook 44, Scales Code as follows:

S.2.1.6. Combined Zero-Tare (“0/T”) Key. The semi-automatic zero-setting and the semi-automatic tare-mechanism can be operated by the same key on Class I, II, and III scales with digital indications provided that:

(a) The overall effect of semi-automatic zero-setting and zero-tracking mechanisms shall be not more than 4 % of the maximum capacity; and

(b) Either automatically maintain a “center-of-zero” condition to ± ¼ scale division or less, or have an auxiliary or supplemental “center-of-zero” indicator that defines a zero-balance condition to ± ¼ of a scale division or less. A “center-of-zero” indication may operate when zero is indicated for gross and/or net mode(s).

Scales not intended to be used in direct sales applications may be equipped with a combined zero and tare function key, provided that the device is clearly marked as to how the key functions. The device must also be clearly marked on or adjacent to the weight display with the statement “Not for Direct Sales.”

Background / Discussion:
Various scale manufacturers have manufactured or imported Class II scales that are equipped with a combined zero/tare button for jewelry sale/purchase applications. Many of these scales are in use in direct retail sales, particularly in the purchasing of gold, silver, and other precious metals and stones. It has not been demonstrated or documented how the combination of tare/zero function causes fraud if the feature complies with the following similar clause in OIML R76: Automatic Indicating Weighing Instruments:

4.6.9 Combined zero-setting and tare-balancing devices
If the semi-automatic zero-setting device and the semi-automatic tare-balancing device are operated by the same key, 4.5.2 (zero within ± 0.25 e), 4.5.5 (zero within ± 0.25 e) and if appropriate 4.5.7 (operation of zero-tracking) apply at any load.

The existence of a unique “type-approved” scale which cannot be used in a “direct sales” transaction, combined with the fact that so many of these scales are being sold by manufacturers and distributors into direct sales applications without the required statement “Not For Use in Direct Sales” has caused confusion. It is believed that this proposal would be preferable to legal actions against the manufacturers for failing to meet conditions on the type-approval certificate because they failed to place the required “Not for Direct Sales” statement on their machines without demonstrated harm to customers. Additionally, it appears that the combination zero/tare feature in Handbook 44 Scales Code paragraph S.2.1.6. is not addressed in NCWM Publication 14 checklist for Digital Electronic Scales.

An argument against the amendment is the inability for a customer to see the “net” weight indication when all (intended) tare values are less than 4 % of the capacity of the scale. However, at least one manufacturer submitted a scale with the 0/T feature without the required marking that was not evaluated due to omissions on the NTEP application. The NTEP CC has been active for several years with nearly 20,000 scales sold in California alone. Weights and measures jurisdictions in California have not reported any complaints or made observations that the feature was used to facilitate inaccurate transactions.
This subject was originally considered by the NTEP Weighing Sector in 1997 and paragraph S.2.1.6. was subsequently adopted by the NCWM in 1998. During the deliberations of the Specifications and Tolerances (S&T) Committee Agenda Item 220-3, the Weighing Sector stated that “because it is common to find tares taken in direct sales operations that are less than seven divisions (7d), they were concerned over the use of this feature in direct sales applications. The laboratories consider these devices acceptable in applications where there would be a clear understanding of the “zero/tare” key function provided: (1) there are clear and definite markings on the scale adjacent to the zero tare key with a statement describing its operation (e.g., for the scale in the example given “Zero up to 7d; tare over 7d” or similar wording); and (2) the scale must be clearly and definitely marked with the statement “Not for Use in Direct Sales to the Public.” The NCWM S&T Committee noted that jurisdictions vary in the type of operations which are considered “direct sales.” For instance, only some jurisdictions consider produce grading and meat room packaging scales as “direct sales” applications. The Committee felt that the classification of an operation should be left to the jurisdiction. The Committee recommended that devices equipped with a “0/T” key be clearly and permanently marked with: (1) a description of how the key functions; and (2) the statement “Not for Direct Sales” adjacent to the display on both the customer’s and operator’s side of the device.

At the 2014 NCWM Interim Meeting the SMA opposed the inclusion of Class III devices in the proposal and the 4% maximum overall effect of semi-automatic zero-setting and zero-tracking mechanisms imposed by the proposal. The SMA noted that NIST Handbook 44 does not limit the zeroing effect of a semi-automatic zero setting mechanism. The SMA also noted that S.1.1.1. (b) is redundant and that if each of these references were removed, there would be no point in making any changes to the paragraph.

The Committee also heard from Mr. Lou Straub (Fairbanks Scales) opposing the inclusion of Class III scales in the proposal.

The Committee heard concerns from OWM regarding the fact that, should the combined “0/T” key be permitted on scales used in direct sales, there will not be a clear indication that a weighing operation starts with the scale on zero or that tare has been taken, and therefore, the feature may not provide adequate consumer protection in direct sale applications. Additionally, the proposal only addresses semiautomatic zero setting and semiautomatic tare mechanisms and doesn’t restrict other types of tare or zero from being used, which might possibly facilitate the perpetration of fraud.

Ms. Angela Godwin (Ventura County Department of Weights and Measures) and Mr. John Young (Yolo County California Agriculture Department) provided comments in support of the proposal.

In considering this item, the Committee first questioned the availability of Class II scales in the marketplace that have been issued an NTEP CC and could be considered suitable for use in direct sale applications. The Committee concluded that there are numerous Class II scales available for purchase meeting this criteria. The Committee then considered whether it’s appropriate to change NIST Handbook 44 to allow scales equipped with a combined “0/T” key be used in direct sale applications. The Committee agreed that it would not be appropriate given the number of available Class II scales already in the marketplace that have been designed for direct sale applications, the concerns raised by OWM, and the opposition expressed by the SMA. Consequently, the Committee agreed to withdraw this item from its agenda.

Regional Associations Comments:
The WWMA received similar proposals on this item. The first proposal by Paul Jordan, Ventura California was withdrawn by the submitter and the second proposal by Steve Cook, California was recommended. The WWMA after hearing testimony from Juana Williams, NIST and Darrell Flocken, Mettler Toledo had concerns about the need for this section in Handbook 44. The WWMA recommended that Steve Cook, California meet with the Weighing Sector to determine whether or not there is a need for this section and, if so, consider if 4% of the scale capacity is an appropriate limit. WWMA forwarded this item to NCWM, recommending that it be a Developing Item.

SWMA heard comments in support of the item, but had some concerns about the 4% limitation. There were also issues regarding the need for the limitation on such a small market of scales in commercial applications. The Committee recommended the item continue to be developed. SWMA forwarded the item to NCWM.
320-2 V UR.2.4. Foundations, Supports, and Clearance

Source:
Schenck Process Inc. (2014)

Purpose:
Allow for an in-motion rail scale to have a continuous rail on the approach and weighing area, such a design is presently in conflict with Scales Code paragraph UR.2.4., which states “clearance shall be provided around all live parts to the extent that no contacts may result when the load-receiving element is empty, nor throughout the weighing range of the scale.”

Item Under Consideration:
Amend NIST Handbook 44, Section 2.20. Scales as follows:

UR.2.4. Foundation, Supports, and Clearance. – The foundation and supports of any scale installed in a fixed location shall be such as to provide strength, rigidity, and permanence of all components, and clearance shall be provided around all live parts to the extent that no contacts may result when the load receiving element is empty, nor throughout the weighing range of the scale. An in-motion railway track scale is not required to provide clearance using rail gaps to separate the live rail portion of the weighing/load-receiving element from that which is not live if the scale is designed to be installed and operated using continuous rail. On vehicle and livestock scales, the clearance between the load receiving elements and the coping at the bottom edge of the platform shall be greater than at the top edge of the platform.*

[*Nonretroactive as of January 1, 1973]

Background / Discussion:
Schenck Process, Inc. is presently testing a scale called the “MultiRail,” which is used to weigh rail cars in-motion and statically and which does not require the rail to be cut prior to the weighing area. During the August 2013 Weighing Sector meeting, the Sector recommended that the requirement for rail gaps that is presently in the checklist/procedures section of Publication 14 be removed.

This equipment was also presented to the AREMA Scales Committee 34 at the October 2013 meeting in Nashville, TN. Discussions have previously been held with Committee 34 regarding the “MultiRail” scale, and Committee 34 wants to ensure the equipment complies with weighing accuracies in H44.

The Schenck MultiRail is new technology for weighing rail cars in the US, but it has been used around the world and is OIML approved.

Testing of the system has been on-going at the American Association of Railroads test center in Pueblo, CO for over one year. These tests have proved the durability of the design, since over 350 million gross tons have crossed the system during this period and NTEP testing is now being conducted in conjunction with GIPSA.

This issue was also presented to the NTEP Committee at the 2013 NCWM Interim Meeting and Schenck Process agreed to install equipment and pass the NTEP test for static and in-motion weighing. When the testing was completed, Schenck advised they wanted to have the requirement for rail gaps removed from NCWM Publication 14 and a CC issued for the device.
At the 2014 NCWM Interim Meeting Dr. Ulrich Rauchschwalbe (Schenck Process, Inc.) provided a presentation regarding the operation of an in-motion railway track scale, which does not use rail gaps to separate the live rail portion of the weighing/load receiving element from portions of the rail that are not live. That is, continuous rail is used throughout. Dr. Rauchschwalbe clarified that the application of this railway track scale is restricted to coupled-in-motion and uncoupled-in-motion weighing and is not intended to be used commercially for static weighing, although there may be instances where the scale could be used statically as a reference scale. That is, the scale could be used statically to determine the reference weights of railcars selected for use in conducting an uncoupled-in-motion or coupled-in-motion test of the scale. Mr. Ed Luthy (Schenck Process, Inc.) indicated that NTEP evaluations have successfully been completed on a device of this design.

Rafael Jimenez (AAR Transportation Technology Center) commented that the AAR supports the proposal as written.

Mr. Steve Beitzel (Systems Associates, Inc.) questioned whether enough U.S. data is available to be able to properly evaluate the performance of the system, noting that “railroading” is much different in the U.S. than in Europe. More U.S. field experience using the system is needed because trains travel at faster speeds in Europe and railcar loads are significantly heavier in the U.S. Mr. Beitzel also questioned the impact of shear forces on device performance and the degree of sensitivity of the device relative to longitudinal or vertical forces that result from the use of continuous rail installed over the weighing/load-receiving element of the scale.

OWM noted that some of the written comments and suggestions it provided to the Committee in advance of the 2014 NCWM Interim Meeting had been addressed, although perhaps not fully, in the presentation provided by Dr. Rauchschwalbe. OWM provided the following written comments to the Committee in advance of the meeting:

- It might be helpful if additional information concerning the technology used and/or the safeguards incorporated into the design of the scale system were made available by the manufacturer of the equipment. Once made available, this information could be used to make an informed decision on whether or not adequate protections have been incorporated into the design of the equipment to ensure weighments will be accurate under normal service conditions and adjustments will remain reasonably permanent. This information might also be beneficial in determining whether or not additional Specification and/or User Requirements are needed.

- One particular issue needing explanation is how an in-motion railroad weighing system, which uses continuous rail (no rail gaps), is able to differentiate between loads applied to the live portion of the weighing/load-receiving element of the scale and loads approaching the live portion, but not yet having arrived, and where the separation occurs between live and dead rail (if in fact there is such a separation). More specifically, how are weight influences from approaching cars in a train filtered out by the system that they have no effect on railcars that are being weighed?

- The intended application of the railroad weighing system needs to be clarified. The proposed footnote to be added specifies “coupled-in-motion railway track scale,” but the “Purpose” of the item specifies “static or in-motion,” leading one to believe the application could be any type of railroad weighing system.

In considering this item, members of the Committee agreed that, based on the presentation and the comments provided during the Open Hearings, which confirmed the NTEP evaluations had been successfully completed, this item was ready for vote. Consequently, the Committee agreed to recommend the item as shown above in the “Item Under Consideration” for a vote.

**Regional Associations Comments:**

CWMA believes this is new technology and there hasn’t been enough data provided to show if this device is suitable for use in this application. The NTEP evaluation is incomplete and because this is an emerging technology a new code(s) may be appropriate for this type of device. CWMA forwarded this item to NCWM recommending it as a Developing Item.

NEWMA heard testimony that the item is approved by the American Association of Railroads and OIML and believe the item is fully developed. NEWMA forwarded the item to NCWM and recommended it as a Voting Item.
SWMA worked with the submitter this of item and editorially corrected it during the Committee work session. The Committee heard comments in support of the item from the Weighing Sector and other scale manufacturers. The Committee supported this item as a Voting Item. SWMA forwarded the item to NCWM.

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

320-3 I Part 2.20. Weigh-In-Motion Vehicle Scales for Law Enforcement – Work Group

Source: NIST, OWM, Mr. Richard Harshman, on behalf of the U.S. Federal Highway Administration (FHWA) (2011)

Purpose: To provide the U.S. Weights and Measures community (equipment manufacturers, weights and measures officials, truck weight enforcement officials, and other users) with legal metrology requirements to address WIM systems used for vehicle enforcement screening.

Item Under Consideration: Adopt the proposed Section 2.25. Weigh-In-Motion Systems Used for Vehicle Enforcement Screening Code shown in Appendix A as a tentative code in NIST Handbook 44, and adopt the proposed definitions of terms used in the tentative code (also included in Appendix A) into NIST Handbook 44 Appendix D - Definitions.

Background / Discussion: The nation’s highways, freight transportation system, and enforcement resources are being strained by the volume of freight being moved and the corresponding number of commercial vehicles operating on its roads. Traditional, static-based vehicle inspection activities simply cannot keep pace with anticipated truck volume increases. Current U.S. Department of Transportation (DOT) forecasts project freight volumes to double by 2035 and commercial vehicles to travel an additional 100 billion miles per year by 2020. WIM technology has been targeted by FHWA and Federal Motor Carrier Safety Administration as a technology capable of supporting more effective and efficient truck weight enforcement programs.

Several DOT efforts are underway and planned for the future to maintain adequate levels of enforcement that ensure equity in the trucking industry market and protection of highway infrastructure. Judicial support for enforcement decisions to apply more intense enforcement actions on specific trucks depends on support from the U.S. legal metrology community. Standards are needed in NIST Handbook 44 to address the design, installation, accuracy, and use of WIM systems used in a screening/sorting application. The implementation of a uniform set of standards will greatly improve the overall efficiency of the nation’s commercial vehicle enforcement process.

Once adopted by the truck weight enforcement community, these requirements will enhance the accuracy of the nation’s WIM scale systems; serve as a sound basis for judicial support of next-generation truck weight enforcement programs; and result in fewer legally loaded vehicles being delayed at static weigh station locations, thus reducing traffic congestion and non-productive fuel consumption and improving the movement of freight on our nation’s roadways.

Purpose of the Project: The FHWA’s Office of Freight Management and Operations recognized a need to encourage uniformity in the design, testing, installation, and performance of WIM technology and subsequently encourage acceptance by prosecution agencies (administrative or judicial) regarding the validity of WIM technology’s role in supporting commercial motor vehicle weight enforcement.

In response to this need and recognizing the value of having a standard included in NIST Handbook 44 because it lends integrity and is more recognizable in legal actions, the FHWA seeks to integrate WIM technology into the
Handbook. The FHWA contracted the services of the Texas Transportation Institute of the Texas A&M University System and Battelle (a private company) to begin this process. Additionally, a small oversight Committee was formed by the FHWA, made up of three representatives from the FHWA, NIST, and a U.S. manufacturer of WIM equipment to validate that each contract deliverable is completed according to contract. NIST OWM also agreed to provide a technical advisor to the associated work group tasked with development of the proposed code.

The intended application of the proposed new code is for screening purposes only (i.e., for screening/sorting commercial vehicles for possible violations of FHWA vehicle weight requirements).

To view a detailed summary on the progress of this project since its inception in December 2011 through 2012, refer to “Timeline of Completed Tasks Relating to the Project” in S&T Agenda Item 360-3 in the Committee’s 2012 Final Report. Additional background information and information on the work is also included in that report.

2013 NCWM Interim Meeting: The Committee agreed to designate the item Informational based on a recommendation from Mr. Darrell Flocken, Chairman of the WIM WG and comments the Committee received in support of the item during its Open Hearings. Mr. Flocken reported that a new Draft WIM Code and a document containing definitions of terms used in the draft Code had been developed by members of the USNWG and were ready for an initial review. Both documents had been posted on the NCWM website and the USNWG was requesting feedback from the W&M community on both parts.

2013 NCWM Annual Meeting: During its Open Hearings, the Committee was provided an update on the development of the draft WIM Code from Mr. Flocken, Chairman of WIM WG. Mr. Flocken also clarified that its scope is strictly for screening purposes. OWM encouraged further development of the draft Code by the Weigh-In-Motion WG and offered the following feedback on the first draft in response to the WG’s request to do so:

1) To ensure that test procedures are applied uniformly, the WG may want to consider including in the draft Code procedures for establishing the reference weights of axle loads, axle-group loads, and gross vehicle weight. The WG may also want to consider specifying the types of scales considered acceptable for use in establishing such test loads and their acceptable degree of accuracy. Currently, Table T.3.1. of the draft Code specifies tolerances for axle load, axle group load, and gross vehicle weight. It also specifies that these tolerances be based on a percentage of the applied test load. In order to apply these tolerances, test loads of known value for axle load, axle-group load, and gross vehicle weight need to be established in advance of dynamic testing of a WIM system using a reference scale suitable for making such determinations. Additionally, in accordance with NIST Handbook 44 Appendix A – Fundamental Considerations, the combined error and uncertainty of the test loads, if used without correction, must be less than one-third the applicable tolerance. The draft Code does not provide an indication of the types of scales considered acceptable for making such reference weight determinations (e.g., vehicle, axle-load, etc.) or the procedures that are to be followed when using those scales to establish the reference weights. OWM notes that the accuracy of the reference scale used for determining gross vehicle weight seems to be adequately addressed in paragraph N.1.3. Reference Scale, which requires each reference vehicle to be weighed on a static scale meeting NIST Handbook 44 maintenance tolerances.

2) The WG may also want to consider including in the draft Code specific requirements applicable to the design, installation, and maintenance of the approach and exit aprons of the weigh sensor(s) of a WIM system. OWM questions whether or not it’s possible to obtain accurate and repeatable axle-load, axle-group-load, and gross vehicle weight determinations from vehicle WIM systems without including such requirements. Such requirements are needed to filter out inconsistent forces such as the following:

- “Wheel hop” (or bounce) causes undesirable accelerated vertical forces to be applied to the weigh sensor(s) of a WIM system as vehicles to be weighed in motion pass over them. Such undesirable
forces result when the tires of a vehicle to be weighed in motion pass over an irregular pavement surface on either side of the weigh sensor(s).

- “Force transfer” is the transfer of applied force from one part of a vehicle being weighed in motion to another part. Such transfer of forces occur, for example, when individual axles or tandem axles of a vehicle are weighed individually and are not in the same plane (i.e., the vehicle being weighed is not level).

During development of the draft Code, the WIM WG agreed not to include specific requirements for aprons in advance of and beyond the load sensor(s), but rather, agreed to include the following language in paragraph UR.2. User Location Conditions and Maintenance to deal with this issue: “The system shall be installed and maintained as defined in the manufacturer’s recommendation.” While the draft Code does include a user requirement intended to address this issue, the draft language alone is not sufficient enough to adequately address this important aspect of a vehicle WIM installation. Based on expert analysis, OWM understands that minimum requirements for apron smoothness, slope, etc., are needed in order to achieve necessary levels of accuracy. Both ASTM E-1318-09 and OIML R134 include requirements that address the area leading to and from the sensor(s) of a WIM system. For example, the ASTM standard includes requirements for horizontal and longitudinal alignment, cross slope, surface smoothness, etc.

3) OWM suggests that the WIM WG revisit the idea of including in the draft Code additional accuracy classes for WIM’s capable of achieving greater accuracy levels. During the most recent WIM WG meeting, some manufacturers of WIM equipment indicated that their equipment could meet a 6% gross vehicle weight tolerance, which is significantly less than the 10% currently specified in the draft Code. The WG then considered whether to include different accuracy classes and specify corresponding tolerances for those accuracy classes in the draft Code. However, the WG ultimately agreed to a single accuracy class and set of tolerances for the following reasons:

- The WG felt it was more expedient to simply specify a single accuracy class and set the limit of accuracy for that classification at the lowest end of what it considered an acceptable level of accuracy given the application of the device, and
- The WG agreed that the tasks performed by a WIM system, whether the WIM system is a “virtual weigh station” or one installed in a ramp at a more permanent site (e.g., a “weigh station” along an interstate highway) are the same.

OWM notes that tiered accuracy classes are already established in both ASTM E 1318-09 and OIML R-134. History has proven that it is better to establish a framework of tolerances around the various performance capabilities of equipment available in the marketplace early on in the development of the Code, rather than designing the Code around systems that provide lowest accuracy and then trying to change the Code later.

In early discussions with representatives from FHWA, it was stated that one of the FHWA’s main goals for developing the draft Code was to improve the accuracy and reliability of WIM systems in order to reduce the number of compliant commercial vehicles (i.e., those within legal load limits) being directed to static scales, which slows the transportation of freight. OWM recognizes the additional work that would be required by the WIM WG if it were to decide to include additional accuracy classes, but by doing so, it would benefit many (including transportation industry and consumers) and improve the chances of the FHWA achieving one of its primary goals.

Mr. Dan Middleton, (Texas A&M University) WIM Project Task Manager, speaking on behalf of the U.S. FHWA, voiced support for the item by stating that the new Code would improve consistency and legal credibility in the courts. He indicated that the U.S. does not have enough resources to adequately enforce highway weight
requirements. Use and recognition of WIM standards in NIST Handbook 44 will allow better use of enforcement resources. In providing further evidence of the need for the Code, he noted that currently less than one percent of vehicles directed to a static scale after being sorted on a WIM System are noncompliant.

Mr. Steve Langford (Cardinal Scale Manufacturing Company) commented that Cardinal Scale Manufacturing Company manufactures a series of WIM scales and encouraged further development of the draft Code. He indicated that tiered accuracy classes are not important, nor needed in the Code, at this time. The purpose of the WIM is to identify vehicles for enforcement; this is contrary to the application of OIML R134, which is intended for WIM systems used in trade. ASTM 1318 provides different accuracy classes, only one of which corresponds with the application of the draft Code.

Mr. Tim Chesser (State of Arkansas) recommended a statement be included in the Application Section of the draft Code clarifying that the Code is intended for screening/sorting purposes only. *NIST Technical Advisor’s note: It is believed that paragraph A.1. of the draft Code already addresses Mr. Chesser’s concern. Paragraph A.1. General. specifies that the Code applies to systems used to weigh vehicles, while in motion, for the purpose of screening or sorting the vehicles based on vehicle weight to determine if a static weighment is necessary.*

Ms. Julie Quinn (State of Minnesota) supported maintaining the “Informational” status of the item and encouraged the WG to move quickly to finalize completion of the draft Code.

Mr. Flocken expressed his appreciation for the comments received and indicated that he would forward them, along with OWM’s feedback, to the WG for consideration.

The Committee reported that it was their understanding that Mr. Flocken would share OWM’s suggestions with members of the WIM WG prior to their next meeting and the WG would consider whether or not additional revisions to the draft Code are necessary prior to proposing the Code to the NCWM for adoption.

At the 2014 NCWM Interim Meeting the WIM Project Leader, Mr. Tom Kearney (USDOT - FHWA) provided an update on progress. Mr. Kearney indicated that the WG had planned to convene during the fall of 2013 to address the three concerns raised by OWM during the 2013 NCWM Annual Meeting but was unable to do so because of scheduling conflicts. Since the 2013 NCWM Annual Meeting, a WG member from the Netherlands had submitted some new comments concerning the draft Code. The purpose of the next WG meeting will be to address the three OWM concerns and to review the new comments that came in from the Netherlands. That WG meeting will likely take place in April or May 2014. It is hoped that revisions to the draft Code can be completed shortly thereafter so that a revised copy of the draft Code can be made available to members of the W&M community prior to the NCWM Annual Meeting in July 2014. In the meantime, the WG continues to seek input on the current draft from anyone wishing to do so.

The SMA commented that it continues to support the efforts of the work group and looks forward to seeing the next draft of the proposed Code.

Mr. Steve Langford (Cardinal Scale Manufacturing Co.) also voiced his support of the efforts of the WG.

The Committee agreed to maintain the Informational status of the item and looks forward to further development of the draft Code by the WG.

**Regional Associations Comments:**

CWMA did not receive any additional comments and recommended that this item remain as an Informational Item.

WWMA recognizes the efforts by the WIM WG and Mr. Flocken’s comments that updated the conference on the progress of the WG. The WWMA looks forward to hearing the results of the WIM WG meeting. WWMA recommended that this item be an Informational Item.

NEWMA awaits final language from the Work Group and recommended that the item be an Informational Item.
SWMA received a Work Group report from Mr. Darrell Flocken. The Committee did not have a recommendation on this item. Based on comments received, the Committee supported further development of the draft Code by the WIM Work Group.

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

321 BELT-CONVEYOR SCALE SYSTEMS

321-1 V UR.1.2. Conveyor Installation

Source:

Purpose:
Simplify the requirement for belt tension by making it consistent regardless of belt length without prescribing the type of device to accomplish this.

Item Under Consideration:
Amend NIST Handbook 44 Belt-Conveyor Scale Systems Code as follows:

UR.1.2. Conveyor Installation

...;
(d) Take-up Device. – If the belt length is such that a take-up device is required, this device shall be of the counter weighted type for either vertical or horizontal travel. Any take-up device shall provide constant and consistent tension for the belt under all operating conditions.

Note: No changes are proposed for other subparagraphs under UR.1.2

Background / Discussion:
During discussions at the 2012 and 2013 meetings of the USNWG on Belt-Conveyor Scales, the working group recognized that there are take-up devices in use on belt-conveyor scale systems that operate favorably that are constructed according to designs other than the “counter weighted” type. One example is a take-up device that is reportedly capable of producing acceptable results and operates by incorporating a hydraulic-operated belt tension adjustment mechanism that responds to input from a load cell that actively monitors belt tension. The USNWG agrees that the existing requirement of a “counter weighted” type of belt tension device is excessively prescriptive and the work group does not consider it appropriate to mandate design criteria for belt-conveyor systems in the HB44 Belt-Conveyor Scale Systems Code.

Furthermore, the existing language in HB44, [2.21] paragraph UR.1.2. (d) does not explicitly require the use of a gravity-type (or counter-weighted) tension device unless the conveyor is of sufficient length that a take-up device is needed. The phrase “of sufficient length” does not provide clearly defined parameters regarding belt length in this existing requirement. Thus, the need for a belt tension device is open to interpretation by enforcement officials and the lack of specificity is believed to detract from the uniform application of the requirement. The current language also implies that relatively shorter conveyors may not need any type of belt tensioning device and the validity of that notion is being questioned by some USNWG members.
At the 2014 NCWM Interim Meeting Mr. Bill Ripka (Thermo Fisher Scientific), Chair of the USNWG on BCSs, spoke on behalf of Thermo Fisher Scientific and the USNWG on BCSs in support of the proposal. Mr. Ripka indicated that the views of the USNWG are clear and based on a belief that NIST Handbook 44 is a set of criteria and not intended to be a design manual. There are many ways of addressing belt tension in the marketplace today. To be able to increase belt speed, some other form of belt tensioning device is needed because a counter weight take-up device can’t accommodate higher speeds. NIST Handbook 44 should not prevent technology from moving forward.

The Committee also heard comments from the SMA in support of the item as written, providing the rationale that a specification should not mandate product design.

Hearing no opposition and only comments in support of the proposed changes to UR.1.2. Conveyor Installation, the Committee agreed to recommend the item as shown above in the “Item Under Consideration” for a vote.

**Regional Associations Comments:**

CWMA forwarded the item to NCWM, recommending it as an Informational Item due to lack of information for available belt tensioning devices and their effect on the metrological integrity.

WWMA heard support and no opposition to the proposal and agreed the current language is open to interpretation. The proposed language provides clear, definitive parameters for the take-up device that don’t mandate design criteria. WWMA forwarded the item to NCWM, recommending it as a Voting Item.

NEWMA defers to the Work Group and other jurisdictions with more knowledge of these devices. NEWMA forwarded the item to NCWM, recommending it as a Voting Item.

SWMA received some comments and discussion on providing clarity of the terms “constant” and “consistent.” However, based on a recommendation from the Work Group, the SWMA agreed to forward the item to the NCWM S&T Committee for consideration.

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

### 330 LIQUID MEASURING DEVICES

#### 330-1 V S.1.6.7. and S.1.6.8. Recorded Representations and UR.3.3. Computing Device

**Source:**
Liquid Controls (2014)

**Purpose:**
Address the issue of receipt (printed, electronic, and optional).

**Item Under Consideration:**
Amend NIST Handbook 44 Liquid Measuring Devices Code as follows:

**S.1.6.7. Recorded Representations.** – Except for fleet sales and other price contract sales and for transactions where a post-delivery discount is provided, a printed receipt providing the following information 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:

(a) the total volume of the delivery;
(b) the unit price;
(c) the total computed price; and
(d) the product identity by name, symbol, abbreviation, or code number.

For systems 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.).
[Nonretroactive as of January 1, 1986]
(Added 1985) (Amended 1997 and 2012)

and,

S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided. – Except for fleet sales and other price contract sales, a printed receipt providing the following information shall be available through a built-in or separate recording element that is part of the system for transactions involving a post-delivery discount:

(a) the product identity by name, symbol, abbreviation, or code number;
(b) transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount(s), including the:
   (1) total volume of the delivery;
   (2) unit price; and
   (3) total computed price of the fuel sale.
(c) an itemization of the post-delivery discounts to the unit price; and
(d) the final total price of the fuel sale after all post-delivery discounts are applied.

For systems 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.).
(Added 2012)

and,

UR.3.3. Computing Device. – Any computing device used in an application where a product or grade is offered for sale at one or more unit prices shall be used only for sales for which the device computes and displays the sales price for the selected transaction.
(Added 1989) (Amended 1992)

The following exceptions apply:

(a) Fleet sales and other price contract sales are exempt from this requirement.

(b) A truck stop dispenser used exclusively for refueling trucks is exempt from this requirement provided that:
   (1) all purchases of fuel are accompanied by a printed receipt of the transaction containing the applicable price per gallon, the total gallons delivered, and the total price of the sale; and
(2) unless a dispenser complies with S.1.6.4.1. Display of Unit Price, the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.

(c) A dispenser used in an application where a price per unit discount is offered following the delivery is exempt from this requirement, provided the following conditions are satisfied:

(1) the unit price posted on the dispenser and the unit price at which the dispenser is set to compute shall be the highest unit price for any transaction;

(2) all purchases of fuel are accompanied by a printed receipt recorded by the system for the transaction containing:

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

b. transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount including the:

1. total volume of the delivery;
2. unit price; and
3. total computed price of the fuel sale prior to post-delivery discounts being applied.

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

d. the final total price of the fuel sale.

For systems 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.)


Background / Discussion:
The concept of electronic receipts is already incorporated in certain provisions of HB44 Liquid Measuring Device Code. Similar provisions are needed in other codes of HB44. At the 2013 NCWM Annual Meeting, members expressed support for including requirements to address the use of electronic receipts in the General Code rather than in individual device codes. Including requirements in the General Code would eliminate confusion and inconsistency, consolidate provisions from individual codes, and confine future updates to a single code. Item 310-2 on the Committee’s agenda includes a proposal to address this issue in the General Code.

This item (330-1) is included as a companion item to 310-2 and would change the LMD Code as follows:

- If a receipt is required, allow the customer to decline the option to receive any type of receipt.
- Add an option of electronic receipt as long as the system can generate electronic receipts.
- If a receipt is desired, allow the customer to select between printed and electronic receipt; or both.
- Remove references to electronic receipts from Liquid Measuring Device Code as they will be redundant.

Some concerns have been raised that this could lead to elimination of printed receipts, particularly for customers who have limited access to internet, smart phone, etc. However, the proposal is written to ensure that the printed receipt remain an option for the customer.
See Items 310-2 and 330-5 for related background and discussions.

At the 2014 NCWM Interim Meeting, OWM noted in its comments to the S&T Committee that this agenda item is intended as a companion to Agenda Item 310-2. If Item 310-2 is adopted, the proposed struck-out portions of this item (330-1) could be eliminated and consumers would continue to be provided the same privileges with respect to receiving hard-copy or electronic receipts for their transactions. If Item 310-2 is not adopted, it would be inappropriate to delete the sentences as shown in this item.

OWM also noted that, should the Committee decide to advance Items 310-2 and 330-1, the Committee should give consideration to consolidating them into a single item for NCWM action. See also Items 331-1 LPG Code Modifications (UR.2.8.) and 332-2 (S.1.5.3. Recorded Representations, Point-of-Sale Systems, LPG Code) which may be impacted by action on 310-2 and 330-1.

The Committee heard comments in support of the proposed changes to paragraphs S.1.6.7. and S.1.6.8. in comments it received for Item 310-2, which it considers a companion item. Hearing no opposition to the proposed changes, the Committee recommended the item for a vote. In acknowledgement of the fact that this item is a companion to Item 310-2, should the changes to paragraph G-S.5.6. Recorded Representations proposed in Item 310-2 fail to be adopted, the statement that refers to electronic receipts in each of the three proposed paragraphs under this item shown struck out should remain. Thus, if Item 310-2 fails to be adopted, the Committee plans to amend the status of this item at the NCWM Annual Meeting and may not offer it for a vote.

Regional Associations Comments:
CWMA supported this item and forwarded it to NCWM recommending it as a Voting Item.

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

330-2  W  S.1.6.7. Recorded Representations

Source:
Illinois Department of Agriculture (2014)

Purpose:
To reduce confusion among the public.

Item Under Consideration:
Amend NIST Handbook 44 Liquid Measuring Devices Code as follows:

**S.1.6.7. Recorded Representations.** Except for fleet sales and other price contract sales and for transactions where a post-delivery discount is provided, a printed receipt providing the following information 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:

(a) the total volume of the delivery;
(b) the unit price;
(c) the total computed price; and
(d) the product identity matching the identity on the dispenser by name, symbol, abbreviation, or code octane number.

Background / Discussion:
The LMD Code currently allows businesses to identify the product being sold on the receipt in a misleading way. For example, many stores in a certain chain have fuel that is labeled “Regular” on the dispenser, but their receipt identifies the product as “BLUE.” If a store has Regular 87 octane fuel for $3.699 and Silver 89 octane fuel for
$3.599, the customer may select the Regular by mistake based on its lower octane rating and name. If the receipt simply identifies the product as “BLUE,” the consumer may not know if they were charged the wrong unit price or if they chose the wrong pump by their own mistake (the Regular nozzle is green).

In another example, a verbal complaint was made to a Weights and Measures Inspector that the receipt was not clear. This customer worked for a company that would reimburse the fuel cost as long as it was “Regular” fuel that was purchased. This customer went to a station and purchased “Regular” fuel, however the receipt had the identity as “Unleaded.” This person was not reimbursed because most gas is unleaded and, thus, the identification of the product as only “Unleaded” does not mean it was “Regular” gas. Adding the phrase “matching the identity on the dispenser” to the requirement makes it clear to the businesses that the product identity on the receipt must agree with the product identity statement on the dispenser. For the same reason, the word “code” should be changed to “octane.” A “code” number could be any number and may confuse consumers when it comes to which product they purchased; however, the “octane” number on the receipt will be understandable to the customer since it matches the octane number displayed on the dispenser.

At the 2014 NCWM Interim Meeting there were multiple comments questioning how the proposed language would apply. Of particular concern was how the reference to “matching” would be interpreted and applied.

The Committee heard from Ms. Juana Williams (NIST OWM) who noted that the provision allowing the use of codes was included at the time the paragraph was added in 1985 to recognize that some systems, both weighing and measuring had limited character capabilities. Mr. Bill Hornbach (Chevron) and Mr. Gordon Johnson (Gilbarco) commented that some systems still have limited character sets and may need to use abbreviations. While the language recognizes the use of “abbreviations,” this seems to conflict with the reference to “matching” identity. The Committee heard several suggestions for alternate language, including a suggestion for replacing the term “matching” with “corresponding.” However, there wasn’t strong support for any specific alternative. Ms. Kristin Macey (CA) and Ms. Williams provided suggestions for alternative modifications to the language that might address some of the comments provided.

The Committee heard several comments suggesting that this issue would be better addressed as a User Requirement. The Committee agreed that, while paragraph S.1.6.7. is necessary to specify what information the device must be able to print on the receipt, it is the user’s responsibility to maintain this information correctly and to enter accurate identity statements.

The Committee also heard multiple comments indicating that the current language in paragraph S.1.6.7. is adequate to address the scenario outlined in the proposal. If the identity of the product on the receipt is different than that on the dispenser, then the receipt is not correctly recording the identity of the product and the device is not being maintained in compliance with paragraph S.1.6.7. Based on the lack of support and the questions raised regarding the specific language in the proposal, the Committee decided to withdraw this item. If the submitter wishes to pursue the item further, the Committee recommends that the submitter consider proposing a User Requirement as an alternative proposal.

**Regional Associations Comments:**
CWMA supports this item and forwarded it to NCWM, recommending that it be a Voting Item.

SWMA received from industry and government officials concerned with the intent of the item. The language of the proposed item does not make intent clear. SWMA did not forward this item to NCWM.

Additional letters, presentations, and data may have been part of the Committee’s consideration. Please refer to [http://ncwm.net/meetings/annual/publication-16](http://ncwm.net/meetings/annual/publication-16) to review these documents.
330-3  V  N.4.2.4. Wholesale Devices

Source:
Flint Hills Resources (2013)

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

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

N.4.2.4. Wholesale Devices. – “Special” tests shall be made to develop the operating characteristics of a measuring system and any special associated or attached elements and accessories. “Special” tests shall include a test at or slightly above the slower of the following rates:

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

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

In no case shall the test be performed at a flow rate less than the minimum discharge rate marked on the device.

Background / Discussion:
The Committee originally received a proposal from the submitter that was intended to clarify that conducting a slow flow test to the marked minimum discharge rate is required for type evaluation and testing to the minimum discharge flow rate developed under the conditions of installation for routine field inspections is appropriate. (See the Committee’s 2013 Final Report for details). The original proposal would:

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

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

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

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

The submitter noted that the current language in NIST Handbook 44 is very rigid and does not take field installation conditions into consideration. It may not be possible or practicable to achieve the marked minimum discharge rate during field tests without changes to upstream equipment (valves, pumps, etc.), changing the flow computer programmed presets, or changing the idling of other fueling bays during testing.

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

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

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

In the LMD Code, retail motor-fuel devices with a marked minimum flow rate are tested “at or near the marked minimum flow rate,” but are not required to be tested at exactly the marked minimum. The proposal would make testing more uniform and consistent among different, but similar device types.

The submitter points out the following supporting arguments:

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

The original proposal did not specify an exact flow rate, but required a test at the minimum flow rate based on the system and the establishment of a meter factor at that flow rate. This approach would have been similar to the recommended tests described in API Manual of Petroleum Measurement Standards (MPMS) Chapter 6.2 Loading Rack Metering Systems. See the Committee’s 2013 Final Report for full details.

During the 2013 NCWM Interim and Annual Meetings, the Committee considered a number of alternative proposals to amend paragraph N.4.2.4. Wholesale Devices, including proposals that would have had the effect of making the “Special” test optional during field evaluation or eliminating the “Special” test entirely for field evaluation. Much of the discussion that took place during the Committee’s Open Hearings relative to these proposals focused on two main issues:

1. Whether or not it’s still necessary, given advances in today’s meter technology, to conduct a “Special” test on a wholesale meter during field evaluation; and
2. Whether the conditions for conducting the “Special” test specified in paragraph N.4.2.4.(a) and (b) should be eliminated and language added to the paragraph that would require the test be performed at or near the minimum flow rate developed under the conditions of installation.
The following is a list of many of the important points raised during the Open Hearings of the 2013 S&T Committee relative to these issues:

- If the concern is that there is not enough flexibility in the reference to “20% of the marked maximum,” the focus should be placed on modifying this reference rather than making other proposed changes.
- It is important to verify the performance of a meter over the range of flow rates for which it is designed to operate. The “normal” test (as described in N.4.1. Normal Tests.) combined with a “slow flow” test (as described in N.4.2.4. Wholesale Devices) allows an inspector or serviceperson to verify the performance of a meter over the range in which it is typically used under the conditions of its installation.
- For positive displacement meters with single point calibration, the results of both tests can be used to determine whether or not a particular meter is providing accurate measurement over the complete range of operating speeds associated with its installation and whether the meter is in good operating condition.
- Product discharge rates are affected by installation particulars, (e.g., the diameter of the piping, pump speed, etc.,) and these can be changed after installation, thus affecting meter performance. For these reasons, it is recommended that the slow flow test remain a required part of an official test as was originally intended by the original submitter of this item.
- As a general rule OWM recommends that test procedures considered part of an official examination of a commercial weighing or measuring device not be made elective because, as such, they create the potential for inconsistent enforcement of legal requirements amongst weights and measures jurisdictions.
- If the parameters of the test were changed from those currently specified in (a) and (b) of paragraph N.4.2.4. to the proposed “at or near the minimum discharge flow rate developed under the conditions of installation,” the change would provide device owners the latitude of being able to try and extend the service life of a meter by compensating for badly worn or otherwise defective parts simply by increasing the minimum flow rate of product through it. Although such action would constitute a violation of G-UR.4.3. Use of Adjustments, it might be very difficult for officials to recognize and enforce.
- The current language in Handbook 44 may not provide the same flexibility that is provided for other meter types (for which tests can be “at or near” the marked minimum); however, I am concerned about backing off of a proper test for what appears to be primarily convenience.
- With many current systems, there frequently is not a way to restrict the flow rate. The location where flow is restricted (e.g., before vs. after the meter) during “Special” tests can also affect the results of testing, and this should be considered in constructing the final language (and associated test procedures) for any proposed change.
- Some registers may use different types of calibration factors and addressing these variations in a single paragraph would be difficult. If changes are made to the test conditions in the LMD Code, similar changes should be made to other measuring codes as needed to ensure consistency.
- The phrase “developed under the conditions of the installation,” may be interpreted to mean that, if a system can be installed to run at maximum flow rates other than “start-up” and “shut-down,” then an official cannot request that the system be “chocked” to reduce the flow. Tennessee has a valve on its prover that can be used to reduce the flow rate during a slow flow test.
- According to the 1949 NCWM S&T Committee Report, requirements to conduct “Special Tests” were established in 1949. The report states that “Special” tests are not defined in detail except that such tests shall include tests at specified minimum discharge rates; other details of “Special” tests are left to the judgment of the official. The primary purpose of the “Special” test is to determine the condition of the meter and determine whether or not the user is maintaining the equipment in proper operating condition.
- Additional work is needed to develop minimum testing requirements for equipment with multi-point calibration capability to ensure consistency in inspection and testing of these systems.

Refer to the Committee’s 2013 Final Report for additional background information and to view the different proposals that have been submitted relative to this item and a more complete summary of the comments heard during the Open Hearings relative to those proposals.

At the 2014 NCWM Interim Meeting. OWM questioned whether or not the proposed changes in the most recent version of the proposal are appropriate and is concerned that the language may hamper officials and service personnel from conducting adequate tests. OWM reiterated the need to conduct a “Special” test at a flow rate appreciably slower than that of a “Normal” test, in order to best determine the condition of the meter. OWM
provided some draft language as shown in Item Under Consideration to address Mr. Cotsoradis’s immediate concern of not being able to perform the “Special” test at exactly the flow rates specified in paragraph N.4.2.4. and noted that if this language were adopted there would be no reason to split the requirements for “Special” test into those that apply to type evaluation and those that apply to field evaluation.

The Committee also heard from the submitter of the proposal, Mr. Constantine Cotsoradis (Flint Hills Resources), who recognized in his comments not only the importance of conducting a slow flow test on a wholesale meter during both type evaluation and field evaluation; but also the need to maintain the current “Special” test criteria in NIST Handbook 44. Mr. Cotsoradis suggested that the community move slow on all of the issues that have been brought to light relating to his proposal. He stated that his primary concern and reason for submitting the proposal is that the current language in NIST Handbook 44 does not provide any flexibility concerning how the test is to be conducted and that it is not practical to conduct the test at exactly the flow rates specified by N.4.2.4. Wholesale Devices. He referenced the draft language that OWM had developed in their analysis of this item and had shared with him, which, if adopted, would allow the test to be performed “at or slightly above” the slower of the flow rates specified in the paragraph. He indicated that this language would provide the kind of flexibility that he’s seeking.

Ms. Julie Quinn (MN), Mr. Randy Jennings (TN), Mr. Henry Oppermann (Weights and Measures Consulting, LLC), and Mr. Rich Miller (FMC Technologies Measurement Solutions, Inc.) provided comments in support of Mr. Cotsoradis’ suggestion to amend the proposal to reflect OWM’s suggested alternative language in paragraph N.4.2.4. Wholesale Devices, thereby making it permissible to perform the “Special” test at or near the slower of the flow rates specified. Mr. Michael Keilty (Endress and Hauser Flowtec AG USA) noted that Canada requires a program that allows a test at normal and lower flow rates.

The Committee acknowledged the comments in support of maintaining the requirement for conducting “Special” tests during routine field inspections and agrees with the premise that the “Special” test needs to be conducted during both type evaluation and field evaluation. The Committee also acknowledged that it is not practical to conduct “Special” tests at exactly the flow rates specified in the current paragraph. Based on comments heard during the Open Hearings indicating that the key concern of the submitter and others is that the current language does not provide any flexibility with respect to the flow rates specified in the paragraph, the Committee agreed to modify the proposal to read as shown in the “Item Under Consideration.” The Committee believes that the item has been adequately reviewed and discussed and recommended that the item be designated as a “Voting” Item.

Regional Associations Comments:
CWMA believes the item has been sufficiently developed and recommended that it be a Voting Item. (Refer to 2014 Publication 15 to view the original proposal considered by the CWMA during its 2014 Annual Meeting)

WWMA understands the developing nature of this issue and the factors associated with pumping systems that have an impact on the test result. The WWMA looks forward to hearing input from meter manufacturers and interested parties that have a stake in addressing special tests on wholesale devices. The WWMA also acknowledges the 1949 S&T Report that identifies “Special” tests are left to the judgment of the official. WWMA recommends that this item be an Informational Item.

NEWMA recommended keeping this item as Informational until the Measuring Sector has a chance to provide data.

SWMA received comments suggesting some of the language regarding wholesale and retail could be better harmonized across different codes. Comments were also received expressing concerns about the wording in regards to operational parameters. Based on comments received, the SWMA recommended the item be further developed.

Additional letters, presentations, and data may have been part of the Committee’s consideration. Please refer to http://ncwm.net/meetings/annual/publication-16 to review these documents.
D. N.4.2.5. Determination of Error on Wholesale Devices with Multiple Flow Rates and Calibration Factors

Source:
Minnesota Weights and Measures Division (2014)

Purpose:
To update Handbook 44 to reflect the technological changes in registers for liquid measuring devices and to alert Weights & Measures officials to the fact that error in start-up and shut-down delivery quantities can introduce linear errors in the calibration at normal flow rates; these errors increase the further the delivered quantity deviates from the prover size used at calibration.

Item Under Consideration:
Add a new paragraph to the NIST Handbook 44 Liquid Measuring Devices Code as follows:

N.4.2.5. Determination of Error on Wholesale Devices with Multiple Flow Rates and Calibration Factors - On wholesale devices which are configured with multiple flow rates where each flow rate has its own calibration factor, and which are programmed to deliver a set quantity at a slow flow rate on start-up and/or shut-down, the effect of start-up and shut-down rates on the accuracy of the typical delivery shall be considered if the typical delivery is greater or less than the test measure used at the time of evaluation. The weights and measures jurisdiction shall determine the size of the typical delivery based upon available evidence.

Background / Discussion:
Wholesale metering systems are used to deliver product at many different flow rates. Many of these systems are equipped with features that allow different calibration factors to be programmed at those flow rates. Companies commonly set accuracy goals of +/- 0.05% at normal and “fallback” delivery rates; however, they are often reluctant to spend time entering different calibration factors for the initial (“start-up”) and ending (“shut-down”) portions of the delivery. Spending time calibrating the metering system at normal and fallback delivery rates to such a high degree of accuracy is wasted if the error introduced into the measurement by the start-up and shut-down quantities is unknown. An additional concern is that an unscrupulous operator could use the error introduced by the start-up and shut-down portions of the delivery (if known) to adjust calibration at the normal delivery rate such that the overall error of a typical delivery is predominantly in the user’s favor. Officials should be aware that when delivered quantities are greater than the prover used at calibration, start-up and shutdown errors have a counter-intuitive effect. Underregistration errors (which are normally in the consumers’ favor) in the start-up and shut-down portions of the delivery may actually create shortages in the total delivery if calibration of the normal rate is adjusted to compensate for that underregistration. While these errors should be well within tolerance if the start-up and shut-down errors are in tolerance, an official who is trying to determine predominance of error should be aware of this effect and know how to determine the expected error in a typical delivery. Operators need to understand the importance of knowing and accounting for the effects of start-up and shut-down errors. Officials need to be aware of the potential for misusing that knowledge. Terminals and refineries want to maximize the accuracy of their liquid measuring devices by optimizing the calibration factors at typical delivery rates.

This proposal is not intended to have any effect on locations which do not use electronic calibration factors to optimize accuracy at every delivery rate. Even at locations which do use multiple calibration factors, no action is required unless the official notices that the error for the start-up and shut-down rates is predominantly in one direction. If the start-up and shut-down errors are predominantly in one direction, the official then needs to determine the size of a typical transaction and the likely predominance of the error. Device owners can easily ensure that they have no problems with this requirement by making sure that their devices are in tolerance at slow flow start-up and shut-down rates and that errors are not predominantly in one direction.

See Appendix B, How Slow Flow Accuracy Affects LMDs.

At the 2014 NCWM Interim Meeting the Committee acknowledged that, at the heart of this issue is the need to develop guidance for inspectors and service personnel in the proper use and inspection of systems with multiple calibration factors. This work may encompass issues such as how the multiple calibration factor features can be
used to adjust meters at different flow rates; to adjust the accuracy of the initial “start-up” and ending “slow-down” portions of a delivery; to adjust the accuracy of a meter when delivering different product types, etc.

During its Open Hearings, the Committee heard questions from Mr. Henry Oppermann (Weights and Measures Consulting) and from Mrs. Tina Butcher (NIST OWM) who questioned how an inspector would analyze the results without conducting accuracy tests at the slower flow rates. Ms. Julie Quinn (MN), thesubmitter of this proposal, clarified that, in order to apply the proposed “Note,” an inspector must run tests at these flow rates to be able to determine the magnitude and direction of the error. Ms. Juana Williams raised some additional questions and noted some comments from NIST OWM (extracted from OWM’s analysis provided to the S&T Committee), including the following.

- How is an inspector to assess the “start-up” and “slow-down” portions of the delivery given that they include quantities delivered at multiple different flow rates and the actual delivery sizes may vary?
- The minimum test draft size requirements may need to be considered and possibly revised to address tests of these systems.
- Caution should be used before making any sort of assessment without conducting any “slow flow” testing as outlined in the example (which assumes that no “slow flow” test was conducted).
- Percentage-based tolerances account and allow for different errors at different delivery sizes.
- If the concern centers on the “start-up” and “slow-down” portions of the delivery, the proposal may need to provide more specific guidance in this regard.

Mr. Constantine Cotsoradis (Flint Hills Resources) recognized the validity of the issue and expressed support for proposals that recognize changing technology, but he also acknowledged the questions that were raised within the regionals and at the Interim Meeting needing to be addressed.

Ms. Quinn clarified the purpose of the item and the circumstances leading to the proposal, noting that she was unable to attend other regional meetings to provide further explanations of this proposal. She noted that, at one time, the amount of product and the flow rate for the start-up and shut-down portions of a delivery were manually controlled. Today’s systems tend to use automated, programmed values for these portions of the delivery. Ms. Quinn noted that, frequently, companies are reluctant to spend additional time validating the calibration factors used in the start-up and shut-down portions of the delivery. The “typical delivery” sizes would be determined from examining records at the terminal. The intent of the proposal is to raise awareness of the need for the inspector to consider the effects of these portions of the delivery on its overall accuracy.

After hearing comments during the Open Hearings and discussing the item further in its work sessions, the Committee agreed to designate this as a Developing Item. The Committee believes that, at least initially, work needs to be focused on the development of guidelines and test procedures that could be incorporated into examination procedure outlines. Ms. Quinn agreed to serve as the contact point for the item. The Committee asks that others interested in this work contact Ms. Quinn. The Committee looks forward to updates on this work as it progresses.

Regional Association Comments:
CWMA believes this item is ready and forwarded it to NCWM, recommending it as a Voting Item.

WWMA did not forward this item to NCWM, because the language is vague and offers no clear solution.

NEWMA does not believe this item is necessary and would not dramatically impact the test results of the meters. NEWMA did not forward the item to NCWM.
SWMA received comments in Open Hearings and the SWMA S&T Committee’s Work Session indicating a strong concern with the wording “typical delivery.” The SWMA recommended the item be withdrawn based upon lack of merit. The SWMA did not forward this item to NCWM.

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

**330-5A V UR.3.3. Computing Device.**

*Item 330-5 was separated into two parts 330-5A and 330-5B during the 2014 Interim Meeting to facilitate review of the issues involved.*

**Source:**
NCWM Task Group (TG) on Retail Motor Fuel Dispenser Price Posting and Computing Capability (2013)

**Purpose:**
Refine the criteria in the LMD Code related to price posting and computing capability of RMFDs for post-delivery discounted transactions to more clearly reflect the recommendations of the NCWM Task Group on RMFD Price Posting and Computing Capability for the indication of the highest unit price.

**Item Under Consideration:**
Amend paragraph UR.3.3.(c)(1) by adding underlined text as follows:

**UR.3.3. Computing Device.** – Any computing device used in an application where a product or grade is offered for sale at one or more unit prices shall be used only for sales for which the device computes and displays the sales price for the selected transaction.

(Added 1989) (Amended 1992)

The following exceptions apply:

(a) Fleet sales and other price contract sales are exempt from this requirement.

(b) A truck stop dispenser used exclusively for refueling trucks is exempt from this requirement provided that:

(1) all purchases of fuel are accompanied by a printed receipt of the transaction containing the applicable price per gallon, the total gallons delivered, and the total price of the sale; and

(Added 1993)

(2) unless a dispenser complies with S.1.6.4.1. Display of Unit Price, the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.

(Added 1993)

(c) A dispenser used in an application where a price per unit discount is offered following the delivery is exempt from this requirement, provided the following conditions are satisfied:

(1) the unit price posted on the dispenser and the unit price at which the dispenser is set to compute prior to the application of any discount shall be the highest unit price for any transaction;
(2) all purchases of fuel are accompanied by a printed receipt recorded by the system for the transaction containing:

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

b. transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount including the:

1. total volume of the delivery;

2. unit price; and

3. total computed price of the fuel sale prior to post-delivery discounts being applied.

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

d. the final total price of the fuel sale.

For systems 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.)

(Added 2012)


**Background / Discussion:**

At the 2013 NCWM Interim Meeting, the NCWM Task Group on RMFD Price Posting and Computing Capability met to review examples of receipts and scenarios for compliance with language adopted into NIST Handbook 44 in 2012 to address systems that are used to offer post-delivery discount pricing in retail motor-fuel dispensing applications. During that review, the TG noted that the language in paragraph UR.3.3.(c)(1) could be incorrectly interpreted to prohibit the application of both pre- and post-delivery discounts in a single transaction; the TG developed proposed changes to the paragraph to address this concern. The current language in (c)(1) states that, in order to qualify for the exemptions offered for post-delivery discounts, the unit price posted on the dispenser and the unit price at which the dispenser is set to compute shall be the highest unit price for any transaction. In instances where a customer elects to receive a discount prior to the delivery (i.e., a “pre-delivery” discount), this might create an unintended conflict. For example, if a customer elects to pay in cash at the start of the transaction, the dispenser might display and compute at a lower, cash unit price. Since UR.3.3.(c)(1) stipulates posting and computing at the highest unit price, some might interpret this to mean that this dispenser may not also participate in post-delivery discount pricing or be entitled to the exemptions in U.R.3.3.(c). The original intent of the changes proposed by the TG and adopted by the NCWM was not to restrict systems from participating in both pre- and post-delivery discounting. Consequently, the TG proposes changes as outlined in UR.3.3.(c)(1) in the “Item Under Consideration” above.

The TG also developed proposed changes to UR.3.3.(c)(2) to acknowledge that: (1) the system must be able to provide a receipt to the customer, but the customer can be given an option of receiving the receipt or not; and (2) an electronic receipt is an acceptable alternative to a hard copy receipt if the purchaser agrees to an electronic receipt in lieu of, or in addition to, a hard copy. The Task Group believes that, should a customer prefer not to receive a receipt or prefer to receive it electronically, this should be permissible. The proposed changes to UR.3.3(c)(2) are shown Item 330-5B.

Lastly, the TG recommended changing the vertical alignment of the statement following UR.3.3.(c)(2) regarding the option of an electronic receipt so that it clearly applies to UR.3.3.(a), (b), and (c) rather than just part (c). As presently shown in NIST Handbook 44, this statement would apply only to UR.3.3.(c). The text shown in the “Item Under Consideration” above aligns that statement such that it would apply to UR.3.3.(a), (b), and (c).
The Committee agreed to add this item to its agenda to address these changes proposed by the TG. The Committee believes the proposed changes have merit and believe they simply clarify the original intent of the language developed by the TG and adopted by the NCWM. However, because the proposed changes were not available for publication and review in NCWM Publication 15, the Committee agreed that the item should be designated as an Informational Item to allow adequate opportunity for the review and comment by all stakeholders potentially affected by the proposed changes. The Committee also believes this will provide an opportunity for input on the specific language to ensure that it clearly and adequately addresses the concerns identified by the TG.

Two government representatives supported the proposed changes and one government representative indicated a neutral position on the item in the 2013 NCWM Online Position Forum.

At the 2013 Annual Meeting, the Committee heard comments from OWM suggesting that the proposed modifications to UR.3.3.(c)(2) are unnecessary given that the paragraph already includes the following statement permitting the use of electronic receipts:

For systems 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.)

Similar provisions are included in paragraphs S.1.6.7. Recorded Representations and S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided. OWM also noted that the originally proposed UR.3.3.(c)(2) inadvertently required that the system be capable of providing an electronic receipt upon customer demand, regardless of whether or not the system was capable of providing one.

The Committee heard multiple comments in support of eliminating the proposed revisions to UR.3.3.(c)(2). The Committee also heard comments from multiple weights and measures jurisdictions expressing the need to retain the requirement for a hard copy receipt for those consumers who do not have access to an electronic version. Mr. Ross Andersen (NY, retired) noted the need to consider any requirements at the State level that apply to electronic records.

Comments received during the Open Hearings indicated that, in applications where receipts are required, the following principles should apply:

- A printed receipt must be made available to the customer.
- If a customer doesn’t want a receipt, it is not necessary to provide one.
- The customer may be given the option of receiving an electronic receipt in lieu of a printed receipt.

The Committee also heard comments from both weights and measures jurisdictions and industry representatives suggesting that a provision be added to the General Code recognizing the acceptance of electronic receipts. Dr. Matthew Curran (FL) commented that identifying and defining different types of discounts, such as “rebates,” would be helpful for consumers as well as officials in understanding how these requirements apply.

At the 2014 NCWM Interim Meeting Ms. Fran Elson-Houston (OH) provided an update on behalf of the NCWM RMFD Price Posting and Computing Capability Task Group regarding the proposals outlined in Item 330-5. The changes proposed to paragraph UR.3.3. in Item 330-5 are to: (1) clarify the unit price posting requirements to ensure that RMFD systems are permitted to participate in both pre- and post-delivery discounts; and (2) clarify the requirements relative to electronic receipts.

Ms. Elson-Houston reported that the Task Group recognized that Item 310-2 on the S&T Committee’s agenda proposes changes to G-S.5.6. Recorded Representations and those proposed changes, if adopted, would affect the Task Group’s proposed changes to LMD Code Paragraph UR.3.3.(c)(2) with regard to the recognition of electronic receipts. The Task Group supports the proposed changes in Item 310-2 and, if those changes are adopted, would suggest eliminating corresponding references in LMD Code paragraph UR.3.3.(c)(2). The Task Group is amenable to linking action on 310-2 and proposed changes to UR.3.3.(c)(2); however, should there be complications in
addressing the requirements relative to electronic receipts, the Task Group did not want the proposed changes to UR.3.3.(1) to be delayed.

Thus, the Task Group recommended splitting Item 330-5 into two parts; one part to address clarifications to unit price posting requirements and one part to address requirements relative to electronic receipts.

Hearing no comments in opposition to the proposal submitted by the Task Group, the S&T Committee agreed to separate the item into two parts. Item 330-5A proposes changes to UR.3.3.(c)(1) as shown in the “Item Under Consideration” above. Item 330-5B proposes changes to UR.3.3.(c)(2). The Committee agreed to designate both items as “Voting” Items.

**Regional Associations Comments:**

CWMA recommends the item remain as an “Information” Item.

WWMA agrees with the proposed language change to UR.3.3. (c) (1). WWMA finds the proposed language in UR.3.3. (c) (2) is not clear and may be interpreted to allow a purchaser to demand an electronic receipt despite the capability of the device. WWMA agrees the existing language in UR.3.3. (c) (2) is adequate. WWMA recommended that this item be a Developing Item.

NEWMA recommended this item be designated as a Voting Item and believes that the proposed changes will help clarify the intent of the WG’s original suggestion.

SWMA did not receive any comments opposing the item. There were comments that the electronic receipt recommendation may also be suited to the General Code as well. The SWMA supported this item as written.

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

### 330-5B V UR.3.3. Computing Device.

**Source:**

**Purpose:**
Refine the criteria in the LMD Code related to price posting and computing capability of RMFDs for post-delivery discounted transactions to more clearly reflect the recommendations of the NCWM Task Group on RMFD Price Posting and Computing Capability for the indication of the highest unit price.

**Item Under Consideration:**
Amend paragraph UR.3.3.(c)(2) to recognize electronic receipts as follows:

(c) A dispenser used in an application where a price per unit discount is offered following the delivery is exempt from this requirement, provided the following conditions are satisfied:

(1) the unit price posted on the dispenser and the unit price at which the dispenser is set to compute shall be the highest unit price for any transaction;

(2) all purchases of fuel are accompanied by a **printed** receipt recorded by the system, for the **transaction containing**: The receipt shall contain:

a. the product identity by name, symbol, abbreviation, or code number;
b. transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount including the:

1. total volume of the delivery;
2. unit price; and
3. total computed price of the fuel sale prior to post-delivery discounts being applied.

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

d. the final total price of the fuel sale.

For systems 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.)

(Added 2012)


Background / Discussion:
Based upon input from the RMFD Price Posting and Computing Capability Task Group, the Committee agreed during the 2014 NCWM Interim Meeting to separate Item 330-5 into two parts. Item 330-5A proposes changes to UR.3.3.(c)(1). Item 330-5B proposes changes to UR.3.3.(c)(2).

The Task Group offered two options for the Committee to consider with respect to proposed changes to paragraph UR.3.3.(c)(2); Option 1 was intended to apply if the Committee agreed not to recommend Item 310-2 for vote; Option 2 was intended to apply if the Committee agreed to recommend Item 310-2 for vote. Since the Committee agreed during the 2014 NCWM Interim Meeting to recommend Item 310-2 for vote, the Task Group’s Option 2 is shown above in the “Item Under Consideration” for Item 330-5B. The Committee agreed to designate both items (330-5A and 330-5B) as “Voting” Items. Refer to Item 330-5A for additional background information pertaining to this item.

The Committee acknowledged that Item 330-5B is a companion to Item 310-2. Should the changes to G-S.5.6. Recorded Representations proposed in Item 310-2 fail to be adopted, the Committee plans to amend Item 330-5B by retaining all the struck out portions of proposed paragraph UR.3.3.(c)(2) prior to vote or may withdraw Item 330-5B completely.

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

330-6 W UR.4. Maintenance Requirements

Source:
Minnesota Weights and Measures Division (2014)

Purpose:
To clarify the application of G-UR.4.1. to liquid measuring devices at a single place of business.
Item Under Consideration:
Add a new User Requirement to the NIST Handbook 44 Liquid Measuring Devices Code as follows:

**UR.4. Maintenance Requirements**

**UR.4.1. Maintenance of Equipment.** – All liquid measuring devices in service and all mechanisms and devices attached thereto or used in connection therewith shall be maintained in proper operating condition throughout the period of such service. All liquid measuring devices in service at a single place of business shall be evaluated by product and grade. Equipment in service associated with a single product and grade at a single place of business which is found to be in error predominantly in a direction favorable to the device user shall not be considered “maintained in a proper operating condition.”

Background / Discussion:
This proposal is meant to limit the opportunity to use tolerances as a way to gain advantage for the user over the consumer. Without this clarification, General Code paragraph G-UR.4.1. might be interpreted to mean that locations would be in compliance if all the devices measuring product with the lowest sales were set to deliver with errors in tolerance in favor of the consumer, and an equal number of devices measuring product with the highest sales were set to deliver with errors in tolerance in favor of the device user. This proposal would not allow that practice. For example, a gas station could not set all their “premium” gas dispensers (for which sales are typically lower) to underregister within tolerance and all their “regular” gas dispenser (for which sales are typically higher) to overregister within tolerance. Instead approximately half of each grade should be short within tolerance, and an equal number long within tolerance.

At the 2014 NCWM Interim Meeting Ms. Julie Quinn (MN), submitter of this item, explained that her jurisdiction is finding companies taking advantage of the applicable tolerances. She noted that Minnesota has been evaluating the results of inspections based on product and grade and believes there is benefit to other jurisdictions using the same approach. She also noted that paragraph G-UR.4.1. uses the phrase “all equipment” at the beginning of the paragraph, which may be interpreted to mean that the paragraph cannot be applied unless all equipment at a given location is found to be in favor of the business. Ms. Quinn acknowledged comments from OWM and others that previous proposals have been made to include more specific guidance in paragraph G-UR.4.1.; however, unlike those proposals, the current proposal isn’t intended to stipulate a formula or be overly specific, just to emphasize the need to evaluate by product and grade rather than look at all devices at a site.

The Committee heard multiple comments that this issue is better addressed in the General Code. Mr. Gordon Johnson (Gilbarco) commented that, while this is directed more to device owners, Gilbarco has been getting calls from their customers who are expressing concern about the application of requirements such as site averages. There are instances where the average error for a site is -1 cubic inch and the locations are being rejected; however, this is within the limits of readability and uncertainty using a test measure or prover. Mr. Johnson also expressed concern about the reference to the expectation that fifty percent of each grade should have plus errors and fifty percent should have minus errors. Mr. Ross Andersen (NY-retired) noted that, while he doesn’t disagree with the concept of evaluating by grade, caution needs to be exercised because of variability that can occur with influences of product viscosity and temperature over time. Even if a device were adjusted as close to zero as practical, one could see drift in the results as conditions varied.

The Committee also heard concerns from OWM that the language might limit jurisdictions from considering other factors that might indicate noncompliance with maintenance and adjustment requirements (for example, device location, full-serve vs. self-serve, etc.). OWM suggested that, if the proposed language is to be considered further, it should be modified to allow more flexibility; OWM provided suggested modifications to the proposal. OWM also questioned whether or not specific guidance for analyzing results should be included in a User Requirement; a Notes paragraph might be more appropriate. While many of the factors discussed are appropriate for inspectors to consider in analyzing maintenance of equipment, device owners are required to adjust devices as close to zero as practical. The Committee also heard comments indicating that there may be other factors that affect test results that need to be considered in making an assessment of compliance with G-UR.4.1.
Based upon the general lack of support for adding a new requirement to the LMD Code, the Committee decided to withdraw this item from its agenda. After hearing an explanation from the submitter and others regarding the difficulties that have been encountered in applying General Code paragraph G-UR.4.1., the Committee believes that it might be more appropriate to consider modifications to the General Code to address the concerns and would encourage the submitter and others to consider pursuing this option as an alternative future proposal.

Those commenting on this item during the Open Hearings noted that their comments also applied to Item 331-2, which proposes a corresponding requirement be added to the Vehicle-Tank Meters Code.

**Regional Associations Reports:**
CWMA supported the item and forwarded it to NCWM recommending it as a Voting Item because it provides specific guidance in the LMD Code and helps support G-UR.4.1.

WWMA did not forward this item to NCWM because of no support. The WWMA believes the current language in G-UR.4.1. is adequate and provides jurisdictions the ability to make determinations for predominance of error.

NEWMA forwarded the item to NCWM and recommended that it be a Developing Item and be assigned to the submitter for development.

SWMA heard several comments during Open Hearings and in the Committee Work Session in opposition to this item. The Committee recommended the item be withdrawn. The Committee believed this item has been sufficiently addressed in the General Code of HB 44. SWMA did not forward this item to NCWM.

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

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**Source:**
NIST, OWM and the Regional Weights and Measures Associations (2008)

**Purpose:**
Review new criteria in the LMD Code related to price posting and computing capability of RMFDs and provide guidance on the application of these requirements.

**Item Under Consideration:**
The NCWM Task Group (TG) on RMFD Price Posting and Computing Capability developed specific proposals for modifying the LMD Code to address price posting and computing requirements for RMFDs. These proposals were adopted by the NCWM in 2012 and published in the 2013 NIST Handbook 44; they are being revisited at the request of the NCWM S&T Committee who has asked the Task Group to complete its review of sample receipts and provide guidance on applying the new criteria. This Item, 360-3, is being retained as a Developing Item pending any additional assignments that may be given by the Committee to the Task Group relative to the implementation of new code requirements that may be adopted. Comments or inquiries may be directed to NIST Technical Advisor, Ms. Juana Williams, at (301) 975-3989 or juana.williams@nist.gov.

**Background / Discussion:**
In the early 1990s, various sections of the LMD Code in NIST Handbook 44 were modified to address multi-tier pricing applications in instances where the same product is offered at different unit prices based on the method of payment (such as cash or credit) or other conditions of the sale. Since that time, marketing practices have evolved to include the addition of new practices, such as frequent shopper discounts and club member discounts. Numerous questions have been posed to NIST OWM and weights and measures officials regarding the requirements for posting unit prices, calculation of total price, customer-operated controls, and other related topics, such as...
definitions for associated terminology. In 2010, the Committee established a task group to further develop this issue. The Task Group proposed a number of changes to the LMD Code to address these issues and those changes were adopted in July 2012.

Additional details on this item can be found in the Committee’s 2008-2012 Final Reports.

During the 2013 NCWM Interim Meeting Open Hearings, the Committee heard a suggestion from Ms. Elson-Houston, speaking as Chair of the Task Group on RMFD Price Posting and Computing Capability on a TG proposal, to further modify paragraph UR.3.3. Computing Device. Ms. Elson-Houston reported that the TG had met and agreed: (1) to develop sample receipts for transactions where motor fuel pricing is discounted after the delivery; (2) the Chair would provide input on the “Do’s and Don’ts” for complying with the requirements that went into effect January 2013 for posting on The Oil Express web newsletter; and (3) to recommend additional amendments to paragraph UR.3.3., which were provided to the Committee. The Committee established a new “Informational” item (See Item 330-4 on the Committee’s 2014 Agenda) to address those modifications and agreed to retain Developing Item 360-3 while the TG continues work to develop guidelines and examples on how the changes made last year to the LMD Code will apply to receipts for post-delivery discounted transactions.

On the 2013 NCWM Online Position Forum, one Government representative indicated support for this item with no additional comments.

At the 2013 NCWM Annual Meeting, the Committee heard comments from Juana Williams (NIST OWM) who emphasized the importance of continuing to develop guidelines and information to assist regulatory officials and industry in interpreting and applying requirements relative to pre- and post-delivery discounts. NIST OWM is working on the development of guidelines and examples that could be included in NIST EPOs and training materials and has already received positive feedback from members of the Task Group on the examples developed thus far. This information may also be of use to NTEP in the further development of checklist criteria for inclusion in NCWM Publication 14. OWM will continue to develop this information and make it available in updates to EPOs and course materials and would appreciate additional input from the community.

Ms. Beth Treseder (API) indicated that API and others within industry would appreciate copies of acceptable receipts as they become available.

The Committee believes that additional work is needed to develop examples and information that will enable consistent and uniform application of the requirements adopted in 2012 and encourages OWM’s continued work on such examples. The Committee asks that the Task Group continue its work by developing and providing additional examples of acceptable receipts to assist regulatory officials and industry in interpreting and applying these requirements. The Committee believes that examples of receipts from deliveries that include both pre- and post-delivery discounts in a single transaction are needed.

At the 2014 NCWM Interim Meeting Ms. Fran Elson-Houston (Ohio) spoke as Chair of the RMFD Price Posting and Computing Capability Task Group regarding a meeting of the TG, which occurred at the 2014 Interim Meeting. Ms. Elson-Houston advised the Committee that she will work with NIST to develop additional examples of receipts to illustrate both compliant and non-compliant receipts that could be included in the NIST EPOs for RMFDs. The examples will be vetted with the TG and TG members agreed to provide input on the examples. Ms. Elson-Houston indicated that the TG believes this task would complete its work, unless the Committee has additional tasks to assign. During the Open Hearings, Ms. Elson-Houston encouraged members working with the post-delivery discount requirements, who might encounter problems or issues with the language that has been adopted, to forward their concerns to a member of the TG.

The Committee expressed appreciation for the TG’s hard work. The Committee supports the development of examples that can be included in the NIST EPOs and recognized these as essential to help ensure consistent interpretation of the NIST Handbook 44 provisions and requirements for post-delivery discounts. The Committee agreed that, once completed, this last task completes the work of the TG. Barring any new issues between now and the NCWM Annual Meeting, this item will be dropped from the Committee’s agenda in July. The Committee acknowledged that should future issues arise regarding the provisions for post-delivery discounts, the Committee may need to request that the TG be resurrected or reconstituted.
Regional Associations Comments:
CWMA believes this item should remain as a Developing Item until the request for clarification is received from the Work Group.

WWMA recommended that this item remain as a Developing Item and looks forward to seeing specific receipt examples from the TG on RMFD Price Posting and Computing Capability.

NEWMA recommended that this item remain as a Developing Item and looks forward to additional data from the TG.

SWMA did not receive any comments on this item. However, the Committee continues to support the work of the Task Group and recommends the item continue to be further developed.

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

331 VEHICLE-TANK METERS

331-1 D N.4.2.1. Determination of Error on Vehicle-Tank Meters with Multiple Flow Rates and Calibration Factors

Source:
Minnesota Weights and Measures Division (2014)

Purpose:
To update NIST Handbook 44 to reflect the technological changes in registers for vehicle-tank meters and to alert Weights & Measures officials to the fact that error in start-up and shut-down delivery quantities can introduce linear errors in the calibration at normal flow rates which increase the further the delivered quantity deviates from the prover size used at calibration.

Item Under Consideration:
Amend NIST Handbook 44 Vehicle Tank Meter Code as follows:

N.4.2.1. Determination of Error on Vehicle-Tank Meters with Multiple Flow Rates and Calibration Factors -On vehicle tank meters which are configured with multiple flow rates where each flow rate has its own calibration factor, and which are programmed to deliver a set quantity at a slow flow rate on start-up and/or shut-down, the effect of start-up and shut-down rates on the accuracy of the typical delivery shall be considered if the typical delivery is greater or less than the test measure used at the time of evaluation. The weights and measures jurisdiction shall determine the size of the typical delivery based upon available evidence.

Background / Discussion:
Many terminals and refineries want to maximize the accuracy of their liquid-measuring devices by optimizing the calibration factors at typical delivery speeds and some bulk delivery companies are beginning to utilize the capabilities of electronic registers with multiple calibration factors to optimize their accuracy at flow rates that are customarily used. Just like registers on wholesale liquid measuring devices, these meters can be configured for a standard initial “start-up” and ending “shut-down” quantity delivered at a slower speed than is used for the remainder of the delivery. Service agents are expected to calibrate devices as close to zero as possible, but spending time calibrating normal delivery rates to a high degree of accuracy is wasted if the error introduced into the measurement by the start-up and shut-down quantities is unknown. On the other hand, an unscrupulous operator
could also use the known error introduced by the start-up and shut-down errors to calibrate the normal delivery rates so that all the errors on typical deliveries work predominantly in the user’s favor. Officials should be aware that when delivered quantities are greater than the prover used at calibration, start-up and shut-down errors have a counter-intuitive effect. Underregistration, which normally operates in the consumers’ favor, may actually create shortages in the total delivery if calibration of the normal rate was adjusted to compensate for that underregistration. While these errors should be well within tolerance if the start-up and shut-down error are in tolerance, an official who is trying to determine predominance of error should be aware of this effect and know how to calculate the expected error in a typical delivery. Operators need to understand the importance of knowing and accounting for the effects of start-up and shut-down errors. Officials need to be aware of the potential for misusing that knowledge.

This proposal has no effect on locations which do not use electronic calibration factors to optimize accuracy at every delivery rate. Even at locations which do, no action is required unless the official notices that the error for the start-up and shut-down rates is predominantly in one direction. If the start-up and shut-down errors are predominantly in one direction, the official then needs to determine the size of a typical transaction and the likely predominance of the error. Device owners can easily ensure that they have no problems with this requirement by making sure that their devices are in tolerance at the slower start-up and shut-down flow rates and errors are not predominantly one way or the other.

See Appendix C, How Slow Flow Errors Affect VTMs.

See comments Item 330-4 for details of comments from the 2014 NCWM Interim Meeting.

After hearing comments during the Open Hearings and discussing the item further in its work sessions, the Committee agreed to designate this as a Developing Item. The Committee believes that, at least initially, work needs to be focused on the development of guidelines and test procedures that could be incorporated into examination procedure outlines. The Committee Chairman noted that the submitter, Ms. Julie Quinn (MN), agreed to serve as the contact point for the item, and will be working with others to further develop guidelines for systems with multiple-point calibration capability. Ms. Quinn thanked those who have offered to help and noted that, although the specific issue presented to the Committee dealt with predominance of errors in certain portions of the delivery, she agreed that the issue is really dealing with metering systems with multiple-point calibration capability. The Committee asks that others interested in this work contact Ms. Quinn. The Committee looks forward to updates on this work as it progresses.

**Regional Association Comments:**

CWMA heard no opposition on this item and based on testimony received from the floor, believes it is ready for a vote. CWMA forwarded the item to NCWM, recommending it as a Voting Item.

WWMA agrees the proposed language is confusing and no support for this item was conveyed. The WWMA agrees the language in the proposal is vague and offers no clear solution. The WWMA did not forward the item to NCWM.

NEWMA found this item confusing and believes that it lacks merit to move forward. NEWMA did not forward the item to NCWM.

SWMA again heard comments concerning the wording “typical delivery.” Based on comments received in Open Hearings and the SWMA S&T Committee’s Work Session, the SWMA agreed to withdraw based on lack of merit. SWMA did not forward this item to NCWM.

Additional letters, presentations, and data may have been part of the Committee’s consideration. Please refer to http://ncwm.net/meetings/annual/publication-16 to review these documents.
331-2 W UR.3. Maintenance Requirements

Source:
Minnesota Weights and Measures Division (2014)

Purpose:
To clarify the application of G-UR.4.1. to liquid measuring devices at a single place of business.

Item Under Consideration:
Add a new User Requirement to the NIST Handbook 44 Vehicle-Tank Meters Code as follows:


UR.3.1. Maintenance of Equipment. – All vehicle-mounted measuring systems in service and all mechanisms and devices attached thereto or used in connection therewith shall be maintained in proper operating condition throughout the period of such service. All vehicle-mounted measuring systems in service at a single place of business shall be evaluated by product and grade. Equipment in service associated with a single product and grade at a single place of business which is found to be in error predominantly in a direction favorable to the device user shall not be considered “maintained in a proper operating condition.”

Background / Discussion:
This proposal is meant to limit the opportunity to use tolerances as a way to gain advantage for the user over the consumer. Without this clarification, paragraph G-UR.4.1. might be interpreted to mean that locations would be in compliance if all the devices measuring product with the lowest sales were in tolerance in favor of the consumer, and an equal number of devices measuring product with the highest sales were in tolerance in favor of the device user. This proposal would not allow that practice. For example, a bulk delivery service could not set all their diesel fuel long within tolerance and all their gasoline short within tolerance. Instead, approximately half of each grade should be short within tolerance and an equal number long within tolerance.

Although jurisdictions have not yet come to an agreement as to a mathematical formula for calculating predominance of error, there seems to be general agreement on the principle that tolerances should not be applied to allow most devices of one grade to be short and most of another grade to be long. Many jurisdictions are already applying this interpretation to their application of G-UR.4.1. If adopted, this proposal will promote uniformity by standardizing enforcement across jurisdictions.

At the 2014 NCWM Interim Meeting, Ms. Julie Quinn (MN), submitter of this item, noted that the rationale for this proposal is the same as for Item 330-6 on the Committee’s Agenda. During its review of Item 330-6, the Committee heard comments from others, who also stated that their comments applied to Item 330-6 and 331-2. See that item for comments and details.

The Committee heard multiple comments that this issue is better addressed in the General Code. The Committee also heard concerns from OWM that the language might limit jurisdictions from considering other factors that might indicate noncompliance with maintenance and adjustment requirements and suggesting that, if the proposed language is to be considered further, it should be modified to allow more flexibility. OWM also questioned whether or not specific guidance for analyzing results should be included in a User Requirement. While many of the factors discussed are appropriate for inspectors to consider in analyzing maintenance of equipment, device owners are required to adjust devices as close to zero as practical. The Committee also heard comments indicating that there may be other factors that affect test results that need to be considered in making an assessment of compliance with G-UR.4.1. The Committee also heard concerns expressed about the need to consider the limits of readability and uncertainty of current test equipment.

Based upon the general lack of support for adding a new requirement to the VTM Code, the Committee decided to withdraw this item from its Agenda.
After hearing an explanation from the submitter and others regarding the difficulties that have been encountered in applying General Code paragraph G-UR.4.1., the Committee believes that it might be more appropriate to consider modifications to the General Code to address the concerns and would encourage the submitter and others to consider pursuing this option as an alternative future proposal.

**Regional Association Comments:**

CWMA supported the item and forwarded it to NCWM, recommending it as a Voting Item because it provides specific guidance in the VTM Code and helps support G-UR.4.1.

WWMA did not hear support for the item and the current language in G-UR.4.1. is adequate and provides jurisdictions the ability to make determinations for predominance of error. The WWMA did not forward this item to NCWM.

NEWMA believed this item is covered in the General Code. NEWMA did not forward this item to NCWM.

SWMA heard comments during the Open Hearings in opposition to the item. The SWMA believes this item is sufficiently addressed in the General Code of HB 44 and recommended the item be withdrawn. SWMA did not forward this item to NCWM.

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

### 332 LPG AND ANHYDROUS AMMONIA LIQUID-MEASURING DEVICES

**332-1**


**Source:**
California Department of Food and Agriculture Division of Measurement Standards (2014)

**Purpose:**

**Item Under Consideration:**
Amend NIST Handbook 44, Liquefied Petroleum Gas and Anhydrous Liquid-Measuring Devices Code as follows:

**S.1.4. For Retail Devices Only (No Change)**

S.1.4.1. Indication of Delivery (No Change)

S.1.4.2. Return to Zero (No Change)

**S.1.4.3. Provisions for Power Loss.**

S.1.4.3.1. Transaction Information.

a) In the event of a power loss, a computing retail liquefied petroleum dispensing device shall display the information needed to complete any transaction in progress at the time of the
**power loss (such as the quantity and unit price, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.**

b) In the event of a power loss, both an electronic digital retail non-computing stationary liquefied petroleum gas dispenser and a vehicle-mounted electronic digital liquefied petroleum gas dispenser shall display the information needed to complete any transaction in progress at the time of the power loss.

**S 1.4.3.2. User Information.** – The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.

S.1.5. For Stationary Retail Devices Only.

S.1.5.1. Display of Unit Price and Product Identity. – In a device of the computing type, means shall be provided for displaying on each face of the device the unit price at which the device is set to compute or to deliver as the case may be, and there shall be conspicuously displayed on each side of the device the identity of the product that is being dispensed. If a device is so designed as to dispense more than one grade, brand, blend, or mixture of product, the identity of the grade, brand, blend, or mixture being dispensed shall also be displayed on each face of the device.

S.1.5.1.1. Unit Price.

(a) A computing or money-operated device shall be able to display on each face the unit price at which the device is set to compute or to dispense.

(b) Except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), whenever a grade, brand, blend, or mixture is offered for sale from a device at more than one unit price, then all of the unit prices at which that product is offered for sale shall meet the following conditions:

(1) For a system that applies a discount prior to the delivery, all unit prices shall be displayed or shall be capable of being displayed on the dispenser through a deliberate action of the purchaser prior to the delivery of the product. It is not necessary that all of the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed prior to the delivery of the product.

(2) For a system that offers post-delivery discounts on fuel sales, display of pre-delivery unit price information is exempt from (b)(1), provided the system complies with S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided.

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

S.1.5.1.2. Product Identity.

(a) A device shall be able to conspicuously display on each side the identity of the product being dispensed.

(b) A device designed to dispense more than one grade, brand, blend, or mixture of product also shall be able to display on each side the identity of the grade, brand, blend, or mixture being dispensed.
S.1.6. For Wholesale Devices Only For Retail Motor Vehicle Fuel Devices Only

S.1.6.1. Zero-Set-Back Interlock, Retail Motor-Fuel Devices. – A device shall be constructed so that:

(a) after a delivery cycle has been completed by moving the starting lever to any position that shuts off the device, an automatic interlock prevents a subsequent delivery until the indicating elements, and recording elements if the device is equipped and activated to record, have been returned to their zero positions;

(b) the discharge nozzle cannot 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) until the starting lever is in its designed shut-off position and the zero-set-back interlock has been engaged; and

(c) in a system with more than one dispenser supplied by a single pump, an effective automatic control valve in each dispenser prevents product from being delivered until the indicating elements on that dispenser are in a correct zero position.

S.1.6.2. Provisions for Power Loss.

S.1.6.2.1. Transaction Information. – 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, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.

S.1.6.2.2. User Information. – The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.

S.1.6.3. Display of Unit Price and Product Identity. Except for fleet sales and other price contract sales, a motor vehicle fuel dispenser used to refuel vehicles shall be of the computing type and shall indicate the quantity, the unit price, and the total price of each delivery. The dispenser shall display the volume measured for each transaction.

S.1.6.4. Totalizers for Retail Motor-Fuel Dispensers. – Retail motor-fuel dispensers shall be equipped with a nonresettable totalizer for the quantity delivered through the metering device.

S.1.6.5. Money-Value Divisions. – A computing type 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 L for devices indicating in metric units and 0.01 gal intervals for devices indicating in inch-pound units.

S.1.7. For Wholesale Devices Only. (Renumbered - No Change)

UR.2.7. Unit Price and Product Identity.

(a) The following information shall be conspicuously displayed or posted on the face of a retail dispenser used in direct sale:

(1) except for unit prices resulting from any post-delivery discount and dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), all of the unit prices at which the product is offered for sale; and

(2) in the case of a computing type or money-operated type, the unit price at which the dispenser is set to compute.
Provided that the dispenser complies with S.1.5.1.1. Display of Unit Price, it is not necessary that all the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed or posted.

(b) The following information shall be conspicuously displayed or posted on each side of a retail dispenser used in direct sale:

1. the identity of the product in descriptive commercial terms; and
2. the identity of the grade, brand, blend, or mixture that a multi-product dispenser is set to deliver.

**UR.2.8 Computing Device.** – Any computing device used in an application where a product or grade is offered for sale at one or more unit prices shall be used only for sales for which the device computes and displays the sales price for the selected transaction.

The following exceptions apply:

(a) Fleet sales and other price contract sales are exempt from this requirement.

(b) A truck stop dispenser used exclusively for refueling trucks is exempt from this requirement provided that:

1. all purchases of fuel are accompanied by a printed receipt of the transaction containing the applicable price per gallon, the total gallons delivered, and the total price of the sale; and
   (Added 1993)
2. unless a dispenser complies with S.1.6.4.1. Display of Unit Price, the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.
   (Added 1993)

(c) A dispenser used in an application where a price per unit discount is offered following the delivery is exempt from this requirement, provided the following conditions are satisfied:

1. the unit price posted on the dispenser and the unit price at which the dispenser is set to compute shall be the highest unit price for any transaction;

2. all purchases of fuel are accompanied by a printed receipt recorded by the system for the transaction containing:
   a. the product identity by name, symbol, abbreviation, or code number;
   b. transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount including the:
      1. total volume of the delivery;
      2. unit price; and
      3. total computed price of the fuel sale prior to post-delivery discounts being applied.
   c. an itemization of the post-delivery discounts to the unit price; and
   d. the final total price of the fuel sale.

For systems 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.)
Background / Discussion:
NCWM Publication 14 checklist for Liquefied Natural Gas (LPG) Retail Motor Fuel Devices verifies compliance with specifications, such as: “Power Loss” (which requires a 15 minute power back up) and “Zero-Setback Interlocks.” However, these specifications are not located in Section 3.32 of NIST Handbook 44.

There are LPG devices with NTEP Certificates of Conformance that meet current “power loss” and “zero-setback interlock” requirements. However, there are other LPG retail motor-fuel devices in the field that consist of an assembly of separable, compatible, and type-certified LPG measuring and indicating elements, key/card lock systems that do not meet the power loss and interlock requirements because those requirements are not within the LPG Code and have not been submitted for type evaluation. This creates unfair competition with holders of type certifications for LPG retail dispensers.

There are newer LPG dispensers coming in to use, where measuring, indicating, and computing elements are assembled in Gilbarco retail motor fuel dispenser housings. These LPG devices serve as both propane bottle fillers and as retail motor fuel devices using separate hoses and nozzles on a dispenser. Many of these dispensers, while they do have a good safety history, are not assembled in compliance with safety standards such as UL 495 or 1238, or NFPA 50. Nor are they typically installed in accordance with NFPA 30A or NFPA 70.

Existing retail LPG dispensers can be adapted to fuel LPG-powered motor vehicles by adding a simple adaptor which attaches to the LPG nozzle on the dispensers hose. There are currently 5 active and 2 inactive NTEP Certificates of Conformance for LPG retail motor-fuel dispensers listed in the NCWM Database.

At the 2014 NCWM Interim Meeting Ms. Juana Williams (NIST OWM) commented that OWM believes these changes will better align the LMD and LPG Code with regard to retail dispensing systems. OWM suggests that the following specific items be considered as the item is further developed:

Nonretroactive Status:
OWM notes that some of the paragraphs in the original proposal are suggested as nonretroactive requirements. In reviewing these paragraphs, consideration should be given as to the appropriate nonretroactive date to propose and whether or not the effective dates provided should mirror the effective dates of corresponding paragraphs in the LMD Code.

S.1.4.3. Provisions for Power Loss:
OWM questions whether or not the provisions for power loss in the proposed paragraph “S.1.4.3.1. Transaction Information” should be restricted to “computing” retail LPG dispensers. This corresponding requirement applies to all retail devices in the LMD Code, not just computing-type devices. If a power loss occurs during the use of a digital volume-only retail LPG dispenser, it would seem appropriate to require provisions to ensure that the quantity information can be recalled so that the transaction can be completed. It isn’t clear why there would need to be a distinction between vehicle-mounted and stationary applications.

Additionally, the language proposed in S.1.4.3.1. Transaction Information has some language that doesn’t read correctly. OWM offers the following alternative:

S.1.4.3. Provisions for Power Loss.

S.1.4.3.1. Transaction Information.

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, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.

S.1.4.3.2. User Information. – The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.
S.1.5.1.1. Unit Price: Consideration should be given to whether or not provision needs to be made for “blends” of product for this application. Additionally, the references to paragraph S.1.6.8. refers to an LMD Code paragraph; this reference should be deleted and, perhaps, replaced with a corresponding paragraph of the LPG Code.

Post-Delivery Discounts: For consistency with the LMD Code, the Committee may wish to consider whether provisions for post-delivery discounts should be added to the LPG Code.

S.1.4.1. Indication of Delivery: OWM suggests that the Committee consider modifying paragraph S.1.4.1. Indication of Delivery as follows so that it mirrors the corresponding paragraph (S.1.6.1. Indication of Delivery) in the LMD Code, both in language and in the requirement for electronic devices to inhibit indications until fueling conditions ensure that the delivery starts on zero.

S.1.4.1. Indication of Delivery. – A retail device shall be constructed to show automatically show on its face the initial zero condition and the amounts quantity delivered up to the nominal capacity of the device. However, the following requirements shall apply:

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.

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 that the delivery starts at zero.

[Nonretroactive as of January 1, 2006]

(Amended 2014)

Ornery suggests the Committee consider what nonretroactive dates, if any, should be associated with this paragraph.

S.1.6.2. Provisions for Power Loss: It would seem that the provisions for power loss are already addressed in the proposed paragraph S.1.4.3. Power Loss. Therefore, OWM would suggest deleting S.1.6.2. and its subparagraphs S.1.6.2.1. and S.1.6.2.2.

S.1.6.3. Display of Unit Price: This proposed paragraph is logical. However, OWM questions whether the last sentence regarding volume display is needed given that the “quantity” is already required in the previous sentence.

UR.2.7. (a) (2) Unit Price and Product Identity Wholesale: The word “device” is missing after the word “type.”

UR.2.8. Computing Device: Delete “Added” dates from parts (b)(1) and (b)(2).

This paragraph may also be impacted by action on 310-2 and 330-1, which address requirements for recorded representations in the General and LMD Codes. Should the proposal in 310-2 to reference the use of electronic receipts be adopted, the corresponding reference in this proposed paragraph (UR.2.8.) should be deleted.

Agreement Between Indications on Auxiliary Elements: Consideration should be given to including a paragraph corresponding to LMD Code paragraph S.1.6.6. which addresses agreement of indications with auxiliary elements such as consoles.

General: As part of this overall proposal, consideration should be given to modifying other sections of the LPG Code to mirror the LMD Code more exactly. This could be done by the Technical Advisor and presented to the submitter as the item is further developed if that would be helpful.

The Committee heard comments from John Young (Yolo County California) in support of the proposed changes. The Committee heard comments from OWM (see above) and Mr. Rich Miller (FMC) regarding the need to more closely examine the power loss requirements and how these apply to specific categories of LPG metering systems.
Mr. Miller noted concern in particular that separate batteries have been required for some vehicle-mounted applications in Europe and this has proven problematic for companies.

The Committee supports the objective of making changes to align the LPG and the LMD Code with respect to requirements for retail motor-fuel dispensing applications. Based on the comments received, the Committee believes that additional work is needed before considering the proposal for voting and decided to designate the item as a “Developing” Item to allow the submitter to address the points raised.

Regional Associations Comments:
The CWMA believes this item is sufficiently developed and forwarded it to NCWM, recommending that it be a Voting Item.

The WWMA believes the proposal has merit and contains a complete proposal addressing the issues. The WWMA believes more time is needed for input from other stakeholders and regional associations. The WWMA forwarded this item to NCWM and recommended that it be an Informational Item.

SWMA did not receive any comments opposing the item if the section is the same as the LMD Code. The SWMA recommended the item be moved forward to the NCWM as a Voting Item.

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

332-2 V S.1.5.3. Recorded Representations, Point-of-Sale Systems

Source:
Tennessee Department of Agriculture (2014)

Purpose:
Update the LPG Code in NIST Handbook 44 to include requirements for Retail Dispensers of LPG that are consistent with retail LMD and Mass Flow Meters Code.

Item Under Consideration:
Add the following new paragraph to Section 3.32. LPG and Anhydrous Ammonia Liquid-Measuring Devices Code of NIST Handbook 44 as follows:

S.1.5.3. Recorded Representations, Point-of-Sale Systems. – Except for fleet sales and other price contract sales, a printed receipt providing the following information 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:

(a) the total volume of the delivery;
(b) the unit price;
(c) the total computed price; and
(d) the product identity by name, symbol, abbreviation, or code number.

For systems 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.).

Should the changes to paragraph G-S.5.6. Recorded Representations proposed in Item 310-2 be adopted, the statement in proposed paragraph S.1.5.3. above that refers to electronic receipts would become redundant. Thus, if
Item 310-2 is adopted, the Committee plans to strike the last sentence in the “Item Under Consideration” above prior to offering this item for a vote.

**Background / Discussion:**
Alternative Fuels continue to develop market shares. Government programs are sponsoring the installation of alternative fuel dispensing devices in order to assist in developing an infrastructure. It has come to the submitter’s attention that the LPG Code has never been updated to be consistent with LMD Code and Mass Flow Meters Code requirements for retail dispensers. We should seek consistency across all device types that are used for the same application; in this case, the application of “retail vehicle fueling.” With regard to certain requirements such as displaying information and providing receipts, it shouldn’t matter what type of fuel or type of metering technology is used; the basic application is the same.

This proposal is consistent with Mass Flow Meters Code paragraph S.2.7. Recorded Representations, Point-of-Sale Systems and LMD Code paragraph S.1.6.7. Recorded Representations. There are relatively few LPG dispensers in the U.S. retail market at this time. It is prudent to add this requirement before the market grows and the changes would potentially have a more burdensome impact on existing industry.

At the 2014 NCWM Interim Meeting Ms. Juana Williams (NIST OWM) commented that OWM believes the proposed change will improve consistency between the LMD Code and the LPG Code. Since the corresponding paragraph in the LMD Code (paragraph S.1.6.7.) is nonretroactive as of January 1, 1986, the Committee may wish to ask for input regarding the retroactive status of the proposed paragraph and even consider whether or not the status of the corresponding LMD Code paragraph might need to be reviewed as a future item.

The Committee heard no objections to the addition of the proposed paragraph or its proposed retroactive status. The Committee believes that the addition of this paragraph will further align the LPG and LMD Codes. Consequently, the Committee recommends this item as a Voting Item.

**Regional Association Comments:**
SWMA did not hear any comments opposing the item. The Committee supports the proposal as written and agrees with the submitter. SWMA forwarded the item to the NCWM.

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

### 336 WATER METERS

#### 336-1 W UR.3. Installation Requirements

**Source:**
Neptune Technology Group Inc. (2013)

**Purpose:**
Establish installation requirements in the Water Meters Code.
Item Under Consideration:
Add a new paragraph UR.3. as follows:

**UR.3. Installation Requirements.**

**UR.3.1. Manufacturer’s Instructions.** – A water meter shall be installed in accordance with the manufacturer’s instructions. For utility-type water meters, the installation shall be sufficiently secure and rigid to maintain this condition.

Background / Discussion:
There are no installation requirements for utility type meters in the Water Meters Code of Handbook 44. The submitter proposed the following new paragraph be added to Section 3.36.:

**UR.3. Installation Requirements.**

**UR.3.1. Manufacturer’s Instructions.** – A utility-type water meter shall be installed in accordance with the manufacturer’s instructions, and the installation shall be sufficiently secure and rigid to maintain this condition.

At the 2013 NCWM Interim Meeting, the Committee heard comments in support of the proposal from Mr. Noel, who indicated that he also spoke on behalf of Badger, Sensus, Elster-AMCO, and Master Meter and noted that the proposed change would mirror similar paragraphs in other NIST Handbook 44 measuring device codes. Mr. Jim Byers (San Diego County, CA) stated that he agreed with the proposed requirement, but notes that the General Code already addresses these requirements. He suggested that, if the language in the General Code is not sufficient, then that language should be reviewed and revised rather than including additional language in the specific code. Ms. Kristin Macy (CA) stated that California agrees with Mr. Byers and believes that the language in the General Code is sufficient. Mrs. Juana Williams (NIST OWM) also acknowledged the similarity with language in other codes.

While the Committee acknowledged comments regarding the redundancy of the proposed paragraph with current General Code requirements, the Committee believes the proposal has merit in helping to ensure proper installation of water meters. The Committee believes the requirement in the first sentence of the proposed paragraph regarding compliance with the manufacturer’s instructions should apply to all water meters, not just utility-type meters. Consequently, the Committee modified the language to restrict only the second sentence to utility-type water meters and agreed to propose the modified paragraph (as shown in the “Item Under Consideration” above) for a vote.

One Government representative indicated support; one Government representative indicated a neutral position; and one Government representative indicated opposition for this item on the NCWM Online Position Forum. The opposing comment was accompanied by a statement indicating that paragraph G-UR.2.1. is adequate to address this concern and that paragraph is also more complete and better articulates the requirements.

During its 2013 Annual Meeting Open Hearings, the Committee heard comments in opposition to this item from Mr. Michael Keilty (Endress & Hauser Flowtec AG, USA) and Ms. Macey suggesting that the addition of requirements to address meter installation would be redundant. Mr. Keilty expressed concern that the absence of specific requirements such as these in all specific device codes might cause confusion about how or if the General Code paragraph would apply in other cases. Ms. Macey also expressed opposition to distinguishing between non-utility type and utility type water meters. NIST OWM commented that the proposed language is consistent with that appearing in other device codes in Handbook 44 and intended for the same purpose. The Committee received letters of support from Badger Meter; Elster AMCO Water, LLC; Sensus; Master Meter, Inc.; and Neptune Technology Group. Mr. Dmitri Karimov (Liquid Controls Corporation), speaking on behalf of the companies who were unable to attend this meeting and the Meter Manufacturers Association, also expressed support for this item.

At the 2014 NCWM Interim Meeting, the Committee heard comments opposing the addition of the proposed paragraph. Comments indicated that the language is redundant with corresponding General Code requirements. Based on these comments, the Committee decided to withdraw the item from its agenda.
Regional Association Comments:
The CWMA believes this item needs no further development and recommended that it be a Voting Item.

The WWMA recognized the redundancy of the proposed language and believes it is sufficiently addressed in G-UR.2.1. The WWMA recommended that this item be withdrawn.

NEWMA had previously recommended this as a Voting Item. However, based on new information offered by Ms. Kristin Macey at the 2013 NCWM Annual Meeting, NEWMA now agreed that the item should be withdrawn.

SWMA heard comments on behalf of the manufactures in favor of the item. However the SWMA believes the proposed language is already addressed in the General Code. The SWMA recommends this item be withdrawn.

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

337 MASS FLOW METERS

S&T Committee Note: Proposals under the Committee’s 2014 Interim Agenda Items 337-1 and 337-4 were withdrawn from the agenda in response to comments from the NGSC and the submitter (also a member of the NGSC) who suggested this action because alternative proposals developed by the submitter are intended to replace both items. The alternative proposals (definitions, requirements for quantity indications and markings for the conversion factor to equivalent volume units) and related background information appear under Item 337-2. The Committee also agreed with the NGSC’s recommendation to consolidate the proposals under Items 337-2, 337-3, and 337-5 into a single Item 337-2 with voting status.

337-1 W Appendix D – Definitions: Diesel Liter Equivalent (DLE) and Diesel Gallon Equivalents (DGE); Natural Gas

Source:
Clean Vehicle Education Foundation (2013)

Purpose:
Enable consumers to make cost and fuel economy comparisons between diesel fuel and natural gas.

Item Under Consideration:
Amend NIST Handbook 44, Appendix D – Definitions as follows:

Diesel Liter Equivalent (DLE). - means 0.756 kg of natural gas.

Diesel Gallon Equivalent (DGE). - means 2.863 kg (6.312 lb) of natural gas.

Background / Discussion:
The gasoline gallon equivalent (GGE) unit was defined by NIST/NCWM in 1994 (See Appendix D) to allow users of natural gas vehicles to readily compare costs and fuel economy of light-duty natural gas vehicles with equivalent gasoline powered vehicles. For the medium and heavy duty natural gas vehicles in widespread use today, there is a need to officially define a unit (already in widespread use) allowing a comparison of cost and fuel economy with diesel powered vehicles. Also natural gas is sold as a vehicle fuel as either Compressed Natural Gas (CNG) or Liquified Natural Gas (LNG) and each method of sale is measured in mass. Therefore the generic term natural gas is proposed to be used in Handbooks 44 and 130 with out the existing term "compressed." The mathematics justifying the specific quantity (mass) of natural gas in a DLE and DGE is included in Appendix D.
The official definition of a DLE and a DGE will likely provide justification for California, Wisconsin, and any other state to permit retail sales of LNG for heavy-duty vehicles in these convenient units.

At the 2013 NCWM Interim Meeting, the Committee heard multiple comments in opposition to the proposal. Mr. Keilty opposed the proposal, noting that a truck running on LNG would be dedicated to that type of fuel; thus, there is no need to make comparisons with diesel fuel on an ongoing basis. He stated that he believes natural gas should be sold in units of mass. Ms. Williams reviewed the following points prepared by OWM and suggested that the Committee consider these points in its deliberations on the proposals for this Item and Item 337-2. A copy of these points was also provided to the S&T Committee and the L&R Committee in writing in advance of the Interim Meeting.

**Collaborative Work Effort**

Work in joint session with the NCWM L&R Committee on corresponding L&R Agenda Items 232-1 (a proposal to recognize the diesel volume equivalent MOS for vehicle fuel) and 237-1 (a proposal to define the diesel volume equivalent unit in relation to mass) which specify the allowable unit of measurement for advertising and sale of natural gas. This collaboration between committees will ensure that the proposed volume equivalent unit for a delivery is properly indicated and calculated by a natural gas dispenser.

**Facilitate Marketplace-Value Comparisons**

A dispenser might serve vehicles that are powered by diesel or gasoline fuel. Therefore, which volume equivalent unit (the DGE or GGE) is appropriate to avoid confusing the consumer? What is the most appropriate means to provide sufficient information to customers attempting to make a comparison of fuel offered by the DGE and GGE, whether at the same station or stations on adjacent street corners? Today’s value comparisons are made to petroleum products, but as other alternative fuels proliferate how easy will it be for consumers to make comparisons to other fuels such as electricity or hydrogen?

An alternative that would provide more flexibility for comparison with other fuels and which would potentially create less confusion than permitting multiple different “equivalent” values as “units” of measure is to require the sale of all natural gas in mass units (kg or lb) as suggested by the SWMA. With this approach, customers could still be provided with supplemental information through mechanisms such as pump toppers that provide information about estimated equivalent units of measurement for deliveries indicated in mass as well as information on web sites such as those that already provide information about fuel economy. This approach might also reduce complaints from some suppliers about the accuracy of equivalent values relative to their product.

Another point that has been raised by some in the community and should be considered by the Committee is whether or not “equivalent values” are as necessary as they might have been at one time to encourage consumer acceptance of natural gas as an alternative fuel. For example, the SWMA questioned whether, once a consumer has purchased a vehicle he or she has the need to make ongoing value comparisons or whether this information is more useful prior to purchasing a vehicle. Given the concerns about consumer confusion with a potential proliferation of “equivalent” values at the dispenser, perhaps requiring mass units on the dispenser (with supplemental information about equivalents) is a more appropriate approach.

**Compliance of Existing Approved Equipment-Indications**

As noted above, NIST OWM suggests the Committee consider SWMA’s recommendation for equipment to indicate in a mass unit of measurement. Currently, there are two LNG dispensers with NCWM NTEP Certificates of Conformance (CC). They are NCWM CC 02-075A2* (Chart Industries) and NCWM CC 04-073A1 (NorthStar, Inc.), which specify these dispensers display in mass. How will the proposal apply to this equipment which may not have the capability to display in units other than mass?
Earlier S&T Committee Positions

Does the S&T Committee plan to revisit its 1999 recommendation where it requested data on LNG be submitted prior to the recognition of this product in a metering application? The Committee might also recall that the S&T Committee took a position in 2008 on a related proposal to recognize the “DGE” recommending that a consensus between stakeholders exist on any single energy value used as a conversion factor. NIST OWM notes that several CNG suppliers have raised concerns about the use of 5.660 lb of CNG for each GGE commenting that this value is too low for the fuel they are providing to customers. OWM asks are other sectors, which rely on the accurate accounting of vehicle motor fuel sales, aware of and in agreement with the proposed mass to volume equivalent unit being proposed as a conversion factor value for natural gas (CNG and LNG)?

The data for the heating values cited in Table B.4. “Heat Content for Various Fuels” in the Transportation Energy Data Book Edition 30 (June 2011) was not developed as part of an NCWM study, but represents an account of work by a government sponsored agency to characterize transportation activity and other factors that influence transportation energy use. The book includes a disclaimer which states “in any attempt to compile a comprehensive set of statistics on transportation activity, numerous instances of inadequacies and inaccuracies in the basic data are encountered;” points out that “an appendix is included to document the estimation procedures;” and notes that “neither ORNL nor DOE endorses the validity of these data.”

Ms. Kristin Macey (CA) opposed the proposal and urged the Committee to stop the proliferation of “equivalent units.” She noted that mass units are perfectly good for routine transactions and echoed comments that comparisons with other fuels are only relevant when making a purchase decision. Ms. Carol Hockert (NIST OWM) further suggested that, during its deliberations, the Committee should consider how the establishment of artificial units would affect metrological traceability. Mr. Dmitri Karimov (Liquid Controls Corporation, LLC), speaking on behalf of MMA, agreed with Ms. Hockert, noting that extensive work is done by companies to establish and maintain metrological traceability and the establishment of what amounts to arbitrary values is counterproductive. Mr. Dan Peterson (Yokogawa Corporation of America) echoed all of the statements made in opposition to the proposal.

Mr. Curtis Williams (CP Williams Energy Consulting) stated that he has had concerns about the use of the GGE and GLE for some years and he is glad that some are questioning the need to reconsider the use of equivalent units. As a participant in the U.S. National Working Group on Hydrogen, he was grateful that the associated code for that alternative fuel established requirements for mass units. He suggested that the Committee also consider examining the potential use of mass units for other fuels and noted that the use of mass units also eliminates questions about temperature compensation.

Ms. Judy Cardin (WI) acknowledged the need for the L&R Committee and the S&T Committee to work together on this and related items. She cited two main tasks to be addressed as: (1) What is the right conversion value for the proposed units? and (2) Should units for the sale of natural gas be in “equivalent” units or mass units?

The Committee heard no comments in support of the proposal during its Open Hearings.

During its work sessions at the Interim Meeting, the S&T Committee met with the L&R Committee to discuss this item and related items on the two Committees’ agendas; the corresponding items on the L&R Committee Agenda are Items 232-1 and 237-1. During the joint meeting, the L&R Committee advised the S&T Committee that it had decided to make the related item on their agenda “Informational” to allow additional time for the community to study the issue and hear from other stakeholders in the community. A proposal was made to ask the FALS to deliberate on an appropriate equivalent value for each of the proposed “units.” However, the two Committees recognized that before asking the FALS to expend resources on further definition, the questions and concerns raised in the Open Hearings regarding the appropriateness of recognizing such units should first be addressed. The Committees agreed to recommend to the NCWM Chairman that a small task group be established to further study this issue. The Committees each agreed to develop a list of tasks that they would ask such a task group to take on and to recommend possible members of the group to ensure balanced representation of stakeholders.
After discussion with the L&R Committee, the S&T Committee reviewed and summarized key comments made during the Open Hearings for S&T Committee Agenda Items 337-1 and 337-2:

- Are equivalent units necessary to promote consumer acceptance of this fuel?
- Is there a significant need for continued comparison to other fuels once you have purchased a vehicle? Does this justify the proliferation of “equivalent” values?
- The intent is to add this for medium- and heavy-duty vehicles such as trucks that operate on LNG. Trucks that operate on LNG are generally dedicated fuel vehicles that run only on a single fuel.
- Is the dispenser the appropriate place to make comparisons with other fuels or is a better place to make those comparisons via mechanisms such as pump toppers, websites, etc.?
- Striking the word “compressed” (in the changes proposed in Item 337-2) expands the proposal to LNG.
- California’s approval of LNG meters indicating in mass units was correct.
- What will the impact be on existing approval of LNG dispensers currently indicating in mass?
- There is much opposition to the proliferation of “equivalent units” for various types of fuels.
- The current recognition of GGE and GLE units has led to complaints about equivalent values from both industry and regulatory officials.
- Mass units should be considered for natural gas and other fuels.
- Will the establishment of equivalent values provide traceability to SI units?
- The community expends significant resources to achieve good meter performance and establishing “fuzzy” equivalent values seems to undermine these efforts.
- The factor for any “equivalent unit” will represent only an “estimate” of an equivalent value.
- There is disagreement amongst the industry regarding the appropriate equivalent value in this proposal. The report containing the data that is referenced as the basis for the proposal includes a disclaimer from Oakridge National Laboratory and U.S. Department of Energy regarding its validity for other than general use in the transportation industry.
- The S&T Committee only heard comments in opposition to the proposal.
- Harmonization with OIML requirements should be considered in the method of sale and associated device requirements.

With respect to Items 337-1 and 337-2, the Committee agreed to work collaboratively with the L&R Committee and to develop a small work group to decide: 1) whether or not DLE and DGE should be considered an acceptable method of sale for natural gas; and 2) if so, what should the factor be to determine their equivalents to gasoline. The Committee agreed that the above list of key points and questions heard during its Open Hearings should be considered, along with other Open Hearing comments, by the chairs of both the L&R and S&T Committee in the development of a list of points to be addressed by the Task Group.

On the NCWM Online Position Forum One Government representative indicated support; one Government representative indicated a neutral position; and one Government representative indicated opposition for this item. The neutral position was accompanied by a comment suggesting the establishment of a joint Task Group and
encouraging a final recommendation that would clarify whether the proposed units are or are not permitted. The opposing position was accompanied by a comment indicating opposition to artificial units of measure.

Prior to the 2013 Annual Meeting, NCWM Chairman, Steve Benjamin, appointed the “NCWM Natural Gas Steering Committee,” which will be chaired by Mr. Mahesh Albuquerque (CO). The primary charge of the Committee is to educate the membership regarding: the technical issues surrounding this application; the rationale for the proposed changes; the anticipated impact of the proposed changes and issues related to their implementation. The Committee was asked to identify and address questions raised during the 2013 Interim Meeting as well as other venues in an effort to enable NCWM members to make informed decisions about proposals under consideration in this area.

Also prior to the 2013 Annual Meeting, the Committee received a proposal from Mr. Douglas Horne (Clean Vehicle Education Foundation) to modify the “Item Under Consideration.” Mr. Horne proposed separate definitions for CNG and LNG gallon equivalent values. The Committee suggested he work with the steering committee to further refine the proposal and suggest changes to the item as appropriate. Mr. Horne’s proposals will be posted on the NCWM website with other documents relative to the committee’s final report. While submitted in an NCWM Form 15 template, Mr. Horne’s proposal is not addressing a new issue, but rather providing comments on a current item (337-1) on the Committee’s agenda.

During its 2013 Annual Meeting Open Hearings, the Committee heard an update from Steering Committee Chairman, Mr. Albuquerque. He reported that the Steering Committee met for the first time on Sunday, July 14 at the beginning of the Annual Meeting and gathered input from those in the audience. Comments indicated that consumers may find gallon equivalent information to be helpful, but the most equitable method for measuring and selling the product is based on mass measurement.

The S&T Committee heard overwhelming comments opposing the use of gallon equivalents and favoring the use of mass as the method of sale. The Committee also heard multiple comments indicating concern about the establishment of a value that would be an approximation of the actual equivalent for a given transaction. Mr. Horne reported that some states have already or are in the process of enacting defined “gasoline equivalent” values; some adopted earlier versions of the equivalent and some are considering new values as outlined in Mr. Horne’s most recent proposal.

Ms. Macey noted that the NCWM successfully adopted a method of sale for hydrogen fuel based on mass and suggested that the natural gas be held to the same standard. Mr. Keilty commented that sale of natural gas as a vehicle fuel has proliferated globally and those sales are based on mass units.

OWM acknowledged appreciation of the establishment of the Steering Committee to further study this issue. OWM encourages the S&T Committee, the Steering Committee, and the weights and measures community to consider the points raised by OWM during the 2013 Interim Meeting as well as the following in their deliberations of Item 337-1 and Item 337-2:

In addition to discussing the proposals in Items 337-1 and 337-2, OWM requests that the Task Group specifically discuss and consider whether or not the continued use of the terms “GLE” and “GGE” are appropriate for commercial CNG metering applications. OWM makes this request based on many of the same points made by OWM at the 2013 Interim Meeting and also given that:

1. this market is well established and consumer confidence and acceptance of CNG and other alternative fuels is not contingent upon continued comparisons with gasoline;
2. there are other methods for comparing relatively efficiency and costs with gasoline;
3. experience with feedback from the community indicates problems with the application and validity of these units with changing gas supplies;
4. the proposal in Items 337-1 and 337-2 proposes language which would address natural gas as a whole and it is, therefore, appropriate to raise the discussion of whether or not the continued use of non-traceable units is appropriate. Additionally, OWM suggests that a proposal to eliminate the use of
the terms “GLE” and “GGE” in favor of indications in mass units be developed and considered by the NCWM to ensure commercial transactions for natural gas are based on NIST traceable units of measure; and

(5) as the number of viable alternative fuel options increase, providing a relatively static comparison with only one alternative fuel will not serve the broad needs of consumers and will make it unlikely that the dispenser is the appropriate location to provide comparison information.

The Committee also heard a comment from Mr. Karimov suggesting that volume units be permitted as a method of sale for LNG.

While many people expressed an understanding of the need for consumers to make comparisons with gasoline, comments indicate that such comparisons would typically be made prior to the purchase of a vehicle and possibly for a short time while becoming accustomed to the vehicle. The Committee heard comments indicating that weights and measures officials would be amenable to permitting the posting or displaying of supplemental information regarding gallon equivalent values.

Additional Contacts: Clean Energy, Seal Beach, CA, NGVAmerica, Washington, DC, Clean Vehicle Education Foundation, Acworth, GA.

At the 2014 NCWM Interim Meeting the NGSC suggested that the Committee withdraw this item. The submitter of this item (who is also a member of the NGSC) submitted an alternative item in 2014 that was intended to replace this item. Consequently, the Committee decided to withdraw this item from its agenda.

Regional Association Comments:
CWMA does not support the item as written and recommends that the status remain as Developing. This is based on the lack of traceability for the conversion units proposed. It is suggested that the conversion units if accepted could be supplemental information. The majority of comments heard were in support of selling this product by a known mass i.e. pounds or kilograms. In addition there was concern raised regarding the validity of the current CNG conversion units (GLE & GGE).

WWMA heard support from the LNG industry however the conversions within their proposals need to be developed. WWMA believes there may be a purpose to the proposal; however opposition exists between some regulators and stakeholders regarding the use of the volume equivalent unit of measure. WWMA requests the submitter work through the NCWM Natural Gas Steering Committee to refine the proposal. WWMA also has concerns about the source of the conversion factors used in determining the DGE/DLE. The majority of comments heard were in support of selling this product by a known mass i.e. pounds or kilograms. In addition there was concern raised regarding the validity of the current CNG conversion units (GLE & GGE).

NEWMA recommended that the item remain Informational to give the Steering Committee time to work the items and make suggestions.

SWMA received comments in the Open Hearings indicating that 337-2 and 337-3 were proposed to provide clarity. The Committee recommended 337-2 and 337-3 replace 337-1. The SWMA S&T and L&R Committees met jointly to discuss CNG and LNG items on both agendas. The Committee recommended that this item be withdrawn.

Additional letters, presentations, and data may have been part of the Committee’s consideration. Please refer to http://ncwm.net/meetings/annual/publication-16 to review these documents.
Appendix D – Definitions: Diesel Liter Equivalent (DLE) and Diesel Gallon Equivalents (DGE) for Compressed Natural Gas and Liquefied Natural Gas; Definition of Gasoline Gallon Equivalent and Gasoline Liter Equivalent for Compressed Natural Gas; S.1.2. Compressed Natural Gas and Liquefied Natural Gas Dispensers; S.1.3.1.1. Compressed Natural Gas Used as an Engine Fuel; S.1.3.1.2. Liquefied Natural Gas Used as an Engine Fuel; S.5.2. Marking of Diesel and Gasoline Volume Equivalent Conversion Factor; Compressed Natural Gas, S.5.3. Marking of Diesel Volume Equivalent Conversion Factor; Liquefied Natural Gas, UR.3.1.1. Marking of Equivalent Conversion Factor for Compressed Natural Gas, UR.3.1.2. Marking of Equivalent Conversion Factor for Liquefied Natural Gas, and UR.3.8. Return of Product to Storage, Retail Compressed Natural Gas and Liquefied Natural Gas

The S&T Committee is responding to the NGSC’s June 10, 2014 request to change the NGSC’s March 2014 recommendation for DGE units. The S&T Committee has agreed that the CNG and LNG conversion factors proposed for use in converting these gases to DGE units should be revised in the Interim Report so that their numerical values are expressed to three decimal places rather than two decimal places. These changes are reflected in the following proposed modifications to paragraph S.5.2., proposed new paragraphs S.5.3., UR.3.1.1., and UR.3.1.2., and to the proposed new definition for “diesel gallon equivalent” to read: 1 Diesel Gallon Equivalent (DGE) is 6.380 6.384 pounds of Compressed Natural Gas and 1 Diesel Gallon Equivalent of Liquefied Natural Gas is 6.056 6.059 pounds.

Source:
Clean Vehicle Education Foundation (2014)

Purpose:
Since natural gas is sold in the retail market place as compressed natural gas (CNG) and liquefied natural gas (LNG) an alternative fuel to gasoline and diesel fuel, the proposed additions and edits to Handbook 44 will provide definitions for volume units of CNG and LNG that are the energy equivalents for diesel liters and gallons so that end users can readily compare cost and fuel economy. At present only equivalents for gasoline are included in NIST Handbooks 44 and 130 for CNG as an engine fuel. The proposal also includes modification to definitions for gasoline volume equivalents to clarify those terms apply to CNG.

Item Under Consideration:
Amend NIST Handbook 44 Appendix D to include new definitions as follows:

(Added 2014)

diesel liter equivalent (DLE). – means 0.765 kilograms of compressed natural gas or 0.726 kilograms of liquefied natural gas. [3.37]
(Added 2014)

Amend NIST Handbook 44 Appendix D definitions as follows:

gasoline gallon equivalent (GGE). – Gasoline gallon equivalent (GGE) means 5.660 pounds of compressed natural gas.[3.37]
(Added 1994)(Amended 2014)

gasoline liter equivalent (GLE). – Gasoline liter equivalent (GLE) means 0.678 kilograms of compressed natural gas.[3.37]
(Added 1994)(Amended 2014)
Amend NIST Handbook 44 Mass Flow Meters Code paragraphs S.1.2., S.1.3.1.1., S.5.2., and UR.3.8. and add new paragraphs S.1.3.1.2., S.5.3., UR.3.1.1. and UR.3.1.2. as follows:

**S.1.2. Compressed Natural Gas and Liquefied Natural Gas Dispensers.** – Except for non-retail fleet sales and other price contract sales, a compressed natural gas and liquefied natural gas dispensers used to refuel vehicles shall be of the computing type and shall indicate the quantity, the unit price, and the total price of each delivery. The dispensers shall display the mass measured for each transaction either continuously on an external or internal display accessible during the inspection and test of the dispensers, or display the quantity in mass units by using controls on the device.

(Added 1994)(Amended 2014)

**S.1.3. Units**

**S.1.3.1. Compressed Natural Gas Used as an Engine Fuel.** – When compressed natural gas is dispensed as an engine fuel, the delivered quantity shall be measured in mass and indicated in “gasoline liter equivalent (GLE) units,” “gasoline gallon equivalent (GGE) units,” diesel liter equivalent (DLE) units, or diesel gallon equivalent (DGE) units (Also see definitions).

(Added 1994)(Amended 2014)

**S.1.3.1.2. Liquefied Natural Gas Used as an Engine Fuel.** – When liquefied natural gas is dispensed as an engine fuel, the delivered quantity shall be measured in mass and indicated in “diesel liter equivalent (DLE) units” or “diesel gallon equivalent (DGE) units” (Also see definitions).

(Added 2014)

**S.5.2. Marking of Equivalent Conversion Factor for Compressed Natural Gas.** – A device dispensing compressed natural gas shall have either the statements “1 Gasoline Liter Equivalent (GLE) is Approximately Equal to 0.678 kg of Compressed Natural Gas” and “1 Diesel Liter Equivalent (DLE) is Approximately Equal to 0.765 kg of Compressed Natural Gas” or the statements “1 Gasoline Gallon Equivalent (GGE) is Approximately Equal to 5.660 lb of Compressed Natural Gas” and “1 Diesel Gallon Equivalent (DGE) is Approximately Equal to 6.384 lb of Compressed Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(Added 1994, amended 2014)

**S.5.3. Marking of Diesel Volume Equivalent Conversion Factor for Liquefied Natural Gas.** – A device dispensing liquefied natural gas shall have either the statement "1 Diesel Liter Equivalent (DLE) is Approximately Equal to 0.726 kg of Liquefied Natural Gas" or "1 Diesel Gallon Equivalent (DGE) is Approximately Equal to 6.059 lb of Liquefied Natural Gas" permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(Added 2014)

**UR.3.1.1. Marking of Equivalent Conversion Factor for Compressed Natural Gas.** – A device dispensing compressed natural gas shall have either the statements “1 Gasoline Liter Equivalent (GLE) is Approximately Equal to 0.678 kg of Compressed Natural Gas” and “1 Diesel Liter Equivalent (DLE) is Approximately Equal to 0.765 kg of Compressed Natural Gas” or the statements “1 Gasoline Gallon Equivalent (GGE) is Approximately Equal to 5.660 lb of Compressed Natural Gas” and “1 Diesel Gallon Equivalent (DGE) is Approximately Equal to 6.384 lb of Compressed Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(Added 2014)

**UR.3.1.2. Marking of Equivalent Conversion Factor for Liquefied Natural Gas.** - A device dispensing liquefied natural gas shall have either the statement "1 Diesel Liter Equivalent (DLE) is Approximately Equal to 0.726 kg of Liquefied Natural Gas" or "1 Diesel Gallon Equivalent (DGE) is Approximately Equal
to 6,059 lb of Liquefied Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.
(Added 2014)

UR.3.8. Return of Product to Storage, Retail Compressed Natural Gas and Liquefied Natural Gas Dispensers. – Provisions at the site shall be made for returning product to storage or disposing of the product in a safe and timely manner during or following testing operations. Such provisions may include return lines, or cylinders adequate in size and number to permit this procedure.
(Added 1998)(Amended 2014)

Background / Discussion:
The gasoline gallon equivalent (GGE) unit was defined by NCWM in 1994 to allow users of natural gas vehicles to readily compare costs and fuel economy of light-duty compressed natural gas vehicles with equivalent gasoline powered vehicles. More background on the efforts of NIST/NCWM is available in the Reports of the 78th and 79th NCWM in NIST Special Publication 854 and 870 (see pages 322 and 327, respectively). Natural gas is sold as a vehicle fuel as either Compressed Natural Gas (CNG) or Liqufied Natural Gas (LNG). For medium and heavy duty natural gas vehicles in widespread use today, there is a need to officially define a unit allowing a comparison of cost and fuel economy with diesel powered vehicles. The submitter stated that the official definition of a DLE and a DGE will likely provide justification for California, Wisconsin and many other states to permit retail sales of CNG for heavy-duty vehicles in these convenient units. The submitter has provided a mathematical justification for the specific quantity (mass) of compressed natural gas in a DLE and DGE which is included in Appendix D.

January 2013 NCWM Interim Meeting

At the 2013 NCWM Interim Meeting, the Committee heard multiple comments in opposition to the proposal. Mr. Michael Keilty (Endress + Hauser Flowtec AG, USA) opposed the proposal, noting that a truck running on LNG would be dedicated to that type of fuel; thus, there is no need to make comparisons with diesel fuel on an ongoing basis. He stated that he believes natural gas should be sold in units of mass.

Ms. Williams reviewed the following points prepared by OWM and suggested that the Committee consider these points in its deliberations on the proposals for this Item and Item 337-2 (a proposal to recognize a gasoline and diesel volume equivalent unit for CNG, a diesel volume equivalent for LNG engine fuel and for marking the fuel dispenser). A copy of these points was also provided to the S&T Committee and the L&R Committee in writing in advance of the Interim Meeting.

Collaborative Work Effort

Work in joint session with the NCWM L&R Committee on corresponding L&R Agenda Items 232-1 (a proposal to recognize the diesel volume equivalent MOS for vehicle fuel) and 237-1 (a proposal to define the diesel volume equivalent unit in relation to mass) which specify the allowable unit of measurement for advertising and sale of natural gas. This collaboration between committees will ensure that the proposed volume equivalent unit for a delivery is properly indicated and calculated by a natural gas dispenser.

Facilitate Marketplace-Value Comparisons

A dispenser might serve vehicles that are powered by diesel or gasoline fuel. Therefore, which volume equivalent unit (the DGE or GGE) is appropriate to avoid confusing the consumer? What is the most appropriate means to provide sufficient information to customers attempting to make a comparison of fuel offered by the DGE and GGE, whether at the same station or stations on adjacent street corners? Today’s value comparisons are made to petroleum products, but as other alternative fuels proliferate how easy will it be for consumers to make comparisons to other fuels such as electricity or hydrogen?

An alternative that would provide more flexibility for comparison with other fuels and which would potentially create less confusion than permitting multiple different “equivalent” values as “units” of measure is to require the sale of all natural gas in mass units (kg or lb) as suggested by the SWMA. With
this approach, customers could still be provided with supplemental information through mechanisms such as pump toppers that provide information about estimated equivalent units of measurement for deliveries indicated in mass as well as information on web sites such as those that already provide information about fuel economy. This approach might also reduce complaints from some suppliers about the accuracy of equivalent values relative to their product.

Another point that has been raised by some in the community and should be considered by the Committee is whether or not “equivalent values” are as necessary as they might have been at one time to encourage consumer acceptance of natural gas as an alternative fuel. For example, the SWMA questioned whether, once a consumer has purchased a vehicle he or she has the need to make ongoing value comparisons or whether this information is more useful prior to purchasing a vehicle. Given the concerns about consumer confusion with a potential proliferation of “equivalent” values at the dispenser, perhaps requiring mass units on the dispenser (with supplemental information about equivalents) is a more appropriate approach.

**Compliance of Existing Approved Equipment-Indications**

As noted above, NIST OWM suggests the Committee consider SWMA’s recommendation for equipment to indicate in a mass unit of measurement. Currently, there are two LNG dispensers with NCWM NTEP Certificates of Conformance (CC). They are NCWM CC 02-075A2* (Chart Industries) and NCWM CC 04-073A1 (NorthStar, Inc.), which specify these dispensers display in mass. How will the proposal apply to this equipment which may not have the capability to display in units other than mass?

**Earlier S&T Committee Positions**

Does the S&T Committee plan to revisit its 1999 recommendation where it requested data on LNG be submitted prior to the recognition of this product in a metering application? The Committee might also recall that the S&T Committee took a position in 2008 on a related proposal to recognize the “DGE” recommending that a consensus between stakeholders exist on any single energy value used as a conversion factor. NIST OWM notes that several CNG suppliers have raised concerns about the use of 5.660 lb of CNG for each GGE commenting that this value is too low for the fuel they are providing to customers. OWM asks are other sectors, which rely on the accurate accounting of vehicle motor fuel sales, aware of and in agreement with the proposed mass to volume equivalent unit being proposed as a conversion factor value for natural gas (CNG and LNG)?

The data for the heating values cited in Table B.4. “Heat Content for Various Fuels” in the Transportation Energy Data Book Edition 30 (June 2011) and used to justify the factors for the conversion of mass to “equivalent volume units” was not developed as part of an NCWM study, but represents an account of work by a government sponsored agency to characterize transportation activity and other factors that influence transportation energy use. The book includes a disclaimer which states “in any attempt to compile a comprehensive set of statistics on transportation activity, numerous instances of inadequacies and inaccuracies in the basic data are encountered;” points out that “an appendix is included to document the estimation procedures;” and notes that “neither ORNL nor DOE endorses the validity of these data.”

Ms. Kristin Macey (CA) opposed the proposal and urged the Committee to stop the proliferation of “equivalent units.” She noted that mass units are perfectly good for routine transactions and echoed comments that comparisons with other fuels are only relevant when making a vehicle purchase decision. Ms. Carol Hockert (NIST OWM) further suggested that, during its deliberations, the Committee should consider how the establishment of artificial units would affect metrological traceability. Mr. Dmitri Karimov (Liquid Controls Corporation, LLC), speaking on behalf of MMA, agreed with Ms. Hockert, noting that extensive work is done by companies to establish and maintain metrological traceability and the establishment of what amounts to arbitrary values is counterproductive. Mr. Dan Peterson (Yokogawa Corporation of America) echoed all of the statements made in opposition to the proposal.

Mr. Curtis Williams (CP Williams Energy Consulting) stated that he has had concerns about the use of the GGE and GLE for some years and he is glad that some are questioning the need to reconsider the use of equivalent units. As a participant in the U.S. National Working Group on Hydrogen, he was grateful that the associated code for that
alternative fuel established requirements for mass units. He suggested that the Committee also consider examining the potential use of mass units for other fuels and noted that the use of mass units also eliminates questions about temperature compensation.

Ms. Judy Cardin (WI) acknowledged the need for the L&R Committee and the S&T Committee to work together on this and related items. She cited two main tasks to be addressed as: What is the right conversion value for the proposed units and Should units for the sale of natural gas be in “equivalent” units or mass units?

The Committee heard no comments in support of the proposal during its Open Hearings.

During its work sessions at the Interim Meeting, the S&T Committee met with the L&R Committee to discuss this item and related items on the two Committees’ agendas; the corresponding items on the L&R Committee Agenda are Items 232-1 and 237-1. During the joint meeting, the L&R Committee advised the S&T Committee that it had decided to make the related item on their agenda “Informational” to allow additional time for the community to study the issue and hear from other stakeholders in the community. A proposal was made to ask the FALS to deliberate on an appropriate equivalent value for each of the proposed “units.” However, the two Committees recognized that before asking the FALS to expend resources on further definitions, the questions and concerns raised in the Open Hearings regarding the appropriateness of recognizing such units should first be addressed. The Committees agreed to recommend to the NCWM Chairman that a small task group be established to further study this issue. The Committees each agreed to develop a list of tasks that they would ask such a task group to take on and to recommend possible members of the group to ensure balanced representation of stakeholders.

After discussion with the L&R Committee, the S&T Committee reviewed and summarized key comments made during the Open Hearings for S&T Committee Agenda items 337-1 and 337-2:

- Are equivalent units necessary to promote consumer acceptance of this fuel?
- Is there a significant need for continued comparison to other fuels once you have purchased a vehicle? Does this justify the proliferation of “equivalent” values?
- The intent is to add this for medium- and heavy-duty vehicles such as trucks that operate on LNG. Trucks that operate on LNG are generally dedicated fuel vehicles that run only on a single fuel.
- Is the dispenser the appropriate place to make comparisons with other fuels or is a better place to make those comparisons via mechanisms such as pump toppers, websites, etc.?
- Striking the word “compressed” (in the changes proposed in Item 337-2) expands the proposal to LNG.
- California’s approval of LNG meters indicating in mass units was correct.
- What will the impact be on existing approval of LNG dispensers currently indicating in mass?
- There is much opposition to the proliferation of “equivalent units” for various types of fuels.
- The current recognition of GGE and GLE units has led to complaints about equivalent values from both industry and regulatory officials.
- Mass units should be considered for natural gas and other fuels.
- Will the establishment of equivalent values provide traceability to SI units?
- The community expends significant resources to achieve good meter performance and establishing “fuzzy” equivalent values seems to undermine these efforts.
- The factor for any “equivalent unit” will represent only an “estimate” of an equivalent value.
• There is disagreement amongst the industry regarding the appropriate equivalent value in this proposal. The report containing the data that is referenced as the basis for the proposal includes a disclaimer from Oakridge National Laboratory and U.S. Department of Energy regarding its validity for other than general use in the transportation industry.

• The S&T Committee only heard comments in opposition to the proposal.

• Harmonization with OIML requirements should be considered in the method of sale and associated device requirements.

With respect to items 337-1 and 337-2, the Committee agreed to work collaboratively with the L&R Committee and to develop a small work group to decide: 1) whether or not DLE and DGE should be considered an acceptable method of sale for natural gas; and 2) if so, what should the factor be to determine their equivalents to gasoline. The Committee agreed that the above list of key points and questions heard during its Open Hearings should be considered, along with other Open Hearing comments, by the chairs of both the L&R and S&T Committee in the development of a list of points to be addressed by the Task Group.

On the NCWM Online Position Forum one Government representative indicated support; one Government representative indicated a neutral position; and one Government representative indicated opposition for this item. The neutral position was accompanied by a comment suggesting the establishment of a joint Task Group and encouraging a final recommendation that would clarify whether the proposed units are or are not permitted. The opposing position was accompanied by a comment indicating opposition to artificial units of measure.

Prior to the 2013 Annual Meeting, NCWM Chairman, Steve Benjamin, appointed the “NCWM Natural Gas Steering Committee,” which will be chaired by Mr. Mahesh Albuquerque (CO). The primary charge of the Committee is to educate the membership regarding: the technical issues surrounding this application; the rationale for the proposed changes; the anticipated impact of the proposed changes and issues related to their implementation. The Committee was asked to identify and address questions raised during the 2013 Interim Meeting as well as other venues in an effort to enable NCWM members to make informed decisions about proposals under consideration in this area.

Also prior to the 2013 Annual Meeting, the Committee received a proposal from Mr. Douglas Horne (Clean Vehicle Education Foundation) to modify the “Item Under Consideration.” Mr. Horne proposed separate definitions for CNG and LNG gallon equivalent values. The Committee suggested he work with the steering committee to further refine the proposal and suggest changes to the item as appropriate. Mr. Horne’s proposals were posted on the NCWM website with other documents relative to the committee’s final report. While submitted in an NCWM Form 15 template, Mr. Horne’s proposal is not addressing a new issue, but rather providing comments on a current item (337-1) on the Committee’s agenda.

**July 2013 NCWM Annual Meeting**

During its 2013 Annual Meeting Open Hearings, the Committee heard an update from Steering Committee Chairman, Mr. Albuquerque. He reported that the Steering Committee met for the first time on Sunday, July 14 at the beginning of the Annual Meeting and gathered input from those in the audience. Comments indicated that consumers may find gallon equivalent information to be helpful, but the most equitable method for measuring and selling the product is based on mass measurement.

At the 2013 NCWM Annual Meeting, the Committee heard comments on Items 337-1 and Items 337-2 jointly. Details of those comments are outlined below.

The S&T Committee heard overwhelming comments opposing the use of gallon equivalents and favoring the use of mass as the method of sale. The Committee also heard multiple comments indicating concern about the establishment of a value that would be an approximation of the actual equivalent for a given transaction. Mr. Horne reported that some states have already or are in the process of enacting defined “gasoline equivalent” values; some
adopted earlier versions of the equivalent and some are considering new values as outlined in Mr. Horne’s most recent proposal.

Ms. Macey noted that the NCWM successfully adopted a method of sale for hydrogen fuel based on mass and suggested that the natural gas be held to the same standard. Mr. Keilty commented that sale of natural gas as a vehicle fuel has proliferated globally and those sales are based on mass units.

OWM acknowledged appreciation of the establishment of the Steering Committee to further study this issue. OWM encourages the S&T Committee, the Steering Committee, and the weights and measures community to consider the points raised by OWM during the 2013 Interim Meeting as well as the following in their deliberations of Items 337-1 and Item 337-2:

In addition to discussing the proposals in Items 337-1 and 337-2, OWM requests that the Steering Committee specifically discuss and consider whether or not the continued use of the terms “GLE” and “GGE” are appropriate for commercial CNG metering applications. OWM makes this request based on many of the same points made by OWM at the 2013 Interim Meeting and also given that:

1. this market is well established and consumer confidence and acceptance of CNG and other alternative fuels is not contingent upon continued comparisons with gasoline;

2. there are other methods for comparing relative efficiency and costs with gasoline;

3. experience with feedback from the community indicates problems with the application and validity of these units with changing gas supplies;

4. the proposal in Items 337-1 and 337-2 proposes language which would address natural gas as a whole and it is, therefore, appropriate to raise the discussion of whether or not the continued use of non-traceable units is appropriate. Additionally, OWM suggests that a proposal to eliminate the use of the terms “GLE” and “GGE” in favor of indications in mass units be developed and considered by the NCWM to ensure commercial transactions for natural gas are based on NIST traceable units of measurement; and

5. as the number of viable alternative fuel options increase, providing a relatively static comparison with only one alternative fuel will not serve the broad needs of consumers and will make it unlikely that the dispenser is the appropriate location to provide comparison information.

The Committee also heard a comment from Mr. Karimov suggesting that volume units be permitted as a method of sale for LNG.

While many people expressed an understanding of the need for consumers to make comparisons with gasoline, comments indicate that such comparisons would typically be made prior to the purchase of a vehicle and possibly for a short time while becoming accustomed to the vehicle. The Committee heard comments indicating that weights and measures officials would be amenable to permitting the posting or displaying of supplemental information regarding gallon equivalent values.

**January 2014 NCWM Interim Meeting**

The Committee met with the L&R Committee to discuss the comments received on Items 337-1 through 337-5 and corresponding items on the L&R Committee’s agenda. Although there are three new proposals on the agenda several appear to require clarification from the submitter on whether they are replacements for several carryover proposals. The two Committees heard an update from Mahesh Albuquerque (CO) speaking as Chairman of the NCWM Natural Gas Steering Committee (NGSC).

Ms. Williams reviewed the following points prepared by OWM and suggested that the Committees consider these points in their deliberations on the proposals:
OWM encourages the:
  - Efforts of the NCWM Natural Gas Steering Committee as it works to provide corresponding proposals to the L&R Committee and S&T Committee.
  - Collaboration with FALS on:
    - Fuel properties data
    - The final vetting of data, formulas, etc. used to arrive at any conversion factors that might be recognized for use in supplemental advertising/sales information

OWM notes that some of the current wording in the 2012 and 2013 proposals is somewhat confusing, in part, because several paragraphs include previous conversion factors no longer under consideration.

The latest proposal encourages a proliferation of equivalent units of measurement, at least six for the CNG and LNG RMFD applications.

Measurement accuracy and traceability are not achieved through computation of the sale’s information in equivalent quantity units since the conversion factor is an estimated value.

OWM suggests input from stakeholders such as the CNG and LNG RMFD OEMs and agencies regulating other sectors (such as the motor fuels taxation departments) in the natural gas infrastructure on the impact of any new proposal.

The last point that OWM would like to suggest the Committees consider that additional work might be necessary to further modify the code to fully recognize the LNG application. NIST has plans to outline an approach for a similar project.

The S&T Committee and L&R Committee agreed with the suggestions provided by the NGSC for addressing these items. As a result of these discussions, the S&T Committee agreed to the following regarding Items 337-1 through 337-5:

- Withdraw Items 337-1 and 337-4 and consolidate the remaining three items (337-2, 337-3, and 337-5) into a single item.
- Ask that the NGSC rework its proposed changes to NIST Handbook 44 to reflect the comments heard during the Committee’s open hearings and in writing.
- Designate the consolidated item as a “Voting” item in anticipation that the NGSC will present a revised version of the proposed changes to NIST Handbook 44 prior to the publication of the Committee’s Interim Report.

If the revised version of the code is not presented prior to the publication date or agreement cannot be reached within the NGSC or the S&T Committee on the revised version, the Committee agreed to designate this consolidated item as an “Information” item.

March 2014 Natural Gas Steering Committee Report to the L&R and S&T Committees

The Natural Gas Steering Committee (NGSC) was formed in July 2013 to help understand and educate the NCWM membership regarding the technical issues surrounding the proposed changes to HB 44 and HB 130 submitted by the Clean Vehicle Education Foundation (CVEF), the anticipated impact of the proposed changes, and issues related to implementation requirements when compressed natural gas (CNG) and liquefied natural gas (LNG) are dispensed and sold as a retail engine fuel in gallon equivalent units.

At the NCWM Interim Meeting in January 2014, Mahesh Albuquerque, chair of the NGSC provided the S&T and L&R Committees with an update from the NGSC, including proposed revisions to the proposals submitted by the CVEF. The NGSC heard comments from the floor related to the proposed revisions and requested additional time to further develop its recommendations. The S&T and L&R Committees agreed to allow the NGSC additional time to meet and develop alternative proposals to those on the S&T and L&R Committees January 2014 agendas, with the expectation that the NGSC recommendations would be ready for inclusion in Publication 16, and moved forward as a voting item at the July 2014 NCWM Annual Meeting.
Summary of NGSC Meeting Discussions

The NGSC met weekly following the January 2014 Interim Meeting, and focused on modifying the Clean Vehicle Education Foundation (CVEF) 2013 proposals for the recognition of diesel gallon equivalent (DGE) units for CNG/LNG dispenser indications and the method of sale for these two natural gas alternative engine fuels. The NGSC reviewed multiple modifications to those proposals including:

- limiting sales to a single unit of mass measurement enforceable by 2016;
- requiring indications in mass and gasoline and diesel gallon equivalents, while phasing in mass only units;
- require sale by mass as the primary means, but allow for the simultaneous display of volume equivalent units, so long as the purchaser always had access to the mass (traceable) measurement; and
- a proposal from NIST OWM which would allow the posting of supplemental information to assist consumers in making value comparisons and for use by taxation/other agencies, but requiring the phase in of indications in mass

The NGSC received:

- updates from CNG (3) and LNG (1) dispenser manufacturers indicating their dispensing systems comply with the requirements in the handbooks, and have the capability to indicate a sale in a single unit of measurement, and any further input on adding displays to the cabinet for additional units would require further cost analysis; while one OEM indicated use of their LNG RMFD in a fleet operation where indications are only in the DGE; and
- feedback from committee members related to the pros and cons of requiring the indication of sale in mass or gallon equivalent units, including traceability, equipment capabilities, marketplace considerations, and units used by state and federal agencies.

Also noted in the NGSC discussions were:

- how a gallon equivalent unit is derived using energy content, and that the gallon equivalent is defined and measured in terms of mass, not volume;
- for the last 20 years, HB44 and 130 have required all dispensing equipment to indicate deliveries of natural gas in GGE units to consumers, and in mass units for inspection and testing purposes. CNG RMFD equipment in the most states comply with the requirements in the handbooks;
- international practices for indicating CNG and LNG engine fuel deliveries are predominantly mass; Canada requires LNG indications in the kilogram and the corresponding OIML R 139 “Compressed gaseous fuel measuring systems for vehicles” standard requires indication of the measured gas in mass;
- the variations in engine efficiency relative to a single conversion factor based on an averaged energy content for LNG and the primary focus of the driving public and fleets on mileage rather than petroleum products no longer used to fuel their vehicles;
- the work ahead over the next year by ASTM committees to develop current CNG and LNG fuel quality standards which will need to be referenced in HB 130;
• differences in the measurement of the gallon and kilogram -- since the gallon is a volume measurement and not an energy measurement, and the HB 44 Mass Flow Meters Code includes a requirement for volume-measuring devices with ATC used in natural gas applications to be equipped with an automatic means to make corrections, if the devices is affected by changes in the properties of the product; it was also noted that U.S. gasoline and diesel dispensers are not required to have ATC; whereas ATC does occur in sales at the wholesale level;

• how traceability applies to the measurement results at each level of the custody chain (to include the determination of the uncertainty of all calibrations and use of an appropriate unit of measurement); and

• the capabilities of equipment in the marketplace.

A DOE representative supported the use of gallon equivalents, and pointed out that they are used in the DOE Transportation Energy Data Book. The DOE representative also pointed out that other federal agencies including the IRS were requiring use of gallon equivalent units for reporting.

Industry representatives on the NGSC indicated that they are actively campaigning to their state and federal offices, encouraging each government branch to recognize sales of CNG and LNG in gasoline and diesel volume equivalent units. Industry sectors represented on the NGSC indicated that their customers are satisfied with the averaged fuel energy values that correspond to the conversion factors for CNG and LNG, with only one exception. The exception was a truck stop chain indicating their customers would be amenable to a single conversion factor for both fuels. The CVEF also provided a comparison of GTI’s 1992 study results and preliminary data from a 2013 study. The CVEF reported the constituents in natural gas as basically unchanged over 21 years since the NCWM first recognized the GGE. Industry unanimously opposed a recommendation for phasing in mass as the only unit of measurement, noting also that U.S. drivers would be confused by SI units while acknowledging that the U.S. is in the minority of countries whereby delivery and sales are by equivalent units. At the conclusion of the NGSC deliberations NGVAmerica provided the following statement:

“One of the major advantages of the proposal as currently drafted with inclusion of the DGE and GGE units for natural gas is that this is a proposal that the natural gas industry can support. It further recognizes what is already the preferred practice for how natural gas is measured and dispensed. The latest proposal with DGE and GGE units provides a pathway forward toward a national consensus approach. If the proposal were to instead require use of kilograms or even pounds as the primary method of sale, industry would not support that proposal and likely would strongly oppose it this summer if NCWM were to consider it as a voting issue. Also, if NCWM finalizes on a standard that does not include DGE or GGE, industry is committed to pursuing adoption of an alternative standard on a state by state basis, which could lead to different treatment across the country. Several states have already introduced legislation to recognize the DGE standard (CA, IL, MO, and VA) and I expect more will do so later this year. And you know Colorado and Arkansas already have put in place standards that recognize the DGE units.”

**NGSC Recommendations:**

After consideration of all of the above, the NGSC recommends alternate proposals to the L&R and S&T Committee Agenda Items which further modify and consolidate the Clean Vehicle Education Foundation 2013 proposals to include:

1) requirements for measurement in mass and indication in gallon equivalent units (HB 44 paragraphs S.1.3.1.1. and S.1.3.1.2.; and HB 130 paragraphs 3.11.2.1. and 3.12.2.1.);

2) posting of a label that has both the GGE and DGE or the GLE and DLE for CNG applications (HB 44 paragraphs S.5.2., S.5.3., UR.3.1.1., and UR.3.1.2.; and HB 130 paragraphs 3.11.2.2. and 3.12.2.2.);

3) expression of all equivalent conversion factors expressed in mass units to 3 significant places beyond the decimal point for consistency (HB 44 paragraphs S.5.2., S.5.3., UR.3.1.1., and UR.3.1.2 and Appendix D and HB 130 Section 1, paragraphs 3.11.2.2. and 3.12.2.2.).
4) correction of the temperatures in the LNG definition (HB 130 Section 1);

5) addition of 16 CFR Part 309 for CNG automotive fuel rating (HB 130 paragraph 3.11.2.2.5.); and

6) reference to NFPA 52 (HB 130 paragraph 3.12.2.2.4.)

With regards to Handbook 44 the NGSC recommends withdrawing S&T Agenda Items 337-1 and 337-4 and the consolidation of Agenda Items 337-2, 337-3, and 337-5 into a newly revised single Voting Item designated as 337-2. The NGSC also recommends further modifications to corresponding HB 130 proposals to align the definitions of related terms and method of sale with definitions, indicated delivery and dispenser labeling requirements being proposed for HB 44.

With regards to Handbook 44, the NGSC also recommends consideration of new a Developing Item addressing proposed changes to paragraph S.3.6 Automatic Density Correction designated as 360-4. This new proposal is consistent with the NGSC decision to encourage further work beyond the current scope of their work on the CVEF’s proposals to fully address all LNG applications.

Representatives of the NGSC and the S&T and L&R Committees met in March 2014, all agreed on the course of action outlined above.

Additional Contacts: Clean Energy, Seal Beach, CA, NGV America, Washington, DC, Clean Vehicle Education Foundation, Acworth, GA. Regional Association Comments: (Fall 2013 Input on the Committee’s 2014 Interim Agenda Items 337-1 through 337-5)

Amend NIST Handbook 44, Appendix D – New Definitions for Diesel Volume Equivalents for Natural Gas (this approach established a single factor for both CNG and LNG) [submitted 2013, formerly 337-1]

Regional Associations Comments:

CWMA does not support the item as written and recommends that the status remain as Developing. This is based on the lack of traceability for the conversion units proposed. It is suggested that the conversion units if accepted could be supplemental information. The majority of comments heard were in support of selling this product by a known mass, i.e., pounds or kilograms. In addition there was concern raised regarding the validity of the current CNG conversion units (GLE & GGE).

WWMA heard support from the LNG industry however the conversions within their proposals need to be developed. WWMA believes there may be a purpose to the proposal; however opposition exists between some regulators and stakeholders regarding the use of the volume equivalent unit of measure. WWMA requests the submittor work through the NCWM Natural Gas Steering Committee to refine the proposal. WWMA also has concerns about the source of the conversion factors used in determining the DGE/DLE. The source being the entities sited for establishing the BTU heating value for diesel. The WWMA also has concerns about the source of the conversion factors used in determining the DGE/DLE. The source being the entities sited for establishing the BTU heating value for diesel. The WWMA also believes consideration should be given to neighboring countries’ established methods of sale and the units of measure for LNG. WWMA believes this item may be better served as a supplementary advertisement and used for customer information and not for a traceable method of sale. The S&T/L&R Committee’s should work together as this item develops. WWMA recommended that the item remain as a Developing Item.

NEWMA recommended that the item remain Informational to give the Steering Committee time to work the items and make suggestions.

SWMA received comments in the Open Hearings indicating that 337-2 and 337-3 were proposed to provide clarity. The Committee recommended 337-2 and 337-3 replace 337-1. The SWMA S&T and L&R Committees met jointly to discuss CNG and LNG items on both agendas. The Committee recommended that this item be withdrawn.

Amend NIST Handbook 44, Appendix D – New Definitions for Diesel Volume Equivalents for Compressed Natural Gas [formerly 337-2]
CWMA did not forward this item to NCWM, stating that it is a duplicate to correct the conversion factor.

WWMA did not forward this item to NCWM and recommends that the submitter incorporate the pertinent information into Item 337-1.

NEWMA forwarded the item to NCWM and recommended the item be designated as Informational to give the Steering Committee time to work the items and make suggestions.

SWMA received comments in the Open Hearing indicating that 337-2 and 337-3 were proposed to provide clarity. The committee recommends 337-2 and 337-3 replace 337-1. The SWMA S&T and L&R Committees met jointly to discuss CNG and LNG items on both agendas. SWMA forwarded this item to NCWM recommending it as a Developing Item.

**Amend NIST Handbook 44, Appendix D – New Definitions for Diesel Volume Equivalents for Liquefied Natural Gas [submitted 2014, formerly 337-3]**

CWMA does not support the item as written and recommends that the status remain as Developing. This is based on the lack of traceability for the conversion units proposed. It is suggested that the conversion units if accepted could be supplemental information. The majority of comments heard were in support of selling this product by a known mass, i.e., pounds or kilograms. In addition there was concern raised regarding the validity of the current CNG conversion units (GLE & GGE).

WWMA did not forward this item to NCWM and recommends that the submitter incorporate the pertinent information into Item 337-1.

NEWMA forwarded the item to NCWM and recommended the item be designated as Informational to give the Steering Committee time to work the items and make suggestions.

SWMA received comments in the Open Hearing indicating that 337-2 and 337-3 were proposed to provide clarity. The committee recommends 337-2 and 337-3 replace 337-1. The SWMA S&T and L&R Committees met jointly to discuss CNG and LNG items on both agendas. SWMA forwarded this item to NCWM recommending it as a Developing Item.

**Amend paragraphs S.1.2., S.1.3.1.1., and S.5.2. [submitted 2013, formerly 337-4]**

CWMA does not support the item as written and recommends that the status remain as Developing. This is based on the lack of traceability for the conversion units proposed. It is suggested that the conversion units if accepted could be supplemental information. The majority of comments heard were in support of selling this product by a known mass, i.e., pounds or kilograms. In addition there was concern raised regarding the validity of the current CNG conversion units (GLE & GGE).

The WWMA heard no support on this item and recommended that it be Withdrawn. The intent of the proposal is to make cost comparisons between diesel fuel and natural gas. The WWMA believes this proposal doesn’t meet the historic definition of “Cost Comparison” and shouldn’t be a specification item in Handbook 44. The WWMA believes Natural Gas should be sold in traceable units and not artificial equivalent units. The NCWM Natural Gas Steering Committee should take into consideration global method of sale and advertising of LNG/CNG. The WWMA believes the urgency of this issue demands quick action by the NCWM because these devices are growing quickly in the market place.

NEWMA forwarded the item to NCWM and recommended the item be designated as Informational to give the Steering Committee time to work the items and make suggestions.

SWMA heard comments in open hearing indicating that Item 337-5 was proposed to further clarify Item 337-4. The Committee agreed with comments heard that 337-4 continue to be a developing item. Based on the comments received the Committee believed this item may be more appropriate as a user requirement and should be kept as developmental status with review by Steering Committee. The Committee believed that the identity should be
indicated in a single unit. The SWMA S&T and L&R Committees met jointly to discuss CNG and LNG items on both agendas.

Amend paragraphs S.1.2., S.1.3.1.1., and S.5.2., and add new paragraphs S.1.3.1.2., and S.5.3. [submitted 2014, formerly 337-5]

CWMA does not support the item as written and recommends that the status remain as Developing. This is based on the lack of traceability for the conversion units proposed. It is suggested that the conversion units if accepted could be supplemental information. The majority of comments heard were in support of selling this product by a known mass, i.e., pounds or kilograms. In addition there was concern raised regarding the validity of the current CNG conversion units (GLE & GGE).

The WWMA heard no support on this item and recommended that it Withdrawn. The intent of the proposal is to make cost comparisons between diesel fuel and natural gas. The WWMA believes this proposal doesn’t meet the historic definition of “Cost Comparison” and shouldn’t be a specification item in Handbook 44. The WWMA believes Natural Gas should be sold in traceable units and not artificial equivalent units. The NCWM Natural Gas Steering Committee should take into consideration global method of sale and advertising of LNG/CNG. The WWMA believes the urgency of this issue demands quick action by the NCWM because these devices are growing quickly in the market place.

NEWMA forwarded the item to NCWM and recommended the item be designated as Informational to give the Steering Committee time to work the items and make suggestions.

SWMA heard comments in open hearing indicating that Item 337-5 was proposed to further clarify Item 337-4. The Committee agreed with comments heard that 337-4 continue to be a developing item. Based on the comments received the Committee believed this item may be more appropriate as a user requirement and should be kept as developmental status with review by Steering Committee. The Committee believed that the identity should be indicated in a single unit. The SWMA S&T and L&R Committees met jointly to discuss CNG and LNG items on both agendas.

With respect to the Item Under Consideration, the Committee received additional letters of support from:

- ANGI Energy Systems,
- California Natural Gas Vehicle Coalition,
- Maine Clean Communities = MC²,
- Sacramento Clean Cities Coalition, and
- Questar Gas Company

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

(Agenda Item 337-2 Revised June 12, 2014)

337-3 Appendix D – Definitions: Diesel Liter Equivalent (DLE) and Diesel Gallon Equivalents (DGE) for Liquefied Natural Gas

The Committee considered the following proposal to establish definitions in Appendix D for “Diesel Liter Equivalent (DLE)” and “Diesel Gallon Equivalent (DGE).” This item (along with accompanying recommendations and background information) was consolidated with Item 337-2 as a result of action by the Committee at the 2014 NCWM Interim Meeting. See Item 337-2 for additional details.

As a result of the June 12, 2014 discussions of the S&T Committee, in conjunction with NGSC recommendations, it has become necessary to further clarify the status of Agenda Items 337-3 and 337-5. In March 2014 the Committee agreed with the NGSC’s recommendation for modifications of the proposed NIST HB 44 requirements in these
agenda items and their consolidation into a single voting item under Agenda Item 337-2. Consequently, the “v” (Voting) designation will no longer appear before Agenda Items 337-3 and 337-5.

Source:
Clean Vehicle Education Foundation (2014)

Purpose:
Since liquefied natural gas (LNG) is sold in the retail market place as an alternative fuel to diesel fuel, the proposed additions and edits to Handbook 44 will provide definitions for liquefied natural gas (LNG) equivalents for diesel liters and gallons so that end users can radially compare cost and fuel economy. At present no LNG equivalents for diesel are included in the handbooks.

Item under Consideration:
Amend NIST Handbook 44, Appendix D as follows:

**Diesel Liter Equivalent (DLE).** - Means 0.7263 kg of liquefied natural gas.

**Diesel Gallon Equivalent (DGE).** - Means 2.749 kg (6.06 lb) of liquefied natural gas.

(Agenda Item 337-3 Revised June 12, 2014)

337-4 W S.1.2. Compressed Natural Gas Dispensers, S.1.3.1.1. Compressed Natural Gas Used as an Engine Fuel, S.5.2. Marking of Gasoline Volume Equivalent Conversion Factor; Natural Gas

Source:
Clean Vehicle Education Foundation (2013)

Purpose:
Enable consumers to make cost and fuel economy comparisons between diesel fuel and natural gas.

Item Under Consideration:
Amend paragraphs S.1.2., S.1.3.1.1., and S.5.2. as follows:

**S.1.2. Compressed Natural Gas Dispensers.** – Except for fleet sales and other price contract sales, a compressed natural gas dispenser used to refuel vehicles shall be of the computing type and shall indicate the quantity, the unit price, and the total price of each delivery. The dispenser shall display the mass measured for each transaction either continuously on an external or internal display accessible during the inspection and test of the dispenser, or display the quantity in mass units by using controls on the device.
(Added 1994)

**S.1.3.1.1. Compressed Natural Gas Used as an Engine Fuel.** – When compressed natural gas is dispensed as an engine fuel, the delivered quantity shall be indicated in “gasoline liter equivalent (GLE) units” or “gasoline gallon equivalent (GGE) units” (see definitions).

(a) "gasoline liter equivalent (GLE) units" or gasoline gallon equivalent (GGE) units,

(b) "diesel liter equivalent (DLE) units" or "diesel gallon equivalent (DGE) units" (see definitions).

(Added 1994)
S.5.2. Marking of Diesel and Gasoline Volume Equivalent Conversion Factor. – A device dispensing compressed natural gas shall have either the statement “1 Gasoline Liter Equivalent (GLE) is Equal to 0.678 kg of Natural Gas” or “1 Gasoline Gallon Equivalent (GGE) is Equal to 5.660 lb of Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(a) either the statement "1 Gasoline Liter Equivalent (GLE) is Equal to 0.678 kg of Natural Gas" or "1 Gasoline Gallon Equivalent (GGE) is Equal to 5.660 lb of Natural Gas",

(b) either the statement "1 Diesel Liter Equivalent (DLE) is Equal to 0.756 kg of Natural Gas" or "1 Diesel Gallon Equivalent (DGE) is Equal to 6.312 lb of Natural Gas" permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(Added 1994)

Background / Discussion:
The gasoline gallon equivalent (GGE) unit was defined by NIST/NCWM in 1994 (see Appendix D) to allow users of natural gas vehicles to readily compare costs and fuel economy of light-duty natural gas vehicles with equivalent gasoline powered vehicles. For the medium and heavy duty natural gas vehicles in widespread use today, there is a need to officially define a unit (already in widespread use) allowing a comparison of cost and fuel economy with diesel powered vehicles. Also natural gas is sold as a vehicle fuel as either Compressed Natural Gas (CNG) or Liquified Natural Gas (LNG) and each method of sale is in mass. Therefore the generic term “natural gas” is proposed to be used in Handbooks 44 and 130 with the existing term “compressed”. The mathematics justifying the specific quantity (mass) of natural gas in a DLE and DGE is included in Appendix D.

The official definition of a DLE and a DGE will likely provide justification for California, Wisconsin and any other state to permit retail sales of LNG for heavy-duty vehicles in these convenient units.

At the 2013 NCWM Interim Meeting, the Committee heard comments from Mr. Keilty who expressed concern about the adoption of the proposed equivalent value as a unit of measure. He noted that the intent of this item is not to allow the user to toggle between mass units and equivalent units at the push of a button. He also noted that, if the units are set as “DLE” or “DGE,” the customer cannot also view units in “GLE” or “GGE.” Mr. Dmitri Karimov (Liquid Controls Corporation, LLC), indicated opposition to the proposal to strike the work “compressed.” Ms. Williams referenced NIST OWM’s comments made in association with Agenda Item 337-1 and suggested that the Committee consider those same comments in their deliberations of this item.

The Committee heard no comments in support of the proposal during its Open Hearings. See Item 337-1 for details regarding the S&T Committee’s collaborations with the NCWM L&R Committee on Items 337-1 and 337-2 on the S&T Committee’s agenda and Items 232-1 and 237-1 on the L&R Committee’s agenda.

On the NCWM Online Position Forum, two Government representatives indicated a neutral position and one Government representative indicated opposition for this item. The neutral position was accompanied by a comment suggesting the establishment of a Joint Task Group and encouraging a final recommendation that would clarify whether the proposed units are or are not permitted. The opposing position was accompanied by a comment indicating opposition to artificial units of measure and noting that establishment of DGE and DLE values perpetuate the use of artificial units.

At the 2013 NCWM Annual Meeting, the Committee heard comments on Items 337-1 and Items 337-2 jointly. Details of comments are included in Item 337-1.

Additional Contacts: Clean Energy, Seal Beach, CA, NGVAmerica, Washington, DC, Clean Vehicle Education Foundation, Acworth, GA.

At the 2014 NCWM Interim Meeting the NGSC suggested that the Committee withdraw this item. The submitter of this item (who is also a member of the NGSC) submitted an alternative item in 2014 that was intended to replace this item. Consequently, the Committee decided to withdraw this item from its agenda.
Regional Associations Comments:
The CWMA does not support the item as written and recommends that the status remain as Developing. This is based on the lack of traceability for the conversion units proposed. It is suggested that the conversion units if accepted could be supplemental information. The majority of comments heard were in support of selling this product by a known mass i.e. pounds or kilograms. In addition there was concern raised regarding the validity of the current CNG conversion units (GLE & GGE).

The WWMA heard no support on this item and recommended that it Withdrawn. The intent of the proposal is to make cost comparisons between diesel fuel and natural gas. The WWMA believes this proposal doesn’t meet the historic definition of “Cost Comparison” and shouldn’t be a specification item in Handbook -44. The WWMA believes Natural Gas should be sold in traceable units and not artificial equivalent units. The NCWM Natural Gas Steering Committee should take into consideration global method of sale and advertising of LNG/CNG. The WWMA believes the urgency of this issue demands quick action by the NCWM because these devices are growing quickly in the market place.

NEWMA recommended that the item be Informational to give the Steering Committee time to work on the items and make suggestions.

SWMA heard comments in Open Hearing indicating that Item 337-5 was proposed to further clarify Item 337-4. The Committee agreed with comments heard that 337-4 continue to be a Developing Item. Based on the comments received the Committee believed this item may be more appropriate as a user requirement and should be kept as developmental status with review by Steering Committee. The Committee believed that the identity should be indicated in a single unit. The SWMA S&T and L&R Committees met jointly to discuss CNG and LNG items on both agendas.

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

337-5 S.1.2. Compressed Natural Gas Dispensers, S.1.3.1.1. Compressed Natural Gas Used as an Engine Fuel, S.5.2. Marking of Gasoline Volume Equivalent Conversion Factor

The Committee considered the following proposal to modify multiple MFM specification paragraphs to recognize gasoline and diesel “equivalent” units for liquid natural gas and compressed natural gas. This item (along with accompanying recommendations and background information) was consolidated with Item 337-2 as a result of action by the Committee at the 2014 NCWM Interim Meeting. See Item 337-2 for additional details.

As a result of the June 12, 2014 discussions of the S&T Committee, in conjunction with NGSC recommendations, it has become necessary to further clarify the status of Agenda Items 337-3 and 337-5. In March 2014 the Committee agreed with the NGSC’s recommendation for modifications of the proposed NIST HB 44 requirements in these agenda items and their consolidation into a single voting item under Agenda Item 337-2. Consequently, the “v” (Voting) designation will no longer appear before Agenda Items 337-3 and 337-5.

Source:
Clean Vehicle Education Foundation (2014)

Purpose:
Since natural gas is sold in the retail market place as compressed natural gas (CNG) to be an alternative fuel to gasoline and diesel fuel and as liquefied natural gas (LNG) to be an alternative fuel to diesel, the proposed additions and edits to Handbook 44 will provide definitions for natural gas equivalents for diesel liters and diesel gallons so that end users can radially compare cost and fuel economy. At present only CNG equivalents for gasoline are included in the handbooks.
Item Under Consideration:
Amend NIST Handbook 44 Mass Flow Meters Code as follows:

S.1.2. Compressed Natural Gas and Liquefied Natural Gas Dispensers. – Except for non-retail fleet sales and other price contract sales, a compressed natural gas and liquefied natural gas dispensers used to refuel vehicles shall be of the computing type and shall indicate the quantity, the unit price, and the total price of each delivery. The dispensers shall display the mass measured for each transaction either continuously on an external or internal display accessible during the inspection and test of the dispensers, or display the quantity in mass units by using controls on the device.
(Added 1994)

S.1.3.1.1. Compressed Natural Gas Used as an Engine Fuel. – When compressed natural gas is dispensed as an engine fuel, the delivered quantity shall be indicated in: “gasoline liter equivalent (GLE) units” or “gasoline gallon equivalent (GGE) units” (see definitions).

(a) Mass (in pounds or kilograms) or
(b) "Gasoline liter equivalent (GLE) units" or “gasoline gallon equivalent (GGE) units”;
(c) "Diesel liter equivalent (DLE) units" or "diesel gallon equivalent (DGE) units" (see definitions).
(Added 1994)

S.1.3.1.2. Liquefied Natural Gas Used as an Engine Fuel. – When liquefied natural gas is dispensed as an engine fuel, the delivered quantity shall be indicated in:
(a) Mass (in pounds or kilograms).
(b) "Diesel liter equivalent (DLE) units" or "diesel gallon equivalent (DGE) units" (see definitions).

S.5.2. Marking of Diesel and Gasoline Volume Equivalent Conversion Factor. – A device dispensing compressed natural gas shall have: either the statement “1 Gasoline Liter Equivalent (GLE) is Equal to 0.678 kg of Natural Gas” or “1 Gasoline Gallon Equivalent (GGE) is Equal to 5.660 lb of Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(a) either the statement "1 Gasoline Liter Equivalent (GLE) is Equal to 0.678 kg of Natural Gas" or 
"1 Gasoline Gallon Equivalent (GGE) is Equal to 5.660 lb of Natural Gas”;
(b) either the statement "1 Diesel Liter Equivalent (DLE) is Equal to 0.765 kg of Natural Gas" or "1 Diesel Gallon Equivalent (DGE) is Equal to 6.38 lb of Natural Gas".
(Added 1994)

S.5.3. Marking of Diesel Volume Equivalent Conversion Factor. – A device dispensing liquefied natural gas shall have: the statement "1 Diesel Liter Equivalent (DLE) is Equal to 0.7263 kg of Natural Gas" or 
"1 Diesel Gallon Equivalent (DGE) is Equal to 6.06 lb of Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

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

(Agenda Item 337-5 Revised June 12, 2014)

Source:
NCWM Natural Gas Steering Committee (2014 Interim Meeting)

Source:
This is a new item (2014) that originated from the NCWM Natural Gas Steering Committee (NGSC) as a result of its deliberations January through March 2014 on agenda item 337-1 (an alternative proposal for defining and establishing legal metrology requirements for quantity indications and markings on a device when CNG and LNG are dispensed and sold as engine fuel in volume equivalent units). The NGSC recommends the proposal as a developing item to allow additional time for the NCWM NTEP Measuring Sector and Measuring Laboratories to fully vet the newly proposed modifications to HB 44 Mass Flow Meters Code paragraph S.3.6. Automatic Density Correction.

Purpose:
Provide a starting point for work identified in March 2014 by the NGSC and S&T Committee that is necessary to fully address legal metrology requirements for LNG retail and wholesale applications.

Item Under Consideration:
Amend NIST Handbook 44 Mass Flow Meters Code paragraph S.3.6. as follows:

S.3.6. Automatic Density Correction.

(a) An automatic means to determine and correct for changes in product density shall be incorporated in any mass flow metering system that is affected by changes in the density of the product being measured.

(b) Volume-measuring devices with automatic temperature compensation used to measure liquefied natural gas as a motor vehicle engine fuel shall be equipped with an automatic means to determine and correct for changes in product density due to changes in the temperature, pressure, and composition of the product.

(Amended 1994 and 1997, and 201X)

Background/Discussion:
After the January 2014 NCWM Interim Meeting, the NGSC and S&T Committee received input from Mr. Dmitri Karimov (Liquid Controls Corporation, LLC and a member of the NGSC), who proposed to differentiate between CNG and LNG in the requirements of paragraph S.3.6 “Automatic Density Correction” when using volumetric devices. Mr. Karimov indicated that density calculations of LNG when measured using a volumetric device, require temperature determination only. CNG devices will not be allowed to use indirect mass measurement in Mr. Karimov’s proposal.

Mr. Karimov’s provided the NGSC and S&T Committee with the following points as rationale for the proposed changes to paragraph S.3.6:

• The requirements for volume-measuring devices were developed in 1994 and 1997 for CNG based on hydrocarbon gas vapor code. See the attached NCWM final reports at the end of the document.

• The concerns might be valid for CNG but not for LNG. For LNG, only temperature input is required to calculate mass value.

• Based on the most recent changes to the Mass Flow Meters Code by the NGSC, indirect mass measurement is proposed to be allowed for LNG but not CNG, so S.3.6 needs to be modified.
• CNG and LNG mass flow meters (Coriolis) with automatic density correction will be covered by paragraph S.3.6.(a)

• LNG volume-measuring devices (such as orifice plate and turbine meters) will be covered by paragraph S.3.6.(b) since indirect mass measurement for CNG is no longer allowed under the proposal by the NGSC.

• CNG (being gas) is very compressible, so pressure is a significant influence factor in density calculation. “Pressure” was added to S.3.6.(b) in 1997 because at that time the paragraph was relied upon only for CNG.

• LNG, on the other hand, is measured at very low pressure, and – being liquid – is not compressible at the pressures at which it is measured. Pressure effect on density of LNG is therefore negligible. See the table below where Mr. Karimov generated data on LNG density changes using the NIST REFPROP database.

• Per documentation received by the NGSC from the Clean Vehicle Education Foundation, the composition of the natural gas remained virtually unchanged over the last 21 years. Therefore, volumetric devices for LNG could use fixed composition in density calculations as per ASTM D4784 Clause 2.1 (see below).

• Finally, indirect mass measurement volumetric devices undergo type evaluation, and only those devices meeting accuracy requirements through proper density calculations are approved.

Supporting documentation:
ASTM D4784 provides models for density calculation.

2. Significance and Use

2.1 The models in this specification can be used to calculate the density of saturated liquid natural gas in the temperature range 90 to 120 K. The estimated uncertainty for the density calculations is ± 0.1 %. The restrictions on composition of the liquefied natural gas are:

<table>
<thead>
<tr>
<th>Component</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>methane</td>
<td>60 % or greater</td>
</tr>
<tr>
<td>nitrogen</td>
<td>less than 4 %</td>
</tr>
<tr>
<td>n-butane</td>
<td>less than 4 %</td>
</tr>
<tr>
<td>i-butane</td>
<td>less than 4 %</td>
</tr>
<tr>
<td>pentanes</td>
<td>less than 2 %</td>
</tr>
</tbody>
</table>

Mr. Karimov also referenced excerpts from past NCWM Final Reports from 1994 and 1997. These excerpts are found in Appendix E to the Committee’s 2014 Interim Report.

Listed below is the table Mr. Karimov generated on LNG density changes using the NIST REFPROP database. Mr. Karimov noted that density changes to LNG are negligible at 120 K with changes in pressure from the base pressure of 27.765 psi up to 200 psi.
<table>
<thead>
<tr>
<th>Temperature (K)</th>
<th>Pressure (psia)</th>
<th>Density (lb_mass/gal)</th>
<th>% Density Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
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<td>120</td>
<td>200</td>
<td>3.4317</td>
<td>-0.319%</td>
</tr>
</tbody>
</table>

120 K (-153 °C) (-243 °F)

2Percent difference in product (pure methane) density is based on calculated variations to the base pressure of 27.765 psi using NIST REFPROP
Initially Mr. Karimov presented his proposal to his colleagues on the NGSC. During the NGSC’s deliberation on the Clean Vehicle Education Foundation’s proposed changes to other Mass Flow Meters Code paragraphs (see Agenda Item 337-1), the NGSC also considered Mr. Karimov’s proposal. The NGSC agreed to encourage further work beyond the current scope of their work on the CVEF’s proposals. Admittedly many of the NGSC indicated not fully comprehending the technical rationale for the Mr. Karimov’s proposal. After discussions with the S&T Committee both committees agreed that the proposal should be vetted by the NCWM NTEP Measuring Sector and Measuring Laboratories to ensure the community understands the intent and impact of the proposed changes to paragraph S.3.6. Additionally, NIST OWM plans to consult with its Cryogenics Group on the proposal. Based on its discussion with the S&T Committee, both Committees believe the proposal has merit and should be included in the S&T Interim Meeting report as a separate new item with developing status.

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

354 TAXIMETERS

354-1 D USNWG on Taximeters – Taximeter Code Revisions and Global Positioning System-Based Systems for Time and Distance Measurement

Note: This item was originally titled “Item 360-5 S.5. Provision for Security Seals” in the Committee’s 2013 Interim Agenda. At the 2013 NCWM Interim Meeting, the Committee combined that item with “Item 354-1 Global Positioning Systems for Taximeters” and “Item 360-6 Global Positioning Systems for Taximeters” to create this new, consolidated item to address the development of recommendations on multiple topics related to taximeters and GPS-based time and distance measuring systems.

Source: NIST USNWG on Taximeters

Purpose:
Develop recommendations for modifying the existing Taximeters Code to reflect current technology (including requirements for sealing, display requirements, and other features) and to examine GPS-based time and distance measuring systems to determine how to best address these measuring systems in NIST Handbook 44 to ensure accuracy and transparency for passengers and businesses.

Item Under Consideration:
This item is under development. Comments and inquiries may be directed to Mr. John Barton (NIST OWM) at 301-975-4002 or john.barton@nist.gov.

The USNWG is considering proposals to modify the sealing requirements in the Taximeters Code to reflect more advanced sealing methods (see 2012 NCWM Final S&T Report); to amend the Taximeters Code to specifically recognize GPS-based time and distance measuring systems; and to amend other sections of the Taximeters Code to reflect current technology and business practices while ensuring accuracy and transparency for customers and a level playing field for transportation service companies.

Background / Discussion:
The Committee has received multiple proposals over the past several years related to updating the current NIST Handbook 44 Taximeters Code to reflect current technology as well as a request to establish criteria for GPS-based time and distance measuring systems. In April 2012, NIST OWM established a U.S. National Working Group to work on these issues. The USNWG has met multiple times since it was established. For details of those meetings as
well as the current proposals being developed by the USNWG, please contact Mr. Barton as noted in the “Item Under Consideration” above.

At the 2014 NCWM Interim Meeting NIST OWM provided an update regarding progress of the USNWG. The USNWG is conducting meetings on a regular basis to continue its work in updating the existing HB44 Taximeters Code. Numerous sections of the current Code are based on older technologies and may not reflect the more recent advances seen in this area. While there are no specific proposed changes to the Taximeters Code at this time, it is anticipated that some proposals will be submitted prior to the next cycle of Regional meetings in 2014. Some of the proposed changes that are expected will affect requirements concerning: the need for a recording element within a system; the advancement of indications; information included on receipts; the display of customer’s indications; and the use of GPS system as a source of distance/time measurements. The next meeting of the USNWG is March 4, 2014. The Committee supports the efforts of the USNWG and looks forward to receiving proposed changes in the future.

Additional information and background on this item can be found in the Committee’s 2013 and earlier final reports.

Regional Associations Comments:
CWMA encourages the continued work of the USNWG and looks forward to continued developments in this area.

WWMA believes this item is still developing and more information is needed in the meter display and receipt requirements. More information is also needed in determining the accuracy of GPS and cell phone technology. WWMA recommended that the item remain as a Developing Item.

NEWMA recognized that the USNWG on Taximeters has the task of updating a code from 1970’s to reflect current technology. The USNWG still needs time to work on developments to this item so NEWMA recommended this item to remain a developing item.

SWMA did not receive any comments received on this item. The SWMA supported further development by the USNWG on Taximeters.

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

358  MULTIPLE DIMENSION MEASURING DEVICES

358-1  Measurement of Bulk Material in Open-Top Truck and Trailer Units

Source:
LoadScan US (2014)

Purpose:
Develop a standardized testing protocol for a non-contact volumetric measurement instrument designed to measure loads of bulk loose solids in open-top truck and trailer units.

Item Under Consideration:
Develop new language for type classification, accuracy classification, and test methodology for load volume scanning devices.

Background / Discussion:
Laser technology allows for accurate volume measurement of bulk materials loaded on open-top truck and trailer bodies. Standard industry practice is to count loader buckets or convert from weight, both highly variable and
inaccurate ways of measuring cubic volume. See Appendix F for detail on Load Scanner Metrology, Test Methods and Suitability for Use.

Contacts: Peter Russell, LoadScan US, 603-831-6014 or peter.russell@loadscan.us and Adrian Ruthe, Loadscan Ltd., +64 7-847-5777 or adrian@loadscan.com.

At the 2014 NCWM Interim Meeting Mr. Peter Russell (LoadScan, Ltd.) and Adrian Ruthe (LoadScan, Ltd.) provided a joint presentation regarding the operation of a device that uses a scanner to measure the volume of product loaded into open-top truck and trailer units. Mr. Russell and Mr. Ruthe indicated that they were not familiar with the procedures of how to go about adding new requirements into NIST Handbook 44; nor did they know where in Handbook 44, requirements intended to apply to their equipment would best fit. They asked the Committee for guidance on how best to proceed concerning these issues.

The Committee acknowledged that there is not yet a specific proposal to consider and that additional information and input is needed for the development of this item. The Committee agreed to designate this item as a “Developing” item on its agenda to allow time for the issue to be further developed by the submitter. The Committee noted that a specific proposal outlining recommended changes to NIST Handbook 44 is needed in order for the item to advance through the process.

While the Committee is not certain if the MDMD Code is the most appropriate code for addressing these devices, the Committee suggested that the MDMD Work Group might be willing to consider this issue and provide input on further development of draft NIST Handbook 44 language. Alternatively, or in addition, the submitter may wish to contact the NTEP Weighing Sector to determine if the Sector or its’ members might be able to provide additional assistance.

The Committee received a document from the submitter (titled “Load Volume Scanner, Proposals for Integration into Handbook 44”) that provides additional information and supporting arguments for addressing this issue, along with some recommended changes to NIST Handbook 44. The Committee has included this document in Appendix G of this report and encourages interested parties to provide input to the submitter.

Regional Associations Comments:
CWMA supports the work of OIML and suggests this remain as a Developing Item.

NEWMA would like to see the submitter move forward with further development of this new item to explore the feasibility of this item in NIST Handbook 44. NEWMA forwarded the item to the NCWM and recommended that it be a Developing Item.

SWMA received a presentation, but heard no additional comments in its Open Hearings. The submitter did have questions from members about the device itself, but there were not any comments on the item. Based on this, the SWMA recommended the item continue to be developed. SWMA forwarded the item to NCWM.

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

360 OTHER ITEMS

360-1 D International Organization of Legal Metrology (OIML) Report

Many issues before the OIML, the Asian-Pacific Legal Metrology Forum, and other international groups are within the purview of the Committee. The Committee has maintained an item on its report as a means of keeping NCWM members abreast of these activities, and NIST OWM has regularly provided an update as part of this item. In recent
years, rather than providing separate reports to individual committees, OWM has begun providing a single update of activities relative to all NCWM committees in conjunction with the Board of Directors’ agenda. The Committee believes that this is the most efficient approach to keep members abreast of these activities, and based on discussions with OWM, the Committee plans to eliminate this item from its agenda beginning with the next NCWM cycle. The Committee will include a note in the preamble to its report referencing the OIML report that is provided as part of the Board of Directors’ Report so that those interested in these activities can locate this information.

Additional information on OIML activities will continue to appear in the Board of Directors agenda and Interim and Final Reports and on the OIML website at www.oiml.org. NIST, OWM staff will continue to provide the latest updates on OIML activities during the BOD’s Open Hearings at NCWM meetings. For more information on specific OIML related device activities, contact the OWM staff listed in the table below. The list below of OIML projects only represents active projects.

<table>
<thead>
<tr>
<th>Contact Information</th>
<th>Responsibilities</th>
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</thead>
</table>
| **Mr. John Barton –LMDP**  
Phone: (301) 975-4002  
Email: john.barton@nist.gov | • R 21 Taximeters  
• R 50 Continuous Totalizing Automatic Weighing Instruments (Belt Weighers)  
• R 60 Metrological Regulations for Load Cells  
• R 106 Automatic Rail-weighbridges |
| **Mr. Kenneth Butcher –LMP**  
Phone: (301) 975-4859  
Email: k.butcher@nist.gov | • TC 6 Prepackaged Products |
| **Dr. Charles Ehrlich –ILMP**  
Phone: (301) 975-4834  
Email: charles.ehrlich@nist.gov | • International Committee of Legal Metrology Member for the U.S.  
• V1 International Vocabulary of Terms in Legal Metrology  
• V2 International Vocabulary of Basic and General Terms in Metrology  
• B 3 OIML Certificate System for Measuring Instruments  
• B 6 OIML Directives for the Technical Work  
• B 10 Framework for a Mutual Acceptance Arrangement on OIML Type Evaluations  
• TC 3/SC 5 Expression of Uncertainty in Measurement in Legal Metrology  
Applications, Guidelines for the Application of ISO/IEC 17025 to the Assessment of Laboratories Performing Type Evaluation Tests  
• TC 3 Metrological Control  
• ISO/IEC Guide to the Expression of Uncertainty in Measurement |
| **Mr. Richard Harshman –LMDP**  
Phone: (301) 975-8107  
Email: richard.harshman@nist.gov | • R 51 Automatic Catchweighing Instruments  
• R 61 Automatic Gravimetric Filling Instruments  
• R 76 Non-automatic Weighing Instruments  
• R 107 Discontinuous Totalizing Automatic Weighing Instruments (totalizing hopper weighers)  
• R 134 Automatic Instruments for Weighing Road Vehicles In-Motion and Measuring Axle Loads |
| **Ms. Diane Lee –LMDP**  
Phone: (301) 975-4405  
Email: diane.lee@nist.gov | • R 59 Moisture Meters for Cereal Grains and Oilseeds  
• R 92 Wood Moisture Meters – Verification Methods and Equipment  
• TC 17/SC 8 Protein Measuring Instruments for Cereal Grains and Oil Seeds |
| **Mr. Ralph Richter –ILMP**  
Phone: (301) 975-3997  
Email: ralph.richter@nist.gov | • D 11 General Requirements for Measuring Instruments – Environmental Conditions  
• R 35 Material Measures of Length for General Use  
• R 49 Water Meters (Cold Potable Water and Hot Water Meters)  
• R 71 Fixed Storage Tanks  
• R 80 Road and Rail Tankers (static measurement) |
- R 85 Automatic Level Gauges for Measuring the Level of Liquid in Fixed Storage Tanks
- R 95 Ship’s Tanks
- R 117 Measuring Systems for Liquids Other Than Water (all measuring technologies)
- R 118 Testing Procedures and Test Report Format for Pattern Examination of Fuel Dispensers for Motor Vehicles
- TC 3/SC 4 Verification Period of Utility Meters Using Sampling Inspections
- R 137 Gas Meters (all measuring technologies)
- R 140 Measuring Systems for Gaseous Fuel (i.e., large pipelines)
- ISO TC 30/SC 7 Water Meters

Dr. Ambler Thompson –ILMP
Phone: (301) 975-2333
Email: ambler@nist.gov

- V1 International Vocabulary of Terms in Legal Metrology
- D 16 Principles of Assurance of Metrological Control
- D 19 Pattern Evaluation and Pattern Approval
- D 20 Initial and Subsequent Verification of Measuring Instruments and Processes
- D 27 Initial Verification of Measuring Instruments Using the Manufacturer’s Quality Management System
- D 31 General Requirements for Software Controlled Measuring Instruments
- R 34 Accuracy Classes of Measuring Instruments
- R 46 Active Electrical Energy Meters for Direct Connection of Class 2

Ms. Juana Williams –LMDP
Phone: (301) 975-3989
Email: juana.williams@nist.gov

- R 81 Dynamic Measuring Devices and Systems for Cryogenic Liquids
- R 139 Compressed Gaseous Fuels Measuring Systems for Vehicles

**List of Acronyms**

<table>
<thead>
<tr>
<th>B</th>
<th>Basic Publication</th>
<th>LMDP</th>
<th>Legal Metrology Devices Program</th>
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<tr>
<td>LMP</td>
<td>Laws and Metrics Program</td>
<td>TC</td>
<td>Technical Committee</td>
</tr>
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**Contact Point:** See contacts listed in the table above for specific technical areas.

**Regional Associations Comments:**

CWMA supports the work of OIML and suggests this remain as a Developing Item.

WWMA thanks NIST for their work in the International arena and looks forward to future updates. FYI, the next OIML meeting will be in Vietnam, 2013. The WWMA recommended that the item remain as a Developing Item.

NEWMA recognized the importance of this item and recommended that it remain as a Developing Item.

SWMA did not receive comments on this item and recommended further development. The SWMA continues to support these issues.

Additional letters, presentations, and data may have been part of the Committee’s consideration. Please refer to http://ncwm.net/meetings/annual/publication-16 to review these documents.
360-2  D  Appendix D – Definitions: Remote Configuration Capability

Source:
NTEP Grain Analyzer Sector (2013)

Purpose:
Expand the scope of definition to cover instances where the “other device,” as noted in the current definition, may be necessary to the operation of the weighing or measuring device or which may be considered a permanent part of that device.

Item Under Consideration:
This item is under development. Comments and inquiries may be directed to NIST Office of Weights and Measures.

A proposal to modify the definition for “remote configuration capability” as follows is under consideration:

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

(Added 1993, Amended 20XX)

Background / Discussion:
Removable digital storage devices can be used in GMMs as either data transfer devices that are not necessary to the operation of the GMM or as data storage devices which are necessary to the operation of the GMM. If removable data storage devices are necessary to the operation of the device, they are not covered by the current definition of remote configuration capability.

A USB flash drive is most likely to be used as a data transfer device. In a typical data transfer application, the USB flash drive is first connected to a computer with access to the GMM manufacturer’s web site to download the latest grain calibrations that are then stored in the USB flash drive. The USB flash drive is removed from the computer and plugged into a USB port on the GMM. The GMM is put into remote configuration mode to copy the new grain calibration data into the GMM’s internal memory. When the GMM has been returned to normal operating (measuring) mode the USB flash drive can be removed from the GMM.

Although a Secure Digital (SD) memory card could also be used as a data transfer device it is more likely to be used as a data storage device. In a typical “data storage device” application, the SD memory card stores the grain calibrations used on the GMM. The SD memory card must be plugged into an SD memory card connector on a GMM circuit card for the GMM to operate in measuring mode. To install new grain calibrations the GMM must be turned “off” or put into a mode in which the SD memory card can be safely removed. The SD memory card can either be replaced with an SD memory card that has been programmed with the new grain calibrations or the original SD memory card can be re-programmed with the new grain calibrations in much the same way as that described in the preceding paragraph to copy new grain calibrations into a USB flash drive. In either case, the SD memory card containing the new calibrations must be installed in the GMM for the GMM to operate in measuring mode. In that regard, the SD memory card (although removable) can be considered a permanent part of the GMM in that the GMM cannot operate without it.

Note: In the above example SD memory card could be any removable flash memory card such as the Secure Digital Standard-Capacity, the Secure Digital High-Capacity, the Secure Digital Extended-Capacity, and the Secure Digital Input/Output, which combines input/output functions with data storage. These come in three form factors: the original size, the mini size, and the micro size. A Memory Stick is a removable flash memory card format, launched by Sony in 1998, and is also used in general to describe the whole family of Memory Sticks. In addition to the original Memory Stick, this family includes the Memory Stick PRO, the Memory Stick Duo, the Memory Stick PRO Duo, the Memory Stick Micro, and the Memory Stick PRO-HG.
At its 2011 Grain Analyzer Sector Meeting the Sector agreed by consensus that the following changes to Table S.2.5. of §5.56.(a) of NIST Handbook 44 should be forwarded to the S&T Committee for consideration:

- Add a note to Table S.2.5. to recognize the expanded scope of remote capability.
- Delete “remotely” from the second paragraph of Category 3 requirements that begins, “When accessed remotely …” to make it clear that the requirements of Category 3 apply whether accessed manually using the keyboard or accessed by remote means.
- Add the modified second paragraph of Category 3 requirements to Categories 3a and 3b to make it clear that these requirements apply to all the subcategories of Category 3.

Because a change to the definition of remote configuration capability will apply to other device types, NIST OWM recommended that the changes to Table S.2.5. approved by the Sector in 2011 be separated into two independent proposals. One proposal would deal with the changes to Category 3 and its subcategories. The second would recommend a modification of the definition of “remote configuration capability” appearing in Appendix D of NIST Handbook 44 to recognize the expanded scope of remote capability; this proposal would be an alternative to adding a note to the bottom of Table S.2.5. to expand the definition for remote configuration for grain moisture meters (as shown in this proposal).

At its 2012 Meeting, the Grain Analyzer Sector agreed to separate its original proposal into two separate proposals and agreed to forward this proposal to change the definition of “remote configuration capability” to the S&T to Committee for consideration. See also August 2012 NTEP Grain Analyzer Sector Summary, Item 5.

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

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

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

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

On the 2013 NCWM Online Position Forum, one Government representative indicated a neutral position on this
item with no additional comments.

At the 2013 NCWM Annual Meeting Open Hearings, the Committee heard comments from Juana Williams (NIST
OWM) who reiterated OWM’s comments from the 2013 Interim Meeting, suggesting that it may be appropriate to
develop separate requirements to address new and future technologies which can be remotely configured with
removable media. OWM plans to develop draft language and ask for input from the various sectors at their
upcoming meetings. Ms. Williams also noted the suggestion made at the 2013 NCWM Interim Meeting by
Mr. Karimov speaking on behalf of the MMA, that a provision might be added to the General Code to address this
type of equipment.

Ms. Julie Quinn (MN) agreed with OWM’s comments and indicated support for possibly including requirements in
the General Code to address newer and emerging technologies. Mr. Karimov, speaking on behalf of MMA,
concurred with this suggestion.

At the 2014 NCWM Interim Meeting the SMA indicated that the language in the “Item Under Consideration” is
acceptable. The Committee received comments from the Measuring Sector indicating opposition to the proposed
language and suggesting that the current definition is adequate. The Committee also heard comments from NIST
OWM expressing concern that the proposed language does not clearly define when a device is considered “remotely
configurable.” OWM noted that it is continuing to develop this issue and has approached the various NTEP sectors
for additional input regarding the capabilities of new technology with regard to metrologically significant
adjustments. During their 2013 meeting, the Weighing Sector asked its members to assist OWM in identifying the
various types of removable storage media used in weighing equipment.
The Committee acknowledged comments from OWM expressing concern that the issue be carefully considered to
avoid unintentional consequences. The Committee agreed to maintain the Developing status of item in
consideration of the ongoing work of OWM to further develop this item.

Regional Associations Comments:
CWMA agrees that remote configuration capability may need to be addressed in the General Code and supports this
as a Developing Item.

WWMA believes this item needs further development and should consider the effects on other device types.
WWMA encourages NIST/OWM to develop draft language and ask for input from various sectors at their upcoming
meetings. The WWMA recommended that the item remain as a Developing Item.

NEWMA members were encouraged by NIST at the 2013 NCWM Annual Meeting to consider this work as it
applies to all device types. NEWMA supported this item as a Developing Item.

SWMA did not receive comments on this item and recommended further development.

Additional letters, presentations, and data may have been part of the Committee’s consideration. Please refer to
http://ncwm.net/meetings/annual/publication-16 to review these documents.
360-3 D Electric Vehicle Fueling and Submetering

Source:
California Department of Food and Agriculture Division of Measurement Standards (2014)

Purpose:
Keep the weights and measures community apprised of work to develop standards for Electric Vehicle Fueling and Submetering (EVF&S) and to encourage their participation in this work.

Item Under Consideration:
The USNWG for Electric Vehicle Fueling and Submetering is developing proposed specifications, tolerances, and other technical requirements for Electric Vehicle Fueling and Submetering Systems for inclusion in NIST Handbook 44. The code currently under development by the USNWG is included in Appendix H; however, this draft is NOT yet ready for consideration by the NCWM. The USNWG plans to complete revisions to this document and submit a final draft version to the regional weights and measures associations by Fall 2014.

Background / Discussion:
In 2013, the NCWM adopted a uniform method of sale for retail electrical energy sold as a vehicle fuel. Adding specifications, tolerances, and other technical requirements for equipment that measures electricity as a motor fuel are necessary to provide consumer confidence that measurement of electricity is accurate and that there is sufficient information for the selection of charging equipment, (Levels I, II, and III), and price to pay.

The U.S. National Work Group on Measuring Systems for Electric Vehicle Fueling and Submetering (USNWG EVF&S) discussed a number of challenges to field inspection and testing of EVSE systems. Utility companies and at least one U.S. Weights and Measures jurisdiction have established test procedures and test equipment specifications for utility-type and submetering electrical energy metering applications.

The USNWG EVF&S was formed to develop proposed requirements for commercial electricity-measuring devices (including those used to measure and sell electricity commercially delivered as vehicle fuel and those used in submetering electricity at residential and business locations) and to ensure that the prescribed methodologies and standards facilitate measurements that are traceable to the International System of Units (SI).

The “West Coast Electric Highway” is a project with an extensive network of electric vehicle DC fast charging stations located every 25 to 50 miles along Interstate 5 and other major roadways in the Pacific Northwest. In California alone, there are currently 1,387 electric charging stations and over one million plug-in electric vehicles (PEV) are projected to be on California roads by 2020. The development of standards for PEV charging equipment is needed to provide consumers with fueling experiences and expectations similar to those at traditional gasoline dispensers.

Additionally, these standards, once they are developed and adopted, will be used to provide training and education to weights and measures officials about testing and regulating these devices, and support uniform standards and enforcement of these standards throughout the United States.

See Appendix H for a Tentative Code being considered by the USNWG EVF&S.

At the 2014 NCWM Interim Meeting Ms. Juana Williams (NIST OWM), Technical Advisor to the USNWG EVF&S reported that the USWNG met two weeks prior to the Interim Meeting and is continuing work on a draft code for eventual inclusion in NIST Handbook 44. Ms. Williams emphasized that because the USWNG has additional work to complete on various portions of the draft Code, the draft is not ready for consideration by the NCWM. The draft included in NCWM Publication 15 has been revised and will be made available on the NIST OWM Web Page. The USNWG will hold several meetings over the next six months and plans to submit a final draft in Fall 2014.
Mrs. Tina Butcher (NIST OWM), Chairman of the USNWG, asked that state and local jurisdictions provide contact information of appropriate personnel from their corresponding public utility to assist the Work Group in identifying specific requirements that apply to EVSE in their jurisdictions.

The Committee acknowledged the need for EVSE Industry to participate in the NCWM process. This need was also expressed through comments heard during the open hearings. The Committee heard additional comments from a member of the Work Group who noted that a limited number of weights and measures officials are members of the Work Group and encouraged more to participate.

The Committee agreed forward to further work by the USNWG and agreed to designate this as a Developing item.

Regional Associations Comments:
CWMA agrees with the submitter’s recommendation and forwarded this item to NCWM, recommending it as a Developing Item.

The WWMA recognized that the draft tentative Code is still under development by the USNWG. The WWMA recommends all jurisdictions review the draft tentative Code and provide comments to the WG. The WWMA recommended that the item remain as a Developing Item.

SWMA did not receive any comments. The SWMA recommends the item remain as a Developing Item. The SWMA forwarded the item to NCWM.

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

Item 320-3 Draft Tentative Code Applicable to Weigh-In-Motion Systems Used for Vehicle Enforcement Screening

Section 2.25. Weigh-In-Motion Systems used for Vehicle Enforcement Screening – Draft Code

A. Application

A.1. General. – This code applies to systems used to weigh vehicles, while in motion, for the purpose of screening and sorting the vehicles based on the vehicle weight to determine if a static weighment is necessary.

A.2. The code does not apply to weighing systems intended for the collection of statistical traffic data.

A.3. The code is intended for field enforcement use only.

A.4. Additional Code Requirements. – In addition to the requirements of this code, Weigh-In-Motion Screening Systems shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Ready Indication. – The system shall provide a means of verifying that the system is operational and ready for use.

S.1.2. Value of System Division Units. – The value of a system division “d” expressed in a unit of weight shall be equal to:

   (a) 1, 2, or 5; or

   (b) a decimal multiple or submultiple of 1, 2, or 5.

   Examples: divisions may be 10, 20, 50, 100; or 0.01, 0.02, 0.05; or 0.1, 0.2, 0.5, etc.

S.1.2.1. Units of Measure. – The system shall indicate weight values using only a single unit of measure.

S.1.3. Value of Other Units of Measure.
S.1.3.1. Speed. – Vehicle speeds shall be measured in miles per hour or kilometers per hour.

S.1.3.2. Axle-Spacing (Length). – The center-to-center distance between any two successive axles shall be measured in feet and/or inches, or meters.

S.1.3.3. Vehicle Length. – If the system is capable of measuring the overall length of the vehicle, the length of the vehicle shall be measured in feet and/or inches, or meters.

S.1.4. Capacity Indication. – An indicating or recording element shall not display nor record any values greater than 105% of the specified capacity of the load receiving element.

S.1.5. Identification of a Fault. – Fault conditions shall be presented to the operator in a clear and unambiguous means. The following fault conditions shall be identified:

(a) Vehicle speed is below the minimum or above the maximum speed as specified.
(b) The maximum number of vehicle axles as specified has been exceeded.
(c) A change in vehicle speed greater than that specified has been detected.

S.1.6. Recorded Representations.

S.1.6.1. Values to be Recorded. – At a minimum, the following values shall be printed and/or stored electronically for each vehicle weighment:

(a) transaction identification number
(b) lane identification (required if more than one lane at the site has the ability to weigh a vehicle in-motion)
(c) vehicle speed
(d) number of axles
(e) weight of each axle
(f) identification and weight of axles groups
(g) axle spacing
(h) total vehicle weight
(i) all fault conditions that occurred during the weighing of the vehicle
(j) violations, as identified in paragraph S.2.1., that occurred during the weighing of the vehicle.
(k) time & date

S.1.7. Value of the Indicated and Recorded System Division. – The value of the system’s division size as recorded shall be the same as the division value indicated.


S.2.1. Violation Parameters. – The instrument shall be capable of accepting user entered violation parameters for the following items:
(a) single axle weight limit
(b) axle group weight limit
(c) gross vehicle weight
(d) bridge formula load

The instrument shall display and or record violation conditions when these parameters have been exceeded.


S.3.1. Multiple Load-Receiving Elements. – An instrument with a single indicating or recording element, or a combination indicating-recording element, that is coupled to two or more load-receiving elements with independent weighing systems, shall be provided with means to prohibit the activation of any load-receiving element (or elements) not in use, and shall be provided with automatic means to indicate clearly and definitely which load-receiving element (or elements) is in use.

S.4. Design of Weighing Devices, Accuracy Class.

S.4.1. Designation of Accuracy. – WIM Systems meeting the requirements of this code shall be designated as accuracy Class A.

S.5. Marking Requirements. – In addition to the marking requirements in G-S.1. Identification (except G.S.1.(e)), G-S.4. Interchange or Reversal of Parts, G-S.6. Marking Operational Controls, Indications, and Features, G-S.7. Lettering, and G-UR.2.1.1. Visibility of Identification. The system shall be marked with the following information:

(a) Accuracy Class
(b) Value of the System Division “d”
(c) Operational Temperature Limits
(d) Number of Lanes
(e) Minimum and Maximum Vehicle Speed
(f) Maximum Number of Axles per Vehicle
(g) Maximum Change in Vehicle Speed during Weighment
(h) Minimum and Maximum Load

S.5.1. Location of Marking Information. – The marking information required in G-S.1. of the General Code and S.5. shall be visible after installation. The information shall be marked on the system or recalled from an information screen.
N. Notes

N.1. Test Procedures.

N.1.1. Selection of Test Vehicles. – All dynamic testing associated with the procedures described in each of the subparagraphs of N.1.5 shall be performed with a minimum of two test vehicles.

   (a) The first test vehicle may be a two axle, six tire, single unit truck; a vehicle with two axles with the rear axle having dual wheels. The vehicle shall have a maximum Gross Vehicle Weight of 10,000 lbs.

   (b) The second test vehicle shall be a five axle, single trailer truck with a maximum Gross Vehicle Weight of 80,000 lbs.

Note: Consideration should be made for testing the systems using vehicles which are typical to the systems daily operation.

N.1.1.1. Weighing of Test Vehicles. – All test vehicles shall be weighed on a reference scale before being used to conduct the dynamic tests.

N.1.2. Test Loads.

N.1.2.1. Static Test Loads. – All static test loads shall use certified test weights.

N.1.2.2. Dynamic Test Loads. – Test vehicles used for dynamic testing shall be loaded to 85 to 95% of their maximum Gross Vehicle Weight. The “load” shall be non-shifting and shall be positioned to present as close as possible, an equal side-to-side load.

N.1.3. Reference Scale. – Each reference vehicle shall be weighed on a static scale meeting NIST Handbook 44, Class III L maintenance tolerances.

N.1.3.1. Location of a Reference Scale. – The location of the Reference Scale must be considered as vehicle weights will change due to fuel consumption.

N.1.4. Test Speeds. – All dynamic tests shall be conducted within 20% below or at the posted speed limit.

N.1.5. Test Procedures.

N.1.5.1. Dynamic Load Test. – The dynamic test shall be conducted using the test vehicles defined in N.1.1. The test shall consist of a minimum of 20 runs for each test vehicle at the speed as stated in N.1.4. The tolerance for each run shall be based on the percentage values specified in Table T.3.1.
N.1.5.2. Axle Spacing Test. – The axle spacing test is a review of the displayed and/or recorded axle spacing distance of the test vehicles. The tolerance value for each distance shall be based on the tolerance value specified in T.3.2.

N.1.5.3. Position of Vehicle during Test Runs. – During the conduct of the dynamic testing the vehicle shall adjust its position along the width of the sensor from one run to the next but ensuring that the vehicle stays within the defined roadway. The test shall be conducted with 10 runs in the center, five runs on the right side, and five runs on the left side. All weighments shall be within tolerance.

T. Tolerances


T.1.1. Design. – The tolerance for a weigh-in-motion system is a performance requirement independent of the design principle used.

T.2. Tolerance Application

T.2.1. General. – The tolerance values are positive (+) and negative (-). No more than 5% of each test shall be outside the applicable tolerances.

T.3. Tolerance Values for Accuracy Class A.

T.3.1. Tolerance Values for Dynamic Testing. – The tolerance values applicable during dynamic load testing are as specified in Table T.3.1.

<table>
<thead>
<tr>
<th>Load Description</th>
<th>Tolerance as a Percentage of Applied Test Load</th>
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<tr>
<td>Axle Load</td>
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<tr>
<td>Axle Group Load</td>
<td>15%</td>
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<tr>
<td>Gross Vehicle Weight</td>
<td>10%</td>
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</table>

T.3.2. Axle Spacing Tolerance. – The tolerance value applied to the axle spacing measurement shall be ± 0.5 feet (0.15 meter).

T.4. Influence Factors. – The following factors are applicable to tests conducted under controlled conditions only.

T.4.1. Temperature. – Systems shall satisfy the tolerance requirements under all operating temperature unless a limited operating temperature range is specified by the manufacturer.

T.5. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility. – The difference between the weight indication due to the disturbance and the
weight indication without the disturbance shall not exceed the tolerance value as stated in Table T.3.1.

**UR. User Requirements**

**UR.1. Selection Requirements.** – Equipment shall be suitable for the service in which it is used with respect to elements of its design, including but not limited to, its capacity, number of scale divisions, value of the scale division or verification scale division and minimum capacity.

**UR.2. User Location Conditions and Maintenance.** – The system shall be installed and maintained as defined in the manufacturer’s recommendation.

**UR.2.1. System Modification.** – The dimensions (e.g., length, width, thickness, etc.) of the load receiving element of a system shall not be changed beyond the manufacturer’s specifications, nor shall the capacity of a scale be increased beyond its design capacity by replacing or modifying the original primary indicating or recording element with one of a higher capacity, except when the modification has been approved by a competent engineering authority, preferably that of the engineering department of the manufacturer of the system, and by the weights and measures authority having jurisdiction over the system.

**UR.2.2. Foundation, Supports, and Clearance.** – The foundation and supports shall be such as to provide strength, rigidity, and permanence of all components.

On load-receiving elements which use moving parts for determining the load value, clearance shall be provided around all live parts to the extent that no contacts may result when the load-receiving element is empty, nor throughout the weighing range of the system.

**UR.2.3. Access to Weighing Elements.** – If necessary, adequate provision shall be made for inspection and maintenance of the weighing elements.

**UR.3. Maximum Load.** – A system shall not be used to weigh a load of more than the marked maximum load of the system.
The following are proposed definitions to be added to NIST Handbook 44, Appendix D to support the Weigh-In-Motion Systems used for Vehicle Enforcement Screening – Draft Code.

**weigh-in-motion** (WIM). A process of estimating a moving vehicle’s gross weight and the portion of that weight that is carried by each wheel, axle, or axle group, or combination thereof, by measurement and analysis of dynamic vehicle tire forces.

**axle.** The axis oriented transversely to the nominal direction of vehicle motion, and extending the full width of the vehicle, about which the wheel(s) at both ends rotate.

**axle-group load.** The sum of all tire loads of the wheels on a group of adjacent axles; a portion of the gross-vehicle weight.

**axle load.** The sum of all tire loads of the wheels on an axle; a portion of the gross-vehicle weight.

**axle spacing.** The distance between the centers of any two axles. When specifying axle spacing, you also need to identify the axles used.

**single-axle load.** The load transmitted to the road surface by the tires lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate).

**tandem-axle load.** The load transmitted to the road surface by the tires of two single-axles lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate).

**triple-axle load.** The load transmitted to the road surface by the tires of three single-axles lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate).

**Weigh-in-Motion Screening Scale.** A WIM system used to identify potentially overweight vehicles.

**Wheel weight.** The weight value of any single or set of wheels on one side of a vehicle on a single axle.

**WIM System.** A set of sensors and supporting instruments that measure the presence of a moving vehicle and the related dynamic tire forces at specified locations with respect to time; estimate tire loads; calculate speed, axle spacing, vehicle class according to axle arrangement, and other parameters concerning the vehicle; and process, display, store, and transmit this information. This standard applies only to highway vehicles.
Appendix B

Item 330-X N.4.2.5. Determination of Error on Whole Sale Devices with Multiple Flow Rates and Calibration Factors

How Slow Flow Accuracy Affects LMD’s

Because the legal tolerance on slow flow tests is so great (+/-0.5%) compared to industry standards (typically +/-0.05%), and because slow flow tests themselves are so time consuming, registered service agents may be tempted to skip slow flow tests entirely during seasonal re-calibrations. Even if one ignores the fact that the Liquid Measuring Device Code in NIST Handbook 44 requires that a special test be done at the slow flow rate, there remains a very good reason that slow flow rates should always be tested. If the error at the slow flow rate is unknown, then it is impossible to calibrate the high flow rates to deliver with the extreme accuracy sought by industry on quantities which are greater or less than the test prover used at the time of calibration.

Imagine a typical whole sale meter which is calibrated using a 1,000 gallon prover at a terminal where the customers’ trucks have pocket sizes between 1,000 and 4,000 gallons. The meter has an electronic register programmed with a slow flow rate for start-up and shut-down, a high-flow rate for typical deliveries, and a mid-speed fallback rate for when the pumps can’t keep up with demand. Startup and shutdown deliveries are 100 gallons each regardless of total quantity delivered.

Now imagine that the service agent calibrating the meter didn’t check the slow flow rate and didn’t know that the meter was short five gallons on a one thousand gallon test. Instead, he calibrated the fallback and normal flow rates without testing the slow flow and introduced a linear error which increases the farther the transaction quantity deviates from the prover size. On a 1,000 gallon delivery the meter would appear to be accurate, but on a 3,400 gallon delivery a three gallon error has been introduced. That is a 0.09% error which is almost twice the typical industry goal.

When calibrating at the normal and fallback speeds, the meter registers 200 gallons of product for the startup and shutdown, but actually delivers only 199 gallons. (99.5 gallons delivered for every 100 gallons registered at slow speed.) If the service technician calibrates the meter to zero at normal and fallback rates, the meter will actually deliver 801 gallons for every 800 gallons it registers at those rates.

Every subsequent delivery of 1000 gallons should receive exactly the right amount. Every delivery exceeding 1000 gallons will be ‘long’ and every delivery less than 1000 gallons will be short.
To determine the error on a typical delivery, the service agent needs to calculate the error introduced by the startup and shutdown gallons, and then the error introduced at the higher flow rates.

For a 3,400 gallon delivery in this example, the meter would register 100 gallons on startup but only deliver 99.5 gallons. It would then jump to normal rate and deliver 801 gallons for every 800 gallons it registers until it goes into shutdown mode when it slows down and again delivers only 99.5 gallons of the 100 gallons it registers. Delivery error is +3 gallons (0.09%).

The math would be reversed if the meter had been five gallons long on a 1,000 gallon slow flow test at the startup and shutdown speed. The meter would deliver 100.5 gallons for every 100 gallons it registered at startup and shutdown, but only 799 gallons for every 800 gallons registered at the normal delivery rate. The total delivery is 3 gallons (0.09%) short. Under-registration, which is favorable to consumers in most situations, can be detrimental to them when it occurs at the slow flow speed.

Does it matter considering that the error introduced is so much smaller than the tolerance allowed in the liquid measuring code? It does to industry, or they wouldn’t set such tight accuracy standards for themselves. And it does to Weights & Measures officials who must consider the predominant direction of error in addition to tolerance. Everyone’s time is wasted chasing extreme accuracy at the normal delivery rate if the accuracy of the startup and shutdown rate has been ignored.
How Slow Flow Errors Affect VTM’s

Imagine a typical VTM which is calibrated using a 100 gallon prover for a bulk delivery company whose customers’ tanks are typically between 100 and 1,000 gallons. The meter has an electronic register programmed with a slow flow rate for start-up and shut-down, and a high-flow rate for typical deliveries. Startup and shutdown deliveries are 10 gallons each regardless of total quantity delivered.

Now imagine that the service agent calibrating the meter didn’t check the slow flow rate and didn’t know that the meter was long 0.4 gallons on a 100 gallon test. Instead, he calibrated the normal flow rate without testing the slow flow and introduced a linear error which increases the farther the transaction quantity deviates from the prover size. On a 100 gallon delivery the meter would appear to be accurate, but on a 500 gallon delivery a -0.4 gallon error has been introduced. That is within tolerance, but if all of his meters have similar errors in the same direction, typical deliveries will be in the operator’s favor at the expense of his customers.

Calibrating high flow means compensating for slow flow error.

When calibrating at the normal speed, the meter registers 20 gallons of product for the startup and shutdown, but actually delivers 20.08 gallons. (10.04 gallons delivered for every 10.00 gallons registered at slow speed.) If the service technician calibrates the meter to zero at normal speed, the meter will actually deliver 79.92 gallons for every 80.00 gallons it registers at that flow rate.

Every subsequent delivery of 100 gallons should receive exactly the right amount. Every delivery exceeding 100 gallons will be ‘short’ and every delivery less than 100 gallons will be ‘long.’
To determine the error on a typical delivery, the service agent needs to calculate the error introduced by the startup and shutdown gallons, and then the error introduced at the higher flow rates.

For a 500 gallon delivery in this example, the meter would register 10 gallons on startup but actually deliver 10.04 gallons. It would then jump to normal rate and deliver 79.92 gallons for every 80 gallons it registers until it goes into shutdown mode when it slows down and again delivers 10.04 gallons as it registers only an additional 10 gallons.

The error would be well within maintenance tolerance so the Weights and Measures official need only be concerned if the slow flow errors on all the meters for a particular product are in the same direction. At that point, the official should determine the direction of the error on a typical delivery to determine if the equipment is being properly maintained. Device users can ensure they have no problems with this requirement by making sure that slow flow errors are not predominantly in one direction.
Appendix D

Agenda Item 337-2: Submitters Background and Justification for Handbook 44 Definition of “Diesel Gallon Equivalent (DGE)” of Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) as a Vehicular Fuel

Clean Vehicle Education Foundation


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Development of the “Gasoline Gallon Equivalent” by NCWM*

In 1993, under the auspices of the National Conference on Weights and Measures (NCWM), a Compressed Natural Gas (CNG) Working Group came together to determine the way in which CNG would be sold to the public at retail as a motor fuel.

The working group focused on three issues:

1. How to provide the Natural Gas Vehicle (NGV) industry a method of sale that would be familiar and acceptable to consumers
2. How to provide weights and measures officials a verifiable and quantifiable means to determine the accuracy of natural gas dispensers; and
3. How to meet these requirements with a uniform, national standard.

NCWM considered three proposals for the method of sale of CNG:

1. Joules, the unit of energy measurement in SI units
2. Mass
3. The Gasoline Gallon Equivalent (GGE)

The Natural Gas Vehicle Coalition (now NGVAmerica) recommended that the Gasoline Gallon Equivalent be adopted as the method of sale for CNG, and that it be based on the energy equivalent of a gallon of gasoline. The use of the GGE was recommended primarily for the convenience of the retail customer comparing the cost and fuel economy of a natural gas vehicle to a comparable gasoline vehicle. During the discussion, a proposal was made to eliminate the reference to energy content of CNG and replace it with a fixed conversion factor based on mass, with the fixed mass of CNG being equal to a gallon of gasoline. Measurement of mass in the retail dispenser and verification by W&M officials is easier and less costly than measurement of energy content.

Since the energy content of a unit measure of CNG (standard cubic foot - scf) and gasoline (gallon) vary widely depending on the sample of fuel measured, the reference gallon of gasoline was determined to be Indolene, the gasoline used by EPA to certify emissions and fuel economy, with an energy content (lower heating value) of 114,118 BTU/gal. Work conducted by the Institute of Gas Technology and the Gas Research Institute (now combined into the Gas Technology Institute) surveyed 6811 samples of natural gas nationwide and concluded that the “average” natural gas in the US had an...
energy content (lower heating value) of 923.7 BTU/scf, and a density of 0.0458172 lbs/cubic foot. This translates 20,160.551 BTU/lb. Dividing gasoline’s 114.118 BTU/gal by natural gas’s 20,160.551 BTU/lb gives 5.660 lbs of natural gas = 1 GGE. Similar calculations determined that a gasoline liter equivalent of natural gas equals 0.678 kg of natural gas.

At its 79th annual meeting in July of 1994, NCWM adopted resolutions that: “All natural gas kept, offered or exposed for sale or sold at retail as a vehicle fuel shall be in terms of the gasoline liter equivalent (GLE) or gasoline gallon equivalent (GGE), and

All retail natural gas dispensers shall be labeled with the conversion factor in terms of kilograms or pounds. The label shall be permanently and conspicuously displayed on the face of the dispenser and shall have either the statement “1 Gasoline Liter Equivalent (GLE) is equal to 0.678 kg of Natural Gas” or “1 Gasoline Gallon Equivalent (GGE) is equal to 5.660 lbs of Natural Gas” according to the method of sale used.”

These statements can be found in NIST Handbook130, along with the definition of “natural gas” which seems to apply only to Compressed Natural Gas, not to Liquefied Natural Gas. Handbook 130, §§3.11 and 3.12 (Engine Fuels, Petroleum Products, and Automotive Lubricants Regulations) confirm that these requirements are for CNG, rather than LNG. Similar requirements and definitions are found in Handbook 44.

During the discussions it was recognized that, although diesel and gasoline are both sold in gallon units, a gallon of diesel fuel has substantially more energy content than a gallon of gasoline. While it is convenient to use the Gasoline Gallon Equivalent unit when comparing the cost and fuel economy of gasoline-powered light-duty vehicles to equivalent natural gas vehicles, a Diesel Gallon Equivalent unit would be more useful for operators of medium and heavy-duty (usually diesel powered) vehicles. However, in 1994, the NCWM working group “agreed to defer development of a “Diesel Gallon Equivalent” until the issues related to the ‘Gasoline Gallon Equivalent’ were decided by the NCWM and agreed to meet again if additional work is necessary.” The issue of the formal definition a Diesel Gallon Equivalent (DGE) unit has not come before NCWM from that time until today, although the DGE is often used in the industry, defined as 6.31 lbs of compressed natural gas.

Need for a Definition of a “Diesel Gallon Equivalent” Unit

Today there are an increasing number of commercial vehicles using natural gas as a fuel, to lower emissions and Greenhouse Gases, decrease America’s use of petroleum, and lower fuel costs (U.S. DOE Clean Cities Alternative Fuel Price Report for April 2012

*“Method of Sale Regulation,” §2.27

CVEF Page 2 11/25/13
shows in Table 2 ‘Overall Average Fuel Price on Energy-Equivalent Basis’ that diesel is priced at $4.12/gal and CNG at $2.32/gal


Since the NCWM’s working group deferred development of a DGE unit in 1994, there has been little call by the natural gas vehicle industry for the formalization of that unit in the sale of Compressed Natural Gas. However the use of Liquefied Natural Gas (LNG) as a motor fuel has been growing (more than 350 LNG stations are being built on the nations interstate Highways) and there is significant interest in using the DGE as a unit for the sale of that fuel.

LNG as a motor fuel is used almost exclusively by commercial vehicles, most of which view diesel as the conventional alternative. Using the same logic as was used for the development of the GGE unit, the convenience of the retail customer comparing the cost and fuel economy of a natural gas vehicle to a comparable conventional vehicle, it makes sense for NCWM to now “officially” define the DGE.

Other than §3.12. Liquefied Natural Gas, in the Engine Fuels and Automotive Lubricants Regulation section of Handbook 130, we find no specific provisions in either Handbook 44 or Handbook 130 for the retail sale of LNG as a motor fuel. However LNG is sold in California and other states on a mass basis (by the pound), which allows for easy confirmation by weights and measures authorities. An “official” definition of the DGE as a specific mass of LNG and CNG would allow states to easily move from retail sale by pound to retail sale by DGE, simplifying the sale process for the retail customer used to dealing with “gallons of diesel” as a fuel measure.

Therefore, at this time we are asking for a definition of the Diesel Gallon Equivalent (and Diesel Liter Equivalent) units by NCWM.

_Justification of the Definition of a DGE as 6.38 Pounds of Compressed Natural Gas_ Handbook 130 contains the following definitions of natural Gas as a vehicle fuel*:

* NIST handbook 130, 2006, Method of State Regulation, §§2.27.1.2 and 2.227.1.3; also Engine Fuels, Petroleum Products, and Automotive Lubricants Regulation, §§1.25 and 1.26.

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**Gasoline liter equivalent**

(GLE). – Gasoline liter equivalent (GLE) means 0.678 kg of natural gas.

**Gasoline gallon equivalent (GGE).** – Gasoline gallon equivalent (GGE) means 2.567 kg (5.660 lb) of natural gas.

As the NCWM working group recognized during its deliberations in 1993 on the Gasoline Gallon Equivalent unit, both gasoline and natural gas can vary in their BTU content from sample to sample. The working group determined the gasoline gallon (energy) equivalent based on a gallon of Indolene (114,118 BTU/gal – lower heating value) and a survey of 6811 natural gas samples nationwide with an average of 923.7 BTU/scf (lower heating value) and a density of 0.0458172 lbs/cubic foot. This equates
to 20,160.551 BTU/lb. Dividing gasoline’s 114.118 BTU/gal by natural gas’s 20,160.551 BTU/lb gives 5.660 lbs of natural gas = 1 GGE. Similar calculations determined that a gasoline liter equivalent of natural gas equals 0.678 kg of natural gas.

Starting with 5.660 lbs of natural gas = 1 GGE and 0.678 kg of natural gas = 1 GLE, we can calculate the mass of natural gas necessary to make a DGE and a DLE by comparing the amount of energy in a gallon of diesel fuel to the amount of energy in a gallon of gasoline fuel and apply that ratio to scale up the masses of natural gas calculated for the GGE and GLE units.

Unfortunately it is no easier today than it was in 1993 to set one energy value as representative of a unit for all gasoline, (or diesel) fuel. EPA’s certification fuel has likely changed in energy content since 1993, as both gasoline and diesel fuels have been modified for improved emissions.

We recommend using the most recent Department of Energy Transportation Energy Data Book*, as an authoritative reference for both gasoline and diesel fuel energy values. Taking further surveys or basing our calculations on today’s EPA certification fuel only delays our action, substantially increases costs, and, in the end, provides a limited potential increase in accuracy based on one point in time. Table B.4 of the Transportation Energy Data Book, on the heat content of fuels lists the net energy of diesel as 128,700 BTU/Gal. The 31st Edition may be downloaded at the following site.


Therefore a Diesel Gallon Equivalent of compressed natural gas is: (128,700 BTU/Gal / 20,160.551 BTU/lb) = 6.38 lb/DGE (2.894 kg/DGE) and a Diesel Liter Equivalent of compressed natural gas is:

2.894 kg/DGE X 0.2642 Gal/Liter = 0.765 kg/DLE

Justification of the Definition of a DGE as 6.06 Pounds of Liquefied Natural Gas

Cooling pipeline natural gas to -259°F makes liquefied Natural Gas (LNG). The pipeline natural gas has the same national average composition as was determined for CNG with a LHV of 20,160.551 BTU/lb. In order to reduce the natural gas temperature for liquefaction carbon dioxide must be removed since it would solidify in the system and nitrogen, which remains a gas at LNG temperatures, is reduced to less than 0.5% by volume in the final product. These changes to the composition of the pipeline gas increase the LHV of LNG to 21,240 BTU/lb.

Therefore a Diesel Gallon Equivalent of LNG is:

128,700 BTU/lb / 21,240 BTU/lb = 6.06 lb/DGE (2.749 kg/DGE)

and a Diesel Liter Equivalent of LNG is:

2.749 kg/DGE X 0.2642 Gal/Liter = 0.7263 kg/DLE

The attached presentation file provides an overview of the CNG and LNG processes from pipeline to dispensing along with the calculation of the LNG LHV based on the change in LNG chemical composition through the liquefaction process.

Prepared by:
Clean Vehicle Education Foundation
http://www.cleanvehicle.org
Clean Vehicle Education Foundation

Proposal for CNG & LNG – DGE
NCWM
March 20, 2013

Douglas Horne – President
Why DGE is Now Needed by the NGV Market

- In the 1994 NCWM set GGE at 5.66 lbs but deferred the development of DGE because:
  - The consumer market was LD gasoline conversions
  - And diesel class NGVs were fleets such as transit that use private stations.

In the last twenty years the market growth has been in HD vehicles and now a national network of public CNG and LNG - LCNG fueling is emerging.
CNG and LNG Delivery Systems

Natural Gas Pipeline Supply
National Average LHV 20,161 BTU/lb

- CO₂ removed & Nitrogen ≤ 0.5%

-259 °F at 2 psig

CNG Compressor, dryer and storage

4500 psig to 3600 psig

CNG Mass flow meter - dispenser

3600 psig

DGE 6.38 lb

DELIVERY

LNG Plant

On site LNG storage 21,240 BTU/LB

-207 °F at 100 psig

DGE 6.06 lb

Delivery by tanker

12/10/13

www.cleanvehicle.org
CNG DGE
Based on 1994 NCWM GGE Standard

- The 1994 acceptance NCWM of Gasoline Gallon Equivalent (GGE) for natural gas to be equal to 5.660 lbs was based on a national weighted average composition of natural gas
  - density of 0.0458172 lbs/scf
  - LHV = 20,160.551 BTU/lb

- Using the same natural gas composition and the LHV of diesel noted in Table B.4 of the DOE Transportation Energy Data Book
  - 128,700/20,160.551 gives the Diesel Gallon Equivalent (DGE) of 6.38 lbs

- For those NGVs that use CNG as a replacement for diesel, a DGE of CNG would be 6.38 lbs
As shown in the LNG delivery system slide the national average pipeline gas has a LHV of 20,160 BTU/lb and during liquefaction the inert gas constituents are reduced thus increasing the LHV to 21,240 BTU/lb

- For those NGVs that use LNG as a replacement for diesel, a DGE of LNG would be 128,700 LHV diesel divided by 21,240 LHV of LNG equaling 6.06 lbs
# DGE & GGE Based on LNG Composition

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100.00 | 100.00 | 0.044771512 | 100 | 21240  | Diesel¹ LHV= | 128,700 |

LNG - DGE= | 6.08 |

1 CNG national average composition of natural gas from the NCWM Laws and Regulations - CNG Working Group letter 10/18/1993 Appendix A. Conversion Factor Background

2 LNG composition based on CNG composition with CO2 removed and nitrogen reduced to 0.5%

3 DOE Transportation Energy Data Book Table B.4

Note: each 0.1% reduction/addition of nitrogen in LNG lowers/raises DGE by 0.01 lb.
CNG dispensers may dispense natural gas in two units:
  GGE = 5.66 lbs
  DGE = 6.38 lbs

LNG dispensers will dispense LNG in one unit:
  DGE = 6.06 lbs
CVEF Contact Information

- Douglas Horne – President
  dbhorne@cloeanvehicle.org
  770-424-8575

- www.cleanvehicle.org
Appendix E


The following background information is excerpted from the NIST SP 920 the 1997 Report of the 82nd NCWM in the Final Report of the Specifications and Tolerances Committee in Agenda Item 337-2:

337-2 VC S.3.6.(b) Automatic Density Correction; Volume-Measuring Devices

(This item was adopted as part of the consent calendar.)

Source: Southern Weights and Measures Association

Recommendation: Modify S.3.6.(b) Automatic Density Correction on Volume-Measuring Devices as follows:

S.3.6. Automatic Density Correction

(b) Volume-measuring devices with automatic temperature compensation used to measure natural gas as a motor vehicle engine fuel shall be equipped with an automatic means to determine and correct for changes in product density, both for changes in the temperature, pressure, and composition of the product.

[Nonretroactive as of January 1, 1995. To become retroactive as of January 1, 1999.]

Discussion: The Southern Weights and Measures Association submitted this proposal after reviewing a proposal from Hoffer Flow Controls to delete S.3.6. Automatic Density Correction on Volume-Measuring Devices from Handbook 44. Hoffer Flow Control’s position was that neither a direct mass flow meter or an inferred mass flow meter is capable of determining composition of a gas without the use of a gas chromatograph or similar type of analytical equipment which can make qualitative and quantitative determinations of the components that makeup a gas.

The Southern believes that there are some misinterpretations of this paragraph relating to the use of the term “composition.” The Southern noted that paragraph S.3.6. recognizes that product density can vary with changes in product composition and with changes in product temperature. Any changes in product density can affect the accuracy of the meter, thus these devices must be equipped with a means to automatically correct for changes in product density. Manual entries of product density are not sufficient to compensate for changes in density which may vary with changes in the supply of product. Based on its review of past NCWM S&T reports the Southern believes the use of the term “composition” was not intended to require a device to automatically monitor changes in the qualitative properties of the gas; the requirement for monitoring changes in product density relates only to the subsequent impact on the measurement determination. Therefore, the Southern does not believe it is appropriate to delete the word “composition” and recommends as an alternative that the focus of the changes to S.3.6. should be to clarify the concerns which have been raised. The Southern notes that it heard additional comments that pressure may also affect product density and recommended that the S&T Committee study whether or not the term “pressure” should be added to S.3.6.

During the open hearing session at the Interim Meeting, comments were heard that indicate other influence factors (in addition to temperature and composition) may affect product density. Based on this information, the Committee recommends that the term “pressure” be added to paragraph S.3.6. to require that these systems have an automatic means to determine and correct for changes in product density due to changes in “pressure.” The Committee recommends that this requirement be revisited as new technologies are developed that indicate other influence factors affect product measurement in these systems.
The Committee heard comments from one manufacturer of an indirect mass flow meter that this item should be made informational until it completes research on these measuring systems. The Committee acknowledged that the study in progress and noted that it may revisit this issue when the study is complete on the effects of product composition.

The following background information is excerpted from NIST SP 870 the 1994 Report of the 79th NCWM in the Final Report of the Specifications and Tolerances Committee in Agenda Item 337-4B:

**337-4B V S.3.6. Automatic Density Correction**

(This item was adopted.)

Based upon comments received, add the following as a new Item 337-4B to address volume-measuring devices used to measure compressed natural gas as an engine fuel.

**Recommendation:** To recognize volume-measuring devices being used to measure Compressed Natural Gas (CNG) as an engine fuel consistent with the requirements of the Hydrocarbon Gas Vapor-Measuring Devices Code and to permit time for these devices to be modified to incorporate automatic density correction, the Committee recommends that S.3.6. be amended to read:

**S.3.6. Mass Flow Meters Automatic Density Correction.**

(a) An automatic means to determine and correct for changes in product density shall be incorporated in any mass flow metering system that is affected by changes in the density of the product being measured.

(b) Volume-measuring devices with automatic temperature compensation used to measure natural gas as a motor vehicle engine fuel shall be equipped with an automatic means to determine and correct for changes in product density, both for the temperature and composition of the product.

(Nonretroactive as of January 1, 1995. To become retroactive as of January 1, 1999.)

**Discussion:** In the absence of a permanent Mass Flow Meters Code, requirements for mass flow meters have been adopted into several codes for measuring devices. The requirements of the Hydrocarbon Gas Vapor-Measuring Devices Code have been applied to devices used to measure CNG. This code permits volume measuring devices to indicate in units of volume, but the method of sale for CNG is currently being considered by the NCWM to be the gasoline gallon equivalent (GGE). The GGE is based upon mass units, hence, the automatic correction for changes in composition of the natural gas is needed to promote more accurate measurement.

To provide time to incorporate automatic density correction for these devices, subparagraph (b) is added as a nonretroactive requirement. During the time volumetric devices are used to measure compressed natural gas as a motor vehicle engine fuel, corrections for changes in product density due to changes in composition will have to be entered manually. It is the owner’s responsibility to maintain the device within tolerance at all times. Subparagraph (b) will become retroactive as of January 1, 1999.
Appendix F

Item 358-1: Measurement of Bulk Material in Open-Top Truck and Trailer Units

Load Volume Scanner Metrology, Test methods & Suitability for Use by Loadscan Ltd.
Load Volume Scanner (LVS)

Metrology, Test Methods and Suitability for Use

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Author: Adrian Ruthe, Technical Manager
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Introduction
This document is intended to provide additional information about the LoadScan/TallyClerk Load Volume Scanner to assist trade measurement authorities in evaluating the instrument only. It is not intended as a general introduction to the product or its usage.

Background
The Load Volume Scanner (LVS) is a non-contact volumetric measurement instrument designed to measure loads of bulk loose solids in open-bin truck and trailer units. Typical applications are in civil construction, quarrying, mining, mulch manufacturing, debris cleanup, recycling and other industries where bulk materials are traded by the truck load and volume is the key quantity of interest or the most practical form of measure.

- The TallyClerk development project was initiated in 1998 to provide a solution to industry requirements for accurate tally of construction aggregate and spoil movements on, off and around civil construction sites.
- The LVS achieved type approval for trade use in New Zealand in 1999 and in Australia in 2010.
- TallyClerk has been re-branded to LoadScan and now has over 75 installations around the world, the majority in New Zealand.
- The LVS format includes fully mobile, portable and fixed-mount models.
- The LVS is now used to measure a wide range of bulk load materials in a full spectrum of truck designs across multiple industries.
Principle of Operation

Trucks are ‘scanned’ by driving slowly below an elevated Scan Head. This is essentially a mounting platform for two scanning laser range-finders, which we will refer to as laser scanners. When a truck crosses the Scan Area below the Scan Head it falls within the field of view of these laser scanners which perform thousands of distance measurements per second.

The LVS processes the distance data measured by the laser scanners as a truck passes below and constructs a composite 3D model or ‘surface profile’ in software. A vehicle is initially scanned empty and recorded into the system database as an empty vehicle profile (zero reference). Load volume is computed on subsequent scans by comparing each new loaded vehicle profile against the recorded empty profile. This involves aligning the empty and loaded vehicle profiles spatially in software and computing a load profile from the difference between them.

The LVS measures the load as it sits in the truck at the time of measurement. The measured volume is the “loose” volume generated by the surface contour and it makes no assumptions about product density or changes in volume over time.
The scanning process is fully automated and a touch-screen Operator Console provides for operator control and monitoring of the system. Trucks and trailers can be identified manually, or they can be fitted with RFID Tags that automatically identify the vehicle(s) when scanned. Measurement results are displayed on the Operator Console screen and loading tickets can be printed automatically with an optional Ticket Printer. Results are also displayed on a high visibility LED Message Board. Permanent records are saved to log files which can be transferred to other systems for analysis, invoice generation and reporting.
### Metrological Characteristics

#### General Metrological Characteristics

<table>
<thead>
<tr>
<th>Basic Specifications</th>
<th>Unit of Measure</th>
<th>Cubic metre (m(^3)) or cubic yard (yd(^3)) according to regional requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Range (per bin)</td>
<td>0 – 130 m(^3) (0 – 170 yd(^3)) or as set by regional trade measurement authorities</td>
<td></td>
</tr>
<tr>
<td>Scale Interval (resolution)</td>
<td>0.1 m(^3) / 0.1 yd(^3) or as set by regional trade measurement authorities</td>
<td></td>
</tr>
<tr>
<td>Measurable Vehicle Types</td>
<td>Open bin road-legal truck, truck-trailer, semi-trailer and B-train combinations (including bottom-dump, side-toper and belt unloaders); Road-trains with up to 4 bins; Rigid bodied and articulated off-highway dump trucks (mine, quarry, underground); solid sided rectangular tractor trailers. Maximum 3m (10') wide, 4.25m (14') high for standard fold-down LVS. Custom mounting may be required for larger trucks.</td>
<td></td>
</tr>
<tr>
<td>Measurable Bin Capacity (truck/trailer size)</td>
<td>1.5 – 130.0 m(^3) (2.0 – 170 yd(^3)) or as set by regional trade measurement authorities</td>
<td></td>
</tr>
<tr>
<td>Measurable Load Types</td>
<td>Except where limited by regional trade measurement authorities: Flowable solids (bulk loose materials) including but not limited to: a) Earth, sand, gravel or other similar material b) Mulch, bark, compost or other similar landscaping products and raw constituent materials c) Woodchip or sawdust d) Unprocessed ore, coal or mining waste e) Bulk recycled materials in crushed, shredded or similar form f) Lumpy, irregular mixed materials where sold as waste or debris</td>
<td></td>
</tr>
<tr>
<td>Maximum Load Particle Diameter (average)</td>
<td>200 mm (7.8&quot;) no limit for non-trade applications</td>
<td></td>
</tr>
<tr>
<td>Typical Measurement Accuracy</td>
<td>Better than 1% to limit of resolution</td>
<td></td>
</tr>
<tr>
<td>Vehicle Speed (during scanning)</td>
<td>0.5 – 6.0 kmph (0.3 - 3.7 mph)</td>
<td></td>
</tr>
<tr>
<td>Power Requirements</td>
<td>24VDC, 13A max or 110-240 VAC, 50/60Hz, 4A max with AC power supply installed</td>
<td></td>
</tr>
<tr>
<td>Laser Protection Class</td>
<td>Class 1 (eye-safe)</td>
<td></td>
</tr>
<tr>
<td>Clearance (from Ground)</td>
<td>5.0 m (16.4') minimum (depends on mounting system and type of vehicles to be scanned)</td>
<td></td>
</tr>
</tbody>
</table>

#### Rated Operating Conditions

| Operating Temperature | -30 – 50°C (-22 – 122 °F) Scan Head, LED Message Board 0 – 45°C (32 – 113 °F) Operator Console, Printer |
| Minimum Visibility | 50 m (164') (dense fog) |
| Maximum Scan-Track Gradient | 5 degrees (0%) |
| Maximum Scan-Track Camber | 3 degrees (5%) |
Type Classification
The LVS does not fit into any existing internationally recognized standard instrument classification defined for other types of measurement instruments and none exists specifically for the LVS. In New Zealand and Australia, where the LVS currently has type approvals, the trade measurement authorities have borrowed from and modified existing classifications to create type approval specifications for the LVS.

In terms of principle of operation and unit of measure, the LVS is best compared to Multi-Dimensional Measuring Instruments used for determining the dimensions and/or volume of objects for the purpose of calculating freight, storage, or postal charges based on the dimensions and/or volume occupied by the object. The scanning laser rangefinder technology utilized by the LVS is essentially the same as used by the latest generation of these instruments. However, the instrument design, metrological characteristics and application is significantly different and the LVS does not fit well into this type classification. Some of the existing guidelines for Multi-Dimensional Measuring Instruments can be applied to the LVS.

In terms of application, the LVS is better compared to instruments for Vehicle Weighing in Motion such as axle weighers and other in-motion weighbridges. However, the technology is very different and these instruments measure weight, not volume. Some elements of the existing guidelines for Vehicle Weighing in Motion can be applied to the LVS.

Brim Measures or Dry Measures including front-end loader buckets or other measures of fixed capacity for the measurement of solids are also comparable in terms of unit of measure and type of materials measured.

Scan Head Mounting
The scan head support structure may be varied to suit the installation or portability requirements. In all cases the mechanical support mechanism provides stable mounting for the scan head, in the required location relative to the scan area and does not alter the metrological characteristics of the instrument. Standard clearance from ground is approximately 5.2m but this may be increased for scanning larger dump trucks.

Calibration
The LVS is not an analogue measurement instrument and cannot be “calibrated” in the traditional sense—it does not include any facility for scaling the measurements up or down or setting a zero point. Calibration from a metrological point of view corresponds to the alignment of the LVS scan head to set the laser scanners in the correct position and orientation relative to the scan track that trucks pass over. However, measurement accuracy does not have a direct linear or non-linear relationship to scan head alignment which can in no way be used to “calibrate” the measurements.

Zero Indication
The LVS does not have a zero indication, only a ready indication. Zero reference is set for each individual truck or trailer body by scanning empty and recording an empty vehicle profile in the system database.

---

1 See for example: NIST Handbook 44 (2012), section 1.58, Multiple Dimension Measuring Devices (USA)
2 See for example: OIML R 134-1 (2006), Automatic instruments for weighing road vehicles in motion and measuring axle loads (OIML)
3 See for example: NIST Handbook 44 (2012), section 4.45, Dry Measure (USA)

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S&T – F 8
Validation Checks
The LVS performs many validity checks designed to prevent the system being used fraudulently or outside the limitations specified. If any validation checks fail, an error is generated and no result is displayed. The following are some of the validation checks performed by the system:

- On start-up, the LVS will not enter ready-state if it detects gradient or camber of the scan area (relative to the scan head) are outside tolerance.
- LVS prevents recording empty truck/trailer trays of less than about 1.5m³ (2.0 yd³) capacity (or as otherwise specified) into the system database.
- No measurement output if covered load detected (e.g. tarpaulin covering tray).
- No measurement output if vehicle speed is outside limits or speed is too uneven.
- No measurement output if tray is scanned with hoist in fully or partially raised position.
- No measurement output if truck turns, drives off-centre or passes at too great an angle through the scan area.
- No measurement output if the basic visible dimensions of the ‘empty’ and ‘load’ trays do not match.
- LVS will not enter ready-state if high levels of dust, fog or other ‘visual pollution’ are detected.
- No measurement output if high levels of dust, fog or other ‘visual pollution’ are detected within scanned vehicle profile data.

Safety and Compliance
Declarations, certifications and reports relating to electrical and mechanical safety and Electro-Magnetic Compatibility (EMC) of the LVS system components are retained on file by LoadScan Ltd. The LVS design meets FCC (radiation), FDA (laser) and UL (electrical safety) requirements for import into the USA.

System Security
The LVS has built-in security features to prevent tampering or misuse. These features include:

- Access to system software and settings is not possible without access procedures and passwords held by LoadScan Ltd.
- Laser scanner serial numbers are stored in the system computer so that scanners or computer cannot be replaced except by staff with the appropriate maintenance password and procedures.
- Access to user configuration and installation settings is limited by a ‘System’ password.
- Access to database functionality and historical measurement records can be limited by a ‘User’ password.

Database Records
Empty vehicle profiles are recorded into the system database as ‘Reference Scans’. These form the zero references for each tray and have a 12-month expiry (or less as required by regional trade measurement authorities), after which they must be updated. Reference scans must also be updated any time that significant structural changes are made to the shape of a truck or trailer tray (e.g. adding or removing topper boards or cover systems). It is still possible to use existing reference scans after expiry, but ‘REFERENCE SCAN EXPIRED’ will be displayed or printed with all measurement indications.

Measurement Records
In addition to screens and sign indications and optional printed tickets, the LVS stores all results and additional details in log-files on electronic media. These files are secure and encrypted. They cannot be modified and create a secure audit trail. Non-encrypted copies of these files are available for download via network connection or USB drive without restriction (user password may be required). Additionally, for every scan, a record of the raw laser measurement data is saved to a file. These files provide a further audit trail and can be downloaded by LoadScan Ltd if necessary. They are automatically deleted after 60 days.
Extended Indication (Test Mode)
A password protected Extended Indication mode to assist in accuracy testing is available. In this mode the scale interval is 0.01m²/yd² across the full measurement range.

Access Log
An entry is automatically created in a secured access log file every time maintenance level configuration setting changes, software upgrades or scanner or computer hardware replacements are made. This log file can be downloaded (password required).

Sources of Measurement Error
A full theoretical error analysis is not feasible due to the complex interaction of thousands of variables. But the LVS has been extensively tested and the accuracy range demonstrated.

The metrologically significant factors that affect measurement accuracy are:
- Distance Measurements (Laser Scanners)
- Data Processing (Software)
- Scan Head Alignment (Installation)
- Environmental Conditions

Distance Measurements (Laser Scanners)
The laser scanners perform thousands of individual distance measurements every second.
- Rated absolute accuracy (typical): ±12 mm (±0.47 in).\(^4\)
- The LVS application is affected by the relative error between individual points, not the absolute error relative to scanner zero location. This significantly reduces the effective error.
- No re-calibration of laser scanners is required. Built-in reference targets enable on-the-fly calibration which ensures that the measurement accuracy remains the same throughout the life time of the units.

| The error in individual distance measurements has no relationship to the size of the truck/trailer bin, size of the load or instrument range settings. |

In practice, each individual distance measurement at a single point can be modeled as largely independent from every other measurement with an equal probability of a positive or negative error within a range of statistical variance:

\(^4\) Manufacturer’s specifications for current model used in LVS (Sick LMS511-20100).
Data Processing (Software)
There are thousands of variables involved in the measurement data processing and error can only be determined by testing. However, an integral part of the LVS design is that every metrologically significant software process determines a ‘confidence level’ based on its input data quality and generates a ‘no measurement’ error condition if the confidence level is not acceptable.

The LVS outputs no measurement if it is not confident of the result.

Software processing error is not directly dependent on the size of the truck/trailer bin, size of the load or instrument range settings. Error probability does however increase roughly proportionally to the visible upper surface area of the load. This surface area is constrained by the physical dimensions of the truck/trailer tray it is contained in. So absolute error tends to increase as load volume increases but level off at higher volumes.

Scan Head Alignment (Installation)
The LVS scan head must be installed in the correct position and orientation relative to the scan area (track) that trucks drive over and the scan area should be well defined. The type of mounting structure can vary and installation, alignment and track marking procedures do not require special skills or qualifications. They can be performed by the system operator.

The better the alignment of the scan head and quality of the scan track, the smaller the statistical variance in measurement error. But this is equally dependent on the position, angle and speed of the truck on the scan track during a scan and does not directly affect the magnitude or sign of average error.

Scan head alignment does not directly affect the direction of error (i.e. whether volume is over-reported or under-reported) and cannot be used to calibrate the instrument.

To ensure only good quality measurements, the LVS monitors the ground profile and analyzes scan data to determine if the scan head alignment is out or if truck position, angle or speed on the scan track is outside acceptable limits. The system has many built-in checks to automatically generate ‘no measurement’ error conditions in such cases. If the alignment is not correct or trucks are not following the designated path and speed then they will not be able to get measurements.

The process of aligning the scan head and defining the scan track does not significantly improve the measurement accuracy – it reduces the chances of getting ‘no measurement’ error conditions.

Environmental Conditions
The effect of environmental conditions such as temperature, humidity, electro-magnetic interference and visibility on raw distance measurements is insignificant compared to other systematic errors and the laser scanners are rated for a very wide range of environmental conditions. *

Dense fog, steam or dust in the air can potentially block the view of the load surface and give false distance measurements. However, the LVS analyzes scan data to detect ‘visual pollution’ and generates a ‘no measurement’ error condition if this occurs.

The LVS does not attempt to measure a load if its view of the target is significantly obstructed.

* Manufacturer’s specifications for current model used in LVS (Sick LMS111-20100)
**Accuracy Classification**

LVS measurement error does *not* theoretically have a directly proportional relationship to measured load volume. However, in practice, in real world conditions, over a full range of truck designs, installation conditions and load types, absolute error magnitude increases roughly proportionally to load volume.

The following charts are indicative only. They are compiled from informal in-house accuracy testing and formal type approval testing results over a 12 year period. A variety of test load constructions, with varying degrees of uncertainty were used, test volumes are not evenly spaced and the number of measurements at each test volume varies. However the trend is clearly demonstrated.

![Graphs showing relationship between error magnitude and load volume](image)

Absolute error magnitude tends to increase roughly proportionally to measured volume. Percentage error magnitude tends to a relatively constant (or slightly improving) value with increasing volume.

Where \( d \) is the scale interval, one possible best-fit MPE (tolerance) for the LVS is:

<table>
<thead>
<tr>
<th>Maximum Permissible Error (MPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \pm 1.00% ) or ( 1.5d ) (whichever is the greater)</td>
</tr>
</tbody>
</table>

This is based on the ’Class 2’ Weighing in Motion (WIM) accuracy class as specified by OIML\(^6\) but with the same MPE for Acceptance and Maintenance (the approach used by NMI for LVS type approval in Australia). The resultant MPE (in cubic metres, with \( d = 0.1 \)) is as below:

![Graph showing error magnitude vs load volume](image)

There are other possibilities. LVS type approval in New Zealand uses a stepped rather than percentage MPE.

---

Test Methods

LVS Accuracy testing requires the generation of suitable test measures. A test load is an artificially generated reference volume, known to a suitable level of uncertainty, loaded onto a truck or trailer.

Current Methods

The following is a summary of methods currently used for generating test loads. LoadScan Ltd has more detailed written procedures on file. These methods can be combined.

Solid Test Load (Reference Standard)

A solid block or hollow shell of known external volume, in the approximate shape of a typical measurable load, may be loaded onto the test vehicle and used as a test load.

Advantages

- A permanent reference standard analogous to test weights used for scales.
- Volume does not change significantly over time.
- Easy to transport and store.
- Fast and practical solution.

Disadvantages

- Only suitable for test volumes that are small compared to instrument capacity.
- Requires a very flat tray floor as it is rigid and does not adapt to contours of test vehicle.

Multiple Brim Measure Loading

A rectangular bin or other brim measure of known capacity can be loaded with suitable material, and this material transferred to the test vehicle one or more times to create a test load.
Advantages
- Uses real load materials and generates realistic load profiles
- May be able to use resources available at test site

Disadvantages
- It is very difficult to control or determine true test load volume because load material compaction may not be the same in truck/trailer bin as in measuring container.
- The uncertainty increases significantly with load size due to the unpredictable compaction or settlement level of the cumulative load. This means it is only suitable for a small number of repeated rim measure transfers.

Levelled and Measured Load
Where the dimensions of the tray on the test vehicle are known, a test load of known volume can be generated by loading the tray to a set level below the tray top-sides and computing the volume from the known dimensions of the tray and the measured level of the load. The load material needs to be compacted or “shaken-down” before leveling to avoid the volume changing over time as the load settles. Additional load material should be added by the rim measure loading method or a solid test load put on top to create a more realistic load profile.

Advantages
- Uses real load materials.
- May be able to use resources available at test site.
- Can test up to larger volumes by this method.

Disadvantages
- Time consuming and requires lots of resources
- Requires suitable test vehicle to be identified in advance and available for testing.
- Unless the vehicle tray profile is very regular and simple the uncertainty in manual dimensional measurements may be too high.

False Floor Measured Load
A false floor (flat or profiled) may be constructed for a truck tray or custom test trailer of known dimensions. A solid test load or a measure of load material (rim measure loading) may be placed on top of this to generate a more realistic load profile. This is essentially the same as the Levelled and Measured Load method, except that the levelled load is generated by a false floor and the floor itself may be profiled to represent a load instead of flat.
Advantages

- Better control of surface profile than leveled and measured load so volume uncertainty is lower.
- Can test up to larger volumes by this method.

Disadvantages

- Time consuming and requires lots of resources
- False floor must be custom-built for a particular test vehicle.
- Unless the vehicle tray profile is very regular and simple the uncertainty in manual dimensional measurements may be too high.

**Practical Constraints on Test Load Generation**

Only approved test loads or methods should be used. General requirements for test loads are:

- True volume (conventional true value) must be determined by a verifiable method to a suitable level of uncertainty.
- Must be made of materials that cannot be easily influenced by environmental conditions.
- Must not be subject to loss or increase in volume over time.
- The shape of the test measure should reflect the shape of the loads to be measured.

Meeting these requirements is challenging, especially for larger volumes. There are practical constraints on:

- Technical construction method
- Ability to determine true volume
- Availability of suitable resources at test sites
- Time
- Cost
- Size
- Transportation and storage

Because of practical limitations it is not feasible to repeatedly generate test loads with volume known to the required level of uncertainty up to the maximum used capacity of the LVS ($133\text{m}^3/17\text{yd}^3$) beyond initial one-time type approval testing. However, as previously noted, the statistical error variance in the physical distance measurements which volume computation is based on has no relationship to actual load volume or instrument range settings and cannot be adjusted (calibrated). An LVS instrument is either working within its accuracy capabilities across its full range or it is faulty.

| Confirmation of acceptable error at lower volumes is adequate to confirm the LVS is functioning correctly within its accuracy capabilities across its usable range. |
In New Zealand, where the LVS has had type approval since 1999, the trade measurement authorities recognized this fact and the difficulties of attempting to create suitable test loads at high volumes. A certified solid test load (reference standard) with a volume of 2.10 m$^3$ is used for all verification/certification testing. Approved maximum capacity is currently 65 m$^3$ in New Zealand. This is adequate for the local market, but type approval testing has been successfully conducted up to 100 m$^3$.

In regions where required maximum capacity is significantly higher, a 2.10 m$^3$ test load may not be considered as adequate for testing LVS performance across the full range as a matter of principle.

For such cases we suggest a requirement to test to 20% of used capacity where used capacity set per device for the particular application, within limits of type approval (up to 130 m$^3$ / 170 yd$^3$).

This is analogous to the 20% rule for scales with a capacity greater than 20,000 kg or 40,000 lb in the USA$^7$.

Note also that the LVS is a portable instrument and that due to system validation checks accuracy is not significantly affected by site-specific installation. The LVS has been approved as a portable instrument in New Zealand since 2000.

The LVS does not require re-verification each time it is installed on a new site.

Alternative Standardized Method

Due to the practical limitations discussed, solid test load is the preferred method for accuracy testing. It is also the most familiar to trade measurement authorities as it involves the use of a permanent reference standard that can be verified, does not change significantly over time and can be stored and transported relatively easily, as for example test weights used to test truck scales.

However, large solid volumes designed to simulate a load on any test vehicle are impractical. Such test loads do not mold to the internal shape of the test bin like a real load and large size is impractical for transport, handling and storage.

LoadScan Ltd has developing a self-contained portable test system that does not require a separate test vehicle. The test vehicle is a large collapsible rectangular bin that is trailer mounted to simulate a truck or trailer body and has a moveable false floor. Combined with solid test loads this method is practical for testing up to medium volumes. The current design can test up to about 35 m$^3$ (46 yd$^3$).

We propose the following accuracy testing regime:

<table>
<thead>
<tr>
<th>Type Approval Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test to max capacity</td>
</tr>
<tr>
<td>with a suitable number of intermediate steps as required by testing authorities.</td>
</tr>
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**Initial Verification (Acceptance)**
Where used capacity is less than or equal to 30 m$^3$ or 40 yd$^3$ (depending on configuration):
- Test at zero and as close as possible to used capacity with intermediate tests as close as possible to minimum capacity and 50% of used capacity

Where used capacity is greater than 30 m$^3$ or 40 yd$^3$ (depending on configuration):
- Test at zero and a maximum test volume at least the greater of 30 m$^3$ / 40 yd$^3$ or 25% of used capacity with intermediate tests as close as possible to minimum capacity and 50% of maximum test volume.

Testing to be conducted with self-contained test system as discussed above. Initial verification can be conducted at any suitable location and the instrument then moved from site to site as required without additional accuracy testing on each site.

**Alternatively, if acceptable to trade measurement authorities, use same method as for In-Service Inspection (below). This is the approved regime in New Zealand and the most practical.**

**In-Service Inspection (Maintenance)**
Test at zero and at a test volume of at least 2 m$^3$ or 3 yd$^3$ (depending on system configuration) with solid test load(s) using any suitable test vehicle available on site.

---

$^7$ See NIST Handbook 44 (2012), section 2.20, Scales, p31, Table 4, Minimum Test Weights and Test Loads (USA)
Suitability for Use

The LVS has proven to have a high degree of suitability for use within its application areas, especially where volumetric truck measure is the standard traded quantity.

Primary Application Areas

Civil Construction

- Bulk civil construction materials are specified and traded in volumetric quantities (m³/yd³)
- Portable measurement device on job sites (move from job to job)
- Monitor incoming construction materials such as rock aggregates, sand and soil
- Monitor outgoing materials such as excavated clay, soil etc

The LVS is well established in the civil construction industry in New Zealand. Some regional/city councils are requiring LVS units to be operated on their infrastructure jobs. Some construction companies are also requiring that their suppliers (quarries) must use an LVS if they wish to supply to their jobs.

Quarrying

- Mainly supply to the construction industry which works in volumetric quantities
- Measure outgoing product such as rock aggregates or sand
- Measure incoming ‘cleanfill’ for land reclamation
Mining

- Often problematic measuring weight due to size of vehicles and environment - LVS is a non-contact, in-motion, low maintenance solution
- Measure unprocessed ore or coal, over-burden and construction materials used on site
- Monitor carry-back (haul-back) where load material stuck in "empty" vehicle trays

Mulch/Landscaping Products

- Bulk landscaping products are specified and traded in volumetric quantities (m³/yard³)
- Measure outgoing processed product
- Measure incoming raw ingredient supplies

Forestry

- Measure woodchip for pulp production (pulp/paper mills)
- Measure woodchip, sawdust or bark for burner fuel or sale to landscape product manufacturers
- Measure construction materials for forestry road building and maintenance
Waste/Recycling

- Landfill reclamation or capping material
- Bulk recycled materials in crushed, shredded or similar form
- Disaster Debris cleanup

Traditional Measurement Methods

Traditional methods for determining volumetric truck measure are often inaccurate but are widely practised.

Converting from Weight to Volume

Measuring and trading by weight and applying conversion factors to determine volume is often very inaccurate. The most obvious problem is that weight to volume ratio varies greatly, depending on the moisture content of the load material.

- Product can become wet because of rain, ground moisture or from deliberate wetting of stockpiles or truck loads to prevent dust. This practice which often occurs in quarries, works in the suppliers favour when measuring weight.
- If the material is wet when loaded, it can weigh considerably more at the point of loading than at the point of unloading because water run-off occurs in transit. Generally trading by weight is based on weight at the point of loading.
- Weight-to-volume conversion factors are typically computed on a dry day in carefully controlled conditions and do not necessarily reflect the weight-to-volume ratio of supplied materials.

Counting Bucket Loads

There are well recognized issues with counting loader bucket scoops as a method of determining volumetric truck measure.

- In practice operators do not load each bucket consistently to the same level. In fact the loader operator cannot generally see the scoop very well and certainly it is not practical to get out and strike-off (level) every scoop. This varies from loader to loader and from operator to operator.
- How the bucket is pushed into the stock-pile significantly affects the effective volume when transferred to truck/trailer. For example, pushing the bucket hard into the bottom of the stockpile produces a more compacted load than loosely scooping off the side of the stock-pile.
- Due to the self-compaction/settlement of heaped material under its own weight, multiple bucket loads may not equate to resultant cumulative heaped volumes in truck bins or in stockpiles generated from truck loads. This issue extends to differences in cumulative heaped volumes generated by small bucket loads or generated by large bucket loads because of material self-compaction within a single scoop.
Manual Surveying

Manual survey methods include:

- Level and measure (manual survey of levelled load in truck bin using tape measure)
- Survey single load on the ground after unloading
- Survey stockpile or 'cut and fill' volume (multiple loads)
- Unload truck load into a container of measured capacity.

These practices are widely used on a 'random check' basis but are very time consuming. A common complaint about the 'level and measure' process is that it requires re-shaping and walking on the load which effectively changes the load volume. Disputes also commonly arise over load settlement in transit. This is the change in volume of a load due to the product "bedding down" or "fluffing up" as a result of vibration, braking and bumps during transport. Often the differences between what the supplier claimed in a truck (in cubic metres or cubic yards) and what the buyer claims, is quite significant. Unloading a truck onto the ground and then re-loading it with the same material and manually surveying the load (level and measure) at the buyer end is one way to check if the supplier's claimed volume is accurate. This method results in a load that should be very close in volume to the original loaded volume at the point-of-loading, before travel influences.

It should also be noted that volumes computed from 'cut and fill' surveys or by surveying large stockpiles generated from multiple truck loads over a period of time may not result in quantities that match the cumulative total of all the truck loads as the surveyed material may be closer to "solid measure" (compacted) than "loose measure" which is the measured and traded quantity.

Counting Truck Loads

A truck or trailer capacity may be determined by manual measurement, but in practice trucks and trailers are not loaded exactly to capacity every time. They may be at less than capacity or loads may be heaped above the sides to greater than struck capacity. Loader/excavator operators often cannot see inside the truck bins as they are lower than the bin sides. It is also difficult to load into the bin corners with a loader or excavator. And in fact, in many cases trucks would be over-loaded if filled to capacity.

Accuracy Limitations in Volumetric Load Determination

Traditional methods of determining truck load volume are often not very reliable. However, this is only partly due to limitations of the measurement methods. The true volume of a given quantity of bulk loose solid material is not a constant value. Volume fluctuates slightly as a result of natural changes in product density due to changing compaction levels, moisture content and environmental conditions. For this reason it is simply not possible to determine a meaningful volume to the same level of accuracy as some other measures, such as weight. This is not covered by legislation or type approval processes, but trade measurement officers involved in testing and enforcement in the field will be familiar with these issues.

Measuring truck load volume to a degree of uncertainty significantly smaller than the magnitude of natural volume fluctuations does not generally provide more meaningful measurement.
Industry understands the limitations in volume determination. It is for example, common practise when trading by truck load or multiple bucket count to round to the nearest cubic metre or yard where a higher resolution measure is not meaningful.

One response to this problem is to trade by weight because this can be determined more accurately. But as discussed above, there are problems with trading by weight where volume is the quantity of interest.

| An accurate measure of weight is often less meaningful than a less accurate measure of volume where volume is the quantity of interest |

**Key Advantages of the LVS**

For trade by volumetric truck measure the best solution is a fair determination of the load volume as it sits in the truck at the time of measurement. This is what the LVS provides. Some key advantages of the LVS are:

- Avoids need to estimate by:
  - Converting from weight
  - Counting bucket scoops or truck loads
  - Manually measuring or guessing
- Fast, fully automated measurement
- Non-contact, so measuring the load does not interfere with the load volume.
- Measures actual load in truck or trailer bin regardless of theoretical bin capacity
- Equity of trade for seller and buyer

Our experience is that the LVS is accepted as providing a fair measure for all and acts to prevent many disputes that otherwise occur. Truck measure is a happy median between individual bucket loads and stockpiles and as such is equally equitable to seller and buyer. It is also our experience that suppliers such as quarries that use the LVS system may lose the small advantage of selling by more easily manipulated methods but their customers are happier.

The LVS is also a portable device, making it suitable for installation on construction sites and other short-term applications.

The ability of the LVS to automatically detect unsuitable measurement conditions, combined with the fact that no re-calibration is necessary makes the LVS very suitable for portable use and installation on different sites by trained operators without any special legal metrological qualifications.

**Limitations and Potential Objections**

**Limitations of the LVS**

- Limited to open-top trucks/trailers/bins
- Measurement of bulk loose solid materials only
- Measurement accuracy is limited
- The LVS is a visual inspection system. It is unable to operate in conditions of "visual pollution" and reports an error condition in cases of:
  - extreme dust
  - dense fog
  - dense clouds of steam rising from load material
Potential Objections to Trade Use of the LVS

Objection
Why should the LVS be approved for trade use when weighing instruments of similar measurement accuracy have been rejected?

Response
The following points should be considered:

- The LVS is not a weighing instrument. It should be compared to existing alternatives, not a different class of instrument.
- The LVS is not a general purpose measurement instrument. Unlike axle-weighers for example, which also have a lower accuracy classification, it cannot measure any type of product of any value. It is limited to measurement of bulk loose solids in open bin truck and trailer units. The application areas where volume is of interest for this type of load is mainly limited to relatively low value product.
- Volume measurement inherently has a higher uncertainty due to natural volume fluctuations. Measuring instantaneous volume is a higher degree of accuracy than the inherent uncertainty is not beneficial.
- The LVS provides a significant improvement in accuracy, consistency and convenience over current standard practices.
- The accuracy is well within that demanded by industry itself (the buyers and sellers) for the types of transactions that LVS is used for.
- Accurate measurement of weight and conversion to volume from known bulk density does not provide a solution.

Objection
The LVS is not suitable for high value products due to accuracy limitation.

Response
The natural limitations of the device and industry requirements largely limit application to lower value products. Generally “high value” products that could be measured with the LVS are bulk dry powders with a high level of consistency in bulk density and so are suitable for measurement by weight and are traded by weight as standard.

Where considered necessary, trade measurement authorities can limit use. At a minimum the following suitability for use applies:

a) Earth, sand, gravel and other similar excavated or mined materials
b) Mulch, compost and other similar specialty mixes and primary raw constituent materials
c) Woodchip, sawdust, bark and similar materials
d) Unprocessed ore, coal or mining waste
e) Bulk recycled materials in crushed, shredded or similar form
f) Lumpy, irregular mixed materials only where traded as waste or debris

Objection
The LVS is only suitable for a limited range of vehicle types and material (product) types. Weight measurement does not have these limitations.

Response
True. The LVS is only suitable for measurement of bulk loose solids in open bin truck and trailer units. It is not intended as a general replacement for weight measurement. In fact it is often used in conjunction with weight measurement. It meets specific requirements of the industries where it is applied.
Objection
The LVS measures surface profile so voids (empty spaces) inside load are included in the measured volume.

Response
- In general the LVS is only intended for the measurements of bulk particulate materials with relatively small particle size so large voids do not occur.
- If the material is used in the same form it is measured in then it will have the same volumetric properties, including voids, in use.
- If the material is crushed/ground or otherwise modified after measurement then it becomes a different product with different properties.
- In special cases such as measurement of debris the material may be lumpy and contain significant voids, but the volume of interest includes the voids.

Objection
Some traders will believe they can make more money selling by the bucket count or weighing wet material so it is not in their interest to adopt this technology.

Response
Firstly, it is the trader’s choice to use the LVS or not. Secondly, the point of measurement is the point of payment so the measurement needs to be as equitable as possible (fair to buyer and seller). Of course rates (i.e. cost per cubic metre or yard) also need to reflect the condition of the traded material at the point of measurement.
Appendix G

Item 358-1 Load Volume Scanner, Proposals for Integration into Handbook 44

Load Volume Scanner
Proposals for Integration into Handbook 44
A submission to NCWM

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Introduction

At the time of writing, the LoadScan Load Volume Scanner (LVS) has been granted ‘Developing Item’ status by NCWM and it is now up to LoadScan as the device manufacturer to prepare specific language for Handbook 44 amendment. **Multiple Dimension Measuring Devices (MDMD)** has been identified as the most suitable classification into which to incorporate the LVS and our aim is to prepare amendments to the MDMD specification, or if not feasible, to submit a new instrument specification modeled on MDMD.

At this stage formal language has not been developed. This document identifies only the most significant areas where the MDMD code cannot be directly applied to the LVS and proposes solutions for consideration by the relevant authorities. Other minor discrepancies between LVS and MDMD can be readily addressed by minor amendments to the MDMD code. Formal code will be developed and minor discrepancies between LVS and MDMD addressed only when consensus and approval in principle has been reached on the key issues.

It is strongly recommended to read the appendix to this document, **LVS Type Approval History Outside of the USA** before considering the proposals below. Some topics are also discussed in more detail in the supporting document to this submission, **Load Volume Scanner - General Metrology, Test Methods and Suitability for Use** (revision of a previously submitted document, not US specific).
Applicability of MDMD Code to the LVS

The LVS has some notable similarities to MDMD:

- MDMD typically uses the same non-contact laser measurement technology as the LVS.
- MDMD and LVS both compute volume from a set of linear dimensional measurements.
- MDMD and LVS both typically measure moving targets passing below the measurement elements of the instrument.
- MDMD and LVS both measure the target relative to a zero reference profile formed by the surface or container that carries the object or load being measured.

There are also some notable differences:

- MDMD measures discrete objects (boxes, packages etc) whereas LVS measures bulk loose flowable solid materials (materials that form heaps).
- MDMD uses a set of rules to compute the volume of a hexahedron occupied by the measured object whereas LVS measures the actual volume of the heap of measured material (“loose” volume based on the surface contour).
- MDMD is intended for calculating freight, storage, or postal charges based on the dimensions and/or volume occupied by the object whereas LVS is intended for determining quantities of material where that material is traded by volume.
- MDMS zero reference is generally a flat conveyor-belt or table top and can be treated as a static 2D profile whereas LVS zero reference is the entire load-bearing container (truck trailer or bin) that moves with the measured load and must be treated as a moving 3D profile.

So consider *Handbook 44, Section 5.58. Multiple Dimension Measuring Devices, Application:*

A.2. Other Devices Designed to Make Multiple Measurement Automatically to Determine a Volume. – Insofar as they are clearly applicable, the provisions of this code apply also to devices designed to make multiple measurements automatically to determine a volume for other applications as defined by Section 1.10. General Code paragraph G-A.1. Commercial and Law-Enforcement Equipment.

This applies to the LVS. However, the need for an instrument description that more explicitly describes the LVS principle of operation and application should be considered, if only to define a clear sub-category that variations in the MDMD code can be specifically applied to. As the manufacturer of a specific instrument, it may not be appropriate for us to define the limitations or terminology of this specific sub-category. But for the purposes of this document “LVS” will refer to such a sub-category of MDMD instruments that the Load Volume Scanner belongs to.

Tolerances

*Handbook 44, Section 5.58. Multiple Dimension Measuring Devices, Tolerances:*

T.3. Tolerance Values. – The maintenance and acceptance tolerance values shall be ± 1 division.
It is not feasible for the LVS to meet these requirements (and the requirements of paragraph S.1.5 and T.2.3) without a multi-interval implementation and choices of division sizes for each interval that may not be suitable for intended application in some cases.

We propose the following variation for instruments of the LVS class:

**The maintenance and acceptance tolerance values shall be ± 1 division or 1 percent of measured load; whichever is the greater.**

In practice, the minimum feasible scale division for the LVS is 0.1 cubic meter or 0.1 cubic yard, dependent on regional configuration. To meet the requirements of the US bark and mulch industries the maximum capacity will need to be 130 cubic meters or 170 cubic yards per individual truck bin.

We realize that this effectively puts the LVS in a lower accuracy classification than allowed for other classes of instrument such as weigh scales used for trade.

The closest comparable class I can find in HB 44 for the volumetric measure of dry solid material is Dry Measures (section 4.45). Obviously the LVS does not fit into this classification. However, as a point of note, the maintenance tolerances for a 1 bushel dry measure (the largest measure specified) are 50 cubic inches in excess and 25 cubic inches in deficiency with acceptance tolerances being one-half the maintenance tolerances (Handbook 44, section 4.45. Dry Measures, Tolerances). Averaging over “in excess” and “in deficiency” this is equivalent to maintenance and acceptance tolerances of approximately 1.74% and 0.87% respectively. And by extension, the same tolerances apply to quantities resulting from multiple 1 bushel dry measures.

What must be considered is the intended purpose and suitability for use of the instrument. This is discussed in the supporting document to this submission, *Load Volume Scanner - General Metrology, Test Methods and Suitability for Use*.

**Limitations on Use**

Consider the following excerpts from *Handbook 130*:

2.18.2. – All mulch shall be sold, offered, or exposed for sale in terms of volume measure in SI units in terms of the cubic meter or liter or in inch-pound units in terms of the cubic yard or cubic foot.

2.29 (a) – Top soil, fill dirt, aggregate or chipped rock, sand (including concrete and mortar sand), decomposed granite, landscape type rock, and cinders must be sold by the cubic meter or cubic yard or by weight.
The LVS was designed to meet the requirements of specific industries such as the mulch and civil construction industries and their suppliers, who either trade by volume already, or would prefer to, if suitable measurement equipment were available. The LVS is intended to meet the requirements of these industries and is not intended as a general use instrument to replace truck scales. As such we propose the following limitations on use for instruments of the LVS class:

- To soil, clay, sand, aggregate or chipped rock and similar excavated or mined materials
- Mulch, compost, specialty horticultural and landscaping mixes and primary constituent materials thereof.
- Woodchip, sawdust, bark and similar materials
- Coal, unprocessed ore, mining waste
- Bulk recycled or waste materials in crushed, shredded or similar form
- Lumpy, irregular mixed materials only where traded as waste or debris

A shorter list may be possible if worded so as to be suitably inclusive.

**Test Procedures – Accuracy Testing**

*Handbook 44, Section 5.58. Multiple Dimension Measuring Devices, Notes:*

**N.1.1. General.** – The device shall be tested using test standards and objects of known and stable dimensions.

**N.1.4.1. Test Objects.** – Verification of devices may be conducted using appropriate test objects of various sizes and of stable dimensions. Test object dimensions must be known to an expanded uncertainty (coverage factor \( k = 2 \)) of not more than one-third of the applicable device tolerance. The dimensions shall also be checked to the same uncertainty when used at the extreme values of the influence factors. The dimension of all test objects shall be verified using a reference standard that is traceable to NIST (or equivalent national laboratory) and meet the tolerances expressed in NIST Handbook 44 Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied to the device).

Due to the practical difficulties in generating LVS test loads of known and stable dimensions, as discussed in the Test Methods section of the supporting document *Load Volume Scanner - General Metrology, Test Methods and Suitability for Use*, we propose that the system of test objects/standards used for certification testing in Australia be adopted (see notes and photos in *Australia* section of the appendix to this document, *LVS Type Approval History Outside of the USA*). This system combines a rectangular bin trailer with moveable false floor and rigid test objects and is suitable for generating test loads with volume known to the required level of expanded uncertainty for the tolerances proposed above. The dimensions of all test objects/bins can readily be verified with a tape measure (NIST traceable reference standard).

Code language to facilitate this could be along the lines of:
Test objects approximating the shape of a heaped load and with geometry that facilitates determination of volume by measurement of linear dimensions may be used to generate test loads in a suitable mobile test container. A raised floor or rigid objects covering the entire test container floor such that no edges are visible may be placed in the test container, supporting the test objects, to generate test loads at larger volumes.

This method of using dedicated test equipment is only suitable for generating test volumes of a limited size. At this stage we have only used this method to test up to 35 cubic meters (45 cubic yards).

Handbook 44, Section 5.58. Multiple Dimension Measuring Devices, Notes:

N.1.4. Test Object Size. – Test objects may vary in size from the smallest dimension to the largest dimension marked on the device, and for field verification examinations, shall be an integer multiple of “d.”

This does not explicitly require testing to maximum capacity. As discussed in the supporting document to this submission, Load Volume Scanner - General Metrology, Test Methods and Suitability for Use, correct operation within accuracy capability for the LVS can theoretically be confirmed at any test volume. We propose the following variation for LVS class instruments:

Test loads shall vary in size from zero (empty test container) to at least 25% of instrument capacity including minimum capacity and at least one other intermediate volume.

For a maximum capacity of 130 cubic meters or 170 cubic yards this would be feasible. This is similar to the requirement for scales with a capacity above 20,000kg or 40,000lb as specified in Handbook 44, Section 2.2. Scales,
Notes, Table 4. It may be considered necessary to specify the 25% rule for instruments with a capacity above a set value as for scales. See further discussion of a Standardized Test Method and other test methods in the supporting document to this submission, Load Volume Scanner - General Metrology, Test Methods and Suitability for Use.

Note that in New Zealand all official certification/verification testing is performed with a single rigid test object of 2.1 cubic meters, which equates to 3.2% of approved maximum capacity of 65m³ per bin (see appendix to this document, LVS Type Approval History Outside of the USA).

Type approval testing may need to be conducted to maximum capacity. This is possible by finding a suitable, very large truck-trailer and manually dimensioning this trailer in detail and generating test loads by a combination of methods. This is very time consuming and requires a lot of resources. This is feasible for one-time type approval testing but not for regular verification testing.

Additionally, it is not practical to generate larger test loads to an integer multiple of the scale interval “d” by the proposed test method. However, the LVS instrument has a test mode that displays measurements at a higher resolution, allowing accurate comparison between measurement indications and computed test load volumes. We propose a requirement along the lines of the following:

The instrument shall have a special test mode that can only be activated for accuracy testing and causes all measurement indications to be output to a resolution of at least 10 times “d”.

Test Procedures – Disturbance Testing

It is simply not feasible to put a standard LVS system in an environmental chamber and perform disturbance tests for type approval. Requirements for any laboratory testing will need to be discussed. Please see the Australia section of the appendix to this document, LVS Type Approval History Outside of the USA for notes on how this was handled for type approval in Australia. We propose a similar approach be adopted for NTEP testing.
APPENDIX - LVS TYPE APPROVAL HISTORY
OUTSIDE OF THE USA

NEW ZEALAND

The LVS was granted type approval in New Zealand in 1999. Approval was based loosely on the OIML specification for Automatic Catchweighing Instruments (OIML R51-1). This was prior to the release in 2000 of the OIML specification for Multi-Dimensional Measuring Instruments (OIML R129) which is the equivalent of MDMD. The New Zealand Certificate of Approval 1556 (type approval) is available for reference. No type approval guide document exists.

The following are some specific points of note.

1. Initial approval was only up to 20m³ load per bin (maximum capacity) with limitation to measurement of sand, gravel and small rock. However, Trading Standards New Zealand (TSNZ) monitored our systems for some time, were happy with the performance and since 2007 approval has been up to 65m³ per bin, for any solid material with a particulate size of less than or equal to 200mm. Minimum capacity is 0.5m³.

2. We have successfully performed field testing with the TSNZ up to 105m³ per bin but have not applied for a type approval variant up to this volume as it is not currently required for the size of trucks operated in New Zealand.

3. We have about 50 trade-legal certified LVS systems operating in New Zealand. There have been no complaints to TSNZ in the 13 years since initial type approval.

4. The accuracy class specified is a variant on Catchweigher class Y(b). For our implementation with a scale interval of 0.1m³ this is similar to US weight class IIII up to 40m³ and better than class IIII above 40m³.

5. Type approval does not require accuracy testing up to maximum capacity. This recognizes the fact that due to the principle of operation of the LVS, measurement accuracy can effectively be confirmed at any volume (see support document Load Volume Scanner - General Metrology, Test Methods and Suitability for Use). Type evaluation testing was of course conducted to maximum capacity.

6. Several methods for generating test loads are approved. However LoadScan maintains a single 2.1m³ test load (reference standard) for all certification/verification testing. This is a rigid profile approximating the shape of a load. The test load is annually re-certified by TSNZ. Volume is determined by the displacement of water in a rectangular tank.
AUSTRALIA

The LVS was granted type approval in Australia in 2010. Type Approval was based as closely as practical on the OIML specification for Multi-Dimensional Measuring Instruments (OIML R129). Before conducting type evaluation the Australian National Measurement Institute (NMI) prepared a type evaluation guide called *Guidelines for the Pattern Approval of Systems used for the Determination of Load Volumes*. This is based primarily on the Australian general guidelines for pattern approval and the OIML specification for Multi-Dimensional Measuring Instruments (OIML R129). This document and *Certificate of Approval No 13/1/15* (type approval) are available for reference. The following are some specific points of note.

1. Current approval is only up to 35m³ load per bin. This is not a limitation imposed by NMI but the result of the resources we had available when field evaluation was conducted only being suitable for loads up to 35m³. This is adequate to cover the requirements of the construction and most other industries except the mulch industry. Minimum capacity is 1.0m³. Further testing will be conducted with NMI for higher volumes.

2. The LVS is approved for measurement of ‘flowable solids such as sand, soil, gravel and agricultural materials’.

3. Approval requires accuracy testing “near (as close as practical)” to maximum capacity. The volume of test loads must be determined to an expanded uncertainty of one fifth of the maximum permissible error or less, in line with the OIML specification for Multi-Dimensional Measuring Instruments (OIML R129).

4. The approval certificate does not require an accuracy class to be marked on the instrument. Only maximum permissible errors (tolerances) are specified. NMI’s view is that no formal accuracy classes exist for this type of instrument so it does not make sense to mark a class. This also allows the instrument to be tested to different accuracy “classes” within the maximum tolerances specified, depending on the intended application and the type/quality of test loads available.
5. The maximum tolerances specified in the approval are based on weight class 5 from the OIML specification for *Automatic instruments for weighing road vehicles in motion and measuring axle loads* (OIML R134). This is a low accuracy class (basically a 2.5% class). The reason for this is not the accuracy of the LVS system but the difficulty in generating test loads with sufficiently accurately known volume (expanded uncertainty 1/5th MPE) to perform accuracy testing up to maximum capacity. However, the LVS may be also be tested to class 2 (1% class) if suitable test loads/standards are available.

6. It is up to individual state authorities to specify any additional limitations on use, depending on the accuracy class the LVS is tested to.

7. LVS approval requires that all measured volume indications are accompanied by a statement that *the volume indicated is that at the time of measurement*. This reflects the fact that flowable solid volumes can fluctuate slightly over time (see support document *Load Volume Scanner - General Metrology, Test Methods and Suitability for Use*).

8. For practical reasons laboratory testing in an environmental chamber for type approval was conducted with a modified mounting system for the LVS to allow it to fit into the test chamber. The testing was also conducted with static (non-moving) test profiles and a modified version of the system software. NMI took the approach that the ability of the LVS software to compute accurate volumes from the raw laser distance measurement data can be determined by field-testing and that for laboratory testing it is only necessary to test the ability of the laser distance measuring components to provide suitable data for the software to process. A variation on the disturbance and other tests given in the OIML specification for Multi-Dimensional Measuring Instruments (OIML R129) were conducted.
Custom-mounted LVS in environmental test chamber, NMI, Sydney, Australia
9. LoadScan maintains a ‘test trailer’ and a 1.0m³ test load (reference standard) for certification testing in Australia. The test trailer is a dimensionally accurate rectangular bin with a false floor that can be positioned at different heights to simulate different levels of loading. The 1.0m³ test load is placed on the trailer floor or false floor to create a more realistic load profile and to test at minimum capacity. The trailer is fully mobile and can be disassembled. The 1.0m³ test load is dimensionally accurate and design is based on basic geometrical shapes so that its volume can be determined by manual measurement with tape measure. Test load volumes can be determined with enough accuracy to test to class 2 (1% class) with this equipment.
Appendix H

Item 360-3: Electric Vehicle Fueling and Submetering

This draft code is currently under development by the USNWG; this draft is NOT yet ready for consideration by the NCWM. Updated versions will be posted on the NIST website as work by the USNWG progresses.

Draft NIST Handbook 44 Device Code Requirements for Electric Vehicle Fueling and Submetering

This tentative code has only a trial or experimental status and is not intended to be enforced. The requirements are designed for study prior to the development and adoption of a final code. Officials wanting to conduct an official examination of a device or system are advised to see paragraph G-A.3. Special and Unclassified Equipment.

(Tentative Code Added 20XX)

A. Application

A.1. General. – This code applies to electronic and mechanical devices, accessories, and systems used for the measurement of electricity dispensed as a vehicle fuel and in other commercial electricity sub-metering applications wherein a quantity determination or statement of measure is used wholly or partially as a basis for sale or upon which a charge for service is based.

A.2. Exceptions. – This code does not apply to:

(a) This code does not apply to the use of any measure or measuring device used by a public utility in connection with measuring electricity subject to the jurisdiction of the Public Utilities Commission.

(b) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.

(c) The wholesale delivery of electricity.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Electricity-Measuring Devices shall meet the requirements of Section 1.10. General Code.

A.3.1. Dual-Purpose Electric Vehicle Supply Equipment (EVSE) and Timing Devices. – A device that is used for both the sale of electricity as vehicle fuel and the sale of other separate time-based services (e.g., vehicle parking) shall meet the requirements Section 5.55. Timing Devices. in addition to the requirements of this code.

A.4. Type Evaluation. – The National Type Evaluation Program (NTEP) will accept for type evaluation only those devices that comply with all requirements of this code.

A.5. Meter Type Notation. – Code sections and subsections with an [EM] notation apply to electronic meters only. Code sections and subsections with a [MM] notation apply to mechanical meters only. Code sections and subsections without [EM] or [MM] notation apply to both meter types.
S. Specifications

S.1. Indicating and Recording Elements.

S.1.1. Electric Vehicle Supply Equipment (EVSE). – A device used to charge electric vehicles shall be of the computing type and shall indicate the electrical energy, the unit price, and the total price of each delivery.

S.1.2. EVSE Indicating Elements. – A device used to charge electric vehicles shall include an indicating element that continuously displays measurement results relative to quantity and total price. Indications shall be clear, definite, accurate, and easily read under normal conditions of operation of the device. All indications and representations of electricity sold shall be clearly identified and separate from other time-based fees indicated by a dual-purpose device that is used for both the sale of electricity as vehicle fuel and the sale of other separate time-based services (e.g., vehicle parking).

S.1.3. EVSE Units.

S.1.3.1. EVSE Units of Measurement. – Deliveries used to charge electric vehicles shall be indicated and recorded in megajoules (MJ) or kilowatt-hours (kWh) and decimal subdivisions thereof.

S.1.3.2. Numerical Value of Quantity-Value Divisions. – The value of an interval (i.e., increment or scale division) shall be equal to:

(a) 1, 2, or 5; or
(b) a decimal multiple or submultiple of 1, 2, or 5.

Examples: quantity-value divisions may be 10, 20, 50, 100; or 0.01, 0.02, 0.05; or 0.1, 0.2, or 0.5; etc.

S.1.3.3. Maximum Value of Quantity-Value Divisions. – The maximum value of the quantity-value division shall not be greater than 0.5% of the minimum measured quantity.

S.1.3.4. Values Defined. – Indicated values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof. An indication of “zero” shall be a zero digit for all displayed digits to the right of the decimal mark and at least one to the left.

S.1.4. EVSE Value of Smallest Unit. – The value of the smallest unit of indicated delivery by an EVSE, and recorded delivery if the EVSE device is equipped to record, shall not exceed the equivalent of 3.6 MJ or 1 kWh.

S.1.5. [MM] Submeter Register. – A meter register shall clearly indicate the number of kilowatt-hours measured by the meter. The register ratio shall be indicated on the front of the registers that are not an integral part of the meter nameplate. Means shall be provided for the tenant to read the meter register.

S.1.6. [EM] Submeter Watthour Indications.

S.1.6.1. Customer Indicating Element. – All submeters in a service system shall have an individual customer indicating element on or at the meter and the minimum value shall not exceed one kilowatt hour.

S.1.6.2. Test Constant. – All submeter systems shall be capable of indicating at least one watthour test constant (K_t) output indication but not more than 20 watthour test constant output indications.
Means for indicating watthour test constant output indications include but are not limited to:
decimal point, contrasting display colors, shorting link, or a means for visual flashing pulse
counts.

S.1.6.3. Indicating Element Value. – The minimum indicating element value (unit of measure)
shall be conspicuously identified on or near the customer indicating element.

S.1.6.4. Segments. – A segmented digital indicating element shall have an easily accessible
 provision for checking that all segments are operational.

S.1.6.5. Real-time Indicating Element. – If the indicating element is not on continuously, it shall
be accumulated continuously so that real-time measurement is indicated during activation.

S.1.7. Multiple Submeter Indicating Elements. – An indicating or combination indicating-recording
element coupled to two or more meter systems shall be provided with means to prohibit indication of
information from any meter system not selected, and shall be provided with automatic means to indicate
clearly and definitely which meter system is associated with the indication.

S.2. EVSE Operating Requirements.

S.2.1. EVSE Return to Zero.

(a) The primary indicating and the primary recording elements of a device used to charge electric
vehicles, if the device is equipped to record, shall be provided with a means for readily returning
the indication to zero either automatically or manually.

(b) It shall not be possible to return primary indicating elements, or primary recording elements,
beyond the correct zero position.

S.2.2. EVSE Indicator Reset Mechanism. – The reset mechanism for the indicating element of a device
used to charge electric vehicles shall not be operable during a delivery. Once the zeroing operation has
begun, it shall not be possible to indicate a value other than the latest measurement, or “zeros” when the
zeroing operation has been completed.

S.2.3. EVSE Provision for Power Loss.

S.2.3.1. Transaction Information. – 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, or sales price) shall be determinable for at least 15 minutes at the device or at the console if
the console is accessible to the customer.

S.2.3.2. User Information. – The device memory shall retain information on the quantity of fuel
dispensed and the sales price totals during power loss.

S.2.4. EVSE Indication of Unit Price and Equipment Level Identity.

S.2.4.1. Unit Price. – A computing or money-operated device shall be able to indicate on each
face the unit price at which the device is set to compute or to dispense.

S.2.4.2. Equipment Level. – A device shall be able to conspicuously indicate on each side the
equipment level (i.e., Level 1, Level 2, or Level 3) of the device.

S.2.4.3. Selection of Unit Price. – When a product is offered for sale at more than on unit price
through a computing device, the selection of the unit price shall be made prior to delivery using
controls on the device or other customer-activated controls. A system shall not permit a change to
the unit price during delivery of a product.
S.2.4.4. Agreement Between Indications. – All quantity, unit price, and total price indications within a measuring system shall agree for each transaction.

S.2.5. EVSE Money-Value Computations. – A computing device shall compute the total sales price at any single-purchase unit price for which the product being measured is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less.

S.2.5.1. Money-Value Divisions, Digital. – 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 0.36 MJ or 0.1 kWh.

S.2.5.2. Auxiliary Elements. – If a system is equipped with auxiliary indications, all indicated money value and quantity divisions of the auxiliary element shall be identical with those of the primary element.

S.2.5.3. Indication of Quantity and Total Price. – When a delivery is completed, the total price and quantity for that transaction shall be indicated on the face of the device for at least 5 minutes or until the next transaction is initiated by using controls on the device or other user-activated controls.

S.2.6. EVSE Recorded Representations. – Except for fleet sales and other price contract sales, a printed receipt providing the following information 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. The printed receipt shall contain the following information for electricity delivered by the device:

(a) the total quantity of the delivery;
(b) the unit price;
(c) the total computed price of the electricity sale;
(d) the EVSE level (i.e., Level 1, Level 2, or Level 3) by name, symbol, abbreviation, or code number;
(e) any additional separate charges included in the transaction (e.g., charges for parking time); and
(f) the final total price of the complete transaction including all items.

For systems 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.)

S.2.7. Indication of Delivery. – The device shall automatically show on its face the initial zero condition and the quantity delivered (up to the capacity of the indicating elements).

S.3. Design of Measuring Elements and Measuring Systems. – Except as otherwise noted within Handbook 44, meters shall meet all applicable design requirements of the latest published ANSI C12.1 Code for Electricity Metering.

S.3.1. Metrological Components. – A meter system shall be designed and constructed so that metrological components are adequately protected from environmental conditions likely to be detrimental to accuracy. Components shall be designed to prevent undetected access to adjustment mechanisms and terminal blocks by providing for application of a physical security seal or an Audit Trail.
S.3.2. **Terminals.** – The terminals of the meter shall be arranged so that the possibility of short circuits while removing or replacing the cover, making connections, or adjusting the meter, is minimized.

S.3.3. **Adjustment Means.** – A measuring system shall be provided with means to change the ratio between the indicated quantity and the quantity of electricity measured by the meter.

S.3.4. **Provision for Sealing.** – Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that no adjustment may be made of:

(a) each individual measurement element;

(b) any adjustable element for controlling voltage or current when such control tends to affect the accuracy of deliveries;

(c) any zero adjustment mechanism; and

(d) any metrological parameter that detrimentally affects the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal. Audit trails shall use the format set forth in Table S.3.4. Categories of Device and Methods of Sealing.

<table>
<thead>
<tr>
<th>Categories of Device</th>
<th>Method of Sealing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 1:</strong> No remote configuration capability.</td>
<td>Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.</td>
</tr>
<tr>
<td><strong>Category 2:</strong> Remote configuration capability, but access is controlled by physical hardware.</td>
<td>The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.</td>
</tr>
<tr>
<td><strong>Category 3:</strong> Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).</td>
<td>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)</td>
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</tbody>
</table>
S.3.5. **[EM] Meter-Control Program.** – The meter-control program shall be an integral part of the meter's firmware read-only memory that cannot be changed in its operating environment. This section does not apply to electronic meters that do not utilize a meter-control program.

S.3.6. **[EM] Data Storage and Retrieval.**

Watthour data accumulated and indicated shall be permanent and accessible.

(b) Values indicated or stored in memory shall not be affected by electrical, mechanical or temperature variations, radio-frequency interference, power failure, or any other environmental influences to the extent that accuracy is impaired.

(c) Memory and/or display shall be recallable for the life of the meter. A replaceable battery shall not be used for this purpose.

S.3.7. **Temperature Range for Metering Components.** - Meters shall be accurate and correct over the temperature range of -20 °C to +50 °C (-4 °F to 122 °F). If the meter or any measuring system components are not capable of meeting these requirements, the temperature range over which the system is capable shall be stated on the NTEP CC, marked on the device, and installations shall be limited to the narrower temperature limits.

S.3.8. **Zero-Set-Back Interlock, Retail EVSE Devices.**

A device shall be constructed so that:

(a) when the device is shut-off at the end of a delivery an automatic interlock prevents a subsequent delivery until the indicating element and recording elements, if the device is equipped and activated to record, have been returned to their zero positions; and

(b) it shall not be possible to return the vehicle connector to its starting position unless the zero-set-back interlock is engaged or becomes engaged.

For systems with more than one device supplied by a single measuring element, an effective automatic control in each device prevents product from being delivered until the indicating elements on that device are in a correct zero position; or

For systems with more than one connection supplied by a single measuring element, effective automatic means must be provided to prevent product from being delivered until the indicating element(s) corresponding to each connection are in a correct zero position.

S.4. **Connections.**

S.4.1. **Diversion of Measured Electricity.** – No means shall be provided by which any measured electricity can be diverted from the measuring device.

S.4.2. **Directional Control.** – If a reversal of energy flow could result in errors that exceed the tolerance for the minimum measured quantity, effective means, automatic in operation to prevent or account for the reversal of flow shall be properly installed in the system. (See N.7. Minimum Measured Quantity)

S.5. **Markings.** – The following identification and marking requirements are in addition to the requirements of Section 1.10 General Code, paragraph G-S.1. Identification.

S.5.1. **Location of Marking Information; EVSE.** – The marking information required in General Code, paragraph G S.1. Identification shall appear as follows:

(a) within 60 cm (24 in) to 150 cm (60 in) from ground level;
(b) either internally and/or externally provided the information is permanent and easily read; and accessible for inspection; and

(c) on a portion of the device that cannot be readily removed or interchanged (e.g., not on a service access panel).

**Note:** The use of a key or tool to access internal marking information is permitted for retail electricity-measuring devices.

**S.5.2. Device Identification and Marking Requirements.** – In addition to all the marking requirements of Section 1.10 General Code, paragraph G-S.1. Identification, each device shall have the following information conspicuously, legibly, and indelibly marked on the nameplate or register, if applicable:

(a) the accuracy class of the device as specified by the manufacturer consistent with Table T.4. Accuracy Classes and Load Test Tolerances for Electricity-Measuring Devices;

(b) AC voltage rating;

(c) Test amperes (TA);

(d) Meter class (CL);

(e) Watthour or rotor constant ($K_a$);

(f) [MM] Register ratio ($R_r$ or $K_r$) and multiplier (if greater than one) preceded by “multiply by” or “mult by” or “$K_r$”;

(g) Frequency rating (Hz);

(h) Number of meter stator(s) or element(s);

(i) Watthour meter or other descriptive term;

(j) [MM] Number of wires ($W$);

(k) [MM] Form designation (FM);

(l) [EM] Watthour test constant ($K_t$);

(m) Minimum measured quantity (MMQ).

Instrument transformer-rated meters shall contain the following additional information:

(n) Instrument transformer ratio or transformer model number;

(o) [MM] Primary watthour constant ($PK_a$);

(p) Temperature Limits, if narrower than and within -20°C to +50°C (-4°F to 122°F).

**S.5.3. Instrument Transformer Identification.** – Each instrument transformer that is non-integral with the meter shall have the following conspicuously, legibly, and indelibly marked on a permanent identification label:

(a) Manufacturer's name, type designation, and non-repetitive serial number;
(b) True ratio, primary versus secondary, ampere or voltage values;
(c) Accuracy class;
(d) Burden designation (B);
(e) Basic lightning impulse insulation level (BIL);
(f) Rated Frequency (HZ).

Note: If evident by the method of integration that instrument transformers are not intended to be detachable or replaceable, the required information may be located on the meter.

**S.5.3.1. Polarity Marking.** – A permanent mark indicating proper installation orientation is required on the instrument transformer when the accuracy of the meter is affected.

**S.5.4. Abbreviations and Symbols.** – The following abbreviations or symbols may appear on a meter, instrument transformer, or indicator.

(a) FM = Form
(b) CL = Class
(c) V = Volts;
(d) Hz = Hertz, Frequency or Cycles Per Second;
(e) TA = Test Amperes;
(f) Kh = Watthour Constant Per Rotor Revolution or Pulse;
(g) PKh = Primary Watthour Constant;
(h) Rr = Register Ratio;
(i) CTR = Current Transformer Ratio;
(j) VTR or PTR = Voltage or Potential Transformer Ratio;
(k) MULT BY = Multiply By;
(l) W = Wire (example: 240V 3W);
(m) Y = WYE Power Supply;
(n) ANSI = American National Standards Institute;
(o) B = Burden;
(p) BIL = Basic Lightning Impulse Insulation Factor;
(q) Kt = [EM] Watthour Test Constant;
(r) AC = Alternating Current (i.e. VAC);
(s) J = Joule;
S.6. **Printer.** – When an assembly is equipped with means for printing the measured quantity, the printed information must agree with the indications on the device for the transaction and the printed values shall be clearly defined.

S.6.1. **Printed Receipt.** – Any delivered, printed quantity shall include a device identification number that uniquely identifies the device from all other devices within the seller’s facility, the time and date, and the name of the seller. This information may be printed by the device or pre-printed on the ticket.

S.7. **Totalizers for EVSE Devices.** – EVSE devices shall be equipped with a nonresettable totalizer for the quantity delivered through each separate measuring device.

S.8. **Minimum Measured Quantity.** – The minimum measured quantity shall satisfy the conditions of use of the measuring system as follows:

Measuring systems shall have a minimum measured quantity not exceeding 3.6 MJ or 1.0 kWh.

**N. Notes**

N.1. **Meter Creep Test.** – A meter creep test shall be conducted by applying rated voltage to the meter under test and no load applied.

N.2. **Meter Starting Load.** – A meter starting load test shall be conducted by applying rated voltage and 0.5-ampere load.

N.3. **[MM] Test Revolutions.** – Full and light load tests shall require 8 or more revolutions of the test standard and at least one revolution of the meter under test.

N.4. **[EM] Meter Test Constant Output Indications.** – Full and light load tests shall consist of 8 or more watthour test constant \( (K_t) \) output indications of the test standard and at least one watthour test constant \( (K_t) \) output indication of the meter under test. Test standards that read out directly in watthours shall meet the watthour equivalent of 8 or more watthour test constant \( (K_t) \) output indications.

N.5. **Meter and System Test Loads.**

(a) **[MM] Mechanical self-contained meters shall be balanced load tested, and may be single element tested, for meter accuracy at full and light loads.**

(b) **[MM] Instrument transformer rated systems shall be single element tested, and may be balanced load tested, for system accuracy at full and light loads. Meter testing shall be accomplished by applying the test load to the current transformer(s).**

(c) **[EM] Instrument transformer(s) rated systems shall be single element tested, for system accuracy at full and light loads. Meter testing shall be accomplished by applying the test load to the instrument transformer(s) with the voltage circuits energized.**

(d) **The reference voltage phases (A, B, or C) at the meter shall be the same phase as the load.**

N.6. **Test of a Meter System.**
Each meter submitted for test shall be a complete system. For example: a meter body and any necessary instrument transformer(s), indicator(s), system software, etc., required to make up a complete system.

The test load applied for a full load test shall be the marked test amperes (TA) on the nameplate of the meter under test.

The test load applied for a light load test shall be conducted at not less than 10% of the marked (TA) test amperes on the nameplate of the meter under test.

The test load applied for a full load test of a meter for a 0.5 power factor setting shall be the marked (TA) test amperes of the nameplate of the meter under test.

The test load applied for a light load test of a meter for a 0.5 power factor setting shall be conducted at not less than 20% of the (TA) test amperes of the meter.

All tests shall be made at the rated voltage ± 10%.

N.7. Minimum Measured Quantity. – The minimum measured quantity shall be specified by the manufacturer.

N.7.1. Minimum Measured Quantity Test. – The device shall be tested for a delivery equal to the declared minimum measured quantity when the device is likely to be used to make deliveries on the order of the declared minimum measured quantity.

N.8. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive tests at the same load and be conducted under controlled conditions where variations in factors are reduced to minimize the effect on the results obtained.

T. Tolerances

T.1. Tolerances, General.

(a) The tolerances apply equally to errors of underregistration and errors of overregistration.

(b) The tolerances apply to all deliveries measured at any load within the rated measuring range of the device.

(c) Where instrument transformers or other components are used, the provisions of this section shall apply to all metering components.


T.2.1. [EM] Meter Creep Test. – The meter indicating element shall not change by more than one least significant digit with the voltage circuit(s) energized and current circuit(s) not energized for a duration of one hour using the watthour test constant (K_h) output indications.

T.2.2. [MM] Meter Creep Test. – A meter rotor shall rotate no more than one complete revolution in 10 minutes with the meter voltage circuit(s) energized and the current circuit(s) not energized.

T.3. Meter Starting Load Test.

T.3.1. [EM] Meter Starting Load Test. – The watthour test constant (K_h) output indication shall continue to advance when a load of 0.5 amperes is applied.

T.3.2. [MM] Meter Starting Load Test. – The meter rotor shall rotate continuously when a load of 0.5 amperes is applied.

T.4. Load Test Tolerances. – The tolerances for electricity-measuring device load tests are listed in Table T.2. Accuracy Classes and Tolerances for Electricity-Measuring Devices. (Proposed tolerance values are based on ANSI C12.1 Code for Electricity Metering Section 5 Standards for In-Service Performance paragraph 5.1.2.2 Acceptable Performance for Maintenance Tolerances and on ANSI C12.20 Electricity Meters-0.2 and 0.5 Accuracy Classes
Section 5 Acceptable Performance of New Types of Electricity Metering Devices and Associated Equipment paragraph 5.5.4.3 Test No. 3: Load Performance for Acceptance Tolerances.)

### Table T.4.

<table>
<thead>
<tr>
<th>Accuracy Class (ANSI C12.20 designation)</th>
<th>Application or Commodity Being Measured</th>
<th>Acceptance Tolerance</th>
<th>Maintenance Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>Electricity as vehicle fuel</td>
<td>0.2 %</td>
<td>2.0 %</td>
</tr>
<tr>
<td>0.5</td>
<td>Electricity as vehicle fuel</td>
<td>0.5 %</td>
<td>2.0 %</td>
</tr>
<tr>
<td>All Others</td>
<td>Electricity as vehicle fuel</td>
<td>1.0 %</td>
<td>2.0 %</td>
</tr>
</tbody>
</table>

**Instrument Transformers Not Integral to the Meter**

<table>
<thead>
<tr>
<th>Accuracy Class</th>
<th>Application or Commodity Being Measured</th>
<th>Acceptance Tolerance</th>
<th>Maintenance Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 or superior</td>
<td>Electricity as vehicle fuel</td>
<td>0.3 %</td>
<td>2.0 % as part of system</td>
</tr>
</tbody>
</table>

**T.4.1. Tolerance Values.** – Maintenance and acceptance tolerances for electric watthour meters shall be as shown in Table T.4. for full and light load tests of Accuracy Class 0.2 and 0.5 meters. For all other Accuracy Class meters tolerances shall be as follows:

(a) Maintenance tolerance shall be 2 percent for full and light loads.

(b) Acceptance tolerance shall be 1 percent for full and light loads.

**T.4.2. Power Factor Tests.** – Power factor tests shall be conducted at 0.5 power factor setting:

(a) Maintenance tolerance shall be 2 percent for full and light loads.

(b) Acceptance tolerance shall be 1 percent for full and light loads.

NOTE: 0.5 power factor light load tests shall be conducted at 20 percent of the Test Amperes (TA).

**T.5. Repeatability.** – When multiple tests are conducted at the same load condition, the range of the load test results shall not exceed 25% of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. (Indiana Code 170 IAC 4-1-8).

**T.6. Instrument Transformer Accuracy Class.** – An instrument transformer that is not an integral part of the meter and is used for revenue metering shall be rated 0.3 accuracy class or more accurate for the burden of a particular meter type. If a meter system requires an instrument transformer more accurate than 0.3 accuracy class, the limitations shall be stated on the meter.

**T.7. Tolerance Application in Type Evaluation Examinations for Devices.** – For type evaluation examinations, the acceptance tolerance values shall apply under the following conditions:

(a) at any temperature, voltage, load, and power factor within the operating range of the device, and

(b) regardless of the influence factors in effect at the time of the conduct of the examination, and
(c) for all quantities greater than the minimum measured quantity.

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Meter Class (CL). – The marked CL shall equal or exceed the total capacity in amperes of the EVSE or the thermal overload protectors of the tenant.

UR.1.2. Suitability of Equipment. – A meter shall be suitable for use on its electrical system. A 3-wire two-phase load which is connected to a 120-208 volt network service shall be metered by a two-stator or two-element meter.

A meter shall accurately measure all loads 5 percent or greater of the electric service capacity of the tenant. Service capacity shall be determined by the master thermal overload protectors to the tenants’ service or by the rated capacity of an electric cord and its connector used to provide power from the service panel to the tenant.

UR.1.3. Instrument Transformer Ratio. – The instrument transformer shall be correctly matched to the meter indicator and multiplier.

UR.1.4. Computing-Type Device; Retail EVSE Device. – A device used to charge electric vehicles shall be of the computing type and shall indicate the electrical energy, the unit price, and the total price of each delivery.

UR.1.5. Connection Line-Length. – The impedance of the connection line on a retail EVSE device shall not result in losses in excess of the tolerance. The length of the connection line:

(a) shall not exceed 4.6 m (15 ft) unless it can be demonstrated that a longer line is essential to permit deliveries to be made to receiving vehicles;

(b) shall be measured from its connection to the EVSE to the inlet of the vehicle connector; and

(c) shall be measured with the connection line fully extended if it is coiled or otherwise retained or connected inside a housing.

An unnecessarily remote location of a device shall not be accepted as justification for an abnormally long connection line.

UR.2. Installation Requirements.

UR.2.1. Manufacturer’s Instructions. – A device shall be installed in accordance with the manufacturer’s instructions, and the installation shall be sufficiently secure and rigid to maintain this condition.

UR.2.2. Load Range. – A device shall be installed so that the current and voltage will not exceed the rated maximum values over which the meter class designation is designed to operate continuously within the specified accuracy. Means to limit current and/or voltage shall be incorporated in the installation if necessary.

UR.2.3. Regulation Conflicts and Permit Compliance. – If any provision of this section (UR.2. Installation Requirements) is less stringent than that required of a similar installation by the serving utility, the installation shall be in accordance with those requirements of the serving utility.

The installer of any new EVSE or electric watthour submeter service shall obtain all necessary permits and shall conform to all applicable regulatory utility commission’s or commissioner’s requirements.
S&T 2014 Interim Report  
Appendix H

UR.2.4. Submeter Installation Requirements.

UR.2.4.1. Certification by Serving Utility or Utilities Commission. – It is the responsibility of the owner of a submeter system to obtain written certification for each submetered service connection from the serving utility or from a person designated as qualified by either the serving utility or by the Utilities Commission (UC).

(a) The required certification shall identify the address, space, or number, of the premise served by the submeter connection; be signed by an authorized serving utility representative or by a designee; and shall clearly state:

(b) the installation meets all serving utility installation and accessibility requirements for similar installations served directly by the serving utility,

(c) the installation is on a tariff schedule that qualifies for submeter use,

(d) the billing format, rates, and charges conform to all applicable serving utility tariff rules,

(e) the date of such determination, and

(f) if performed by a designee, the designee’s name and title, and the name and title of the serving utility company or Public Utilities Commission representative authorizing the designee to make the determination.

The certification shall be provided prior to a submeter being used for commercial purposes.

UR.2.4.2. Submeter Test Facilities. – All submeters shall be provided with the same test facilities required of a similar meter by the serving utility.

UR.2.4.3. [MM] Test Blocks. – All three-phase self-contained submeter installations shall be equipped with test blocks, which are approved by the serving utility, for safe meter testing.

UR.2.4.4. [MM] Test Switches. – Submeter installations that are equipped with current or potential transformers, or both, shall have test switches installed, which are approved by the serving utility, for safe meter testing.

UR.2.4.5. [MM] Circuit Closing Devices. – All self-contained submeter installations that cannot accept a short interruption of the electrical service, for the purpose of testing the meter, shall be equipped with a manual circuit closing device as approved by the serving utility. Automatic circuit closing devices shall not be used on any submeter installation.

UR.2.4.6. Metered Circuits (Submeter Load Service). – All electricity used by a tenant shall be taken exclusively from the load service of the tenant's meter. This service and its associated meter shall accurately measure the tenant's load and be capable of being used only at the discretion of the tenant.

UR.2.4.7. Unmetered Circuits (Submeter Line Service). – The tenant’s electric circuit shall not be taken from the line terminals of the meter, meter socket, or line service. The owner of the submeter system may utilize this service.

UR.2.4.8. Dedicated Tenant Submeter Service. – A meter shall serve only the space, lot, building, room, suite, stall, slip, or premise occupied by the tenant.

UR.2.4.9. Submetered Tenant Premise Identification. – Tenant premise identification shall be clearly and permanently shown on or at the submeter, and on all separate components of a meter system, including, but not limited to, instrument transformer(s), modem(s), and transmitter(s) if equipped. Remote
indications and all printed indications shall be readily identifiable and readily associated with the tenant’s premise. Printed indications shall also include time and date information.

**UR.3. Use of Device.**

**UR.3.1. Unit Price for Retail EVSE Devices.** – The unit price at which the device is set to compute shall be conspicuously displayed or posted on the face of a retail EVSE device used in direct sale.

**UR.3.2. Return of Indicating and Recording Elements to Zero.** – The primary indicating elements (visual) and the primary recording elements shall be returned to zero immediately before each delivery.

**UR.3.3. Printed Ticket.** – The total price, the total quantity of the delivery, and the price per unit shall be printed on any ticket issued by a device of the computing type and containing any one of these values.

**UR.3.4. Steps After Charging.** – After delivery to a customer from a retail device:

(a) the device shall be shut-off at the end of a charge, through an automatic interlock that prevents subsequent charging until the indicating elements and recording elements, if the device is equipped and activated to record, have been returned to their zero positions; and

(b) the vehicle connector shall not be returned to its starting position unless the zero set-back interlock is engaged or becomes engaged by the act of disconnecting from the vehicle or the act of returning the connector to the starting position.

**UR.3.5. Submeter Required.** – When a tenant is not directly served by the serving utility, and charges for electric energy are not included in the fixed periodic rent charges, a dedicated electric watt-hour submeter that measures only the energy used at the discretion of the tenant shall be used.

**Appendix D. Definitions**

The specific code to which the definition applies is shown in [brackets] at the end of the definition. Definitions for the General Code [1.10] apply to all codes in Handbook 44.

A

**accuracy class, instrument transformers.** – A performance specification for instrument transformers which expresses the maximum deviation from the true value of a measured quantity. (Instrument Transformer Accuracy Class) example: a 0.2 accuracy class transformer would be more accurate than a 0.3 accuracy class transformer.[3.XX]

**active (real) power.** – The component of electric power that performs work, typically measured in kilowatts (kW) or megawatts (MW). Also known as "real power." The terms "active" or "real" power are used to modify the base term "power" to differentiate it from reactive and apparent power. The active power (Pac) or real power measured by a meter, is the product of voltage (E) times current (I) times the cosine of the angle by which the current lags the voltage (cos φ) or power factor (pf). P_{ac} = (E) (I) (pf) = (E) (I) (cos φ) where φ is the phase angle of the lag.[3.XX]

**alternating current (AC).** – An electric current that reverses direction in a circuit at regular intervals.[3.XX]

**ampere.** – The practical unit of electric current. It is the quantity of current caused to flow by a potential difference of one volt through a resistance of one ohm. One ampere is equal to the flow of one coulomb of charge per second. One coulomb is the unit of electric charge equal in magnitude to the charge of 6.24 x 10^{18} electrons.[3.XX]

**apparent power.** – The product of the RMS current (I) and the RMS voltage (E) in a circuit.[3.XX]

**audit trail.** – An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device.[1.10, 2.20, 2.21, 2.24, 3.30, 3.37, 3.39, 3.XX, 5.56(a)]
balanced load. – Balanced load is used to indicate equal currents in all phases and relatively equal voltages between phases and between each phase and neutral (if one exists); with approximately equal watts in each phase of the load.[3.XX]

basic lightning impulse insulation level (BIL). – A specific insulation level expressed in kilovolts of the crest value of a standard lightning impulse. (Example: BIL = 10 Kv)[3.XX]

burden (B). – The impedance of the circuit connected to the instrument transformer's secondary winding. (Example: B = 21 Ohms Max.][3.XX]

calibration parameter. – Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy, e.g., span adjustments, linearization factors, and coarse zero adjustments.[2.20, 2.21, 2.24, 3.30, 3.37, 3.39, 3.XX, 5.56(a)]

central location. – A laboratory or meter shop used for the testing of meters to measure in-service accuracy.[3.XX]

certified meter type. – A metering device which is tested and certified to meet the certification testing as specified in the ANSI C12 standard for a specific meter type. It shall include any optional circuit boards, devices, or modules enclosed within the meter cover as a part of this certified meter type.[3.XX]

configuration parameter. – Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component, e.g., division value (increment), sensor range, and units of measurement.[2.20, 2.21, 2.24, 3.30, 3.37, 3.XX, 5.56(a)]

connection line impedance. – The impedance of the circuit used to convey energy sold from a fueling device to the storage of an electric vehicle.[3.XX]

creep. – A continuous apparent measurement of energy indicated by a meter with operating voltage applied and no power consumed (load terminals open circuited).[3.XX]

current. – The rate of the flow of electrical charge past any one point in a circuit. The unit of measurement is amperes or coulombs per second.[3.XX]

electric vehicle, plug-in. – A vehicle that employs electrical energy as a primary or secondary mode of propulsion. Plug-in electric vehicles may be all-electric vehicles (EV’s) or plug-in hybrid electric vehicles (PHEV’s). All-electric vehicles are powered by an electric motor and battery at all times. All-electric vehicles may also be called battery-electric vehicles (BEV’s). Plug-in hybrid electric vehicles employ both an electric motor and an internal combustion engine that consumes either conventional or alternative fuel or a fuel cell. In a parallel type hybrid-electric vehicle, either the electric motor or the engine may propel the vehicle. In a series type hybrid-electric vehicle, the engine or fuel cell generates electricity that is then used by the electric motor to propel the vehicle. EV’s, BEV’s, and PHEV’s are capable of receiving and storing electricity via connection to an external electrical supply. Not all hybrid-electric vehicles are of the plug-in type. Hybrid-electric vehicles that do not have the capability to receive electrical energy from an external supply (HEV’s) generate electrical energy onboard with the internal combustion engine, regenerative braking, or both.[3.XX]
**electric vehicle supply equipment (EVSE).** – The conductors, including the ungrounded, grounded, and equipment grounding conductors; the electric vehicle connectors; attachment plugs; and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of measuring, delivering, and computing the price of electrical energy delivered to the electric vehicle.[3.XX]

**electricity sold as vehicle fuel.** – Electrical energy transferred to and/or stored onboard an electric vehicle primarily for the purpose of propulsion.[3.XX]

**electricity meter.** – A device that measures and registers the integral of an electrical quantity with respect to time.[3.XX]

**electronic meter [EM].** – An electric (solid state) watthour meter that does not have a rotor.[3.XX]

**element (stator).** – A combination of a voltage-sensing unit and a current-sensing unit, which provides an output proportional to the quantities measured.[3.XX]

**energy.** – The integral of active power with respect to time.[3.XX]

**energy flow.** – The flow of energy between line and load terminals (conductors) of an electricity meter. Flow from the line to the load terminals is considered energy delivered. Energy flowing in the opposite direction (i.e., from the load to line terminals) is considered as energy received.[3.XX]

**equipment, commercial.** – Weights, measures, and weighing and measuring devices, instruments, elements, and systems or portion thereof, used or employed in establishing the measurement or in computing any basic charge or payment for services rendered on the basis of weight or measure. As used in this definition, measurement includes the determination of size, quantity, value, extent, area, composition (limited to meat and poultry), constituent value (for grain), or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award.[1.10, 2.20, 2.21, 2.22, 2.24, 3.30, 3.31, 3.32, 3.33, 3.34, 3.35, 3.38, 3.XX, 4.40, 5.51, 5.56.(a), 5.56.(b), 5.57, 5.58, 5.59] (Added 2008)

**equipment level.** – A designation given to different categories of EVSE’s that conveys the general speed with which charging will occur.[3.XX]

**event counter.** – A nonresettable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable calibration or configuration parameters of a device.[2.20, 2.21, 3.30, 3.37, 3.39, 3.XX, 5.54, 5.56(a), 5.56(b), 5.57] (Added 1993)

**event logger.** – A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter.[2.20, 2.21, 3.30, 3.37, 3.39, 3.XX, 5.54, 5.56(a), 5.56(b), 5.57] (Added 1993)

**face.** – That portion of a computing-type pump or dispenser which displays the actual computation of price per unit, delivered quantity, and total sale price. In the case of some electronic displays, this may not be an integral part of the pump or dispenser.[3.30, 3.XX] (Added 1987)

**fixed service.** – Service that continuously provides the nominal power that is possible with the equipment as it is installed.[3.XX]
form designation (FM). – [MM] An alphanumeric designation denoting the circuit arrangement for which the meter is applicable and its specific terminal arrangement. The same designation is applicable to equivalent meters for all manufacturers. (Example: FM 2S)[3.XX]

H

hertz (Hz). – Frequency or cycles per second. One cycle of an alternating current or voltage is one complete set of positive and negative values of the current or voltage.[3.XX]

I

instrument transformer. – A transformer that reproduces in its secondary circuit, in a definite and known proportion, the voltage, or current of its primary circuit, with the phase relation preserved. Sometimes these devices may be referred to as VTs (Voltage Transformers) or CTs (Current Transformers).[3.XX]

instrument transformer-rated meter. – A metering system with terminals arranged for connection to the secondary windings of external instrument transformers.[3.XX]

instrument transformer ratio. – The stated ratio of the primary circuit current or voltage compared to the secondary circuit current or voltage. (Example: CTR = 200 : 0.1)[3.XX]

J

megajoule (MJ). – An SI unit of energy equal to 1,000,000 joules.[3.XX]

K

kilowatt (kW). – A unit of power equal to 1,000 watts.[3.XX]

kilowatt-hour (kWh). – A unit of energy equal to 1,000 watthours.[3.XX]

L

line service. – The service terminals or conductors connecting the meter to the power source.[3.XX]

load service. – The service terminals or conductors connecting the meter to the electrical load (e.g., vehicle, tenant, etc.))[3.XX]

load, full. – A test condition with rated voltage, current at 100% of test amps level, and power factor of 1.0.[3.XX]

load, light. – A test condition with rated voltage, current at 10% of test amps level, and power factor of 1.0.[3.XX]

M

master meter, electric. – An electric watthour meter owned, maintained, and used for commercial billing purposes by the serving utility. All the electric energy served to a submetered service system is recorded by the master meter.[3.XX]

mechanical meter [MM]. – A watthour meter with a rotor.[3.XX]

meter class designation (CL). – The manufacturer's designated maximum amperes a meter can measure continuously without damage or exceeding limits of accuracy. (Example: CL 200)[3.XX]

meter, electricity. – An electric watthour meter.[3.XX]
metrological components. – Elements or features of a measurement device or system that perform the measurement process or that may affect the final quantity determination or resulting price determinations. This includes accessories that can affect the validity of transactions based upon the measurement process. The measurement process includes determination of quantities; the transmission, processing, storage, or other corrections or adjustments of measurement data or values; and the indication or recording of measurement values or other derived values such as price or worth or charges.[3.XX]

nominal power. – Refers to the “intended” or “named” or “stated” as opposed to “actual” rate of transfer of electrical energy (i.e., power).[3.XX]

nonresettable totalizer. – An element interfaced with the measuring or weighing element that indicates the cumulative registration of the measured quantity with no means to return to zero.[3.30, 3.37, 3.39, 3.XX]

ohm. – The practical unit of electric resistance that allows one ampere of current to flow when the impressed potential is one volt.[3.XX]

percent registration. – Percent registration is calculated as follows:

\[
\text{Percent Registration} = \frac{\text{Wh measured by METER}}{\text{Wh measured by STANDARD}} \times 100
\]

[3.XX]

percent error. – Percent Error = Percent Registration – 100. A meter is said to be “slow” that has percent registration below 100% and negative percent error.[3.XX].

point-of-sale system. – An assembly of elements including a weighing or measuring element, an indicating element, and a recording element (and may also be equipped with a “scanner”) used to complete a direct sales transaction.[2.20, 3.30, 3.32, 3.37, 3.39, 3.XX]
(Added 1986) (Amended 1997)

power factor. – The ratio of the active power to the apparent power in an AC circuit. The power factor is a number between 0 and 1 that is equal to 1 when the voltage and current are in phase (load is entirely resistive).[3.XX]

primary watthour constant (PKh) [MM]. – The meter watthour constant per revolution or pulse (Ksh) multiplied by the product of the current and/or voltage transformer ratio(s):

\[
PK_h = K_{sh} \times (\text{Current Transformer Ratio X Voltage Transformer Ratio})
\]
[3.XX]

reactive power. – For sinusoidal quantities in a two-wire circuit, reactive power is the product of the voltage, the current, and the sine of the phase angle between them, using the current as the reference.[3.XX]

register ratio (Rr) [MM]. – The number of revolutions of the gear meshing with the worm or pinion on the rotor shaft per complete rotation of the fastest (most sensitive) wheel or dial pointer.[3.XX]
remote configuration capability. – The ability to adjust a weighing or measuring device or change its scalable parameters from or through some other device that is not itself necessary to the operation of the weighing or measuring device or is not a permanent part of that device.[2.20, 2.21, 2.24, 3.30, 3.37, 3.39, 3.XX, 5.56(a)]
(Added 1993)

retail device. – A measuring device primarily used to measure product for the purpose of sale to the end user.[3.30, 3.32, 3.37, 3.39, 3.XX]
(Amended 1987 and 2004)

revolution equivalent. – The number of watthours represented by one increment (pulse period) of serial data.[3.XX]

root mean square (RMS). – The mathematical convention used to describe the average quantity of a property (such as current) that is varying as a sine wave.[3.XX]

S

serving utility. – The utility distribution company that owns the master meter and sells electric energy to the owner of a submeter system.[3.XX]

side. – That portion of a pump or dispenser which faces the consumer during the normal delivery of product.[3.30, 3.XX]
(Added 1987)

starting load. – The minimum load above which the device will indicate energy flow continuously.[3.XX]

stator [MM]. – The unit which provides the driving torque in a watthour meter. It contains a voltage coil, one or more current coils, and the necessary steel to provide the required magnetic paths.[3.XX]

submeter. – A meter furnished, owned, installed, and maintained by the customer who is served through a utility owned master meter.[3.XX]

T

tenant. – The person or persons served electric energy from a submetered service system.[3.XX]

test accuracy – in-service. – The device accuracy determined by a test made during the period that the meter is in service. It may be made on the customer’s premises without removing the meter from its mounting, or by removing the meter for testing either on the premises or in a laboratory or meter shop.[3.XX]

test amperes (TA). – The full load current (amperage) specified by the device manufacturer for testing and calibration adjustment. (Example: TA 30)[3.XX]

test block. – Device that facilitates safe meter testing by disconnecting the meter from the circuit without interrupting the service to the tenant.[3.XX]

thermal overload protector. – A circuit breaker or fuse that automatically limits the maximum current in a circuit.[3.XX]

U

unit price. – The price at which the product is being sold and expressed in whole units of measurement.[1.10, 3.30, 3.XX]
(Added 1992)
variable service. – Service that may be controlled resulting in periods of reduced, and/or interrupted transfer of electrical energy.[3.XX]

volt. – The practical unit of electromotive force. One volt will cause one ampere to flow when impressed across a resistance of one ohm.[3.XX]

voltage transformer. – A device that provides a secondary voltage that is a precise fraction of the primary voltage.[3.XX]

W

watt. – The practical unit of electric power. In an alternating-current circuit (AC), the power in watts is volts times amperes multiplied by the circuit power factor.[3.XX]

watthour (Wh). – The practical unit of electric energy, which is expended in one hour when the average power consumed during the hour is one watt.[3.XX]

watthour meter. – An electricity metering system comprised of components functioning together that measures and registers the integral, with respect to time, of the active or real power of the circuit in which it is connected. This power integral is the energy delivered to the circuit during the interval over which the integration extends. The unit in which this integral is measured is usually the kilowatt-hour.[3.XX].

watthour meter – field standard. – A portable meter that is traceable to NIST and is used as a standard meter to test meters in commercial applications. This meter is also known as a portable standard or working standard.[3.XX]

watthour meter – self-contained. – A meter in which the terminals are arranged for connection to the circuit being measured without using external instrument transformers.[3.XX]

watthour meter constant (K_h). – The expression of the relationship between the energy applied to the meter and one rotor revolution, or output indication, expressed as watthours per revolution or, watthours per output indication.[3.XX]

watthour meter – test constant (K_t) [EM]. – The expression of the relationship between the energy applied to the meter system and corresponding occurrence of one test output indication expressed as watthours per test output indication.[3.XX]