U.S. National Work Group
for the
Development of Commercial Hydrogen Measurement Standards

June 17, 2009

Joint Device Standards Subcommittee and Fuel Specifications Subcommittee
Teleconference/Webconference

MEETING SUMMARY

Time: Wednesday, June 17, 2009/3:00 p.m. - 5:00 p.m. EDT-USA & Canada (GMT - 4:00)

This joint USNWG Subcommittee meeting was sponsored by the U.S. Department of Energy and U.S. Department of Commerce's National Institute of Standards and Technology.

This meeting was hosted by CSA America, Inc.

Purpose: The U.S. National Work Group (USNWG) met to continue its work to promote the establishment of a comprehensive set of (1) design, accuracy, installation, use, and method of sale requirements, (2) test procedures, and (3) quality standards for hydrogen fuel and equipment used in hydrogen measurements for vehicle and other refueling applications.

AGENDA ITEMS

Table A Attachments List		
Appendix	**Related Agenda Items(s)**	**Title**
A	(2) (a)	Draft Summary of the April 2009 USNWG Meeting (Under Development)
B	(3)	Draft 4.1 (R/W) NIST Handbook 44 Hydrogen Gas-Measuring Devices Code with Recommendations for Retail and Wholesale (R/W) Application Requirements
C	(3)	Analysis of Paragraphs That Do Not Apply to Wholesale/Bulk Deliveries
D	(3)	Current NIST Handbook 44 Retail/Wholesale Code Requirements
E	(1)	Attendee List

Joint Device Standards Subcommittee (DSS)

and

Fuel Specifications Subcommittee (FSS)

Joint USNWG Subcommittees Teleconference/Webconference

Meeting Summary

(1) Welcome Current/New Members and Roll Call
(See Appendix E)

(2) Administrative Business
The USNWG discussed procedures for managing and documenting its technical work. The USNWG wishes to express its thanks to Julie Cairns, CSA America, Inc., for hosting and organizing the June 17, 2009 teleconference and webconference meeting.

The following item(s) were addressed:

(a) Approve the Summary of the April 2009 USNWG Meeting (Appendix A – Under Development)
Since the draft summary of the April 28-30, 2009 USNWG in-person meeting is still under development, the USNWG agreed the DSS Technical Advisor – Juana Williams should send an email to poll the USNWG for its approval of the summary. Modifications that the April 2009 USNWG Subcommittees made to the draft NIST Handbook 44 (HB 44) and NIST Handbook 130 (HB 130) hydrogen codes were outlined in the June meeting notice (emailed June 17th) and will appear in the April 2009 meeting summary. The April 2009 USNWG Meeting Summary will be distributed to the USNWG in July 2009 for its review and approval.

(3) Development of Device Standards and Test Procedures for Commercial Hydrogen Measurement
During its April 2009 meeting, the USNWG agreed the upcoming June 17, 2009 teleconference/webconference meeting discussions should focus on retail and wholesale applications in the HB 44 Hydrogen Gas Measuring Devices Code. The draft code is oriented toward systems and/or devices that *meter* gaseous hydrogen deliveries for refueling vehicles and for use in related applications. The intent of this draft code should be the same as other measuring device codes in that it should apply to both retail and wholesale meters. In many wholesale operations contractual agreements may exist between the buyer and seller. A contract cannot be used to circumvent the law. The same regulators of retail equipment will be called on to arbitrate any disputes about wholesale deliveries.

The weights and measures community, being unfamiliar with hydrogen, will need to rely on the USNWG for expertise and guidance on both retail and wholesale hydrogen refueling applications. Although the USNWG's initial plan was to provide the community with legal metrology requirements that address retail refueling systems, it may now find the best use of its resources might be to include requirements that address both wholesale and retail refueling systems, rather than develop a separate code for wholesale devices at some later date.

The DSS Technical Advisor presented new draft requirements (see Appendix B) to the USNWG that are intended to address both retail and wholesale applications by taking the same approach used in other measuring device code sections (see Appendix D). The analysis created by Bob Boyd (Linde Group) and Joe Cohen (APCI) of draft code paragraphs that do not apply to wholesale applications was modified to include a new column outlining some strategies for addressing these gaps for wholesale devices (see Appendix C).

The June 2009 meeting began with a review of the proposed changes to Draft 4.1 of the HB 44 Hydrogen Gas-Measuring Devices Code to determine if this draft included viable code options that first identity the differences between retail and wholesale transactions, where necessay, and then specify appropriate requirements for both retail and wholesale systems. However, the first topic of discussion was the classification of hydrogen refueling equipment as either "retail," "wholesale," and "bulk" which, once defined, would enable the USNWG to develop separate and appropriate requirements for these systems. The USNWG is aware that bulk deliveries (often categorized as wholesale deliveries) are commercial applications and as such are not exempt from HB 44 code requirements. The USNWG also discussed systems that use meters and those that use the pressure-volume-temperature (PVT) method in the determination of the quantity of hydrogen delivered. The results of the USNWG's discussions on these two topics are covered below.

Several examples of hydrogen deliveries were presented to the USNWG for discussion and are shown in Table A.

Table A
Examples of Commercial Hydrogen Delivery Measurement

	Design (Storage/Receiving Vesssel)	Draft Code Addresses/Applicable Code	Fill Type/Charge	Unit of Measure	Commercial Retail or Wholesale
A	Cylinder	See NIST Handbook 130	Cylinder Exchange/	?	Retail
B	Tube trailer	Carry over to July 2009 teleconference	-Exchange of full tank for an empty tank /Charged for full tank -Measure fill based on tank capacity along with temperature and pressure/Billed based on quantity delivered into receiving tank	Standard cubic foot or cubic meter	Wholesale
C	Tube trailer	Carry over to July 2009 teleconference	-Fill vehicle tank from tube trailer /Charged on the basis of the measurement at	Standard cubic foot or cubic meter	Wholesale

			the time of fill; Measurement is based on water volume content of tank, gas density, and the temperature and pressure calculation before and after fill NOTE: No credit for product left in returned tank		
D	Retail motor-fuel dispenser	Yes	-Delivered into vehicle tank /Charge based on metered gas	kilogram	Retail
E	Retail motor-fuel dispenser	Carry over to July 2009 teleconference	-Gas delivered into vehicle tank /Charged based on PVT calculations performed to determine the quantity	kilogram	Retail

(a) Wholesale Applications
Current HB 44 measuring device codes are intended to apply to all commercial devices whether classified for use in retail or wholesale applications. Measuring equipment is considered a commercial application when measurements or computations obtained from this equipment are the basis for a charge or payment (this includes a credit). Commercial equipment falls under the jurisdiction of the weights and measures authority. HB 44 General Code 1.10 paragraph G-A.1. Commercial and Law-Enforcement Equipment and Appendix D – Definitions for "equipment, commercial" fully describes a variety of applications in which equipment and any associated or auxiliary devices meet the definition for commercial equipment. The following definition of "commercial equipment" was excerpted from HB 44 Appendix D:

> **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, 4.40, 5.51, 5.56.(a), 5.56.(b), 5.57, 5.58, 5.59] (Added 2008)

For decades a distinction was made between retail and wholesale measuring devices based on an individual delivery to a vehicle and the magnitude of that delivered quantity, where the specified amount of 100 gallons or less was the typical delivery size in a retail application. In 2004, a retail device was redefined as one that is used for a delivery to the end user and anything else is a wholesale device.

The USNWG will continue with its April 2009 objective to review Draft 4.1 of the HB 44 Hydrogen Gas Measuring Devices Code in preparation to fully address wholesale applications. Based on discussions and the progress made on proposed requirements for retail and wholesale devices in HB 44, the USNWG has targeted an additional teleconference/webconference meeting for July 7, 2009 to fully develop appropriate language in the code.

(b) Code Exemptions and Variations

There are instances where an individual HB 44 measuring device code paragraph allows exemptions or may include separate, but comparable requirements for equipment when it is used in both retail and wholesale applications. Even though this type of device may have separate requirements or is exempted from some requirements, there are sufficient safeguards to ensure the transaction is transparent, the potential for fraud is addressed, and value comparisons are possible. Thus buyer and seller in both retail and wholesale transactions are protected and get what they pay for.

Exemptions may exist when a requirement becomes too burdensome on the equipment manufacturer, often making the device too costly to purchase or operate. In several instances HB 44 exempts from code requirements the posting of pricing information. Such an exemption exists in the Liquid Measuring Devices Code 3.30 for fleet operations, truck refuelers, and price contract sales. These operations typically represent instances where the buyer and seller are familiar with the many intricacies of the transaction and are frequently involved in negotiations that result in detailed documentation of the sales transaction.

There are also variations in requirements for the design and operational parameters for devices used in both retail and wholesale applications such as the size of an indicated value for a quantity. The maximum allowable size for an indicated value for the quantity delivered through a wholesale meter might be 10 times greater than an indication on a retail meter.

The USNWG will consider if similar circumstances might exist where variances are necessary due to limitations in the equipment's design, special conditions for conducting the sales transaction, etc. The USNWG will also examine the need for guidelines to ensure safeguards are in place for accurate measurement.

(c) Bulk Sales

The question of how to apply legal metrology requirements to a system or device suitable for use in bulk sales raised several questions relative to whether this equipment (1) is defined as a commercial operation, (2) is for use in either retail or wholesale deliveries, and (3) should be excluded from the draft code.

Historically, bulk sales might have taken place at a terminal, wagon, or truck loaded with a commodity, where a commodity was measured out and purchased in whatever quantity needed by the buyer. The term bulk sale can apply to both retail (sold to the end user) and wholesale (sold to be resold) sales.

Bulk sales for weights and measures purposes are defined in HB 130 (see definition below) and represent transactions where the commodity is measured at the time of sale.

NIST Handbook 130 "Uniform Laws and Regulations in the Areas of Legal Metrology and Engine Fuel Quality" Section III. Uniform Laws, Part A. Uniform Weights and Measures Law Section 1. (see page 21, 2009 Ed.]) defines a sale from bulk as:

Section 1. Definitions

1.6. Sale from Bulk. – The term "sale from bulk" means the sale of commodities when the quantity is determined at the time of sale.

The conditions for a sale from bulk when either the buyer or seller are not present are also prescribed in HB 130as follows (see page 28, 2009 Ed.)as follows:

Section 18. Sale from Bulk

All bulk sales in which the buyer and seller are not both present to witness the measurement, all bulk deliveries of heating fuel, and all other bulk sales specified by rule or regulation of the director shall be accompanied by a delivery ticket containing the following information:

(a) the name and address of the buyer and seller;

(b) the date delivered;

(c) the quantity delivered and the quantity upon which the price is based, if this differs from the delivered quantity for example, when temperature compensated sales are made;
(Amended 1991)

(d) the unit price, unless otherwise agreed upon by both buyer and seller;
(Added 1991)

(e) the identity in the most descriptive terms commercially practicable, including any quality representation made in connection with the sale; and

(f) the count of individually wrapped packages, if more than one, in the instance of commodities bought from bulk but delivered in packages.
(Amended 1983 and 1991)

In situations where a commodity is not sold in bulk, but placed in a package (container, cylinder, etc.) then the method of sale is specified. When a commodity has a quality that affects the accuracy of its measurement during that commodity's delivery, then a method of delivery may be prescribed. For example, if a product clings to the walls of a container if poured, then in this case it might be appropriate to deliver the product through a meter.

Conclusion

The USNWG agreed to address the draft code paragraphs such as division size, displays, etc., to arrive at the appropriate language for wholesale deliveries. The USNWG will draw from its observations, experiences with commercial devices, and existing measuring device code sections to fully develop the code language. The USNWG requests input from the hydrogen and weights and measures communities, especially industry, to examine this language to ensure both retail and wholesale applications are adequately addressed.

(d) Measurement Technology
The draft HB 44 Hydrogen Gas-Measuring Devices Code requirements for the design, performance, test, and the conditions for use of hydrogen equipment apply to all such devices in commercial use. When the USNWG formed and began its work, the goal was to immediately address legal metrology requirements for gaseous hydrogen dispensing systems used to refuel vehicles and other related applications. Dispensers used to deliver liquid hydrogen were to be addressed in a later stage of its work.

The USNWG observed that hydrogen dispensers currently in use were primarily equipped with mass flow meter technology for measurement of hydrogen gas. Since then, the USNWG has also observed gaseous hydrogen dispensers that use the pressure-volume-temperature (PVT) method to determine the quantity of hydrogen (in mass units) delivered into vehicles. Does the draft code adequately address the design of equipment used in the PVT method and are there other methodologies in use? Will the weights and measures community see this method continue to grow and be the basis for measurements used in commercial transactions? Is there a technical basis to say the PVT method does or does not provide accurate and repeatable measurements for all or only some deliveries (e.g., large deliveries greater than 1000 kg)? Are there key elements in the PVT method that require specific guidelines such as temperature sensors to ensure measurement accuracy?

The USNWG discussed one critical element for the PVT method which is the receiving tank dimensional information. HB 130 prescribes the method of sale for compressed gas cylinders in Section IV Uniform Regulations Part B. Uniform Regulation of the Method of Sale of Commodities Section 2. Non-food Products paragraph 2.16. Compressed or Liquefied Gases in Refillable Cylinders through subparagraph 2.16.3.4 (see page 123, 2009 Ed.). These paragraphs specify methods for expressing and determining either the net contents of compressed gas in the refillable cylinder in mass or volume (under standard reference conditions) as follows:

2.16. Compressed or Liquefied Gases in Refillable Cylinders

2.16.1. Application. – This section does not apply to disposable cylinders of compressed or liquefied gases.

2.16.2. Net Contents. – The net contents shall be expressed in terms of cubic meters or cubic feet, kilograms, or pounds and ounces. See Section 2. 21. Liquefied Petroleum Gas for permitted expressions of net contents for liquefied petroleum gas. A standard cubic foot of gas is defined as a cubic foot at a temperature of 21 ºC (70 ºF) and a pressure of 101.35 kilopascals (14.696 psia) except for liquefied petroleum gas as stated in Section 2.21.

2.16.3. Cylinder Labeling. – Whenever cylinders are used for the sale of compressed or liquefied gases by weight, or are filled by weight and converted to volume, the following shall apply:

2.16.3.1. Tare weights

(a) **Stamped or stenciled tare weight.** – For safety purposes, the tare weight shall be legibly and permanently stamped or stenciled on the cylinder. All tare weight values shall be preceded by the letters "TW" or the words "tare weight." The tare weight shall include the weight of the cylinder (including paint), valve, and other permanent attachments. The weight of a protective cap shall not be included in tare or gross weights. The Code of

Federal Regulations Title 49, Section 178.50-22 requires the maker of cylinders to retain test reports verifying the cylinder tare weight accuracy to a tolerance of 1 %.

(b) **Tare weight for purposes of determining the net contents**. – The tare weight used in the determination of the final net contents may be either:

(1) the stamped or stenciled tare weight or

(2) the actual tare determined at the time of filling the cylinder. If the actual tare is determined at the time of filling the cylinder, it must be legibly marked on the cylinder or on a tag attached to the cylinder at the time of filling.

(c) **Allowable difference.** – If the stamped or stenciled tare is used to determine the net contents of the cylinder, the allowable difference between the actual tare weight and the stamped (or stenciled) tare weight, or the tare weight on a tag attached to the cylinder for a new or used cylinder, shall be:

(1) ½ % for tare weights of 9 kg (20 lb) or less or

(2) ¼ % for tare weights of more than 9 kg (20 lb).

(d) **Average Requirement.** – When used to determine the net contents of cylinders, the stamped or stenciled tare weights of cylinders at a single place of business found to be in error predominantly in a direction favorable to the seller and near the allowable difference limit shall be considered to be not in conformance with these requirements.

2.16.3.2. Acetylene gas cylinder tare weights. – Acetone in the cylinder shall be included as part of the tare weight.

2.16.3.3. Acetylene gas cylinder volumes. – The volumes of acetylene shall be determined from the product weight using approved tables such as those published in NIST Handbook 133 or those developed using 70 ºF (21 ºC) and 14.7 ft^3 (101.35 kPa) per pound at 1 atmosphere as conversion factors.

2.16.3.4. Compressed gases such as oxygen, argon, nitrogen, helium, and hydrogen. – The volumes of compressed gases such as oxygen, argon, nitrogen, helium, or hydrogen shall be determined using the tables and procedures given in NIST Technical Note 1079, Tables of Industrial Gas Container Contents and Density for Oxygen, Argon, Nitrogen, Helium, and Hydrogen and supplemented by additional procedures and tables in NIST Handbook 133.

(Added 1981) (Amended 1990)

The USNWG discussed the current method in use for establishing the capacity of the receiving cylinder/tank. Examples B and C in Table A (see above) represent applications where the tank capacity value is used in calculating the quantity of hydrogen delivered. Part of this measurement process relies on the pressure vessel's ASME capacity certification stamp for its water volume content. From a legal metrology standpoint there needs to be some documentation on the establishment of this volume and traceability to references tables, etc., and equations used in this verification process.

Each methodology has multiple factors that are driving its development. Several involve the consumer's expectations for an experience similar to what occurs with a vehicle fill-up at a gasoline pump (self-

service, 3-5 minutes wait time, time between fill ups, etc.). Additionally, the weights and measures officials must have a suitable means to verify this methodology in a manner that is efficient, not cost prohibitive, represents real-world use of the device, and is somewhat standardized so as to be reproducible and lessen the likelihood of introducing unacceptable errors into the process.

The task now before the USNWG is to arrive at practical requirements that do not create "serious injury to either the buyer or seller, yet not make manufacturing or maintenance cost disproportionately high." As the USNWG works to establish tolerances it must consider factors such as the repeatability and linearity in the measurement process, the environment, the effects of time, accuracy of the test standard, and variability in the device's performance in the test process over a range of operating conditions. The USNWG must also consider tolerances that exist for similar applications and in doing so not give an advantage to any one technology.

The USNWG promotes all methodologies that provide accurate measurements. The USNWG should examine the PVT methodology from a technological standpoint for it merits for use in this application. The USNWG will need to agree on whether or not the draft code adequately addresses refueling dispensers that use this methodology to establish and display the quantity of a delivery. If not, this needs to be acknowledged in the draft code until such time as the work can be completed. Future work to address this methodology will require the USNWG to consider strategies for including the necessary corresponding requirements for pressure, volume, and temperature in the draft code or if it is more appropriate to place guidelines in NIST Handbook 130.

(4) Next Steps/Tasks

The USNWG discussed upcoming events in the weights and measures standards development process (see Table B below), project funding, and the impact of these elements on the work to fully develop hydrogen measurement standards and test procedures.

Related Events

Table B
Upcoming Regional Associations and National Weights and Measures Meetings

Central Weights and Measures Association http://www.ncwm.net/central ***Interim Meeting*** September 13-16, 2009 Rock Island, Illinois – Holiday Inn Contact: Jonelle Brent (jonelle.brent@illinois.gov)	**Northeastern Weights and Measures Association** http://www.newma.us ***Interim Meeting*** October 14-15, 2009 TBD Contact: James Cassidy (jcassidy@cambridgema.gov)
Western Weights and Measures Association http://www.westernwma.org ***Annual Meeting*** September 20-24, 2009 Las Cruces, New Mexico – Hotel Encanto de Las Cruces Contact: Joe Gomez (jgomez@nmda.nmsu.edu)	**National Type Evaluation Technical Committee (NTETC) Measuring Sector** http://www.ncwm.net **Meeting** October 4-7, 2009 Clearwater Beach, Florida – Hilton Clearwater Beach Contact: NCWM HQ (info@ncwm.net)

Southern Weights and Measures Association http://www.ncwm.net/southern ***Annual Meeting*** October 4-7, 2009 Clearwater Beach, Florida – Hilton Clearwater Bch. Contact: Steve Hadder (hadders@doacs.state.fl.us/standards	**National Conference on Weights and Measures, Inc.** **(NCWM)** ***2010 Interim Meeting:*** January 24-27, 2010 Hilton Nashville Downtown - Nashville, TN Contact: NCWM HQ (info@ncwm.net) ***2010 Annual Meeting:*** July 11-15, 2010 The Crown Plaza, St. Paul Riverfront - St. Paul, MN Contact: NCWM HQ (info@ncwm.net)

Project Funding
In light of the present administration's plan to eliminate funding for hydrogen from the 2010 federal Fiscal Year budget, the NIST Weights and Measures Division announced tentative plans to reprioritize its project goals for hydrogen. The USNWG has done an outstanding job in its work to stay on schedule in the development of HB 44 and HB 130 hydrogen code requirements. The completion of the code requirements will continue as outlined in the 2008-2012 Five Year Plan in an effort to fully develop legal metrology requirements, test procedures, and training for commercial hydrogen measurement.

(5) Next Meeting(s)

(a) Upcoming August 2009 In-Person Meeting Status
In April 2009, the USNWG Subcommittees rescheduled the August 2009 meeting. The USNWG was reminded of the dates, times, and location for that upcoming in-person meeting are:

Date(s)	Location
August 11-13, 2009 August 11th 1:00 p.m. – 5:00 p.m. EDT FSS Meeting; August 12th & 13th 8:30 a.m. – 5:00 p.m. EDT DSS Meeting	NIST 100 Bureau Drive Bldg. 222/Room B263 Gaithersburg, MD 20899

The USNWG will work in these sessions to ready proposals for the hydrogen codes and to develop a strategy in support of their approval and adoption in July 2010 by the weights and measures community.

(b) New July/August 2009 Teleconference/Webconference
The USNWG agreed an additional two-hour teleconference/webconference is necessary before the upcoming August 11-13, 2009 in-person meeting to fully develop separate requirements for retail and wholesale applications. The DSS Technical Advisor polled the USNWG on a date and time in July or August 2009 that was agreeable to the group. The next teleconference/webconference of the USNWG will be Tuesday, July 7, 2009, from 3:00 p.m. to 5:00 p.m. EDT.

Appendix E Attendee List-June 17, 2009 Teleconference/Webconference Meetings of the USNWG				
Name	Agency	Device Standards Subcommittee (DSS) Member Yes (Y)	Fuel Specifications Subcommittee (FSS) Member Yes (Y)	Attended USNWG June 17, 2009 Yes (Y)
Robert Boyd	Hydrogen Solutions – Linde Group	Y	Y	Y
Tina Butcher	NIST – TS Wgts. & Meas. Div. (WMD)	Y	Y	Y
Marc Buttler	Emerson Process Mgmt-Micro Motion, Inc.	Y	Y	Y
Ron Hayes	Missouri Dept. of Ag.	Y	Y	Y
Norm Ingram	CA – Food and Ag., Div. of Measurement Standards	Y	Y	Y
Diane Lee	NIST – TS WMD	Y	Y	Y
Kristin Macey	CA – Food and Agriculture, Division of Measurement Standards	Y	Y	Y
Dev Patel	Kraus Global, Inc.	Y	Y	Y
Lisa Warfield	NIST – TS WMD	Y	Y	Y
Curt Williams	Georgia Ag. Dept./ CPW Energy Consulting	Y	Y	Y
Juana Williams	NIST – TS WMD	Y	Y	Y
John Wright	NIST – CSTL Process Measurement Div.	Y	Y	Y
GUESTS				
Roger Macey	CA – Food and Ag. Div. of Measurement	--	--	Y

	Standards			
Mark McDougall	Powertech Labs			Y
Dan Reiswig	CA – Food and Ag. Div. of Measurement Standards	--	--	Y
Van Thompson	CA – Food and Ag. Div. of Measurement Standards	--	--	Y