

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

October 12, 2011

Joint Device Standards Subcommittee (DSS) and Fuel Specifications Subcommittee (FSS)

Tele/Web Conference Meeting

MEETING SUMMARY

Time: Wednesday, October 12, 2011/1:00 p.m. – 2:30 p.m. EDT-USA & Canada (GMT - 05:00)

Meeting Name: H₂ U.S. National Work Group, October 12, 2011

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

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

Attachment List – Appendices A-C	2
Glossary of Acronyms	2
(1) Welcome Current/New Members and Roll Call	3
(2) Administrative Business	3
(a) Agenda Updates for October 2011	3
(3) FSS Items - Development of Quality Standards and Definitions for Commercial Hydrogen Fuel	
(a) Report on the September 27, 2011, E-mail Ballot Results and Discussion on the Wording of the Proposed Definitions for Hydrogen Fuel for Internal Combustion Engines and Fuel Cell Vehicles	3
(b) Proposed Joint Statement from the USNWG in Support of the NCWM Hydrogen Fuel Specification Agenda Items	6
(4) DSS Items - Development of Device Standards and Test Procedures for Commercial Hydrogen Measurement	6
(a) Review and Approve Proposed Checklist for Addition to NCWM Publication 14	6
(b) Progress Report on the Development of Hydrogen Test Methods and Gap Analysis	7
(5) Next Steps/Tasks	7
(6) Next Meeting	8

Attachments List			
Appendix	Related Agenda Item(s)	Title	Page
A**	(5)	Proposal to SWMA on the Development of Quality Standards and Definitions for Commercial Hydrogen Fuel	9
B*	(4) (a)	Hydrogen Checklist forwarded by the Measuring Sector to the NCWM NTEP Committee	12
C	(1)	Attendee List – October 12, 2011 USNWG Meeting	28
*Device Standards Subcommittee (DSS)			
**Fuel Specifications Subcommittee (FSS)			

Glossary of Acronyms			
ASTM	American Society of Testing and Materials International	NCWM	National Conference on Weights and Measures
CaFCP	California Fuel Cell Partnership	NGV	Natural Gas Vehicle
CDFA DMS (CADMS)	California Department of Food and Agriculture, Division of Measurement Standards	NIST	National Institute of Standards and Technology
CSA	Canadian Standards Association, Incorporated	NTETC	National Type Evaluation Technical Committee
DSS	Device Standards Subcommittee	NTP	Normal Temperature and Pressure
EPO 29	Draft Hydrogen Gas Retail Motor-Fuel Dispenser Examination Procedure Outline (EPO) 29	OEM	Original Equipment Manufacturer
FSS	Fuel Specifications Subcommittee	OIML	International Organization of Legal Metrology
HB 44	NIST Handbook 44, <i>Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices</i>	OIML R 139	Recommendation for Compressed gaseous fuel measuring systems for vehicles
HB 130	NIST Handbook 130, <i>Uniform Laws and Regulations in the Area of Legal Metrology and Engine Fuel Quality</i>	OWM	Office of Weights and Measures (NIST)
HGV	Hydrogen Gas Vehicle	RMFD	Retail Motor-Fuel Dispenser
ISO	International Organization for Standardization	SAE	Society of Automotive Engineers
MMQ	Minimum Measured Quantity	SI	International System of Units
MOS	Method of Sale	SWMA	Southern Weights and Measures Assn.
MPa	megapascal	USNWG	U.S. National Work Group
NEWMA	Northeastern Weights and Measures Association	WWMA	Western Weights and Measures Assn.
This table is meant to assist the reader in the identification of acronyms used in this agenda and does not imply that these terms are used solely to identify these organizations or technical topics.			

DISCUSSION AND DECISIONS ON AGENDA TOPICS

1:00 P.M. (EDT)

(1) Welcome Current/New Members and Roll Call

New members of the USNWG and visitors were welcomed and the meeting was called to order. After roll call (see Appendix C), the meeting's purpose was reviewed.

(2) Administrative Business

(a) Agenda Updates for October 2011

The USNWG discussed the agenda for the meeting and no additions or changes to the agenda were proposed.

(3) FSS Items - Development of Quality Standards and Definitions for Commercial Hydrogen Fuel

(a) Report on the September 27, 2011, E-mail Ballot Results and Discussion on the Wording of the Proposed Definitions for Hydrogen Fuel, Internal Combustion Engine, and Fuel Cell

Marc Buttler (NIST OWM) reported on the results of the September 27, 2011, e-mail ballot proposing to amend the three hydrogen related definitions the USNWG recommended be added to NIST Handbook 130 – “Uniform Engine Fuels and Automotive Lubricants Regulation,” Section 2. Standard Fuel Specifications.

The results were reported as:

Approve:	9
Conditional* Approval:	1
Oppose**:	1
Abstain:	1

* Pending confirmation of Inter-laboratory Comparisons.

** “I prefer the original version, but defer to the fuel experts if they approve the changes.”

The ballot had proposed the following updates for the USNWG to consider:

- Revise the language in the proposed definition of “Fuel Cell” to harmonize with the language in SAE J2574.
- Revise the language in the proposed definitions for both “Hydrogen Fuel” and “Internal Combustion Engine” as proposed in comments received at the July 2011 National Conference on Weights and Measures.

At the conclusion of its October 12, 2011, meeting, after further modifications to the definitions, the USNWG agreed to recommend to the January 2012 NCWM, alternative definitions move forward for a vote in July 2012 to read:

1.XX. Fuel Cell. – An electrochemical energy conversion device in which fuel and an oxidant react to generate electricity without any consumption, physically or chemically, of its electrodes or electrolyte. (Added 201X)

1.XX. Hydrogen Fuel. – A fuel composed of molecular hydrogen intended for consumption in a surface vehicle or electricity production device with an internal combustion engine or fuel cell.
(Added 201X)

1.XX. Internal Combustion Engine. – A device used to generate power by converting chemical energy bound in the fuel via spark-ignition or compression ignition combustion into mechanical work to power a vehicle or other device.
(Added 201X).

Background

On August 4, 2011, a summary of the changes to the definitions of *hydrogen fuel*, *internal combustion engine*, and *fuel cell* proposed in July 2011 by Jim McGetrick (BP America) was distributed to the USNWG for their consideration and comment. The proposal resulted in the voting status of the definition being downgraded to an information item and carried over to the 2012 NCWM agenda.

The proposal did not alter the status of the corresponding information item, which is a proposal for a new hydrogen fuel specification still under development in the fuel standards community. The July 2011 alternate proposal for defining all three hydrogen related terms read:

1.XX Fuel Cell. – An electrochemical energy conversion device in which fuel and an oxidant react to generate ELECTRICAL energy without consumption of its electrodes or electrolytes.
(Added 201X)

1.XX. Hydrogen Fuel. – A fuel composed of the chemical MOLECULAR hydrogen intended for consumption in a surface vehicle OR ELECTRICITY PRODUCTION DEVICE with an internal combustion engine or fuel cell.
(Added 201X)

1.XX. Internal Combustion Engine. – A device used to generate power by converting chemical energy bound in the fuel VIA SPARK-IGNITION OR COMPRESSION IGNITION COMBUSTION into mechanical work to power a vehicle OR OTHER DEVICE.
(Added 201X)

On September 6, 2011, the NIST Technical Advisors to the USNWG held a teleconference with James McGetrick and Dr. James Sinnick (BP America), the developers of the July 2011 alternate proposal shown above. The teleconference was held to: (1) clarify the nature of their comments (technical, editorial, etc.); (2) ensure any suggested alternate language does not result in any omission or exclusion of any intended applications; and (3) possibly respond to any questions about the USNWG's proposals. The submitters indicated their comments on the fuel quality standard proposal were meant to encourage academia and industry to fully vet the values for the maximum constituent levels before proceeding further; to avoid adoption of excessively stringent requirements. The suggested alternate language for the definitions, although technical in nature, was primarily intended to further clarify the meaning of the terms and, ultimately, not critical to their meaning. The Technical Advisors provided a history of: (1) the work by the USNWG; (2) the ongoing work by its members on various fuel quality standards committees such as ASTM, SAE, and ISO; and (3) the group's goal to recommend a nationally and internationally accepted specification developed by a recognize standard's body.

On September 7, 2011, Jackie Birdsall (CaFCP) recommended the USNWG consider the alternate definition for *fuel cell* in SAE J2574 Information Report Fuel Cell Electric Vehicle Terminology (NOTE: SAE J2574 was published on September 6, 2011) that would modify the proposed definition to read:

1.XX Fuel Cell. – An electrochemical energy conversion device in which fuel and an oxidant react to generate ELECTRICITY without ANY consumption, PHYSICALY OR CHEMICALLY, of its electrodes or electrolyte.

The USNWG was balloted by e-mail on September 20, 2011, and then by an amended ballot on September 27, 2011. The SAE J2574 definition for *fuel cell* and the alternate definitions for *hydrogen fuel* and *internal combustion engine* that were proposed in July 2011 were all distributed in the September 27 ballot for the USNWG's review, comment, and vote and in preparation for the group's October 12, 2011, meeting.

On September 25 - 29, 2011, the Western Weights and Measures Association (WWMA) met and considered NCWM carryover Items 237-1 (Engine Fuel Quality Requirements for Hydrogen) and 237-2 (Definitions for Hydrogen Fuel for Internal Combustion Engines and Fuel Cell Vehicles). The proposed definitions in agenda Item 237-2 included all of the alternate language recommended by the October 2011 USNWG. DSS Chair, Kristin Macey (CA DMS), reported to the USNWG that the WWMA voted unanimously to move the items forward as voting items to the 2012 NCWM. The USNWG acknowledges and thanks Chair Macey for representing the work of the group at the WWMA meeting.

The USNWG wishes to express its appreciation to Bill Collins of UTC Power who presented a history on the development of SAE J2719 at the October 2011 NEWMA regional association interim meeting. This information was intended to aid the NEWMA L&R Committee in completing their technical analysis of carryover Items 237-1 and 237-2. NEWMA supported Item 237-1 as an informational item and Item 237-2 as a voting item.

October 2011 Discussions

During its October 12, 2011, meeting, the USNWG addressed multiple questions about its hydrogen fuel quality standard proposal. The USNWG had a question regarding what was intended by the latest proposal to add the text "electricity production device" to the definition of Hydrogen Fuel. Marc Buttler explained that this is generally in reference to the increased use of fuel cells in stationary electrical power generation applications and Joe Cohen added that cell towers is one very specific application.

Jim Ohi (Consultant DOE) had a question about whether the definition for Hydrogen Fuel, as proposed would be exclusively for gaseous fuels. FSS Chair Bob Boyd (Boyd Hydrogen, LLC) explained that the proposed new terminology, including the word "molecular" could encompass both gaseous and liquid retail sales of hydrogen fuel. Furthermore, Mr. Boyd stated that he is not opposed to the use of the word molecular in this instance. The calculations referenced in NIST Handbook 44 Section 3.39. Hydrogen Gas-Measuring Devices – Tentative Code in paragraph N.7. Density encompass the thermophysical properties of gaseous and liquid hydrogen. No comments were received in opposition to the term "molecular" on a technical basis.

The USNWG members present supported the results of the e-mail ballot with general consensus in favor of revising the proposal to include the latest modifications as shown above.

Juana Williams (NIST OWM) pointed out that *Paragraph 2.32.1. Definitions for Hydrogen Fuel* from the "Uniform Regulation for the Method of Sale (MOS) of Commodities" section of NIST Handbook 130 should also be updated so that both the MOS and the fuel specifications sections of HB 130 will have the same definition of hydrogen fuel. Marc Buttler will propose this amendment to L&R Committee Item 237-2 (Definitions for Hydrogen Fuel for Internal Combustion Engines and Fuel Cell Vehicles) at the SWMA meeting in Norfolk, Virginia, on October 23 - 26, 2011.

(b) Proposed Joint Statement from the USNWG in Support of the NCWM Hydrogen Fuel Specification Agenda Items

During the USNWG's October 2011 discussion of its position statement for Item 237-1 (Engine Fuel Quality Requirements for Hydrogen), the FSS Chair, Bob Boyd, proposed replacing the table that had been developed with a direct reference to SAE J2719. This proposal was made with the understanding that the publication of SAE J2719 was imminent and that direct reference to the standard is now possible. Both Jackie Birdsall and Jim Ohi supported the proposal. Jim Ohi stated that this change "reduces future confusion." A direct reference to the SAE standard is also in line with the precedence set by citing other fuels specifications already in HB 130. There was general consensus in support of this alternative proposal among the USNWG members present. The USNWG's new alternative fuel specification proposal was developed to replace Table 1 and reads:

2.X. Hydrogen Fuel. – Shall meet the most recent version of SAE J2719, "Hydrogen Fuel Quality for Fuel Cell Vehicles."

The USNWG has monitored the national and international work to develop a fuel specification to avoid redundancy and encourage harmonization of the standard. The permissible constituent values in SAE J2719 and ISO/DIS 14687-2 "Hydrogen Fuel - Product Specification - Part 2 PEM Fuel Cell Applications for Road Vehicles" are reported to be identical and were also reflected in Table 1. The USNWG's Table 1 was an interim measure and more suited to the group's work as it monitored the ongoing progress to develop a hydrogen fuel standard.

Juana Williams mentioned during the USNWG meeting that the NCWM process includes the opportunity for comments during both open hearings and voting session, up until the actual vote on an item occurs. The group discussed what to do if changes to items developed by the USNWG are proposed and amended during the NCWM; however, the group did not reach a firm conclusion other than to submit its most recent alternative proposals to the NCWM with a strong recommendation to adopt them as submitted.

(4) DSS Items - Development of Device Standards and Test Procedures for Commercial Hydrogen Measurement

(a) Review and Approve Proposed Checklist for Addition to NCWM Publication 14

Kristin Macey reported that CADMS has used the draft checklist to conduct multiple inspections and during one type evaluation. Michael Keilty (Endress & Hauser), leader of the NCWM group that developed the draft checklist, added that the draft was patterned after those used for gasoline and CNG dispensers. Tina Butcher (NIST OWM) pointed out that the checklist is a reflection of requirements that the USNWG developed in their recommendation for the hydrogen device code that was adopted during the 2010 NCWM and subsequently published in the 2011 NIST HB 44 as Section 3.39. Hydrogen Gas-Measuring Devices – Tentative Code and, therefore, the checklist does not introduce any new requirements beyond what are already found in HB 44.

The group voted on the draft checklist (see Appendix B) with no changes and three votes in support were heard. However, four other USNWG members abstained and requested more time to complete a thorough review of the checklist. Following the meeting, one of the abstentions contacted Marc Buttler to change their vote in favor and another sent comments, but did not specify that their review was completed or position established. At this time, no requests were made to delay the NCWM's approval of the checklist. Future comments by any stakeholder can be submitted to the NCWM NTEP administrator (jim.truex@ncwm.com) and should be copied to Marc Buttler (marc.buttler@nist.gov) for distribution to the entire USNWG.

(b) Progress Report on the Development of Hydrogen Test Methods and Gap Analysis

Marc Buttler updated the USNWG on NIST efforts to develop and validate Examination Procedure Outlines (EPOs) for the three test methods recognized in NIST Handbook 44 (gravimetric, master meter, and PVT). Members of the USNWG are asked to contact Marc as they become aware of any opportunities to witness any progress being made in the development of test methods that should be considered for validation and documentation as a NIST EPO.

(5) Next Steps/Tasks

The following action items were taken by the FSS Technical Advisor in an effort to meet USNWG goals for the adoption of a uniform hydrogen fuel quality standard.

Status of SAE J2719

Marc Buttler confirmed that after a meeting with the Chair of the SAE work group on J2719 (Mike Steele), the title of J2719, as stated in the language developed during the discussion of agenda item (3) (b), was correct and up to date with the version to be published. Furthermore, FSS Technical Advisor Buttler confirmed in October 2011 that publication had taken place and that SAE J2719 is available for purchase.

The Weights and Measures Standards Development Process

FSS Technical Advisor Buttler prepared a statement summarizing all FSS decisions made on the October 2011 USNWG agenda items (3)(a) and (3)(b) to update the SWMA regional association at their annual meeting in Norfolk, Virginia, on October 23 - 26, 2011. This statement can be found in Appendix A of this meeting summary. The statement was delivered and considered by the SWMA. The SWMA voted to adopt all the alternative changes proposed by the USNWG and move both items forward as voting items (as revised) to the NCWM.

Development of the Type Evaluation Checklist

During their annual meeting that was held October 21 - 22, 2011, in Norfolk Virginia, the NCWM NTETC Measuring Sector also reviewed the checklist (see discussions in Agenda Item (4) (a)) and voted to move it forward to the January 2012 NCWM NTEP Committee for inclusion in NCWM Publication 14. The recommendation from the Measuring Sector adds a new note to the beginning of the hydrogen checklist that directs readers to Section I. Field Evaluation and Permanence Tests for Mass Flow Meters of Publication 14 for guidance on compressed gas test methods and permanence tests, and thereby establishes an identical set of requirements for product throughput and time for permanence examination as those already in use for CNG measuring devices. The note reads as follows:

Note: Refer to Section I Field Evaluation and Permanence Tests for Mass Flow Meters (All topics with the exception of “Testing for Volume Units Only or to Add Volume Units to Existing Certificates”) for test procedures.

Technical Advisor’s Note: During its annual meeting, the Measuring Sector also voted in favor of two other items related to type approval of hydrogen gas-measuring devices. The first item was to recognize hydrogen in the list of product categories for meters in Technical Policy C. This policy specifies the test procedures that must be conducted on a device before a device can be approved for use in a single or multiple product application(s). The second item adds the “kilogram” (kg) as an approved unit of measurement that can be displayed on a retail fueling dispenser’s indications when the device is used to deliver hydrogen.

The NCWM NTEP Committee will consider the recommendation from the Measuring Sector to add the checklist to NCWM Publication 14 for Measuring Devices. Marc Buttler will also forward any comments from the USNWG on the draft checklist that are received prior to the January 2012 final review of the draft by the NCWM NTEP Committee for the Committee's consideration, along with the Measuring Sector's recommendation.

(6) Next Meeting

The group agreed to schedule future meetings on an "as needed" basis as we approach the next annual NCWM in July, 2012.

APPENDIX A: Proposal Delivered to Annual Meeting of the Southern Weights and Measures Association (SWMA)

Proposed New Hydrogen Fuel Quality Specification and Definitions for NIST Handbook 130 October 19, 2011

The earlier proposed hydrogen fuel quality specification and related definitions were before the July 2011 National Conference on Weights and Measures and were carried over to 2012 as informational items.

On October 12, 2011, the U.S. National Work Group (USNWG) for the Development of Commercial Hydrogen Measurement Standards considered and approved the following changes to the items carried over from the 2011 NCWM to adopt new fuel quality requirements and related definitions for NIST Handbook 130 (HB 130) to address gaseous hydrogen refueling applications.

237-1 I HB 130, Engine Fuel Quality Requirements for Hydrogen

Source: Western Weights and Measures Association (WWMA)

Purpose: Adopt engine fuel quality requirements for hydrogen in HB 130 to address gaseous hydrogen refueling applications.

Item Under Consideration: In April 2009, the U.S. National Work Group (USNWG) for the Development of Commercial Hydrogen Measurement Standards Fuel Specifications Subcommittee (FSS) presented the original recommended fuel quality standard for consideration.

The U.S. National Work Group (USNWG) Fuel Specifications Subcommittee (FSS) presents the following updated recommendation for consideration to be added to **NIST Handbook 130 – IV. Uniform Regulations - G. Uniform Engine Fuels and Automotive Lubricants Regulation, Section 2. Standard Fuel Specifications.**

Specification for Hydrogen Fuel: The FSS has been notified that publication of the SAE standard J2719 is imminent. The document has been approved by SAE for publication and is currently being prepared by the publisher for an expected release before the end of September 2011. In light of this development, the USNWG now recommends replacing the previously recommended table with the following quality standard by direct reference:

2.X. Hydrogen Fuel. – Shall meet the most recent version of SAE J2719, “Hydrogen Fuel Quality for Fuel Cell Vehicles.”

This fuel quality standard for hydrogen by direct reference to SAE standard J2719 is proposed to replace entirely the previous table below that had been developed by the USNWG to reflect the constituents, maximum allowable levels, and corresponding ASTM test methods. The USNWG had developed the table to be harmonized with the developing SAE J2719 standard. Now that SAE J2719 has been approved for publication, a NIST Handbook 130 standard by direct reference to SAE J2719 is preferred by the FSS to facilitate continued harmonization with the SAE standard and to reflect the precedence of directly referencing SAE and ASTM standards that is set by other fuel quality standards found in **Section 2. Standard Fuel Specifications** (e.g., Gasoline and Gasoline-Oxygenated Blends, Diesel Fuel, Aviation Turbine Fuels, LPG, CNG, etc.).

Table 1. Hydrogen Fuel Quality Specification appears as follows:

Table 1. Hydrogen Fuel Quality Specification*					
Constituent	Value	Unit	Limit	Test Method(s)	Responsible Standards Committee and Status of test method
Standard Practice for Gaseous Sampling				ASTM D7606-11	
1	Hydrogen Fuel Index	99.97	%	Minimum	(a)
2	Total Allowable Non-Hydrogen, Non-	100.0	ppm v/v	Maximum	(b)

	Helium, Non-Particulate					
3	Total Non-Hydrogen Gases	300.0	ppm v/v	Maximum	(e)	
4	Ammonia	0.1	ppm v/v	Maximum	ASTM D7653-10	
5	Carbon Dioxide	2.0	ppm v/v	Maximum	ASTM D7653-10 ASTM D7649-10	
6	Carbon Monoxide	0.2	ppm v/v	Maximum	ASTM D7653-10	
7	Formaldehyde	0.01	ppm v/v	Maximum	ASTM D7653-10	
8	Formic Acid	0.2	ppm v/v	Maximum	ASTM D7550-09 ASTM D7653-10	
9	Helium	300.0	ppm v/v	Maximum	ASTM D1945-03	
10	Nitrogen and Argon	100.0	ppm v/v	Maximum	ASTM D7649-10	
11	Oxygen	5.0	ppm v/v	Maximum	ASTM D7649-10	
12	Particulate Concentration	1.0	mg/kg	Maximum	ASTM D7650-10 ASTM D7651-10	
13	Total Halogenated Compounds	0.05	ppm v/v	Maximum	to be specified	WK-23815 under ASTM D03.14
14	Total Hydrocarbons	2.0 (d)	ppm v/v	Maximum	ASTM D7675-11	
15	Total Sulfur Compounds	0.004	ppm v/v	Maximum	ASTM D7652-11	
16	Water	5.0	ppm v/v	Maximum	ASTM D7653-10 ASTM D7649-10	
Footnotes to Table 1—						
(a) Hydrogen fuel index = Sum of all non hydrogen gases (as % of sample) subtracted from 100 %.						
(b) Total Allowable Non Hydrogen, Non Helium, Non Particulate = Sum of all constituents listed on the table, except hydrogen, helium, and particulates.						
(c) Total Non Hydrogen Gases = Sum of all constituents listed on the table except hydrogen and particulates.						
(d) Total Hydrocarbons may exceed 2 ppm v/v only due to the presence of methane, provided that the total _____ gases do not exceed 300 ppm v/v.						
* The FTC's Fuel Rating Rule (16 CFR Part 309 see the requirements in "Labeling of Alternative Fuels" at http://www.ftc.gov/bep/edu/pubs/business/autos/bus29.shtm) requires dispensers to bear a declaration of the minimum percent of hydrogen determined according to test methods described in "Standard Test Method for Analysis of Natural Gas by Gas Chromatography (ASTM D1946).						
Updated 7/12/2011						

The USNWG supports the addition of the single sentence direct reference to SAE J2719 above to NIST Handbook 130 for the purpose of meeting the need in the market place for uniformity in hydrogen fuel quality, conditional on the expected and imminent publication of the SAE J2719 standard. The USNWG acknowledges that, if the final SAE J2719 standard is still pending publication in July 2012, the NCWM L&R committee may downgrade the proposal's status and carryover the item to the 2013 NCWM agenda."

The USNWG will continue to accept input and work on this item as needed until the NCWM interim meeting in January.

237-2 I HB 130, Definitions for Hydrogen Fuel for Internal Combustion Engines and Fuel Cell Vehicles

Source: Western Weights and Measures Association (WWMA). This item was previously within Item 237-1.

Purpose: Adopt definitions for hydrogen fuel, internal combustion engine, and fuel cell.

Item Under Consideration: In April 2009, the U.S. National Work Group (USNWG) for the Development of Commercial Hydrogen Measurement Standards Fuel Specifications Subcommittee (FSS) presented the original recommended definitions for consideration.

The U.S. National Work Group (USNWG) Fuel Specifications Subcommittee (FSS) presents the following updated recommendation for consideration to be added to **NIST Handbook 130 – IV. Uniform Regulations - G. Uniform Engine Fuels and Automotive Lubricants Regulation, Section 1. Definitions.**

FSS supports the proposed new definitions below to address gaseous hydrogen refueling applications.

The following updates were proposed for the USNWG to consider after the July NCWM:

- Revise the language of the definition of “Fuel Cell” to harmonize with the language in SAE J2574 (see below).
- Revise the language of the definitions for both “Hydrogen Fuel” and “Internal Combustion Engine” as proposed (see below) in comments received at the July 2011 National Conference on Weights and Measures.

The information regarding the changes to the definitions was first provided to the USNWG on August 4 following the July NCWM. A ballot was issued via e-mail on September 20 to formally approve the definition modifications in time for the September 26 - 29 WWMA. The updates below were unanimously recommended to move forward at the WWMA as a voting item.

The USNWG held a meeting on October 12, 2011, to allow for further discussion. Final approval of the update was confirmed during this meeting.

The definitions appear with the proposed changes as follows:

1.XX. Fuel Cell. – An electrochemical energy conversion device in which fuel and an oxidant react to generate **energy electricity** without **any** consumption, **physically or chemically**, of its electrodes or electrolytes.
(Added 201X)

1.XX. Hydrogen Fuel. – A fuel composed of **the chemical-molecular** hydrogen intended for consumption in a surface vehicle **or electricity production device** with an internal combustion engine or fuel cell.
(Added 201X)

1.XX. Internal Combustion Engine. – A device used to generate power by converting chemical energy bound in the fuel **via spark-ignition or compression ignition combustion** into mechanical work to power a vehicle **or other device**.
(Added 201X)

In addition, it is proposed that the scope of Item 237-2 be expanded to include the following revision to **NIST Handbook 130 – IV. Uniform Regulations - B. Uniform Regulation for the Method of Sale of Commodities, Section 2. Non-food Products, Paragraph 2.32.1. Definitions for Hydrogen Fuel.** as follows:

2.32.1. Definitions for Hydrogen Fuel. – A fuel composed of **the chemical-molecular** hydrogen intended for consumption in **a surface vehicle or electricity production device with** an internal combustion engine or fuel cell.

The purpose of adding this change to the Method of Sale Regulation is to avoid confusion and maintain consistency between the definitions of Hydrogen Fuel found in the two sections of NIST Handbook 130 –IV. Uniform Regulations (i.e., the Method of Sale Regulation and the Engine Fuels and Automotive Lubricants Regulation).

The USNWG will continue to accept input and work on this item as needed until the NCWM interim meeting in January.

Appendix B: Checklist as Forwarded by Measuring Sector following the Sector's October 21 - 22, 2011, Annual Meeting

National Type Evaluation Program Liquid Measuring Devices – Additional Checklists and Test Procedures for Hydrogen Gas-Measuring Devices

Additional Checklists and Test Procedures for Hydrogen Gas-Measuring Devices

Note: Refer to Section I Field Evaluation and Permanence Tests for Mass Flow Meters (All topics with the exception of “Testing for Volume Units Only or to Add Volume Units to Existing Certificates”) for test procedures.

47. Indicating Elements, Recording Elements, and Recorded Representations

Code Reference: S.1.1. Indicating Elements

47.1. A device shall be equipped with a primary indicating element that continuously displays measurement results relative to quantity and total price. Yes No N/A

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

Code Reference: S.1.2. Vehicle Fuel Dispensers

Dispensers used to fuel vehicles shall be of the computing type and shall indicate the mass, the unit price, and the total price of each delivery. Yes No N/A

Code Reference: S.1.1. Indicating Elements, S.2. Operating Requirements

Primary indicating and recording elements may advance only as a result of the operation of the device. However, means shall be provided for readily returning the device to zero. Once the zeroing operation has begun, it shall not be possible to return primary indicating elements or primary recording elements beyond the correct zero position. It shall not be possible to indicate a value other than the latest measurement, or “zeros” when the zeroing operation has been completed.

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

During the reset operation, it shall not be possible to return primary indicating elements or primary recording elements to any value other than zero. Yes No N/A

During the reset operation, it shall not be possible to indicate a value other than the latest measurement, or “zeros” when the zeroing operation has been completed. Yes No N/A

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

Indicating elements must be appropriately designed and adequate in amount. Specifically, a device must have sufficient display capacity to indicate the quantities and total prices, if it applies in the normal encountered specific application. Electronic devices shall either have sufficient display capacity to indicate the normal quantities and money values or automatically stop the delivery before exceeding the display capacity of either the quantity or total price. This consideration may apply when evaluating a system that may be used in either a truck stop or an automobile service station.

47.7. An electronic digital indicating element shall either:

47.7.1. Have adequate display capacity for the application, **OR** Yes No N/A

47.7.2. Automatically stop the delivery before exceeding the maximum quantity or Yes No N/A

maximum total price that can be indicated.

Code Reference: G-S.7. Lettering

47.8. All required markings and instructions shall be distinct and easily readable and shall be of such character that they will not tend to become obliterated or illegible. Yes No N/A

Code Reference: G-S.5.2.4. and S.1.3.4. Values Defined

Values shall be adequately defined by a sufficient number of figures, words, or combinations to include a zero display for all displayed digits to the right of the decimal mark and at least one to the left. Yes No N/A

Code Reference: G-S.5.2.2; Digital Indication and Representation; S.2.4.4. Agreement Between Indications

Basic operating requirements for devices are that:

All digital values of like value in a system shall agree.

Digital values shall round off to the nearest digital division that can be indicated or recorded.

When a digital zero display is provided, the zero indication shall consist of at least one digit to the left and all digits to the right of the decimal point.

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

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

47.10. Digital quantity indications must agree. Yes No N/A

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

47.12. When delivery from a computing device is based upon a **pre-set quantity**, the quantity indicated on the dispenser and any auxiliary device must be equal to or greater than the pre-set quantity at the conclusion of the transaction. Yes No N/A

Code Reference: G-S.5.5. Money Values, Mathematical Agreement

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

47.11. Any recorded money-value and any digital money-value indication on a computing – type measuring device used in retail trade shall be in mathematical agreement with its associated quantity representation or indication to the nearest 1 cent of money value. (e.g., within each element, the values indicated or recorded must meet the formula) Yes No N/A

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

47.16. The quantity, unit price, and total price indications on the **console** shall be in mathematical agreement with the dispenser and printed ticket. Yes No N/A

47.17. The following applies when a quantity value indicated or recorded by an **auxiliary element** such as a console, ticket printer, or remote customer display, is a derived or computed value based on data received from a retail vehicle fuel dispenser.

47.15.1. The quantity values indicated or recorded on a console, electronic cash

register, or other auxiliary indicating or recording element may differ, however:

- 47.15.1.1. All indicated or recorded total money values for an individual sale shall agree, **AND** Yes No N/A
- 47.15.1.2. The indicated or recorded quantity, unit price, and total sales price values shall be in mathematical agreement. Yes No N/A
- [Quantity x Unit price = Total sales price] to the closest cent.
Examples: \$4.5549 rounds to \$4.55
\$4.5551 rounds to \$4.56
\$4.5550 rounds to either \$4.55 or \$4.56

Code Reference: S.2.5.1. Auxiliary Elements

Money value divisions on auxiliary elements such as remote consoles and printers shall be the same as on the primary element. Any recorded money value and any digital money value indication on a primary indicator must agree mathematically with its associated quantity representation or indication.

Formula: Unit Price x Indicated quantity = Total Sale

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

- 47.18.1. At various flow rates, including maximum and minimum. Yes No N/A
- 47.18.2. Closing and reopening the nozzle outlet valve several times during delivery. Check mathematical agreement each time flow is halted. Yes No N/A
- 47.18.3. At several unit prices including the low prices and the maximum pricing capability of the computer and when operating at the maximum flow rate. Yes No N/A
- 47.18.4. Turn the dispenser off during delivery with nozzle outlet valve open. Yes No N/A

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

Discount Pricing

NIST Handbook 44 requires that, when a product or grade is offered for sale at more than one unit price through a computing device, the selection of the unit price shall be made prior to delivery using controls on the device or other customer-activated controls.

Should the customer elect to use another method of payment following completion of delivery, the console may be used to recalculate the total price — provided the dispenser complies with all applicable *NIST Handbook 44* requirements. For example, the customer selects the credit card unit price on the dispenser and dispenses product at that unit price. However, the customer discovers that he forgot his credit card and decides to pay cash. In this case, the console might be used to calculate the total price at the cash unit price. In keeping with the intent of National Conference on Weights and Measures action in 1989 to require dispensers to calculate at all unit prices for which a product is offered for sale, it is anticipated that the console would be required to recalculate the new total price using the formula (quantity x unit price = total price). A receipt providing the total quantity, unit price, total computed price, and product identity shall be available through a built-in or separate recording element for all transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash (Code Reference S.2.6. Recorded Representations, Point of Sale Systems) as the transaction was completed. The recorded and displayed total quantity on the receipt and dispenser, respectively, shall agree.

Selectable Unit Price Capability

Selectable unit price capability is a design feature that permits the customer to select the unit price for a particular transaction at the time of sale. A dispenser may then allow the unit price for a delivery to be selected from two or more unit prices.

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

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

Code Reference: S.2.5.2. Display of Quantity and Total Price

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

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

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

Code Reference: S.2.4.1. Unit Price and S.2.4.3. Selection of Unit Price

- 47.19. The selected unit price must be made clearly evident on the dispenser. Yes No N/A
- 47.20. A dispenser may be equipped with means for selecting more than one unit price, provided that the selected unit price cannot be changed after the initial flow begins. Yes No N/A

Code Reference: S.2.5.2. Display of Quantity and Total Price

- 47.21. The selected unit price displayed at the dispenser prior to the delivery of product must be continuously displayed at the conclusion of the delivery, after automatic termination by the dispenser or after manual termination by the customer using the controls at the device, until the start of the next transaction by whichever occurs first:
 - 47.21.1. Customer initiation of the delivery using the controls at the device, **OR** Yes No N/A
 - 47.21.2. "Authorization/Approval" by the console operator. Yes No N/A
- 47.22. When a delivery is completed, the total price and quantity for that transaction shall be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated by using controls on the device or other user-activated (e.g., customer-activated) controls. Yes No N/A
- 47.23. In a system where a base unit price is automatically displayed on the dispenser after the completion of a transaction (e.g., product is dispensed and payment is settled), the dispenser may display the values for quantity, unit price, and total price that do not result in a mathematically correct equation. That is provided when the total price value displayed is divided by the quantity value displayed, the result is a unit price that is "posted" for a particular kind of transaction. Yes No N/A

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

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

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

47.25. The customer receipt must contain the following information:

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

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

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

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

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

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

Code Reference: S.1.3.1. Primary Elements/Units

47.28. A hydrogen gas-measuring device shall indicate, and record if the device is equipped to record, its deliveries in kilograms or decimal multiples or submultiples of the kilogram. Yes No N/A

Code Reference: S.1.3.2. Numerical Value of Quantity-Divisions and S.1.3.3. Maximum Value of Quantity-Value Divisions

47.29. The value of the scale division for the indicating and recording element must be in values of 1, 2, or 5 and uniform throughout the series. The maximum value of the quantity-value division shall not be greater than 0.5 % of the minimum measured quantity. Yes No N/A

Code Reference: S.1.4. Value of Smallest Unit

47.30. The value of the quantity division shall not exceed the equivalent of 0.001 kg on devices with a marked maximum flow rate of 30 kg/min or less. Yes No N/A

47.31. The value of the quantity division shall not exceed the equivalent of 0.01 kg on devices with a marked maximum flow rate greater than 30 kg/min. Yes No N/A

Code Reference: S.2.7.; Indication of Delivery and S.3.5. Pressurizing the Discharge Hose

47.32. Retail devices shall automatically show their initial zero condition and amount delivered up to the nominal capacity of the device. The measurement, indication of Yes No N/A

delivered quantity, and the indication of total sales price shall be inhibited until the fueling position reaches conditions necessary to ensure the delivery starts at zero.

Test Method:

- a. Remove nozzle from dispenser and connect to test cylinder. Test cylinder initial pressure should not be greater than 2.5 MPa (360 psig) and should not be less than 2 MPa (290 psi) to simulate an actual delivery.
- b. Turn nozzle valve from “OFF” to “FILL” position.
- c. Empty discharge hose.
- d. Turn nozzle valve to “OFF” position
- e. Activate dispenser.

47.33. Dispenser indications shall not advance.

Yes No N/A

Code Reference: S.2.3. Provisions for Power Loss and S.2.3.1. Transaction Information

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

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

Code Reference: S.2.3.2. User Information

47.34. The quantity and total sales price shall be recallable for 15 minutes after the power failure.

Yes No N/A

47.35. The quantity and total sales price values shall be correct if the power fails between deliveries.

Yes No N/A

47.36. The quantity and total sales price values shall be correct if the delivery is continued after a power failure.

Yes No N/A

47.37. The operator's information shall be retained in memory during a power failure.

Yes No N/A

47.38. Remote controllers which stack completed sales must have a means to enable the transaction information to be recalled and verified for at least 15 minutes.

Yes No N/A

Code Reference: S.2.1. Return to Zero

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

47.39. Does the device have a primary recording element?

Yes No N/A

47.40. The indicating and recording elements of a retail device shall be readily returnable

Yes No N/A

to a definite zero indication.

- 47.41. Key-lock and self-operated devices shall have an indicating element that return to zero. Yes No N/A
- 47.42. Does the device have:
- 47.42.1. A cumulative indicating element? Yes No N/A
- 47.39.2. A cumulative recording element? Yes No N/A
- 47.43. Primary indicating and recording elements shall not go beyond their correct zero position. Yes No N/A

Code Reference: S.2.4. Display of Unit Price and Product Identity

A computing or money-operated device shall have a means on the face of the device for displaying the unit price at which it is set to compute or deliver and for posting the product identity. When a product is offered for sale at more than one unit price from a device, then all of the unit prices at which that product is offered for sale shall be displayed or shall be capable of being displayed on the dispenser using controls available to the customer prior to the delivery of the product. The unit price shall be expressed as a decimal value in dollars.

Code Reference: S.2.4.1. Unit Price, S.2.4.2. Product Identity, and S.2.4.3. Selection of Unit Price

- 47.44. Means shall be provided to display the unit price on each face of the device. Yes No N/A
- 47.45. Means shall be provided to post on each side of the device the identity of the dispensed product. Yes No N/A
- 47.46. When a product is offered for sale at more than one unit price from a device, then all of the unit prices at which that product is offered for sale:
- 47.46.1. Shall be displayed prior to the delivery of the product, **OR** Yes No N/A
- 47.46.2. Shall be capable of being displayed on the dispenser using controls available to the customer. Yes No N/A
- 47.46.3. A system shall not permit a change to the unit price during delivery of product. Yes No N/A

Note: It is not necessary to simultaneously display all of the unit prices, provided the dispenser complies with HB 44 section S.2.4.1.

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

- a. Displayed simultaneously for all products,*
- b. Displayed simultaneously for each product separately, **OR***
- c. Displayed individually in a unit-price display only if controls permit the customer to sequence the display through the unit prices for each and every product.*

- 47.47. The unit price shall be expressed in dollars and decimals of dollars using a dollar sign. A common fraction shall not appear in the unit price, (e.g., \$4.29 not \$4 29/100). Yes No N/A

Code Reference: S.2.5.2. Display of Quantity and Total Price

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

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

48. Computing

Code Reference: S.2.5. Money-Value Computations

A hydrogen gas dispenser used to fuel vehicles shall be capable of computing total sale prices for all unit prices and for all deliveries within the range of measurement or computing capacity.

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

Code Reference: S.2.4.4. Agreement between Indications

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

Code Reference: S.2.5.1. Auxiliary Elements

48.3. All indicated money value divisions and quantity value divisions on auxiliary elements shall be identical with those of the primary element. Yes No N/A

49. Recorded Representations, Point of Sale Systems, and Printed Receipt

A printed receipt shall be available through a built-in or separate recording element for transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash. The printed receipt shall contain the following information for products delivered by the dispenser.

Code Reference: S.2.6. Recorded Representations, Point of Sale Systems

49.1. A printed receipt shall be available for devices activated by debit cards, credit cards, and/or cash. The printed receipt: Yes No N/A

49.1.1. Shall contain the total mass of the delivery; Yes No N/A

49.1.2. Shall contain the unit price; Yes No N/A

49.1.3. Shall contain the total computed price; and, Yes No N/A

49.1.4. Shall contain the product identity by name, symbol, abbreviation, or code number. Yes No N/A

Code Reference: S.6. Printer

49.2. Printed information must agree with the indications on the dispenser. Yes No N/A

49.2.1. Printed values shall be clearly defined. Yes No N/A

Code Reference: S.6.1. Printed Receipt

49.3. Any delivered, printed quantity

49.3.1. Shall include an identification number, and; Yes No N/A

49.3.2. Shall include the time and date, and; Yes No N/A

49.3.3. Shall include the name of the seller. Yes No N/A

50. Design of Measuring Elements and Measuring Systems

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

50.1. The ratio of the maximum to minimum flow-rates for devices measuring gases shall be 10:1 or greater. Yes No N/A

Code Reference: S.3.2. Adjustment Means

50.2. Means shall be provided to change the ratio between the indicated quantity and the quantity of gas measured by the assembly. Yes No N/A

50.2.1. A bypass on the measuring assembly shall not be used for these means. Yes No N/A

Code Reference: S.3.2.1. Discontinuous Adjustment Means

50.2.2. When the adjusting means changes the ratio between the indicated quantity and the quantity of measured gas in a discontinuous manner, the consecutive values of the ratio shall not differ by more than 0.1%. Yes No N/A

Code Reference: S.3.3. Provision for Sealing

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

50.3. A measuring element shall have provisions for either:

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

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

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

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

50.6. Audit trails shall use the format set forth in the Common and General Code Criteria section of this checklist (Code Reference G-S.8 LMD-23) and in Appendix A, Philosophy for Sealing. Yes No N/A

50.7. Retail vehicle fuel dispensers with remote configuration capabilities shall be sealed according to Table S.3.3. of NIST HB 44 Section 3.39 Hydrogen Gas-Measuring Devices – Tentative Code and according to Appendix A, Philosophy for Sealing. Yes No N/A

Code Reference: S.3.4. Automatic Density Correction

50.8. An automatic means to determine and correct for changes in product density due to changes in temperature, pressure, and composition, shall be incorporated in any hydrogen gas-measuring system that is affected by changes in the density of the product being measured. Yes No N/A

Code Reference: S.3.6. Zero-Set-Back Interlock, Retail Vehicle Fuel Devices

The zero-set-back interlock on a dispenser is critical to prevent fraudulent practices. A retail vehicle fuel device shall have an effective automatic interlock such that once the dispenser shuts off, it cannot be restarted without resetting the indicating element to zero.

This requirement also applies to the recording element if one is present. The dispenser shall be designed so that the starting lever must be in the shut-off position and the interlock engaged before the discharge nozzle can be returned to its designed hanging position. If a single pump supplies more than one dispenser, then each dispenser shall have an automatic control valve that prevents product from being delivered by a dispenser until its indications have been set to zero.

- 50.9. After the device is turned off by moving the lever that stops the flow, a subsequent delivery shall be prevented until the indicators (and recording element if present) have returned to their correct zero positions. Yes No N/A
- 50.10. The starting lever shall be in shut off position and zero-set-back interlock engaged before the nozzle can be returned to its designed hanging position. That is any position where the tip of the nozzle is placed in its designed receptacle and the lock can be inserted. Yes No N/A
- 50.11. If more than one dispenser is connected to a single source, an automatic control valve shall prevent fuel from being delivered until the indicating elements have been returned to their correct zero position and engaged. Yes No N/A
- 50.12. The use of the interlock shall be effective under all conditions when any control on the console, except a system emergency shut-off, is operating and after any momentary power failure. Yes No N/A

51. Discharge Lines and Valves

Code Reference: S.4.1. Diversion of Measured Product

- 51.1. No means shall be provided by which any measured product can be diverted from the measuring device. Yes No N/A

Code Reference: S.4.2. Directional Flow Valves

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

Code Reference: S.4.3. Other Valves

- 51.3. Check valves and closing mechanisms that are not used to define the measured quantity shall have relief valves (if necessary) to dissipate any abnormally high pressure that may arise in the measuring assembly. Yes No N/A

52. Markings

Code Reference: S.5. Marking Requirements

- 52.1. A measuring system shall be conspicuously, legibly, and indelibly marked with:
- 52.1.1. Pattern approval mark (e.g., type approval number); Yes No N/A
 - 52.1.2. Name and address of the manufacturer or his trademark and, required by the weights and measures authority, the manufacturer's identification mark in addition to the trademark; Yes No N/A
 - 52.1.3. Model designation or product name selected by the manufacturer; Yes No N/A
 - 52.1.4. Non-repetitive serial number; Yes No N/A
 - 52.1.5. Accuracy class of the meter as specified by the manufacturer consistent with Table T.2. Accuracy Classes and Tolerances for Hydrogen Gas-Measuring Devices; Yes No N/A

- 52.1.6. Maximum and minimum flow rates in kilograms per unit of time; Yes No N/A
- 52.1.7. Maximum working pressure; Yes No N/A
- 52.1.8. Applicable temperature range if other than - 10 °C to +50 °C; Yes No N/A
- 52.1.9. Minimum measured quantity (MMQ.); Yes No N/A
- 52.1.10. Product limitations (such as fuel quality) if applicable. Yes No N/A

Code Reference: S.5.1. Location of Marking Information; Retail Vehicle Fuel Dispensers

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

- 52.2.1. Within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser, Yes No N/A
- 52.2.2. Either internally and/or externally provided the information is permanent and easily read and accessible, **AND** Yes No N/A
- 52.2.3. On a portion of the device that cannot be readily removed or interchanged (e.g., not on a service access panel.). Yes No N/A

Note: The use of a dispenser key or tool to access internal marking information is permitted for retail hydrogen-measuring devices.

53. Totalizers

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

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

54. Minimum Measured Quantity

Code Reference: S.8. MMQ

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

- 54.1.1. An MMQ not exceeding 0.5 kg for measuring systems with maximum flow rate less than or equal to 4 kg/min, **OR** Yes No N/A
- 54.1.2. An MMQ not exceeding 1.0 kg for measuring systems with maximum flow rate greater than 4 kg/min but not greater than 12 kg/min. Yes No N/A

55. Card-Activated Hydrogen Gas-Measuring Devices

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

There is great concern regarding the potential for accidental or intentional fraud when card-activated systems are used in service stations, especially because bank-card-activated systems give direct access to bank accounts. The following criteria and test procedures apply to card-activated retail vehicle fuel dispensers.

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

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

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

- 55.1. The dispenser must de-authorize in not more than three minutes if the pump "control" is not turned on. Yes No N/A
- 55.2. If the time limit to deactivate a dispenser is programmable, it shall not accept an entry greater than three minutes. Yes No N/A
- 55.3. When a power loss greater than 10 seconds occurs after the pump "control" is on, the dispenser must de-authorize. Yes No N/A
- 55.4. When there is a loss of power, but the dispenser "control" is not on, the dispenser must de-authorize in not more than three minutes. Yes No N/A

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

- 56.1. Authorize the dispenser and, with the pump "control" on, interrupt power to any part (or all) of the system. The pump should de-authorize immediately. Yes No N/A
 - 56.1.1. Authorize with a card and turn the "control" on. Power down briefly, then restore power. Try to dispense product: the dispenser must not dispense because the power failure should have de-authorized the dispenser. Yes No N/A
- 56.2. Authorize the dispenser using a card (leaving control off); wait more than three minutes, and try to start the dispenser. It should not start because the authorization should have timed out. Yes No N/A
 - 56.2.1. Authorize with a card, but do not turn the "control" on. Power down for more than three minutes, and then restore power. Try to dispense product; the dispenser should have "timed-out" and not dispense. Yes No N/A
 - 56.2.2. Authorize and dispense with card #1. Allow the system to time out and de-authorize (if it does). Do not turn off the "control." Authorize and dispense with card #2. The transactions shall be properly recorded for each card. Yes No N/A
 - 56.2.3. Authorize with card #1. Turn the "control" on, then off. Authorize with card #2. Dispense product and complete the delivery. Check the printed receipt to verify that the delivery has been properly charged to card #2 Yes No N/A
 - 56.2.4. Turn the dispenser "control" on, and use a card to authorize the dispenser. Turn the "control" off. After a period of 15 seconds, turn the "control" on. Try to deliver product; the dispenser must not dispense. Yes No N/A
 - 56.2.5. Authorize with card #1 (do not turn the "control" on) and interrupt power for at least 10 seconds. This should de-authorize the dispenser. Resupply power; turn the "control" on; try to dispense. The dispenser shall not deliver product. Yes No N/A
 - 56.2.6. Authorize with card #1 (turn the "control" on) and interrupt power for at least 10 seconds. This should de-authorize the dispenser. Resupply power; turn the "control" on; try to dispense. The dispenser shall not deliver product. Yes No N/A

Note: This test is not required if the device under test complies with paragraph 10.1.

- 56.2.7. Authorize a dispenser with card #1, but do not turn the dispenser "control" on. Try to authorize the same dispenser with card #2; it should not be accepted until after the 3 minute time-out. Yes No N/A
- 56.3. Attempt to override or confuse the card system by varying the length of time the card is in the slot, (e.g., vary the "swipe" times) and pushing all other keys on the keypad Yes No N/A

during each step of the authorization process.

57. Cash Activated Hydrogen Gas-Measuring Devices

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

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

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

All portions of the transaction must be accounted for in order to complete the transaction. This information includes the following: (1) the total amount of money that was inserted into the device prior to the power interruption; (2) the amount of product already dispensed (which should be available from the dispenser and which must comply with the requirements of S.2.3. Provision for Power Loss; (3) and any bill that has been inserted but has not yet been recognized by the cash acceptor.

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

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

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

Code Reference: S.2.3. Provisions for Power Loss

57.1. Systems with Battery Back-up or Uninterruptible Power Supply or Equivalent - Some systems are equipped with a battery back-up or an uninterruptible power supply (or equivalent) which allows a transaction to continue in the event of a power loss. For such systems, the transaction in progress at the time of a power interrupt must continue as if no power interruption had occurred (or comply with the requirements for systems not equipped with a battery back-up.) That is, all bills (including bills being fed into the device at the time of the power loss) must be correctly accounted for, and the quantity and total sale amounts must be mathematically correct. Check these systems by interrupting power at several points in the transaction to ensure that all information (total price, quantity, mathematical agreement, and total dollar amount inserted by the customer) is accounted for correctly.

Yes No N/A

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

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

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

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

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

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

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

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

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

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

It is expected that the retail vehicle fuel dispenser will comply with paragraph S.2.3. Provision for Power Loss; and the information on the product already dispensed can be recalled through this portion of the system.

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

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

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

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

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

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

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

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

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

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

Code Reference: S.2.6. Record Representation, Point of Sale Systems

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

57.5.2. The customer receipt must contain the following information:

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

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

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

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

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

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

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

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

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

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

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

Automatically issue a printed receipt indicating the amount tendered and the amount returned,

OR

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

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

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

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

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

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

Appendix C

Attendee List-October 12, 2011

Meetings of the USNWG Hydrogen Device Standards and Fuel Specifications Subcommittees

Name	Agency	Device Standards Subcommittee (DSS) Member Yes (Y)	Fuel Specifications Subcommittee (FSS) Member Yes (Y)	Attended Yes (Y)
Robert Boyd, Chair FSS	Boyd Hydrogen, LLC	Y	Y	Y
Tina Butcher	NIST OWM LMDP	Y	Y	Y
Marc Buttler	NIST OWM LMDP	Y	Y	Y
Jacquelyn Birdsall	California Fuel Cell Partnership		Y	Y
Paul Cecil	Emerson Process Management– Micro Motion, Inc.	Y	Y	Y
Joseph Cohen	Air Products and Chemicals, Inc.	Y	Y	Y
R. J. Frame	Linde	Y	Y	Y
Michael Keilty	Endress & Hauser Flowtec AG	Y	Y	Y
Jeff Lampmann	NE-Dept. of Ag. Weights and Measures	Y	Y	Y
Kristin Macey Chair DSS	CA – Food and Agriculture, Division of Measurement Standards	Y	Y	Y
Juana Williams	NIST OWM LMDP	Y	Y	Y
John Mough	CA-Food and Ag. Div. of Measurement Standards		Guest	Y
Jim Ohi	Consultant (DOE)		Guest	Y
John Roach	CA-Food and Ag. Div. of Measurement Standards		Guest	Y
Sam Snyder	Linde		Guest	Y