

## Proposed New Hydrogen Fuel Quality Specification for NIST Handbook 130

The U.S. National Work Group (USNWG) for the Development of Commercial Hydrogen Measurement Standards continues to recommend adopting new fuel quality requirements and related definitions for NIST Handbook 130<sup>1</sup> (HB 130) to address gaseous hydrogen refueling applications. The proposed hydrogen fuel quality specification and related definitions will appear in the 2011 National Conference on Weights and Measures (NCWM) Laws and Regulations (L&R) Committee Interim Report (available spring 2011) as Information Item 237-1 and Voting Item 237-2, respectively. The proposed language for the interim fuel specification and related definitions are outlined below.

### **Background**

In July 2010 a corresponding NIST Handbook 44<sup>2</sup> Tentative Hydrogen Gas-Measuring Devices Code and NIST Handbook 130 Method of Sale Regulation for hydrogen were adopted by the NCWM and subsequently published in the 2011 editions of these handbooks.

The proposed hydrogen fuel specification and related definitions address legal metrology requirements, which are a necessary component in the commercial hydrogen infrastructure. The USNWG believes the code has merit and continues to recommend the weights and measures community consider these proposals since 24 states now have hydrogen refueling stations in operation.

The USNWG began work on this project in October 2007. In January 2011 the USNWG's Draft 3.1 of the HB 130 Hydrogen Fuel Specification Code was modified to reflect recent developments by committees responsible for work on each test method.

An in-depth summary of L&R issues is available in the paper titled "The Starting Point: A Discussion Paper Describing a Proposed Method of Sale and Quality Specification for Hydrogen Vehicle Fuel" (August 2009) developed by Ken Butcher and updated by Lisa Warfield, past NIST Technical Advisors to the USNWG Fuel Specifications Subcommittee.

The USNWG recommends citing the appropriate reference for the hydrogen fuel quality standard in NIST HB 130 Section IV. Uniform Regulations Part G. Uniform Engine Fuels, Petroleum Products, and Automotive Lubricants Regulations Section 2. Standard Fuel Specifications. The proposed standard was developed by the California Division of Measurement Standards and most recently modified in January 2011 by the USNWG to reflect the latest work by standard's committees.

At the January 2011 NCWM Interim Meeting held in Dallas, Texas, the L&R Committee accepted updates to Table 1. Hydrogen Fuel Quality Specification from the NIST Technical Advisor to the USNWG. The USNWG submitted updates on the availability of specifications for the allowable level of the constituents listed in Table 1. for hydrogen fuel and corresponding standardized procedures for collecting and measuring the constituents of: Ammonia [1], Carbon Dioxide [2], Carbon Monoxide [3], Formaldehyde [4], Formic Acid [5], Nitrogen and Argon [8], Oxygen [9], Particulate Concentration [10], and Water [16]. The next stage in the development of these standards is to round robin the methods to establish precision and bias.

Standard Test Methods for Sulfur [15] and Hydrocarbons [14] will be made available shortly since these standards are in publishing. ASTM Subcommittee D03.14 on Hydrogen and Fuel Cells has tentative plans for sending the standards for Helium [6] and Halogenates [13] to ballot in March 2011.

The proposal for the interim fuel specification will be published in early spring 2011 in the NCWM L&R Committee Interim Report Agenda Item 237-1, as an information item. The proposed fuel quality specification, including the allowable levels for constituents and their corresponding test methods, is compiled in Table 1. Hydrogen Fuel Quality Specification as follows:

<sup>1</sup>NIST Handbook 130-"Uniform Laws and Regulations in the Areas of Legal Metrology and Engine Fuel Quality"

<sup>2</sup> NIST Handbook 44-"Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices"

Table 1. Hydrogen Fuel Quality Specification*						
Property	Value	Unit	Limit	Test Method(s)	Responsible Standards Committee and Status of test method	
1	Ammonia	0.1	ppm v/v	Maximum	ASTM D7653-10	
2	Carbon Dioxide	2.0	ppm v/v	Maximum	ASTM D7653-10 ASTM D7649-10	
3	Carbon Monoxide	0.2	ppm v/v	Maximum	ASTM D7653-10	
4	Formaldehyde	0.01	ppm v/v	Maximum	ASTM D7653-10	
5	Formic Acid	0.2	ppm v/v	Maximum	ASTM D7550-09 ASTM D7653-10	
6	Helium	300.0	ppm v/v	Maximum	to be specified	ASTM D03.14
7	Hydrogen Fuel Index	99.97	% (a)	Minimum	to be specified	
8	Nitrogen and Argon	100.0	ppm v/v	Maximum	ASTM D7649-10	
9	Oxygen	5.0	ppm v/v	Maximum	ASTM D7649-10	
10	Particulate Concentration	1.0	mg/kg	Maximum	ASTM D7650-10 ASTM D7651-10	
11	Total Allowable Non-Hydrogen, Non-Helium, Non-Particulate constituents	100.0	ppm v/v	Maximum	to be specified	
12	Total Non-Hydrogen Gases	300.0	ppm v/v (b)	Maximum	to be specified	
13	Total Halogenated Compounds	0.05	ppm v/v	Maximum	to be specified	WK 23815 under ASTM D03.14
14	Total Hydrocarbons	2.0	ppm v/v (c)	Maximum	to be specified	WK 22378 under ASTM D03.14
15	Total Sulfur Compounds	0.004	ppm v/v	Maximum	to be specified	WK 24073 under ASTM D03.14
16	Water	5.0	ppm v/v	Maximum	ASTM D7653-10 ASTM D7649-10	
Footnotes to Table 1 –						
a. Hydrogen fuel index is the value obtained with the value of total gases (%) subtracted from 100 %.						
b. Total Gases = Sum of all impurities listed on the table except particulates.						
c. 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 <a href="http://www.ftc.gov/bcp/edu/pubs/business/autos/bus29.shtm">http://www.ftc.gov/bcp/edu/pubs/business/autos/bus29.shtm</a> requires dispensers to bear an declaration of 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 1/20/2010						

The USNWG also recommends adding new definitions to NIST HB 130 Section IV. Uniform Regulations Part G. Uniform Engine Fuels, Petroleum Products, and Automotive Lubricants Regulations Section 1. The proposed new definitions will appear in NCWM L&R Committee Interim Report Agenda Item 237-2, as a voting item, as follows:

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

**1.XX. Hydrogen Fuel.** – A fuel composed of the chemical hydrogen intended for consumption in a surface vehicle 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 into mechanical work to power a vehicle.  
(Added 201X)

More information on the discussion paper and work by the USNWG is available on the NIST WMD web site at <http://www.nist.gov/pml/wmd/lmdg/usnwg.cfm>. To comment on the proposals, contact Marc Buttler, NIST WMD Technical Advisor, by email at [marc.buttler@nist.gov](mailto:marc.buttler@nist.gov), by telephone at: 301.975.4615, by fax at: 301.975.8091 or by postal mail at: NIST WMD, 100 Bureau Drive, MS 2600, Gaithersburg, MD 20899-2600.