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Designation: ~~D7606 – 11~~ D7606 – 17

Standard Practice for Sampling of High Pressure Hydrogen and Related Fuel Cell Feed Gases[1]

This standard is issued under the fixed designation D7606; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard practice describes a ~~hydrogen quality sampling apparatus (HQSA) and a procedure for the sampling~~ sampling procedure of high pressure hydrogen at fueling ~~nozzles of~~ stations operating at 35 or 70 ~~Mega Pascal (MPa) fueling stations.~~megapascals (MPa) using a hydrogen quality sampling apparatus (HQSA).

1.2 This practice does not include the analysis of the acquired sample. Applicable ASTM standards include but are not limited to test methods referenced in Section 2 of this practice.

1.3 This practice is not intended for sampling and measuring particulate matter in high pressure hydrogen. For procedures on sampling and measuring particulate matter see ASTM D7650 and D7651.

1.4 The values stated in SI units are standard. The values stated in inch-pounds are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4150 Terminology Relating to Gaseous Fuels

D7650 Test Method for Sampling of Particulate Matter in High Pressure Hydrogen used as a Gaseous Fuel with an In-Stream Filter

D7651 Test Method for Gravimetric Measurement of Particulate Concentration of Hydrogen Fuel

2.2 *SAE Standards*[3]

SAE J2600 Compressed Hydrogen Surface Vehicle ~~Refueling~~Fueling Connection Devices

~~SAE J2799 70 MPa Compressed Hydrogen Surface Vehicle Fuelling Connection Device and Optional Vehicle to Station Communications~~

SAE ~~TIR~~ J2719 ~~Information Report of the Development of a Hydrogen Quality Guideline~~ Hydrogen Fuel Quality for Fuel Cell Vehicles

SAE J2799 Hydrogen Surface Vehicle to Station Communications Hardware and Software

~~2.3 *California Code of Regulations:*[4]~~

~~California Code of Regulations Title 4, Division 9, Chapter 6, Article 8, Sections 4180 – 4181~~

3. Terminology

3.1 *Definitions:* See D4150 for definitions of terms for use with gaseous fuels.

3.2 ~~*Definitions:*~~*Definitions of Terms Specific to This Standard:*

[1] This practice is under the jurisdiction of ASTM Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.14 on Hydrogen and Fuel Cells.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

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~~3.1.1 *absolute pressure*—Pressure measured with reference to absolute zero pressure, usually expressed in MPa, mm Hg, or pound per square inch (psi).~~

3.2.1 ~~*contaminant*—~~*high pressure hydrogen—*~~impurity that adversely affects the components within fuel cell or hydrogen storage systems~~hydrogen pressurized between 35 and 70 MPa.

~~3.1.3 *gauge pressure*—Pressure measured above ambient atmospheric pressure. Zero gauge pressure is equal to ambient atmospheric (barometric) pressure.~~

~~3.1.4 *gaseous fuel*—Material to be tested, as sampled, without change of composition by drying or otherwise.~~

3.2.2 *hydrogen quality sampling apparatus (HQSA)*—an apparatus used to collect hydrogen from a 35 or 70 MPa hydrogen fueling ~~nozzle~~dispenser (SAE J2600 and SAE J2799) into a sample container.

~~3.2 *Definitions of Terms Specific to This Standard:*~~

~~3.2.1 *high pressure hydrogen*—For the purposes of this practice, high pressure hydrogen is hydrogen defined as hydrogen pressurized to 35 or 70MPa.~~

4. Summary of Practice

4.1 This practice describes an apparatus and procedure for the sampling of high pressure hydrogen from fueling ~~nozzles~~stations conforming to SAE J2600 or SAE J2799. This practice is intended as a guideline for ensuring collection of a representative sample without introducing trace levels of contaminants. Samples collected using this practice should be suitable for trace analysis of contaminants, utilizing a variety of analytical techniques.

5. Significance and Use

5.1 Hydrogen is delivered to fuel cell powered automotive vehicles and stationary appliances at pressures up to 87.5 MPa. The quality of hydrogen delivered is a significant factor in maximizing fuel cell efficiency and life span. Contamination can ~~arise~~occur during the production of fuel cell feed gases, contaminating storage containers, station tubing, and fuel lines ~~up to the nozzle~~ used for fuel delivery. Collection of a representative fuel sample without the introduction of ~~contamination~~contaminants even as low as parts-per-billion (ppb) per contaminant during collection is crucial for assessing the quality of fuel in real world applications.

5.2 This practice is intended for application to high pressure, high purity hydrogen; however, the apparatus design and sampling techniques may be applicable to collection of other fuel cell ~~supply~~feed gases. Many of the techniques used in this practice can be applied to lower pressure/lower purity gas streams.

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6. Apparatus Design

6.1 ~~The~~ A recommended general design of the ~~HQSA is~~ HQSA, shown in Fig. 1, ~~which~~ is a depiction of the apparatus with the nozzle hydrogen pressure regulated to ~~approximate~~approximately 6.9 MPa (1000 psi) before sampling. The ~~pressure of 6.9 MPa (1000 psi) is selected as an example since it is, generally, the~~ lowest pressure tolerated by hydrogen station safety shutoff systems

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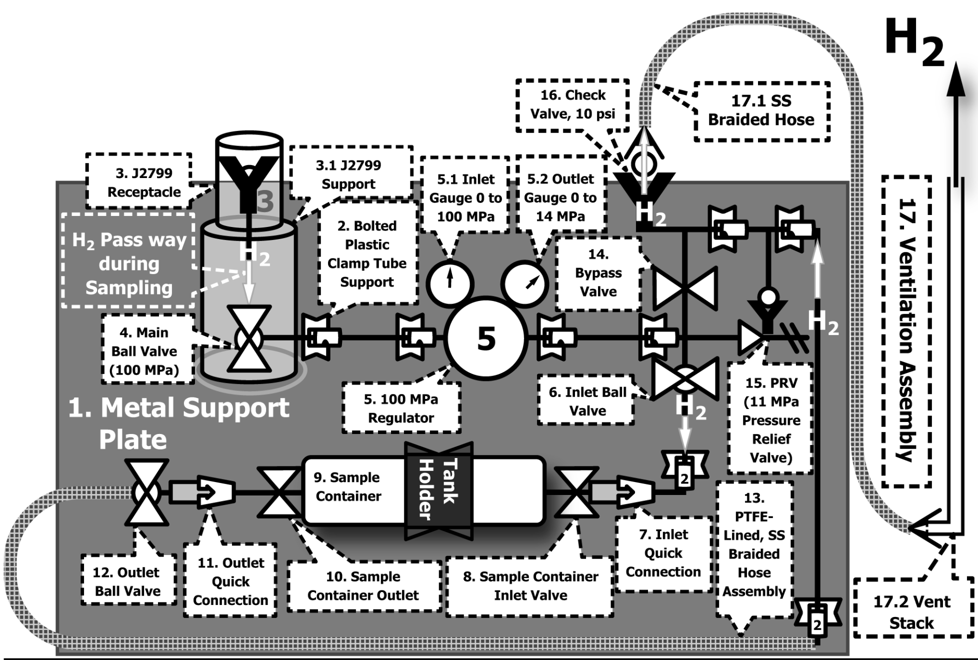

FIG. 1 Hydrogen Quality Sampling Apparatus

while still providing a sample that analytical laboratories can safely handle ~~routinely.~~ routinely is 6.9 MPa (1000 psi). All HQSA parts, including the ventilation ~~tubes, are~~ hoses, should be made of 316 grade stainless steel (SS).

6.2 *HQSA Metal Support Plate ~~(1,~~ (1, Fig. 1)*—The HQSA metal support plate is utilized to mitigate damage during transportation and support the apparatus. The HQSA is firmly fixed to a metal support plate by tube supports (2, Fig. 1.).

~~6.3 *Movable Adjustable Platform*—Before sampling, the metal plate holding the HQSA is firmly clamped onto a height adjustable and movable platform, such as a heavy duty cart with a hydraulic adjustable horizontal platform and brakes on its wheels. The cart is moved to a position close to the fueling station and the height of platform is adjusted so that the fueling nozzle attaches easily to the receptacle of HQSA. The platform height is adjusted to provide a safe and comfortable work space. The cart is then locked into place using the cart wheel brakes.~~

6.3 *SAE J2799 Receptacle (3, Fig. 1)*—~~SAE J2799 Receptacle (3, Fig. 1) –~~This receptacle can adapt to both 35 and ~~70MPa hydrogen fueling~~ 70 MPa nozzles. For safety ~~reason,~~reasons, the receptacle ~~must~~should be positioned vertically so that the ~~fueling~~ nozzle attaches to the receptacle from the top. To support the weight of the ~~fueling nozzle, the receptacle must have an~~ nozzle, additional support (3.1, Fig. 1), ~~which~~ is fixed to the metal support plate is recommended (1, Fig. 1).

6.4 *Main Valve (4, Fig. 1)*—The functions of the main valve are explained as follows:

6.4.1 *Station and HQSA ~~leak test~~—Leak Test*—The station leak test is performed before ~~hydrogen fuel~~ sampling to ensure there are no leaks in the ~~hydrogen fuel~~ delivery system. ~~For sampling the station personnel must attach the fueling~~ While the main valve is closed, attach the nozzle to the SAE J2799 receptacle (3, Fig. 1~~) first while the main valve is closed. The station leak test procedure is then initiated. A hand held hydrogen leak detector is used to check~~). Check for leaks around all of the connections from the nozzle to the main valve as in 10.7~~. There is residual high pressure hydrogen left in the station hose when the station is not fueling. The residual high pressure hydrogen can be used for checking the leakage in the complete HQSA system, including the sample container, as shown~~ and the complete HQSA system as in 10.8~~.~~ using a hand held hydrogen leak detector.

6.4.2 *Prevention of High Pressure Hydrogen Passing through the Regulator*—If the main valve (4, Fig. 1) is not installed and the station fueling starts, the diaphragm of the regulator (5, Fig. 1) may fail due to rapid hydrogen pressurization. In this case, pressure relief valve ~~(PRV)~~(PRV, 15, ~~(~~Fig. 1) will open to release hydrogen pressure above 10.3 MPa (1500 psi). The main valve (4, Fig. 1) when closed, is designed to contain high pressure hydrogen when ~~the station~~ sampling starts. The main valve is slowly turned to the open position and the ~~high pressure~~ hydrogen is regulated to 6.9 MPa (1000 psi).

6.5 *Regulator ~~5 (~~(5, Fig. 1) and all connections from the* SAE J2799 *Receptacle to Regulator*—~~The regulator and all the connections, including tubing, tubing~~All the connections (including tubing, tube fittings, adapter fittings and ~~unions~~unions) from the ~~SAE J2799 receptacle to the main valve and main valve to~~ receptacle to regulator must have a pressure rating of 103 ~~Mpa~~MPa (15,000 psi) or higher. The regulator should have two ~~gauges, 5.1 and 5.2 in~~ gauges (5.1 and 5.2, Fig. 1~~,~~) to monitor both inlet and outlet pressures.

6.6 *Inlet and Outlet Valves (6 and 12, Fig. 1, respectively)*—The valves should be easily opened and closed, such as ball valves. The HQSA and sample container are cleaned by ~~pressurizing and, releasing hydrogen from~~allowing hydrogen to pass through the HQSA and sample container ~~(~~(10.9)~~10.11)~~ using these valves. ~~This cleaning procedure can be repeated many times (10.11) but must be performed at least 10 times to ensure a valid sample under most sampling conditions.~~

6.7 *Sample ~~Containers~~—Containers (9, Fig. 1)*—The pressure rating of the sample containers must exceed the set point on the PRV (15, Fig. 1). The maximum pressure rating for sample containers before bursting is 12.4 MPa (1800 psi). The sample containers and both inlet and outlet valves (8 and 10, Fig. 1, respectively) are internally coated with silicon (Si) since sulfur gas analysis ~~to~~ in the low ppb range is required under SAE ~~TIR J2719 and other hydrogen fuel quality specifications.~~ J2719. To avoid air contamination during sampling, both inlet and outlet valves of the sample containers ~~are~~ can be equipped with quick ~~connects – one end of the container has a quick-connect stem and the other end a quick-connect body.~~ connects. These two quick-connections (7 and 11, Fig. 1) and the inlet and outlet valves provide a double seal on both ends of the sample container.

6.8 *~~HQSA Pressure Release~~ Bypass Valve (14, Fig. 1)*—The ball valve is ~~always~~ closed before and during sampling. After sample collection, the ~~pressure release~~ bypass valve is opened, before ~~removal of the pressurized and sealed sample container~~ the sample container is removed, to release the hydrogen pressure in the HQSA through ~~a~~the check valve (16, Fig. 1). ~~Hydrogen at 6.9 MPa (1000 psi) contained inside the HQSA must be released before next sample container can be safely connected to the inlet quick-connection (7, Fig. 1).~~

6.9 *~~Proportional~~Pressure Release Valve (PRV, 15, Fig. 1)*—The PRV is set at ~~10.3MPa~~ 10.3 MPa (1500 psi) to protect the ~~12.4 MPa (1800 psi) pressure proof~~ sample container.

6.10 *Check ~~Valve~~—Valve (6, Fig. 1)*—The check valve ~~(16,~~must ~~Fig. 1) with 69 Kilo Pascal (KPa) (10 psi) crack pressure~~ be able to withstand a cracking pressure of 69 kilopascal (kPa; 10 psi) and is installed at the vent of the HQSA (Fig. 1) to prevent ~~air from~~ back diffusion of air into the HQSA.

6.11 *Ventilation Assembly (17, Fig. 1)*—~~The ventilation assembly contains a 3 meter (m) (10 ft)~~ Hydrogen must be vented at a safe distance from personnel and equipment. A design that has been successfully implemented uses at least a 3 meter (m; 10 foot (ft) long SS braided ~~tubing interfaced~~hose connected to a ~~dual~~ vertical, retractable 2.4 m (8 ft) ~~long~~by 1.27 ~~cm (~~centimeter (cm;

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