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Gaseous hydrogen — Fuelling stations

Part 9: Sampling for fuel quality analysis

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Foreword

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Gaseous hydrogen — Fuelling stations —

Part 9:
Sampling for fuel quality analysis

WARNING — The use of sampling apparatuses, such as those described in the annexes to this document, is associated with the safety risks associated with high pressure flammable gases. This document explains the general concepts of how gaseous and particulate samples may be taken. Sampling should be performed only by highly trained technicians experienced with the hazards of high-pressure hydrogen.

1 Scope

This document outlines requirements for sampling from hydrogen fuelling stations for samples taken at the dispenser. The document defines the best practice for sampling at the nozzle of a hydrogen fuelling station as part of the fuelling station acceptance testing, and ongoing operation.

Further, the document describes the minimum safety requirements for sampling.

This document is targeted for the sampling from the hydrogen fuelling station dispenser. Many of the generic requirements within this document are applicable to sampling at other locations within the hydrogen fuelling station, which can be carried out for hydrogen quality assurance, see ISO 19880-8, however, further specific requirements that can be necessary for safe sampling are not addressed in this document.

The intention of sampling hydrogen is to enable analysis against the requirements of ISO 14687, and by analytical methods validated by protocols described in ISO 21087.

This document supersedes, and is an extension to, the guidance published in ISO 19880-1:2020, Annex K.

NOTE Analytical methods are divided into on-line analyses and off-line analyses. On-line analysis allows for real time analysis at hydrogen stations and is not covered in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14687, *Hydrogen fuel quality — Product specification*

ISO 21087, *Gas analysis — Analytical methods for hydrogen fuel — Proton exchange membrane (PEM) fuel cell applications for road vehicles*

ISO 17268, *Gaseous hydrogen land vehicle refuelling connection devices*

ISO 19880-1, *Gaseous hydrogen — Fuelling stations — Part 1: General requirements*

ISO 19880-8, *Gaseous hydrogen — Fuelling stations — Part 8: Hydrogen quality control*

SAE J2600, *Compressed Hydrogen Surface Vehicle Fuelling Connection Devices*

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
bleed
<venting> intentional expiration of a fluid from a fluid system

3.2
building
structure, usually enclosed by walls and a roof, constructed to provide support or shelter for intended occupancy

3.3
canopy
roof, overhead shelter, or hood which affords a degree of weather protection

3.4
compressed hydrogen storage system
CHSS
hydrogen storage on-board vehicle

3.5
component pressure rating
maximum pressure at which it is permissible to operate a component as specified by the manufacturer at a specified temperature

Note 1 to entry: See ISO 19880-1 for further details.

3.6
connector
matching parts (such as male and female parts) that can be put together to form a "connection" which permits the transfer of fluids, electric power, or control signals

Note 1 to entry: *Fitting* (3.12) are a type of connector used in piping systems.

Note 2 to entry: Examples of connectors commonly used in hydrogen systems are as follows:

a) The fuelling *nozzle* (3.28) “connector” mates with the *receptacle* (3.36) “connector” on the vehicle to form the connection for transfer of compressed hydrogen between the *dispenser* (3.7) and the vehicle, as defined in ISO 17268 for this specific application;

b) The hose assemblies have connectors on each end that allow coupling to the hoses and connection to the piping system, e.g. hose *breakaway device* or fuelling nozzle;

c) *Control systems* often use electrical connectors to allow rapid and secure assembly or replacement.

3.7
dispenser
equipment in the *dispensing system* (3.9), including the *dispenser cabinet(s)* (3.8) and support structure, that is physically located in the fuelling area

Note 1 to entry: The hydrogen dispenser typically includes, as a minimum, the *fuelling assembly* (3.14), required temperature and pressure instrumentation, filters, and the user interface to conduct vehicle fuelling.

Note 2 to entry: The manufacturer of the hydrogen dispenser can elect to include additional equipment in the dispenser, including the possibility of all equipment in the dispensing system.

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3.8
dispenser cabinet
protective *housing* (3.21) that encloses process piping and can also enclose measurement, control and ancillary *dispenser* (3.7) equipment

3.9
dispensing system
system downstream of the hydrogen supply system comprising all equipment necessary to carry out the vehicle fuelling operation, through which the compressed hydrogen is supplied to the vehicle

3.10
enclosure
structure, protective *housing* (3.21), container, machine cabinet, etc. which encloses or partially encloses equipment of a station that can have access for maintenance but is not intended to be occupied

Note 1 to entry: The use of an enclosure can be to protect equipment from the environment, provide noise attenuation, or provide *safety* (3.40) to the areas surrounding the equipment.

Note 2 to entry: A *canopy* (3.3) without walls is not regarded as an enclosure in this context.

3.11
explosive gas atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapour, which, after ignition, permits self-sustaining flame propagation

Note 1 to entry: Although a mixture which has a concentration above the upper flammable limit (UFL) is not an explosive gas atmosphere, it can readily become so and, generally for area classification purposes, it is advisable to consider it as an explosive gas atmosphere.

[SOURCE: IEC 60079-10-1:2015, 3.2]

3.12
fitting
part or design feature on a component used to join (i.e. connect) any pressure retaining components in the system

3.13
forecourt
surfaced area where vehicle dispensing operations are conducted including the *fuelling pad* (3.15) and any area underneath a *canopy* (3.3)

3.14
fuelling assembly
assembly consisting of a hose breakaway device, a hose(s), a *nozzle* (3.28) and connections between these components that is part of the *dispenser* (3.7) providing the interface between the *hydrogen fuelling station* (3.16) and the vehicle

Note 1 to entry: The fuelling assembly can include, or not, a nozzle vent line (with hose breakaway device and hose) depending on the type of nozzle, and communications, if used.

3.15
fuelling pad
area with special construction requirements adjacent to the hydrogen *dispensers* (3.7), where customers park their vehicles during fuelling

3.16
hydrogen fuelling station
HRS
fuelling station
hydrogen refuelling station
hydrogen filling station
facility for the dispensing of compressed hydrogen vehicle fuel, including the supply of hydrogen, and hydrogen compression, storage, and *dispensing systems* (3.9)

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3.17
harm
physical injury or damage to the health of people, or damage to property or the environment

[SOURCE: ISO/IEC Guide 51:2014, 3.1, modified — The word "physical" has been added.]

3.18
hazard
potential source of *harm* (3.17)

[SOURCE: ISO/IEC Guide 51: 2014, 3.2]

3.19
hazardous area
classified area
<explosive gas atmospheres> area in which an *explosive gas atmosphere* (3.11) is present or can be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment

Note 1 to entry: The interior of many items of process equipment are commonly considered as a hazardous area even though a flammable atmosphere may not normally be present to account for the possibility of air entering the equipment. Where specific controls such as inerting are used the interior of process equipment may not need to be classified as a hazardous area.

[SOURCE: IEC 60079-10-1:2015, 3.3.1, modified — The alternative preferred term "classified area" has been added.]

3.20
hose assembly
assembly which includes the hose and end connections, including any necessary *fittings* (3.12), bend restrictors, and appropriate markings.

3.21
housing
guard or *enclosure* (3.10) for operating parts, control mechanisms, or other components, that need not be accessible during normal operation.

3.22
hydrogen service level
HSL
pressure level in MPa used to characterize the hydrogen service of the *dispensing system* (3.9) based on the *NWP* (3.27) of the vehicle.

Note 1 to entry: The numerical value of HSL also matches the number after the “H” in the *pressure class* (3.32) (see Table 1).

Note 2 to entry: See ISO 19880-1: 2020, Annex E for application of pressure terminology to hydrogen dispensing systems and vehicles.

3.23
incident
any unplanned event that resulted in injury or ill health of people, or damage or loss to property, plant, materials or the environment or a loss of business opportunity

Note 1 to entry: The use of the term incident is intended to include the term accident.

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3.24
maximum allowable working pressure
MAWP
maximum pressure permissible in a system at the temperature specified for the pressure

Note 1 to entry: The maximum allowable working pressure can also be defined as the design pressure, the maximum allowable operating pressure, the maximum permissible working pressure, or the maximum allowable pressure for the rating of pressure vessels and equipment manufactured in accordance with national pressure vessel codes.

Note 2 to entry: See Annex E for discussion of pressure terminology and its application to *dispensing systems* (3.9) and *fuelling stations* (3.16) in general.

3.25
maximum fuelling pressure
MFP
maximum pressure expected during a normal (fault-free) vehicle fuelling

Note 1 to entry: Per the UN GTR No. 13, the maximum fuelling pressure is 125 % *NWP* (3.27).

Note 2 to entry: Also referred to as Maximum Fill Pressure.

Note 3 to entry: See Annex E for discussion of pressure terminology and its application to *dispensing systems* (3.9) and *fuelling stations* (3.16) in general.

3.26
maximum operating pressure
MOP
highest pressure that is expected for a component or system during normal operation including anticipated transients

Note 1 to entry: In the case of the *dispensing system* (3.9), the MOP is equivalent to the *maximum fuelling pressure* (3.26) of the vehicle.

Note 2 to entry: See Annex E for discussion of pressure terminology and its application to dispensing systems and *fuelling stations* (3.16) in general.

3.27
nominal working pressure
NWP
pressure of a vehicle *CHSS* (3.4) at 100 % *state of charge (SOC)* at a gas temperature of 15 ºC

Note 1 to entry: See UN GTR No. 13 clause II-3.37, on page 54.

Note 2 to entry: For road vehicles, this is typically 35 MPa or 70 MPa.

Note 3 to entry: See Annex E for discussion of pressure terminology and the correspondence between vehicle terminology and *dispensing systems* (3.9).

Note 4 to entry: Also known as “settled pressure” in ISO 10286.

3.28
nozzle
device connected to a fuel *dispensing system* (3.9), which permits the quick connect and disconnect of fuel supply to the vehicle storage system

[SOURCE: ISO 17268:2012, 3.8]

3.29
particle
small piece of matter or oil

3.30
particulate
one or more solid or liquid particles suspended in hydrogen

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3.31
pre-cooling
process of cooling hydrogen fuel temperature prior to dispensing

3.32
pressure class
non-dimensional rating of components designed to dispense hydrogen to road vehicles at the required pressure and temperature

Note 1 to entry: The numbers following 'H' in the pressure class are numerically the same as *HSL* (3.22), but the HSL identifies only the level of the dispensing service whereas the pressure class designation shows the component are fully capable of meeting the pressure and temperature requirements for dispensing hydrogen at the indicated service level.

Note 2 to entry: See Annex E for discussion of pressure terminology and its application to *dispensing systems* (3.9) and *fuelling stations* (3.16) in general.

Note 3 to entry: Additional examples of pressure class come from ISO 15649; e.g. "600", "3000" or "6000".

3.33
pressure relief device
PRD
safety (3.40) device that releases gases or liquids above a specified pressure value in cases of emergency or abnormal conditions

Note 1 to entry: PRDs can be activated by pressure or another parameter, such as temperature, and can be either re-closing devices (such as valves) or non-re-closing devices (such as rupture disks and fusible plugs). Common designations for these specific types of PRDs are as follows:

— pressure safety valve (PSV) — pressure activated valve that opens at specified set point to protect a system from rupture and re-closes when the pressure falls below the set point. Requirements for PSVs used in *dispensing systems* (3.9) can be found in 19880-1:2020. PSVs protecting the dispensing system can reclose above the *MOP* (3.26);

— thermally-activated pressure relief device (TPRD) — a PRD that opens at a specified temperature to protect a system from rupture and remains open.

Note 2 to entry: See Annex E for discussion of pressure terminology and its application to pressure protection of the dispensing system and *fuelling stations* (3.16) in general.

3.34
probability
expression of the chance (likelihood) that a considered event will take place to property, system, business or to the environment

3.35
qualified personnel
personnel with knowledge or abilities, gained through training and/or experience as measured against established requirements, standards or tests, that enable the individual to perform a required function

[SOURCE: ISO 10417:2004, 3.13, modified — The word "characteristics" has been replaced with "knowledge".]

3.36
receptacle
device connected to a vehicle storage system which receives the *nozzle* (3.28)

Note 1 to entry: This can also be referred to as a fuelling inlet or gas filling port in other documents.

[SOURCE: ISO 17268:2020, 3.11]

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3.37
risk
combination of the *probability* (3.34) of occurrence of *harm* (3.17) and the severity of that harm; encompassing both the uncertainty about and severity of the harm

[SOURCE: ISO/IEC Guide 51:2014, 3.9, modified — The part "encompassing both the uncertainty about and severity of the harm" has been added.]

3.38
risk assessment
determination of quantitative or qualitative value of risk related to a specific situation and a recognised threat (also called *hazard* (3.18))

Note 1 to entry: Based on national requirements, a review of a risk analysis or a *safety* (3.40) concept by third party is sometimes required.

3.39
risk level
assessed magnitude of the risk

3.40
safety
freedom from unacceptable risk

[SOURCE: ISO/IEC Guide 51:2014, 3.14]

3.41
safety distance
separation distance
safe distance
setback distance
distance to acceptable *risk level* (3.39) or minimum risk-informed distance between a *hazard* (3.18) source and a target (human, equipment or environment), which will mitigate the effect of a likely foreseeable *incident* (3.23) and prevent a minor incident escalating into a larger incident

Note 1 to entry: Safety distances can be split into restriction distances, clearance distances, installation layout distances, protection distances and external risk zone.

3.42
safety perimeter
area around the location of the sampling activity where people not involved in the sampling activity are prevented from entering, the extent of which is based on the appropriate *safety distance* (3.41)

4 Abbreviated terms

APRR	average pressure ramp rate
ERP	emergency response plan
FCEV	fuel cell electric vehicle
H35	indication for 35 MPa NWP hydrogen fuelling as defined in ISO 17268
H70	indication for 70 MPa NWP hydrogen fuelling as defined in ISO 17268
HAZOP	hazard and operability study
HPSA	hydrogen particle sampling apparatus
HQSA	hydrogen quality sampling apparatus

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HSG	health and safety guidance
HSTA	hydrogen station test apparatus
IrDA	Infrared Data Association
LFL	lower flammability limit
P&ID	piping and instrumentation diagram
PPE	personal protective equipment
PSV	pressure safety valve
QRA	quantitative risk assessment
SAE	SAE International formerly known as Society of automotive engineers
TPRD	temperature-activated pressure relief device

5 Sampling hydrogen at fuelling stations for hydrogen fuel quality analysis

5.1 General

Analytical methods are divided into on-line analyses and off-line analyses. On-line analysis allows for real time analysis at hydrogen stations and is not covered in this document. For off-line analysis of samples, the analytical methods used shall be validated by protocols described in ISO 21087.

Sampling is used to perform an accurate and comprehensive analysis of impurities, which is done externally, typically at a laboratory.

Sampling of hydrogen involves collecting a sample of the fuel from the dispenser in a gas container or in the case of particulate matter on a filter. Sampling can be performed at maximum operating pressure, but very often require pressure reduction for sample collection into gas containers.

The sample should be:

— representative of a normal fuelling sequence;

— collected at a pressure that ensures the sample is representative of dispensed hydrogen;

— collected at a flow that ensures the sample is representative of dispensed hydrogen.

Gas phase impurities in the dispensed hydrogen may be captured with a sampling apparatus and taken off site in a dedicated sample vessel for laboratory analysis. A representative sample from multiple fuelling station hydrogen storage banks should be taken to confirm that all storage banks have been cleaned and purged properly.

5.2 Sampling hydrogen at the dispenser for off-line hydrogen fuel quality

To enable off-line analysis of hydrogen as dispensed from hydrogen fuelling stations, samples of hydrogen are typically taken from the hydrogen dispenser fuelling nozzle. Figure 1 shows the general concept of sampling for off-line analysis.

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