



**International  
Standard**

**ISO 19880-9**

**Gaseous hydrogen — Fuelling  
stations —**

**Part 9:  
Sampling for fuel quality analysis**

**First edition  
2024-07**

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Published in Switzerland

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 197, *Hydrogen technologies*.

A list of all parts in the ISO 19880 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

# 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*

### 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:

- 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;
- 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;
- 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.

**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)

**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.

### 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 °C

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

### 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]

**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

HSG	health and safety guidance
HSTA	hydrogen station test apparatus
IrDA	Infrared Data Association
LFL	lower flammability limit
P&ID	pipng 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.

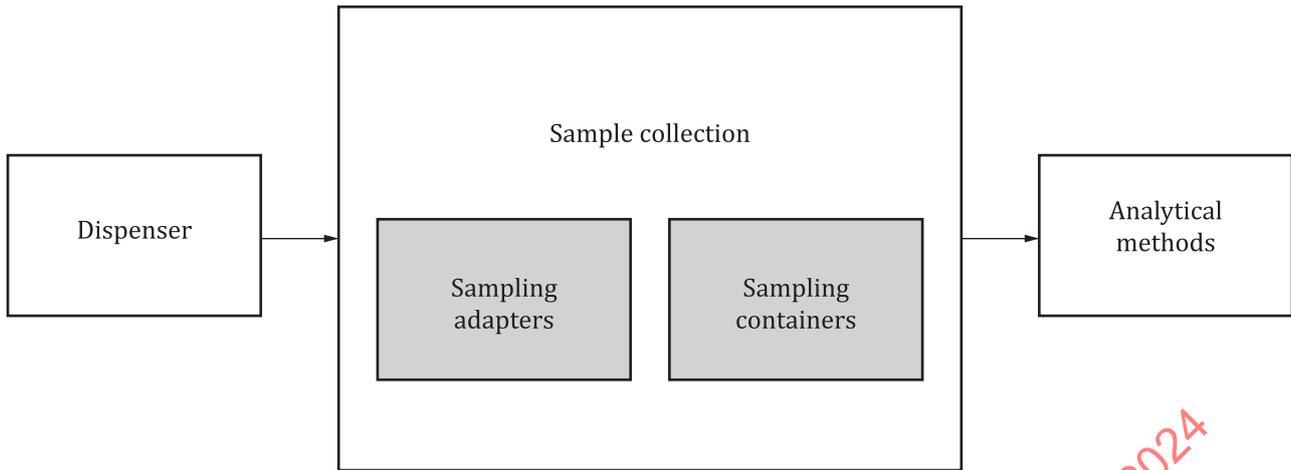


Figure 1 — Schematic of hydrogen sampling to analytical methods

The annexes to this document describe examples of different methodologies that can be followed in order to collect samples from the dispenser nozzle. There are three different methodologies for hydrogen gas sampling and two methods for particulate sample collection described in these annexes.

NOTE Samples can be taken for analysis from other points of the station for hydrogen quality assurance, see ISO 19880-8, however the requirements for this are not included in this document.

The characteristics of the different example methodologies are listed in [Table 1](#).

NOTE Depending upon equipment availability and local regulations, certain methods can be desirable over others, i.e. the option of HRS manual dispensing (safety override) and availability of fuel cell electric vehicles (FCEVs).

Table 1 — Characteristics of different example sampling strategies

Method	Sample Type	Sampling time	HRS fuelling override	Sink	Sample container volume (example)	Reference sample pressure	Annex containing further details
Method A	Gas	~3 min	No <sup>a</sup>	FCEV or test CHSS	≤10 L	<16 MPa	A
Method B	Gas	<1 minute per container	Yes	Vent system	≤2 L	<7 MPa	B
Method C	Gas	<20 min	Yes	Vent system	≤47 L	<12 MPa	C
Method D	Particulate	< 10 min	Yes	Vent system	Not applicable	Average pressure ramp rate (APRR) according to SAE J 2601 <sup>b</sup>	D
Method E	Particulate	~3 min	No <sup>a</sup>	FCEV or test CHSS	Not applicable	APRR according to SAE J 2601 <sup>b</sup>	E

<sup>a</sup> Sampling while fuelling into a CHSS (instead of venting).

<sup>b</sup> Representative fuel passing the filter should be of a minimum 2,5 kg hydrogen.

It is important that the sample for gas and particulates is collected safely and that the sample is representative of the dispensed hydrogen.

The hydrogen quality sampling apparatus (HQSA) described in this document can be subject to conventional hydrogen fuelling parameters such as the 87,5 MPa (1,25 × nominal working pressure (NWP)) test pulse for H70 fuelling when methods not applying HRS fuelling override (e.g. Methods A, E).

Station side bank shifting can impact representative sample collection. Sampling strategies presented in the annexes of this document do not ensure that sample is collected from all banks.

The hydrogen particulate sampling methods described in this document can be used to check the technical cleanliness (particulates) according to ISO 14687 of the fuel in 70 MPa hydrogen fuelling stations at fuel delivery flow rates up to 60 grams per second.

HQSA and hydrogen particle sampling apparatus (HPSA) devices may relay IrDA communications (such as described in SAE J2799).

## 6 Safety for sampling hydrogen gas at the dispenser nozzle

### 6.1 General

Gas sample collection and particulate collection sampling system design, setup, and sampling procedure should be based on a risk assessment. Collection shall be suitable for hydrogen service as defined in [Clause 7](#), under the process conditions defined in [7.1.2](#), unless other safety precautions have been taken. Piping systems and other equipment comprising the hydrogen sampling apparatus shall comply with the requirements in [7.2](#).

Hydrogen sampling at the dispenser requires gas flow, vent or sink. This document assumes that one or more of the following will be available:

- a) a dedicated fixed vent port and line at the hydrogen station (this is preferred) for hydrogen venting/purging during sampling (see [8.4](#));
- b) a temporary vent stack located in an area away from adjacent hazards. Ensure adequate separation from ignition sources, and people/objects that would be affected by both unignited and ignited hydrogen releases;
- c) a vehicle CHSS: FCEV (see [8.3](#)), hydrogen station test apparatus (HSTA), or test tank system.

The general guidance from this document should be observed. In addition, specific guidance based on the hydrogen sampling methodology is found in the annexes to this document.

In order to conduct gas sampling, the safety regulations relevant to the dispenser and fuelling station where sampling is to be conducted should be taken into consideration.

Where sampling equipment uses the dispenser vent line for purging or relief venting, this shall be in accordance with guidelines given in [Clause 8](#).

Personal safety equipment, e.g. safety glasses, fire resistant clothing, gloves and hearing protection, should be worn at all times when sampling of hydrogen is conducted.

NOTE Further guidance on vent system design can be found in EIGA Doc 211/17 and CGA G-5.5.

### 6.2 Safety training

Safety precautions should be taken when sampling hydrogen gas and particulates at a hydrogen fuelling station.

Sampling operators shall be trained in the operations of the sampling apparatus and the necessary procedures at HRS for dispensing the sample gas, including the station emergency response plan. For sampling of hydrogen, it is important to understand that the hydrogen provided by the station is at a very high pressure.

### 6.3 Operational safety during sample collection

A safety perimeter should be established preventing public access to the HRS sampling device and the vent system assembly. The safety perimeter should be established from HRS or sampling apparatus documentation safety requirements or per risk assessment.

Smoking or use of ignition sources should be prevented within this perimeter.

High-pressure hydrogen releases have the potential to ignite. Discharges can originate from the high velocity flow over surfaces. Arcing can also originate from mechanical operations, therefore, non-sparking tools (e.g. brass spanners) should be used.

All hose assemblies should be attached to a suitable anchor point using an anti-whip during sampling to prevent the hose from whipping should the connection become uncoupled.

Electrical grounding of the sampling device to the dispenser's earth ground should be ensured.

Pressure release from bleed valves should be performed with caution as fast pressure release can ignite the hydrogen released.

To counteract the temperature increase by hydrogen fuelling, hydrogen is often pre-cooled down to  $-40\text{ }^{\circ}\text{C}$  in order to achieve fast fuelling rates. Issues such as "freeze on" of the fuelling nozzle to the HQSA or HPSA while sampling hydrogen can occur.

Low temperatures can also affect the functionality of connections (quick connects and nozzle adapters). Appropriate protective gloves should be worn by operators of the sampling instrumentation.

Leak detection should be performed prior to sampling with a portable hydrogen detector to assist in confirming proper connection integrity. Leak detection using soap bubbles, or any liquid shall not be used in order to avoid contamination of the sample.

### 6.4 Safe operation limits

During sample collection the device operator should take care to not allow the sample container to exceed operational limits.

a) exceeding the maximum fuelling pressure:

Monitor the pressure and the ramp rate of the sample container during sampling. If pressure falls or rises outside operational limits, then terminate the sampling;

b) exceeding the fuelling gas temperature:

Check the temperature of the sample container while sampling, and suspend the fuelling immediately if it is outside operational limits.

### 6.5 Warning signs

Warning signs shall be placed to warn public/people not involved in the sampling about hazards identified, for example including (but not limited to) the following types of hazards:

- flammable, pressurized hydrogen;
- hazardous areas, where flammable, potentially explosive gas atmospheres may be present;
- no smoking, open flames, or other ignition sources;
- authorized access only.

Warning signs should be of sufficient durability to withstand the physical environment involved, including the effects of weather.

## 7 Hydrogen sampling apparatus – hardware

### 7.1 Sampling apparatus – design requirements

#### 7.1.1 General

The sampling equipment may have different requirements. The sampling system should consider the requirement for sampling container (flow and pressure requirements), the type of material used, the HRS requirements (flow, pressure and filling protocol), and the process (pressure pulse, venting).

It is important to differentiate the section, flow, and pressure requirements to ensure the system is safe and fit for service. There is a section of the sampling system that will be in contact with HRS nozzle (need to comply with HRS requirements) and a section of the sampling system that may be in contact with reduced flow and pressure (after pressure regulator and pressure relief valve).

The cycle life for the components of the sampling assembly should be defined and stated so that planned maintenance activities can pre-empt a failure.

High pressure hydrogen dispensing system components should be marked with the pressure class only if components are designed and verified to meet or exceed the pressure, temperature, material compatibility, and service life requirements.

High pressure components shall be mounted in strict compliance with the supplier's instructions, following a well-defined assembly procedure. The sampling system should be clearly labelled with all information as stated in [6.5](#).

Sampling systems shall be protected against over pressurization. This may use over pressure protection incorporated into the dispensing system where appropriate, see [7.1.2](#), or necessitate further overpressure protection within the sampling system where components are not rated to the dispensing system maximum allowable working pressure (MAWP), see [7.1.3](#).

Vent valves and over pressure protection shall be capable of being connected to either the dedicated fixed vent line, or temporary vent stack described in [6.1](#).

In addition to the pressure rating, the HQSA or HPSA should meet the following requirements:

- an ambient temperature range of  $-40\text{ °C}$  to  $+50\text{ °C}$ , unless local conditions permit or require other temperature limits, for the gas container. It is important to consider temperature and pressure change in the definition of the pressure regulation. This is to ensure that the gas container pressure will not be over-pressurised during transport of the gas container;
- material compatibility of materials normally in contact with hydrogen;
- a specified cycle life before maintenance or replacement.
- components rated for the maximum hydrogen flow delivered; it is important to ensure that the maximum flow can be achieved by the components according to the fuelling protocol. If components are used that are below the flow ratings of the HRS fuelling protocol, then the maximum flow of the dispensing system shall be lowered accordingly to the component with the lowest flow rating.

The fuelling receptacle shall comply with ISO 17268 and/or SAE J2600. Where included in the sampling apparatus, the fuelling nozzle shall comply with ISO 17268 and/or SAE J2600.

**NOTE** Fuelling protocols include pauses in the fuelling, which need to be considered in the design/operation of the sampling apparatus. A pause is typically included at the start of fuelling in order to perform a leak test. In certain protocols, further pauses for leak checks are also defined part way through the fuelling.

### 7.1.2 Maximum allowable working pressure for parts of a sampling system directly connected to the dispenser nozzle

Where no pressure regulation is incorporated into the sampling system, or upstream of any pressure regulation, all components shall be rated to the maximum allowable working pressure of the dispensing system.

The MAWP of dispensing systems may vary from station to station. For example, a dispensing system compliant with ISO 19880-1 will be protected against over-pressurization according to the dispensing system MAWP as defined in [Table 2](#), relative to the dispenser hydrogen service level (HSL), the pressure class (as defined in ISO 17268). See ISO 19880-1 for explanation of dispensing system pressure levels.

**Table 2 — Dispensing system pressure levels and recommended component minimum pressure ratings**

Hydrogen service level (HSL)	Pressure class	Maximum operating pressure (MOP)	Dispensing system MAWP Minimum component pressure rating for dispensing system components
<i>Equal to NWP of vehicle being fuelled</i>		$1,25 \times HSL$ <i>Highest pressure during normal fuelling</i>	$1,375 \times HSL$ <i>Highest permissible setpoint for dispensing system pressure protection</i>
25 MPa	H25	31,25 MPa	34,375 MPa
35 MPa	H35	43,75 MPa	48,125 MPa
50 MPa	H50	62,5 MPa	68,75 MPa
70 MPa	H70	87,5 MPa	96,25 MPa

These are maximum values of MOP and MAWP, and recommended minimum component pressure ratings based on achieving the MOP needed to fuel the CHSS of the hydrogen vehicle over the full range of operating conditions.

In addition to the pressure rating, the hydrogen sampling apparatus should meet the following requirements:

- an ambient temperature range of -40 °C to +50 °C, unless local conditions permit or require other temperature limits.

### 7.1.3 Maximum allowable working pressure for parts of a sampling system downstream of pressure regulation

Gas sampling may require using a sample container or other component that is rated lower than the dispensing system MAWP. The sampling components rated lower than the MAWP should be positioned after pressure regulation and be protected by an additional pressure relief device(s) (PRD) set appropriately for the MAWP for this part of the sampling system. Pressure regulating devices should not be self-venting without capture to vent.

PRD's shall be compliant with ISO 4126-1 or ISO 4126-2 as appropriate.

The pressure relief valve and any other purging system should be compliant in term of pressure and flow with the venting assembly (i.e. flow and pressure specification of the HRS vent if accessible or mobile vent stack). The sampling assembly should not create over-pressurization to the dispensing system. Any pressure safety valve (PSV) or venting components should be connected to a safe vent to avoid any significant hydrogen vented on HRS forecourt.

## 7.2 Gas sample containers to be used with HQSA

Hydrogen gas sample containers should have the appropriate certification, marking, and suitable packaging for transportation with hydrogen. The use of the containers should be within the operating temperature and pressure range given by the manufacturer.

In order to obtain a representative sample, containers with wall treatment, such as passivation, to minimize adsorption of gas impurities onto container wall should be used.

NOTE Further information to assist in the selection of appropriate containers to be used for specific impurities can found in Reference [\[1\]](#).

Stainless steel valves should be used in the sample collection system, avoid brass.

The containers should be cleaned to an appropriate level by purging with high purity hydrogen and/or by evacuation of their content; typically to 0,000 1 MPa.

The maximum filling pressure and the filling capacity, as appropriate, of the sampling container shall be indicated on the container following local laws and regulations. The sample container shall be within their validity period and require periodic testing and inspection as defined in ISO 18119 or otherwise following local laws and regulations.<sup>[2]</sup>

In many cases (depending on the method), the sample container pressure rating may be lower than the dispenser MAWP, and in this case, pressure reduction must be carried out within the sampling system.

A sample container suitable for hydrogen fuel sampling should be employed with a specific means to prevent contamination at the time of sampling. Recommendations for preparation of sampling containers are given in ISO 21087.

### 7.3 Sampling apparatus technical documentation

The information provided with the hydrogen sampling equipment shall include a technical file of critical documentation that shall be made available to the operator.

The technical file shall include the following minimum documentation:

- a) installation, operation, and maintenance manual(s), including instructions for periodicity of maintenance (e.g. cleaning between samples);
- b) technical specifications;
- c) assembly and layout drawings;
- d) component and spare parts lists and certification, where applicable;
- e) schematics and technical diagrams;
- f) HAZOP or underlying risk assessment;
- g) test report or certification;
- h) declarations of conformity/manufacturer's declarations, where applicable.

The information shall be in an appropriate language(s) for the anticipated installation, operation, and maintenance personnel.

The information provided may vary with the complexity of the equipment. For very simple equipment, the relevant information may be contained in one document, provided that the document shows all the devices of the equipment and, if applicable, enables the connections to any necessary utilities to be made.

### 7.4 Marking of sampling apparatus

Where applicable, equipment should bear a data plate or combination of adjacent labels located so as to be easily read when the equipment is in a normally installed position.

The data plate/label(s) should include the following information, as applicable:

- a) manufacturer's name, trademark, and location;
- b) the model number or type;
- c) serial number;
- d) date of construction;

- e) component or assembly process ratings:
  - 1) pressure rating, in MPa;
  - 2) temperature range, in °C.
- f) utility connections, where applicable:
  - 1) electrical:
    - electrical input range, in volts;
    - current rating, in amperes;
    - frequency in hertz and number of phases;
    - rated nominal power input (watts or VA).
- g) environmental ratings:
  - 1) IP rating;
  - 2) ambient temperature range;
  - 3) if applicable, the area classification rating.

## 8 Hydrogen sampling apparatus –operational requirements

### 8.1 General

Operational instructions for the sampling strategies described in this document are detailed in [Annexes A to E](#). This chapter describes additional requirements for sampling. Operational safety for sampling is covered in [Clause 6](#).

### 8.2 Inspection and maintenance of the sampling system

The sampling system shall have a documented inspection and maintenance program in place.

The functionality of the assembled sampling device should be verified before every use of the sampling system.

The maintenance schedule should include safe maintenance intervals based on sampling experience and inspection requirements. In addition to the maintenance requirements for the individual components, replacement frequencies, such as indicated expiry dates on components like the high-pressure hoses, shall be accounted for. Maintenance of each piece of equipment should follow the manufacturer's instructions.

Repair or direct replacement of sampling system components should require verification and validation. Modifications and repairs should be carried out under appropriate change management and control systems.

NOTE See ISO 9001, ISO 14001, OSHAS 18001 and OSHAS 18002 for guidance on management of change systems.

The sampling maintenance record should be available for inspection as necessary.

Components shall be shipped and stored in a manner according to the manufacturer's instructions prior to installation. Where applicable, the manufacturer's shelf-lives shall be adhered to.

### 8.3 Sampling equipment requiring the use of an FCEV

Sampling with an FCEV can cause damage to the vehicle and shall only be done when the following requirements are met:

- a) At a station that is fully operational and meets the requirements of 19880-8, and 19880-1, including the fuelling protocol;

- b) With approval from the vehicle owner; The vehicle owner should confirm the potential risk, impact and warranty implications on the FCEV with the vehicle manufacturer;
- c) Using Method A or E (or in combination as described in [Annex F](#));
- d) Sampling from a previously contaminated station or a station where there are doubts that the hydrogen is not meeting the hydrogen quality requirements in ISO 14687 and ISO 19880-8 shall not be performed with a FCEV, until compliance with ISO 14687 has been re-established.

#### 8.4 Sampling with venting to atmosphere

Sampling with venting to atmosphere should consider using the HRS vent. When a temporary vent stack is used, the vent must be vented at a safe distance from personnel, hazardous materials and conditions, ignition sources, buildings, and equipment. The vent stack must be constrained to withstand thrust forces from release and made of appropriate materials. The vent stack outlet should be located at least 3 meters from the sampling point and at least 2,5 meters from the ground. The vent stack should not be placed under any overhead obstructions or nearby objects that may trap gas, for example, a canopy. Depending on the ambient conditions, the venting hydrogen may flow in directions other than directly vertical to the ground. Ensure that venting is performed in accordance with a risk assessment and applicable national, regional, and local laws and regulations. It is recommended to set a dispersing vent stack downwind of the dispenser and sampling location.

#### 8.5 Reporting

The information necessary for understanding the sampling realised shall be supplied in the appropriate forms, for example, sampling report.

The information shall be in an appropriate language(s) for the analytical laboratory, final users.

The information provided may vary with the sampling strategy, complexity of the equipment, type of installation sampled.

For sampling, the relevant information may be contained in one document, provided that the document shows all the information and parameters of the sampling exercise.

The information provided with the hydrogen fuelling station sample shall include a sampling report that shall be made available to the end user and if necessary, to the analytical laboratory.

The sampling report shall include the following minimum documentation:

- a) location of the hydrogen fuelling station(s), date of the sampling and information about the HRS (i.e. type of nozzle, status of the station (normal operation, maintenance));
- b) the sampling strategy (e.g. method A-E);
- c) the sampling hardware used (e.g. which system model);
- d) information about sampling process including purging or FCEV used and amount of gas sampled; the status of the HRS during the sampling, any information around the sampling (i.e.: FCEV used, pressure bank sampled if HRS in manual operation);
- e) gas sample container (type, unique identifier, preparation);
- f) sampling operator;
- g) sampling conditions (e.g. pre-cooling temperature, pressure, fuelling protocol where applicable).

An example sampling report is provided in [Annex G](#).

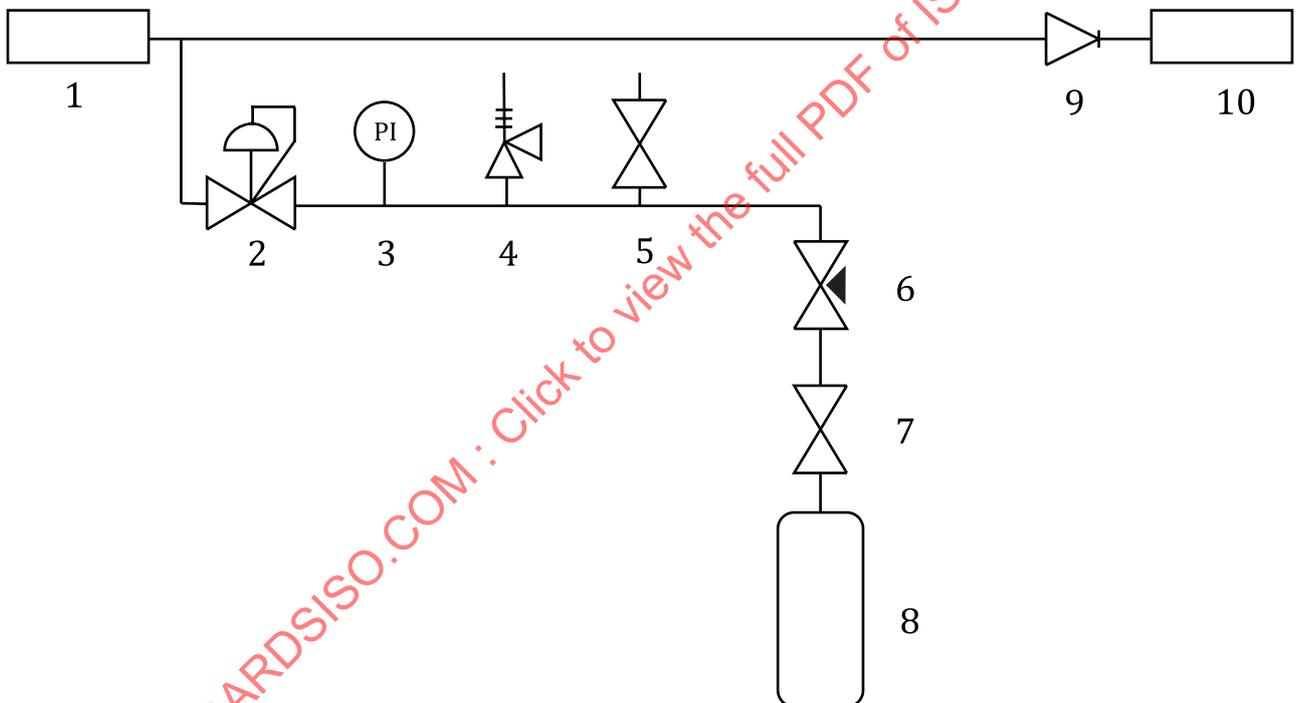
**Annex A**  
(informative)

**Hydrogen gas sampling — Method A**

**A.1 General**

Figure A.1 shows an example schematic for a method for hydrogen gas sampling, where the sample can be taken using a “T fitting” to fuel a CHSS (FCEV or representative hydrogen storage system) while fuelling a sample vessel at the same time. The needle valve is used to throttle the sampling as to collect a representative sample from the fuelling process.

A suitable step-down pressure regulator is used when the sample container has a lower pressure rating than the MAWP of the dispensing system, with a PSV set at or below the sample vessel/system pressure rating, to protect the vessel/system as appropriate, and the vent from the PSV directed to a safe location. There should also be a suitable orifice to control the fuelling rate to a safe flow rate.



**Key**

- 1 receptacle
- 2 pressure reduction valve
- 3 pressure indicator
- 4 pressure relief valve
- 5 purge valve
- 6 needle valve
- 7 stop valve

- 8 sample container
- 9 check valve
- 10 nozzle / CHSS connector

Figure A.1 — Example schematic of method for hydrogen gas sampling

## A.2 Hydrogen gaseous sampling — Description of commercially available sampling systems

### A.2.1 General

This section describes commercially available, either currently or in the past, sampling systems as an example to illustrate methodologies used. It is not an endorsement of the systems in question and it is expected that other sampling systems will become available in the future, that would have similar capabilities to those described below.

### A.2.2 H2 Qualitizer™

The H2 Qualitizer™<sup>1)</sup> sampling system is a sampling method which uses a special receptacle/nozzle adapter (Figure A.2) with a pressure reduction valve (Figure A.3). The sampling apparatus functions as a “T” inserted between the HRS nozzle and the FCEV. The receptacle – nozzle – T device can be seen in Figure A.2.



**Key**

- 1 receptacle
- 2 sample stream coupling

Figure A.2 — Sampling T-device

Both parts are rated for 103,4 MPa and a maximum operating pressure of 87,5 MPa and a temperature range of -40 °C to 85 °C. A sealed safety valve is installed, to prevent exposure of the sample container to higher pressures. The maximum outlet pressure of this sampling system is 16,0 MPa.

1) H2 Qualitizer™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

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The reduction valve is connected to a sample container, typically a 10 L aluminium canister with a DIN 477- No. 1 fitting. The apparatus is connected to the reduction valve through a high-pressure hose with quick connectors. Electrical grounding is provided for both quick connectors. The apparatus is typically not equipped with IR communication interface (such as SAE J2799). This implies that fuelling will be in some cases limited to 60 MPa due to safety reasons due to no temperature and pressure feedback from the vehicle compressed hydrogen storage system.

Without IR communications the vehicle will not be able to abort the fuelling process if the vehicle CHSS is exceeding 85 °C. Care should be taken when using this device in hot weather to make certain that the CHSS is not overheated during the sample collection process. Fuelling of the sample container is limited by a throttle valve in order to avoid overly fast fuelling of the container. The throttle valve is set to fuel a 10 L container in approximately 3 min. As the reduction valve low-pressure gauge is upstream of the throttle, the dynamic pressure is displayed. Only at the end of sampling does this gauge display the actual sample container pressure.



### Key

- 1 pressure safety valve
- 2 pressure relief valve
- 3 inlet pressure gauge
- 4 reserve connections
- 5 outlet pressure gauge
- 6 inlet coupling with check valve
- 7 bottle hand connection

**Figure A.3 — Example of a “qualitizer system” with a pressure reduction valve, with quick connect and safety relief valve**

### A.2.3 Hy-SaM<sup>2)</sup>

The system is divided into three modules. Module 1 contains all parts for simultaneously sampling up to three containers (2,25 or 10 L) parallel to fuelling a CHSS, see [Figure A.4](#).



#### Key

- 1 pressure regulator
- 2 micrometre valve (flow adjustment)
- 3 valves (flushing, depressurization and connection to sample containers)
- 4 HRS connection interfaces (sampling inlet, sample containers, vent line)
- 5 sample containers

Figure A.4 — Hy-SaM module 1

The complete sampling line of module 1 including quick connectors for the cylinders is coated against adsorption of trace impurities. The sampling system is designed to accommodate 10 L containers with DIN 477 N.1 valve outlet or 2,25 l double-ended stainless-steel containers with internal coating. For connection to the sampling device, both container types have quick connectors. All valves and connectors are coated with Silconert® 2000<sup>3)</sup>. The containers are usually filled to a sample pressure about 9 MPa. The device is designed to sample into containers prefilled with UHP hydrogen. Using evacuated containers is also possible.

Module 2 is the mobile vent, see [Figure A.5](#).

2) Hy-SaM is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3) Silconert® 2000 is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.



Figure A.5 — Hy-SaM module 2 (mobile vent)

Module 3 contains a buffer tank including the necessary safety components, see [Figure A.6](#).



Figure A.6 — Hy-SaM module 3 - simulated tank

By using module 3, sampling can be performed without fuelling a FCEV. Optionally, the vent lines (including safety relief valves) from modules 1 and 3 can be connected to module 2 or the HRS vent line. Also optional is the simultaneous sampling for particles.

### A.3 Operational hydrogen gas sampling procedure – method A

The following procedure describes the common approach of this sampling methodology. Prior to execution, the sampling apparatus operating manual should be carefully read and followed. Method A usually employs a sample stream in parallel to a non-comm fuelling. Depending on the device, more than one container may be filled at the same time.

a) Installation of HQSA

The sampling containers should be securely fastened. The sampling device should be set up according to the manufacturer's manual. In all cases, this involves electrical grounding, secure connection of the apparatus to the container(s), followed by connection of vent lines to a mobile or HRS vent stack.

b) Connection of sampling apparatus to receptacle (either FCEV or HSTA) and HRS nozzle

The sampling apparatus is then connected to the receptacle of the CHSS. The HRS nozzle is then connected to the sampling apparatus receptacle.

c) Purging of setup

After visual inspection of the assembled setup, a fuelling is initiated. After initial pressure is built up the sequence is aborted on the HRS side. The hydrogen located within the high-pressure side of the setup is used for leak detection and purge procedures according to the operation manual or checklist. Purging may contain backflushing via UHP hydrogen from the sampling vessels if supported.

d) Sampling

The sampling containers should be prepared for sampling. If prefilled with UHP hydrogen, the stop valves of the container(s) can be opened at this stage. A second fuelling is initiated after leak detection and purging of the system. Once the HRS initiates dispensing, the bleeding or pressure reduction valve to the sampling segment is opened slowly, in order to prevent triggering the HRS safety protocols. In case of evacuated container(s), the stop valves are opened slowly after the low-pressure segment is pressurized with sample gas from the HRS.

e) End of sampling

When fuelling is completed, the sample container stop valve is closed. The setup is depressurized by slowly opening the purge valve.

f) Sampling setup disconnect and disassembly

The sampling apparatus is disconnected from the HRS. In case of a simulated FCEV's CHSS, hydrogen is vented via a connected vent stack and according to manufacturer's manual. Disassembly of the apparatus is performed in reverse of assembly. The sample containers are then secured and stored for transport.

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## Annex B (informative)

### Hydrogen gas sampling — Method B

#### B.1 General

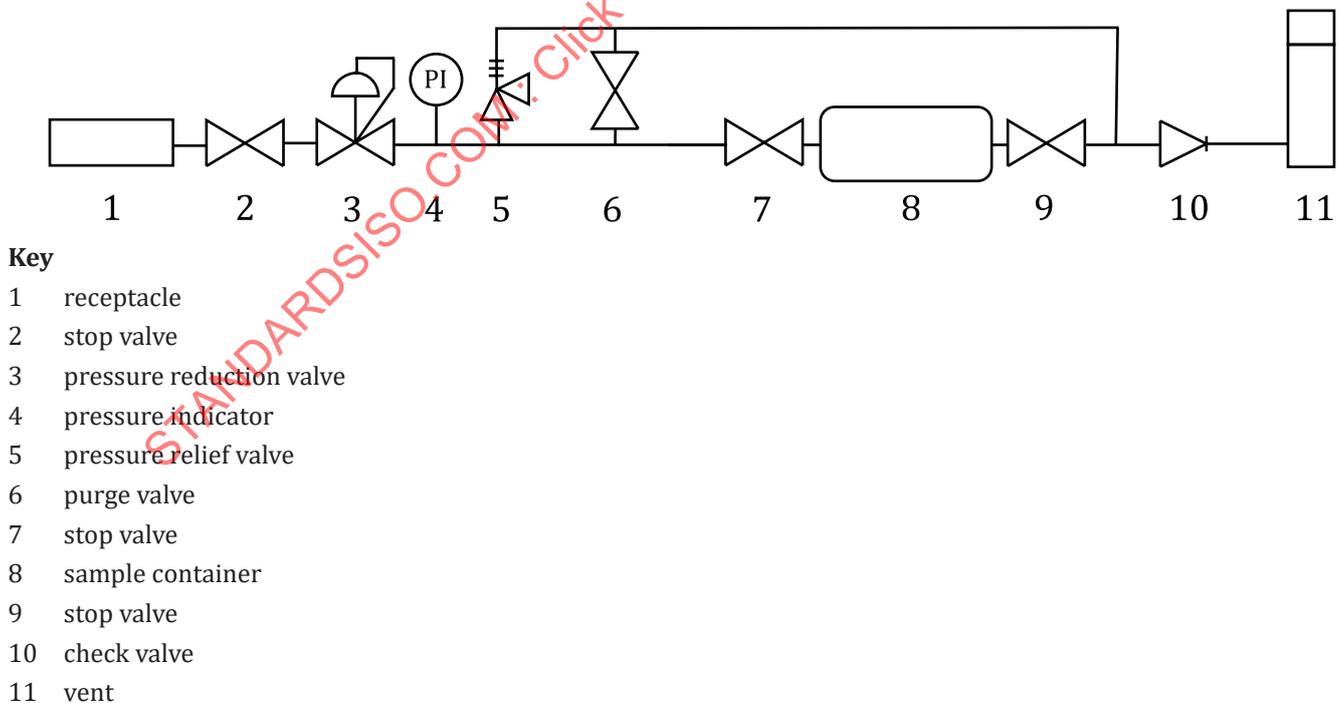
The sampling of gas is conducted by application of a sampling device that vents hydrogen to the atmosphere rather than using a FCEV as a sink. The sampling is conducted after purging the sampling device with approximately 1 kg of hydrogen fuel through a venting assembly.

When there is no dedicated vent connection at the HRS, an example of a vent system assembly can consist of a stainless-steel braided hose assembly connected to two 12 mm tubes, or one 18 mm tube arranged vertically. The height of the tubes should extend at least 2,5 m.

The hydrogen series sampling device consists of a receptacle designed in accordance with ISO 17268:2020 and capable of handling pressures up to 87,5 MPa for connecting to the HRS nozzle. A stop valve with a working pressure of least 87,5 MPa is placed after the receptacle and before the pressure regulator. The pressure regulator is equipped with pressure gauges indicating upstream and downstream pressures. A pressure relief valve is installed before the sample container.

Downstream of the sample container, a vent system assembly should be connected to the HRS vent line. A check valve set to 0,05 MPa should be attached to the end of the vent hose when connected to the HRS vent line.

[Figure B.1](#) shows an example schematic. A suitable step-down pressure regulator should be considered where sample vessel has a lower pressure rating than the MAWP of the dispensing system, with a PSV set at or below the sample vessel/system pressure rating, to protect the vessel/system as appropriate. The vent from the PSV should be directed to a safe location.



**Figure B.1 — Example sampling device schematic.**

## B.2 Health and safety considerations

General and operational safety considerations are given in [6.1](#) through [6.3](#).

## B.3 Operational hydrogen gas sampling procedure

The following list describes the operation procedure for conducting sampling of gas using a serial HQSA.

Prior to execution, the sampling apparatus operating manual should be carefully read.

### a) Installation of HQSA

The sampling apparatus should be assembled in accordance with operating manual.

Sample container and vent system assembly should be connected to the sampling device. The device should then be electrically grounded.

### b) Connection of hydrogen fuelling station nozzle to the sampling apparatus H70 receptacle

After pressurization, leak testing is conducted. The stop valve is opened, and the pressure is regulated to 3,5 MPa. Leak tests, now including the downstream assembly, are repeated.

The reduction valve is opened and regulated to the sampling pressure 7 MPa.

Leak tests, now including the downstream assembly, are repeated.

### c) Purging and sampling

The HQSA is purged up to the sample container inlet hose through the vent system assembly.

At the start of sampling, the sample container outlet valve is closed to leak check the container. The outlet valve is then opened, and hydrogen fuel is purged through the sample container to the vent assembly. Typically, 1 kg hydrogen is purged.

### d) End of sampling

When fuelling is completed, the sample container outlet valve is closed followed by the inlet valve. The fuelling sequence is stopped.

The HQSA is then depressurized by closing the stop valve and slowly opening the vent valve before the HRS nozzle is disconnected from the HSQA receptacle.

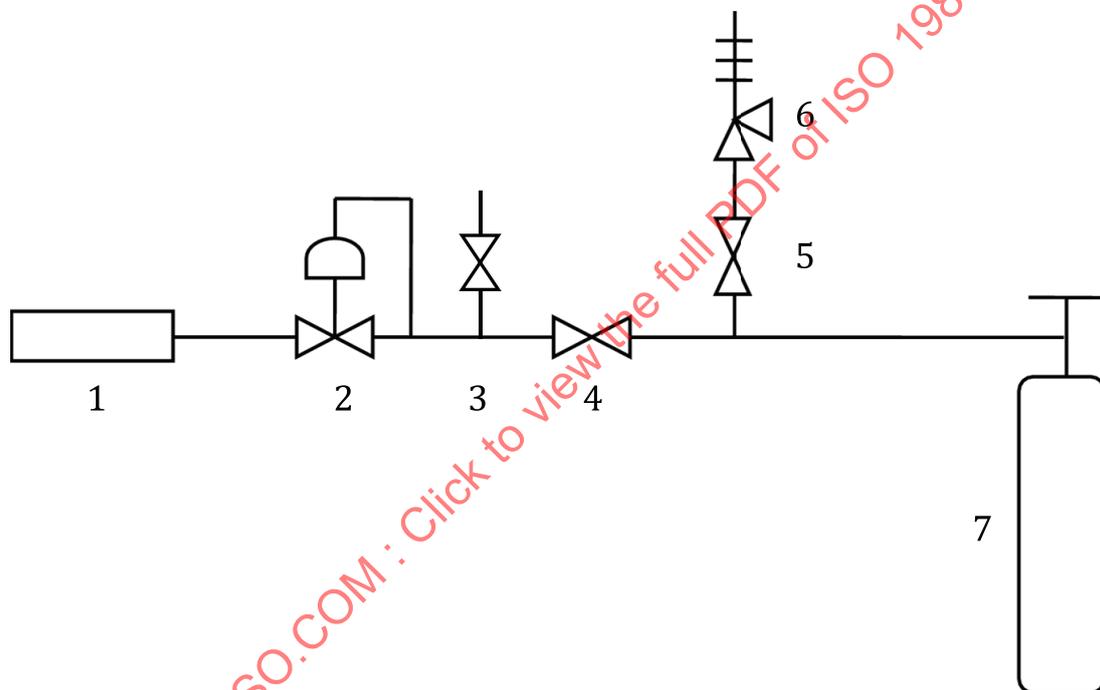
## Annex C (informative)

### Hydrogen gas sampling – Method C

#### C.1 General

The general sample container system for hydrogen quality analysis consists of a receptacle, decompression measures (e.g. pressure regulator), safety measures (e.g. safety valve) and a sampling container etc. (See [Figures C.1](#) and [C.2](#)).

A pressure sensor should be positioned and operating in close proximity to the gas container for safety reasons.

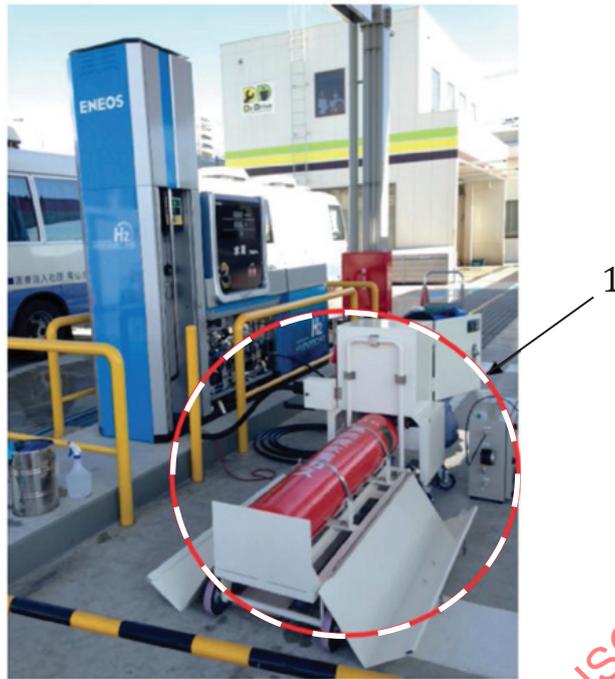


#### Key

- 1 receptacle
- 2 pressure regulator
- 3 purge valve
- 4 stop valve
- 5 stop valve
- 6 pressure relief valve
- 7 sampling container with stop valve

**Figure C.1 — Sampling system for hydrogen quality**

A suitable step-down pressure regulator should be considered when sample containers have a lower pressure rating than the MAWP of the dispensing system. This should have a PSV set at or below the sample vessel/system pressure rating, to protect the vessel/system as appropriate, and the vent from the PSV directed to a safe location.



**Key**

- 1 hydrogen sampling equipment

**Figure C.2 — Sampling of hydrogen fuel from a fuelling station in Japan with hydrogen sampling equipment**

**C.2 Operational hydrogen gas sampling procedure**

Sampling is not a part of normal operation for station operators and therefore needs to be performed with full attention to safety.

a) Checking the procedure

The sampling manual should be reviewed in advance. It is especially important to prevent any abnormal pressure rises, and temperature decreases at the time of sampling.

In addition to checking the set value of hydrogen flow rate and the suspension of pre-cooling, emergency procedures should be reviewed in advance.

b) Connecting a sample container system

Sampling operators connect a sample container to the sample container system, and then connect the release line of the station to the sample container system. Station operators connect the dispenser nozzle to the sample container system.

c) Leak check of the sample container system

Use a hand-held hydrogen leak detector to check the sample container system for leakage.

d) Purge of the sample container

Purge the sample container with the hydrogen to be sampled.

e) Fuelling the sample container

Close the valve to a certain degree before starting sampling in order to limit the flow rate into the container. Start sampling slowly while monitoring the pressure.

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Ensure that there are no leaks by using a hand-held hydrogen leak detector or foamy solution and that the temperature is within a range by monitoring the container temperature.

End sampling as soon as the pressure reaches the level that indicates there is enough sample hydrogen in the container.

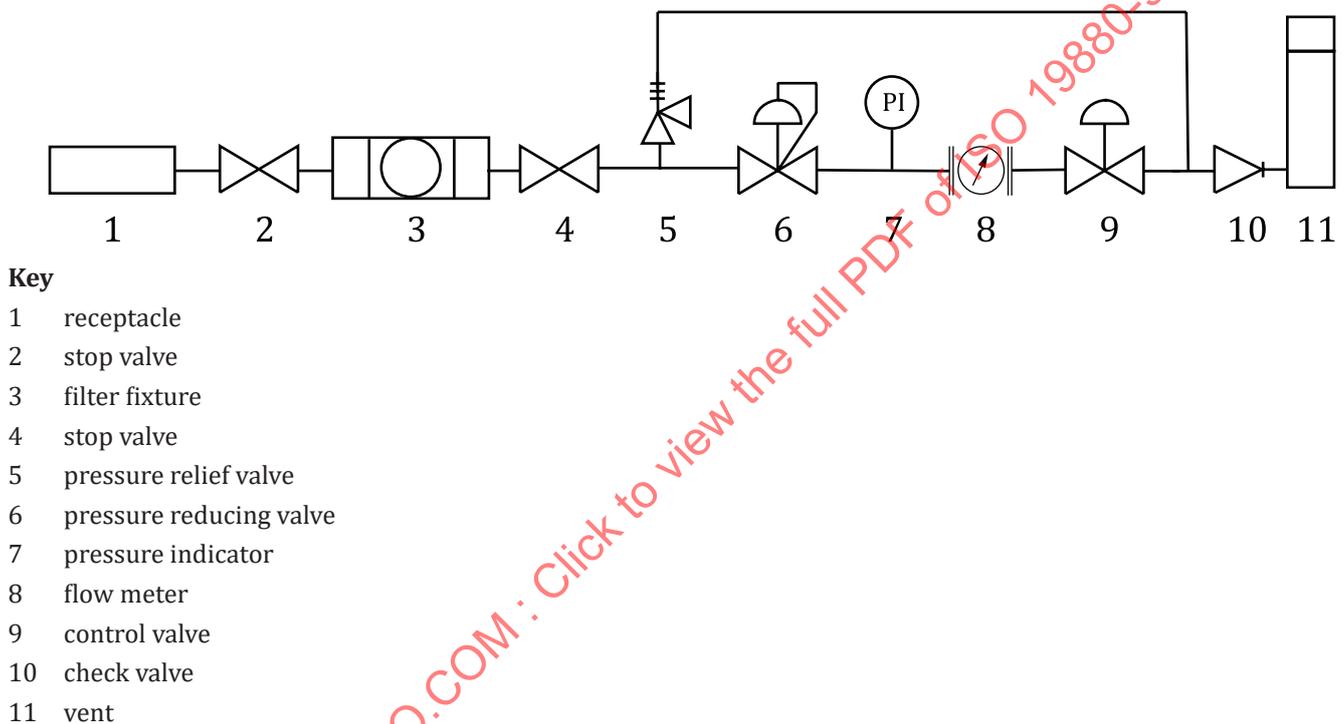
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## Annex D (informative)

### Hydrogen particulate sampling – Method D

#### D.1 General

Figure D.1 shows a schematic for the H70 hydrogen particulate sampling when venting to atmosphere. A back pressure is introduced to avoid unobstructed venting of hydrogen to atmosphere. The mass of hydrogen dispensed should be displayed by the dispenser. A flow meter may be introduced to record the mass of hydrogen passed over the filter.



**Figure D.1 — Schematic of method for hydrogen particulate sampling with venting to atmosphere**

The sampling strategy makes it possible to take samples at representative hydrogen flow rates and pressures. It has been documented that flow rate has an impact on the particle size and concentration collected on the particulate filter. The test report should also include the peak sampling flow rate or fuelling conditions (CHSS size, APRR).

#### D.2 Particulate sampling instrumentation description

The sampling instrument is designed to collect particulate matter larger than 0,2  $\mu\text{m}$  from the hydrogen flow out of the nozzle of a fuelling station.

The apparatus design consists of the following features:

- a) Receptacle for connection to dispenser nozzle;
- b) Filter, filter element support and filter fixture;

- c) Pressure relief valve to protect against over-pressurization;
- d) Downstream purge or bleed valve;
- e) Pressure indicator to monitor pressure of the instrument;
- f) Check valve;
- g) Connection to vent.

Since direct venting of high, e.g. 70 MPa pressure to atmosphere is not viable, an applied back pressure, e.g. 20 MPa, is applied during sampling. The mass of hydrogen passed over the filter may be monitored with an integral flow meter. This methodology requires the fuelling station to be used manually overridden when operated with a back pressure in order to provide a constant flow of hydrogen.

To allow for safe venting of hydrogen, vent and pressure relief valves should be connected to the HRS safety vent.

The filter fixture should be designed for the H70 MAWP of 87,5 MPa. The fixture is normally comprised of two halves assembled gas-tight by means of two or several O-rings. The filter element should be installed on a filter support in order to avoid filter rupture from the 87,5 MPa pressure pulse at the beginning the fuelling protocol.

Flow and pressure regulation upstream of the filter fixture should be avoided as this can potentially trap particulates. The inlet and outlets of the filter fixture should be capped when not in use to avoid contamination during transport and storage. After sampling, care should be taken to keep the filter in an upright position.

### D.3 Particulate sampling health and safety considerations

Refer to [Clause 6](#) for general safety considerations when connecting to the HRS dispenser nozzle to collect samples.

Personal protective equipment, i.e. safety glasses, gloves and hearing protection, should be worn at all times when sampling hydrogen.

Electrical grounding of the HPSA to the dispenser's earth ground should be ensured.

To counteract low temperature of hydrogen fuel, gloves should be worn by operators of the HPSA.

Leak detection should be performed prior to sampling with a portable hydrogen detector.

### D.4 Particulate sampling — Operational procedure

Particle sampling is not a part of normal operation for station operators and therefore needs to be performed with full attention to safety.

- a) Checking the procedure

The sampling manual should be reviewed in advance.

- b) Connecting the HPSA to the hydrogen fuelling station

Sampling operators remove the apparatus at the HRS from a suitable clean device (e.g. anti-static bag) and install the HPSA in accordance with manufacturer's instructions. After all accessories and safety devices are installed, the sampling operator will connect the HPSA to the fuelling station.

Anti-whip should be used to secure any hoses and ensure they don't become a whip during sampling. The apparatus should be grounded to the dispenser's earth ground.

- c) Leak test/ purge of the particulate sampling apparatus

Use a hand-held hydrogen leak detector to check all connections for leakage.

d) Start sampling procedure

The current procedure requires the HRS to be operated in a manual override mode:

- 1) Dispenser startup and fuelling protocol should include all pulsations such as connection pulse and leak checks;
- 2) Activate the dispenser;
- 3) Adjust the gas flow to ensure that the pressure after the filter is 20 MPa throughout the dispensing;
- 4) Stop fuelling when at least 2,5 kg of samples has been collected;
- 5) Record the mass of hydrogen dispensed from the HRS dispenser or from flow meter if present.

## D.5 Particle sampling apparatus assembly and maintenance

The assembly of the particulate sampling apparatus should preferably be conducted in a clean environment in order to avoid contamination of the filter element. A weighed filter is installed on the screen support and the fixtures assembled in accordance with the manufacturer's instructions.

Before each sample is taken, it should be ensured that all the necessary preparations of the sampling equipment are carried out by appropriately qualified personnel.

For quality assurance and safety, it is important to follow specific assembly sequences according to the operation manual.

Service and maintenance intervals of the device and auxiliary equipment should be observed according to the manufacturer instructions for use.

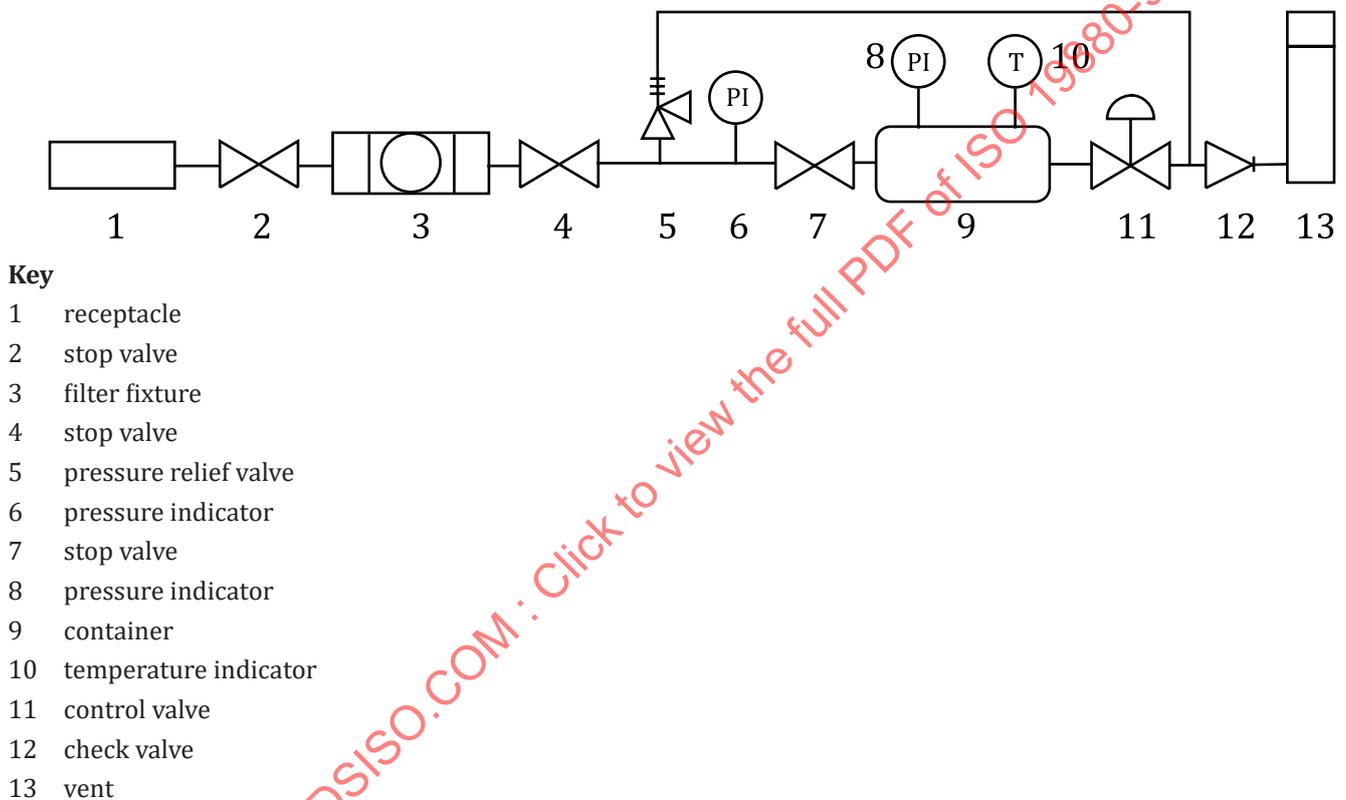
Cleaning of the HPSA should be performed in accordance with manufacturer's instruction.

## Annex E (informative)

### Hydrogen particulate sampling – Method E

#### E.1 General

[Figure E.1](#) shows a schematic for the H70 hydrogen particulate sampling using a method where a H70 rated container or CHSS is used as sink. The mass of hydrogen dispensed can be calculated from pressure and temperature monitoring of the container and should match the amount displayed by the dispenser. The container allows for the slow release of hydrogen through the vent after sampling is complete.



**Figure E.1 — Schematic of method for hydrogen particulate sampling using a container as sink**

[Figure E.2](#) shows a schematic for the H70 hydrogen particulate sampling method using a FCEV as sink.