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Gaseous hydrogen — Fuelling stations —

Part 1: General requirements

Carburant d'hydrogène gazeux — Stations-service —

Partie 1: Exigences générales

Reference number
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Contents

Page

Foreword ... **vii**

1 Scope ... **1**

2 Normative references ... **3**

3 Terms and definitions ... **3**

4 Abbreviated terms ... **15**

5 Risk management ... **16**
5.1 Hydrogen fuelling station safety recommendations ... 16
5.2 Risk assessment ... 17
5.3 Mitigation measures to improve system safety ... 17
5.3.1 General ... 17
5.3.2 Mitigations which reduce the potential for the formation of a flammable mixture ... 17
5.3.3 Mitigation for the formation of a flammable mixture in enclosures ... 18
5.3.4 Mitigation for the formation of a flammable mixture under a canopy ... 18
5.3.5 Mitigations which reduce the potential for ignition ... 19
5.3.6 Mitigation of the escalation and/or impact of a fire or explosion originating from the fuelling installation ... 20
5.3.7 Mitigation of the effect of an external fire/events on the fuelling station installation ... 21
5.3.8 Mitigation of risk to the high pressure hydrogen storage system of the vehicle being fuelled ... 23
5.4 Safety distances ... 23
5.4.1 General ... 23
5.4.2 Safety distances relating to hydrogen vent stack outlets ... 24
5.5 Protection measures for non-hydrogen hazards ... 24
5.5.1 General ... 24
5.5.2 Protection measures for asphyxiation hazard in an enclosure (confined space) ... 24
5.5.3 Protection measures for emergency egress from enclosed spaces ... 25
5.5.4 Ingress protection measures ... 25
5.5.5 Protection measures for hose whip ... 25
5.5.6 Protection measures for noise ... 26
5.5.7 Protection against exposure to extremely cold or hot temperatures ... 26

6 Hydrogen supply safety and operation ... **26**
6.1 On site generation ... 26
6.1.1 Hydrogen generators using water electrolysis ... 26
6.1.2 Hydrogen generators using fuel processing technologies ... 26
6.2 Hydrogen delivery ... 27
6.2.1 Gaseous hydrogen supply by tube trailers and multiple element gas containers (MEGC) ... 27
6.2.2 Liquid hydrogen supply by tanker ... 28
6.3 Pipeline ... 31

7 Equipment and Components ... **32**
7.1 General recommendations ... 32
7.1.1 Hydrogen materials ... 32
7.1.2 Material hydrogen compatibility ... 32
7.1.3 Other material recommendations ... 33
7.2 Piping carrying hydrogen ... 33
7.2.1 General ... 33
7.2.2 Pipe fittings, valves, hoses, for gaseous hydrogen ... 33
7.3 Hydrogen storage recommendations ... 34
7.3.1 General ... 34
7.3.2 Gaseous hydrogen storage vessels ... 34

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7.3.3 Gaseous hydrogen storage siting recommendations 34
7.4 Hazardous areas (with potentially flammable mixtures) 36
7.4.1 General 36
7.4.2 Equipment in hazardous areas 37
7.5 Hydrogen compressors 37
7.5.1 General 37
7.5.2 Vibration and movement 38
7.5.3 Control and monitoring 38
7.6 Instruments for gaseous hydrogen systems 39
7.7 Filters for gaseous hydrogen 39
7.8 Gaseous hydrogen vent systems 40
7.8.1 General 40
7.8.2 Vent outlet 40
7.8.3 Vent sizing 41
7.8.4 Multiple relief devices 42
7.9 Pneumatics and hydraulics 42
7.10 Hydrogen purifier 43
7.11 Enclosures and buildings containing hydrogen equipment 43
7.11.1 General design 43
7.11.2 Maintenance access and possible occupancy 43
7.11.3 Ventilation of enclosures and buildings containing hydrogen equipment 44
7.11.4 Use of enclosures or compartments within enclosures to control hazards areas 44
7.11.5 Electrical and mechanical equipment within enclosures and buildings containing hydrogen equipment 45
7.11.6 Over-pressure protection of enclosures and buildings containing hydrogen equipment 45

8 Dispensing systems 45
8.1 General requirements 45
8.2 Hydrogen vehicle fuelling 46
8.2.1 Dispensing system process control 46
8.2.2 Dispensing system safety devices 49
8.3 Dispensing systems 52
8.3.1 General design and assembly 52
8.3.2 Dispensing system hydrogen components 52
8.3.3 Dispenser housings and cabinets 55
8.3.4 Dispenser fuelling assembly 55
8.4 Dispenser installation 56
8.4.1 General 56
8.4.2 Location and protection of dispensers 56
8.4.3 Fuelling pad 57
8.4.4 Hazardous area around the dispenser 57
8.4.5 Installation of the fuelling assembly to prevent damage in service 57
8.4.6 Electrical continuity for bonding and grounding 57
8.5 Operating considerations 58
8.6 Maintenance and inspection 58

9 Hydrogen quality 58
9.1 General 58
9.2 Dispensing system fuel filters 58

10 Electrical 59
10.1 General electrical 59
10.1.1 Components 59
10.1.2 Site (interconnections to and/or between equipment assemblies) 59
10.1.3 Electrical bonding and grounding 60
10.1.4 Lightning protection 60
10.2 Hazardous areas (potentially flammable mixtures) 60
10.2.1 General 60
10.2.2 Protection requirements for electrical equipment within hazardous areas 60

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10.2.3 Protection from ignition due to accumulation of static charge 60
10.3 Electromagnetic compatibility and interference (EMC) 62
10.3.1 General 62
10.3.2 Industrial (EMC) Environments 62
10.3.3 Residential, Commercial, and Light-Industrial (EMC) Environments 62

11 Instrumentation and control system 62
11.1 General 62
11.2 Emergency shutdown functionality 63
11.2.1 General 63
11.2.2 Manually actuated emergency stop devices 64
11.2.3 Hydrogen detection systems 64
11.3 Remote system control 65
11.4 Modifications to control system 66

12 Station inspection and tests 66
12.1 General 66
12.2 Pressure test 66
12.3 Leak test 67
12.4 Electrical testing 67
12.5 Fuelling safety and performance functional testing 68
12.5.1 General 68
12.5.2 Fuelling protocol test 68
12.5.3 Test procedure 69
12.5.4 Site acceptance testing options 69
12.5.5 Additional performance considerations for fuelling 71
12.6 Hydrogen quality testing 72
12.7 Station inspection and tests following modifications 72

13 Operation 72
13.1 General 72
13.2 Warning signs 72
13.3 Dispenser operational instructions 73
13.4 Functional identification 74
13.5 Marking of equipment (data plate) 74
13.6 Reference designations 75
13.7 Training 75
13.8 Emergency response plan 75
13.9 Emergency contact information 76

14 Technical documentation 76
14.1 General 76
14.2 Information to be provided 76
14.3 Recommendations applicable to all documentation 78
14.4 Installation documents 78
14.4.1 General 78
14.4.2 Installation documentation for hazardous areas 79
14.4.3 Venting documentation 79
14.4.4 Seismic documentation 79
14.4.5 Handling and lifting documentation 79
14.5 Overview diagrams and function diagrams 80
14.6 Circuit diagrams 80
14.7 Flow (P&ID) diagrams 80
14.8 Fuelling station operating manual 81
14.9 Maintenance and service manuals 81
14.10 Parts list 81

15 Inspection and maintenance 82
15.1 Inspection and maintenance program 82
15.2 Maintenance and testing frequency of gas detection 83
15.3 Maintenance and inspection frequency of filters 83

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15.4 Maintenance of pressure relief devices 84
15.5 Hot work 84
15.6 Modifications to the hydrogen fuelling station and associated equipment 84

Annex A (informative) **Safety methodologies and risk assessment** **85**

Annex B (informative) **Further guidance on risk management** **107**

Annex C (informative) **Hydrogen dispensing and examples of fuelling and communications protocols, and corresponding verification testing** **113**

Annex D (informative) **Reference fuelling limits of hydrogen and fuel cell vehicles** **131**

Annex E (informative) **Pressure level application to design verification requirements for hydrogen dispensing systems and compressed hydrogen storage systems** **132**

Annex F (informative) **Countermeasures for unsuitable hydrogen fuelling protocols** **137**

Annex G (informative) **Recommendations for, and example of, vehicular impact protection measures** **138**

Annex H (informative) **Example for leakage testing of hydrogen fuelling system** **141**

Annex I (informative) **Minimum fuelling station acceptance inspection, testing and validation checklist** **142**

Annex J (informative) **Hydrogen station testing apparatus (HSTA)** **149**

Annex K (informative) **Sampling procedures and hardware for hydrogen fuel quality analysis** **151**

Bibliography **167**

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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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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.

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

This first edition cancels and replaces ISO/TS 19880-1:2016, which has been technically revised.

The main changes compared to the ISO/TS 19880-1:2016 are as follows:

— where appropriate, guidance information from the TS was converted to requirements;

— the difference between the risk assessment and the design requirement clauses were clarified and references were added to ensure that the appropriate clauses were linked;

— Annex A from the TS on safety distances was removed;

— Annex C from the TS on hydrogen quality control was removed to ISO 19880-8;

— the presentation of the information was improved and much of the guidance information was moved to informative annexes.

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.

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Gaseous hydrogen — Fuelling stations —

Part 1: General requirements

1 Scope

This document defines the minimum design, installation, commissioning, operation, inspection and maintenance requirements, for the safety, and, where appropriate, for the performance of public and non-public fuelling stations that dispense gaseous hydrogen to light duty road vehicles (e.g. fuel cell electric vehicles).

This document is not applicable to the dispensing of cryogenic hydrogen, or hydrogen to metal hydride applications.

Since this document is intended to provide minimum requirements for fuelling stations, manufacturers can take additional safety precautions as determined by a risk management methodology to address potential safety risks of specific designs and applications.

While this document is targeted for the fuelling of light duty hydrogen road vehicles, requirements and guidance for fuelling medium and heavy duty road vehicles (e.g. buses, trucks) are also covered.

Many of the generic requirements within this document are applicable to fuelling stations for other hydrogen applications, including but not limited to the following:

— fuelling stations for motorcycles, fork-lift trucks, trams, trains, fluvial and marine applications;

— fuelling stations with indoor dispensing;

— residential applications to fuel land vehicles;

— mobile fuelling stations; and

— non-public demonstration fuelling stations.

However, further specific requirements that can be necessary for the safe operation of such fuelling stations are not addressed in this document.

This document provides requirements for and guidance on the following elements of a fuelling station (see Figure 1 and Figure 2):

— hydrogen production/delivery system:

  — delivery of hydrogen by pipeline, trucked in gaseous and/or liquid hydrogen, or metal hydride storage trailers;

  — on-site hydrogen generators using water electrolysis process or hydrogen generators using fuel processing technologies;

  — liquid hydrogen storage;

  — hydrogen purification systems, as applicable;

— compression:

  — gaseous hydrogen compression;

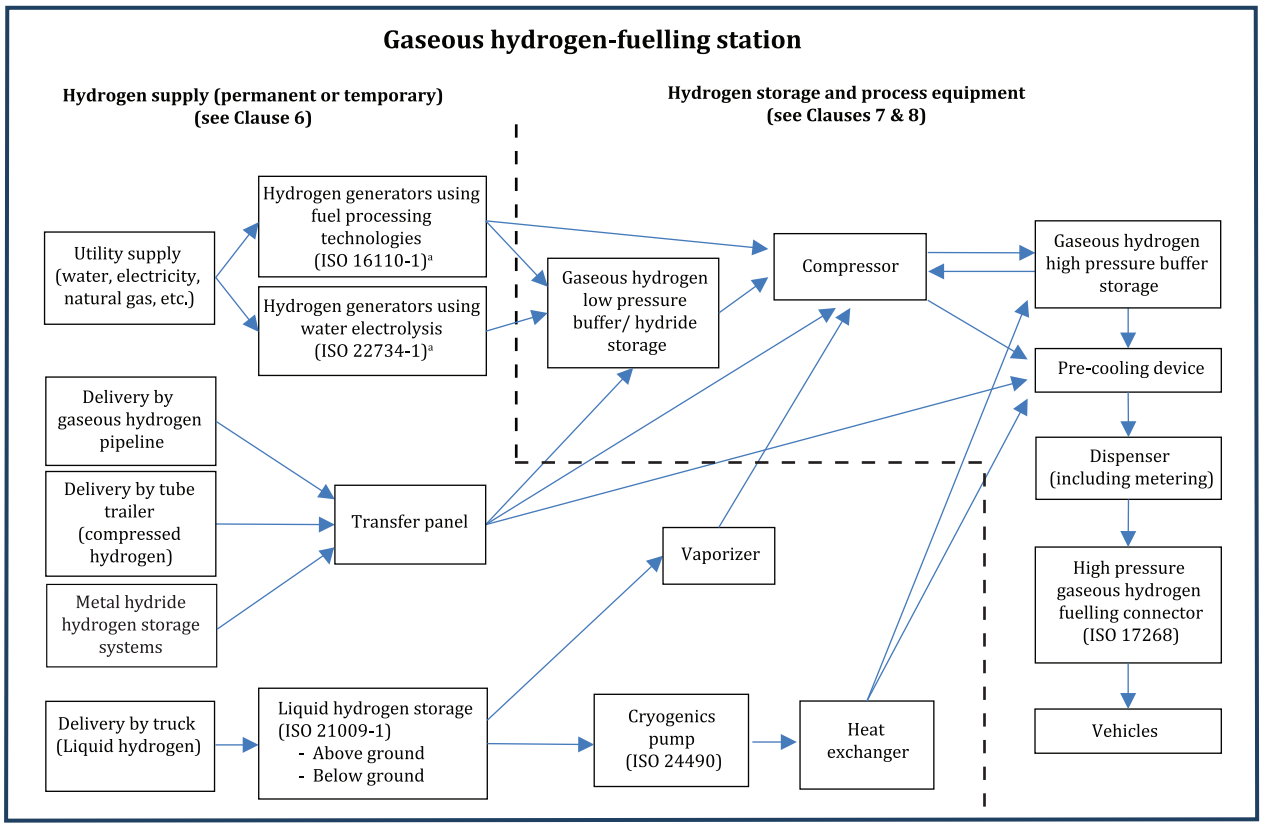
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— pumps and vaporizers;

— gaseous hydrogen buffer storage;

— pre-cooling device;

— gaseous hydrogen dispensing systems.



a May include a buffer vessel (or accumulator) for dampening or adjusting flow of compressor suction inlet.

Figure 1 — Example of typical elements that a fuelling station consists of, including hydrogen supply

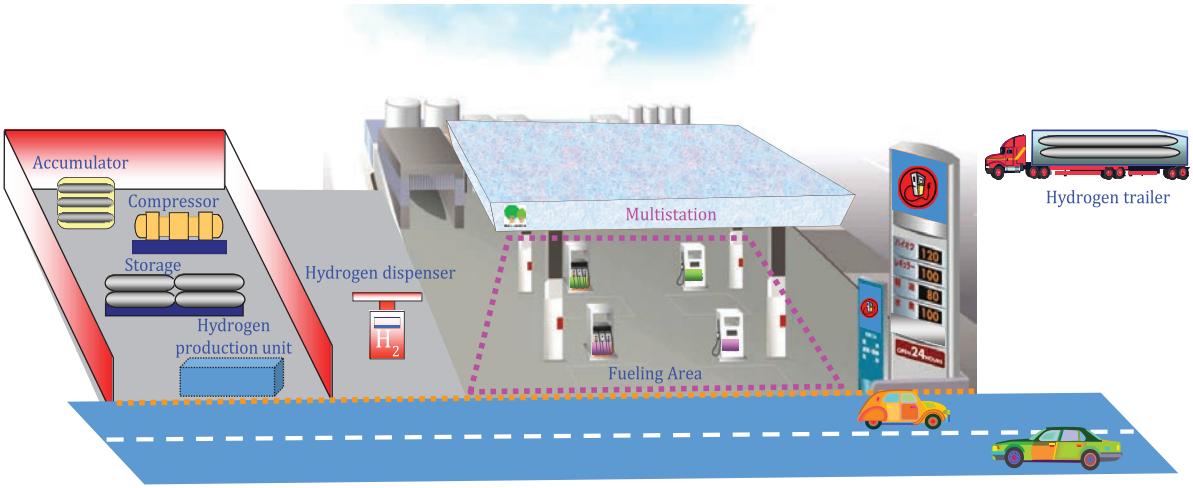


Figure 2 — Image of an example hydrogen fuelling station

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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 13850, *Safety of machinery — Emergency stop function — Principles for design*

ISO 14687, *Hydrogen fuel — Product specification*

ISO 15649, *Petroleum and natural gas industries — Piping*

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

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

ISO 21013-1, *Cryogenic vessels — Pressure-relief accessories for cryogenic service — Part 1: Reclosable pressure-relief valves*

ISO 21013-2, *Cryogenic vessels — Pressure-relief accessories for cryogenic service — Part 2: Non-reclosable pressure-relief devices*

ISO 21013-3, *Cryogenic vessels — Pressure-relief accessories for cryogenic service — Part 3: Sizing and capacity determination*

ISO 22734, *Hydrogen generators using water electrolysis*

ISO/IEC 80079 (all parts), *Explosive atmospheres*

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 62282-3-100, *Fuel cell technologies. Stationary fuel cell power systems. Safety*

EN 13445-5, *Unfired pressure vessels. Inspection and testing*

SAE J2600: 2015-08, *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 terminological databases for use in standardization at the following addresses:

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

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

3.1
acceptance criteria
<risk or harm > acceptable level of risk or *harm* (3.34), locally defined as:

— a tolerable risk value; or

— a specified harm level; or

— requirements in a prescriptive document

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3.2
accessory
device with an operational function

3.3
bleed
<venting> intentional expiration of a fluid from a fluid system

3.4
basic process control system
BPCS
system which responds to input signals from the process, its associated equipment, other programmable systems and/or an operator and generates output signals causing the process and its associated equipment to operate in the desired manner but which does not perform any safety-instrumented functions with a claimed *SIL* (3.73) ≥ 1

[SOURCE: IEC 61511-1:2004, 3.2.3]

3.5
breakaway device
device on the *fuelling hose* (3.27) that disconnects the hose from the *dispenser* (3.13) when a tension limit is exceeded and blocks the flow of hydrogen from the dispenser, e.g. if the vehicle moves away with the fuelling hose connected to the vehicle

3.6
buffer storage vessels
pressure vessels designed for the purpose of storing compressed hydrogen, which can be located between a hydrogen generator and a compressor for an even flow of gas to the compressor or between the compressor and *dispensing system* (3.17) for accumulation of pressurized gas supply for vehicle fuelling

3.7
building
structure, usually enclosed by walls and a roof, constructed to provide support or shelter for intended occupancy

3.8
canopy
roof, overhead shelter, or hood which affords a degree of weather protection

3.9
compressed hydrogen storage system
CHSS
hydrogen storage on-board vehicle, as defined in the GTR#13

3.10
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: Components designed with a maximum allowable pressure per the European PED represent the component pressure rating by the manufacturer that as indicated by the value of “PS”.

Note 2 to entry: This is sometimes referred to as the *maximum allowable working pressure* (3.45) for the component, for example for vessels.

Note 3 to entry: In addition to the specification of the maximum temperature, the manufacturer can define an allowable minimum temperature or temperature range expected for service. For additional thermal conditions and risks potentially experiences during *fires* (3.23), see 5.3.6.4.

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Note 4 to entry: Pressures up to 10 % above the rating can occur during fault management by PSV. See E.3 regarding limited cycle testing to 110 % of the rating as part of verification testing to demonstrate capability of the component.

Note 5 to entry: See Annex E for discussion of pressure terminology and its application to *dispensing systems* (3.17) and *fuelling stations* (3.29) in general.

3.11
control system
system which responds to input signals from the process and/or from an operator and generates output signals causing the process to operate in the desired manner

Note 1 to entry: Also see *safety-instrumented system (SIS)* (3.72) and *basic process control system (BPCS)* (3.4).

3.12
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: *Fittings* (3.24) 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* (3.53) "connector" mates with the *receptacle* (3.64) "connector" on the vehicle to form the connection for transfer of compressed hydrogen between the *dispenser* (3.13) 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* (3.5) or fuelling nozzle;

c) *Control systems* (3.11) often use electrical connectors to allow rapid and secure assembly or replacement.

3.13
dispenser
equipment in the *dispensing system* (3.17), including the *dispenser cabinet(s)* (3.14) 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* (3.26), 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.

3.14
dispenser cabinet
protective *housing* (3.40) that encloses process piping and can also enclose measurement, control and ancillary *dispenser* (3.13) equipment

3.15
dispenser fuel pressure
pressure of the hydrogen gas supplied to the vehicle by the station

Note 1 to entry: See Annex E for discussion of pressure terminology and its application to *dispensing systems* (3.17).

3.16
dispenser fuel temperature
temperature of the hydrogen gas supplied to the vehicle by the station

3.17
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

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3.18
enclosure
structure, protective *housing* (3.40), container, machine cabinet, etc. which encloses or partially encloses equipment of a station that may have access for maintenance but is not intended to be occupied

Note 1 to entry: The use of an enclosure could be to protect equipment from the environment, provide noise attenuation, or provide *safety* (3.69) to the areas surrounding the equipment.

Note 2 to entry: A *canopy* (3.8) without walls is not regarded as an enclosure in this context.

3.19
explosion
ignition and rapid combustion that causes an over-pressure

Note 1 to entry: A rapid deflagration and/or a detonation are explosions.

Note 2 to entry: Slow deflagrations or jet flames do not create an over-pressure and are therefore not considered to be explosions.

3.20
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]

3.21
factory acceptance testing
FAT
tests performed in the factory on *fuelling station* (3.29) equipment or systems to verify functionality and/or integrity prior to shipment to the site, (or an appropriate alternative type acceptance methodology)

3.22
fallback
back-up control strategy, for example in the fuelling protocol when the anticipated precooling of hydrogen to within a specified range of temperatures is not achieved, however fuelling is able to continue, typically at a different fuelling rate

3.23
fire
non-premixed combustion process of a solid, liquid pool, or a jet plume of flammable substance

Note 1 to entry: A fire is the combustion of a solid or liquid of a process first of pyrolysis or evaporation to a combustible gas where a non-premixed combustion process ensues. Also, a non-premixed combustion of a flammable plume (jet fire) is also covered by this definition as is combustion of metals and of hydrogen released by a metal hydride. A fire as defined here does not create an over-pressure therefore is not an *explosion* (3.19), nor is it a deflagration or a detonation which are premixed combustion phenomena.

3.24
fitting
part or design feature on a component used to join (i.e. connect) any pressure retaining components in the system

3.25
forecourt
surfaced area where vehicle dispensing operations are conducted including the *fuelling pad* (3.28) and any area underneath a *canopy* (3.8)

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3.26
fuelling assembly
part of the *dispenser* (3.13) providing the interface between the *hydrogen fuelling station* (3.29) and the vehicle - an assembly consisting of a hose *breakaway device* (3.5), a hose(s), a *nozzle* (3.53) and connections between these components

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.

3.27
fuelling hose
flexible conduit used for dispensing gaseous hydrogen to vehicles through a fuelling *nozzle* (3.53)

3.28
fuelling pad
area with special construction requirements adjacent to the hydrogen *dispensers* (3.13), where customers park their vehicles during fuelling

3.29
hydrogen fuelling station
fuelling station
facility for the dispensing of compressed hydrogen vehicle fuel, often referred to as a hydrogen refuelling station (HRS) or hydrogen filling station, including the supply of hydrogen, and hydrogen compression, storage, and *dispensing systems* (3.17)

3.30
stand-alone
<hydrogen fuelling station or dispenser> independent for the dispensing of compressed hydrogen only

3.31
integrated
<hydrogen fuelling station or dispenser> being part of an existing, or new build, conventional *fuelling station* (3.29) for the dispensing of compressed hydrogen

3.32
fuelling station operator
person or organization responsible for the safe operation, maintenance and housekeeping of the *fuelling station* (3.29)

3.33
guard
part of a machine specially used to provide protection by means of a physical barrier

Note 1 to entry: Depending on its construction, a guard can be called casing, cover, screen, door, enclosed guard, etc.

3.34
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.]

3.35
harmonised standard
European standard developed by a recognised European Standards Organization (CEN, CENELEC, or ETSI), in line with a European Directive

3.36
hazard
potential source of *harm* (3.34)

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

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3.37
hazard distance
distance from the *hazard* (3.36) to a determined physical effect value that can lead to a range of *harm* (3.34) to people, equipment or environment

Note 1 to entry: It can be used as an input to quantitative *risk assessment* (3.66) to, for example, estimate the risk of injury or fatality to people (e.g. via probit functions).

Note 2 to entry: Hazards include, for example, physical, thermal, or pressure effects that can cause harm and can be determined by physical or numerical modelling, experience, or by a regulation.

3.38
hazardous area
classified area
<explosive gas atmospheres> area in which an *explosive gas atmosphere* (3.20) is or may 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.]

3.39
hose assembly
assembly which includes the hose and end connections, including any necessary *fittings* (3.24), bend restrictors, and appropriate markings.

3.40
housing
guard (3.33) or *enclosure* (3.18) for operating parts, control mechanisms, or other components, that need not be accessible during normal operation

3.41
hydrogen purifier
equipment to remove undesired constituents from the hydrogen

Note 1 to entry: Hydrogen purifiers can comprise purification vessels, dryers, filters and separators.

3.42
hydrogen service level
HSL
pressure level in MPa used to characterize the hydrogen service of the *dispensing system* (3.17) based on the *NWP* (3.51) of the vehicle.

Note 1 to entry: The numerical value of HSL also matches the number after the “H” in the *pressure class* (3.58) (see Table 1).

Note 2 to entry: See Annex E for application of pressure terminology to hydrogen dispensing systems and vehicles.

3.43
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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3.44
lower flammable limit
LFL
concentration of flammable gas, vapour or mist in air below which an *explosive gas atmosphere* (3.20) will not be formed

[SOURCE: IEC 60079-10-1:2015, 3.6.12]

3.45
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* (3.17) and *fuelling stations* (3.29) in general.

3.46
maximum fuelling pressure
MFP
maximum pressure expected during a normal (fault-free) vehicle fuelling

Note 1 to entry: Per the GTR#13, the maximum fuelling pressure is 125 % *NWP* (3.51) (see Annex D).

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* (3.17) and *fuelling stations* (3.29) in general.

3.47
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* (3.17), the MOP is equivalent to the *maximum fuelling pressure* (3.46) of the vehicle.

Note 2 to entry: See Annex E for discussion of pressure terminology and its application to dispensing systems and *fuelling stations* (3.29) in general.

3.48
mitigation
combination of the measures incorporated at the design stage and the measures required to be implemented by the station operator, *dispenser* (3.13) operator, or others involved with the operation and maintenance of the *fuelling station* (3.29) to reduce the *probability* (3.60) or severity of an *incident* (3.43)

3.49
mobile storage
multiple-element gas container (3.50) or liquid hydrogen tank fixture mounted on a vehicle or trailer and used for the transportation of hydrogen to *hydrogen fuelling stations* (3.29)

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3.50
multiple-element gas container
MEGC
multimodal assembly of cylinders, tubes or bundles of cylinders which are interconnected by a manifold and assembled within a framework, including service equipment and structural equipment necessary for the transport of gases

Note 1 to entry: This definition is taken from the UN Model Regulations. ADR[79] uses a different definition.

[SOURCE: ISO 10286:2015, 2.2.1, 210]

3.51
nominal working pressure
NWP
pressure of a vehicle *CHSS* (3.9) at 100 % *SOC* (3.78) at a gas temperature of 15 ºC

Note 1 to entry: See GTR#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* (3.17).

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

3.52
non-public fuelling station
fuelling station (3.29) that does not sell or dispense gaseous hydrogen to the general public

EXAMPLE Private or municipal vehicle fleet operation.

3.53
nozzle
device connected to a fuel *dispensing system* (3.17), which permits the quick connect and disconnect of fuel supply to the vehicle storage system

[SOURCE: ISO 17268:2012, 3.8]

3.54
outdoors
location outside of any *building* (3.7) or structure, or location under a roof, weather shelter, or *canopy* (3.8) provided this area is not enclosed on more than two sides

3.55
plinth
raised area on the *forecourt* (3.25), supporting and protecting the *dispensers* (3.13) and associated equipment

3.56
positive isolation
complete separation of one part of the plant or equipment from other parts of the system

Note 1 to entry: Positive isolation can be provided to equipment or piping items for maintenance purposes using various arrangements depending on following factors, as piping rating, equipment in shutdown or equipment under service.

Note 2 to entry: Physical disconnection, for example, spool removal, or use of a blind or a spade are typical ways to provide positive isolation.

Note 3 to entry: Alternatively, *proved isolation* (3.61) can be deemed acceptable based on *risk assessment* (3.66).

Note 4 to entry: Further information can be found in HSG253.

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3.57
pre-cooling
process of cooling hydrogen fuel temperature prior to dispensing

3.58
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* (3.42), 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* (3.17) and *fuelling stations* (3.29) in general.

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

3.59
pressure relief device
PRD
safety (3.69) 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 PRVs used in *dispensing systems* (3.17) can be found in 8.2.2.3. PSVs protecting the dispensing system can reclose above the *MOP* (3.47).

— 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* (3.29) in general.

3.60
probability
expression of the chance (likelihood) that a considered event will take place to property, system, business or to the environment

3.61
proved isolation
valved isolation where the effectiveness of valves closure can be confirmed via vent or *bleed* (3.3) points

Note 1 to entry: Proved isolation can often be used instead of *positive isolation* (3.56), where this is deemed acceptable based on *risk assessment* (3.66).

Note 2 to entry: An assembly commonly referred to as Double Block and Bleed is often used. For such systems, two block valves are required for additional isolation between the operational process side and the device requiring maintenance. A bleed valve is used to drain or vent the fluids trapped between the two block valves.

Note 3 to entry: Further information can be found in HSG253.

3.62
public fuelling station
fuelling station (3.29) that sells gaseous hydrogen to the general public

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3.63
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".]

3.64
receptacle
device connected to a vehicle storage system which receives the *nozzle* (3.53)

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

[SOURCE: ISO 17268:2012, 3.11]

3.65
risk
combination of the *probability* (3.60) of occurrence of *harm* (3.34) 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; Note 1 to entry has been removed.]

3.66
risk assessment
determination of quantitative or qualitative value of risk related to a specific situation and a recognised threat (also called *hazard* (3.36))

Note 1 to entry: Based on national requirements, a review of a risk analysis or a *safety* (3.69) concept by third party is sometimes required.

3.67
risk level
assessed magnitude of the risk

3.68
safeguarding
instruments or final elements related to *safety-instrumented system, SIS* (3.72), or *pressure relief device, PRD* (3.59)

Note 1 to entry: Safeguarding can be instrumental safeguarding or mechanical safeguarding.

3.69
safety
freedom from unacceptable risk

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

3.70
safety distance
separation distance
safe distance
setback distance
distance to acceptable *risk level* (3.67) or minimum risk-informed distance between a *hazard* (3.36) source and a target (human, equipment or environment), which will mitigate the effect of a likely foreseeable *incident* (3.43) and prevent a minor incident escalating into a larger incident

Note 1 to entry: Safety distances could be split into Restriction distances, Clearance distances, Installation layout distances, Protection distances and External risk zone. See A.5.2 for further details.

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3.71
safety function
function to be implemented by a *safety-instrumented system* (3.72), which is intended to achieve or maintain a safe state for the process, with respect to a specific hazardous situation

Note 1 to entry: Other technologies or risk reduction measures have a safety function not achieved through a safety-instrumented system, however validation of these measures is equally important.

3.72
safety-instrumented system
SIS
instrumented system used to implement one or more safety-instrumented functions

Note 1 to entry: A safety-instrumented system is composed of any combination of sensors, logic solvers, and final elements.

Note 2 to entry: A separate safety-instrumented system (SIS), typically with a greater reliability than the more *basic process control system (BPCS)* (3.4), can be required, according to the manufacturer's *risk assessment* (3.66), to respond solely to safety critical alarms. Further information is provided by IEC 61508 and IEC 61511.

3.73
safety integrity level
SIL
discrete level (one out of a possible four), corresponding to a range of safety integrity values, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest

Note 1 to entry: The target failure measures (see IEC 61508-4) for the four safety integrity levels are specified in IEC 61508-1:2010, Tables 2 and 3.

Note 2 to entry: Safety integrity levels are used for specifying the safety integrity requirements of the *safety functions* (3.71) to be allocated to the E/E/PE *safety-related systems* (3.74).

Note 3 to entry: A safety integrity level (SIL) is not a property of a system, subsystem, element or component. The correct interpretation of the phrase "SIL n safety-related system" (where n is 1, 2, 3 or 4) is that the system is potentially capable of supporting safety functions with a safety integrity level up to n.

Note 4 to entry: See 8.2.

[SOURCE: IEC 61508-4:2010, 3.5.8, modified — Note 4 to entry has been added.]

3.74
safety-related system
designated system that both implements the required *safety functions* (3.71) necessary to achieve or maintain a safe state for the EUC and is intended to achieve, on its own or with other E/E/PE safety-related systems, other technology safety-related systems or external risk reduction facilities, the necessary safety integrity for the required safety functions

Note 1 to entry: The term refers to those systems, designated as safety-related systems, that are intended to achieve, together with the external risk reduction facilities (IEC 61508-5:2010, 3.4.3), the necessary risk reduction in order to meet the required tolerable risk (IEC 61508-5:2010, 3.1.6 and Annex A).

Note 2 to entry: The safety-related systems are designed to prevent the EUC from going into a dangerous state by taking appropriate action on receipt of commands. The failure of a safety-related system would be included in the events leading to the determined *hazard* (3.36) or hazards. Although there can be other systems having safety functions, it is the safety-related systems that have been designated to achieve, in their own right, the required tolerable risk. Safety-related systems can broadly be divided into safety-related *control systems* (3.11) and safety-related protection systems, and have two modes of operation (IEC 61508-5:2010, 3.5.12).

Note 3 to entry: Safety-related systems are potentially an integral part of the EUC control system or interface with the EUC by sensors and/or actuators. That is, the required *safety integrity level* (3.73) is achieved by implementing the safety functions in the EUC control system (and possibly by additional separate and independent systems as well) or the safety functions can be implemented by separate and independent systems dedicated to safety.

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Note 4 to entry: A safety-related system is designed:

a) to prevent a hazardous event (i.e. if the safety-related systems perform their safety functions then no hazardous event arises);

b) to mitigate the effects of the hazardous event, thereby reducing the risk by reducing the consequences;

c) to achieve a combination of a) and b).

3.75
site acceptance testing
SAT
tests performed after installation of the *fuelling station* (3.29) at the site to verify functionality and/or integrity

3.76
skid
process system contained within a frame that allows the process system to be easily transported and installed for operation

3.77
standards development organization
SDO
industry- or sector-based standards organizations that develop and publish industry specific standards

Note 1 to entry: In some cases, international industry-based SDOs may have direct liaisons with international standards organizations. SDOs are differentiated from standards setting organizations (SSOs) in that SDOs may be accredited to develop standards using open and transparent processes.

Note 2 to entry: In the European Union, only standards created by CEN, CENELEC, and ETSI are recognized as European standards, and member states are required to notify the European Commission and each other about all the draft technical regulations. These rules were laid down in Directive 2015/1535/EU with the goal of providing transparency and control with regard to technical regulations.

3.78
state of charge
SOC
density (or mass) ratio of hydrogen in the *compressed hydrogen storage system (CHSS)* (3.9) between the actual CHSS condition and the capacity at *NWP* (3.51) when the system is equilibrated at 15 °C

Note 1 to entry: SOC is expressed as a percentage and is computed based on the gas density according to formula below.

Note 2 to entry: The accuracy of the NIST formula has been quantified to be to within 0,01 % from 255 K to 1 000 K with pressures to 120 MPa at the publishing of this document.

Note 3 to entry: (%) can be calculated as follows:

$$\frac{\rho_1}{\rho_2} \times 100$$

where

ρ_1 is the density of hydrogen under the specific gas conditions;

ρ_2 is the density of hydrogen at the nominal working pressure at a gas temperature of 15 °C.

The hydrogen densities at the two major nominal working pressures are:

— density of H_2 at 35 MPa and 15 °C = 24,0 g/l

— density of H_2 at 70 MPa and 15 °C = 40,2 g/l

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Note 4 to entry: The ρ_1 function for hydrogen is available from the National Institute of Standards and Technology (NIST) at https://nvlpubs.nist.gov/nistpubs/jres/113/6/V113.N06.A05.pdf.

3.79
target pressure
dispenser (3.13) fuel pressure that the hydrogen fuelling protocol targets for the end of fuelling

Note 1 to entry: Further guidance on pressure terminology is included in Annex E.

3.80
vaporizer
device, other than a tank, that receives hydrogen in a liquid form and adds sufficient heat to convert the liquid to a gaseous state

3.81
maximum developed pressure
maximum accumulated pressure
highest pressure expected during fault management by the *dispensing system* (3.17)

Note 1 to entry: Per the GTR, the maximum developed pressure is 1,50 × NWP. See Annex D.

Note 2 to entry: The estimate of maximum developed pressure is based on a "worst case" assumptions — the highest possible setpoint for the pressure protection and maximum allowable values for setpoint accuracy and "lift" to open the PSV for full relieving.

4 Abbreviated terms

AiCHE	American Institute of Chemical Engineers
ALARP	as low as reasonably practicable
API	American Petroleum Institute
APRR	average pressure ramp rate
CABF	conformity assessment bodies forum
CENELEC	French: Comité Européen de Normalisation Électrotechnique (European Committee for Electrotechnical Standardization)
CFD	computational fluid dynamics
CGA	Compressed Gas Association
DDT	deflagration to detonation transition
E/E/PE	electrical/electronic/programmable electronic
ERP	emergency response plan
ESReDA	European Safety, Reliability and Data Association
ETSI	European Telecommunications Standards Institute
EUC	equipment under control
FCEV	fuel cell electric vehicle
FEMA	failure modes and effects analysis
H35	indication for 35 MPa NWP hydrogen fuelling as defined in ISO 17268

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