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Natural gas fuelling stations — CNG stations for fuelling vehicles

Stations-service de gaz naturel — Stations GNC pour le ravitaillement de véhicules

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Foreword

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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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/PC 252, *Natural gas fuelling stations for vehicles*.

Natural gas fuelling stations — CNG stations for fuelling vehicles

1 Scope

This document covers the design, construction, operation, inspection and maintenance of stations for fuelling compressed natural gas (CNG) to vehicles, including equipment, safety and control devices.

This document also applies to portions of a fuelling station where natural gas is in a gaseous state and dispensing CNG derived from liquefied natural gas (LCNG) according to ISO 16924.

This document applies to fuelling stations supplied with natural gas as defined in local applicable gas composition regulations or ISO 13686. It also applies to other gases meeting these requirements including biomethane, upgraded coal-bed methane (CBM) and gas supplies coming from LNG vaporization (on-site or off-site).

This document includes all equipment for downstream gas supply connection (i.e. point of separation between the CNG fuelling station piping and the pipeline network). Fuelling station nozzles are not defined in this document.

This document covers fuelling stations with the following characteristics:

— slow fill;

— fast fill;

— private access;

— public access (self-service or assisted);

— fuelling stations with fixed storage;

— fuelling stations with mobile storage (daughter station);

— multi-fuel stations.

This document is not applicable to domestic CNG fuelling devices without buffer storage.

NOTE This document is based on the condition that the gas entering the fuelling station is odorized. For unodorized gas fuelling stations, additional safety requirements are included in Clause 10.

2 Normative references

The following documents are referred to in 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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 834-1, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 4126-1, *Safety devices for protection against excessive pressure — Part 1: Safety valves*

ISO 8580, *Rubber and plastics hoses — Determination of ultra-violet resistance under static conditions*

ISO 9809-1, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1 100 MPa*

ISO 9809-2, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1 100 MPa*

ISO 11119-1, *Gas cylinders — Refillable composite gas cylinders and tubes — Design, construction and testing —Part 1: Hoop wrapped fibre reinforced composite gas cylinders and tubes up to 450 l*

ISO 11119-2, *Gas cylinders — Refillable composite gas cylinders and tubes — Design, construction and testing — Part 2: Fully wrapped fibre reinforced composite gas cylinders and tubes up to 450 l with load-sharing metal liners*

ISO 11119-3, *Gas cylinders — Refillable composite gas cylinders and tubes — Design, construction and testing — Part 3: Fully wrapped fibre reinforced composite gas cylinders and tubes up to 450L with non-load-sharing metallic or non-metallic liners*

ISO 11439, *Gas cylinders — High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles*

ISO 11925-3, *Reaction to fire tests — Ignitability of building products subjected to direct impingement of flame — Part 3: Multi-source test*

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13847, *Petroleum and natural gas industries — Pipeline transportation systems — Welding of pipelines*

ISO 14120, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 15500-2, *Road vehicles — Compressed natural gas (CNG) fuel system components — Part 2: Performance and general test methods*

ISO 15500-17, *Road vehicles — Compressed natural gas (CNG) fuel system components — Part 17: Flexible fuel line*

ISO 15589-1, *Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline systems — Part 1: On-land pipelines*

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

IEC 31010, *Risk management — Risk assessment techniques*

IEC 60079-0, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements*

IEC 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres*

IEC 60079-11, *Explosive atmospheres — Part 11: Equipment Protection by Intrinsic Safety "i"*

IEC 60079-14, *Electrical apparatus for explosive gas atmospheres — Part 14: Electrical installations in hazardous areas (other than mines)*

IEC 60079-25, *Explosive atmospheres — Part 25: Intrinsically safe electrical systems*

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

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

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:

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

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

3.1
assembly
sub-system of fuelling stations comprising several components

3.2
auto-extinguishing
feature of a material that ceases combustion upon removal of flame or ignition source

3.3
biomethane
methane rich gas derived from biogas or from gasification of biomass by upgrading with the properties similar to natural gas

[SOURCE: ISO 14532:2014, 2.1.1.15]

3.4
bonding
equipotential zone where potentially live exposed metallic parts are electrically connected with at least one point connected to ground/earth

3.5
breakaway device
coupling which separates at a predetermined section when required and each separated section contains a self-closing shut-off valve which seals automatically

[SOURCE: ISO/TS 18683:2015, 3.1.3]

3.6
buffer storage
one or more suitable pressure vessels designed for the purpose of storing compressed natural gas

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

3.8
burst pressure
p_b
pressure that causes failure and consequential fluid loss through the component envelope

3.9
canopy
roof, overhead shelter, or hood, that affords a degree of weather protection

3.10
CNG fuelling station
facility at which compressed natural gas is dispensed to vehicles

3.11
competent person
person having the ability, appropriate training, knowledge and experience, to supervise or carry out the work being undertaken in a safe and proper manner

3.12
compressed natural gas
CNG
natural gas which has been compressed and stored for use as a vehicle fuel

[SOURCE: ISO 15500-1:2000, 3.2]

3.13
compressor
machine that increases the pressure of gas

3.14
conduit
casing, tubing or liner, either metallic or non-metallic

[SOURCE: ISO 14310:2008, 3.6]

3.15
cylinder
pressure vessel used for the storage of compressed natural gas

3.16
cylinder working pressure
settled pressure of a fully filled cylinder at a uniform temperature of 15 °C

3.17
dispenser
equipment through which the fuel is supplied to the vehicle

Note 1 to entry: This equipment can include metering.

3.18
dryer
equipment which decreases the water vapour content (moisture) of natural gas

3.19
enclosure
structure, not being a building or canopy, that encloses a component of the fuelling station

EXAMPLE Housing, container and machine cabinet.

3.20
explosive gas atmosphere
mixture of substances with air, under atmospheric conditions, in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture

[SOURCE: IEC 61340–4-4:2014, 11, 3.4]

3.21
fail-safe
design feature that ensures that safe conditions are maintained in the event of a malfunction of a control device or an interruption of a supply source

3.22
fast fill
fuelling operation which has a designed flow rate greater than 100 $m^3(N)/h$ per nozzle

3.23
field piping
piping installed for interconnection between equipment at the site

3.24
fire resistant
property that prevents or retards the passage of excessive heat, hot gases or flames under specified conditions

3.25
fire wall
wall, or separating partition erected to reduce the effects of radiated heat

3.26
fuelling
transfer of fuel from dispenser to the vehicle

3.27
fuelling pressure
pressure at which the fuel is delivered to the vehicle

3.28
fuelling station
facility at which vehicles fuels are dispensed

3.29
grounding
electrical connection of potentially live exposed metallic parts to earth

3.30
hazardous area
area in which an explosive gas atmosphere is present, or can be expected to be present, in quantities such as to require special precautions for the construction, installation and use of apparatus to prevent ignition

[SOURCE: IEC 60079–10–1:2008, 3.3]

3.31
hose
pipeline of flexible material with end fittings attached

3.31.1
vent hose
pipeline of flexible material through which natural gas is vented from the fuelling connection at a vehicle

3.31.2
hose assembly
hose or hoses with ancillary components, such as bend restrictors, breakaways and nozzles, attached

3.32
intrinsically safe circuit
circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under specified test conditions

3.33
lower explosive limit
LEL
volume concentration of flammable gas or vapour in air, below which the mixture is not flammable

[SOURCE: ISO 19372:2015, 3.7, modified — “explosive” has been changed to “flammable”.]

3.34
maximum allowable operating pressure
MAOP
maximum pressure that the component or system is subjected to during normal operation

Note 1 to entry: MAOP is typically not greater than 90 % of the maximum allowable working pressure of the component or system.

3.35
maximum allowable working pressure
MAWP
maximum pressure to which a component or system is designed to be subjected and which is the basis for determining the strength of the component or system

[SOURCE: ISO 12991:2012, 3.10, modified — "or system" has been added and "under consideration" has been removed.]

3.36
mobile storage
multi-cylinder or tank fixture mounted on a vehicle or trailer and used for the transportation of natural gas to CNG fuelling stations

3.37
multi-fuel dispenser
dispenser delivering CNG and other fuels (liquid or gaseous)

3.38
multi-fuel station
fuelling station that can fuel natural gas as well as other fuels, for example diesel, petrol, LPG

3.39
natural gas
complex gaseous mixture of hydrocarbons, primarily methane, but generally includes ethane, propane and higher hydrocarbons, and some non-combustible gases such as nitrogen and carbon dioxide

Note 1 to entry: Natural gas can also contain components or containments such as sulfur compounds and/or other chemical species.

[SOURCE: ISO 14532:2014, 2.1.1.1]

3.40
non-combustible
not capable of undergoing combustion under specified conditions

[SOURCE: ISO 13943:2008, 4.239]

3.41
normal operation
situation when the equipment is operating within its design parameters

[SOURCE: ISO 16110-1:2007, 3.50]

3.42
non-hazardous area
area in which an explosive gas is not expected to be present in quantities such as to require special precautions for the construction, installation and use of apparatus

[SOURCE: ISO 16110-1:2007, 3.48]

3.43
odorant
intensely smelling organic chemical or combination of chemicals added to natural gas at low concentration and capable of imparting a characteristic and distinctive (usually disagreeable) warning odor so gas leaks can be detected at concentrations below their lower flammability limit

Note 1 to entry: ISO/TR 16922 gives the specifications and guidelines for the methods to be used in the odorization of natural gas under a safety point of view and specifies the principles for the odorization technique (including handling and storage of odorants) and the control of odorization of natural gas.

[SOURCE: ISO 14532:2014, 2.8.1, modified — Note 1 to entry has been added.]

3.44
odorization
process of introducing odorant(s) into natural gas

3.45
overpressure
condition under which the pressure exceeds the maximum allowable working pressure

3.46
power failure
reduction in power such that any electrical component or sub system (such as flow control) are operating outside manufacturers specification

3.47
refuelling receptacle
<CNG> device connected to a vehicle or storage system which receives the CNG refuelling nozzle and permits safe transfer of fuel

[SOURCE: ISO 14469-1:2004, 3.7]

3.48
separation distance
minimum separation between a hazard source and an object, which is required to mitigate the effect of a likely foreseeable incident and prevent a minor incident escalating into a larger incident

3.48.1
external separation distance
separation distance between a hazard source and an object situated outside the boundaries of the fuelling station

3.48.2
internal separation distance
separation distance between a hazard source and an object situated within the boundaries of the fuelling station

3.49
service duct
enclosed conduit through which gas piping, utility piping, electrical cabling, etc. is routed

3.50
settled pressure
gas pressure when a given settled temperature is reached and there is no gas flow

3.51
settled temperature
uniform gas temperature in the cylinder after the dissipation of any heat caused by fuelling

3.52
slow fill
fuelling operation which has a designed flow rate equal or less than 100 $m^3(N)/h$ per nozzle

3.53
vault
room or space, typically situated underground

3.54
ventilation
movement of air and its replacement with fresh air due to the effects of wind, temperature gradients, or artificial means (for example fans or extractors)

3.55
venting
controlled release of natural gas to the atmosphere

3.56
zone
hazardous area classified based upon the frequency of the occurrence and duration of an explosive gas atmosphere

[SOURCE: IEC 60079-10-1:2015, 3.3.3, modified — "gas" has been added.]

4 Symbols and abbreviated terms

4.1 Symbols

p_b	burst pressure
p_{MAWP}	maximum allowable working pressure

4.2 Abbreviated terms

CNG	compressed natural gas
IS	intrinsically safe
ERP	emergency response plan
LEL	lower explosive limit
MAOP	maximum allowable operating pressure
MAWP	maximum allowable working pressure
NGV	natural gas vehicle
P&I	process and instruments

5 Risk management

5.1 Risk assessment shall follow the techniques described in ISO 12100 for assessment of machinery safety and IEC 31010 for general site risk management, or local applicable standards.

5.2 The CNG fuelling station installation shall be sited to minimize risk to users, operating personnel, properties, and environment.

5.3 Risk assessment shall include design, construction, operation and maintenance of the CNG fuelling station. The risk assessment process shall be used to evaluate the consequences of hazardous events and to determine appropriate means of risk reduction and/or mitigation of consequences.

5.4 Measures to reduce fire and explosion risks shall be applied, including but not limited to:

— prevention of the formation of a flammable or explosive mixture;

— prevention of static charge build-up;

— avoidance of ignition sources;

— mitigation of the effects of a fire or explosion.

5.5 Protection from ignition in explosive atmospheres shall be by the use of protection systems defined in the IEC 60079 series where the applicable hazard zones are defined in IEC 60079-10-1.

NOTE Examples of hazardous area classifications are given in Annex A.

6 General design requirements

6.1 General

6.1.1 Installation and equipment design shall minimize the number of connections and other possible points of leakage or release to atmosphere.

6.1.2 Configurations generating the possibility of a confined explosive atmosphere should be avoided. Fire and explosion risk prevention shall take into account foreseeable malfunctions and misuse.

6.1.3 Underground service ducts routing natural gas pipeline shall not be shared with other services (e.g. water piping, fuel piping, electrical cabling).

6.1.4 Pressure indication shall be provided such that the pressure on any piping segment can be determined.

6.1.5 Pressure piping system shall have provision for safe manual depressurization. Depressurization shall not be performed by opening pipe joints.

6.1.6 The mounting of equipment and supporting foundations shall be designed and constructed to be suitable for local seismic and geological conditions.

6.1.7 All CNG equipment exposed to the risk of vehicle collision shall be provided with barriers or other mechanisms to protect the gas equipment from collision damage.

6.1.8 The CNG fuelling station shall be designed to shut down safely in the event of a loss of power. Restoration of power shall be in accordance with 16.2.

6.1.9 The CNG fuelling station shall include firefighting equipment in accordance with local applicable regulations.

6.1.10 The CNG fuelling station shall have means of ensuring that oil carryover from the compressor, dust, water and other contaminants in the gas stream meet the local applicable gas quality standards or regulations.

6.1.11 All equipment shall be operated within temperature and pressure limits specified by the manufacturer.

6.1.12 The CNG fuelling station shall be designed while taking into account the specific climatic conditions of the site location and expected minimum and maximum temperatures.

6.2 Site layout

6.2.1 The CNG fuelling station separation distances shall follow the requirements listed in Annex B.

6.2.2 The CNG fuelling installation shall be designed so that authorized personnel shall have easy access to and exit from the operating area of the installation at all times.

6.2.3 Adequate means of escape in the case of emergency shall be provided. In cases where authorized personnel can be trapped inside compounds, there shall be at least two separate outward opening exits, remote from each other, strategically placed in relation to the hazard considered.

6.2.4 All gates shall open outward or comply with the local fire and building codes. The gates shall be wide enough to provide for an easy access and exit of authorized personnel. Gates shall not allow entry without a key during normal operation. Gates shall have access outwards and if equipped with a latch, shall be equipped on the inside with fast release hardware that can be operated without a key.

6.2.5 Consideration shall be given to the provision of an additional emergency exit where the size of the fenced area or equipment location necessitates this.

6.2.6 Access to the installation, except for the fuelling area, shall be prevented to all unauthorized persons. Any security perimeter (fence, walls, etc.) shall be constructed of non-combustible, fire-resistant or auto-extinguishing materials and be at least 1,5 m high.

6.3 Pressure safety relief valves and venting

6.3.1 Pressure safety relief valves shall be installed in accordance with ISO 4126-1 and the manufacturer's instructions.

6.3.2 Vent piping for pressure safety relief valves shall be designed for either the rated capacity of the relief valve or the maximum determined flow capacity required to limit pressure accumulation within the restrictions of ISO 4126-1.

6.3.3 The compressor piping system, including inlet, inter-stage, discharge and ancillary piping, shall be protected from overpressure with pressure safety relief valves. The setting of the pressure safety relief valve shall be equal to or lower than the maximum allowable working pressure of the piping design. Pressure safety relief valves shall be in accordance with ISO 4126-1.

6.3.4 Multiple pressure safety relief valves at different set pressures relieving into a common vent header shall not be subject to pressure accumulation higher than the limit set by the relief valve with the lowest pressure set point. The vent header shall be designed for the event of simultaneous relief valve discharge if substantially probable.

6.3.5 Structural steel shall not be used for relief valve venting.

6.3.6 Vent piping shall exit an enclosure or building for safe venting at a minimum of 3 m above ground level and other working areas or 1 m higher than surrounding buildings within a radius of 5 m whichever is higher. The axis of discharge flow shall not be directed downward or towards other structures or equipment within 5 m.

6.3.7 Vent piping shall have provisions to prevent ingress of rain, snow, birds or other vermin. Vent piping shall have provision for draining of liquids at low points, if necessary.

6.3.8 During normal operation, gas venting to atmosphere shall be restricted to pilot valve operation, nozzle disconnections and compressor seal or packing venting.

6.3.9 All parts of a pressure piping system that can be isolated during normal or emergency operation shall be connected to a safety relief device or valve.

7 Fuel supply to the fuelling station

7.1 Supply by pipeline

7.1.1 The interface between the natural gas pipeline and the fuelling station shall include the following functions:

— isolation for maintenance and/or for emergency;

— safe relief of pressure and inert gas purging;

— dielectric isolation.

7.1.2 The following functions may also be included:

— pressure regulation;

— filtration;

— metering.

NOTE 1 The interface between the pipeline and the fuelling station is typically located within the fuelling station boundary and can belong to the gas distribution company. In some cases, the equipment is installed inside a compressor enclosure.

NOTE 2 The design and sizing of internal piping and equipment need to ensure that the systems meet the requirements of the gas supply connection specifications (e.g. pulsation).

7.2 Supply by mobile storage

7.2.1 The natural gas delivery and storage area shall be located so that it is readily accessible to mobile supply equipment at ground level and to authorized personnel. Suitable roadways or other means of access for emergency equipment, such as fire department apparatus, shall be provided.

7.2.2 Where security fencing or enclosures are used, a minimum clearance of 1 m shall be provided around the mobile storage to allow unrestricted egress from the area.

7.2.3 The tube trailer or transportable module station area shall be level. Front and rear ends of the tube trailer or transportable module bays should be kept open. A bump stop or equivalent shall indicate normal tube trailer or transportable module position.

7.2.4 Tube trailers or transportable modules shall not be stationed outside of the designated trailer unloading bays.

7.2.5 The fuelling activity shall be fully suspended during the tube trailer or transportable modules exchange operation unless the exchange can be made without interfering with the safe activities of the fuelling station.

NOTE A designated temporary tube trailer or transportable modules parking location can be provided for carrying out tube trailer or transportable modules exchange.

7.2.6 Means to ground tube trailers and transportable modules prior to flexible hose connection shall be used.

7.2.7 The storage area shall be protected by physical means such as a fence to prevent access of unauthorized persons. Activities other than those directly related to the natural gas tube trailer and/or transportable modules operation shall not be permitted in the storage area.

7.2.8 Separation distances shall comply with those given for buffer storage systems. A minimum clearance of 1 m shall be maintained on all sides of each tube trailer or transportable module.

8 Dryer

8.1 A dryer shall be installed to dehydrate the natural gas, if necessary, to meet the requirements of the gas quality as defined in the applicable local regulations.

NOTE In this way, moisture does not affect the safe operation of the fuelling station.

8.2 The dryer shall be designed for the operating conditions (flow rate and pressure of gas) found at the inlet of the dryer and shall have sufficient capacity to remove the moisture that is contained in the gas and dehydrate it to a level as required by the operating conditions and the ambient conditions (minimum seasonal temperature). As a minimum, the pressure water dew point of the gas shall be at least 5 °C below the lowest expected temperature in operation at the maximum operating pressure.

8.3 The natural gas fuelling station shall not reduce the level of odorant in the gas below the level as described in 12.1.

8.4 A filter shall be installed on the outlet side of the dryer to prevent particles from entering the gas stream if the dryer type can be expected to add particles to the stream.

NOTE The dryer can be installed upstream or downstream of the compressor. Installation upstream of the compressor is recommended as it will protect the compressor from liquid water and the dryer will not be affected by potential oil carryover from the discharge of the compressor.

9 Compressors

9.1 General

9.1.1 A compressor shall be mounted on a structure designed to withstand the dynamic forces exerted by the compressor, which may be integral to a compressor enclosure and placed upon a surface that has been prepared using good engineering practice for drainage and support.

9.1.2 Compensation for movement and vibration shall be provided between the compressor and the fuelling station piping.

9.1.3 Compressor power transmission apparatus and other exposed moving parts, including belts, couplings and fans shall be guarded in accordance with ISO 14120.

9.1.4 Compressors shall include a final discharge check valve to prevent back flow of high pressure gas to the compressor upon shutdown.

9.1.5 Gas venting from rod seals shall be collected and vented at a safe location according to 6.3.

9.1.6 Compressor and piping assemblies shall operate without excessive vibration in order to minimize the risks of induced fatigue failures and loosening of fittings and connections. Vibration level at any point on the compressor shall not exceed 30 mm/s. Vibration levels on attached piping and appurtenances shall not exceed 45 mm/s.

9.1.7 Compressors may be installed on elevated structures (including canopies above the dispensing area), provided that these structures meet the local building codes, considering the weight, maintenance procedures and operating conditions of the equipment.

9.2 Instrumentation and control

9.2.1 The gas supply to the compressor shall be isolated automatically upon normal compressor shutdown, emergency shutdown or loss of electrical power. The gas isolation system shall be fail-safe.

9.2.2 A pressure sensor shall be installed on the compressor inlet piping and shall shut down the compressor in the event of a low or high inlet pressure condition. Under no circumstances is the inlet pressure allowed to drop below atmospheric pressure. A pressure sensor shall be installed at compressor discharge. Final gas discharge pressure shall not exceed MAOP, otherwise the compressor shall shut down.

9.2.3 A temperature sensor shall be installed at compressor discharge downstream of the after-cooler. Final gas discharge temperature post after-cooling shall not exceed 60 °C. If the final gas discharge temperature downstream of the after-cooler exceeds 60 °C, the compressor shall shut down.

9.2.4 The compressor shall be equipped with a system for separating and collecting oil and condensed water from the gas.

9.3 Crankcase design

9.3.1 Atmospheric or unpressurized crankcases shall be protected against a catastrophic failure that causes a high pressure flow of gas into the crankcase.

9.3.2 Pressurized crankcases shall be protected from overpressurization by a pressure safety relief valve or other overpressure protection device set at the maximum allowable working pressure of the crankcase. Safety relief valves shall comply with ISO 4126-1. Other overpressure protection devices shall comply with the applicable part of ISO 4126.

9.3.3 Pressurized crankcases operating above 400 kPa (gauge) shall be manufactured of ductile iron, cast steel or fabricated steel with a material elongation of a minimum of 18 %. Aluminium and other materials with equivalent ductility may be used; however a fatigue analysis shall be conducted to prove that the material endurance limit is not exceeded for the maximum possible life of the product. Cast iron may be used for crankcases operating at 400 kPa or below.

9.3.4 Pressurized crankcase designs shall be qualified with a test burst pressure of a representative manufacturing sample, whereby the maximum allowable working pressure is determined by Formula (1). A manufacturing sample shall use the same processes, materials and quality controls. A change in any of the above requires another destructive test. A test sample shall be scrapped upon completion of test.

$$p_{MAWP} = p_b/6 \times (S_{min}/S_{avg}) \quad (1)$$

where

p_b is the burst pressure;

S_{min} is the specified minimum tensile strength at room temperature;

S_{avg} is the average tensile strength of three test specimens taken from the same ladle of iron or as used in the part at room temperature.

9.3.5 Test conditions: As the crankcase and test equipment are being filled with an incompressible test fluid, care shall be taken to ensure that no air is trapped in the circuit by operating the hydraulic pump

until test fluid is discharged from the vent or air-release valve. During the test, pressurization shall be carried out in two successive stages:

a) In the first stage, the pressure shall be increased in increments of not more than 0,5 MPa up to a pressure value corresponding to the initiation of plastic deformation.

b) In the second stage, the pump discharge rate shall be maintained at as constant a level as possible until the crankcase bursts.

9.3.6 Test installation: The test equipment shall be capable of operating in accordance with the test conditions specified in 9.3.5 and of producing accurately the information specified in 9.3.4.

9.3.7 The MAWP for pressurized crankcases that operate at elevated temperatures where the material tensile strength is less than what it is at room temperature shall be determined by Formula (2):

$$p_o = p_{MAWP} \times S/S_{avg} \quad (2)$$

where

p_o is the maximum allowable working pressure at the design temperature;

S is the specified tensile stress at the design temperature.

9.3.8 Pressurized crankcases shall include a minimum temperature rating and shall not be subject to service temperatures causing material embrittlement.

9.3.9 All pressurized crankcases shall be hydrostatically tested to two times the MAWP and held while examined for leaks. Leaks found in castings may be repaired using plugs with pipe threads in accordance with ISO 7-1. Plugs shall have full-thread engagement corresponding to the thickness of the repaired section. Other plugs may be used provided the full engagement and effective sealing are obtained. The ligament efficiency between two adjacent plugs shall not be less than 80 %. The ligament efficiency is calculated by using Formula (3):

$$E = [p - (d_1 + d_2) / 2] / p \quad (3)$$

where

E is the ligament efficiency;

p is the distance between plug centres;

d_1, d_2 is the respective diameters of the two plugs under consideration.

The crankcase passes the test if no leak is detected.

9.3.10 Repaired castings shall be retested to twice the MAWP to verify no leakage.

9.3.11 Rotating shaft seals shall be positively installed without reliance on press fitting to prevent blow out due to excessive internal pressure.

9.4 Compressor enclosures, buildings and canopies

9.4.1 Ventilation requirements shall be calculated in accordance with IEC 60079-10-1. Electrical equipment shall be suitable for the zone in which it is installed.

NOTE Examples of hazardous zones are given in Annex A.

9.4.2 Compressor enclosures, buildings and canopies shall be constructed of non-combustible, fire resistant or auto-extinguishing materials.

9.4.3 Compressor buildings and enclosures shall be of a design that does not allow the accumulation of leaked natural gas and shall not be modified to reduce the ventilation allowed by the designer of the compressor enclosure.

9.4.4 When a compressor enclosure shares one wall of a building that is occupied, it shall be gas tight and have at least a 2 h fire resistance rating.

9.4.5 A compressor enclosure or building large enough to admit service personnel shall have an access door that opens outward, and, if equipped with a latch, the door shall be capable of being opened from the inside with fast release hardware and without a key.

9.4.6 Compressor enclosures and buildings large enough to admit service personnel shall have passageways for egress of at least 1 m in width.

9.4.7 Equipment shall be installed such that there is adequate access for operation, inspection and maintenance.

9.4.8 A compressor shall be protected from unauthorized access following the requirements of 6.2.6.

9.4.9 Compressors may be installed in buildings or rooms including at ground level, upon elevated structures (including on structural canopies) and below ground. Deflagration venting shall be provided in exterior walls or roof only.

9.4.10 Deflagration vents shall be permitted to consist of any one or any combination of the following:

— walls of light material;

— lightly fastened hatch covers;

— outward opening doors in exterior walls or lightly fastened wall or roofs;

— other provisions satisfying the authority having jurisdiction.

9.4.11 Rooms within or attached to other buildings shall be constructed of non-combustible, fire-resistant or auto-extinguishing materials.

9.4.12 Walls or partitions separating a compressor room from an attached building shall be continuous from floor to ceiling, shall be securely anchored and shall have a fire rating of at least 2 h.

9.4.13 At least one wall of a room shall be an exterior wall and access to the room shall be from outside the primary structure. If access to the room from outside the primary structure is not possible, access from within the primary structure shall be permitted where such access is made through a barrier space having two vapour-sealing, self-closing fire doors having the appropriate rating for location where installed.

9.4.14 A ventilation system for a room within or attached to another building shall be separated from any ventilation system for the other building.

9.5 Underground compressor installations

9.5.1 Compressors installed below ground level in rooms or vaults shall include provision for deflagration venting. If deflagration venting is not practical, equivalent safety measures shall be incorporated with the approval of the authority having jurisdiction.

9.5.2 At least one exit/entrance stairway or passage shall be provided with a width of at least 1 m. A secondary escape route shall be provided and may consist of a manhole or ladder and quick release hatchway as a minimum.

9.5.3 Vaults or rooms may be designed for access by other more restrictive methods including manholes, ladders, hatches or other means. Access of this type shall be designated as "confined space entry" and entry shall be executed by trained personnel in accordance with specific procedures in compliance with local regulations and approved by the authority having jurisdiction.

9.5.4 Underground rooms or vaults with compressor installations shall be adequately ventilated. The ventilation shall be mechanical. Area classification shall be in accordance with IEC 60079-10-1.

NOTE Personnel accessing the underground installations needs to be aware of the safety procedures for operating in confined spaces.

9.5.5 Safety escape route and guidelines in case of emergency shall be displayed.

9.6 Hazardous area classification

9.6.1 The areas surrounding a compressor and the area surrounding a building or other enclosure housing a compressor shall be classified in accordance with IEC 60079-10-1. Electrical equipment shall be in accordance with IEC 60079-14.

9.6.2 A compressor shall be installed such that the area classified in accordance with 9.6.1 does not extend beyond the property line.

9.6.3 A vehicle shall not be considered a source of ignition, and the area around the nozzle is not classified.

10 Buffer storage

10.1 Full-metal buffer storage vessels for the storage of natural gas shall be manufactured according to ISO 9809-1, ISO 9809-2 or to a locally applicable standard.

10.2 Buffer storage vessels of composite construction shall be manufactured according to ISO 11119-1, ISO 11119-2 or ISO 11119-3 as applicable, or according to locally applicable standards.

10.3 Buffer storage vessels shall be protected by a pressure relief device set at a pressure not higher than the maximum allowable working pressure. The relief device set point shall be at least 10 % above the maximum allowable operating pressure.

10.4 Buffer storage vessels shall be equipped with individual isolation valves.

10.5 Each group of buffer storage vessels shall be equipped with their own set of pressure relief devices, independent from the other groups.

10.6 The installation design of buffer storage vessels shall include a means to mitigate risks in the case of fire. Suitable mitigation methods may include fixed firewater protection, product venting, pressure relief devices and thermal shielding. Composite cylinders shall be protected by thermally activated pressure relief devices.

10.7 Buffer storage vessels shall be mounted and placed to provide adequate clearance for periodic inspection as required by local regulations. Procedures for periodic inspection and testing are given in ISO 6406 for seamless steel cylinders, ISO 10461 for aluminium alloy cylinders, and ISO 11623 for composite cylinders.

10.8 Buffer storage vessels may be collocated next to compressors and other CNG equipment in the same enclosure, building or vault. Installations of this type shall meet the requirements of 9.5 or 9.6.

11 Dispensers

11.1 General requirements

11.1.1 Metered dispensers shall incorporate an excess flow instantaneous limiting system. The response shall be less than 5 s. The excess flow limiting system shall actuate when flow exceeds 10 % of the maximum expected flow during normal operation.

11.1.2 Dispensers shall have an automatic fuelling pressure limiting system that will stop the flow of gas when the fuelling pressure reaches the specified limit. The fuelling pressure controls shall include a secondary pressure-limiting device or system to limit the maximum fuel delivery pressure to no more than 130 % of the cylinder working pressure in the event of failure of the primary pressure controls. This protection can consist of a pressure relief valve, or other protection device, either internal or external to the dispenser.

11.1.3 Dispensers can have a manual isolation valve that will stop gas flow to the hose.

NOTE This document does not specify the type of nozzle to be used, however it is recommended that the type of nozzle installed on a dispenser will only permit fuel delivery if the nozzle is connected to a mating refuelling receptacle on the vehicle. Connectors in accordance with ISO 14469 meet this recommendation.

11.1.4 Multi-fuel dispensers shall comply with the safety requirements of each fuel type and any implications of being in the same enclosure and using common components.

11.2 Breakaway devices

11.2.1 Breakaway devices shall be designed and manufactured specifically for CNG fuelling service. As such they shall be designed to withstand extreme temperature swings and continuous pressure cycling.

11.2.2 Breakaway devices shall be marked with the manufacturer's name (or identifying symbol), model, maximum allowable working pressure, gas flow direction, date and location of manufacture.

11.2.3 Breakaway devices shall be suitable for use at a temperature range of –40 °C to 65 °C.

11.2.4 The device shall have a maximum allowable working pressure (MAWP) rating based on a burst pressure that is greater than four times the MAWP.

11.2.5 Metallic materials shall be corrosion resistant. They shall comply with the salt spray test of ISO 15500-2.

11.2.6 Non-metallic materials used shall comply with the non-metallic material immersion and oxygen ageing of ISO 15500-2 and shall be suitable for the intended service.

11.2.7 A breakaway device shall be designed such that upon separation under pressure, the separation shall cause the flow of gas from the dispenser to stop within 1 s and allow the bleed down of gas between the downstream portion of the breakaway and vehicle fuelling nozzle through an orifice of diameter 1 mm ± 0,1 mm or equivalent area. Within 1 s of the separation, the flow of gas from the downstream portion of the breakaway will be reduced to the bleed down flow.

11.2.8 A breakaway device shall separate upon application of a maximum hose tension force of 660 N, but not less than 220 N when the device is installed as specified by the manufacturer.

11.2.9 The electrical resistance between the ends of the hose breakaway device shall not exceed 10 ohms when measured at the maximum allowable operating pressure and when measured with the device completely depressurized.

11.2.10 The manufacturer shall specify periodic inspection procedures and intervals and maximum number of disconnects which may be 1.

11.2.11 Reassembly and inspection shall follow manufacturer's instructions and testing. The manufacturer shall guarantee that the procedure will restore the breakaway to the original functional specifications. The procedure shall specify the method to safely vent gas that can be trapped in both sections of the hose. The procedure shall be performed by trained personnel. The reassembly operation shall be recorded.

11.2.12 Inspection of the hose and nozzle shall follow manufacturer's instructions and testing after separation. Special care shall be taken to ensure that there is no damage to fittings and nozzle.

11.2.13 Vent hose assemblies (if present) shall have a breakaway with a separation force not greater than the disconnect force of the fuelling hose breakaway.

11.3 Fuelling hose assemblies

11.3.1 The breakaway device of the hose assembly shall comply with 11.2.

11.3.2 Hoses shall be installed and used in accordance with manufacturer's instructions.

11.3.3 Hose assemblies shall be constructed so as to provide an electrically conductive path between fittings ends at each end of the hose in order to dissipate static electricity.

11.3.4 Hose assemblies shall be mounted in such a way that there is continuity of the conductive path from the hose into the dispenser, which shall be electrically bonded in accordance with IEC 60204-1.

11.3.5 Hose assemblies that include an in-line breakaway device with a second short dispenser hose section shall also exhibit electrical continuity throughout the entire length of the hose assembly.

11.3.6 Hose assemblies shall be tested for electrical continuity prior to the first use. When applying a Megohm meter with an applied potential of 500 VDC with a 20 MΩ scale, the resistance shall not exceed 1 MΩ/m, with a maximum of 5 MΩ for the whole length. This test shall be conducted while the hose is (1) depressurized and (2) pressurized at the dispenser maximum allowable operating pressure using a non-inflammable test gas.

11.3.7 Hose assemblies should have a maximum length of 5 m. If special applications require longer hoses, special provisions should be taken to avoid that hoses come in contact with the ground and are entangled.

11.3.8 Venting at the nozzle prior to disconnection shall be directed in a manner that prevents vented gas from being discharged in an area where there are potential ignition sources.

11.3.9 Hose assemblies shall be installed to avoid abrasion from ground surfaces at all times.

11.3.10 On dispenser hose assemblies which incorporate a vent hose, the vent hose shall have the same pressure rating as the supply hose.

11.4 Fuelling hoses

11.4.1 Hoses shall be designed and manufactured specifically for CNG fuelling service and shall be permanently marked accordingly.

11.4.2 Hoses shall be suitable for use at a temperature range of –40 °C to 65 °C.

11.4.3 Hoses shall be designed for a burst pressure of four times the manufacturer's specified maximum allowable working pressure (MAWP). The MAWP shall be permanently marked on the hose by the manufacturer.

11.4.4 Hose materials shall be resistant to the degrading effects of common automotive fluids with which it can come in contact. Hoses complying with the oxygen ageing and non-metallic material immersion of ISO 15500-17 are considered as complying with this requirement.

11.4.5 Hoses shall be constructed in such a manner that permeation or leakage from the inner tube does not expand or damage the outer cover, braids and inner plies. Hoses shall comply with ISO 15500-17 permeability test.

11.4.6 Hoses shall comply with the leakage test in ISO 15500-2.

11.4.7 Hose materials shall be UV resistant. They shall be tested in accordance with ISO 8580.

11.4.8 Hose outer covers shall be constructed of non-electrically conductive materials (i.e. metallic braids shall not be exposed between fittings ends).

11.4.9 End fittings used on hoses shall be permanently attached with pull-off force at least 1 340 N.

11.4.10 Hose fittings shall be provided with a standard wrench flat grip.

11.4.11 Fittings shall be made of corrosion resistant metal or provided with corrosion resistant plating. They shall comply with the salt spray test of ISO 15500-2.

11.5 Enclosure

11.5.1 The enclosure shall comply with IP-23 as a minimum according to IEC 60529 to protect the equipment against direct contact and weather conditions to ensure safe and reliable operation.

11.5.2 Enclosures should maintain their IP rating following a 7 J impact test in accordance with IEC 60079-0.

11.5.3 Machinery design and construction hazards shall be avoided through compliance with ISO 12100.

11.5.4 The dispenser shall be properly mounted on an adequate foundation, following the manufacturer's instructions.

11.5.5 The area inside the dispenser enclosure is considered Zone 1, unless additional measures are adopted in accordance with IEC 60079-10-1.

11.5.6 The enclosure shall be designed to prevent the accumulation of any potential gas release.

11.5.7 Metallic materials shall be corrosion resistant.

11.5.8 Plastic enclosures shall be antistatic or conductive and tested in accordance with IEC 60079-0.

11.5.9 The enclosure shall be non-flammable and tested in accordance with ISO 11925-3.

11.5.10 Parts and components installed inside the enclosure shall be protected against unauthorized access (e.g. locks, switches).

NOTE Provisions could be made to minimize the amount of process tubing and fittings outside the cabinet.

11.5.11 The dispenser cabinet shall not distort, bend or have its structural integrity altered when a force of 2 000 N is applied at the point on the dispenser cabinet where the force generates the maximum bending moment in relation to its anchorage. The force shall be maintained for at least 120 s.

11.5.12 Components, integral parts and user control that may require adjustment or replacement during servicing, operation and maintenance shall be easily accessible.

11.5.13 The dispenser cabinet shall have an appropriate nozzle storage device that protects the nozzle and fittings from accidental damage and contamination by dirt or water.

11.5.14 Dispensers at public fuelling stations shall require an intentional secondary action before the dispenser is activated to flow gas. This may be accomplished by removing the nozzle from a holster, pushing of a button or other action.

11.5.15 Dispensers at public fuelling stations shall complete the transaction after the nozzle is returned to its original position (holster, mount, etc.).

11.5.16 In the case of electronic fuelling controls, the transaction shall be considered as complete when the electronic system terminates a transaction either due to the vehicle being filled to its cylinder working pressure or due to the failure of an input to the electronic system. In the case of a fill being terminated by an electronic safety system, the transaction shall be terminated.

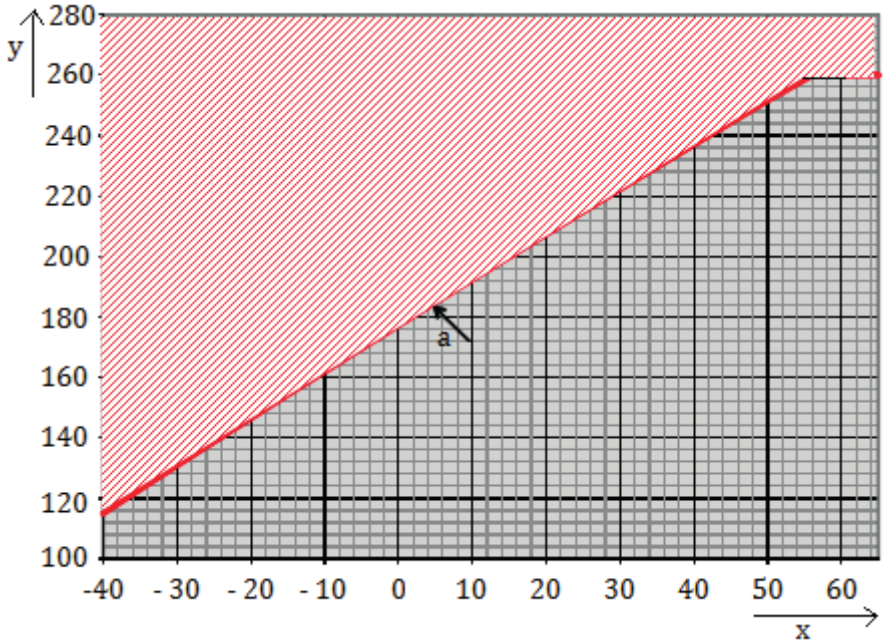
11.6 Fuelling controls and instrumentation

11.6.1 A vehicle cylinder shall be filled to a settled pressure no greater than the cylinder working pressure based on a 15 °C gas temperature inside the cylinder.

NOTE 1 A cylinder designed for a cylinder working pressure of 20 MPa will be filled to a maximum settled pressure not exceeding 20 MPa when the gas temperature inside the cylinder is 15 °C.

NOTE 2 At the cylinder working pressure and 15 °C gas temperature a maximum target gas density is defined dependent on gas composition.

11.6.2 Fuelling controls shall not allow a final fill gas density greater than the target density under any gas temperature conditions (see Figure 1).



Key

	acceptable fill pressure
a	constant density line
x	gas temperature (°C)
y	pressure (bar)

Figure 1 — Temperature compensated fuelling pressure control

11.6.3 For a 20 MPa rated cylinder designed and manufactured in accordance with ISO 11439, the final fuelling pressure shall not exceed 26 MPa under any circumstances and regardless of density. Other cylinder ratings are also acceptable. The maximum fuelling pressures may be determined with a factor of 1,3 times the nominal cylinder rating. For example, a nominal cylinder pressure rating of 25 MPa needs not to be filled to a final pressure greater than 32,5 MPa. The maximum fuelling pressure shall not be exceeded for any cylinder regardless of the target density.

11.6.4 Temperature compensation controls shall terminate the fill immediately or allow further fuelling only up to a maximum fuelling pressure as defined in 11.6.3 in the event of a failure. Fuelling without temperature compensation shall have a maximum fuelling pressure not greater than the fuelling pressure as defined in 11.6.3.

11.6.5 Mechanical temperature compensated fuelling controls (i.e. dome-loaded regulators) that reference ambient temperature shall only be applied if the final settled temperature in the vehicle cylinder is equal to or greater than ambient temperature under all conditions of use (see Note 3).

NOTE 1 The measurement of gas temperature upstream of the cylinder (i.e. in the dispenser) is not to be confused with the actual temperature of the gas inside the cylinder. The two can be significantly different with the gas temperature inside the cylinder being much higher than the gas temperature inside the dispenser. This is due to gas re-compression inside the cylinder.

NOTE 2 Measurement of the gas temperature inside the dispenser can be used to determine gas enthalpy as a means of inferring the gas temperature inside the cylinder through the use of energy balance based algorithms.

NOTE 3 Dispensing of gas originating from an LCNG system can be very cold and can result in a settled gas temperature below ambient temperature.

11.7 Electrical systems and interconnections

11.7.1 Electrical systems within a CNG dispenser shall comply with the requirements in IEC 60204-1 and subordinate standards where applicable.

NOTE The table of subclauses in the Foreword of IEC 60204–1 usefully identifies four categories where design action needs to be considered:

a) selection from the measures given in IEC 60204-1;

b) additional requirements;

c) different requirements;

d) other standards (or regulations) that can be relevant.

11.7.2 After return of power either deliberately or automatically, the dispenser shall not permit gas flow until a specific attendant or user action has been performed. This requirement applies to any interruption of the dispensing operation.

11.7.3 All non-intrinsically safe (non-IS) external connections shall be made within a junction box in accordance with IEC 60079-11. Such connections may be made in a non-hazardous area, provided transit through any hazardous area complies with the zone classification and zone separation systems are employed.

11.7.4 A tool shall be required to make, or unmake, such non-IS electrical connections.

11.7.5 All connections shall employ a screw-type terminal or a spring connector if used with multi-strand cables. Insulation-displacement connectors shall not be used.

11.7.6 Only one electrical power conductor shall be fitted to each terminal.

11.7.7 Solid core external electrical power cables shall not be used.

11.7.8 All internal connections shall comply with IEC 60204-1.

11.7.9 Intrinsically safe circuits shall comply with IEC 60079-25.

11.8 Documentation

A process and instruments (P&I) diagram and wiring schematic with installation, operation, maintenance and commissioning instructions detailing all external and internal subsystem connections shall be provided with every dispenser. The schematic and associated instructions shall identify all safety critical connections and materials required to comply with the manufacturer's recommendations for electrical safety.

12 Gas odorization

12.1 Natural gas delivered to any natural gas vehicles shall be odorized to a similar level found in the local distribution system (see for example ISO 13734).

12.2 Natural gas introduced into any system covered by this document shall have a distinctive odor potent enough for its presence to be detected down to a concentration in air of not over one fifth of the LEL. If natural gas introduced into any system covered by this document does not meet this requirement, methane detection systems shall be installed.

12.3 Any maintenance or servicing anticipated during operation of the fuelling station shall not adversely affect the composition of gas supplied from the fuelling station, including the odorant content.

12.4 If local regulations allow the dispensing of non-odorized gas, a warning sign shall be displayed at the dispensing location and/or dispenser, in the local language and in English: "WARNING: NON-ODORIZED GAS".

12.5 Warning signs shall be provided on equipment access doors and panels with the words "WARNING — NO SMOKING — NO MOBILE PHONES — FLAMMABLE GAS".

12.6 Odor standards and tests, when required, shall be the same as those being used and performed on the local distribution system servicing the fuelling station.

NOTE Attention is to be paid to national standards or other locally applicable regulations in this regard.

12.7 CNG fuelling stations performing odorization on-site shall have safety measures in place to automatically and completely shut down all dispensing of CNG if the odorant supply is inadequate. Restoration after shutdown shall be in accordance with 16.2.

13 Pipework

13.1 General

13.1.1 Field piping shall be constructed, tested and inspected in accordance with ISO 15649 and local regulations. Piping and tubing shall be seamless.

13.1.2 Field piping shall be constructed and installed by trained and competent persons. Welded piping shall be fabricated by qualified pressure welders.

13.1.3 Field tubing constructed and joined with compression fittings shall be assembled by trained and competent persons.

13.1.4 All field piping connections shall be leaked tested at the maximum allowable operating pressure. Leaks shall be repaired and re-tested as required.

13.2 Buried piping

13.2.1 Joints in buried piping system shall be welded only. Welding shall be in accordance with ISO 13847. Mechanical joints including threading, compression fittings, flanges and other joints that can be disassembled are prohibited underground.

13.2.2 Carbon steel piping shall be coated, cathodically protected and monitored in accordance with ISO 15589-1.

13.2.3 Buried stainless steel tubing shall be protected from corrosion with a protective sheath that may consist of PVC piping or other protective conduit. Protective conduits shall stub up above ground level before terminating. Conduits shall not allow the ingress of rain or snow and shall be vented to the

atmosphere to prevent moisture build-up. Protective screens or other means shall be provided to prevent ingress of vermin through vents.

13.2.4 Buried piping shall be a minimum of 600 mm below ground level measured to the top of the pipe, tube or sheath (as applicable).

13.2.5 A warning tape shall be installed at least 150 mm below ground level and directly above the buried pipeline running along its entire length to provide early warning in the event of an excavation.

13.2.6 Electrical conduit and cables running in the same trench shall be separated in distance from gas piping in accordance with local regulations. Electrical conduits and cables may be run at the same elevation or below gas piping elevation. Electrical conduits and cables shall not be placed above the elevation of gas piping running in the same trench.

13.2.7 Trenches and back fill shall be free of sharp rock or other material that may damage piping systems upon installation. A 150 mm layer of sand installed both above and below the piping is recommended for piping protection.

14 Electrical

14.1 Labelling

Any potential contact with electrical circuits capable of causing injury shall be marked using symbols defined in IEC 60204-1:2005, Section 16 (Ed 5.1) and where text instructions are given, they shall be in the local language, and preferably also in English.

14.2 Contact with live parts

14.2.1 Electrical housings and enclosures shall be in accordance with IEC 60204-1.

14.2.2 Live parts shall be protected or located or guarded such that unintentional contact is not possible.

14.2.3 In normal operation, all live parts shall be in accordance with IEC 60204-1.

14.2.4 Live parts such as terminals or electronics that can be accidentally contacted during live service shall be shielded by a removable cover with a caution notice attached.

14.3 Cables

14.3.1 All power cables and all cables in a hazardous atmosphere shall meet IEC 60079 series specifications appropriate for the application.

14.3.2 To prevent gas transmission between areas of a different hazard classification, cables shall be sealed in accordance with IEC 60079.

NOTE The interstitial space in multicore electrical cables is a potential gas conduit where a pressure differential can exist. Where those parts are in different ignition zone classifications this can invalidate the safety concepts employed.

14.4 Performance after power fail and restoration

14.4.1 After a power failure all gas flow shall stop by automatic means.

14.4.2 Reactivation of the compressor and system shall be by manual restart and shall be conducted by trained and authorized personnel.

14.4.3 After return of power either deliberately or automatically the dispenser shall not permit gas flow until a specific attendant or user action has been performed.

14.4.4 These requirements shall also apply to a control system restart caused by other phenomena.

14.5 Electrical bonding and grounding

14.5.1 All electrical equipment and metal frames and structures that are within hazardous zones shall be bonded and grounded in accordance with IEC 60204-1.

14.5.2 Lightning protection measures shall be considered.

15 Instrumentation and control system

15.1 Gas detection

15.1.1 If the natural gas delivered to the natural gas fuelling station is not odorized, an engineered and validated methane detection system shall be in place.

NOTE Gas detection is seen as a measure to reduce the risk of hazard. The application of gas detection does not reduce the hazardous area classification unless combined with appropriate ventilation according to IEC 60079–10–1.

15.1.2 If gas detectors are installed, they shall be located where gas accumulation might be expected in the event of a leak.

NOTE For the determination of the locations of the detectors near dispensers, it is assumed that each dispenser has a secondary grade of release of leak of up to 1 g/s.

15.1.3 If gas detectors are installed, they shall be linked to a central processing system from which actions are controlled. The processing system shall be easily accessible and not placed in the space to be monitored unless suitable for the hazardous zone rated in accordance with IEC 60079-10-1.

15.1.4 If gas detectors are installed, the processing system shall display the status of the gas detectors. The alarm relay shall be normally open and self-holding. The resetting of the alarm shall be performed by trained personnel only.

15.1.5 If gas detectors are installed, the detection system shall be installed according to the instructions and specifications of the manufacturer.

15.2 Emergency shutdown devices

15.2.1 Emergency shutdown (ESD) devices shall be suitably located throughout the fuelling station. For self-service fuelling stations, special attention shall be paid to location of instructions and marking for ESD push buttons.

15.2.2 Manually activated, fail-safe ESD button switches shall be provided near the compressor on the skid, on the enclosure, near the dispenser and inside the supervisor office (if provided) as a minimum. If there are multiple compressors, all units shall cease operating and gas shall be isolated similarly.

16 Emergency shutdown

16.1 Emergency shutdown procedure

16.1.1 An emergency shutdown (ESD) procedure shall be provided to shut down the CNG fuelling station safely and isolate the gas inlet, buffer storage and dispenser.

16.1.2 The ESD procedure shall include at least the following:

a) The compressor and dispensers shall be shut down, and the outlets of any buffer storage shall be isolated by the operation of fail-safe automatic valves. The isolation shall be made as close to the storage as possible.

b) The power supply shall be isolated with the exception of power for safety control and mechanical ventilation systems.

c) The gas supply shall be shut off at the fuelling station gas supply inlet, compressor inlet, buffer storage outlet and dispenser.

16.1.3 ESD procedures shall be initiated by the activation of the manual emergency shutdown buttons. ESD procedures may also be initiated by other hazardous situation detection devices, including detection of high gas concentration, smoke, fire, heat, seismic, etc.

16.2 Restoration after emergency shutdown

16.2.1 Reactivation of the fuelling station shall be by manual restart and shall be conducted by authorized personnel after ensuring emergency conditions have been resolved.

16.2.2 The gas flow to the dispenser shall be shut off until a specific action has been conducted by trained and authorized personnel.

17 Indoor fuelling

17.1 General

17.1.1 The installation and use of an indoor fuelling system shall be in accordance with Clause 5.

17.1.2 The fuel dispensing area shall be separated from all other portions of the building by walls, partitions, floors, and floor-ceiling assemblies having a fire resistance rating of not less than 1 h in accordance with ISO 834-1.

17.1.3 Personnel doors and window openings in fire-rated interior walls shall have a fire protection rating of not less than 1 h. Doors shall be self-closing. They may remain open during normal operations if they are designed to close automatically in an emergency by means of closure devices. They shall be kept unobstructed at all times.

NOTE Indoor fuelling is not allowed in some countries.

17.2 Ventilation

17.2.1 A mechanical ventilation system serving only the fuel dispensing area shall be provided.

17.2.2 The ventilation system shall be designed so that ventilation air flow is established before any dispensing device can operate. Failure of ventilation air flow shall automatically shut down the dispensing system.

17.2.3 The ventilation system shall be designed to provide air movement across all portions of the dispensing area.

17.2.4 Exhaust ducts shall be positioned in such a way that there is no accumulation of gas in the ceiling area of the fuelling room.

17.2.5 Ventilation rates shall be at least 0,3 $m^3/min/m^2$ of floor area, based on the fuel dispensing area or in accordance with IEC 60079-10-1. Exhaust ducts shall discharge to a safe location outside the building

17.2.6 Forced air heating, air conditioning, and ventilating systems serving an indoor dispensing area shall not be interconnected with any such systems serving other occupancies in the building.

17.3 Additional requirements

17.3.1 Potentially hazardous objects such as the buffer storage and the compressor shall not be in the same room or enclosure as the dispenser.

17.3.2 There shall be no permanently occupied areas above the fuelling building.

17.3.3 Piping should be mounted outside the indoor dispensing area as much as possible and preferably above ground in a visible location and protected from impacts.

17.3.4 Traffic patterns at indoor fuelling facilities shall be designed to inhibit movement of vehicles that are not being fuelled from passing through the dispensing area.

17.3.5 For “slow fill” facilities, the emergency stop switches shall be posted at the (emergency) exits and/or escape routes as a minimum.

17.3.6 If there are any heat-producing appliances inside the indoor dispensing area, they shall be suitable for use in the classified area IEC 60079-10-1.

18 Testing and commissioning

18.1 Approval and renewal verification shall follow local applicable regulations. If conformity to this document is first or second party assessed, it shall be ensured that it is performed by competent persons.

18.2 Prior to start-up of a new natural gas fuelling station, the following shall be considered and verified:

— construction of the fuelling station according to the design;

— electrical equipment is rated in accordance to the hazardous area;

— pressure ratings;

— leak testing;

— purging;

— safety devices and sensor operation within specified requirements (e.g. sensors tested with calibrated gas);

— tests in this document have been performed.

19 Operation

19.1 Fuelling procedures

The fuelling station shall have a documented fuelling procedure posted near the dispenser. For examples, see Annex C.

19.2 Safety signs

19.2.1 The natural gas fuelling station shall prominently display safety signs to alert personnel to dangers, risks and hazard mitigation features.

NOTE It is recommended to follow ISO 7010.

19.2.2 A sign with the words "AUTHORIZED PERSONNEL ONLY" and "NO SMOKING — NO MOBILE PHONES — FLAMMABLE GAS" shall be posted in a highly visible location near the entry point to a gas storage and/or compression facility. Lettering shall be a minimum of 45 mm.

19.2.3 A sign shall be posted on the buffer storage stating the maximum allowable operating pressure (e.g. "NATURAL GAS 25 MPa") in letters of 25 mm minimum.

19.2.4 Near each fill hose location, a general purpose warning sign "NO SMOKING" and "IGNITION OFF" using minimum of 25 mm lettering or an international symbol for "NO SMOKING" and "IGNITION OFF" of 100 mm diameter shall be provided.

19.2.5 A sign with the words "DANGER — EQUIPMENT MAY START AUTOMATICALLY WITHOUT WARNING" and "NO SMOKING" using a minimum of 25 mm lettering or equivalent international symbol of minimum 100 mm diameter, shall be posted near entry points to a compressor facility.

19.2.6 A sign shall be posted at each emergency shutdown button with the words "EMERGENCY SHUTDOWN" in minimum 25 mm lettering.

19.2.7 Electrical control panels shall be marked to indicate high voltage and shock hazards using international symbols of an appropriate size.

19.2.8 Other signs shall be posted as required to identify risks, hazards and mitigation features as specific to the installation.

19.3 Training

19.3.1 Fuelling station operators, maintenance personnel and fuelling attendants shall be trained in the operations of the fuelling station as applicable.

19.3.2 New employees shall be trained in emergency response plan (ERP) procedures at the start of their employment. All operations personnel shall be re-trained in the ERP procedures at least once per year.

19.3.3 A personnel training manual shall be provided and readily available at the fuelling station for consultation by personnel.

19.4 Emergency response plan

19.4.1 The fuelling station shall have an ERP prepared as a documented procedure that considers all aspects of the management of an emergency to ensure the safety of the station and its occupants. This document shall be readily available to operations personnel.

19.4.2 Emergency instructions shall be posted at the natural gas fuelling station in locations that are highly visible. As a minimum instructions shall be provided at the compressor, at each dispenser and in the operator or attendants office as applicable.

NOTE An example of emergency instructions is given in Annex D.

19.5 Operations manual

A manual containing operating instructions shall be present and readily available at the fuelling station at all times. This document shall contain the following information and instructions as a minimum:

a) equipment operation instructions;

b) list of control shutdowns, alarms and set points;

c) instructions for fuelling station remote monitoring and control;

d) electric power isolation and lock-out, if applicable;

e) fuelling station shutdown;

f) recommendations for the use of personal protective equipment (PPE);

g) site drawing showing locations of all safety equipment (ESD pull stations, gas detection, fire extinguisher, alarms, etc.);

h) maintenance schedule, procedures and consumable specifications (i.e. oil, fluids, filters, etc.) (see Annex E);

i) instrument adjustment and calibration instructions;

j) compressor/equipment normal operating process conditions (i.e. pressures, temperatures, speed, flow, etc.);

k) instructions for the winterization of equipment;

l) trouble shooting instructions;

m) instructions for the disposal of hazardous waste (i.e. oil, fluids, molecular sieve, etc.);

n) piping and instrumentation diagram;

o) pressure and temperature ratings for all pressure equipment;

p) hazardous area diagrams.

20 Inspection and maintenance

20.1 Inspection and maintenance program

The fuelling station equipment shall be maintained in accordance with the service requirements of the manufacturer, locally applicable standards or authorities having jurisdiction. An example can be seen in Annex E.

20.2 Maintenance and testing frequency of gas detection

20.2.1 The gas detection system shall be maintained in accordance with the service requirements of the manufacturer. The service frequency shall be once per year as a minimum, or more often if so specified by the manufacturer.

20.2.2 Maintenance shall be performed by competent persons.

20.2.3 The following periodic maintenance actions shall be performed as a minimum:

— each gas detector shall be calibrated following procedures specified by the manufacturer;

— the entire system shall be checked for the desired settings;

— an overall function test shall be performed including the associated actions (see Clause 16);

— an operation test shall be performed.

20.2.4 Special attention shall be given to detectors that are in an environment where pollution is influencing the operation, or detectors that are exposed to substances which reduce the lifetime of the detector.

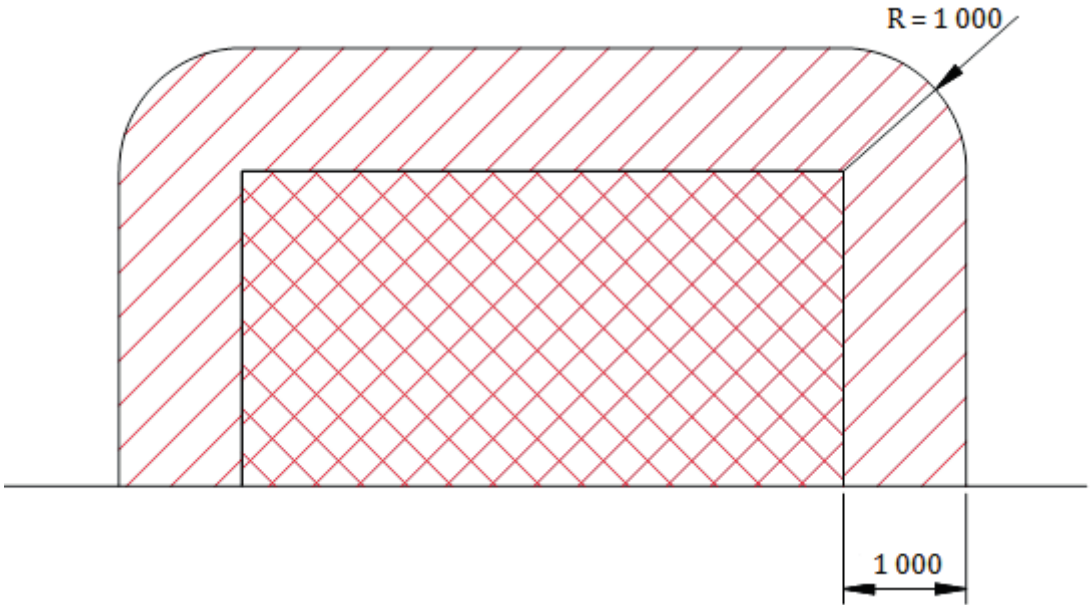
20.2.5 All maintenance operations shall be recorded in a fuelling station log.

Annex A
(informative)

Examples of hazardous zone classification

Figures A.1 to A.9 on hazardous zones is informative and represents maximum extent of zone for the equipment shown. The extent of zone may be reduced based on application of IEC 60079-10-1 protection methods.

Dimensions in millimetres



Key

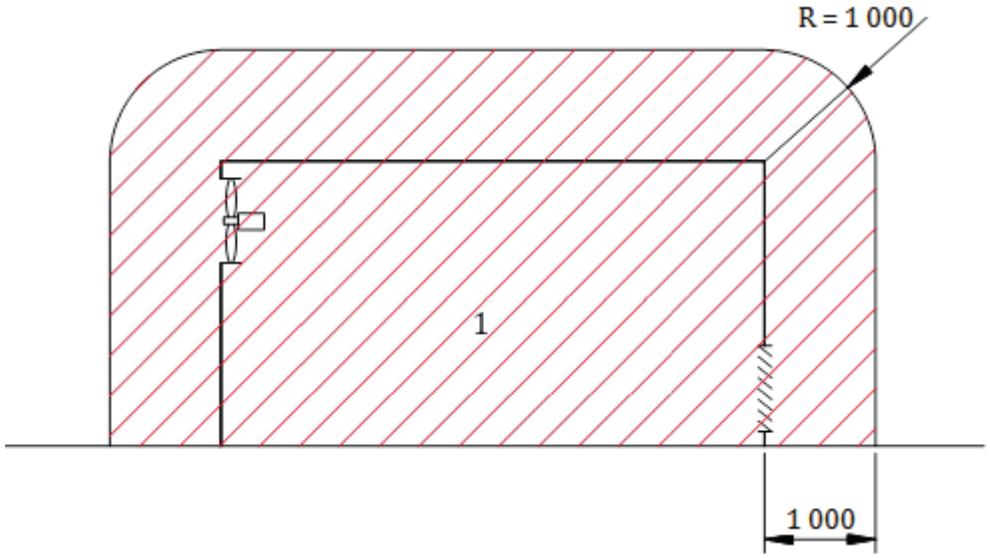
Zone 1 area: enclosed compressor

Zone 2 area

NOTE Hazardous zones for gas drying equipment can be considered identical.

Figure A.1 — Hazardous zones for enclosed CNG compressors

Dimensions in millimetres



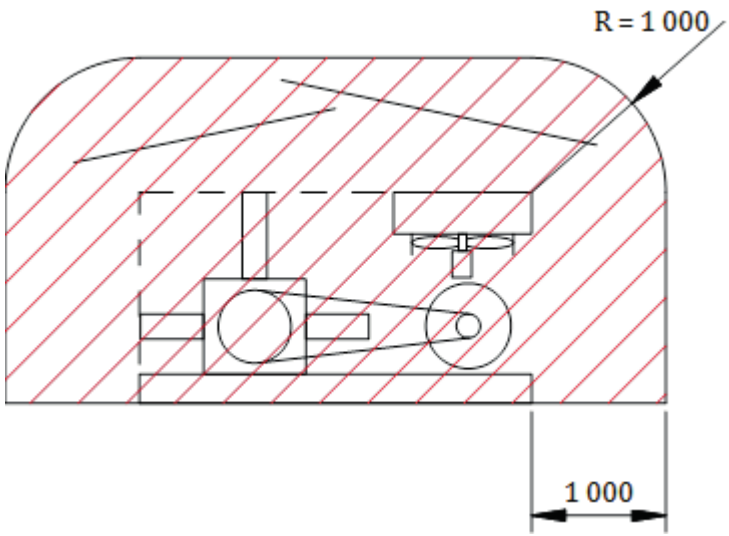
Key

1 enclosed compressor with ventilation and gas detection

NOTE The ventilation rate should provide a minimum of six air changes per hour (ACH). The enclosed space may be declassified to Zone 2 with the addition of continuous mechanical ventilation that is proven by using a flow switch or other device that will isolate power to the enclosed space in the event of a loss of ventilation, or gas detection and ventilation in which if a gas concentration of 20 % lower flammable limit (LFL) or greater is detected, the ventilation fan will operate and if a gas concentration of 40 % LFL is detected, power will be isolated from the enclosed space.

Figure A.2 — Hazardous zones for enclosed and ventilated CNG compressors

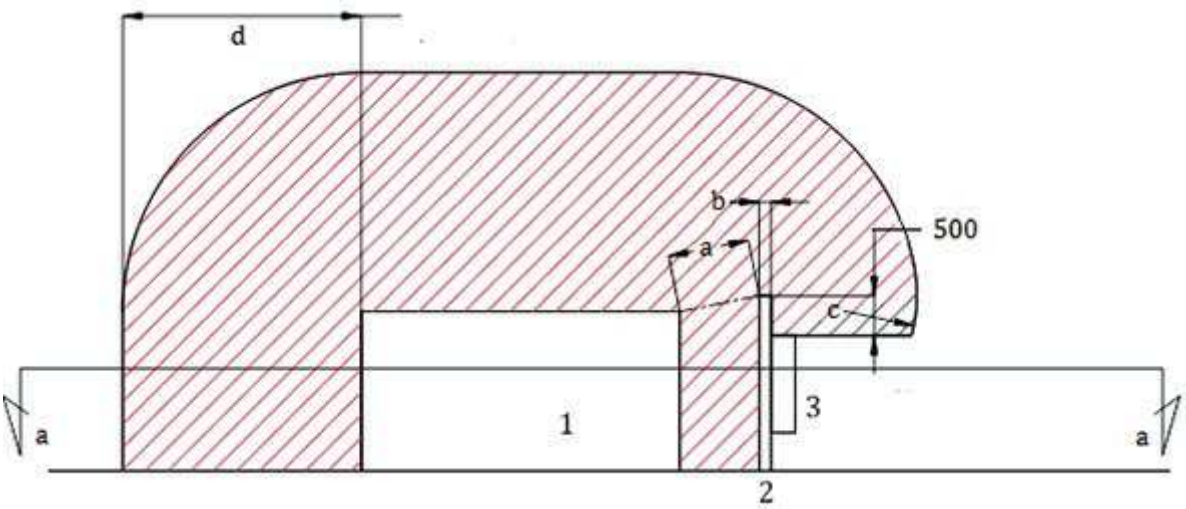
Dimensions in millimetres



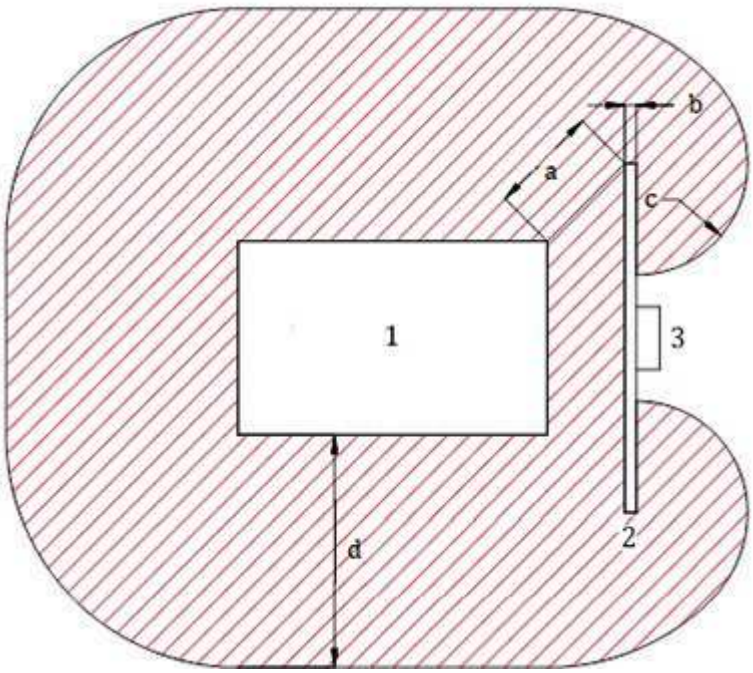
NOTE Shelters with at least three of four walls open and a ventilated roof can also be considered unenclosed.

Figure A.3 — Hazardous zones for unenclosed CNG compressors

Dimensions in millimetres



a) Side view



b) Top view [from a to a in diagram a)]

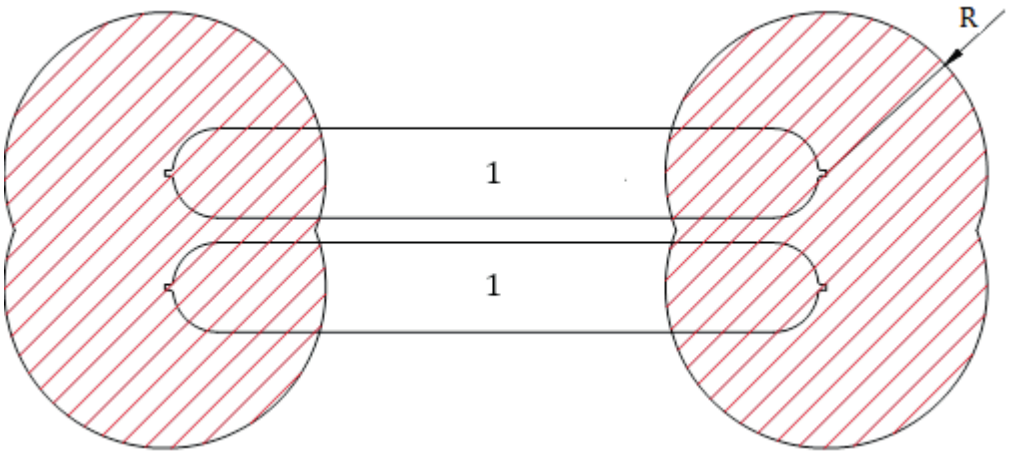
Key

Zone 2 area

1	CNG equipment: compressor, storage and ancillaries
2	gas tight wall
3	general purpose electrical equipment

NOTE Distances a, b, c and d are zones that can be extended as applicable.

Figure A.4 — Hazardous areas around CNG equipment separated by a gas tight wall



Key

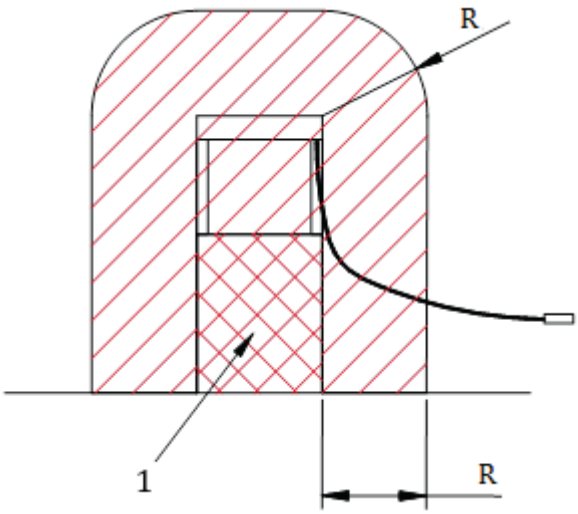
1 buffer vessel

NOTE Dimension R is measured from any opening in the buffer vessel in accordance with the aggregate size of the buffer storage assembly as per Table A.1.

Figure A.5 — Hazardous zones around a buffer storage

Table A.1 — Extent of zone for buffer storage volumes

Total buffer storage volume capacity l	Dimension R mm
Up to and including 4 000	2 500
From 4 001 to 10 000	4 000
Over 10 000	10 000



Key

1 enclosed space

NOTE 1 Dimensions R are shown in Table A.2.

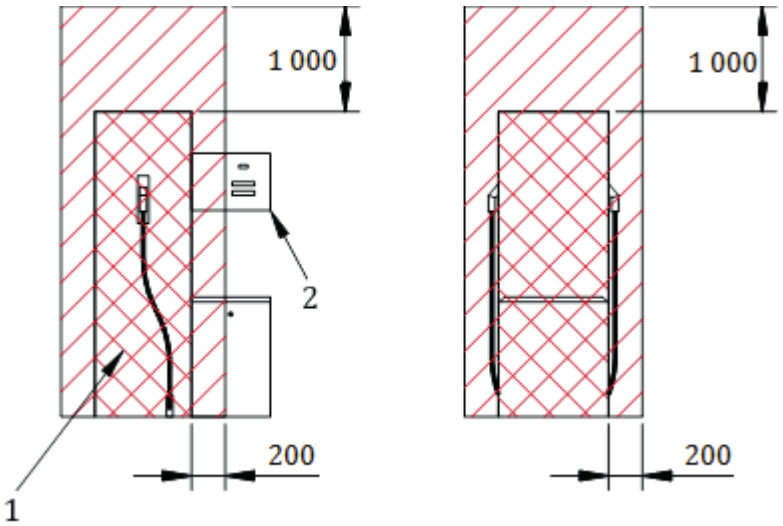
NOTE 2 The CNG hose and nozzle connection point are not considered to create a hazardous zone.

Figure A.6 — Hazardous zone around a CNG dispenser

Table A.2 — Extent of zone for CNG dispenser

Dimension R	Application
As determined by calculation or certification	The extent of zone dimension R may be determined in accordance with IEC 60079-10-1 by the use of protection systems that include gas tight partitions or walls, pressurisation (from safe area), gas detection, ventilation, continuous vapour barriers and other means. See example zone for C-Frame dispensers in Figure A.7. Use of certified protection systems may also be applied.
1 000 mm	This default dimension should be applied without design specific calculation evidence in accordance with IEC 60079-10-1 or certified protection systems.

Dimensions in millimetres



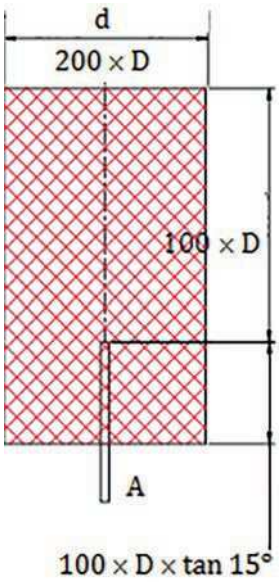
Key

1 enclosed space

2 electronic display

Figure A.7 — Hazardous zone around a "C" Frame type CNG dispenser

Dimensions in millimetres



Key

1 vent stack

D vent orifice diameter (pipe I.D.)

d diameter

NOTE For safety relief valve vents, the orifice diameter, D, is the nominal outlet port size of the relief valve.

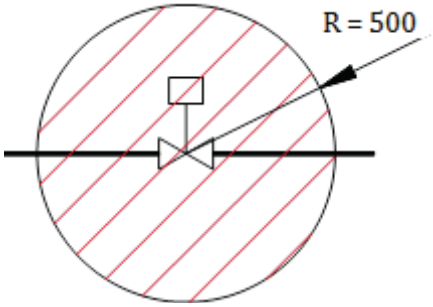
Figure A.8 — Hazardous zone around a vent

Table A.3 — Hazardous zones around piping and valves

Location		Extent of hazardous location	Zone
Pipe and tube lines joined by threaded fittings, tube fittings, welding, flanges including block valves, check valves, pressure gages and line instrumentation devices	Unenclosed Outdoors	Unclassified	Unclassified
	Enclosed with adequate ventilation[a]	To extent of enclosed area	Zone 2
		Outside of enclosed area	Unclassified
	Enclosed with inadequate ventilation	To extent of enclosed area	Zone 1
		1 000 mm from enclosed area	Zone 2
Process control valves including regulators, back pressure valves, actuated valves and modulating valves	Unenclosed Outdoors	Within 500 mm of the point of release (see Figure A.9)	Zone 2
	Enclosed with adequate ventilation[a]	To extent of enclosed area	Zone 2
		Outside of enclosed area	Unclassified
	Enclosed with inadequate ventilation	To extent of enclosed area	Zone 1
		500 mm from enclosed area	Zone 2

[a] Adequate ventilation should be designed and proved in accordance with IEC 60079-10-1.

Dimensions in millimetres



NOTE A control valve includes a regulator, back pressure valve, actuated valve, modulating valve and other valve with moving seals that wear with use.

Figure A.9 — Hazardous zone around a control valve in open air

Annex B
(normative)

Separation distances

B.1 General

A separation distance is the minimum separation between a hazard source (an installation component with a hazardous substance) and the potentially affected object of the hazard (a person, vulnerable installation component or building within the establishment), with the purpose of preventing or limiting the harmful effect as a result of a foreseeable incident and hence preventing either an escalation to a bigger incident (domino effect), in the case of internal separation distances or effects to external objects, in the case of external separation distances. A foreseeable incident in one installation component could not lead to the (partial) failure of another installation component. An internal separation distance therefore prevents a relatively small incident developing into a big incident. Adequate internal separation distances are hence a condition for safe execution of the CNG delivery installation.

B.2 External separation distances

CNG fuelling station external separation distances are not required to exceed those for other liquid fuels.

B.3 Internal separation distances

Internal separation distances shall be determined in accordance with Table B.1.

Table B.1 — Internal separation distances

Total site storage below 10 000 l		
Hazard source	**Dispenser**	**Storage cylinders and compressor**
Buildings openings	>3 m	>3 m
Building walls (non-combustible)	≥0m	>1 m
Facility perimeter	>5 m	>5 m (>10 m for storage > 10 000 l)

If a 2 h fire wall is located between CNG equipment and the property line, the separation distance may be reduced to 1 m. The fire wall shall have a minimum height equal to 0,5 m greater than the maximum height of the equipment and shall limit the hazardous zone from crossing the property line.

Annex C
(informative)

Fuelling procedures

C.1 Fast fuelling procedure (typical)

The procedure for fast fuelling should be posted at each dispenser and should be similar to the following:

a) do not use mobile phones or electrical appliances;

b) turn off engine;

c) remove the dust plug from the vehicle refuelling receptacle;

d) attach the fuelling nozzle to the refuelling receptacle;

e) authorize the dispenser;

f) on completion of the fill, carefully disconnect the fill nozzle; a small escape of gas from the fuelling nozzle can occur at this time;

g) return the nozzle to the holder on the dispenser;

h) refit the dust plug/cap.

If fuelling is performed from a multi-fuel dispenser, only one fuel at a time should be delivered to the same vehicle. Different vehicles may be fuelled with different fuels on different sides of the multi-fuel dispenser.

C.2 Slow fuelling procedure (slow-fill)

The procedure for time fuelling should be posted at each time fill dispenser and should be similar to the following:

a) turn off engine;

b) remove the dust plug from the vehicle refuelling receptacle;

c) attach the fuelling nozzle to the refuelling receptacle;

d) open the fuel valve on the fill post;

e) after the expected fill time has elapsed and the vehicle vessel(s) is/are full, close the fuel valve on the time fill dispenser,

f) carefully disconnect the fill nozzle; a small escape of gas from the fuelling nozzle can occur at this time;

g) return the fill nozzle to the nozzle holder on the time fill dispenser;

h) refit the dust plug/cap.

Annex D
(informative)

Emergency instructions example

Actions to carry out in case of fire or serious gas leakage of a fuelling station:

a) press the emergency shutdown device (button);

b) extinguish all ignition sources, also in the buildings (pilot lights) and in the surrounding area;

c) turn off engines;

d) notify the fire brigade, tel. 000-00000;

e) notify the operator, name: ....., tel. 000-00000;

f) notify people in the vicinity and direct them to a safe area;

g) do not use electrical switches (i.e. light switches and other contact type switches);

h) do not start engines.

Annex E
(informative)

Example of fuelling station periodic inspection and maintenance

This maintenance schedule provided is an informative example only. Fuelling station operators should determine a maintenance schedule that considers the particular fuelling station design, environmental conditions, fuelling loads, operating hours, frequency of use and other factors impacting equipment use and wear. Not all maintenance items listed need to be applicable to a particular installation and some items can be missing. The fuelling station owner should develop a customized maintenance schedule and develop safe maintenance intervals based on fuelling station experience and inspection requirements based on local regulating authorities. It is recommended that fuelling station maintenance intervals remain conservative (shorter) initially and then extended only if experience warrants it.

The person or organization responsible for the operation of the fuelling station should carry out, the maintenance measurements, inspections or check-ups stated in this document. Only trained and competent persons (own or subcontracted) should perform the tasks. The results should be stored and kept available for inspection by authorities for at least three subsequent inspection periods or for the period specified by the applicable national or local regulations.

Maintenance of each piece of equipment should follow the manufacturer's instructions. An example of scheduled maintenance is provided in Table E.1.

In-service dispenser hoses may be checked for continued continuity, but only using a low-voltage ohm meter approved for use in hazardous atmospheres.

Table E.1 — Example of a scheduled maintenance

Maintenance and inspection schedule	Interval					
	Weekly	Monthly	6 months	1 year	2 years	4 years
General						
Overall fuelling station inspection	X					
Check repair and visibility of safety signs	X					
Check fire extinguisher pressure		X				
Replace fire extinguishers					as required	
Buffer storage vessels and other vessels						
External visual check	X					
Isolation valve functional check				X		
Internal inspection						as required
Check for condensate in vessels by draining			X			
Flanges, fittings and piping						
Corrosion check				X		
Damage check				X		
Leakage check				X		
Check earth leakage buried of steel piping				X		

Table E.1 *(continued)*

Maintenance and inspection schedule	Interval					
	Weekly	Monthly	6 months	1 year	2 years	4 years
Valves						
Functional check of valves				X		
ESD function check				X		
Safety relief valve						
Visual inspection				X		
Recalibration						as required
Vent pipe blockage check				X		
Gas dryer						
Dewpoint check		X				
Change desiccant					as required	
Instrumentation						
Functional test of pressure switches/transmitters						
Recalibration of pressure switches/transmitters						
Check pressure gauges			X			
Gas detector functional check			X			
Gas detector calibration			X			
Dispenser						
Wear and damage inspection of CNG nozzle		X				
Hose damage check	X					
Visual check of breakaway		X				
Leakage check of nozzle		X				
Leakage check of breakaway		X				
Check conductivity of hose assembly			X			
Check functioning of excess flow valves			X			
Dispenser fill pressure calibration check			X			
Pressure transmitter calibration						
Equipment bonding and ground						
Bonding continuity check				X		
Bonding continuity to earth ground check				X		
Hazardous zone verification						
Check integrity of hazardous zones				X		
Documentation						
Verify logbook entries		X				
Enter repairs and inspection data		X				
Enter calibration data			X			
Enter cathodic protection data				X		

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1) To be published. Revises ISO 14469-1, ISO 14469-2 and ISO 14469-3.

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