ISBN 978-0-626-40546-5

SANS 16924:2021

Edition 1

ISO 16924:2016

Edition 1

SOUTH AFRICAN NATIONAL STANDARD

Natural gas fuelling stations — LNG stations for fuelling vehicles

This national standard is the identical implementation of ISO 16924:2016, and is adopted with the permission of the International Organization for Standardization.

WARNING
This document references other documents normatively.

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SANS 16924:2021
Edition 1
ISO 16924:2016
Edition 1

Table of changes

Change No.	Date	Scope

National foreword

This South African standard was prepared by National Committee SABS/TC 1019, *Gas supply, handling and control (fuel, industrial and medical gases)*, in accordance with procedures of the South African Bureau of Standards, in compliance with annex 3 of the WTO/TBT agreement.

This document was approved for publication in November 2021.

Compliance with this document cannot confer immunity from legal obligations.

INTERNATIONAL STANDARD

ISO 16924

First edition
2016-12-01

Natural gas fuelling stations — LNG stations for fuelling vehicles

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

Reference number
ISO 16924:2016(E)

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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 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 — LNG stations for fuelling vehicles

1 Scope

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

This document also specifies the design, construction, operation, maintenance and inspection of fuelling stations for using LNG as an onsite source for fuelling CNG to vehicles (LCNG fuelling stations), including safety and control devices of the station and specific LCNG fuelling station equipment.

NOTE Specific CNG equipment is dealt with in ISO 16923.

This document is applicable to fuelling stations receiving LNG and other liquefied methane-rich gases that comply with local applicable gas composition regulation or with the gas quality requirements of ISO 13686.

This document includes all equipment from the LNG storage tank filling connection up to the fuelling nozzle on the vehicle. The LNG storage tank filling connection itself and the vehicle fuelling nozzle are not covered in this document.

This document includes fuelling stations having the following characteristics:

— private access;

— public access (self-service or assisted);

— metered dispensing and non metered dispensing;

— fuelling stations with fixed LNG storage;

— fuelling stations with mobile LNG storage;

— movable fuelling stations;

— mobile fuelling stations;

— multi-fuel stations.

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 4126 (all parts), *Safety devices for protection against excessive pressure*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

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

ISO 12617, *Road vehicles — Liquefied natural gas (LNG) refuelling connector — 3,1 MPa connector*

ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries*

ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*

ISO 15609-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 2: Gas welding*

ISO 15609-3, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 3: Electron beam welding*

ISO 15609-4, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 4: Laser beam welding*

ISO 15609-5, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 5: Resistance welding*

ISO 15609-6, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 6: Laser-arc hybrid welding*

ISO 20421-1, *Cryogenic vessels — Large transportable vacuum-insulated vessels — Part 1: Design, fabrication, inspection and testing*

ISO 21011, *Cryogenic vessels — Valves for cryogenic service*

ISO 21012, *Cryogenic vessels — Hoses*

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

ISO 21029-1, *Cryogenic vessels — Transportable vacuum insulated vessels of not more than 1 000 litres volume — Part 1: Design, fabrication, inspection and tests*

ISO 24490, *Cryogenic vessels — Pumps for cryogenic service*

ISO 31000, *Risk management — Principles and guidelines*

IEC 31010, *Risk management — Risk assessment techniques*

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

IEC 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection*

IEC 60079-17, *Explosive atmospheres — Part 17: Electrical installations inspection and maintenance*

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

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61511 (all parts), *Functional safety — Safety instrumented systems for the process industry sector*

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
ambient vaporizer
heat exchanger that vaporizes LNG with the heat of ambient air

3.2
assembly
sub-system of the fuelling station comprising several components

3.3
approved
having approval for the intended usage from an authority having jurisdiction or having the manufacturer's declaration for intended use

3.4
boil-off gas
gas produced from evaporation of LNG in the LNG storage tank and other parts of the fuelling station including the gas returned from the vehicle tank

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

3.8
bund
elevated boundary of the containment, like wall, dike or embankment

3.9
burst pressure
pb
pressure that causes failure and consequential fluid loss through the component envelope

3.10
canopy
roof, overhead shelter, or hood, that affords a degree of weather protection

3.11
cold end
cryogenic part of a reciprocating LNG pump

3.12
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

3.13
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]

3.14
compressor
machine that increases the pressure of gas

3.15
conduit
casing, tubing or liner, either metallic or non-metallic

[SOURCE: ISO 14310:2008, 3.6]

3.16
containment
area, surrounded by a bund, to contain spilled LNG within that area

3.17
cryogenic
intended for service over the temperature of –153 °C and –196 °C, the lower point being the normal boiling point of nitrogen

3.18
cryogenic pump
pump that delivers LNG at a higher pressure

Note 1 to entry: Pumps used for delivery of LNG to the LNG dispenser are typically centrifugal pumps; however, slow speed reciprocating pumps are also used.

Note 2 to entry: Pumps used for delivery of high-pressure liquid into the high-pressure vaporizer are typically reciprocating piston pumps.

3.19
detachable joint
mechanical joint that can be readily disassembled

EXAMPLE Flanges, threaded joints and similar.

3.20
dispenser
equipment through which the fuel is supplied to the vehicle

Note 1 to entry: This equipment can include metering.

3.21
dry air
air with a maximum dew point of –40 °C

3.22
enclosure
structure, not being a building or canopy, that encloses a component of the fuelling station

EXAMPLE Housing, container and machine cabinet.

3.23
explosive gas atmosphere
mixture of substances with air, under atmospheric conditions, in the form of gases, vapours or mists in which, after ignition has occurred, combustion spreads to the entire unburned mixture

Note 1 to entry: Derived from definition of “explosive atmosphere” in IEC 61340-4-4:2014, 11, 3.4.

3.24
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

3.25
filling
process of transferring LNG into the LNG storage tank

3.26
fire resistance
property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases or flames under specified conditions

3.27
fire wall
wall or separating partition erected to reduce the effects of radiated heat

3.28
flash gas
gas generated from liquid when delivered to the tank to lower pressure than is its boiling pressure at its temperature

3.29
fuelling
transfer of fuel from dispenser to the vehicle

3.30
fuelling nozzle
device which permits quick connection and disconnection of the fuelling hose to/from the refuelling receptacle

3.31
fuelling pressure
pressure at which the fuel is delivered to the vehicle

3.32
fuelling station
facility at which vehicle fuels are dispensed

3.33
grounding
electrical connection of potentially live exposed metallic parts to earth

3.34
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 60079-10-1:2015, 3.3]

3.35
hose
pipeline of flexible material with end fittings attached

3.36
hose assembly
hose, or hoses, with anciliary components, such as bend restrictors, breakaways and nozzles, attached

3.37
LCNG fuelling station
facility at which CNG derived from LNG is dispensed to vehicles

3.38
liquefied natural gas
LNG
natural gas that has been liquefied, after processing, for storage or transportation purposes

3.39
LNG fuelling station
facility at which LNG is dispensed to vehicles

3.40
LNG offloading area
area where the LNG tanker connects to the LNG fuelling station for offloading LNG into the LNG storage tank

3.41
LNG pump
cryogenic pump for transferring LNG

3.42
LNG storage tank
cryogenic vessel used for the purpose of storing LNG

3.43
LNG tanker
vehicle that delivers LNG for offloading to the LNG storage tank at the LNG fuelling station

3.44
LNG transfer point
connection point between the hose of the LNG tanker and the fixed pipeline to the LNG storage tank

3.45
lower explosion 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”.]

3.46
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.]

3.47
maximum fuelling pressure
maximum pressure to which the vehicle tank can be filled

3.48
mobile LNG fuelling station
LNG fuelling station (and/or LCNG fuelling station) having an LNG storage tank capacity of more than 1 000 litres that can be transported with LNG onboard

3.49
mobile storage
LNG storage tank assembly, having a gross volume of more than 1 000 litres, mounted on a vehicle and used at the LNG fuelling station as a temporary LNG storage tank

3.50
movable LNG fuelling station
LNG fuelling station (and/or LCNG fuelling station) having an LNG storage tank capacity of more than 1 000 litres and consisting of one or more units intended for easy installation and possible relocation

3.51
multi-fuel station
fuelling station that can fuel natural gas as well as other fuels, for example diesel, petrol, LPG

3.52
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 sulphur compounds and/or other chemicals.

[SOURCE: ISO 14532:2014, 2.1.1.1]

3.53
net positive suction head
NPSH
inlet total head increased by the head (in flowing liquid) corresponding to the atmospheric pressure at the test location and decreased by the sum of the head corresponding to the vapour pressure of the pump liquid at the inlet temperature and the inlet impeller height

[SOURCE: ISO 24490:2016, 3.5]

3.54
non-combustible
not capable of undergoing combustion under specified conditions

[SOURCE: ISO 13943:2008, 4.239]

3.55
normal operation
situation when the equipment is operating within its design parameters

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

3.56
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 odour 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.]

3.57
odorization
process of introducing odorant(s) into natural gas

3.58
odorizer
equipment used to introduce odorant into natural gas

3.59
offloading
process of transferring LNG from the LNG tanker.

3.60
overpressure
condition under which the pressure exceeds the maximum allowable working pressure

3.61
pump unit
unit that transfers LNG and that consists of one or more pumps, including all associated piping and equipment

3.62
refuelling connector
joined assembly of LNG fuelling nozzle and LNG refuelling receptacle

3.63
refuelling receptacle
<LNG> device connected to a vehicle or storage system, which receives the LNG fuelling nozzle and permits safe transfer of fuel

Note 1 to entry: The receptacle consists as minimum of a receptacle body and a check valve mounted inside the body.

[SOURCE: ISO 12617:2015, 3.9]

3.64
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

3.65
saturation pressure
pressure at which the liquid boils

Note 1 to entry: Saturation pressure is used as an expression of the thermal state of LNG. LNG of different compositions will have a different temperature at the same saturation pressure.

3.66
test pressure
p_t
pressure at which the installation or part of the installation is tested

Note 1 to entry: Different test pressures can be required for storage pressure vessels and other components.

3.67
thermal relief valve
relief valve that is installed to relieve excess pressure caused by vaporization of cryogenic liquid trapped in an isolated section of a pipeline or other small components of the LNG fuelling station

3.68
trim heater
heat exchanger that heats the gas from the vaporizer to a temperature acceptable for the downstream equipment

Note 1 to entry: Trim heater is typically an electric heater or hot water bath.

3.69
try cock
valve connected to a pipe, the inlet of which is at the position of the maximum fill level of the tank

3.70
vaporizer
heat exchanger that vaporizes LNG and delivers it in the gaseous phase

3.71
vehicle tank
cryogenic tank mounted on a vehicle for the storage of LNG as a fuel for that vehicle

3.72
ventilation
movement of air and its replacement with fresh air due to the effects of wind, temperature gradients, or mechanical means (for example fans or extractors)

3.73
venting
controlled release of natural gas to the atmosphere

3.74
vent stack
pipe that allows gas to be vented at a safe elevation and location

3.75
warm end drive
non-cryogenic part of a reciprocating LNG pump, comprising the pump drive part

3.76
water bath vaporizer
heat exchanger that vaporizes LNG using the heat from water that is warmed by the ambient air or an external source of energy including water from natural sources (e.g. river, sea)

3.77
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 Abbreviated terms

CNG	compressed natural gas
DGS	dry gas seal
ESD	emergency shut-down
LCNG	compressed natural gas, sourced from LNG
LEL	lower explosive limit
LNG	liquefied natural gas
MAWP	maximum allowable working pressure
NGV	natural gas vehicle
NPSH	net positive suction head

5 Risk management

5.1 Risk assessment

5.1.1 General

Risks shall be managed throughout the life cycle of the LNG fuelling station through the adoption of a risk management policy and framework that systematically identifies, analyses and evaluates the risks to personnel, the environment and equipment. The principles and guidelines of ISO 12100, ISO 31000 and IEC 31010 shall be followed in developing a risk management policy and a risk management framework. One or more of the risk assessment techniques described in IEC 31010 shall be used to conduct risk assessments. Appropriate risk mitigation measures can then be identified and implemented to reduce the risks to as low as reasonably practicable. Risk mitigation can be achieved through various measures to reduction of the probability and/or the consequences of a risk scenario. Risk mitigation measures may include one or more of the following:

— the use of inherently safe designs and technologies;

— the use of protective devices and systems;

— the adoption of specific operating and maintenance procedures;

— the use of personal protective equipment;

— the provision of information and training;

— the adoption of emergency planning and emergency procedures.

5.1.2 Protection against overpressure

5.1.2.1 Safety devices

5.1.2.1.1 The LNG fuelling station shall be equipped with safety devices that prevent overpressure in all parts of the LNG fuelling station.

5.1.2.1.2 Safety devices shall

— be independent of other functions, and

— comply with the requirements of ISO 4126.

5.1.2.2 Auxiliary safety devices

Auxiliary safety devices shall include at least the following:

— automatic emergency isolation valves to isolate:

— the LNG storage tank content from the rest of the LNG fuelling station equipment;

— the CNG dispenser(s), as specified in ISO 16923;

— the LNG dispensers;

— one or more emergency stop buttons.

5.1.2.3 Protection against overpressurization of vehicle tank

The LNG dispensing system shall be equipped with at least one safety system to prevent overpressurization of the vehicle tank.

If the LNG dispensing system is capable of delivering LNG to the vehicle tank at a pressure that is higher than the maximum allowable working pressure of the vehicle tank, the LNG dispensing system shall be equipped with at least two independent safety systems to prevent overpressurization of the vehicle tank.

EXAMPLE 1 An automatic safety system, which interrupts the power supply to the pump.

EXAMPLE 2 A sufficiently-sized relief valve.

5.1.2.4 Maximum fuelling pressure of CNG

The maximum fuelling pressure of CNG shall be in accordance with ISO 16923.

5.1.3 Static electricity

Measures shall be taken to avoid electrostatic risk. Protection against static electricity shall be carried out according to applicable standards.

5.2 Fire protection

5.2.1 Hazardous area classification

5.2.1.1 A hazardous area classification analysis according to IEC 60079-10-1 shall be undertaken for all the locations in which an explosive gas atmosphere can be present in quantities such as to require special precautions in relation to electrical and other sources of ignition. Annex A provides recommendations for determining the size of hazardous areas for the major units of the LNG fuelling station.

5.2.1.2 Special attention shall be given to existing equipment such as high voltage cables and their insulation and protection. Vaulted or underground installations shall be deemed to provide engineered protection from overhead power lines.

5.2.1.3 If other combustible or hazardous liquids can encroach on any parts of the LNG fuelling station, means shall be provided to protect those parts.

5.2.1.4 Fired equipment (flame heated equipment) shall be located outside hazardous areas.

5.2.1.5 The hazardous area shall not exceed the boundaries of the LNG fuelling station within the separation distances as defined in Tables B.1 to B.3, unless a complementary risk assessment is carried out.

5.2.2 Sources of ignition

5.2.2.1 Sources of ignition are not permitted at

— the LNG offloading area while transfer of LNG is in progress, and

— the LNG dispensing area during fuelling of vehicles.

5.2.2.2 LNG fuelling facilities shall be free from rubbish, debris, and other material that present a fire hazard.

5.2.2.3 Combustible materials shall not be stored or left uncontrolled in the hazardous areas of the LNG fuelling station. Grass from unpaved areas shall be removed before it gets dry.

5.2.3 Fire fighting

5.2.3.1 Fire-fighting equipment shall be available at the LNG fuelling station in accordance with the requirements of the local fire prevention authority. Access routes for movement of fire-fighting equipment to an LNG fuelling station shall be maintained at all times.

5.2.3.2 There shall be at least one dry powder fire extinguisher of suitable size near every dispenser.

5.2.3.3 Fire-fighting procedures approved by the local fire prevention authority shall be available at the LNG fuelling station.

5.2.3.4 A simplified version of fire-fighting procedures shall be displayed at (a) suitable place(s) on the site. Indication of the positions of ESD manual buttons should be included in the procedures.

5.3 Explosion protection measures

5.3.1 Explosion protection measures shall be taken in accordance with the applicable parts of IEC 60079.

5.3.2 All electrical and non-electrical equipment and components used in hazardous areas shall be designed and manufactured according to good engineering practice and shall conform with the requirements categories for Group II, Class T1 equipment to ensure avoidance of any ignition source as specified in IEC 60079.

5.3.3 Ignition in explosive atmospheres shall be prevented by the use of protection systems defined in the applicable parts of IEC 60079 series where the applicable hazard zones are defined in IEC 60079-10-1.

5.3.4 Non-electrical equipment and components used in potentially explosive atmospheres shall comply with the requirements of applicable standards (e.g. EN 13463-1).

6 General design requirements

6.1 General

6.1.1 Design philosophy

6.1.1.1 All equipment, components, pipework, fittings and materials shall be assembled in a manner suitable for their intended use, for the full range of process conditions [pressures, fluids, temperatures, and weather conditions (maximum and minimum ambient temperature, maximum wind, maximum rainfall, maximum snowfall, etc.)] and loadings that can occur under normal and extreme conditions, such as an earthquake. Equipment shall be installed and used in accordance with the manufacturer's instructions.

6.1.1.2 The design shall take into consideration the need to depressurize pressurized components prior to removal for maintenance purposes. This can be achieved by the provision of valves and gauges to validate that sections are depressurized before service interventions.

6.1.1.3 The LNG fuelling station shall be designed and constructed such that any maintenance or servicing of the LNG fuelling station does not adversely affect the composition of LNG supplied from the LNG fuelling station. In particular, moisture shall be prevented from entering the LNG equipment. If this cannot be achieved, the equipment shall be dried prior to operation with LNG.

6.1.1.4 Examples of general flow diagrams of the LNG, LCNG and combined LNG and LCNG fuelling stations are presented in Annex C, Annex D, and Annex E, respectively.

6.1.2 Buildings and civil works

6.1.2.1 Consideration shall be given to local building regulations.

6.1.2.2 The LNG fuelling station shall be installed on adequate foundations. The design of foundations shall follow applicable standards taking into account local geological, wind, precipitation and seismic conditions.

6.1.2.3 The design of the buildings and civil works shall be such that any LNG released

— does not enter the surface water drainage system (e.g. canalization) or other underground infrastructure (e.g. sewers, cable ducts or pipeworks),

— does not enter another installation where hazardous substances are stored or used,

— does not enter the access roads, and

— cannot accumulate under the LNG transfer point, the LNG tanker, the vehicle being fuelled with LNG.

6.1.2.4 The design of the surface of the working area shall take into consideration applicable loads, drainage of rain water, removal of snow and drainage of LNG in the event of an accidental release. The surface of the working area shall be constructed of non-combustible material.

6.1.2.5 Consideration shall be given to accessibility by fire fighters and their equipment.

6.1.2.6 Enclosures and canopies

6.1.2.6.1 It is common practice to install any cryogenic pump (centrifugal or reciprocating) or storage facility in the open air. However, where this is unacceptable, for reasons of safety, security, noise, or weather protection requirements, for example, consideration may be given to the use of an enclosure with adequate ventilation.

6.1.2.6.2 Cryogenic pumps (centrifugal and/or reciprocating) and storage facilities, including their ancillaries, may be housed in the same compartment.

6.1.2.6.3 The enclosure or canopy, intended to house or cover equipment that forms part of the LNG and/or LCNG fuelling station shall not be used for any other purpose with the exception of an enclosure or canopy used to cover the LNG and/or CNG dispensers.

6.1.2.7 Requirements on CNG part of LCNG fuelling station

The CNG part of the LCNG fuelling stations shall be in accordance with ISO 16923.

6.1.2.8 Fire wall

If a fire wall is constructed for the purpose of reducing the separation distances, it shall be of at least one hour fire-resistant construction. The fire wall shall not restrict the access of fire fighters and their equipment.

6.1.3 Installation and construction

6.1.3.1 Materials

6.1.3.1.1 All materials used for the LNG fuelling station shall conform to the required specifications. Documentation shall be provided by the material manufacturer affirming compliance with the specification.

6.1.3.1.2 If light alloy materials are used for components that contain gas or LNG, appropriate measures shall be taken to automatically isolate the component in the event of fire.

6.1.3.1.3 The manufacturer of the LNG fuelling station shall document the compliance with the design and materials with the appropriate standards for the construction of pressurized parts.

6.1.3.1.4 The manufacturer shall select the materials taking into account that the materials shall:

a) have suitable properties for all operating conditions and for all test conditions. For cryogenic parts, only materials suitable for cryogenic service shall be used. Reference can be made to ISO 21028-1 or other applicable standards;

b) avoid galvanic corrosion when the various materials are in direct contact.

6.1.3.1.5 Elastomeric material shall comply with an applicable code, e.g. EN 682.

6.1.3.2 Prerequisites for various elements of assembly

6.1.3.2.1 The design of the LNG fuelling station components shall take into account the range of operating conditions and the conditions that the components can be exposed to during manufacturing, assembly, installation and testing.

6.1.3.2.2 All components shall be protected against corrosion by the use of non-corrosive or low-corrosive materials, and/or by means of suitable coating systems, such as painting, and/or by cathodic protection, taking into account environmental conditions.

6.1.3.3 Permanent joints

6.1.3.3.1 Any joining of components shall only be performed by a competent person. In particular, welded connections shall only be produced by a welder qualified in accordance with applicable standards.

6.1.3.3.2 Welding shall be performed in accordance with a procedure specified in ISO 15609-1 or ISO 15609-2 taking into account any necessary heat treatment and traceability of materials.

6.1.3.3.3 Brazed connections shall be made with a brazing filler material having a melting point exceeding 538 °C.

6.1.3.3.4 Permanent joints shall be subject to non-destructive tests carried out by qualified personnel, e.g. in accordance with ISO 9712.

6.1.3.4 Traceability

A system shall be established to ensure traceability of materials, components and accessories used in the installation.

6.1.3.5 Quality manual

When the construction and installation of the LNG fuelling station is completed, a quality manual that includes all records of the manufacturing and processes and the tests performed in accordance with Clause 18 shall be compiled.

6.1.3.6 Installation of electrical equipment

The installation of electrical equipment shall comply with IEC 60079-14.

6.2 Site layout

6.2.1 Separation distances

Site location and internal layout shall comply with separation distances, as specified in the Annex B, risk assessment and local regulations.

6.2.2 Traffic management

6.2.2.1 Consideration shall be given to the flow of vehicles on the LNG fuelling station premises.

6.2.2.2 The LNG fuelling station components shall be adequately protected against collision of vehicles, for example, by using guard rails or steel poles filled with concrete, or by equivalent protection designed to withstand the expected collision force. Special consideration shall be given to collision protection of the LNG storage tank and the dispenser.

6.2.2.3 The entry and exit routes to the LNG offloading area should be unobstructed and provide easy access for the LNG tanker, with a minimum of manoeuvring. In the event of an emergency, the LNG tanker should be able to drive away in a forward direction.

6.2.2.4 Dispensers shall be positioned so that vehicles have adequate space for manoeuvring into and out of the fuelling position.

6.2.3 Security

6.2.3.1 Adequate means of security shall be provided such that the safety of operation cannot be affected by unauthorized access.

6.2.3.2 Wherever security fences or similar protection are used, at least two emergency exits, located such that they provide easy exit from all parts of the area, shall be provided.

6.2.4 Requirements for location of equipment

6.2.4.1 Location of LNG containing equipment

LNG containing equipment should be located outdoors and in a naturally ventilated environment. Such equipment may be placed under a canopy, or in a room or building provided attention is paid to ventilation, gas detection and other precautions relevant to confined spaces.

6.2.4.2 Location of ambient air vaporizers

Ambient air vaporizers shall be located so that atmospheric air circulation around the vaporizer is not restricted. Vaporizers should be separated from traffic areas so that fog, generated by cooling the air around the vaporizer, does not impact the safety of vehicles and of people.

6.2.4.3 CNG part of the LCNG fuelling station

CNG equipment that is part of the LCNG fuelling station shall be located so as to avoid exposure to temperatures that are lower than the minimum design temperature of the equipment.

6.2.4.4 Location of electrical equipment

Electrical equipment and non-electrical equipment that is capable of producing an ignition source shall be designed for use in hazardous areas, as determined by a hazardous area classification analysis, or shall be located outside the hazardous areas.

6.2.4.5 Access

Safe means of access and sufficient space for inspection, maintenance and service shall be provided to all equipment requiring maintenance or operator intervention.

6.3 Environmental considerations

6.3.1 Noise attenuation

Control of noise shall comply with local legislation and site requirements.

6.3.2 Prevention of venting of natural gas

6.3.2.1 The design and operation of the fuelling station shall minimize the venting of boil-off gas to the atmosphere.

6.3.2.2 During normal operation, venting should be limited to minor releases of gas resulting, for example, from disconnection of hoses.

6.3.2.3 Boil-off gas from other parts of the LNG fuelling station may be returned to the LNG storage tank for accumulation and/or treated in other suitable ways.

6.3.2.4 In the case of emergency, venting of boil-off gas to the atmosphere is permitted provided that it is vented in a safe manner to a safe location.

EXAMPLE Through a vent stack.

The secondary relief valve output may be headed directly to the atmosphere.

6.3.2.5 During maintenance, repairs, refurbishment and purging of equipment venting of natural gas to the atmosphere should be minimized and the quantity and flowrate should be limited in order to prevent the formation of an explosive atmosphere.

7 Fuel supply to the fuelling station

7.1 Application

This clause specifies the requirements for safe delivery of LNG from the LNG tanker to the LNG fuelling station and protection against overpressurization and overfill of the LNG storage tank.

7.2 Equipment compatibility

The equipment of the LNG fuelling station shall be suitable for the LNG supplied.

7.3 Filling connector

7.3.1 The filling receptacle shall be placed so that it is easily accessible by the driver of the LNG tanker or other competent person for connection of the offloading hose without entering the containment.

7.3.2 The type of filling receptacle shall be compatible with the filling nozzle of the offloading hose of the LNG tanker. Similar rules shall be applied in those cases where an offloading arm is used.

7.4 Requirements for filling

7.4.1 General requirements

7.4.1.1 At least one qualified person (usually the LNG tanker driver) shall be in continuous attendance and shall have an unobstructed view of the LNG transfer point while offloading is in progress. This person shall be able to monitor the level and pressure of the LNG storage tank and control the offloading process.

7.4.1.2 The qualified person shall sanction the filling process either continuously or intermittently at periods not exceeding three minutes (e.g. by holding or pushing a button). Failure to do so shall automatically interrupt the filling process by stopping the transfer pump.

7.4.1.3 Venting of the LNG storage tank during filling shall only be done under emergency conditions and in a manner acceptable to local authorities.

7.4.1.4 For the prevention of vapour displacement and for minimum pressure after filling, the LNG storage tank should be filled from the top except when it is necessary to use combined top and bottom filling in order to maintain a pressure in the LNG storage tank that is higher than the saturation pressure of the delivered liquid.

7.4.1.5 When the LNG in the LNG storage tank after filling is saturated by the use of a saturation vaporizer, the transfer pump shall automatically be stopped at a set pressure lower than the set pressure of the relief valves of the LNG storage tank.

7.4.2 Prevention of overpressurization and overfilling

7.4.2.1 The maximum LNG pressure achievable at the LNG storage tank filling nozzle during filling should be lower than the set pressure of the relief valve of the LNG storage tank.

7.4.2.2 Where it is not possible to meet this requirement, two independent high level trips shall be provided for the LNG storage tank and the detection of high level shall automatically stop the transfer pump and close the loading line valve(s).

NOTE For this purpose, the two independent systems of liquid level measurement according to 8.1.1.9.2 can be used, or additional liquid level systems may be added.

7.5 Prevention of back flow

Reversed flow in the filling line shall be prevented using a check valve in addition to the isolation valve. Combined isolation valve with check function is acceptable.

7.6 Bleed connections

Bleed or vent connections shall be provided so that loading arms and hoses can be drained and depressurized prior to disconnection if necessary. The connections shall relieve to the vent stack.

7.7 Draining of liquid from the LNG storage tank

Provisions shall be made for transferring of the contents of the LNG storage tank to another vessel.

7.8 LNG tanker

7.8.1 Immobility

Prior to connection, the LNG tanker wheels shall be rendered immobile.

7.8.2 Anti-drive-away equipment

7.8.2.1 Anti-drive equipment helps to mitigate risk in the event that an LNG tanker moves (or attempts to move) away from the LNG fuelling station during the product transfer operation and can be required by some national standards or regulations. Primarily, it is intended to prevent movement of the vehicle in relation to the LNG fuelling station; the opening of the LNG tanker valve cabinet door typically triggers a pneumatic valve which activates the brakes of the vehicle. In some countries this is considered insufficient, for instance under conditions where the road surface is icy and the LNG semitrailer can be towed away in spite of activated brakes. In such situations, an interlock system between the LNG tanker and the LNG fuelling station can be required, which automatically shuts the main liquid valve on the LNG tanker when a cable connection between the LNG tanker and the LNG fuelling station is broken.

7.8.2.2 In cases where offloading from an LNG tanker not equipped with anti drive-away equipment is permitted, a breakaway coupling element with check valves on both ends shall be installed at the LNG fuelling station side of the LNG offloading hose.

7.8.3 Turning off the engine

7.8.3.1 The LNG tanker engine shall be turned off while the transfer hose or piping is being connected or disconnected.

7.8.3.2 If required for LNG transfer, the engine shall be permitted to be started and used during the liquid transfer operations.

7.8.4 Equalizing the potentials

Before connecting the transfer hose to the fill connector, the LNG tanker shall be grounded to the LNG fuelling station grounding system.

8 Storage

8.1 LNG storage

8.1.1 Design and construction

8.1.1.1 General requirements

8.1.1.1.1 The LNG storage tank is a pressure vessel intended for operation at cryogenic temperatures. As such, it shall comply with the applicable standards for cryogenic pressure-vessel storage tanks (e.g. ISO 21009 series, EN 13458, ASME VIII Div.1).

8.1.1.1.2 The LNG storage tank shall operate safely in conditions of applicable climatic conditions (wind, snowfall, etc.). It shall be designed for resistance to earthquake in the applicable earthquake zone without discharge of liquid. All its plumbing shall be from material, specified for usage at cryogenic temperatures.

8.1.1.1.3 The vessel and its supports shall be designed in accordance with an appropriate standard or code, which takes into account seismic and operating loads.

8.1.1.1.4 LNG storage tanks shall be of a double-walled construction, where the inner vessel which is designed to hold the LNG is contained within the outer vessel. Annular space between the vessels shall contain insulation and shall be evacuated of air to minimize heat transfer.

8.1.1.2 Identification

Each LNG storage tank shall be identified by the attachment of (a) nameplate(s) in an accessible location marked with the information as required by the relevant codes or regulations and otherwise containing the following as a minimum:

a) manufacturer name and date tank was built, serial number;

b) nominal volumetric liquid capacity;

c) design pressure at the top of the tank;

d) maximum permitted liquid density;

e) maximum filling level;

f) minimum design temperature.

8.1.1.3 Outer vessel

The outer vessel shall be of welded construction. The material shall have a melting point greater than 1 093 °C. Where vacuum insulation is used, the outer vessel shall be designed to the respective outer pressure. Any portion of the outer vessel surface that could be exposed to LNG temperatures shall be suitable for such temperatures or protected from the effects of such exposure. All penetrations of the outer vessel shall be identified to ensure correct connection.

8.1.1.4 Inner vessel supports

The inner vessel supports shall be designed for shipping, seismic and operating loads in accordance with applicable code (e.g. IBC code, EN 1998). The internal vessel support system shall be designed to accommodate expansion and contraction of the inner vessel so that the resulting stresses imparted to the inner and outer tanks are within allowable limits.

8.1.1.5 Saddles and legs

Saddles and legs shall be designed in accordance with recognized structural engineering practice, taking into account shipping loads, erection loads, wind loads, and thermal loads. Supports shall be protected to have a fire resistance at radiation of 15 kW/m^2 of not less than one hour. If insulation is used to achieve this requirement, it shall be resistant to dislodgment by fire hose streams.

8.1.1.6 Vent stack

The vent stack shall be designed to prevent entry of precipitation such as rain and snow. Drainage at the bottom of the vent stack should be considered to allow removal of potentially trapped atmospheric condensates. Additional LNG fuelling station vent lines to the LNG storage tank vent stack is permitted provided that the gas from such lines is dry and that the stack can adequately handle the extra venting capacity without compromising the operation of any interconnected relief devices due to excessive backpressure. Detection of temperatures lower than −80 °C in the vent stack should trigger the LNG fuelling station ESD.

8.1.1.7 Pipework

All piping that is part of an LNG storage tank as delivered by the tank manufacturer, including piping between the inner and outer vessels, shall be in accordance with applicable standards and codes with respect to thermal and pressure loads. Thermal expansion and contraction and related stress shall be considered and design measures taken accordingly. All piping and tubing shall be austenitic stainless steel applicable to service at temperatures down to –196 °C. All piping and piping components shall have a minimum melting point of 816 °C. Brazing filler metal shall have a minimum melting point exceeding 538 °C.

8.1.1.8 Valves

Valves exposed to temperatures below **–**40 °C during operation or abnormal situation shall comply with ISO 21011 or other applicable standards. Extended valves shall normally be used on cryogenic liquid lines. The spindle shall be normally oriented upwards vertical or inclined. Bellows are not permitted within the insulation space of the LNG storage tank. All valves including and up to the first welded ESD valve shall be fire rated in compliance with ISO 10497 or equivalent.

8.1.1.9 Instrumentation

8.1.1.9.1 Pressure gauges

Each LNG storage tank shall be equipped with a pressure gauge that permanently indicates the pressure in the tank above its maximum fill level.

8.1.1.9.2 Liquid level gauges

8.1.1.9.2.1 An LNG storage tank shall be fitted with two independently operated level measuring systems. Each of the level measuring systems shall be capable of automatically stopping the offloading pump and closing the valve through which LNG is supplied to the storage tank to prevent the LNG tank exceeding the maximum permitted filling level.

8.1.1.9.2.2 Any try cock that opens to the atmosphere shall not be used for measurement, but it may be used for level measurement equipment verification. For prevention of frequent venting natural gas to the atmosphere, the try cock shall not be any routine tool used at every filling of the LNG storage tank.

8.1.2 Safety requirements

8.1.2.1 Overpressure

8.1.2.1.1 Maximum allowable working pressure

8.1.2.1.1.1 The maximum allowable working pressure of the LNG storage tank should be selected such that is reasonably higher than the larger of

— the boiling pressure of LNG (saturation) at delivery, or

— the pressure to which LNG is saturated as required for operation

and still having a reasonable holding time that allows reasonably long non-venting operation so that possible gas venting is limited to emergency situations only.

8.1.2.1.1.2 For guaranteed compliance, the maximum allowable working pressure of the LNG storage tank should be at least 300 kPa higher than the maximum allowable working pressure of the tank of the LNG tanker. Where such requirements cannot be fulfilled, fail-safe design measures and/or procedures for checking the saturation of the delivered LNG or project design measures for maintaining excess flash gas shall be applied.

8.1.2.1.2 Primary pressure relief valves

8.1.2.1.2.1 The vessel shall be equipped with at least two relief valves (also "primary" relief valves), connected to the top of the inner vessel, each of them sized according to 8.1.2.1.4. The relief valves shall comply with ISO 21013-1. Each pressure relief valve shall discharge to open atmosphere. Where discharge of gas to the atmosphere is considered unsafe, the relief valve vent line shall be headed to a vent stack, which enables safe discharge to atmosphere.

8.1.2.1.2.2 The set opening pressure of the primary relief valve shall be lower or equal to the maximum allowable working pressure of the LNG storage tank. The LNG storage tank pressure shall not be higher than 1,1 times the maximum allowable working pressure at relief valve maximum flowrate.

8.1.2.1.3 Secondary pressure relief valves

Secondary relief valves may be installed in parallel to primary relief valves. Their function is to open in case the primary relief valve fails for any reason. Opening of any secondary relief valve should occur at a pressure lower than the test pressure of the LNG storage tank.

8.1.2.1.4 Sizing of pressure relief valves

8.1.2.1.4.1 The sizing of relief valves shall be calculated using appropriate methods, with consideration of the design of the inlet and outlet lines according to the largest of the following:

a) normal boil-off plus the largest of

— full flow through a pressure build-up or saturation vaporizer (continuous flow),

— maximum vapour inlet from subcooling of a pump (one of quantity of gas),

— maximum vapour inlet from recirculation through a pump (continuous flow), and

— maximum venting of a vehicle tank (one off quantity of gas);

b) fire and loss of vacuum in the insulation space according to the applicable standards (e.g. ISO 21013-3);

c) other sources of gas or heat, in combination or alternatively to the aforementioned items a) to b).

8.1.2.1.4.2 The inlet and outlet piping of a relief valve including the vent stack shall be sized so that relief valve seat chatter is prevented. The pressure drop of these pipelines shall be lower than 3 % of the relief valve opening pressure at the maximum relief valve design capacity for prevention of chattering.

8.1.2.1.5 Rupture (bursting) discs

Rupture (bursting) discs are not recommended for the function of pressure relief device due to risk created by large emissions of natural gas into the atmosphere.

8.1.2.1.6 Vacuum pressure relief devices

A pressure relief device shall be fitted to the outer jacket. The device shall be set to open at a pressure which prevents collapse of the inner vessel and is not higher than 50 kPa. The discharge area of the pressure relief device shall not be less than 0,34 mm^2/l capacity of the inner vessel and in any case need not exceed 5 000 mm^2. Vacuum-jacketed equipment shall be equipped with instruments or connections for checking the pressure in the annular space.

8.1.2.1.7 Depressurization

For decreasing the pressure in the LNG storage tank, a manual or automatic venting system shall be provided (for example for venting into low pressure pipeline) unless the over pressurization of the LNG storage tank is prevented by other means (see 6.3.2). The pressure relief devices installed on the LNG storage tank shall not be used for venting the boil-off gas as a routine way of operation.

8.1.2.2 Leaks and spillage

8.1.2.2.1 Leak detection

Consideration shall be given to the installation of leak-detection devices and means to control the evaporation rate in the containment. The basin may be partitioned to reduce vaporization of LNG and therefore gas emission into the atmosphere. Accidental leakage of LNG should be detected by low-temperature sensing on the foundation. Low temperature sensors should be installed on the foundation surface in areas nearest the most probable occurrence of LNG of the LNG fuelling station system. If the containment is split into parts, low temperature sensor should be placed in every part, where LNG spill is possible.

8.1.2.2.2 Containment

8.1.2.2.2.1 General design

LNG fuelling stations shall include a means of containing spilled LNG in order to reduce the consequences of a spill. The parts of the LNG fuelling station that contain LNG shall either be located inside the containment, or shall be located such that spilled LNG can be safely drained to the containment.

It is not necessary to provide containment for LNG spills from the LNG storage tank(s) and associated equipment if it can be demonstrated that the consequences of LNG spills can be safely mitigated without the use of containment.

It is not necessary to provide containment of LNG spills in areas where LNG is offloaded from the LNG tanker and areas where LNG is dispensed to vehicles when these operations are carried out under the continuous supervision of a qualified person.

Containment may be located around, or adjacent to, the LNG storage tank or may be located remotely and connected to all areas where there is potential for an LNG spill by a safe drainage system. The bottom of the containment can be under the surrounding terrain level, equal to it or above it.

The design of the containment shall be such that flammable fluids do not enter the surface water drainage system (i.e. canalization) or other underground infrastructure like sewer, cables, waterworks. For any location reachable by drained LNG, separation distances as specified from the LNG storage tank according to Table B.2 shall apply.

When pipework is routed through the bund of a containment basin, a suitable seal shall be provided.

8.1.2.2.2.2 Size of the containment

The volume of the containment should be equal to the volume of the LNG storage tank installed in the containment. Smaller volumes can be justified.

— In case of an installation consisting of multiple LNG storage tanks, the volume of the largest tank only shall be considered for the sizing of the containment.

— In case where different parts of the equipment are placed in separate containments, the volume of each containment shall be specified according to the volume of LNG, stored in the respective containment including the volume of LNG, which can enter the respective containment in case of accident.

— In case that the detection of LNG spillage is guaranteed with plant design and an automatic shutdown of the main LNG storage tank valves is triggered automatically by the ESD system, the volume of the containment can be limited to the maximum volume of liquid, that could be discharged during a 10-minute period from any single accidental leakage source or lesser time period based on demonstrable surveillance and shutdown provisions acceptable to the authority having jurisdiction.

Containment areas, if provided to serve LNG transfer areas, shall have a minimum volumetric capacity equal to the greatest volume of LNG that could be discharged into the area during a 10-minute period from any single accidental leakage source or a lesser time period based on demonstrable surveillance and shutdown provisions acceptable to the authority having jurisdiction.

Sizing of the containment shall take into consideration possible occurrence of rain water, snow, ice or mud with respect to local conditions. Drainage of precipitated water shall be considered including melting of snow or defrosting of the equipment. Rain or fire water, which could accumulate in the containment, shall be removed by relevant means without transferring spilled LNG. The top level of the bund shall not be so high as to prevent fire brigade intervention and excessive vapour confinement.

8.1.2.3 Isolation

8.1.2.3.1 Primary isolation

The LNG storage tank and its equipment shall be designed to avoid the complete loss of liquid in accidental situations. Isolation valves shall be welded onto liquid pipes as close to the pressure vessel as possible (or as close to the vacuum jacket as possible in the case of vacuum-insulated vessels).

8.1.2.3.2 Secondary isolation

Lines from the LNG storage tank that can release LNG to atmosphere shall have a secondary means of isolation with the exception of the lines from the relief valves, the try cock, and the instrument lines. A check valve or isolation check valve may be used as the secondary means of isolation on the filling line.

8.1.2.3.3 Liquid outlet isolation

An automatic emergency isolation valve shall be fitted to the LNG storage tank liquid outlet. Depending on the size of the LNG storage tank, remote actuation of these valves triggered by ESD system shall be provided. For any additional requirements, local norms and regulations shall be applied. Where these do not exist, the requirements of 8.1.2.3.5 should be applied.

8.1.2.3.4 Relief valve isolation

8.1.2.3.4.1 Suitable isolation valves shall be arranged to allow each relief valve to be isolated individually for testing or maintenance whilst still maintaining the full capacity of the relief valve/valves in any position of the closing valve system (e.g. a full-port-opening three-way valve).

8.1.2.3.4.2 After removing a relief valve, for instance for calibration or repair, it shall be immediately replaced by an equivalent relief valve. The closing valve system shall be locked or sealed in order to prevent unauthorized operation. Valves for depressurization of the inlet of each relief valve directly to the atmosphere may be installed.

8.1.2.3.5 Emergency isolation

8.1.2.3.5.1 Emergency isolation valves shall be fail-safe. A normally-closed actuated isolation valve triggered by the ESD system shall be fitted to the inlet of each dispenser.

8.1.2.3.5.2 The method of actuation of LNG emergency isolation valve of the LNG storage tank depends on the capacity of the LNG storage tank as specified in Table 1.

Table 1 — Actuation of LNG storage liquid isolation valves

Gross volume of LNG storage m^3	Actuation of the liquid emergency isolation valves
up to 10	Safe manual operation in emergency.
10 to 120	Automatic isolation valve, before or after the first manual shut-off valve, activated by a trip of the ESD system.
>120	Automatic isolation valve, with a position indicator, before or after the first manual shut-off valve, activated by a trip of the ESD system.

8.1.2.4 Inertization

The LNG storage tank shall be shipped filled with inert gas under a minimum internal pressure of 50 kPa.

8.1.3 Installation guidance

8.1.3.1 Foundations

8.1.3.1.1 LNG storage tank foundations shall be designed and constructed in accordance with recognized structural and geotechnical engineering practices including provisions for seismic and wind loading.

8.1.3.1.2 Where the LNG storage tank is installed in an area subject to flooding, the tank shall be secured in a manner that will prevent release of LNG or floatation of the tank in the event of a flood.

8.1.3.2 Buried storage

8.1.3.2.1 Buried and underground LNG storage tanks shall be provided with means to prevent the 0 °C isotherm from penetrating the soil. Where heating systems are used, they shall be installed such that any heating element or temperature sensor used for control can be replaced.

8.1.3.2.2 All buried or mounded components in contact with the soil shall be constructed from material resistant to soil corrosion or protected to minimize corrosion.

8.1.3.2.3 If the LNG storage tank is buried, the design shall account for loads exerted upon it due to earth mass, underground water, and other dynamic or static loads from above-ground installation or activities. A buried LNG storage tank shall be anchored to a sufficiently-sized foundation for prevention of any lifting of the tank with buoyancy force.

8.1.3.2.4 Buried LNG storage tanks shall be equipped with access to all the tank equipment on the outside of the outer vessel. The relief vent stack and the vacuum relief device vent shall be safely piped to the aboveground area. The vacuum safety device vent stack cross section shall be twice as large as the cross section of the vacuum relief device. Presence of insulation particles shall be taken into consideration when designing the vacuum device vent stack.

8.1.3.3 Mobile storage

8.1.3.3.1 The mobile LNG storage tank shall be designed to meet the requirements of applicable codes and standards for the carriage of cryogenic and dangerous goods, such as ISO 20421-1, ADR, DOT or equivalent.

8.1.3.3.2 During service the mobile LNG storage tank shall not have a resistance higher than 1 MOhms (MΩ) relative to ground.

8.1.3.3.3 During service, the mobile tank shall be parked and unloaded from a dedicated location that complies with the requirements of separation distances and explosion zones in accordance with this document.

8.1.3.3.4 In situations where the mobile LNG storage tank is parked on a bogie, 7.8.1 and 7.8.2 apply.

8.1.3.3.5 The mobile LNG storage tank shall have a normally closed automatic shut-off valve in the liquid outlet line located close to the outlet of the LNG storage tank. The valve shall close in the event of an emergency or when triggered by operator by (a) device(s) installed on the unit. The automatic shut-off valve shall also be linked to either the LNG fuelling station ESD system or its own autonomous ESD system whereby a special risk analysis is required.

8.2 CNG buffer storage

8.2.1 CNG buffer storage shall comply with the requirements of ISO 16923.

8.2.2 CNG as vaporized from LNG does not contain moisture, oil or hydrocarbons heavier than butane. Also, if the equipment was exposed to humid air, during repairs for example, the dry CNG will bring the humidity out during operation. Consequently, neither corrosion nor accumulation of oil or humidity can take place during operation. This can be taken into consideration when considering the required frequency for maintenance and periodical inspections, subject to approval by authority having jurisdiction.

8.2.3 CNG buffer storage shall be protected from exposure to temperatures lower than its minimum design temperature. Failure of the vaporizing system to provide an adequately warm gas shall trigger the shut-down of the high pressure cryogenic pump.

9 Pumps and compressors

9.1 Connection of LNG pumps to the LNG storage tank

9.1.1 General

Connection of pumps to LNG storage tanks should be done in accordance with the pump manufacturer's recommendations. The pipe connection should be designed with minimal pressure-losses and kept well-insulated to prevent heat leak to the working fluid. Operating conditions should be taken into account in order to prevent vapour-lock conditions from arising bubbles, leading to pump cavitation and loss of prime due to local lowering of cryogenic liquid pressure just below its vapour pressure.

9.1.2 NPSH requirements

The efficient operation of the cryogenic pump is dependent from adequate NPSH. The NPSH available (NPSHA) at the cryogenic pump inlet shall be higher or equal to the NPSH required (NPSHR) by the pump. Further details on process requirements for the effective cryogenic pump operation can be found in Annex F.

9.1.3 Vapour return

Any vapour, generated by cool down, operation and cold standby, from degassing line of the pump shall be collected to the LNG storage tank or somewhere else to prevent venting to the atmosphere.

9.1.4 Protection against weather

Cryogenic pumps intended for outdoor installation shall be adequately protected against weather conditions as recommended by the pump manufacturer to ensure safe and reliable operation.

9.1.5 Accessibility

Components, integral parts and user controls that can require adjustment or replacement during operation and maintenance shall be easily accessible.

9.2 LNG centrifugal pump (including ancillaries)

9.2.1 General provisions

9.2.1.1 A centrifugal pump shall be in compliance with ISO 24490. ISO 13709 shall be applied as far as applicable. For sealless pumps, as far as not covered by these ISO standards, reference can be made to API 685.

9.2.1.2 Consideration shall be given to the effects of the operation of the centrifugal cryogenic pump with the cryogenic storage tank and installation involving the use of cryogenic liquid.

9.2.2 Liquid inlet to the centrifugal pump

The installation of the liquid inlet to the centrifugal pump shall be done in accordance with the recommendations from the LNG storage tank and the cryogenic pump manufacturers. An example can be found in Annex G.

9.2.3 Centrifugal pump design

9.2.3.1 A variety of centrifugal pump designs exist ranging from mechanical shaft seal designs to sealless designs with submerged motors, canned motors, or magnetic couplings. For the different designs, careful review of consequences of humidity frosting is needed and its avoidance can be required by the manufacturer. Stand-by in cold conditions shall be included into the cryogenic pump design specification. Recommendations on centrifugal pump design are given in Annex H.

9.2.3.2 The centrifugal cryogenic pump shall be designed for safe operation and should be capable of intensive use, according to applicable standards to IEC 60079-10-1, IEC 60079-14, IEC 60079-17 and IEC 60079-19.

9.2.3.3 The centrifugal pump consists typically of a volute or diffuser pump housing, shaft with impeller(s) and inducer. The shaft is supported by adequate bearings. This assembly is usually called “cold end”. The cold end is coupled to a drive assembly typically called “warm end drive” or to submerged motor running in the pumped liquid and/or in the vapour space above the liquid level. The “warm end drive” can be either an electric or hydraulic motor, often with speed increasing gearbox.

9.2.3.4 The required pump discharge pressure is achieved by a number of pump stages and by pump speed. The pump design shall carefully assess the rotor axial thrust for the correct axial bearing dimensioning.

9.2.3.5 The pump and drive design and the auxiliaries’ selection shall be suitable for the hazardous area of installation.

9.2.3.6 Specific recommendations for centrifugal pumps design are included in Annex F.

9.2.4 Vibration

The centrifugal pump rotating components shall be adequately balanced [pump shaft, impeller(s), motor rotor, coupling] to eliminate pump and system vibration. Adequate supports or mounting shall be provided to minimize the transmission of the mechanical vibration to the structure.

9.2.5 Detection of shaft seal leak

Instrumentation shall be provided to stop the pump and isolate the supply of LNG to the pump upon detection of seal leakage (e.g. seal body temperature sensor). This is not required for submerged pumps.

9.2.6 Detection of cavitation

Instrumentation shall ensure the pump is stopped upon detection of cavitation.

9.3 LNG reciprocating pump for LCNG fuelling stations (including ancillaries)

9.3.1 General provisions

9.3.1.1 A reciprocating pump shall be in compliance with ISO 24490.

9.3.1.2 Consideration shall be given to the effects of the operation of the reciprocating cryogenic pump on the installation with the cryogenic storage tank and installation involving the use of cryogenic liquid.

9.3.2 Liquid supplied to the reciprocating pump

The installation of the liquid supply pipeline to the reciprocating pump shall be done in accordance with the recommendations from the LNG storage tank and the cryogenic pump manufacturers. An example of a typical installation can be found in Annex I.

9.3.3 Design

9.3.3.1 The reciprocating cryogenic pump shall be designed for safe operation and should be capable of intensive use. A typical design consists of a cold end and of a warm end drive.

9.3.3.2 The cold end consists of vacuum jacketed cylinder, reciprocating piston, with adequate piston rings, piston shaft with adequate seals, suction and discharge valve assemblies, filter as well as specific provision for vapour venting. The warm-end drive includes mainly a motor, mechanical transmission and supporting parts.

9.3.4 Vibration

The reciprocating pump shall be provided with adequate means of balancing (crank shaft counterweight, flywheel, and multiple cylinders), support or mounting to minimize the transmission of mechanical vibration to the structure.

9.3.5 Pulsation

The reciprocating pump shall be provided with a suitable device which protects the system from unacceptable pressure pulsations. This is typically an upwards blind volume (pulsation dampener, buffer) at the pump outlet, which under normal operation contains a portion of liquid and a gas cushion above the liquid level. Pressure changes are partially compensated by compression of the gas.

9.4 Commonalities for LNG centrifugal and reciprocating pumps

9.4.1 Suction line

9.4.1.1 A normally closed valve shall be fitted to isolate the LNG supply to the pump whilst the pump is off-line or in long standby.

9.4.1.2 A suitable filter shall be provided in the inlet of the cryogenic pump to prevent solid particles from causing damage to the pump components.

9.4.1.3 The connections to the LNG storage tank shall be designed to absorb the piping stresses resulting from temperature changes.

9.4.2 Instrumentation

9.4.2.1 The system instrumentation and accessories required for safe operation of pumps include the following:

— cooling down sensor to ensure the pump is ready to start;

— high pressure venting cryogenic valve (manual or/and automatic), when required by the design of the pump. Possible venting shall be maintained with respect to the requirements of 6.3.2;

— emergency stop button (may be integrated with the ESD system of the LNG fuelling station).

9.4.2.2 Additional equipment may be supplied in accordance with the processes and risks analysis made on the complete fuelling system.

9.4.2.3 Pumps shall shut down safely in the event of loss of energy supply.

9.4.3 Markings of a pump

A cryogenic pump shall be marked by the manufacturer. It shall carry the following markings in a durable, legible manner on a firmly attached plate:

— identification of the manufacturer and, where appropriate, identification of his authorized representative;

— the year of manufacture;

— unique identification of the pump such as type, series or batch identification and/or serial number;

— essential process data such as design pressure and temperature, rated power in kW (kilowatts) and supply voltage in V (Volts);

— warning or special conditions for safe use.

9.4.4 Instructions

9.4.3.1 The manufacturer of the pump shall be required to provide comprehensive operating instructions. The operating instructions shall be in a language, or languages, understood by the operator(s) as well as any language prescribed by local regulations.

9.4.3.2 The texts shall be simple, appropriate, complete and suitable for the personnel in charge of the pump.

9.4.3.3 The documentation delivered with the pump shall reflect its complexity and as minimum contain the following information:

— procedures for safe operation, including warnings concerning known hazardous practices, undesignated use and residual risks;

— procedures for maintenance and servicing;

— a list of parts required for service.

9.4.3.4 Examples of content required for a cryogenic pump operation manual are provided in Annex J.

9.4.3.5 The operating instructions shall be readily available to the operator(s) at all times.

9.5 Natural gas compressor

If a natural gas compressor is used at the LNG or LCNG fuelling station (e.g. for compression of boil-off gas), the requirements of ISO 16923 apply. Specific requirements related to LNG technology at the LNG or LCNG fuelling station can include, for example:

— prevention of low temperature at the compressor inlet;

— accidental exposure of the compressor assembly to low temperature or spilled LNG.

10 Dispensers

10.1 LNG dispensers

10.1.1 General requirements

10.1.1.1 LNG delivered to the vehicle

10.1.1.1.1 The maximum size of particulates in the LNG supplied to the vehicle shall be 150 microns unless otherwise specified by the manufacturer of the dispenser.

10.1.1.1.2 The pressure of LNG at the nozzle shall be lower than the maximum allowable working pressure of the vehicle tank. Consideration shall be given to the effects of the pressure changes in the LNG storage on the cryogenic pump discharge pressure, as well as to the characteristics of the cryogenic pump and the maximum pressure it can deliver.

10.1.1.1.3 The maximum allowable volume of liquid of the vehicle tank shall not be exceeded.

10.1.1.1.4 The temperature of the LNG delivered to the vehicle shall be compatible with the LNG system specifications for the vehicle.

NOTE Typically, the saturation pressure is used as a measure of the LNG temperature.

10.1.1.1.5 The quantity of LNG supplied to the vehicle may be determined by measuring either mass or volume and applying the density of the LNG at the dispenser.

10.1.1.1.6 The LNG dispenser may be operated in several modes, which include the following:

a) manually or automatic;

b) metered or un-metered;

c) assisted or self-service.

10.1.1.1.7 LNG may be delivered through a dispenser to a vehicle tank either directly from an onsite LNG storage tank or by using a cryogenic pump.

10.1.1.2 Dispenser functions

The dispenser shall be capable of performing the following functions:

a) safe delivery of LNG from the dispenser to the vehicle tank;

b) limited leakage from the nozzle of the dispenser hose and the vehicle receptacle to the residual gas that is released from the interspace between the nozzle and receptacle upon disconnection of the dispenser hose after fuelling;

c) safe handling of the LNG that remains in the fuelling hose after the fuelling is finished by returning it, together with any vapour produced from it, back to the LNG fuelling station storage;

d) recovery of vapour from the vehicle tank when double hose fuelling is used or when the vehicle presents for refuelling with excessive pressure in the vehicle tank;

e) optionally, measurement of the quantity of LNG dispensed:

   — for non-commercial dispensing, it may be conducted without a certified metering system;

   — for commercial transactions, certification of the dispenser by the national authority or other regulatory body (such as MID certification) is typically required;

10.1.1.3 Hazardous areas

The dispenser location shall comply with the requirements for the hazardous area in which the dispenser is placed.

LNG dispenser may be located closely to other fuel dispensers provided hazardous area requirement are complied with.

10.1.1.4 LNG dispenser components

The dispenser is typically equipped with the following components:

— nozzle(s) for fuelling LNG with or without vapour return/recovery;

— hose(s) for fuelling LNG with or without vapour return/recovery;

— hose(s) for vapour recovery when not integrated with the fuelling hose;

— dummy receptacle or parking dock for the nozzle when the fuelling hose is not in use;

— breakaway device(s), which may be an integral part of the hose assembly;

— system for safe stowage of the hose(s) when not in use;

— flow meter(s);

— optional LNG vessel to contain the flow meter;

— temperature and pressure sensors and transmitters;

— electronic evaluation unit, which may communicate with a payment terminal;

— monitor displaying quantity, price, etc.;

— pipe work and control valves, including thermal and pressure relief valves;

— electrical and pneumatic power supply;

— housing;

— start and stop buttons;

— emergency stop button, which can also be used as start-stop button;

— dead man's button or handle according to 10.1.6.2.

10.1.2 Breakaway system

10.1.2.1 The breakaway system shall break the connection of the hose to the dispenser at a defined place in case of excessive force. It shall seal each of the separated parts so that spillage of LNG from any of both the sides is prevented. For this purpose, check valves shall be installed at each of the separated parts. Where required by local regulations, two check valves in series shall be used.

10.1.2.2 The disconnection force (the axial force in the fuelling hose) of the breakaway device shall, in any direction, be

— less than 850 N for high flow refuelling connectors according to ISO 12617,

— less than 500 N for smaller refuelling connectors,

— less than 70 % of the allowed extension force of the fuelling hose, and

— less than 80 % of the allowed force in the hose with respect to the maximum allowed load of the refuelling connector without leak or damage as defined in ISO 12617 or elsewhere for other refuelling connectors.

10.1.3 Fuelling hoses

10.1.3.1 Fuelling hose assembly

10.1.3.1.1 The fuelling hose assembly shall consist of

— the fuelling nozzle according to 10.1.4,

— the hose,

— a breakaway system according to 10.1.2, if not part of the dispenser, and

— a connection to the dispenser.

10.1.3.1.2 The length of the fuelling hose assembly shall be the minimum required for easy fuelling, but shall not be longer than 5 m.

10.1.3.1.3 The electrical resistance of the fuelling hose assembly shall be in accordance with 14.2.5.1.

10.1.3.2 Hose properties

10.1.3.2.1 The fuelling hose shall comply with ISO 21012. The fuelling hose shall be

— suitable for LNG and designed to reduce and/or avoid the risk of cryogenic frostbite,

— suitable for the pressure duty,

— resistant to corrosion and mechanical damage, protected by stainless steel wire-braiding or an equivalent design, and

— adequately supported or coated to prevent kinking and abrasion, if thermoplastic/composite hoses are used.

10.1.3.2.2 When the requirements 14.2.5.1 are considered, the electrical resistance of the hose relates to the whole hose assembly.

10.1.3.3 Marking

Marking shall be done in accordance with ISO 21012.

10.1.3.4 Strength

The hose connections shall withstand the hose's burst pressure.

10.1.3.5 Venting

The hose design and installation shall include provisions for returning of the liquid remaining in the fuelling hose after fuelling and the associated vapour back to the LNG storage. Heat leak rate, pressurization and hydrostatic head aspects of such a system shall be taken into account.

10.1.4 Fuelling nozzles

10.1.4.1 Connection

The fuelling nozzle shall be designed such that LNG can only be transferred when the nozzle is correctly connected to the receptacle of the vehicle tank.

NOTE Connectors in accordance with ISO 12617 meet this requirement.

10.1.4.2 Prevention of frosting of the nozzle mating surface

To prevent frosting of the cold parts of the nozzle and subsequent ingress of moisture/humidity/ice crystals into the vehicle fuel system, adequate measures shall be applied in the design and operation requirements. These can include the following.

— Cleaning the nozzle by dry air or nitrogen and subsequent connection of the nozzle to a cleaned receptacle counterpart whilst preventing ingress of ambient air. This method results in shorter lifespan of the sealing due to double frequency usage.

— Placing the nozzle into a dock, which is purged continuously with dry air or nitrogen. Docks that accept nozzles freely in the unconnected position can help to increase the lifespan of the nozzle seal. To enable the defrosting of the nozzle, the docking station may be heated, but the effect of thermal cycling shall be taken into consideration. The docking station may be integrated with piping cool down system.

— Any other similarly adequate measure.

10.1.5 Dispenser enclosure

10.1.5.1 The design of the dispenser enclosure shall prevent excessive frosting in areas where human contact can normally occur on the dispenser box.

10.1.5.2 The dispenser shall preferably be located in the open air or in a well-ventilated position, but under certain conditions, it may be located within a room or building, provided it is subjected to a risk assessment in accordance with 5.1.

10.1.5.3 The hose shall be replaced before the expiry date, specified by the manufacturer.

10.1.6 Other requirements

10.1.6.1 Protection against collision

The dispenser shall be protected against vehicle collision. Protection against the spillage of LNG in the event that the dispenser is damaged by external force shall be provided.

10.1.6.2 Attendance during fuelling

The dispenser shall be equipped with a button or handle (or similar hand operated element), such that the fuelling will only begin and continue, when this button or handle is manually operated either continuously or intermittently in short intervals of not more than 60 s.

10.1.6.3 Flowmeter

Diversion of the metered flow to anywhere other than to the vehicle tank shall be prevented.

10.1.6.4 Vapour recovery

10.1.6.4.1 The dispenser shall be equipped with a hose and a nozzle to recover the overpressure gas in the vehicle tank. In the case of double-hose fuelling, the hose shall be used for continuous withdrawal of vapour during the refuelling process. In the case of single-hose fuelling, the hose shall be used before vehicle fuelling commences when in situations where the vehicle presents for refuelling with a pressure in the vehicle tank that is too high to permit effective fuelling.

10.1.6.4.2 The hose shall be in accordance with 10.1.3 and the nozzle shall be in accordance with 10.1.4.

10.1.6.4.3 Hoses and nozzles smaller than those used for refuelling are typically used.

10.1.6.5 Inspections

10.1.6.6.1 Inspection of the LNG dispenser shall be in accordance with the applicable requirements for pressure equipment.

10.1.6.6.2 Inspection of the flowmeter shall be in accordance with the requirements of the weights and measures authority.

10.1.6.6.3 Hose assemblies shall be inspected in accordance with the manufacturer's recommended procedures at the intervals specified by the manufacturer and taking into account the frequency of fuelling. Visual inspection shall be carried out

— by the LNG fuelling station operator at least once a week, and

— by a trained and suitably qualified technician at least once every three months.

10.2 CNG dispensers

10.2.1 Gas delivered to the CNG dispenser and to CNG vehicles shall comply with ISO 16923, which defines the fuelling pressure and limits the minimum temperature to −40 °C.

10.2.2 For the purpose of this document, the CNG dispenser is used for dispensing CNG from vaporized LNG. The CNG dispenser shall be in accordance with ISO 16923.

10.2.3 Requirements on the isolation of gas inlet to the CNG dispenser are described in ISO 16923.

NOTE 1 CNG vaporized from LNG has no moisture, oil or hydrocarbons heavier than butane. Thus, corrosion or accumulation of oil in CNG buffer storage vessels, dispensers and associated equipment are not of concern in an LCNG fuelling station.

NOTE 2 If humid air enters the CNG system during maintenance, subsequent fills of dry CNG would absorb the moisture.

NOTE 3 Since the CNG does not contain oil, it does not provide any lubrication of the dispenser components or of the vehicle onboard equipment (e.g. regulator, injection equipment).

11 Vaporizers and heaters

11.1 Application

11.1.1 The purpose of the vaporizer is to convert the LNG from liquid to gaseous state. The purpose of the heater is to increase the temperature of the gas. The function of vaporizers and heaters can overlap in various operation regimes and application in the LNG fuelling station. This clause describes typical application, but other process systems can require other functions.

11.1.2 Vaporizer and heaters are used in LNG fuelling stations for the following functions.

— The primary vaporization for conversion of LNG to vapour/gas. In an LCNG fuelling station, the LNG from the high-pressure cryogenic pump flows through the vaporizer, where it is vaporized and warmed by the heat received from ambient air, warm water, electricity or any other suitable source of heat.

— A secondary heating system, commonly installed after the primary vaporizer. This heater is designed to assist defrosting and/or to increase the outlet temperature to be compatible with the design temperature of the downstream equipment.

— A pressure-build-up vaporizer for vaporizing LNG, withdrawn from the LNG storage tank and returning it to the same LNG storage tank in order to increase the pressure in the tank.

— A saturation vaporizer to heat up or vaporize LNG in order to increase the temperature of the LNG in the LNG storage tank.

11.2 Design of vaporizers and heaters

11.2.1 If vaporizers and heaters are classified as pressure vessels or pipes liable to applicable legislation, appropriate design codes shall be applied.

11.2.2 Thermal strength and expansion/contraction load cases of components of the vaporizer shall be considered for the design.

11.2.3 The design pressure of vaporizers and heaters shall exceed the maximum possible pressure achievable during operation of the LNG fuelling station, taking into account the maximum allowable working pressure of the LNG storage tank, the hydrostatic head of the LNG when the tank is full, the pressure head of the LNG pump and all other possible sources of pressure and their combinations.

11.2.4 The design pressure of the pressure-build-up vaporizer shall be higher than the LNG storage tank design pressure plus the hydrostatic pressure caused by the LNG in the LNG storage tank, so that overpressurization cannot cause the pressure-build-up vaporizer relief valve to open even when the LNG storage tank relief valve is fully open.

11.2.5 The design temperature of the vaporizer shall be −162 °C, excepting that, when it is intended to test the vaporizer with liquid nitrogen, the design temperature shall be −196 °C.

11.2.6 The vaporizer shall be anchored and connecting piping shall be sufficiently flexible to provide for expansion and contraction due to temperature change.

11.2.7 The vaporizer shall be designed to withstand the loads created by wind, earthquake and frost and snow accumulation.

11.2.8 The vaporizer relief valve shall be sized to 150 % of the vaporizer's maximum capacity, as specified by the manufacturer for the projected operating conditions. This contingency is needed to cover situations where the vaporizer is operating without any frosting and hence a high vaporization capacity.

11.2.9 For vaporizers used at LCNG fuelling stations, a low temperature sensor or other accepted means shall be installed in the vaporizer or group of vaporizers to prevent LNG or cold natural gas entering the CNG containers and other equipment not designed for cryogenic temperature.

11.3 Ambient air vaporizer

11.3.1 General

The ambient air vaporizer is a heat exchanger for the vaporization and/or heating of LNG with the heat of the ambient air. The design pressure shall be specified with respect to the maximum possible pressure achievable during operation of the LNG fuelling station.

11.3.2 Defrosting

11.3.2.1 A single vaporizer can be utilised when its operation is intermittent and the periods of non-operation are sufficient for melting and/or sublimation of frost and ice under the local climatic conditions.

11.3.2.2 When defrosting cannot be achieved during periods of non-operation, two or more vaporizers shall be installed and shall be switched in and out of operation to allow melting and/or sublimation of frost and ice.

11.3.2.3 Under extreme climatic conditions vaporizer and/or high load, switching of vaporizers may not provide sufficient defrosting. In this case, the frost and ice shall be removed using an external source of heat (hot air, hot water or steam). The removal of frost and ice by mechanical means shall not be permitted as it could cause damage to the vaporizer.

11.3.3 Aluminium vaporizers

If aluminium heat exchangers are used, one of the following requirements shall be met.

a) They shall have continuous core pipes of stainless steel to maintain the vaporizing circuit structural integrity during fire.

b) The liquid inlet line shall be equipped with an ESD valve that closes in the event of fire and gas detection.

11.4 Electric vaporizer/heater

11.4.1 For an LCNG fuelling station an electric trim heater may be used to warm the gas leaving the vaporizer, or vaporizers, to a temperature compatible with the design temperature of the downstream equipment. The minimum requirements are as follows.

— The trim heater should be intended for use with natural gas.

— The electrical components and installation in the hazardous area shall be in accordance with Clause 14.

— The electric heater shall have protection against overheating.

— A temperature-limit monitoring, both high and low, shall be installed downstream of the trim heater.

11.4.2 The heating capacity shall be taken into account in the calculation for the pressure relief device.

11.5 Water bath vaporizer

11.5.1 The water bath vaporizer typically consists of tubes for the LNG and a shell for warm water or a mixture of water with an antifreeze component such as glycol. Appropriate calculation methods shall be used for prevention of ice blockage, with sufficient reserve for irregular distribution of flow in the heat exchange space.

11.5.2 The relief valves shall be located such that they are not subjected to temperatures exceeding their maximum allowable operational temperature.

11.5.3 Every water bath vaporizer shall be provided with a local and remote device to shut off the heat source.

11.6 Fired vaporizers

11.6.1 The water bath of fired vaporizers can be heated directly by immersed burners or indirectly by one or more flame tubes.

11.6.2 Vaporizers using combustion of gas or other fuel for LNG vaporization shall be located outside hazardous areas.

11.6.3 The combustion air required for the operation of integral heated vaporizers or the primary heat source for remote heated vaporizers shall be taken from an area outside hazardous areas.

11.7 Remotely heated vaporizers

Remotely heated vaporizers use circulating warm water, which is heated by remote external boiler, waste-heat water or non-heated water from natural sources (e.g. river or sea). Shut-off valves shall be installed at the water inlet and outlet to the vaporizer.

12 Odorization

12.1 General requirements

12.1.1 LNG is not odorized. If odorized CNG is required, an odorizer shall be installed.

12.1.2 The odorization point shall be located downstream of the vaporization train and as close as practically possible to it.

12.1.3 The level of odorization is defined in ISO 16923.

12.1.4 There shall be a method of monitoring odorization of the natural gas (see 12.4).

12.1.5 If non-odorized CNG is to be delivered, the requirements of ISO 16923 shall be followed.

12.2 High-pressure odorizer

12.2.1 The high pressure odorizer doses odorant into the stream of the vaporized high-pressure gas leaving the high pressure vaporizer in a quantity suitable for achieving the criteria for odorized CNG. A high pressure odorizer consists of a fixed or exchangeable odorant container, a high pressure pump and an injector. The pump may be a small positive displacement pump and may be driven pneumatically or electrically.

12.2.2 The strokes of the pump shall be corresponding and calibrated to suit the flowrate of the natural gas, which in practical terms is the same as the flow of LNG through the high-pressure cryogenic pump. There may be a flow detector or other equipment for monitoring the consumption of odorant and a level indicator for the odorant container. An example flow diagram of a high-pressure odorizer is given in Annex K.

12.3 Safety

The key safety aspects of design, installation and operation of the odorizer are as follows.

— If the odorant is flammable, venting shall be done in a safe location.

— The odorizer normally creates a hazardous area.

— If the odorizer is located in a hazardous area, its electrical equipment shall be designed in accordance with Clause 14.

— Venting shall not take place indoors or in any place where it could impact the health of persons in the vicinity.

— Odorizer shall preferably be located in a well-ventilated location.

— Odorizer shall be able to withstand at least the maximum pressure of the gas pipeline.

— If there is a valve upstream of the injection point, the equipment upstream of that valve shall be able to withstand the maximum odorant pump pressure or a pressure relief valve shall be installed.

— A non-return valve is recommended on the odorant pump outlet.

— Very small amount of leaking odorant yields a strong smell.

— Other requirements shall be applied as appropriate for the type of odorant being used.

12.4 Monitoring

12.4.1 Monitoring of the odorization of the natural gas is necessary. This can be done for example by

— a flow detector on the odorant delivery pipe, and

— regular manual checks at a point downstream of the odorizer, carried out at suitable intervals determined by the conditions at each fuelling station.

If a flow detector is installed, manual checking is still recommended, but the frequency of the checks can be reduced.

12.4.2 Monitoring of the odorant level is necessary, to prevent operation without odorization and/or complete shutdown of the LNG fuelling station. This can be done for example by

— a level switch that provides a signal long before odorant runs out, and

— regular manual checking of odorant level at suitable intervals.

12.4.3 LCNG fuelling stations dispensing odorized CNG shall have safety measures in place to completely shut down the CNG dispensing systems automatically if the odorant supply is inadequate.

12.4.4 The level of odour shall be as specified by applicable standards.

12.5 Odorant

Operational and environmental issues shall be addressed when selecting the type and content of odorant. Odorized gas tends to be sulphuric in nature and therefore can be hazardous to the health.

12.6 Dynamics of function

Odorizer function shall be synchronized with periodical operation of the LCNG high-pressure pump. Typically, high-pressure pump delivers odorant in individual doses, which contaminate the lubrication element and downstream pipes and equipment. This equalizes concentration of the odorant in the gas. Setting of parameters of odorization process shall be validated for the type of the LCNG fuelling station.

13 Pipework

13.1 General

13.1.1 Valves in natural gas service shall comply with ISO 21011.

13.1.2 Pipework and fittings shall be firmly and securely fixed to prevent disconnection in normal operation. Components installed on foundations that can move independently from one another, shall be connected by flexible connections.

13.1.3 Thermal expansion and contraction shall be taken into account in the design of pipes exposed to cryogenic temperature.

13.1.4 Thermal relief valves shall be installed at any section of the fuelling system where pressure could develop due to the vaporization of cryogenic liquid that is trapped in that section, for example between valves or other closing elements.

13.1.5 The discharge port of the thermal relief valves shall be oriented so as to minimize the risk to personnel and equipment. In general the discharge port shall be connected to a vent stack.

13.1.6 Drains and vents shall be provided to facilitate the safe and controlled release of LNG or natural gas when there is no alternative means of handling them. Precautions shall be taken to minimize the risks created by the release of liquid and gas to personnel and equipment including the risk of frostbite from contact with cryogenic liquid or non-insulated pipes.

13.1.7 Vent lines for wet streams shall not be connected to vent systems and vent stacks for dry cryogenic gas streams.

13.2 Pipework design

13.2.1 General

13.2.1.1 Pipework shall comply with the applicable standards (e.g. EN 13480). The number of detachable joints (such as flanged joints, threaded joints or similar) shall be kept to a minimum.

13.2.1.2 Pipework shall be located in a position, where it cannot be damaged by moving vehicles, or suitable protection shall be provided.

13.2.1.3 Welded joints on pipeworks shall be made by welders qualified by national authorities to ISO 9606-1 with procedures in accordance with ISO 15609 or other equivalent standards.

13.2.2 Overground pipework

13.2.2.1 All aboveground pipework shall be constructed of appropriate corrosion protected or corrosion resistant pipes.

13.2.2.2 Where overhead pipework crosses any vehicle access way, it shall be positioned and protected to avoid damage from high vehicles.

13.2.2.3 Aboveground pipework shall be inspected on a regular basis according to local regulations.

13.2.3 Underground pipework

13.2.3.1 All underground pipework joints shall be welded and the pipework shall be constructed of appropriate material.

13.2.3.2 Underground LNG pipework shall be in ducts or pipe sleeves, unless they are specifically designed and approved to be buried.

13.2.3.3 Underground pipework shall be inspected on a regular basis.

13.2.3.4 All underground pipework shall be protected against corrosion and mechanical damage. Stainless steel pipework, if buried, shall be buried in sand.

13.2.3.5 Where the piping is cathodically protected or when other considerations call for it, insulated connections shall be fitted to electrically isolate fuelling devices from gas pipework.

13.2.3.6 Insulated connections installed aboveground in hazardous areas should be provided with adequate distances to avoid sparking.

13.2.3.7 When insulated connections are installed outdoors, the section of underground piping, including the insulation joint(s), shall be externally wrapped.

13.2.3.8 The as-built positioning and route of all underground pipework shall be recorded in the instructions that are passed to the LNG fuelling station operating company.

13.2.4 Pipework in ducts

13.2.4.1 Pipework may be installed in underground ducts provided the ventilation and drainage is adequate to prevent the formation of an explosive mixture.

13.2.4.2 The construction and quality of the pipework in ducts shall be the same as for the aboveground pipework.

13.2.4.3 LNG pipework in ducts shall be constructed of stainless steel vacuum insulated pipe having the outer shell also of stainless steel. All joints shall be welded.

13.2.4.4 The ducts shall be protected against accumulation of snow and water.

13.2.4.5 The ducts shall be sized to bear the loads from the aboveground traffic.

13.2.4.6 The ducts shall allow easy access for visual inspection of the pipework.

13.2.5 Flexible connections

Flexible connections shall be suitable for the intended duty and shall be compatible with requirements of 14.2.5.1.

14 Electrical equipment and wiring

14.1 General

14.1.1 Where electrical equipment and wiring are placed in a hazardous area, their design, selection and installation shall follow IEC 60204-1, IEC 60079-14 and other relevant parts of IEC 60079.

14.1.2 Where measures to limit the overloading of cables and electrical equipment in the event of lightning are required, they shall be in accordance with IEC 62305.

14.2 Main considerations

14.2.1 Grounding

For equalization of electrical potentials, all metallic structures shall be electrically bonded to a common earth according to IEC 60204-1.

14.2.2 Lightning

14.2.2.1 Facilities shall be protected against lightning. Major items of equipment such as vessels and tall equipment such as vent stacks shall be grounded directly to the earth point and not rely upon the piping conductivity as outlined in 14.2.1.

14.2.2.2 Measures for protection against lightning shall be considered to limit the overloading of cables and electrical equipment.

14.2.3 Contact with live parts

14.2.3.1 Electrical housings and enclosures shall conform to IEC 60204-1.

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

14.2.3.3 In normal operation, all live parts shall conform to IEC 60204-1.

14.2.3.4 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.

14.2.4 Cables

14.2.4.1 All power cables and all cables in a hazardous areas shall meet the relevant parts of IEC 60079.

14.2.4.2 To prevent gas migration between hazardous areas having different zone classifications, cables shall be sealed in accordance with IEC 60079.

NOTE The interstitial space in multi-core electrical cables is a potential gas conduit where a pressure differential can exist. Where cables run through hazardous areas having different zone classifications, this can invalidate the safety concepts employed.

14.2.5 Static electricity

14.2.5.1 During fuelling

14.2.5.1.1 Protection against static electricity is required when fuelling vehicles in order to prevent discharges between the fuelling nozzle and the vehicle.

14.2.5.1.2 The materials used shall be such that the resistance between the fuelling nozzle and earth is less than 1 MOhms (MΩ). If this cannot be achieved, additional grounding is required.

14.2.5.2 During offloading

Protection against static electricity with grounding is required when LNG tanker is loaded or unloaded.

14.3 Other considerations

14.3.1 Interface

14.3.1.1 Every interface between a flammable fluid system and an electrical system, including process instrument connections, integral electric valve actuators, foundation heating coils, pumps with a canned motor and blowers, shall be sealed or isolated to prevent the passage of flammable fluids to other parts of the electrical installation.

14.3.1.2 Every seal, barrier or other means of isolation shall be designed to prevent the passage of flammable fluids or gases through the interface medium, e.g. a conduit, stranded conductors or cables.

14.3.2 Primary seal

A primary seal shall be provided between the flammable fluid systems and the electrical systems. Every primary seal shall be designed to withstand the service conditions to which it is expected to be exposed.

14.3.3 Additional seal

14.3.3.1 If the failure of the primary seal would allow the passage of flammable fluids to another part of the electrical system, an additional seal, barrier or other means shall be provided to prevent the passage of the flammable fluid beyond the additional device or means in the event that the primary seal fails.

14.3.3.2 Every additional seal, barrier and interconnecting enclosure, if any, shall meet the pressure and temperature requirements of the conditions to which it could be exposed in the event of failure of the primary seal, unless other means are provided to accomplish this purpose.

14.3.4 Conduit seals

Unless specifically designed and approved for the purpose, the seals specified in 14.3.2 and 14.3.3 are not intended to replace the conduit seals required by IEC 60079.

14.3.5 Detection vents

Where primary seals are installed, drains, vents or other devices shall be provided for detection of leakage of flammable fluids.

15 Instrumentation and control system

15.1 General

Instrumentation as required for safe and reliable operation of the LNG fuelling station shall be provided. Electrical instrumentation shall comply with 14.1.

15.2 Gas detectors

Methane detectors shall be installed above the locations where gas from leaks is most likely to be found, e.g. inside canopies covering potentially leaking equipment, and shall be suitably positioned, so that they provide a high probability of leak detection. As a minimum,

— one methane detector shall be placed at each of the LNG dispensing areas, and

— a suitable number of methane detectors shall be placed at locations within the LNG fuelling station to provide coverage of all potential sources of gas leaks. Special attention shall be given to the LNG offloading area.

15.3 Flame detectors

Flame detectors and/or suitably placed temperature sensors shall be installed to provide coverage of the LNG fuelling station, including the cryogenic part of the LNG fuelling station, the dispensing area and other places where a risk of ignition exists.

15.4 Pressure gauges

All pressure gauges installed in the LNG fuelling station, including those on the LNG storage tank and the dispenser, shall use the same system of units.

15.5 Temperature sensors

15.5.1 A temperature sensor shall be installed on the pipeline connecting the high-pressure vaporizer with the CNG part of the LNG fuelling station. The gas flow shall be stopped if the temperature below −40 °C is detected.

15.5.2 Temperature sensors should be provided at the foundation of the LNG storage tank. Temperature sensors should be located at the places where temperatures lower than possible at local climate is most likely to be found in the event of a release of LNG.

15.6 Manual emergency shutdown devices

Manual ESD devices shall be suitably placed throughout the LNG fuelling station at locations where they can be safely accessed by the operator. A manual ESD device shall be placed on or in vicinity of every LNG or CNG dispenser and adjacent to all points of exit from the LNG fuelling station. Special attention shall be paid to this requirement in self-service LNG fuelling stations. The locations of manual ESD devices shall be clearly marked.

15.7 Emergency power supply unit

Emergency power source shall be provided to supply uninterrupted power for flame and methane detection systems.

16 Emergency shutdown

16.1 Application

An LNG fuelling station shall be equipped with an emergency shutdown (ESD) system. The requirements of the ESD system shall depend on the size of the LNG storage tank as follows.

— For LNG storage tanks with a capacity of not more than 5 tonnes, the first valve of the supply line shall be close to the tank and capable of being safely operated in an emergency.

— Automatic ESD systems shall be installed at LNG fuelling stations having an LNG storage capacity exceeding 5 tonnes.

— Where the LNG storage capacity does not exceed 200 tonnes, the ESD system may be part of the plant control system.

— Where the LNG storage capacity exceeds 200 tonnes, the ESD system shall be an independent system.

16.2 Procedure

The instrumentation for the LNG fuelling process shall be designed so that ESD system and procedures can put the process into a fail-safe condition that can be maintained until the operator(s) can take appropriate action to either reactivate or secure the process. The ESD system shall be designed in accordance with the principles of IEC 61508 and IEC 61511. All components of the system shall be designed to fail-safe on loss of power or equipment failure.

16.3 Activation

The ESD system shall be activated by the following:

— the gas detectors; the typical value of the set point for high methane concentration is detected at 40 % of the LEL; an alarm shall be activated at 20 % of the LEL;

— the flame detectors;

— the low temperature sensors provided at the foundation of the LNG storage tank; the typical value of the set point is −75 °C;

— failure of the main power, instrument power or air/nitrogen supplies.

— manual activation of any ESD push button;

— earthquake sensors, if installed; earthquake sensors should be considered for LNG fuelling stations having an LNG storage capacity exceeding 5 tonnes and located in an area with an increased risk of seismic activity.

16.4 ESD action

16.4.1 The ESD system shall switch the plant valves and other equipment into a safe state. As minimum the emergency shutdown shall actuate the following valve closures, electrical isolations and equipment shutdowns by means of fail-safe operation of automatic valves and switches:

— closing the LNG storage tank liquid outlet valves;

— closing the main LNG supply valve of the LNG storage tank(s);

— closing the main LNG supply valve on the LNG tanker;

— shutting down the LNG delivery pump on the LNG trailer;

— shutting down the LNG pump(s) of the LNG fuelling station;

— closing the inlet valves of each dispenser;

— closing the valves of the dispenser(s) fuelling inlets and/or outlets;

— shutting down the dispensers;

— isolating the power supplies to all electrical components, with the exception of those components required to safely monitoring and control the LNG fuelling station during ESD, as determined by a HAZOP study.

16.4.2 When the ESD is activated, a local alarm with audible and visual signals shall be activated and the LNG fuelling station operating company shall be automatically notified by means of an alarm, an electronic communication or other similarly effective means.

16.5 Reset

In the event of ESD actuation, all ESD equipment shall only be reset manually (see also 19.8).

17 Special configurations

17.1 Movable LNG fuelling station

17.1.1 General requirements

Movable LNG fuelling stations shall comply with all the requirements of this document, except for the deviations permitted by 17.1.2 and 17.1.3. When the movable LNG fuelling station is being transported, it shall not contain LNG and it shall not be pressurized to more than 0,05 MPa.

17.1.2 Anchoring

Skid mounted parts of the LNG fuelling station do not require anchoring to foundations if their stability complies with the statutory requirements that apply at the place of operation in relation to wind load, earthquake and other possible risks (e.g. flooding).

17.1.3 Containment

The containment for movable LNG fuelling stations may be integrated with the skid or framework on which the LNG fuelling station is supported provided the materials of the containment are resistant to cryogenic temperature.

17.2 Mobile LNG fuelling station

17.2.1 General requirements

Mobile LNG fuelling stations shall comply with all the requirements of this document, except for the deviations as permitted by 17.2.2 to 17.2.5.

17.2.2 Anchoring

Skid mounted parts of the LNG fuelling station do not require anchoring to foundations if their stability complies with the statutory requirements that apply at the at the place of operation in relation to wind load.

17.2.3 Containment

17.2.3.1 Containment according to 8.1.2.2.2 is not mandatory at a mobile LNG fuelling station, provided additional precautions are taken to protect against LNG spillage. Such additional precautions shall be specified in the operation manual.

17.2.3.2 If containment is used for a mobile LNG fuelling station, it may be integrated with the skid or framework on which the LNG fuelling station is supported provided the materials of the containment are resistant to cryogenic temperature.

17.2.4 Design

17.2.4.1 Mobile LNG fuelling stations that are intended to be operated on a vehicle shall be firmly mounted on the frame of the vehicle.

17.2.4.2 Mobile LNG fuelling stations that are intended for stand-alone operation shall be mounted to a skid or framework, and shall be firmly secured on the delivery vehicle during transportation of the mobile LNG fuelling station to the place of operation.

17.2.4.3 Valves, piping, electrical components, steel structures and all other parts of the LNG fuelling station shall be designed to withstand all loads to which the equipment can be exposed during transportation.

17.2.4.4 All the equipment of a mobile LNG fuelling station shall comply with applicable standards for equipment transportable under pressure. In particular, the LNG fuelling station components shall comply with either ISO 20421-1 or ISO 21029-1, where applicable.

17.2.5 Additional requirements for operation

17.2.5.1 The place of operation of a mobile LNG fuelling station shall be selected to minimise exposure to the risk of collision with other vehicles or mobile equipment.

17.2.5.2 The movement of vehicles, approaching the fuelling station for fuelling and leaving the LNG fuelling station after fuelling, shall be controlled by marked traffic lanes or manual or other signalization. Clearly visible instructions for drivers of these vehicles shall be posted.

17.2.5.3 An area of the LNG fuelling station that encompasses all the hazardous areas shall be designated and clearly marked, and only authorised persons shall be permitted to enter this area.

18 Testing and commissioning

18.1 Testing

18.1.1 Electrical testing

The testing of electrical equipment and electrical installations shall comply with IEC 60079-17.

18.1.2 Pressure strength testing

18.1.2.1 All pressure equipment (e.g. vessels, pumps, valves) shall be visually inspected and pressure strength tested before being put into service.

NOTE Typically, this is carried out at the place of manufacture of the equipment.

18.1.2.2 All pressure testing shall be in accordance with the standard or code to which the pressure equipment was designed and fabricated.

18.1.2.3 Any pressure equipment that was not pressure strength tested in accordance with regulations applicable at the location of the LNG fuelling station shall be subjected to pressure strength testing at the LNG fuelling station in accordance with the applicable regulations.

18.1.2.4 All pressure equipment and piping fabricated on-site shall be pressure strength tested in accordance with the standard or code to which it was designed and fabricated. This requirement particularly relates to assemblies of pipes, valves and other piping components.

18.1.2.5 On-site testing may be carried out either hydrostatically, using water, or pneumatically, using dry air or nitrogen. The LNG storage tank, LNG pumps, LNG dispensers, vaporizers, valves and all other equipment that will be in contact with LNG shall be excluded from hydraulic pressure testing at the LNG fuelling station, due to the potential problems that can result from the introduction of water into the equipment.

18.1.2.6 If on-site hydrostatic pressure testing of equipment to be used in cryogenic service cannot be avoided, it shall only be performed if there are provisions for adequately drying the equipment after pressure testing. Where adequate drying after hydrostatic pressure testing is not possible, pneumatic testing in accordance with 18.1.3 shall be used.

18.1.2.7 The quality of water used for hydrostatic testing shall be of potable water quality, containing not more than 200 mg/kg (200 ppm) of chlorides.

18.1.2.8 After hydrostatic testing, the vessel or piping shall be drained and stainless steel components shall be flushed immediately with distilled or demineralised water containing not more than 10 mg/kg chlorides and dried.

18.1.2.9 Records of all pressure strength testing shall be made and retained as part of the quality manual (see 6.1.3.5).

18.1.3 Leak testing

18.1.3.1 A leak test at the maximum allowable working pressure or at such lower pressure as considered sufficient shall be performed after the pressure test to ensure there are no leaks in the system. A leak test can be made by monitoring the pressure in the system over a period of time (e.g. 24 hours) or by using such methods as leak detection gas or leak detection spray. The test fluid shall be dry air or nitrogen.

18.1.3.2 Records of all leak testing shall be made and retained as part of the quality manual (see 6.1.3.5).

18.2 Commissioning

18.2.1 General provisions

Commissioning tests shall be performed before the start of operation. The procedures for commissioning and decommissioning operations shall be defined at the design stage.

18.2.2 Purging

18.2.2.1 The LNG fuelling station shall be adequately purged with dry air or nitrogen before being commissioned. If purging is conducted using dry air, the LNG fuelling station shall be subsequently purged with inert gas.

18.2.2.2 Purging shall also be carried out whenever air or other impurities can have entered pipework and vessels during inspections, repair and maintenance or modifications.

18.2.2.3 Consideration should be given to installing a temporary filter upstream of the cryogenic pump during purging to remove particulates from the purging gas.

18.2.3 Functional testing

18.2.3.1 The proper operation of all safety equipment, with the exception of relief safety valves, shall be demonstrated and documented.

18.2.3.2 The integrity and documentation of primary safety devices shall be checked by reference to the manufacturers' documentation and ascertaining the integrity of an anti-tampering system.

18.2.3.3 Electrical safety functions shall be tested during commissioning. This includes all manual emergency shutdown devices and all emergency shutdown functions. It also includes safety functions, if installed, such as

a) high temperature protection, e.g. on trim heaters,

b) low temperature protection, e.g. gas temperature into the CNG buffer storage,

c) high pressure protection, e.g. electrical stop before safety valve opening pressure,

d) low pressure alarm, i.e. for detecting a leak,

e) gas detectors and flame detectors, and

f) LNG storage tank overfilling protection devices.

18.2.3.4 Functional testing shall be carried out by or under the control of a competent person.

18.2.4 First filling of the LNG storage tank and other components

When LNG is admitted to the LNG storage tank and other components of the LNG fuelling station for the first time or at any other time, when the equipment is at ambient temperature, the suppliers' procedures for cooling down and filling with LNG shall be followed.

19 Operations

19.1 LNG tanker offloading

Only non-sparking tools shall be used when connecting the transfer hose to the LNG tanker and to the LNG storage tank.

19.2 Fuelling procedure

19.2.1 Fuelling shall only be carried out by a person who has been trained in accordance with 19.5.

19.2.2 Instructions on how to fuel a vehicle shall be displayed at the dispenser.

19.2.3 The person carrying out the fuelling shall be adequately protected against spray of LNG.

19.2.4 Special attention shall be given to the positioning of signage for the manual emergency shutdown device (e.g. ESD button).

19.3 Safety signs

19.3.1 General on identification labels

19.3.1.1 Design of marking plates

The marking plates shall be permanently fixed in a prominent position so that they can be read by the operator. The markings should be durable and corrosion resistant. To assist with visibility under poor lighting conditions, the size of script should be considered and its colour should be in contrast to the background.

19.3.1.2 Language of markings

All markings and signs of an LNG fuelling station shall be in the official language(s) of the country, where it is installed. Additional translations into other frequently used foreign languages are recommended.

19.3.1.3 LNG fuelling station signs

19.3.1.3.1 Signs shall be displayed at appropriate locations to indicate, as a minimum, the following:

— owner's name and emergency contact data;

— prohibited access of unauthorized persons to non-public areas;

— the presence of hazardous areas;

— flammable liquid and gas;

— low temperature (cryogenic) liquid;

— prohibition of smoking, open fire, and use of non-explosion protected electric or electronic equipment including electronic personal instruments (cameras, telephones, computers, radios, etc.).

19.3.1.3.2 Any potential points of contact with electrical circuits capable of causing injury shall be marked using symbols defined in IEC 60204-1:2005, Clause 17.

19.3.2 Equipment marking

19.3.2.1 General

19.3.2.1.1 Each major item of equipment shall carry a manufacturer's name plate containing the data required by the applicable code.

19.3.2.1.2 The name plate shall be firmly fixed to a part of the equipment or to independent supports such that it is easily visible. It should be constructed of durable materials and maintained in good condition.

19.3.2.2 LNG dispenser signs

19.3.2.2.1 The LNG dispenser should have the same markings as the LNG fuelling station and in addition the following markings:

— identification of LNG fuel with a symbol defined in Annex L;

— fuelling instructions;

— signage relating to the use of personal protective equipment.

19.3.2.2.23 The fuelling instructions shall be displayed clearly at dispensing units immediately adjacent to each fuelling hose. The instructions shall include the relevant safety precautions with particular references to non-smoking, and turning-off the engine.

19.3.2.2.3 All signs shall comply with local legislation.

NOTE 1 If unspecified, signs defined in ISO 3864 can be used.

NOTE 2 Signs can include the following:

— warning sign of cold liquid/danger of frostbite;

— warning sign of flammable gas;

— indication of the type of vehicle tank receptacle (see ISO 12617);

— prohibition of non-approved adapters for fuelling;

— indication of maximum fuelling pressure;

— indication of minimum saturation pressure of LNG, constant or variable on request;

— indication of a system of communication between the vehicle and the fuelling system, if installed.

19.3.2.3 CNG dispenser signs

The CNG dispenser markings shall be in accordance with ISO 16923.

19.4 Equipment and pipework identification

19.4.1 All valves, pipework and instruments shall have clear and permanent identification.

19.4.2 All pipes shall have the following markings:

— classification or name of fluid;

— indication of the phase, i.e. liquid phase or gaseous phase;

— direction of flow;

— identification number of the line of the pipework.

19.5 Training

19.5.1 LNG fuelling station operators and persons who carry out fuelling shall be trained, especially in the following:

— safety procedures and precautions;

- fuelling procedures and any other routine actions needed for long term operation of the LNG fuelling station;
- assessment of normal and abnormal operation of equipment;
- actions to be taken in emergency situations (e.g. ESD);
- other safety procedures and precautions;
- fire fighting to the extent of the responsibility of each individual.

Training shall be conducted upon employment and at least every two years thereafter as well as after any change of procedures.

19.5.2 All LNG fuelling station personal shall be trained immediately upon commencement of their employment.

19.5.3 For customers of self-service LNG fuelling stations, additional precautions shall be taken as follows.

- Arrangements shall be made to ensure that only trained customers, registered with the LNG fuelling station operating company have access to fuelling and that the vehicle to be fuelled is suitable for refuelling at the LNG fuelling station and is registered with the LNG fuelling station operating company.
- Instructions posted at the dispenser shall be detailed and clear with respect to self-service operation.
- A fixed communication system shall be provided to allow communication from the LNG fuelling station to a help desk.

19.6 Installation and operating instructions

19.6.1 The installation and operating instructions shall be delivered with the fuelling station in the official language of the country of installation or region, as specified by the fuelling station operating company. Application of the local or otherwise agreed language may be limited to certain level of documents by agreement between the vendor and the fuelling station operating company.

19.6.2 The installation and operating instructions shall contain, as a minimum, instructions on the following:

- how to install the equipment including assembly of pressure equipment;
- how to put the LNG fuelling station into service;
- the proper operation of the LNG fuelling station;
- the minimum requirements for maintenance of the LNG fuelling station including routine inspections by the operator (e.g. the visual inspection of the fuelling hose and nozzle);
- the requirements for periodic inspection of the LNG fuelling station;
- the requirements for periodic replacement of the hoses;
- the requirements for markings and warning signs that shall be permanently displayed at the LNG fuelling station, as required by 19.3.1.3.

19.6.3 For a full understanding of the instructions technical information, drawings and diagrams should be included.

19.6.4 All potential hazards shall be considered and included in the installation and operating instructions, together with measures to mitigate such hazards and warning signs to be used (e.g. high pressure, high voltage).

19.7 Emergency plan

An emergency plan shall be established for the LNG fuelling station.

19.8 Maintaining the emergency shutdown

19.8.1 In the event of an emergency shutdown (ESD) actuation according to 16.3, the LNG fuelling station shall be inspected by the operator and the cause of the ESD shall be identified.

19.8.2 The time and the cause of the activation of the ESD shall be recorded.

19.8.3 The identified cause(s) of the ESD activation shall be rectified before the fuelling station is put back into normal service. Restart shall not be possible if all faults that triggered the ESD have not been rectified.

19.8.4 Before a restart, all the equipment shall be set to a state required for a safe start.

20 Inspection and maintenance

20.1 Inspection

20.1.1 General requirements

20.1.1.1 All inspection and testing shall follow the relevant standards and codes.

20.1.1.2 The inspection and testing of all safety critical equipment shall be by a competent person with a recognized qualification (CompEx or equivalent), who shall be authorized to perform such work by a national authorizing body.

20.1.1.3 The physical condition of the LNG fuelling station shall be inspected together with pressure equipment review, which shall include possible effect of corrosion aspects on the LNG fuelling station safety and operability.

20.1.1.4 Pressure equipment, in particular the cryogenic pressure equipment, shall be inspected according to applicable standards.

20.1.1.5 The inspection intervals shall not exceed three years for auxiliary equipment of vessels containing LNG.

20.1.1.6 The periodic inspection of pressure equipment shall include, as minimum

— safety devices against overpressure,

— safety shut-off devices,

— gauges, and

— controlling devices.

20.1.2 Inspection and testing of electrical systems

20.1.2.1 The inspection of electrical equipment and electrical installations shall comply with IEC 60079-17.

20.1.2.2 Records of all inspections shall be made and retained as part of the quality manual (see 6.1.3.5).

20.1.3 Inspection and re-testing of the safety relief valves

20.1.3.1 If not specified by local regulations, the inspection and testing intervals shall be determined by a competent person according to the operating conditions, taking into consideration the recommendations of the manufacturer, material properties, the possibility of corrosion, and the possibility of plugging.

20.1.3.2 Recommended inspection intervals are provided in Table 2.

Table 2 — Examinations/inspection periods

Type of safety relief valve (SV)	At commissioning	Yearly	2 years	3 years	10 years
Pilot operated SV	A	B; C	—	—	—
SV for flammable gases/ gas mixture	A; B	—	B	C	—
Thermal valves	A	—	—	B	C

A: Documentation and marking

Checking of the marking and/or manufacturer's declaration/data:

— identification, type approval;

— conformity with drawings, specifications, type approval;

— suitability (medium, size, temperature, pressure, setting).

Review of the documents on the last inspection and on the last performance test.

B: Visual inspection

Within the visual inspection the following shall be checked:

— general condition;

— installation/orientation;

— leak tightness;

— vent location:

— unobstructed discharge piping.

C: Performance test

Within the performance test following parameters shall be checked:

— set pressure;

— lift/stroke;

— leak tightness.

20.1.3.3 As alternative to the performance test of the safety relief valves is replacement.

20.1.3.4 The inspection and testing shall be carried by a competent person.

20.1.3.5 Where redundancy is provided, the inspection intervals may be extended in agreement with competent person.

20.1.3.6 The inspection can be made with the valve *in situ* or on the test bench.

20.1.3.7 The results of the inspection and testing shall be recorded and kept at least until at least the next inspection.

20.1.4 Safety and fire protection equipment

Safety and fire protection equipment shall be inspected and tested in accordance with local regulations and at intervals not to exceeding 12 mo.

20.2 Maintenance

20.2.1 Preventive maintenance planning

20.2.1.1 A preventive maintenance program consistent with the recommendations of the suppliers of the systems and equipment shall be established and shall include a schedule of procedures for the inspection and testing of the LNG fuelling station systems and equipment.

20.2.1.2 The maintenance program shall be carried out by competent personnel.

20.2.1.3 Maintenance activities on fire-fighting equipment shall be scheduled so that a minimum of equipment is taken out of service at any one time and fire prevention safety is not compromised.

20.2.2 Maintenance procedures

20.2.2.1 Documentation of the LNG fuelling station shall be archived by the LNG fuelling station owner. Controlled copies shall be made available for maintenance.

20.2.2.2 Maintenance shall be carried out in accordance with the manufacturers' instructions.

20.2.2.3 Maintenance records shall be kept and retained for the life of the LNG fuelling station.

20.2.2.4 Each component, including its support system, shall be maintained in a condition that is compatible with its operation or safety function by repair, replacement, or other means and recommendations, if available from the equipment supplier.

20.2.2.5 If a safety device is taken out of service for maintenance, the component being served by the device shall also be taken out of service, unless the same safety function is provided by an alternative means.

20.2.2.6 If the inadvertent operation of a component taken out of service could cause a hazardous condition, that component shall have a tag attached to its controls bearing the words "DO NOT OPERATE" or a similar warning in the local official language and other languages appropriate to the situation.

20.2.2.7 Maintenance of electrical equipment shall be carried out in accordance with IEC 60079-17.

20.2.3 Maintenance safety

20.2.3.1 All maintenance and servicing shall follow the written procedures that are based on good working practice.

20.2.3.2 All tools, especially electrically driven tools, shall comply with the requirements of IEC 60079.

20.2.4 Draining of the LNG storage tank

When the LNG storage tank has to be drained for repair or for any other reason, the draining shall be carried out under the supervision of a competent person and in accordance with operation and safety procedures, prepared specifically for this process, and as agreed by all the relevant parties.

Annex A
(informative)

Examples of hazardous zones classification

Table A.1 shows the LNG fuelling station electrical (hazardous) area classification according to NFPA 52. Figures A.1 to A.3 show examples of zone classification.

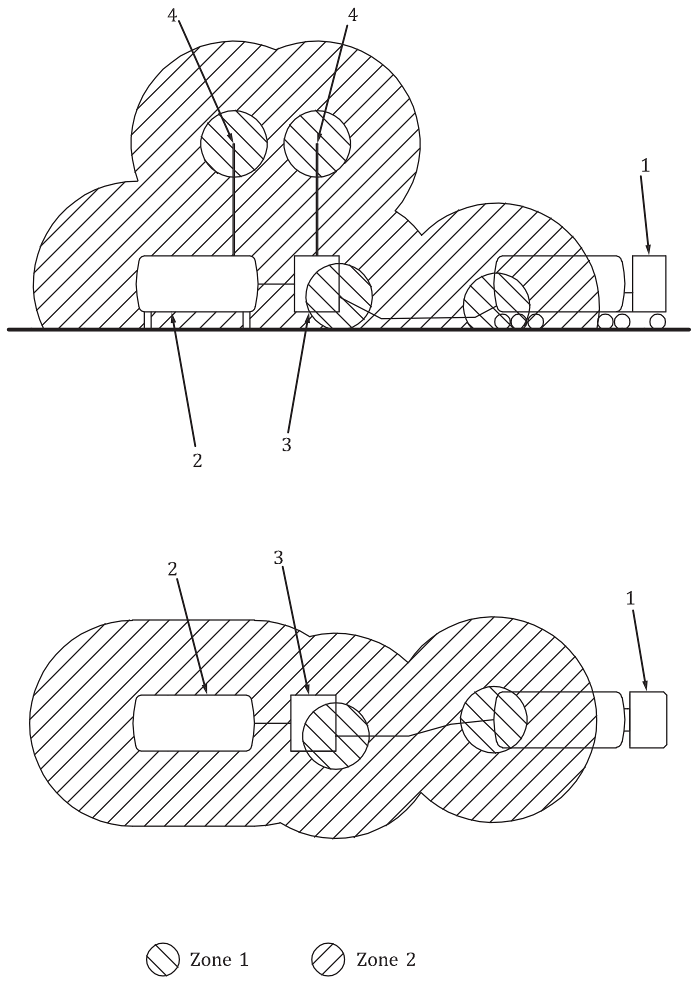
Table A.1 — LNG fuelling station electrical (hazardous) area classification

Part	Location	Zone[a]	Extent of classified area[b]
A	Fuelling station LNG storage tank area		
	Indoors	1	Entire room
	Outdoor, aboveground LNG storage tanks (other than portable)	1	Open area between a high-type dike and LNG storage tank wall where dike wall height exceeds distances between dike and LNG storage tank walls
		2	Within 4,6 m in all directions from LNG storage tank, plus area inside a containment up to the height of the containment wall
	Outdoor, buried and underground storage tanks	1	Within any open space between LNG storage tank walls and surrounding grade or dike
		2	Within 4,6 m in all directions from the top of the LNG storage tank and sides above grade
B	Non-fired LNG process areas containing pumps, compressors, heat exchangers, piping, connections vessels, etc.		
	Indoors with adequate ventilation	2	Entire room and any adjacent room not separated by a gastight partition, and 4,6 m beyond any ventilation discharge vent or lower
	Outdoors in open air at or aboveground	2	Within 4,6 m in all directions from this equipment
C	Pits, trenches or sumps located in or adjacent to division 1 or 2 areas	1	Entire pit, trench, or sump
D	Discharge from relief valves, drains	1	Within 1,5 m from point of discharge
		2	Beyond 1,5 m but within 4,6 m in all directions from point of discharge
E	LNG tanker/cargo transfer area		
	Indoors with adequate ventilation[c]	1	Within 1,5 m in all directions from point of transfer
		2	Beyond 1,5 m of entire room and 4,6 m beyond ventilation vent
	Outdoors in open air at or aboveground	1	Within 1,5 m in all directions from point of transfer
		2	Beyond 1,5 m but within 4,6 m in all directions from the point of transfer

[a] See IEC 60079-10-1.

[b] The classified area is not permitted to extend beyond an unpierced wall, roof, or solid vapour tight partition.

[c] Ventilation is considered adequate when provided in accordance with the provisions of this document.



Key

1 LNG road tanker

2 LNG storage vessel

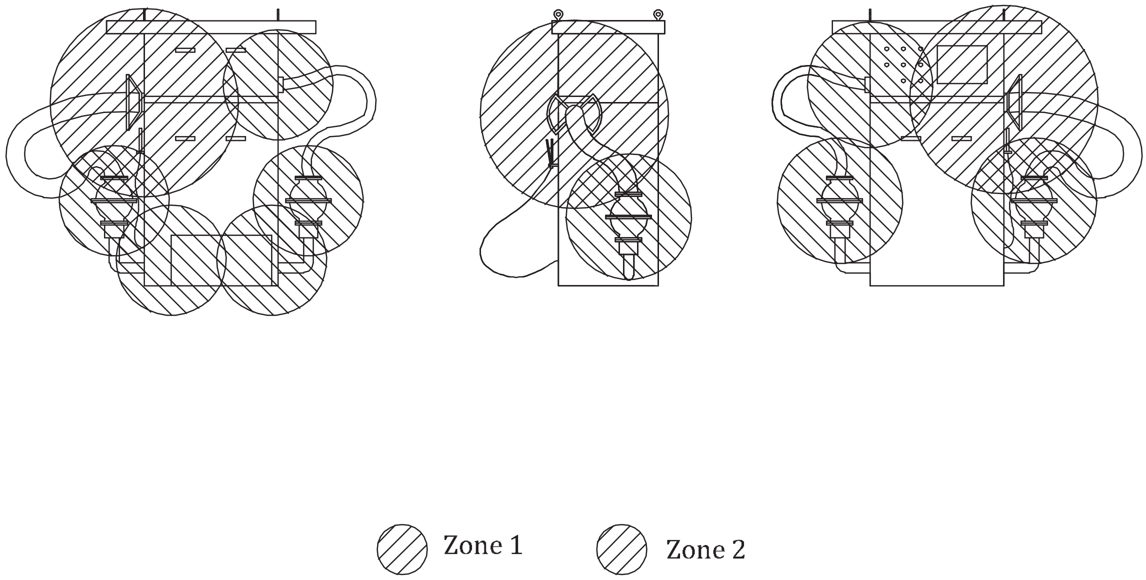
3 equipment, pumps, piping, etc.

4 outlet of the vent stack

Zone 1 1,5 meter in all directions

Zone 2 4,6 meter in all directions

Figure A.1 — Example of zones classification around a small LNG fuelling station with a horizontal LNG storage tank according to NFPA 52

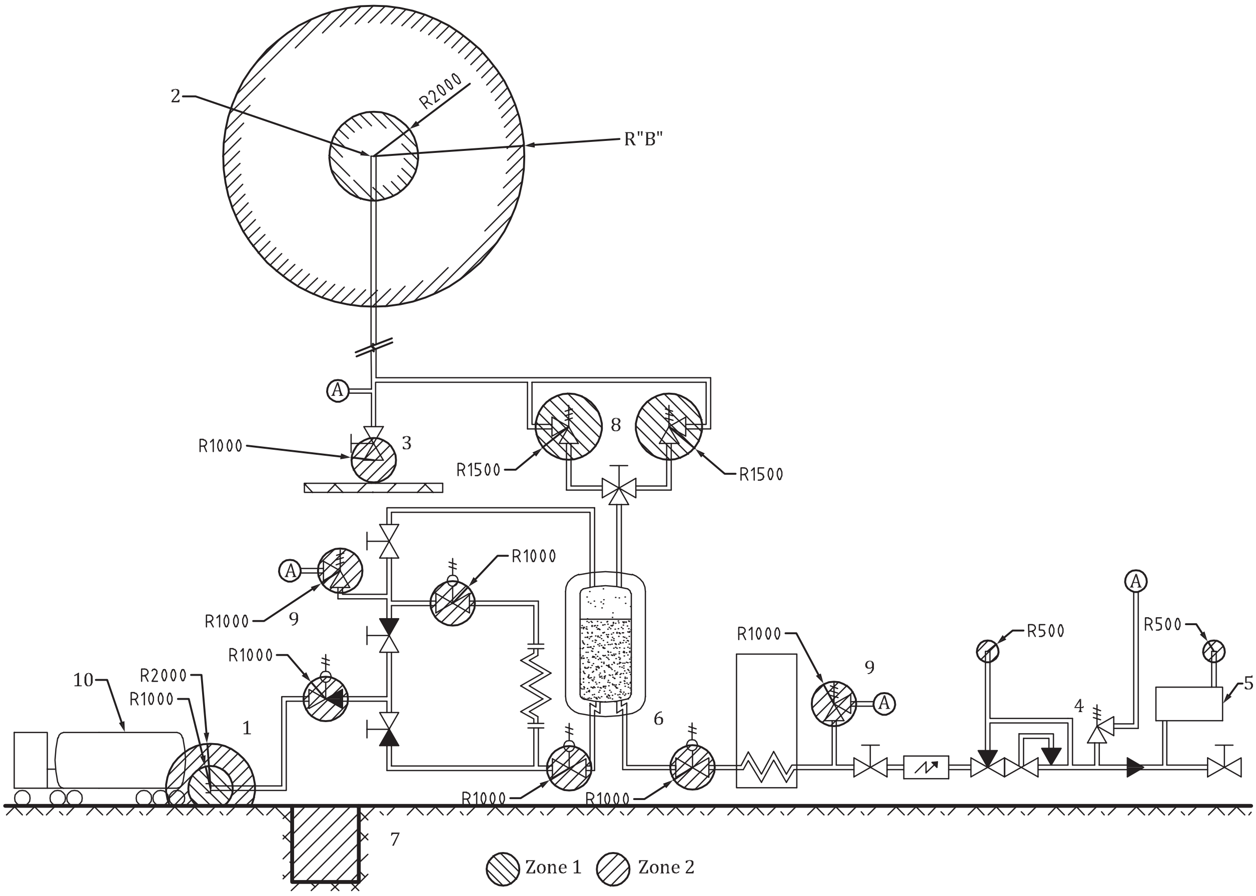


Key

Zone 1 radius R = 1 000

Zone 2 radius R = 1 500

Figure A.2 — Example of zones classification around an LNG dispenser according to IEC 60079-10-1



Key

1 unloading

2 vent stack

3 drain of condensate from the vent stack

4 pressure control

5 odorizer

6 distantly actuated shut-off valves

7 (external) LNG containment

8 safety relief valves of the LNG storage tank

9 (thermal) safety relief valves of pipework

Figure A.3 — Example of zones classification around an LNG plant according to IEC 60079-10-1

Annex B
(normative)

Separation distances

B.1 Separation distances of the aboveground LNG equipment

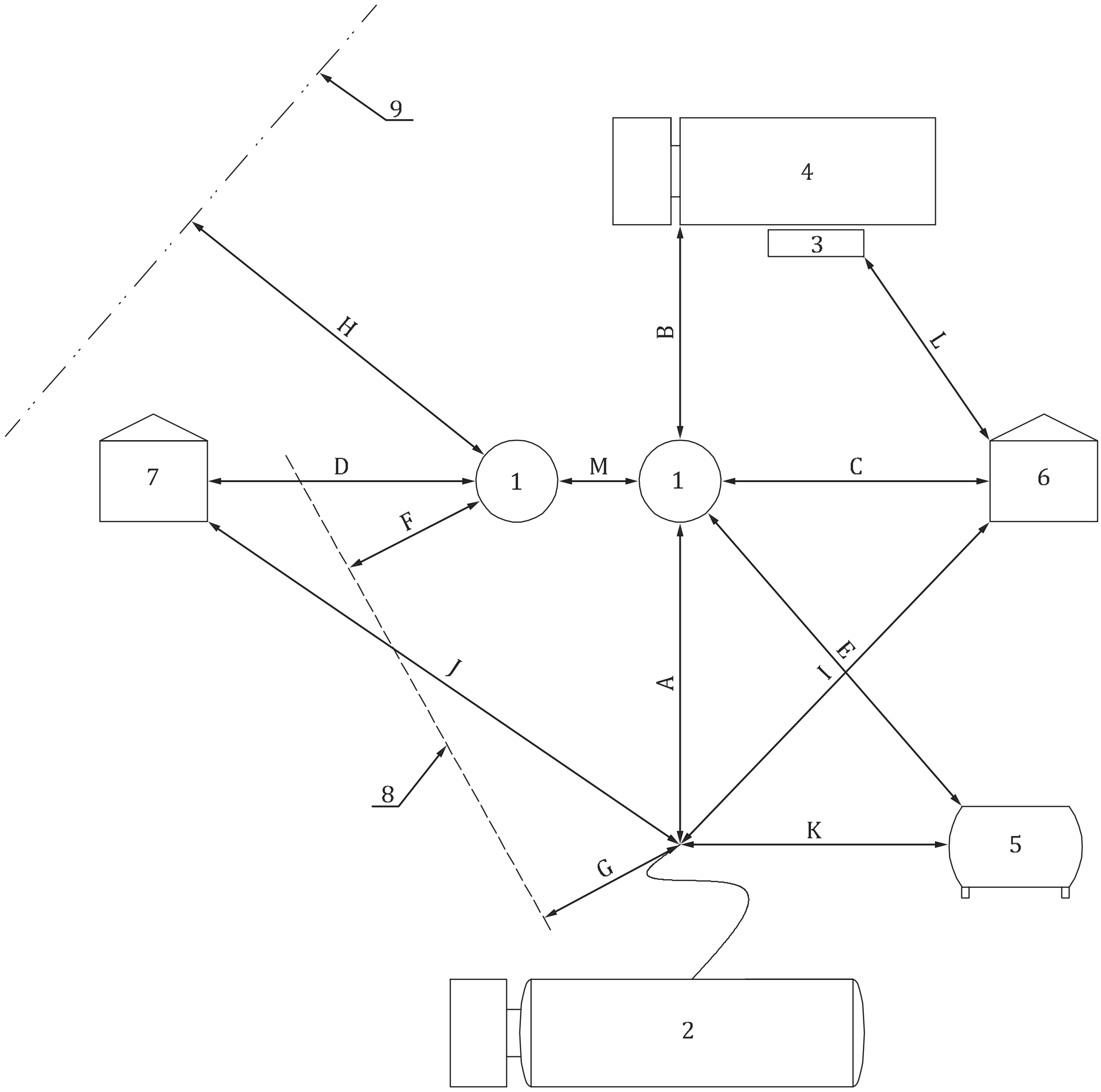
Separation distances between the LNG storage tank, the LNG transfer point, the site boundaries, building, storage of other flammable liquids and gases and other equipment of the LNG fuelling station shall be sufficient to limit the potential for escalation of an LNG related incident to adjacent activity and vice versa shall be in accordance with Table B.1 and Table B.2. The separation distances as defined in Table B.1 are applicable if the buildings are outside the hazardous areas. Separation distances can be reduced if a fire wall is constructed in accordance to 6.1.2.8.

Table B.1 — Separation distances from buildings

Number of persons in building	**Additional comment**	**Onsite buildings**			**Offsite buildings**	
		Dimension (Figure B.1)	**Minimum distance** m		**Dimension** (Figure B.1)	**Minimum distance**[a] m
Distance from LNG storage and other components containing LNG						
None		C	0 to 3		D	3
<10		C	10		D	15
10 to 100		C	15		D	30
>100		C	15		D	30
Distance from offload connection						
None	buildings with non-combustible walls	I	0 to 3		J	3
	buildings with combustible walls	I	10		J	10
<10	with ground pump	I	10		J	10
	without ground pump	I	20		J	20
10 to 100		I	30		J	30
>100		I	50		J	50
[a] Or distance in accordance with QRA 10^6.						

Table B.2 — Separation distances of stationary LNG fuelling installation

Dimension (Figure B.1)	Comment	Minimum distance m
A	Offloading connection - outer shell of the LNG tank	6
	If a fire protection wall or another fire resistant shield is installed or if the LNG storage tank has 1 hour fire resistance at a radiation of 15 kW/m^2.	0,5 to 6
B	Fuelling vehicle – outer shell of the LNG tank	4
E	Onsite tank for flammable liquids and their gas vent - outer shell of the LNG tank	5
F	Boundary limit – outer shell of the LNG tank:	
	LNG storage tanks <120 m^3	3
	LNG storage tanks 120 m^3 to 300 m^3	6
	LNG storage tanks >300 m^3	10
G	Boundary limit – LNG tank offloading connection	3
H	Overhead electric power lines, above 600 V	10
K	Onsite tank for flammable liquids and their gas vent – LNG tank offloading connection	5
L	Dispenser – onsite buildings	6
	If dead man’s button limits the accidental discharge of LNG to 60 s	3
M	Distance between LNG tanks	1,5



Key

1 LNG storage tank
2 LNG trailer at offloading
3 LNG dispenser
4 LNG vehicle at fuelling
5 storage of flammable liquid
6 onsite building
7 offsite building
8 boundary limit of the LNG fuelling station
9 electric power line

Figure B.1 — Separation distances LNG fuelling station

B.2 Separation distances of underground LNG storage tanks

Table B.3 specifies the distances from underground LNG storage tanks and exposures. Buried and underground LNG storage tanks shall be provided with means to prevent the 0 °C isotherm from penetrating the soil. This requirement can have additional impact on the separation distances between underground LNG storage tanks. This requires calculation of the temperature between adjacent buried LNG storage tanks.

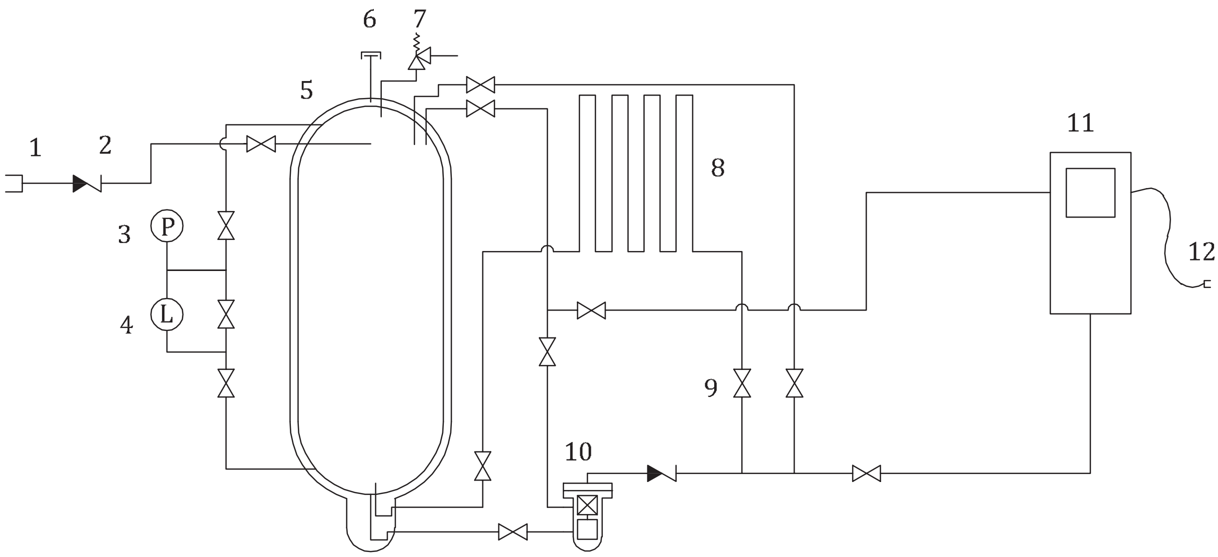
Table B.3 — Distances from underground LNG storage tanks and exposures

LNG storage tank water capacity m^3	Minimum distance from buildings and the adjoining property line that can be built upon m	Minimum distance between LNG storage tanks m
<10	4,5	4,5
10 to 120	7,5	4,5
>120	15	4,5

Annex C
(informative)

Example flow diagram of an LNG fuelling station

Figure C.1 shows an example of a flow diagram of an LNG fuelling station.



Key

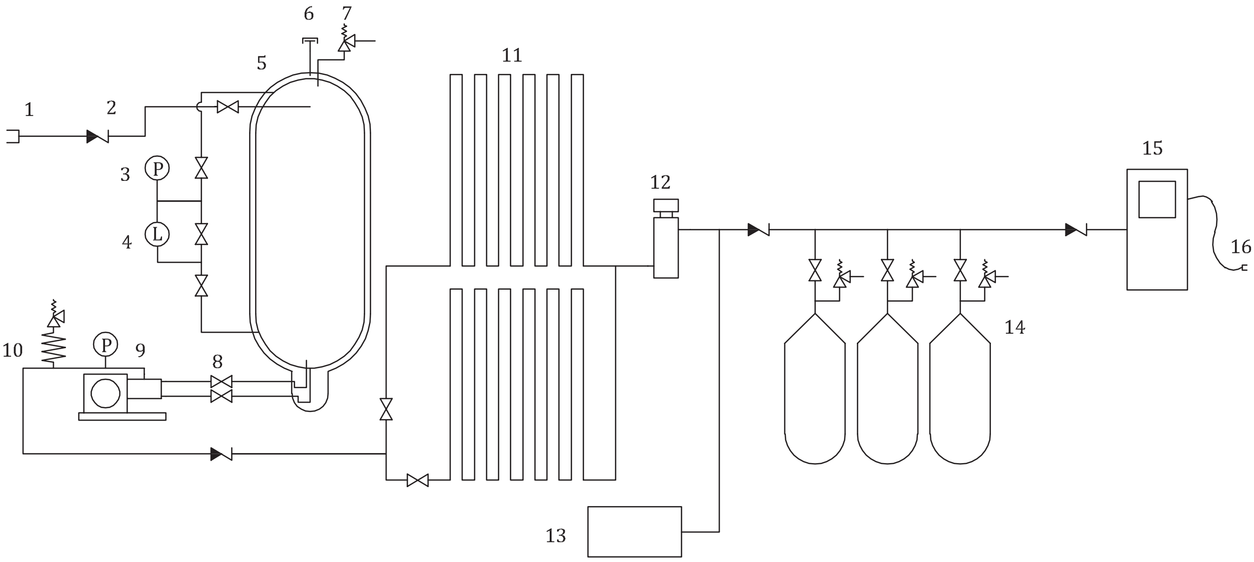
1	LNG fuelling receptacle
2	non-return valve
3	pressure gauge
4	liquid level gauge
5	LNG storage tank
6	vacuum safety device
7	pressure relief device
8	saturation vaporizer
9	isolation valves
10	centrifugal LNG pump
11	LNG dispenser
12	LNG fuelling hose with a nozzle

Figure C.1 — Example flow diagram of an LNG fuelling station

Annex D
(informative)

Example flow diagram of an LCNG fuelling station

Figure D.1 shows an example of a flow diagram of an LCNG fuelling station.



Key

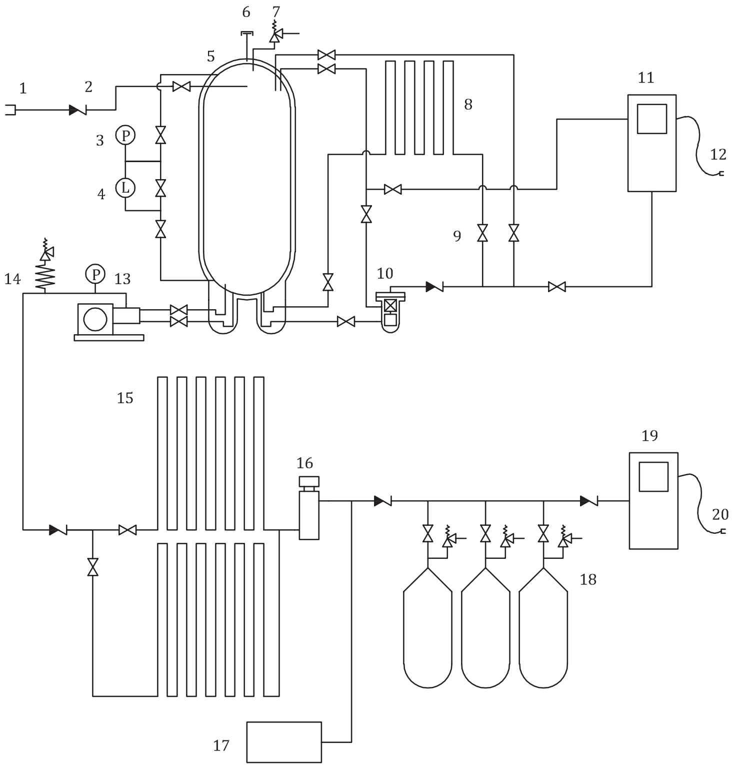
1	LNG fuelling receptacle
2	non-return valve
3	pressure gauge
4	liquid level gauge
5	LNG storage tank
6	vacuum safety device
7	pressure relief device
8	isolation valves
9	LNG pump
10	pulsation damper
11	high-pressure vaporizer
12	high-pressure trim heater
13	high-pressure odorizer
14	CNG buffers
15	CNG dispenser
16	CNG fuelling hose with a nozzle

Figure D.1 — Example flow diagram of an LCNG fuelling station

Annex E
(informative)

Example flow diagram of an LNG and LCNG fuelling station

Figure E.1 shows an example of a flow diagram of an LCNG fuelling station.



Key

1 LNG fuelling receptacle
2 non-return valve
3 pressure gauge
4 liquid level gauge
5 LNG storage tank
6 vacuum safety device
7 pressure relief valve
8 saturation vaporizer
9 isolation valves
10 centrifugal LNG pump

11 LNG dispenser
12 LNG fuelling hose with a nozzle
13 high-pressure LNG pump
14 high-pressure pulsation damper
15 high-pressure vaporizer
16 high-pressure trim heater
17 high-pressure odorizer
18 CNG buffers
19 CNG dispenser
20 CNG fuelling hose with a nozzle

Figure E.1 — Example flow diagram of an LNG and LCNG fuelling station

Annex F
(informative)

Process requirements for the effective cryogenic pump operation

F.1 NPSH

The efficient operation of the cryogenic pump is dependent on adequate NPSH. The NPSH available (NPSHA) at the cryogenic pump inlet should be higher or equal to the NPSH required (NPSHR) by the pump, as specified by the pump manufacture. An incompatibility in terms of NPSH can cause cavitation and/or loss of prime.

Basically, the NPSHA consists of the hydrostatic pressure of the height difference between the level of liquid in the LNG storage tank and the height of the pump inlet, reduced by dynamic pressure drop between the LNG storage tank and the pump inlet and reduced of increase of saturation pressure (boiling pressure) of liquid between the level of liquid in the LNG storage tank and the inlet of the pump considering stratification in the LNG storage tank and heat leak of pipework. The NPSHA can be improved by use of a vertical LNG storage tank instead of a horizontal LNG storage tank, by further elevating the foundation of the LNG storage tank and/or by lowering the pump into a pit. Also increasing the gas pressure above the cryogenic liquid surface by pressure built up coil will raise the NPSHA.

F.2 Cavitation

Cavitation is defined as the formation of vapour cavities in a liquid by local pressure decrease below the fluid vapour pressure and the immediate implosion of them, when the pressure increases again. The cryogenic liquids are operated closely to their boiling point with very low sub cooling, which implies high risk of cavitation when design measures are not applied.

When the pressure at the inlet of the pump or in the pump drops below the vapour pressure, the liquid will vaporize resulting in biphasic state. The mixture of liquid and gas can cause a pump to lose the prime and/or cavitation. This condition will cause excess vibrations, noise and possibly dry running, which can cause damage.

F.3 Loss of prime

The direct effects of loss of flow through the pump due to locking by vapour are dry running and possible excess vibrations, due to intermittent incoming liquid slugs, which can cause damage and leakage.

F.4 Pressure losses

In the interconnecting piping between the LNG storage tank outlet and the suction of the cryogenic pump, there are several pressure drops in the piping itself by friction, in elbows, in valves, in filters, etc. These pressure losses reduce the cryogenic liquid pressure at the pump inlet to be closer to vapour pressure and thus reduce NPSHA. This can cause cavitation and/or loss of prime.

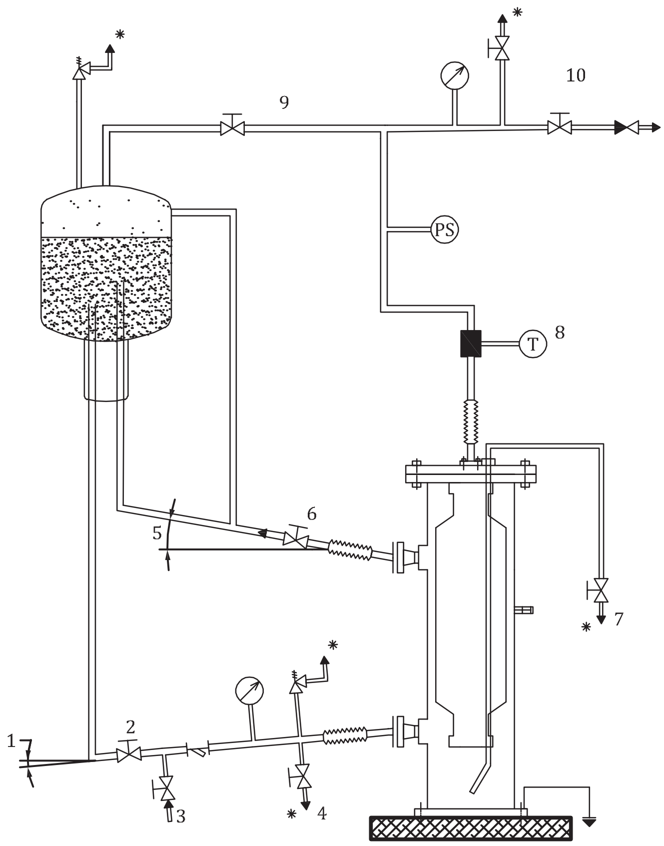
F.5 Heat in leak

As a cryogenic liquid is stored close to its boiling point, boiling can be caused by further warming. Special considerations should be given to minimize leaking of heat between the LNG storage tank outlet and the suction of the pump. This leaking of heat will warm the cryogenic liquid and thus reduce NPSHA. This can cause cavitation and loss of prime.

Annex G
(informative)

Recommendations for installation of a centrifugal pump

A typical cryogenic pump installation consists of the pump connected to vacuum insulated cryogenic tank. The installation layout should be adapted to the LNG storage tank design. The typical tank-pump set-up for centrifugal pumps is schematically shown in Figure G.1.



Key

1 beta
2 suction line
3 N_2
4 drain
5 alpha
6 degassing line
7 sump drain
8 external pipe temperature
9 bypass line
10 discharge line

Figure G.1 — Typical tank-pump set-up for centrifugal pumps

Annex H
(informative)

Recommendations for centrifugal pump design

H.1 Pump design with shaft seal

The pump cold end is connected to the warm end drive either directly or through a gearbox. The pump shaft protruding through the pump housing should be adequately sealed by a dynamic seal, to prevent or to minimize any gas leakages. The following seals or sealing systems has proven to be adequate and accepted by the LNG industry:

— simple mechanical seal;

— gas buffered labyrinth seal;

— gas buffered dry gas seal (DGS);

— liquid buffered dual mechanical seal;

— gas buffered dual DGS.

Some of these seals are suitable only for vertical or only for horizontal shaft sealing; some are suitable for both positions. The sealing systems can include closed purged and vented lantern, according to the sealing system selected. At the seal discharge, a temperature sensor is often installed to detect seal leakage in case of a seal failure.

Pump duty determines the selection of the seal, the sealing system cost, the acceptance or non-acceptance of any minor gas leakage and on the buffer gas and purging gas consumption and their availability. The suitable sealing system evaluation should be performed in conjunction with the pump manufacturer.

Additional information on centrifugal cryogenic pump design is given in the EIGA’s IGC Document 148/08 and in ISO 24490.

H.2 Pump design with submerged motor

The pump cold end is connected to the submerged motor in the motor housing; this is then connected to the pump housing. Both housings together are built as statically sealed enclosures. The motor stator insulation and the shaft supporting bearings should be designed for operation in LNG, which can include heavier hydrocarbons and impurities. These conditions and the frequent start/stop operation will influence the bearings life time and will reduce the time between overhauls. The pump rotor axial thrust has also major influence on the bearings life time. These aspects should be reviewed with the pump manufacturer.

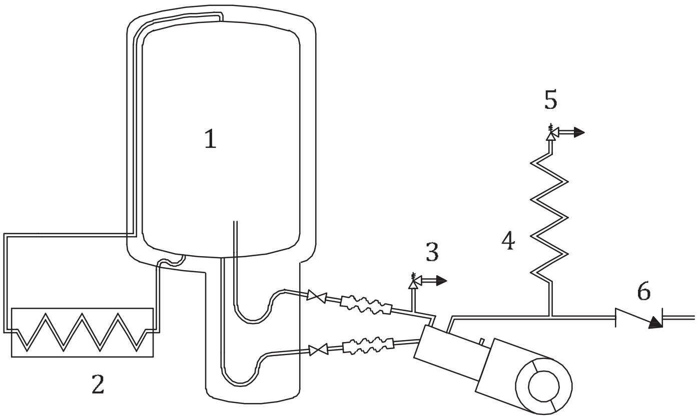
Alternatively, the pump housing with open suction mouth together with the motor in its housing may be installed in a suction barrel (slave tank). Such configuration is preferred for difficult NPSH conditions, because at the barrel suction nozzle the NPSHR is usually zero. However, alternative installations can be proposed by the pump manufacturer.

Annex I
(informative)

Recommendations for installation of a reciprocating pump

Sufficient NPSH is usually ensured by the vertical position of the LNG storage tank, the pump installation close to the LNG storage tank, short suction pipeline length, correct pipe and flexible hoses sizing and suitable type of valves, filters and fittings. The NPSHR and suction pressure conditions are specific to each pump model and should be reviewed individually with the pump manufacturer.

A typical cryogenic pump installation consists of the pump connected to vacuum insulated cryogenic tank. The installation layout should be adapted to the LNG storage tank design. The typical tank-pump set-up for reciprocating pumps is schematically shown in Figure I.1.

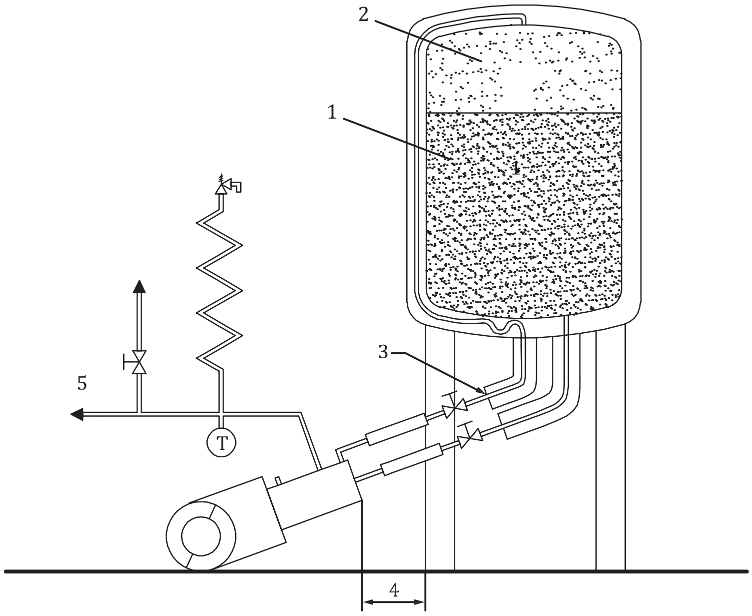


Key

1 storage tank
2 pressure build-up vaporizer (PBU)
3 pump suction relief valve
4 pulsation damper
5 delivery relief valve
6 non-return valve

Figure I.1 — Typical tank-pump set-up for reciprocating pumps

A typical cryogenic pump installation consists of a vacuum insulated cryogenic tank connected to a vacuum jacketed reciprocating pump with short pipes and flexible hoses. The installation lay-out should be adapted to the LNG storage tank design. The LNG storage tank can be of conventional or thermosiphon design (see Figures I.2 and I.3, respectively). Thermosiphon design is considered for more reliable operation with sufficient prime even with minimum liquid level in the tank.



Key

1 liquid

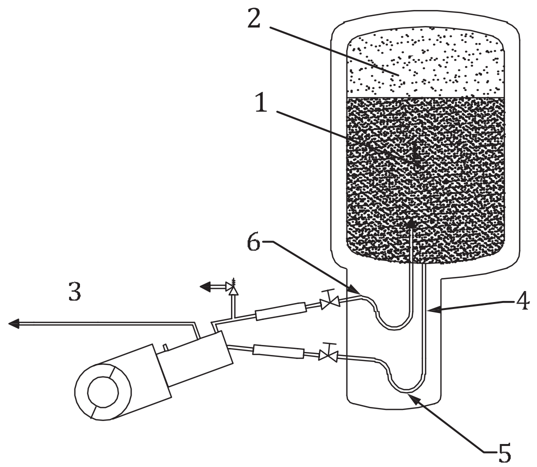
2 gas

3 return

4 shortest possible distance

5 discharge

Figure I.2 — Conventional arrangement: pump with K-connection for conventional LNG storage tanks



Key

1 liquid

2 gas

3 discharge

4 suction

5 lowest point

6 suction return

Figure I.3 — Thermosiphon arrangement: pump with T-connection for thermosiphon LNG storage tanks

Annex J
(informative)

Recommendations on the content of the cryogenic pump operation instructions

J.1 Operation instructions

The operation instructions should include the following:

— the same instructions as the data plate;

— drawings, diagrams, instructions and information covering:

— installations and assembly;

— disconnection from electric power supply for the pump;

— commissioning;

— switch off;

— decommissioning and specific procedure to apply before maintenance operation;

— handling and lifting (e.g. of the mass of the pump or of the major components);

— adjustment and calibration;

— information concerning the process application;

— fluids for which the pump is designated;

— temperatures data and settings;

— suction and discharge pressures;

— design pressure;

— specifications for lubricants and filters in view of quality, amount and recommended replacement intervals;

— environmental condition limits;

— operation speed;

— the necessity to install pressure relief devices and other protective devices if they are not part of the delivery of the pump;

— warning to operate the pump eventually in an explosive atmosphere unless it is designed for such purpose; in that case information should be provided about necessary safety measures.

J.2 Information concerning the operation

The information about the operation should include the following:

— recommendations about safety;

— start and stop procedure;

— emergency stop device, dry running and leakage sensors setting;

— guidelines for simple trouble shooting;

— cooling down recommendations and temperature setting;

— symbols;

— routine inspections, cleaning and maintenance work including the cleaning of radiators, refill jobs and the exchange of simple parts (e.g. air or oil filters);

— recommendation to wear specific protection, if appropriate;

— position of extensive hot or cold surfaces;

— risk to inhale hazardous gases, fogs or steams;

— risk of formation of ice and cryogenic burning risks;

— measures required for the protection of the operating personnel against residual risks.

J.3 Delineation of the working area

The cryogenic pump operation manual should include the delineation of the working area, if applicable.

J.4 Servicing instruction

The servicing instruction should outline those duties to be performed by specially trained personnel. These duties are in addition to the routine inspections, cleaning and maintenance work. The servicing instruction should contain the following:

— the same information as given on the data plate;

— drawings and diagrams required for periodical maintenance and simple repairs;

— list of components and parts subject to wear and tear requiring regular inspection or regular exchange;

— guidelines for trouble shooting;

— schedule for regular inspection and exchange of components and parts subject to wear and tear;

— guidelines for the safe execution of maintenance work and subsequent;

— guidelines for the safe commissioning, decommissioning;

— address of the service fuelling station(s) authorized by the manufacturer;

— warning that only one safety function may be out of service at one time for the purpose of inspection, maintenance and repair.

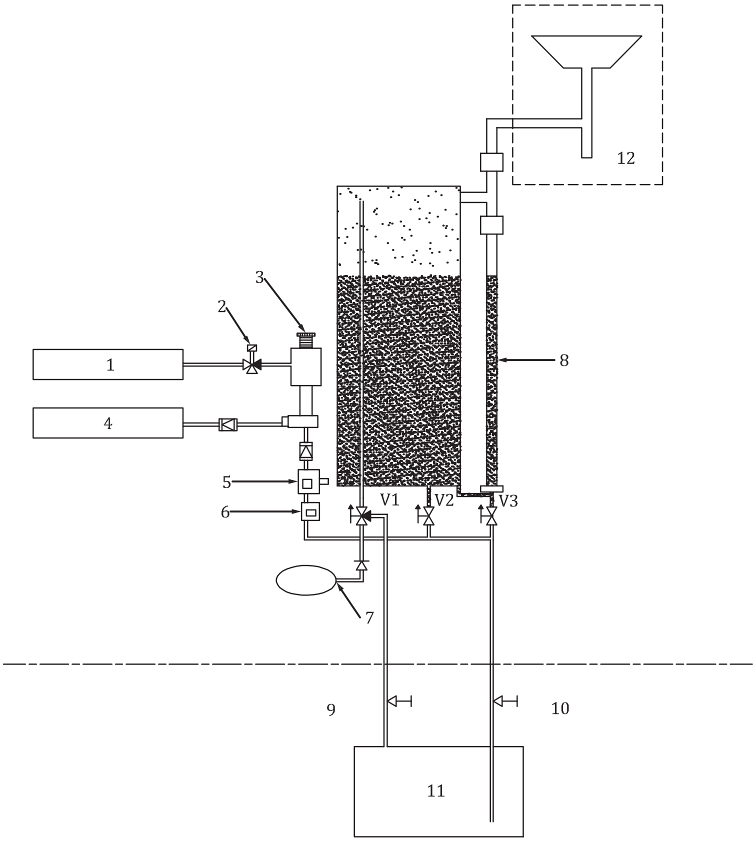
J.5 List of parts required for servicing

The manufacturer should provide a list giving information about all relevant parts for servicing, with unmistakeable identification and indicating the location of their installation at the pump.

Annex K
(informative)

Example flow diagram of a high-pressure odorizer

Figure K.1 shows an example of a flow diagram of a high-pressure odorizer.



Key

1 instrument air
2 dosing pump
3 buffer tank about 6 litre
4 odorizer feed line
5 flow switch
6 filter + adjustment
7 hand pump
8 sight glass with scale
9 air side
10 liquid side
11 odorizing barrel
12 to atmosphere
V1 valve 1
V2 valve 2
V3 valve 3

Figure K.1 — Example flow diagram of a high-pressure odorizer

Annex L
(informative)

LNG identification mark of an LNG fuelling station

LNG identification mark of an LNG fuelling station is defined as follows:

— the sign consists of a sticker which should be weather resistant;

— the colour and dimensions of the sticker should fulfil the following requirements:

  — colours:

    — background: green;

    — border: white or white reflecting;

    — letters: white or white reflecting;

  — dimensions:

    — border width: 4 mm - 6 mm;

    — character height: 25 mm;

    — character thickness: 4 mm;

    — sticker width: 110 mm - 150 mm;

    — sticker height: 80 mm - 110 mm;

— the word “LNG” should be centred in the middle of the sticker.

Figure L.1 shows an example of the LNG label.

Figure L.1 — Example of LNG label

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