International Standard

ISO 10665

First edition
2024-11

Ships and marine technology — Ship design — CNG and LNG propulsion system

Navires et technologie maritime — Conception maritime — Système de propulsion GNC et GNL

Reference number
ISO 10665:2024(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

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

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

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

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

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

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology,* Subcommittee SC 8, *Ship design*.

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

Introduction

This document specifies requirements for the installation of equipment for the use of compressed natural gas (CNG) and liquefied natural gas (LNG) in the propulsion systems of ships and crafts.

This document includes procedures which the use substances and procedures that can be injurious to health if adequate precautions are not taken. This document refers only to technical suitability.

Natural gas, either in gaseous (CNG) or liquid phase (LNG), is a very efficient and ready-to-use solution which can facilitate compliance with the more stringent environmental regulations as well as the compliance with the principles of the circular economy. Regulations can concern the impact of a product on the environment during its entire life cycle, including the expenditure of energy and during all phases such as use, scrapping and recycling of materials. Some parts of this document also address environmental aspects.

Ships and marine technology — Ship design — CNG and LNG propulsion system

1 Scope

This document specifies the requirements for the installation of compressed natural gas (CNG) and liquefied natural gas (LNG) propulsion systems and components on ships and crafts.

This document does not apply to large sea-going ships covered by SOLAS Chapter II-1 vessels.

This document does not cover appliances with directly attached gas cylinders, such as portable container.

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 9094, *Small craft — Fire protection*

ISO 10240, *Small craft — Owner's manual*

ISO 11105, *Small craft — Ventilation of petrol engine and/or petrol tank compartments*

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

ISO 11591, *Small craft — Field of vision from the steering position*

ISO 12217-1, *Small craft — Stability and buoyancy assessment and categorization — Part 1: Non-sailing boats of hull length greater than or equal to 6 m*

ISO 12217-2, *Small craft — Stability and buoyancy assessment and categorization — Part 2: Sailing boats of hull length greater than or equal to 6 m*

ISO 12217-3, *Small craft — Stability and buoyancy assessment and categorization — Part 3: Boats of hull length less than 6 m*

ISO 12614 (all parts), *Road vehicles — Liquefied natural gas (LNG) fuel system components*

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

ISO 12991, *Liquefied natural gas (LNG) — Tanks for on-board storage as a fuel for automotive vehicles*

ISO 13297:2020, *Small craft — Electrical systems*

ISO 14469, *Road vehicles — Compressed natural gas (CNG) refuelling connector*

ISO 15500 (all parts), *Road vehicles — Compressed natural gas (CNG) fuel system components*

ISO 23684, *Road vehicles — Technical personnel dealing with natural gas vehicles (NGVs) — Training and qualification*

ISO 24671, *Road vehicles — Qualification and certification of technical personnel dealing with natural gas vehicles (NGVs)*

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

EN 3-7:2004+A1:2007, *Portable fire extinguishers — Part 7: Characteristics, performance requirements and test methods*

EN 14291, *Foam producing solutions for leak detection on gas installations*

EN 28846, *Seagoing vessels — Aluminum alloy castings for machinery and general engineering use - Chemical composition and mechanical properties*

3 Terms and Definitions

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

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

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

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

3.1
accessible
capable of being reached for inspection, removal or maintenance without removal of permanent ship/craft structures

Note 1 to entry: Hatches are not regarded as permanent ship/craft structures in this sense, even if tools such as wrenches or screwdrivers are needed to open them.

3.2
appliance
device designed for heating, cooking, lighting, refrigeration, hot water production or electricity production (fuel cell or generator), using natural gas as its energy source

3.3
automatic valve
valve which is not operated manually

3.4
bi-fuel engine
engine that has two independent fuel systems (one of them for natural gas) and can run alternatively on either fuel, but only on one fuel at a time

3.5
check valve
automatic valve (3.3) which allows gas to flow in only one direction

3.6
cockpit
volume open to the air intended for the accommodation of people

Note 1 to entry: For the purpose of this document, the term "cockpit" is used either for a proper cockpit or for any recess as clarified in Note 2.

Note 2 to entry: Bulwarks can create a large cockpit, open crafts can effectively comprise a cockpit which includes nearly all the craft, cockpit(s) can be situated anywhere in the craft, and a cockpit can open aft to the sea.

Note 3 to entry: Cockpits can retain water, however briefly, due to rain, waves, ship heeling, etc.

3.7
compressed natural gas propulsion system
CNG propulsion system
fuel system which includes cylinder or cylinders, the assembly, one or more refuelling connectors, and the components described in ISO 10665

Note 1 to entry: Cylinders are replaceable items and cannot be supplied with the boat system

Note 2 to entry: See ISO 11439 for information on cylinders; see ISO 14469 for information on the assembly; and see the ISO 15500 series for the components listed.

3.8
compressed natural gas
CNG
natural gas which has been compressed and stored for use as a fuel

3.9
connector
fitting used to join a conduit, tubing, or hose systems

3.10
container
cryogenic vessel used for the storage of *liquefied natural gas* (3.28)

3.11
container housing
ventilated enclosure intended solely for storage of one or more *compressed natural gas* (3.8) *cylinders* (3.13) or *liquefied natural gas* (3.28) *containers* (3.10), pressure regulators and safety devices, which is located on the exterior of the ship or craft where any leakage would flow overboard

3.12
container locker
gas-tight enclosure on a ship or craft with an overboard drain, where any leakage would flow overboard, intended solely for storage of one or more *compressed natural gas* (3.8) *cylinders* (3.13) or *liquefied natural gas* (3.28) *containers* (3.10) in a cockpit or recessed into the ship or craft

3.13
cylinder
transportable, refillable *container* (3.10) with a water capacity from 0,5 l up to and including 150 l for the storage of *compressed natural gas* (3.8)

3.14
design pressure
highest pressure related to the circumstances for which the system has been designed and is intended to be used

3.15
dual-fuel engine
engine system that is designed to simultaneously operate with liquid fuel and a gaseous fuel, both fuels being metered separately, where the consumed amount of one of the fuels relative to the other one may vary depending on the operation

[SOURCE: ISO 8178-4:2020, 3.17]

3.16
excess flow valve
valve which automatically shuts off or limits the gas flow when the flow exceeds a set design value

3.17
filler valve
valve system for fill service

3.18
filter
component containing a screen or media that is intended to remove foreign debris from the gas stream

3.19
fixed container
compressed natural gas (3.8) *cylinder* (3.13) or *liquefied natural gas* (3.28) *container* (3.10) permanently installed to the structure of the ship and craft

3.20
fuel pipeline
tubing or hose through which natural gas flows

Note 1 to entry: Flexible fuel lines are also part of fuel pipeline.

3.21
gas/air mixer
device for mixing the gaseous fuel and intake air for the engine

3.22
gas detection
revealing of the presence of natural gas due to exposure outside the natural gas containment system

3.23
gas flow adjuster
gas flow restricting device, installed downstream of a pressure regulator, controlling gas flow to the engine

3.24
gas injector
device for introducing gaseous fuel into the engine or associated intake system

3.25
gas-tight housing
device which vents gas leakage to outside the vehicle including the gas ventilation hose, the clear opening of which is at least 450 mm^2

3.26
installer
organization or person, who by qualification, training, experience and resources can assume technical responsibility for the installation of a *compressed natural gas* (3.8) or *liquefied natural gas* (3.28) propulsion system

3.27
level indicator
fuel content gauge based on the pressure difference between the top and bottom of the fuel in LNG tank or the pressurized device (a gauge or a sensor) which indicates the gas pressure inside the CNG cylinder

Note 1 to entry: The system measures the weight of the liquefied gas in case of LNG.

Note 2 to entry: Other systems can be used to measure the level of LNG inside the tanks.

3.28
liquefied natural gas
LNG
natural gas which has been liquefied after processing for storage, transportation, or use as a fuel

[SOURCE: ISO 12614-1:2021, 3.11]

3.29
liquefied natural gas propulsion system
LNG propulsion system
fuel system using liquefied natural gas (LNG) which includes container(s), mounting, one or more fuelling connectors and the components described in ISO 10665

Note 1 to entry: LNG containers are replaceable items; it is not possible to supply them with the ship system.

Note 2 to entry: See ISO 12991 for further details on containers; see ISO 21593 for further details on connectors; and see ISO 22547 and ISO 22548 for details on the components described.

3.30
manual valve
valve which is operated manually and controls the flow of gas to the fuel system

3.31
mono-fuel engine
engine which operates on natural gas only

3.32
natural gas
NG
complex gaseous mixture of hydrocarbons comprising primarily methane, but generally includes ethane, propane and higher hydrocarbons, and some non-combustible gases such as nitrogen and carbon dioxide

3.33
permanently installed
securely fastened so that it is necessary to use for removal

3.34
pressure indicator
pressurized device that indicates the gas pressure; it can be an indicator or a sensor

3.35
pressure regulator
device used to control the delivery pressure of gaseous fuel to the engine

3.36
pressure relief device
PRD
safety device that releases gases or liquids above a specified pressure value in cases of emergency or abnormal conditions

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

— Pressure safety valve (PSV): pressure activated valve that opens at specified set point to protect a system from rupture and re-closes when the pressure falls below the set point.

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

[SOURCE: ISO 19880-1:2020, 3.59, modified — Note 2 to entry removed.]

3.37
pressure relief valve
PRV
discharge valve
self-closing device which opens to prevent a pre-determined pressure being exceeded

3.38
qualified person
individual subjected to a qualification process, and who has passed the qualification

[SOURCE: ISO 23684:2023, 3.26]

3.39
qualification
demonstrated education, training and work experience, where applicable, required to properly perform the assigned task as awarded or conferred as described in the document

Note 1 to entry: Adapted from ISO/IEC 17024:2012, 3.7

3.40
readily accessible
capable of being reached for operation, inspection or maintenance without the removal of any ship or craft structure, the use of any tools, or the removal of any item of portable equipment stowed in places intended for storage of portable equipment such as lockers, drawers or shelves

3.41
rigid fuel line
tubing which has been designed not to flex in normal operation and through which natural gas flows

3.42
service valve
manual valve which is closed only when servicing the engine

3.43
shut-off valve
valve to provide a leak-tight seal which is operated either manually, remotely or is self-closing

3.44
valve
device by which the flow of a fluid may be controlled

3.45
vaporiser
device intended to vaporise the cryogenic liquid fuel to a gaseous state with a gas range from -40 °C to +85 °C

3.46
ventilation system
assembly of ducts and an electrical ventilator that is capable of extracting hydrocarbons from the inside of the craft and allowing the entrance of fresh air

4 Components

4.1 General provisions

4.1.1 All operations on the CNG and LNG systems and propulsion systems shall be operated by a qualified person.

4.1.2 Individual components of the system, and the system as a whole, shall be designed to withstand the combined conditions of pressure, vibration, shocks, corrosion and movement encountered under normal operation.

4.1.3 All materials used in CNG or LNG systems shall be compatible with CNG and LNG and with other liquids or compounds with which it can come into contact under normal operating conditions, e.g. grease, lubricating oil, bilge solvents, fresh and sea water.

4.1.4 Efforts should be made to prevent grease, lubricating oil, bilge solvents and other chemicals contaminating the marine environment.

4.2 CNG cylinders and LNG containers

4.2.1 General provisions

The CNG cylinders and LNG container(s) shall be protected from corrosion in the marine environment by an adequate surface treatment system, or be constructed from materials suitable for the marine environment.

For the purpose of this document, two types of NG storage systems are identified:

— cylinders;

— fixed containers.

4.2.2 Cylinders

4.2.2.1 CNG cylinders can be used to fuel the engine of a ship/craft in gaseous phase depending on the choice of technology (e.g. mono-fuel, bi-fuel, dual-fuel) and the required power. The cylinders used on ship/craft shall conform to ISO 11439.

4.2.2.2 The quantity of fuel on board shall be indicated by the use a pressure indicator.

4.2.2.3 A PRV shall be fitted to any cylinder.

4.2.3 Fixed container

4.2.3.1 Fixed containers shall conform to ISO 12991.

4.2.3.2 The quantity of fuel on board shall be indicated by the use of a level indicator.

4.2.3.3 Consideration shall be given to the potential of liquid movement within the fixed container and measures put in place. e.g. appropriate design by installing a number of baffles inside.

4.2.3.4 A primary and secondary PRV shall be fitted to any container.

4.2.4 Components fitted to the cylinder or fixed container

4.2.4.1 The cylinders shall be equipped with the following components, which can be either separate or combined (e.g. multivalve):

a) filler valve;

b) manual valve;

c) automatic valve;

d) pressure indicator;

e) PRD;

f) excess flow valve.

4.2.4.2 The cylinders can be equipped with a:

a) gas-tight housing; or

b) PRV.

4.2.4.3 All components fitted to the container shall comply with the applicable part of the ISO 15500 series.

4.2.4.4 The filler valve shall conform to ISO 14469.

4.2.4.5 Containers shall be equipped with the following components, either separated or combined:

a) filler valve;

b) manual valve;

c) automatic valve;

d) level indicator;

e) PRD;

f) excess flow valve;

g) pressure regulator;

h) PRV primary or secondary;

i) check valve;

j) excess flow valve.

4.2.4.6 All components fitted to the container shall conform to the applicable part of the ISO 12614 series.

4.3 Fuel system components

4.3.1 Vaporizer

4.3.1.1 The vaporizer shall comply with ISO 12614-16 and shall be suitable for use in the marine environment with anticorrosion treatment and stainless-steel bolts.

4.3.1.2 The materials of the vaporizer, which are in contact with the engine coolant, shall be compatible with the coolant and shall be designed to withstand a working pressure as per ISO 12614-16.

4.3.2 Other components

The following components of the CNG fuel system, where used, shall conform with the following parts of the ISO 15500 series:

— the gas injector shall be in accordance with ISO 15500-7;

— the pressure regulator shall be in accordance with ISO 15500-9;

— the gas flow adjuster shall be in accordance with ISO 15500-10;

— the gas/air mixer shall be in accordance with ISO 15500-11;

— PRV shall be in accordance with ISO 15500-12;

— rigid fuel lines in stainless steel shall be in accordance with ISO 15500-16;

— flexible fuel lines shall be in accordance with ISO 15500-17;

— the filter shall be in accordance with ISO 15500-18;

— fittings shall be in accordance with ISO 15500-19;

— rigid fuel lines in material other than stainless steel shall be in accordance with ISO 15500-20.

These components shall also be suitable for use in the marine environment.

The following components of the LNG fuel system, where used, shall comply with the following parts of the ISO 12614 series

— the overpressure regulator shall be in accordance with ISO 12614-6[1)];

— rigid fuel lines in stainless steel shall be in accordance with ISO 12614-10;

— fittings shall be in accordance with ISO 12614-11;

— rigid fuel lines in copper and its alloys shall be in accordance with ISO 12614-12.

These components shall also be suitable for use in the marine environment.

5 Installation requirements

5.1 General requirements

5.1.1 The CNG or LNG system shall be installed by a qualified person in accordance with ISO 23684 and ISO 24671, taking into account the manufacturers' instructions and sound engineering practice.

5.1.2 All parts of the CNG or LNG system shall be permanently installed.

5.1.3 All parts of the CNG or LNG system shall be securely fastened.

5.1.4 The completed CNG or LNG system shall be adequately protected against corrosion.

5.1.5 All valves and other components intended to be manually operated, or observed during normal operation of the ship/craft, or for emergency purposes, shall be readily accessible.

5.1.6 All other components of the CNG or LNG system shall be accessible.

5.1.7 No component of the fuel system shall be located within 100 mm of the exhaust or similar heat source, unless adequate shielding against heat is provided.

5.1.8 Clearance between dry exhaust components and an LNG container or CNG cylinder shall not be less than 250 mm, unless an equivalent thermal barrier is provided.

5.1.9 Fuel containers and cylinders and components of fuel systems shall not be installed directly above batteries, unless the batteries are protected against the effects of fuel leakage.

5.1.10 The fuel system shall function in such a manner that the pressure for which it has been designed and approved cannot be exceeded.

5.1.11 The fuel system shall be adequately protected against every kind of damage (e.g. those caused by the movement of the goods stored on board).

5.1.12 No component of the CNG or LNG system shall obstruct the field of vision from the helm position in accordance with the requirements of ISO 11591.

1) Withdrawn.

5.1.13 Permanent and clearly visible labels indicating CNG or LNG shall be fixed on one or more of the following locations:

— on or close to the engine(s);

— on or adjacent to the container housing(s);

— on or close to container and cylinder lockers(s); and

— on the exterior of the ship/craft.

NOTE Annex C provides an example of a suitable label.

5.2 Installer of the CNG or LNG system

5.2.1 The installer shall possess the competence and expertise necessary for the proper installation of the CNG or LNG system and ensure that the installation of the system meets the requirements of this document. The competence and expertise of the installer is assumed if the installation activities are made by or under the control of a technical manager qualified in accordance with ISO 23684 and ISO 24671.

5.2.2 The installer shall install components in accordance with the manufacturer's instructions or other limitations.

5.2.3 The installer shall endeavour to minimize wastage of materials used and shall dispose of surplus materials in an environmentally friendly manner.

5.2.4 Material segregation bins shall be used for recycling materials.

5.2.5 The installer shall maintain records of the commissioning tests as detailed in Clause 8.

5.2.6 The installer shall issue a signed installation certificate incorporating a certificate of conformity to this document upon satisfactory completion of the CNG or LNG system installation and commissioning.

NOTE An example of an installation certificate is given in Annex B.

5.2.7 The installer shall supply an owner's manual for the CNG or LNG system as per Clause 7.

5.3 Additional CNG or LNG systems not connected to the propulsion system

The operation of the propulsion system shall not be affected by the introduction of additional CNG or LNG systems.

5.4 Modifications to the structure of the ship or craft

5.4.1 Any alteration or modification to any ship or craft resulting from the installation of CNG or LNG equipment shall be carried out in accordance with sound engineering practices.

5.4.2 The installation of CNG cylinders/LNG containers shall not adversely affect the stability and buoyancy of the ship/craft when evaluated in accordance with ISO 12217-1, ISO 12217-2 and ISO 12217-3

5.4.3 Where any substantial modification is made to the ship/craft structure to facilitate the installation of the fuel system, a written agreement, accompanied by a detailed drawing, shall be obtained from the manufacturer of the ship/craft or a notified body.

5.5 Container or cylinder installation

5.5.1 General

5.5.1.1 The container or cylinder shall:

— be stowed either in the open air or in a container locker;

— not be stowed in the engine compartment, unless in a container locker (see 5.5.4);

— not be stowed in accommodation spaces;

— be securely fastened to the ship/craft;

— be installed in the correct orientation in accordance with the container manufacturer instructions;

— be installed in such a manner that it does not form an obstruction:

— be installed in such a way that provisions for escape in the event of fire or inversion, or both, are not negatively affected; and

— allow drainage from their surfaces when the ship/craft is in its static flotation position.

5.5.1.2 When stored in open air CNG cylinder/ LNG containers, pressure regulators and safety devices shall be shielded from direct solar radiation and shall have the vents protected against the ingress of dirt and water by positioning or shielding.

5.5.1.3 Containers/cylinders, pressure regulators and safety devices located below decks or in cockpits shall be mounted in container lockers.

5.5.1.4 No provision shall be made in a container locker or container housing for the storage of loose components that can damage the container/cylinder, pressure regulator, piping or hose installation or obstruct the locker drain.

5.5.1.5 Containers and cylinders shall be installed and fixed so that a 3 g acceleration can be absorbed without any damage in any direction of movement while the container is fully loaded.

5.5.1.6 Containers and cylinders shall not be directly in contact with the floor and shall be spaced a minimum of 20 mm from the floor.

5.5.1.7 The container/cylinders shall be installed so that there is no metal-to-metal contact, other than at any permanent fixing points.

5.5.2 Fixed containers/cylinders

5.5.2.1 Containers and cylinders shall be permanently installed in such a manner that they do not support decks, bulkheads or other ship/craft structures, unless they are designed for the purpose.

5.5.2.2 Containers and cylinders shall not be integral with the hull.

5.5.2.3 Containers and cylinders shall be installed in a manner that allows inspection and maintenance of fittings, hose connections, etc.

5.5.2.4 Supports, chocks or hangers shall be separated from the surface of metal containers by a non-metallic, non-hygroscopic, non-abrasive material, unless welded to the container.

5.5.2.5 Foam shall not be the sole means used to secure containers and cylinders in place. Where foam is in contact with the container/cylinder, due care shall be taken to avoid corrosion.

5.5.2.6 Metallic containers and cylinders within the hull shall be installed with the container and cylinder bottom no less than 25 mm above the normal maximum bilge water level.

5.5.3 Cylinders and Containers

5.5.3.1 Cylinder and containers shall be securely fastened by a dedicated system to the structure of the ship/craft. This requirement also applies to unconnected cylinders.

5.5.3.2 Cylinders and containers shall be installed so that they are readily accessible.

5.5.4 Cylinders and containers lockers

5.5.4.1 Cylinders lockers openable from inside the cockpit shall be opened only from the top, while containers lockers openable from inside the cockpit shall be opened from the top or from the front.

5.5.4.2 Lockers, when closed, shall be gas-tight to the ship/craft interior, vented at the bottom by a drain of not less than an internal diameter of 19 mm (or the equivalent area if not circular) for containers having a combined capacity of up to 15 kg. The check valves shall remain accessible.

5.5.4.3 The internal diameter of the drain shall be enlarged pro rata where additional containers are carried, or where the capacity exceeds 15 kg.

5.5.4.4 The locker drain shall be run directly overboard, i.e. to the outside of the ship/craft; and shall not be fitted with sumps which can retain water. The locker drain shall either:

a) have the exit at the highest point possible to avoid inhalation or the possibility of ignition. The designer, in positioning the exit, shall consider:

   1) the places where people can stay continuously;

   2) the presence of either ignition or heat sources, or both;

   3) the physical state of the fuel;

   4) the possibility of indicating by suitable means the possible presence of gas in the specific area;

or:

b) be fitted with forced ventilation meeting the following requirements:

   1) a gas sensor, connected to a suitable acoustic signal that indicates the presence of gas and to a safety system shall be inserted in the locker at the highest level where the gas can be accumulated;

   2) the ventilation system shall be explosion proof;

   3) the ventilation fan shall be flameproof and run for a minimum of 60 s before the engine can be started; and

   4) at least one outlet duct situated at the highest part shall be fitted to the locker.

The outlet duct can be made with flexible lines compatible with the type of fuel used and with the marine environment.

5.5.4.5 The outlet duct shall be:

— remote (at least 250 mm) from the engine exhaust system;

— protected from blockage by virtue of its position or other means; and

— located at least 500 mm from any hull opening to the interior of the ship/craft.

5.5.4.6 All hoses or metal piping penetrating the locker walls shall be sealed at the wall so as to maintain gas tightness to the ship/craft interior.

5.6 Components fitted to the fixed container/cylinder

5.6.1 General requirement

The components on and in the container and cylinder shall be installed under the responsibility of the holder of the bonfire test certificate as described in ISO 11439 and ISO 12991.

5.6.2 Remote-controlled service valve and excess flow valve on the container

5.6.2.1 The remote-controlled service valve shall be installed directly on the container/cylinder. The excess flow valve shall be installed inside the container/cylinder

5.6.2.2 The remote-controlled service valve shall be installed so that it automatically closes when the engine stops or when the ignition is turned off.

5.6.3 Pressure relief valve

The PRV shall be installed in or on the container and cylinder so that it is connected to the vapour space and shall discharge to the atmosphere directly, or via a gas-tight housing, if fitted.

5.6.4 Filler valve

The filler valve shall conform to:

— ISO 14469 and 5.8.3 for the CNG;

— ISO 12617 for the LNG.

The protection against overfill shall be guaranteed by the dispenser unit.

5.6.5 Level indicator

The level indicator shall be suitable for the container and shall be installed in the correct position to ensure its proper operation.

Where an instrument panel is fitted, a level indicator readout should be installed on the panel.

5.6.6 Fittings

The fittings shall be protected from ingress of dirt and water.

5.6.7 Pressure relief device

The pressure relief device (PRD) shall be rigidly fitted in or on the container and cylinder and operate independently and without interference from other devices so that it discharges overboard directly or via the container and cylinder locker, where fitted.

5.7 Gas pipes and hoses

5.7.1 Gas piping and hoses shall be installed as high as practicable above the bilge water level and shall not be in direct contact to seawater.

5.7.2 Gas piping shall be routed at least 30 mm away from electrical conductors, unless the piping passes through a conduit with no joints, or the conductors are sheathed or in a conduit or trunking (see ISO 13297 for details).

5.7.3 Gas piping shall be supported by fixing devices or other means, such as inside vented, non-metallic, supported conduit or piping, to prevent chafing or vibration damage.

5.7.4 Gas piping and hoses shall be secured so that they are not subject to excessive stress, such as stresses caused by thermal expansion of the hull and associated components or engine induced vibration.

5.7.5 Gas piping shall not be in direct contact with metallic parts and shall be adequately protected at the fixing points in order to prevent abrasion.

5.7.6 Gas piping and hoses shall be secured by clamps to the main structure of the ship/craft or to parts rigidly connected to the main structure of the ship/craft.

5.7.7 The fixing devices shall be corrosion resistant, non-abrasive, designed to prevent cutting or other damage to the piping and compatible with the pipe material.

5.7.8 Fixing devices shall be pipe rings spaced at intervals not exceeding 0,5 m for copper or stainless-steel piping, and not more than 1 m for piping of other materials.

5.7.9 Gas piping and hoses passing through bulkheads intended to maintain watertight integrity in the ship/craft at the level of penetration shall be sealed by suitable materials or fittings at the point of penetration.

5.7.10 Gas piping and hoses shall be protected from abrasion or chafing at the point where they pass through walls or bulkheads. A grommet shall be fitted to the hole where piping or flexible hoses pass through the structure of the ship/craft. The outside diameter of the hole through the structure shall be at least 1,5 times the diameter of the pipe or hose that passes through it.

5.7.11 Only seamless copper piping, copper nickel piping or drawn stainless steel piping, which are galvanically compatible, shall be used for rigid fuel supply lines. The minimum wall thickness for CNG piping shall be 1 mm up to outside diameter of 6 mm or greater.

5.7.12 Seamless copper gas pipes shall be protected by a rubber or plastic sleeve or coating.

5.7.13 A rigid pipeline shall not be used between parts which can move relative to each other. A flexible hose conforming to the requirements of ISO 15500-17 and ISO 12614-20 shall be used.

5.7.14 Metallic piping routed through engine compartments shall be protected by conduit or trunking or supported by non-abrasive attachments, which are no more than 500 mm apart.

5.7.15 Metallic piping shall be at least 100 mm from exposed terminals of electrical devices or accessories.

5.7.16 To avoid the risk of static electricity a properly earth connection of the fuel lines shall be carried out.

5.8 Other components

5.8.1 Gas connections between components of the CNG or LNG system

5.8.1.1 Soldered joints shall not be used in CNG and LNG systems.

5.8.1.2 Welded or brazed joints are permitted, provided that such joints are limited to the factory assembly of components.

The environmental impact of welding and allied processes should be assessed according to EN 14717. A check list should be provided for the assessment.

5.8.1.3 The melting point of materials at welded or brazed connections shall be not lower than 450 °C.

5.8.1.4 Solder shall have a melting point of not lower than 450 °C.

5.8.1.5 The design pressure of the couplings shall be the same or higher than that specified for the gas pipe.

5.8.1.6 Gas manifold shall be made of corrosion resistant material.

5.8.1.7 Fittings for connections and joints in piping shall be metallic and of any of the following types:

— hard soldered connections;

— cutting-ring fittings;

— compression fittings made of copper alloy with solid or thick-walled copper rings on copper piping; or

— stainless steel rings on stainless steel piping.

5.8.1.8 The wall thickness of the ring shall be greater than or equal to 0,5 mm and a jointing compound shall not be used on compression of flared fittings.

5.8.1.9 Fittings shall be galvanically compatible with the metallic piping to which they are connected. Gas pipes shall be connected by appropriate fittings compatible with the material of the pipe.

5.8.1.10 End-connection fittings shall be of corrosion-resistant material such as brass or stainless steel. Where cutting-ring fittings are used in conjunction with copper piping, a brass insertion sleeve and brass cutting ring shall be fitted. All components shall be matched, i.e. they shall be of the same series.

5.8.1.11 The number of joints and fittings shall be kept to a minimum. All joints and fittings shall be readily accessible for inspection.

5.8.1.12 All joints and connections in piping and hoses in the systems shall be made such that no undue stress is created at the fitting.

5.8.1.13 Except for bulkhead fittings, there shall be no joints or fittings in the piping that passes through engine compartments.

5.8.1.14 Connections shall only be made in ventilated compartments with the exception of the engine space.

5.8.1.15 In the accommodation or other enclosed compartment, the gas pipe or flexible hose shall not be longer than required for safe installation.

5.8.1.16 Hose clamps, if used to secure cylinder/container -locker vent hoses, shall be made of corrosion-resistant material, such as stainless steel of type 18Cr 8Ni, or equivalent, and shall be reusable.

5.8.1.17 Hoses carrying CNG or LNG under pressure shall be provided with re-usable mechanical connections.

5.8.1.18 Hose connections shall be stress free, i.e. not subjected to tension or kinking under any conditions of use.

5.8.1.19 Regulators and safety devices shall be secured against any movement that is expected to result from marine service.

5.8.2 Remote-controlled shut-off valve

NOTE 1 Fixed container, liquid phase.

A remote-controlled shut-off valve shall be installed in the piping between the container and the pressure regulator/vaporizer, as close as possible to the pressure regulator/vaporizer. The shut-off valve shall be of the normally closed type.

NOTE 2 The remote-controlled shut-off valve can be combined with the pressure regulator/vaporizer.

The remote-controlled shut-off valve shall be operated in such a way that the fuel supply is cut off when:

— the ignition is switched off,

— the engine stops; or

— in the case of dual-fuel, the alternative fuel is selected.

5.8.3 Filling unit

The filling unit shall:

a) conform to ISO 14469.

b) be secured against rotation and shall be protected against dirt and water.

c) be clearly marked to indicate CNG and LNG.

d) be on the outside of the ship/craft and shall not be mounted directly on the container/cylinder.

e) not be positioned within 400 mm horizontal radius or vertically above any ventilation opening.

5.9 Electrical installation

5.9.1 Fuel system electrical components shall be installed in accordance with ISO 13297.

5.9.2 There shall be no potential sources of ignition in CNG cylinder/LNG container lockers, housings or other compartments.

5.9.3 Electrical devices shall be ignition-protected in accordance with EN 28846 when located in:

— container and cylinder lockers, container and cylinder housings; or

— compartments containing valves, fittings or connections of the CNG or LNG system; or

— compartments containing unattended appliances of the CNG or LNG system.

5.9.4 Compartments open to the atmosphere outside the ship/craft having an open area of at least 0,34 m^2/m^3 of compartment volume are exempt from the requirements of 5.9.3.

NOTE Spaces below cabin floors or soles are not considered as part of the accommodation space unless there are permanent openings, for example if they are not separated by close fitting doors or panels.

5.9.5 The electrical components of the CNG or LNG -system shall be protected against overloads and at least one dedicated fuse or circuit breaker shall be provided.

The fuse/circuit breaker shall be installed in a known location and shall be readily accessible.

5.9.6 Fuses or circuit breakers shall not be installed inside the gas-tight housing.

5.9.7 The electrical power to components, which carry CNG or LNG, shall not be conducted by a gas pipe. Gas pipes shall not be used for earthing.

5.9.8 Electrical cables shall be adequately protected against damage.

5.9.9 The electrical connections inside the engine compartment or other enclosed compartment shall be in accordance with the degree of protection class IP 40 specified in IEC 60529. All other electrical connections shall conform to insulation class IP 54 specified in IEC 60529.

5.9.10 Electrical connections and components in the gas-tight housing shall be constructed so that no sparks are generated.

5.9.11 Electrical connections, with the exception of the earth connection, shall be electrically insulated.

5.9.12 Bare metal conductors are not permitted.

5.10 Fuel selection system

5.10.1 An overlap time of a maximum of two seconds for switching-over is allowed. This does not apply to ship/craft that have engines that operate on both fuels at the same time (dual-fuel).

5.10.2 To ensure that the engine continues to operate safely in the event of a fault in one of the fuel systems during switch-over operations, the bi-fuel or dual-fuel system shall include an electronic control unit (ECU) intended to be fitted as a component of an interconnected CNG or LNG system. Such a fault shall be clearly indicated to the engine operator.

5.11 Gas detection

5.11.1 General

Where either the engine or the CNG or LNG storage are below deck and there is a possibility of gas accumulation, a gas detection system shall be installed.

The gas detection system shall be permanently fixed to the ship/craft and shall be in accordance with the following:

a) be suitable for the marine environment, resistant to corrosion and the entry of dust;

b) be capable of continuous operation from a low voltage source (e.g. wired direct to a battery via fuses) and indicate the operational status within 30 s after power being supplied;

c) have at least two electrical outlets for connection of external equipment (audible alarm, bilge blowers, etc.);

d) have a latching system that continues to indicate an alarm condition until cancelled;

e) be self-checking and indicate both normal and fault conditions;

f) have fully serviceable units and be supplied with full installation and operating instructions;

g) have switches that indicate their operational position; this indication shall be permanently marked; and

h) have all markings visible on the unit, including the manufacturer's name and address (permanently marked).

When gas is detected at 20 % of the lower explosive limit (LEL), an audible and visual warning alarm shall start and the ventilation system described in 5.12 shall start. The visual alarm shall not be overridden other than by turning off the electrical supply of the fuel system.

5.11.2 Alarm position

The alarm on the gas detection system shall be positioned to ensure that it is audible and visible from the helm position or wheelhouse under normal operating conditions.

5.11.3 Sensors position

A minimum of two sensors shall be fitted, one in the engine compartment of inboard engine ship/craft and one in the bilge at the lowest level where gas can accumulate but above the high-bilge-water level. Where the engine compartment is also the lowest point above the high-bilge-water level, only one sensor is required.

Consideration should be given to the positioning of additional sensors in the gas container compartments and accommodation spaces.

5.12 Forced ventilation

5.12.1 General

Engine compartments shall have forced ventilation in accordance with ISO 11105 and the requirements of 5.12.2. This ventilation system shall be ignition-protected in accordance with EN 28846.

5.12.2 Purging of engine space

The ventilation fan shall run for a minimum of 60 s before the engine can be started. The "green light" for the engine start shall be under the control of the electronic gas detector, which shall have the necessary time to make a pre-check of all controlled compartments.

The gas detector shall be turned on at all times.

5.12.3 Position of venting

At least one inlet duct shall extend down to the lower one-third of the engine compartment and above the normal level of accumulated bilge water to clear fumes from the bilge and promote the circulation of fresh air.

6 Fire-extinguishing equipment

Fire-extinguishing equipment shall be installed and meet the requirements for petrol engines in accordance with ISO 9094. Portable fire extinguishers shall conform to EN 3-7:2004+A1:2007.

7 Owner's manual

7.1 The ship/craft manufacturer shall provide an owner's manual, which is in accordance with ISO 10240, in the language of the country of use, and shall include the user instructions supplied by the manufacturers of equipment and appliances.

7.2 In the case of retrofits, the installer shall provide an owner's manual, in English and the common language of ship/craft, for the specific use of the ship/craft running on CNG or LNG.

7.3 Requirements and guidance for the contents of the owner's manual shall be in accordance with Annex A.

7.4 The location of the fuse / circuit breaker shall be included in the owner's manual.

8 Commissioning

The commissioning process is based on the following steps.

8.1 Tightness test

8.1.1 Except for the case approved within the subclause 8.1.2, any system, including the container(s) and all joints, shall be submitted to an inert gas tightness test at a test pressure of at least 10 bar[2)] but at a maximum of 90 % of the container's design pressure for a minimum of 10 min. A proprietary leak detection fluid in accordance with EN 14291 shall be used. Other methods of equivalent sensitivity can be used.

8.1.2 If the container(s)/cylinder(s) and the components are tested independently from the rest of the system and are filled with CNG or LNG, the rest of the system shall be tested separately in accordance with 8.1.1 before connecting it to the fuel container(s) and terminal joint(s), then it shall be submitted to a tightness test under the fuel container's available pressure.

8.1.3 To pass the test, no leaks shall be ascertained.

8.2 Leakage test

Either the CNG or LNG system shall be pressurized at the working pressure and tested for leakage with a surface active agent without formation of bubbles for three min or by using a demonstrated equivalent method.

The test shall be interrupted if leaks occur while filling the system up to the respective test pressures. In this case, the leak shall be rectified after having depressurized and then re-sealed the system. Then the system shall be tested again.

8.3 Initial filling of the container and cylinder and the system with LNG/CNG

The fuel container(s)/cylinder(s) can only be filled with LNG/CNG for the first time when the tightness testing as per 8.1 has been completed and confirmation that all leaks have been eliminated.

The tightness test shall be interrupted if leaks occur while filling the system up to the respective test pressures. In this case, the leak shall be rectified after having depressurized and then re-sealed the system. Then the system shall be tested again.

8.4 Fuel System test

After the initial filling with CNG or LNG, a final tightness test shall be performed on all joints which have not yet been tested under CNG or LNG pressure. See 8.1.

The control system should be tested at this stage.

2) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

8.5 Water trial

After successful completion of the previous tests listed in 8.1, 8.2, 8.3 and 8.4, the ship/craft shall undergo a water test to verify that the performance under normal working conditions is satisfactory.

For bi-fuel engines working with CNG or LNG and gasoline, fuel switching shall be done to verify that the transition takes place satisfactorily.

Where the CNG or LNG fuel system is included in the type approval of the ship/craft, it is possible that the water trial is not mandatory for each individual ship/craft produced.

Annex A
(normative)

Owner's manual

A.1 General requirements

The owner's manual shall be in accordance with ISO 10240 and shall include instructions for the operation and maintenance of the CNG or LNG system, including user instructions supplied by the manufacturers of the installation equipment. It shall also contain at a minimum the following instruction:

"Before sailing to a foreign coast, any restrictions on the use of CNG or LNG fuelling system shall be established and all necessary actions taken".

NOTE The minimum requirements of owner's manual are defined in ISO 10240,

A.2 Availability of CNG or LNG supply

The following warning shall appear in the owner manual.

WARNING — Before sailing, the owner shall take on board sufficient fuel for the intended journey, taking into account the risk of changing weather conditions.

A.3 Position and operation of emergency shut-off valve

The position and operation of the emergency shut-off-valve shall be clearly illustrated in the owner's manual.

A.4 Safety instructions to be included in the manual

A.4.1 The following safety related instructions and warnings shall appear in the owner's manual.

— Regularly check all connections for leakage.

— WARNING — DO NOT USE SOLUTIONS CONTAINING AMMONIA.

— WARNING — NEVER USE A FLAME TO CHECK FOR LEAKS.

— Do not obstruct access to CNG or LNG system components in any way.

— Keep valves on empty cylinders closed and disconnected. Keep protective covers, caps or plugs in place. Store reserve cylinders in ventilated housings on open decks or in gastight lockers, which are vented overboard and intended for that purpose.

— Keep any unconnected CNG cylinder or LNG container, whether full or empty, secured in a manner similar to the cylinders and containers connected to the system.

— Do not use CNG cylinder or LNG container housings or cylinder/container lockers for storage of any other equipment.

— WARNING — Do not smoke or use an open flame when replacing CNG cylinders or LNG containers.

— Inspect hoses in the CNG or LNG system regularly, at least annually, and replace with hoses of the same type approval if any deterioration is found.