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Small craft — Liquefied petroleum gas (LPG) systems

Petits navires — Installations alimentées en gaz de pétrole liquéfiés (GPL)

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO 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).

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

This document was prepared by Technical Committee ISO/TC 188, *Small craft*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 464, *Small Craft*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 10239:2014), which has been technically revised.

The main changes are as follows:

— the Scope has been clarified;

— new definitions for "room-sealed appliance" and "open-flued appliance" have been added;

— new definitions for "cylinder locker" and "cylinder housing" have been added, including some examples in a new Annex E;

— Clause 9 on the location and installation of LPG cylinders has been revised;

— a new Clause 12 has been added with details of a commissioning label;

— the location of pressure regulating devices has been clarified;

— Annex C has been revised to update the instructions to be included with the owner's manual;

— a new Annex E has been added to provide examples of cylinder lockers and cylinder housings.

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.

Small craft — Liquefied petroleum gas (LPG) systems

1 Scope

This document specifies requirements for the installation of permanently installed liquefied petroleum gas (LPG) systems and LPG-burning appliances on small craft.

This document is applicable to portable cooking appliances with internal LPG cartridges, with a capacity of 225 g or less (see Annex D).

This document is applicable to the storage of all LPG cylinders.

NOTE 1 National regulations can apply to the technical requirements of LPG cylinders.

This document does not contain procedures for commissioning new LPG installations or system maintenance or upgrades.

This document does not apply to LPG-fuelled propulsion engines or LPG-driven generators.

NOTE 2 National codes and procedures appropriate to the country concerned can be available.

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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 565, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings*

ISO 8434-1:2018, *Metallic tube connections for fluid power and general use — Part 1: 24° cone connectors*

ISO 8666, *Small craft — Principal data*

ISO 8846, *Small craft — Electrical devices — Protection against ignition of surrounding flammable gases*

ISO 9094, *Small craft — Fire protection*

ISO 11812, *Small craft — Watertight or quick-draining recesses and cockpits*

EN 751-2, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water — Part 2: Non-hardening jointing compounds*

EN 751-3, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water — Part 3: Unsintered PTFE tapes and PTFE strings*

EN 1254-2, *Copper and copper alloys — Plumbing fittings — Part 2: Compression fittings for use with copper tubes*

EN 1949, *Specification for the installation of LPG systems for habitation purposes in leisure accommodation vehicles and accommodation purposes in other vehicles*

EN 15266, *Stainless steel pliable corrugated tubing kits in buildings for gas with an operating pressure up to 0,5 bar*

EN 16129:2013, *Pressure regulators, automatic change-over devices, having a maximum regulated pressure of 4 bar, with a maximum capacity of 150 kg/h, associated safety devices and adaptors for butane, propane, and their mixtures*

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
craft
small craft
recreational boat, and other watercraft using similar equipment, of up to 24 m length of hull (L_H)

Note 1 to entry: The measurement methodology for the length of hull (L_H) is defined in ISO 8666.

[SOURCE: ISO 8666:2020, 3.15, modified — Note 1 to entry added.]

3.2
liquefied petroleum gas
LPG
mixture of light hydrocarbons, gaseous under conditions of normal temperature and pressure, and maintained in the liquid state by increase of pressure or lowering of temperature

Note 1 to entry: The principal components are propane, propene, butanes or butenes.

Note 2 to entry: LPG can be obtained as commercial butane, commercial propane or a mixture of the two.

[SOURCE: EN 624:2011, 3.1.7, modified — Note 2 to entry added.]

3.3
permanently installed
securely fastened so that tools are required for removal

[SOURCE: ISO 10088:2022, 3.3]

3.4
cylinder housing
ventilated enclosure with or without a door which is vapour tight to the interior of the *craft* (3.1), intended solely for storage of one or more *liquefied petroleum gas* (3.2) cylinders, *pressure regulating devices* (3.12) and safety devices, and located so that leakage flows overboard unimpeded

3.5
cylinder locker
enclosure which is vapour-tight to at least the height of the cylinder valve and other high-pressure components and is completely vapour tight to the interior of the *craft* (3.1), intended solely for storage of one or more *liquefied petroleum gas* (3.2) cylinders, *pressure regulating devices* (3.12) and safety devices, and fitted with a drain so that leakage flows overboard unimpeded

3.6
liquefied petroleum gas system
LPG system
system consisting of an arrangement of cylinder(s), safety device(s), *pressure regulating device(s)* (3.12), connection(s), valve(s), *piping* (3.23), *hose assembly(ies)* (3.20), fitting(s) and devices intended to store, supply, monitor or control the flow of *LPG* (3.2) up to and including the appliance

Note 1 to entry: The cylinders are replacement items and are sometimes but not always supplied with the LPG system in the *craft* (3.1).

3.7
habitable space
space surrounded by permanent structure in which there is provision for any of the following activities: sleeping, cooking, eating, washing/toilet, navigation and steering

Note 1 to entry: Spaces intended exclusively for storage, open cockpits with or without canvas enclosures and *engine compartments* (3.21) are not included.

[SOURCE: ISO 11105:2020, 3.1, modified — "engine compartments" replaced "engine rooms" in Note 1 to entry.]

3.8
readily accessible
capable of being reached quickly and safely for effective use under emergency conditions without the use of tools

[SOURCE: ISO 9094:2022, 3.2]

3.9
unattended appliance
device intended to function without the constant attention of an operator and which can cycle on and off automatically

EXAMPLE Water heaters, refrigerators, cabin heaters.

Note 1 to entry: Stoves, ovens and gas lamps are not considered to be unattended appliances.

3.10
high pressure side
part of an installation between the cylinder valve and the inlet of a *pressure regulating device* (3.12) in a *liquefied petroleum gas system* (3.6)

Note 1 to entry: Vapour pressure at 20 °C for propane = 700 kPa and for butane = 175 kPa.

Note 2 to entry: 100 kPa = 1 bar.

3.11
low pressure side
part of an installation exposed to the regulated pressure of the *liquefied petroleum gas (LPG)* (3.2) *pressure regulating device* (3.12) in an *LPG system* (3.6)

3.12
pressure regulating device
device to reduce, in a controlled manner, the high pressure of the *liquefied petroleum gas system* (3.6) to the required *operating pressure* (3.16) of the appliances

3.13
appliance shut-off valve
device to isolate an appliance from the gas supply

3.14
main shut-off valve
device to isolate the entire *liquefied petroleum gas system* (3.6) from the *high pressure side* (3.10) of the supply

3.15
flame supervision device
device that has a sensing element that causes the inlet of the *liquefied petroleum gas* (3.2) supply to a burner to be open in the presence of a flame and closed in the absence of a flame

3.16
operating pressure
inlet pressure of the *liquefied petroleum gas* (3.2) appliance(s)

3.17
ventilator
device that allows air to pass into and out of *habitable spaces* (3.7)

3.18
room-sealed appliance
appliance having a combustion system in which incoming combustion air and outgoing products of combustion pass through ductwork sealed to *habitable spaces* (3.7) and connected to an enclosed combustion chamber

3.19
open-flued appliance
appliance where combustion air is drawn from the space containing the appliance and the outgoing products of combustion pass through a flue incorporating a draught diverter

3.20
hose assembly
length of hose equipped with permanently attached fittings on both ends, such as a swaged sleeve or sleeve and threaded insert

3.21
engine compartment
compartment of the *craft* (3.1), containing spark or compression ignition internal combustion engine(s)

[SOURCE: ISO 9094:2022, 3.3]

3.22
critical bilge water level
level at which bilge water contacts metallic fuel tanks, couplings, engine pans, non-submersible machinery, or non-watertight electrical circuits and connections, with the *craft* (3.1) in the static upright floating position at maximum load condition (m_{LDC})

[SOURCE: ISO 15083:2020, 3.6]

3.23
piping
rigid metallic pipe or semi-rigid, pliable corrugated stainless-steel tubing

4 General provisions

4.1 An LPG system and all its components shall be capable of withstanding storage at −30 °C to +60 °C.

4.2 LPG systems shall be of the vapour withdrawal type, i.e. LPG released only under gas phase conditions.

4.3 All LPG appliances installed on a single LPG system shall be designed for use at the same operating pressure and the same LPG type, e.g. propane, butane or a mixture of the two. The operating pressure shall

be labelled in the vicinity of the LPG cylinder enclosure and be clearly visible when the cylinder(s) is/are installed.

The cylinder(s) selected and other supply equipment shall be of sufficient capacity to ensure safe and satisfactory operation of all appliances simultaneously. The cylinder enclosure shall be capable of accommodating the capacity of cylinders needed.

4.4 Where an additional LPG system is installed:

— there shall be no connection between each of the LPG supplies;

— the cylinder(s) for each gas supply may be installed in the same cylinder enclosure.

If an additional cylinder enclosure is used, there shall be a warning sign inside each cylinder enclosure which indicates that there is an additional LPG supply.

Inside the cylinder enclosure it shall be clearly indicated which appliances are supplied by each LPG supply. This shall also be stated in the owner's manual.

4.5 Each LPG system shall be fitted with simple means to test the LPG system for leakage before use of any appliances (e.g. a pressure gauge, bubble leak detector).

Where a bubble leak detector is fitted in the LPG system, it shall be securely mounted and installed in accordance with the manufacturer's instructions in the low pressure side of the LPG system and in the cylinder enclosure.

If pressure gauges are used, they shall read the cylinder pressure side of the pressure regulating device. The gauge scale shall have a pressure range from 0 kPa to a maximum of between 1 000 kPa and 1 600 kPa to be able to show pressure drops during the LPG system check (see Clause C.3).

5 Pressure regulating device

5.1 Each LPG system shall be equipped with, or have provision for the installation of, a pressure regulating device. This pressure regulating device shall be designed to provide a defined operating pressure suitable for the consuming appliances, but not more than 5 kPa.

5.2 The pressure regulating device shall have an overpressure unit to prevent uncontrolled pressure increase in the low pressure side to a value above 15 kPa. Any LPG discharge of the overpressure unit shall be inside the cylinder enclosure, or shall be separately vented outside the craft. The overpressure unit may be a pressure relief governor, a pressure relief valve or an automatic safety shut-off valve.

5.3 The operating pressure shall be marked on the pressure regulating device.

5.4 The setting of pressure regulating devices shall be fixed and shall not have external manual output pressure adjustment.

5.5 The pressure regulating device shall be located within the cylinder enclosure.

5.6 If not rigidly connected to, and supported by, the cylinder connection, the pressure regulating device shall be separately secured within the cylinder enclosure to protect it from damage and exposure to dirt and water. Pressure regulating devices not rigidly connected to, and supported by, the cylinder connection shall be connected to the cylinder by a high-pressure hose assembly as specified in Clause 6.

5.7 Pressure regulating devices shall be located such that the inlet to them is at or above the level of the cylinder outlet connection.

5.8 Pressure regulating devices shall be made of corrosion-resistant metallic material or have an effective coating against external corrosion. Fasteners used shall be of corrosion-resistant material or have a corrosion-resistant plating or coating.

5.9 First and single stage pressure regulating devices with a cylinder valve connection shall be fitted with an integral filter.

The filter shall be situated on the regulating devices inlet upstream of the valve pad. The filter mesh shall not exceed the recommended dimensions for the nominal size of opening 125 (in micrometre) in accordance with ISO 565, or exceed 0,14 mm diameter in cases of perforated sheet.

NOTE Pressure regulating devices in accordance with EN 16129:2013, Annex M, meet these requirements and are marked with “Marine.”

6 LPG supply line

6.1 General

6.1.1 The LPG supply line from the cylinder enclosure to the appliance(s) shall be:

— piping in accordance with 6.2, or

— a continuous hose assembly from the cylinder enclosure to each appliance in accordance with 6.3.

The layout of each supply line shall be such that the length of piping and/or hose assemblies are as short as practicable.

6.1.2 Hose assemblies shall be used to connect:

— gimballed appliances to any LPG supply line piping;

— cylinders to pressure regulating devices (high pressure side of the system) where the pressure regulating device is not connected directly to the cylinder; in such arrangements, the hose assembly shall be within the cylinder enclosure;

— cylinder mounted pressure regulating devices to any LPG supply line piping (low pressure side of the system); in such arrangements, the hose assembly shall be within the cylinder enclosure.

NOTE Hose assemblies can be used to connect appliances that are not gimballed to their LPG supply line piping if installed in accordance with the appliance manufacturer’s instructions.

6.1.3 Piping and hose assemblies shall be sized so that any pressure drop does not reduce the operating pressure at any appliance below that required by the appliance manufacturer when all appliances are operating simultaneously.

NOTE Annex A provides design guidelines for pressure drop due to hose/pipe resistance for various connected appliance kW ratings.

6.2 Piping

6.2.1 Piping shall be solid drawn copper or drawn stainless steel pipe, or semi-rigid, pliable corrugated stainless steel tubing.

Wall thickness for copper or stainless steel pipe shall be equal or greater than 0,6 mm for pipe up to 12 mm outside diameter and a minimum of 0,8 mm for pipe with an outside diameter greater than 12 mm.

Semi-rigid, pliable corrugated stainless steel tubing (PCT) shall conform to EN 15266.

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

— welded, hard soldered and brazed connections;

— cutting ring fittings in accordance with ISO 8434-1:2018, Table 4 (where cutting ring fittings are used in conjunction with copper pipe, a brass insertion sleeve and brass cutting ring shall be fitted);

— copper rings on copper piping and compression fittings in accordance with EN 1254-2;

— stainless steel rings on stainless steel piping;

— connections in accordance with EN 16129:2013, Annex M;

— PCT fittings in accordance with EN 15266.

All threaded connections required to ensure gas tightness of the LPG system shall be of taper pipe thread type conforming to ISO 7-1 or fittings conforming to EN 1949, with sealants conforming to EN 751-2 or EN 751-3. Sealants shall be applied to the male thread only, before assembly.

Jointing compound for flared fittings or flared rings and gas tightness by compression of ductile joints, except connections in accordance with EN 16129:2013, Annex M, shall not be used.

6.2.3 Piping shall be made up with as few fittings as practicable. Joints and fittings shall be capable of being reached for inspection, removal or maintenance without removal of any permanent craft structure.

6.3 Hose assemblies

6.3.1 A hose shall only be used when part of a hose assembly. Materials and components of hose assemblies shall be designed to be suitable for LPG and to withstand the stresses and exposures found in the marine environment.

Hose assemblies in accordance with one or more of the relevant standards given in Table 1 meet this requirement.

Table 1 — Hose assembly manufacturing standards

Manufacturing standard	Max. operating pressure	Application
Hose assembly to EN 16436-2 incorporating hose to EN 16436-1 Class 2	10bar[a]	Regulated, appliance operating pressure only
Hose assembly to EN 16436-2 incorporating hose to EN 16436-1 Class 3	30 bar	Unregulated cylinder pressure and regulated appliance operating pressure
Hose assembly to EN 14800	0,5 bar	Regulated, appliance operating pressure only
Hose assembly to ISO 10380	0,5 to 450 bar (depending on marked specification on individual hose assembly)	Unregulated cylinder pressure and/or regulated appliance operating pressure (depending on marked specification on individual hose assembly)
[a] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.		

6.3.2 Hose assemblies, including connections, shall be:

— capable of being reached for inspection, removal or maintenance without removal of any permanent craft structure;

— installed so as to avoid stress or tight radius turns;

— installed so that they are not subject to tension or kinking under any conditions of use.

6.3.3 Where hose assemblies are used to directly connect appliances to the pressure regulating device, the assembly shall be:

— of minimum practical length;

— continuous and have no joints or fittings from within the cylinder enclosure to the appliance, or the readily accessible shut-off valve near the appliance (see 6.6.3).

Where two or more appliances are installed, a suitable manifold shall be located within the cylinder enclosure to enable the individual appliance supply line hose assemblies to be connected to the pressure regulating device.

6.3.4 Low pressure hose assemblies used to connect the LPG supply line piping to appliances shall be of minimum practical length.

Low pressure hoses between pressure regulating devices and the LPG supply line piping shall not exceed 1 m in length.

If a bubble leak detector is installed within a cylinder enclosure, up to 1 m of hose can be used between the cylinder mounted pressure regulating device and the bubble leak detector, and up to 1 m of hose may be used within the cylinder enclosure between the bubble leak detector and LPG supply piping.

6.3.5 High-pressure hose assemblies used to connect cylinders to pressure regulating devices shall be of minimum practical length not exceeding 1 m.

6.4 Materials

6.4.1 Materials used for hard soldered or brazed connections shall not have a melting point less than 450 °C.

6.4.2 Fittings through which LPG flows shall be compatible with LPG and shall be galvanically compatible with the metallic components to which they are connected.

6.4.3 Hose clamps, if used to secure cylinder locker drain hoses, shall be made of corrosion-resistant material and shall be reusable.

6.4.4 All fittings shall be of corrosion-resistant material, such as brass or stainless steel, or shall be of equivalent corrosion resistance in a marine environment.

6.4.5 Where cutting ring fittings are used in conjunction with copper pipe, a brass insertion sleeve and brass cutting ring shall be fitted.

6.5 Installation

6.5.1 Metallic LPG supply lines and components shall not have direct contact with metallic parts of the craft structure of higher galvanic nobility.

6.5.2 Metallic LPG supply lines and components shall be routed at least 30 mm away from electrical conductors unless the LPG supply line and components are run jointless through non-conducting conduit, or the conductors are sheathed or in non-conducting conduit or trunking. Metallic LPG supply lines and components shall be at least 100 mm from exposed terminals of electrical devices or accessories.

6.5.3 LPG supply lines and components shall be above the critical bilge water level.

6.5.4 LPG supply lines and components shall be at least 100 mm from engine exhaust components and appliance flue systems.

6.5.5 LPG cylinders, pressure regulating devices and other safety devices shall be at least 250 mm from dry engine exhaust components or other heat sources unless a thermal barrier is provided.

6.5.6 LPG supply lines shall be supported in order to prevent damage from chafing or vibration. For copper or stainless steel pipe, such supporting devices shall be spaced at intervals not exceeding 0,5 m. For hose assemblies and PCT, the intervals shall not exceed 1 m. Additional requirements for the securing of piping passing through engine compartments are given in 6.5.11 and 6.5.12. Fixing devices shall be corrosion-resistant, non-abrasive, designed to prevent cutting or other damage to the lines and galvanically compatible with the supply line material. In the case of conduit, it shall be vented and non-metallic.

All joints shall have at least one fixing device per line no more than 150 mm away from the joint.

NOTE Joints secured by specific integral fixings such as mounting plates or bulkhead fittings can be considered as meeting this requirement.

6.5.7 Connections in piping and hose assemblies shall be installed to prevent undue stress at the connection.

6.5.8 Piping and hoses passing through bulkheads intended to maintain watertight integrity in the craft at the level of penetration shall be sealed by materials or fittings capable of maintaining the water tightness.

6.5.9 Piping and hoses shall be protected from abrasion or chafing at the point where they pass through walls or bulkheads or other material that can cause abrasion or chaff damage.

6.5.10 Hose assemblies shall not be routed through an engine compartment.

6.5.11 There shall be no joints or fittings in piping passing through engine compartments.

6.5.12 Piping passing through engine compartments shall be protected by conduit or trunking, or supported by non-abrasive attachments which are no more than 300 mm apart.

6.6 Shut-off valves

6.6.1 Each single cylinder LPG system with a pressure regulating device directly connected to the cylinder shall be equipped with a singular main shut-off valve, either:

— as a readily accessible manually operated valve, or

— a solenoid valve, operated from a readily accessible location. A label shall be located close to the solenoid command/switch to identify the purpose of the solenoid valve.

Where the pressure regulating device is directly connected to the cylinder, the main shut-off valve may be the cylinder valve.

The main shut-off valve may be incorporated in the pressure regulating device, providing its action isolates the cylinder contents from the pressure regulator input and removal of the pressure regulating device from the cylinder closes the cylinder valve.

Each single cylinder LPG system with a pressure regulating device connected via a high pressure hose to the cylinder and each multiple cylinder LPG system shall be equipped with a singular main shut-off valve on the low pressure side immediately downstream of the pressure regulating device, either:

— as a readily accessible manually operated valve, or

— a solenoid valve, operated from a readily accessible location. A label shall be located close to the solenoid command/switch to identify the purpose of the solenoid valve.

6.6.2 A multiple cylinder LPG system shall be provided with an automatic or manual change over device (selector valve), and shall be fitted with non-return valves, in addition to each cylinder shut-off valve, to prevent the escape of LPG when any cylinder is disconnected.

In multiple cylinder LPG systems where more than one cylinder is required concurrently to meet total appliance kW demand, the cylinders required to achieve the necessary kW supply shall be connected using hose assemblies incorporating non-return valves but without any device that prevents the cylinders being used concurrently.

6.6.3 An appliance shut-off valve shall be installed in the low pressure LPG supply line to each appliance. The valve or its control shall be readily accessible and operable from within a 1 m zone surrounding the appliance, and operable without reaching over the top of open flame appliances such as stoves.

If there is only one appliance in the LPG system and the main shut-off valve at the cylinder is readily accessible from the 1 m zone surrounding the appliance, the appliance shut-off valve on the low pressure LPG supply line is not required.

A solenoid valve fulfils this requirement, if:

— it is located within the cylinder enclosure on the high or low pressure side of the pressure regulating device;

— it is operable from a readily accessible location within the 1 m zone surrounding the appliance;

— it is closed in cases of lack of tension, i.e. loss of electrical actuating energy;

— a label is located close to the solenoid command/switch to identify the purpose of the solenoid valve.

6.6.4 Unmistakable and easily recognized means of identifying the open and closed positions of shut-off valves shall be provided. This requirement applies to manually operated shut off valves and to solenoid valve commands/switches.

6.6.5 For appliance shut-off valves which are not located immediately adjacent to the appliance that they control, a means of identifying the appliance controlled shall be provided. If a valve is not visible from the appliance, its location shall be clearly indicated by means of a visible and permanent marked label secured in place.

6.6.6 Taper plug type valves shall be spring loaded and may be used only in the low pressure side of the LPG system.

6.6.7 Shut-off valves shall be located such that inadvertent or accidental operation is avoided.

6.6.8 Needle valves shall not be used as shut-off valves in the low pressure side of the LPG system. Gate valves shall not be used as shut-off valves.

7 Appliances

7.1 Only appliances manufactured for use with LPG in a marine environment shall be installed in the LPG system. They shall be fitted in accordance with the manufacturer's instructions for installation in craft.

7.2 Appliances shall not be installed in engine compartments unless this location is in accordance with the manufacturer's instructions for installation in craft.

7.3 Each appliance shall be securely fixed to the craft to eliminate undue stress on piping, connections, hose assemblies and on ducts and flues for air intake and combustion product discharge.

7.4 Each appliance, including lamps, shall be equipped with a flame supervision device for each burner and pilot light.

7.5 Unattended appliances shall either be:

— room-sealed appliances, or

— open-flued appliances and equipped with an integrated oxygen depletion sensor.

7.6 If installed in an enclosed space with a bath or shower, unattended appliances shall be room-sealed appliances.

7.7 Each appliance shall be labelled to indicate the type of LPG to be used, e.g. “PROPANE” or “BUTANE”, or the mixture thereof. In addition, the label shall refer to the appliance manufacturer’s owner’s manual.

7.8 For cooking appliances, a permanent, legible warning label, with a minimum character height of 4 mm, shall be affixed in a conspicuous position on or adjacent to the appliance (cooking stove or oven). This label shall provide at least the following information, in a language acceptable in the country of intended use:

DANGER — Avoid asphyxiation. Provide ventilation when the cooking appliance is in use. Do not use for space heating.

7.9 The proximity and flammability of materials in relation to appliances shall be in accordance with ISO 9094.

7.10 Space heaters and water heaters installed in exposed locations in habitable spaces of craft shall be installed with regard to minimizing the risk of injury due to inadvertent contact with hot surfaces.

7.11 Adequate free area shall be provided around appliances, in accordance with ISO 9094 and the manufacturer’s instructions, in order to prevent overheating of adjacent surfaces and to permit inspection and servicing.

7.12 Means shall be provided on or adjacent to stove top cooking surfaces to prevent both deep and shallow cooking pans from sliding across or off the stove during craft motion, at pitch angles up to 15°, or roll angles up to 30° for monohull sailing craft, 15° angles of pitch or roll for engine driven craft and multihull sailing craft.

7.13 Cooking appliances with integral LPG cartridges shall meet the requirements in Annex D.

8 Ducts and flues for air intake and combustion product discharge

8.1 Flue components, including ductwork and terminals, shall be installed in accordance with the manufacturer’s instructions for craft installations.

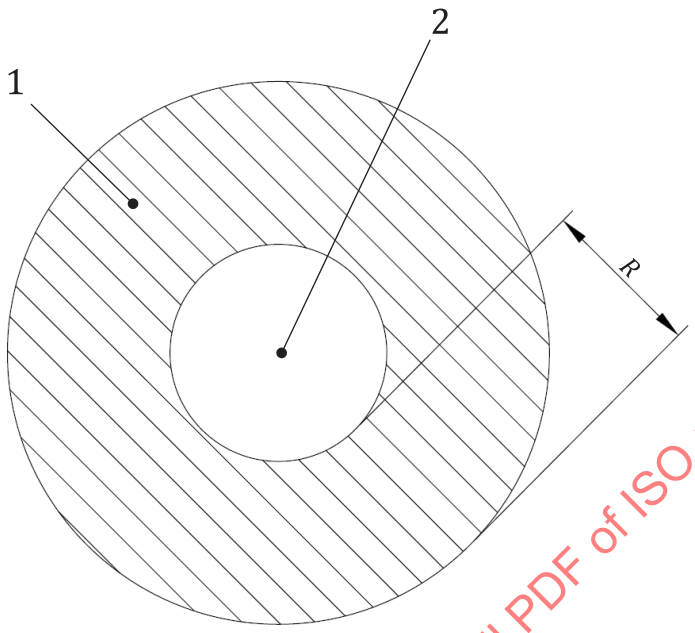
8.2 Flues shall be routed and sized to ensure complete discharge of the products of combustion outside the craft, including any areas which can be enclosed by canopies, and so as not to be obstructed by an accumulation of water.

8.3 Dampers (shut-off valves) shall not be installed in flue systems.

8.4 The entire air intake and flue system shall be capable of being reached for inspection, removal or maintenance without removal of a permanent craft structure.

8.5 Flue terminals shall not be positioned within 500 mm of a refuelling point or fuel tank breather outlet or any ventilator outlet from the fuel system(s).

Flue terminals shall not be located within 300 mm of a ventilator, opening port, hatch, window for the habitable space or an opening part of a window, see Figure 1.



Key

1 prohibited zone for flue terminals

2 ventilator, opening port, hatch or window

R ≥ 300 mm

Figure 1 — Ventilators — Prohibited zone for discharge openings for the products of combustion

8.6 Flue terminals shall be of substantial construction or provided with guards sufficient to prevent damage by accidental contact. Such guards shall also prevent injury from contact with hot surfaces.

9 Location and installation of LPG cylinders

9.1 General

9.1.1 LPG cylinders including reserve cylinders, whether empty or full, pressure regulating devices and safety devices shall be installed in a cylinder enclosure. Cylinder enclosures shall take the form of cylinder lockers or cylinder housings.

9.1.2 Craft design and openings of cylinder enclosures shall be such that escaping vapours can only flow overboard unimpeded.

9.1.3 Cylinder enclosures shall be constructed of suitable material to maintain vapour tightness and so that the integrity of the material is not adversely affected by the insertion, stowage and removal of cylinders.

9.1.4 Cylinder enclosures shall not be fitted with hatches or other openings into the interior of the craft.

9.1.5 All LPG hose or piping penetrating cylinder enclosures shall be sealed to maintain vapour tightness using bulkhead fittings, grommets, sleeves or sealant of non-abrasive material.

9.1.6 No provision shall be made for storage of loose components that can damage the cylinder(s), pressure regulating device, piping or hose installation, or obstruct the cylinder locker drain or cylinder housing ventilation.

9.1.7 Cylinders, valves and pressure regulating devices shall be installed so that they are:

— readily accessible;

— secured against movement that is expected to result from normal use;

— protected from damage and exposure to dirt and water.

9.2 Cylinder lockers

9.2.1 Cylinder lockers shall only open onto the exterior of the craft or within cockpits. In addition:

— cylinder lockers in cockpits not open to the sea, as defined in ISO 11812, shall only be openable from the top (see Figure E.3);

— cylinder lockers in cockpits open to the sea, as defined in ISO 11812, shall be openable from the top or from the side (see Figure E.4);

— cylinder lockers on the exterior of the craft shall be openable from the top or from the side.

9.2.2 Cylinder lockers openable from the top shall be provided with a lid or cover to prevent accidental mechanical damage to the contents.

9.2.3 Cylinder lockers shall be vented at the bottom by a drain. The locker drain shall be run directly overboard, and shall be:

— without sumps which can retain water;

— with the outlet at a level lower than the locker bottom and as high as practicable;

— with the outlet not less than 75 mm above the at-rest waterline when in maximum loaded condition as defined in ISO 8666;

— with the outlet above the heeled waterline as defined in ISO 11812;

— not less than 19 mm internal diameter or the equivalent area if not circular.

This does not exclude the use of flanges or welded joints, which shall be as close to the bottom as practicable but no more than 30 mm above the lowest point of the locker.

9.2.4 Cylinder locker drain outlets shall be located at least 500 mm from any opening into the interior of the craft.

9.3 Cylinder housings

9.3.1 Cylinder housings shall only open onto the exterior of the craft. Cylinder housings shall not open into cockpits or other recesses (see Figure E.5).

9.3.2 Cylinder housing ventilation openings shall extend down to at least within 30 mm of the lowest point of the housing.

9.3.3 Cylinder housing ventilation openings shall be located at least 500 mm from any opening to the interior of the craft.

10 Ventilation

Natural ventilation shall be provided into:

— habitable spaces where appliances that are not room-sealed are installed; or

— compartments containing such appliances which are connected by open passageways.

The design of such ventilation shall take into account the air consumption of the appliances and occupants of the spaces and allow outside air to pass through fixed openings. Minimum requirements for sizing and locations of ventilation openings are given in Annex B.

11 LPG installation tightness test

The LPG supply line and fittings shall be tested for tightness with air. This test shall be performed after installation of the system and appliance(s) as follows:

a) open every branch of the distribution system from the pressure regulating device connection point to the appliance(s);

b) connect the test equipment and pressurize to not less than three times the operating pressure of the pressure regulating device but not more than 15 kPa;

c) allow a period of 5 min for pressure equilibrium;

d) check that the pressure remains constant for not less than an additional 5 min.

If any leakage is indicated by a drop in pressure, check the entire LPG system with a suitable leak detection solution to locate the leak while the system is under the test pressure. Test solutions shall be non-corrosive and non-toxic.

NOTE Foam producing solutions for leak detection on gas installations in accordance with EN 14291:2004 meet these requirements.

12 LPG system commissioning label

On completion of the LPG installation air test (see Clause 11), a label shall be affixed either in a prominent location in the vicinity of the cylinder enclosure or at an appliance location, as shown by Figure 2.

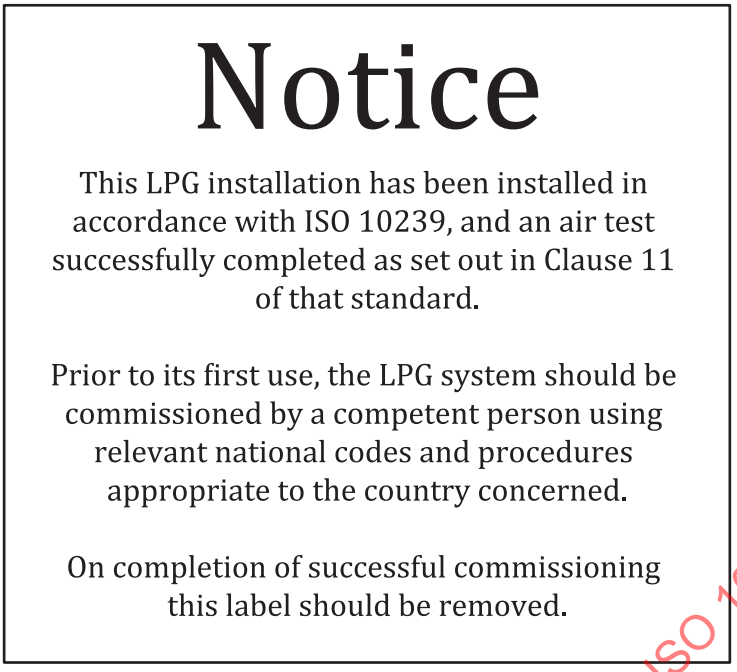


Figure 2 — Specifications for an LPG system commissioning label

The required information characters shall be at least 5 mm in height. The label title "Notice" shall be at least 20 mm in height.

The label text shall be in a language acceptable to the country of intended use.

13 Ignition protection from electrical devices

There shall be no potential sources of ignition in LPG cylinder enclosures.

Only ignition-protected items in accordance with ISO 8846 shall be installed in compartments (including cylinder enclosures), that contain:

— LPG cylinders and cartridges;

— LPG supply line fittings, with the exception of connections in the habitable space near the appliance.

14 Owner's manual

The craft manufacturer shall provide an owner's manual in a language acceptable to the country of use, and shall include with it the user instructions supplied by the equipment and appliance manufacturers.

An owner's manual shall be provided with the craft, which shall include at least the information contained in Annex C.

NOTE Requirements for owner's manuals are provided in ISO 10240.

Annex A
(informative)

Design guidelines for pressure drop due to hose/pipe resistance

Table A.1 — Design guidelines for pressure drop due to hose/pipe resistance

Inside diameter of hose/pipe mm	Pressure drop per metre of hose/pipe length kPa										
	Connected appliance input										
	1 kW	2 kW	3 kW	4 kW	6 kW	8 kW	10 kW	12 kW	15 kW	20 kW	25 kW
4	0,004	0,015	0,03	0,05	0,15	0,23	—	—	—	—	—
6	0,001	0,004	0,007	0,012	0,03	0,04	0,07	0,10	0,14	0,26	—
8	< 0,001	0,001	0,002	0,003	0,01	0,015	0,02	0,025	0,04	0,07	0,11
10	—	< 0,001	< 0,001	0,001	0,003	0,004	0,006	0,009	0,013	0,022	0,032
15	—	—	—	< 0,001	0,001	0,001	0,002	0,002	0,004	0,006	0,01
22	—	—	—	—	< 0,001	< 0,001	< 0,001	0,001	0,001	0,001	0,001

NOTE 1 This table is for use with propane at 3 kPa, 3,7 kPa and 5 kPa, and butane at 3 kPa and 5 kPa.

NOTE 2 Equivalent lengths of pipe for fittings are:

— tee and elbow 0,6 m;

— straight connector 0,3 m;

— hose or pipe bend 0,3 m.

It is advisable to minimize the volume of pipework by using the smallest pipe sizes consistent with the pressure drop requirement.

Annex B
(normative)

Ventilation

The minimum required effective area of natural ventilation openings for habitable spaces containing an LPG open flame (unflued) appliance (such as a cooker, stove or oven) or an open-flued appliance (such as an instantaneous water heater) is given by Formula (B.1):

$$A \geq 2\,200U + 440F + 650P \quad \text{(B.1)}$$

where

- A is the effective area, in square millimetres, and should not be less than 4 000 mm^2;
- U is the nominal input rating of unflued appliances, in kilowatts;
- F is the nominal input rating of open-flued appliances, in kilowatts;
- P is the number of persons for which the habitable space is designed; it should normally be taken as the maximum persons capacity shown on the craft's builder's plate.

Formula (B.1) applies to any habitable space that can be closed off and contains an unflued or open-flued LPG appliance.

When determining the minimum sizing of ventilation, due consideration shall be given to any other air consuming appliances in the habitable space, burning other types of carbon fuels.

The minimum effective area shall take into account the reduction by screening or louvers.

Ventilation shall be supplied by at least two equally sized fixed openings in the habitable space, with one opening as high as practicable and one as low as practicable. Both openings shall be positioned or shielded such that they cannot be inadvertently obstructed.

Natural ventilation pathways shall not pass through engine or machinery compartments other than through sealed ducting.

NOTE For additional information, see EN 721.

Annex C
(normative)

Instructions to be included with the owner's manual

C.1 General

When an LPG system is installed in a craft, the owner's manual shall provide instructions for its correct operation and inspection, including user instructions supplied by equipment and appliance manufacturers.

The manual shall address the following:

— Operating pressure of the LPG system.

— Location and type of ventilation openings (e.g. closable ventilators such as windows, hatches, mushroom and dorade ventilators) in accommodation spaces containing LPG consuming appliances.

— Recommendation not to obstruct access to LPG system components in any way.

— If a second LPG system is fitted, information on which appliances are connected to each LPG system and the operating pressure of each LPG system.

— Location and function of the LPG system main shut-off valves and any appliance shut-off valves.

— A plan, sketch or similar showing the LPG system (including the cylinder locker or housing, all appliances, the routing of the LPG supply line and all connections and all hose assemblies).

— Procedures for changing gas cylinders.

— Precautions to avoid contact of materials with open flames and other hot areas.

— Regular inspections of hoses and flue pipes in the LPG system shall be undertaken at least annually, and replaced by a competent person if any deterioration is found.

— Valves on empty cylinders shall be kept closed and disconnected. Protective covers, caps or plugs shall be kept in place. Reserve or empty cylinders and or cartridges shall be stored in a specified LPG cylinder locker or housing.

— LPG cylinder enclosures shall not be used for storage of any other equipment.

C.2 Operation of the LPG system

The following requirements shall be included in the owner's manual:

— LPG system main shut-off valve shall be closed when appliances are not in use, before craft refuelling and immediately in an emergency.

— Appliance burner control valves shall be closed before opening the LPG system main shut-off valve.

— The user shall be informed on the need for natural ventilation when operating appliances that consume cabin oxygen. This information shall also be provided by the warning notice, see Clause C.4.

— If the stove is not gimballed, it shall not be used when high angles of roll or sustained angles of heel are likely.

C.3 LPG system check

The following requirements shall be included in the owner's manual:

— The LPG system shall be checked for leakage, with all appliance shut-off valves open before each use by means of the following:

  — With a gauge fitted: operate as per manufacturer's instructions, or if no instructions are provided, close appliance burner control valve(s), open LPG cylinder valve, allow indicated gauge pressure to stabilize, close LPG cylinder valve, and observe pressure gauge reading for 3 min. The pressure gauge reading should remain constant if no leak in the LPG system is present.

  — With a bubble leak detector fitted: operate as per manufacturer's instructions.

— The manual shall specify that the gauge does not provide an indication of liquid LPG remaining in the cylinder, only its vapour pressure, which is a constant at any given temperature.

— If LPG leakage is detected or suspected, the following action shall be taken immediately:

  — shut off the LPG supply at the LPG system main shut-off valve(s);

  — extinguish naked flames and other ignition sources (heaters, cooking appliances, pilot lights, etc.);

  — do not operate electric switches;

  — ventilate affected area;

  — evacuate the area if possible.

— The manual shall include a clarification that the above user tests do not replace an LPG system check by a competent person and a warning not to use a flame to check for leaks. See warning notices as provided in Clause C.4.

C.4 Warnings to be included in the owner's manual

The following warnings shall be included in the owner's manual:

a) WARNING — Never leave craft unattended when open flame LPG consuming appliances are in use.

b) WARNING — Do not smoke or use open flame when replacing LPG cylinders. Close cylinder valves on empty cylinders before disconnecting for replacement.

c) WARNING — Never use a flame to check for LPG system leaks. If using a solution for manual leak testing, always use a proprietary LPG system lead detection fluid.

d) WARNING — Fuel burning open flame appliances consume cabin oxygen and release products of combustion into the craft. Do not use the stove or oven for space heating. Natural ventilation is required when appliances are in use. Open designated vent and openings while appliances are in use. Never obstruct ventilation openings. The ventilation requirements have been calculated to suit the LPG appliances as installed. Additional ventilation might be required if other appliances are operated simultaneously.

e) WARNING — Do not modify the craft's LPG system. Installation, alterations and maintenance shall be performed by a competent person. Have the system inspected at regular intervals or as required by national requirements.

f) WARNING — If a leak is detected, shut off the main LPG supply valve and do not use LPG appliances.

g) WARNING — Do not use an installation that has leaked until it has been inspected and repaired by a competent person.

Annex D
(normative)

Cooking appliances with integral LPG cartridges with a capacity of 225 g or less

D.1 Boat builders may choose to install cooking appliances with integral LPG cartridges with a capacity of 225 g or less as an alternative to a permanently installed LPG system. In such circumstances, the specifications given in D.2 to D.10 shall be followed.

D.2 Only cooking appliances suitable for use with LPG in a marine environment shall be installed and shall be fitted in accordance with the manufacturer's instructions. The proximity and flammability of materials in relation to appliances shall conform to ISO 9094.

D.3 Cooking appliances intended for use in the habitable space shall have no more than 225 g of attached LPG capacity. Only one cartridge may be in use at a time and shall incorporate a self-closing device to enable its removal for storage when not in use. The owner's manual shall instruct the operator to remove and to replace cartridges in the open air and away from sources of ignition.

D.4 The cooking appliance shall be designed to ensure that only LPG vapour reaches the burner and it shall be capable of normal operation under the conditions specified in D.7.

Extinguishment of the flame or leakage of LPG constitutes failure to meet this requirement.

D.5 Operating controls shall be readily accessible, and located to minimize possible injury from burners or elements when being used.

D.6 Burner controls shall be equipped or designed to require two-stage operation when going from the "off" to "on" position to prevent unintentional or accidental opening of valves during handling and storage.

D.7 Appliances designed with continuously burning pilot lights shall not be used.

D.8 Cooking appliances in use shall have a positive means of mechanical retention and shall be secured in a location designated by the boat manufacturer.

Means shall be provided on or adjacent to stove top cooking surfaces to prevent both deep and shallow cooking pans from sliding across or off the stove during craft motion, at pitch angles up to 15° or roll angles up to 30° for monohull sailing craft, and at 15° angles of pitch or roll for engine driven craft and multihull sailing craft. Alternatively, guidance shall be provided to use the cooking appliance only when safe to do so.

D.9 Reserve or empty cartridges shall be stored only on the boat exterior, protected from the weather and mechanical damage, and where escaping vapours can only flow overboard.

D.10 Printed instructions shall be provided with each cooking appliance and shall include information on:

— proper installation, location for use and storage;

— storage of in-use and reserve cartridges;

— the appliance manufacturer's instructions on operation, maintenance and changing LPG cartridges.