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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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Foreword

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

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 188, *Small craft*.

This third edition cancels and replaces the second edition (ISO 10239:2008), which has been technically revised. The major technical changes include:

— suitable user and manufacturer checks of the LPG system tightness;

— specifying a suitable hose material;

— describing the information to be provided in the owner's manual;

— clarification on LPG powered fuel cells included or excluded from standard.

Introduction

This International Standard does not contain procedures for commissioning new LPG installations or system maintenance or upgrades. Competent persons responsible for commissioning LPG installations should use relevant national codes and procedures appropriate to the country concerned.

Small craft — Liquefied petroleum gas (LPG) systems

1 Scope

This International Standard covers the installation of permanently installed liquefied petroleum gas LPG systems and LPG burning appliances on small craft of up to 24 m length of hull.

It does not cover devices used for LPG-fuelled propulsion engines or LPG-driven generators.

This International Standard covers cooking appliances with internal LPG cartridges, with a capacity of 225 g or less (See Annex D).

It covers storage of all LPG cylinders but is not intended to regulate the technical requirements for such cylinders that are subject to national regulations

It does not contain procedures for commissioning the LPG installation.

NOTE New designs, materials and methods of assembly giving at least equivalent results can be considered to be complying with the requirements of this International Standard when approved by a relevant body.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 8434-1:2007, *Metallic tube connections for fluid power and general use — Part 1: 24 degree cone connectors*

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

ISO 9094[1)], *Small craft — Fire protection*

ISO 10133, *Small craft — Electrical systems — Extra-low-voltage d.c. installations*

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

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 13297, *Small craft — Electrical systems — Alternating current installations*

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*

EN 1254-2, *Copper and copper alloys - Plumbing fittings - Part 2: Fittings with compression ends for use with copper tubes*

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

1) Under preparation.

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

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.

3.1
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 with addition of Note 2 to entry]

3.2
permanently installed
securely fastened so that tools need to be used for removal

[SOURCE: ISO 10088:2013, definition 3.3]

3.3
cylinder housing
ventilated enclosure intended solely for storage of one or more LPG cylinders, pressure regulation device and safety devices, and located so that leakage flows to the outside

3.4
cylinder locker
enclosure which is vapour tight to the interior of the craft with a drain to the outside intended solely for storage of one or more LPG cylinders in a cockpit or recessed into the craft

3.5
LPG system
system consisting of an arrangement of cylinder(s), safety device(s), pressure regulation device(s), connection(s), valve(s), piping, tubing, hose, fitting(s) and devices intended to store, supply, monitor or control the flow of LPG up to and including the appliance

Note 1 to entry: The cylinders are replacement items and might or might not be supplied with the LPG system in the craft.

3.6
interior space
enclosed space that is surrounded by permanent boat structure and that is intended to remain dry during normal use

3.7
readily accessible
capable of being reached quickly and safely for maintenance or effective use under emergency conditions without the use of tools

[SOURCE: ISO 10088:2013, definition 3.2]

3.8
unattended appliance
device intended to function without the constant attention of an operator and which can cycle on and off automatically

3.9
high pressure side
part of an installation between the cylinder valve and the inlet of a pressure regulation device in a LPG system

Note 1 to entry: Vapour pressure at 20 °C for propane = 700 kPa and for butane = 175 kPa[2)].

3.10
low pressure side
part of an installation exposed to the regulated pressure of the LPG pressure regulation device in a LPG system

3.11
pressure regulation device
device to reduce the high pressure of the LPG system to the required operating pressure of the appliances

3.12
piping
pipeline of rigid metallic material

[SOURCE: EN 624:2011, definition 3.1.8]

3.13
hose
pipeline of flexible material

3.14
shut-off valve
device to isolate an appliance from the gas supply

3.15
main shut-off valve
device to isolate the entire LPG system from the high pressure side of the supply

3.16
flame supervision device
device that has a sensing element, that causes the inlet of the LPG supply to a burner to be open in the presence of a flame and closed in the absence of a flame

3.17
operating pressure
inlet pressure of the LPG appliances

3.18
ventilator
device that allows air to pass into and out of an interior space

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.

2) 100 kPa = 1 bar.

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 clearly labelled in the vicinity of the cylinder shut-off valve.

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 locker or cylinder housing 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 locker or cylinder housing.

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

Inside the cylinder locker or cylinder housing 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 tester).

Where a bubble leak detector is fitted in the LPG system, it shall be securely mounted in the low pressure side of the LPG system and in the cylinder housing or cylinder locker.

If pressure gauges are used, they shall read the cylinder pressure side of the pressure regulation 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 C.3).

5 Pressure regulation device

5.1 Each LPG system shall be equipped with, or have provision for the installation of, a pressure regulation device (see 3.11). This device shall be designed to provide a defined operating pressure suitable for the consuming appliances, but not more than 5 kPa. A label indicating the operating pressure of the LPG appliances installed shall be affixed in the vicinity of the LPG cylinder locker or cylinder housing.

5.2 The LPG pressure regulation 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 unit shall be inside the cylinder locker or housing, or shall be separately vented outside the craft. The 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 regulation device.

5.4 Pressure regulation devices with external manual output pressure adjustment shall not be fitted.

5.5 The pressure regulation device shall be located within the cylinder locker or housing.

5.6 If not rigidly connected to, and supported by, the cylinder connection, the pressure regulation device shall be separately secured within the cylinder locker or cylinder housing to protect it from damage and exposure to dirt and water.

It shall be mounted above the cylinder valve so that the flow of LPG from the cylinder valve is always in a rise to the pressure regulation device.

5.7 Pressure regulation 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.

NOTE Pressure regulation devices in accordance with EN 16129:2013, Annex M, meet these requirements.

6 LPG supply line

6.1 General

6.1.1 The LPG supply line shall be either solid piping in accordance with 6.2, except for short hose connections to the pressure regulation device or to stoves, or continuous hose in accordance with 6.3.

The layout of the supply line shall be such that the length of piping and hoses is as short as possible.

6.1.2 Hoses shall be used to connect

— gimballed stoves to their LPG supply,

— supply piping to the pressure regulation device (either high or low pressure side of the system).

The hose and its connections to the pressure regulation device shall be within the cylinder locker or cylinder housing.

6.1.3 Piping and hose shall be sized so that any pressure drop due to pipe resistance does not reduce the operating pressure at any appliance below that required by the appliance manufacturer when all appliances are operating simultaneously. See Annex A.

6.2 Piping

6.2.1 Only solid drawn copper or drawn stainless steel piping shall be used for rigid supply lines. Attention should be given to galvanic compatibility when connecting different materials.

Wall thickness for piping shall be equal or greater than 0,6 mm for piping up to 12 mm outside diameter and a minimum of 0,9 mm for piping with an outside diameter greater than 12 mm. Semi-rigid, pliable corrugated stainless steel tubing (PCT) shall conform to EN 15266, or equivalent.

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

6.2.3 Metallic LPG supply piping routed through engine compartments shall be protected by conduit or trunking, or supported by non-abrasive attachments which are no more than 300 mm apart.

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

— hard soldered and brazed connections;

— cutting ring fittings in accordance with ISO 8434-1:2007, Table 4 (see also 6.4.2, 6.4.4, 6.4.5);

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

— stainless steel rings on stainless steel piping;

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

— pliable corrugated stainless steel tubing (PCT) fittings to EN 15266, or equivalent.

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.

6.2.5 Piping shall be installed above bilge water as high as practicable.

6.2.6 Piping shall be made up with as few fittings as practicable. Joints and fittings shall be readily accessible.

6.3 Hoses and hose lines

6.3.1 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.

6.3.2 Hoses shall not be routed through an engine compartment and shall be of minimum practical length.

6.3.3 Hoses shall have permanently attached end fittings, such as swaged sleeve or sleeve and threaded insert, and shall be capable of being reached for inspection, removal or maintenance without removal of a permanent craft structure. Hoses shall be installed so as to avoid stress or tight radius turns.

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

6.3.5 Hoses used for LPG supply line shall be continuous and have no joints or fittings from within the cylinder locker or cylinder housing to the appliances, or the readily accessible shut off valve near the appliance (see 6.6.3), except where metallic supply piping is connected to flexible hose leading to a movable appliance, such as a gimballed stove.

6.4 Materials

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

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

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

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

6.4.5 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 to avoid galvanic corrosion.

6.5 Installation

6.5.1 Piping shall not have direct contact with metallic parts of the craft structure of higher galvanic nobility than the piping.

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 is run jointless through conduit, or the conductors are sheathed or in conduit or trunking in accordance with ISO 10133 and ISO 13297. Metallic LPG supply lines shall be at least 100 mm from exposed terminals of electrical devices or accessories.

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

6.5.4 LPG supply lines shall be supported in order to prevent damage from chafing or vibration. For copper or stainless steel piping, such fixing devices shall be spaced at intervals not exceeding 0,5 m; for hoses, the intervals shall not exceed 1 m. 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. Joints secured by specific integral fixings such as mounting plates or bulkhead fittings can be considered as meeting this requirement.

6.5.5 All joints and connections in piping and hose in the LPG system shall be made such that no undue stress is created at the fitting.

6.5.6 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.

6.5.7 Piping and hoses shall be protected from abrasion or chafing at the point where they pass through walls or bulkheads

6.5.8 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 or equivalent, with sealants conforming to EN 751-2 or EN 751-3 or equivalent. Sealants shall be applied to the male thread only, before assembly.

6.6 Shut-off valves

6.6.1 Each LPG system shall be equipped with a readily accessible manually operated main shut-off valve in the high pressure side. The main shut-off valve can be the cylinder valve. The main shut-off valve may be incorporated in the pressure regulation device, as long as its action isolates the cylinder contents from the pressure regulator input and removal of the pressure regulation device from the cylinder closes the cylinder valve.

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

6.6.3 A shut-off valve shall be installed in the low pressure supply line to each appliance. The valve or its control shall be readily accessible and operable from within the vicinity of 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 vicinity of the appliance, the shut-off valve on the low pressure supply line is not required. A solenoid valve located within the cylinder locker or cylinder housing on the high or low pressure side of the pressure regulation device, operable from the vicinity of the appliance, is considered as meeting this requirement. Solenoid valves shall be closed in cases of lack of tension, i.e. loss of electrical actuating energy.

6.6.4 Unmistakable and easily recognized means of identifying the open and closed positions of shut-off valves shall be provided.

6.6.5 For 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, 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 suitable 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 small craft.

7.2 Each LPG consuming appliance shall be securely fixed to the craft so as to eliminate undue stress on piping, hose and fittings.

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

7.4 Unattended appliances

7.4.1 All appliances designed to function unattended shall have a combustion system in which outgoing products of combustion pass through sealed ductwork connected to the enclosed combustion chamber and terminating outside the craft, including any areas that can be enclosed by canopies.

NOTE Examples of unattended appliances are water heaters, refrigerators and cabin heaters. Stoves, ovens and gas lamps are not considered to be unattended appliances.

7.4.2 All appliances designed to function unattended shall have a combustion system in which either:

— incoming combustion air passes through sealed ductwork connected to the enclosed combustion chamber and terminating outside the craft, including any areas that can be enclosed by canopies, or

— mechanisms are incorporated in the appliance to prevent backdrafting from the exhaust and oxygen depletion in interior spaces.

7.4.3 If the incoming air is not delivered through sealed ductwork terminating outside the craft, and if the appliance is installed in interior spaces, ventilation shall be provided that allows outside air to pass through fixed openings. Minimums for sizing of ventilation openings are given in Annex B.

7.5 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 owner's manual.

7.6 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.

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

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

7.9 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.

7.10 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.

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

8 Location and installation of LPG cylinders

8.1 LPG cylinders including reserve cylinders, whether empty or full, pressure regulation device and safety devices shall be installed in cylinder lockers or cylinder housings and be secured against any movement that is expected to result from marine service.

Cylinders, pressure regulators, regulation devices and safety devices located below decks or in cockpits shall be mounted in cylinder lockers.

8.2 Craft design and openings of cylinder lockers and cylinder housings shall be such that escaping vapours can only flow to the outside of the craft. In addition:

— Cylinder lockers inside enclosed cockpits shall only be accessible from the top;

— Cylinder lockers inside cockpits with open transoms may also be accessible from the side;

— Cylinder lockers shall be vented at the bottom by a drain.

8.3 The locker drain shall be run outboard, i.e. to the outside of the craft, 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, but not less than 75 mm above the at-rest waterline when in maximum loaded condition as defined in ISO 12217-1, and

— 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.

8.4 All hoses or metal piping penetrating cylinder locker walls shall be sealed at the wall so as to maintain vapour tightness to the craft interior.

8.5 Cylinder locker drain openings and cylinder housing ventilation openings shall be located at least 500 mm from any hull opening to the interior of the craft.

8.6 No provision for storage of loose components that could damage the cylinder, pressure regulation device, piping or hose installation, or obstruct the locker drain, shall be made in a cylinder locker or cylinder housing.

8.7 Cylinders, valves and pressure regulation devices shall be installed so that they are readily accessible,.

9 Ventilation

Ventilation shall be provided in accommodation spaces where open flame unflued appliances are used or to which compartments containing such appliances 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. Minimums for sizing and locations of ventilation openings are given in Annex B.

10 LPG installation tightness tests

NOTE This clause has been written in line with the scope of this standard. It excludes commissioning of the system and final appliance function testing. It is recommended to test the complete system charged with LPG by a competent person prior to first use by the craft owner.

The LPG supply line and fittings shall be tested 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 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 regulation 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 LPG installations in accordance with EN 14291 meet these requirements.

If the pressure regulating device is not rigidly connected to, and supported by, the cylinder connection, high pressure side components shall be checked for leakage by application of a leak detection fluid.

11 Ignition protection from electrical devices

There shall be no potential sources of ignition in LPG cylinder lockers or housings. If electrical devices are located in such places, the equipment shall be ignition protected in accordance with ISO 8846.

12 Owner's manual

The craft manufacturer shall provide an owner's manual in a language acceptable in the country of use, and shall include with it the user instructions supplied by the equipment and appliance manufacturers Requirements and guidance for the contents of the owner's manual are given in Annex C.

13 Ducts and flues for air intake and combustion product discharge

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

13.2 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.

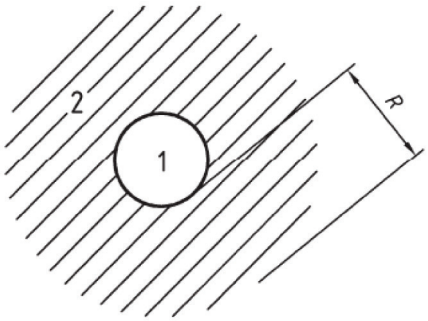
13.3 The flue system and air intake duct system shall each be continuous and sealed to be vapour tight both between the air intake outside the craft and the appliance and from the appliance to its terminal outside the craft.

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

13.5 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.

13.6 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 living space or an opening part of a window, see Figure 1.



Key

1 ventilator, opening port, hatch or window

2 prohibited zone for discharge opening for the products of combustion

$R \geq 300$ mm

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

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

Annex A
(informative)

Design guidelines for pressure drop due to pipe resistance

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

Inside diameter of hose/pipe mm	Pressure drop per metre of 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.

NOTE 3 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 ventilation openings for accommodation spaces containing an LPG open flame (unflued) appliance (such as a cooker, stove or oven) is given by the formula in Formula (B.1):

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

where

A is the effective area, in square millimetres;

U is the nominal input of unflued appliance, in kilowatts;

P is the number of persons for which accommodation space is designed.

This formula applies to any accommodation space in the craft containing unflued LPG appliances that can be closed off.

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

The minimum effective area, A, of fixed ventilation is 4 000 mm^2.

NOTE 1 Screening or louvers over ventilation openings reduce effective area by approximately 50 %, or more if the wire or bar size exceeds the opening dimensions between, and needs to be accounted for.

Ventilation shall be supplied by at least two equally sized fixed openings in the accommodation 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.

NOTE 2 For additional information, see EN 721[3].