PUBLISHED DOCUMENT

PD 5482-3:
2005

Code of practice for domestic butane and propane gas-burning installations —

Part 3: Installations in boats, yachts and other vessels

ICS 47.080; 97.100.20

Confirmed
December 2011

BSI
British Standards

Committees responsible for this British Standard

The preparation of this Published document was entrusted to Technical Committee GME/33, Small craft, upon which the following bodies were represented:

Association of Canoe Traders

Broads Authority

British Marine Federation

British Waterways Board

Consumer Policy Committee of BSI

CORGI — The Council for Registered Gas Installers

DTI — Standards Policy Unit

IMarEST — The Institute of Marine Engineering, Science and Technology

Marine and Coastguard Agency

National Association of Boat Owners

Royal Yachting Association

Wooden Boatbuilders Trade Association

Co-opted members

The following bodies were also represented in the drafting of this standard, through panel GME/33/-/5, LPG Issues.

LP Gas Association

National Caravan Council Limited

Institution of Gas Engineers

HSE — Health and Safety Executive

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 26 September 2005

The following BSI references relate to the work on this standard:
Committee reference GME/33

Amendments issued since publication

Amd. No.	Date	Text affected

ISBN 0 580 46721 X

Contents

Foreword

This Published Document has been prepared jointly by GME/33 and GSE/31. It recommends good practice for installation of liquefied petroleum gas (LPG) appliances in boats, yachts and other vessels.

This Published Document replaces BS 5482-3:1999, which is withdrawn. As a code of practice this Published Document takes the form of guidance and recommendations.

For installations constructed to BS EN ISO 10239, *Small craft — Liquified Petroleum Gas (LPG) systems*, that standard should be referred to for examination of the adequacy of construction.

Attention is drawn to the Gas Safety (Installation and Use) Regulations [1], [2]. Any work on gas appliances, including their installation, that falls within the scope of the Gas Safety (Installation and Use) Regulations (i.e. most work outside of factories) must be carried out by a business that is a "member of a class of persons" approved for the time being by the Health and Safety Executive (HSE). At the time of publication, the body with HSE approval to operate and maintain a register of businesses who are "members of a class of persons" is the Council for Registered Gas Installers (CORGI). Thus it is essential that all business or self-employed gas fitters be registered with CORGI.

Guidance on the individual competency required for gas work is given in the Health and Safety Commission's Approved Code of Practice (ACOP) [3].

Persons deemed competent to carry out gas work are those who hold a current certificate of competence in the type of activity to be conducted, issued under the ACOP arrangements, or by a certification body accredited by the United Kingdom Accreditation Service (UKAS).

As a code of practice, this Published Document takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

This Published Document calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 28, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

1 Scope

This part of this Published Document covers gas burning installations in boats, yachts and other vessels[1)] of up to 24 m in length, using liquefied petroleum gas (LPG) from either cylinders stowed on board or, in the situation of a fixed shore bulk supply, the onboard aspects of the gas system, operating at 28–30 mbar[2)] for commercial butane and 37 mbar for commercial propane. It does not cover use of LPG for propulsion of vessels for which guidance is given in LPGA Code of Practice No. 18 [4].

It gives guidance on selection of materials, appliances and components, design considerations, installation requirements, inspection, and testing, and preparing instructions for the user. This part of this Published Document gives recommendations for selection and maintenance of room sealed appliances and non-room sealed cooking appliances. It is intended for new installations, but recommendations for existing installations are given in Annex A.

This Published Document does not cover installation of bulk supplies of LPG or portable LPG-burning appliances.

This Published Document does not cover appliances with directly attached gas cylinders such as portable self-contained camping stoves or portable gas lamps and does not cover the installation of LPG generators.

NOTE Further information can be found in Document IGE/UP/8 [5].

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this Published Document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 476-7, *Fire tests on building materials and structures — Part 7: Method of test to determine the classification of the surface spread of flame of products.*

BS 476-20, *Fire tests on building materials and structures — Part 20: Method for determination of the fire resistance of elements of construction (general principles).*

BS 669 (both parts), *Flexible hoses, end fittings and sockets for gas burning appliances.*

BS 1179:1967, *Glossary of terms used in the gas industry.*

BS 1179-6:1980, *Glossary of terms used in the gas industry — Part 6: Combustion and utilization including installation at consumers' premises.*

BS 1552, *Specification for open bottomed taper plug valves for 1st, 2nd and 3rd family gases up to 200 mbar.*

BS 1723, *Specification for brazing.*

BS 3016, *Specification for pressure regulators and automatic changeover devices for liquefied petroleum gases.*

BS 3212, *Specification for flexible rubber tubing, rubber hose and rubber hose assemblies for use in LPG vapour phase and LPG/air installations.*

BS 5258-11, *Safety of domestic gas appliances — Part 11: Flueless catalytic combustion heaters (3rd family gases).*

BS 6172, *Installation and maintenance of domestic gas cooking appliances (2nd and 3rd family gases) — Specification.*

BS 6362 (ISO 7598), *Specification for stainless steel tubes suitable for screwing in accordance with BS 21 "Pipe threads for tubes and fittings where pressure-tight joints are made on the threads".*

BS 6956, *Jointing materials and compounds.*

BS 7838, *Specification for corrugated stainless steel semi-rigid pipe and associated fittings for low-pressure gas pipework of up to 28 mm.*

---

1) Attention is drawn to the various Merchant Shipping Acts that apply to British registered ships.

2) 1 mbar = 10^2 N/m^2 = 100 Pa.

BS EN 331, *Manually operated ball valves and closed bottom taper plug valves for gas installations in buildings.*

BS EN 449, *Specification for dedicated liquid petroleum gas appliances — Domestic flueless space heaters (including diffusive catalytic combustion heaters).*

BS 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.*

BS EN 837-1, *Pressure gauges — Bourdon tube pressure gauges — Part 1: Dimensions, metrology, requirements and testing.*

BS EN 1044, *Brazing — Filler metals.*

BS EN 1057, *Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications.*

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

BS EN 12864, *Low-pressure, non-adjustable regulators having a maximum outlet pressure of less than or equal to 200 mbar, with a capacity of less than or equal to 4 kg/h, and their associated safety devices for butane, propane or their mixtures.*

BS EN 13878, *Leisure accommodation vehicles — Terms and definitions.*

BS EN 28846, *Small craft — Electrical devices — Protection against ignition of surrounding flammable gases.*

BS EN ISO 10239, *Small craft — Liquified petroleum gas (LPG) systems.*

EN 1763, *Flexible rubber and plastics hose, tubing, nozzles and assemblies for use with propane and butane in the vapour phase — Specification.*[3)]

3 Terms and definitions

For the purposes of this part of this Published Document, the term and definitions in BS 1179:1967, BS 1179-6:1980 and BS EN 13878 apply, together with the following.

3.1
liquefied petroleum gas
LPG
mixture of light hydrocarbons, gaseous at normal temperature and pressure, maintained in the liquid state by increased pressure or lowered temperature

3.2
high pressure stage
part of an installation between the valve of the cylinder and the inlet of the pressure regulator

3.3
low pressure stage
part of an installation between the outlet of the single stage pressure regulator and the inlet of the appliance

3.4
cylinder
portable and refillable vessel of approved design, used to contain LPG under pressure

3.5
low pressure regulator
device that maintains an outlet pressure constant independent of the variations of inlet pressure and/or rate and/or temperature within defined limits

[3)] In preparation.

3.6
cylinder locker
vapour-tight enclosure with an overboard drain intended solely for storage of one or more LPG cylinders in a cockpit or recessed into the craft

3.7
cylinder housing
ventilated enclosure intended solely for storage of one or more LPG cylinders, pressure regulators and safety devices and located on the exterior of the craft, where any leakage would flow overboard

3.8
flame supervision device
device that prevents gas flowing to the burner, ignition burner, or pilot light if there is no flame at the burner or pilot light

3.9
room sealed appliance
appliance with a system in which incoming combustion air and outgoing combustion products pass through sealed ductwork connected to an enclosed combustion chamber and terminating outside the vessel

3.10
accessible
capable of being reached for inspection, removal or maintenance, without removal of a permanent vessel structure

NOTE Hatches are not included as permanent vessel structures, even if tools are required to open them.

3.11
readily accessible
capable of being reached for operation, inspection or maintenance, without removal of a vessel structure, or use of tools or keys, or removal of any item of portable equipment stowed in a place intended for storage of portable equipment (e.g. lockers, drawers or shelves)

3.12
main shut-off valve
valve for isolating an LPG system from a high pressure stage supply

3.13
ventilator
device that allows air to pass into and out of an accommodation space

3.14
appliance connector
pipe or hose connecting an appliance isolation valve and the appliance inlet connection

3.15
supply control valve
isolating valve immediately upstream of the test section during the soundness test. This may be the cylinder or tank outlet valve or an intermediate valve depending on the section of pipework to be tested

3.16
burner tap
user-operated tap

NOTE For example, a cooker hot-plate tap.

3.17
let-by
internal gas leakage past a shut-off valve seat when fully closed

3.18
bourdon gauge
dial-type pressure gauge conforming to BS EN 837-1

3.19
appliance isolation valve
valve fitted in the supply pipe to an individual appliance to allow isolation in emergency or for servicing purposes

3.20
intermediate pressure stage
part of the installation between a first stage regulator and a second stage regulator

3.21
closed-flue appliance
appliance where the flue is closed from a room or internal space due to the absence of a draught diverter, flue break and any draught break within the flue

3.22
conventionally flued instantaneous water heater
water heater of the B_{11BS} type

NOTE A type B_{11BS} type is a type B_{11} appliance fitted with a combustion products discharge safety device. A type B_{11} is a natural draught type B_1 appliance. A type B_1 is a type B appliance incorporating a draught diverter. A type B is an appliance intended to be connected to a flue that evacuates the products of combustion to the outside of the room containing the appliance. The combustion air is drawn directly from the room in which the appliance is installed.

3.23
combustion products discharge safety device
device that causes at least safety shutdown of the main burner, when there is an unacceptable spillage of combustion products from the draught diverter of type B_{11BS} water heaters

4 Pipework materials

The following materials should be used for installation pipework:

a) seamless copper tube conforming to BS EN 1057 with fittings in accordance with **5.3**;

b) stainless steel tube conforming to BS 6362. Corrugated stainless steel pipes should conform to BS 7838. Appropriate compression or screwed fittings should be used;

c) copper nickel alloy, of a grade suitable for use with LPG and a marine environment, and appropriate compression or screwed fittings.

The following materials should not be used for installation pipework, for the reasons given:

a) aluminium (corrosion, low melting point, vibration);

b) lead (creep);

c) brass tubing (season cracking);

d) steel tubing (corrosion);

e) plastics (low melting point, low-temperature embrittlement).

Tubing of the type fabricated from sheet steel, coated internally and externally and wrapped, is subject to atmospheric corrosion and should not be used.

Care should be taken to ensure that PVC does not come into contact with stainless steel, owing to the risk of corrosion.

5 Selection of components

5.1 General

Components should be suitable for use with LPG and a marine environment.

5.2 Valves

Ball valves should conform to BS EN 331.

Tapered plug cocks should conform to BS 1552, and should be spring-loaded and fitted with an operating handle designed to indicate clearly whether the cock is in the open or closed position. Valves should be clearly marked with direction of rotation to open or close, or open and closed positions should be obvious by design.

A cock at floor level should be of either the drop fan or the loose key type or so positioned to prevent inadvertent operation.

Needle valves and gate valves should not be used as isolating valves.

Lubricants used in valves upstream of appliances should be of a type suitable for use with LPG, e.g. lubricants having a 25 % molybdenum disulfide base.

5.3 Joints

Compression fittings should be made of copper or copper alloy conforming to BS EN 1254-2. Annealed olives should be used.

Stainless steel rings should be used on stainless steel piping.

Brazed connections made in accordance with BS 1723 using BS EN 1044 filler metals. The melting point of materials at hard soldered or brazed connections should not be less than 450 °C.

Push-fit quick release hose fittings conforming to BS 669 should be installed in accordance with BS 6172.

5.4 Joint and thread sealing

Washers or gaskets should be of a material suitable for use with LPG, durable, robust, and gas tight. Fibre washers and hemp should not be used.

PTFE tape should conform to BS EN 751-3 and should be used in accordance with the manufacturer's recommendations. (PTFE tape conforming to BS 7786 should not be used on pipework.)

Jointing compounds should conform to BS 6956 and should only be applied to tapered male threads of components.

6 Selection of appliances

6.1 General

Appliances should be recommended by the manufacturers as suitable for use in a marine environment. Appliances should be room sealed (with the exception of cooking appliances and conventionally flued instantaneous water heaters used for replacement purposes).

Only appliances that carry an appropriate CE mark should be installed.

6.2 Flame supervision devices

Appliance burners, ignition burners and pilot lights should be fitted with flame supervision devices that completely close the LPG supply to the burner to which it is fitted.

7 Cylinder location design considerations

7.1 Layout of supply system

Layout should be such that the length of pipe from the inlet of the gas supply to the highest rated appliances is as short as possible and all pipe runs, particularly at intermediate pressure stage, should be as short as practicable.

NOTE 1 Further information is given in the LPGA Code of Practice 22 [6].

NOTE 2 Health and Safety Executive recommendations indicate that under no circumstances should the temperature of the cylinder exceed 45 °C.

7.2 Cylinder supply

When designing a cylinder installation, the installer should ensure that the cylinder(s) selected and other supply equipment (e.g. the regulator) are of sufficient capacity to ensure safe and satisfactory operation of all appliances simultaneously.

NOTE Gas consumption details for each installed appliance can be found on the appliance data badge.

Table 1 provides guidance on conversion from heat input to gas rates.

Table 1 — Conversion of heat inputs (kW) to gas rate (kg/h)

kW	0	1	2	3	4	5	6	7	8	9
0	0.00	0.07	0.15	0.22	0.29	0.37	0.44	0.51	0.58	0.66
10	0.73	0.80	0.88	0.95	1.02	1.10	1.17	1.24	1.31	1.39
20	1.46	1.53	1.61	1.68	1.75	1.83	1.90	1.97	2.04	2.12
30	2.19	2.26	2.34	2.41	2.48	2.56	2.63	2.70	2.77	2.85
40	2.92	2.99	3.07	3.14	3.21	3.29	3.36	3.43	3.50	3.58
50	3.65	3.72	3.80	3.87	3.94	4.02	4.09	4.16	4.23	4.31
60	4.38	4.45	4.53	4.60	4.67	4.75	4.82	4.89	4.96	5.04
70	5.11	5.18	5.26	5.33	5.40	5.48	5.55	5.62	5.69	5.77
80	5.84	5.91	5.99	6.06	6.13	6.21	6.28	6.35	6.42	6.50
90	6.57	6.64	6.72	6.79	6.86	6.94	7.01	7.08	7.15	7.23

NOTE Due to the very similar gas rates of butane and propane and for practical purposes, this table covers both gases.

For a continuous supply, multiple cylinders may be installed. These may be installed in pairs or in banks of cylinders, interconnected via an automatic changeover device that switches gas supply as cylinders empty. Alternatively, they may be directly connected through wall block arrangements.

Table 2 provides guidance on recommended off-takes for temperate climates

Table 2 — Recommended off-takes for temperate climates

Butane		Propane	
Cylinder size kg	Off-take kg/h	Cylinder size kg	Off-take kg/h
15	0.696	13	1.054
—	—	19	1.319
—	—	47	2.373

For butane cylinders, satisfactory service might not be obtained at a temperature of less than 10 °C; the most suitable temperature range is from 13 °C to 30 °C. For temperatures less than 13 °C, the use of propane should be considered.

EXAMPLE

Calculate the total heat input in kilowatts of all gas appliances to be supplied by cylinder(s) as follows.

Cooker	14.0 kW
Space heater	5.5 kW
Water heater	13.5 kW
Total	33.0kW

NOTE For cookers, 70 % of the maximum gas rate may be used. In the example above, the cooker input is 20 kW. Based on 70 %, this would equate to 14 kW for this example.

Therefore the gas rate (deduced from Table 1) would be 2.41 kg/h.

To calculate the number of cylinders required, divide 2.41 kg/h by the cylinder off-take rates given in Table 2:

a) for butane:

2.41 kg/h ÷ 0.696 (off-take rate for a 15 kg butane cylinder) = 3.46.
Therefore this installation would require 4 × 15 kg butane cylinders;

b) for propane:

2.41 kg/h ÷ 1.319 (off-take rate for a 19 kg propane cylinder) = 1.83.
Therefore this installation would require 2 × 19 kg propane cylinders.

7.3 Cylinder location

Cylinders (full or empty, stored or in use) should be:

a) secured on the open deck, on cabin tops, or outside cockpits, so that any leakage flows overboard; or

b) in a cylinder locker with a drain that directs any leakage outside the hull, in any condition of heel and loading. Cylinders, when in position, should not obstruct the drain.

NOTE Cylinders in self-draining cockpits may be secured in a cylinder housing if it is LPG tight to the interior of the vessel.

Cylinders should be stowed as follows.

a) The possibility of cylinders damaging low pressure regulators or pipework should be minimized.

b) Cylinders and cylinder lockers or housings should not form an obstruction.

c) Cylinders should be upright with the valve uppermost, and secured so that damage cannot occur to the cylinders, regulators, hoses, or pipework.

d) Cylinders should be accessible and removable in an emergency.

e) Cylinders should be secured so that damage cannot occur to the cylinders, regulators, hoses, or pipework.

7.4 Stowage on open decks and cabin tops or outside cockpits

Cylinders on open decks or cabin tops or outside cockpits should be stowed as follows.

a) Cylinders, low pressure regulators and associated equipment should be stowed so that any leaked LPG flows overboard.

b) Cylinders, low pressure regulators and associated equipment should be stowed at least one metre from hatches and other openings to the interior of the vessel and possible sources of ignition.

NOTE Cylinders, low pressure regulators and associated equipment may be stowed in a cylinder locker or cylinder housing on open decks and cabin tops or outside cockpits, if the cylinder locker or cylinder housing conforms to a) and b).

7.5 Stowage below decks or in cockpits

Cylinders, low pressure regulators and associated equipment not stored either on open decks or cabin tops or outside cockpits (see **7.4**) should be stowed in a cylinder locker.

Cylinder lockers not on open decks or cabin tops or outside cockpits should be as follows.

a) Cylinder lockers should not contain any items of equipment that could damage low pressure regulators or associated pipework, or obstruct the drain or ignite leaked LPG.

b) Cylinder lockers should not be located near to heat sources.

c) Cylinder lockers should be LPG tight to the interior of the hull, at least to the level of the cylinder, low pressure regulator and associated equipment. Cylinder lockers should only be openable from the top. Side opening cylinder lockers constructed in accordance with BS EN ISO 10239 should have an effective seal which is LPG-tight when the door is closed.

d) Installation pipework from cylinder lockers should either be from a bulkhead fitting or above the level of the cylinder, low pressure regulator and associated equipment.

e) Cylinder lockers should have a lid or cover to protect cylinders, low pressure regulators and associated equipment from mechanical damage.

f) A means should be provided to drain any leaked LPG away from the vessel, from the lowest point of the cylinder locker, to a point outside the hull above the deepest loaded waterline. Any drain pipes or hoses should be continuous and should fall continuously to the external connection.

g) Drain pipes, hoses and connections should be of a material suitable for the purpose. Drains should have an internal diameter of at least 19 mm. Hoses should be connected in accordance with **9.4**.

h) Cylinder lockers should be ventilated from outside the vessel, above the level of the cylinder.

i) Materials of construction of cylinder lockers should have a fire resistance of 30 min tested in accordance with BS 476-20. Cylinder lockers constructed in accordance with BS EN ISO 10239 should be constructed of material offering an equivalent level of fire resistance to that of the surrounding deck or hull material.

j) The opening into a cylinder locker should enable operation of valves, replacement of cylinders, and access to connections or regulating devices.

k) The opening into a cylinder locker should not be situated in accommodation, engine, fuel, or battery spaces.

l) There should be no electrical joints in a cylinder storage housing or locker except those installed in electrical equipment designed and manufactured to meet the requirements of BS EN 28846.

m) Electrical cables not required for the operation of equipment in a gas compartment should not pass through a gas cylinder compartment unless they are contained in a suitable conduit.

NOTE LPG cylinder housings may be situated in self-draining cockpits if:

— the drain outlets are above the deepest loaded waterline;

— the cockpit is LPG tight to the interior of the vessel (including to the height of any bridge deck or fixed cill to an accommodation space), at least to the level of the cylinder, low pressure regulator and associated equipment;

— hatches or openings in the cockpit are watertight;

— the cylinder housing conforms to **7.5**a), and **7.5**b) and **7.5**f), **7.5**g), **7.5**h),**7.5**i), **7.5**j), **7.5**k), **7.5**l) and **7.5**m).

8 High pressure stage design considerations

High pressure stage components should be installed on the open deck or cabin tops or outside cockpits, or in a cylinder locker or cylinder housing.

If two or more cylinders are connected, each high pressure stage connection should be protected by a non-return valve.

High pressure stage components not directly attached to the cylinder valve should be connected by a pre-assembled length of flexible hose conforming to type 2 of BS 3212 or the relevant requirements of EN 1763, fitted with permanently attached end fittings such as swaged sleeve or sleeve and threaded insert. The hose should be of the minimum practicable length to allow replacement of cylinders, and should not exceed one metre.

High pressure stage components not directly attached to the cylinder valve should be secured in a position that provides protection from mechanical damage;

Regulators and automatic changeover devices should conform to BS EN 12864 or BS 3016 and should be located such that the inlet to them is at or above the level of the cylinder outlet valve connection.

Vent holes in regulators should be carefully orientated or otherwise protected against the possible ingress of water or substances that could cause blockage, and also to allow for drainage.

The appropriate size of pressure regulator should be determined according to the maximum gas rate, calculated according to Table 1.

External manual adjustment type regulators should not be used.

9 Low pressure stage design considerations

9.1 Pipe sizes

Pipes should be of a size and length to ensure correct operation of the appliance.

NOTE 1 In general, this can be achieved if pipework is designed with the aim that there is no pressure drop greater than 2.5 mbar between the outlet of the pressure regulator and any draw-off point when the installation is subjected to the expected maximum load. A suitable testing procedure can be found in Annex D, **D.2**.

NOTE 2 Design guidelines for estimating theoretical pressure drop due to pipeline resistance are given in Table 3.

The smallest pipe diameter practicable should be used in applications.

Table 3 — Pressure drop due to pipeline resistance

Pipe outside diameter	Pressure drop[a] per metre of pipe, for appliances of output										
	1 kW	2 kW	3 kW	4 kW	6 kW	8 kW	10 kW	12 kW	15 kW	20 kW	25 kW
mm	mbar	mbar	mbar	mbar	mbar	mbar	mbar	mbar	mbar	mbar	mbar
6	0.04	0.15	0.3	0.5	1.5	2.3	—	—	—	—	—
8	0.01	0.04	0.07	0.12	0.03	0.4	0.7	1.0	1.4	2.6	—
10	<0.01	0.01	0.02	0.03	0.01	0.15	0.2	0.25	0.4	0.7	1.1
12	—	<0.01	<0.01	0.01	0.03	0.04	0.06	0.09	0.13	0.22	0.32
15	—	—	—	<0.01	0.01	0.01	0.02	0.02	0.04	0.06	0.1
22	—	—	—	—	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01

NOTE Outside diameters only refer to drawn copper tubing. For flexible hoses, use the internal bore diameter.

[a] For the following cylinder pressures:
— propane: 30 mbar; 37 mbar;
— butane: 30 mbar.

The equivalent lengths of pipe for fittings are as given in Table 4.

Table 4 — Equivalent lengths of pipe for fittings

Fitting	Length m
Elbow	0.6
Tee	0.6
Straight coupler	0.3
90° bend	0.3
Globe valve (15 mm)	1.0
Globe valve (22 mm)	1.4

9.2 Inlet connection

The inlet gas connection on installation pipework should be securely fixed and readily accessible. For cylinders stowed below decks or in cockpits, the inlet gas connection should be situated inside the cylinder locker or cylinder housing. Flexible hose conforming to **9.4** should be fitted between the low pressure regulator and inlet gas connection.

9.3 Installation pipework

Installation pipework materials should conform to Clause **4**.

Appliances should be connected with rigid metal piping.

NOTE Flexible hose conforming to **9.4** may be used as the appliance connector provided this is in accordance with the appliance manufacturer's installation instructions.

9.4 Flexible hose

Flexible hose should conform to type 2 of BS 3212 or the relevant requirements of BS EN 1763.

NOTE 1 Flexible hoses conforming to BS 669 may be used for cooker connections provided that they are marked to identify their suitability for LPG applications and are installed in accordance with the appliance manufacturer's installation instructions.

Flexible hose should be of the minimum practicable length and should not exceed one metre.

NOTE 2 If only a cooking appliance is installed, flexible hose may be used to connect it to the low pressure regulator, provided the length does not exceed one metre.

"All hose" systems installed in accordance with BS EN ISO 10239 should meet all of the relevant hose installation requirements of that standard.

NOTE 3 It is possible that hose on installations conforming to BS EN ISO 10239 might be found exceeding one metre length. Hose length in excess of one metre is not recommended.

Flexible hose passing through bulkheads, partitions, deck-heads, or decks should be protected from abrasion.

Flexible hose should be readily accessible and installed so as to avoid stress or tight radius turns under any conditions of use.

For low pressure applications, flexible hose should be fitted with permanently attached end fittings such as swaged sleeve or sleeve and threaded insert, or secured to nozzles by a metal crimped clip or worm drive hose clamp (bayonet or plug-in connectors may be used for cooking appliances).

Hose clamps fixed by spring tension should not be used. Hose clips and clamps should be of the correct size for the hose.

Flexible hose manufactured to BS 3212 should not be used where it could be subjected to temperatures above 50 °C.

10 Flue design considerations

Flue components, including ductwork and terminals, should be as recommended by the appliance manufacturer and should be installed in accordance with the appliance manufacturer's recommendations for installations in vessels.

Flue terminals and air inlets should not be positioned within 300 mm of a ventilator, opening port, hatch or window, or within 500 mm of a refuelling fitting or tank vent outlet.

Flue terminals should be outside the vessel, in a position that minimizes the risk of accidental damage, and away from areas that could be enclosed by canopies.

11 Ventilation design considerations

All accommodation spaces in the vessel should be ventilated from outside, through ventilators with fixed openings, to prevent hazards from leaked LPG or combustion products.

Ventilation systems should be designed to avoid draughts, even in adverse weather conditions, and should allow for the air consumption of all appliances and occupants of the ventilated space.

The minimum effective area of total fixed ventilation should be 4 000 mm^2, or the area given by the equation in Annex B, whichever is the larger. The fixed ventilation area should be divided as equally as practicable between high and low level, with the upper ventilators as high as practicable, and lower ones positioned so they cannot be inadvertently obstructed. The area of fixed ventilation should be calculated for and applied to any part of the vessel normally divided as a separate compartment or that can be temporarily divided (except by curtaining).

NOTE 1 The area of fixed ventilation given by the equation in Annex B is the minimum needed to secure efficient distribution of fresh air. It does not include the normal adjustable ventilation provided by windows or roof-lights.

NOTE 2 The area of ventilation provided through cockpit coverings should be at least 50 % larger than the area of fixed ventilation required for any part of the vessel divided as a separate compartment.

Ventilators should be weathertight in accordance with conditions the vessel could encounter. Vessels that regularly go to sea may be fitted with closable ventilators if severe weather conditions could be encountered. If closable ventilators are fitted, a warning should be permanently attached on or near to cooking appliances as follows: "WARNING: Open ventilator before use".

12 Installation of pipework

12.1 Pipework design considerations

Pipework should be as short as practicable between cylinders and the highest rated appliances.

Pipework should be as short and as high up as practicable within the hull (preferably at gunwale level).

All pipework should be accessible.

Except for bulkhead fittings, there should be no joints or fittings in pipework within engine compartments.

A test fitting should be installed in the pipework in the event such a facility is not available for use on an appliance.

The number of pipe fittings and joints should be kept to a minimum.

Joints should be made at a point where stress is minimized.

12.2 Pipework

Pipework should be rigidly secured. Supports and fixings should minimize vibration. Fixing clips should be attached at least every 500 mm for rigid metal piping.

Pipework clips should be of compatible materials to prevent electrolytic corrosion and where the pipework is subject to vibration or movement, the clips should be protected to prevent abrasion to the pipe or be non-metallic.

Where there is a joint between rigid pipework and a flexible tube or hose, the pipework should be adequately supported at the point of connection.

Pipework should be physically protected against, or located where it is not liable to be subject to, mechanical damage. The bore should not be restricted by kinks, burrs, foreign matter or in any other way.

Pipework that penetrates bulkheads should be protected by sleeves, bulkhead fittings or grommets.

Pipework should not run below bilge water level. It is essential that pipework in contact with any material that could cause corrosion is protected.

12.3 Pipe fittings and joints

Joints should be rigidly secured. Pipework fixing clips should be attached no more than 150 mm from each joint.

The final connection to an appliance should be accessible. All other joints should be readily accessible.

12.4 Connection and disconnection of pipes and fittings

Where any installation pipework is no longer required, the pipe(s) should be disconnected as close to the point of supply as practicable. All pipe ends should be properly sealed, e.g. with a plug or cap.

During any work that necessitates connection or disconnection of any installation pipework, where appropriate, a temporary electrical continuity bonding connector should be fixed securely to the pipework.

12.5 Positioning of LPG pipework relative to other services

LPG installation pipework:

a) should not pass through a ventilation or air conditioning duct;

b) should not be exposed to leakage from water services;

c) should be remote and/or insulated from, and should not pass through the same duct as, electricity or telecommunication services;

d) should be separated from electrical cables not in a conduit by at least 30 mm;

e) should not be situated less than 75 mm from exhaust pipes.

13 Shut-off valves

13.1 Main shut-off valve

LPG installations should include a readily accessible main shut-off valve, situated outside accommodation spaces and as close to the LPG cylinder as practicable.

NOTE A readily accessible LPG cylinder or low pressure regulator valve may be used as the main shut-off valve, unless two or more cylinders are connected by an automatic changeover device.

If the main shut-off valve is not in a clearly visible position, or is in a space that can be closed off by doors or lids, its location should be clearly marked. If there is more than one main shut-off valve, this and the locations of the other main shut-off valves should be clearly marked on or adjacent to each.

13.2 Appliance isolation valves

Appliance isolation valves should be installed in the supply line to each appliance (unless there is only one appliance, in which case the main shut-off valve is sufficient). Valves not situated immediately adjacent to appliances should clearly indicate which appliance they serve. Valves should be readily accessible.

If valves operate by rotation, closing should be clockwise. "Open" and "closed" positions should be clearly marked on all valves. Valves at floor level should be located to prevent inadvertent operation, or should be of the drop fan or loose key type.

Tapered plug valves should be spring loaded. Needle valves should not be used.

WARNING Pipework to appliances permanently removed or removed for servicing should be properly plugged or capped. Isolation valves should not be used for this purpose.

14 Appliances

14.1 General

Appliances should conform to Clause **6** and should be installed in accordance with the manufacturer's recommendations for installation in vessels.

Appliances should not be installed in engine spaces unless this location accords with the manufacturer's recommendations for installation in vessels.

The installer should provide the user with all the appliance manufacturer's instructions and warnings accompanying the appliance.

Consideration should be given to loose furnishings such as curtains, blinds and fold out beds, such that they cannot infringe the minimum separation distances for combustible materials as specified by the manufacturer of the appliance.

Appliances should be connected so that there is no stress on pipework and fittings.

Pipework should not be used to retain the appliance.

Appliances should be secured against accidental movement.

Appliances should be situated in sufficient space, as instructed by the manufacturer, to prevent overheating of nearby surfaces.

The surfaces of adjacent structures in contact with the appliance should be of materials that can withstand temperatures of 65 °C.

Where combustible material adjacent to an appliance might otherwise have a temperature rise in excess of 50 °C, provision should be made to protect the material.

Room sealed appliances installed in closed compartments should have adequate ventilation to prevent overheating.

14.2 Cooking appliances

Cooking appliances (and gimbals, if fitted) should be securely installed. Gimballed cooking appliances should be secure at all angles of heel.

Materials in the vicinity of cooking appliances should be non-combustible or protected with a finish of class 1 surface spread of flame rating as specified in BS 476-7.

Cooking appliances should be installed in accordance with manufacturer's instructions ensuring minimum separation from Class 1 combustible surfaces and materials as indicated in Figure 1. If the manufacturer's instructions are not available, use the clearances shown in Figure 1.

Materials and finishes used in the vicinity of open-flame cooking and heating devices within the ranges defined in Figure 1 should take into account the movement of the burner up to an angle of 20° for monohull sailboats or 10° for multihulls and monohull motorboats, where gimballed stoves are fitted.

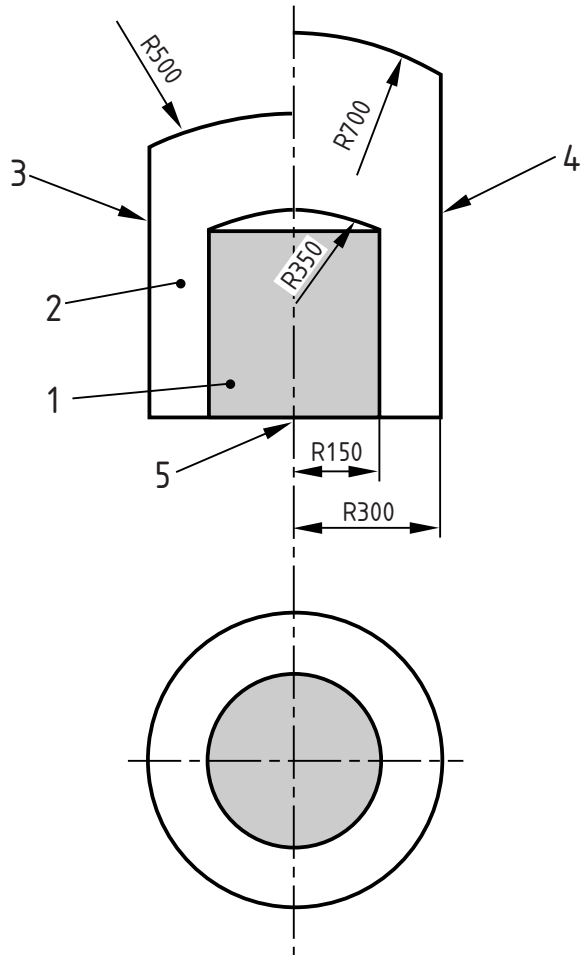
— Free-hanging curtains or other fabrics should not be fitted in Zone I and Zone II, or enter into these zones when released from any openable retaining device.

— Exposed materials installed in Zone I should be glass, ceramics, aluminium, ferrous metals, or other materials with similar fireproof characteristics, or be thermally insulated.

— Exposed materials installed in Zone II should be glass, ceramics, metal or other materials with similar fireproof characteristics, or be thermally insulated from the supporting substrate to prevent combustion of the substrate, if the surface temperature exceeds 80 °C.

NOTE The thermal insulation may be achieved by an air gap or the use of a suitable material.

Dimensions in millimetres



Key

1 Zone I

2 Zone II

3 LPG appliances

4 Liquid fuel appliances

5 Centre of burner

NOTE 1 Measurements taken from the centre of the burner.

NOTE 2 This figure is taken from BS EN 9094.

Figure 1 — Distance measurements from burners to combustible materials

15 Commissioning

Installations should be tested at commissioning as follows.

a) Test the low pressure stage, with appliances connected or appliance connectors capped or plugged, in accordance with Annex C.

b) Connect the high pressure stage to the low pressure stage, and, with the supply turned on, check for gas tightness with a leak detector fluid.

WARNING A naked flame should not be used for this test.

c) Commission appliances in accordance with the manufacturer's recommendations.

d) Test the operating pressure at each appliance in accordance with Annex D.

e) Verify that the ventilation conforms to Annex B.

16 Soundness

The gas system should be sound when checked in accordance with the relevant section of Annex C.

17 Information and instructions for safe usage

The following information, and, should be provided for the user:

a) manufacturer's or supplier's instructions for the LPG equipment and appliances, including capacity of the LPG installation, appliance working pressures and type of LPG in use;

b) emergency procedures;

c) safe usage;

d) the locations and type of ventilation;

e) the information in Annex E.

Any gas leak detection should conform to Annex F.

Annex A (normative)
Existing installations

NOTE "Existing" installations are those installed before 15 May 1999.

A.1 General

Existing installations should conform to this standard unless recommended otherwise in this Annex.

A.2 Appliances

Existing appliances may be non-room sealed. Unflued, open flued or closed flue appliances may be found. On sea-going vessels, the warning notice recommended in the final paragraph of Clause **11** should be attached on or near to appliances.

A.3 Replacement of existing appliances

Replacements for existing appliances (except cooking appliances) should be room sealed and installed in accordance with the manufacturer's instructions and this standard.

In circumstances where it is not possible to replace an existing conventional or unflued instantaneous water heater with a room sealed appliance, one conventionally flued instantaneous water heater, type B_{11BS}, with a maximum input rate not exceeding 11.6 kW net, fitted with a combustion products discharge safety device may be installed.

In this instance, the installer should carry out and record an assessment of any risk associated with the appliance replacement. For example, it is essential that any conventionally flued appliance and/or its combustion air supply does not communicate with any room/cabin containing a bath or shower.

A.4 Refrigerators

Pilot lights and burners on LPG refrigerators installed in vessels propelled by a petrol engine should be completely enclosed.

Combustion air and combustion products should be drawn and exhausted through a suitable flame trap, or combustion air piped to the appliance from outside the vessel, or from a point inside the vessel above the level of the windows, other openings, or other means of ventilation, in the accommodation space.

Only the flue supplied or recommended by the manufacturer should be used with refrigerators flued to the outside.

A.5 Flame supervision device

Catalytic type LPG appliances or appliances with a pilot light or continuous flame designed to be left unattended with burners operating continuously, should be fitted with a flame supervision device. Catalytic type appliances should conform to BS 5258-11 or BS EN 449.

A.6 Flues and draught diverters

Flues and draught diverters should be of the type approved by the manufacturer, and properly fitted and maintained. Flues should be of suitable material, effectively insulated, and of appropriate internal diameter to ensure safe transfer of gases to outside the vessel, away from areas that could be enclosed by canopies. Appliances designed for use with a flue or draught diverter and flue should have these fitted.

NOTE Some examples of appliances designed for use with a flue are:

— multipoint instantaneous water heater;

— single point instantaneous water heater for shower or bath;

— any appliance fitted with a flue spigot.

Appliances should be tested to ensure the flue is effective, as follows.

a) Check that the flue is not obstructed by foreign matter, the flue terminal is undamaged and the appliance is operating at the correct pressure.

b) Close doors, windows and any closable ventilators, and operate any fan that could adversely affect the performance of the flue. (If there is a fan in an adjoining space, this should be operated, with connecting doors open.)

c) Operate the appliance and check that it clears the products of combustion, either in accordance with the manufacturer's recommendations, or in accordance with d)

d) If there are no manufacturer's recommendations available for testing the flue, perform a flow visualization check using a smoke producing device (e.g. smoke match, puffer or joss-stick) that produces an even trace so that the flow can be observed, as follows.

1) Check the flue performance at the draught diverter or gas fire canopy, within five minutes of lighting the appliance. All smoke, apart from the odd wisp, which may be discounted, should be drawn into the flue and removed to the outside air.

2) If smoke spillage occurs, leave the appliance operating for a further 10 min and recheck.

If an appliance fails the flue test, it should be disconnected from the gas supply.

NOTE If there is adequate ventilation provided, an appliance can fail the flue spillage test due to insufficient length of flue. In this case, a proprietary flue extension may be considered or, alternatively, a flue extraction fan with flow failure safeguards, or replacement of the appliance with a room sealed type.

A.7 Instantaneous water heater inlet

Water piped to an instantaneous water heater inlet should originate from the cold water system of the vessel.

A.8 Appliance operating pressure

Visual checks should be carried out to ensure a correct flame picture at each burner with all appliances operating at the maximum rate. If visual checks do not indicate this, the appliance operating pressure tests should be carried out in accordance with Annex D, **D.1**.

A.9 Appliance isolation valve

Appliances connected with flexible hose should be fitted with a readily accessible isolation valve.

A.10 Modifications and additions

Modifications or additions to an existing installation should be performed in accordance with the manufacturer's recommendations. Operating pressures to new appliances should be verified in accordance with Annex D, **D.2**.

A.11 Appliance test fittings

If there is no test fitting directly attached to an existing appliance, one should be fitted in the pipework, except if there is a bubble tester installed in the LPG cylinder locker.

A.12 Fire risk

Wood, curtains and other combustible materials near to appliances should be insulated or treated with a flame retardant as appropriate.

A.13 Cylinder lockers

NOTE It is permissible that existing cylinder lockers are not ventilated to outside the vessel, above the level of the cylinder.

Cylinder lockers for cylinders up to 15 kg total capacity should be provided with a drain at least 12 mm in internal diameter. Cylinder lockers for cylinders with a greater total capacity should be provided with a proportionately larger drain.

A.14 Appliance installation

Appliances should be secured so that stress on pipework and fittings is minimized, and so that they cannot overturn in case of vessel collision. Appliances should not be installed in petrol engine spaces.

A.15 Cylinder lockers and cylinder housings

Cylinder lockers and cylinder housings should be of metal of thickness at least 0.9 mm, with welded or brazed joints, or of fibre reinforced plastics (FRP) of thickness 5 mm. Cylinder lockers should have a drain to outside as near as practicable to the bottom.

C.16 Cylinder locker location

Cylinder lockers within the hull of the vessel should be located in a low risk position outside engine, fuel or battery spaces.

A.17 Engine compartments with installed diesel engines

Joints and fittings in LPG supply lines are permitted in craft with diesel engines.

NOTE **A.17** applies to existing installations up to the date of publication of this standard.

Annex B (normative)
Area of fixed ventilation

The effective area of fixed ventilation for accommodation spaces containing an LPG appliance, *V*, in square millimetres, should be calculated from the following equation:

$V = 2\,200U + 650P + 440F$

where:

U is the input rating of unflued appliances, in kilowatts;

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

F is the input rating for all open-flued appliances, in kilowatts.

Additional ventilation might be required for accommodation spaces containing appliances burning other fuels.

V should be at least 4 000 mm^2.

Ventilation should be supplied by at least two, equally sized, fixed openings in each accommodation space, with one as high as practicable and another as low as practicable. This may be achieved using ducting.

The openings should have external fittings and should be positioned so they cannot be inadvertently obstructed.

Adjustable ventilation provided by openable windows, roof lights, or hatches should not be included in calculation of *V*.

Where outside air is conveyed to an open flued or unflued appliance through an external air vent (vent no. 1) into a room and thereafter through one internal wall or partition air vent (vent no. 2), both vents should be sized according to the normal calculation method. Where there is more than one internal vent, the free area of each internal vent should be increased by at least 50 % over that required for vent no. 1.

Series ventilation systems for appliances and accommodation areas should not pass through engine spaces.

Where ventilation air is ducted to a space from an outside source, the duct free area should be maintained throughout its length, be securely fixed and accessible for inspection and should not have forms that can trap liquids.

Open flued appliances in closed compartments (cupboards) should have ventilation at both high and low level as recommended by the manufacturer. Room sealed appliances installed in cupboards should have adequate ventilation to prevent overheating.

Ventilators that have variable settings should only be included in the calculations at their lowest optional rating.

Mechanical ventilation systems should be constructed to prevent the possibility of igniting any fuel vapour in the system by the use of flame proof motors or siting the fan motor outside the ducting system.

These systems should not to be counted as part of the fixed ventilation as they can:

— be turned off;

— fail safe in the event of a problem;

— suffer from battery failure.

Annex C (normative)
Testing of low pressure stage of installation

C.1 Testing of complete installations

The complete system comprising the high pressure stage, low pressure stage and an intermediate pressure stage, when used, should be tested by the installer using the methods given in this Annex.

NOTE The test(s) may take the form of one single test on the complete installation. Alternatively, the installation pipes may be tested separately first.

The adjustment of appliances should be in accordance with the manufacture's instructions.

C.2 Purging installation pipework

Every new or rearranged installation pipe should be purged of air after satisfactorily passing the soundness test (see **C.3**) and being connected to the gas supply.

During the purging operation, gas should not be allowed to accumulate in any confined space. Steps should be taken within the vicinity of the purge point to ensure good ventilation, to prevent inadvertent operation of any electric switch or appliance and to prohibit smoking or naked lights.

C.3 Gas soundness testing of LPG service pipework, installation pipework, and appliances

Pipework should be tested as sound to ensure no discernible pressure drop. The permitted maximum leak-rates and equivalent pressure drops for typical installations given in Table C.1 should be followed.

NOTE These procedures are based on testing with a pressure gauge for pressure loss in the pipework and appliance system when under pressure with all inlets and outlets sealed. This is usually the most practical method. However alternative procedures are possible. Pipework soundness is expected to meet the "no discernible pressure drop" criterion based on the use of a "U" gauge (low pressure) or a Bourdon gauge (intermediate pressure). These procedures therefore refer to the use of these gauges but more sensitive instruments might be substituted in which case they should be in accordance with the definition of "no discernible pressure drop".

Gas appliances for practical reasons are allowed a very small leakage, which can occasionally create a discernible pressure drop when complete installations are tested particularly if the pipework and appliance internal volume is small.

NOTE A pressure drop of 0.25 mbar or less on a "U" gauge is considered not discernible. Where "no discernible pressure drop" is needed for the soundness test of pipework alone using a "U" gauge, 0.25 mbar is therefore still an acceptable pressure drop if measured by more sensitive instruments such as an electronic/digital gauge providing they are regularly re-calibrated.

Table C.1 — Permissible pressure drop for test with appliances connected and LPG supplied by cylinder(s) or bulk tank installation pipework

Volume of installation[a] m^3	Number of appliances installed	Permissible pressure drop	
		Initial test pressure	
		37 mbar	28–30 mbar
		Pressure drop in two minutes mbar	
More than 0.001	3+	2.0	2.0
	2	1.5	1.5
	1	1.0	1.0
Less than 0.001	3+	4.0	3.0
	2	3.0	2.0
	1	1.5	1.0

[a] The system volume can be calculated but, as a guide, if the system is piped in 15 mm pipe or larger and/or the appliances are distributed throughout a boat of large size, then the volume is likely to be at the top end of the range. Where the pipework is all small diameter and the appliances are installed in a compact space then the volume is likely to be low.

As a further guide, a two-metre length of 8 mm copper pipe has a volume of approximately 0.000 06 m^3, a two-metre length of 10 mm copper pipe has a volume of approximately 0.000 1 m^3 and the same length of 15 mm pipe a volume of approximately 0.000 3 m^3.

C.4 Calibration

All gauges should be calibrated in accordance with the manufacturer's instructions.

C.5 Principle

A test to ensure gas soundness should be carried out:

— before gas charging and commissioning of all newly-installed pipework, or extensions to existing pipework;

— whenever any work is carried out on an installation that might affect gas soundness;

— if a gas escape is suspected, or if there is a smell of gas;

— before re-establishing an existing gas supply.

A soundness test as given in **C.6** should be carried out for newly-installed pipework only, and comprises a test with air with appliances disconnected or isolated.

A soundness test as given in **C.7** comprises a test with LPG including appliances, and should be carried out either on an existing installation or, for newly-installed pipework, after the test given in **C.6**.

C.6 Test method for soundness testing of a new installation with appliances disconnected or isolated at the appliance isolation valve and before gas charging

C.6.1 *Preparation*

Use air as the test medium. Cap or plug all open points in the system except for the one that will be used to admit air to the system.

C.6.2 *Procedure for service and/or installation pipework to operate at 37 mbar for propane or 28 mbar for butane*

The following recommendations are applicable.

a) Ensure that gas appliances are disconnected or are positively isolated by closing their gas inlet valve. Cap or plug all open ends.

b) Connect an in-line test tee. Attach a "U" gauge to the test tee.

c) Inject air or an inert gas into the system until the "U" gauge registers 45 mbar.

d) Isolate the pressurizing source.

e) Leave for at least five minutes to allow the temperature in the system to stabilize.

f) Note the "U" gauge reading.

g) Leave for two minutes.

h) Note the "U" gauge reading. The pipework is considered sound if there is no discernible pressure drop from that of **C.6.2**f). If the pressure has fallen, examine the entire installation and check each joint with leak detection fluid to locate the source of leakage.

i) Eliminate the leak and repeat the procedure in **C.6.2**c), **C.6.2**d), **C.6.2**e), **C.6.2**f), **C.6.2**g) and **C.6.2**h) until the installation is proved sound and no discernible pressure drop is recorded.

C.6.3 *Final test stage*

Once the entire pipework system has been proved sound under air in accordance with **C.6.2**, appliances can be connected or turned on at their appliance isolation valves, the system purged of air and charged with LPG in preparation for a soundness test under LPG pressure (see **C.7**).

C.7 Test method for soundness testing with LPG

C.7.1 *General*

Before testing the entire installation for soundness with LPG, a let-by test as given in **C.7.2** should be carried out.

C.7.2 *Let-by test of the cylinder valve*

C.7.2.1 *Valve selection*

The valve to be tested for let-by should be that valve which is used to isolate the pipework from a higher upstream pressure when tested for soundness in accordance with **C.7.3**. This is to ensure that let-by will not mask any leakage from fittings downstream.

C.7.2.2 *Let-by test of entire installation*

C.7.2.2.1 *Preparation*

Ensure that all appliance isolation valves are turned off and the LPG supply is isolated at the cylinder/tank valve (or whichever valve is to be used during the soundness test). This will be referred to in this procedure as the supply control valve.

C.7.2.2.2 *Procedure*

Carry out the following stages.

a) Connect an in-line test tee in the section of pipework downstream of the supply control valve and final stage regulator. Attach a "U" gauge.

b) Gradually open the supply control valve until the regulators lock up (normally at 45 to 50 mbar for a 37 mbar regulator).

c) Close the supply control valve.

d) Open one appliance isolation valve and light a burner and note carefully the drop in pressure in the "U" gauge. When the pressure has dropped to about 5 mbar, close the appliance burner tap and its isolation valve.

NOTE 1 If there is an under pressure shut-off (UPSO) downstream of the supply control valve, this will close as the pressure falls. In this case, once the pressure has been reduced to about 5 mbar as in **C.7.2.2.2**d), operate the UPSO reset to release the trapped upstream pressure and then allow it to reshut. There may be a small sudden rise in the "U" gauge reading as the upstream pressure is released into the downstream pipework.

e) Wait for at least five minutes for temperature stabilization, and record the "U" gauge reading.

f) After a further two minutes observe the "U" gauge reading and record it. If there is no discernible pressure rise, "no let-by" can be recorded for the supply control valve.

NOTE 2 If the procedure in **C.7.2.2.2** Note 1 has been necessary, the UPSO reset will need to be operated again after the two minute period, and before recording the second "U" gauge reading.

A rise in pressure will indicate either:

— the gas temperature has risen during the test; or

— the supply control valve is letting-by.

If a gas temperature rise is suspected, repeat the test procedures given in **C.7.2.2.2**d), **C.7.2.2.2**e) and **C.7.2.2.2**f).

For cylinder installations using high pressure hoses between the cylinder valve and regulator where the cylinder valve is the only form of supply control valve, install an additional supply control valve upstream of the regulator if a rise in pressure is recorded due to hose relaxation. This valve may be either left in place once the let-by and soundness tests are completed, or removed and any joints made after the soundness test checked with leak detection fluid.

C.7.3 *Soundness test procedure for entire system using propane or butane cylinders*

C.7.3.1 *Principle*

This procedure tests the entire pipework system from cylinder outlet valve up to and including the appliances.

The procedure is suitable for all cylinder installations.

The procedure tests the system including the appliances first, but it is permissible to test the pipework only first as given in **C.7.3.3**f) and **C.7.3.3**g) if this is seen as more convenient.

C.7.3.2 *Preparation*

Carry out a let-by test on the cylinder valve(s) as given in **C.7.2.2**.

Ensure that all appliance isolation valves are open, cooker hot-plate/oven taps and all other appliance burner control taps are shut, and the LPG supply side is isolated by closing the cylinder valve(s) or tank valve.

On cookers with a fold-down lid, the lid should be raised to a fully open position during the soundness test so that any safety shut-off valves on the supply to the hot plate taps are open.

C.7.3.3 *Procedure*

Carry out the following stages.

a) Connect a "U" gauge to a permanent in-line test tee or where necessary fit a suitable test tee in the pipework for this purpose.

b) Open a cylinder valve or the tank outlet valve to re-establish the gas supply until lock up pressure is achieved. Close the cylinder or tank valve.

c) Wait for at least five minutes for temperature stabilization. For small installations the pressure may fall during this time due to allowable appliance leakage. If the pressure falls below the initial test pressure required by **C.7.3.3**d), repeat **C.7.3.3**b) and **C.7.3.3**c) but reduce the five minutes to two minutes.

d) Light a burner on one appliance and allow the pressure to drop to 37 mbar propane or 28 mbar butane and close the appliance burner control tap. Record immediately the "U" gauge reading.

The lowering of the pressure is necessary to ensure that the locked up high pressure in the system upstream of the regulator is released into the piping downstream and this high pressure section will then be included in the test.

e) Wait a further two minutes and again record the "U" gauge reading.

f) If a discernible pressure drop occurs or there is a smell of gas, isolate the appliances by closing their isolation valves and repeat **C.7.3.3**b), **C.7.3.3**c), **C.7.3.3**d), and **C.7.3.3**e). This will test just the pipework and only a no discernible pressure drop is acceptable (see **C.3** and **C.4**).

NOTE 1 For this test, the test tee needs to be in the pipework section under test.

g) If a discernible pressure drop or its equivalent leak-rate still persists or there is a smell of gas, leak-test all visible joints with leak detection fluid or a suitable gas detector and repair as necessary. Repeat steps **C.7.3.3**b), **C.7.3.3**c), **C.7.3.3**d) and **C.7.3.3**e) to prove pipework sound.

h) After proving the pipework sound, repeat steps **C.7.3.3**b), **C.7.3.3**c), **C.7.3.3**d) and **C.7.3.3**e) with appliance isolation valves open to include the appliances. A pressure drop is acceptable provided it does not exceed the values given in Table C.1 for the relevant type of installation and there is no smell of gas.

NOTE 2 Appliance standards for practical reasons permit a very small leakage, which can cause the pressure drop observed in the first test particularly if the internal volume of pipework and appliances is small.

i) If the system pressure drop exceeds that permitted, repeat steps **C.7.3.3**b), **C.7.3.3**c), **C.7.3.3**d) and **C.7.3.3**e) but with only one appliance isolation valve open and repeat for each appliance in turn to check if the cause is one particular appliance. Rectify the fault(s) if possible, or seek advice from the appliance manufacturer(s). Repeat **C.7.3.3**b), **C.7.3.3**c), **C.7.3.3**d) and **C.7.3.3**e) to prove the installation acceptable.

j) After proving the installation acceptable, release the system pressure by lighting a burner. Remove the test tee if it is a temporary fitting and reconnect the pipework. Seal off the test tee if it is a permanent fitting.

k) Re-establish the gas supply and test all joints in the high pressure section and any joints made after the soundness tests with leak detection fluid or a suitable gas detector. Rectify leaks if found.

l) Re-commission the installation.

Annex D (normative)
Testing appliance operating pressure

D.1 General

The test in this Annex should be carried out on installations after satisfactory testing in accordance with **C.7**.

NOTE 1 The test in this Annex is designed to ensure that the gas pressure at inlets for appliances is appropriate for safe and effective use.

If an appliance does not have a pressure test point, a test point should be installed adjacent to the inlet.

Check the nominal operating pressure and gas group of the appliance (this normally appears on the data plate on the appliance).

NOTE 2 The operating pressure is usually 28 mbar (sometimes 28 mbar to 30 mbar) for butane appliances, and 37 mbar (or 30 mbar to 37 mbar) for propane. Appliances installed in craft manufactured in the USA or Germany can differ.

NOTE 3 The code G30 is sometimes used for butane and G31 for propane.

Appliances with the imperial markings 110 (butane) or 140 (propane) are at least 20 years old and should be replaced.

Check the nominal outlet pressure of the regulator and ensure that it is compatible with the inlet pressure of the appliance. Regulators marked in imperial units, or more than 10 years old (check the date of manufacture on the body or union nut) should be replaced. Carry out the following tests on the appliance inlet pressure:

a) *with no gas flow ("lock up")*: Turn off all appliances and gas outlets and turn on the gas at the main supply. The "lock up" pressure should not exceed the maximum values given in Table D.2 and should not increase after a stabilization period of 60 s.
b) *with full gas flow (all appliances operating)*: With all appliances operating, check that the inlet pressure at each appliance is not below the minimum values recommended in Table D.1. A suitable test procedure is outlined in **D.2**.

D.2 Test to verify regulator and pipework sizing (e.g. after pipework modification or appliance installation)

This test should be carried out only after the system has been proved to be sound. Open fully any closed ventilators for the duration of the test.

a) Ensure that all appliances are turned off.

b) Gas supply is turned off at the main control.

c) Check the zero on a pressure gauge and connect it to the test point on the appliance furthest from the gas supply.

d) Turn on the gas supply at the main control and ignite one burner at maximum rate. Observe and record the working pressure (28 ± 5) to (30 ± 5) mbar for butane, and (37 ± 5) mbar propane in the UK).

e) Turn on and ignite all the remaining gas burners to produce the maximum gas load.

f) Observe and record the working pressure. The recorded value should not drop by more than an additional 2.5 mbar from that recorded in d).

g) Turn off all burners and main gas supply, disconnect pressure gauge from the pressure test point and reseal it. Turn on the gas supply and check the gas tightness of the pressure test point using an ammonia free leak detector.

Table D.1 — Appliance inlet pressures

Gas	Group[a]	Nominal pressure of appliance[b] mbar	Maximum pressure of appliance[c] mbar	Minimum pressure of appliance[d] mbar
Butane (G30)	Cat I_{3+} }	28	35	20
	Cat I_{3B} }	or 28–30	35	20
	Cat $I3_{B/P\ (30)}$	30	35	25
	Cat $I3_{B/P\ (50)}$	50	57.5	42.5
Propane (G31)	Cat I_{3+} }	37	45	25
	Cat I_{3P} }			
	Cat $I_{3B/P\ (30)}$	30	35	25
	Cat $I_{3B/P\ (50)}$	50	57.5	42.5

[a] Gas group is a national identifier identifying local gas pressures within the EU. Countries using the Groups $I_{3B/P}$ generally do not have separate butane and propane gas bottles and utilise instead a mixed gas in a single cylinder containing a gas blend that varies seasonally.

[b] This is the pressure normally expected with a single appliance burner operating although this can vary slightly due to manufacturing settings.

[c] Lock up pressure above these values can indicate a faulty regulator.

[d] The minimum pressure figures are the lowest pressures at which appliances are recognized to operate safely. Performance will be affected.

Table D.2 — Suitable test procedure (taken from EN 12864:2001)

Gas	Nominal pressure mbar	Lock up pressure mbar
Butane	28–30	40
Propane	37	50
Butane	50	62.5
Propane	50	62.5
LPG	29	40
LPG	50	62.5

Annex E (normative)
Information for users

E.1 Emergency procedures

E.1.1 *Leakage*

If LPG leakage is detected or suspected, the following action should be taken immediately.

a) Shut off the LPG supply at the cylinder valve(s).

b) Extinguish naked flames and other ignition sources (heaters, cooking appliances, pilot lights, cigarettes, etc.).

c) Do not operate electric switches.

d) Ventilate the area with a through draught.

e) Evacuate the area if possible.

If leakage is from a cylinder and cannot be stopped, move the cylinder to where LPG can disperse away from the vessel (and other vessels). Take care not to spill LPG while moving the cylinder.

Do not use an installation that has leaked until it has been checked by a competent person.

E.1.2 *Fire from an LPG leak*

If an LPG leak has ignited, action should be taken in accordance with a) or b) as appropriate.

a) If the vessel is moored:

1) alert everyone in the area and evacuate if possible;

2) call the fire brigade if practicable;

3) do not attempt to extinguish any flame unless it is safe to do so. Shut off the LPG supply before attempting to extinguish the flame. After shutting off the LPG supply, extinguish any free burning materials with extinguishers or water;

4) do not reuse the installation until it has been checked by a competent person.

b) If the vessel is offshore:

1) alert everyone on the vessel;

2) if it is safe to do so, shut off the gas supply;

3) extinguish any free burning materials with extinguishers or water;

4) Do not reuse the installation until it has been checked by a competent person.

E.1.3 *Fire close to an LPG cylinder*

WARNING LPG cylinders exposed to fire can explode.

If there is a fire close to an LPG cylinder, the following action should be taken.

a) Alert everyone in the area and evacuate if possible.

b) Call the fire brigade if practicable.

c) If it is safe to do so, shut off the gas supply and move the cylinder to a safe place in the open. If the cylinder cannot be moved, keep it cool with wet blankets and spraying with water.

d) Do not reuse the installation until it has been checked by a competent person.

E.2 Safe usage

E.2.1 *Changing a cylinder*

The following safe practices should be complied with when changing a cylinder.

a) Ensure that any manually operated valves on both the full and empty cylinder are turned off before changing. Replace the plastics safety cap or plug on disconnected cylinders.

b) Store, transport and use cylinders vertically with the valve uppermost.

c) Do not use a cylinder if the cylinder, valve or regulator are damaged. Return the cylinder to the supplier. Do not attempt to repair the fault.

d) Before changing a cylinder, extinguish any fire, flame or source of ignition, including cigarettes and pilot lights.

e) Joints should be firm and gas tight. If a leak is suspected after changing a cylinder and opening the valve, check the cylinder valve with an ammonia-free leak detection fluid. Do not use a naked flame for testing.

f) If a leak cannot be stopped, move the cylinder to a safe place in the open, ensuring that the leaking LPG is dispersed safely.

g) Ensure that replacement cylinders are appropriate for the installation.

h) Ensure that the regulator is appropriate for the appliances, and use in accordance with the manufacturer's recommendations.

i) Ensure that sealing washers, if required, are sound and correctly positioned prior to connecting. Mating surfaces of connections that require metal-to-metal sealing should be clean and undamaged. Do not use damaged valves or connections.

j) Use the correct size of spanner for connections, and tighten firmly. Self-sealing valves should be connected in accordance with the manufacturer's recommendations.

k) Regulators fitted with integral relief valves should be ventilated to the open, away from sources of ignition.

l) Ensure that all appliance taps are turned off before reconnecting cylinders that have been closed, or connecting replacements.

m) Light appliances without an ignition device by applying a match or taper to the burner before turning on the supply.

E.2.2 *Refuelling petrol, diesel or LPG powered vessels*

As well as taking normal precautions against spillage, smoking or naked lights when refuelling petrol, diesel or LPG powered vessels, ensure that all gas burners are turned off, and permanent pilot lights extinguished. Disable automatic ignition systems on appliances while refuelling.

E.2.3 *Appliance usage*

The following should be complied with when using appliances.

a) Operation and maintenance of appliances should be carried out in accordance with the manufacturer's recommendations.

b) Ventilate the area. Do not obstruct ventilator openings. Do not use cooking appliances to heat the area.

WARNING Non-room sealed fuel-burning appliances consume oxygen and can release combustion products into the vessel.

c) Check flexible hoses regularly. Replace if cracked or otherwise deteriorated. Ensure that the ends of replacement flexible hoses are secure and gas tight.

d) Ensure that the LPG system is regularly tested for leakage. Connections should be checked by:

1) routine observation of a bubble tester installed in the cylinder locker or housing; or

2) routine observation of a pressure gauge in the high-pressure side of the system; or

3) testing with leak detection fluid, with the appliance burners turned off and the main shut-off valve open.

WARNING If there is a leak discovered in the LPG system, close the cylinder valve and ensure that it is repaired by a competent person.

WARNING Do not use solutions containing ammonia to detect leaks.

WARNING Do not check for leaks with a naked flame.

e) Check flue pipes at least once per year and replace as appropriate.

f) Check the cylinder locker is not damaged so as to allow the escape of leaked LPG and check and the cylinder locker drain is not blocked or damaged.

NOTE For side opening cylinder lockers installed in accordance with BS EN ISO 10239, check the effectiveness of any seal.

Annex F (normative)
Gas leak detection

F.1 General

Means for detecting gas leakage may be installed.

NOTE Detection equipment may, for example, consist of a (0 to 100) mbar pressure gauge or bubble leak indicator installed in the low pressure pipework, as near as practicable to the outlet of the regulator.

Maintenance of gas leak detectors should be carried out by competent persons.

Detectors should be tested frequently whilst the vessel is in service.

F.2 Types of gas detector

Gas detectors should actuate promptly in a gas concentration in air of no greater than 0.5 % (approximately 25 % of the lower explosive limit), and should incorporate both an audible and a visible alarm (although on small vessels a portable, manually operated detector may be used). If electrical detection equipment is fitted, it is essential that it is flame-proof or intrinsically safe for the gas. If practicable, the alarm unit and indicating panel of detectors should be operable from outside the space containing the gas storage and consuming appliances.

Bibliography

Standards publications

BS 5482-3:1999*, Domestic butane- and propane-gas-burning installations — Part 3: Installations in boats, yachts and other vessels.*

BS 7786:1995*, Specification for unsintered PTFE tape — General requirements.*

BS EN 437:1994*, Test gases — Test pressures — Appliance categories.*

Other publications

[1] GREAT BRITAIN. Gas Safety (Installation and Use) Regulations 1998 (SI 2451).

[2] GREAT BRITAIN. Gas Safety (Installation and Use) Regulations (Northern Ireland) 1997 (SI 194).

[3] Approved Code of Practice (ACOP). Health and Safety Commission.

[4] *Code of Practice 18. Safe use of LPG as a propulsion fuel for boats, yachts and other craft*. Ringwood: LP Gas Association. September, 2003.

[5] IGE/UP/8. *Gas installations for caravan holiday homes, residential park homes and permanently moored boats.* Institution of Gas Engineers & Managers, 2001.

[6] Code of Practice 22. *LPG Piping system design and installation*. Ringwood: LP Gas Association. February, 1996.

blank

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL