

MRA DRAFT FOR CONSULTATION PURPOSES - NO LEGAL VALUE

MRA LPG

Code of Practice C2:2008

LPG DRIVEN MACHINERY

The safe use of LPG as a propulsion fuel for boats, yachts
and other craft

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This Code has been prepared by the Malta Resources Authority in consultation with the Malta Environment and Planning Authority (MEPA), the Malta Standards Authority (MSA), the Occupational Health and Safety Authority (OHSA), the Civil Protection Department (CPD) and Enemalta Corporation (EMC).

Before publication, the contents of this document were sent out for wide consultation to all stakeholders with an interest in the transportation, storage or use of L P Gas. Many of the comments received have been incorporated in the document.

The aforementioned Authorities believe that the contents of this Code demonstrate good practice in the L P Gas Industry and commend its use.

The MRA LPG Code of Practice C2

The Safe Use of LPG as a Propulsion fuel for boats, yachts and other craft

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Section 1: Introduction, Scope, References and Definitions

1.1 Introduction

1.1.1 This Code of Practice has been prepared by the Malta Resources Authority in consultation with the Malta Environment and Planning Authority, the Malta Standards Authority, the Malta Transport Authority, the Occupational Health and Safety Authority, the Malta Maritime Authority, the Civil Protection Department and Enemalta Corporation for the guidance of parties interested in the use of LPG as a propulsion fuel for boats, yachts and other vessels.

1.1.2 The term 'LPG' includes Butane, Propane as defined in BS 4250:1997 or mixtures thereof as defined in MSA EN 589.

1.1.3 LPG has been used as an internal combustion engine fuel for many years. This edition recognises advances in engine design, improvements in engine management systems and developments in installation practice.

LPG fuel systems are now available for all generations of spark ignition management systems. These are broadly defined as follows:-

- 1st generation: Carburettor air-gas mixing systems;
- 2nd generation: Carburettor systems with micro processor control derived from engine speed, manifold pressure and lambda sensor for optimising 3-way exhaust catalyst operation;
- 3rd generation: Multi-point liquid or vapour injection systems, but with non-adjustable self learning feedback controls.

Most LPG conversions from petrol retain the petrol fuel system as an alternative.

It should be noted that certain engines, particularly those which have been installed for some time, may not be suitable for operation on LPG due to the design or materials used in such items as fuel pumps, carburettors and valve seats.

Engine manufacturers should be consulted to ascertain the suitability of an engine for conversion.

Diesel conversions are dedicated LPG systems since diesel compression ratios are too high for LPG and require piston or cylinder head modification.

1.1.4 Statutory Regulations, particularly the Recreational Craft Regulations (L.N. 128 of 2005), the Commercial Vessels Regulations (L.N. 284 of 2002) and other legislation concerning the design and operation of boats, yachts and other vessels should be consulted.

- 1.1.5 For the use of LPG in boats other than as a propulsion fuel the installation should conform to Annex 4 of the Code of Practice issued in terms of the Commercial Vessels Regulations (LN 284 of 2002) PD 5482-3:2005 or MSA EN ISO 10239.
- 1.1.6 This Code of Practice adopts the recommendations of MSA EN, BSI, CEN and ISO for the presentation of numeric values. The thousand separator is therefore a space (e.g. one million is represented as 1 000 000) and the decimal separator a comma (e.g. one point five is represented as 1,5).

1.2 Scope

This Code covers the installation of LPG fuel containers and the design and installation of fittings, connections and controls, to provide LPG as a fuel, wholly or as an alternative, for the propulsion of the craft.

This Code also covers the filling, commissioning, operation and maintenance of the LPG equipment, re-filling procedures and fuelling facilities.

1.3 References

This Code of Practice incorporates by dated or undated reference, provisions from other Codes of Practice. These references are cited at the appropriate places in the text and the publications are listed in Appendix C. For dated references, subsequent amendments to or revisions of any of their publications apply to this Code of Practice only when incorporated in it by amendment or revision.

1.4 Definitions

For the purpose of this Code the following definitions apply:-

- 1.4.1 **Competent Person:** A person with knowledge, training and ability to carry out their work safely and with the necessary proficiency to ensure the subsequent safe operation of the vessel.
- 1.4.2 **Component:** Any equipment through which LPG or other fuel flows and is added as part of the vessel conversion.
- 1.4.3 **Contents Gauge:** A gauge which gives visual indication of the liquid contents in the fuel container.
- 1.4.4 **Fixed Maximum Liquid Level Indicator:** A gauge which indicates the maximum permitted liquid level in the fuel tank. It comprises a tube arranged with its open

end located at the maximum permitted liquid level, so that gaseous discharge changes to a visible liquid discharge as the liquid surface reaches the level during filling.

- 1.4.5 **Hydrostatic Relief Valve:** A valve whose purpose is to relieve and prevent over pressure due to thermal expansion in any pipework carrying LPG in the liquid state.
- 1.4.6 **Stop Fill Valve:** A double check level device, which prevents the over filling of a fuel tank beyond a pre-determined liquid level (usually 80%).
- 1.4.7 **Lock-off Valve:** A term used to describe a shut-off valve in the fuel feed line which will automatically shut-off the fuel feed to the engine under specified conditions relating to vessel operation and safety.
- 1.4.8 **Lambda (λ):** The ratio of air supplied to an engine to the stoichiometric air required. At stoichiometric $\lambda = 1$; lean burn $\lambda > 1$.
- 1.4.9 **Multiple Valve:** A manifold block which requires only a single nozzle opening in the fuel tank which incorporates all or some of the following fittings: 80% stop-fill valve, level indicator, pressure relief valve, service valve with excess-flow valve, and fuel pump.
- 1.4.10 **Gas-Tight Housing:** A cover mounted over fuel tank fittings to protect them and to prevent gas leakage entering the interior of a vessel, and to vent any such leakage to the open air.
- 1.4.11 **Non-Return Valve:** A device to permit flow in one direction and prevent the flow in the opposite direction.
- 1.4.12 **Check Valve (device):** Another term for a non-return valve.
- 1.4.13 **Fill-Connector:** The self-sealing fitting at the fuel tank or at the terminal of the fill pipe extension designed to accept the self-sealing coupling of the refuelling facility.
- 1.4.14 **Design Pressure:** In this Code, design pressure is the pressure for design purposes in MSA EN 13322-1:2003 or equivalent European standards. Care is necessary in using other pressure vessel standards as design is sometimes based on the test pressure which may not be the same.
- 1.4.15 **Excess flow valve:** A device which automatically and instantaneously reduces to a minimum the flow of gas through the valve when the flow rate exceeds a set value.
- 1.4.16 **Gas container:** A cylinder or a fixed tank containing LPG.

- 1.4.17 **Cylinder:** A portable and refillable vessel of approved design containing LPG under pressure.
- 1.4.18 **Accessible:** Capable of being reached for inspection, removal or maintenance without removal of a permanent part of the craft structure, with or without the use of tools.
- 1.4.19 **Readily Accessible:** Capable of being reached quickly and safely for effective use under emergency conditions without the use of tools

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Section 2: LPG Fuel Containers

2.1 Design

- 2.1.1 Fuel containers should be designed and constructed in accordance with ECE Regulation 67-01, MSA EN 1442:2006, MSA EN 13322-1:2003 or other equivalent recognised Pressure Vessel Standard.
- 2.1.2 Fuel containers should have a design pressure of not less than 26 bar gauge, and preferably be constructed of steel. Other materials are not precluded where equivalent standards of physical, thermal and chemical integrity have been demonstrated.
- 2.1.3 Means should be provided for attaching the fuel container securely to the craft. This provision may take the form of cradles, metal straps, or bonds, attached to the craft.
- 2.1.4 Where necessary the exterior of the fuel container should be protected from corrosion in the marine environment either by choice of materials of construction or an adequate surface treatment system.

2.2 Marking

- 2.2.1 Each fuel container should be conspicuously and permanently marked with its design/test pressure and other data required by the pressure vessel standard.
- 2.2.2 The information should include at least the following:-
- (a) the specification or code to which the fuel container is manufactured;
 - (b) the manufacturer's name or identification mark;
 - (c) the fuel container serial number;
 - (d) the nominal water capacity in litres;
 - (e) the design/test pressure in bar gauge;
 - (f) the year and month of manufacture;
 - (g) the date of the hydraulic test,
- 2.2.3 These marks should be not less than 6 mm in height unless the design standard indicates otherwise.
- 2.2.4 Fuel containers, other than exchangeable vapour offtake cylinders, should be clearly and permanently marked to indicate the correct orientation to ensure the correct operation of the valves and contents gauge.

2.3 Location of Fuel Container(s)

2.3.1 Stowage of exchangeable vapour offtake cylinders

2.3.1.1 General

Liquefied petroleum gas cylinders should be stowed either on the open deck in the open air or in a locker or compartment within the vessel which is vented at low level and high level, so that any leakage of gas can disperse rapidly and be prevented from entering the hull interior.

Lockers or housings should not be used for the storage of any equipment other than LPG cylinders, and associated control equipment and kept clear of extraneous materials. Unconnected reserve or empty cylinders should be stowed similarly to those in service. Cylinder valves should be kept closed when the engine is not in use and when cylinders are regarded as empty.

Cylinders should never be stowed below the deepest loaded water line.

Cylinders should not be mounted outside the plan view of the hull.

Stowage on deck

The siting of the stowage area should be such that:-

- (a) the possibility of cylinders sustaining mechanical damage is reduced to the minimum;
- (b) neither the cylinders nor the compartment form an obstruction;
- (c) the area is at least 1 m away from hatches, other openings or possible sources of ignition;
- (d) the cylinders are secured in the correctly orientated position;
- (e) the cylinders are easily accessible and readily removable in an emergency.

2.3.1.2 Stowage within a vessel

Stowage within a vessel means any location within the hull of the vessel including the cockpit of launches or recesses in decks as well as below decks or within the superstructure of larger vessels.

In all cases cylinders should be stowed in a separate locker or housing.

LPG cylinders should not be stowed in accommodation spaces.

Design, Construction and Use of Cylinder Lockers and housings

Cylinder lockers and housings should be designed and constructed so as to:

- (a) minimise the risk of gas entering the hull;
- (b) facilitate the exchange of cylinders;
- (c) maintain cylinders in a secure, correctly orientated position;
- (d) provide ventilation at low and high level to outside the hull or superstructure. The low level ventilation should be from bottom of the locker or housing and fall continuously to a point outside the hull or superstructure above the deepest loaded water line. Drainage/vent pipes should be of not less than 19mm internal diameter for containers having a combined capacity of up to 15 kg but they should be enlarged pro rata where additional gas is carried. The opening should be remote from the engine exhaust system and at least 250 mm from it. The opening should, by position or other means, be protected from blockage, both from within the locker or housing and from the outside of the hull or superstructure;
- (e) provide access to connections or regulating devices;
- (f) provide fire protection by the use of materials having a 30 minute fire resistance (BS 476-20:1987) in the construction;
- (g) be vapour tight to the hull interior and only openable from the top unless a deck locker which may be openable from the side;
- (h) discourage the use of the locker for storing flammable liquids, any potentially flammable material (e.g. paper, cloth), or equipment which might damage the gas container;
- (i) Provide for gas connection to the fixed pipework by means of a suitable bulkhead connection.

2.3.2 *Stowage of fuel containers other than exchangeable vapour offtake cylinders*

2.3.2.1 General

Fuel containers, other than those sited in the open air, should have their valves, fittings and extensions to the outside enclosed in a gas tight housing attached to the tank. This housing should be vapour tight to the interior of the vessel, but vented to the outside of the vessel, e.g. by a vent tube. The vent tube should have a free ventilation cross sectional area not less than 450 mm² should fall continuously to a point outside the hull or superstructure and should terminate at a position at least 250 mm from the exhaust system and in a position above the deepest loaded waterline where it is not likely to be blocked.

Readily ignitable material (e.g. cloth, paper, flammable liquids) should not be placed in areas used to accommodate the container, and the fittings immediately associated with it.

Fuel containers should be securely attached to the vessel structure so that they are unlikely to be displaced or come loose when subjected to the loads which may be experienced on the particular type or vessel.

The fuel containers should be secured in the correctly orientated position.

2.3.2.2 Stowage in the open air

The siting of the containers should be such that:-

- (a) the possibility of fuel containers sustaining mechanical damage is reduced to the minimum;
- (b) the fuel containers do not form an obstruction.

2.3.2.3 Stowage within a vessel

Stowage within a vessel means any location within the hull of the vessel including the cockpit of launches or recesses in decks as well as below decks or within the superstructure of larger vessels.

In all cases gas containers should be stowed in a locker or housing. Gas containers should not be installed in accommodation spaces.

2.3.2.4 Design, Construction and Use of Container Lockers and Housings

Container lockers and housings should be designed and constructed so as to:

- (a) minimise the risk of gas entering the vessel interior;
- (b) provide water drainage to outside the hull;
- (c) provide access to connections or regulating devices;
- (d) provide fire protection by the use of materials having a 30minute fire resistance (BS 476-20:1987) in the construction;
- (e) provide for gas connection to the fixed pipework by means of a suitable bulkhead connection.

Section 3: Fixed fuel tank fittings and connections

3.1 General

- 3.1.1 All fittings should be constructed for LPG service and suitable for operation at the pressure not less than the working pressure of the fuel tank concerned.
- 3.1.2 All connections and fittings should, by position or other means, be protected against physical damage, weather and tampering where possible. Manually operated valves should be readily accessible.
- 3.1.3 All fittings should be designed or protected to prevent seawater and the marine environment, causing corrosion.

3.2 Connections

- 3.2.1 All connections to fuel tanks greater than 3 mm diameter for liquid and 8 mm for vapour, with the exception of those for relief valves, and contents gauges, should be provided with an appropriate self closing device e.g. an excess flow valve, or Non return valve, to prevent escape of product in the event of damage to the connections.
- 3.2.2 All liquid and vapour connections to and from fuel tanks with the exception of those for relief valves, plugged openings, and those where blind connections through the fuel tank shell are not greater than 1,5 mm diameter, should have shut off valves located as close to the fuel tank as practicable. For filling connections this requirement is met by 3.3.1 (a).
- 3.2.3 Manually operated fuel supply valves should be clearly marked with the direction of rotation to close.
- 3.2.4 The position of manual fuel shut off valves, if not visible from the outside of the craft, should be indicated by a suitable notice clearly visible from outside the craft.

3.3 Fittings

Fittings and components subject to fuel tank pressure should be proven suitable for contact with vapour and liquid phase LPG and designed for a pressure not less than the fuel tank design pressure. They may be separately mounted on the fuel tank or they may be in the form of a multiple valve system incorporating some or all of the fittings in a single fuel tank entry/exit.

3.3.1 *Fuel tank Fill Valves and Fill Connector*

- (a) The fill valve on the fuel tanks should incorporate a double check valve to prevent reverse flow and an automatic stop fill shut-off device fitted directly to each fuel tank. The automatic stop fill shut-off device should be designed to limit the maximum quantity of LPG to 80% of each fuel tank capacity, and should meet the requirements of ECE Regulation 67 or equivalent.
- (b) Where fuel tanks are located inside a craft an extended fill line to the outside of the craft, or to a position where the construction of the vessel permits natural drainage, should be provided terminating with a further check-valve and refilling connection. This should be protected to prevent ingress of dirt or water. The fill connector should be securely fixed to the vessel structure. Types fitted to a flexible hose which require lifting out of the vessel should not be used.
- (c) The fill connector should be located so as to be readily accessible for a filler nozzle, be external to the hull and superstructure and suitably protected by position or other means against external damage. It should not be positioned within or vertically above a 400 mm horizontal radius of any ventilation opening, except when the craft's coaming, superstructure or hull creates a barrier to prevent vapour entering the craft.
- (d) The fill-connector should be compatible with the mating coupling of the refuelling facilities. The need for adapters should be discouraged.

The fill Connector or housing should be clearly marked to indicate LPG.

The fill Connect should be securely fixed to the vessel structure. Types fitted to a flexible hose which require lifting out of the vessel should not be used.

- (e) The essential design requirements of the fill-connector and its mating coupling are:
 - i. there should be no leakage to atmosphere during the filling operation;
 - ii. the design operating pressure should be not less than the fuel tank design pressure;
 - iii. automatic self-sealing should occur immediately the refuelling coupling is disconnected;
 - iv. there should be no significant LPG release from the connector as the mating coupling is disconnected;
 - v. the seals used should provide long-term resistance to liquid phase LPG to MSA EN 549:1995 or equivalent;
 - vi. adequate endurance in operation should be proven, preferably by testing, to suit the predicted operation of the vessel;
 - vii. the connector should be provided with a protective cover which is vented by an aperture not greater than 1,5mm in diameter and which is secured to the vessel by a chain, strap or other means.

3.3.2 Fuel Feed Valves

The fuel feed outlet from each fuel tank should include: -

- (a) a suitably sized excess flow valve mounted directly to the fuel tank;
- (b) an electrically controlled solenoid valve which closes on de-energising and closes automatically when the ignition control is in the off position and also whenever the engine is not running;
- (c) a device to relieve thermal over pressure in the fuel feed pipework due to lock-up when the solenoid valve is closed, the valve for single fuel tank installations may be designed to permit reverse flow back to the fuel tank. If the valve does not permit this a hydrostatic relief valve will need to be incorporated which may relieve back to the fuel tank, where the volume of gas which is locked up exceeds 200 ml. See 4.6.

For inter-connected multi-fuel tanks reverse flow solenoid valves may not be suitable unless other means are provided to ensure that overfilling of any fuel tank from the others is prevented. See 3.4.

Note: The excess flow and solenoid valves may be integrated.

3.3.3 Safety Relief Valve

- (a) Each fuel tank should always be fitted with a spring-loaded safety relief valve mounted directly in the vapour space of the fuel tank.
- (b) Safety relief valves should be designed to start discharge and attain full flow at pressures in accordance with the design code of the fuel tank to which they are fitted with full allowance for the effect of extended discharge pipework. Reference should be made to MRA LPG Code of Practice D2 or ECE 67 01. This requires relief valves to be marked with specified information which includes the set pressure.
- (c) The discharge from safety relief valves should be vented to the outside of the vessel and as far as practicable from possible sources of ignition. It should, in no case be positioned within, or vertically, above a 400 mm horizontal radius of any ventilation opening, except when the craft's coaming, superstructure or hull creates a barrier to prevent vapour entering the craft. The outlet should be positioned in such a manner as to prevent impingement of escaping gas on any fuel tanks, and in any case of externally mounted fuel containers directed downwards, and in such a way as to prevent ingress of water. A captive raincap or other captive protector should be used to keep water and dirt from collecting in the vent pipe but which should not prevent free discharge when venting.
- (d) Piping or ductwork used to convey the escaping gas from the safety relief valve should be of a material suitable for use with LPG, and should not reduce its maximum flow to less than that required by 3.3.3 (b) Elbows and

bends can have a severe effect on flow. The minimum size of discharge line should not be less than 19 mm.

Such a discharge line should be able to withstand the pressure resulting from the discharge of vapour when the safety relief valve is in the fully open position. It should be of sufficient mechanical strength and adequately protected against physical damage or leaks.

The piping or duct work connection to the relief valves should be mechanically secured and should not rely on adhesives etc. for retention.

Piping or duct work used to convey escaping gas should have a continuous fall from the safety relief valve to outside the craft above the deepest loaded waterline.

3.3.4 *Contents Gauge (Optional Fitting)*

- (a) Direct reading magnetic type float gauges are recommended.
- (b) Contents gauges should clearly indicate "FULL" at 80% of total capacity.
- (c) The sensing device of any indicator operated by an electrical system that may be exposed to LPG vapour should be of an approved construction for use in flammable atmospheres.
- (d) All wiring connections within the fuel tank valve box should be adequately fixed and protected.
- (e) A remote reading fuel gauge should be provided for dashboard mounting.

3.4 Multiple LPG Tanks

A single refuelling connection is normal for multiple LPG tanks, and the fuel feed outlets are manifolded to a single feed pipe to the engine. Appropriate check valves should be fitted at each fuel tank connection to prevent inadvertent flow between fuel tanks.

Section 4: Pipework

4.1 Materials and Construction

4.1.1 Materials used should be suitable for use in a marine environment and capable of withstanding such vibration as may be experienced by the type of vessel.

4.1.2 LPG pipework operating with vapour above 1 bar pressure or liquid should be effectively protected against external corrosion throughout their exposed length. Except for special grades of normalised stainless steel this protection may be in the form of close wrapping or a surface coating to exclude moisture, unless the material is corrosion resistant under the conditions it is likely to encounter in service, e.g. salt spray.

Rigid lines should be of stainless steel to BS 6362:1990, ISO 7598:1988 or equivalent, or copper or copper alloy to DIN 1787 or 17671 or equivalent.

Note: Copper lines may not be suitable in environments where there is significant engine vibration or loading due to vessel movement.

Flexible connections should be to BS 4089:1999, ISO 8789 or equivalent. Hose to BS 3212:1991 is not appropriate for this application.

4.1.3 LPG pipework operating with vapour below 1 bar pressure may be of a rigid or flexible material suitable for use with LPG and capable of sustaining five times the maximum pressure likely to be encountered in service.

4.2 Joints and Connections

4.2.1 Every joint or connective fitting should be of metal and of a type suitable for service with LPG at the operating pressure. This does not preclude the use of suitable non metallic seals within the fitting, complying with MSA EN 549:1995. Jointing compound for screw threads where appropriate should be suitable for use with LPG and comply with MSA EN 751-2:1997 or MSA EN 751-1:1997.

4.2.2 Brazed or silver solder joints may be used to secure suitable fittings to the pipe. Silver solder may be integral with the fittings or fed into the fitting during the installation. The solder should have a melting point of not less than 450°C.

4.2.3 The number of joints and connections should be the minimum for the inclusion of essential components. Joints and connectors should be readily accessible.

4.2.4 Joints or connections in LPG liquid pipelines should be in accessible positions and should be of a type not relying solely upon interfacial friction between the pipe and any sleeve, ferrule or jointing ring.

- 4.2.5 Joint fittings and connections should be compatible with one another and their mating materials should not create electrolytic corrosion.

4.3 Sizing of Pipework

- 4.3.1 The bore of LPG liquid pipework should be as small as possible to avoid undue rigidity and sufficiently large to provide for maximum engine fuel demand.
- 4.3.2 It should be recognised that an excess flow valve incorporated into an LPG service valve will not protect the pipe in every eventuality, and it is therefore emphasised that the liquid pipeline should be as small a bore as is practicable whilst meeting the maximum fuel requirement of the engine. In the event of a liquid feed pipe fracture, the engine will stop from a lack of fuel, and the electric valve at each fuel tank will, therefore, be de-energised to provide complete shut off.

4.4 Pipework location

- 4.4.1 LPG pipework should be kept as short as practicable and contain the minimum number of joints or connections.
- 4.4.2 LPG pipework should be protected from accidental damage, and as high as practicable.
- 4.4.3 Where it is necessary for high pressure pipework to be located within spaces other than engine spaces in the hull or superstructure any joints or connections should be enclosed in a vapour-tight sleeve and vented to the outside of the hull or superstructure. (3.3.3(d) gives guidance on venting).
- 4.4.4 Pipework should be remote from the engine exhaust system and nowhere closer than 250 mm to it.
- Pipework should be at least 100 mm from components of the engine exhaust system. Metallic LPG lines should be at least 100 mm from exposed terminals of electrical devices or accessories.
- Where this is not practicable, the pipework should be shielded from the engine exhaust system by a suitable heat shield.
- 4.4.5 Pipework should be effectively secured at intervals of not more than 600 mm.
- 4.4.6 Where pipework passes through bulkheads and partitions it should be protected by suitable grommets.
- 4.4.7 Piping and hoses passing through bulkheads intended to maintain watertight integrity in the craft at the level of penetration should be sealed by suitable materials or fittings at the point of penetration.

- 4.4.8 Flexible pipework should not be fitted within the accommodation space unless the fuel container incorporates an electrically operated, normally closed, shut off valve designed to shut off the fuel supply when there is no demand from the engine or under the control of an automatic safety control system.

Flexible hoses should not be routed through bilges.

4.5 Flexibility

Pipework should be installed so as to take up safely the relative movement between the structure and the fuel system components and secured in such a manner so as to prevent wear or vibration induced hardening or cracking taking place. All runs of rigid pipework between components should be installed with gentle curves, U bends or loops to provide flexibility.

4.6 Pipework Over Pressure Protection

- 4.6.1 Every section of LPG liquid pipework between positive shut-off or lock-off valves should be protected against resultant damage from over pressure due to liquid thermal expansion.
- 4.6.2 Hydrostatic relief valves, where fitted, should be vented away from the vessel exhaust or people, to open air (3.3.3(d) gives guidance on venting).

Section 5: LPG Control Equipment

5.1 General

The control equipment comprises components which are necessary to supply the LPG in a state, either vapour or liquid, and at the pressure required by the engine design and the fuel management system and to ensure safe and efficient operation under all foreseeable modes of vessel operation and use. Where an alternative fuel system is installed (bi-fuel), neither should impair the safety nor efficiency of the other.

5.2 Fuel supply safety system

Unless the LPG container, its associated pipework and fittings and the engine(s) are all installed in a way which makes it impossible for any leakage of gas to escape into the vessel, a safety system capable of closing the fuel supply at the outlet of the gas container should be fitted.

In the event of gas leakage and when the engine is cold such a system should prevent the engine ignition system being energised, prevent the flow of fuel from the gas container, start ventilation blowers and sound an alarm. When the vessel is under way it may be appropriate to allow the fuel supply to remain open and the engine to remain in operation to prevent a hazard to other shipping.

Such a system normally consists of gas sensors, ventilation blowers, electrically operated fuel shut off valves, audible alarms and their associated controls and circuitry as described in 5.2.1 to 5.2.4.

Systems should incorporate a self test regime to prevent the fuel supply opening if there is a system fault and be designed to fail to safety.

5.2.1 Gas sensors

Gas sensors should be of flameproof or intrinsically safe design and suitable for use in a marine environment. They should be fitted at a low level in the engine compartment of inboard engined vessels, gas container compartments and in accommodation spaces. They should be protected from damp and bilge and other water ingress.

They should be capable of detecting all hydrocarbon fuel gases and LPG at not more than 25 % of the lower explosive limit.

They should be checked for correct operation at intervals not exceeding 12 months.

5.2.2 *Ventilation blowers*

All compartments containing engines should be fitted with ventilation blowers.

The blowers should extract air from the lowest part of the compartment and vent it outside the hull.

Ventilation blowers should be capable of extracting not less than 3m³/min of air and be ignition protected to MSA EN 28846:1993 (Marine).

- MSA EN ISO 9097 gives further details on electric fans for small craft.

5.2.3 *Audible alarms*

It should not be possible to override any alarm other than by turning off the electrical supply to the engine and fuel system.

5.2.4 *Control system and wiring*

Control systems and wiring should be suitable for the marine environment.

Electrical connections, switches and junction boxes should be waterproof (IP65 or equivalent).

Electrical control boxes, which contain active circuitry, should be fully protected against water ingress (e.g. epoxy potted).

5.3 **Components for all Engines**

5.3.1 *Installation*

The LPG control equipment should be:-

- (a) installed in accordance with the supplier's instructions;
- (b) installed in positions that are accessible for routine inspection, maintenance and adjustment;
- (c) securely mounted and protected as far as practicable by location from accidental damage;
- (d) as remote as possible from any engine exhaust system which is not water cooled or be protected by a heat shield.

5.3.2 *Fuel Supplier Filters*

Systems in which components are susceptible to mal-function or damage from solid particulate matter may need a filter of suitable mesh in the fuel supply or such other device which will protect these components. Some components have integral filters or devices.

5.3.3 Lock-off valve

- (a) Immediately after any filter and upstream of any pressure reducing regulators an efficient lock-off valve should be installed.
- (b) The lock-off valve should be designed for automatic closure whenever there is no fuel demand from the engine.
- (c) The lock-off valve should be capable of automatically opening to relieve excess hydrostatic pressure generated on the engine side of the valve.

5.3.4 Engine Automatic Safety Controls

- (a) Safety control systems should be initiated by at least two means, either of which should cut off the LPG supply to the engine, and at least one of which should operate if the engine stops for any reason.

Various methods can be adopted to meet these requirements. The following are examples:

- i. a pressure regulator designed to give total closure on zero engine manifold depression;
 - ii. a manifold pressure sensitive switch, normally open at zero depression, connected in series with the electric supply to the lock-off valve;
 - iii. an oil pressure sensitive switch open for zero oil pressure, connected in series with the electric supply to the lock-off valve;
 - iv. an ignition coil triggered switch in the electric supply to the lock-off valve which is open when the coil is de-energised.
- (b) Electrical switches controlling the lock-off valve should be connected in series with the electrical supply to the solenoid shut-off valves at the fuel container(s) required by 3.3.2(b) to provide simultaneous shut-off.
 - (c) Electrical switches or mechanical means used to bypass a device as defined in (a) above to facilitate engine starting or tuning should require continuous pressure to operate and should automatically return to the off position.

5.4 Components for Non-fuel Injection Engines

5.4.1 Vaporisers

Vaporisers for engines normally utilise heat from the engine coolant system.

- (a) Where water circulation is employed:
 - i. a continuous flow of water should be ensured which is not subject to interruption by operation of the vessel heater controls;

- ii. the design of the water jacket of the vaporiser should take into account the possibility of internal expansion resulting from water freezing and should be resistant to antifreeze;
 - iii. where seawater is used the vaporiser should be resistant to the action of salt water.
- (b) The use of exhaust gas/ LPG heat exchangers is not recommended.
 - (c) Every vaporiser should be constructed of materials suitable for use with LPG and be capable of withstanding the maximum pressure likely to be encountered in service.

5.4.2 Pressure Regulators

- (a) LPG systems have one or two stages of pressure reduction. The pressure regulators and the vaporiser may be separate units but frequently are combined into a single unit referred to as a converter.
- (b) The first stage regulator should reduce the pressure to a value appropriate to the second stage regulator inlet pressure.
- (c) The second stage regulator should be designed to give the pressure required at the carburettor, gas-air mixer or injectors.
- (d) Every pressure regulator should be constructed of materials suitable for use with LPG and capable of withstanding the maximum pressure likely to be encountered in service.

5.4.3 Carburettors and Adapters

The carburettor or adapter is a gas/air mixing device in which the gas and air are metered in the correct proportions for combustion. The choice of carburation depends on the engine layout and application:-

- (a) LPG fuel only - applies where complete conversion to LPG is effected, and a purpose designed LPG carburettor may be employed;
- (b) LPG or petrol fuel - applies on an engine which may be supplied with an alternative fuel, normally petrol, the engine operating wholly on one or other fuel according to choice.

Note: LPG fuel only operation is preferred. If capability to use petrol has to be maintained, special attention should be paid to carburettors and mechanical fuel pumps due to the possibility of damage during periods of running dry whilst the engine is operating on LPG.

5.5 Components for Vapour Phase Fuel Injection

5.5.1 Vaporiser

The fuel is changed to a vapour by the use of water heat and then is transferred under pressure to a distribution valve that feeds the vapour to the injectors. The essential requirements are the same as for a non-fuel injection system. See 5.4.1.

5.5.2 Distributor

The distributor should be designed to provide the fuel to the injectors at the right time and quantity and linked into the electronic control system via the Lambda sensor.

5.5.3 Safety

The unit should be designed to fail safe in any condition and be triggered electronically.

5.6 Components for Liquid Phase Fuel Injection

5.6.1 Fuel Feed System

The essential difference between the fuel feed system for a liquid fuel injection system and a non-fuel injection engine (carburettor) or a vapour injection engine is the absence of a vaporiser.

5.6.2 Fuel Feed Pump

A pump is required to raise the fuel pressure, which will otherwise be at the vapour pressure of the liquid in the fuel container, to a sufficiently high pressure to ensure it remains liquid throughout the fuel system allowing for heat gain in the vicinity of the engine when running and to avoid hot restart problems due to heat soak after shut down, or at switch-over, if it is a system capable of operating on both LPG and petrol.

- (a) Pump external to the fuel container. Feed from the bottom of the fuel container or from the top via a dip tube. In either case the suction line should be generous in diameter and as short as possible to avoid pump damage from cavitation.
- (b) Submerged pump in the fuel container. This avoids the likelihood of cavitation.

5.6.3 Pressure Control

To provide a constant feed pressure to the injectors, a pressure controller is normally provided. This may form part of the management system of the engine or the conversion equipment.

Section 6: Commissioning, Maintenance and Inspection

6.1 Installation and Commissioning

6.1.1 General

Installation and commissioning of the fuel supply system should only be carried out by competent persons adequately trained in LPG installation work on engines and who are conversant with the properties of LPG.

6.1.2 Leak Test

- (a) Except as described in (b) the complete system, including the fuel container(s) and all joints, should be leak tested with air or inert gas at a pressure not less than 6 bar gauge, but not more than 90% of the fuel container design pressure for a minimum period of 10 minutes. A proprietary leak detection fluid, or other method of at least equal sensitivity, should be used.
- (b) If the fuel container(s) and fittings are tested independently of the remainder of the system, and charged with LPG as 6.1.3, the remainder of the system should be tested separately as (a) before connection to the fuel container(s) and the final connection(s) then leak tested at the available fuel container pressure.

6.1.3 Charging the Fuel tank and System with LPG

Subject to the elimination of all leaks as 6.1.2, the fuel container(s) may be charged with LPG.

6.1.4 Testing the Fuel System

Once LPG has been introduced, a final leak test should be carried out on any joints not previously tested under LPG pressure. (see 6.1.2)

Testing of controls under static conditions may be undertaken at this stage.

6.1.5 Test under way

Following engine tuning, the vessels should be given a thorough test under way for satisfactory performance. Vessels capable of operating on LPG and petrol should be subjected to fuel change over tests to ensure smooth transition.

6.1.6 Final Certificate and Documentation

A competent person responsible for ensuring compliance with the Code of Practice and relevant Statutory Regulations should, upon satisfactory completion

of all tuning and tests, issue a signed certificate of conformity for the purchaser. See Appendix B for suggested format.

6.2 Operation Manual

6.2.1 Technical Specifications

The manual should contain at least the following information:

- (a) description of the system;
- (b) limits imposed by ambient influences, e.g. fuel mix;
- (c) information about initial running in and/or adjustment of the system when needed.

6.2.2 Safety Instructions

The manual should give:

- (a) instructions for safe use of the system;
- (b) a warning of possible dangers due to misuse or when the manual or procedures are not observed;
- (c) actions to be taken when the user detects a gas smell or gas leakage;
- (d) any adverse effects due to temperature or humidity (e.g. if there is a risk of starting problems due to vaporisation in liquid feed pipes when the vessel is moved during very hot weather).

6.2.3 LPG System Description

6.2.3.1 Filling of the LPG system

The manual should indicate the sequence of operations needed to fill the LPG tank.

Particular attention should be paid to the maximum filling level of 80% of the total volume of the tank installed in the vehicle.

The manual should indicate that in case of a malfunction of the automatic 80% filling system the user should stop filling manually at the 80% value that can be indicated by the LPG system installer when the total tank volume is known.

6.2.3.2 Switchover Procedure

The manual should clearly describe the method of switching over from one fuel to the other by giving the sequence of operations.

6.2.3.3 Opening/Closing of manual valves

The manual should indicate the proper procedure to operate any manual valves. This is particularly important when maintenance of the LPG system has to take place.

6.2.3.4 Level Indicator

The manual should state the location of the level indicator, for example at the dashboard or at the tank. The read-out should be explained, giving particular attention to the 80% filling level.

6.2.4 *Maintenance and Inspection*

The Service Manual for LPG fuelled craft should specify regular service requirements for the LPG fuel system, safety control system and any additional checks for bi-fuelled vessels.

Every service shall include a check of the condition of all valves and connections for corrosion, damage or leakage, and connected or replaced as necessary.

Flexible pipework should be replaced at intervals not exceeding 5 years.

Fuel tank(s)

- (a) Examinations and tests should be carried out by a competent person.
- (b) Every year an external visual examination should be made of the fuel tank(s) and its fittings, including the pressure relief valve, for signs of deterioration, corrosion or leakage. This may require removal of the tank(s).
- (c) Every 15 years the fuel tank(s) should be re-qualified and marked with the date.
- (d) The accuracy of the 80% stop fill valve should be verified whenever the fuel tank is emptied by using a re-fuelling meter.

6.2.5 *Defects and Repair*

The manual should indicate what to do in the case of a defect and of repair of faulty components in the LPG system.

When the LPG system is equipped with a diagnosis system the manual should describe this system and indicate what actions need to be taken.

6.2.6 *Scrapping*

The manual should indicate that:

- LPG fuel tanks should be removed from a vessel before it is sent to be scrapped;
- Tanks should be handled with care and stored in accordance with MRA LPG Code of Practice B1 "Storage of Full and Empty LPG Cylinders and Cartridges";
- Tanks to be scrapped should be destroyed in accordance with MSA EN 1803:2002 or MSA EN ISO 12816 , and in a manner rendering them unserviceable for holding gas.

6.3 Storage, Repair and Maintenance

Craft fuelled with LPG may be parked, serviced and repaired inside workshops provided that the following conditions are observed:

- (a) Only trained and competent personnel on the use of LPG as a fuel for boats should be allowed to work on the engine's LPG fuel system;
- (b) There should be no leaks in the fuel system and the fuel tanks should not be filled beyond the 80% maximum level;
- (c) Craft should not be positioned within 3 m of sources of heat, open flames or other sources of ignition;
- (d) Unless the fuel is required for engine operation, LPG fuelled craft being repaired in workshops should have the fuel container(s) shut-off valve closed and the LPG fuel in the service line exhausted by running the engine or, if this is not possible, by disconnecting, in the open air, in a manner in which the LPG cannot accumulate either locally or in bilges.

6.4 Hotwork

Craft undergoing repairs involving welding or the application of heat, to any part within 1m of the fuel container, should have the fuel lines emptied as 6.3(a) and the fuel container removed or shielded from the source of heat.

No hotwork, e.g. welding, cutting or bending should be carried out on craft unless the risk of affecting the L.P.G. fuel container or system has been eliminated.

Section 7: LPG Re-fuelling Facilities

7.1 General

Refuelling facilities should be in accordance with MRA LPG Code of Practice C3 the craft being regarded as a motor vehicle. The re-fuelling facility should be licenced to operate according to LN249/2008.

A vessel can be re-fuelled through a bowser only following a site specific risk assessment under an authorisation issued from all the competent Authorities.

7.2 Position

7.2.1 Consideration should be given to the position of the dispenser unit relative to the waterway to minimise access to other craft whilst filling is underway.

7.2.2 Craft should be securely moored whilst filling is in progress.

7.2.3 Filling hoses should not be taken over other craft and should be positioned to avoid chafing and crushing.

7.2.4 Due allowance should be made in the positioning of hoses for any tidal changes.

7.2.5 Hoses should be supported above the water at all times.

7.2.6 Hoses should not be connected except when filling is taking place.

7.2.7 Safety notices bearing text of the following form should be in a prominent position and in view of visiting craft for refuelling:

- LPG Filling
- No smoking
- No naked lights
- All communications equipment and mobile phones to be turned off
- Switch off all engines and gas burning appliances
- Do not operate electrical switches or equipment
- Disable automatic ignition systems on appliances

7.3 Filler couplings and nozzles

Filler couplings and nozzles should be designed and constructed to meet the criteria of ECE 67.

Section 8: Emergency Procedures

8.1 General

The emergency action to be taken depends upon the situation which is categorised as:

- leakage of LPG without fire;
- leakage of LPG which has ignited;
- fire external to containers or appliances.

8.2 Leakage of LPG without Fire

8.2.1 Because LPG is normally odourised, a leakage will normally be detected by smell but can be detected by an automatic gas detector, if fitted.

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

- (a) shut down engine;
- (b) do not operate other electric switches;
- (c) shut off the supply of gas by closing the main container valve(s);
- (d) extinguish all naked flames and other sources of ignition, e.g. heaters, cookers, pilot lights, cigarettes, etc;
- (e) ventilate by creating a through draught to disperse the gas;
- (f) if possible, evacuate the area because leak with no fire may form an explosive mixture;
- (g) if leakage cannot be stopped remove containers from the vessel to a safe place, preferably in the open air. Place the container in a position on deck where the leaking gas will be blown away from other vessels in the vicinity. Extreme care should be taken to remove the container and/or the self-contained appliance in such a way as to prevent spillage of liquid;
- (h) do not use the installation again until it has been checked and, if necessary, the fault rectified by a competent person.

8.3 Leakage of LPG which has Ignited

Action will depend upon whether the boat is (a) at a landing or (b) off-shore.

- (a) At a landing:
 - (1) raise the alarm and, if practicable, call the Civil Protection Department;
 - (2) alert everyone in the vicinity and, if possible, evacuate the area;

- (3) if it is safe to do so, the flame should be extinguished by shutting off the supply of gas, preferably by closing the container valve. No attempt should be made to extinguish the flame in any other way. After closing the container valve use extinguishers provided or water from over the side for free burning fires;
 - (4) inform the Civil Protection on arrival of the location of the gas container;
 - (5) do not use the installation again until it has been checked and rectified by a competent person.
- (b) Off-Shore:
- (1) alert everyone on board;
 - (2) close the container valve(s) to stop the flow of gas;
 - (3) after closing the valve(s), use extinguishers provided or water from over the side for free burning fires.
 - (4) do not use the installation again until it has been checked and rectified by a competent person.

8.4 Fire External to Containers or Appliances

If there is a fire external to a LPG container or self-contained appliances, which has or could spread to the container, the following action should be taken:

- (a) alert everyone on board. Anyone not fighting the fire should, if possible, leave the boat;
- (b) close container valves and, if safe and possible to do so, remove containers to a safe place in the open air;
- (c) if containers cannot be moved, it is essential that every effort is made to keep them cool by covering with wet blankets, etc. and spraying with water. If safe continue to spray with water until the water being sprayed stops turning into steam and starts running onto the cylinder ;
- (d) do not use the installation again until it has been checked and rectified by a competent person.

- Note:**
- 1) Emergency Procedures are based on PD 5482-3:2005
 - 2) The boat should not have less than a 6kg drypowder fire extinguisher in the vicinity of the storage area.

Appendix A: Safe Handling and Properties of LPG

A.1 Safe Handling of LPG

The liquid petroleum gas which is generally available in Malta consists of a mixture of Butane and Propane (70-80% and 30-20% respectively) according to MSA EN 589 depending on the season. These component gases of the present LPG mixture may be made available for sale and use as separate products in accordance with BS 4250:1997.

The mixture is normally supplied in cylinders up to 25 kg capacity and has a much lower vapour (or cylinder) pressure than propane.

The combustion of LPG produces carbon-dioxide (CO₂) and water vapour, but sufficient air must be available. Inadequate appliance flueing and/or ventilation, or poor air-gas mixing e.g. due to lack of servicing, can result in the production of toxic carbon monoxide (CO).

Everyone concerned with the storage and handling of LPG should be familiar with the following characteristics and potential hazards: -

- (a) LPG is stored as a liquid under pressure. It is almost colourless and its weight is approximately half that of an equivalent volume of water.
- (b) LPG vapour is denser than air, butane is about twice as heavy as air and propane about one and a half times as heavy as air. Consequently, the vapour may flow along the ground and into drains, sinking to the lowest level of the surroundings and be ignited at a considerable distance from the source of leakage. In still air vapour will disperse slowly.
- (c) LPG can form a flammable mixture when mixed with air. The flammable range at ambient temperature and pressure extends between approximately 2 % of the vapour in air at its lower limit and approximately 10 % of the vapour in air at its upper limit. Within this range there is a risk of ignition. Outside this range any mixture is either too weak or too rich to propagate flame. However, over-rich mixtures can become hazardous when diluted with air. At pressures greater than atmospheric, the upper limit of flammability is increased but this increase with pressure is not linear.
- (d) Escape of even small quantities of the liquefied gas can give rise to large volumes of vapour/air mixture and thus cause considerable hazard. A suitably calibrated explosimeter may be used for testing the concentration of LPG in air.

A NAKED FLAME SHOULD NEVER BE USED TO SEARCH FOR A LEAK.

- (e) At very high concentrations in air, LPG vapour is anaesthetic and subsequently an asphyxiant by diluting or decreasing the available oxygen.
- (f) Commercial LPG is normally odorised before distribution by the additional of an odorant such as ethyl mercaptan or dimethyl sulphide, to enable detection by smell of the gas at concentrations down to one-fifth of the lower limit of flammability (i.e. approximately 0,4 % of the gas in air). However in certain cases where the odorant may be detrimental to a process (for example in aerosol applications) the LPG is not odorised.
- (g) Escape of LPG may be noticeable other than by smell. When the liquid evaporates, the cooling effect on the surrounding air causes condensation and even freezing of water vapour in the air. This effect may show itself as frost at the point of escape and thus make it easier to detect an escape of LPG. Because the refractive index of LPG differs from air, leaks can sometimes be seen as a 'shimmering'.
- (h) Owing to its rapid vaporisation and consequent lowering of temperature, LPG, particularly liquid, can cause severe frost burns if brought into contact with the skin. Personal protective equipment (e.g. hand and eye protection) should be worn if this hazard is likely to occur.
- (i) A container, which has held LPG and is 'empty' may still contain LPG in vapour form and is thus potentially dangerous. In this state the internal pressure is approximately atmospheric and if a valve is leaking or is left open, air can diffuse into the container forming a flammable mixture and creating a risk of explosion; alternatively, LPG can diffuse to the atmosphere.

Note: These properties are general characteristics of LPG and items such as (h) should not occur in normal cylinder usage.

A.2 Typical properties of commercial LPG

	Commercial Butane	Commercial Propane
Relative density of liquid at 15°C	0,57 to 0,58	0,50 to 0,51
Imperial gallons / ton at 15°C	385 to 393	439 to 448
Litre / tonne at 15°C	1 723 to 1760	1 965 to 2 019
Relative density of gas compared with air at 15°C & 1 013,25mbar	1,90 to 2,10	1,40 to 1,55
Volume of gas (litres) per kg of liquid at 15°C & 1 013,25mbar	406 to 431	537 to 543
Volume of gas (ft ³) per lb of liquid at 60°F and 30 in Hg	6,5 to 6,9	8,5 to 8,7
Boiling point at atmospheric pressure °C approx.	-2	-45
Vapour pressure for products at their maximum specified vapour pressure (gauge):		
Temp. °C	bar	bar
-40	-	0,5
-18	*	2,3
0	0,9	4,5
15	1,93	6,9
38	4,83	14,5
45	5,86	17,6
Latent heat of vaporisation (kJ/kg) at 15°C	372,2	358,2
Latent heat of vaporisation (Btu/lb) at 60°F	160	154
Specific heat of liquid at 15°C (kJ/kg °C)	2,386	2,512
Sulphur content per cent weight	Negligible to 0,02	Negligible to 0,02
Limits of flammability (percentage by volume of gas in a gas-air mixture to form a combustible mixture)	Upper 9,0 Lower 1,8	Upper 10,0 Lower 2,2
Calorific Values:		
<i>Gross:</i>		
(MJ / m ³) dry	121,8	93,1
(Btu / ft ³) dry	3 270	2 500
(MJ / kg)	49,3	50,0
(Btu / lb)	21 200	21 500
<i>Nett:</i>		
(MJ / m ³) dry	112,9	86,1
(Btu / ft ³) dry	3 030	2310
(MJ / kg)	45,8	46,3
(Btu / lb)	19 700	19 900
Air required for combustion (m ³ to burn 1m ³ of gas)	30	24

* Minimum Commercial Butane vapour pressure at -18 °C is minus 524 mbar g.

Appendix B: Example of a Typical Inspection Certificate

Installer's Letter Heading

Certificate No: _____

Craft Details:

Make and Model: _____

Year: _____

Registration No: _____

Name of Vessel: _____

Hull Material: _____

Number of Engines: _____

Maximum Power: _____

LPG Fuel tank Details:

Manufacturer: _____

Serial No: _____

Water Capacity: _____

Test/Reset Date: _____

Safety Relief Valve Details:

Type no: _____

Exchange Date: _____

This is to certify the LPG system of the above vessel has been installed, examined and tested in accordance with the MRA LPG Code of Practice 8 found to be satisfactory.

Signed _____

Name _____

Date _____

Appendix C: References

British Standards

BS 4089:1999	Specification for metallic hose assemblies for liquid petroleum gases and liquefied natural gases
BS 4250:1997	Specification for commercial butane and commercial propane
BS 476-20:1987	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles)
MSA 3212:1991	Specification for flexible rubber tubing, rubber hose and rubber hose assemblies for use in LPG vapour phase and LPG/air installations
MSA EN 13322-1:2003	Transportable gas cylinders. Refillable welded steel gas cylinders. Design and construction. Carbon steel
MSA EN 1803:2002	Transportable gas cylinders. Periodic inspection and testing of welded carbon steel gas cylinders
PD 5482-3:2005	Code of practice for domestic butane and propane gas-burning installations. Installations in boats, yachts and other vessels
BS 6362:1990, ISO 7598:1988	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'
MSA EN 751-2:1997	Sealing materials for metallic threaded joints in contact with 1 st , 2 nd and 3 rd family gases and hot water. Non-hardening jointing compounds
MSA EN 751-1:1997	Sealing materials for metallic threaded joints in contact with 1 st , 2 nd and 3 rd family gases and hot water. Anaerobic jointing compounds
MSA EN 28846:1993	Small craft. Electrical devices. Protection against ignition of surrounding flammable gases

MSA EN 549:1995	Specification for rubber materials for seals for diaphragms for gas appliances and gas equipment
MSA EN 589:2004	Automotive fuels. LPG. Requirements and test methods
MSA EN 751	Sealing materials for metallic threaded joints in contact with 2 nd and 3 rd family gases and hot water
MSA EN 751-1	Anaerobic jointing compounds
MSA EN 751-2	Non hardening jointing compounds
MSA EN 1442:2006	Transportable refillable welded steel cylinders for liquefied petroleum gas (LPG). Design and construction
MSA EN ISO 9097	Small craft – Electric fans
MSA EN ISO 10239:2000	Small craft – Liquefied Petroleum Gas (LPG) Systems
MSA EN ISO 12816	Transportable refillable steel and aluminium LPG cylinders – Disposal
DIN 1787	Copper Composition
DIN 17671 Part 1	Wrought Copper and Copper Alloy Tubes. Properties
IP 65	IP Codes and Testing Procedures are defined in the Norms IEC 60529 and CEN-ELEC-EN 60529 'Degrees of Protection Provided by Enclosures'

Regulations

Recreational Craft Regulations, Legal Notice 128 of 2005.

Commercial Vessels Regulations 2002, Legal Notice 284 of 2002.

MRA LPG CODES OF PRACTICE	
<u>Number</u>	<u>DESCRIPTION</u>
<u>GROUP A - BULK VESSELS</u>	
A1	Design and Installation
A2	Examination and Inspection
A3	Buried/Mounded LPG Storage Vessels
A4	Purging LPG Vessels and Systems
A5	LPG Central Storage and Distribution Systems for Multiple Consumers
<u>GROUP B - SMALL CYLINDERS STORAGE AND FILLING</u>	
B1	Storage of Full and Empty Vessels
B2	Recommendations for the Safe Filling of LPG Cylinders at Depots
B3	Hazard Information and Packaging for Commercial LPG Cylinders
<u>GROUP C - LPG DRIVEN MACHINERY</u>	
C1	Autogas Installations
C2	The Safe Use of LPG as a Propulsion fuel for boats, yachts and other craft
C3	Automotive LPG Refuelling Facilities
C4	Gas Installations for Motive Power on Mechanical Handling and Maintenance Equipment
<u>GROUP D - ANCILLARY EQUIPMENT</u>	
D1	Hoses for the Transfer of LPG in Bulk: Installation, Inspection, Testing & Maintenance
D2	Safety Valves
D3	Valves for Transportable LPG Containers
D4	Flow rates up to 80 litres/min in Installations dispensing Road Vehicle Fuel
D5	Flow rates above 80 litres/min between Mobile Equipment and Fixed LPG Storage
D6	LPG Piping Systems: Design & Installation
<u>GROUP E - LPG CYLINDER USAGE AT DIFFERENT PREMISES</u>	
E1	The Use & Storage of LPG in Cylinders at Residential Premises
E2	The Storage and Use of LPG on Construction Sites
E3	Use of Propane in Cylinders at Commercial and Industrial Premises

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