MRA LPG

Code of Practice A3:2008

Bulk Vessels

Buried / Mounded LPG Storage Vessels

The information in this Code of Practice is given in good faith and belief in its accuracy at the time of its publication, but does not imply any legal liability or responsibility by the Malta Resources Authority.

Users of this Code of Practice must give regard to any relevant legislation or authoritative recommendations, especially to those which may have evolved subsequent to the date of publication.

This guidance is not an authoritative interpretation of the Law, but if you do follow the Guidance, you will normally be doing enough to comply with the Law.

Malta Resources Authority Officials may refer to this Guidance as illustrating good practice.

This document is heavily based on UKLPG's suite of Codes of Practice (for further information see www.uklpg.org). Their permission to use these within Malta is gratefully acknowledged.

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 A3

Buried/Mounded LPG Storage Vessels

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Section 1: Introduction, Objectives and Scope

1.1 Introduction

This Code has been prepared for the guidance of those involved in the safe practice of storing and handling LPG in bulk at fixed installations in Malta.
To allow reduced separation distances and improve the visual aspect of bulk LPG storage vessels the option is often taken of burying them below ground level or covering them with an earth mound to a standard that would protect them against the effects of heat from a fire. Visual impact is often regarded as a major consideration for domestic installations, whether for individual premises or for estates, mobile home parks and caravan parks. It may also be a consideration for depot storage.
This Code of Practice supplements, and should be read in conjunction with, Code of Practice I part 1. Other relevant Codes and Standards are listed in Appendix C.
This Code of Practice adopts the recommendations of 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 is a comma (e.g. one point five is represented as 1,5).

1.2 Scope

This Code of Practice deals solely with installations where LPG is stored under pressure at ambient temperatures in fixed underground or mounded vessels having a capacity greater than 150 litres. It applies to all such installations (whether or not the material is stored for use on site or for trans-shipment and subsequent use off site) and includes guidance on the design of LPG storage vessels.
Whilst the general principles and much of the more detailed information in this Code may be applicable to petrochemical storage and process facilities, dependent on the nature of the product stream, additional guidance and models may be more appropriate and detailed site specific risk assessments should be undertaken, together with consultation with the Malta Resources Authority as necessary.
For more detailed guidance on LPG pipework refer to MRA LPG Code of Practice D6, LPG Pipework System Design and Installation.
For maintenance of LPG vessels see MRA LPG Code of Practice A2, Periodic Inspection and Testing.
The design and installation of LPG piped supplies to multiple consumers is covered in MRA LPG Code of Practice A5 which extends the requirements given in this Code of Practice.

External corrosion protection by a suitable coating supplemented, where appropriate by cathodic protection is covered in detail.

1.3 Definitions

1.3.1 Gas Dispersion Wall

A wall intended to ensure an adequate dispersion distance to boundaries, buildings and sources of ignition for LPG which might be released from the vessel or its fittings where normal separation distances cannot be achieved.

1.3.2 Holiday Spark Test

A test to establish the integrity of a surface coating. The test involves the application of an appropriate electrical potential between the vessel and a detection brush. The brush is then

moved over the surface of the vessel and any fault in the coating results in an increase in current flowing in the circuit.

1.3.3 Buried Vessel

A vessel, whose pressure shell, excluding its associated valves and fittings, is at or below the pre-existing ground level.

1.3.4 Mounded Vessel

A vessel any part of whose pressure shell is above the pre-existing ground level and is covered, for fire protection, separation distance reduction or aesthetic reasons, by soil, sand or similar materials.

Section 2: Vessel Location and Safety Distances

2.1 Hazardous Places

2.1.1 General

The requirements of the Workplace (Minimum Requirements for Work) (Confined spaces and Spaces having explosive atmospheres) Regulations LN 41/2003 apply to LPG storage installations and their surroundings.
Hazardous places are defined as places in which an explosive atmosphere may occur in such quantities as to require special precautions to protect the health and safety of the workers concerned.
Hazardous places are classified into zones on the basis of the frequency and duration of the occurrence of an explosive atmosphere. Further information is given in the MRA LPG Code of Practice A1.
For an LPG bulk storage installation designed, constructed and maintained in accordance with the MRA LPG Codes of Practice a release of LPG should only occur during product transfer; any release should be small and controlled. The risk of ignition of an explosive atmosphere is low provided that appropriate precautions are taken, in accordance with this code. The required precautions include display and observance of appropriate warning notices (2.7), control of access (2.6), sources of ignition (2.1.2, 2.1.3), and selection of appropriate equipment.

2.1.2 Requirements

Within the hazardous places described in 2.1.3:

- fixed sources of ignition (i.e. pilot lights, naked flames) should be prohibited;
- smoking should be prohibited;
- all other potential sources of ignition should be controlled;
- only vehicles associated with the product transfer and handling operations should be permitted;
- only equipment suitable for use in zoned areas and constructed to a recognised standard (e.g. MSA EN 50014:1998) should be installed. Older equipment built to earlier standards remains acceptable provided it is correctly maintained and a risk assessment shows it is still suitable.
- electrical equipment should be suitable for the zoned area in which it is installed.

  Apparatus, which *may* be a potential source of ignition (e.g. electrical equipment, rotating parts) and required to operate in a designated zone must be tested, approved and certified in accordance with the Workplace (Minimum Requirements for Work) (Confined spaces and Spaces having explosive atmospheres) Regulations LN 41/2003.

Guidance on electrical installation requirements is given in Code of Practice 1 Part I.

2.1.3 Area Classification

Factor	*Extent of Classified Area*	*Area Classification*
Valve boxes and access chambers	Entire Volume When carrying out cathodic protection checks with the valve-box lid open, the valve-box may be considered as un-zoned provided operating procedures require the lid to be opened before the test equipment is unloaded from the vehicle carrying it.	Zone 1
Discharge orifice of liquid level detection devices (e.g. fixed liquid level gauges or rotary or slip gauges.	Within 1,5 m of the point of discharge **during operation only.**	Zone 1
Tank Vehicle Loading / Unloading Connections	Within 1,5 m in all directions from a point where connections are made or disconnected for product transfer **during operation only.**	Zone 1

2.2 Layout of Vessels

The storage site and the position of vessels should receive careful consideration to ensure that:

- The site is properly accessible. Access needs to be provided for the LPG delivery vehicle, which should be agreed with the LPG supplier;
- There is *a* clear line of sight to both the delivery vehicle and the vessel fill point from a position where the person in charge of the delivery can exercise adequate safe control of the delivery;
- Adequate emergency escape routes are available;
- Suitable provision can be made for the positioning of cathodic protection anodes where applicable.

2.3 Location and Spacing of Storage Vessels

2.3.1 Separation Distances

Storage vessels, whether buried or mounded, should, in general, be spaced and located in accordance with Table I. The distances refer to the horizontal distance in plan between the valve assembly or vessel shell (as specified) and the nearest point of a specified feature (such as an adjacent storage vessel, building or boundary). Reduced separation distances may be permitted when justified by a suitable risk assessment and where provision has been made for levels of equipment, training and supervision in excess of those in this and other MRA LPG Codes of Practice, for example:

- Automatic overfill protection;

- High level alarm;
- Automatic emergency shut off;
- Closed circuit television surveillance;
- Two man operation.

The position of the vessel(s) should be marked above ground, either by marker pegs of robust construction which are at least 70mm in diameter or by other suitable means. Separation distances around the exposed surfaces of semi-mounded vessels with one or both ends exposed should comply with the MRA LPG Code of Practice A1.

Table 1: Minimum Separation Distances for Mounded / Buried Vessels

LPG Capacity (Tonnes)	Distance from Buildings, Boundary, Property Line or Fixed Source of Ignition			Distance between Vessels (Metres)
	To Vessel Surface (Metres)	To Valve Assembly		
		Without Gas Dispersion Wall	With Gas Dispersion Wall	
0.05 to 4	1*	3	1.5	1
> 4 to 60	3	7.5	4	**
> 60 to 150	3	11	6	**
> 150 to 300	3	15	8	**

* For vessels >1,1 tonnes LPG capacity the distance between the vessel surface and buildings, boundary, property line or fixed source of ignition may need to be increased to ensure compliance with 2.3.5 and 5.1.3.

** The spacing between adjacent vessels should be determined by the person responsible for the design of the installation by considering site conditions and the need for safe installation, testing and maintenance and should not be less than 1m. The means of determining the distance should be recorded and retained for future reference.

2.3.2 Underground Services and Installations

Other services, gas, water, sewers, land drainage pipes, electricity, telecommunications etc., should not pass through the vessel excavation.
A site survey should be carried out at the planning stage to determine the location of underground services or installations. Where available, plans should be inspected for sewer, cesspit, drain or any other underground installation locations. Electricity, water services and other pipeline locations should be determined using a suitable means of pipe and cable location detection.

2.3.3 Flooding

Buried storage vessels should not be sited in areas prone to flooding.

2.3.4 Protection from Damage by Vehicles

Vessel location should be selected to minimise the risk of physical damage to vessels from vehicles. Where necessary, protection should be provided by bollards, barriers or other suitable means. Vessels should not be located under public rights of way. See also section 2.6.

2.3.5 Effects of Excavation on Neighbouring Properties

Consideration should be given at the planning stage to the possible effect of a buried or mounded vessel excavation on neighbouring properties and any existing installation.

2.3.6 Covering the Vessel Area

The vessel area (the area over the buried vessel) may be turfed, shingled etc. Where cathodic protection is used, no continuous concrete or tarmac covering should be permitted over this area.
Evaporation Areas are not required.
Where the vessel area is covered with concrete or tarmac this should be load bearing or means provided to prevent loads being placed on the cover. The covering should be designed and laid in such a way as to allow subsequent inspection of the vessel.
Trees or deep-rooted shrubs should not be permitted within the separation distances shown in Table I.

2.3.7 Bunded Areas

Buried or mounded LPG storage vessels should not be located within any bunded area.

2.4 Multiple Vessel Installation

Multiple vessel installations should be designed and installed as follows:

(a) The minimum separation distance between vessels, buildings and boundaries should be as shown in Table 1.

(b) LPG vessels should not be installed above or below other LPG vessels other flammable liquid tanks or vessels containing corrosive dangerous substances

(c) Consideration should be given to the possible effects of additional excavations on existing tank installations.

(d) Vessels interconnected in the liquid phase should be of similar cross-section and diameter, set at the same horizontal level and also be interconnected in the vapour phase to avoid inadvertent interchange of contents.

(e) Where removal of the cover on one vessel might prejudice the cover on another, all the vessels in the group which are affected should be made safe (e.g. by emptying) before the cover is removed.

2.5 Gas Dispersion Walls

2.5.1 General

Gas dispersion walls permit separation distances to be reduced. They should be of such a length that the distance from the valve assembly to a boundary or fixed ignition source measured around the end of the wall is not less than the relevant separation distance given in Table 1 for an installation without a gas dispersion wall.

2.5.2 Construction and Siting

The following considerations apply to the construction and siting of gas dispersal walls:

(a) A gas dispersion wall should be imperforate, substantially constructed from brick, concrete or solid masonry and should not be less than 0,5 m in height.

(b) Gas dispersion walls should not be provided on more than two sides and normally only on one side. In all cases the natural ventilation should not be significantly impaired. Where two walls are being considered the Malta Resources Authority should be consulted.

(c) If a dispersion wall is built on a property boundary providing it should be wholly under the control of the occupier of the LPG site.

(d) There should be no holes or openings in a gas dispersion wall within the distances described in Table 1.

(e) Gas dispersion walls should be constructed on sub-soil and with the foundations clear of the inert back fill material.

(f) Gas dispersion walls should not be sited so as to direct rain water onto the LPG vessel.

2.6 Storage Protection

2.6.1 General

The installation, including any above-ground equipment, should be protected to minimise interference by trespassing, tampering or accidental impact. At sites other than individual domestic premises this should be achieved by a combination of site demarcation, physical barriers and warning signs.

2.6.2 Enclosure/Demarcation

a) Industrial/commercial premises

The installation should be enclosed by an industrial-type mesh or palisade fence at least l,8 m high, located at least I m from the edge of the tank shell in plan. The fence should not restrict ventilation. It should have at least two means of exit, situated to minimise the distance to be travelled to escape from a dead end. Gates should open outwards and be easily and immediately openable from inside. They should not be self-locking, and should provide unobstructed means of escape.
A fence at the installation may not be required if the installation is within an adequate site perimeter fence, unless the site is remotely located, subject to infrequent surveillance or liable to trespass.

b) Retail premises

A fence should be provided as in (a) above unless the installation is in a fully-enclosed area (such as a yard or garden) under the control of the site owner.

c) Central Storage for Multiple Customers

The preferred standard is a fence or enclosed area as in (b) above.
Where there are difficulties in achieving this standard, for example because of planning constraints or technical restrictions on layout, it may be acceptable to demarcate the area around the installation by raised ground or a contrasting non-combustible surface cover, such as gravel. It should extend to at least the appropriate distance to the vessel surface and to the valve assembly given in Table 1, and at least 1 m beyond the edge of the tank shell in plan. The perimeter of the demarcated area should be marked by low fencing or chain secured to posts. The surface cover itself should be kept clear of any plant growth other than grasses, and no other material or structure unconnected with the installation should be placed on it. In deciding whether this standard is acceptable, account should be taken of the likelihood and manner of foreseeable trespass or tampering and whether the
person providing the gas supply to consumers has full control over access to the tank and associated equipment.
Vehicular access should be prevented by substantial barriers or bollards. Alternatively a low wall around the area can be used, with the ground within made up to the wall height and the valvebox cover(s) set at this level. A wall higher than the area it encloses should not be used unless adequately ventilated at low level (e.g. by screen block), to avoid the risk of trapping gas.
For installations not within the boundary of a residence, notices warning against trespass and smoking should be provided, visible from all sides of the area, in addition to those required by clause 2.7.

d) Autogas Forecourts

A fence should be provided as in a) above, unless either:

- all or part of the vessel is installed under a load bearing cover and the vessel fittings access cover is equally load bearing; or

- the vessel is installed in an area where vehicular access is prevented by the provision of substantial kerbs, barriers or bollards.

For additional guidance on Autogas Forecourts see the MRA LPG Code of Practice C3.

2.6.3 Vessel Access Points

Valve boxes and other access points to buried and mounded vessels should be protected by a substantial cover. The cover should be lockable and sufficiently rigid to prevent flexing of the cover by hand. Covers at ground level should be capable of supporting the maximum foreseeable superimposed load. Ventilation to atmosphere should be provided to deal with small releases of LPG in normal operation. In addition means should be provided to safely vent to atmosphere any LPG released from relief valves.

2.6.4 Above-ground Equipment

Equipment located above ground level such as regulators, pumps, remote filling points etc. should either be within a fenced enclosure as described in 2.6.2(a) or housed in a substantial, ventilated, locked kiosk or other enclosure.

2.6.5 Locks

Locks for fencing gates, kiosk doors or valvebox covers, together with the structure to which they are attached, should be constructed and installed to resist casual attack. Padlocks with chains should not be used, nor locks using the same key as any gas meter box at the consumer side of the installation on a metered estate.

2.7 Warning Notices

2.7.1 Wording and Form of Notices

Warning notices should be displayed on the security fence or compound, or other associated above ground structure with the words *Flammable – LPG.*
Prohibition of smoking or naked flames and No Unauthorised Entry (if applicable) should be indicated by signs complying with the Work Place (provisions of Health and safety signs) Regulations LN 41/2002. These are defined in BS 5499 Part 5:2002. The signs should be durable, clearly visible and legible.
For sites storing more than 25 tonnes, notices are required in accordance with the Dangerous Substances (Notification) Regulations LN 318/2001.

2.7.2 Vessel Fittings Access Cover

Where there is no above ground structure, the vessel fittings access cover should be clearly marked or labelled to comply with 2.6.1.

Section 3: Vessel Design and Vapour Withdrawal Rates

3.1 Vessel Design Code

New vessels should be designed and constructed to MSA EN 14075:2002, MSA EN 13445-8:2006 or an alternative, appropriate standard meeting the conditions set out in 3.2 and 3.3 below. Alternative pressure vessel standards may be used only if it can be shown that they will give an equivalent standard of safety.
New vessels require design approval, manufacture and CE marking in accordance with the Pressure Equipment Regulations LN 248/2002.
The design of any vessel should be based on the application of a single recognised standard.
The mixed application of standards to the design of a vessel should be avoided.
The designer/supplier must provide sufficient written information to the user so that the Pressure Equipment Regulations 2002 can be complied with.

The vessel design conditions in 3.2 apply unless a full technical assessment of the extreme design criteria for a vessel and its operating system carried out by a competent person shows these criteria can be or need to be modified.
Assessment needs to be carried out in any case if the storage vessel is to be subject to unusual conditions such as high liquid fill or discharge rates, or if supplementary vapour top loading is to be employed.

3.2 Design Conditions

3.2.1 Extremes of Temperature

The design pressures and temperatures and the construction materials should take into account the extremes of temperature the contents will reach in service. They should not be less onerous than the service limits given in Table 2 below.

Table 2 LPG Service Limits

	Commercial Butane	Commercial Propane	
		Liquid Offtake	Vapour Offtake
Maximum Temperature	50º C	50º C	50º C
Maximum Pressure	4,75 bar	18,0 bar gauge	18,0 bar gauge
Minimum Temperature	Minus 18º C	Minus 18º C	Minus 40º C
Minimum Pressure	480 mbar absolute	Zero Gauge	Zero Gauge

3.2.2 Superimposed Loads

The strength of the vessel and saddles should allow for the loads superimposed on it by:

- back-fill; or
- the mound cover;

under the most onerous condition (i.e. under the lowest internal pressure).

3.2.3 Other Loads

Other loads to be considered in design include flotation restraint and possible back-fill settlement under the vessel, particularly for high aspect ratio vessels (i.e. those with a high length to diameter ratio), frost, heave or drought.

3.3 Design Requirements

3.3.1 Vessels without Manways

3.3.1.1 The valves and fittings described in Section 4 of this Code of Practice should be grouped within an access valvebox attached to the outside of the vessel. The valvebox should meet the following specifications:

(a) It should extend upwards to a height to accommodate the depth of cover to be provided, (see 5.4.8).

(b) It should be of rigid construction capable of withstanding the forces exerted by the backfill and of a material adequately protected against corrosion or of an inherently non-corrodible material.

(c) It should be provided with a lockable weather cover designed to project just above ground or mound level. A ground level cover should be capable of withstanding safely any foreseeable superimposed load on it and, in any case, a load of not less than 10 000 N as a load concentrated over an area 150 mm x 50 mm.

***Note**:* For vessels of up to 6 tonnes LPG capacity no aperture above the relief valve is necessary.

(d) It should be provided with drain outlets at low level on both sides of the vessel.

3.3.1.2 Consideration should be given to the ease of access to filling connections and fixed liquid level gauges, for example by extending connections to a height nearer to ground or mound level, or designing the valvebox size to allow delivery driver entry. Bracing should be provided for extended connections unless inherent strength is adequate to resist lateral forces in service.

3.3.1.3 The access valvebox should have, or have provision for, the supply pipework to pass through. Where pipework is to pass through the valvebox, it should be adequately supported and protected against damage or abrasion and sealed where it passes through.

3.3.2 Vessels with Manways

Vessels having a capacity in excess of 6 tonnes LPG capacity should have an access manway. The manway, in the form of an extended nozzle, forms part of the pressure vessel and should be subject to the design requirements of 3.1 and 3.2. It should extend to ground or mound level or above or be enclosed in a valve chamber (see 3.3.1). If necessary a top flange designed to carry the valves should be provided and fittings described in Section 4 of this Code of Practice may be provided. Any access manway should have an internal diameter of not less than 575 mm.

3.3.3 Liquid Off take Vessels with Submersible Pumps

3.3.3.1 The pump should be installed in a purpose designed housing within the storage vessel with connections and isolating valves which provide for its removal for service and maintenance without the need to depressurise the entire vessel. The housing should be provided with a valved connection to permit degassing and purging in a safe manner.

3.3.3.2 The electric pump motor, cabling and terminals for either submersible or external drives should meet the requirements of the EN 50014 series for use in a flammable air-gas atmosphere, and for weather protection as appropriate.

3.3.4 Protection against Corrosion
Vessels should be adequately protected against corrosion by coating as described in Section 7 of this Code of Practice.

3.3.5 Cathodic Protection
For cathodic protection, as described in Section 8 of this Code of Practice, suitable anode electrical connections to the vessel should be provided, suitably protected and conveniently located for maintenance and periodic monitoring described in MRA LPG Code of Practice A2.

3.3.6 Bonding Connection

3.3.6.1 A bonding connection providing bare metal contact with the bonding cable from the LPG road tanker should be attached or connected to the vessel.

3.3.6.2 Buried earth rods should not be used or connected to buried mounded storage vessels using cathodic protection, either for electro-static dissipation or for the earthing of electrical equipment.

3.3.6.3 Electric pumps should be earthed through the electric supply system.

3.3.7 Vessel Data Plate

The vessel data plate should be located where it can be easily read once the vessel is installed.

3.4 Vaporisation Rates

3.4.1 Available Offtake Rates

Available LPG vapour offtake rates from buried / mounded vessels will generally be less than those for equivalent size above ground vessels because the heat transfer from the soil / backfill is generally lower than can be achieved in the open air.

3.4.2 Factors Affecting Vaporisation Rates

The rate of vaporisation is dependent on many factors, for example soil type and condition, vessel vapour outlet pressure, ground water, frequency of refilling, temperature of fill, continuity of supply required.

3.4.3 Calculation of Offtake Rates

The many factors involved preclude an accurate calculation method for assessing the offlake rate available for a particular service requirement. Practical experience has nevertheless indicated that a rate of 50% of that for an equivalent above ground vessel in equivalent service conditions is a reasonable basis for vessel sizing.

3.4.4 Dangers of High Offtake Rates

Vaporisation will lower the temperature of the backfill. High offtake rates may cause freezing of any ground water or moisture in the soil. It should be borne in mind that in extreme circumstances this can cause frost heave with possible movement of the vessel and damage to its coating and attached pipework.

Section 4: Valves, Regulators, Fittings and Adjacent Pipework

4.1 Access

4.1.1 Access from Above

All valves and fittings on buried or mounded vessels should be accessible from above, except for those mounded vessels where a bottom connection may be extended at ground level through the mound.

4.1.2 Ease of Servicing and Safety

Valves and fittings within a valvebox should be designed or selected with a view to the ease of servicing and the safety of persons carrying out this work, particularly the removal of relief valves with check device from vessels under pressure.
See also 4.4.6 for further details on the identification of the check device.

4.2 Fittings

4.2.1 Requirements

Each vessel should be provided with at least one of each of the following fittings:

(a) Safety relief valve connected to the vapour space (see 4.4);

(b) Drainage, or other means of removing the liquid contents (see 4.8);

(c) A fixed maximum liquid level device or a maximum level fill stop valve;

(d) Filling connection (see note below);

(e) Service connection (see note below);

(f) Contents gauge;

(g) For vessels over 2,5 tonnes LPG capacity a pressure gauge connection to the vapour space, for determining the pressure in the vessel (e.g. a valved tapping in the vapour space of the vessel, a fitting or adjacent pipework).

Note: The location of the connections, particularly in combination valve clusters, should ensure that liquid is not entrained in a vapour service offtake during filling operations.

4.2.2 Temperature and Pressure Ranges

Fittings attached to the vessel should be suitable for LPG service over the range of temperatures and pressures that the product will reach in service.
Important: Where liquid may be trapped between closed valves, pipework and fittings could be subjected to pressure greater than the vessel design pressure due to thermal expansion of the liquid. In such cases the hydrostatic relief valve pressure is then the required minimum

design pressure of that part of the system.
See MRA LPG Code of Practice A1 for further details on hydrostatic relief valve pressures.

4.2.3 Jointing Compounds

Jointing compounds for screwed joints should be resistant to liquid phase LPG. Compounds conforming to MSA EN 751-2:1997, or PTFE tape to BS 7786:1995 or equivalent, are acceptable. They should be applied to the male thread only, so that jointing material cannot enter the fitting. Red lead, hemp or Boss White should not be used.

4.2.4 Gaskets

Gaskets for flanged joints should he resistant to liquid phase LPG. Gaskets of natural rubber or bonded with natural rubber should not be used.
See the warning on the use of asbestos products in MRA LPG Code of Practice D6.

4.3 Service Connection

For small vapour offtake vessels with a POL left hand female outlet service valve, the recommended connection is the American CGA Standard ANSI B57.1 valve outlet No. 510. The UK equivalent (MRA LPG Code of Practice D3, Figure 1) is larger and the male half coupling is not compatible with a female CGA half-coupling.

4.4 Pressure Relief Valves

4.4.1 Valve Construction

Each vessel should be equipped with one or more pressure relief valves of the tamper proof, direct spring loaded or equivalent type. Relief valves should be constructed so that the breakage of any part should not obstruct the free discharge of LPG under pressure. Weight loaded valves should not be used.

4.4.2 Discharge Pressure

Safety relief valves should be set to start to discharge at a pressure:

(a) not greater than the design pressure of the vessel in which they are installed; and

(b) not less than the maximum service pressure of the grade of LPG that the system will contain.

4.4.3 Flow Capacity

For buried and fully mounded vessels, the fill flow capacity of the pressure relief system should not be less than 30% of that required by MRA LPG Code of Practice A1, for an above ground vessel of the same size, or such other value as will adequately protect the vessel. The relief valve discharge capacity required may be reduced if the assessment referred to in 3.1 above confirms that such lower flow rates will prevent pressurising the vessel beyond its test pressure arising from all foreseeable relevant fault conditions.

Relief valve discharge rates for mounded vessels with one or both ends exposed should be increased according to the area exposed using the formula for above ground vessels given in

MRA LPG Code of Practice A1. Extended vent stacks may be required if any exposed vessels areas would otherwise be adversely affected by back radiation from an ignited discharge.

4.4.4 Isolation of Pressure Relief Valves

Isolation valves should not be fitted between a single pressure relief valve and the vessel. In the case of manifolded pressure relief valves, any provision made for isolating any relief valve (e.g. for testing or servicing) should ensure that the remaining relief valves connected to the vessel provide the full capacity required at all times.
Where the removal of a relief valve would leave the vessel protected by less than the full discharge capacity, then a replacement relief valve must be fitted immediately.

4.4.5 Automatic Check Devices

In the case of vessels fitted with separate or single relief valves, provision may be made for their removal for testing or servicing by the use of an automatic check device, providing that this valve:

(a) is retained in the fully open position by the presence of the relief valve, and

(b) closes before the relief valve is completely removed.

When carrying out the removal procedure it is essential that the storage vessel is not left unprotected, and a replacement relief valve is fitted immediately.

4.4.6 Identification of Automatic Check Device

It is essential that the closing device in 4.4.4 and *4.4.5* above is adequately identified by marking, so that the correct and safe method of removal of the relief valve can be established. The design should provide for the means to check that the pressure beneath the valve is relieved and that the closing device is closed before removal.

4.4.7 Excess Flow Valves

Excess flow valves should not be installed between the vessel and any safety relief valve.

4.4.8 Marking of Safety Relief Valves

Each safety relief valve should be plainly and permanently marked to comply with MRA LPG Code of Practice D2.

4.4.9 Relief Valve Vent Pipes

Underground and mounded vessels do not normally require relief valve vent pipes.

4.5 Shut-off Valves and Emergency Valves

Shut-off valves and emergency shut-off valves should be fitted as recommended in MRA LPG Code of Practice A1.

4.6 Maximum Liquid Level Device

4.6.1 Fixed Maximum Liquid Level Device

4.6.1.1 The device should be of a type that allows vapour or liquid to be bled from a valve attached to a dip-tube to indicate when the maximum permitted liquid level is reached during filling.

4.6.1.2 The design length of the dip-tube should be determined by the grade of LPG to be stored, and should indicate a maximum permitted level which should not exceed the following values:

Commercial Propane: 87% vessel capacity
Commercial Butane: 90% vessel capacity

The maximum fill may be increased provided the assessment referred to in 3.1 above confirms that thermal expansion will not cause the level to rise beyond 97% vessel capacity for foreseeable ambient temperatures and thermal insulation properties of the vessel cover, and the lowest product fill temperature.

4.6.1.3 The passageway through the device should not be larger than 1,4 mm diameter, unless it is fitted with an excess flow valve.

4.6.1.4 The operational bleed screw should remain captive at all times.

4.6.1.5 The bleed valve should be installed so that it can be conveniently reached and visible from the filling point, unless special precautions are taken, as required by MRA LPG Code of Practice A1.

4.6.1.6 On vessels that have the bleed valve installed within a valvebox, the discharge from the bleed valve should be in a direction that will not cause harm or danger to the filling operative.

4.6.2 Maximum Level Fill Stop Valve

4.6.2.1 As an alternative to the gauge described in 4.6.1 a purpose designed automatic shut-off valve may be used which is activated by a float or other means so that it shuts positively during filling to limit the liquid level to not more than that specified in 4.6.1.2 above.

4.6.2.2 Fill stop valves and actuation mechanism should be of adequate proven reliability for a life expectancy not less than the storage vessel inspection or maintenance interval.

4.6.2.3 The valve and mechanism should have been subjected to a type test for endurance and effectiveness not less onerous than that specified for autogas stop fill valves in EN 12806.

4.7 Filling Connections

4.7.1 Requirements

Filling connections should comply with the requirements for above ground vessels in MRA LPG Code of Practice A1, and may incorporate a maximum fill shut-off device as described in 4.6.2. The system design should ensure a satisfactory filling rate.

4.7.2 Strength of Filling Connections

Extended filling connections should be braced unless their inherent strength is adequate to resist safely lateral forces of the delivery hose in service.

4.8 Drain Connections

4.8.1 Use of Check-Locks

4.8.1.1 For vessels in vapour service, drain connections are often achieved using a proprietary actuated liquid withdrawal device (or located in the top of the vessel. This device incorporates a check valve and an eduction tube extended to the bottom of the vessel. The outlet remains normally plugged, but the plug can be removed and replaced by a suitable valve for uplift purposes. The action of fitting the valve opens the check-valve which then acts as an excess flow valve.

4.8.1.2 These devices should not be used as a permanent liquid offtake unless warranted for such use by the manufacturers.

4.8.1.3 Due consideration should be given to the layout of the equipment installed in a valvebox to allow installation and safe use of the opening assembly.

4.8.2 Vessels in Liquid Service

For vessels in liquid service or interconnected in the liquid phase, the drain point may be on or part of the liquid pipework.

4.8.3 Drain System Valves

4.8.3.1 The outlet of a drain system valve should be blank-flanged, plugged or otherwise secured against tampering when not in use.

4.8.3.2 Pipework between the drain system valves and between any valve and a blank- flange or plug should be protected by a hydrostatic relief valve.

4.8.3.3 The outlet valve on drain systems used for the purposes of sampling, flaring, removing water or residues should not be larger than 25 mm nominal diameter.

4.8.4 Proximity to Other Drainage Systems

No drain or blow-off line should discharge into, or be in the proximity of, any public or other drainage system or in a place where this would be liable to create a hazard.

4.9 Contents Gauges

See MRA LPG Code of Practice A1 for details of the design and installation of contents gauges.

4.10 Vapour Offtake Regulators and Over I Under Pressure Shut-Off Devices

4.10.1 Location of Regulators and Shut-Off Devices

Regulators and over pressure/under pressure shut-off devices at the storage vessel should be located within the vessel valvebox if fitted or in a secure, purpose designed, ventilated cubicle or compound. For multiple vessel installations they should be housed in a secure compound, or in a purpose designed ventilated cubicle. See 2.6 for further details on security.

4.10.2 Prevention of Ingress of Water

Where regulators or safety devices are installed below ground level in a location which may become flooded, steps should be taken to prevent water entering any vent.
Important: Vents should never be plugged in an attempt to prevent the ingress of water.

4.11 Pipework

4.11.1 Requirements

Pipework should comply with the requirements of MRA LPG Code of Practice D6.

4.11.2 Buried Service Pipework

Except for multiple vessel interconnecting pipework up to the first stage regulator, buried service pipework should be laid at the depths required by MRA LPG Code of Practice D6, and be brought to the necessary height to enter the valvebox of the storage vessel as near to the vessel / valvebox as practicable.

4.11.3 Prevention of Collection of Re-condensed Propane

Pipework carrying vapour at vessel pressure should be run without loops or bends in the vertical plane which could collect re-condensed LPG.

4.11.4 Avoidance of Pump Damage from Cavitation

Liquid phase inlet pipework to non-submersible pumps should to be as short as practicable and sized in accordance with the pump manufacturer recommendations to avoid pump damage from cavitation.

4.11.5 Interconnecting Pipework

The design, layout and installation of interconnecting pipework between multiple vessel installations should take account of the following:

(a) Buried metallic pipework should be adequately protected against corrosion as specified in Section 7 of this Code of Practice, or by running within external sleeving which extends into the valveboxes or hoods of the vessels.

(b) The pipework layout and terminals should allow for differential movements of vessels which can occur due to ground movement, subterranean water or freezing.

(c) the connected vessels have cathodic protection, the interconnecting piping should be electrically continuous, but care should be taken to prevent any exposure of the pipework to the soil, back-fill or mound. If this is not possible, electrical isolation breaks or non-metallic piping should be used.

Section 5: Excavation, Back filling and Mounding

5.1 Excavation for Vessels

5.1.1 Checking for Underground Services

Before excavation, the area should be checked for the presence of underground pipes, cables, etc. See 2.3.2 for further details.

5.1.2 Excavation Dimensions

5.1.2.1 The excavation dimensions should be such as to enable safe working by personnel within the excavation for the attachment of anchor straps, checking of coating, placement and wetting of any cathodic protection system anodes, etc.

5.1.2.2 It is recommended that a minimum of 600mm is provided all round the vessel at the base of the excavation and a minimum of 1 m at vessel centre height or where personnel have to work for purposes other than strapping down or installation of cathodic protection.

5.1.2.3 The depth of the excavation should be such that, together with any mounding, the minimum depth of cover over the vessel shell should be not less than that given in 5.4.8.

5.1.3 Safety of Working Conditions

The civil engineering or installation contractor should determine the need for shuttering or the sloping of the excavation sides in order to ensure safe working conditions for personnel working in or near the excavation during vessel installation.

5.1.4 Depth of Excavation

The base of the excavation upon which the vessel sits should be level, flat and compacted. The depth of the excavation must be checked before placing the vessel to ensure that the top of the valvebox or hood is not below the level of the surrounding ground.

5.1.5. Anode Location Shelves

Where required, anode location may be created during excavation or after partial back-filling to suit site conditions. The height of the anode, when in position, should be such that the lowest part of the anode is not above the lowest part of the vessel body but above the bottom of the excavation or top of hard core.

5.1.6 Curing of Concrete Base

If a concrete base with anchoring means is cast in-situ, sufficient time must be allowed for curing before placing the vessel onto it. See section 6.

5.2 Vessel Installation

5.2.1 Care of Vessel Coating

Prior to installation, the vessel coating should be visually checked for damage and repaired as necessary. Great care must be taken when lifting and maneuvering a vessel into the excavation, to avoid damage to the coating caused by the lifting equipment or by contact with the sides of the excavation.

5.2.2 Weather Cover Level

After placing a vessel into an excavation, the top of the weather cover should be flush with or slightly above ground level. Under no circumstances should the top of the cover be below the level of the ground.

5.2.3 Anchoring Materials

The vessel should be anchored using dimensionally stable, non-degradable or corrosion resistant materials except when an assessment (as in Section 6) indicates that flotation will not occur.

5.2.4 Inspection of Vessel Coating

Before back-filling or mounding a careful inspection of the vessel coating should be carried out in accordance with Section 7 of this Code of Practice. Any areas of damage must be repaired and re-inspected using a procedure approved by the coating supplier and a written record made.

5.3 Vapour Offtake Service Connection

5.3.1 Connection to Consumer Gas Supply Pipework

Connection to the consumer gas supply pipework may be carried out after placing of the vessel or after partial back-filling or mounding, however, the vessel should not be commissioned until the back-filling or mounding is complete.

5.3.2 Leak Testing

Provided there are no buried joints in the pipework, the leak testing may be carried out after completion of back-filling or mounding.

5.4 Back-Filling and Mounding

5.4.1 Protection of Coating

Prior to back-filling or mounding, the upper portion of the vessel should be protected in order to minimise the risk of damaging the vessel coating. Porous material such as felt may be used, and may remain in place as it does not impede the effectiveness of the cathodic protection system.

5.4.2 Care during Back-filling and Mounding

5.4.2.1 Back-filling or mounding must be carried out with great care and in a controlled manner, to ensure that the vessel, and where applicable, the anchoring straps, service pipe and, after putting in place, any anode connection wires are not strained or damaged.

5.4.2.2 The back-fill must be carefully compacted underneath the vessel and at stages throughout the back-filling process to prevent voids and excessive subsequent settlement.

5.4.3 Mound Cover

5.4.3.1 Mound cover may be achieved with naturally stable embankments conforming to current civil engineering practice, or by enclosure inside partial or full-height retaining walls.

5.4.3.2 The mound cover should be finished or protected in a manner which will guarantee long term stability under all foreseeable weather conditions.

5.4.3.3 The construction of retaining walls should permit self draining, but should prevent loss of mound cover material under adverse weather conditions or should be provided with a structure which prevents the ingress of water.

5.4.4 Appropriate Materials for Back-filling and Mounding

5.4.4.1 For vessels with a cathodic protection system, graded sand, uncontaminated soil or other inert material should be used for the back-fill or mound. However, excavated material may be used for back-filling, provided that it does not contain sharp rocks and stones or any other sharp objects which might damage the surface protection of the vessel and is capable of adequate compaction.

5.4.4.2 Consideration should be given to the use of graded sand immediately adjacent to the vessel shell or to the use of protective measures such as a sprayed concrete coating.

5.4.4.3 For vessels without a cathodic protection system the back-fill or mounding material should be graded sand or other inert material.

5.4.5 Precautions against Rain Water Flooding of the Valvebox

Where water may enter from above flooding of the valvebox should be considered and appropriate measures taken on an individual installation basis. These measures may include, but are not limited to:

(a) Providing drain tubes leading from the low points either side of the valvebox and leading to a soak-away pit, filled with hard core or rubble, or similar material, adjacent to or below the excavation for the vessel. In the latter case the top of the soak-away must be at the depth level with the bottom of the excavation. The back-fill up to the hood drain tubes on the vessel needs to be sand or similar material.

(b) Providing hood drain tubes connected to a specially provided drain facility. If the drain connects into an existing storm drain, a gas interceptor must be provided to prevent LPG released inside the hood (e.g. during filling) from passing into the drain system.

(c) Reducing the depth of excavation for semi mounded or hillside locations by approximately 400 mm so that the bottom of the hood is slightly above the natural ground level. On completion of back-fill, an artificial mound is created using sand covered with top-soil or turf The mound must cover the top of the vessel, be level with the top of the hood, and have sides sloping down to meet the edges of the excavation at ground level.

5.4.6 Installation of Anodes

When cathodic protection is to be used, the anodes should be installed prior to or during back-filling or mounding, as specified in Section 8 of this Code of Practice.

5.4.7 Use of Warning Mesh

When the back-fill or mound is roughly 200 mm below the finished level, a plastic warning mesh should be spread over the vessel area prior to completion of the backfill flush with the lid. This should only be omitted where the presence of a buried / mounded vessel and the area occupied are compounded or are otherwise obvious.

5.4.8 Depth of Cover

The depth of cover over the vessel shell, after completion of back-fill or mounding, should nowhere be less than:
300 mm for buried vessels up to and including 13 m^3 or 500 mm for larger vessels;
500 mm for mounded vessels.

5.4.9 Retention of Spare Back-Filling / Mounding Material

It is recommended that an amount of spare back-fill or mounding material is retained on completion of installation for making good any subsequent settlement.

5.5 Marker Pegs

Following completion of back-filling, four marker pegs or similar should be inserted into the ground or other means provided to indicate the position of the vessel or group of vessels. The top of the marker pegs should be flush with the ground.

Section 6: Flotation Protection

6.1 Importance of Flotation Protection

An LPG vessel will float in water. Buried vessels in waterlogged ground will be subject to a flotation force of 1 tonne per m^3 and without precautions they have been known to surface, bringing the pipework with them. Buried LPG vessels should be anchored to a foundation slab, pre-cast ballast slabs or otherwise securely anchored to prevent any possible flotation.

6.2 Flotation Protection Requirements

The total mass of ballast and the strength of the anchoring arrangements should be sufficient to resist the maximum residual flotation force of the empty vessel against total immersion in water.

6.3 Protection from Corrosion

All parts of the flotation protection system, including any anchoring points to base slabs, strapping and strap tensioning devices should be should be protected against corrosion and should be made of dimensionally stable or corrosion resistant or non-degradable materials.

Section 7: Corrosion Protection – Coatings

7.1 General

Note: The use of a coating in conjunction with cathodic protection is general practice.

7.1.1 Coating Requirements

7.1.1.1 Unless manufactured from corrosion resistant materials, the external surface of underground LPG storage vessels should be prepared and treated with an external corrosion protection coating.

7.1.1.2 The coating should resist both chemical and mechanical deterioration in order to maintain the integrity of the vessel during the lifetime of the installation.

7.1.1.3 All coatings should be suitable for underground or submerged use.

7.1.1.4 The coating should be capable of withstanding handling of the vessel and back- filling of the excavation without any loss of integrity of the protective system when the vessel is installed in accordance with the manufacturer's instructions.

7.1.2 Application of Coatings

Vessel surfaces should be prepared and the coatings applied and tested strictly in accordance with the coating supplier recommendations.

7.2 Coatings Used in Conjunction with Cathodic Protection

7.2.1 General

Where a coating is used in conjunction with cathodic protection, if coating failure occurs in service, corrosion of the exposed vessel surface is prevented by the cathodic protection system.

7.2.2 Coating Characteristics

The coating characteristics should be chosen to complement those of cathodic protection.

7.2.3 Testing of Integrity

The coating integrity should be checked after application by a holiday spark test at a voltage chosen to suit the coating type and thickness.

7.2.4 Inspection

At the time of installation the vessel coating should be visually inspected for damage and if necessary repaired.

7.3 Coatings Used Without Cathodic Protection

7.3.1 General

Where cathodic protection is not used, the corrosion protection of the vessel is totally dependent on the integrity of the coating after burial. Because of this, the coating needs to be more resistant to damage and deterioration than coatings used with cathodic protection systems.

7.3.2 Coating Standards

Coatings may be of the hot applied, fibre reinforced bitumastic type to MSA EN 10300:2005 or of very high build epoxy types.

Note: The latter should comply with a recognised standard and have a dry thickness not less than 1 mm.

A suitable standard is DIN 4681, Part 3.

7.3.3 Wrapped Tape Coatings

Wrapped tape coatings may be used provided the method of wrapping is such as to eliminate the risk of exposure of the vessel wall in the event of sideways movement of a section of tape.

7.3.4 Inspection and Testing of Coatings

After placement of the vessel in the excavation and prior to back-fill or mounding, the entire surface of the coating should be checked for integrity by both visual examination and a holiday spark test by a competent person in accordance with a written work instruction. The spark test voltage should be chosen to suit the coating type and thickness, in accordance with the test equipment manufacturer's instructions.
All defects found should be repaired and re-tested before burial.

7.3.5 Suspected Damage during Back-Fill or Mounding

Should coating damage during back-fill or mounding be suspected, the suspect area must be re-tested and if necessary repaired.

Section 8: Corrosion Protection - Cathodic

8.1 Types of Cathodic Protection

Cathodic protection of underground LPG storage vessels may be of the following types:

(a) sacrificial anode, or

(b) impressed current.

In either case the system should comply with BS 7361-1:1991.

8.2 Supply of Cathodic Protection Systems

Cathodic protection systems should be designed by, or in conjunction with, specialist cathodic protection engineers or consultants.
In simple anode systems the cathodic protection system is generally supplied with the vessel, by the vessel manufacturer.

8.3 Sacrificial Anode System

8.3.1 Basic Principles

8.3.1.1 In these systems, sacrificial anodes made from magnesium, aluminium or zinc are electrically connected to the vessel and buried in the ground near to it. The selection of the most suitable anode material depends on a number of factors including soil resistivity, but generally magnesium anodes are utilised for LPG vessels.

8.3.1.2 The anode material is more electro-negative, in simple terms more reactive with corrosive materials in the soil, than the steel from which the vessel is constructed. Provided that the anodes are correctly sized and located, and are electrically bonded to the vessel, any corrosion will occur at the anodes, which will gradually be eaten away, rather than at the vessel surface.

8.3.1.3 By taking a number of relatively simple electrical measurements of the system periodically, its condition and hence its ability to protect the vessel can be monitored and assurance gained that no external corrosion of the vessel is taking place.

8.3.1.4 The anodes offer the most effective protection to parts of the vessel they can “see”, so they are generally positioned symmetrically either side of the vessel. In multiple vessel installations, especially if the vessels are electrically linked by the interconnecting pipework, a different disposition and possibly a reduced number of anodes may be more appropriate.

8.3.1.5 When used in conjunction with very high integrity coating systems, anodes can lose their effectiveness over a period of time due to lack of activity. In this case consideration may be given to the provision of a bare metal coupon to generate a controlled level of activity in the system.

8.3.2 System Installation

8.3.2.1 Anodic systems supplied by the vessel manufacturer generally consist of two anodes (per vessel). These consist of an anode, together with a moisture retaining material inside a cloth bag. It is vital that the cloth bags are removed from any plastic protective wrapping before being placed. The bag containing the anode must be in direct contact with the soil or back-fill.

8.3.2.2 The anodes need to be connected by cable to a suitable lug attached to the vessel, usually via a junction box which may incorporate suitable test buttons to facilitate the taking of electrical measurements.

8.3.2.3 Except as noted in 8.3.1.4 the anodes should be located roughly half way along the vessel on either side and at a depth no higher than the underside of the vessel shell. This is to ensure that the anodes will be kept moist at all times when the back-fill around the vessel is wet.

The minimum recommended distance between the anode and the vessel shell is 1m

8.3.2.4 After removal from any wrapping and placement in position, the anodes should be soaked with water and covered with graded soil prior to back-filling the excavation.

8.3.2.5 Care should be taken during back-filling to avoid damage to the wiring from the anodes to the vessel and strain being placed on electrical connections.

8.3.3 System Monitoring

To check that a newly installed system is functioning satisfactorily, the CP system should be checked (Code of Practice I part 2 describes in service checking):

(a) immediately following installation, to confirm correct functioning and electrical continuity, and

(b) not less than I week, nor more than 3 months after installation, to establish base readings following stabilisation of the system.

Section 9: Fire Precautions

9.1 General

Further guidance on fire control is given in MRA LPG Code of Practice A1.

The worst case event of fire engulfment or impingement on to the surface of an above ground LPG storage vessel is greatly reduced when it is buried or mounded in accordance with this Code of Practice.

9.2 Water Supply

The provision or accessibility of a water supply called for in MRA LPG Code of Practice A1 is not required if no part of the pressure containing part of the vessel is exposed. Allowance should however be made for water supplies for any exposed areas of semi-mounded tanks, extended nozzles, pipework carrying liquid phase LPG and road tanker bays, where required by the Fire Precautions Section of the MRA Code of Practice A1.

Water sprays should not prejudice the cover on mounded or buried sections of the vessel.

9.3 Availability of Fire Extinguishers during Refilling

During refilling of storage vessels, the road tanker should deploy suitable fire extinguishers for use as necessary during this operation.

Section 10: Instruction Requirements

10.1 General

Consumers should be provided with instructions for the safe use and, where appropriate, maintenance of their installation and on the procedure to adopt in the event of a gas escape, which will normally be detected by smell, or of the production of carbon monoxide by appliances. These instructions should include at least those listed in 10.2 and 10.3 below. The instructions should also give guidance on the ownership and responsibility holder for the various parts of the installation.

10.2 User Instructions for Action in an Emergency

10.2.1 Emergency Instructions

Emergency instructions should include:

- Telephone number of the 24 hour emergency service; and
- Procedure for calling the CPD.

10.2.2 Advice in the Event of Suspected Gas Leakage

Emergency instructions should advise, in the event of a **gas leakage** or **suspected leakage**:

- Extinguish all naked flames and ignition sources;
- Turn off all gas appliances;
- Do not switch **on** or **off** any electrical equipment;
- Turn off the gas supply at the gas emergency control and the storage tank
- If the leak is indoors, open doors and windows to increase ventilation;
- **Immediately** notify the gas supplier and /or the 24 hour emergency service in order that the installation may be tested and made safe, and any necessary repair carried out;
- Do not turn on the gas until the system is proved safe and all appliances controls are turned off.

10.2.3 Advice in the Event of Fire

Emergency instructions should advise, in the event of **fire:**

The emergency services (CPD) should be called immediately and should be informed that an LPG vessel is on the premises;

The gas supply should be turned off, if practicable and safe to do so;

Do not turn on gas until the system is proved safe and all appliances are turned off.

10.3 Miscellaneous Consumer Instructions

In addition to 10.2 consumers should be given instructions to enable the installation to be used safely and sensibly. These should include instructions:

- Not to disturb the cover on the vessel;
- Not to drive posts into the area delineated by the vessel markers;
- Not to light bonfires near the vessel.

10.4 Legal Requirements for Safety Notices

The recommendations in 10.2 above are in addition to the legal requirement in the Bulk LPG Regulations LN xx/2009, for a notice to be displayed adjacent to the emergency control (shut-off) valve at the point where a gas supply enters each premises subject to the Regulations.

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 or equivalent.

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 harmless carbon-dioxide (CO_2) 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.

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 bums 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.

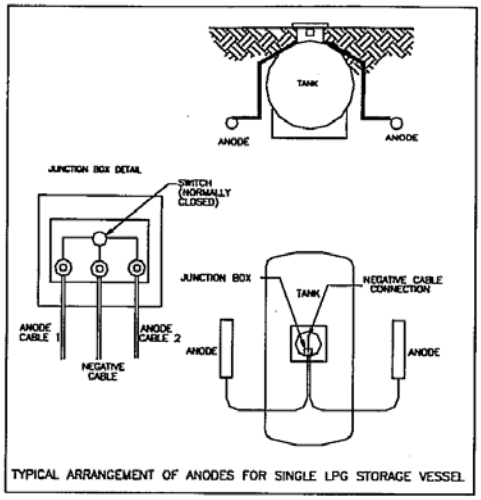
Note: These properties are general characteristics of LPG and items such as (h) should not occur in normal cylinder usage.

A.2 Typical properties of commercial LPG

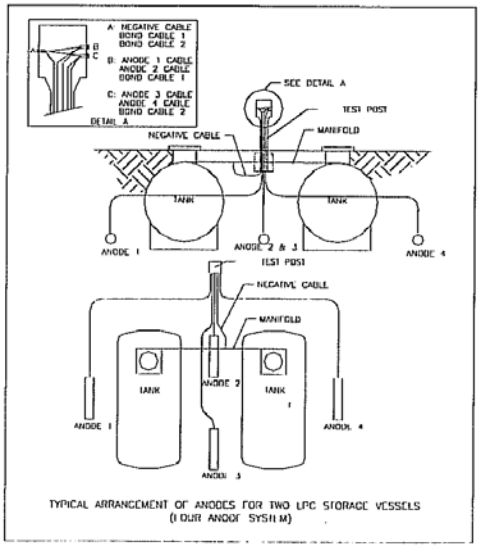
	Commercial Butane	***Commercial Propane***
Relative density of liquid at 15°C	0,57 to 0,58	0,50 to 0,51
Imperial gallons/ton at 15 °C	385 to 393	439 to 448
Litre/tonne at 15°C	1 723 to 1 760	1 965 to 2 019
Relative density of gas compared with air at 15 °C and 1013,25 mbar	1,90 to 2,10	1,40 to 1,55
Volume of gas (litres) per kg of liquid at 15°C and 1 013,25 mbar	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. DC	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:		
Gross:		
(MJ/m3) dry	121,8	93,1
(Btulft3) dry	3 270	2 500
(MJ/kg)	49,3	50,0
(Btu/lb)	21 200	21 500
Nett:		
(MJ/m3) dry	112,9	86,1
(Btulft3) dry	3030	2310
(MJ /kg)	45,8	46,3
(Btu/lb)	19 700	19 900
Air required for combustion (m^3 to burn 1 m^3 of gas)	30	24

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

Appendix B: Anode Layouts for Cathodic Protection



TYPICAL ARRANGEMENT OF ANODES FOR SINGLE LPG STORAGE VESSEL



TYPICAL ARRANGEMENT OF ANODES FOR TWO LPG STORAGE VESSELS
(FOUR ANODE SYSTEM)

Appendix: C

References

BS 4250:1997 Commercial Butane and Propane

BS 5499-5:2002 Fire Safety Signs, Notices and Graphic Symbols Specifications for Fire safety Signs

BS 6031:1981 Code of Practice for Earthworks

BS 7361-1:1991 Cathodic Protection. Code of Practice for land &marine application

BS 7786:1995 Specification for unsintered PTFE tapes for general use

MSA EN751-2:1997 Sealing Materials for Metallic Threaded Joints

MSA EN10300:2005 Steel Tubes & Fittings for onshore & offshore pipelines. Bitumen hot applied materials for external coating

MSA EN13445 Unfired Pressure Vessels. Additional requirements for aluminium & aluminium alloy pressure vessels

MSA EN14075:2002 Static welded steel cylindrical tanks produced for LPG storage tanks greater than 13m^3

MSA EN50014:1998 Electrical Apparatus for potentially Explosive Atmospheres

MSA EN60079-18:2004 Electrical Apparatus for Explosive Gas Atmospheres

MRA LPG CODES OF PRACTICE

Number	DESCRIPTION
	GROUP A - BULK VESSELS
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
	GROUP B - SMALL CYLINDERS STORAGE AND FILLING
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
	GROUP C - LPG DRIVEN MACHINERY
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
	GROUP D - ANCILLARY EQUIPMENT
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
	GROUP E - LPG CYLINDER USAGE AT DIFFERENT PREMISES
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