

**MRA LPG**

Code of Practice D6:2008

Ancillary Equipment

LPG Piping Systems: Design and Installation

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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.

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

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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 D6**

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## Section 1. Introduction, Scope and Legal Requirements

### 1.1 Introduction

**1.1.1** This Code has been prepared for the guidance of those involved in the design and installation of LPG pipework systems to be constructed in the Maltese Islands.

- Other relevant Codes and Standards are listed in Appendix D.
- 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).
- Pressures used in this document are gauge pressures.

**1.1.2** In this Code the term LPG means commercial butane and commercial propane in accordance with BS 4250:1997 or its equivalent and mixtures thereof, including unodorised product, and automotive LPG in accordance with MSA EN 589.

- Other properties are given in Appendix A.

### 1.2 Scope

The Code covers pipework for conveying LPG both in the liquid and vapour phases. It is not intended as complete guidance on steel pipework over 150 mm nominal bore, copper pipe over 35 mm outside diameter or polyethylene pipework over 90 mm outside diameter for which additional requirements may be necessary.

Whilst primarily intended for static installations its recommendations may be applied to mobile equipment including road tankers. It may therefore be used to supplement other MRA LPG Codes of Practice in which pipework is included.

This Code includes pipework at premises subject to the LPG legislation (as issued by the MRA) upstream of and including the emergency valve. For installation piping downstream of the emergency control reference should be made to BS 5482 or equivalent.

- The design and installation of LPG piped supplies to multiple consumers is covered in the MRA LPG Code of Practice A5, which extends the requirements given in this Code of Practice.

The following are not covered by this Code of Practice:

- Pipework for automotive purposes on vehicles (MRA LPG Code of Practice C1);
- Pipework for propulsion purposes on boats (MRA LPG Code of Practice C2);

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- Pipework for motive power on mechanical handling equipment (MRA LPG Code of Practice C4).

The information in this guidance gives one way of achieving a minimum standard of safety. Each case should be considered on its merits, and special circumstances may necessitate variations from the recommendations.

The information in this guidance is not intended to preclude the use of alternative designs, materials and methods where these provide equivalent safety standards. The guidance given is primarily intended for new installations, but will equally apply to modifications and alterations to existing installations.

The guidance is given without prejudice to the general requirements under the Health and Safety at Work, LN 36 of 2003, that risks should be reduced to as low as is reasonably practicable.

### **1.3 Legal Requirements**

**1.3.1** In the Legal Notice 249 of 2008, LPG Market Regulations, a “competent person” means a person approved by the Malta Resources Authority who holds a warrant to practice the profession of an engineer under the Engineering Profession Act or the equivalent professional qualification as provided under the Mutual Recognition of Qualifications Act, and who has suitable training, sufficient knowledge, experience and skill in gas technology as approved by the Authority to:

- carry out assessment inspections of authorised facilities;
- supervise material alterations at authorised facilities;
- certify in writing that authorised facilities are designed, constructed, tested and maintained as prescribed in any authorisation conditions and according to guidelines and codes of practice duly approved by the Authority;
- carry out other work of a technical nature that is complimentary or ancillary to the above.

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- *No person other than a competent person shall supervise the carrying out any work or certification in relation to an LPG fitting or an LPG storage vessel.*
- *No person can carry out work in relation to a bulk LPG installation unless he is a competent person, approved in writing by the Authority, or unless he is under the supervision of a competent person.*
- *The employer of any person carrying out any work in relation to an LPG fitting or an LPG storage vessel at any place of work or premises under the control of the said employer, or who is in charge of the work being carried in any place of work or premises, shall ensure that only a competent person shall supervise the carrying out of such work.*

### **1.3.2 OHS Act 2000 (Cap 424)**

The scope of these regulations is to introduce measures by which to encourage and ensure improvements in the health and safety of workers at work through the prevention of risks, the promotion and safeguard of occupational health and safety, and through the elimination of those risks and factors which are likely to cause accidents at work.

### **1.3.3 Health and Safety at Work Places – L.N. 36 of 2003**

It shall be the duty of an employer to ensure the health and safety at all times of all persons who may be affected by the work being carried out for such an employer.

The measures that need to be taken by an employer to prevent physical and psychological occupational ill-health, injury or death, shall be taken on the basis of the following general principles of prevention, that is by:

- (a) the avoidance of risk;
- (b) the identification of hazards associated with work;
- (c) the evaluation of those risks which cannot be avoided;
- (d) the control at source of those risks which cannot be avoided;

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(e) the taking of all the necessary measures to reduce risk as much as reasonably practicable, including the replacement of the hazardous by the non-hazardous or by the less hazardous;

(f) giving collective protective measures priority over individual protective measures;

(g) adapting the work to the worker, particularly in so far as the design of work places, the choice of work equipment and the choice of working and production methods are concerned, in particular with a view to alleviating monotonous work and work at a predetermined work-rate, and to reducing their effect on health;

(h) by adapting to technical progress in the interest of occupational health and safety; and

(i) by the development of a coherent overall prevention policy which covers technology, the organisation of work, working conditions, social relationships and the influence of factors related to the working environment. It shall be the duty of every worker to co-operate with the employer and with the Health and Safety Representative or Representatives at the work place on all matters relating to health and safety.

The scope of these regulations is to introduce measures by which to encourage and ensure improvements in the health and safety of workers at work through the prevention of risks, the promotion and safeguard of occupational health and safety, and through the elimination of those risks and factors which are likely to cause accidents at work.

### **1.3.4 The Pressure Equipment Regulations (L.N. 248/2002 and Transportable Pressure Equipment Regulations (L.N. 331/2002 to Cops – (Pressure System Safety Regulations)**

The Pressure Equipment Regulations shall apply to the design, manufacture and conformity assessment of pressure equipment and assemblies with a maximum allowable pressure PS greater than 0.5 bar. The provisions of these regulations are applicable to all imported pressure equipment as well as to that manufactured for the local market.

The latter regulations (L.N. 331/2002) are applicable to all imported pressure equipment as well as to that manufactured for the local market. The purpose of these regulations shall be to enhance safety with regard to transportable pressure equipment approved for the inland transport of dangerous goods by road and by rail and to ensure the free movement of such

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equipment, including the placing on the market and repeated putting into service and repeated use aspects.

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## Section 2. Location and Design

### 2.1 Location

#### 2.1.1 General

Pipework should be routed away from or otherwise protected from areas where it might be exposed to excessive heat or cold.

Pipework buried underground should be inherently resistant to or otherwise adequately protected against corrosion, for example by using polyethylene piping or installing cathodic protection. Joints in underground pipework should be readily accessible for inspection unless of a type specifically designed for the purpose, e.g. welded joints, polyethylene fusion and transition fittings.

Pipework containing LPG in the liquid phase or the vapour phase at nominal operating pressures greater than 2 bar should not be routed into or through buildings unless necessary for process purposes, e.g. aerosol filling or engine testing.

#### 2.1.2 Distribution pressures in Domestic and Commercial Premises

Within domestic and commercial premises, such as bars, restaurants and offices, installation pipework should not carry liquid phase LPG nor carry vapour at a nominal operating pressure greater than 37 mbar.

Distribution systems within other buildings such as warehouses and factories should be designed to operate at the lowest practicable pressure consistent with the safe and satisfactory operation of appliances.

#### 2.1.3 Service Pipework Entries, Emergency Controls and Meters in Domestic and Commercial Premises

- The following recommendations apply to LPG supplies to domestic and similar low rise premises. For medium and high rise buildings, reference should be made to IGE/TD/4 or for industrial and commercial buildings IGE/UP/2.

2.1.3.1 Service pipe entries to buildings should, wherever possible, be above ground. There should be an emergency control to which there is adequate access situated as near as reasonably practicable to the point where the pipe enters the building. If the emergency valve is located inside the building, it should be as close possible to the entry point.

2.1.3.2 Any emergency control valve should be installed as close as practicable to the point where the gas enters the premises and so that:

- (a) Any key, lever or hand-wheel of the control is securely attached to the

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- operating spindle;
- (b) Any such key or lever is attached so that:
- i. the key or lever is parallel to the axis of the pipe in which the control is installed when the valve is in the open position, **and:**
  - ii. where the key or lever is not attached so as to move only horizontally, gas cannot pass beyond the control when the key or lever has been moved as far as possible downwards, **and:**
  - iii. **either** the means of operating the valve are clearly and permanently marked, **or** a notice is prominently displayed so as to indicate when the valve is open and/or when it is shut;
- (c) Any hand-wheel indicates the direction of opening and/or closing;
- (d) An emergency procedure label is displayed on or near the valve as shown below, or words to that effect.

<p style="text-align: center;"><b>GAS EMERGENCY CONTROL</b></p> <p style="text-align: center;"><b>IN THE EVENT OF GAS LEAKAGE OR SUSPECTED LEAKAGE SHUT THIS VALVE</b></p> <p style="text-align: center;"><b>IF LEAKAGE OUT DOORS SHUT OFF AT THE CYLINDERS (OR TANK)</b></p> <p style="text-align: center;"><b>IF GAS CONTINUES TO ESCAPE NOTIFY THE GAS EMERGENCY SERVICE</b></p> <p><b>*GAS EMERGENCY TEL NO:</b></p> <p style="text-align: center;"><b>DO NOT RE-OPEN CONTROL UNTIL REMEDIAL ACTION IS TAKEN</b></p> <p style="text-align: center;"><b>IN CASE OF FIRE TELEPHONE THE CPD NO: 112 AND INFORM THEM OF THE PRESENCE OF LPG</b></p> <p><b>DATE:</b></p>
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\*May refer to entry in telephone directory.

- 2.1.3.3 Meters should be installed as close as possible to the entry point to the building and wherever practicable outside the building. When located outside a building the meter should be housed together with the emergency valve in a purpose made built-in or surface mounted meter box<sup>1</sup>.

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7 <sup>1</sup> Further advice on the installation of meters (having a capacity up to 6m<sup>3</sup>/h), may be found from British Standard 6400.

## 2.2 Design

### 2.2.1 General

Before installation commences the system design should be considered in line with the recommendations of this Code. Design limits should not be less than those set out in Table 3.

All pipe, fittings and joints etc., should be properly assessed for suitability for the service conditions. All items used should be suitable for the phase of LPG being conveyed and the extremes of pressure and temperature that may be encountered during service. The types of pipe acceptable for the various LPG service conditions are set out in Section 3.

All stainless steel flexible pipes and proprietary materials or systems should be assembled and installed in accordance with manufacturer's instructions.

For pipework having a nominal diameter exceeding 50 mm pipework design, and, where appropriate, stress analysis should be carried out to a recognised Code by a competent person.

For other systems the pipework may be adequately specified without full formal design and stress analysis by using the standards and guidance recommended in this Code.

### 2.2.2 Underground Pipework

The pipework route should be permanently marked or recorded.

Routes should be chosen that minimise the length of pipe required and create minimal disturbance of any underground services, e.g. existing pipework, cables etc.

To facilitate future repair and maintenance a minimum clearance of 250 mm should be maintained whenever reasonably practicable between LPG pipes and the known position of other utilities (including electric cables etc). This separation distance may be reduced for crossings subject to adequate protection being provided, e.g. slabs and sleeving.

Metallic pipework (other than proprietary systems intended for underground use) should only be buried when unavoidable, consideration should be given to the use of polyethylene or proprietary systems as appropriate.

However, where necessary metallic pipe may be laid either:

- a) in a trench backfilled with inert, non corrosive material free of abrasive material likely to damage its corrosion protection;
- b) inside a buried outer pipe or duct which terminates either above ground or in a suitable inspection pit.

Whichever system is chosen the design should make allowance for any additional loading or constraint imposed by backfill or location.

Unless otherwise provided with means to assess the condition of buried metallic pipework, suitable provision should be made to facilitate periodic leak testing.

### **2.2.3 System Pressure**

Vapour distribution pressures should be selected and controlled at levels below that at which condensation may occur at the lowest foreseeable vapour temperature in the pipework system (typically 2,0 bar on propane). Where higher pressures are necessary for the application, precautions need to be taken to prevent condensation, e.g. by heat tracing the pipework system or the use of an LPG-air mixture. Heat tracing should not be applied to polyethylene pipework.

All components should be assessed for suitability for the maximum and minimum pressure and temperatures expected to be found in service. Where necessary, suitable pressure relief valves should be selected. When pressure relief valves are used their pressure should be set below the lowest design pressure of any component being protected and above the maximum operating pressure of the system.

### **2.2.4 Sizing**

Pipework should be sized so as to restrict the contents to a practical minimum.

The size should be selected after consideration of the maximum flows, the acceptable pressure drops and required mechanical strength. The pressure loss for pipe sizing should be calculated for the maximum predicted flow in the system.

For vapour systems, it recommended that a maximum loss of 10% of the nominal set outlet pressure of the 1st stage regulator be used to determine pipe size for pipework between the 1st and final stage regulators. Pipework after the final stage regulator should be sized for an overall pressure loss not exceeding 2,5 mbar, up to the inlet to all appliances. This loss should include that of any meter or other fittings. The pressure at the inlet of appliances under foreseen maximum system demand should not in any case be less than that required for the safe operation.

- Appendix B gives further guidance.

### **2.2.5 Protection against over-pressurisation**

Wherever liquid phase LPG may be trapped e.g. between closed valves or check valves, protection against the pressure exceeding the design pressure of the system should be provided.

Where hydrostatic relief valves are used they should be set to discharge above the maximum *working* pressure of the system but not greater than the *design* pressure of the pipework at ambient temperature and components being protected.

Typical discharge pressures are:

- Propane: 24 bar (19 bar where ASA 150 or similar flanges are used);
- Butane: 19 bar gauge.

The discharge point of hydrostatic relief valves should be located and orientated so that in the event of a release the discharge would not impinge on personnel, vessels or equipment.

The outlets of any hydrostatic relief valve system should be fitted with suitable caps to prevent the entry of water/debris.

To reduce the risk of blockage the hydrostatic relief valve inlet connections should not be on the underside of pipework.

When PTFE tape is applied to the male threads of hydrostatic relief valves the tape should be left off the first thread to prevent carryover into the mechanism in the event of the valve operating.

Where it is necessary to install hydrostatic relief valves in enclosed spaces, sufficiently sized discharge pipework should be taken to an outside area. Suitable signs should be fitted adjacent to the discharge pipework.

Where extensions are fitted these should be suitably supported to prevent mechanical stress on the hydrostatic relief valves.

### **2.2.6 Routing**

The routing of above ground pipework should be selected to minimise the possibility of:

- trip hazards;
- inadvertent physical contact;
- physical damage, e.g. by vehicles or mobile equipment;
- misuse, e.g. by children as a climbing apparatus or as a convenient 'hanging' device.

Where necessary, additional protection such as bollards or barriers should be provided.

Pipework should not be laid under:

- foundations of a building;
- the footings of a load bearing wall;

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- a floating raft foundation.

Pipework shall not be installed in an unventilated space.

Pipework shall not be run within cavity walls. Every pipe passing through a cavity should take the shortest practicable route.

Pipework passing through any external wall should be sleeved. Sleeves should be of material which is continuous, non-porous and protected against corrosion e.g. polythene, copper, plastic coated steel, PVC or other suitable materials. Metallic sleeves of dissimilar metal to the pipework should not be used. Sleeves should be sealed at the inner end with a flexible fire resistant compound. They should be sealed to the structure with a suitable building material e.g. cement mortar. The installation should ensure that gas cannot pass between the pipe and the sleeve and between the pipe and the wall or floor and should allow normal movement of the pipe.

### 2.2.7 Supports and Anchors

Pipework supports and anchors should be located and designed to ensure that pipework stresses and deflections due to predictable loads are within acceptable limits. If necessary this should include flexibility to accommodate any unavoidable movement.

In determining pipe supports and their location consideration should be given to loads other than self weight and other predictable loads, e.g. for small pipework superimposed loads due to personnel standing on or pulling on pipework.

**Table 1:  
Guide to maximum distance between horizontal pipework supports**

<b>Steel</b>													
Nominal inside diameter (mm)	8	10	15	20	25	40	50	65	80	100	125	150	
Span (m)	1.0	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.5	6.0	7.0	8.0	
<b>Copper</b>													
Nominal outside diameter (mm)	10	12	15	22	28	35							
Span (m)	1.0	1.0	1.3	1.75	2.0	2.0							

#### Notes:

1. No allowance has been made for superimposed loads or anchoring against structural forces.

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2. For medium weight steel pipe reduce the spans by 10 %.
3. For vertical runs, maximum distance between supports can be increased by approximately 30 %.

Vibration, surge pressures and valve operating torque should be considered in the design of pipework and supports incorporating mechanical equipment such as pumps and valves.

When laid in an open trench pipework should be supported above the bottom. The trench dimensions and pipe supporting arrangements should be such as to facilitate visual inspection and maintenance e.g. wire brushing, repainting of the pipe and supports. Trenches should not enter buildings.

Protection should be provided in the form of load-bearing slabs or covers for those sections over which traffic passes or on which other loads may be superimposed.

Piping may be laid in the same trench as piping carrying inert or flammable liquids or gases, but not with piping carrying oxygen. It should not be laid in the same trench as piping carrying toxic or corrosive fluids, or fluids at a temperature significantly above ambient, e.g. steam.

Electric cables should not be run in the same trench as liquid phase LPG pipework unless they are protected by an outer pipe or sleeve.

- Mobile installations, e.g. road tanker pipework, need particular consideration of vibration and relative movement between equipment.

### 2.2.8 Thermal Expansion

Pipework layout and supports should provide adequate allowance to accommodate any movement that may occur due to thermal expansion or contraction over the range of temperature expected in service.

**Table 2: Thermal Expansion**

Linear thermal expansion from -20°C to 40°C.	
Carbon Steel	0,67 mm/m
Copper	1,00 mm/m
Polyethylene	8,70 mm/m

Average coefficient of linear thermal expansion	
Carbon Steel	$11,6 \times 10^{-6}$
Copper	$17,2 \times 10^{-6}$

Polyethylene	150 x 10 <sup>-6</sup>
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### 2.2.9 Corrosion Protection

Installations and components not inherently resistant to corrosion should be suitably protected.

For above ground pipework these include galvanising, painting or wrapping. For below ground these include wrapping and/or sleeving and cathodic protection.

- Trace heated lines and lagged pipework are difficult to protect and specialist advice should be sought.

Where no suppliers' instructions are available for wrapping the following procedures should be adopted:

- (a) leak testing and examination of joints should be carried out before the joints are wrapped;
- (b) after preparation by cleaning and drying the wrapping should be applied spirally to the pipe in one direction only ensuring a minimum overlap greater than 50 %;
- (c) the wrapping should extend to overlap any existing pipe coating for at least 50mm;
- (d) where irregular shapes are involved, the use of a coating mastic with an overlap of tape should be considered;
- (e) where pipework rises out of the ground the wrapping should extend to at least 150mm above ground level;
- (f) the complete wrapping should be carefully inspected before and after installation. The visual inspection can be supplemented by other tests e.g. inspection with a holiday spark detector;
- (g) care should be taken in the handling of wrapped pipe to avoid damage to the coating, since any flaw will provide a centre for accelerated corrosion.

Cathodic protection systems should be designed by persons competent in this field.

Where cathodic protection is applied or likely to be applied to buried metallic pipe work, above ground pipework to which it is connected should be electrically insulated from the buried section by means of non-conducting fitting, or insulated flange joint, suitable for use with LPG<sup>2</sup>.

Buried or mounded storage vessels with cathodic protection should be electrically insulated from any connected metal pipework not intended to be included in the protection.

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<sup>2</sup>MSA EN 60871-4: 1997 , IEC 60871-4: 1996 gives further guidance

### **2.2.10 Colour Coding and Pipeline Identification**

Where LPG pipework needs to be distinguished from pipework for other services, it should be colour coded. BS 1710: 1984 or equivalent specifies the colour coding for gas, but not specifically for LPG pipework, as British Standard 4800: 1989 'yellow ochre' 08C35 or equivalent. Where other 'gases' are present which would also need to be colour coded 08C35 in accordance with BS 1710: 1984 or its equivalent, supplementary identification should be included e.g. "Propane", "Natural Gas" etc.

Pipework containing LPG in the liquid phase should be identified as such.

### **2.2.11 Valving**

Valves should be suitable for the system design, phase of LPG, the pressures and temperatures that can be reached in service and for the operating conditions. They should be installed and tested in accordance with the manufacturer's instructions and any standards relative to the system design.

Shut-off valves should be installed in the system to enable items of equipment and sections of pipework to be readily isolated. Where sections of pipe containing liquid LPG can be isolated, the pipework should be protected from over pressurisation e.g. by fitting of suitable hydrostatic relief valves. See 2.2.5.

Where valves are installed in polyethylene pipework precautions should be taken to avoid damage to the pipework arising from the operating torque of the valve. This may be achieved by valve design or by anchoring the valve and/or the installation of anti-shear sleeves.

Manual emergency control valves should be installed as required by 2.1.3.2.

All valves should be installed free of excessive external stress and adequately supported or secured against foreseeable forces e.g. valve operating torque.

Valves may be flanged, welded or threaded. Where seals are made on the thread, female threads used for liquid and vapour service above 4 bar should have a tapered form.

Valves used on liquid or vapour service above 4 bar and/or subject to significant thermal variations or shock should be either:

- steel;
- bronze;
- forged brass;
- ductile iron to MSA EN 1563: 1997 or equivalent with an elongation at fracture of not less than 18%.

### **2.2.12 Earthing and Cross Bonding**

Pipework within premises should be electrically earthed by cross bonding in accordance with BS 7671: 2008 or equivalent. If a gas fitting is disconnected, a suitable temporary bond to maintain electrical continuity should be used. Gas piping should not be used as the earth for electrical apparatus.

External pipework carrying liquid should have electrical continuity with the storage vessel(s), except as required by 2.2.9 as a precaution against static electricity. The use of bonding straps is not normally required for flanged pipework.

Notwithstanding the requirement in 2.2.9 consideration should be given to electrically insulating above ground pipework in premises from buried metallic pipework particularly where the buried pipework is extensive and may be subject to induced stray currents.

- For installations on petrol filling stations attention is drawn to the IP/APEA “Guidance for the design, construction, modification and maintenance of petrol filling stations”.
- For installations at other industrial sites attention is drawn to EEMUA Publication 186 “A Practitioner’s Handbook - Electrical Installation and Maintenance in Potentially Explosive Atmospheres.”

### **2.2.13 Jointing**

Joints should be made to the standard required by the materials being used. Threaded joints, flanged joints or compression fittings should be kept to a minimum to limit potential leak sources. Multiple threaded reducers should be avoided.

Compression fittings should be carefully selected as suitable for contact with LPG and to withstand the internal pressure and end tension forces to which they may be subjected. They should be installed in accordance with the manufacturer’s instructions.

Elastomeric (rubber) seals should be resistant to both phases of LPG and meet the relevant requirements of MSA EN 549: 1995

Sealing materials for threaded joints should meet the relevant requirements of MSA EN 751: 1997

### **2.2.14 Flexible Connections**

Non metallic flexible connections in permanent pipework should be avoided where practicable.

If hoses to BS 3212: 1991 or MSA EN 1762: 2003 are used to connect installations to fixed pipework (see MRA LPG Code of Practice A5) they should be armoured against rodent attack.

Where connectors are used to allow for unavoidable pipework movement, vibration or misalignment, their lengths should be as short as reasonably practicable and, where

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applicable, maintain electrical continuity. Their orientation and length should ensure the movement does not put them into tension or impose torsional stresses. Figs. 1, 2 and 3 illustrate the principles.

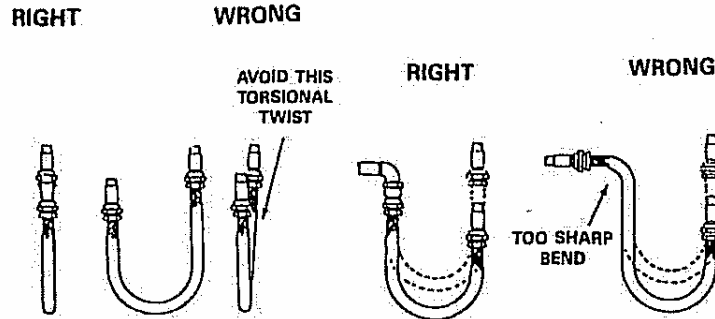


Figure 1: General principles of correct orientation of flexible tubing.

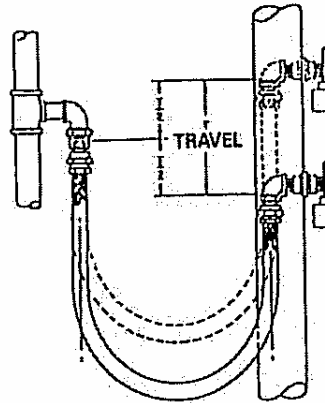


Figure 2: Flexible tube installation — vertical loop for maximum vertical travel

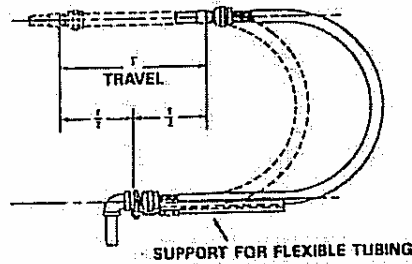


Figure 3: Flexible tube installation for horizontal travel

Hoses should comply with a standard ensuring they are acceptable for conveying LPG as

vapour or liquid as required and for the service intended.

MSA EN 1762: 2003 and BS 4089: 1999 give further guidance.

Hoses in pipework conveying liquid LPG, or vapour at vessel pressure, should have excess flow valves, remotely operated valves or non-return valves as appropriate as close to the hose inlet and/or outlet as practicable which are designed to limit the discharge of LPG in the event of a failure of the hose.

### **2.2.15 Breakaway/Pullaway Couplings**

Breakaway/pullaway couplings, or other equipment providing equivalent protection, should be used to avoid the risk of hose or rigid piping fracture from the drive away of a connected vehicle or road/rail tanker. The fixed half coupling needs to be anchored to resist the break away force which should be less than that which would cause permanent pipe or hose distortion or failure or damage to the vehicle/tanker fitting. The manufacturer's instructions should be strictly followed. In liquid transfer lines, protection against over pressurisation, e.g. by the fitting of suitable hydrostatic relief valves, is necessary between the coupling and its associated shut-off valve.

### **2.2.16 Pressure Measurement and Test Points**

Facilities for pressure measurement and/or suitable test points for operational use and/or for commissioning, e.g. leak testing and purging, should be provided in a safe and accessible position.

Where pipework runs underground a purpose designed access may be necessary.

### **2.2.17 Polyethylene Pipework**

Polyethylene pipe is for installation underground (i.e. buried) but the ends should be brought above ground level for connection to above ground pipework. These ends should be as short as practicable, and in no case the total should exceed 2m in length, and be connected to metal pipe or fitting by means of suitable transition fittings having anti-shear protection. The part of polyethylene pipe above ground needs to be suitably protected against sunlight and mechanical damage by the use of steel, GRP or other suitable sleeving.

Where underground transition between polyethylene and metallic pipe cannot be avoided the anti-shear protection (see 3.5.5) should be fitted with additional corrosion protection applied to the metallic pipe paying special attention to any exposed threads.

Polyethylene pipe should not be taken into or under buildings. When suitably sleeved it may be taken up the outside ground floor wall of a building either to an external terminal or meter box or to an above ground entry position.

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## Section 3. Pipework Materials and Construction of Assemblies

### 3.1 Pipework Design Limits

Pipework, joints, fittings etc should be of a standard suitable for the extremes of pressures and temperatures and mechanical stresses that could occur in service. In addition, they should be sufficiently robust to withstand reasonably foreseeable damage or other extraneous forces without hazardous failure.

**Table 3: Typical Design Limits**

<b>Liquid Phase</b>	
Pressure	Not less than the vessel design pressure or higher pressure if indicated by the process, e.g. pumps etc. Recommended design pressures for non-pumped systems: <i>Propane:</i> 24 bar gauge (19 bar if ASA 150 flanges or other similar rated equipment installed) <i>Butane:</i> 19 bar gauge
Temperature	<i>Maximum:</i> not less than the upper design temperature of the vessel. <i>Minimum:</i> minus 20°C
<b>Vapour Phase</b>	
<b>At Storage Pressure</b>	
Pressure	Not less than the vessel design pressure, or higher pressure, if dictated by the process, e.g. compressors, vaporisers etc.
Temperature	<i>Maximum:</i> not less than the upper design temperature of the vessel Or higher temperature if dictated by the process <i>Minimum:</i> minus 20°C (where two phase flow may occur a lower temperature may be appropriate)
<b>After 1st Stage Regulator</b>	
Pressure	Not less than vessel design pressure to protect against regulator pressure creep under lock-up or regulator failure, or the pressure set by any additional pressure limiting device where fitted.
Temperature	<i>Maximum:</i> 50°C above ground or, in accordance with manufacturers specification for underground pipework <i>Minimum:</i> minus 20°C
<b>After 2nd Stage Regulator</b>	
Pressure	Not less than maximum upstream pressure, to protect against regulator pressure creep under lock-up regulator failure, or the pressure set by any additional pressure limiting device where fitted.
Temperature	<i>Minimum Outdoors:</i> minus 20°C <i>Minimum Indoors:</i> 0°C

### 3.2 Types of Pipe for LPG Service

Table 4 summarises the broad types of pipework that may be used for various LPG services.

Table 5 gives further data on specific types of pipe.

**Table 4: Types of Pipework for LPG Service**

	Above Ground			Below Ground (Buried)		
	Liquid	Vapour 4 bar up to vessel pressure	Vapour up to 4 bar	Liquid	Vapour 4 bar up to vessel pressure	Vapour up to 4 bar
Carbon Steel	Yes	Yes	Yes	Yes	Yes	Yes
Carbon Steel BS 1387 or equivalent	No	No	Yes	No	No	Yes
Cast Iron	No	No	No	No	No	No
Copper: Solid Drawn	No	Yes	Yes	No	Yes	Yes
Polyethylene SDR11 or 17	No	No	No	No	No	Yes
Stainless Steel	Yes#	Yes#	Yes#	Yes#	Yes#	Yes#
Proprietary Systems	Yes#	Yes#	Yes#	Yes#	Yes#	Yes#

# Subject to manufacturers' specification

Table 5: Pipe Data

Material	Specification	Notes
CARBON STEEL	Max. Carbon 0,25 % MSA EN 10216-1: 2002 / MSA EN 10217-1:2002 MSA EN 10217-5: 2002 / MSA EN 10217-3: 2002  API 5B ASTM A 106B	For use with welded fittings wall thickness equivalent to 'Schedule 40' or 'Standard wall' may be used.  When used with threaded fittings to BS 3799: 1974 or equivalent wall thickness equivalent to 'Schedule 80' or 'Extra Strong' must be used to prevent distortion during threading.  MSA EN 10216-1: 2002 / MSA EN 10217-1:2002 and MSA EN 10217-5: 2002 / MSA EN 10217-3: 2002 pipes are available dimensioned to MSA EN 10220: 2002 or BS 1600: 1991/MSA EN 1600: 1997 or BS 1387 or equivalent. Great care is needed therefore to ensure that pipe and fittings/flanges are compatible. API & ASTM pipes are dimensioned to ANSI B.36.10 equivalent to BS 1600:1991 / MSA EN 1600: 1997.
WELDED SEAM	BS 1387 or equivalent	Suitable for welding or for screwing to BS 21: 1985 pipe threads or equivalent.
COPPER	Solid Drawn MSA EN 1057: 2006 Temper Designation, R220 or R250 to MSA EN 1057: 2006	n/a
POLYETHYLENE	Extruded Polyethylene MSA EN 1555-1/2/5: 2002 or MSA EN 1552-2 (when published)	Polymer classification PE80 or PE100 in accordance with ISO TR 9080.  Pipe marking as required by the Standard.
STAINLESS STEEL	BS 4089: 1999/BS 6501-1: 2004 BS 6362: 1990 or their equivalent, ISO 7598: 1998. MSA EN ISO 1127	Flexible tubes. Stainless steel tubes suitable for screwing in accordance with BS 21: 1985 or equivalent.
PROPRIETARY SYSTEMS	n/a	Manufacturer's specification.

### 3.3 Construction of Carbon Steel Pipework Assemblies

#### 3.3.1 Welded Fittings

Forged steel butt weld or socket weld fittings may be used.

For butt weld fittings the thickness of the fitting should be compatible with the thickness of the pipe.

For socket weld fittings the method of preparation of the pipe and its subsequent welding to the socket should be carried out as detailed in the relevant standards.

#### 3.3.2 Threaded Fittings

Wrought steel or malleable iron fittings may be used for vapour service at pressures up to 4 bar. If galvanised pipework is used the fittings should also be galvanised. Where the seal is made on the thread, male threads should always be tapered, female threads may be tapered or parallel.

Threads to BS 21:1985 (BSP), ANSI B.1.20.1 (NPT) or equivalent should be used where the seal is made on the thread.

Threaded fittings should only be used on below ground pipework if subsequently seal welded or if specifically designed for the purpose e.g. transition fittings for polyethylene tubing.

Threaded fittings should not be used for pipe joint sizes greater than 50mm. Threaded connections for sizes up to and including 80mm may be made to items such as valves, pumps, meters etc.

Joints above these sizes should be made by welding or by welded flanges.

Threaded fittings for liquid service or vapour service at pressures of 4 bar and above should be of forged carbon steel. Both male and female threads should be tapered and of the same form. Only "Schedule 80"/"Extra Strong" pipe should be used for threading to reduce the risk of deformation.

#### 3.3.2 Welded Flanges

Welded flanges should be rated for the maximum system design pressure and the pipe thickness used.

Slip-on or weld-neck flanges may be used.

For slip-on flanges the bore of the flange should be suitable for the outside diameter of the pipe. The flange should be welded on both sides (i.e. double continuous fillet weld).

Welded flanges should only be used on below ground level (buried) pipework where essential for assembly/disassembly. They should be protected against corrosion and be

readily available for inspection.

### **3.3.3 Threaded Flanges**

Threaded flanges should not be used for pipe joint sizes greater than 50 mm. Threaded flanges for sizes up to and including 80mm may be used for connections to items such as valves, pumps, meters etc.

Joints above these sizes should be made by welding or by using welded flanges.

Threaded flanges for liquid service or vapour service at pressures of 4 bar and above should be of forged carbon steel. Both male and female threads should be tapered and of the same form. Only "Schedule 80"/"Extra Strong" pipe should be used for threading to reduce the risk of deformation.

Threaded flanges should not be used on below ground pipework unless essential for assembly/disassembly. Threads should be subsequently seal welded. Threaded flanges should be protected against corrosion and be available for inspection.

### **3.3.4 Compression Fittings**

Compression fittings should only be used on carbon steel pipework if specifically designed for the purpose.

## **3.4 Construction of Copper Pipework Assemblies**

### **3.4.1 General**

Copper pipework assemblies should not be used where vibration may cause work hardening leading to failure.

When installed below ground additional external corrosion protection such as a factory applied plastic coating should be employed. Such protection should terminate above ground level.

Buried copper pipework should be laid in the longest lengths practicable to minimise buried joints. This is facilitated by using annealed tubing, which can be supplied in coils of much longer length than half-hard.

### **3.4.2 Brazed or Soldered Fittings**

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. Solder having a melting point of not less than 450 °C should be used in liquid service or vapour service at pressures above 4 bar.

Fittings used for below ground connections should be de-zincification resistant or de-zincification immune.

### 3.4.3 Compression Fittings

Fittings should be suitable for LPG at the design pressure. They should be non-ferrous and compatible with the pipe standard. Where plastic coated copper pipe is used appropriate compression fittings designed for the specific coating thickness should be used.

Unless specifically designed for the purpose, compression fittings should not be used for below ground connections.

### 3.4.4 Threaded Fittings

Copper pipe should not be threaded. Connection to threaded fittings requires a transition fitting using a compression, brazed or soldered connection to the pipe.

## 3.5 Construction of Polyethylene Pipework Assemblies

### 3.5.1 General

Polyethylene Pipework should only be used for below ground systems.

Polyethylene pipe with a Standard dimensional ratio (SDR) of 11 may be used for pressures up to 4 bar.

**Note:** Continuous improvement in material properties may modify these recommendations and reference should be made to the manufacturers for current temperature and operating pressure limits.

- Propane distribution at nominal operating pressures greater than 2 bar are not normally used because of the possibility of vapour condensation at low temperature.

### 3.5.2 Fusion Fittings

Electrofusion fittings should comply with MSA EN 1555-3: 2002 or ISO 8085 part 3.

Fittings for fusion jointing of polyethylene pipe should be compatible with the pipe polymer and specification.

Butt fusion welding should not be used for pipe less than 63 mm diameter.

Only competent fully trained operatives should carry out fusion operations.

### 3.5.3 Compression Fittings

Compression fittings may be used for polyethylene pipe up to and including 63 mm diameter, they should be compatible with the pipe specification.

Manufacturer's fitting instructions should always be observed. A tube liner, usually supplied with the fitting should be used to make a satisfactory joint.

Fittings should have a resistance to pulling apart and disconnection from the pipe as a result of end tension at least equal to the tensile breaking strength of the adjacent pipe.

All metal components should be corrosion resistant or adequately protected against corrosion. Such protection may be applied at the time of installation, and the components of any such protection medium should not be deleterious to polyethylene.

### **3.5.4 Other Mechanical Fittings**

Fittings other than compression fittings, e.g. using cold swaging techniques to form a polyethylene to metal connection, should meet the requirements of 3.5.3.

### **3.3.5 Anti-Shear Sleeves**

Anti-shear sleeves or other means to protect polyethylene pipe, up to and including 63 mm diameter, against bending stresses, should be installed at:

- (a) polyethylene to metal pipe junctions;
- (b) service branch connections to metal mains of sizes 63mm or greater;
- (c) valves, to react against operating torques unless the valve is suitably anchored.

Polyethylene pipe adjacent to polyethylene to steel transition couplings and polyethylene branch pipes adjacent to tees should be protected from distortion caused by external forces by the use of an anti-shear sleeve of adequate length. The transition coupling or branch fitting should be designed to accept such a sleeve. Plastic anti-shear sleeves used above ground should be stabilised against ultra-violet radiation.

Anti-shear sleeves are not required at electrofusion couplings due to the support and reinforcement imparted by the heating wires and extended socket length.

## **3.6 Construction of Stainless Steel Pipework Assemblies**

### **3.6.1 Welded Fittings**

Welded joints should be used to secure suitable fittings to the pipe.

### **3.6.2 Compression Fittings**

Fittings should be suitable for LPG at the service pressure. They should be compatible with the pipe standard. Compression fittings should not be used for below ground connections unless specifically designed for the purpose.

### **3.6.3 Threaded Fittings**

Stainless steel pipe should not be threaded unless specifically designed for this purpose. Other threaded fittings require a transition fitting using a compression or welded connection to the pipe.

## **3.7 Construction of Proprietary Pipework Assemblies**

Assemblies made up of proprietary systems meeting the requirements given in Appendix C should be made up in accordance with the system supplier's instructions.

Transition to other types of pipework or to equipment should be via purpose-designed fittings.

## Section 4. Fabrication and Assembly

### 4.1 General

Pipe should be cut squarely. Any burrs, swarf, shavings or spatter from cutting, threading or welding should be removed.

### 4.2 Steel Pipe

#### 4.2.1 Welded Joints

**Note:** For pipework within the scope of the Pressure Equipment Regulations weld procedures and welder qualification may need to be approved by a competent third party.

Before the start of any work procedures, including those for inspection, should be established in accordance with the appropriate welding standard.

- MSA EN 288-9: 1999 gives further information.

The standard to be used should be established depending on the proposed service and pipe size.

Welding should only be carried out by a suitably Approved welder.

- MSA EN 287-1: 2004 gives guidance on welder approval.

Galvanised pipe should not be welded.

Carbon steel pipe and fittings should not have a metal temperature below 5°C when any hot cuffing or welding is carried out.

#### 4.2.2 Bending

Pipe should not be bent beyond its recommended minimum bend radius.

#### 4.2.3 Thread Form

Pipe should be of a suitable thickness for threading.

All threads should be clean and correct to gauge for their length and depth.

The thread on the pipe must be compatible with that on the fittings.

- Threads to BS 21: 1985 (BSP) or equivalent are not compatible with American ANSI B.1.20.1 (NPT) threads or equivalent.

Male threads should be tapered.

Female threads in liquid service or vapour service at pressures above 4 bar should be tapered.

Female threads in vapour service at pressures at or below 4 bar may be parallel or tapered.

#### **4.2.4 Thread Sealants**

To ensure long term pressure tightness of the joints, PTFE tape or sealant compound should be used. Non-setting sealants are preferred.

Joining materials should be checked to ensure suitability for the joint design, pressure and phase of LPG being conveyed.

**Note:** Some sealants marked for LPG use are only suitable for use with LPG in the vapour phase.

#### **4.2.5 Thread Engagement**

Adequate thread engagement depends on the thread standard and dimensions, for which the relevant standard should be consulted.

As a guide the minimum, hand tight, engagement should not be less than:

- 4 turns for pipe sizes  $\frac{1}{4}$ " –  $1\frac{1}{2}$ ";
- 5 turns for pipe size 2" and above.

#### **4.2.6 Seal Welding**

Seal welding of threaded joints should only be used when no other satisfactory means of joining is available.

The materials should be suitable for welding.

- This precludes the use of malleable fittings.

The joint should be made up clean and dry and free of jointing materials. The seal weld should cover all the exposed threads.

Welding should be carried out in accordance with an established procedure by a welder who is suitably trained for the procedure e.g. MSA EN 287-1: 2004 and MSA EN 288-9: 1999.

#### **4.2.7 Flanged Joints**

Steel flanges and flanged fittings should be selected for an appropriate duty and pressure rating.

Flanges to different standards and pressure classification should not be mixed or interchanged. Mating flanges should be compatible.

Fabrication should leave flange faces parallel and their centres in line. Excessive strain can

cause leakage at the flange and/or damage to adjacent equipment.

Gaskets should be suitable for the duty required and be of the correct size and shape for the flanges and of a thickness suitable for the system pressure.

Gaskets of natural rubber or bonded with natural rubber should never be used.

- The application of inappropriate jointing compound may adversely affect performance of the gasket/flange.

#### **4.2.8 Compression Joints**

Compression joints should be suitable for the duty and installed in accordance with the manufacturer's recommendations.

#### **4.2.9 Pipe Corrosion Protection**

Carbon steel pipework not protected by galvanising or equivalent should be protected from corrosion by some other method e.g. painting. Particular attention should be paid to protecting the pipe where it rests upon supports.

Damage to galvanising, e.g. on threads, should be repaired with a suitable coating.

### **4.3 Copper Pipework**

#### **4.3.1 Brazed or Solder Joints**

For nominal pressures above 75 mbar fittings should be assembled using a solder or spelter having a melting point above 450 °C.

For nominal pressures of 75 mbar and below, capillary fittings can be assembled using "tradesmen's" or soft solder.

Capillary fittings in mobile installations should be assembled using a solder or spelter with a melting point above 450 °C.

Fittings may either be integral solder ring type or end feed type.

#### **4.3.2 Compression Joints**

Installation and choice of olive design/materials should be carried out in accordance with the manufacturer's instructions.

Particular care is required in preparing tube ends. Over tightening beyond manufacturer's recommended torque may distort the joints or tube and cause leakage.

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Where plastic coated copper pipe is used appropriate manufacturer's instructions need to be consulted for correct assembly and if appropriate for extending the corrosion protection.

Sealant should not be applied to olives.

### **4.3.3 Bending**

Cold bending may be carried out providing the necessary precautions are taken against flattening of the pipe.

## **4.4 Proprietary Systems**

Proprietary systems should be fabricated in accordance with the supplier's recommendations.

## **Section 5. Special Requirements for Pipework Installed Below Ground Level (Buried)**

### **5.1 General**

Fabrication and welding techniques should be as set out in Section 4.

Joints should be kept to the absolute minimum in buried sections of pipe.

Due consideration should be paid to preserving the integrity of any corrosion protection of the pipe and fittings.

### **5.2 Depth of Cover**

#### **5.2.1 General**

Pipe should be laid at a sufficient depth to provide cover adequate for the likely superimposed loads. Where depth of cover alone is insufficient to protect against such a load, additional protection should be provided.

#### **5.2.2 Fixed Piped Networks Mains and Liquid Pipework**

Where no abnormal loading is likely, the cover should not be less than: -

- 600 mm within private property and under tarmac or grass footpaths where there is no likelihood of heavy traffic.
- or
- 750 mm under roadways and adjacent grass verges, and elsewhere.

Lesser cover may be approved by a competent person if experience indicates that the proposed location gives rise to a negligible risk of interference or damage or the trench design or cover is such as to spread load or minimise the risk of interference or damage.

Further guidance may be found in the MRA LPG Code of Practice A5.

#### **5.2.3 Service Pipework (wholly on private property)**

Cover of not less than 375 mm is acceptable where the risk of interference damage or mechanical damage is negligible. Otherwise the depth of cover should not be less than 600 mm unless the pipe is protected against possible damage e.g. by the laying of concrete slabs or substantial tiles approximately 100 mm above the pipe.

### 5.3 Trench Preparation

Open trenches should be protected against accidental entry.

Trenches should be excavated to the appropriate depth for the pipe to rest on firm, even ground, free from stones, rocks, bricks or concrete etc. If appropriate, topsoil or surface materials should be kept separate from the excavated sub-soil for subsequent replacement.

When pipe laying across rock or ground of irregular consistency, the trench should be excavated to 75 mm below the required depth to enable the pipe to be laid on a bed of sharp sand and shingle or other suitable fine material.

Pipework carrying liquid should always be laid on a sand bed.

To assist in maintaining depth of cover and gradient where necessary and to avoid obstructions without making sharp deviations from the route for long runs, the trench should be excavated approximately 15-20 metres ahead of pipe laying.

The trench width should be kept to a minimum consistent with the method of construction. Joint holes and access points may be required to allow joints to be properly made and subsequently inspected.

### 5.4 Pipe Indication

A yellow plastic indicator tape, or equivalent should be laid between 100mm and 300 mm above the pipe, unless the pipe is in vapour service **and:**

- (a) the route of the pipe is adequately recorded or marked or is obvious, or:
- (b) other means are available for pipe location, or:
- (c) the pipe is a service or installation pipe which can be isolated from the main or gas supply.

Where employed, indicator tapes for polyethylene pipe should incorporate a metallic core wire, for locating the pipe route by using a suitable instrument.

### 5.5 Trench Backfilling

Care should be taken not to damage pipe pre-coating or corrosion protection during installation. Prior to backfilling all coating and wrapping should be inspected and where necessary repaired.

Where cathodic protection is used back-filling must be carried out carefully to avoid damage to wiring between cathodic protection anodes and the pipework and strain being placed on electrical connections.

The trench may be backfilled prior to pressure testing provided all joints and connections are left exposed. The backfill should be carried out progressively in layers from one end of the pipe system.

The backfill at the sides of and immediately above the pipe should be the same as that used for the under bedding.

The initial cover of backfill should be placed in layers and carefully consolidated by hand to provide firm lateral support between the pipe and the trench side.

Use of wet clay should be avoided immediately adjacent to the pipe. It cannot be sufficiently compacted and is liable to swell, shrink and erode. Fill such as hard chalk, which breaks up when wet, should not be used.

Special consideration and selection of backfilling materials will be necessary if the risk of surface subsidence is an important factor, e.g. under roads. Where necessary concrete slabs or steel sheets on a cushion of filling material above the pipe should be used as protection against inadvertent damage.

## **5.6 Pipe Laying Without Trenching**

Mole ploughing or boring may be used as alternatives to open trench laying. Procedures should follow recommendations of the equipment suppliers, recognised Codes, or other competent authority. A suitable inspection technique should be employed to ensure that pipes are not damaged during insertion or burial.

## **5.7 Polyethylene Pipework**

### **5.7.1 General**

Polyethylene pipework should always be laid in backfilled trenches, outer tubes or covered ducts and carefully supported by backfill.

The installation of polyethylene pipe should always be carried out, by competent trained persons, in accordance with the manufacturer's recommended procedures.

### **5.7.2 Laying**

Pipework should be laid without tension on the base of the prepared trench. It should be laid to avoid kinking or gouging. Changes in direction may be made by use of suitable fittings or by utilising the flexible properties of polyethylene. In the latter case radii used should not be less than:

- Plain pipe with sockets, joints or fittings on the bend 25 x diameter
- Plain pipe 15 x diameter

The pipework should be laid in the trench so that it is not left in tension. The final tie in should be delayed until the pipe has had sufficient time to relax. This applies particularly in summer months. In winter the pipe lengths are likely to be at their minimum and any final tie in may be completed without allowance for further relaxation.

### **5.7.3 Pipework Alteration (squeeze off technique)**

To facilitate 'in service' pipework alterations, sections of Polyethylene Pipework can be isolated from the gas supply by the use of a squeeze-off tool. Only tools approved by the pipe manufacturer should be used, and they must be suitable for the diameter and SDR of the pipe. Squeeze off may only be applied not less than 3 pipe diameters from any pipe fitting or from where any squeeze off has already been applied. Where double squeeze off is applied 6 pipe diameters should be allowed between the squeeze points. Double squeeze off is recommended for pressures above 75 mbar, and all pipes exceeding 63 mm diameter.

The tool squeezes and deforms the pipe sufficiently to close the bore. After removal the pipe should be encouraged to return to its normal shape by the use of an approved re-rounding tool.

Squeeze off which might result in interruption of supply should only be carried out in accordance with a written procedure.

The position squeezed off should only be used once. To avoid repetition, the place should be marked with a tape marked '*Squeeze off applied here.*'

## **5.8 Proprietary Systems**

Proprietary systems should be laid in accordance with manufacturers' instructions.

Pipework should be laid in the longest lengths practicable to minimise buried joints.

Installation should only be undertaken, by appropriately trained competent personnel, in accordance with the proprietary system supplier's instructions.

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## Section 6. Pre-Service Inspection, Testing and Commissioning

### 6.1 General

Before putting into LPG service the complete piping installation should be inspected, tested and then commissioned.

- Consideration should be given to the provision and use of personal protective equipment during testing and commissioning.

After assembly and before commissioning, pipework systems should always be pressure tested to ensure they are fit for service.

There are two types of pressure test, proof test and leak test. 6.4 describes when proof testing is required.

All assemblies should be leak tested in accordance with 6.5.

Guidance on pressure testing, procedures, equipment and records is given in 6.6.

### 6.2 Inspection

Prior to testing the complete piping installation should be checked to confirm it is assembled correctly.

Hydrostatic relief valves should be checked to confirm location and correct set pressures.

Welded joints should be tested and/or inspected as required by the relevant design and welding standards.

Fittings should be examined to ensure correct alignment and that there is no undue strain.

Flanges, gaskets and bolts should be examined to ensure correct alignment that there is no undue strain and they are correctly assembled.

Threaded joints should be examined to ensure correct assembly; appropriate use of sealant and that there are no excessive exposed threads.

Pipe supports should be examined to ensure that there is no undue strain on the pipe or the support.

Compression joints should be examined to ensure there is no undue distortion of tube and the nuts have not been over tightened.

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Capillary joints should be visually examined to confirm that the spelter or solder has run correctly between the tube and fitting.

Polyethylene joints should be examined to ensure they are correctly made and that there is appropriate above ground protection.

### 6.3 Proof Testing

Welded, brazed or soldered systems or spools used for liquid phase or vapour phase LPG at a nominal operating pressure in excess of 4 bar, should be proof pressure tested at a pressure of not less than 1,5 times maximum system design pressure.

Proof testing is *not* required when:

- the system is designed for vapour service at a nominal operating pressure not exceeding 4 bar, or:
- the system is assembled entirely using screwed, flanged and or compression fittings due to the inherent strength of such joints, or:
- the installation comprises a proprietary system previously whose parts have been tested and certified by the manufacturer to a recognised standard or procedure in accordance with the Pressure Equipment Regulations, and assembled in accordance with manufacturer's instructions or accepted industry methods at ambient temperature.

A recognised standard method for Proof Testing is given in ASME B.3 1.3.

### 6.4 Leak Testing

A test should be carried out before commissioning using the method recommended in Table 6 or such other method as determined by a competent person.

Pre-service leak testing should be carried out using air or nitrogen unless the use of LPG is specifically permitted by the test method.

Tests should be carried out at the test pressure not less than that given in Table 7 unless otherwise specified in the test method.

Tests should be carried out before the site application of any corrosion protection (such as painting), which would inhibit the detection of a leak.

Joints in buried pipework should be left exposed until the testing is satisfactorily completed. (Where mechanical backfilling and/or consolidation is employed, consideration should be

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given to a further pressure drop test on completion of the ground works).

Where leak testing is carried out on sections of an installation then a final test on the connection joints between sections should be made before the installation enters service.

**Table 6: Leak Testing Methods**

Service	Installation Type	Method
Liquid	Above and below ground	Pipework Joint Leak Detection Test (6.6)
Vessel Vapour Pressure	Up to the 1 <sup>st</sup> stage regulator where the 1 <sup>st</sup> stage regulator is not mounted on a bulk vessel	Pipework Joint Leak Detection Test (6.6) or IGE/UP/1
	Cylinder installations or where the 1 <sup>st</sup> or final stage regulator is mounted on a bulk vessel and is supplying an installation with a pipework volume of less than 0,02m <sup>3</sup> (20 litres)	BS 5482 Part 1: 2005 or equivalent
Vapour Service - intermediate pressure (downstream of the 1st stage regulator)	Above ground with a pipework volume equal to or greater than 0,02m <sup>3</sup> (20 litres)	IGE/UP/1
	Underground with a pipework volume equal to or greater than 0,02m <sup>3</sup> (20 litres)	IGE/TD/3 or IGE/TD/4
Vapour Service (downstream of the 1st stage regulator)	Above or below ground with a pipework volume equal to or greater than 0,02m <sup>3</sup> (20 litres)	BS 5482 Part 1: 2005 or equivalent

**Table 7: Leak Testing Pressure**

Service	Minimum Test Pressure (bar)	Maximum Test Pressure
Propane Liquid	6	90% of the vessel relief valve set pressure. Or 90% of the HRV set pressure where a pump is installed
Butane Liquid	3	
Propane Vapour Pressure	6	90% of the vessel relief valve set pressure.
Butane Vapour Pressure	3	

## 6.5 Pipework Joint Leak Detection Test

Where the specification of a system provides a guarantee of its soundness, and all joints are accessible, the leak test may be confined to checking each joint whilst the installation is under test pressure.

This method may also be used to locate a leak indicated by other methods. The test should be carried out at the appropriate test pressure given in Table 7. After application of the test pressure a period must be left for any leakage path to be established. For most installations 10 minutes is sufficient.

All joints should be checked using a proprietary leak detection fluid or detection equipment of equal sensitivity. Buried pipework may be partially backfilled but all joints should be left sufficiently exposed so any leakage can be safely observed.

Leak detection fluid should be compatible with the materials to which they are to be applied.

- Certain chemicals used in some detection fluids, e.g. ammonia, may cause unwanted effects such as stress corrosion cracking.

Leak detection fluid used to test pipework joints should be washed off with clean water at the end of the test.

## 6.6 Pressure Testing

### 6.6.1 Test Procedure

Testing under pressure requires proper planning. The procedure should consider the following:

- (a) type of test;
- (b) pressurising medium to be used;
- (c) maximum safe operating pressure of the installation being tested. This may vary in different parts of the system.
- (d) extent of installation to be tested;
- (e) test pressure(s);
- (f) rate of pressure rise and release;
- (g) duration of test(s). (For pressure drop tests the period of temperature stabilisation must be established. Note that temperature changes can be induced by air compressors (increasing temperature) or by compressed gas cylinders (reducing temperature by expansion);
- (h) test equipment and point(s) to apply the pressure;
- (i) how to retest any connections that may need to be undone to allow the pressure to be applied;

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- (j) means of positive isolation, and where necessary, protection of appliances or parts of the installation not being included in the tests;
- (k) identification of items, which may isolate sections, e.g. non-return/back check valves, pressure regulators etc., and invalidate the test;
- (l) any additional securing of pipework for the duration of the test;
- (m) precautions including the provision of warning signs and, if necessary, barriers to keep unauthorised persons from the test area.

### 6.6.2 Pneumatic Pressure Testing

This is when the pressure is applied by compressed air, compressed inert gas or in some cases LPG vapour.

- Care must be taken when carrying out pneumatic testing due to the potential energy stored in the system, which would be released in the event of a catastrophic failure of any equipment.

When testing at above 1,5 bar an initial test should be carried out at this pressure before gradually increasing the pressure to the required figure.

The supply of air or inert gas from compressed gas cylinders should be controlled by two-stage pressure regulators, preferably with a relief valve set approximately 20% higher than the desired test pressure.

Supply of air from a compressor should be suitably regulated and filtered.

Any hoses employed should have a working pressure greater than the test equipment relief valve setting.

### 6.6.3 Test Records

A record of any test(s) should be made and signed by a competent person verifying that the tests have been completed and the results.

Typical information should include:

- (a) date and location;
- (b) identification of pipework tested;
- (c) new or existing installation;
- (d) type of test;
- (e) pipework volume;
- (f) test medium (air, nitrogen, LPG etc);
- (g) test pressure;
- (h) test period;
- (i) test result.

### **6.6.3 Test Equipment**

Manometers, dial gauges or other pressure or leak measuring devices should be chosen to give the accuracy, repeatability and sensitivity necessary for the test.

Dial gauges should indicate the test pressure at between one third and two thirds full-scale reading.

Pressure gauges and pressure transducers for digital gauges should be routinely calibrated against a recognised standard and the results recorded.

## **6.7 Commissioning**

Except where permitted by the test method, LPG should not be introduced into a pipework system unless it has passed a leak test for the entire system to be commissioned, and signed records are available.

Purging of pipework systems should only be carried out by or under the supervision of competent persons. Pipework up to and including 32 mm may be purged directly with LPG.

For larger pipework and systems which include large volume items, e.g. vaporisers, air-gas mixers etc, the system should be purged, before introducing LPG. Purge gas should be introduced in a controlled manner using an adjustable pressure regulator.

- MRA LPG Code of Practice A4 gives guidance on purging of LPG systems.

When commissioning liquid systems, sudden chilling of the system from rapid vaporisation can be avoided by pre-charging with LPG vapour up to vapour pressure before introducing liquid, or by pre-pressurisation with the inert gas.

During the introduction of LPG it may be necessary to release any inert gas from the system. The gas should be released at a safe location and must not be allowed to accumulate in any confined space. A flare stack with permanent pilot and flame arrester may be used, provided it is adequately supervised and is located at a safe distance from the LPG storage vessel or other vulnerable structure.

If necessary, the introduction of LPG may be undertaken in sections provided suitable purge gas release points have been provided. For simple or small systems it is preferable to commission the entire system through the final appliance(s) in accordance with the manufacturer's or other competent and responsible person's instructions.

The setting and testing of controls and priming of any pumps should be undertaken during this final commissioning stage.

Following commissioning a final leak check should be carried out in operating mode with a proprietary leak detection fluid.

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Final checks of the operating pressures of appliances should be carried out to ensure that the system is functioning correctly.

- Appendix B gives guidance on domestic appliance operating pressures.

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## Section 7. Examination and Modification / Repairs

### 7.1 Legal Requirements

Pipework operating at pressure above 0,5 bar at commercial and industrial installations are subject to the L.N. 249 of 2008, LPG Market Regulations, and the Bulk LPG Regulations (Installation and Use) – still in draft form.

The Regulations require that there is a Written Scheme of Examination for the installation and that the system is maintained in good repair so as to prevent danger.

The Scheme must either be drawn up by a competent person, or be certified as suitable by a competent person. A competent person must then carry out examination within the intervals specified in the scheme.

Under the Control of Major Accident Hazard Regulations 1999 (COMAH) there is also a general duty on operators at establishments with more than 50 tonnes of LPG to take all measures necessary to prevent major accidents and limit their consequences to persons and the environment. Operators with more than 200 tonnes of LPG on their establishments are required to demonstrate, in a Safety Report, that adequate safety and reliability have been incorporated into the design, operation and maintenance of the installation and its equipment.

### 7.2 Modifications/Repairs

If modification / repairs are required to any part of the Pressure System then a competent person must assess these before they are carried out and any necessary alterations made to the Written Scheme of Examination.

## 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 carbon-dioxide (CO<sub>2</sub>) and water vapour, but sufficient air should 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.

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- (f) Commercial LPG is normally odourised before distribution by the addition of an odourant 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 odourant may be detrimental to a process (for example in aerosol applications) the LPG is not odourised.
- (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**

	<b>Commercial Butane</b>	<b>Commercial Propane</b>
Relative density of liquid at 15°C Imperial gallons / ton at 15°C Litre / tonne at 15°C	0,57 to 0,58 385 to 393 1 723 to 1760	0,50 to 0,51 439 to 448 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 Volume of gas (ft <sup>3</sup> ) per lb of liquid at 60°F and 30 in Hg	406 to 431 6,5 to 6,9	537 to 543 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	0,9	2,3
0	1,93	4,5
15	4,83	6,9
38	5,86	14,5
45		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 <sup>3</sup> ) dry	121,8	93,1
(Btu / ft <sup>3</sup> ) dry	3 270	2 500
(MJ / kg)	49,3	50,0
(Btu / lb)	21 200	21 500
<i>Nett:</i>		
(MJ / m <sup>3</sup> ) dry	112,9	86,1
(Btu / ft <sup>3</sup> ) dry	3 030	2310
(MJ / kg)	45,8	46,3
(Btu / lb)	19 700	19 900
Air required for combustion (m <sup>3</sup> to burn 1m <sup>3</sup> of gas)	30	24

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

## Appendix B: Pipe Sizing and Domestic Appliance Operating Pressures

### B.1 Pipe Sizing

Pipe sizes can be calculated by using the Pole formula for low pressure which in the metric form is as follows:

For low pressures up to 50 mbar and steel pipework:

Gas flow 
$$Q_m = \frac{1}{140,62} \sqrt{\frac{d_m^5 P_m}{S \cdot L_m}}$$

Or

Pipe internal diameter 
$$d_m = 7,231 \sqrt[5]{\frac{Q_m^2 \cdot S \cdot L_m}{P_m}}$$

Where

- $Q_m$  = Flow in m<sup>3</sup>/h
- $d_m$  = pipe internal diameter in mm
- $S$  = specific gravity relative to air
- $L_m$  = Equivalent pipe length in metres
- $P_m$  = Pressure drop in mbar

### PRACTICAL ASSESSMENT

Piping sizing in practice is usually achieved using a proprietary device such as a Mear's Gas Flow Calculator or by reference to tables or graphs.

The following tables provide a useful quick assessment for sizing pipework for low-pressure supplies. For other design parameters, non-standard sections and proprietary systems guidance should be sought from suppliers.

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**Table I.** Piping sizing for Propane Vapour for a pressure drop of 2,5 mbar with a nominal inlet pressure of 37 mbar.

**Steel pipe to BS 1387 or equivalent**

Equivalent length of piping	Nominal bore							
	1/4"		1/2"		3/4"		1"	
m	kW	m <sup>3</sup> /h	kW	m <sup>3</sup> /h	kW	m <sup>3</sup> /h	kW	m <sup>3</sup> /h
3	13,2	0,50	110	4,25	220	8,50	483	18,70
6	9,1	0,35	73	2,83	154	5,95	330	12,74
9	7,6	0,29	59	2,26	121	4,67	256	9,91
12	6,4	0,25	51	1,98	102	3,96	220	8,50
15	5,9	0,23	44	1,70	88	3,40	190	7,36
18	5,3	0,20	40	1,53	80	3,11	175	6,80
21	5,0	0,19	37	1,42	75	2,92	161	6,23
24	4,7	0,18	33	1,27	70	2,72	146	5,66

**Metric Copper tube to MSA EN 1057: 2006**

Equivalent length of piping	Outside diameter									
	6mm		10mm		15mm		22mm		28mm	
m	kW	m <sup>3</sup> /h	kW	m <sup>3</sup> /h	kW	m <sup>3</sup> /h	kW	m <sup>3</sup> /h	kW	m <sup>3</sup> /h
3	2,93	0,12	22,60	0,88	38,4	1,49	207	8,01	412	15,92
6	2,05	0,085	14,65	0,57	26,1	1,01	135	5,21	230	8,86
9	1,76	0,071	12,31	0,48	20,5	0,79	108	4,19	215	8,33
12	1,47	0,059	10,84	0,42	17,9	0,70	94	3,62	187	7,25
15	1,17	0,048	9,67	0,38	15,5	0,60	82	3,20	168	6,51
18	1,17	0,048	8,79	0,35	13,5	0,53	74	2,86	145	5,61
21	0,88	0,040	8,21	0,32	12,9	0,50	67	2,58	135	5,24
24	0,88	0,040	7,62	0,29	12,0	0,47	61	2,38	126	4,87

**Polyethylene pipe to MSA EN 1555-1,2,5: 2002**

Equivalent length of Piping	Outside diameter 25mm		Equivalent length of piping	Outside diameter 32mm	
	kW	m <sup>3</sup> /h		kW	m <sup>3</sup> /h
m			m		
30	58,6	2,22	80	61,8	2,34
40	50,9	1,93	100	54,6	2,07
50	45,6	1,73	120	50,8	1,92
60	41,8	1,58	140	47,1	1,78
70	38,6	1,46	160	44,0	1,67
			180	41,5	1,57
			200	39,3	1,49
			220	37,0	1,40

Note 1: For Butane multiply the flow rates by 0,87 and kW by 1,15.

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Note 2: Equivalent length of piping is the physical length plus allowances for fittings. See Table II.

**Table II. EQUIVALENT LENGTH OF PIPE FOR VARIOUS FITTINGS**

Fitting	Length in Metres
Elbow or Tee	0,6
Connector of 90° Bend	0,3
Gate Valve 15mm	0,12
Gate Valve 19mm	0,18

### B.2 Domestic Appliance Operating Pressures

Gas	Nominal pressure of appliance mbar	Minimum pressure with full gas flow <sup>bc</sup> (all appliances operating) mbar	Maximum pressure with low <sup>d</sup> gas flow mbar	Maximum "lock up" pressure <sup>a</sup> mbar
Butane	28/29/30	20	35	40
Propane	37	25	45	50

<sup>a</sup> lock up pressures above these maximum values usually indicate a faulty regulator, which should be replaced.  
<sup>b</sup> full gas flow pressures below these minimum values indicate an incorrect pipe sizing or regulator capacity.  
<sup>c</sup> these are safety minimum pressures (see MSA EN 437: 2003 and MSA EN 12864: 2001). At minimum pressure, appliance performance may be affected.  
<sup>d</sup> 15g/h, e.g. a single pilot, thermostat bypass rate or hotplate simmer setting.

## Appendix C: Proprietary Pipework Systems for Liquefied Petroleum Gas (LPG)

### Specification

This appendix has been included to give guidance on the type approval, use and testing of Proprietary Pipework Systems for use with liquid LPG. It is not intended as a complete specification in its own right.

Pipework and components shall comply with the Pressure Equipment Regulations LN 248 of 2002, including, where appropriate, the requirements of CE marking.

### C.1 Service Conditions

Proprietary pipework systems should be designed for the following service conditions:

Product:	Liquefied Petroleum Gas (LPG), consisting of Propane, Butane and other trace hydrocarbon products, both saturated and unsaturated. (Limiting properties of commercial butane and commercial propane and automotive LPG are given in BS 4250: 1997 or equivalent & MSA EN 589: 2004)
Trace impurities	Water, Methanol, Caustic Soda, Ammonia, Plasticisers, e.g. Phthalates, and Release Agents, e.g. Adipates.
Working Pressure (max)	25 bar
Type Test Pressure (min)	100 bar
Temperature Range	-20°C to +50°C
Working Life (min)	25 years

### C.2 Materials and Construction

All materials used within the construction of proprietary pipework, fittings, joints and end connections should:

- i. be appropriate for use with liquid phase LPG;
- ii. incorporate an acceptable factor of safety (see above for type test pressure);
- iii. be designed to function without regular maintenance;
- iv. be independently assessed by a competent authority as being suitable for the service conditions above;
- v. be inherently resistant to, or otherwise adequately protected against, external corrosion;
- vi. employ methods chosen to minimize permeation through both pipework/ couplings and associated joints. Permeation rates should not increase throughout the normal working life of the pipe system;
- vii. be supplied with sufficient instructions and labelling to ensure correct selection, installation and test.

### **C.3 Manufacturers Testing**

Pipework systems shall be subject to Conformity Assessment in accordance with the relevant requirements of the Pressure Equipment Regulations L.N. 248 of 2002

All materials used within the construction of proprietary pipework, fittings, joints and end connections should be subject to an appropriate quality assurance regime to ensure that the parameters in A3.1 and A3.2 are met.

### **C.4 Installation**

Proprietary pipework is typically installed underground. It should only be used in above ground installations where authorized by the manufacturer or their agent.

Underground joints should be kept to a minimum.

Welded joints should be tested and / or inspected as required by the relevant design and welding standard.

Any pipework with underground welded joints shall be proof tested in accordance with 6.4.

Pipework systems should always be used strictly in accordance with manufacturers, or their authorized representatives, instructions.

Non-welded connections should be readily accessible for inspection, after installation, testing and commissioning as well as during.

Electrical conductivity should be maintained throughout continuous lengths of pipework and joints / end connections. Insulation fittings may be required when cathodic protection is used.

### **C.5 Site Testing and Commissioning**

Site testing and commissioning should be carried out in accordance with Section 6.

## Appendix D: References and Bibliography

### British Standards

BS 21:1985	Pipe threads for tubes and fittings where pressure tight joints are made on the threads.
BS 1600:1991	Dimension of steel pipe for the petroleum industry
BS 1710:1984	Identification of pipelines and services
BS 3212:1991	Flexible rubber tubing and hose for use in LPG vapour phase and LPG/Air installations.
BS 3799: 1974	Steel pipe fittings, screwed and socket welding for the petroleum industry.
BS 3974: 1980	Pipe supports.
BS 4089: 1999	Hose and hose assemblies for liquefied petroleum gas lines.
BS 4250: 1997	Commercial butane and commercial propane.
BS 4800: 1989	Schedule of paint colours for building purposes.
BS 5482-1: 2005	Code of Practice for domestic butane - and propane - gas burning installations. Installations at permanent dwellings, residential park homes and commercial premises, with installation pipework sizes not exceeding DN25 for steel and DN 28 for corrugated stainless steel or copper.
BS 6362: 1990, ISO7598: 1988	Specification for stainless steel tubes suitable for screwing in accordance with BS21.
BS 6501-1: 2004	Flexible metallic hose assemblies.
BS 7671: 2008	Requirements for electrical installations. TEE Wiring Regulations Sixteenth Edition.

### MSA EN Standards

MSA EN 287-1:2004	Approval testing of welders for fusion welding.
MSA EN 288-9:1999	Approval of welding procedures for metallic materials.
MSA EN 437:2003	Specification for test gases, test pressures and categories of appliance for gas appliances.

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MSA EN 549:1995	Rubber materials for seals and diaphragms for gas appliances and gas equipment.
MSA EN 589:2004	Automotive liquefied petroleum gas.
MSA EN 751:1997	Sealing materials for metallic threaded joints in contact with 1 <sup>st</sup> , 2 <sup>nd</sup> and 3 <sup>rd</sup> family gas and water.
MSA EN 1057:2006	Copper and copper alloys. Seamless round copper tubes for water and gas in sanitary and heating applications.
MSA EN1552-2:2003	Underground mining machines. Mobile extracting machines at the face. Safety requirements for shearer loaders and plough systems.
MSA EN 1555-1/2/3/5	Plastics piping systems for gaseous fuels supply polyethylene.
MSA EN 1563: 1997	Founding. Spheroidal graphite cast iron.
MSA EN 1600: 1997	Welding consumables. Covered electrodes for manual metal arc welding of stainless and heat resisting steels. Classification.
MSA EN 1762: 2003	Rubber hoses and hose assemblies for liquefied petroleum gas, LPG (liquid or gaseous phase) and natural gas up to 25 bar.
MSA EN 6087 1-4: 1997	IEC 60871-4: 1996 shunt capacitors for ac power systems having a rate voltage above 1kV. Internal Fuses.
MSA EN 10216-1: 2002	Seamless steel tubes for pressure purposes. Technical delivery conditions.
MSA EN 10217-1: 2002	Welded steel tubes for pressure purposes. Technical delivery conditions. Non-alloy steel tubes with specified room temperature properties.
MSA EN 10217-3: 2002	Welded steel tubes for pressure purposes. Technical delivery conditions. Alloy fine grain steel tubes.
MSA EN 10217-5: 2002	Welded steel tubes for pressure purposes. Technical delivery conditions. Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties.
MSA EN 10220: 2002	Seamless and welded steel tubes. Dimensions and masses per unit length.

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MSA EN 12864: 2001	Low-pressure, non adjustable regulators having a maximum outlet pressure of less than or equal to 200 mbar, with a capacity of less than or equal to 4kg/h, and their associated safety devices for butane, propane or their mixtures.
MSA EN ISO 1127	Stainless steel tubes. Dimensions, tolerances and conventional masses per unit length.
ISO 8085-3: 2001	Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels. Metric series. Specifications. Electrofusion fittings.

### **American Society of Mechanical Engineers Publications**

ASME/ANSI B.1.20.1	“Pipe threads, General Purpose, Inch”.
ASME/ANSI B. 16.3	“Malleable Iron Threaded Fittings”.
ASME/ANSI B.16.5	“Pipe Flanges and Flange Fittings”.
ASME/ANSI B.16.9	“Factory Made Wrought Steel Buttwelding Fittings”.
ASME/ANSI B.16.1 1	“Forged Fittings Socket Welded and Threaded”.
ASME/ANSI B.31.3	“Process Piping Code.
ASME/ANSIB.36.10	“Welded and Seamless Wrought Steel Pipe”.

### **Institution of Gas Engineers Publications**

IGE/TD/3 Distribution Mains.  
IGE/TD/4 Gas Services.  
IGE/UP/1 Soundness testing and purging of industrial and commercial gas installations.  
IGE/UP2 Gas installation pipework, booster and compressors on industrial and commercial premises.

### **National Joint Utilities Group Publications**

NJUG Publication No.4	“Identification of Small Buried Mains and Services”.
NJUG Publication No.7	“Recommended Positioning of Utilities’ Mains and Plant for New Works”.

### **Engineering Equipment Manufacturers and Users Association, UK**

EEMUA Publication 153 “EEMUA Supplement to ASME B31.3.”  
EEMUA Publication 1 86 “A Practitioner’s Handbook - Electrical Installation and Maintenance in Potentially Explosive Atmospheres.”

### **International and other Standards and Publications**

ISO TR 9080 “Thermoplastics pipes for the transport of fluids - Methods of extrapolation of hydrostatic stress rupture data to determine the long-term hydrostatic strength of thermoplastics pipe materials.” International Standards Organisation, Switzerland.

NFPA 58. “Standard for the storage and handling of Liquid Petroleum Gases.” National Fire Protection Association, USA.

API 5B “Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads.” American Petroleum Institute, USA.

ASTM A106B “Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.” American Society for Testing and Materials, USA.

IP/APEA “Guidance for the design, construction, modification and maintenance of petrol filling stations.” Institute of Petroleum, UK.

## Appendix E: Definitions

**Anti-shear sleeve** - A sleeve used to minimise local stresses in rigid polyethylene pipe joints e.g. between polyethylene and metal services.

**Cathodic protection** - A method of inhibiting corrosion in buried metal structures including pipework by making them the cathode of an electrochemical cell either by impressing a voltage upon the structure or connecting it to sacrificial anodes.

**Cross bonding** - The means of ensuring electrical continuity between the gas installation pipe and the consumer's electrical supply earth terminal.

**Emergency control** – A strategically located valve to shut off the gas supply in an emergency.

**GRP** - Glass reinforced plastic.

**Holiday Spark Test** - A test to establish the integrity of a surface coating in which an appropriate test potential is applied between the vessel and a detection brush. Any fault in the coating being made evident by an increase in current flowing in the circuit.

**Hydrostatic relief valve** - A device to prevent excessive pressure caused by the expansion of liquid between two closed valves in a pipeline.

**Installation Pipework** - Any pipework conveying gas for a particular consumer and any associated valve or other gas fitting but not service pipework (see definition). The term includes pipework from the emergency control valve to the appliance(s).

**Insulating fitting** - An electrical insulator installed in order to prevent stray electric currents flowing into or from a service pipe, usually as a result of Cathodic protection.

**Leak test** - A pneumatic pressure test to ensure the gas tightness of pipework fittings and components, may also be used to check the effectiveness of shut-off devices.

**Meter box** - A box designed to be attached to or built into an outside wall to house a meter and its associated pipework. May also refer to a box to house the second stage regulator and/or an emergency valve.

**Main** -A pipe other than service pipework, used for conveying gas in a distribution system.

**Maximum operating pressure (MOP)** - The maximum pressure at which a system can operate continuously under normal conditions. NOTE -Normal conditions are with no faults in any device or stream.

**Polyethylene** - A type of plastic material used for buried mains and service pipes and fittings.

**Proprietary Pipework System** - A system of pipe and associated fittings produced by a single manufacturer for specific purpose(s), e.g. autogas installations, which requires special

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end fittings to enable it to be connected to conventional pipework and equipment.

**Proof test** - A pressure test to establish that the mechanical integrity of pressure containing pipework, fittings and components meets the required standard.

**Regulator** - A device for maintaining gas pressure at a steady value within close limits as required by the application, and over a range of flow rates down to zero.

**Saddle** - A fitting that conforms to the contour of a main and is used for making a service connection to a main.

**Service pipework** - Pipe for supplying gas to premises from a gas storage vessel, being any pipe between the gas storage vessel and the outlet of the emergency controls.

**Standard dimensional ratio (SDR)** - The outside diameter of polyethylene pipe divided by the wall thickness.

**Squeeze off** - A means of stopping flow in a polyethylene service by squeezing off the pipe with a special tool.

**Transition fitting** - A fitting used to connect metallic pipe to polyethylene pipe.

<b>MRA LPG CODES OF PRACTICE</b>	
<u>Number</u>	<u>DESCRIPTION</u>
<b><u>GROUP A - BULK VESSELS</u></b>	
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
<b><u>GROUP B - SMALL CYLINDERS STORAGE AND FILLING</u></b>	
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
<b><u>GROUP C - LPG DRIVEN MACHINERY</u></b>	
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
<b><u>GROUP D - ANCILLARY EQUIPMENT</u></b>	
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
<b><u>GROUP E - LPG CYLINDER USAGE AT DIFFERENT PREMISES</u></b>	
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