SRI LANKA STANDARD 1196 : PART 3 : 2000
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CODE OF PRACTICE FOR
TRANSPORT, STORAGE AND HANDLING OF LPG
PART 3 : LPG PIPING SYSTEM - DESIGN AND INSTALLATION

SRI LANKA STANDARDS INSTITUTION

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SLS 1196 : Part 3 : 2000

Gr.18

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SRI LANKA

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

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FOREWORD

This standard was approved by the Sectoral Committee on Liquefied Petroleum Gas Industry and was authorized for adoption and publication as a Sri Lanka Standard by the Council, of the Sri Lanka Standard Institution on 2000-09-21 .

The objective of this part of the Code of Practice is to give guidance to the selection of materials, the design, installation and testing of pipework for LPG liquid or vapour.

The other parts of this Code of Practice are as follows :

Part 1 : General provisions
Part 2 : Design installation and maintenance of bulk LPG storage at fixed installation
Part 4 : Safe filling of LP gas at depots
Part 5 : Storage of full and empty LPG cylinders and cartridges
Part 6 : Use of LP gas in cylinders at residential premises
Part 7 : Transport of LP gas in cylinders by road, rail or on water
Part 8 : Safe handling and transport of LPG in bulk by road

The Sri Lanka Standards Institution gratefully acknowledges the use of the following publication, in the preparation of this code:

a) Code of Practice 22 – LPG piping system – Design and installation published by the Liquified Petroleum Gas Industry Technical Assocation (UK).

1 SCOPE

This part of the Code of Practice covers pipework in carbon steel, copper or polyethylene for conveying LPG conforming to SLS 712.

It is not intended as complete guidance on carbon steel pipework over 150 mm nominal bore, copper pipe over 35 mm or polyethylene pipework over 90 mm, for which additional requirements may be necessary. Whilst aimed at static installations its recommendations apply also to mobile equipment including road tankers, boats and yachts.

This part of the code excludes - Stainless steel pipework
- Liquid phase pipework for automotive purposes.

NOTE

This code does not preclude the use of alternative designs, materials and methods where these could provide equivalent standard of safety as judged by a competent person.

2 REFERENCES

BS 1306 Coper and copper alloy pressure piping systems
BS 1387 Steel tubes and tubulars suitable for screwing to BS 21 pipe thread
BS 1716 Idnetficaiton of pipelines
BS 2789 Spheroidal graphite or nodular graphite cast iron
BS 4375 Unsintered PTFE tape for thread sealing applications
BS 5482 Code of Practice for domestic butane and propane gas burning installations
Part 1. Installations in permanent dwellings
Part 2. Installations in caravans and non-permanent dwellings
Part 3. Installations in boats, yachts and other vessels
BS 7281 Polyethylene pipes for the supply of gaseous fuels
SLS 712 Liquefied petroleum gas
SLS 1172 Hoses and hose assemblies for LPG; Parts 1,2 & 3
SLS 1177 Filling ratios and developed pressures for liquefied and permanent gases
SLS 1180 Pressure regulators and automatic changeover devices for LPG
SLS 1183 Domestic LPG burning installations at permanent dwellings

Institution of Gas Engineers Publications

IGE/UP/1 Soundness testing and purging of industrial and commercial gas installations.
IGE/UP/2 Gas installation pipework.
IGE/TD/4 Gas service

3 DEFINITIONS

For the purpose of this standard the following defonitions shall apply:

3.1 anti-shear sleeve : A sleeve used to minimize local stresses in rigid polyethylene (PE) pipe joints e.g. between PE and metal services.

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

3.3 cross bonding : A means of ensuring electrical continuity between the gas installation pipe and the consumer's electrical supply earth terminal.

3.4 emergency valve : A strategically located valve to shut-off the gas supply in an emergency.

3.5 GRP : Glass reinforced plastic.

3.6 hydro-static relief valve : A device to prevent excessive pressure caused by the expansion of liquid between two closed valves in a pipeline.

3.7 installation pipework : Any pipework conveying gas for a particular consumer and any associated valve or other gas fitting but not service pipework. The term includes pipework from the emergency control valve to the appliance(s).

3.8 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.

3.9 leak test : A pneumatic pressure test to ensure the gas tightness of pipework fittings and components and the effectiveness of shut-off devices.

3.10 main : A pipe other than service pipework, used for conveying gas in a distribution system.

3.11 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.

3.12 MOP : Maximum operating pressure. The maximum pressure at which a system can operate continuously under normal conditions.

3.13 network systems : Reticulation pipework for distribution to multiple consumers. e.g. metered estates.

3.14 PE Polyethylene : A type of plastic material used for buried mains and service pipes and fittings.

3.15 proof test : A pressure test to establish that the mechanical integrity of pressure containing pipework, fittings and components meets the required standard.

3.16 saddle : A fitting which conforms to the contour of a main and is used for making a service connection to a main.

3.17 service pipework : A pipe connecting a gas main or LPG storage vessel up to an including the emergency control valve to a single or a group of consumers.

3.18 SDR : 'Standard dimensional ratio'. This is the outside diameter divided by the wall thickness of polyethylene (PE) pipe.

3.19 squeeze off : A means of stopping flow in a PE service by squeezing off the pipe with a special tool.

3.20 transition fitting : A fitting used to connect metallic pipe to PE pipe.

4 DESIGN AND LAYOUT

4.1 Location

4.1.1 Where practical, service pipework shall be routed in the open air and above ground level. It shall be routed away from or protected against excessive heat or cold. Pipework may be buried underground provided it is inherently resistant to or otherwise adequately protected against corrosion.

4.1.2 Within domestic and commercial premises, installation pipework shall not carry liquid phase LPG nor carry vapour at a nominal operating pressure greater than 3.7 kPa beyond the emergency valve or greater than 7.5 kPa before the emergency valve. Distribution systems within other buildings shall be designed to operate at the lowest practicable pressure consistent with safe and satisfactory operation of appliances.

4.1.3 *Service pipework entries, emergency shut-off valves and meters*

4.1.3.1 The following recommendations apply to LPG supplies to domestic and other low rise premises. For medium and high rise buildings further rules apply.

NOTE

For more information regarding medium and high rise buildings reference may be made to IGE/TD/4 and regarding industrial and Commercial buildings IGE/Up/2.

4.1.3.2 Service pipe entries to buildings shall preferably be above ground. There shall be an emergency shut-off valve with adequate access and located as close as practicable to the point where the supply pipe enters the building. It may be located inside or outside the building.

Polyethylene (PE) service pipe shall be buried and shall connect to metal pipework adjacent to the storage vessel and at the premises. Suitable transition fittings shall be used

above or below ground, and in case it is above ground the part of the PE pipe above ground must be suitably protected.

4.1.3.3 An emergency valve conforming to a recognised national or international standard shall be installed as close as practicable to the point where the LP gas pipeline enters the premises and so that:

a) any key, lever or hand wheel to operate the valve is securely attached to the operating spindle.
b) the manner of operating the valve is clearly marked indicating when the valve is open and/or when it is shut.
c) an emergency procedure label is displayed on or near the valve as shown below, or words to that effect.

GAS EMERGENCY SHUT-OFF VALVE

In the event of gas leakage or suspected leakage
shut this valve.

If leakage outdoors shut off at the cylinder/tank.

If gas continues to escape notify the gas
emergency service. (Tel. No…….)

Do not reopen the valve until remedial action is taken.

In case of fire, telephone the Fire Brigade
(Tel. No....) and inform them of the presence of LPG.

4.1.3.4 Meters, where required, shall be installed as close as possible to the entry point. If located outside the building the meter should be housed together with the emergency valve in a purpose made built-in or surface mounted meter box.

4.1.3.5 Service entries shall wherever possible be above ground level.

4.1.3.6 Pipework shall not be laid under foundations of a building or under the footings of a load bearing wall or under a floating raft foundation.

4.1.3.7 Pipework shall not be installed in an unventilated space.

4.1.3.8 Pipework shall not be run within cavity walls. Pipe passing through a cavity wall shall take the shortest practicable route.

4.1.3.9 Pipework passing through a solid wall or cavity wall shall be sleeved. Sleeves shall be of material which is continuous, non porous and protected against corrosion e.g. polythene, copper, plastic coated steel, PVC or other suitable material, and shall where practicable be sealed at each end to the with a flexible fire resistant compound. They shall be sealed to the structure with a suitable building material such as cement mortar. The installation shall ensure that gas cannot pass between the pipe and the sleeve and between the pipe and the wall or floor and shall allow normal movement of the pipe.

4.1.3.10 Pipework laid across joists in ceiling or roof spaces fitted with floor boards shall be located in purpose made notches. Notches shall not be made in joists of less than 100 mm height.

4.2 Materials

All pipes, fittings and joints etc. shall be properly assessed for suitability for the service conditions. All items used shall be suitable for the phase of LPG being conveyed and the extremes of pressure and temperature that may be encountered during service. The classes of pipe acceptable for LPG are set out in Appendix **B**.

Cast iron pipes shall not be used.

All proprietary equipment shall be installed in accordance with the manufacturer's instructions.

4.3 Design

4.3.1 *General*

4.3.1.1 Before installation commences the system design must be considered in line with the recommendations of this part of the code and the conditions set out in Appendix **A**.

4.3.1.2 For pipework above 50 mm nominal diameter containing vapour at full vessel pressure or containing liquid, pipework design and stress analysis shall be carried out to a recognised code by a competent person.

4.3.1.3 For systems not covered by **4.3.1.2** the pipework may be adequately specified without full formal design stressing by using the standards and guidance recommended in this part of the code.

4.3.2 *System pressure and protection*

4.3.2.1 General

All components to be used shall be checked for suitability for the maximum and minimum pressure and temperatures expected to be encountered in service. Where necessary suitable pressure relief devices shall be used.

4.3.2.2 Liquid phase distribution

Wherever liquid LPG may be trapped e.g. between shut-off valves or blank flanges, excessive pressure caused by thermal expansion of the contents must be avoided. This is normally achieved by the use of hydrostatic relief valves. They must always set above the maximum working pressure in the line, and below the safe design pressure of the pipework, flanges and components in the section to be protected.

The recommended design pressures are:

propane	2.4 MPa gauge
butane	1.9 MPa gauge

Hydrostatic relief valves which discharge to the open air shall be located and orientated so as not to endanger personnel, vessels or equipment and shall be fitted with raincaps where their location dictates.

4.3.2.3 Vapour phase distribution

Vapour distribution pressures must be selected and controlled at levels below that at which recondensation may occur at the lowest foreseeable vapour temperature in the pipework system. Where higher pressures are needed for the application, precautions need to be taken to prevent recondensation, e.g. by heat tracing the pipework system or the use of an LPG-air mixture.

Heat tracing shall not be applied to polyethylene pipework.

4.3.3 *Sizing and routing*

Pipework shall be sized and routed so as to restrict the contents to a practical minimum.

The piping size shall 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. It is recommended that a maximum loss of 10 per cent of the nominal set outlet pressure of the 1st stage regulator is 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 250 Pa, up to the inlet for 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 shall not in any case be less than that required for the safe operation.

The routing of pipework should be selected to minimise the possibility of physical damage particularly from vehicles and mobile equipment. Where necessary for above ground pipework additional physical protection should be provided e.g. bollards, barriers, etc.

4.3.4 *Supports and anchors*

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

Vibration, surge pressures, valve operating torque must all be considered in the design of pipework and supports incorporating mechanical equipment such as pumps and valves. Mobile installations e.g. road tanker pipework, need particular consideration of vibration and relative movement between equipment.

4.3.5 *Thermal expansion*

Pipework layout and supports shall provide adequate allowance to accommodate any movement that may occur due to thermal expansion or contraction over the range of temperature of the product being conveyed.

4.3.6 *Corrosion protection*

Installations not inherently resistant to corrosion shall be suitably protected. This can be done by several methods.

For above ground pipework these methods could be galvanizing, painting or wrapping. For underground these include wrapping and/or sleeving and cathodic protection.

Where cathodic protection is applied or likely to be applied to buried metallic pipework, above ground pipework to which it is connected shall be electrically insulated from the buried section by means of a suitable non conducting fitting, or insulated flange joint, suitable for use with LPG.

Buried or mounded storage vessels with cathodic protection shall be eletrically insulated from any connected metallic pipework not intended to be included in the protection.

4.3.7 *Colour coding and pipeline identification*

Where LPG pipework needs to be distinguished from pipework for other services, it should be colour coded British Standard 'yellow ochre' 08C35 (BS 1710). Pipework containing LPG in the liquid phase too should be identified as such.

4.3.8 *Valving*

4.3.8.1 Shut-off valves shall 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 pipework must be protected from over pressurisation by fitting suitable hydrostatic relief valves. (See **4.3.2.2**)

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

4.3.8.3 All valves shall be installed free of excessive external stress and adequately supported or secured from foreseeable forces, e.g. valve operating torque.

4.3.8.4 Valves can either be flanged, welded or threaded. Female threaded valves for liquid and vessel pressure vapour service, shall have a tapered thread.

4.3.8.5 Where 'Test House approvals' are quoted they shall be checked to confirm suitability before installation on systems operating above a nominal 7.5 kPa.

4.3.8.6 Valves used on liquid or vapour service above 500 kPa and/or subject to significant thermal variations or shock shall be either:

Steel - carbon or stainless
Bronze
Forged brass
Ductile iron to BS **2789** or equivalent with an elongation at fracture of not less than 18 per cent.

4.3.8.7 Diaphragm valves shall not be used on service above 500 kPa.

4.3.9 *Earthing/cross bonding*

Pipework within premises shall be electrically earthed by cross bonding in accordance with IEE regulations. If a gas fitting is disconnected, a suitable temporary bond to maintain

electrical continuity shall be provided. Gas piping shall not be used as the sole earth for electrical apparatus. External pipework carrying liquid shall have electrical continuity

with the storage vessels, except as required by **4.3.6,** as a precaution against static electricity.

NOTE

*Notwithstanding the requirement in **4.3.6,** consideration should also be given to electrically insulate above ground pipework in premises from buried metallic pipework particularly where the buried pipework is extensive and may be subject to induced stray currents.*

4.3.10 *Jointing*

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

Compression fittings where appropriate need to 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 shall be installed in strict accordance with the manufacturer's instructions.

4.3.11 *Flexible connections*

Flexible connections in permanent pipework shall be avoided where possible. When hoses are used to allow for unavoidable pipework movement their lengths shall be kept as short as possible, and shall maintain electrical continuity where applicable. Their orientation and length shall ensure that the movement will not put them into tension or impose torsional stresses. Figure **1,** Figure **2** and Figure **3** illustrate the principles.

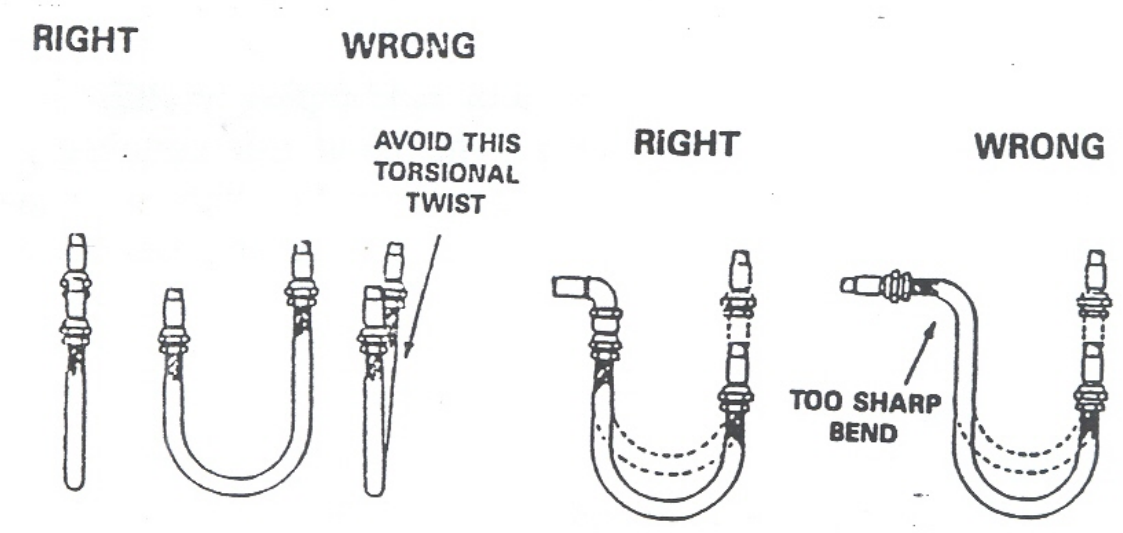

FIGURE 1 - General principles of correct orientation of flexible tubing

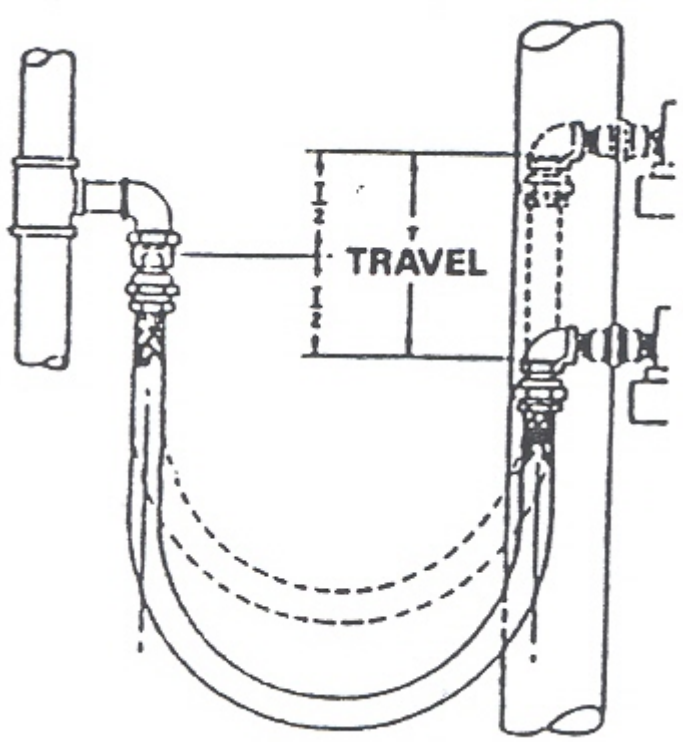

FIGURE 2 - Flexible tube installation - vertical loop for maximum vertical travel

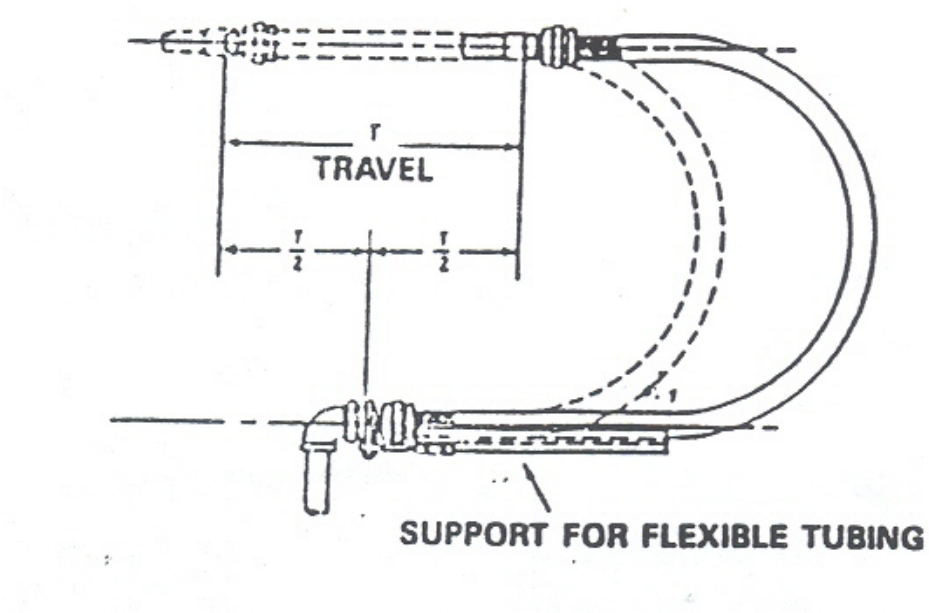

FIGURE 3 - Flexible tube installation for horizontal travel

All hoses shall comply with a standard ensuring their suitability for conveying LPG as vapour or liquid as required and for the service intended.

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

4.3.12 *Breakaway couplings*

These are couplings 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 shall be less than that which would cause permanent pipe or hose distortion or failure. The manufacturer's instructions shall be strictly followed in its installation.

4.3.13 *Pressure measurement and test points*

Facilities for pressure measurement and /or suitable test points both for operational use and/or for commissioning e.g. leak testing, shall be provided. The provision of test points which facilitate leak testing and purging of buried pipework shall not be overlooked.

5 PIPEWORK MATERIALS AND CONSTRUCTION - ABOVE GROUND

5.1 Liquid

5.1.1 *Carbon steel pipework*

Only seamless carbon steel pipe is permitted.

NOTE

*See Appendices **B & C** for acceptable classes of pipe.*

5.1.1.1 Pipe

Only seamless pipe to an acceptable standard and thickness shall be used.

5.1.1.2 Welded fittings

Two types of welds on carbon steel are acceptable.

- butt weld
- Forged steel socket weld

5.1.1.3 Threaded fittings

Threaded fittings shall only be used for joint sizes of 50 mm or less although threaded joints up to and including 80 mm are accepted for proprietary items such as valves, pumps and meters etc.

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

Threaded fittings shall only be of forged carbon steel. Both male and female threads shall be tapered and of the same form. Only heavy quality pipe shall be used for threading to reduce the risk of deformation.

5.1.1.4 Flanges

Carbon steel flanges rated for the maximum system design pressure shall be used. These flanges can either be welded or threaded to the pipe.

5.2 Vapour at 500 kPa pressure and above

All pipework shall be of only carbon steel and copper.

5.2.1 *Carbon steel pipework*

Welded seam gas pipe, heavy or medium weight or seamless pipe to an acceptable thickness are acceptable for pipework after a first stage regulator.

5.2.2 *Copper pipework*

Suitable only for tube size 15 mm and below. Should not be used where vibrations may cause work hardening leading to possible failure.

5.2.2.1 Pipe

Solid drawn tube in the half-hard or annealed condition.

5.2.2.2 Brazed or soldered fittings

Brazed or silver soldered joints shall 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 less than 600 ^{o}C shall not be used.

5.2.2.3 Compression fittings

Fittings shall be suitable for LPG at the service pressure. They shall 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 shall be used.

5.2.2.4 Threaded fittings

Copper pipe shall not be threaded. Threaded fittings require a transition fitting using a compression, brazed or soldered connection to the pipe.

5.3 Vopour below 500 kPa pressure

5.3.1 *Carbon steel pipework*

5.3.1.1 Pipe

Welded seam gas pipes, heavy or medium weight, or seamless pipe to an acceptable thickness will be permitted.

5.3.1.2 Welded fittings

Two types of weld on carbon steel are acceptable.

- butt weld
- forged steel socket weld

5.3.1.3 Threaded fittings

Wrought steel or malleable iron or forged carbon steel fittings may be used. If galvanized the fittings should also be galvanized.

5.3.1.4 Flanges

Carbon steel flanges rated for the maximum system design pressure shall be used. These flanges can either be welded or threaded to the pipe.

5.3.2 *Copper pipework*

The requirements for copper pipework shalll comply with **5.2.2** except as follows:

a) tube up to and including 35 mm diameter is acceptable for low pressure services after the final stage regulator.
b) soldered joints are not acceptable for installation in boats, yacht and other vessels.
c) except for capillary fittings hard solder shall be used for soldered joints in caravan installations.

6 PIPEWORK MATERIALS AND CONSTRUCTION - BELOW GROUND (BURIED)

All buried pipework and fittings must be inherently resistant to corrosion or otherwise protected against it. See section 8 and Summary Table - Appendix B.

6.1 Liquid

All pipework shall be only of carbon steel

6.1.1 *Carbon steel pipework*

Carbon steel pipework shall be as specified in **5.1.1** except:-

a. preferably all joints welded with fittings as **5.1.1.2.**

b. threaded fittings permissible when essential for assembly, and when subsequently seal welded. See **7.1.3.4**

c. flanges only permissible where they are essential for assembly.

d. compression fittings not permitted.

6.2 Vapour 500 kPa and above

All pipework shall be only of carbon steel and copper.

6.2.1 *Carbon steel pipework*

Carbon steel pipework shall be as specified in **6.1.1**

6.2.2 *Copper pipework*

6.2.2.1 As specified in **5.2.2** except that tubing shall be of a class suitable for buried service.

6.2.2.2 Additional external corrosion protection is recommended. Factory applied plastic coating is preferred.

6.2.2.3 Pipework shall 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 lengths than half hard.

6.2.2.4 Buried pipework joints shall only be soldered or brazed.

6.2.2.5 Brass fittings shall be de-zincification resistant or de-zincification immune.

6.3 Vapour below 500 kPa

All pipework should be only of carbon steel and copper.

6.3.1 *Carbon steel pipework*

As carbon steel pipework shal be as specified in 5.3.1

6.3.2 *Copper pipework*

As **6.2.2** except that tube up to and including 35 mm is acceptable.

6.3.3 *Polyethylene (PE) pipework*

6.3.3.1 PE pipe shall be suitable for continuous operation at the design limits specified in Appendix **A**.

PE pipe with a Standard dimensional ratio (SDR) of 11 is acceptable for sizes up to 90 mm and nominal operating pressures up to 400 kPa. Continuous improvements in material properties may influence to modify these recommendations and reference should be made to the manufacturers for current temperature and operating pressure limits.

6.3.3.2 Fusion fittings

Fittings for fusion jointing of PE pipe must be compatible with the pipe polymer. The following shall be noted:-

a) butt fusion. Not recommended for pipe less than 63 mm.
b) saddle fusion. Not suitable for branches on pipe of less than 63 mm.
c) suitable for all pipe covered by this code.

6.3.3.3 Compression fittings

Compression fittings are acceptable for PE pipe up to and including 63 mm diameter.

An essential requirement is that the fittings shall 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 must be corrosion resistant or adequately protected against corrosion.

6.3.3.4 Other mechanical fittings

Fittings other than compression fittings, e.g. using cold swaging techniques to form a PE to metal connection, shall also meet the requirements of **6.3.3.3.**

6.3.3.5 Anti-shear sleeves

These or other means to protect PE pipe up to and including 63 mm diameter against bending stresses shall be installed at;

a) PE to metal pipe junctions;
b) service branch connections to metal mains of sizes 63 mm or greater; and
c) valves, to react against operating torque's unless the valve is suitably anchored.

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

7 INSTALLATION ABOVE GROUND

7.1 Carbon steel pipe

7.1.1 Welded joints

Welding is not recommended for galvanized pipes.

Welding joints shall be made to be either Class 1 or 2 standard by either electric arc or oxy-acetylene methods. The standard to be decided depending on the proposed service and pipe size.

Before commencing work the following shall be agreed in accordance with the appropriate welding standard:

a) weld procedure approval -
To be appropriate to the work being carried out.
b) welder approval -
For all welders working on the installation.
c) parent metal -
Maximum carbon content recommended not to exceed 0.25 per cent
d) weld metal -
Shall be as in the approvals and suitable for welding the parent metal.
e) shielding gases (if appropriate) -
As specified in the approvals.
f) equipment to be used -
Type of welding equipment and available power which needs to be appropriate for the work to be carried out.
g) weld process including joint preparation and preweld assembly.
h) pre and post weld heating -
The only limitations on carbon steel pipes and fittings normally used for LPG installations is that the metal temperature should not be below 5 ^{o}C when hot cutting or welding is carried out.
i) type of fabrication -
This includes butt welds, branches, small bore connections, sleeve and socket welds.
j) type of attachments.
k) inspection required -
This includes fault limitations and the rectification of faults.

7.1.2 *Bending*

Bending is not recommended on pipe that is received galvanized.

7.1.3 *Threaded joints*

7.1.3.1 Thread form

All threads shall be clean and true for their length and depth. The thread on the pipe shall be compatible with that on the fittings. When using forged steel fittings both threads shall be tapered. When using malleable or wrought fittings the female thread may be parallel or tapered and that of the pipe tapered. These are only suitable for use with vapour below 500 kPa.

7.1.3.2 Thread sealants

To facilitate tightening during assembly and to promote long term pressure tightness of the joints, PTFE tape or sealant compound shall be used. Non-setting sealants are preferred. Jointing materials used shall be compatible with the phase of LPG being conveyed as some sealants marked for LPG use are only suitable for use with LPG in the vapour phase.

7.1.3.3 Thread engagement

Adequate engagement of male taper threads is essential to ensure a proper gas tight seal, and provide adequate joint strength.

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

As a guide the minimum engagement shall not be less than:

4 turns for pipe size 6 - 35 mm (1/4 "- 11/2")
5 turns for pipe size 35 - 50 mm (11/2" - 2").

7.1.3.4 Seal welding

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

The materials must be weldable i.e. this precludes the use of malleable fittings. The joint shall be made clean and dry. All the exposed threads must be covered by the seal weld.

7.1.4 *Flanged joints*

7.1.4.1 Standards

Steel flanges and flange fittings shall be selected for an adequate pressure rating. For use with liquid and vapour at vessel design pressure, pipe flanges shall be carbon steel. Mating flanges shall be compatible.

Important- *Flanges to different standards and pressure classifications are not normally interchangeable.*

7.1.4.2 Alignment

Fabrication shall leave flange faces parallel and their centres in line. Excessive strain on pipe or flange is not permitted, as this could cause leakage at the flange and/or damage to adjacent equipment.

7.1.4.3 Gasket materials

Proprietary gaskets must be warranted suitable for the duty required.

Gaskets must be resistant to the phase of LPG being conveyed. Gaskets of natural rubber or bonded with natural rubber shall not be used.

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

Correctly sized gaskets of a suitable material between properly aligned flanges do not require sealing compounds on their faces. The application of such compound may adversely affect the performance.

Compressed asbestos fibber gaskets (CAF) are the most commonly accepted gaskets, but suitable alternatives are available.

When using gaskets containing asbestos e.g. CAF and some spirally wound gaskets, suitable health precautions should be observed.

7.1.5 *Compression joints*

When compression joints are used they must be suitable for the proposed service and installed according to the manufacturer's instructions.

7.1.6 *Pipe corrosion protection*

Steel pipework not protected by galvanizing or equivalent means shall be protected against corrosion by other means e.g. painting. Particular attention shall be paid to protecting the pipe where it rests on supports. Damage to galvanizing shall be repaired with a suitable coating.

7.2 Copper pipework

Pipe and jointing shall be in accordance with **5.2.2** and **5.3.2.**

7.2.1 *Brazed or solder joints*

Not acceptable for pipework in boats, yachts and other marine or river craft vessels.

For nominal design pressures above 500 kPa fittings shall be used with solder having a melting point above 600 ^{o}C.

For nominal design pressures of 500 kPa and below, normal fittings can be used with soft solder, except for capillary fittings in mobile installations such as caravans when a hard solder with a melting point above 450 ^{o}C shall be used.

The fittings may either be integral solder ring type or end feed type.

7.2.2 *Compression joints*

Installation shall be carried out in accordance with manufacturer's instructions.

Particular care is required in preparing tube ends. Over tightening beyond recommended torque may distort the joints or tube and cause leakage. Where plastic coated copper pipe is used appropriate manufacturer's instructions need to be consulted for correct assembly.

7.2.3 *Bending*

Cold bending is permitted with the necessary precautions against flattening of pipe.

8 INSTALLATION - BELOW GROUND LEVEL (BURIED)

Metal pipework shall only be buried when unavoidable. Materials and construction shall conform to 6. The pipeline route shall be permanently marked and recorded. It must be adequately protected against corrosion and mechanical damage. Trace heated lines and lagged pipework are difficult to protect and specialist advice should be sought.

Fabrication and welding techniques are as set out in **7** subject to the limitations of **6**.

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

8.1 Carbon steel pipe

8.1.1 *Pipe protection*

8.1.1.1 Liquid phase pipework

a) piping design shall make due allowance for any additional loading or constraint imposed by the backfill or the location;
b) alternatively, piping may be adequately supported and laid in a shallow open concrete or masonry-lined trench with open grid covers where necessary, to allow safe movement of pedestrians. The trench dimensions and pipe supporting arrangements shall be such as to facilitate visual inspection and maintenance e.g. wire brushing, repainting of pipe and supports. Trenches must not enter buildings;

c) if the trench is backfilled it shall be with an inert, non-corrosive material free from abrasive particles likely to damage the corrosion protection and designed to prevent the formation of a flammable gas-air mixture in the event of a leak;

d) corrosion protection of pipework and fittings shall be provided where necessary, e.g. proprietary wax or tar/bitumen impregnated tape wrapping, and/or cathodic protection for backfilled systems or painting for open trench systems;

e) as a further alternative to (b) the pipe may be run inside an outer pipe which shall terminate above ground or in a suitable inspection pit;

f) protection shall be provided in the form of load bearing slabs or covers for those sections over which traffic passes or other loads may be super imposed;

g) piping may be laid in the same trench as piping carrying inert or flammable liquids or gases, but not with piping carrying oxygen unless adequate precautions are taken to prevent possible mixing from simultaneous leakage. It shall 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); and

h) electric cables shall not be laid in the same trench with liquid phase LPG pipework unless they are protected by an outer pipe or sleeve.

8.1.1.2 Vapour phase pipework

a) pipework may be buried in an open excavation backfilled with a suitable material. (See **8.4, 8.5** and **8.6**)

b) corrosion protection shall be provided e.g. proprietary wax or tar/bitumen impregnated tape wrapping and/or polyethylene type with suitable cathodic protection.

c) piping design shall make due allowance for any additional loading or constraint imposed by back fill or underground location.

d) protection shall be provided in the form of load bearing slabs or covers or other adequate means for pipework over which traffic passes where superimposed loads may occur.

e) piping may be laid in the same trench as piping carrying inert or flammable liquids or gases, but not with piping carrying oxygen unless adequate precautions are taken to prevent possible mixing from simultaneous leakage. It shall 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 pipes).

Further requirements for PE pipe are given in **8.3.7.3.**

f) to facilitate future repair and maintenance a minimum clearance of 250 mm shall be maintained whenever practicable between the 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.

8.2 Copper pipework

8.2.1 The requirements of **8.1.1.2** shall apply.

8.2.2 Factory applied corrosion protection is preferred. (See **6.2.2.2)**

8.2.3 Care shall be taken not to damage pipe precoating during installation.

8.2.4 Joints shall be kept to the absolute minimum in buried sections of pipe. Jointing methods shall be as in **7.2** with due precautions to preserving the integrity of the corrosion protection of the pipe and fittings.

8.3 PE pipework

The requirements for **8.1.1.2** except for item (b) shall apply.

The installation of PE pipe shall always be carried out by competent trained persons.

8.3.1 Fusion jointing

The jointing surfaces of the pipe and fittings are raised to a specific temperature by the application of heat. The softened surfaces formed are brought together with a firm constant pressure and held steady while cooling takes place. With the exception of electro fusion, fusion jointing shall not be used between pipework of different polymers. All fusion operations shall be carried out following manufacturer's recommended procedures.

NOTE

Electro Fusion. A system using sleeve couplers with internal heating coils. Confirmation shall be obtained from pipe suppliers where joints between pipes and fittings of different polymers are to be used.

8.3.2 *Compression fittings*

It is essential to comply with the manufacturer's fitting instructions. It is necessary to use a tube liner, usually supplied with the fitting to make a satisfactory joint.

8.3.3 *Anti-shear sleeves*

PE pipe adjacent to PE to steel transition couplings and PE branch pipes adjacent to tees must 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 shall be designed to accept such sleeve. Plastic anti-shear sleeves used above ground (see **8.3.7.1**) must be UV stabilised.

8.3.4 *Valves*

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

8.3.5 *Pipe cutting*

PE pipe shall be cut squarely and any burrs and shavings removed.

8.3.6 *Pipework alteration*

To facilitate 'in service' pipework alterations, section of PE pipework can be isolated from the gas supply by the use of a squeeze-off tool. Only tools approved by the pipe manufacturers or other competent authority shall be used, and they must be suitable for the diameter and the Standard Dimensional Ratio (SDR) of the pipe. Squeeze off may only be applied not less than three 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 shall be allowed between the squeeze points. Double squeeze off is recommended for pressures above 7.5 kPa ,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.

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

8.3.7 *Routing*

8.3.7.1 PE pipe is for installation underground (i.e. buried) but the ends shall be brought above ground level. These ends shall be as short as possible and connected to metal pipe by means of suitable transition fittings having anti-shear protection. That part of PE pipe above ground needs to be suitably protected against sunlight and mechanical damage by steel or other suitable sleeving. Where underground transition between PE and metallic

pipe cannot be avoided, the anti-shear protection must be fitted with additional corrosion protection applied to the metallic pipe paying special attention to any exposed threads.

8.3.7.2 Building connections

PE pipe must not be taken into or under buildings except as allowed by **4.1.3.5.** It may be taken up outside ground floor wall of a building. Suitably sleeved as **8.3.7.1** either to an external terminal or meter box or to an above ground entry position.

8.3.7.3 Adjacent services

PE service pipework shall be laid no closer than 150 mm from other service pipes carrying inert or flammable liquids or gases.

PE mains shall be laid no closer than 200 mm from these other services. PE pipework shall be adequately separated from steam pipes or other sources of heat.

8.3.7.4 Laying

Pipework shall be laid without tension on the base of the prepared trench. It shall be laid avoiding kinking or gouging. Changes in direction may be made by suitable fittings or by utilising the flexible properties of PE. In the latter case minimum permitted bend radii are:-

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

Plain pipe only15 x pipe diameter

The final tie in shall be delayed until the pipe has had sufficient time to relax. This is very important in hot months.

8.4 Depth of cover

8.4.1 *General*

Pipes shall be laid at a sufficient depth to provide cover adequate for the likely superimposed loads. Where depth of cover alone is insufficient, additional protection shall be provided.

8.4.2 *Mains*

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

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

8.4.3 *Service pipework*

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 shall 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, at approximately 100 mm above the pipe.

8.5 Trench preparation

8.5.1 Trenches shall 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, top soil or surface materials shall be kept separate from the excavated sub-soil for subsequent replacement.

8.5.2 Where laying across rock or ground of irregular consistency, the trench shall be excavated to 75 mm below the required depth to enable the pipe to be laid on a bed of sand or other suitable fine material.

8.5.3 To facilitate 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 shall be excavated approximately 15 - 20 m ahead of pipe laying.

8.5.4 The trench width shall be kept to a minimum consistent with the method of construction. Joint holes may be required to allow joints to be properly made.

8.6 Trench backfilling

8.6.1 Prior to backfilling all coatings and wrappings shall be inspected and repaired where necessary.

8.6.2 The trench may be backfilled between pipe joints i.e. leaving all joints and connections exposed, prior to pressure testing. The backfill shall be carried out progressively i.e. from one end of the pipe system.

8.**6.3** The backfill at the sides and immediately above the pipe shall be of similar material to that specified for the under bedding. (See **8.5.2**)

8.6.4 Use of wet clay immediately adjacent to the pipe shall be avoided. It cannot be sufficiently compacted and is liable to swell, shrink and erode.

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

8.6.6 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 shall be used as protection against inadvertent damage.

8.6.7 *Pipe indication*

A yellow plastic indicator tape, or equivalent shall be laid between 100 mm and 300 mm above the pipe, except where:

a) the route of the pipe is adequately recorded or marked or is obvious;
b) other means are available for pipe location; and
c) the pipe is a service or installation pipe which can be isolated from the mains or gas supply.

Indicator tapes for PE pipe shall preferably incorporate a metallic core wire, for locating the pipe route by using a suitable instrument.

8.7 Pipe laying without trenching

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

9 INSPECTION, TESTING AND COMMISSIONING

Before commissioning with LPG the complete piping installation shall be examined and/or tested as described.

9.1 Pipe joints

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

Threaded joints shall be visually inspected to ensure correct assembly, appropriate sealant and absence of excessive exposed threads.

Compression joints shall be visually examined to ensure absence of distortion of tube.

Capillary joints shall be visually examined to confirm that the solder has run well.

PE joints shall be visually examined to ensure appropriate fitting

9.2 Pressure testing

9.2.1 After assembly and before introduction of LPG, pipework systems shall be proof tested and/or leak tested as appropriate in accordance with **9.3** and **9.4.**

9.2.2 *Test procedure*

Testing under pressure requires proper planning. The procedure shall include consideration of the following:

a) method of test and pressurising medium to be used;
b) maximum safe operating pressure of the pipework and fittings to be tested;
c) test pressure(s);
d) rate of pressure rise. (See **9.2.3**);
e) duration of test including time for temperature stabilisation;
f) test equipment. (See **9.4.8**);
g) extent of pipework to be tested;
h) means of positive isolation of appliances or pipework sections not included in the test programme;
j) identification of non-return valves (back check valves) and pressure regulators which may lock up and invalidate the test;
k) additional security of pipework if necessary; and
l) precautions including warning signs and keeping away of unauthorised persons from the test area.

9.2.3 *Pneumatic pressure testing*

Care must be exercised when carrying out pneumatic pressure testing due to possible hazard in the event of failure. Testing above 150 kPa shall be preceded by a preliminary test at that pressure before gradually increasing the pressure to the required value.

Supply of air or inert gas from compressed gas cylinders must be controlled by two stage pressure regulators preferably with a relief set approximately 20 per cent higher than the desired test pressure. Any hoses used must be suitable for the test pressures to be applied.

9.3 Proof testing

Unless it has been previously tested, pipework operating at vessel pressure shall be proof pressure tested at 1.5 (hydraulic) or 1.1 (pneumatic) x maximum pipework design pressure, when installed. It shall be leak tested in accordance with **9.4.**

Pipework as specified in **4.3.1.2** shall be proof pressure tested in accordance with the recognised code based for its design.

9.4 Leak testing

9.4.1 After assembly but before entry into service, pipework systems shall be leak tested using one of the methods given in **9.4.9** or such other method as determined by a competent person. These tests shall be carried out before the site application of any corrosion protection. Leaks identified shall be corrected and the joints and any pipework disturbed shall be retested.

9.4.2 Where leak testing has been carried out on sections of the pipework system, a final check on the connection joints between those sections shall be made before the introduction of LPG.

9.4.3 Joints in buried pipework shall be left exposed during leak testing.

NOTE

Where mechanised back-filling or consolidation is employed, consideration shall be given to a subsequent system retest.

9.4.4 Leak testing shall be carried out using air or an inert gas e.g. nitrogen, except as permitted by **9.4.5.**

9.4.5 Propane vapour may only be used to pressurise the system for leak testing prior to commissioning where all the following are met;

a) external pipework only;
b) volume not greater than 0.030 m^3 ; and
c) diameter not exceeding 32 mm nominal bore.

Propane vapour shall only be used for pressurising the system, and before any purging of the complete system takes place.

9.4.6 *Test records*

The following shall be recorded for each test;

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

9.4.7 *Leak test pressures*

Leak test should be carried out at the appropriate test pressures given in Table **1**.

TABLE 1 - Leak test pressures

Duty	**Test Pressures**
Pipework conveying liquid or pipework conveying vapour, before the 1st stage regulator	Propane pipework: Not less than 600 kPa gauge. Butane pipework: Not less than 300 kPa gauge. In either case not more than 90 per cent of any relief valve set pressure, in the section being tested.
Pipework after the 1st stage regulator operating above 3.7 kPa gauge maximum operating pressure (MOP).	Not less than 1.5 x maximum operating pressure.
Pipework operating at or below 3.7 kPa gauge maximum operating pressure.	4.5 kPa gauge pre-service test. Maximum operating pressure for in service test.

9.4.8 *Test equipment*

Manometers, dial gauges, or other pressure or leak measuring devices shall be chosen to give the accuracy, repeatability and sensitivity necessary for the test. Pressure gauges and pressure transducers for digital gauges shall be routinely calibrated to a suitable standard. The calibration date shall be recorded.

9.4.9 *Test methods*

9.4.9.1 Pipework joint leak detection test

Where the pipe specification of a system provides a guarantee of its soundness, and all joints are accessible, the leak test may be confined to leak detection at each joint.

This shall be carried out at the appropriate test pressure given in **9.4.7** and by the use of a proprietary leak detection fluid, or a soap and water solution. Buried pipework may be only partially back-filled leaving all joints sufficiently exposed to observe any bubbles clearly.

Components isolated to protect them from the test pressure shall be tested on reconnection at the highest acceptable pressure but not less than the Maximum Operating Pressure (MOP). Joint leak testing shall also be used as a method to locate the source if pressure indicate leakage.

Important - Any leak detection fluid used for PE pipework or fittings must be washed off with clean water immediately after the test. Detergents must not be used on PE pipework or fittings.

9.4.9.2 Pressure drop leak test

a) pipework subject to storage pressure

Pipework subject to storage pressure shall be leak tested prior to commissioning in accordance with **BS 5482** part **1**, Part **2** or Part **3** as appropriate or as **9.4.9.1.**

b) pervice pipework of volume 0.1 m^3 or greater

service pipework shall be tested prior to commissioning in accordance with IGE/UP/1 "Soundness Testing and Purging of Industrial and Commercial Gas Installations".

c) service pipework of volume less than 0.1 m^3 and pressures above 3.7 kPa

Pipework between 1st stage and 2nd stage regulators shall be tested prior to commissioning as (b) above or in accordance with **BS 5482 :** Part **1,** Part **2** or Part **3** as appropriate. The test pressure shall not be less than 1.5 x MOP (Maximum Operating Pressure).

d) Service pipework and installation pipework of volume less than $0.1m^3$ and pressures 3.7 kPa or less

i) A "U" gauge test with air at 4.5 kPa shall be carried out prior to commissioning in accordance with the **BS 5482** part **1,** Part **2** or Part **3** as appropriate,except that the gas system including the section upstream of the final stage regulator shall be completely depressurised before the test. Following a 5 minute temperature stabilisation period, there shall be no discernible pressure drop over a further period of 5 minutes.

ii) The LPG supply side must then be isolated and the system upstream of the installed regulator depressurised. Following a 5 minute temperature stabilisation period, there shall be no discernible pressure drop over a further period of 5 minutes.

iii) An "in service" leak test for domestic and small commercial installation pipework with appliances connected but turned off(see note), may be carried out as for (ii) but at MOP or lock-up pressure as follows:

NOTE
Inlet valves to appliances with flame failure devices should be kept open during the test, but any pilot light extinguished.

With appliances turned off and lock up pressure established, the cylinder or tank valve or other upstream valve shall be closed and the pipework section upstream of the final stage regulator depressurised before the stabilisation period and the 5 minute test period.

Alternatively, the pipework upstream of the final stage regulator may remain connected and pressurised during the following procedure. The nominal regulator pressure shall be determined by lighting an appliance burner. The cylinder or tank valve or other upstream valve shall then be closed and the appliance burner turned off when the appliance pressure has dropped by 50 Pa (0.5 mbar). During the stabilisation period a rise in the pressure will indicate a "let-by" through the regulator or upstream valves which will need correction.

The permitted pressure drop *p* during the 5 minute test period shall be:-

Caravan and boat installations:- no discernible loss.

Other installations:-*p* maximum = 300 Pa or

p maximum = 1000/V Pa

where V is pipework volume in dm^3.

e) where a "U" gauge test is indicated, other more sensitive measuring instruments may be used. In such cases the increased sensitivity may indicate a pressure drop where "no discernible pressure loss" is called for. While zero loss shall be aimed for, a loss not exceeding 25 Pa may be accepted.

9.4.9.3 Leak-rate flow test

Extremely sensitive flow meters such as the soap-film flow meter are available which may be used with a constant pressure test medium to read directly the volumetric leak rate of a pipework system. They should be capable of an accuracy within not less than ± 0.2 pre cent of the leak rates determined by this method, the permitted leak rates shall be that recommended in IGE/UP/1.

9.4.9.4 Bubble leak test

This method is suitable for low pressure only.

The equipment and procedure shall be as described in **BS 5482 : Part 1** except that the gas system including the section upstream of the final stage regulator shall be completely depressurised before the test and the test pressure shall be 4.5 kPa. The test is designed to ensure a leak rate not exceeding 85 cm^3 per hour, and is suitable for simple bulk or cylinder supplies to domestic or small commercial installations as an alternative to **9.4.9.2 (d).**

9.4.10 ***Setting and testing of controls***

Where the system can be connected to a supply of air or inert gas at appropriate pressure, the opportunity shall be taken to check the setting of pressure regulators and any over and under pressure shut-off devices before introducing LPG. Adjustment shall only be made if the devices are suitable for on-site adjustment by the installer. Where means are provided regulators shall be left sealed against unauthorised interference.

9.4.11 *Records*

A record of the test(s) shall be made and signed by a competent person certfying that the pipework is sound.

9.5 Commissioning

9.5.1 Except for pressurising for testing (See **9.4.5**) LPG shall not be introduced into a pipework system unless it has passed a leak test as in **9.4** for the entire system to be commissioned, and signed records are available as in **9.4.11.**

9.5.2 Purging of pipework systems shall only be carried out by or under the supervision of competent persons. Pipework up to and including 32 mm nominal bore and meeting the requirements of **9.4.4** may be purged directly with LPG. For larger pipework and systems which may include large volume items e.g. vaporisers, air-gas mixers etc. the system shall be purged with an inert gas e.g. nitrogen, so that the oxygen level is reduced to less than 9 per cent by volume, before introducing LPG. Purge gas shall be introduced in a controlled manner using an adjustable pressure regulator.

9.5.3 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 inert gas.

9.5.4 During the introduction of LPG, the purge gas shall 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 structures.

9.5.5 The introduction of LPG may be undertaken in sections if necessary, 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 appliances in accordance with the manufacturer's instructions or that of other competent and responsible person.

9.5.6 Unless the setting and testing of controls have been satisfactorily carried out according to **9.4.10,** necessary adjustments and checks will be required during the final commissioning stage.

APPENDIX A

PIPEWORK DESIGN LIMITS

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

Before commissioning, all parts of an installation operating above 50 kPa gauge need to be assessed to establish the safe operating limits.

A.1 Liquid phase

A.1.1 *Pressure*

Not less than the vessel design pressure or higher pressure if indicated by the process, e.g. pumps, shut-off valves etc.

Hydrostatic relief valves shall be set above the Maximum Operating Pressure (MOP), as high as practicable but not exceeding the design pressure of the section which they are required to protect.

Recommended design pressures for non-pumped systems as follows:

Propane - 2.4 MPa gauge. (1.9 MPa if ASA 150 flanges or other similarly rated equipment installed.)

Butane - 1.9 MPa gauge

A.1.2 *Temperature*

Maximum - not less than the upper design temperature of the vessel.

Minimum - minus 20 ^{o}C

A.2 Vapour Phase

A.2.1 *At storage pressure*

A.2.1.1 Pressure

Not less than the vessel design pressure, or higher pressure if dictated by the process, e.g. compressors etc.

A.2.1.2 Temperature

Maximum - not less than the upper design temperature of the vessel or higher temperature if dictated by the process.

Minimum - minus 20 ^{O}C

A.2.2 *After 1st stage regulator*

A.2.2.1 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.

APPENDIX B

CLASSES OF PIPE FOR LPG SERVICE

This table summarises the broad classes of pipework acceptable for various LPG services. Full details will be found in the appropriate sections of the code and in Appendix **C**.

TABLE 2 - Classes of pipe for LPG services

Above ground				**Below ground (Buried)**		
Class of pipe (1)	Liquid (2)	Vapour 500 kPa and up to vessel pressure (3)	Vapour below 500 kPa (4)	Liquid (5)	Vapour 500 kPa and up to vessel pressure (6)	Vapour below 500 kPa (7)
Carbon Steel Seamless	yes	yes	yes	yes	yes	yes
Carbon steel Welded seam	no	no	yes	no	no	yes
Copper Solid drawn:*						
22 - 35 mm Table X	no	no	yes	no	no	no
22 - 35 mm Table Y	no	no	yes	no	no	-
15 mm and less Table X	no	yes	yes	no	no	no
Table Y or W	no	yes	yes	no	yes	yes
PE: SDR 11	no	no	no	no	no	yes

* Copper Solid Drawn - **BS 2871 : Part 1**

APPENDIX C

PIPE DATA

Table 3 - Pipe data

Material (1)	**Specification** (2)	**Notes** (3)
Carbon Steel	Seamless Carbon Max.0.25 % **BS 3601, BS 3602** API 5LB **ASTM A 106B** Welded seam **(**Gas Pipe **BS 1387)**	For use with welded fittings, wall thickness equivalent to 'schedule 40' or standard wall ' is recommended. For use with threaded fittings to **BS 3799.** Wall thickness equivalent to 'schedule 80' or 'Extra strong' must be used to prevent distortion during threading. Use only medium or heavy quality, galvanised or plain.
Copper	Solid Drawn, **BS 2871** part **1** Table X (half hard) Table Y (half hard) Table W (half hard) or annealed Table W (6, 8, 10 mm) annealed Bundy tube	 Manufacturer's specification (not less than **BS 2871**)
Polyethylen**e**	Extruded PE **BS 7281**	Pipe marking as required by the Standard

APPENDIX D

PIPE SIZES

Steel pipe - sized on nominal bore (NB - Imperial/NP - Metric)
Copper pipe - sized on outside diameter (OD)
Polyethylene pipe - sized on outside diameter (OD)

TABLE 4 - Approximate size comparisons

Steel, Nominal size Imperial (Inches)	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6
Steel, Nominal size Metric (mm)	8	10	15	20	25	32	40	50	65	80	100	125	150
Copper, Tube size Metric mm	10	12	15	22	28	35	--	--	--	--	--	--	--
Polyethylene Tube size Metric mm.	--	16	20	25	32	50	55*	63	75	90	--	--	--

* Non-preferred size.

TABLE 5 - Pipe volume (For standard steel pipe) dm^3

Length (m)	Pipe Size (mm)								
	15	20	25	32	40	50	80	100	150
0.5	0.10	0.18	0.30	0.55	0.68	1.1	2.5	4.3	10
1	0.20	0.36	0.60	1.1	1.4	2.2	5.0	8.6	20
2	0.40	0.72	1.2	2.2	2.8	4.4	10	17	40
3	0.60	1.1	1.8	3.3	4.2	6.6	15	26	60
4	0.80	1.4	2.4	4.4	5.6	8.8	20	34	80
5	1.0	1.8	3.0	5.5	7.0	11	25	43	100
6	1.2	2.2	3.6	6.6	8.4	13	30	52	120
7	1.4	2.5	4.2	7.7	9.8	15	35	60	140
8	1.6	2.9	4.8	8.8	11	18	40	69	160
9	1.8	3.2	5.4	9.9	13	20	45	77	180
10	2.0	3.6	6.0	11	14	22	50	86	200
15	3.0	5.4	9.0	16	21	33	75	129	300
20	4.0	7.2	12	22	28	44	100	170	400
30	6.0	11	18	33	42	66	150	260	600
40	8.0	14	24	44	56	88	200	340	800
50	10	18	30	55	70	110	250	430	1000
60	12	22	36	66	84	130	300	520	1200
70	14	25	42	77	98	150	350	600	1400
80	16	29	48	88	110	180	400	690	1600
90	18	32	54	99	130	200	450	770	1800
100	20	36	60	110	140	220	500	860	2000

To obtain volume in $\mathbf{m^3}$divide by 1000.
For non-standard steel pipe and PE pipe calculate using actual bore size.

APPENDIX E

PIPEWORK SUPPORTS

Guide to maximum distance between horizontal pipework supports based on BS 3974

TABLE 6 - Steel (heavy weight) pipework

Nominal size (mm)	8	10	15	20	25	40	50	65	80	100	125	150
Span (m)	n/a	n/a	2.0	2.5	3.0	3.5	4.0	4.5	5.5	6.0	7.0	8.0

TABLE 7 -Copper (half hard) pipework

Nominal size (mm)	10	12	15	22	28	35
Span (m)	n/a	n/a	1.3	1.75	2.0	--

NOTE

1 n/a indicates 'not covered' by the British Standards. Spans shall not exceed 1 m.

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

3 For medium weight steel pipe reduce the span by 10 per cent.

4 Annealed copper pipe needs uniform support.

5 For vertical runs, maximum distance between supports can be increased by approximately 30 per cent.

6 PE pipe runs are buried and require uniform support from the trench preparation.

APPENDIX F

THERMAL EXPANSION

Linear thermal expansion from – 20 ^{o}C to 40 ^{o}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	11.6×10^{-6}
Copper	17.2×10^{-6}
Polyethylene	150×10^{-6}

APPENDIX G

GENERAL GUIDANCE ON APPLYING CORROSION PROTECTION WRAPPING TO PIPEWORK

This guidance is provided for use where no supplier's instructions are available.

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 per cent.

c) the wrapping should extend to overlap any existing pipe coating for at least 50 mm.

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 coating or wrapping should extend to at least 150 mm above the ground level.

f) the complete wrapping should be carefully inspected before and after installation. The visual inspection may be supplemented by other tests.

g) care should be taken in handling of wrapped pipe to avoid damage to the coating, since any flaw will provide a centre for accelerated corrosion.

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