**SRI LANKA STANDARD 1196 : PART 2 : 2000**
**UDC 665.72**

# CODE OF PRACTICE FOR
# TRANSPORT, STORAGE AND HANDLING OF LPG
## PART 2 : DESIGN, INSTALLATION AND MAINTENANCE OF BULK LPG STORAGE AT FIXED INSTALLATIONS

**SRI LANKA STANDARDS INSTITUTION**

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# CODE OF PRACTICE FOR TRANSPORT, STORAGE AND HANDLING OF LPG
# PART 2 : DESIGN, INSTALLATION AND MAINTENANCE OF BULK LPG STORAGE AT FIXED INSTALLATIONS

**SLS 1196 : Part 2 : 2000**

**Gr. 22**

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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 Standards Institution on 2000-09-21.

The objective of this part of the Code of Practice is to set safety standards and requirements for the design, installation and periodic inspection and testing of bulk LPG storage at fixed installations. This standard has been published for the guidance of those involved with the handling of LPG in bulk.

The other parts of this code of practice are as follows:

Part 1 : General Provisions
Part 3 : LP Gas piping system - Design and 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 publications, in the preparation of this code:

a) **Code of practice 1** - Design, installation and maintenance of bulk LPG storage at fixed installations,
Part 1 : Design and installation
b) Installation and maintenance of bulk LPG storage at consumers' premises,
Part 3 : Periodic inspection and testing

published by the Liquefied Petroleum Gas Industry Technical Association (UK).

## 1 SCOPE

This part of the Code of Practice deals with the design, installation, periodic inspection, examination and testing of bulk LPG storage at fixed installations. It covers underground/mounded and above ground storage vessels at fixed installations with vessels of water capacities above 150 l, and including associated equipment up to but not including the consuming equipment.

The following are excluded from the coverage of this standard:

a) Refrigerated or partially refrigerated storage.
b) Design and installation of LPG piped supplies to multiple consumers.

**NOTE**

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

## 2 REFERENCES

| | |
|---|---|
| ASA B1.5 | American National Standard for ACME screw threads |
| ANSI B57.1 | Cylinder valve outlet and inlet connections |
| BS 2789 | Spheroidal graphite or nodular graphite cast iron |
| BS 4375 | Unsintered PTFE tape for thread sealing applications |
| BS 5292 | Jointing materials and compounds for installations using water low pressure steam or 1st, 2nd and 3rd family gases |
| BS 5306 | Code of practice for fire extinguishing installation and equipment. |
| BS 5345 | Code of practice for selection, installation and maintenance of electrical apparatus for use inpotentially explosive atmosphere |
| BS 5351 | Steel ball valves for the petroleum, petrochemical and allied industries. |
| BS 5500 | Unfired fusion welded pressure vessels |
| BS 5378 | Safety signs and colours |
| BS 5958 | Code of practice for control of undesirable static electricity |
| BS 6755 | Testing of valves; Part 2; fire type-testing requirements |
| SLS 712 | Liquefied petroleum gas |
| SLS 752 | Rating and fire-testing of fire extinguisher |
| SLS 1172 | Hoses and hose assemblies for LPG; Parts 1,2 & 3 |
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| SLS 1177 | Filling ratios and developed pressures for liquefied and permanent gases |
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| SLS 1183 | Domestic LPG burning installations at permanent dwellings |
| SLS 1196 | Code of practice for transport, storage and handling of LPG |
| | Part 3 LPG Gas piping system – design and installation |
| SLS 1197 | Inspection access and entry openings for pressure vessels |

## 3 DEFINITIONS

For the purpose of this standard the following definitions shall apply**:**

**3.1 back pressure check valve :** A device designed to close automatically and prevent a reverse flow of vapour or liquid.

**3.2 bonding :** The means of ensuring all parts of metal structures are at the same electrical potential.

**3.3 bund :** A wall surrounding a storage vessel usually designed to retain the contents of the largest vessel in the group event of a failure.

**3.4 cathodic protection :** A method of preventing corrosion in a metal structure by making it the cathode as in an electro chemical cell.

**3.5 drnching system :** A fixed array of high velocity water spray nozzles.

**3.6 emergency valve :** A strategically located valve provided to enable the LPG supply to be shut-off in an emergency.

**3.7 excess flow valve :** A device designed to close when the liquid or vapour passing through it exceeds a predetermined flow and pressure drop and which reopens when the pressure differential is restored.

**3.8 firewall (radiation wall):** A wall, screen or separating partition erected in the open air to reduce the effect from radiated heat on an LPG vessel and to ensure an adequate dispersion distance for LPG leaking from the vessel.

**3.9 fixed maximum liquid level device :** A small bleed valve connected to a dip-tube terminating at the maximum permitted filling level in a bulk vessel to indicate its maximum permitted level when being filled.

**3.10 hydrant :** A fixed water terminal with a coupling to connect fire fighting hoses.

**3.11 hydrostatic relief valve :** A relief valve which allows release of liquid from a shut off pipeline in the event of a pressure rise due to thermal expansion of the liquid in the pipeline.

**3.12 kerb :** A low wall designed to contain small volumes of spillage or to direct spillage to a specific area.

**3.13 LPG-Air mixing plant :** A plant designed to accurately control the ratio of air and gas flows and their mixing to meet the demand of a distribution system.

**3.14 monitor :** A specifically designed fire fighting water nozzle either fixed or portable with coupling to suit fire fighting hoses.

**3.15 mounded vessel :** A vessel partially or entirely above ground with earth or other suitable material covering the above ground surfaces except for any entry manholes where fitted, relief valves, transfer connections and other service fittings.

**3.16 regulator :** A device for automatically maintaining gas pressure at a steady value within close limits required for the application, and over a range of flow rates down to zero.

**3.17 saddles :** Supports for cylindrical vessels which are shaped to conform to the outside of the vessel.

**3.18 storage vessel :** A vessel manufactured according to a recognised international standard for the storage of LPG.

**3.19 underground vessel :** A vessel buried except for any manholes, safety relief valves, transfer connections and other service fittings.

**3.20 vaporiser :** A heat exchanger for vaporising liquid phase LPG to provide a vapour/gas supply

## 4 LPG PLANT LOCATION AND SAFETY DISTANCES

### 4.1 Accessibility and area classification

All above ground items of LPG plant should be easily accessible for control, maintenance and fire-fighting purposes. Areas shall be classified safe or hazardous according to Appendix **4** and electrical plant installation in these areas should meet the requirements specified under **7.**

No source of ignition should be permitted within these hazard zones and smoking, naked flames and spark producing equipment should be prohibited within these zones.

### 4.2 Lay-out of vessels

The lay-out and grouping of vessels as distinct from spacing should receive careful consideration so as to ensure

a) Adequate free ventilation,

b) Accessibility for fire-fighting,

c) Avoidance of spillage from one vessel affecting any other vessel or nearby important areas,

d) A clear line of sight for a person whilst in a position to control a product transfer to see both the receiving vessel and the delivery vehicle.

### 4.3 Storage vessels - location and spacing

**4.3.1** Storage vessels are normally installed above ground in the open air but they can also be buried underground or mounded. They shall never be installed in buildings or in open pits. Storage vessels, whether at ground level, underground or mounded should be spaced and located in accordance with Appendix **2**. The distances given are the minimum permitted and refer to the horizontal distance in plan between the vessel and the nearest point of a specified feature, e.g. an adjacent storage vessel, building, property line, except for underground and mounded vessels where some distances are measured from the valve assembly on the manhole cover(s).

**4.3.2** Separation distances are intended to protect the LPG facilities from the radiation effects of fires involving other facilities as well as to minimise the risk of escaping LPG being ignited before being dispersed or diluted.

**4.3.3** Separation distances for above ground vessels may be reduced as shown in Appendix **2**, Table **1** by provision of radiation walls complying with **4.4.** Alternatively they may be reduced by the provision of greater fire protection than that set out in **6,** but advice should be sought from the enforcing authority.

**4.3.4** Multiple vessel installations shall be designed and installed as follows:-

**4.3.4.1** Location and spacing to be as stipulated in **4.3** and Appendix **2**, Table **6(a)** and **6(b**).

**4.3.4.2** LPG vessels shall not be installed above or below any other vessel or tank such that their outlines overlap when viewed in plan.

**4.3.4.3** Precautions must be taken when vessels are interconnected in the liquid phase to ensure that the maximum permissible liquid level in any vessel is not exceeded.

**4.3.4.4** A vapour balance line of adequate size interconnecting all vessels which are interconnected in the liquid phase is essential.

**4.3.4.5** Separate filling of each vessel is preferred. Extended fill lines should be readily identified with the relevant vessel (See **4.7)**. A common fill line serving multiple vessels should not be installed unless adequate precautions are taken to ensure that unintentional filling of any vessel is prevented.

**4.3.4.6** Installations having liquid return line to the storage vessels, e.g. from pumps, vaporisers etc. must be designed to avoid overfilling by the inadvertent return of product to vessels otherwise isolated.

**4.3.5** The minimum distance of separation between an LPG storage vessel and a vessel containing a flammable liquid or liquid oxygen is set out in Appendix **2**, Table **7** and **8**.

**4.3.6** The number of above ground LPG storage vessels in one group shall not exceed six, subject to the total capacity of a group not exceeding that given by Appendix **2**, Table **6(a).** Any vessel in one group shall be 7.5 m or the separation distance given in Table **6(a)** column (a) whichever is the greater from the nearest vessel in another group unless a fire wall is erected between the two groups.

**4.3.7** No permanent source of heat shall be located within 1.5 m of an LPG storage vessel.

**4.3.8** Weeds, long grass, shrubs and trees and any combustible material shall be removed from an area within the separation distance in Appendix **2**, Table **6** column **(a)** from any vessel not exceeding 2,500 l capacity and within 6 m of larger vessels. Chemical weed killers such as sodium chlorate which are themselves potential sources of fire risk must not be used in these areas.

**4.3.9** Where a visual screen is required for LPG vessels, e.g. at domestic installations, this shall not interfere with ventilation and shall be located at one side of the vessel only. For the purpose of such screening, evergreen shrubs or trees or a non flammable open ranch type fence may be located 1 m from vessels not exceeding 5,000 l capacity or 6 m from larger vessels.

**4.3.10** LPG storage vessels, vaporisers, pumps, gas-air mixing plants etc. shall not be located directly beneath electrical power cables. For cables carrying less than 1.0 kV, the vessels should be sited at least 1.5 m from a line drawn vertically downwards from the power cables. For cables carrying 1.0 kV or greater the distance should be increased to 10 m. It was also should be ensured that a break in overhead line does not in contact with the vessel.

### 4.4 Location of off-loading/reception facilities

**4.4.1** Filling connections shall be as close to the vessel as is practicable but not directly underneath. Offset/remote fill points shall be used whenever vehicle access would otherwise be difficult.

**4.4.2** Filling connections shall be located within the storage fenced area when practicable; if outside, the terminal fitting shall be secured against tampering.

**4.4.3** Filling connections shall be easily accessible.

**4.4.4** Filling connections shall be located so that the safe positioning of the delivery vehicle and its quick removal in an emergency are facilitated.

**4.4.5** Offset/remote filling connections including vapour returns shall be clearly labeled 'liquid' or 'vapour' as appropriate.

**4.4.6** When siting offset/remote filling connections, consideration shall be given to their area classification (electrical) as shown in Appendix **4**.

**4.4.7** Filling connection that include vapour returns should be clearly labeled "liquid" or "vapour" as appropriate. Where butane and propane loading/unloading connections are adjacent they should be clearly distinguished.

**4.4.8** To avoid abrasion and other damage to the hose during filling it should not pass over walls or fences or similar features likely to cause damage**.** Hoses should be securely supported and stored accordingly when not in use.

### 4.5 Location of product transfer equipment

**4.5.1** Pumps, compressors and their motors shall be protected against accidental damage and the weather by suitable positioning and/or protection. They shall not be sited beneath vessels.

**NOTE**

*Flameproof motors are not necessarily weatherproof.*

**4.5.2** Any electrical equipment must be sited in accordance with the area classification shown in Appendix **4**.

**4.5.3** The location of pumps shall be selected to minimise the risk of cavitation under the specified operating conditions.

**4.5.4** Pumps shall be located to facilitate ease of maintenance.

**4.5.5** If compressors are located in a building the structure should be non combustible with a light roof, well ventilated and used for no other purpose than the compression and distribution of LPG.

**4.5.6** Pipe work should be adequately supported and not used as a step or path.

## 4.6 Location of meters

**4.6.1** Meters shall be protected against accidental damage by suitable positioning and/or protection; they shall not be sited beneath vessels.

**4.6.2** Meters shall be located to facilitate installation, maintenance and use.

## 4.7 Location of vaporisers

**4.7.1** Vaporisers shall not be installed within 1.5 m of a storage vessel.

**4.7.2** Direct fired or non-flameproof electrical vaporisers shall be installed no nearer to LPG storage vessels than the distances permitted in Appendix **2**, Table **6** columns **(a)** and **(d)** as appropriate.

**47.3** The distance between any vaporiser and the nearest adjacent building or line of adjoining property shall be in accordance with Appendix **3**.

**4.7.4** where the design of the vaporiser permits installation close to the storage vessel(s) as in **4.7.1,** it may be considered as part of the vessel(s) for installation safety distances (See Appendix **2**).

**4.7.5** Vaporisers may be installed in buildings subject to the following:

a) they are flameproof, steam, hot fluid or of the process heater type;
b) the building is used exclusively for gas manufacture and/or distribution;
c) the building is of light, non combustible construction;
d) the building is well ventilated near the floor and the roof level , with floor level ventilation not more than 150 mm above the floor level ; and
e) the building floor is not below the surrounding ground level.

**4.7.6** Particular care shall be taken with the location of vaporisers to facilitate their safe draining.

**4.7.7** The distance between any vaporiser and the nearest adjacent building or line of adjoining property be in accordance with the Table **1**.

**TABLE 1 - Minimum recommended separation distance**

| Capacity of vaporiser (kg/h) | Minimum distance of vaporiser from nearest adjacent building or line of adjoining property. (m) |
|---|---|
| up to 35 | 3 |
| >35 to 225 | 7.5 |
| >225 | 15 |

## 4.8 Location of regulators

The first stage pressure regulator shall be located as close as practicable to the vessel or vaporiser where applicable. They shall also be easily accessible.

## 4.9 Location of LPG - air plants

**4.9.1** No mixing plant shall be located within 3 m of the bund of open-vented tanks containing flammable liquids or 6 m from the tanks if they are not bunded. No mixer shall be located within the bund of a flammable liquid vessel.

**4.9.2** Mixing plants may be installed in buildings subject to the conditions as given in **4.7.5.**

## 4.10 Fire walls

**4.10.1** The purpose of a fire wall is to protect a vessel or vessels from a fire nearby and to ensure an adequate dispersion distance to boundaries and sources of ignition for LPG leaking from the vessel or its fittings where normal separation distance cannot be achieved.

**4.10.2** Fire walls should be sited between 1 m and 1.5 m from the nearest point of the vessel and may permit the distance from the vessel to buildings, boundaries etc**.** to be reduced to the values given in Column (b) of Table **6(a)** Appendix **2**. However, this distance can be reduced only if the distance from the vessel to those features around the end of the fire wall is at least given in Column (a) of this table.

**4.10.3** Radiation walls shall be imperforate and substantially constructed from brick, concrete or solid masonry and for vessels up to and including 500 l water capacity, they shall not be less than the height of the vessel. For larger vessels they shall be not less than 2 m high or the height of the vessel, whichever is the greater.

**4.10.4** Not more than two radiation walls shall be provided for any storage area and the remaining two sides shall be such that the natural ventilation is not significantly impaired.

**4.10.5** A radiation wall may be built on a boundary, but in such cases it must be wholly under the control of the occupier of the LPG storage site.

**4.10.6** For vessels up to and including 2,500 l water capacity the radiation wall may be the wall of an existing building, in which case the following additional requirements must be met.

**4.10.7** There shall be no openings in the wall either to the sides or above the top of the storage vessel for distances shown in Column**(a),** Table **6(a),** Appendix **2.**

**4.10.7.1** There shall be no overhanging eaves or similar projections constructed from combustible materials immediately above any storage vessel. No external stairway or fire escape shall be positioned above a storage vessel or be allowed to terminate in the storage area.

**4. 11 Storage area**

**4.11.1** Conventional bunds shall not be used around LPG storage vessels.

**4.11.2** Diversion kerbs with a height not exceeding 500 mm to avoid forming gas traps may be required to direct possible spillage away from vessels and sources of ignition to a safe area for evaporation or containment.

**4.11.3** Evaporation areas shall have to be at least 3 m from the LPG vessel and these area should be surfaced with the stone chipped or similar material to increase the surface area and promote evaporation and dispersion of gas**.**

**4.11 .4** No LPG storage vessel shall be located within the bunded enclosure of:

a) a vessel or tank containing any other flammable liquid;
b) a vessel containing liquid oxygen or other hazardous or cryogenic substance;
c) low pressure refrigerated LPG vessels; and
d) any heated storage vessel, e.g. a fuel oil tank.

**4.11.5** The ground beneath or adjacent to vessel connections or ancillary equipment shall be concreted or compacted and arranged to prevent either the accumulation of any liquid beneath them or its flow affecting other vessels or important areas. Provision shall be made for handling the run-off of cooling water applied in case of fire. (See **6.2.6**).

**4.11.6** To prevent the formation of gas pockets the vicinity of LPG storage vessels shall be free from pits and depressions within the separation distance given in Appendix **2**, Table **6(a).**

**4.11.7** Open drains, gullies or ducts located within the vessel safety distances which would permit access and passage of LPG vapours shall be fitted with a water trap or be otherwise suitably sealed.

**4.11.8** Storage area shall not contain equipment other than those specified in this COP.

**4.11.9** LPG vessels of capacity 11,250 l or more with a connection below the liquid should have provision made for directing any spillage of LPG to in evaporation area or a catchment pit.

**4.11.10** Any catchment pit should be separated from the LPG vessel, buildings ,and boundaries etc. so that if filled with LPG which ignites, the thermal radiation would not exceed the following levels:

a) 7.8 kW/$m^2$ at work areas, process facilities and unprotected LPG;
b) 12.6 kW/$m^2$ at boundaries;
c) 31.5 kW/$m^2$ at LPG vessels protected by water sprays or thermal insulation.

## 4.12 Storage compound protection

**4.12.1** Except where the provisions of **4.12.2** and **4.12.3** apply, and to prevent trespassing or tampering, the area which includes above ground vessels and pumping equipment, shall be enclosed by an industrial type fence which is at least 1.8 m high and at a distance of not less than 1.5 m from the storage installation, unless otherwise it is adequately protected. Around the immediate vessel area, fences shall have at least two means of exit, not adjacent to each other. Gates or access shall open outwards, shall not be self locking and shall provide easy means of escape.

**4.12.2** Storage installations for supply to multiple consumers to which the public have uncontrolled access, e.g. housing estates, home parks, without controlled access and a secure perimeter fence, shall be enclosed by a security fence as in **4.12.1** except that its distance from the storage vessels shall be increased to not less than 3 m.

**4.12.3** The provisions of **4.12.1** need not apply to vessels less than 9 000 liters water capacity which are equipped with a positive means of denying access to valves and fittings other than pressure relief valves, e.g. by a ventilated hinged cover capable of being locked in the closed position or by a blank flange or plug on drain connections, or by an open wire mesh fence with lockable access between support piers of vessels with bottom connections, where a lockable cover is provided and the key should be readily available in an emergency. This relaxation should not applied when public have uncontrolled access.

**4.12.4** Where damage to the storage installations equipment from vehicular traffic is a possibility, precautions against such damage must be taken. A suitable protection shall be provided to prevent mechanical damage to valves, etc. e.g. by the use of crash barriers, bollards or a wall. If an imperforate wall is used for these purposes it shall not exceed 380 mm in height and shall not be continuous.

**4.12.5** Underground vessels shall be protected from superimposed above ground loading, e.g. due to vehicular traffic or other causes, either by fencing off the area under which the vessels are buried or protecting them with a reinforced concrete slab or other adequate cover. The perimeter of the area under which the vessel(s) are buried shall be permanently marked.

**4.12.6** Mounded vessels shall be protected as appropriate, either by fencing off the area around the mound or by other adequate means. Where the vessel area is not fenced off the manhole and vessel fittings shall be protected against damage and tampering.

**4.12.7** *Warning notices*

**4.12.7.1** Each vessel shall be clearly marked '**Highly Flammable - LPG.**

**4.12.7.2** Prohibition of smoking or naked flames or operation of spark producing equipment and No Unauthorized entry, shall be indicated by signs complying with the Safety Signs as defined in **BS 5378** Part **1**. The signs shall be clearly visible and legible at the applicable safety distance (Table **6** of Appendix **2**) and shall be firmly fixed to the fence or wall or the vessel itself.

**4.6.7.3** For underground or mounded vessels to comply with the above requirement it is recommended that notices be displayed adjacent to the installation.

## 5. DESIGN

### 5.1 Storage vessels

**5.1.1** *Design code*

**5.1.1.1** New vessels shall be designed and constructed to **BS 5500** and for the conditions set out in **5.1.2** and **5.1.3.**

Other pressure vessel standards may be used if it can be shown that they will give an equivalent standard of safety or better.

**5.1.1.2** The use of partial standards or duplicity of standards is not permitted.

**5.1.2** *Design conditions*

**5.1.2.1** The design pressures and temperatures shall take into account the extreme ambient and service temperatures that the contents may reach in operation.

**5.1.2.2** The design conditions for storage vessels shall not be less onerous than the service limits given in the following Table **2**.

**TABLE 2 - Design conditions for storage vessel**

| | **Commercial Butane** | **Commercial Propane** | |
|---|---|---|---|
| **(1)** | **(2)** | **Liquid off take (3)** | **Vapour off take (4)** |
| Maximum temperature<br>Maximum pressure | 42.5 $^0$C<br>0.552 MPa gauge | 42.5 $^0$C<br>1.675 MPa gauge | 42.5 $^0$C<br>1.675 MPa gauge |
| Minimum temperature<br>Minimum pressure | minus18 $^0$C<br>Zero gauge | minus20 $^0$C<br>Zero gauge | Minus 40 $^o$ C<br>Zero gauge |

**NOTES**

1 *These developed pressure reference temperatures are for vessels finished in white. Other finishes may reduce normal reflection of solar radiation and therefore require a higher design temperature/pressure.*

2. *A higher minimum temperature may only be used for dedicated service controls are provided to limit the lower product temperature to a higher value.*

3 *A higher minimum temperature for butane storage may only be used if the system incorporates a positive means for preventing unacceptable vacuum conditions occurring in the vessel of if local minimum abeyant temperature ensure that the product temperature will be higher than minus 180* $^o$ C.

4 *This temperature allows for auto refrigerate effect in the absence of a vapour balance system for vessels up to 100 tonnes nominal capacity and for off take rates up to 30 tonnes per hour. Outside these [parameters this design temperate should be minus 40* $^o$ *C unless a technical assessment for the operation confirms a higher figure.*

**5.1.3** *Markings*

Each vessel shall be provided with a permanently fixed and clearly visible corrosion resistant data plate which should include at least the following information:

a) the pressure vessel design code;
b) the manufacturers name and the vessel serial number;
c) the water capacity in litres;
d) the maximum and minimum design pressures in MPa;
e) the maximum and minimum safe operating temperatures;
f) date of test, pressure applied, inspecting authorities' identification; and
g) provision for subsequent test marking ; and
h) the date of manufacture.

**5.1.5** *Lifting*

Where lifting lugs are fitted to vessels, these should be capable of taking the total weight of the vessel nominally full of LPG.

**5.1.6** *Vessel supports*

**5.1.6.1** Vessel supports shall comply with the pressure vessel standard taking account of the vessel shell stressing and transmission of the loading to the ground.

**5.1.6.2** Saddle bearing or corrosion plates shall be designed in accordance with the standard to which the vessel is designed and shall be of steel. Where the saddles are not welded to the vessel, bearing and/or corrosion plates shall be used.

**5.1.6.3** Saddles or supports shall project downwards more than any other projection on the lowest part of the vessel. Where saddles are not used, the vessel supports shall be shaped to conform with the vessel shell.

**5.1.6.4** For vessels above 5,000 l water capacity and/or where piers are used as part of the vessel support, provision shall be made for securing the vessel at one end, and the other being free to move as required. The end so secured shall be that to which the principal liquid and vapour lines are attached.

**5.1.6.5** Vessel supports shall be designed to prevent, or to drain, any accumulation of water and be of sufficient height to allow adequate access for installation, maintenance and use of the bottom fittings.

**5.1.6.6** Supports for vertical vessels shall be constructed so as to provide adequate support to the vessel. Where skirts are used, adequate ventilation with a minimum of two vents/inspection openings being provided, with at least one located at ground level.

**5.1.6.7** Provision shall be made to prevent the floating in case of flood. A siutable earthing device or bonding connection shall be provided an all vessels.

**5.1.6.8** Above ground vessel should be properly installed on firm foundations and where appropriately by supported on concrete, masonry or structural steel supports. These supports( excluding supporting feet 500 mm or less in height, vessel saddles, or skirts, of vertical vessels) should also be so constructed or protected to ensure their load bearing capacity is maintained for at least the same period as fire resistance is provided for the vessel.

**5.1.7** *Internal inspection*

For vessels up to and including 1,500 mm internal diameter, provision for internal inspection through vessel connections of 35 mm internal diameter are adequate for advanced optical techniques. Where such techniques are not likely to be available, the openings shall be spaced in accordance with **SLS 1197**.

Vessels exceeding 1,500 mm internal diameter shall have a manhole not less than 460 mm in diameter.

For underground and mounded vessels the manhole where provided, shall not be less than 575 mm internal diameter and shall be in the form of an extended nozzle of sufficient length to expose the manhole cover (See **5.1.10**).

**5.1.8** *Protection against corrosion*

**5.1.8.1** An adequate external protection system shall be applied to the vessel and the vessel supports, e.g. by zinc metal spraying and painting. The external surfaces of vessels should be suitably prepared, e.g. by grit blasting or chemical treatment.

**5.1.8.2** The external surfaces of underground and mounded vessels shall be suitably prepared and treated to give adequate protection to resist soil corrosion conditions too.

**5.1.8.3** The form of corrosion protection applied must allow for any expansion/contraction of the vessel which takes place with change of temperature and internal pressure conditions.

**5.1.9** *Fittings*

**5.1.9.1** Each vessel shall be provided with at least one of each of the following fittings:

a) safety relief valve connected to the vapour space (**5.1.12**);
b) drains, or other means of removing the liquid contents (**5.1.19**);
c) a fixed maximum liquid level device and preferably a content gauge. The level device should be independent of the content gauge (**5.1.16**);
d) filling connection (See Note below);
e) service connection (See Note below) ; and
f) a pressure gauge connected to the vapour space if the vessel is over 5,000 litre water capacity. For vessels 5,000 litre water capacity and below other type of provision may be made for determining the pressure in the vessel, e.g. a valved tapping in the vapour space of the vessel or adjacent pipework.

**NOTE**

*The location of connections particularly in combination valve clusters shall ensure that liquid is not entrained in a vapour service off-take during filling operations.*

**5.1.9.2** Vessels for the storage of butane shall be provided with means of preventing excessive vacuum where necessary (See Appendix **7**).

**5.1.9.3** All fittings attached to the vessel shall be suitable for LPG service over the temperatures and pressures that the product will reach in service.

**5.1.9.4** Jointing compounds for screwed joints shall be resistant to liquid phase LPG. Compounds conforming to **BS 6956 : Part 6**, or PTFE tape to **BS 4375** are acceptable, and should be applied to the male thread only so that jointing material cannot enter the fitting. Red lead, hemp or Boss White shall not be used.

**5.1.9.5** Gaskets for flanged joints shall be resistant to liquid phase LPG. Gaskets of natural rubber or bonded with natural rubber shall not be used. Compressed asbestos fiber (CAF) gaskets are acceptable.

**5.1.10** Fittings on underground or mounded vessels shall be accessible from above ground level.

**5.1.11** *Safety relief valves*

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

**5.1.11.2** pressure relief valves shall be set to start to discharge at a pressure not less than the maximum service pressure given in **5.1.2.**

**5.1.11.3** For above ground vessels the rate of discharge at full flow of the relief system shall not be less than that specified in the Table **10** of Appendix **5**.

**NOTE**

*These rates of flow are the minimum permissible at full discharge and apply to relief valve systems including pipework, check devices etc. as installed. Allowance must therefore be made for the reduction of quoted safety relief valve discharge rates arising from the flow resistance of check devices, multiple valve manifolds or other restrictions, when determining the size or number of relief valves required.*

**5.1.11.4** For underground and fully mounted vessels the full flow capacity of the pressure relief system may be reduced to not less than 30 per cent of the capacity specified in Appendix **5**.

**5.1.11.5** (a) Where a vessel designed for propane is used for butane service, safety relief valves with a capacity not less than that specified in Appendix **5** and set at the vessel design pressure may be used.

**5.1.11.5** (b) Where a vessel designed for propane is used for butane service relief valves set at butane service pressure may be used. The safety relief capacity shall not be less than the capacity in Appendix **5** related to the vessel design pressure.

**5.1.11.6** In the case of manifolded safety relief valves any provision made, for isolating for an extended period of time any one relief valve for testing or servicing, shall ensure that the remaining relief valves connected to the vessel provide the full capacity required. Where the removal of a relief valve would leave the vessel protected by less than full discharge capacity, then a replacement relief valve must be fitted immediately.

**5.1.11.7** In the case of vessels fitted with separate or single relief valves, provision may be made for their removal for testing or servicing by the use of an automatic check device, provided this valve is retained in the fully open position by the presence of the relief valve and closes before the relief valve is completely removed.

**5.1.11.8** Excess flow valves must not be installed between the vessel and any safety relief valve. Check devices must comply with **5.1.11.7.** Shut-off valve shall not be located between pressure relief valve and the container except in situation described under **5.1.11.6**.

**5.1.11.9** Each safety relief valve shall be plainly and permanently marked wit the following:

a) manufacturer's identification including name and catalogue or type number;
b) start to discharge pressure;
c) certified capacity; and
d) date of last test and tester's identification symbol.

**5.1.11.10** a) for above ground vessels exceeding 1,500 mm internal diameter and for all underground and mounded vessels, the relief valves shall be fitted with vent pipes adequately supported and having outlets at least 1.8 m above the top of the vessel to which they are fitted and not less than 3 m above ground level.

b) vent pipes shall be sized for the full flow of the relief valves to which they are fitted,

c) the vent pipe shall be so designed and installed that in the event of ignition of discharged products, flame impingement on any vessel, equipment or piping is avoided.

d) the top of the vent pipe should be provided with a rain cap and a water drainage point shall be included in the vent pipe if the relief valve does not provide for same.

e) pressure relief valve shall be designed to minimize the possibility of tempering. Externally set or adjusted valves shall be provided with on appropriate means of sealing the adjustment.

**5.1.11.11** For vessels of 1,500 mm and less internal diameter where vent pipes are not fitted the relief valve shall be installed so that any discharged products will not impinge on any vessel equipment or piping.

**5.1.12** *Shut-off valves and emergency valves*

**5.1.12.1** All liquid and vapour connections which permit flow out or into a vessel shall have a shut-off valve capable of manual operation located as close as practicable to the vessel, except that this requirement shall not apply to connections for safety relief valves or where the passageway into the vessel is 1.5 mm diameter or less.

**5.1.12.2** Shut-off valves required by **5.1.12.1** for connections of 32 mm nominal bore or greater shall be ball valves except where such a connection is to take a proprietary combination multi valve on vessels upto and including 9,000 l water capacity. Such ball valves shall conform to **BS 5351** or equivalent standard in design and **BS 6755** : **Part 2** or equivalent standard in fire test requirements.

**5.1.12.3** All connections into the vessel greater than 3 mm diameter for liquid and 8 mm diameter for vapour with the exception of those for relief valves, shall be protected with an excess flow valve or a back check valve (non return valve).

**5.1.12.4** Valves and their components shall comply with **5.1.9.3** and shall be made of steel, bronze or forged brass. Cast-iron shall not be used, but ductile iron conforming to **BS 2789** or equivalent with an elongation at fracture of not less than 18 per cent is acceptable.

**5.1.12.5** All vessels of capacity 7 tonnes, the outlet should have a remotely operated shut-off valves.

**5.1.13** *Excess flow valves*

**5.1.13.1** An excess flow valve is a valve which is held in the open position by means of a spring. When the flow of liquid or vapour exceeds the design flow rating this causes the valve to close. The valve remains closed until the pressure on the downstream side of the valve balances with that on the upstream side thereby allowing it to reopen. The balancing orifice shall not be greater than 1.4 mm.

**5.1.13.2** The flow rate for closure of excess valves shall be below that likely to result from complete fracture of the line it is protecting but, to prevent premature closing, should be substantially above the design flow rate.

**5.1.14** *Back check valves*

A back check valve is a spring loaded non-return valve which is normally held in the closed position. The valve remains closed against reverse flow until the pressure on the upstream side is greater than the downstream side, at which time the valve opens and allows the product to flow.

**5.1.15** *Fixed maximum liquid level devices*

**5.1.15.1** The device shall be of a type that allows liquid to bleed from a valve attached to a dip-tube to indicate when the maximum permitted level is reached during filling.

**5.1.15.2** The design length of the dip-tube shall be determined by the grade of LPG being stored and shall indicate a maximum permitted level which shall not exceed the following values of Table **3** (See also Appendix **6**):-

**TABLE 3 - Maximum fill percentage volume of vessels**

| **Product** | **Max. fill % volume of vessel** |
|---|---|
| Commercial Propane | 86.6 |
| Commercial Butane | 89.9 |

**5.1.15.3** The connection through the vessel shall not be larger than 1.4 mm diameter unless it is fitted with an excess flow valve.

**5.1.15.4** The operational bleed screw shall remain captive at all times.

**5.1.15.5** The bleed valve for the liquid shall be installed so that it can be conveniently reached and is visible from the filling point unless special precautions are taken (See **5.4.4)**.

**5.1.16** *Filling connections*

**5.1.16.1** All filling connections shall be equipped at the storage vessel with;

a) an excess flow valve or back flow valve as in **5.1.12.3** and
b) a shut-off valve capable of manual operation as in **5.1.12.1** and **5.1.12.2** or
c) a remotely controlled valve of the fail safe type which is operated from a safe area and which is capable of manual operation.

**5.1.16.2** During the filling operation a pressure increase may occur and consideration shall be given to either fitting internal spray pipes or the use of vapour balancing lines for pressure equalization between the delivery tanker and the storage vessel.

**5.1.16.3** To maintain an Industry standard and to minimize the use of adapters, couplings for liquid fill and vapour return connections shall be one of the types and sizes indicated below.

(a)Preferred Types

Liquid

3 1/4" ACME (M) R.H.x6 TPI
2 1/4" ACME (M) R.H.x6 TPI
1 3/4" ACME (M) R.H.x6 TPI

Vapour

2 1/4" ACME (M) R.H.x6 TPI
1 3/4" ACME (M) R.H.x6 TPI
1 1/4" ACME (M) R.H.x5 TPI

ACME thread should conform to ASA B1.5 class 2G

(b) Self-sealing Couplings

This type of coupling will not be compatible with the ACME coupling. Where self sealing couplings are used, the type and size must have compatible mating halves, and to avoid the use of adapters the sizes should be restricted to:

| Liquid | Vapour |
|---|---|
| 3" (75 mm) | 2" (50 mm) |
| 2" (50 mm) | 1" (25 mm) |
| 1.5" (38 mm) | |

**5.1.16.4** Where a storage vessel is to be filled on a regular basis by one supplier the use of adapters should be avoided.

**5.1.16.5** Where the use of an adapter is unavoidable only one single adapter should be used.

**5.1.16.6** Left hand threads shall only be used for liquid or vapour couplings for unodorised products (Appendix **8**).

**5.1.17** *Pressure gauges*

Vessels of more than 5,000 litres water capacity shall be equipped with a suitable pressure gauge connected to the vapour space of the vessel and easily readable from ground level. Pressure gauge connections shall be protected either by a tapping reduced internally to a bleed hole not larger than 1.5 mm diameter or by a suitable excess flow valve and shut-off valve.

**5.1.18** *Drain connections*

**5.1.18.1** Drain connections should be provided with a shut-off valve which is of quick acting type and preferably not more than 50 mm diameter. The outlet of the drain valve should be provided with a length of piping terminating with a second shut-off valve. The length of piping should be such that the risk of simultaneous obstruction of the two valves is minimised. The second valve shall be positioned to facilitate operation of both valves by one person.

**NOTE**

*Tanks below one tonne may have only one shut-off valve.*

a) the second valve and the piping should be adequately supported and secured to prevent mechanical damage or breakage by jet forces.

b) both valves on the drain system shall have a means of actuation which cannot readily be removed or moved from the closed position except by intentional operation.

c) the additional pipework and second valve may be fitted temporarily in to the system at time of draining provided that the fixed drain valve is protected by an excess flow valve fitted upstream.

d) the outlet of the drain valve system shall be blank-flanged, plugged or otherwise secured against tampering when not in use.

e) pipework between the drain system valves and between any valve and a blank flange or plug etc. shall be protected by hydrostatic relief valves (See **5.3.8**).

**5.18.2** Drain system used for other purpose such as sampling. Flaring, removing water. Etc. should terminate at a safe place away from vessel, to ensure that any discharge does not travel beneath the vessel, and any ignition of discharge would not impinge on the vessel. The second valve should not be larger than 25 mm nominal diameter.

**5.1.18.3** No drain or blow-off line shall discharge into or be in the proximity of any public or other drainage system where it would be liable to create a hazard.

**5.1.19** *Contents gauges*

**5.1.19.1** All content gauges shall clearly indicate whether they read in percentage of water capacity, percentage or fractional LPG capacity, or actual contents in gallons, tonnes etc.

**5.1.19.2** Any gauging device that relies on bleeding to atmosphere, such as a rotary tube, fixed tube or slip tube, shall be such that:

a) the bleed hole maximum opening is not larger than 1.5 mm diameter unless it is protected by an excess flow valve;
b) it cannot be completely withdrawn in normal gauging operations; and
c) the gland is capable of being repacked without withdrawing the vessel from service.

**5.1.19.3** Any gauging device that relies on differential pressure shall be installed so that the effect of condensation in the balance line and pressure fluctuations in the storage vessel do not interfere with its satisfactory operation.

**5.1.20** *Temperature gauges*

Temperature gauges when fitted shall be installed in blind pockets. These pockets shall be in the form of blind tubes of suitable length and strength, oil filled, permanently welded to the vessel and constructed in accordance with the vessel design code.

## 5.2 Civil engineering aspects

**5.2.1** *Above ground vessels*

Vessels shall be supported on concrete, masonry or structural steel supports. Design of these supports and foundations shall take into consideration the following:-

a) ground conditions with special reference to the allowable bearing pressures.
b) the necessity to avoid floatation, if there is a risk of flooding.
c) the necessity avoid settlement, particularly differential settlement.
d) expansion and contraction of the vessel shell.
e) the greatest combined effect incurred by static loading due to the weight of vessel and its contents, water used for hydraulic tests, wind loading, operational loading such as vibrations, thermal effects etc.
f) drainage of vessel - See **5.1.6.5.**
g) fire protection - See **6.3.**

**5.2.2** *Underground and mounded vessels*

**5.2.2.1** The size of any excavation shall be sufficient to allow for easy installation and servicing. When placing the vessel in position care should be taken to avoid damage to the protective coating.

**5.2.2.2** Vessels shall be set on firm foundations and shall be securely restrained against floatation.

**5.2.2.3** A mounded vessel shall be regarded as an underground vessel for the purpose of separation distances, provided it has not less than 0.5 m of cover.

**5.2.2.4** The cover over mounded vessels shall be stable under all weather conditions.

## 5.3 Distribution system

**5.3.1** Pipework shall be in accordance with **SLS 1196 : Part 3**.

**5.3.2** System shut-off valves shall be provided at strategic points in the system to enable the supply of LPG to be cut off readily in the event of an emergency. They shall be provided at the terminals of pipelines and where pipelines enter buildings and works complexes.

**5.3.3** The valves specified in **5.3.2** may be manual, remotely actuated or automatic depending on the size and complexity of the installation.

**5.3.4** Valves and other ancillary equipment shall be suitable for LPG at pressures and temperatures that can be reached in service. They shall be installed to the manufacturer's instructions and to such relevant standards as would apply to the installation design. All equipment shall be installed free of excessive external stress and adequately supported or secured against foreseeable forces e.g. valve operating torque.

**5.3.5** Materials for valves and other ancillary equipment shall be steel, bronze or forged brass and shall comply with **5.3.6.** Cast iron valves, fittings and other ancillary equipment (other than those of ductile iron to **BS 2789** or equivalent with an elongation at fracture of not less than 18 per cent) shall not be used for:

a) liquid service;
b) vapour service upstream of the first stage of pressure regulation;
c) vapour service designed to operate at 0.483 MPa gauge or above; and
d) where thermal shocks are likely.

**5.3.6** Valve seats, gland packings, seals and any polymer materials in contact with LPG shall be suitable for use with LPG.

**5.3.7** Consideration shall be given to the provision of pressure gauges or test points to determine service pressure and for setting regulators.

**5.3.8** Wherever liquid LPG may be trapped, e.g. between shut-off valves or blank flanges, protection against excessive pressure caused by thermal expansion of the contents shall be provided. This is normally achieved by the provision of thermal relief valves. These hydrostatic relief valves shall be set to discharge above the maximum working in the line but not greater than the design pressure of the pipework and components in the section to be protected. For relief valves that discharge to the open air the set pressures shall not be less than the following:-

propane- not less than 2.4 MPa gauge
(not less than 1.8 MPa where ASA 150 or equivalent flanges are used).

butane- not less than 1.0 MPa gauge.

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

## 5.4 Off-loading/ reception facilities

**5.4.1** Filling connections mounted directly on the vessel shall comply with **5.1.16.**

**5.4.2** Extended fill, off loading, or vapour balance lines, shall terminate with a manual shut-off valve and transfer hose half coupling protected immediately upstream of the valve by a non return valve or excess flow valve as appropriate. This shall be in addition to the valve adjacent to the vessel as **5.1.16.1** and hydrostatic relief valve as **5.3.8.**

**5.4.3** Transfer hoses shall meet the requirements of **SLS 1171** or an equivalent standard and if steel wire braiding or steel wire reinforcement is used it shall be of stainless steel. Hoses shall have electrical continuity between end couplings (See also **7.2.4**.). Service vapour hoses should comply with **SLS 1171** Type 1 (low pressure) and Type 2 ( high pressure) as necessary.

**5.4.4** Where the fixed liquid level device is not clearly visible from the filling point special precautions and procedures to prevent overfilling must be adopted for example tow person operation or remote reading system.

**5.4.5** Adequate artificial lighting shall be provided where operations are to take place during the hours of darkness. Lighting equipment located in a Zone 1 or 2 area shall comply with **7.1.2.**

## 5.5 Pumps and compressors

**5.5.1** The design of pumps, compressors, etc. and the materials of construction should suit the grade of LPG and the range of temperatures and pressures that the products will reach in service. Cast irons should not be used unless they have adequate ductility and resistance to brittle fracture. Ductile iron to **BS 2789** or equivalent with an elongation at fracture of not less than 18 per cent is acceptable.

**5.5.2** The available pressure head at the pump inlet at maximum off-take rate under the most onerous specified operating conditions shall be adequate to ensure proper operation and avoid cavitation.

**5.5.3** Consideration shall be given to the design of pump by-pass system to minimise heating of recirculated product which could lead to cavitation. Positive displacement pumps must have a by-pass or other suitable protection against excessive pressure. It positive displacement pump is used a relief by-pass valve must be incorporated before the shut-off valve and by-pass valve relieving back to the section.

**5.5.4** Consideration should be given to the protection of pumps by suitable strainer/filter units.

**5.5.5** Mechanical seals are preferable to packed glands.

**5.5.6** Electric motors and other electrical equipment must be suitable for use in areas as classified in Appendix **4**. Belt drives shall be of the anti-static type (See also **7**).

**5.5.7** Where remote starters are installed, a flame-proof means of isolation with lockout should be fitted adjacent to the pump motor to facilitate servicing or a work permit system shall be used. Vapour compressors should preferably be installed in the open air in a well ventilated position at least 4.5 m from any LPG vessels, building or boundaries.

**5.5.8** If installed in a building, the building should be made of non-combustible material with a light weight roof. Adequate natural ventilation should be provided by permanent openings in the outside wall equal in area to at least 12 per cent of the area of one of the out side walls or 2.5 per cent of the total area of the walls and roof whichever is the greater. The opening should be well dispersed at both high and low level. The building should not be used for any purpose other than the compression and distribution of LPG and other gases.

Compressors should have at least one of the following:

a) a high pressure cut-off switch or similar device on the discharge of the compressor; and
b) a means to prevent liquid LPG entering the compressor, e.g. a catchpot with a liquid level sensor.

### 5.6 Pressure regulators - vapour

**5.6.1** The pressure of vapour at the consuming appliance shall be controlled by pressure regulators within limits necessary for safe and satisfactory performance over the entire operating range.

**5.6.2** Where necessary to achieve requirements of **5.6.1** or to avoid problems from low vapour temperatures arising out of high pressure drops, two stage regulation shall be employed. The first stage pressure regulator should be located as close as practicable to the storage vessel. Requirements for domestic installations are covered by **SLS 1183**

**5.6.3** Where applicable, regulators should meet the requirements of **SLS 1180**. Pressure regulators and automatic change over devices for LPG.

**5.6.4** Vent holes on regulators shall be carefully oriented or otherwise protected against the possible ingress of water or substances which could cause blockage, and also to allow for drainage.

**5.6.5** Regulators shall be adequately supported.

**5.6.6** Isolating valves shall be located close to regulators to facilitate maintenance.

**5.6.7** Consideration should be given to the duplication of pressure regulators to facilitate servicing where continuity of supply is required.

## 5.7 Vapour meters

**5.7.1** The design, materials and construction shall comply with **5.3.4** and **5.3.5.**

**5.7.2** Flow meters shall be sized to give the required accuracy of measurement over the full range of flow rates, rate of change of flow rate, and range of pressure and temperature expected in service. The pressure drop through the meter needs to be allowed for in the system design.

**5.7.3** Flow meters shall indicate the units of flow being measured and the pressure and temperature of the vapour for which it is calibrated. If the read out is corrected to a standard condition this must be indicated, or a correction factor determined. If the meter is automatically compensated for actual pressure and/or temperature, the standard conditions of the read out must be indicated.

## 5.8 Vaporisers

**5.8.1** *Classification of vaporisers*

Vaporisers can be classified in to three groups:-

**5.8.1.1** Indirect vaporisers shall be those which do not constitute a source of ignition, e.g. Steam heaters, hot fluid heaters or process heaters and flame proof electrical heaters.

**5.8.1.2** Direct fired vaporisers shall be those in which a source of ignition may be present, e.g. Fuel-fired radiant or convective heaters, fuel-fired fluid bath heaters and non-flameproof electrical heaters.

**5.8.1.3** Carrier gas heaters, although not classified as vapourisers, heat a carrier gas so that it would cause liquid LPG to vapourise when mixed with it.

**5.8.2** *General*

**5.8.2.1** The vapouriser capacity shall not be less than that required for the conversion of liquid LPG at minus 18 $^{o}$C to vapour at a temperature above the dew point at the maximum inlet pressure to the vapouriser and at the maximum off-take rate.

**5.8.2.2** Precautions should be taken against the accumulation of condensate in all pipelines carrying LPG vapour. These may require insulation and trace heating. The design temperature should be at least 6 $^{o}$C above the dew point of LPG at the maximum design pressure.

**5.8.2.3** Exceptionally high vapour withdrawal rates cause excessive cooling of the liquid LPG in the vapouriser. With steam and hot water heated vapourizers, precautions should be taken to freezing of steam condensate or water.

**5.8.2.4** Heating coils shall not be installed inside an LPG storage vessel as a substitute for a vapouriser.

**5.8.3** *Design and construction*

**5.8.3.1** Vaporisers should be designed, constructed and tested in accordance with a recognized and appropriate pressure vessel code.

**5.8.3.2** The vaporiser shell and tubes in contact with liquid LPG shall be of steel of grade appropriate to the operating conditions

**5.8.3.3** Vaporiser heat exchangers shall be designed for a working pressure at least equal to the sum of the maximum differential pressure of the LPG pump if fitted and the maximum working pressure of the systems supplying it.

**5.8.3.4** The vaporiser and all piping components and relief valves up to and including the discharge valve shall be designed for the same conditions as the inlet pipework.

**5.8.4** *Valves*

**5.8.4.1** Valves shall be installed to shut off the liquid and the vapour connections between the storage vessel and the vaporiser. Manifolded vaporisers shall have a positive means of individual isolation.

**5.8.4.2** All liquid and vapor connections on vaporisers, other than those for relief valves, plugged openings and those where the connection through the vessel shell is not greater than 1.5 mm diameter, shall have shut-off valves capable of manual operation located as close as practicable to the vaporiser. It is recommended that ball valves designed in accordance with **BS 5351** and conforming to the fire test requirements of **BS 6755 : Part 2**, shall be used.

**5.8.4.3** For vaporiser having a water capacity in excess of 6 liters all connections in to the vapouriser greater than 3 mm diameter for liquid and 8 mm diameter for vapor, with the exception of those for relief valves and drain connections, shall be protected by either an excess flow valve or a remotely controlled valve of the 'fail safe' type capable of local manual operation and which can be operated remotely from a safe area.

**5.8.4.4** The flow rate for closure of excess flow valves shall be below that likely to result from complete fracture of the line it is protecting, but should, to prevent premature closing, be substantially above the normal flow rate expected to prevent premature closing.

**5.8.5** *Drain connections*

**5.8.5.1** Drain connections designed to permit drainage to atmosphere should be provided with a shut-off valve which is preferably not more than 50 mm nominal diameter and in accordance with **5.8.4.** The outlet of the drain valve should be provided with a length of piping terminating with a second shut-off valve, preferably not more than 25 mm nominal diameter. The drain valve adjacent to the vaporizer connection shall be of a quick acting type and the length of piping between the two valves shall be such that the risk of their simultaneous obstruction is minimized.

a) The second valve and the piping shall be adequately supported and secured to prevent mechanical damage or breakage by jet forces;
b) Both valves on the drain system shall have a means of actuation which cannot readily be removed or moved from the closed position except by intentional operation;
c) The additional pipe work, and the second valve required downstream of the drain valve above may be fitted at the time of draining provided that the fixed drain valve is protected by an excess flow valve, fitted upstream.
d) The outlet of the drain valve system shall be blank flanged, plugged or otherwise secured against tampering when not in use; and
e) Pipework between the drain system valves and between any valve and a blank-flange or plug etc. shall be protected by a hydrostatic relief valve against excess pressure caused by thermal expansion (See **5.3.10**).

**5.8.5.2** Drain systems used for product transfer shall be designed with a suitable coupling after the second valve.

**5.8.5.3** Drain systems used for purposes other than that described in **5.8.5.2** e.g. sampling, flaring, removing water etc. shall ensure that discharge does not take place beneath the vessel, and the second valve should not be larger than 25 mm nominal diameter.

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

**5.8.5.5** In the case of direct-fired and non-flameproof electrical vaporisers, the source of heating must be shut off prior to drainage and not restarted until the area is free from flammable vapour.

**5.8.5.6** Care shall be exercised in the handling and disposal of flammable residues drained from the vaporisers. Adequate ventilation must be ensured during this operation and residues shall on no account be allowed to pass to drains or sewers.

**5.8.6** *Pressure relief*

**5.8.6.1** Vaporiser systems shall have a safety relief valve in direct communication with the vapour space and set to discharge and reach full flow conditions as required by the code to which the vaporiser is designed and constructed.

**5.8.6.2** The minimum required rate of discharge to protect the vaporiser alone is derived as follows:

Add the surface area of the vaporiser shell to that of the heat exchanger directly in contact with the LPG liquid [items (d) and (e) of section **5.8.9** ] and from Appendix **5** obtain the minimum requirement for the rate of discharge.

**5.8.6.3** The safety relief valve(s) shall provide an effective rate of discharge which should be directed upwards into the open air and away from the vaporiser or shell of an adjacent LPG vessel.

**5.8.6.4** Fusible plugs and frangible discs for pressure relief shall not be fitted to vaporisers.

**5.8.7** *Liquid control*

**5.8.7.1** Vaporisers shall be provided with suitable automatic means to prevent LPG liquid passing through the vaporiser to the vapour discharge piping under all operating conditions.

**5.8.7.2** A liquid level control, if fitted, shall be integral with each vaporising vessel or shall be fitted immediately adjacent to it.

**5.8.8** *Heat input control*

**5.8.8.1** The vaporiser heat input shall be controlled to ensure that the start-to-discharge pressure of the relief valve(s) is not reached in the course of normal operation.

**5.8.8.2** Direct-fired and electrically heated vaporisers and carrier gas heaters shall be fitted with an automatic control to prevent overheating.

**5.8.8.3** Direct-fired vaporisers shall be fitted with suitable flame failure devices.

**5.8.9** *Marking*

Each heat exchanger/vaporiser shall be provided with a permanent and clearly visible corrosion resistant data plate marked with the following:

a) the pressure vessel design code;
b) the manufacturer's name and vessel serial number;

c) the maximum working pressure and temperature of shell and tube or the coil of a carrier gas heater;
d) the outside surface area of the vaporiser shell in square metres;
e) the inside heat exchange area in square meters;
f) the vaporising fluid for which the vessel is designed;
g) the heating medium for which the vessel is designed;
h) date of test, pressure applied and inspecting authorities' symbol; and
j) provision for subsequent test markings.

## 6. FIRE PRECAUTIONS

### 6.1 General

**6.1.1** The possibility of a major fire outbreak leading to direct flame impingement on the storage vessels can be minimised by sound engineering in plant design and layout, good operating practice and proper education and training of personnel on both routine operations and on action to be taken in an emergency. Consultations with the Fire Authority on the provision of fire protection facilities should take place in early planning stages. It is recommended that the Fire Authority should be consulted with regard to fire fighting equipment, water supplies, means of access for fire brigade appliances, protection of fire fighting personnel and arrangements generally to ensure an early call to the fire brigade in the event of an outbreak of fire.

**6.1.2** Underground (buried) vessels or those protected by mounding or by thermal insulation giving protection equivalent to **6.2.2** will not need the provision of on-site cooling water supplies other than for exposed surfaces.

### 6.2 Water Supply (See Appendix **12**)

**6.2.1** To provide adequate protection to above ground uninsulated storage vessels threatened by fire, a film of water needs to be established over the whole vessel surface and supports at a rate of 7 l per minute per square m. Exposed surfaces of vessels which are otherwise protected by burial (underground), mounding or thermal insulation shall be similarly protected.

For fixed water spray systems, a typical design spray rate to achieve this drenching density is 9.8 l/m $^2$/ min.

**6.2.2** The water storage shall be capable of providing the rate of application in **6.2.1** to give protection for at least for the duration for which the fire will burn or till the fire brigade arrives.

**6.2.3** Recirculation system:- Where water is supplied via a recirculation system the reservoir shall hold at least a 30 minute supply without recirculation. The design must also ensure that any LPG spillage will not be returned with the recycled water.

**6.2.4** Domestic installations, or small commercial or industrial installations where the capacity of each vessel does not exceed 2,500 l (1.1 tonne LPG) shall have ready access to an adequate water supply for the fire brigade use. Such supplies may be available from hydrants, ponds, canals or rivers. These should generally be no more than 100 meters from the vessel(s). At remote installations it may be acceptable for the water supply to be more than 100 meters from the vessel(s). In these circumstances the fire brigade should be consulted.

**6.2.5** Larger commercial and industrial installations up to 56,250 l water capacity total inventory may also be adequately supplied with water from natural sources, or public supplies if they meet the requirements of **6.2.1** and **6.2.2** and have the approval of the local fire brigade. Where such sources are inadequate, and for installations exceeding a total inventory of 56,250 l, on site supplies must be provided for the use of the fire brigade or for such other facilities as are set out in the summary table. Special consideration should be given to the possibility of loss of electrical power on site and the need for back-up facilities. Preferably minimum of 50 per cent of engine drives stand-done pumps should be installed or larger capacity.

**6.2.6** Installation with inventories greater than 56,250 litres (25 tonnes ) but less than 112,500 l (50 tonnes ) should have available portable or fixed monitors to be used by the fire brigade, or by the firm's emergency response team until the arrival of the fire brigade. The monitor and he water supply to these should be capable of providing a nominal water coverage over the vessels 9.8 $l/m^2$ /min.

**6.2.7** All installation with inventories of 112.500 l (50 tonnes ) or more, the vessel should be provided with fixed water deluge system or adequately protected by other means.

The fixed deluge system should be capable of achieving water coverage of at least 9.8 $l/m^2$ /min over the whole vessel surface and its supports. Manual control may be acceptable where continuous supervision is maintained. In other cases control should be automatic. Connection points for fire brigade appliances should be provided at sefe locations in the water supply pipeline to the fixed drenching system, to be able to supplement the supply if necessary.

It is essential for "dry' systems to ensure that adequate and correctly located drainage points are provided.

**6.2.8** *Drainage*

There shall be adequate drainage to deal with water used for fire fighting and control purposes. Water sealed interceptors should be provided where necessary to prevent LPG entering storm drains and sewers.

## 6.3 Fire protection equipment (See Appendix **13**)

**6.3.1** The provision of equipment depends upon the size and type of installation. The Appendix **13** sets out good practice for above ground installations where special circumstances do not exist and where alternative means of protection are not employed, e.g. mounding or insulation.

Where special circumstances do prevail, more or less stringent requirements may be appropriate, e.g. a remote site with a few but well trained personnel may not call for the full specifications, but a site where there is an unusual fire risk, greater precautions may be required.

**6.3.2** On-site hydrants, monitors and fixed drenching systems shall be so designed that water flow can be controlled from a position where location or distance from the storage makes it relatively safe.

**6.3.3** Fixed drencher systems shall be designed by a competent person and/or to an appropriate Code of Practice. (**BS 3360**).

Manual control is acceptable where continuous supervision is maintained. In other cases control shall be automatic. Connection points for fire brigade appliances should be provided at safe locations in the water supply pipelines to fixed drenching systems.

Multiple vessel installations may not need simultaneous drenching of all vessels and means may be provided to permit drenching of individual or groups of vessels.

**NOTE**

*All fitting for fire fighting should comply with the standard adopted by the local fire authority.*

**6.3.4** For installations of 56,250 l water capacity (25 tonnes LPG) or more the road tanker bay shall be provided with water protection to the level appropriate to the size and type of installation of the fixed storage as set out in the Appendix **12**.

**6.3.6** Unless adequately protected by other means, fixed water spray systems shall be provided for bulk vessels at cylinder filling plants.

This requirement shall not apply where the sole activity is the dispensing of automotive LPG or where the storage capacity of the filling cylinder is less than 1.5 tonns.

**6.3.7** For installations with inventories of 112,500 l (50 tonne LPG) and greater, the vessels shall be provided with fixed water spray systems as in **6.3.3.**

### 6.4 Passive thermal insulation

**6.4.1** Thermal insulation as an alternative to water spray protection shall be capable of limiting the vessel temperature to less than 450 $^{o}$C for a minimum of one hour when exposed to full fire engulfment.

**6.4.2** *Insulation shall* :

a) be resilient to the action of hose directed jets;
b) be impervious to water vapour, either by cellular construction or the provision of an efficient water barrier;
c) be sufficiently strong so that minor mechanical damage will not destroy the vapour barrier and shall be durable and easily repaired;
d) be non corrosive to the vessel surface;
e) be unaffected by environmental conditions whether natural or from local leaks, spillage or pollution; and
f) not become a hazard in case of a fire whether by spalling, spreading flames, or by producing toxic fumes.

### 6.5 Portable fire fighting equipment (See Appendix **12**)

**6.5.1** There shall be sufficient and suitable portable fire fighting equipment on the premises. This equipment should be selected and located to enable fires adjacent to the vessels to be extinguished and so prevent fire spreading to or jeopardising the LPG installation. Fire extinguishers or hose reels or an equivalent combination of the two types of equipment shall be provided. Fire extinguishers shall be selected, sized, located and maintained in accordance with **SLS 752** and **BS 5306 : Part 3 : 1980** and hose reels shall be selected and installed in accordance with **BS 5306 : Part 1.**

**6.5.2** Fixed LPG installations shall be provided with at least one 19 mm hose reel. At small installations with vessels not exceeding 2,500 l water capacity two 9 l water extinguishers may be provided as an alternative. Hose reels and fire extinguishers need not be provided at domestic premises and 'metered' estates because of the lack of trained people to operate them at these sites.

**6.5.3** In addition to the requirements in paragraphs **6.5.1** and **6.5.2** at least two fire extinguishers suitable for an LPG fire shall be provided. Powder extinguishers of capacity 9 kg would normally be suitable.

### 6.6 Access

Access to and around the installation as per the requirement of local fire authority shall be provided for fire fighting and shall be kept free at all times.

### 6.7 Fire instructions and training

People on premises where LPG is stored should receive adequate instructions with training as appropriate to enable them to understand the fire precautions and action to be taken in the event of fire or leakage of LPG. The instructions and training should be appropriate to their responsibilities in the event of an emergency. Those trained to fight LPG fires should be aware that these fires should not normally be extinguished unless the source of LPG can be isolated.

At commercial and industrial sites notices setting out the emergency procedures shall be prominently displayed near the LPG storage area.

At domestic installations and 'metered' estates the user shall be provided with full instructions which include the action to be taken in an emergency.

## 7. ELECTRICAL AND ELECTROSTATIC HAZARD PRECAUTIONS

### 7.1 Electrical requirements

Relevant IEE Regulations safety standards for dealing with electricity shall be complied with as applicable.

All electrically operated alarm/control systems shall be connected to a common electrical supply to avoid possible partial isolation. The selection, installation and maintenance of electrical apparatus for use in hazardous areas should be in accordance with the recommendations of
**BS 5345 : Part 1** to **8**

**7.1.1** *Area classification*

The area detailed in Appendix **4** of this code are classified according to the degree of probability that flammable concentrations of gas (or vapour) may arise. The hazardous area definitions are as follows:-

Zone 0 - an area in which an explosive gas-air mixture is continuously present in normal operation.

Zone 1 - an area in which an explosive gas-air mixture is likely to occur in normal operation.

Zone 2 - an area in which an explosive gas-air mixture is not likely to occur in normal operation, and if it occurs it will exist only for a short time.

By implication an area which is not classified Zone 0, 1 or 2 is deemed to be non-hazardous or safe with respect to the selection of electrical apparatus.

**7.1.2** All electrical apparatus for use in classified zones must have certification, e.g. BASEEFA for the appropriate zone, gas group and temperature classification as detailed in **BS 5345 :** Part **1** and Part **2**.

All wiring and cable within a classified zone shall be in accordance with **BS 5345:Part 1** Section **25 (BSEN 60079).**

Maintenance of electrical equipment within a classified zone shall be in accordance with **BS 5345 : Part 1** Section **33/BSEN 60079.**

**7.1.3** Any portable electrical equipment used temporarily within a classified area, shall either be suitable for the zone or otherwise a gas free permit to work shall be issued prior to its use.

### 7.2 Electrostatic precautions

**7.2.1** Means shall be provided to ensure that no electrostatic potential exists between the tanker delivery connection and the static vessel fill connection which could cause a spark when these connections are either made, or broken. The following precautions shall therefore apply.

**7.2.2** Except as permitted by **7.2.3** vessels shall be permanently bonded to an effective grounded earthing point to prevent the accumulation of static electricity. The earthing point should be located so that the bulk tanker vehicle can discharge any static electricity to this earth by means of its earthing/bonding cable before delivery connections are made (See also **9.3.3.7** and **9.3.7)**.

**7.2.3** Electrical continuity shall exist between vessel transfer couplings and the earthing point or bonding connection, through the vessel. The earthing or bonding connection shall always provide a good electrical connection, and shall therefore always be kept free of rust and shall not be painted.

**7.2.4** All earthing points for the dissipation of static electricity shall have an electrical resistance to earth of not greater than $1 \times 10^6$ ohms.

**7.2.5** Pipelines, fittings and hoses conveying liquid phase LPG shall have electrical continuity and be effectively connected to earth. In the case of ball valves attention is drawn to the need for the ball and actuating lever to have electrical continuity with the valve body and adjacent pipework.

## 8. INSTALLATION AND COMMISSIONING

### 8.1 General

**8.1.1** The installation and commissioning of the plant shall be undertaken only by competent personnel, and in accordance with manufacturer's instructions where applicable.

**8.1.2** Before any storage vessel is placed on a site, the area shall be surveyed for any possible hazards. Particular attention shall be paid to overhead power cables etc. and to the ground conditions, ensuring suitability for delivery vehicles, cranes etc.

**8.1.3** Where there is a risk to personnel of exposure to LPG release during commissioning, suitable protective clothing shall be worn (See Appendix **7)**.

## 8.2 Storage vessel and fittings

### **8.2.1** *Lifting*

Care must be taken when lifting vessels to avoid distortion or damage to them or their coatings.

**8.2.1.1** All lift procedures shall be carried out with due regard to safe practices.

**8.2.1.2** Where lifting lugs are provided, these may be used, provided they are adequate for the lift. Unless it is clearly indicated that the lifting lugs have been designed and constructed to lift a vessel containing liquid product, this shall not be attempted.

### **8.2.2** *Securing*

Above ground vessels shall be secured in place as required by **5.1.6.4.**

### **8.2.3** *Floatation*

Underground vessels mounded vessels, partially below ground level must be secured at both ends against floatation and they must also be secured against movement at the end to which connections are made whilst providing adequate freedom of movement horizontally at the other end to accommodate thermal expansion and contraction. See also **5.2.2.**

### **8.2.4** *Visual examination*

Care shall be taken to ensure that there is no extraneous matter present in vessels before valving.

### **8.2.5** *Valves*

The operation of shut-off valves, emergency valves and excess flow valves but excluding safety relief valves shall be checked for correct orientation and correct operation.

### **8.2.6** *Leak testing - vessels and fittings*

**8.2.6.1** Vessels delivered to site containing LPG shall have had all connections leak tested prior to delivery and upon receipt of site., but any site made connections shall be tested using soap solution or similar detergent.

**8.2.6.2** Vessels, associated fittings and equipment containing air or an inert atmosphere shall be leak tested to a pressure not less than 300 kPa gauge for butane, and 600 kPa gauge for propane, but not more than 90 percent of the vessel design pressure using one of the following methods indicated in Table **4**. Care should be taken to ensure that the vessel is not subject to tests outside its design criteria.

**TABLE 4 -Vessel leak test methods**

| Test Medium | Method | Advantages<br><br>(3) | Disadvantages<br><br>(4) |
|---|---|---|---|
| 1. Air<br><br>**Note**;<br>*Only for new vessel or LPG free vessel* | Pressurised with air, Check joints with soap solution. | Emergency valves can be tested for operation. | i)Suitable compressor equipment has to be provided.<br>ii)Water may be introduced into the system with compressed air.<br>iii)Necessary to purge. |
| 2. Inert Gas | Pressurised with gaseous nitrogen or carbon dioxide and proceed as for air. | i) No danger of condensed water or need for drying.<br>ii) Vessel can be filled directly with LPG into the inert atmosphere.<br>iii) Emergency valves can be tested for operation. | i) Supply of inert gas must be arranged.<br><br>ii) If the source of inert gas is in liquid form, precaution has to be taken to prevent undue chilling of vessel and fittings. |
| 3. Water | Fill tank with water-pressurized - check to ensure zero pressure drop in 30 minutes. | i) Water easily available.<br>ii)Less hazard.<br>iii)Emergency valves can be tested.<br>iv) Vessel can be charged with LPG directly on top of water. | i) Need for complete removal of water.<br>ii) Care necessary to avoid a vacuum forming whilst draining water.<br>iii) Plinth or base must be capable of taking total weight. |

**8.2.7** *Initial fill*

A responsible person shall be present and in control throughout the initial fill.

Care should be taken to limit flash vaporisation on initial fill. This can be achieved by pressurising the vessel with vapour before introducing liquid LPG.

During initial fill, any inert gas should be safely vented from the vessel.

**8.2.8** *Content gauges*

**T**hese shall be checked for freedom of action/movement by internal inspection where practicable or otherwise by observation during initial fill. Fixed ullage should be closely checked during the initial fill.

## 8.3 Pipework, valves and fittings

Detailed requirements for pipework systems are given in **.SLS 1196 : Part 3.**

## 8.4 Off-loading/reception facilities

All valves, couplings and threads shall be checked for cleanliness and freedom from mechanical damage.

## 8.5 Product transfer systems

**8.5.1** Prime movers shall be safely located in accordance with **4.8**.

**8.5.2** All equipment, e.g. pumps, compressors etc., shall be installed and lubricated in accordance with the manufacturer's instructions.

**8.5.3** The correct alignment of all prime movers shall be checked.

**8.5.4** The direction of rotation of all prime movers shall be checked before introducing LPG.

**8.5.5** Vapour shall be vented safely and pumps primed with liquid phase LPG before being put into operation.

**8.5.6** Pumps shall be started with by-pass valves/liquid pressure controllers fully open and after ensuring free flow adjusted to required pressures in accordance with manufacturer's instructions.

## 8.6 Regulators

**8.6.1** Before installation, dust caps, transit locking pins etc. shall be removed, and the orientation and the correct direction of flow determined. Regulators shall be adequately supported and orientated in accordance with the manufacturer's instructions.

**8.6.2** Regulators for domestic installations shall be installed and commissioned in accordance with **SLS 1183**.

**8.6.3** Adjustable regulators shall be set to their lowest outlet pressure followed by adjustment to their required operating pressure under flow conditions.

**8.6.4** The system shall be flow tested to ensure that regulators are suitable to maintain the required pressure control over the range of the system demand, and give tight shut-off at zero flow (lock-up).

**8.6.5** Where applicable regulators should be sealed against tampering.

## 8.7 Meters

**8.7.1** Prior to installation the meter data plate shall be checked to ensure that the flow capacity and pressure rating are suitable for the application. Before installation dust caps , transit locking pins etc. should be removed and the correct direction of flow determined.

**8.7.2** Before installation dust caps , transit locking pins etc. should be removed and the correct direction of flow determined. Meters shall be adequately supported and orientated in accordance with the manufacturer's instructions.

## 8.8 Vaporisers

**8.8.1** Vaporisers shall be installed in accordance with manufacturer's instructions ensuring adequate support and without undue strain on associated pipework.

**8.8.2** Vaporisers shall be free from leaks under test pressure and purged into service in accordance with manufacturer's instructions.

**8.8.3** The satisfactory operation of such items as level controls, heat input controls, emergency valves (other than pressure relief valves), flame failure devices, pressure controllers, etc. shall be established during commissioning checks.

**8.8.4** Before installation the heating system rated capacity shall be checked against design. All necessary steps shall be taken to ensure the safe and satisfactory functioning of the systems before and during commissioning, e.g. thermostats and flame failure devices should be set before start-up.

### 8.9 LPG - air plants

**8.9.1** Before the introduction of LPG, the LPG-Air mixing equipment shall be checked for correct mechanical/electrical operation, for leakage and satisfactory operation of safety/alarm systems.

**8.9.2** Plant shall be started up to produce a rich (safe) mixture and subsequently adjusted to the required mixture. A check should then be made that the mixture is correctly maintained over the required flow range.

### 8.10 Electrical

**8.10.1** Electrical connections shall be made in accordance with the equipment manufacturer's instructions.

**8.10.2** Flames proof glands and connections shall be correctly assembled and all access covers securely fastened.

### 8.11 Earthing and static bonding arrangements (See **7.2**)

**8.11.1** It is necessary to ensure, that the vessel is earthed properly. The earthing rod shall be placed in position and connected to the vessel.

**8.11.2** If applicable, the earthing point or bonding connection for use by the delivery vehicle shall be placed in position.

### 8.12 Fire fighting precautions

**8.12.1** All combustible material including long grass etc. shall be cleared from the storage area before initial fill of LPG.

**8.12.2** Suitable first aid fire fighting extinguishers shall be available during commissioning.

**8.12.3** The satisfactory operation of water drenching systems, where fitted, shall be tested before LPG is introduced in to the system.

**8.12.4** Automatic actuating systems and alarms, if fitted, shall be tested before or during the initial filling.

### 8.13 Corrosion protection

**8.13.1** Paint coatings for vessels, pipework and other equipment exposed to the atmosphere shall be applied in accordance with the manufacturer's instructions to provide the protection required.

**8.13.2** The corrosion protection applied to underground and mounded vessels, buried pipelines, etc. shall be checked before covering. If cathodic protection is employed the presence of sacrificial anodes shall be verified. Where wrapping is used, it is essential that the correct surface preparation and the manufacturer's instructions are followed.

## 9. OPERATIONS

### 9.1 Training and user instructions

**9.1.1.1** Personnel responsible for and involved with the operation of plant equipment and the handling of LPG should understand the physical characteristics of the product, be adequately instructed in the correct operation of equipment and plant and be familiarised with the relevant sections of this Code.

**9.1.1.2** Properly documented opening manuals and standing instruction shall be prepared and made readily available by the occupier of the premises. Such manuals shall be revised periodically.

**9.1.2** Personnel concerned with the storage and handling of LPG should where appropriate be familiar with the fundamentals of fire fighting and fire control with particular reference to fires involving LPG. They should also be familiar with the correct handling of any fire fighting and fire control equipment where provided and, where appropriate, be exercised in this respect at frequent intervals. The location of the main electrical isolating switches, fire hydrants and manual water deluge valves, and vapour and liquid LPG valves should be known and their use understood.

**9.1.3** The emergency procedures laid down shall be clearly displayed and shall be documented and clearly define responsibilities to all personnel concerned. They should be familiar with these procedures and be trained to handle emergency situations.

### 9.2 Segregation of product

**9.2.1** All vessels and where necessary, pipelines, filling connections and other equipment, shall be clearly marked to show the product being used.

**9.2.2** Where more than one grade of LPG is handled, any interconnecting systems shall be thoroughly checked to ensure that a grade of LPG is not charged into vessels, pipelines or other equipment not designed to handle it and that unacceptable product contamination will not occur.

### 9.3 Product transfer

**9.3.1** A responsible and competent person over the age of 18 years shall remain in control throughout all transfer operations.

**9.3.2** Protection, e.g. gloves, eye protection etc. shall be used whenever there is a likelihood of contact with liquid LPG ( See Appendix **7)**.

**9.3.3** Before LPG is transferred from any delivery vehicle to a fixed installation, the following procedure shall be carried out:-

**9.3.3.1** The receiving vessel shall be checked to ensure that it is in safe working order and that the grade of LPG to be transferred is compatible with its contents and design working conditions.

**9.3.3.2** Where appropriate the receiving vessel shall be checked to establish the quantity that can be delivered into it.

**9.3.3.3** The interconnection system, i.e. pipework, fittings, valves, hoses, etc. shall be visually checked to ensure that it is in safe working condition and that the tanker hose coupling is compatible with the storage vessel fill coupling.

**9.3.3.4** The tanker shall be located on level ground and prevented from accidental movement during the operation.

**9.3.3.5** The vehicle driving unit and any electrical equipment not required and not specifically designed for the transfer operation shall be stopped and isolated.

**9.3.3.6** Fire extinguishers shall be located in easily accessible positions and temporary warning notices prominently displayed.

**9.3.3.7** The tank of the delivery vehicle shall be earthed to dissipate any electrostatic potential before the transfer hoses are connected. This can be achieved by either of the following means:

a) Connecting an earth lead from the vehicle to the earthing point of the fixed installation; or
b) Where the installation has no earth point (See **7.2.3**), by a vehicle earth tread plate and/or by connecting an earth lead from the vehicle directly to the vessel bonding connection.

**9.3.3.8** Drive-away protection devices where provided on the delivery vehicle or the fixed installation shall be used to ensure the vehicle cannot be moved before the hose(s) is disconnected.

**9.3.4** During LPG transfers, a constant check shall be kept on the receiving vessel to ensure that overfilling or other hazardous condition is avoided.

**9.3.5** If the responsible person in charge of the operation has to leave the place for any reason and no other competent person is available to take over the control, then the operation must be stopped and the isolating valves closed.

**9.3.6** On completion of the transfer, the receiving vessel shall be checked to ensure that it has not been overfilled.

**9.3.7** On completion of the transfer, all transfer hose connections shall be disconnected before removing the electrical bonding.

**9.3.8** Before any vehicle involved in a transfer operation is moved, it shall be checked to ensure that it is in a safe condition.

**9.3.9** Operations shall not be carried out during the hours of darkness unless adequate artificial lighting is provided as required by **5.4.5.**

### 9.4 Storage vessels - filling

**9.4.1** The maximum allowable filling level is normally determined by the setting of the maximum liquid level device which shall be used by a person in attendance whenever a vessel is being filled to ensure that overfilling does not occur. Filling must be stopped immediately the maximum filling level is reached. The level set by the fixed maximum liquid level device is designed to ensure that the vessel is not overfilled under any foreseeable circumstances (See Appendix **6**).

Important:- Fixed liquid level gauges only give effective indication of the liquid level if the transition from vapour to liquid discharge is witnessed during filling.

**NOTE**

*Any overfilled tanker or vessels should have the excess LPG removed in a safe manner immediately*.

### 9.5 Use of vessel drain system

**9.5.1** The use of drain system described in **5.1.18** shall only be undertaken under the supervision of a competent person with suitable experience and authority. Where LPG will be released to atmosphere a permit to work system should be employed, the permit being authorised by the competent person who shall ensure that it is safe to do so. Suitable protective clothing should be worn.

**9.5.2** Draining to atmosphere, e.g. to test for water, should not be necessary at consumer installations and should be discouraged.

**9.5.3** Where for quality control purposes it is necessary to carry out draining of water, it is recommended that at no time shall that both valves described in **5.1.18** be open at the same time. The second valve shall be opened to drain off the contents downstream of the first valve, and then shut. The first valve shall then be opened to charge the interconnecting space and again be shut. the cycle shall be repeated until all the water is cleared and then both valves shall be shut.

### 9.6 Sampling

Sampling of product, either vapour or liquid should only be undertaken by a suitably trained competent person using purpose designed and constructed sampling containers and suitable interconnecting pipework. Where significant release to atmosphere may occur a permit to work system should be used as for **9.5.1** and suitable protective clothing worn.

## 10. INSPECTION AND EXAMINATION

### 10.1 Scheme of inspection and examination

**10.1.1** The inspections, examinations and tests specified in this code should form the basis of a scheme which may be undertaken all or in part by the operator, an inspection authority or by the LPG supplier. Where the duties are shared between such organizations, a written scheme must clearly identify the respective areas of responsibility.

**10.1.2** LPG suppliers should ensure that users are aware of the importance of carrying out a scheme of inspection in accordance with this code. Suppliers to those consumers who cannot arrange this for themselves should make such service available to them, or direct them to other competent organizations.

**10.1.3** LPG installations shall be subjected to Routine Inspections and Major (Periodic) Examinations.

**10.1.4** Routine inspections of LPG installations shall be carried out in accordance with **10.2** of this code, by an appropriately trained person. The scheme of inspection should ensure that the necessary action is taken as identified by the inspection.

**10.1.5** Major examinations shall be undertaken by such person(s) as are competent as a result of practical and theoretical knowledge and actual experience of the equipment concerned as will enable him to detect defects or weaknesses as expected from the examination. To assess their importance, and ultimately to certify such equipment as fit for its purpose prior to its further use.

**10.1.6** Written schemes should draw attention to the following. Disassembly or removal of items of plant whilst any part of a system is under pressure is hazardous and should not be permitted unless the absence of pressure on or in that item of plant can be verified. This will necessitate a full knowledge of the construction, operation and assembly of the part. Attention is particularly drawn to relief valve check devices and split bodied ball valves.

**10.1.7** Modifications or repairs to an installation for whatever purpose, including change of duty shall comply with the requirements of this Part of the Code of Practice.

No entry should be permitted to any vessel without being gas freed and emptied and positively isolated and certified as gas freed.

## 10.2 Routine inspections

**10.2.1** *Storage vessels in liquid off-take service*

Storage vessels that are on liquid withdrawal service shall be inspected annually and all ancillary equipment e.g. valves, strainers, pumps, etc. that are in liquid service should be checked for leaks. The checks that are listed in **10.2.3** should also be included.

**10.2.2** Storage vessels in vapour off-take service

Storage vessels that are on vapour off-take service should be inspected as follows.

a) Vessels - 5 $m^3$ water capacity and above
These should be inspected annually and ancillary equipment e.g. valves etc. checked for leaks. The items listed in **10.2.3** should be included.

b) Vessels - below 5 $m^3$ water capacity
These vessels should be inspected either on a routine basis when being filled or at an annual inspection. The items listed in **10.2.3** should be included.

**10.2.3** *Items to be covered in routine inspections*

The items listed below as questions should form part of an inspection, the frequency of which depending on the type of installation and should be determined as detailed in **10.2.1** and **10.2.2.**

*a) Storage site*

(i) Is the area around the bulk tank free of flammable materials? Is the area under and immediately around the bulk vessel clear of excessive vegetation? (See **10.6.5.5)**
(ii) Have there been any obvious change to the bulk vessel installation or immediate surroundings?

b) *Condition of LPG vessel*

(i) Above ground
Are there any signs of corrosion, significant paintwork deterioration or other damage on the vessel or its supports including any fireproof coatings?
(ii) Underground/Mounded
Are there any signs of corrosion or damage to the visible parts of the vessel?

**NOTE**

*Repair/renewal of paintwork or other corrosion protection systems must allow for the presence of condensation on the vessel if carried out whilst the vessel is in service, particularly vapour off- take service.*

c) *Vessel fittings and immediate pipework*

(i) Are valve hand wheels or levers free to move?

**IMPORTANT: The danger of shutting off/turning on a gas supply in use must be taken into account when checking a valve operation.**

(ii) Are there any signs of physical damage to fittings?
(ii) Are there obvious signs of leaks?

d) *Tank Hood (where applicable)*

Is the hood in a satisfactory condition and capable of being locked?

e) *Earthing and Static Bonding Arrangements (where applicable)*

(i) Is the earthing rod in position and connected to the tank?
(ii) Is there an earthing point or bonding connection for use by the bulk tanker?

f) *Concrete pads and piers*

(i) Is the condition of the concrete pads and piers satisfactory?
(ii) Are there any signs of differential settlement?

g) *Warning notices*

(i) Are the notices on the tank and compound (where applicable) in place and readable?

h) *Service pipework and associated equipment*

(i) Is the external condition of visible pipework and equipment satisfactory?
(ii) Are there any signs of physical damage?
(iii) Are there obvious leaks?

i) *Storage compound protection*

(i) Is fencing satisfactory?
(ii) Are protective kerbs etc. satisfactory?

j)*Fire fighting facilities*

(i) Are appropriate fire fighting facilities available?

## 10.3 Major examinations

**10.3.1** *Storage vessels*

Major examinations of storage vessels shall be carried out by a competent person and the data plate marked with the date of examination, by marking the month and year of examination. For e.g. 8/99

Vessel records for above ground vessels should distinguish between 5 year visual external inspection and 10 year examinations, or alternatively the symbol 'V' for visual should be added as a suffix to the date entry of the 5 year intermediate visual inspection marked on the data plate.

Examinations must be carried out before the end of the fifth or the tenth year (as appropriate), following the date of the previous examination.

The frequency of examination for identified storage vessels shall comply with the following Table **5**. For unidentified vessels see **10.3.5.**

**TABLE 5 - Frequency of vessel examination**

| Type of storage vessel (1) | Frequency (2) | Vessel examination (3) |
|---|---|---|
| Above ground | Every 5 years | Full external visual examination. NDT may be used to supplement the external examination if necessary. Vessels with thermal insulation or intumescent coating should have separated areas of the vessel exposed for visual examination or NDT. The number and spacing of such exposed areas to be determined by a competent person. |
| Above ground | Every 10 years | Full visual internal examination (see **10.3.6.3)** or thickness test or hydraulic test |
| Underground and mounded vessels | Every 5 years | Full visual internal examination and thickness check or hydraulic test.(see **10.3.6 and Appendix 10).**<br>In the case of vessels without manholes, alternative procedures may be considered subject to the approval of a competent person and, where appropriate, the inspecting authority. Such procedures will be considered as an addendum to this Code of Practice when adequate experience is available. |

**NOTE**

*It is suggested that advantage might be taken of an occasion when a vessel is empty to start a new cycle.*

**10.3.2** *Above ground 5 year examination*

**10.3.2.1** Identify vessel by data plate/vessel markings or stampings. (Where this detail cannot be established see **10.3.5).**

**10.3.2.2** Visual examination of external surfaces and all welds for signs of defects. Where considered necessary, defects may be assessed by NDT methods.

**10.3.2.3** carry out wall thickness measurement using NDT methods. If this is not done, full visual examination should be carried out.

**10.3.2.4** Carry out examination of fittings in accordance with **10.4.**

**10.3.2.4.1** Check that vessel relief valves have been replaced in accordance with **10.4.1.** The relief valves should satisfy the design requirements of the vessel in terms of set pressure and capacity.

**10.3.2.5** After satisfactory examination ensure that the date is marked on the data plate.

**10.3.2.6** Issue report. (See **10.7)**

**10.3.3** *Above ground 10 year examination*

**10.3.3.1** Carry out stages as listed in 5 year examination (**10.3.2).**

**10.3.3.2** Carry out wall thickness checks or hydraulic tests or internal examination. Where entry is required see Appendix **11**.

**10.3.3.3** After satisfactory examination ensure that the date is marked on the data plate.

**10.3.3.4** Issue report. (See **10.7)**

**10.3.4** *Underground/mounded 5 year examination*

**10.3.4.1** Identify vessel by data plate/vessel markings or stampings. (Where this detail cannot be established see **10.3.5).**

**10.3.4.2** Full internal visual examination and also wall thickness check or hydraulic test. (Where internal examination is not practical the outside surfaces of the vessel must be exposed for examination or as directed by the competent person) where entry is required (see Appendix **11)**.

**10.3.4.3** Check that fittings are in order. (See **10.4)**

**10.3.4.4** Check that vessel relief valves have been replaced in accordance with **10.4.1.** The relief valves should satisfy the design requirements of the vessel in terms of set pressure and capacity.

**10.3.4.5** After satisfactory examination ensure that the date is marked on the data plate.

**10.3.4.6** Issue report. (See **10.7)**

**10.3.5** *Unidentified vessel (above and underground/mounded) detailed examination*

**10.3.5.1** From information available and the checks listed below an appropriate Standard/Code/Class can be established.

**10.3.5.2** Confirm suitable material have been used in the fabrication of the vessel. This may involve chemical analysis of parent and weld materials and hardness tests.

**10.3.5.3** Carry out full dimensional check. Carry out design calculations on the vessel and metallic legs to satisfy compliance to requirements of this Code.

**10.3.5.4** Carry out visual examination of external and internal surfaces (where possible) and all welds for signs of defects. Where considered necessary, defects may be assessed by NDT methods.

**10.3.5.5** Carry out ultrasonic/radiographic checks on 10 per cent of the main seams, including all the 'T' junctions. (Ultrasonic test from the inside preferred in the case of these vessels.)

**10.3.5.6** Carry out hydraulic test.

**10.3.5.7** Ensure that all essential fittings are provided and they are all in order and that:

a) the relief valves satisfy the design requirements of the in terms of test pressure and capacity; and
b) the fixed liquid level gauge is set for the maximum fill capacity appropriate for the service intended.

**10.3.5.8** Attach a data plate containing the information details in section **10.7.**

**10.3.5.9** Issue report.

**10.3.6** *Examination methods*

**10.3.6.1** Hydraulic test - Where required the hydraulic test should be carried out in accordance with the original design code. Before carrying out this test it must be established that the vessel and its foundations are capable of withstanding the total load.

**10.3.6.2** Ultrasonic examination (See Appendix **10).**

**10.3.6.3** Visual internal examination. This may be done by entry or for vessels 1500 mm diameter and below by optic probe or other means.

## 10.4 Vessel fittings inspection

**10.4.1** *Safety relief valves*

**10.4.1.1** Relief valves shall be replaced every 5 years with new or reconditioned units set at a pressure not exceeding the vessel maximum working pressure. The test date and other details stamped on the body should be checked. At the same time, consideration should be given to replacing any non corrosion protected stack pipes with galvanised or equivalent. To facilitate removal, stack pipes should not be fitted into valves using sealing compounds. PTFE tape is sufficient for this purpose.

Relief valve drain holes shall be checked to ensure that they are clear. Where internal corrosion of stack pipes is suspected, consideration shall be given to the removal of the stack pipes for examination of the relief valves to ensure that their operation would not be jeopardised by corrosion or corrosion debris. Missing rain caps shall be replaced.

Multiport relief valve manifold clapper mechanism shall also be operated and checked for effectiveness, at least once a year.

**10.4.1.2** A relief valve shall not be removed from a multiport or check-device whilst a vessel is under pressure unless a serviceable replacement is available to be fitted immediately.

**10.4.1.3** No attempt must be made to remove a relief valve mounted in a vessel under pressure unless the type and construction of the check device can be identified and the manufacturers instructions for the safe removal of the relief valve fully understood. These devices shall include positive means of confirming that the check device has closed before unscrewing the relief valve.

**10.4.2** *Pressure gauges*

When fitted, pressure gauges shall be examined regularly and gauge isolating valves operated at least once per year. Gauges shall be checked against a test gauge or replaced at intervals of not more than 10 years.

**10.4.3** *Excess flow valves and non-return valves*

Check the operation of excess flow valves and non return valves at intervals of not more than 10 years.

**10.4.4** *Contents gauges*

Any gauging device that relies on bleeding to atmosphere such as a rotary tube, fixed tube or slip tube shall be tested for effective operation at least once a year. Other types of contents gauges shall be checked as necessary, e.g. during product transfer.

**10.4.5** *Temperature gauges*

Temperature gauges when fitted shall be checked for accuracy of reading at intervals of not more than 5 years.

**10.4.6** *Shut-off valves*

**10.4.6.1** Manual shut-off valves shall be tested for ease of operation at least once a year, or at a frequency determined by a competent person.

**NOTE**

*The danger of shutting off/turning on a gas supply must be taken into account when checking valve operation.*

**10.4.6.2** Remotely operated shut-off valves shall be checked for operation at intervals of not more than one year, or at a frequency determined by a competent person.

**10.4.6.3** All shut-off valves shall be tested for effective operation at intervals of not more than 5/10 years as the case may be when vessels are taken out for periodic examination.

**10.4.6.4** Split-body ball valves can have two or three parts fastened together with external bolts. When removing pipework which has been isolated and made safe by such a valve which is therefore still under pressure, care must be taken to ensure that the body bolts are not undone instead of pipe flange bolts.

**10.4.7 Filling/off-loading equipment**

**10.4.7.1** Filling connections shall be visually checked for damage/wear/leakage at intervals of not more than one year.

**10.4.7.2** Hoses shall be visually examined every day if used daily and at each time before use if used less frequently.

**10.4.8** *Regulators*

First stage regulators shall be checked for leakage in accordance with the manufacturer's or other competent person's instructions or at intervals of not more than 5 years. Regulators shall be checked for correct operation and satisfactory lock up at intervals of not more than 10 years.

**10.4.9** *Studs and bolts*

Studs/bolts, nuts and washers shall be renewed if they are damaged or show signs of severe corrosion.

**10.5 Pipework, valves and fittings inspection**

**10.5.1** *Above ground pipework*

**10.5.1.1** All above ground piping shall be inspected for corrosion and damage at intervals of not exceeding one year. Repairs, repainting etc. including that of pipeline markings shall be carried out as required under this part of the Code.

**10.5.1.2** Pipeline supports shall be maintained in satisfactory condition. The point of contact between support and piping needs special attention during the examination specified in **10.5.1.1.**

**10.5.1.3** Thermal insulation shall be inspected for damages at intervals not exceeding one year.

**10.5.2** *Underground pipework*

**10.5.2.1** Pipelines conveying LPG vapour below 500 kPa shall be surveyed for leakage at a frequency dictated by the risks associated with their location, operating pressure and the aggressiveness of the environment.

**10.5.2.2** Pipelines conveying liquid LPG or vapour operating at pressures 500 kPa or above, the intervals between surveys shall not be more than 10 years. Where practicable this survey may be a repeat of the pressure test carried out upon installation.

**10.5.2.3** Double pipe systems i.e. pipe within a pipe, may be subjected to a repeat of the pressure test carried out upon installation. Where a system is constantly or frequently monitored, no further test or survey is necessary.

**10.5.2.4** Pipelines conveying liquid LPG or vapour operating at pressures 500 kPa or above, which incorporate buried screwed or flanged joints, or where there is doubt about the efficacy of their corrosion protection system, shall be pressure tested annually to the requirements of this part of the Code, or excavated annually for visual inspection and leak test under operating pressure, using soapy water or equivalent for leak detection.

**10.5.3** *Valves and fittings*

**10.5.3.1** Examination and maintenance of shut-off valves, excess flow valves, non-return valves, pressure gauges and first stage regulators shall be in accordance with **10.4.**

**10.5.3.2** Second stage regulators shall be maintained in accordance with manufacturer's instructions, or other schedule determined by a competent person.

**10.5.3.3** Hydrostatic relief valves shall be checked to ensure that they are clear and free of leakage, at intervals not exceeding one year. Drainage holes shall be checked and cleared as necessary and caps fitted where applicable.

**10.5.3.4** Hydrostatic relief valves shall be replaced at intervals of not more than 10 years with new or reconditioned units set to ensure the safety of the equipment they are designed to protect.

## 10.6 Other equipment

### 10.6.1 *Product transfer systems*

Pumps, compressors and associated equipment such as strainers shall be maintained in accordance with the manufacturers instructions, or other schedule prepared by a competent person. Particular attention shall be paid to seals and lubrication.

### 10.6.2 *Vaporisers*

**10.6.2.1** LPG may contain small quantities of extraneous matter which can collect and may settle in the vaporiser vessel. If necessary this may be removed via the vaporiser drain. Great care shall be taken in removal and disposal of such flammable material.

**10.6.2.2** When possible and at least at yearly intervals, examine/check the satisfactory operation of such items as level controls, heat input controls, emergency valves (other than pressure relief valves), flame failure devices, pressure controllers, etc. Particular attention shall be paid to solenoid valves and other items which may not be called upon to function in normal operation. Compressed air lines shall be drained at regular intervals.

**10.6.2.3** Clean and adjust all pilot and main burner systems at intervals not exceeding one year.

**10.6.2.4** Vaporisers shall be tested for LPG leaks at intervals not exceeding one year.

**10.6.2.5** Vaporisers shall be hydraulically tested at intervals not exceeding 5 years or as specified by a competent person. Direct fired vaporisers shall be tested hydraulically or by other means as agreed by the competent person at intervals not exceeding one year. Special attention shall be paid to flame impingement areas of these vessels.

### 10.6.3 *LPG air plants*

LPG air plants shall be inspected and examined in accordance with manufacturer's/installers instructions.

### 10.6.4 *Electrical equipment and electrostatic protection*

**10.6.4.1** The whole of the bonded system shall be inspected visually at intervals not exceeding one year to ensure that it is in satisfactory condition.

**10.6.4.2** All ancillary electrical equipment including cables and connections, particularly flame proof connections, switches etc. shall be inspected at intervals not exceeding one year or in accordance with manufacturer's/installer's instructions or other schedule prepared by a competent person to ensure that they are in satisfactory working condition.

**10.6.5** *Fire precautions and equipment etc.*

**10.6.5.1** Fire extinguishers shall be checked, tested and maintained at regular intervals according to the manufacturers' instructions or other schedule prepared by a competent person.

**10.6.5.2** Fire hoses, nozzles, fire pumps and water spray systems shall be checked for correct operation in accordance with the suppliers' instructions, or other schedule prepared by a competent person.

**10.6.5.3** Fire alarm system shall be tested regularly.

**10.6.5.4** The existence, location and legibility of warning and emergency notices as detailed in this part of the Code shall be checked regularly.

**10.6.5.5** Regularly check that the stipulated safety distances from LPG vessels are kept free from weeds, long grass or any readily combustible material.

**10.6.6** *Corrosion protection*

Sacrificial anodes shall be inspected regularly in accordance with the suppliers/installers instructions and replaced as required.

**10.7 Records**

**10.7.1** *Vessel data*

**10.7.1.1** Data plates and/or documentation for both new and existing vessels shall where practicable indicate the following:

a) design code;
b) manufacturer's name and vessel serial number;
c) water capacity in litres;
d) maximum and minimum safe working pressures in MPa;
e) minimum design temperature;
f) year of manufacture;
g) hydraulic test date;
h) hydraulic test pressure;
j) date of last examination; and
k) inspection Authority identification.

**10.7.1.2** Where legibility of vessel identification on data plate has become impaired replacement data plate shall be made of corrosion resistant material.

**10.7.2** *Installation data*

Records of all major examination of vessel(s) and installation shall be kept. These shall include:

a) pressure test certificate(s) for vessel(s);
b) safe operating limits;
c) current major examination reports confirming fitness for purpose;
d) details of scheme of maintenance; and
e) details modifications or major repairs.

## APPENDIX 1
## PROPERTIES OF COMMERCIAL LPG

**TABLE 6 - Typical properties of commercial LPG**

| (1) | Commercial Butane (2) | Commercial Propane (3) |
|---|---|---|
| Relative density of liquid at 15.6 $^{o}$C | 0.57 to 0.58 | 0.50 to 0.51 |
| Imperial gallons/ton at 15.6 $^{o}$C | 385 to 393 | 439 to 448 |
| litre/tonne at 15.6 $^{o}$C | 1723 to 1760 | 1965 to 2019 |
| Relative density of gas compared with air at 15.6 $^{o}$C and at 101.59 kPa pressure. | 1.90 to 2.10 | 1.40 to 1.55 |
| Volume of gas (litres) per kg of liquid at 15.6 $^{o}$C and 101.59 kPa pressure | 406 to 431 | 537 to 543 |
| Boiling point at atmospheric pressure in $^{o}$C approx. | -2 | -45 |
| Vapour pressure (gauge) maximum specified for products at selected key temperatures<br>Temp $^{o}$C<br>-40<br>-18<br>0<br>15.6<br>38<br>45 | <br><br>kPa<br>-<br>-<br>90<br>193<br>483<br>586 | <br><br>kPa<br>50<br>230<br>450<br>690<br>1450<br>1760 |
| Latent heat of vaporisation (kJ/kg) at 15.6 $^{o}$C | 372.2 | 358.2 |
| Specific heat of liquid (kJ/kg) 15.6 $^{o}$C | 2.386 | 2.512 |
| Sulphur content percent 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<br>Lower 1.8 | Upper 10.0<br>Lower 2.2 |

| | | |
|---|---|---|
| Calorific Value;<br>Gross ($MJ/m^3$) dry<br>(MJ/kg)<br><br>Net ($MJ/m^3$) dry<br>(MJ/kg) | <br>121.8<br>49.3<br><br>112.9<br>45.8 | <br>93.1<br>50.0<br><br>86.1<br>46.3 |
| GJ/tonne | 49.3 | 50.0 |
| Air required for combustion<br>($m^3$ to burn 1 $m^3$ of gas) | 30 | 24 |

## APPENDIX 2

## MINIMUM RECOMMENDED SEPARATION DISTANCES FOR LPG STORAGE VESSELS

**TABLE 6(a) -** Distances from buildings, boundaries and sources of ignition - for above ground vessels

| **Maximum water capacity** | | | **Minimum separation distances** | | |
|---|---|---|---|---|---|
| **Of any single vessel in a group** | | **Of all vessels in a group** | **Above ground vessels** | | |
| **Litres** | **Nominal LPG capacity (tonnes)** | **Litres** | **From building boundary, property line or fixed source of ignition** | **With fire wall** | **Between vessels** |
| **(1)** | **(2)** | **(3)** | **(a) m (4)** | **(b) m (5)** | **(c) m (6)** |
| 150 to 500 | 0.05 to 0.25 | 1500 | 2.5 | 0.3 | 1 |
| >500 to 2500 | 0.25 to 1.1 | 7500 | 3 | 1.5 | 1 |
| >2500 to 9000 | 1.1 to 4 | 27000 | 7.5 | 4 | 1 |
| >9000 to 135000 | 4 to 60 | 450000 | 15 | 7.5 | 1.5 |

**TABLE 6 (b) -** Distances from buildings, boundaries and sources of ignition - for Buried or mounded vessels

| **Maximum water capacity** | | | **Minimum separation distances** | | |
|---|---|---|---|---|---|
| **Of any single vessel in a group** | | **Of all vessels in a group** | **Buried or mounded vessels** | | |
| **Litres** | **Nominal LPG capacity (tonnes)** | **Litres** | **From buildings etc. to valve assembly** | **From buildings etc. to vessel** | **Between vessels** |
| **(1)** | **(2)** | **(3)** | **(4) (d) m** | **(5) (e) m** | **(6)(f) m** |
| 150 to 500 | 0.05 to 0.25 | 1500 | 2.5 | 0.3 | 0.3 |
| >500 to 2500 | 0.25 to 1.1 | 75000 | 3 | 1 | 1.5 |
| >2500 to 9000 | 1.1 to 4 | 27000 | 7.5 | 3 | 1.5 |
| >9000 to 135000 | 4 to 60 | 450000 | 7.5 | 3 | 1.5 |

**TABLE 7 -** Distances from other flammable liquids

| **Flammable liquid (FP - Flash point)** | **Minimum separation of LPG vessel up to 135 $m^3$** |
|---|---|
| FP < 32 $^oC$ | 6 m to bund wall |
| EP 32 $^oC$ - 65 $^oC$<br>Tank size upto 3000 litres | Safety distance for LPG vessel or 3 m to the tank/bund which ever is the lesser |
| Tank size over 3000 litres | 3 m to bund wall or diversion wall and 6 m to tank |

**TABLE 8 - Distances from liquid oxygen storage**

| **Vessel Sizes** | | |
|---|---|---|
| **Liquid Oxygen (Litres)**<br><br>**(1)** | **LPG (tonnes)**<br><br>**(2)** | **Separation Distance (Metres)**<br>**(3)** |
| Up to<br>125,000 | 0 - 1<br>1 - 4<br>4 - 60 | 6<br>7.5<br>15 |
| over<br>125,000 | 0 - 2<br>2 - 220 | 30<br>45 |

## APPENDIX 3
## SEPARATION DISTANCES

**TABLE 9 - Minimum recommended separation distances for LPG vaporisers** (Paragraph **4.11** refers)

| **Capacity of vaporiser**<br>kg/hr | **Minimum distance of vaporiser from nearest adjacent building or line of adjoining property (m )** |
|---|---|
| up to 35<br>35 to 225<br>over 225 | 3<br>7.5<br>15 |

## APPENDIX 4

## AREA CLASSIFICATION

**TABLE 10 - Area classification**

| Factor<br><br>(1) | Extent of classified area<br><br>(2) | Area classification<br>(3) |
|---|---|---|
| Storage Vessel | (a) Within 1.5 metres from the discharge orifice of liquid level detection devices. e.g. fixed liquid level gauges, rotary or slip gauges. | Zone 1 |
| | (b) Up to 1.5 meters above ground level and decreasing uniformly to zero within the distances set out for fixed source of ignition. See Appendix 2 | Zone 2 |
| Relief Valve | (a) Within direct path of discharge | Fixed electrical equipment should not be nstalled |
| | (b) Within 1.5 m in all other directions | Zone 1 |
| | (c) Beyond 1.5 m but within 4.5 m in all directions from the point of discharge (or the separation distance in Appendix 2, column(a) in the case of vessels of water capacity not exceeding 2,500 litres) | Zone 2 |
| Tank Vehicle Loading/ Unloading Connections | (a) Within 1.5 m in all directions from a point where connections are made or disconnected for product transfer. | Zone 1 |
| | (b) Beyond 1.5 m but within 4.5 m in all directions from the point of connection or disconnection (or the separation distances in Appendix 2, Column (a) in the case of vessels of water capacity not exceeding 2,500 litres). | Zone 2 |

**TABLE 10 – Area clarification (concluded)**

| Factor<br><br>(1) | Extent of classified area<br><br>(2) | Area classification<br>(3) |
|---|---|---|
| Pumps, Compressors LPG-Air Plant and Vaporisers other than direct fired: | | |
| (i)outdoor in open air at or above ground level | (a) Within 1.5 m in all directions. | Zone 1 |
| | (b) Beyond 1.5 m but within 4.5 m in all directions from the vaporiser (or the separation distances in Appendix 2, Column (a) in the case of vessels of water capacity not exceeding 2,500 litres). | Zone 2 |
| (ii) indoor location with adequate ventilation | Entire room and any adjacent room not separated by a vapour tight partition. | Zone 1 |
| | | |

**NOTE 1**

*Any pit, trench, duct entry or depression falling within a Zone 1 or Zone 2 location shall be treated as being Zone 1 throughout, unless a suitable interceptor is installed.*

**NOTE 2**

*For electrical hazards attention is drawn to the 'electricity at work regulations' (SI 635 ).*

**NOTE 3**.

*The term 'outdoor in open air' includes pumps, compressors and vaporisers which are covered by a canopy.*

**NOTE 4**

*Zones are clarified as per 7.11*

## APPENDIX 5

## MINIMUM RATE OF DISCHARGE FOR STORAGE VESSEL SAFETY RELIEF VALVES

The discharge rate of the safety valves shall not be less than that shown in the Table **11**, which is based on an adequate release rate for a vessel exposed to fire conditions. This rate is given as the equivalent discharge at standard conditions when using air, and the required rate shall be achieved before the pressure rises to 120 per cent of the set pressure.
For vessel sizes not included in the table the following formula may be used.

Discharge rate = $10.655 \times S^{0.82}$ in $m^3$ /minute of air
at 15 $^{o}$C at atmospheric pressure.

Where S is the total exterior surface area of the storage vessel in square metres.

**IMPORTANT.** The rates of flow given in the Table 10 are the minimum permissible at full discharge at 120 per cent of the set pressure and apply to relief systems as installed. Allowance must be made for the reduction in quoted discharge rates for the valves alone, created by the resistance of check devices, or multiple valve manifolds or other restrictions in assessing the actual installed rates.

**TABLE 11 - Required flow rates for vessels**

| Surface $m^2$ 1 | Air Flow m3/min | Surface $m^2$ 2 | Air Flow m3/min | Surface $m^2$ 3 | Air Flow m3/min |
|---|---|---|---|---|---|
| 1 | 10.65 | 20 | 124.22 | 130 | 576.48 |
| 1.5 | 14.86 | 21 | 129.29 | 135 | 594.58 |
| 2 | 18.81 | 23 | 134.31 | 140 | 612.58 |
| 2.5 | 22.58 | 22 | 139.30 | 145 | 630.48 |
| 3 | 26.23 | 24 | 144.25 | 150 | 648.25 |
| 3.5 | 29.77 | 25 | 149.16 | 155 | 665.91 |
| 4 | 33.20 | 26 | 154.03 | 160 | 683.47 |
| 4.5 | 36.57 | 27 | 158.87 | 165 | 700.94 |
| 5 | 39.87 | 28 | 163.69 | 170 | 718.31 |
| 5.5 | 43.12 | 29 | 168.46 | 175 | 735.59 |
| 6 | 46.30 | 30 | 173.21 | 180 | 752.78 |
| 6.5 | 49.45 | 31 | 177.92 | 185 | 769.86 |
| 7 | 52.53 | 32 | 182.62 | 190 | 786.91 |
| 7.5 | 55.59 | 33 | 187.29 | 195 | 803.85 |
| 8 | 58.62 | 34 | 191.93 | 200 | 820.71 |
| 8.5 | 61.61 | 35 | 196.55 | 205 | 837.49 |
| 9 | 64.57 | 36 | 201.14 | 210 | 854.21 |
| 9.5 | 67.50 | 37 | 205.71 | 215 | 870.86 |
| 10 | 70.32 | 38 | 209.85 | 220 | 887.42 |
| 10.5 | 73.26 | 39 | 214.78 | 225 | 903.92 |
| 11 | 76.12 | 40 | 219.29 | 230 | 920.37 |
| 11.5 | 78.94 | 45 | 241.54 | 235 | 936.73 |
| 12 | 81.70 | 50 | 263.33 | 240 | 953.06 |
| 12.5 | 84.48 | 55 | 284.73 | 245 | 969.29 |
| 13 | 87.25 | 60 | 305.79 | 250 | 985.50 |
| 13.5 | 89.99 | 65 | 326.53 | 255 | 1,001.63 |
| 14 | 92.71 | 70 | 346.99 | 260 | 1,017.69 |
| 14.5 | 95.42 | 75 | 367.19 | 265 | 1,033.73 |
| 15 | 98.11 | 80 | 387.17 | 270 | 1,049.68 |
| 15.5 | 100.79 | 85 | 406.88 | 275 | 1,065.63 |
| 16 | 103.44 | 90 | 426.51 | 280 | 1,081.50 |
| 16.5 | 106.09 | 95 | 445.73 | 285 | 1,097.26 |
| 17 | 108.71 | 100 | 465.20 | 290 | 1,113.03 |
| 17.5 | 111.33 | 105 | 483.87 | 295 | 1,128.79 |
| 18 | 113.91 | 110 | 502.66 | 300 | 1,144.44 |
| 18.5 | 116.53 | 115 | 521.33 | | |
| 19 | 119.10 | 120 | 539.84 | | |
| 19.5 | 121.66 | 125 | 558.23 | | |

Surface $m^2$ = total exterior surface of the tank in $m^2$

Air flow $m^3$/min = cubic meters of air to be allowed to escape per minute at 15 $^oC$ at atmospheric pressure.

## APPENDIX 6

## MAXIMUM FILLING CAPACITY OF LPG STORAGE VESSELS

LPG in its liquid phase, has an extremely high coefficient of thermal expansion. For this reason no LPG container should be completely filled because a rise in temperature could cause the relief valve to open and release liquid LPG to atmosphere. The maximum volume of LPG which is permissible to fill into any container must therefore be such that the hydraulically full condition will not be reached for any foreseeable range of product temperature in normal service.

To ensure this condition is met there must always be sufficient ullage (free space above the liquid level) so that the vessel is not more than 97 per cent full at the 'filling reference temperature' and should not be liquid full 5 $^{o}$C above this temperature.

The filling reference temperature to be used in Sri Lanka is 45$^{o}$C as specified in **SLS 1174**.

The maximum permissible volume of liquid in LPG storage vessels can be calculated as follows:-

$$U_{max} = 0.97\ V \times g_i/g_t$$

where $g_t$ is the relative density of the liquid at its lowest likely temperature at filling.
$g_i$ is the relative density at the filling reference temperature.
V is the internal volume of the storage vessel.
$U_{max}$ is the maximum permitted liquid volume.

For LPG to **SLS 712**, the hydraulically full condition will not be reached at 5$^{o}$C above the reference temperature if the volume does not exceed 97 per cent full at the reference temperature.

The fixed liquid level gauge required by **5.1.9.1 (c)** has a dip tube the end of which is reached by the liquid surface as it rises to indicate the maximum permitted volume during the filling operation. The controlled vapour released from the device changes from invisible vapour, to a visible white mist. At this point the filling must cease immediately.

## APPENDIX 7

## RECOMMENDED PROTECTIVE CLOTHING

Protective clothing should be worn by personnel engaged in product transfer operations, e.g. road/rail transfers, cylinder filling, plant commissioning etc.

Clothing material should minimise the risk of inducing sparks. Additionally fabrics such as nylon should not be worn as these can also increase the severity of burns in a fire situation.

Protective footwear with covered impact resistant toe-caps should be worn by all personnel. There should be no steel tips on sole or heels.

Gloves to resist cold burns should be worn by all relevant personnel, e.g. those involved in bulk transfer or filling of LPG. Eye protection is also recommended for such operations.

Other than these specific items, good industrial practice should be followed to reduce the risks of a normal place of work.

## APPENDIX 8

## STORAGE OF UNODORISED LPG

This Appendix relates to product supplied or used for a particular application which requires the LPG to have a low odour. Such LPG is therefore, not in compliance with **SLS 712** with regard to odour.

Because of the nature of the product, it is recommended that the following extra precautions and safety procedures be taken.

**8.1** Storage vessels should be clearly marked to indicate that it is UNODORISED.

**8.2** Consideration should be given to the use of couplings which will prevent or minimise the risk of delivery of unodorised LPG into normal odorised stock.

**8.3** Pressure gauges shall be fitted on all storage vessels.

**8.4** For certain applications requiring very close control of product quality, e.g. the aerosol market, consideration should be given to positive means of isolation of plant sections to facilitate cleaning or renewal. For similar reasons provision of suitable sampling points and permanent drain connections should be considered.

**8.5** Pipework where practicable should be welded and flanged, and be clearly identified as carrying unodorised product.

**8.6** A visual inspection for leaks should be undertaken regularly by a competent person familiar with the product.

**8.7** Where the ultimate process takes place inside a building, the provision of suitable automatic flammable gas detectors is strongly recommended.

**8.8** All enclosures within which LPG may be vented to atmosphere as part of the process should be provided with mechanical ventilation extracting at low level and discharging to atmosphere at high level. Consideration should be given to electrical interlock to prevent process machinery from being started before the ventilation system is in operation.

**8.9** To prevent inadvertent delivery of normal odorised LPG into a storage vessel or vice versa, it is recommended that fitting connections on the fixed storage installation and the delivery vehicle hose end coupling are provided with left-hand screw threads.

## APPENDIX 9
## INSPECTION ANS EXAMINATION

**TABLE 12 – Summary of inspections and examinations**

| Period (1) | Inspection/Examination (2) | Reference (3) |
|---|---|---|
| Routine/Annual Inspections | Vessels, pipelines and ancillary equipment | 10.2.1, 10.2.2<br>10.2.3 |
| | Vessel fittings | 10.4 |
| | Safety relief valves | 10.4.1.1 |
| | Shut-off valves | 10.4.6 |
| | contents gauges | 10.4.4 |
| | Filling/Off-loading equipment | |
| | Pipework & supports- above ground | 10.4.7 |
| | Pipework underground | |
| | Pipework thermal insulation | 10.5.1 |
| | Hydrostatic relief valves | 10.5.2<br><br>10.5.1.3<br><br>10.5.3.3/4 |
| 5 year examination | Vessel | 10.3.1,10.3.2<br>10.3.4 |
| | Safety relief valves | 10.4.1.1,<br>10.4.1.2,<br>10.4.1.3 |

| | | |
|---|---|---|
| 10 year examination | Vessel<br>Pressure gauges<br>Temperature gauges<br>Excess flow valves<br>Non-return valves<br>Regulators - 1st stage<br>Hydrostatic relief valves<br>Pipelines - underground | 10.3.1, 10.3.3<br>10.4.2<br>10.4.5<br>10.4.3<br>10.4.3<br>10.4.8<br><br>10.5.3.4<br>10.5.2 |
| Manufacturers' instructions | Pumps, compressors and associated equipment<br>LPG - Air plant<br>Vaporisers<br>Electrical equipment<br>Fire precaution (equip)<br>Cathodic protection<br>Regulators | <br>10.6.1.1<br>10.6.3<br>10.6.2.5<br>10.6.4.2<br>10.6.5.1/2<br>10.6.6<br>10.4 8.1 |

## APPENDIX 10

## ULTRASONIC THICKNESS TESTING OF VESSEL

### 10.1 Scope

This appendix gives guidelines on ultrasonic thickness testing of an LPG vessel, shell and ends.

### A.10.2 Introduction

The user is required to use equipment that will provide comparisons of wall thickness consistent with minimum vessel wall thickness values. He shall be suitably trained to use the instrument and interpret the readings.

The use of the testing equipment must be in accordance with the manufacturers instructions which should include regular calibration.

Most ultrasonic equipment cannot be considered intrinsically safe where flammable gas is present. Therefore, before carrying out any ultrasonic examination, all vessel and pipe joints within a minimum distance of 1.5 m should be proved to be gas tight e.g. test with soapy solution.

No product transfer should take place during this operation e.g. deliveries or cylinder filling.

### 10.3 Thickness testing method

The thickness reading shall be taken on the following grid pattern.

**10.3.1** *Shell*

Readings at approximately 380 mm spacing should be taken at BDC (where practical). Further readings to give assurance of integrity of the tank should be taken at suitable positions as determined by the competent person e.g. 60º from the top.

**10.3.2** *Heads*

The readings are taken at the regular positions as detailed for the shell and at 150 mm from the knuckle radius as appropriate.

**10.3.3** *Control readings*

The control readings are:

Shell at TDC

Heads on knuckle radius at TDC.

The rejection criteria will be based on actual readings compared to the control readings.

**10.4** *Certificate*

The actual and control readings will be recorded on a suitable certificate and signed by the person doing the testing.

## APPENDIX 11

## PREPARATION OF VESSEL FOR ENTRY AND EXAMINATION

### 11.1 Vessel isolation

The vessel to be examined should be physically isolated from any other vessel by removing interconnecting pipework or by spade blanks across flanges. Isolation by valves is not acceptable.

### 11.2 Purging out of service

This requires specialist attention with experienced personnel.

### 11.3 Ventilation with air for entry

This requires specialist attention with experienced personnel. No entry for inspection should be permitted until a gas-free certificate, issued by a competent person declaring the vessel fit for entry without breathing apparatus, is available to the inspector.

## Appendix 12
## SUMMERY

**TABLE 13 - Summary**

| Installation Capacity (1) | | Fire Precautions (2) | Paragraph (3) |
|---|---|---|---|
| **Litres Water Capacity** | **tonnes** | | |
| 150 - 2,500 Domestic | <1.1 | Water supply for fire brigade use. | 6.2.4 |
| 150 - 2,500 Commercial and Industrial | <1.1 | Water supply for fire brigade use.<br>19 mm hose reel or extinguishers.<br>2 x 9 kg dry powder extinguishers. | 6.2.4<br>6.5.2<br>6.5.3 |
| 2,500 - 56,250 | >1.1 <25 | Water supply for fire brigade use.<br>19 mm hose reel.<br>2 x 9 kg dry powder extinguishers. | 6.2.4<br>6.5.2<br>6.5.3 |
| 56,250 - 112,500 | >25 <50 | Water supply.<br>Fixed and/or portable monitors for vessels and road vehicle bays.<br>19 mm hose reel.<br>2 x 9 kg dry powder extinguishers. | 6.2.5<br>6.3.2<br>6.3.4<br>6.5.2<br>6.5.3 |
| 112,500 | ≥50 | Water supply.<br>Fixed water sprays for vessel.<br>Road/rail vehicle bays.<br>19 mm hose reel.<br>2 x 9 kg dry powder extinguishers. | 6.2.5<br>6.3.3/7<br>6.3.4<br>6.5.2<br>6.5.3 |
| 15,750 Individual vessel capacity with liquid off- take where para 6.3.5 applies | >7 | Water supply.<br>Consideration of provision of means to apply cooling water to vessels e.g. fixed or portable monitors etc.<br>19 mm hose reel.<br>2 x 9 kg dry powder extinguishers. | 6.2.5<br>6.3.5<br><br><br>6.2.5<br>6.5.3 |
| 'Metered' Estates Caravan Parks etc. | | Water supply for fire brigade use. | 6.2.4 |

## APPENDIX 13
## PREPARATION OF VESSEL FOR RETURNING TO SERVICE AFTER ENTRY AND EXAMINATION

**13.1** *Visual check*

**A**fter testing the vessel atmosphere an internal examination of the vessel should be made to ensure that there is no entraneous matter present.

**13.2** *Flanged connections*

Where the flanged connections have been broken, the joint faces including that of the manhole cover should be thoroughly cleaned and checked for distortion. All gaskets and joint rings shall be renewed and all bolts, studs, nuts and bonding strips shall be examined and renewed where necessary.

**13.3** *Screwed connections*

Where screwed joints have been broken, all threads shall be cleaned, examined and where satisfactory, remade using LPG thread sealant to a suitable standard e.g.BS 5292 or BS 4375. Care should be taken to ensure that excessive quantities of sealant are not used.

**13.4** *Leak testing*

See installation and commissioning requirements in this Part of the Code.

**13.5** *Purging into service*

This requires specialist attention with experienced personnel.

**13.6** *Filling procedure*

Follow the filling procedure specified in this Part of the Code.

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