HOME OFFICE

CODE OF PRACTICE
FOR THE STORAGE OF
LIQUEFIED PETROLEUM GAS
AT FIXED INSTALLATIONS

LONDON
HER MAJESTY'S STATIONERY OFFICE
PRICE 30p NET
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1971
FOREWORD

This Code provides a general guide to safe practice in storing and handling liquefied petroleum gas (LPG) at fixed storage installations where tanks are filled on site. It has been prepared primarily as a guide for any bodies which may be given the task of enforcing safety requirements at these installations. It is, however, recognised that each case must be considered on its merits, and special circumstances may necessitate variations of the requirements here recommended. It is not intended to preclude the use of alternative designs, materials and methods where these provide equivalent standards of safety. Further it is not the intention that the recommendations of the Code should be applied rigidly to existing premises, where for a variety of reasons it may not be practicable to comply with them. Only such alterations as are considered to be reasonable, or essential for the public safety should be made.

The Code is divided into four parts; Part 1 gives general information on LPG; Part 2 covers the larger storage facilities at refineries, bulk plants for distribution of LPG and gas works; Part 3 covers the smaller storage facilities at industrial, commercial and domestic premises, but if the storage at these premises is large reference is made to Part 2 of the Code; Part 4 gives recommendations for safe operating practice. Installations are covered only up to the inlet of first stage line pressure reduction.

The design and construction of plant and equipment for the storage and handling of LPG in bulk should be carried out only by experienced people. Personnel responsible for operations should understand the physical characteristics of the products and should be trained in the use of the LPG equipment and the action to be taken in an emergency. Attention is drawn to the recommendations in the Code on commissioning new facilities, on the care necessary in draining water or drawing samples from tanks and on product transfer operations.

The Code does not include detailed guidance on the design, construction and maintenance of LPG equipment. For such guidance reference should be made to the Codes of Practice listed in Appendix A.
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PART I GENERAL

1.1 LIQUEFIED PETROLEUM GAS (LPG)

a. "Liquefied Petroleum Gas" or 'LPG' is a generic term, used to describe liquefiable gases consisting predominantly of C₃ and C₄ hydrocarbons.

b. These hydrocarbons exist as gases at normal atmospheric temperatures and pressure but they can be liquefied under moderate pressure. If the pressure is subsequently released, the hydrocarbons again become gaseous.

c. As liquids they occupy only about 1/250th of the space they would need if they were stored as gases. From a commercial point of view it is therefore more practicable to store and convey the hydrocarbons as liquids than as gases.

d. The two liquefied petroleum gases in general use are known as 'Commercial Butane' and 'Commercial Propane'. The characteristics and composition of these products are set out in BS 4250.

e. LPG may be stored as a liquid EITHER at ambient temperature under moderate pressure OR in a refrigerated condition at a lower pressure. If the temperature of storage is sufficiently low, the LPG may be stored at substantially atmospheric pressure.

f. At 15°C commercial butane has a vapour pressure of about 25 psig and commercial propane has a vapour pressure of about 105 psig.

1.2 CHARACTERISTICS AND HAZARDS

a. LPG is colourless, and its weight as a liquid is only just over half that of an equivalent volume of water.

b. LPG vapour is denser than air, commercial butane being about twice as heavy as air and commercial propane about one and a half times as heavy as air. Because of this, the vapour may flow along the ground and into drains, sinking to the lowest level of the surroundings. In still air conditions any accumulation of vapour will take time to disperse.

c. When mixed with air in certain proportions, LPG forms an inflammable mixture. The inflammable range extends between approximately 2% of the vapour in air at its lower limit and approximately 10% of the vapour in air at its upper limit. Outside this range, any mixture is either too weak or too rich to propagate flame. Within the range there is the risk of explosion. Small quantities of the liquefied gas can give rise to large volumes of vapour/air mixture and thus cause considerable hazard. A suitable, properly calibrated explosimeter may be used for testing the concentration of LPG in air. On no account should a naked flame be used to detect a leak.
d. Because of the characteristics outlined in Clauses 1.2b. and 1.2c. any vapour/air mixture arising from leakage or other cause may become ignited some distance from the point of escape, and the flame may travel back to the original source of leakage.

c. LPG vapour is slightly anaesthetic and may also cause suffocation if present in sufficiently high concentrations.

d. LPG is normally odorised before distribution, by the addition of an odorant such as ethyl mercaptan or dimethyl sulphide, enabling detection by smell of the gas at concentrations down to one fifth of the lower limit of inflammability (i.e. approximately 0.4% of the gas in air). However, in some cases where, for example, the odorising material may be harmful to a process or does not serve any useful purpose as a warning agent, the LPG is not odorised.

g. Escape of LPG may be noticeable otherwise than by smell. When the liquid evaporates, the cooling effect on the surrounding air causes condensation and even freezing of water vapour in the air. This may show itself as frost at the point of escape and thus make it easier to detect an escape of LPG.

h. Owing to its rapid vaporisation and consequent lowering of temperature, LPG can cause severe frost burns if brought into contact with the skin. Protective clothing such as gloves and goggles should be worn if exposure to this hazard is likely to occur.

i. A container which has held LPG and is ‘empty’ may still contain LPG in vapour form and is potentially dangerous. In this state the internal pressure is approximately atmospheric and if a valve is leaking or left open, air can diffuse into the container, forming an inflammable mixture and creating a risk of explosion while LPG can be displaced to the atmosphere.

PART 2 STORAGE AT REFINERIES AND BULK PLANTS

2.1 SCOPE

2.1.1 This Part of the Code covers LPG storage installations at refineries, bulk plants for distribution of LPG and gas works. Where the total LPG storage at a gas works does not exceed 30,000 gallons water capacity the recommendations of Part 3 should be followed. Part 3 covers storage at industrial, commercial or domestic premises, unless storage at these premises involves tanks of individual capacity greater than 30,000 gallons water capacity or group storage greater than 100,000 gallons water capacity, when the recommendations of Part 2 should be followed.

2.2 STORAGE TANK LOCATION AND SAFETY DISTANCES

2.2.1 Pressure storage

a. Location and spacing

i. The distances given in Table 2.2.1 are minimum recommendations for above-ground tanks and refer to the horizontal distance in plan between the nearest point on the storage tank and the nearest point of a
specified feature (e.g. an adjacent storage tank, building, boundary). The distances are for both spherical and cylindrical tanks.

ii. With the provision of radiation walls or adequate fixed water spray systems, separation distances may be reduced but specialist advice should be obtained.

Table 2.2.1

<table>
<thead>
<tr>
<th>Location and spacing for pressure storage at refineries and bulk plants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor</strong></td>
</tr>
<tr>
<td>1. Between LPG pressure storage tanks</td>
</tr>
<tr>
<td>2. To tanks containing inflammable liquids with a flash-point below 150°F</td>
</tr>
<tr>
<td>3. To low pressure refrigerated LPG tanks</td>
</tr>
<tr>
<td>4. To process unit, office building, workshop, laboratory, warehouse, boundary, busy internal road carrying uncontrolled traffic, or any fixed source of ignition</td>
</tr>
<tr>
<td>Gallons</td>
</tr>
<tr>
<td>Over 250-500</td>
</tr>
<tr>
<td>Over 500-2000</td>
</tr>
<tr>
<td>Over 2000-30,000</td>
</tr>
<tr>
<td>Over 30,000-75,000</td>
</tr>
<tr>
<td>Over 75,000</td>
</tr>
</tbody>
</table>

b. Spillage

i. The provision of conventional bunds (see Clause 2.2.2b. around LPG pressure storage tanks designed and constructed in accordance with Clause 2.3.1 is not required (but see Clause 2.2.1b.iii for separation kerbs).

ii. The ground beneath tanks should either be concreted or compacted, and so sloped as to:

a. prevent the accumulation of any liquid beneath them; and

b. ensure a flow away from the tanks and any important areas.
Notes: 1. Where all the connections of the vessel are grouped at one end the above provisions need only be required beneath the connections.

2. Provision should also be made for a flow away from the tanks and any important areas of cooling water applied under fire conditions.

iii. Separation kerbs, low to avoid gas traps, with a maximum height of 2 ft may be required to direct spillage to suitable places away from the tanks and other important areas.

iv. To prevent the forming of gas pockets, which might affect the safety of the tank, the vicinity of LPG storage tanks should be free of pits and depressions, other than those necessarily required for the containment of spillage.

v. LPG storage tanks should be installed well away from tanks containing liquid oxygen or other hazardous substances and in such cases specialist advice should be obtained on spacing. In any case, no pressure storage tank for LPG should be located in any bund where there is any permanent source of heat (e.g. steam mains) or within the bunded enclosure of:

a. a tank containing an inflammable liquid with a flashpoint below 150 °F;

b. a tank containing liquid oxygen or any other hazardous substance;

c. low-pressure refrigerated LPG tanks;

d. any heated storage tank (e.g. fuel oil tank).

c. Lay-out of tanks
The lay-out and grouping of tanks, as distinct from spacing, should receive careful consideration so as to ensure accessibility for fire-fighting and the avoidance of spillage from one tank flowing towards any other tank or towards a nearby important area. The number of storage tanks in one group should not exceed 6, subject to the maximum total capacity of a group given in Table 2.2.1. Any tank in one group should be at least 25 ft from any tank in another group unless a radiation wall is erected between the groups.

d. Fencing
To prevent trespassing or tampering, the area which includes tanks, pumping equipment and loading and unloading facilities should be enclosed by an industrial type fence at least 6 ft high at a distance of not less than 5 ft from the installation unless the fence is a boundary fence, when the distances given in Table 2.2.1 will apply. Where necessary, fences should have at least two means of exit, not adjacent to one another. Gates should open outwards, should not be self locking, and should provide easy means of escape from within.
2.2.2

a. Location and Spacing

The distances given in Table 2.2.2 are minimum recommendations and refer to the horizontal distance in plan between the nearest point on the storage tank and the nearest point of a specified feature (e.g., an adjacent storage tank, building, boundary).

Table 2.2.2

Location and spacing for low pressure refrigerated storage

<table>
<thead>
<tr>
<th>Factor</th>
<th>Recommendations for Low-Pressure Refrigerated LPG Storage</th>
</tr>
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<tbody>
<tr>
<td>1. Between refrigerated LPG storage tanks</td>
<td>One half of the sum of the diameters of the two adjacent tanks</td>
</tr>
<tr>
<td>2. To tanks containing inflammable liquids with a flash-point below 150°F</td>
<td>The diameter of the largest refrigerated storage tank but not less than 100 ft</td>
</tr>
<tr>
<td>3. To pressure storage tanks</td>
<td>The diameter of the largest refrigerated storage tank but not less than 100 ft. The pressure storage tank should be not less than 50 ft from the top of the bund surrounding the refrigerated storage tank</td>
</tr>
<tr>
<td>4. To process unit, office building, workshop, laboratory, warehouse, boundary, busy internal road carrying uncontrolled traffic, or any fixed source of ignition</td>
<td>150 feet</td>
</tr>
</tbody>
</table>

b. Bund or Impounding Basin

i. A bund should be provided around all low pressure tanks containing refrigerated LPG. The tanks should be completely surrounded by the bund, unless the topography of the area is such, either naturally or by construction, that spillages can be directed quickly and safely, by gravity drainage and diversion walls if required, to a depression or impounding basin located within the boundary of the plant. Bunds should be designed to be of sufficient strength to withstand the pressure to which they would be subjected if the volume within the bunded enclosure were filled with water. The area within the bund, depression or impounding basin should be isolated from any outside drainage system by a valve, normally closed unless the area is being drained of water under controlled conditions.

ii. Where only one tank is within the bund, the net capacity of the bunded enclosure, including the capacity of any depression or impounding basin, should be not less than 75 per cent of the tank capacity. Where
more than one tank is within the main enclosure, intermediate bunds should be provided, so as to give an enclosure around each tank of 50 per cent of the capacity of that tank, and the minimum effective capacity of the main enclosure, including any depression or impounding basin, should be 100 per cent of the capacity of the largest tank, after allowing for the volume of the enclosure occupied by the remaining tanks. It is desirable for the required capacity to be provided by bunds not exceeding an average height of 6 ft as measured from the outside ground level.

iii. The number of storage tanks within a main enclosure should not exceed three.

iv. The area within the bund should be graded to levels which ensure that any spillage has a preferential flow away from the tank.

v. No tanks other than low pressure tanks for refrigerated LPG should be within the bund.

c. Lay-out of Tanks
The lay-out and grouping of tanks, as distinct from spacing, should receive careful consideration so as to ensure accessibility for fire fighting.

2.3 PRESSURE STORAGE

2.3.1 Design
a. Storage tanks should be designed, fabricated and tested in accordance with a recognised pressure vessel code for static chemical plant.

b. The design pressure of the tank should be not less than the vapour pressure of the actual LPG to be stored, at the highest temperature that the contents of the tank will reach in service (see Appendix B).

Note: The vapour pressure is dependent on the surface temperature of the contents (cf. Clause 2.3.9)

c. Careful consideration should be given to the materials used for construction, bearing in mind the minimum temperature that the material of the tank will reach in service. In the case of smaller tanks with high draw-off rates, this may be below the minimum ambient temperature.

d. Storage tanks for refrigerated pressure storage should be designed in accordance with the low temperature requirements of the Code referred to in Clause 2.3.1a. Storage tanks for low pressure refrigerated storage of LPG should be designed in accordance with Section 2.4 of this Code.

e. For refrigerated pressure storage, the capacity of the refrigeration system or the means of vapour disposal should be adequate to maintain the LPG in the tank at a temperature such that its vapour pressure is below the pressure setting of the relief valves on the tank.

2.3.2 Tank fittings
a. Each tank should be provided with at least one each of the following fittings, all of which should be suitable for use with the LPG at a pressure
not less than the design pressure of the tank to which they are fitted and for temperatures appropriate to the characteristics of the LPG and working conditions:

i. Pressure relief valve connected directly to the vapour space.
ii. Drain, or other means of removing the liquid contents.
iii. Contents gauge or maximum level indicator.
iv. Pressure gauge connected to the vapour space.
v. Where a maximum level indicator is not fitted, means of measuring the temperature of the contents of the tank.

b. Since LPG is non-corrosive, it is normally unnecessary to subject small tanks to internal examination; manholes and hand-holes are therefore normally required. However, manholes or hand-holes should be provided on tanks exceeding 1100 gallons water capacity, to facilitate periodic examination.

2.3.3 Tank connections
Tank connections should be designed and attached to the tank in accordance with the requirements of the Code referred to in Clause 2.3.1a.

2.3.4 Pressure relief
The requirements for pressure relief in the Code referred to in Clause 2.3.1a, should be followed. Relief valves should be direct springloaded or pilot-operated.

2.3.5 Capacity of relief valves
The full flow capacity of pressure relief valves should be sufficient to protect the tank under fire exposure conditions.

2.3.6 Relief valve information
Every relief valve should incorporate permanent markings as follows:
- Manufacturer's identification, including manufacturer's name and catalogue or type number.
- Start to discharge pressure
- Certified capacity in terms of air at 60°F (15.6°C) and 14.7 psia.

2.3.7 Relief valve installation

a. In the case of multiple safety relief valves, if provision is made to isolate any one relief valve for testing or servicing, it should be ensured that the remaining relief valves connected to the tank provide the full capacity required by Clause 2.3.5. In the case of tanks fitted with single relief valves, provision may be made for their removal for testing or servicing by the use of an automatic shut-off valve, provided this valve is retained in the fully open position by the presence of the relief valve and will close when the relief valve is removed. In carrying out this procedure, it is essential that the storage vessel is not left unprotected and a replacement relief valve should be immediately fitted.
h. For tanks over 1100 gallons water capacity, the relief valves should be fitted with vent pipes adequately supported and having outlets at least 6 ft above the top of the tank to which they are fitted and at least 10 ft above ground level. Vent pipes should be designed to allow for drainage of water and to ensure that, in the case of ignition of discharging products, flame impingement on the tank, or on any adjacent tank, piping or equipment is avoided. Vent pipes may be provided with loose-fitting rain caps. In the case of smaller tanks fitted with valve protecting covers, a vent or vents sufficient to permit the free discharge of LPG from the relief valve or from any protection cap fitted to it should be provided. The vent or vents should be in such a position as not to spread the LPG over the tank shell.

2.3.8 Shut-off valves and emergency shut-off valves

a. All liquid and vapour connections on tanks, with the exception of those for relief valves (see Clause 2.3.7a.), plugged openings, and those where the connection through the tank shell is not greater than No 54 morse drill size should have shut-off valves located as close to the tank as practicable. Pressure gauge mounting connections should be protected internally by a tapping reduced internally to a bleed hole not larger than a No 54 morse drill size or by a suitable excess flow valve.

b. Emergency shut-off valves (e.g. an excess flow valve, an automatically operated valve or a remotely controlled valve) should be fitted to liquid connections on tanks (except drainage and sampling connections of small diameter).

c. Drain connections should be provided with a shut-off valve in accordance with Clause 2.3.8a., and should preferably be not more than 2 in. nominal size. This shut-off valve should be provided with a length of piping terminating with a second shut-off valve, preferably not more than 1 in. nominal size. The first valve should be a quick shut-off type; the second valve should be a throttling type.

The length of piping between the valves should be such that the risk of simultaneous obstruction of both valves by the freezing of any water present in the LPG is minimised. A sufficient length of piping should be provided downstream of the second valve to ensure that discharge will not take place beneath the tank. The second valve and the piping should be adequately supported and secured to prevent mechanical damage or breakage by jet forces. Both valves on the drain system should have a means of actuation which cannot be readily removed or moved from the closed position except by intentional operation.

d. The additional pipework and manual valve called for by Clause 2.3.8c. may be fitted at the time of draining provided that the drain valve required by Clause 2.3.8c. is protected by an emergency shut-off valve (e.g. an excess flow valve, an automatically operated valve or a remotely controlled valve) fitted upstream.

2.3.9 Filling capacity

The maximum quantity of LPG which should be filled into any tank should be such that the tank will become no more than 97% liquid full due
to expansion of the contents with rise of temperature to the highest temperature which the contents will reach in service* (See Appendix B).

*Note:* The volume of the product is dependent on the bulk mean temperature of the contents (cf. Clause 2.3.1b.)

2.3.10 Insulation and heating of valves

a. Insulation, when provided on refrigerated pressure tanks, should
   i. withstand, together with the cladding, direct impingement from hose streams;
   ii. be impervious, either by a cellular construction or the provision of an efficient vapour barrier, to the ingress of water vapour;
   iii. be sufficiently robust so that minor mechanical damage will not significantly impair the insulation;
   iv. be protected from, or be resistant to, fire.

b. Insulation, steam heating or other means should be used to prevent icing of valves or other fittings if product quality, operating techniques and/or ambient temperatures are favourable to ice formation.

2.3.11 Protection against corrosion

Storage tanks and their supports should be adequately protected against corrosion, by painting or other means.

*Note:* Storage tanks should be finish painted in light colour in order to increase reflection from them and minimise temperature rise of their contents.

2.3.12 Maintenance

All tanks should be examined at regular intervals and the date of the last examination marked on the tank.

2.3.13 Marking of tanks

Each pressure storage tank should be conspicuously and permanently marked to include the following:

a. The pressure vessel code to which it is made.
b. The manufacturer’s name and serial number.
c. The water capacity in gallons, litres or cubic metres.
d. The maximum safe working pressure.
e. In the case of a refrigerated pressure tank, the minimum temperature for which the tank is designed.
f. The year in which the tank was made.

* The filling ratio should be calculated to allow a guaranteed free space of 3% at these reference temperatures, after allowance for the degree of uncertainty in the liquid density data. However, to allow for liquids of high coefficient of expansion, the filling ratio should in no case give rise to a liquid full condition at a temperature less than 5 deg. C above the filling ratio reference temperature.
2.4 LOW PRESSURE REFRIGERATED STORAGE

2.4.1 Scope

a. This section of the Code applies to large low pressure welded steel tanks for the bulk storage of LPG in a refrigerated state.

b. This section does not apply to pressure tanks for storage of refrigerated LPG. Such tanks should be designed and constructed in accordance with Section 2.3.

2.4.2 Design

a. Tanks for the storage of LPG in a refrigerated state and all their fittings should be designed, constructed and tested in accordance with a recognised standard for large welded low pressure storage tanks for refrigerated products.

b. The refrigeration system or other suitable methods of vapour disposal should be designed to maintain the LPG at a temperature such that its vapour pressure does not exceed the design pressure of the tank.

c. Materials should be selected for their notch ductility at design metal temperatures, and should be in accordance with materials listed in the standard referred to in Clause 2.4.2a.

2.4.3 Liquid level

The filling level should be such that the tank will not be full of liquid at the equilibrium temperature of the product for the pressure at which the relief valves are set to operate. This means in practice that the filling level will be sufficiently below the curb angle to allow for liquid expansion in, for example, the event of a fire incident or the failure of the refrigeration system.

2.4.4 Capacity of refrigeration system

The refrigeration system should be of a capacity adequate to deal with normal boil-off plus maximum tank filling rate.

2.4.5 Tank fittings

Each tank should be provided with a pressure and vacuum relief system and a contents gauge.

2.4.6 Pressure/vacuum relief

a. Pressure and vacuum relief valves should be fitted to protect the tank under all operating conditions. Emergency venting should be provided to protect the tank under fire exposure conditions. This may be provided by means of a weak shell-to-roof seam.

b. Where the pressure relief valves discharge to the vent collecting system of a flare, additional relieving devices, set at a slightly higher pressure, capable of handling the total venting requirement, may be provided discharging directly to atmosphere.
c. Care must be taken to eliminate all liquid traps in vent lines.

d. Precautions should be taken to counter the effect of icing on relief valves.

e. Relief valves discharging directly to the atmosphere should be designed and installed so that in the event of ignition of discharging vapour, flame impingement on the tank or its equipment will be avoided.

2.4.7 Insulation

Insulation should be:

a. capable of withstanding, along with its cladding, direct impingement from hose streams;

b. impervious, either by a cellular construction or the provision of an efficient vapour barrier, to the ingress of water vapour;

c. sufficiently robust so that minor mechanical damage will not significantly impair the insulation;

d. be protected from, or be resistant to, fire.

2.4.8 Protection against corrosion

Tanks and their fittings should be adequately protected against corrosion.

2.4.9 Marking of tanks

Each refrigerated storage tank should be identified by the attachment of a name plate which should indicate the following information:

a. The manufacturer's name and serial number.

b. The maximum level to which the tank may be filled with LPG.

c. The liquid volume of the tank when filled with LPG to the maximum level.

d. The maximum design pressure.

e. The minimum temperature for which the tank is designed.

f. The maximum level to which the tank may be filled with water for test purposes.

g. The year in which constructed and tested.

2.5 PIPING, VALVES AND FITTINGS

2.5.1 Piping

a. Piping systems should conform to the provisions of a recognised piping code.

b. Piping for low temperature service should conform to the relevant low temperature provisions of the code referred to in Clause 2.5.1a.
2.5.2 Materials

a. All materials including non-metallic parts for valves, seals, gaskets and diaphragms should be resistant to the action of LPG under the service conditions to which they are subjected.

b. All piping over ½ inch size should be made of steel.

c. Cast iron or other unsuitable piping materials should not be used.

d. Copper or brass pipe and tubing should be seamless and should only be used for sizes ½ inch and under.

e. Materials for low temperature service should conform to the low temperature service requirements of the code referred to in Clause 2.5.1.

2.5.3 Pipe joints

a. Pipe joints over 2 inches nominal size should be welded or flanged. Joints of 2 inches nominal size or smaller may be welded, flanged or screwed.

b. Screwed joints should not be used in piping for low temperature service, except for small diameter lines such as instrument lines and pressure gauge connections.

2.5.4 Valves

a. The primary shut-off valves for a tank with a water capacity in excess of 2000 gallons should be made of steel or of nodular iron made to BS 27899 or an equivalent standard.

b. Other valves should be of steel or forged brass, except that valves of nodular iron made to BS 27899 or an equivalent standard may be used.

c. Cast iron valves should not be used, other than those of nodular iron made to BS 27899, or an equivalent standard.

2.5.5 Thermal pressure relief

Pipelines in which liquid may be trapped, for example between shut-off valves, should be protected against excessive pressure caused by thermal expansion of the contents. If pressure relieving devices discharge to atmosphere, the discharge should be to the open air and should be directed so as not to endanger personnel or equipment.

2.5.6 Installation and testing

a. Liquid and vapour pipelines should be properly supported and installed so as to have adequate flexibility to accommodate any settlement of tanks or other equipment, thermal expansion or contraction or any other stresses which may occur in the pipework system. Flexibility should not be provided by the introduction of flexible hose into the pipeline system.

b. All pipeline systems should be tested after installation, and proved free from leaks at not less than the maximum operating pressure.
c. Piping should be protected against physical damage.

2.5.7 Insulation
Pipeline insulation required for refrigerated systems, or which may be required for vapour lines or drains of non-refrigerated systems, should be in accordance with the provisions of the code referred to in Clause 2.5.1a.

2.5.8 Hoses
a. The design, material and construction of hoses should be suitable for the grade of LPG which they are to handle. They should be designed to withstand a minimum bursting pressure of four times the maximum pressure they will carry in service.

b. Hoses for refrigerated LPG should be suitable for the lowest operating temperatures to which they will be subjected in service.

c. Hoses should be examined visually every day if used continually and at each time of use if used intermittently. They should be replaced when they show visible signs of deterioration, and in any case at intervals not exceeding five years.

d. Hoses, when not in use, should be protected from deterioration.

e. Emergency shut-off valves should be installed in pipelines to which hoses are connected, to prevent discharge of LPG in the event of failure of the hose.

2.5.9 Articulated pipe connections
The design, materials and construction of articulated pipe connections should be suitable for the LPG which they are to handle. They should be capable of withstanding a test pressure of twice the maximum pressure they will carry in service.

2.6 SUPPORTS FOR TANKS AND PIPING

2.6.1 Tank supports
a. Tanks should be supported on concrete, masonry or structural steel supports. These supports (excluding supporting feet 18 inches or less in height, tank saddles, or skirts of vertical tanks) should be so constructed or protected as to have a standard of fire resistance of at least 2 hours.

b. The design of supports should follow the recommendations in the code to which the tank is constructed.

c. Supports should permit movement of the tank due to changes in temperature.

d. Tank supports should be designed to prevent or to drain any accumulation of water.

e. Where piers are used as part of the tank support for horizontal tanks of water capacity exceeding 1100 gallons, provision should be made for securing the tank at one end, the other being free to move as required in
Clause 2.6.1c. The end so secured should be that to which the principal liquid and the vapour pipelines are attached. Where saddles are not welded to the tank, their support should be shaped to conform with the tank shell. Supports for horizontal tanks, normally two, should be located to give minimum moments and deflections to the tank shell. Additional supports may be required to meet special circumstances.

f. The tank should be securely anchored or weighted or adequate pier height provided to avoid flotation due to flood water.

g. Skirts for vertical tanks should be provided with vents to prevent accumulation of vapour and with inspection openings.

2.6.2 Pipe supports
Supports should be adequately designed, spaced and secured to suit the pipework configuration and to withstand anchorage and guide friction forces. In the case of pipe supports in the immediate vicinity of the tanks, consideration should be given to their construction or protection so as to secure a standard of fire resistance of at least 2 hours.

2.7 LOADING AND UNLOADING FACILITIES

2.7.1 Pumps
a. The design, materials and construction of pumps should be suitable for the grade of LPG which they are to handle, and they should be designed for the maximum outlet pressure to which they will be subjected in operation.

b. Positive displacement pumps should have a by-pass or other suitable protection against over pressure, discharging to the pump suction or to a safe place.

2.7.2 Compressors
a. The design, materials and construction of compressors should be suitable for the grade of LPG which they are to handle, and they should be designed for the maximum outlet pressure to which they will be subjected in operation.

b. Positive displacement compressors should be equipped with pressure relieving devices, discharging to the compressor suction or to a safe place.

2.7.3 Meters
The design, materials and construction of meters should be suitable for the grade of LPG which they are to handle.

2.7.4 Transfer Systems
a. Transfer systems should be designed so that risk by operating error of LPG of higher vapour pressure being transferred to equipment designed for LPG of lower vapour pressure is avoided.

b. Excess flow valves, automatically operated valves or remotely controlled valves should be installed in pipelines to which hoses or flexible
Pipe connections are connected to prevent discharge of LPG in the event of failure of the hose or connection.

c. In the case of transfers between storage and ship or pipeline external to the site:
   i. There should be positive means of rapidly shutting off flow, located at a safe distance from the storage which is being filled or emptied.
   ii. Automatic alarm devices to indicate approach to maximum permissible filling height, automatic shut-off valves or comparable devices to prevent overfilling should be used.

2.7.5 Protection

Pumps, compressors and meters should be protected against accidental damage by suitable positioning and/or protection. Pumps, compressors, meters and similar equipment should not be sited beneath tanks.

2.8 VAPORISERS

2.8.1 General

a. i. Vaporisers can be low pressure steam heated, hot water heated, electrically heated, or direct gas fired type.
   ii. Vaporisers should be of sufficient capacity to supply the latent heat of vaporisation necessary to convert the liquid into vapor at the maximum offtake required from the installation.
   iii. Where necessary, precautions against the accumulation of condensate in the vapour discharge line should be taken. This may require insulation and heat tracing of the vapour discharge line, with the provision of condensate pockets capable of containing the quantity likely to be condensed during a plant shut-down.
   iv. With hot water heated vaporisers, anti-freeze may be added to the water to prevent freezing.

b. Vaporiser systems should be equipped with a means of safe removal of any heavy products which may collect in the LPG part of the system. The point of discharge should not be directly beneath the vaporiser.

c. Heating coils should not be installed inside a storage tank to act as a vaporiser.

d. Valves should be installed to shut off the liquid and/or the vapour connection between the storage tank and the vaporiser.

e. Vaporisers, other than direct fired and non-flameproof electrical types, should be installed at a minimum distance of 5 ft from the nearest storage tank. Direct fired and non-flameproof electrical vaporisers should be installed at minimum safety distances, in accordance with Tables 2.8.1 i. The minimum distance between a vaporiser and the nearest important building or line of adjoining property is set out in Table 2.8.1 ii.
Table 2.8.1 i

<table>
<thead>
<tr>
<th>Water capacity of storage tank</th>
<th>Minimum distance of vaporiser from storage tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallons</td>
<td>Feet</td>
</tr>
<tr>
<td>Over 250-500</td>
<td>10</td>
</tr>
<tr>
<td>Over 500-2000</td>
<td>25</td>
</tr>
<tr>
<td>Over 2000-30,000</td>
<td>50</td>
</tr>
<tr>
<td>Over 30,000-75,000</td>
<td>75</td>
</tr>
<tr>
<td>Over 75,000</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2.8.1 ii

<table>
<thead>
<tr>
<th>Capacity of Vaporiser lb/hr</th>
<th>Minimum distance of vaporiser from nearest important building or line of adjoining property Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 80</td>
<td>10</td>
</tr>
<tr>
<td>80-500</td>
<td>25</td>
</tr>
<tr>
<td>Over 500</td>
<td>50</td>
</tr>
</tbody>
</table>

f. Vaporisers should not be installed in a building except where the building is used exclusively for gas manufacturing or distribution. Such buildings should be of non-combustible construction and well-ventilated near the floor line and roof.

g. Particular care should be taken with the design and location of direct fired vaporisers to minimise the effects of any failure.

2.8.2 Construction

a. Vaporisers should be designed, fabricated and tested in accordance with a recognised pressure vessel code.

b. Each vaporiser should be marked to include the following:
   - The pressure vessel code to which it is made.
   - The manufacturer's name and serial number.
   - The maximum working pressure and temperature.
   - The vaporising capacity in pounds per hour.
   - The year in which made.

2.8.3 Pressure relief

a. Vaporisers should be fitted with a relief valve or valves. Pressure relief should be in accordance with the code referred to in Clause 2.8.2a.

b. The full flow capacity of pressure relief valves should be sufficient to protect the vaporiser under fire exposure conditions.
2.8.4 Liquid control

a. Vaporisers should be provided with suitable automatic means to prevent liquid LPG passing through the vaporiser to the gas discharge piping under all operating conditions.

b. The liquid level control, if fitted, may be integral with the vaporiser vessel or fitted immediately adjacent to it.

2.8.5 Heat input control

a. The heat input should be suitably controlled to prevent the pressure in the vaporiser vessel reaching the start-to-discharge pressure of the pressure relief valve or valves in the vaporiser system.

b. Direct fired and electrically heated vaporisers should be fitted with an automatic control to prevent overheating of the equipment.

c. Direct fired vaporisers should be fitted with suitable flame failure devices.

2.8.6 Maintenance

Vaporisers should be examined at regular intervals.

2.9 ELECTRICAL

2.9.1 Area classification

British Standard Code of Practice CP 10037 and the Institute of Petroleum Electrical Safety Code8 give recommendations for the installation of electrical equipment in areas in which an inflammable atmosphere which could be ignited by an electrical source may be present (dangerous areas). The areas detailed in these Codes include the following Divisional classifications which are dependent on the probability of a dangerous atmosphere being present, i.e. an atmosphere containing a significant quantity of inflammable gas or vapour in a concentration capable of ignition.

Division 1—an area in which a dangerous atmosphere is likely to occur in normal operating conditions.

Division 2—an area in which a dangerous atmosphere can occur only in abnormal conditions and not in normal operation.

Safe areas—all areas not classified as dangerous areas.

Table 2.9.1 indicates the area classification of various operations.

2.9.2 Electrical apparatus, earthing and bonding

Electrical apparatus and installations, earthing and bonding, telecommunications and instrumentation should comply with the recommendations of the Institute of Petroleum Electrical Safety Code8 and relevant British Standards7/12. LPG storage tanks do not require lightning protection.
<table>
<thead>
<tr>
<th>Factor</th>
<th>Extent of Classified Area</th>
<th>Area Classification</th>
</tr>
</thead>
</table>
| Storage tanks | a. Within 5 ft in all directions from the tank connections or shell  
   b. Up to 5 ft above ground level and within the distances set out for a fixed source of ignition in Table 2.2.1 for Pressure Storage or Table 2.2.2 for LP Refrigerated Storage as appropriate | Division 1  
   Division 2 |
| Relief Valve Discharge | a. Within direct path of discharge  
   b. Within 5 ft in all other directions from point of discharge  
   c. Beyond 5 ft but within 15 ft (10 ft in the case of tanks of water capacity not exceeding 500 galls) in all other directions from point of discharge | Fixed electrical equipment should not be installed  
   Division 1  
   Division 2 |
| Tank Vehicle and Tank Car Loading and Unloading | a. Within 5 ft in all directions from a point where connections are regularly made or disconnected for product transfer  
   b. Beyond 5 ft but within 15 ft (10 ft in the case of tanks of water capacity not exceeding 500 galls) from point of connection or disconnection | Division 1  
   Division 2 |
| Pumps, Compressors and Vaporisers other than Direct Fired | a. Within 5 ft in all directions  
   b. Beyond 5 ft but within 15 ft in all directions (10 ft in the case of tanks of water capacity not exceeding 500 galls) | Division 1  
   Division 2 |

**Note:** Where high standards of maintenance of pumps and pump seals obtain, the area within 5 ft in all directions from the pump may be classified as Division 2.

**b. Indoor location with adequate ventilation**

**Entire room and any adjacent room not separated by a vapour-tight partition**  
Division 1

**Notes:**
1. Where any area is classified under more than one factor the higher classification should prevail.
2. Any pit, trench or depression falling within a Division 1 or Division 2 area should be treated as being a Division 1 area throughout.
3. The term ‘outdoors in open air’ includes pumps, compressors and vaporisers which are covered by a canopy.
2.10 FIRE PROTECTION

2.10.1 General
The possibility of a major fire outbreak, leading to direct flame impingement on the storage tank, can be minimised by sound engineering in plant design and lay-out, good operating practice and proper education and training of personnel on both routine operations and on action to be taken in an emergency. Consultation with the fire authority on the provision of fire protection facilities should take place in the 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.

2.10.2 Communications
Consideration should be given to the provision of an adequate communications system for summoning the emergency services. This communications system should be tested at regular intervals.

2.10.3 Water supply
a. Provision should be made for an adequate supply of water for fire protection. The application of water may be by hydrants, hoses and mobile equipment, fixed monitors or fixed spray systems, which may be automatic. Wherever possible automatic fixed spray systems, which offer obvious advantages, should be installed. Control of water flow, including suitable sectionalisation of any piped water supplies, should be possible from outside the danger area, and preference should be given to water equipment which can readily be brought into use and enable personnel to withdraw from the danger area.
b. Hydrants, where provided, should be readily accessible at all times and so located as to provide for the protection of all tanks.
c. Sufficient lengths of fire hose should be provided and be readily available. It is desirable to equip the outlet of each hose line with a combination jet and spray nozzle.
d. Mobile equipment, fixed monitors or fixed spray systems should be designed to discharge water at a rate sufficient to maintain an adequate film of water over the surface of the tank and supports under fire conditions.
e. Consideration should be given to the provision of mobile or fixed water-spray systems giving suitable and effective protection for road tanker and rail tank car loading and unloading areas where large transfers of LPG are made frequently.

2.10.4 First-aid fire extinguishers
A sufficient number of first-aid fire extinguishers of adequate size, preferably of the dry powder type, should be available at strategic locations. Dry powder extinguishers should conform to BS 34656. Foam extinguishers are not suitable for LPG fires.
2.10.5 Access
Suitable access to and around the installation should be provided for firefighting appliances and kept free at all times.

2.10.6 Isolating valves
Provision should be made for automatic or remote control shut-off so that if accidental leakage occurs, the supply of LPG can be stopped. Other shut-off valves should be located at strategic points.

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

2.10.8 Grass and weed removal
Weeds, long grass and any combustible material should be removed from an area within 10 ft of any LPG storage tank of up to 500 gallons water capacity and within 20 ft of larger tanks. If weed killers are used, chemicals such as sodium chlorate which are a potential source of fire danger should not be selected for this purpose.

2.10.9 Warning signs
Where smoking and naked lights are prohibited, prominent notices to this effect should be posted, particularly at access points.

PART 3 INDUSTRIAL, COMMERCIAL AND DOMESTIC BULK STORAGE

3.1 SCOPE
3.1.1 This Part covers LPG bulk storage installations at industrial, commercial and domestic consumers' premises, and at gas works where the total LPG storage capacity is 30,000 gallons water capacity or less. Installations are covered only up to the inlet of first stage line pressure reduction. This part is not intended to cover the following:
   a. LPG storage installations at refineries;
   b. bulk plants for LPG distribution;
   c. refrigerated storage;
   d. industrial installations involving either tanks of individual capacity greater than 30,000 gallons water capacity or group storage capacity greater than 100,000 gallons water capacity (see Clause 3.2.1.e.)
In these cases the recommendations of Part 2 should be followed.

3.2 STORAGE TANK LOCATION AND SAFETY DISTANCES
3.2.1 Location and spacing
   a. Storage tanks are normally installed above ground; if tanks are to be installed underground, reference should be made to Clause 3.3.11, but storage tanks should not be installed in basements. Storage tanks, whether at ground level or underground should be spaced and located in accordance with Table 3.2.1. The distances given are minimum recommendations,
Table 3.2.1
Location and spacing for tanks for industrial, commercial and domestic bulk storage

<table>
<thead>
<tr>
<th>Gallons</th>
<th>Gallons</th>
<th>Minimum Separation Distance in Feet</th>
<th>Between tanks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>From building, boundary, property line* or fixed source of ignition</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above ground</td>
<td>Below ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Buried portion</td>
<td>Valve assembly† and loading/unloading point above ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 100</td>
<td>300</td>
<td>None</td>
<td>10</td>
</tr>
<tr>
<td>Over 100-500</td>
<td>1500</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Over 500-2000</td>
<td>6000</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Over 2000-30,000</td>
<td>100,000</td>
<td>50</td>
<td>10</td>
</tr>
</tbody>
</table>

*Whether built on or not.
†The isolation valves, filling valves and pressure relief valves located on the manhole cover of the underground tank.
and refer to the horizontal distance in plan between the nearest point on the storage tank and the nearest point of a specified feature (e.g. an adjacent storage tank, building, property line).

b. With the provision of radiation walls or adequate fixed water spray systems, separation distance for above-ground tanks may be reduced but specialist advice should be obtained. Where separation distances are reduced, diversion walls may be necessary to ensure that the path of gas leaking from a storage site to a building, boundary or source of ignition is not less than that shown in Table 3.2.1.

c. Storage tanks should not be installed one above the other.

d. No LPG storage tanks should be installed nearer than 20 ft to any tank containing an inflammable liquid with a flash-point below 150°F. The minimum distance of separation between an LPG storage tank and the top of the bund of any tank containing an inflammable liquid should be 10 ft. LPG storage tanks should be installed well away from tanks containing liquid oxygen or other hazardous substances and specialist advice should be obtained on spacing.

No LPG storage tank should be located within the bunded enclosure of a tank containing an inflammable liquid, liquid oxygen or any other hazardous substance.

No LPG storage tank should be located in any bund where there is any permanent source of heat (e.g. steam mains) or within the bunded enclosure of any heated storage tank (e.g. fuel oil tank).

e. The number of storage tanks in one group should not exceed 6, subject to the maximum total capacity of a group given in Table 3.2.1. Any tank in one group should be at least 25 ft from any tank in another group unless a radiation wall is erected between the groups, or adequate fixed water spray systems are provided.

3.2.2 Spillage

a. The provision of bunds around LPG storage tanks designed and constructed in accordance with Clause 3.3.1 is not required (but see Clause 3.2.2c. for separation kerbs).

b. The ground beneath tanks should either be concreted or compacted, and so sloped as to:

i. prevent the accumulation of any liquid beneath them, and

ii. ensure a flow away from the tanks and any important areas.

Notes: 1. Where all the connections of the tank are grouped at one end the above provisions need only be required beneath the connections.

2. Provision should also be made for a flow away from the tanks and any important areas of cooling water applied under fire conditions.
c. Separation kerbs, low to avoid gas traps, with a maximum height of 15 inches may be required to prevent spillage reaching important areas. They will not be required for tanks with no bottom liquid LPG outlet.

d. To prevent the forming of gas pockets, which might affect the safety of the tank, the vicinity of LPG storage tanks should be free of pits and depressions, other than those necessarily required for the containment of spillage.

3.2.3 Protection

a. To prevent trespassing or tampering, the area which includes tanks and pumping equipment should be enclosed by an industrial type fence at least 6 ft high at a distance of not less than 5 ft from the installation unless the fence is a boundary fence, when the distances given in Table 3.2.1 will apply. Where necessary, fences should have at least 2 means of exit not adjacent to one another. Gates should open outwards, should not be self-locking, and should provide easy means of escape from within.

b. The provisions in Clause 3.2.3a. need not apply to tanks of less than 2000 gallons water capacity, which are equipped with a positive means of denying access to valves and fittings (e.g. a domed hinged cover which is capable of being locked in the closed position).

c. When damage to LPG systems from vehicular traffic would be a possibility, precautions against such damage should be taken.

d. Underground tanks should be protected from above-ground loadings due to vehicular traffic or other cause, either by fencing off the area under which the tanks are buried, or by placing them in a reinforced concrete-lined pit protected by a reinforced concrete slab or other adequate cover. If the tank area is not fenced off, the tank manhole cover and the tank fittings should be protected against damage and tampering. The perimeter of the area under which tanks are buried should be permanently marked.

3.3 STORAGE TANKS

3.3.1 Design

a. Storage tanks should be designed, fabricated and tested in accordance with a recognised pressure vessel code for static chemical plant.

b. The design pressure of the tank should not be less than the vapour pressure of the actual LPG to be stored at the highest temperature that the contents of the tank will reach in service (see Appendix B).

Note: The vapour pressure is dependent on the surface temperature of the contents (cf. Clause 3.3.8).

c. Careful consideration should be given to the materials used for construction, bearing in mind the minimum temperature that the material of the tank will reach in service. In the case of smaller tanks with high draw-off rates, this may be below the minimum ambient temperature.
3.3.2 Fittings

a. Each tank should be provided with at least one of each of the following fittings, all of which should be suitable for use with LPG at pressures not less than the design pressure of the tanks to which they are fitted and for temperatures appropriate to the characteristics of the product and operating conditions:

- Pressure relief valve connected to the vapour space.
- Drain, or other means of removing the liquid contents.
- Contents gauge or maximum level indicator.
- Pressure gauge, connected to the vapour space, if the tank is over 500 gallons water capacity.

b. Tank connections should be designed and attached to the tanks in accordance with the code referred to in Clause 3.3.1a.

c. Since LPG is non-corrosive, it is normally unnecessary to subject small tanks to internal examination; manholes and handholes are not therefore normally required on above-ground tanks. However, manholes or handholes may be provided on tanks exceeding 1100 gallons water capacity, to facilitate periodic examination. Underground tanks should be fitted with a manhole of not less than 22 inches internal diameter. The manhole should be in the form of an extended nozzle of sufficient length to bring the manhole cover above ground level.

d. All tank fittings and connections of underground tanks should be on the manhole cover or covers.

3.3.3 Pressure relief

A spring-loaded relief valve or valves should be provided. Pressure relief should be in accordance with the code referred to in Clause 3.3.1a.

3.3.4 Capacity of relief valves

The full flow capacity of pressure valves should be sufficient to protect the tank under fire exposure conditions. For underground tanks the full flow capacity of pressure relief valves may be reduced to not less than 30% of the above-ground capacity.

3.3.5 Relief valve information

Every relief valve should incorporate permanent markings as follows:

- Manufacturer's identification, including manufacturer's name and catalogue or type number.
- Start to discharge pressure.
- Certified capacity in terms of air at 60°F (15.6°C) and 14.7 psia.

3.3.6 Relief valve installation

a. In the case of multiple safety relief valves, if provision is made to isolate any one relief valve for testing or servicing, it should be ensured that the remaining relief valves connected to the tank provide the full capacity
required by Clause 3.3.4. In the case of tanks fitted with single relief valves, provision may be made for their removal for testing or servicing by the use of an automatic shut-off valve, provided this valve is retained in the fully open position by the presence of the relief valve and will close when the relief valve is removed. In carrying out this procedure, it is essential that the storage vessel is not left unprotected and a replacement relief valve should be immediately fitted.

b. For above-ground tanks over 1100 gallons water capacity and for all underground tanks, the relief valve should be fitted with vent pipes adequately supported and having outlets at least 6 ft above the top of the tank to which they are fitted and at least 10 ft above ground level. Vent pipes should be designed to allow for drainage of water and to ensure that, in the case of ignition of discharging products, flame impingement on the tank, or on any adjacent tank, piping or equipment is avoided. Vent pipes may be provided with loose-fitting rain caps. In the case of smaller tanks fitted with valve protective covers, a vent or vents sufficient to permit the free discharge of LPG from the relief valve or from any protection cap fitted to it should be provided. The vent or vents should be in such a position as not to spread the LPG over the tank shell.

3.3.7 Shut-off valves and emergency shut-off valves

a. All liquid and vapour connections on tanks, other than those for relief valves, plugged openings, and those where the connection through the tank shell is not greater than No 54 morse drill size, should have shut-off valves located as close to the tank as practicable. Pressure gauge mounting connections should be protected internally by a tapping reduced internally to a bleed hole not larger than a No 54 morse drill size or by a suitable excess flow valve.

b. Emergency shut-off valves (e.g. an excess flow valve, an automatically operated valve or a remotely controlled valve) should be fitted to liquid connections on tanks (except drainage and sampling connections of small diameter).

c. Drain connections for larger tanks should be provided with a shut-off valve in accordance with Clause 3.3.7a., and should preferably be not more than 2 in. nominal size. This shut-off valve should be provided with a length of piping terminating with a second shut-off valve, preferably not more than 1 in. nominal size. The first valve should be a quick shut-off type; the second valve should be a throttling type. The length of piping between the valves should be such that the risk of simultaneous obstruction of both valves by the freezing of any water present in the LPG is minimised. A sufficient length of piping should be provided downstream of the second valve to ensure that discharge will not take place beneath the tank. The second valve and the piping should be adequately supported and secured to prevent mechanical damage or breakage by jet forces. Both valves on the drain system should have a means of actuation which cannot readily be removed or moved from the closed position except by intentional operation.
d. The additional pipework and manual valve called for by Clause 3.3.7c. may be fitted at the time of draining provided that the drain valve required by Clause 3.3.7c. is protected by an emergency shut-off valve (e.g. an excess flow valve, an automatically operated valve or a remotely controlled valve) fitted upstream.

3.3.8 Filling capacity

The maximum quantity of LPG filled into any tank should be such that the tank will become not more than 97% liquid full due to expansion of the contents with rise of temperature to the highest temperature which the contents will reach in service* (see Appendix B).

Note: The volume of the product is dependent on the bulk mean temperature of the contents (cf. Clause 3.3.1b.).

3.3.9 Tank supports

a. Tanks should be supported on concrete, masonry or structural steel supports. These supports (excluding supporting feet 18 inches or less in height, tank saddles, or skirts of vertical tanks) should be so constructed or protected as to have a standard of fire resistance of at least 2 hours.

b. Supports should permit movement of the tank due to changes in temperature.

c. Where piers are used as part of the tank support for horizontal tanks of water capacity exceeding 1100 gallons. provision should be made for securing the tank at one end, the other being free to move as required in Clause 3.3.9b. The end so secured should be that to which the principal liquid and the vapour pipelines are attached. Where saddles are not welded to the tank, their support should be shaped to conform with the tank shell. Supports for horizontal tanks, normally 2, should be located to give minimum moments and deflections to the tank shell. Additional supports may be required to meet special circumstances.

d. Skirts for vertical tanks should be protected with vents to prevent accumulation of vapour and with inspection openings. Such openings should be as few as possible in number, as small as practicable and reinforced where necessary.

e. Tank supports should be designed to prevent or to drain any accumulation of water.

f. The tank should be securely anchored or weighted, or adequate pier height provided, to avoid flotation due to flood water.

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* The filling ratio should be calculated to allow a guaranteed free space of 3% at these reference temperatures, after allowance for the degree of uncertainty in the liquid density data. However, to allow for liquids of high coefficient of expansion the filling ratio should in no case give rise to a liquid full condition at a temperature less than 5 deg C above the filling ratio reference temperature.
3.3.10 Protection against corrosion
Tanks and their supports should be adequately protected against corrosion, by painting or other means.

3.3.11 Installation of underground tanks

a. The surface of the tank should first be prepared by shot blasting or chemical treatment and then, before being placed underground, be given a protective coating adequate to resist soil corrosion conditions.

b. The size of the excavation should be sufficient to allow for easy installation. The pit should be large enough to permit a clear gap of at least 3 ft between the shell of the tank and the walls before backfilling. When lowering the tank into place, care should be taken to avoid damage to the coating. When the tank is in place, the coating should be checked by suitable fault detection apparatus and any discontinuities repaired.

c. Tanks should be supported on concrete or masonry supports as required in Clause 3.3.9. The backfill material should be free from rocks or other abrasive materials and should be carefully consolidated. It is recommended that approximately 2 ft of cover should be provided over the top of the tank. Where concrete or masonry-lined pits are not used, adequate provision must be made to prevent migration of the backfill material.

d. It is recommended that specialist advice should be obtained on corrosion protection of tanks, including coating materials and application, and on whether cathodic protection is necessary.

3.3.12 Maintenance
All tanks should be examined at regular intervals and the date of the last examination marked on the tank.

3.3.13 Marking of tanks
Each tank should be conspicuously and permanently marked to include the following:

a. The pressure vessel code to which it is made.

b. The manufacturer's name and serial number.

c. The water capacity in gallons, litres or cubic metres.

d. The maximum safe working pressure.

e. The year in which the tank was made.

3.4 PIPING, VALVES AND FITTINGS

3.4.1 Materials

a. All materials including non-metallic parts for valves, seals, gaskets and diaphragms should be resistant to the action of LPG under the service conditions to which they are subjected.

b. All piping over 1/2 inch size should be made of steel.

c. Cast iron or other unsuitable piping materials should not be used.
d. Copper or brass pipe and tubing should be seamless and should only be used for sizes \( \frac{3}{4} \) inch and under.

### 3.4.2 Pipe joints

Pipe joints over 2 inches nominal size should be welded or flanged. Joints of 2 inches nominal size or smaller may be welded, flanged or screwed.

### 3.4.3 Valves

- **a.** The primary shut-off valves for tanks with a water capacity in excess of 2000 gallons should be of steel or of nodular iron made to BS 2789\textsuperscript{9} or an equivalent standard.

- **b.** Other valves should be of steel or forged brass, except that valves of nodular iron made to BS 2789\textsuperscript{9} or an equivalent standard may be used.

- **c.** Cast iron valves should not be used, other than those of nodular iron made to BS 2789\textsuperscript{9}, or an equivalent standard.

### 3.4.4 Thermal pressure relief

Pipelines in which liquid may be trapped, for example between shut-off valves, should be protected against excessive pressure caused by thermal expansion of the contents. If pressure relieving devices discharge to atmosphere, the discharge should be to the open air and should not endanger personnel or equipment.

### 3.4.5 Installation and testing

- **a.** Liquid and vapour pipelines should be properly supported and installed so as to have adequate flexibility to accommodate any settlement of tanks or other equipment, thermal expansion or contraction or any other stresses which may occur in the pipework system. Flexible hose should not be introduced into the pipeline system to provide flexibility unless the following conditions are satisfied:
  1. the capacity of the installation should not exceed 1100 gallons water capacity;
  2. the minimum necessary length of hose (not, in any case, exceeding 9 inches) should be used;
  3. the bore of the hose should not exceed 1 inch;
  4. the hose should be fully armoured and of high quality;
  5. the hose connection to the LPG supply/withdrawal point of the tank (measured in plan at right angles to the tank shell) should be at least one tank diameter from the nearest part of the tank shell;
  6. the hose should be inspected and maintained in accordance with the provisions of Clause 3.4.6b.

- **b.** All pipeline systems should be tested after installation, and proved free from leaks at not less than the maximum operating pressure.

- **c.** Piping should be protected against physical damage.
3.4.6 **Hoses**
a. The design, materials and construction of hoses should be suitable for the grade of LPG which they are to handle. They should be designed to withstand a minimum bursting pressure of four times the maximum pressure they will carry in service.

b. Hoses should be examined visually every day if used continually and at each time of use if used intermittently. They should be replaced when they show visible signs of deterioration, and in any case at intervals not exceeding five years.

c. Hoses, when not in use, should be protected from deterioration.

d. Emergency shut-off valves should be installed in pipelines to which hoses are connected, to prevent discharge of LPG in the event of failure of the hose.

3.5 **PUMPS, COMPRESSORS AND METERS**

3.5.1 **Pumps**
a. The design, materials and construction of pumps should be suitable for the grade of LPG which they are to handle, and they should be designed for the maximum outlet pressure to which they will be subjected in operation.

b. Positive displacement pumps should have a by-pass or other suitable protection against over pressure.

3.5.2 **Compressors**
a. The design, materials and construction of compressors should be suitable for the grade of LPG which they are to handle, and they should be designed for the maximum outlet pressure to which they will be subjected in operation.

b. Positive displacement compressors should be equipped with pressure relieving devices on the discharge side.

3.5.3 **Meters**
The design, materials and construction of meters should be suitable for the grade of LPG which they are to handle.

3.5.4 **Protection**
Pumps, compressors and meters should be protected against accidental damage by suitable positioning and/or protection. Pumps, compressors, meters and similar equipment should not be sited beneath tanks.

3.6 **VAPORISERS**

3.6.1 **General**
a. i. Vaporisers can be low pressure steam heated, hot water heated, electrically heated, or direct gas fired type.
ii. Vaporisers should be of sufficient capacity to supply the latent heat of vaporisation necessary to convert the liquid into vapour at the maximum offtake required from the installation.

iii. Where necessary, precautions against the accumulation of condensate in the vapour discharge line should be taken. This may require insulation and heat tracing of the vapour discharge line, with the provision of condensate pockets capable of containing the quantity likely to be condensed during a plant shut-down.

iv. With hot water heated vaporisers, anti-freeze may be added to the water to prevent freezing.

b. Vaporiser systems should be equipped with a means of safe removal of any heavy products which may collect in the LPG part of the system. The point of discharge should not be directly beneath the vaporiser.

c. Heating coils should not be installed inside a storage tank to act as a vaporiser.

d. Valves should be installed to shut off the liquid and/or the vapour connection between the storage tank and the vaporiser.

e. Vaporisers, other than direct fired and non-flameproof electrical types, should be installed at a minimum distance of 5 ft from the nearest storage tank. Direct fired and non-flameproof electrical vaporisers should be installed at minimum safety distances, in accordance with Table 3.6.1 i. The minimum distance between a vaporiser and the nearest important building or line of adjoining property is set out in Table 3.6.1 ii.

<table>
<thead>
<tr>
<th>Water capacity of storage tank</th>
<th>Minimum distance of vaporiser from storage tank</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 250-500</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Over 500-2000</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Over 2000-30,000</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Over 30,000-75,000</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Over 75,000</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacity of Vaporiser</th>
<th>Minimum distance of vaporiser from nearest important building or line of adjoining property</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1hr/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 80</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>80-500</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Over 500</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>
f. Vaporisers should not be installed in a building except where the building is used exclusively for gas manufacturing or distribution. Such buildings should be of non-combustible construction and well ventilated near the floor line and roof.

g. Particular care should be taken with the design and location of direct fired vaporisers to minimise the effects of any failure.

3.6.2 Construction

a. Vaporisers should be designed, fabricated and tested in accordance with a recognised pressure vessel code.

b. Each vaporiser should be marked to include the following:
   - The pressure vessel code to which it is made.
   - The manufacturer’s name and serial number.
   - The maximum working pressure and temperature.
   - The vaporising capacity in pounds per hour.
   - The year in which made.

3.6.3 Pressure relief

a. Vaporisers should be fitted with a relief valve or valves. Pressure relief should be in accordance with the code referred to in Clause 3.6.2a.

b. The full flow capacity of pressure relief valves should be sufficient to protect the vaporiser under fire exposure conditions.

3.6.4 Liquid control

a. Vaporisers should be provided with suitable automatic means to prevent liquid LPG passing through the vaporiser to the gas discharge piping under all operating conditions.

b. The liquid level control, if fitted, may be integral with the vaporiser vessel or fitted immediately adjacent to it.

3.6.5 Heat input control

a. The heat input should be suitably controlled to prevent the pressure in the vaporiser vessel reaching the start-to-discharge pressure of the pressure relief valve or valves in the vaporiser system.

b. Direct fired and electrically-heated vaporisers should be fitted with an automatic control to prevent overheating of the equipment.

c. Direct fired vaporisers should be fitted with suitable flame failure devices.

3.6.6 Maintenance

Vaporisers should be examined at regular intervals.
3.7 ELECTRICAL

3.7.1 Area classification

British Standard Code of Practice CP10037 and the Institute of Petroleum Electrical Safety Code8 give recommendations for the installation of electrical equipment in areas in which an inflammable atmosphere which could be ignited by an electrical source may be present (dangerous areas). The areas detailed in these Codes include the following Divisional classifications which are dependent on the probability of a dangerous atmosphere being present, i.e. an atmosphere containing a significant quantity of inflammable gas or vapour in a concentration capable of ignition.

Division 1—an area in which a dangerous atmosphere is likely to occur in normal operating conditions.

Division 2—an area in which a dangerous atmosphere can occur only in abnormal conditions and not in normal operation.

Safe areas—all areas not classified as dangerous areas.

Table 3.7.1 indicates the area classification of various operations.

3.7.2 Electrical apparatus, earthing and bonding

Electrical apparatus and installations, earthing and bonding, telecommunications and instrumentation should comply with the recommendations of the Institute of Petroleum Electrical Safety Code8 and relevant British Standards7/12. LPG storage tanks do not require lightning protection.

3.8 FIRE PROTECTION

3.8.1 General

The possibility of a major fire outbreak, leading to direct flame impingement on the storage tank, can be minimised by sound engineering in plant design and lay-out, good operating practice and proper education and training of personnel on both routine operations and on action to be taken in an emergency. 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.

3.8.2 Water supply

a. Provision should be made for an adequate supply of water for fire protection. The application of water may be by hydrants, hoses and mobile equipment, fixed monitors or fixed spray systems, which may be automatic. For small installations, however, a ¾ inch hose reel installation may be adequate. Control of water flow, including suitable sectionalisation of any piped water supplies, should be possible from outside any danger area.

b. Hydrants, where provided, should be readily accessible at all times and so spaced as to provide for the protection of all tanks. Sufficient lengths of fire hose should be provided and be readily available. It is desirable to equip the outlet of each hose line with a combination jet and spray nozzle.
### Table 3.7.1

<table>
<thead>
<tr>
<th>Factor</th>
<th>Extent of Classified Area</th>
<th>Area Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage tanks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Within 5 ft in all directions from the tank connections or shell</td>
<td>Division 1</td>
</tr>
<tr>
<td>b.</td>
<td>Up to 5 ft above ground level and within the distances set out for a fixed source of ignition in Table 3.2.1</td>
<td>Division 2</td>
</tr>
<tr>
<td>Relief Valve Discharge</td>
<td>a.</td>
<td>Within direct path of discharge</td>
</tr>
<tr>
<td>b.</td>
<td>Within 5 ft in all other directions from point of discharge</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Beyond 5 ft but within 15 ft (10 ft in the case of tanks of water capacity not exceeding 500 gallons) in all other directions from point of discharge</td>
<td>Fixed electrical equipment should not be installed</td>
</tr>
<tr>
<td>Tank Vehicle and Tank Car Loading and Unloading</td>
<td>a.</td>
<td>Within 5 ft in all directions from a point where connections are regularly made or disconnected for product transfer</td>
</tr>
<tr>
<td>b.</td>
<td>Beyond 5 ft but within 15 ft (10 ft in the case of tanks of water capacity not exceeding 500 gallons) from point of connection or disconnection</td>
<td>Division 1</td>
</tr>
<tr>
<td>b.</td>
<td>Entire room and any adjacent room not separated by a vapour-tight partition</td>
<td>Division 1</td>
</tr>
</tbody>
</table>

Notes:

1. Where high standards of maintenance of pumps and pump seals obtain, the area within 5 ft in all directions from the pump may be classified as Division 2.

2. Any pit, trench or depression falling within a Division 1 or Division 2 area should be treated as being a Division 1 area throughout.

3. The term ‘outdoors in open air’ includes pumps, compressors and vaporisers which are covered by a canopy.
c. Mobile equipment, fixed monitors or fixed spray systems should be designed to discharge water at a rate sufficient to maintain an adequate film of water over the surface of the tank and supports under fire conditions.

d. Where large deliveries are made frequently, consideration should be given to the provision of mobile or fixed water-spray systems giving suitable and effective protection for road tanker and rail tank car loading and unloading areas.

3.8.3 First-aid fire extinguishers
A sufficient number of first-aid fire extinguishers of adequate size, suitable for LPG fires, preferably of the dry powder type, should be available at strategic locations. Dry powder fire extinguishers should be to BS 3465. Foam extinguishers are not suitable for LPG fires.

3.8.4 Access
Suitable access to and around the installation should be provided for firefighting equipment and kept free at all times.

3.8.5 Isolating valves
Shut-off valves, which may be automatic or remotely controlled, should be provided at the tank, so that if accidental leakage occurs the supply of LPG can be stopped. Other shut-off valves may be provided at strategic points.

3.8.6 Grass and weed removal
Weeds, long grass and any combustible material should be removed from an area with 10 ft of any LPG tank of up to 500 gallons water capacity, and within 20 ft of larger tanks. If weed killers are used, chemicals such as sodium chlorate which are a potential source of fire danger should not be selected for this purpose.

3.8.7 Warning signs
Where smoking and naked lights are prohibited, prominent notices to this effect should be posted, particularly at access points.

PART 4 OPERATIONS

4.1 TRAINING
a. Personnel responsible for the operation of equipment and the handling of LPG should understand the physical characteristics of the product and be familiar with the relevant sections of this Code appertaining to their spheres of responsibility.

b. All persons concerned with the storage and handling of LPG should 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
provided and, where appropriate, should be exercised in this respect at
frequent intervals. The location of all gas and liquid piping and valves
should be known and their use understood.

c. At the larger plants a proper emergency procedure should be laid down
and clearly posted. Responsibilities should be adequately defined and all
personnel trained in handling emergency situations.

4.2 SEGREGATION OF PRODUCTS
a. All tanks, and where necessary pipelines and other equipment, should
be clearly marked to show the grade of LPG for which they are suitable.

b. Where more than one grade of LPG is handled, the inter-connecting
systems should be double-checked to ensure that a grade of LPG is not
charged into tanks, pipelines or equipment not designed to handle it and
that unacceptable product contamination will not occur.

4.3 PURGING AND FILLING TANKS AND SYSTEMS
a. When new tanks and systems are to be taken into commission, or
tanks and systems which have been gas-freed are filled, they should first be
cleared of air.

b. Air should be removed by evacuation or replaced by water, inert gas or
LPG, dependent on circumstances.

Notes: i. Evacuation
This method is only suitable for tanks designed for full vacuum
conditions. Tanks should be evacuated down to 20" of mercury
vacuum (10° of mercury absolute).

ti. Water
Provision should be made for the complete removal of the water.
Water should not be used in the case of storage for refrigerated
LPG.

iii. Inert gas
Admit sufficient inert gas until the oxygen content of the residual
mixture is less than 10% by volume (i.e. inert gas of free volume
equal to the tank capacity).
If the source of inert gas is in liquid form, precautions should be
taken to ensure complete vaporisation and that no liquid enters
the tank or system.

iv. LPG
If LPG vapour is used to replace the air, then the tank and system
will for a period of time contain an inflammable mixture and an
inflammable mixture will be vented from the tank and system;
adequate precautions to prevent its ignition are essential.

THIS METHOD SHOULD NOT BE USED UNLESS UNDER THE STRICT CON­
TROL OF COMPETENT AND EXPERIENCED PERSONNEL.
c. In filling the tank and system, care should be taken to prevent excessive chilling by the too rapid evaporation of the LPG pumped into it.

4.4 DRAINING OF TANKS

Particular care should be exercised when draining water from tanks in order to prevent escape of LPG. There should be 2 drain valves as recommended in Clauses 2.3.8c and 3.3.7c. The valve nearer the tank should be opened first to an extent sufficient to maintain a liquid full condition on the downstream side, and draining controlled by gradually opening the valve further from the tank. On completion of the draining operation, the valve further from the tank should be closed first, then the valve nearer to the tank (see also Clauses 2.5.5 and 3.4.4).

4.5 PRODUCT TRANSFERS

a. Before LPG is transferred from a tank to any other tank, whether it is a storage tank, road tanker or rail tank car, the following procedure should be followed:

i. The receiving tank should be checked to ensure that it is in safe working condition and that it is not to be filled with a grade of LPG for which it is not designed.

ii. The receiving tank should be checked to establish the quantity that it can safely receive.

iii. The inter-connecting system (i.e. pipe work, fittings, valves, hoses etc.) should be checked to ensure that it is in safe working condition.

b. Before and during LPG transfers from tank to tank and on completion of the operation the receiving tank should be checked to ensure that it is not being overfilled and on completion is not filled above its safe working level.

c. In the case of road tankers and rail tank cars the following procedure should also be followed:

i. The vehicle should be prevented from accidental movement during the transfer operation. The parking brake of a road tanker or the hand brake of a rail tank car should be on, and where necessary wheel chock blocks should be used.

ii. Any driving unit or electrical equipment not required and not specifically designed for the transfer operation should be stopped and isolated.

iii. Any accumulated static electricity on a road tanker should be discharged to earth and then the tank of the road tanker should be electrically bonded to the fixed installation before any LPG transfer operation is carried out.

iv. Before the vehicle is moved the liquid and vapour connections should be disconnected; the electrical bonding connections should then be broken.
4.6 ATTENDANCE DURING OPERATIONS

a. A responsible person should remain in attendance during all transfer operations.

b. No drain valve, bleed valve, pipeline etc in the LPG system which communicates directly to the outside air should be left open without an operator in attendance.

c. If it is necessary to discontinue a transfer operation temporarily and return to complete it later, the loading hose should be disconnected.

d. The person in charge of operations should ensure that transfer operations are stopped and all valves closed if any of the following occur:
   i. Uncontrolled leakage
   ii. A fire in the vicinity
   iii. An electrical storm in the vicinity of an operation involving venting of LPG.

4.7 ACTION IN EMERGENCY

In any emergency situation it is of paramount importance to avoid endangering human life. It is almost impossible to lay down a definite procedure to follow in all cases, but the following actions are indicated:

a. Summon help and fire-fighting services.

b. Wherever possible, turn off all valves to cut off or reduce the source of gas escape.

c. Evacuate all persons, except those necessary to deal with the emergency, from the danger area, especially from any area which is in the path of the gas cloud.

Always approach any fire or gas leak from upwind. Gas fires should normally be controlled but not extinguished until the source can be cut off.

4.8 LIGHTING STORAGE AND OPERATING AREAS

Operations should not be carried out during the hours of darkness unless adequate safe artificial lighting is used.
APPENDIX A

REFERENCES

2. 'Installation of Fixed Bulk Storage at Consumers' Premises': LPGITA 1969.
3. 'Maintenance of Fixed Bulk LPG Vessels at Consumers' Premises': LPGITA 1969.
4. 'Recommendations for prevention or control of fire involving LPG': LPGITA 1963.
11. BS 1515: 'Fusion welded pressure vessels for use in the chemical, petroleum and allied industries': British Standards Institution 1965 (Part 1) and 1968 (Part 2).

Note: Acceptance of the above Codes relates only to the edition of the Code as noted.
APPENDIX B

REFERENCE TEMPERATURES

1. Reference temperatures for design
In accordance with current practice in the United Kingdom, tanks should be designed and constructed to BS 150010, BS 151511 or other recognised pressure vessel codes for the following minimum design working pressures:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Min. design working pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Butane</td>
<td>70 psig</td>
</tr>
<tr>
<td>Commercial Propane</td>
<td>210 psig</td>
</tr>
</tbody>
</table>

However, British Standards based on the Report of the Home Office Gas Cylinders and Containers Committee (April 1968) are currently being prepared. For tanks designed and constructed in accordance with these requirements, the temperature referred to in Clause 2.3.1.b and 3.3.1.b. may be taken as:

- 50°C for tanks having a capacity exceeding 130 litres (approximately 28 gallons) but not exceeding 1m³ (approximately 550 gallons)
- 47.5°C for tanks having a capacity exceeding 1m³ but not exceeding 5m³ (approximately 1100 gallons)
- 42.5°C for tanks having a capacity exceeding 5m³ but not exceeding 30m³ (approximately 6600 gallons)
- 41°C for tanks having a capacity exceeding 30m³ but not exceeding 100m³ (approximately 22,000 gallons)
- 40°C for tanks having a capacity exceeding 100m³.

2. Reference temperatures for filling ratio
In accordance with current practice in the United Kingdom, the highest temperature which the contents of the tank will reach in service should be taken as 38°C for tanks above 3 ft in diameter and 45°C for tanks of smaller diameter. However, British standards based on the Report of the Home Office Gas Cylinders and Containers Committee (April 1968) are currently being prepared. For tanks designed and constructed in accordance with these requirements, the temperature referred to in Clauses 2.3.9 and 3.3.8 may be taken as:

- 42.5°C for tanks having a capacity not exceeding 5m³ (approximately 1100 gallons)
- 38°C for tanks having a capacity exceeding 5m³ but not exceeding 30m³ (approximately 6600 gallons)
- 37°C for tanks having a capacity exceeding 30m³ but not exceeding 100m³ (approximately 22,000 gallons)
- 36°C for tanks having a capacity exceeding 100m³.