Guide to
Good Industry Practices for Bulk LP Gas Installations

WORLD LP GAS ASSOCIATION

The World LP Gas Association

The World LP Gas Association was established in 1987 in Dublin, Ireland, under the initial name of The World LPG Forum.

The World LP Gas unites the broad interests of the vast worldwide LP Gas industry in one organisation. It was granted Category II Consultative Status with the United Nations Economic and Social Council in 1989.

The World LP Gas Association exists to provide representation of LP Gas use through leadership of the industry worldwide.

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Guide to Good Industry Practices

Bulk LP Gas Installations

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Chapter One

Background

The WLPGA is committed to providing independent advice to LP Gas stakeholders to ensure safety in the operation of LP Gas equipment.

The two WLPGA guides - Best Business Practices and Best Safety Practices - have been used extensively during the last ten years all over the world to provide guidance across all areas of the LP Gas industry.

These two guides have been designed to provide general advice to all stakeholders on best practices throughout the supply and distribution chain.

Following the success of these guides it has been decided to develop and publish more detailed advice in certain areas of the supply and distribution chain that are considered more critical and where more prescriptive advice would be helpful.

This is the second of a series of guides issued by the WLPGA and this one deals with the subject of Bulk LP Gas Installations. This document addresses the engineering, operation and safety requirements for bulk installations in terminals and depots, cylinder filling plants, customer installations and Autogas refuelling sites.

The guidelines in this document are adopted from globally recognised LP Gas standards and Codes of Practice as well as best practices from major LP Gas companies. It is recommended that these guidelines be applied in conjunction with any applicable local or regional laws/regulations to enhance the overall safety performance of your LP Gas business.

Chapter Two

Guide to Good Industry Practices for Bulk LP Gas Installations

An example of a Bulk LP Gas facility

LP Gas is commonly stored in pressure vessels in various facilities i.e. terminals and depots, cylinder filling plants, Autogas fuelling stations and customer sites. The capacities of these facilities can range from 100,000 MT (metric tonnes) for large import terminals to as small as 0.5 MT for a domestic installation. Whatever the size of an LP Gas installation, any safety incident whether due to equipment failure or external threats has the potential to cause injury and/or property damage not only to people working within these facilities but also the population of the surrounding communities.

It is therefore important to all stakeholders in the industry to manage and reduce the risks associated with operating an LP Gas facility to As Low As Reasonably Practicable (ALARP). This can be achieved with suitable design and engineering standards, safe operations, and comprehensive and rigorous maintenance programmes combined with effective staff training programmes.

This guide should always be used in conjunction with local standards and regulations. If the requirements of the local standards or regulations are less than the guide, the latter should be adopted to ensure a higher level of safety for the LP Gas facility.

The recommendation in this guide applies to pressurised LP Gas facilities covering terminals and depot, cylinder filling plants, Autogas fuelling sites and industrial, commercial, agricultural and domestic installations permanently installed and refilled onsite.

This Guide does not cover refrigerated terminals, caverns, salt domes and mobile cylinder installations.

Chapter Three

Tank Location and Layout

The location and layout for a LP Gas bulk installation should take into consideration the size of the storage tanks and nature of operations that will occur onsite. Siting the tanks properly with respect to nearby structures, prevailing wind - coupled with good design - will significantly reduce risks and the impact of incidents associated with LP Gas i.e. gas clouds or jet flame. The worst case scenario of an LP Gas tank BLEVE (Boiling Liquid Expanding Vapour Explosion) is not considered here as experience has shown this risk to be minimal. This section provides recommendations on the location of LP Gas tanks and separation distances to other structures and boundaries.

3.1 General

3.1.1 Location

- All LP Gas bulk tanks should be located in the open with adequate ventilation and be easily accessible for operation, maintenance and fire-fighting. LP Gas tanks should be sited according to the required separation distances (see 3.2).
- The ground underneath or adjacent to connections into LP Gas tanks or LP Gas ancillary equipment should be concreted or compacted and free from depressions, pits, culverts or drains. If all connections are congregated at one end of the tank, it may only be necessary to compact or concrete under the connections. See 3.1.8.
- Care should be taken to avoid siting tanks in locations where the surrounding ground slopes towards vulnerable features e.g. other tanks, buildings, houses, drains etc., especially where there is an ignition risk, even though these may be outside normal separation distances.
- Locate mounded or underground tanks in a way that maximises the ventilation around the pressure relief valves and manhole, according to the separation distances required in local legislation or 3.2 whichever is larger.
- No part of the LP Gas tank should be located underneath a structure of the premises or any extensions from it e.g. roof eaves, car port etc. nor beneath overhanging tree branches.
- LP Gas bulk tanks should never be installed on roofs of buildings due to the inherent hazards/risks associated with leakage, fire and access for emergency response and services. If this cannot be avoided, the local enforcing authorities should be consulted.
- The location should be accessible to vehicle delivery. It should avoid routing such that the filling hose has to pass over walls or fences or similar features that are likely to cause abrasion or other damages to the hose.
- The location should provide a clear line of sight between the receiving tank and delivery vehicle for the person in control of the product transfer operation particularly if only a single person is involved in the transfer operation.
- If the frequency of delivery to a customer's premises is high e.g. an Autogas refuelling site or customer installation, consideration should be given to increasing the separation distances and/or providing additional fire protection.

3.1.2 Screening

If trees or shrubs are planted to screen LP Gas tanks, they should not obstruct ventilation, i.e. locate them only on one side of the tanks. Take care to plan too for:

- The size of the trees/shrubs when full grown.
- The capacity of tree roots to interfere with underground pipes, foundations or concrete footings.
- The chance of tree branches breaking off in high winds and falling onto the tank or associated pipes and fittings.
- Access needs for maintenance purposes.
- Increasing the risk of an additional fuel source in the vicinity.

3.1.3 Flammable Materials

Long grass, weeds, deciduous trees or shrubs and trees plus any combustible material should be removed from within 3 metres of any 2,500 litres water capacity or smaller LP Gas tank and within 6 metres of larger tanks. Never use sodium chlorate or other chemicals (which present a fire risk) to clear weeds near LP Gas tanks.

3.1.4 Horizontal Direction

- Where possible, arrange horizontal LP Gas tanks so that they are in parallel and do not point towards other tanks containing dangerous substances, nearby occupied buildings or important equipment.
- Tanks should not be installed one on top of another in order to avoid gas being released and ignited from one tank causing fire impingement on the other tank.

3.1.5 Multiple Tanks

- Not more than six above ground LP Gas tanks should be in a single group. Any tank in one group should be separated from the nearest tank in another group by the appropriate separation distance to a public place (see Table 1), unless a fire wall is built between the two groups.
- If more than one row of tanks is installed, the adjacent ends of the tanks in each row should be separated by at least 3 metres.
- Within a group of tanks the distance between adjacent tanks should be (D1 + D2)/4 where D is the diameter of the tank, with a minimum separation distance of 1 metre.

3.1.6 Overhead Electric Cables

LP Gas tanks, vapourisers, pumps and gas/air mixing plants etc. should not be located directly beneath electrical power cables. LP Gas tanks should be sited:

- At least 1.5m from a line drawn vertically down from a cable carrying less than 1 kV.
- At least 7.5m if cable is carrying 1 KV or more.
- Or a competent engineer, usually from the local electricity supplier, makes a judgement on a particular installation on its own merits.

3.1.7 Bunded Enclosures

LP Gas tanks should not be sited inside the bunded enclosure of tanks holding:

- Any flammable liquid.
- Heated liquids such as heavy fuel or bitumen.
- Liquid oxygen or cryogenic substances.
- Any other hazardous substance.

3.1.8 Spillage Planning

LP Gas spillage containment (e.g. evaporation areas) should be installed for:

- Propane tanks of 56,250 litres water capacity or greater, with connections below the liquid level, unless they are plugged or blanked off.

- Butane tanks of 11,250 litres water capacity or greater, with connections below the liquid level, unless they are plugged or blanked off.

Spillage containment areas should be safely sited away from boundaries, occupied buildings and ignition sources. The ground below the tank and its connections should slope and be compacted or concreted so as to avoid pools of liquid building up. It should allow escaping LP Gas to be directed to a safe evaporation area which should never be closer to LP Gas tanks than 3 metres. Low walls (usually 500mm or less) can also act as an effective channel.

3.1.9 Spillage Planning

In general, LP Gas cylinders should not be stored close to bulk tanks to avoid any unnecessary restrictions to access. However, if it is necessary for overriding security reasons or a bulk reserve supply for short-term use, then these conditions can be considered:

- Less than 50kg may be stored adjacent to the tank.
- If storing cylinders with horizontally venting PRVS (pressure relief valves) with a total quantity in excess of 50kg - separate by 7.5 metres from tanks of over 5,000 litres water capacity or 3 metres from tanks below this size.
- If storing vertically venting cylinders (e.g. for forklift trucks) - separate by at least 1 metre from the tank and do not exceed 300kg of storage close to the tank.

3.1.10 Natural Phenomenon

Local rules should be applied to safeguard against natural phenomena, including:

- Lightning - Protection is not usually needed in temperate countries, but may be required in tropical countries or those with a high frequency of lightning strikes.
- Earthquakes - Supports and foundations should meet local design requirements. In areas falling in earthquake zones, seismic valves may be installed to shut off gas flow during an earthquake.
- Flooding - Try to avoid siting tanks where there is a known flood risk. Liquid LP Gas has a density around half that of water so prevent flotation by securely anchoring tanks. Underground tanks should be securely anchored where there is a high water table.
- Hurricanes or Cyclones - Where prevalent, consideration should be given to the effect of high wind loading.

3.2 Separation Distance

- Separation distances are designed to protect the LP Gas installation from the immediate radiation effects of fires involving other facilities as well as to minimise the risk of escaping LP Gas from being ignited before it has dispersed or diluted.
- Most countries should have local regulations on separation distances for LP Gas tanks and these should be fully complied with. If local regulations do not exist, companies should comply with separation distances by referring to Tables 1 to 5 of this section. If the distances in local regulations are less than those indicated in Tables 1 to 5, consideration should be given to applying the latter.
- Separation distances for above ground tanks are measured from the nearest surface while mounded or underground tanks are measured from the pressure relief valve and filling connection.
- All separation distances in this section are based on tank installations that are fully compliant with requirements in other sections of this guideline with the minimum of joints and flanges in pipework and a rigorous asset integrity management regime applied.

3.2.1 Separation Distances between Tanks, Important Buildings and Other Properties

Separation distances of LP Gas tanks to important buildings, boundaries, fixed sources of ignition and other tanks are indicated in Table 1. This is based on Table 6.3.1 of NFPA 58 Liquefied Petroleum Gas Code by the National Fire Protection Association (NFPA).

Table 1 Separation Distances Between Tanks, Important Buildings and Other Properties

Tank Water Capacity per Container (Litre)	Minimum Separation Distances		
	Mounded or underground Tanks (Metre)	Above ground tanks (Metre)	Between tanks (Metre)
<500	3	0	0
500 - 1000	3	3	0
>1000 - 1900	3	3	1
>1900 - 7600	3	7.6	1
>7600 - 114000	15	15	1.5
>114000 - 265000	15	23	1/4 of sum of diameters of adjacent tanks
>265000 - 341000	15	30	
>341000			

Notes to Table 1

1. Separation distances in Table 1 for tanks with 1,900 to 7,600 litres water capacity can be reduced to 3m for a single tank of 4,500 litres or less water capacity where such tank is at least 7.6m away from another LP Gas tank.
2. Separation distances in Table 1 between tanks and buildings used exclusively for filling of LP Gas cylinders should refer to 3.2.6. If the quantity of LP Gas cylinders filled is less than 300 kg. i.e. for forklift cylinder supply, the minimum distance will not apply.
3. Separation distances in Table 1 may be reduced by half by the provision of a fire wall designed and constructed in accordance to section 3.3. Alternatively, separation distances may be reduced by provision of a greater fire protection than that set out Table 1. However, specialist advice should be sought from the enforcing and/or fire authorities in this case.
4. If the aggregate capacity of a multi-tank installation comprising of tanks with less than 500 litres capacity is 1,900 litres or more, the aggregate capacity should be used instead of capacity per tank provided that the installation is separated from any other installation by at least 7.6 metres. The minimum distances between tanks will not apply in such installations.
5. If the LP Gas is located adjacent to a structure with an extension or an overhang, the horizontal distance between the portion of the building that overhangs out of the building wall and a LP Gas tank of 500 litres or more water capacity should comply with the following:

    - The horizontal distance measured from a point determined by projecting outside edge of the overhanging structure vertically downward should be at least 50 per cent of the separation distance required in Table 1.
    - This applies only if the overhang extends more than 1.5 metres from the building and the overhang is 15 metres above the relief valve discharge outlet.
    - This will not apply to tanks with capacities more than 7,600 litres where the tank distance from a building is in accordance with Table 1 as it is unlikely to have a building overhang of more than 7.6 metres.

3.2.2 Flammable Liquids

Tanks containing a flammable liquid with a flashpoint of 65^{o}C or less should be sited not less than the separation distances given in Table 2.

Table 2 Separation Distances - Flammable Liquids and LP Gas Tanks

Flammable Liquids		Minimum Separation distance
Flashpoint less than 32°C e.g. Petrol		6m to Bund Wall
Flashpoint >32°C to 65°C e.g. Kerosine, Diesel, Gasoil	Tank size up to 3000 litres	Separation distance for the LP Gas tank or 3m to the tank/bund wall whichever is lesser
	Tank size more than 3000 litres	3m to bund wall or diversion wall and 6m to tank

3.2.3 Cylinder Connection

LP Gas and liquid oxygen tanks should be sited according to the separation distances in Table 3. Separate LP Gas tanks from other tanks holding toxic or dangerous liquids stored under pressure by at least 15 metres.

Table 3 Separation Distances - Liquid Oxygen and LP Gas Tanks

LP Gas Tank		Liquid Oxygen Capacity (Litre)	Separation Distance (Metre)
Water Capacity (Litre)	Nominal Capacity (MT)		
Up to 265,000	Up to 60	Up to 566,000	6.0
Up to 4500 From 4500 to 265000	Up to 2 2 to 120	More than 566,000	7.5 15.0
Above 265000	Above 120	All capacities	Perform full Risk Assessment

3.2.4 Separation Distances from Cylinder Filling Plant

LP Gas tanks should be sited such that the distance between any part of the cylinder filling building and the storage tank meets the distances in Table 4. Furthermore, cylinder filling buildings should be located at least 15 metres away from boundaries and other buildings.

Table 4 Separation Distances – Cylinder Filling Plant to LP Gas Tanks

Tank Capacity (Litre)	Minimum Distance (Metre)
Up to 135,000	10
>135,000	15

3.2.5 Separation Distance from Cylinder Stacks

- LP Gas cylinders in the cylinder filling plants both filled and empty should be stored at least 15 metres away from LP Gas tanks. The quantity for each cylinder stack should be limited to 5 MT and the next stack should be at least 7.6 metres away.
- LP Gas cylinders in automotive retail sites should be stored at least 7.6 metres away from the LP Gas storage tanks.

3.2.6 Separation Distances in Automotive Retail Sites

Where there are no local regulations LP Gas tanks should be sited with respect to other facilities/equipment in an Automotive retail station in accordance with Table 5. If local regulations exist and require larger distances, they should be used in preference.

Table 5 Separation Distances for LP Gas tanks in Automotive Retail Sites

Automotive Retail Site Feature	Minimum distance (Metre)
LP Gas dispenser	3
Liquid fuel dispenser	3
Motor vehicle LP Gas filling connection	3
Buried tank (Flammable liquid) manway fill connection and vents	3
Above ground storage tank/bund (Flammable liquid) flash point <65oC	6
Parked motor vehicles	1.5
LP Gas cylinder storage area	8
Site boundary, buildings, fixed sources of ignition	Refer to Table 1

3.2.7 Separation Distances in Automotive Retail Sites

- No separation distance is required between LP Gas dispensers and flame-proof liquid automotive fuel dispensers. LP Gas dispensers can therefore be installed on the same island as flame-proof liquid automotive fuel dispensers.
- LP Gas dispensers and vehicle LP Gas filling connection should be at least 4.5 metres away from site boundaries, buildings, and fixed sources of ignition.
- LP Gas dispensers should be located away from flammable liquids tank by at least 3 metres if underground and 6 metres if above ground.
- Any spillage from the flammable liquids tank, i.e. during filling, should be directed away from the LP Gas tank and/or prevented from remaining under or near the LP Gas tank. Pool fires from flammable liquids spillage should not result in flame impingement on LP Gas facilities.

3.3 Fire Walls

3.3.1 Purpose

Fire walls shield the public and vulnerable equipment from thermal radiation caused by fire and they ensure an adequate vapour dispersion distance to boundaries, buildings and sources of ignition in the event of an LP Gas leak occurring. They also enable the use of shorter separation distances.

3.3.2 Siting

Fire walls should not be used on more than two sides, or where the ventilation would be impaired, and normally they should only be used on one side of a tank or tank grouping. In exceptional circumstances fire walls may be used along one long side and two short sides of a tank installation if a risk assessment shows that measures have been taken to bring the risk to As Low As Reasonably Practicable (ALARP). Also:

- They should be sited no closer than 1.5 metres from the nearest point of the tank.
- Separation distances may be reduced to the distance around the ends of the fire wall to a public place as defined in Table 1.
- A fire wall for a tank up to 2,500 litres water capacity may form part of a building.

3.3.3 Construction

Fire walls should be solid, without any openings and made of brick, concrete or other suitable non-combustible material. They should also be:

- Capable of resisting fire for 60 minutes.
- Totally within the boundary of the LP Gas storage area.
- For tanks up to 2,500 litres water capacity, as high as the top of the tank or highest piece of high pressure or liquid pipework or fitting connected directly to the tank and may form part of a building or site boundary.
  For tanks over 2,500 litres water capacity, at least 2 metre high or as high as the top of the tank, or highest piece of high pressure or liquid pipework or fitting connected directly to the tank, whichever is the greater.

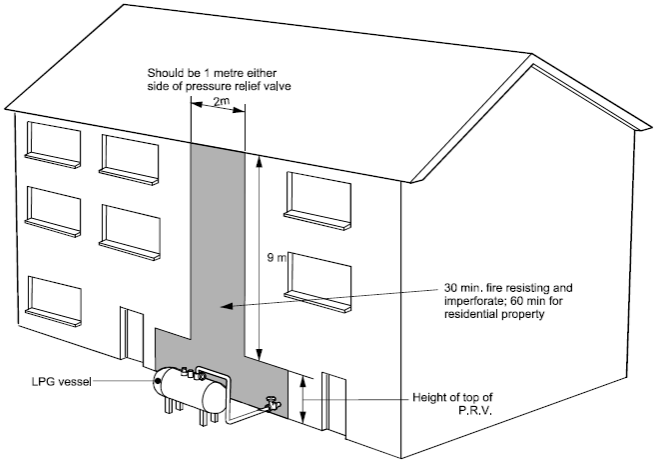

Fig. 1 Fire wall for tanks 2,500 litres or less
(*Source: UK LPGA COP 1*)

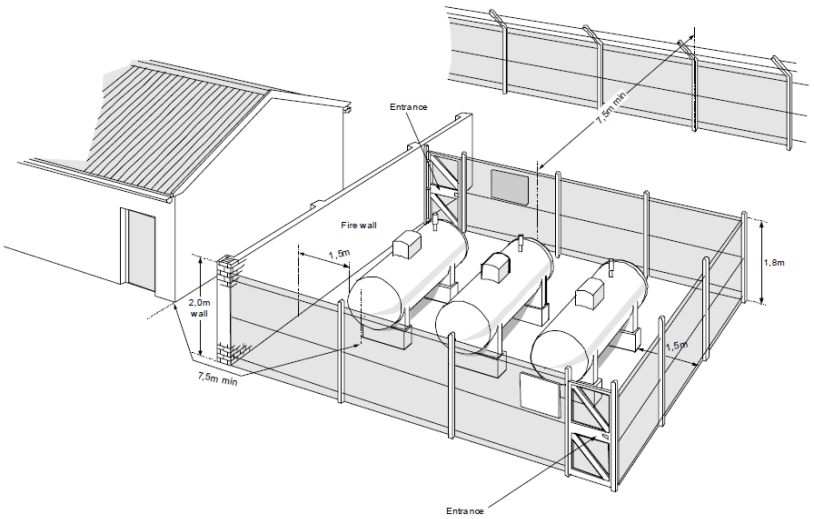

Fig. 2 Tank compound with fire wall and security fence
(Source: UK LPGA COP 1)

3.4 Site Security

3.4.1 General

All tanks, fittings and equipment should be protected from accidental damage or vandalism. The level of security required will depend on how accessible the tank site is to the public.

3.4.2 Sites with Restricted Public Access

These sites may not need individual fences for tanks, pumps and vapourisers if the tanks are smaller than 9,000 litres water capacity and valves and fittings are inaccessible, e.g. use open mesh wire fencing between the support pillars. A lockable cover may be used as long as the key is available in an emergency and the cover is locked at all other times except during tank filling. Examples of sites with restricted public access include domestic installations, industrial installations with perimeter fences and having continuous surveillance, etc.

3.4.3 Sites with Unrestricted Access to Public

Sites such as Autogas refuelling stations, open plan industrial sites, housing estates, etc. where the public has uncontrolled access, should be secured by a security fence based on the following guidelines:

- Up to 2,500 litre water capacity tanks – the fence should be at least 1.5 metres from the tank.
- Above 2,500 litre water capacity tanks – the fence should be at least 3 metres from the tank.
- Arrangements should also prevent the build-up of combustible materials and uncontrolled siting of ignition sources within the separation area (e.g. weeds, rubbish etc).

3.4.4 Security Fence Construction

- The design of security fence should not significantly impair ventilation across the site. Never use wooden designs as they burn easily and obstruct ventilation.
- The security fence should be at least 1.8 metre high and made of strong industrial grade wire mesh e.g. 12 gauge chain link or 12 gauge 52mm x 55mm mesh welded panels, fixed to concrete or steel pillars.
- There should be at least two means of exit at opposite sides of the security fence to minimise the distance personnel have to travel to escape in case of an incident. Gates or access should open outwards and be easily and immediately open from inside. It should not be self- locking and should provide unobstructed means of escape.

3.5 Protection Against Damage from Vehicles

3.5.1 Location

Do not site tanks, pipes and associated equipment in areas used by vehicles; if this cannot be avoided, install strong bollards or crash barriers appropriate to the size and weight of vehicles that are likely to use roads in the area. Never rely simply on the security fence or the use of warning signage or road marking.

3.5.2 Vehicle Parking Area

Designating a parking area for vehicles away from the LP Gas tanks can reduce the risk of vehicular damage. Classify the parking areas according to the type of vehicle being parked i.e.

- Vehicles controlled by the site operator should be parked no closer than 3 metres, providing that ventilation around the tank is not obstructed.
- Vehicles not controlled by the site operator (e.g. driven by the public), should not be parked any closer than 3 metres or the separation distances in Table 1, whichever is the greater.

Chapter Four

Tank Design

4.1 General

LP Gas is a hazardous product which needs to be contained inside pressure vessels and any uncontrolled discharge prevented. Tank failures due to poor construction can result in serious consequences. For this reason pressurised tanks should be designed and manufactured to a recognized code or standard to ensure their safety.

At customer sites, where the majority of the pressurized tanks are installed, tanks are likely to be supplied and owned by customers in which case LP Gas companies should verify that the specifications comply with the required standards or codes and that they are fit for service before filling.

4.2 Design Code

LP Gas tanks should be designed, manufactured, inspected and tested in accordance with a recognised design code e.g. ASME VIII, etc. Where local regulations require the use of national standards or alternative codes it is important to confirm that they at least equal the requirements of ASME VIII or the equivalent.

The design of any tank should be based on the application of a single standard only. The application of mixed standards to the design of a tank should be avoided.

4.3 Design Conditions

4.3.1 Maximum Pressure

- Tanks should be designed to safely contain the vapour pressure of the product at the assessed temperature for the location where the tank will be installed, and dependent on the reflectivity of the tank.
- Where tanks will be used for butane, propane and mixtures thereof at different times, the standards shown for propane should be followed EXCEPT for minimum safe operating pressure, which should follow the butane recommendation.
- In determining the maximum design safe operating pressure, the assessed temperature will either be established by national and/or local regulations or by the design code for the location or Table 6 can be used for guidance for tanks which are painted white.

4.3.2 Maximum Pressure

If the product to be contained in the tank is butane and where the atmospheric temperature at its intended site could fall below zero degrees (freezing) then the tank should be capable of withstanding negative pressure. Alternatively, the installation can incorporate positive means for preventing unacceptable vacuum conditions to occur in the tank i.e. the use of propane vapour pressurisation system or hot vapour return system.

Table 6 Developed Pressure

Location	Tank Water Capacity (Litre)	Assessed Temperature °C	Developed Pressure Bar gauge	
			Butane	Propane
Temperate Climate	< 7000	35	6.5	16
	>7000		5.5	15
Temperate Climate	<7000	40	7.2	18
	>7000		6.2	17
Desert Climate	<7000	45	7.9	20
	>7000		6.9	19

Note: In practice, many tanks are manufactured to standard design pressures.

4.3.3 Constructions

- Pressurised LP Gas tanks are either spherical or cylindrical in shape. Larger capacities tend to be spherical which requires less space but more complex construction process.
- Cylindrical LP Gas tanks have either semi-ellipsoidal or hemispherical ends depending on the requirement. The majority of cylindrical LP Gas tanks are designed for horizontal installation but vertical tanks are also used primarily if space is a premium.
- LP Gas tanks should be of welded steel construction. The steel used should have suitable properties, particularly with regard to impact resistance for operation over a range of temperatures between minus 20oC and 50oC.
- Tanks with capacities up to 2,500 litres should have a hinged, lockable hood to protect fittings and prevent unauthorised tampering.
- Above ground tanks should be painted a light colour, preferably white, to increase reflection and minimise the temperature rise of the contents from solar heat gain.

4.3.4 Maximum Filling Capacity

- The maximum quantity of LP Gas which may be filled into any tank should be such that the tank will not exceed 97% liquid full due to expansion of its contents at the assessed temperature. This is to prevent uncontrolled discharge of LP Gas through the pressure relief valve.

- The maximum filling capacity by volume is calculated as follows:

$$V_f = 0.97 \times V \times g_i / g_L$$

Where: V_f = maximum safe fill volume, litres

V = water capacity of storage tank, litres

g_i = density of LP Gas at assessed temperature, kg / litre

g_L = density of LP Gas at lowest possible fill temperature, kg / litre

4.4 Corrosion Protection

The tank and tank supports should be adequately protected against corrosion preferably by zinc metal spraying and painting, after suitable preparation such as grit blasting or chemical treatment. Any form of corrosion protection should allow for tank expansion/contraction occurring with changes in temperature and internal vapour pressure. Attention should be given to the protection of the internal faces of flanges and flange studs/bolts against corrosion.

4.5 Tank Supports

- Design for tank supports should comply with the relevant tank construction code of practice. In particular, supports should:
    - Allow the tank to move within the range of temperature change
    - Permit the drainage of any water
    - Located (for horizontal tanks) to give minimum deflections and moments to the tank shell
    - Be reinforced with extra supports where appropriate
- Supports may not be necessary for underground tanks, but they may be required where it is necessary to anchor the tank because of potential flotation.
- Tanks should be installed on structural steel, concrete or brick supports, with solid foundations. Supports should be fire resistant to a standard of at least 2 hours (except 460mm high or smaller feet, tank saddles or skirts for vertical tanks).
- The supports should be of sufficient strength to support the tank when full of water. Vertical tanks should have an open support structure that encourages effective airflow and provides explosion relief. Where cylindrical supporting skirts are used, pipes from the tank within the skirt should have welded or welded flanged joints.

4.6 Tank Markings and Labelling

4.6.1 Purpose

- Tank markings help highlight the hazards associated with the product contained inside the tank and prevent confusion at any time during normal operations or an emergency, which may either precipitate or aggravate an incident.
- The markings and labels should be visible, legible and indelible. If tags or plates are used, they should be securely fixed to the part to which it relates. Never use paper labeling.

4.6.2 Specific Information

The following design, manufacturing and operational information should be plated on the tank:

- Design code
- Maximum operating pressure
- Minimum operating pressure
- Maximum design temperature
- Minimum design temperature
- Date of manufacture
- Manufacturer's identity
- Serial Number
- Water capacity
- Date of test
- Test pressure
- Inspection authority's identification

- The markings and labels should be visible, legible and indelible. If tags or plates are used, they should be securely fixed to the part to which it relates. Never use paper labeling.

4.6.3 Labels

- 'Liquefied Petroleum Gas' should be clearly painted on the tank or, if there is any risk of confusion, a more detailed description of tank contents; the words 'Highly Flammable' or a suitable visual symbol should also be added.
- Emergency contact telephone numbers should be displayed or readily available particularly at customer sites.

4.6.4 Warning Notices

- Prohibition of smoking or naked flames, and 'NO Unauthorised Entry' signs (if applicable) should be indicated by warning notices complying with local regulations.
- Warning signs should be durable, clearly visible and legible from the applicable separation distance (Table 1) and should be firmly fixed to the fence/wall or the tank itself.

4.6.5 De-stenched/Odourless LP Gas

Special precautions are required when LP Gas is supplied or used after de-stenching or with a low odour e.g. for use in aerosols as a propellant. This includes the following:

- Clearly mark tanks to indicate contents are de-stenched or odourless.
- Fit pressure gauges to all tanks.
- Identify pipework as carrying odourless products.
- Where practicable pipework should be welded and flanged.
- Provide sampling points, drain connections and means of isolating plant sections where quality is a consideration.
- Filling connections on the tank installation and delivery vehicle hose end should have left hand screw threads or alternative distinctly different connections to those used for stenched product, to prevent the delivery of odourless product into stenched storage or vice versa.
- A competent person familiar with the product should carry out regular visual inspections for leaks.
- Install gas detection systems.

4.7 Mounded and Underground Tanks

4.7.1 Location

Mounded and underground tanks should be located in ground which is well drained and less prone to flooding.

4.7.2 Super Imposed Load

Consideration should be given to the additional stress caused by the pressure of the back fill or covering and any other super imposed load such as differential settlement, flotation restraint, frost, snow or drought.

4.7.3 Excavation

Excavation should be large enough to allow for easy installation and a gap of at least 1 metre between the tank and the walls before back-filling.

4.7.4 Foundation

- A solid foundation for the tank is required, protected from scouring and erosion by storm waters and flooding. Underground tanks may be placed in excavated ground without additional added foundations where ground conditions are appropriate.
- Measures to avoid flotation or movement should be provided.

4.7.5 Covering

Mounded tanks should be covered and underground tanks back-filled with a material that is:

- Inert and non-corrosive.
- Non-abrasive and free of particles which are likely to damage the tank coating.
- Resistant to thermal radiation.
- A consistent minimum of 300mm in depth (when compacted) for tanks up to 13,000 litres water capacity. For larger tanks this should be increased to 500mm.
- Robust enough to resist jet flame impingement.
- In the case of underground tanks, protected by an impact resistant coating to a relevant standard, some of the earth removed to install the tank may be used to back-fill the installation. The use of dry washed sand is preferred for back filling.

The area above the tank may be turfed, covered with concrete slabs or covered in shingle.

4.7.6 Manhole

A manhole of minimum 575mm internal diameter should be fitted to mounded and underground tanks to provide access for inspection. If this is not done, it may be necessary to excavate the tank when inspection is due (when tank fittings are attached directly to the tank and not via a manhole).

4.7.7 Corrosion Protection

- A suitable system of cathodic protection (typically sacrificial anode for small installations and impressed current for large installations) should be provided. Appropriate current and voltage readings should be taken periodically, recorded and analyzed to ensure that the condition of the tank is effectively monitored.
- External surfaces of the tank should be suitably prepared and treated with a coating manufactured and applied in accordance with a recognised standard, to both protect against chemical and mechanical damage and minimise cathodic protection current drain.
- Avoid damage to the tank coating during installation. Fault detection equipment can be used to check that the coating is intact. Rectification of any damage should be completed before back-filling the tank.

4.7.8 Small Mounded/Underground Tanks

Special requirements for tanks below 5,000 litres water capacity are as follows:

- A manhole to facilitate internal periodic inspection is not needed, provided a cathodic protection system is fitted and the effectiveness of the protection is monitored and recorded at intervals no longer than a year. If the effectiveness of the cathodic protection is proved to continue to be satisfactory the maintenance interval may extended and the tank may remain in service underground for up to 20 years.
- Locate the underground tank such that vehicular traffic does not pass over it, unless a load bearing structure has been constructed to prevent any load being transferred to the tank.
- Small underground tanks may be installed in open ground without supports on a bed of sand or other suitable material provided that account is taken of the need to avoid uneven stressing of the tank shell and flotation and movement.
- A means of removing liquid product should be located in the top section of the tank, with an internal pipe to the bottom of the tank.

- A protective valve cover need not have a hole for relief valve discharge.

4.8 Skid Mounted and Mobile Tanks

4.8.1 Skid Mounted Tanks

LP Gas tanks which are fixed in a static frame e.g. ISO tanks, for ease of transportation and installation.

4.8.2 Mobile Tanks

LP Gas tanks which are mounted on their own wheels or a trailer should be designed and operated in accordance with road transport specifications. Under no circumstances should a mobile tank incorporating a tank designed for static use be used for delivery operations.

4.8.3 Separation Distances

All skid mounted and mobile tanks should comply with the fixed tank separation distances in Table 1. Preference should be given to fixed tank installations, as skid mounted and mobile tanks are not as safe, being temporary and uncontrolled in nature.

Chapter Five

Tank Fittings

5.1 General

5.1.1 Suitability

Tank fittings used should be made of materials compatible with LP Gas and designed to suit the range of pressures and temperatures that will occur in service.

5.1.2 Minimum Fittings

Every tank should have at least one each of the following:

- A pressure relief valve directly connected to the vapour space.
- A maximum liquid level indicator or maximum level fill stop valve and preferably a contents gauge. Where both devices are installed they should be independent of each other to provide a separate means to prevent overfilling.
- A filling connection.
- A service outlet connection(s) for vapour and/or liquid duty if required.
- A drain connection, or some other way of draining liquid product from the tank. This should be double locked.
- A pressure gauge for tanks over 5,000 litres water capacity.
- A temperature gauge may be required if stock reconciliation has to be carried out.
- A vacuum prevention measure where excessive vacuum may occur i.e. storage of butane in low temperatures.

5.1.3 Location of Fittings

Minimise the number of direct connections below the liquid level to lower the risk of leakage of liquid LP Gas. Wherever possible, only one connection, excluding the drain line, should be provided and all the rest should terminate at the vapour space.

5.2 Pressure Relief Valves

5.2.1 General

All above ground tanks should be fitted with one or more pressure relief valves (PRV), in compliance with a recognized code of practice, which will protect the tank in the event of a fire. The setting and sizing of the pressure relief valve(s) should protect the tank from overpressure of more than 120% of the design pressure, which could be generated under fire exposure conditions.

5.2.2 Underground Tanks

For mounded or underground tanks, the full flow capacity of pressure relief valves may be reduced to a value that can be shown to adequately protect the tank. Calculation of this value should also consider whether the relief valves are

required to prevent overpressure of the tank by overfilling and may therefore require a capacity to relieve liquid LP Gas at the maximum filling rate.

5.2.3 Isolation Valves

Care should be taken to ensure that the design and certified discharge capacity of pressure relief valves are not restricted by the introduction of check valves etc. which may be used to facilitate exchange whilst the tank remains in service, i.e. the relief valve(s) may have to have more capacity than that calculated without the check valve in order to deliver the correct amount of LP Gas when a check-valve is used (seek manufacturer's data for flow reduction).

- Manual isolation valves should not be fitted between the tank vapour space and a single pressure relief valve. They may inadvertently be left closed and block the PRV.
- With single pressure relief valves - an automatic shut-off valve should be installed to allow for the removal of the relief valve for servicing/testing to take place; this should be fully 'open' when the relief valve is in place and 'closed' before the relief valve is removed. The tank should never be left unprotected and a replacement relief valve should be fitted immediately.
- Where multiple pressure relief valves are fitted with provision to allow for the removal and servicing of individual pressure relief valves, the remaining pressure relief valves should have adequate capacity to provide full protection for the tank.

5.2.4 Vent Pipes

Vent pipes are fitted on pressure relief valves to prevent ignited LP Gas flames from impinging on the tank, pipework, equipment or nearby tanks. They should be used on above-ground tanks over 1,500mm internal diameter and greater than 5,000 litre water capacity. In fitting vent pipes, the following should be considered:

- Vent pipes should be adequately supported, with outlets at least 1.8 metres above the tank to which they are fitted.
- Vent pipes should be carefully designed to avoid the risk of mechanical damage to the relief valve(s).
- Vent pipes should be protected against corrosion and be fitted with loose-fit rain caps, with provision for water drainage.
- Vent pipes may need protection in high wind areas.

5.3 Drain Connections

LP Gas tanks require a specific valve and piping arrangement to ensure draining can be done safely and the freeze up of drain valves is to be avoided.

5.3.1 Specifications

- Drain connections should be provided with two shut off valves in series which are of the quick acting type. The nominal bore diameter of the valves should not be greater than 50mm.
- 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.
- The two valves should be separated by at least 500mm to avoid freezing water, which may be present in the LP Gas, obstructing both valves at the same time, but close enough to allow operation of both valves by a single person.
- The second valve, and piping, should be adequately fixed in place to prevent breakage by vibration and jet forces or mechanical damage and should not discharge under the tank.
- At customer premises the drain pipe and second valve should be removed and the primary valve plugged or flanged off. When draining is performed by trained personnel they should bring with them the required drain pipe and second valve. At depots the entire drainage assembly may remain in place. Small tanks may alternatively be fitted with a check valve and internal dip tube.

- Keeping the second valve to not greater than 25mm nominal bore diameter and using spring-loaded dead man operation type can enhance the safety of the installation.

5.3.2 Safety Distance

Drain lines should discharge more than 6 metres away from any system of surface water drainage.

5.4 Contents Gauges

5.4.1 Purpose

Content gauges are used for indicating accurately when a tank is full at its maximum normal capacity. Gauges that operate by releasing LP Gas into the atmosphere should have a maximum opening diameter of 1.5mm.

Contents gauges should indicate clearly whether they read in % of water capacity, % of fractional LP Gas capacity, or actual contents in gallons, tonnes, etc.

5.4.2 Fixed Liquid Level Devices

These indicate when the maximum liquid level is reached during filling by allowing vapour or liquid to discharge to atmosphere from a valve attached to a dip tube, the design length of which is determined by the maximum permissible fill for the grade of LP Gas stored. Where possible, bleed jets from fixed liquid level gauges should be fitted so that the discharge jet is vertical. This enables the most rapid dilution of the vapour cloud and the least possible size of flammable cloud.

5.4.3 Tanks below 5,000 litres

Tanks below 5000 litres will normally be fitted with a simple magnetic float gauge in addition to the mandatory fixed liquid level device.

5.4.4 Tanks 5,000 litres and above

These should normally be equipped with a contents gauge which may be a simple magnetic float gauge, capacitance gauge or rotary gauge etc., in addition to a fixed liquid level gauge. Larger storage tanks in terminals and depots requiring more accurate content gauges for stock accounting purposes are typically equipped with radar type level gauges.

5.4.5 Maximum Level Fill Stop Valve

An alternative to a fixed liquid level gauge described in 5.4.2 is a purpose designed automatic shut-off valve which is activated by a float or other means so that it shuts positively during filling when the maximum level is reached. Fill stop valves and actuation mechanisms should be of adequate proven reliability for a life expectancy not less than the storage tank inspection or maintenance interval.

5.4.6 Slip Tubes and Sight Glasses

These devices are not recommended for use as level indicators on LP Gas tanks for safety reasons. They should be replaced with more suitable devices when the tank is next gas freed.

5.4.7 High and Low Level Alarms

These may be fitted to monitor abnormally high and low liquid levels. High level alarms if fitted should be designed to interlock with emergency shut down valves (ESD) to shut off the flow of LP Gas into the storage tank when the highest set point has been reached. Low level alarms are fitted as protection for pumps against cavitation or “dry running”.

5.5 Service Valves

5.5.1 Requirements

All tank vapour and liquid service outlet connections should have a service/isolation valve, except where pressure relief valves are fitted or tank connections are less than 1.5mm in diameter. They should be suitable for LP Gas and be fitted directly to the tank or immediately after the first flange.

5.5.2 Protection

Vapour connections greater than 8mm diameter and liquid connections (including drains) greater than 3mm diameter should be protected with an excess flow valve (installed upstream), non-return valve or a remotely operated emergency shutdown valve.

5.5.3 Multi-Valves

Vapour service valves on small tanks (typically up to and including 9,000 litre water capacity) may be incorporated in either individual or combination brass multi-valves. This eliminates the need to have too many openings on a small tank.

5.5.4 Liquid Service Valves

These should be fire safe, quick acting ball valves. For tanks up to and including 9,000 litre water capacity a specifically designed LP Gas liquid offtake valve incorporating an excess flow valve may be used.

5.6 Filling Connection

5.6.1 Direct Connection

Tanks should be equipped with a liquid fill connection, which connects directly to the vapour space of the tank. The filling connection should be positioned for easy access to connect the filling gun. For larger tanks, this can be achieved by extending the fill connection at the top of the tank to a convenient point at ground level to avoid having to drag the filling hose up access steps. Alternatively, the liquid fill connection can be designed to enter tank via a welded boss and internal pipe to the vapour space.

5.6.2 Spray Filling

The internal discharge from fill connections should be designed to form a liquid spray in the vapour space of the tank to facilitate rapid transfer. Care should be taken to avoid liquid spray entering the vapour service connections.

5.6.3 Manual Shut-Off

The filling connection should be equipped with a manual shut - off valve and automatic back check valve. On tanks below 5,000 litres capacity where a manual shut-off valve is not fitted, the delivery tanker should use a filling gun adaptor with an additional back check valve. If the automatic filler valve on the tank fails to close, the adaptor on the end of the filling gun can be left in place and capped to seal off the leakage until the valve on the tank can be replaced. The road tanker should therefore carry a spare adaptor if it is to continue making deliveries to similarly equipped tanks.

5.6.4 Vapour Balance

During the filling operation, pressure inside the tank may increase and vapour balancing lines will help equalise the pressure between the delivery vehicle and receiving tank to expedite filling. This is commonly used for internal depot transfers but not recommended for metred customer deliveries because the vapour returns are not accounted for in the metred quantity.

5.6.5 Couplings and Adapters

- Filling systems should be designed and installed to avoid the use of adapters during normal operations. A common system used in the industry is the ACME type quick connect coupling. Right Hand Acme threaded couplings are normally used for tanks storing commercial grades of odourised LP Gas. Left Hand Acme threaded couplings are used for tanks storing unodourised product for distinction (see 4.6.5). ACME couplings come in different thread sizes and the correct one should be selected for compatibility.
- Self-sealing couplings provide added safety but are not compatible with ACME couplings. They are designed to emit minimal LP Gas and seal automatically once disconnected from the fill point even when disconnection occurs accidentally.
- Where there is an opportunity to standardise to one type of fill coupling, use of self-sealing couplings is recommended.

5.7 Hydrostatic Valves

5.7.1 Requirement

Wherever liquid LP Gas may be trapped along the pipework (for example between shut-off valves or blank flanges), protection against excessive pressure caused by thermal expansion of the contents should be provided. This is normally achieved by the use of hydrostatic relief valves.

5.7.2 Discharge Setting

Hydrostatic relief valves should be set to discharge above the maximum working pressure in the line but not greater than the design pressure of the pipework and components in the section to be protected. For hydrostatic relief valves which discharge to the open air, the set pressure should not be less than the following:

Propane: Not less than 24 bar gauge (Not less than 18 bar gauge where ASA150 or equivalent flanges are used);
Butane: Not less than 10 bar gauge.

5.7.3 Installation

Hydrostatic relief valves which discharge to the open should be located and orientated so as not to endanger personnel, tanks or equipment, and should be fitted with rain caps where their location dictates.

5.8 Emergency Shutdown Valves

5.8.1 Type

Emergency shutdown (ESD) valves are remotely operated, positive, fail closed, shut-off valves, used to isolate tanks and sections of piping/equipment in emergency situations.

5.8.2 Automatic Operation

ESD valves should preferably be actuated automatically, e.g. by a fusible link in the energy supply to the actuator, by the plant alarm system and/or gas detection system, or by manual control. They should preferably be pneumatically actuated and designed to operate in a controlled manner (not snap action) to avoid pressure surges which could lift hydrostatic relief valves, or on opening cause inadvertent operation of excess flow valves etc.

5.8.3 Installation

ESD valves should be installed for liquid service connections from tanks having a nominal internal diameter greater than 25mm and where:

- There are routine LP Gas depot operations such as cylinder filling, tanker transfer activities or
- The public has unrestricted access to the activity e.g. hospitals or school, or
- Where there are people not familiar with the emergency procedures and prompt evacuation would be difficult e.g. Autogas refuelling sites and fork lift truck facilities.

Consideration should be given to installing ESD valves in smaller sized liquid services or even vapour services at strategic points in critical locations such as Autogas refuelling sites and cylinder filling plants to ensure overall emergency control.

5.8.4 Locations

Careful attention should be given to the location of the remote controls for ESD valves, and to the number of ESD valves included in a single shut-down system. For example, in a small depot or customer installation it may be considered safer to include all ESD valves in a single system, such that all ESD valves in the system are closed simultaneously, whereas in other plants it may be necessary to use several ESD systems.

The shutdown controls should be located at various positions over the site and should be clearly indicated with an appropriate notice.

- For LP Gas depots and filling plants, the location of the controls for opening ESD valves will depend on the manner in which the plant is supervised and operated, but the number of positions from which the ESD valves can be activated should be limited to the minimum required for safe operation.
- For Autogas sites, the controls should be located at the control point in the sales kiosk, LP Gas tank compound adjacent to each exit, and incorporated at the site main exterior emergency switch.

5.9 Pressure Gauges

Pressure gauges, when fitted, should be installed directly into the vapour space of the tank and easily readable from ground level. Pressure gauge connections should be protected either by a tapping reduced internally to a bleed hole not larger than 1.5mm diameter or by a suitable excess flow valve and shut-off valve.

5.10 Temperature Gauges

Temperature gauges, when fitted (normally for stock accounting purposes), should be installed in blind pockets. These should be in the form of blind tubes of suitable length and strength, oil filled, permanently welded to the tank and constructed in accordance with the tank design Code.

5.11 Lightning Protection

Lightning protection is often not required on LP Gas tanks, but local requirements should be checked and applied, particularly in respect of vertical tanks.

Chapter Six

Pumps, Compressors, Vapourisers and Dispensers

6.1 General

- The design of pumps, compressors, vapourisers, etc. and the materials used in their construction should be suitable for the safe handling of LP Gas over the range of pressures and temperatures that the product will reach in service.
- Pressure containing castings should be of suitable carbon steel that have adequate ductility and resistance to brittle fracture.
- The electric motor used should be suitable for operating in a potentially flammable atmosphere according to the zone if located within a hazardous area Zone 1 or 2.

6.2 Pumps

6.2.1 Design

Pumps used at LP Gas installations should comply with the following:

- Designed with internal bypass to minimise heating of recirculated products which could lead to cavitation. Positive displacement pumps should have a bypass or other suitable protection against excessive pressures.
- The available pressure head at the pump inlet at maximum off-take rate under the most onerous specified operating conditions should be adequate to ensure proper operation and avoid cavitation.
- Equipped with mechanical seals rather than packed glands.
- Protected by guard such that no part of the transmission is left exposed, to avoid personnel coming into contact with moving parts.
- Protected against dry running where pump is installed on Autogas fuelling sites.

6.2.2 Installation

Pump installations should meet the following requirements:

- Pumps should not be located under tanks.
- Flange connections should be arranged such that a gasket failure would not result in direct flame impingement on LP Gas tanks.
- Correct alignment of drive unit and pump should be ensured if they are not integral units.
- Pump sets should be installed rigidly on suitable foundations.
- Suction piping should be as short and direct as possible.
- Positive displacement pumps, and ideally centrifugal pumps, should be fitted with a bypass back to the LP Gas storage tank to prevent excessive pressure developing.
- A suitable strainer/filter should be fitted on the pump inlet.
- A flameproof isolation lockout should be fitted adjacent to the pump set, to prevent remote starter operation during maintenance shutdown.

6.3 Compressors

6.3.1 Design

Compressors used at LP Gas installations should comply with the following:

- Oil free compressors should be specified to ensure acceptable product quality.
- A liquid trap should be fitted in the suction piping to prevent liquid entering the compressor.
- A pressure-relieving device should be fitted on the delivery side of the compressor.
- A high-pressure shut-off switch (or similar) should be fitted on the discharge side.
- A flame proof means of isolation with lockout should be fitted into the compressor motor supply to protect personnel and equipment against inadvertent operation.

6.3.2 Installation

Compressor installations should comply with the following:

- Located in the open air, with good ventilation, at least 1.5 metres from buildings, boundaries and any LP Gas tanks.
- Located in buildings only if they are purpose-built (and used) and made of non-combustible materials, with good (especially low level) natural ventilation and a lightweight roof.

6.4 Vapourisers

6.4.1 Types

There are five basic types of vapouriser, all of which should be capable of vapourising LP Gas at the maximum offtake rate needed from the installation:

- Low pressure steam-heated
- Hot water heated
- Electrically heated
- Direct gas fired (This type of vapouriser should not be used and should be removed at the earliest opportunity)
- Atmospheric

6.4.2 Design

Vapourisers used at LP Gas installation should comply with the following requirements:

- Heat exchangers should be designed and constructed in accordance with an approved pressure vessel code.
- The design pressure should be not less than 17 bars or the set pressure of the relief valve whichever is the greater. In all cases the design pressure should be at least that of the LP Gas liquid installation.
- Shell and tubes in contact with LP Gas should be constructed of steel.
- The design of hot water and steam units should ensure that there is no risk of water (or steam condensate) freezing during periods of high offtake or low ambient temperature conditions.
- The vapouriser capacity should be not less than that required for the conversion of liquid to vapour at a temperature above dew point at the maximum first stage regulator inlet pressure and maximum offtake rate.
- The vapouriser and all piping components and relief valves up to and including the discharge valve should be designed for the same conditions as the inlet pipework.

6.4.3 Location

Vapourisers should be sited such that the minimum distance from the nearest important building or line of property is as follows:

- 3 metres up to 36 kg/hr capacity.
- 7.5 metres from 37 to 227 kg/hr capacity.
- 15 metres over 227 kg/hr capacity.

Vapourisers may be mounted on the wall of a building if it can be considered to be a fire wall, with a defined fire resistance and have no openings.

6.4.4 Precautions

Precautions should be taken to:

- Prevent the accumulation of condensate in all pipelines carrying LP Gas vapour. This may take the form of insulation or heat tracing. Drain pots should be provided and all horizontal pipe runs should be inclined slightly rising away from the vapouriser so that any condensate runs back to a drain pot.
- Avoid freezing of the steam condensate or water associated with steam or hot water vapourisers.

6.5 Dispensers

6.5.1 Design

LP Gas dispensers used at Autogas fuelling sites should comply with the following:

- Equipped with a suitable flexible hose and filling control nozzle; liquid flow should only be possible when the nozzle is connected to the vehicle's fill connection. The design of the nozzle should both minimise the release of LP Gas at disconnection and provide means for safely venting any liquid that may be trapped in the nozzle.
- Dispensing is controlled by a "dead man's handle" where release of the control handle or button will stop the flow of LP Gas through the dispenser.
- Dispenser hoses are provided with a breakaway/pull-away coupling correctly designed and installed to minimise damage and loss of product due to a vehicle driving off whilst still connected to the dispenser.
- Excess flow valves or emergency shutdown valves (ESD) are provided to prevent uncontrolled release of LP Gas in the event of hose failure or vehicular impact on the dispenser. The excess flow valve or ESD should be positioned in such a way that it remains intact and functioning even after the dispenser has been damaged.
- A provision for a shear valve or dry break valve in the dispenser base to shut off in case of high impact.

6.5.2 Installation

- LP Gas dispensers and filling hoses anchoring points at Autogas refuelling sites should be positioned so that:
    - Vehicles can be re-fuelled easily in a convenient position.
    - Vehicles being re-fuelled do not restrict the movement of others.
    - Hoses should not be twisted or extended unduly.
    - Hoses should not be damaged by contact with vehicles, stanchions' or other obstructions.
- The meters and filling hose attachments to fixed pipework should be located so as to minimize the chance of vehicular damage and consideration given to protection by the use of bollards, crash barriers or kerbing or mounting on a raised plinth.
- At attended self-service re-fuelling stations, meters and filling hoses should be located where the vehicle being filled can be adequately viewed and supervised from the sales kiosk.

- ESD control buttons/switches should be located in the sales kiosk and on the forecourt and be readily accessible to the cashier/operator to isolate the electrical supply to pumps and dispensers and to allow remote operation of the ESD valves on LP Gas storage tanks and, where fitted in LP Gas liquid risers to dispensers.

Chapter Seven

Pipework and Regulators

7.1 Pipework

7.1.1 Design

- Pipework and fittings should comply with the relevant standards and be of a material suitable for LP Gas and the extreme service conditions likely to be encountered.
- The number of joints in pipework should be minimised. In steel pipework over 50mm nominal bore it is particularly important to minimise the number of flanges.
- Pipework should be welded where possible and flanges should as much as possible never be orientated in a position where the failure of a gasket could result in an ignited leakage causing a jet flame to impinge on an LP Gas tank or other pressurised equipment.
- In addition it is important to remember that one release if ignited may cause a cascade effect by impinging on another fitting. Eliminate this possibility by good design.

7.1.2 Materials

Materials commonly used in LP Gas pipework are:

- **Carbon Steel** - Seamless pipe to an acceptable thickness or galvanized heavy/medium weight welded seam pipe.
- **Copper** - Half - hard or annealed solid drawn copper. The risks of work hardening should be considered. Copper pipes or tubes are not suitable for pipework carrying liquid LP Gas.
- **Polyethylene (PE)** - This type of pipe, if to a suitable standard, can be used for LP Gas vapour and LP Gas/air mixtures, providing it is mostly buried. In general, medium density PE is suitable for use with LP Gas vapour at pressures up to 4 bar and a temperature range of minus 20oC to 40oC.
- **Corrugated Stainless Steel** - Proprietary brands of flexible stainless steel pipe may be used for underground liquid LP Gas service at Retail forecourts and similar installations.

7.1.3 Types of Pipework

LP Gas pipework can be classified as follows:

- Vapour application below 5 bar - Carbon steel, copper up to 35mm diameter or PE may be used underground.
- Vapour application 5 bar and above - Seamless carbon steel to an acceptable thickness or copper up to 15mm diameter may be used.
- Liquid application - Seamless carbon steel to an acceptable thickness should be used.
- Over 50mm nominal bore - Seamless carbon steel to an acceptable thickness should be used.

7.1.4 Type of Fittings

- Screwed joints may be used for pipework with an outside diameter of 50mm or less.

- Welded or flanged joints (except when attaching to equipment with screw fittings) should be used for outside diameters greater than 50mm and should be of an appropriate class and be raised face weld neck type. Spiral wound graphite filled metal gaskets (ASME B16.20) are preferred over asbestos gasket for flanges in pipework carrying liquid LP Gas. Jointing compounds for screwed connections, flanged gaskets and any other component parts should be suitable for use with LP Gas.
- Heat fusion or mechanically jointed fittings may be used for copper or polyethylene pipe. The latter should be designed to resist the pipe from pulling out.

7.1.5 Supports and Anchors

- Pipework supports and anchors should be located and designed to ensure that pipework stresses and deflections due to predictable loads are within acceptable limits. If necessary this should include flexibility to accommodate any unavoidable movement.
- In determining pipe supports and their location consideration should be given to loads other than self-weight and other predictable loads, e.g. for small pipework superimposed loads due to personnel standing on or pulling on pipework.
- Vibration, surge pressures and valve operating torque should be considered in the design of pipework and supports incorporating mechanical equipment such as pumps and valves.
- When laid in an open trench, pipework should be supported above the bottom. The trench dimensions and pipe supporting arrangements should be such as to facilitate visual inspection and maintenance e.g. wire brushing, repainting of the pipe and supports. Trenches should not enter buildings.
- Protection should be provided in the form of load-bearing slabs or covers for those sections over which traffic passes or on which other loads may be superimposed.

7.1.6 Routing

The routing of piping should be designed to minimise pipe contents and thereby reduce the potential hazard. The chosen pipe route should:

- Minimise risks of vehicle damage (e.g. avoid site roads or protect with bollards).
- Preferably run above ground and in the open air where practicable.
- If buried or underground, pipes should be inherently resistant to corrosion. e.g. manufactured from polyethylene or if steel then adequately protected by cathodic protection, bitumen/tar wraps, impregnated tape etc.
- Avoid or protect from extremes of cold or heat.
- Avoid running pipe-work through buildings if carrying liquid LP Gas or where the vapour pressure is likely to be above the national standard low-pressure. Where this is impractical, the pipe length should be minimised, protected from physical damage and ventilation around the pipe maximized within the building.

7.1.7 Electrical Continuity

- Pipelines, fittings and hoses used for liquid phase LP Gas transfer should have electrical continuity and be reliably connected to earth. The resistance to earth should not exceed 106 ohms in order to avoid the buildup of static electricity. Achieving a resistance of no more than 100 ohms should not be difficult and, unless the pipes suffer significant corrosion, this is unlikely to degrade over time to levels above 106 ohms.
- It is not usually necessary to bridge flanges with bonding straps to achieve an acceptable level of continuity, however it may be necessary to bridge certain types of valve and connecting joints with a bonding strap to obtain continuity.

7.1.8 Flexible Hoses

Flexible hoses used in LP Gas installations and Autogas refuelling sites should comply with the following:

- Flexible hoses used in LP Gas service should be designed and manufactured in accordance with relevant design code. Specifically, rubber hoses should comply with EN 1762, composite hoses to BS EN 13766 Class A Type 1 and metallic hoses to BS 4089 specifications or equivalent.
- Hoses for LP Gas service should be designed for a minimum working pressure rating of not less than 25 bar and a minimum burst pressure of 100 bar.
- Hoses should be electrically continuous. If rubber hoses are steel wire-braided or reinforced, these should be of stainless steel.
- Hoses should be in one continuous manufactured length without intermediate joints or couplers, except for Autogas dispensing hoses where an intermediate pull-away coupling is fitted; and there should be no more than two lengths.
- Protected by hydrostatic relief valves to the lower of fixed pipe operating pressure, or the design maximum for the hose, and fitted with emergency isolation devices to prevent risk of LP Gas leaking from a failed hose. This may be in the form of excess flow valve, remotely operated valve or non-return valve.

7.1.9 Above Ground PE Pipework

Where PE terminals are brought above ground at tanks or premises, the exposed pipework should be shielded from mechanical or ultra-violet damage by sleeving, and normally limited to no more than 2 metres and in any case as short as practicable. Alternatively, a suitable fitting may be used below ground to achieve the transition to metal pipework on either or both terminal transitions.

7.1.10 Underground Pipework

Pipework buried in an open trench, which is back-filled with noncorrosive material, should meet the following requirements:

- Backfill should contain no abrasive and potentially damaging particles. For metal pipes anti-corrosion measures should be used, e.g. cathodic protection, bitumen/tar overwraps, proprietary wax impregnated tape etc.
- In general, underground liquid or tank pressure pipework should be avoided. Where this is unavoidable, pipework should be protected from vehicular loading by installing either load-bearing covers or exclusion fencing. Pipework should be run in a shallow brick or concrete lined trenches covered with open grids where appropriate for safe pedestrian access.
- Design should compensate for any extra constraint or loading or constraint due to backfill or underground siting.
- Where any kind of superimposed load may occur, the pipe affected should be protected with covers or well-supported load-bearing slabs.
- Isolation valves should be fitted at both ends of the underground length of pipe.
- Pipes carrying flammable or inert liquids may be laid in the same trench but NOT pipes carrying toxic or corrosive materials.
- Do not run pipework in the same trench as electric cables unless an outer sleeve or pipe insulates them.
- Electrical cables should be separated at least 300mm from LP Gas pipework.
- Where cathodic protection is used on LP Gas pipework specialist advice is required.
- A plan should be made to record the pipe layout and, if possible, permanently mark the route above ground.

7.1.11 Pipework Used to Carry Liquid and/or Vapour at Tank Pressure

Pipework carrying liquid LP Gas and/or vapour at tank pressure should comply with the following:

- Should be well supported and installed.
- Either load-bearing covers or exclusion fencing should be installed. Pipework should be run in a shallow brick or concrete lined trench covered with open grids where appropriate for safe pedestrian access.

- As an alternative to using a brick or concrete lined trenches, liquid-containing pipe may be run inside an outer 'sleeve' pipe, ensuring that this is sealed at both ends (with at least one end accessible for inspection) and the space between inner and outer pipes is monitored for leaks (e.g. by detecting pressure changes).
- Hydrostatic relief valves should be fitted in any pipework in which liquid LP Gas may be trapped (e.g. between shut-off valves) to protect against excessive pressure. Where possible do not fit these valves beneath tanks. Valves fitted under tanks should not allow LP Gas to escape across the tank surface or nearby access points. Atmospheric discharges should be to the open air and should not pose any danger to life or equipment. Where possible hydrostatic relief valves should be orientated to discharge upwards to maximise dispersion of the LP Gas vapour.

7.2 Pressure Regulators

7.2.1 General

Pressure regulators control wide variations in tank pressure and deliver the required outlet pressure despite a variable gas flow caused by intermittent use. Installing the incorrect type of regulators can result in malfunction of the LP Gas consuming equipment.

7.2.2 Types

There are three basic types of regulators

- First stage (high-pressure) - Designed to reduce vapour supply pressure to the required intermediate high pressure. Used as a first stage regulator in a two-stage system or where a high outlet pressure is required.
- Second stage (low-pressure) - Designed to reduce intermediate pressure to the required final operating pressure.
- Single-stage - Designed to reduce vapour pressure down to final operating pressure in a single stage.

Although single-stage, low-pressure regulators have been used in some countries with bulk tanks (and they are usually the norm with simple LP Gas cylinder usage) they should not be used with bulk supply systems as they are more susceptible to freezing. Two stage systems give better pressure control performance and enable the use of small bore piping.

7.2.3 Design

Regulators should comply with a recognised standard. The design, materials and construction should be suitable for the full range of operating conditions. Additional safety controls such as pressure relief valves and high/low pressure cut-offs may be specified depending on the application.

7.2.4 Selection

Regulators suitable for LP Gas should be selected by an assessment of the following factors:

- Climatic conditions - should be suitable for ambient temperature range in country of use, designed to prevent the ingress of rain/snow and insects etc., resistant to corrosion (especially in marine environments) etc.
- Flow capacity - should be big enough for highest demand of equipment (but avoid excessive over capacity to ensure good control performance under low flow conditions and minimise cost).
- Inlet pressure - anticipated range.
- Delivery pressure - specific or range.
- Gas demand - the total gas requirement for all the equipment being supplied.
- Regulator setting point and performance curves - to match the requirements of the installation.
- Connections - inlet and outlet thread or flange size and form.

- Additional safety controls - such as under/over pressure shut-off, partial pressure relief etc.
- Installation conditions, e.g. underground and mounded tanks - perhaps additional corrosion protection measures may be necessary, or if the location could be flooded then breather and relief vents should be extended to a point where water ingress can be prevented etc.

7.2.5 Installation

Ensure that:

- Regulators are adequately supported and correctly orientated in accordance with manufacturer's instructions.
- First stage regulators are located as close as practicable to the tank/vapouriser connection.
- Second stage regulators are located on the exterior wall of the supplied premises. They should not be installed inside buildings other than in exceptional circumstances, and in such circumstances the vent and any relief valve etc. should be piped to the outside of the building.
- Consideration is given to the security of regulators if unauthorised interference is a possibility.

7.3 Identification and Markings

7.3.1 Pipe Colour Code

Use logical markings or colour code to communicate the contents and whether vapour or liquid phases are present. In many locations the practice is to paint vapour lines yellow and liquid lines blue for distinction.

7.3.2 Valves and Connections

The following should be clearly marked and identified for each valve/connection:

- How to operate manual isolation valves?
- How/where to operate remote isolation valves?
- How/where to operate manual fixed water drench systems?
- Adjacent connections for propane and butane loading and unloading.
- Pressure relief valve set pressure.

Chapter Eight

Electrostatic and Electrical Precautions

8.1 Electrostatic and Electrical Precautions

8.1.1 Requirement

Provision should be made to ensure that no electrostatic potential exists between the tanker delivery connection and the stationary tank fill connection which could generate a spark when the connection is made, or broken. The following should therefore apply:

- All tanks except those whose capacity does not exceed 2,500 litres water capacity should be permanently bonded to an effective grounded earthing point to prevent any build up of any static electricity. The earthing point should be situated so that it is readily available for the tanker to discharge any static electricity by means of its earthing cable before the delivery hose connection is made.
- For tanks up to and including 2,500 litres water capacity, a bonding connection may be provided on the tank to allow the direct attachment of the tanker earthing/bonding cable before making the delivery hose connection.
- Underground tanks which are not fitted with cathodic protection require an earthing rod.
- Underground tanks which are fitted with cathodic protection and do not require an earthing rod should have a bonding connection on the tank to allow direct connection by the delivery vehicle earthing lead.

8.1.2 Earthing Connections

Earthing connections should comply with the following:

- Electrical continuity between the tank transfer connection(s) and the earthing point or bonding connection, through the tank should be ensured. Earthing or bonding connections should always be kept clean, unpainted and free from corrosion to ensure a good electrical connection.
- Earthing points should have low electrical resistance to earth and never greater than 1 x 106 ohms to ensure the satisfactory dissipation of static electricity.
- For LP Gas depots, the use of a permissive system linked to tanker bonding, where transfer of LP Gas cannot take place until bonding is continuous, is a good practice.

8.2 Electrical Equipment Installation

- All permanent electrical equipment installed within hazardous areas (see 8.3) should conform to recognized standards for ignition protected equipment.
- Electrical cabling and connections should be made in accordance with the equipment manufacturer's instructions and tested in accordance with local regulations.
- Flame proof glands and connections should be correctly assembled and all access covers securely fastened. Ensure any painting has not covered the flameproof gap.

8.3 Hazardous Areas

- Hazardous areas are areas in which an explosive gas atmosphere is present, or may be expected to be present, under "normal operations" in quantities such as to require special precautions. Practically, for LP Gas, these are areas where the percentage of LP Gas in air by volume may be between its flammability limits of 2% and 10%.
- "Normal operation" occurs when the installation is used within its design parameters (as defined within EC Directive Annex 1, note 2). Failures (such as the breakdown of pump seals, flange gaskets or spillage caused by accidents) are not normal operations.
- Hazardous areas are classified into different zones based on likelihood of presence of combustible gases.

8.3.1 Area Classification

- Zone 0

  An area in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas vapour or mist is present continuously or for long periods or frequently.

  Note: In the LP Gas industry there are no Zone 0 areas. Even the inside of an LP Gas storage tank does not satisfy the definition of Zone 0 because there is no mixture with air.

- Zone 1 Hazardous Area

  An area in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas vapour or mist is likely to occur in normal operation occasionally.

  Note: This would normally be the result of a "primary grade of release". i.e. an area immediately around a cylinder filling head.

- Zone 2 Hazardous Area

  An area in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short time. All electrical equipment installed in hazardous areas should comply with the requirements for that area.

- Non-Hazardous Area

  An area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of apparatus.

- Temporary Hazardous Area

  A hazardous area existing only while equipment is temporarily present and it is being operated to give the possibility of the presence of an explosive atmosphere. As a consequence temporary activity will lead to a temporary hazardous area. e.g. there would be a temporary hazardous area at an LP Gas road tanker loading bay while the tanker ullage gauge is in use or the hose is being disconnected.

8.3.2 Application of Area Classification to LP Gas Facilities

- The area classification for cylinder filling plants, LP Gas terminals and depots including in Table 7 is applicable to the following:
  - Cylinder filling plants

- LP Gas terminals and depots including all storage and transfer facilities
- Road tanker loading and unloading facilities
- Ship and barge loading and unloading facilities
- Rail tanker loading and unloading facilities

- At all other sites including domestic installations, commercial installations such as restaurants, hotels, factories and Autogas refuelling locations, local regulations will apply to installation of electrical equipment. Where local regulations do not exist, no electrical equipment should be installed within 2.5 metres of any LP Gas filling point, connection point, fixed ullage gauge, pump, compressor, vapouriser or relief valve unless it is rated for application for the Zone 1.

- Appropriate measures should be taken to ensure that equipment that might provide a source of ignition is not within the hazardous zone during connection and disconnection of LP Gas supplies, or maintenance work involving the opening of any part of the LP Gas system.

Table 7 Application of Area Classification to LP Gas Facilities

ACTIVITY/EQUIPMENT	LOCATION	AREA CLASSIFICATION	Notes
Disconnection point of hoses or hard arms following completion of product transfer operation between LP Gas storage tanks and road tankers/ships or vice versa	Depot Terminals Filling plants	**Temporary Zone 1** : 0.5 m radius around coupling-to-coupling break point or bleed point for release of inter-coupling product.	1,7
	Jetty	**Temporary Zone 1** : 2.5 m radius around coupling-to-coupling break point or bleed point for release of inter-coupling product.	2,7
LP Gas pumps and compressors	Depot Terminals Filling plants	**Zone 1** : 0.5 m radius around LP Gas wetted external pump shaft seals. Unclassified for canned or magnetic drive pumps.	3
LP Gas additive injection, including methane and ethyl mercaptan, typically at terminals and depots	Depot Terminals Filling plants Transfer facilities	**Zone 1** : 0.5 m radius around LP Gas wetted external pump shaft seals. Unclassified for canned or magnetic drive pumps.	3
Bulk storage in depots, terminals, and commercial premises, above ground, underground or mounded	Depot Terminals Filling plants	**Zone 1** : 0.5 m radius around the bleed point for the fixed ullage gauge or rotogauge type contents gauge(s).	1
Filling cylinders inside a building at a cylinder filling plant	Filling plants	**Zone 1** : in a range of radii between 0.5m and 2.5m around the filling machine depending on the volume of LP Gas released when the filling gun disconnects. **Zone 2** : for the rest of the cylinder filling building	4
Filling cylinders in open air at a cylinder filling plant	Filling plants	**Zone 1** : in a range of radii between 0.5m and 2.5m around the filling machine depending on the volume of LP Gas released when the filling gun disconnects.	5
Venting residual LP Gas from cylinder in the open air prior to revalving or refurbishing	Filling plants	Zone 1 : 2.5 m radius around the cylinder venting area.	
LP Gas cylinder storage area	Filling plants	Non hazardous area	6
Cylinder loading and unloading from means of transport	Filling plants	Non hazardous area	6

Notes:

1. See Ref 1, chapter 9.7.8.2 of ADR 2007. This reference requires a 0.5 metre radius Zone 1 around venting devices.

2. A release of LP Gas takes place when a pressurized hose is disconnected. Normal practice would be to release this pressure via a bleed valve of no more than 1.5mm diameter until atmospheric pressure is reached. The pressure of release declines rapidly from the operating pressure to atmospheric. The worst possible case would be for the pressure to remain constant throughout the release, creating a jet of LP Gas. This jet has a dispersion distance of 2.5m when calculated according to Ref 6, "Calculations in Support of IP15: Area Classification Code for Petroleum Installations" published by The Institute of Petroleum (now the Energy Institute), London.
3. Pumps with mechanical seals that are wetted by the product pumped will have a minute leakage rate which is ventilated very rapidly to below flammable limit by the minimum air movement conditions experienced. To be conservative in the estimation of hazardous area we have allowed a 0.5m zone around the pump seal. Pumps of a completely sealed design, normally using a magnetic coupling between motor and pump, will not create a hazardous area.
4. When LP Gas cylinders are being filled, the release rate to atmosphere depends on the type of cylinder valve and the type of filling head used to fill it. The volume released each time a filling head disconnects is quantifiable and the frequency of disconnection is also defined. Calculating the dispersion to lower flammability limit of typical releases produces distances from 0.5m to 1.5m. As rectification of leaking cylinders and other work involving cylinders may take place in a filling building, the whole building is classified as Zone 2 because occasional unplanned releases may take place at random locations.
5. When filling cylinders in open air the liquid released when a filling head disconnects is the same as for indoor operations and results in the same Zone 1 around the filling machines. The minor releases of vapour occurring during the other cylinder rectification operations do not give rise to a zone as they do not normally occur and are rapidly diluted to the lower flammability limit by natural ventilation.
6. Prior to transporting cylinders to a filling plant for filling the driver checks them for leakage, as it is not permissible to transport leaking cylinders. The empty cylinders will be stored at the filling plant prior to filling. During the filling process and after filling the cylinders are inspected and will not leave the filling plant if they are leaking. In addition to having a closed valve, the cylinders are capped by a secondary seal. There is therefore no situation in normal operations where a cylinder will release LP Gas to atmosphere.
7. Temporary hazardous areas, as defined in 8.3.1 above, should be marked and should not have any permanent equipment installed in the area that would create a source of ignition i.e. for the installation of equipment it is to be treated as a permanent zone. When the operation that created the temporary zone is not taking place, normal industrial equipment may enter the area. Procedures and controls should be in place to ensure that the temporary hazardous area is enforced during the operation requiring it. This is marking and signage for the area.

Chapter Nine

Fire Precautions

9.1 General

9.1.1 Principles

Minimise major fire risks (including escalation) through installation design, layout and resourcing that both comply with all relevant local legislation and codes of practice, and specifically optimizes:

- Best practice in engineering.
- The implementation and enforcement of sound operating procedures.
- Emergency procedures.
- Staff training (both routine and emergency procedures).
- Location of water supplies.
- Location and marking of shut-off valves.
- Access, protection and equipment for fire fighters.
- Contingency plans and drills for fire incidents.
- Arrangements to call fire brigade promptly in the event of a fire.
- Prevention or shutdown of any release of LP Gas is the most effective way of controlling an incident.

9.1.2 Responsibilities

Where the local fire authority is responsible for organising, equipping and maintaining a fire brigade and managing fire fighting operations, any fire which may threaten any LP Gas in storage should be attended by the fire brigade, who will take control of fire fighting operations on arrival, even if they involve site fire teams in their efforts.

9.1.3 Planning

The local fire authority may want to be involved in the planning of any new LP Gas storage facilities; if, during planning, further guidance on fire precautions is needed and cannot be found in this standard, consult the enforcing authority (see definitions).

9.1.4 Access

All sites should at all times be accessible without hindrance to fire fighters.

9.2 Fire Protection

9.2.1 General

- The most effective form of fire protection is for there to be no release of LP Gas or if a release occurs, to detect it immediately and shut it down. The use of gas and fire detection and shutdown systems should therefore be strongly considered where a risk assessment indicates that this approach would bring the risk to ALARP. It should be noted that such system can be effective if a rigorous testing is in place and their reliability can be demonstrated from comprehensive records.

- Research regarding fire protection of LP Gas tanks once a fire is in progress has led to the following conclusions:
    - The only sources of heat that threaten the integrity of an LP Gas tank are jet flames or pool fires.
    - Water sprays are ineffective against a jet flame and only a suitably positioned fire water monitor will deflect the jet flame from the surface of a tank.
    - Good design will significantly reduce the probability of a pool fire engulfing a tank, by directing any LP Gas spillage away from beneath the tank.
    - Fires adjacent to an LP Gas tank which do not engulf the tank in flames are unlikely to cause failure of the tank. However increased pressure can lead to additional release of LP Gas through relief valves.
    - Underground or mounded tanks are much less at risk from radiant heat and will only require protection for any exposed parts.
    - Whilst fixed water sprays have been specified to deliver cooling water to LP Gas tanks to protect against radiant heat, reliability has proven problematic. Systems have failed to deliver water to the full volume, reliably, in a number of emergency cases. Nozzles get blocked with scale, or pipes on the tanks have failed.
    - Water monitors positioned to deliver the equivalent volume of water and set in an appropriate pattern to cover all parts of the tanks in a dense water spray are considered more reliable than spray systems when needed.
    - Monitors have the additional advantage that should a jet flame impinge on a tank, water monitors can be redirected and adjusted to a narrower jet, to provide greater protection against this risk.

Given the foregoing this guideline recommends the following for large bulk installations:

For existing installations: Fixed water spray systems that perform reliably when required do not need to be replaced. However for any major facility refurbishment or if there are known problems with existing spray systems replacement with fixed water monitors delivering the same equivalent water volumes should be strongly considered.

For new installations: Fixed monitors are strongly recommended to be installed whenever possible. Some spray systems may still be required dependent on site layout if, for example monitors cannot be set to provide the required water coverage to all parts of all tanks. (e.g. the tops of spheres may best be covered using a water deluge system) All local operational staff should be trained in the use of the fire protection system including the adjustment of the monitors.

9.2.2 Methods of Protecting Tanks from Jet Flames or Pool Fires

- **Fire monitors** - Sufficient water supply, storage and numbers of monitors should be provided to enable any area of tank shell to receive a direct jet of water.
- **Intumescent coating** - Above ground tanks and exposed portions of mounded or buried tanks may be protected from radiant heat by intumescent coating. This will provide protection for a time stipulated in the design and application data for the coating.

9.2.3 Water Supplies

Where water is the chosen medium for prevention of radiation effects there should be enough water available for emergency use, specifically:

- Standard fire protection - the supply should be able to apply sufficient water for any tank at a rate of at least 9.8 litres per m2 per minute over the entire tank surface for no less than an hour.
- Sites with no reserve water supplies nearby - plan for standard fire protection plus extra capacity.
- Water re-circulating systems - the storage reservoir should hold 30 minutes supply without recirculation.

- Power failure - Plans should be prepared for what should happen in the event of a local power failure during fire-fighting efforts.
- Drainage - The drainage on site should be capable of handling the likely flow of water during fire-fighting or fire protection, and install water-sealed interceptors where necessary to prevent LP Gas entering storm drains and sewers.
- Control of water flow - The design of fixed drench and hydrant systems should allow control of water flow from the safety of distances greater than specified in Table 1 for distance to a public place. Additionally, the water supply to fixed drench systems should incorporate connections for fire- fighting use, at safe locations agreed with the local fire authority.

9.2.4 Fire Protection Equipment

The need for fire protection equipment at LP Gas storage sites depends on:

- The size of individual tanks.
- The site's maximum storage capacity.
- The frequency of tanker deliveries.
- The calculated fire risk according to site conditions (e.g. higher for a cylinder filling facility).

See 9.2.5 to 9.2.8 for standards generally demanded by enforcing authorities. Additional precautions may be necessary under certain conditions such as slow fire brigade response times, remotely located water supplies or high fire risks in adjacent sites.

9.2.5 Tanks Up to 56,250 Litres Water Capacity (25 MT of LP Gas)

Domestic and small commercial and industrial installations may be required to have a water supply sufficient for use by the fire brigade, easily accessible and no more than 100 metres from the tank; e.g. hydrants, rivers, canals, ponds, except for liquid offtake tanks with a water capacity greater than 15,750 litres (See 9.2.7); however, balance this with other advice in this guideline plus the likely fire brigade response and area evacuation times.

9.2.6 Remote Sites with Low, Easily Evacuated Adjacent Population

Distance from the water supply to the tanks may be over 100 metres, subject to agreement with the local fire authority and the existence of a detailed, fully publicised (i.e. to local residents) and tested evacuation plan.

9.2.7 Liquid Offtake Tanks Greater than 15,750 Litres Water Capacity (7 MT of LP Gas)

Minimum fire protection should be an appropriate fire fighting water supply plus, where liquid outlet connections have no remotely operated emergency valves, some form of tank radiation protection e.g. fixed/portable monitors or intumescent coating.

9.2.8 Total Tank Inventory of 56,250 Litres Water Capacity (25 MT of LP Gas) but less than 112,500 Litres Water Capacity (50 MT LP Gas)

Minimum fire protection should be an appropriate fire fighting water supply plus some form of tank radiation protection, e.g. fixed/portable monitors or intumescent coating.

9.2.9 Total Tank Inventory of more than 112,500 Litres Water Capacity (50 MT of LP Gas)

Minimum fire protection should be an appropriate fire fighting water supply plus fully automatic water delivery system triggered by a fire detector capable of detecting a fire threatening the tanks (i.e. not just an excess tank pressure sensor). Manual systems are only acceptable where there is 24 hour supervision, and these may be configured to target individual rather than all tanks; however, such systems should be activated remotely (See 9.2.2).

9.3 Other Facilities where Fire Protection is needed:

9.3.1 Cylinder Filling Sites

Tanks at these, and similar sites (e.g. aerosol filling sites), should be protected by fixed monitor systems or intumescent coating, unless the operation is very small (e.g. cylinder filling only for fork lift trucks).

9.3.2 Road Tanker Gantries

Road tanker gantries should have fire protection equal to that of the storage tanks if:

- Storage tank capacity exceeds 56,250 litres water capacity (25 MT of LP Gas).
- Road tanker loading/unloading averages twice or more per week (i.e. averaged over 6 months, including winter).

9.3.3 Rail Loading/Unloading Gantries

Fixed monitors or comparable fire protection should be provided.

9.3.4 Individual Versus Group of Tanks

In sections 9.2.5 to 9.3.2 tanks may be treated individually if they are spaced apart by a distance equal to the sum of the separation distances in Table 1 to a public place.

9.4 Portable Fire Fighting Equipment

9.4.1 General

All LP Gas storage sites should have enough of the correct portable fire fighting equipment to extinguish fires next to LP Gas tanks and prevent escalation of any incident. The 'correct' equipment comprising fire extinguishers and access to water will be defined by local or national fire protection standards or codes of practice, which will also specify an appropriate 'mix' of equipment, plus location, maintenance and levels of capability.

9.4.2 Requirement

- The fire extinguishers provided at all fixed LP Gas storage sites storing more than 4,000 litres water capacity (2 MT of LP Gas) should consist of at least two LP Gas-compatible fire extinguishers 9 kg capacity dry powder.
- Fire extinguishers are not required at domestic installations since users are usually untrained in LP Gas fire fighting.

Table 8 Fire Precautions Summary

INSTALLATION CAPACITY		PRECAUTIONS	Ref
Water Capacity (Liter)	**Nominal LP Gas Capacity (MT)**		
Less than 150-4000 (Domestic tank capacity)	Less than 1.1	-Water supply for fire brigade use up to 100 m away	9.2.2 9.2.3
Less than 150-4000 (Commercial and Industrial tank capacity)	Less than 1.1	-Water supply for fire brigade use up to 100 m away -Two 9kg dry powder extinguishers	
Greater than 4,000 to 56,250	Greater than 2 to 25	-Water supply for fire brigade use up to 100 m away -Two 9kg dry powder extinguishers	9.2.1 9.2.3 9.4.2
Greater than 15,750 (Liquid offtake tank capacity with remotely operated shutoff)	Greater than 7	-Water suppy Two 9kg dry powder extinguishers	9.2.1 9.4.2
Greater than 15,750 (Liquid offtake tank capacity without remotely operated shutoff)	Greater than 7	-Water suppy -Fixed and/or portable monitors -Two 9kg dry powder extinguishers	9.2.1 9.2.7 9.4.2
56,250 to less than 112,500	25 to less than 50	-Water suppy '-Fixed and/or portable monitors Two 9kg dry powder extinguishers	9.2.1 9.2.8 9.4.2
112,500 or more	50 or more	-Water suppy '-Fixed and/or portable monitors Two 9kg dry powder extinguishers	9.2.1 9.2.9 9.4.2
Cylinder filling		-Water supply '-Automatic fixed water sprays '-Two 9kg dry powder extinguishers	9.2.1 9.3.1 9.4.2

Note:
In all tank protection cases above, the requirement for water for tank cooling may be replaced with intumescent coating of the tank with a coating certified for one hour and applied and maintained in accordance with the manufacturer's instructions.

Chapter Ten

Tank Commissioning and Decommissioning

10.1 General

- Only fully competent, trained staff familiar with LP Gas tank commissioning and decommissioning should be assigned to carry out these procedures.
- For tanks up to 5,000 litres water capacity, the preferred approach is for most commissioning and decommissioning procedures to be carried out under controlled conditions at the LP Gas Company (or contractor) depot, using appropriate handling/transportation systems and methods, rather than at the customer's premises. Tanks above 5,000 litres water capacity would normally be dealt with at the customer's premises using specialised equipment and personnel.

10.2 Commissioning

10.2.1 Leak Testing/Purging Conditions

- Tanks, associated fittings, and equipment should have all the connections leak tested to a pressure not less than 3 bar gauge for butane, and 6 bar gauge for propane but no more than 90 per cent of the tank design pressure.
- During leak testing and purging care should be taken to ensure tank is not subjected to pressures, temperature or vacuum conditions outside its design criteria.

10.2.2 Testing

All tanks and associated equipment should be tested and certified fit for purpose prior to filling.

10.2.3 Purging

All tanks and associated fittings should be purged until there is insufficient oxygen inside to support combustion. To do so, the air should be either evacuated or replaced with inert gas, water or LP Gas.

- **Inert gas purging** - If inert gas is used (e.g. gaseous nitrogen or carbon dioxide), this needs to be removed from the tank with LP Gas, taking care to direct the purged gas/LP Gas mixture safely away from other tanks, ignition sources, boundaries, buildings or public places or to a flare stack. Care should be taken during purging to ensure the safe dispersion of unignited purge gases. If purge gases are flared this should be outside the normal separation distances.
- **LP Gas vapour purging** - When LP Gas vapour is used to replace air, the tank and fittings will for a period of time contain a flammable mixture. A competent person should vent this to atmosphere in a safe manner. A flame arrestor should be fitted in the vent line to prevent flashback should the LP Gas/air mixture ignite.
- **Water purging** - If using water as a purge medium, check before starting that the tank and its supports will be capable of holding the full weight of water. After purging, ensure that all the water is removed from the tank.
- **Evacuation** - If using evacuation as the purge method, check before starting that the tank is designed to sustain full vacuum conditions.

10.2.4 Initial Fill

- A responsible person should be present and in control throughout the initial fill. Care should be taken to limit flash vapourisation on initial fill. This can be achieved by pressurising the tank with vapour before introducing liquid LP Gas.
- During initial fill, any inert gas should be safely vented from the tank.
- Contents gauges should be checked for freedom of action/movement by internal inspection, where practicable, or otherwise by observation during the initial fill.

10.3 Decommissioning

10.3.1 Isolation

Tanks and fittings to be decommissioned should be isolated from any process, tank or equipment, usually by disconnecting and removing adjoining pipework or blocking it off with spades or blanks. Closing shut-off valves is not enough.

10.3.2 Preparation

Prior to de-commissioning:

- Remove as much liquid LP Gas from the tank as possible via normal use or through controlled transfer to other tanks, or by flaring. If it is necessary to vent residual vapour this should be kept to the absolute minimum possible.
- Purge with inert gas until the LP Gas content remains less than 4%.
- Purge by displacement with water or other suitable method.
- Care should be taken to ensure that no flammable vapours are generated from residual heavy ends.

Chapter Eleven

Transfer Operations

11.1 General

11.1.1 Operating Procedures

All staff who take part in loading/unloading should be issued with written procedures that clearly specify their responsibilities.

11.1.2 Supervision/Staffing

A competent person should remain in control throughout all transfer operations, and there should be adequate supervision throughout the transfer operation.

Whilst staffing on LP Gas loading/unloading will depend on site size or type, there should never be less than two trained people involved, e.g. a site employee plus the road tanker driver/rail tanker operator/ship master or his representative. The only exceptions to this rule are:

- Domestic or very small sites, where having any additional staff would be impractical.
- Automated depots designed for one man operation.

11.1.3 Personal Protection Equipment (PPE)

Staff involved in LP Gas transfer operations where there is a likelihood of contact with liquid LP Gas should be provided with suitable personal protection equipment, e.g. gloves, eye protection, apron, etc.

11.1.4 Pre Transfer Check

- The quantity and type of LP Gas should be checked by someone in authority to confirm its suitability for transfer to the receiving tank. Checks should also be made to ensure that the receiving tank is in safe working condition.
- The interconnection system, i.e. pipework, fittings, valves, hoses, etc. should be visually inspected to ensure that it is in a safe working condition and that the tanker hose coupling is compatible with the storage tank fill coupling.

11.1.5 Other Safety Precautions

- The driving unit and any electrical equipment not required and not specifically designed for the transfer operation should be stopped and isolated.
- Fire extinguishers should be located in easily accessible positions and temporary warning notices prominently displayed before product transfer commences.

11.1.6 Prevention of Overfilling

- During LP Gas transfers, a constant check should be kept on the receiving tank to ensure that overfilling or other hazardous conditions do not occur. On completion of the transfer, the receiving tank should be checked to ensure that it has not been overfilled.
- In the event of overfilling, excess LP Gas should be removed from overfilled tanks or tankers immediately in a safe way. Failure to do so may contribute to a serious incident.

11.1.7 Flexible Hoses

Flexible hoses used for transfer operation should be:

- Properly identified.
- Protected from damage to, or intake of, foreign matter through their end fittings.
- Protected against external damage (where this is likely).
- Protected in transit, storage or when not in use from weathering or other physical damage.
- Inspected and tested regularly to confirm their fitness to use (see 14.4.5).
- Kept to absolute minimum the length to avoid hoses having to be dragged long distances.

11.1.8 Static Electricity Protection

The transfer procedure should include the following as a minimum:

- Discharge to earth of any accumulated static electricity from the road/rail tanker before connecting the transfer hose, by bonding the tanker to an earthing point or to the tank to be filled.
- Bonding the tanker to the tank being filled before connecting the hose coupling and maintaining this bond throughout the transfer.
- Detachment of the electrical bond only after the liquid and where used the vapour balance connection have been disconnected.

11.2 Road Tanker Loading/Unloading

11.2.1 Siting

The following precautions against accidental road tanker movement during transfer operations should be taken:

- Siting of transfer points on well-drained essentially level ground, preferably with a slight slope or camber in one direction to take any spillage away from the tanker and prevent it from flowing and collecting under any fixed tanks or pipework.
- Place wheel chocks against all wheels (or provide other means to prevent vehicle movement) before transfer begins and remove only after transfer ends.

11.2.2 Road Tanker Position

The following criteria should be applied during transfer operations:

- Road tanker should preferably be positioned off the public highway whilst unloading.
- Where off-road parking is impossible (e.g. at domestic sites), clear guidance on parking procedures to avoid causing obstruction to other road users, pedestrians etc. and to comply with legal requirements should be provided.
- During unloading the tanker should be positioned a minimum of 2 metres from the tank at customers' premises to provide an adequate working space.

At cylinder filling plants and bulk distribution depots this should be increased to 15 metres. Wherever possible the tanker parking position should not be within the separation distances in Table 1.

- All shut-off valves on both the tanker and the tank should be readily accessible during transfer operations. Tanker access to the discharge position should avoid the need for reversing. If necessary, arrangements should be made for the tanker to be reversed in and driven out in the forward direction.
- Tanker access to the discharge position should avoid the need for reversing. If necessary, arrangements should be made for the tanker to be reversed in and driven out in the forward direction.
- During transfer operations the tanker should be positioned so that it can be readily driven away in an emergency.
- There should be a clear line of sight between the tanker and the tank being filled, and at all times during the operation the driver should be able to immediately stop the transfer, either normally when the tank is full or in an emergency. If there is no clear line of sight, a second trained person should assist during the transfer operation or a remote tanker control system capable of shutting down the pump and foot-valve on the road tanker should be used.

11.2.3 Drive-Away Protection/Prevention

One or more drive-away protection/prevention measures such as the following should be used:

- A system of simultaneously activating emergency isolation valves on both tanker and tank.
- A self-seal breakaway coupling.
- Brake flaps that lock on the vehicle brakes when moved aside to access the filling connection.
- A trip switch that locks on the vehicle brakes when the flexible hose is unloaded from its normal stowage position.
- Interlocked physical barrier or similar system on either road tanker or fixed installation.

11.2.4 Operating Restrictions

- Loading/unloading operations should only be carried out when safe to do so and preferably be separated from other traffic movement. Diversions for passing vehicles and pedestrians (e.g. barriers, warning signs) should be used.
- Operations should not be carried out during the hours of darkness unless adequate artificial lighting suitable for hazardous area is used.

11.2.5 Remote Power Shut-Off

A remote switch should be fitted to tankers that rely on engine power to drive pumps or other equipment, allowing emergency engine shut-down from outside the cab.

11.2.6 Hose Routing

Hoses should not be routed across public areas such as pavements or footpaths unless it clearly will not endanger the public or there is absolutely no alternative, in which case warning notices should be placed on both sides of the hose. These should be readable from 6 metres and carry warnings such as:

DANGER - NO SMOKING OR NAKED FLAMES

WARNING - LP GAS TRANSFER IN PROGRESS

11.3 Rail Tanker Loading/Unloading

11.3.1 Location of Transfer Point

- All rail loading/unloading activities should be well clear of other rail traffic (e.g. in a siding), at least 15 metres away from other fixed tanks, ignition sources, boundaries and buildings, in a location with good ventilation. Wherever possible the rail tanker parking position should not be within the separation distances in Table1.
- Transfer points should be sited on well-drained essentially level ground to minimize risk of accidental rail tanker movement. A slight gradient of less than 1:250 is permissible so long as this is away from the main line or towards the buffers, to take any spillage away from the tanker and prevent it from flowing and collecting under any fixed tanks or pipework.

11.3.2 Rail Operations

The following should be observed:

- Rail tankers containing LP Gas should not be shunted when separated from the locomotive or train.
- Physical barriers should be provided where there is the risk of a rail tanker being damaged by a road vehicle.
- A barrier gate and other positive isolation means should be provided to protect against the risk of the train being accidentally moved whilst the rail tank wagons are still connected to the LP Gas reception facilities. Such measures could include removal of the locomotive, application of rail tank wagon hand brakes, locked points, removal of the towing cable or isolation of the capstan motor etc.
- Positive interlocks incorporating the product transfer pumps or compressors, isolation valves, etc. should be considered to ensure the rail tank wagons have been correctly positioned before transfer operations are commenced.
- A simple communication system similar to a Permit to Work should be in place between the rail service operator and the LP Gas storage operator, to ensure a clear handover and hand-back of the tank wagons and to prevent entry of a locomotive into the tank area while discharge or filling is taking place.
- Signals may provide additional protection.

11.3.3 Emergency Shutdown Valve Protection

The following protection should be used for transfer points:

- Remotely operated, fail safe, fire safe emergency shutdown valves on the reception facilities and, where appropriate, for vapour lines.
- Manual shut-off valves on every liquid LP Gas branch pipe, fitted with dedicated handles/keys for quick use.
- Non-return valves on common manifolds to prevent liquid back flow during transfer.

11.3.4 Extra Pull-Away Protection

Additional measures against pull-away incidents and to prevent the resultant leakage should be provided. This may be in the form of self-sealing break away couplings, isolation valves/rail tanker wagon movement interlock systems or other comparable systems.

11.4 Completion of Transfer

On completion of the transfer, all transfer hose connections should be disconnected before removing the electrical bonding. The immediate surrounding should be checked to ensure it is safe before any vehicle involved in the transfer operation is allowed to drive away.

11.5 Draining

- Draining of LP Gas tanks is a critical operation and should be carried out with special care to minimize escape of LP Gas into the surroundings. Where this is carried out after product receiving for quality control purposes i.e. tests for water, it should only be undertaken by competent personnel under a written operational procedure.
- At no time should both drain valves described in section 5.3.1 be opened simultaneously in order to prevent possible freezing. One procedure that will ensure safe draining is as follows:
    - Fully open the drain valve closest to the tank first and allow pipe to fill.
    - Close the valve.
    - Then control draining by gradually opening the second valve. If no draining occurs, close the valve immediately and investigate.
    - Repeat this procedure until all the water and any other contamination has been drained.
- Suitable protective clothing should be worn by personnel carrying out draining.
- Draining of customer installations may not be necessary and should be discouraged.

Chapter Twelve

Training

12.1 General

- Training is an essential element of an effective Health, Safety and Environment (HSE) management system. All those that work in HSE critical activities should be properly trained and competent for the activities undertaken.
- A sufficient number of people should be appointed and trained to carry out and supervise procedures and operations. Staff that have not acquired the necessary experience or competency requirement for their role should not go on duty without close supervision.

12.2 Training Program

It is the responsibility of management to make sure that all staff involved in LP Gas operations clearly understand the characteristics of LP Gas and its associated risks. Staff should be regularly trained and assessed in the knowledge and practice of normal operations, including as appropriate:

- Company safety policy, drugs and alcohol policy
- LP Gas product knowledge
- Safety in day to day operations
- Use of personal protective equipment (PPE)
- First aid
- Loading/unloading
- Emergency procedures and shut-down
- Fire-fighting
- Inspection and maintenance

To be effective, training should be continuous, with a rolling schedule of refresher courses and where appropriate at least an annual emergency procedure practice.

12.3 Change Control

Any changes to plant, fittings or equipment or operating procedures should be correctly assessed for risks, authorized and communicated to those affected. If necessary, retraining may be required.

12.4 Training Record

Individual staff training records giving details of initial induction training and periodic refresher training should be kept.

12.5 Fire Instruction and Training

All staff involved in LP Gas operations should clearly understand the fire/leakage precautions and emergency procedures. Staff at operational sites should be regularly trained and assessed to ensure their knowledge and practice of actions to be taken in an emergency, including:

- Emergency shut-down procedures
- Dealing with LP Gas releases
- The nature of LP Gas fires
- Fire fighting

Chapter Thirteen

Written Operating and Emergency Procedures

13.1 General

- Documenting the operating and emergency procedures is important because it ensures that the procedures are clear and consistent throughout the organisation and that the procedures are not lost when experienced staff leaves or moves to a different role.
- All staff and contractors should be instructed to familiarise themselves with the relevant procedures required by their roles. Any deviations from the written procedures should be supported by written authority, which may include a work permit from the relevant responsible person.

13.1.1 Scope

Each LP Gas storage site should have a set of written operating procedures that:

- Clearly detail the tasks of each employee involved with LP Gas on site.
- Cover both normal and emergency activities.
- Are issued in part or in full to site staff, as well as visiting contractors.
- Are regularly reviewed to check that they reflect current operating methods.
- Are amended to reflect changes or alterations to the plant or site.

13.1.2 Specifics

Activities that should be covered in detail by written procedures include:

- LP Gas transfers to or from the site.
- LP Gas deliveries to customer sites or other locations.
- Emergency procedures.
- Plant maintenance and modification, including electrical equipment.
- Permit to work system.
- Drainage of storage tanks.

13.2 Customer sites

- All bulk customers should be provided with bold and clear emergency procedure notices displayed near all storage tanks. The user should be provided with full documentation including information on the actions to be taken in an emergency. This should include procedures in the event of gas leakage or suspected leakage and in the event of fire.
- Emergency instructions should include also:
    - 24 hour emergency service contact telephone number
    - Local fire service contact telephone number

- Industrial/commercial customers should be encouraged to incorporate plans for dealing with LP Gas incidents into their overall emergency plans.

Chapter Fourteen

Maintenance and Examination

14.1 General

- LP Gas tanks, equipment, pipework and associated systems should be kept in good working order by a combination of routine inspection, periodic examination and regular maintenance. Such work should be carried out to a written scheme of examination which has been prepared by a competent person.
- The maintenance scheme should emphasise elements of the system that affect the integrity of the tanks and equipment and the ability to react in an emergency.
- Only trained and experience personnel under the appropriate supervision of a competent person should be allowed to carry out all maintenance work on a LP Gas installation.
- A detailed report should be issued after an examination and kept on record (see 14.7).

14.2 Maintenance Scheme

Each LP Gas storage installation should have a maintenance scheme, which includes the protective equipment and instrumentation relevant to the scale and complexity of the installation. For a depot or large installation this will be a site specific written scheme of examination (see appendix 1 for more detail) prepared and authorised by a competent person. For smaller customer installations a generic scheme may be applied. Dependent upon the equipment on site the maintenance scheme should include:

- Frequency of periodic tank and fittings inspection.
- Inspection of tank supports, foundations and holding down arrangements.
- Direct heated vapouriser inspection at a frequency of not more than once a year.
- Integrity and corrosion inspections of aboveground and underground LP Gas pipework.

14.3 Frequency of Periodic Examination

In many countries the scope and period of examination and testing of the LP Gas system will be defined in local legislation. For those countries where this is not the case, Table 7 provides guidance on frequency and scope of inspection for LP Gas equipment. Table 7 assumes routine inspections are carried out in accordance to section 14.6. This frequency may be adjusted by the Competent Person on the basis of a combination of experience, statistical data or equipment manufacturer's recommendation.

Table 7 Frequency of periodic Examination

ITEM	INTERVAL	Ref.
Aboveground tanks	10 yrs	14.4.1
Underground tanks		
w/ Cathodic Protection	10 yrs	14.4.2
w/out Cathodic Protection	5 yrs	14.4.2
Pipeworks		
Aboveground pipeworks	10 yrs	14.4.3
Underground pipeworks	5 yrs	14.4.4
Vaporisers		
Direct fired	Annual	14.5.2
Indirectly heated	5 yrs	14.5.2

14.4 Periodic Examination of Tanks and Pipework

14.4.1 Aboveground Tanks

Periodic examination of above ground tanks should include:

- Visual examination of external surfaces and all welds for signs of defects such as damage, corrosion, cracking, erosion, deformation, leakage etc.
- A check of wall thickness by internal visual examination or a wall thickness survey (e.g. by the use of an ultrasonic thickness gauge).
- Replacement of pressure relief valves with new or reconditioned units set at a pressure not less than the tank maximum working pressure but not above the tank design pressure. Capacity of the pressure relief valve should meet design requirements.
- Inspection of shut off valves, including remotely operated types and other tank fittings for effective operation, corrosion or damage or replacement. Shut off valves and other tank fittings should be replaced when they reached 20 years of service regardless of condition.

14.4.2 Mounded or Underground Tanks

Periodic examination of mounded/underground tanks should include:

- A visual check of exposed surfaces for signs of corrosion, damage, leakage, etc.
- Replacement of pressure relief valves with new or reconditioned units set at a pressure not less than the tank maximum working pressure but not above the tank design pressure. Capacity of the pressure relief valve should meet design requirements.
- Where cathodic protection is provided, the operation of sacrificial anodes or impressed current systems should be checked in accordance with a written procedure and replaced as necessary. Records should be maintained to allow comparisons of the readings obtained so as to allow investigation of any anomalous readings (see also 14.7.1).
- Where cathodic protection is not provided, an internal visual examination should be conducted and either a wall thickness check or a hydraulic test. Where internal examination is not reasonably practicable the external surfaces of the tank should be exposed for examination as directed by the competent person.

- Inspection of shut off valves, including remotely operated types and other tank fittings for effective operation, corrosion or damage or replacement. Shut off valves and other tank fittings should be replaced when they reached 20 years of service regardless of condition.

14.4.3 Aboveground Pipework

Periodic examination of aboveground pipework should include:

- Checking for corrosion and damage particularly on sections where the pipe passes through supports.
- Checking for satisfactory condition of pipe supports.
- Inspecting thermal insulation for damage if used. Any suspect areas should be removed to allow inspection of the pipe.
- Pressure testing of pipework and checking end to end electrical continuity for terminal and depot pipework with the exception of cathodically protected sections.
- Replacement of hydrostatic valves every 10 years with new units set at a pressure not less than the maximum working pressure but not more than the more than the design pressure of the equipment they are protecting.

14.4.4 Underground Pipework

Periodic examination for vapour pipework operating below pressure of 5 bar should include:

- Checking for leakage by appropriate means such as pressure testing, gas detection etc. at a frequency dictated by the risks associated with its location, pressure of operation and aggressiveness of their environment.

Periodic examination for liquid pipework and vapour pipework operating at pressure of 5 bar or above should include:

- Check for leakage by appropriate means such as pressure testing, gas detection etc. at a frequency dictated by the risks associated with its location, pressure of operation and aggressiveness of their environment. Pipework may be subjected to same pressure test done during installation where practicable. No further testing is necessary if the system is constantly monitored e.g. by gas detection.
- Pipework should be pressure tested or excavated for visual inspection and leak tested under operating pressure when it incorporates buried screwed or flanged joints or where there is any doubt of the effectiveness of the corrosion protection system.

14.4.5 Flexible Hoses

- Each hose should be subjected to formal external visual inspections by a competent person at the following intervals. Results of these formal inspections should be recorded.

Road tanker/rail/jetty hoses	-	6 months
Autogas dispenser hoses	-	6 months
Cylinder filling hoses	-	12 months

- A hose should be inspected for defects such as leakage, cuts, soft spots, kinks, twists, flattening or blistering. Hoses with defects should be rejected for LP Gas service.
- In addition, jetty hoses should also be tested hydraulically to its maximum working pressure at least every year.
- Hose end couplings should be checked using appropriate gauges i.e. GO/NO GO thread gauges for ACME couplings.

- Hoses should be checked at least every year for electrical continuity.

14.5 Periodic Examination of Other Equipment

14.5.1 Product Transfer System

Pumps, compressors and other associated equipment should be checked in accordance to the manufacturer's instructions or other procedures prepared by a competent person. Seals and lubrication should be given particular attention.

14.5.2 Vapourisers

Periodic examination of vapourisers should include:

- Check for satisfactory operation of items such as level control, heat input controls, emergency valves (other than pressure relief valves), flame control devices, pressure controllers, etc. Safety devices such as solenoid valves and similar items should be given particular attention.
- Check for corrosion and damage and hydraulic test. Flame impingement areas of direct fired equipment should be given special attention.
- Check for LP Gas leakage under operating pressure.

14.5.3 Regulator

Pressure regulators should be replaced with new unit every ten years.

14.5.4 Electrostatic Protection

Earthing and bonding connections should be inspected visually and the electrical resistance should be checked to ensure it is not more than 10^6 ohms.

14.5.5 Electrical Equipment

Ancillary electrical equipment such as cables and connections, particularly flameproof connections, switches etc. should be inspected to ensure they are in satisfactory condition in accordance with manufacturers/installers instructions or other schedule prepared by a person competent in electrical installations.

14.5.6 Fire Fighting/Emergency System

Firewater, gas detection, over-fill prevention and alarm systems and other safety critical equipment should be checked for correct operation in accordance with the manufacturer's instructions or other schedules prepared by a competent person. If stand by power generation is part of the fire fighting/emergency response system, it should be tested under load.

Fire extinguishers should be inspected and maintained at regular intervals according to the manufacturer's instructions, or other schedule prepared by a competent person.

14.6 Routine Examination

14.6.1 General

Routine examination of tanks and other equipment in an LP Gas installation should be carried out at least annually but in many sites this may be done conveniently as part of the routine filling operation. Routine examination should be done in accordance to a written procedure with appropriate remedial action plans for defects observed.

14.6.2 Scope

Routine examination should include:

- Full visual inspection for corrosion, damage and leakage for tanks, equipment and pipework. Particular emphasis on undersides of pipe and areas in contact with supports.
- Inspection of storage site for any flammable material stored around the tank and if ventilation is adequate.
- Checking the concrete pads and piers to ensure they are in satisfactory condition and that there are no signs of differential settlement.
- Checking the pressure relief valves to ensure it is free from corrosion and drain holes are not blocked to prevent water from retaining in the pressure relief valve.
- Visual inspection of flexible hoses each time it is used or, in the case of hoses in daily use e.g. cylinder filling and autogas dispenser hoses, every day prior to start up.
- Thread gauging with the use of Go-No Go gauges of all depot and terminal ACME couplings and replacement if worn.
- Recording the cathodic protection voltage for protected underground tanks and/or pipework to confirm it is within specifications.
- Checking that insulating flanges and couplings are not bridged and that they are providing isolation of cathodically protected parts of the system from above ground parts.
- Checking that the earthing rod is securely connected to the tank and earthing/bonding connections are in good condition.

14.7 Records

Detailed records should be maintained of all inspections, tests, and repairs or replacement of tanks, equipment or fittings.

14.7.1 Inspection Reports

Where inspections reveal defects or significant deterioration, this should be recorded and the inspection methods used plus any remedial action taken should be detailed. The competent person should also assess the effects of such deterioration, defect or repair and either endorse or revise the safe working limits of the tank or equipment. Specifically, the following should be recorded:

- Minimum safe operating temperature
- Minimum safe operating pressure
- Maximum safe operating pressure
- Maximum permissible loading on supports
- Date of next inspection

14.7.2 Repair Standards

The standard of any modifications or repair work should be at least equivalent to the original design and manufacturing standard. If installation integrity may be affected by such work, it should be supervised and certified by a competent person, who should endorse or revise the safe operating limits.

Appendix One

Written Scheme of Examination

A Written Scheme of Examination (WSE) should be prepared prior to commissioning of any LP Gas installation. The scheme for customer installations may be generic, i.e. one WSE describes the method of assuring the integrity for all of this class of installation. At depots, terminals and plants a specific written scheme of examination should be prepared which covers the following:

- Identification of the items of plant or equipment within the system
- Those parts of the system which are to be examined
- The nature of the examination required, including the inspection and testing to be carried out on any protective devices
- The preparatory work needed for the item to be examined safely
- Where appropriate, the nature of any examination needed before the system is first used
- The maximum interval between examinations
- The critical parts of the system which, if modified or repaired, should be examined by a competent person before the system is used again
- The name of the competent person certifying the written scheme of examination
- The date of certification

Therefore in order to prepare a WSE:

- The system design criteria should be established, i.e. what pressure should each part withstand.
- A drawing of the system should show the items of equipment that are under pressure and number them for reference in an equipment list.
- The list of equipment should show the pressure ratings of the equipment and test certificates for each item should be held on an a system integrity file.
- Where the history of the installation has led to the loss of certificates for components of the LP Gas system, the integrity can be verified by reference to markings on the items and by a pressure test at which point the integrity of the system can be certified.

A competent person should decide:

- Which parts of the system are going to be inspected and/or tested
- What inspection/testing is to be done
- How the system is to be safe while the inspection/testing is done
- How often the parts of the system are to be inspected/tested and how it is to be done
- What independent inspection is required from a notified body

A defined person should be responsible for each LP Gas system and for ensuring that the WSE is applied and that records are kept for the design, and maintenance of the system integrity. He should appoint or may be the competent person who creates the WSE. A competent person should have the necessary knowledge, experience and independence to undertake the functions required of them.

The WSE should be periodically reviewed for suitability by a competent person.

Appendix Two

Definitions

Braided A layer (or layers) of cylindrically woven wires covering the hose and attached to the hose ends and fittings, serving the functions of:

a) restraining the hose against elongation; and
b) damping vibration of the hose.

Competent person A person with knowledge, training and ability to carry out their work safely and with the necessary proficiency to ensure the subsequent safe operation of the equipment.

Enforcing authority The authority responsible for enforcing national and local health and safety legislation and other relevant statutory requirements. (Can either be a national body or a local authority).

Evaporation area Safe ground adjacent to LP Gas storage tank(s) where LP Gas can evaporate and disperse safely.

Fire wall A screen, wall, or dividing partition set up in open air to protect LP Gas tanks, pipes or equipment from radiated heat and to ensure enough dispersion distance in the event of a leak from a protected tank.

Fire resisting The ability of materials to resist a fire for specific periods of time, if tested from either side, whilst still retaining properties of insulation, integrity and stability.

Mounded tank A storage tank partly buried or above ground and covered by a mound of earth or other inert material.

Non-combustible Material which will not support combustion when tested in accordance with recognized standards.

Point of liquid transfer The point at which liquid transfer connections and disconnections are made.

Remotely operated emergency shutdown valve A shut-off valve that can be activated remotely to automatically shut when engulfed by fire, deprived of actuating power or some other hazardous condition is detected.

Separation distance The horizontal distance between a specified feature and the nearest part of a storage tank.

Tank A container or vessel of over 150 litres water capacity, designed and manufactured to a recognized pressure vessel code.

Water capacity The water volume (in litres of water) that will completely fill a tank.

Underground tank A storage tank buried below ground level.

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