Guidelines for Good Safety Practices in the LP Gas Industry
About 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 organization. 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 the LP Gas use through leadership of the industry worldwide.

About the United Nations Environment Programme

Created in 1972, UNEP represents the United Nations' environmental conscience. Based in Nairobi, Kenya, its mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

About UNEP (Division of Technology, Industry and Economics)

The UNEP Division of Technology, Industry and Economics (DTIE) helps Governments, Local Authorities and decision makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

- Sustainable consumption and production
- The efficient use of renewable energy
- Adequate management of chemicals
- The integration of environmental costs in development policies

The Office of the Director, located in Paris, coordinates activities through:

The International Environmental Technology Centre - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.

Sustainable Consumption and Production (Paris) promotes sustainable consumption and production patterns as a contribution to human development through global markets.

Chemicals (Geneva) catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.

Energy (Paris) fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.

OzonAction (Paris) supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.

Economics and Trade (Geneva) helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

UNEP DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships, and implementing international conventions and agreements.
Guidelines for
Good Safety Practices
in the LP Gas Industry
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LP Gas is a clean, modern fuel that brings comfort to tens of millions of consumers worldwide. However, as with any fuel, safety in operations and handling is imperative for consumers and for the industry. The effects of safety incidents do not necessarily stop at the factory gate but can impact people, property and the environment outside the enterprise, sometimes at considerable distances. In addition to the human cost and material damage, the reputation of the product can be significantly impaired if safety is not managed appropriately.

These guidelines aim to inform the principal stakeholders in the LP Gas industry of the hazards at different stages of the distribution chain as well as recommended good safety practices to minimize the associated risks. ‘Prevention is better than cure’ and effective safety promotion starts by getting things right within the production facilities, storage depot, bottling plant or transport system. The importance of having an effective emergency management system, for the occasion when something does go wrong has also been recognized for a long time.

The World LP Gas Association (WLPGA), the global voice of the LP Gas industry, has long promoted the importance to our industry, our customers and our communities of good safety practices. This is particularly important, since in many countries and regions around the world LP Gas is a social product used in millions of homes daily. LP Gas has a very important role to play in bringing clean, modern energy to communities around the world. Whether it is freeing women from the drudgery of collecting firewood, reducing children’s exposure to the deadly contaminants of indoor air pollution or providing light and refrigeration for vaccines to rural health clinics, the portability and storability of LP Gas make it an ideal clean, modern fuel in areas where the infrastructure for grid-based energy does not exist.

Industry all over the world has a vital role to play in accident prevention and ensuring that the sustainable development process is not threatened by the effects of safety-related incidents. The WLPGA is pleased to contribute to this worldwide effort by preparing and disseminating these Safety Guidelines. They will contribute to the process of sharing safety expertise as widely available as possible within the international LP Gas industry, so as to encourage continuous safety improvement throughout the world.

WLPGA
July 2008

The United Nations Environment Programme (UNEP) encourages actions promoting safety practices, prevention and preparedness measures. In this respect, UNEP supports the Guidelines for Good Safety Practices in the LP Gas Industry publication developed by the WLPGA, and considers it a useful resource for policy makers, government officials and industry managers who are concerned with good safety practice in relation to LP Gas handling, distribution and use. UNEP encourages all stakeholders to enhance safety in their everyday work, to prevent accidents from happening.

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July 2008
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These Guidelines for Good Safety Practice in the LP Gas Industry have been developed by the World LP Gas Association (WLPGA) to provide global LP Gas Industry participants with a tool for ensuring the marketplace, and more importantly the customer, is not compromised by unsafe practices.

The guidelines identify the key stakeholders within the LP Gas industry and go on to describe their responsibilities to ensure a safe environment for LP Gas throughout the distribution chain; from the LP Gas producers at the refineries and gas fields, right through the distribution chain to the final application for the product.

Included within the stakeholders are the LP Gas equipment and appliance providers, together with the installers, the LP Gas suppliers and marketers, Authorities and Associations and of course the consumer.

The importance of a sound regulatory framework for the LP Gas industry and the impact that has on a safe environment is discussed.

The product itself is then described, highlighting the key physical properties and characteristics and how these affect the safe handling of LP Gas.

There is a need for full understanding of the distribution chain and controls to be ever present and exercised at every point to ensure safe operations and this is explained.

Trans-shipment terminals and the various methods of product movement throughout inland facilities are described together with the importance of understanding and managing the risks of storing and handling large quantities of LP Gas.

The importance of good safe practices when storing, handling and distributing bulk LP Gas and filling and handling cylinders is included in this guide.

The role of the consumer and the responsibilities expected in maintaining a safe environment for LP Gas is a key part of this guide.

The subject of managing safety and planning for emergencies is included in the final sections.

In the Appendices there are numerous references and links to Organisations, Institutions and Associations that have a key role in the subject of LP Gas safety.

The United Nations Environment Programme (UNEP) DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships, and implementing international conventions and agreements.

The UNEP has kindly provided valuable input to these Guidelines and a description of the UNEP, together with the work they do, is also included in this publication.
Introduction

The phrase liquefied petroleum gases (LP Gas) refers to a group of hydrocarbon-based gases derived from crude oil refining or natural gas fractionation. Propane and butane, and mixtures of the two, are its key constituents.

LP Gas can be liquefied (under moderate pressure or low temperature), which facilitates its transportation and distribution.

Although, as a fossil fuel, LP Gas releases carbon dioxide into the atmosphere during combustion. However, it burns more completely than other, notably solid, fuels and is thus more efficient and cleaner.

These properties of LP Gas have made it a convenient replacement for traditional cooking fuels (mainly, wood, coal and animal dung) and motor vehicle fuels in certain contexts.

Like all forms of energy, LP Gas is potentially hazardous if mishandled or misused. The promotion of safety is one of the key aims of The World LP Gas Association (WLPGA).

These Guidelines are intended for non-experts who may have responsibility for or are otherwise concerned with good safe practice in relation to LP Gas handling, distribution and use.

They have been developed by the WLPGA to form the central part of a Safety Promotion Project.

While safety is an important issue, it should also be emphasised that LP Gas is an excellent, versatile and often preferred fuel for many applications. It is also recognised as an environmentally friendly fuel with many social advantages.

As with all forms of energy, LP Gas is potentially hazardous if mishandled or misused. Care in the handling and use of LP Gas will help to minimise the number of incidents, accidents and their consequences. This is the key driver in the Safety Promotion Project and with these Guidelines.

Within the LP Gas industry, there is a wealth of knowledge and experience which is used to enhance safety and which is reflected in these Guidelines. It is the policy of the WLPGA that the safety expertise available within the international LP Gas industry should be shared as widely as possible in the interest of participants, consumers and the community, despite concerns relating to litigation and other legal action.

These Guidelines are intended for policy makers, government officials and industry managers at international, national and local levels who are concerned with good safety practice in relation to LP Gas handling, distribution and use.

The hazard commonly associated with LP Gas is an uncontrolled release followed by fire. These Guidelines address such a hazard but they also take a more comprehensive view of LP Gas safety.

The Guidelines follow the LP Gas distribution chain up to and including the point of use. Hazards are identified at each stage of the process and good safety practices are outlined. More detailed technical guidance references are provided in Appendix Three together with web links.
The principal participants in the LP Gas industry - marketers, equipment manufacturers, transporters and installers - all have responsibilities in the area of safety. They should collaborate to ensure the efficient discharge of their responsibilities; primarily they should comply with the law.

Users of LP Gas should consider adopting ISO 14000 standards on Environment, Health and Safety and OSHAS guidelines (on Occupational Safety and Health). [refer: www.iso.org]

When appropriate, national and local authorities should take advantage of the expertise within the LP Gas industry to ensure an informed and uniform approach to good safety practice.

Consumers should adhere to the safety instructions which are provided for them. There are many stakeholders and all have a role to play.
1.1 LP Gas Marketer/Supplier

1.1.1 The LP Gas marketer/supplier may be a producer, importer, a primary marketer or a distributor appointed by the marketer. It may be a state-owned or private-sector enterprise. Site safety of the operational premises shall be a key responsibility of the LP Gas marketer / supplier besides other responsibilities which cover all components of the distribution chain.

1.1.2 The marketer/supplier will be responsible for the quality of LP Gas supplied, i.e. for conformity with a declared standard or specification, and for quantity, i.e. for conformity with a declared volume or weight.

1.1.3 The marketer/supplier frequently retains ownership of the tanks and cylinders used to supply LP Gas. In this event conformity with prescribed or declared manufacturing standards with specified periodic inspection or re-qualification procedures must be maintained.

1.1.4 The marketer/supplier should be encouraged to work closely with manufacturers, suppliers and installers of LP Gas appliances and equipment as part of a coordinated industry approach to good safety practice. The marketer/supplier should influence appliance and equipment manufacturers and installers to adopt appropriate safety standards and practices and promote strict implementation of safety procedures in their mutual interest.

1.2 Appliance Manufacturer/Supplier

1.2.1 Manufacturers of LP Gas appliances usually distribute them through suppliers who may be sellers of household appliances and/or who may be LP Gas suppliers. Where a manufacturer based in another country sells through an import agent, the agent should fully understand the required safety standards and the safety implications for the users. In some countries the importer may be regarded as the manufacturer and assume the manufacturers responsibilities.

1.2.2 Virtually all commercial, household and leisure applications for LP Gas require an appliance. Some appliances are made specifically for LP Gas but many commercial and household appliances are manufactured primarily for use with natural gas. Natural Gas, whose basic constituent is methane gas, differs from LP Gas in physical characteristics since it is lighter than air and may be handled at much higher pressures depending upon its end-use.

1.2.3 Only LP Gas compatible appliances should be used with LP Gas. It is a key responsibility of the supplier to ensure that LP Gas appliances are capable of safe, efficient and convenient operation with the grade or grades of LP Gas being sold in the market.

1.2.4 Suppliers should provide clear operating and safety instructions for the clients and user, including compatibility between burner and product (butane, propane or mixtures). If necessary, connections should be designed to avoid the use of incompatible appliances and products.

1.2.5 Suppliers of LP Gas and appliances should collaborate to ensure that consumers are offered a choice of appliances which are energy efficient and which can be operated safely in particular markets.

1.2.6 Important but often overlooked LP Gas appliances include those produced by aerosol manufacturers that use LP Gas as a propellant and refrigeration and air conditioning equipment that uses LP Gas as the refrigerant.

1.3 Equipment Manufacturer/Supplier

1.3.1 LP Gas equipment includes a variety of products associated with handling and use, such as storage tanks, cylinders, pressure regulators, gauges and controls. These include small volume/high value and mass-produced, high precision items.

1.3.2 Equipment may be installed in an LP Gas marketer’s plant on a truck or pipeline at a consumer installation or at the immediate point of use. Manufacturers and suppliers should ensure that the equipment being used is suitable for the intended purpose and for the intended environment, including climatic conditions. They should prevent illegal use, e.g. product transfer by incompetent persons or via unapproved connections.

1.3.3 LP Gas marketers should take a direct informed interest in the equipment which they employ and recognise the relationship between quality and safety. Sub-standard equipment increases risk and has no place in the LP Gas industry. Enforcement may be by national type or product approval or by a voluntary code.
1.4 **Installer**

1.4.1 The function of the installer is to put the LP Gas supply in place using appropriate equipment and having connected the supply to the appliance ensure the system is working correctly and in a safe environment, including access to proper ventilation.

1.4.2 While the LP Gas supplier will be responsible for any installed equipment which remains his property it is usually the installer who introduces the consumer to the safety features of the installation.

1.4.3 Key responsibilities of the installer include that:

- The work is in conformance with all relevant statutory requirements
- The installation is gas-tight and, as far as practicable, secure from damage or interference
- Adequate combustion air is available and that the products of combustion (or any product leaks) will be safely disposed of
- Controls and safety systems are functioning correctly
- The consumer understands the normal operation of the installation, its maintenance needs - including storage, safety procedures and precautions - the action to be taken in an emergency and has the emergency phone numbers

1.5 **Consumer**

1.5.1 Because of the wide range of LP Gas applications and the variations in the scale of usage there are many categories of consumer. These range from households (often the largest single category) to industrial or chemical complexes where LP Gas may be only one of many hazardous products on site.

1.5.2 The ‘duty of care’ concept increasingly found in the Western European approach to safety and the ‘duty to inform’ found in the United States of America - where there is an obligation on the consumer to heed the safety information provided by the supplier as part of his duty to inform - are very appropriate for LP Gas consumers and could usefully be adopted by other countries.

1.5.3 The consumer should be supplied with safety notices and instructions. Having been supplied, the consumer should heed them and avoid a cut-price or ‘do-it-yourself’ approach, to LP Gas installations. Some LP Gas applications, especially those in the leisure sector, lend themselves to self-assembly but most require the services of a competent installer.

1.5.4 When the consumer is expected to operate or maintain specific equipment such as vapourisers, they should be trained and approved as competent.

1.6 **LP Gas Industry Association**

1.6.1 The key responsibility of a national or local LP Gas Industry Association should be the promotion of good safety practice in the LP Gas industry. It should have a mission and structure to facilitate the progressive raising of technical and safety standards.

1.6.2 Membership of a LP Gas Industry Association should be open to the appliance, equipment, transporter and installer sectors, as well as to LP Gas producers, suppliers and marketers.

1.6.3 National LP Gas Associations should seek to be consulted in the preparation of LP Gas related legislation and regulations, and if appropriate, act in a coordinating role.

1.6.4 National LP Gas Associations are urged to maintain membership and open communication with the WLPGA, particularly in addressing international LP Gas issues.
1.7 **National and Local Authorities**

1.7.1 Typically, LP Gas represents a small component of a nation’s total energy supply, especially in countries with well-developed natural gas and electricity distribution networks. However, the use of LP Gas is sometimes encouraged for specific energy related or environmental related reasons such as the replacement of solid fuel or Chlorofluorocarbons (CFC’s), or as an alternative to traditional transportation fuels.

1.7.2 National Authorities should ensure that they and the relevant public bodies understand and address safety issues in respect of LP Gas handling, distribution and usage, including LP Gas used for servicing equipment in refrigeration and air-conditioning appliances. They should appreciate and accept the safety implications of promoting or permitting particular applications.

1.7.3 National Authorities should ensure that appropriate technical and safety standards are in place for LP Gas, LP Gas appliances, equipment and installation. It is usually quite practical and sometimes more efficient to adopt standards which have good international recognition rather than develop national standards from first principles. The emphasis should be on adoption, not adaptation, as long as it does not contradict other adopted practices and suits the local operational environment.

1.7.4 National and Local Authorities should initiate or encourage dialogue with the LP Gas industry to ensure an informed and uniform approach to good safety practice. At national and international level the LP Gas industry is encouraging a scientific and risk-based approach to such matters as land use planning.

1.7.5 A Local Authority will probably be responsible for sanctioning the development of the LP Gas distribution infrastructure and the routing of LP Gas transportation. It may also be responsible for sanctioning the operation of elements of the distribution infrastructure such as cylinder filling plants. These Guidelines are intended to assist Local Authorities in exercising such duties.
Chapter Two

Regulatory Framework

LP Gas safety may be regulated directly or within the broader regulation of hazardous substances and activities. The regulatory system should promote safety in production, storage, handling, transportation and use. The LP Gas industry should have a key role in the preparation of regulations through its national or other representative association.

2.1 General

2.1.1 In these Guidelines the focus is only on the regulatory framework for safety.

2.1.2 In countries which have wide-ranging systems of regulation for public, employee and consumer safety, it is normal to find LP Gas included in schedules of hazardous substances. Typically, such systems provide for regulation of many substances, in storage, handling, transportation and use.

2.1.3 In the absence of such wide-ranging systems regulations may be introduced specifically for LP Gas or the LP Gas industry may be self regulating. Self-regulation is usually on the basis of recognised technical standards and codes of practice which are accepted and overseen by an official inspectorate or authority.

2.2 Points to be Regulated Directly

2.2.1 The most serious events tend to be associated with large quantities and frequent transfers of LP Gas in storage or transportation. Such events may be infrequent but will probably have consequences beyond their immediate location.

2.2.2 The location of LP Gas storage and handling facilities should be directly regulated within general hazardous substances regulations or in their absence by LP Gas specific regulations. A threshold level of inventory should be set which will determine whether a facility falls within the scope of the regulations. Progressively more stringent conditions should apply as the assessed risk increases.

2.2.3 Planning regulations should take account of the potential hazard, the hazard consequences and the probability of the occurrence of hazardous events.

2.2.4 The operation of LP Gas storage and handling facilities may be subject to license which sets limits to the capacity throughput and scope of activities. The license should provide for periodic inspection and renewal.

2.2.5 LP Gas transport should be regulated to take account of the inherent hazard and the risks associated with the transportation mode, e.g. pipeline, water-borne, rail and road. Where national or local regulations are deemed to be inadequate or in need of strengthening a code should be adopted which has international recognition.

2.2.6 Many of the incidents (including fatalities) involving LP Gas occurs at or close to the point of use. They may result from defects in the LP Gas supply, in the appliance, the equipment or the manner of installation. Some incidents are the result of misuse by the consumer. Such misuse may be accidental or due to the consumer being inadequately informed: in the extreme, it may not be accidental but deliberate.
2.2.7 Broad-based consumer protection regulations will provide a measure of safety for LP Gas users. The emphasis in direct regulation should be on:

- LP Gas of the specified grade and standard in containers (tanks and cylinders) manufactured, installed and maintained to the appropriate standard
- Appliances and equipment manufactured and installed to the appropriate standards
- Type approval procedures – n.b. approval of the prototype product by the testing authorities, based on which, mass production can be carried out - and the exclusion of sub-standard appliances, equipment and installers

2.3 Points to be Regulated Indirectly

2.3.1 Many aspects of LP Gas safety can be regulated indirectly where well developed systems for the regulation of public, employee and consumer safety are in place and effective. However, it is important that when LP Gas is included in such regulatory systems the potential hazards are correctly identified and the risks quantified to an acceptable level and required degree of accuracy. The appropriate infrastructure and procedures should be installed to mitigate those risks.
Chapter Three

LP Gas Safety

LP Gas is potentially hazardous from the point of production until it has been safely used and the combustion products have been properly disposed of. The term LP Gas describes a range of products which have much in common but also have their differences which affect the approach to safety.

Safety comes from understanding the behaviour of LP Gas and keeping it under control.

Every uncontrolled release is a hazardous event and should receive urgent attention. As pure LP Gas is odourless and invisible, a distinctive odour is usually added to warn of its presence. This allows even the smallest leak to be detected and receive the appropriate attention. However, as LP Gas is heavier than air an underground or low level leak might not be detected immediately.

LP Gas containers should be readily identifiable as such. Consumers should be given safety information and having been informed should exercise reasonable care in handling and use.

Good appliance and installation standards are essential for safety.

3.1 General

3.1.1 The term LP Gas is an abbreviation for Liquefied Petroleum Gas and refers to hydrocarbon products, sometimes also described as light fractions. Butane and Propane are the predominant constituents of LP Gas.

3.1.2 In common with other forms of energy, LP Gas can be hazardous unless it is properly handled in a controlled manner. It is potentially hazardous from the time of production until it has been used and the products of combustion have been disposed of safely.

3.1.3 LP Gas has its own special hazardous characteristics. LP Gas safety comes from understanding these characteristics and behaviour and from the exercise of control under both normal and abnormal conditions.

3.1.4 The behaviour of LP Gas is predictable and the technology for control is well understood. Good technical and safety expertise is to be found in the primary supply and marketing companies and in the major equipment manufacturers. The application of this expertise becomes progressively more difficult as LP Gas is moved along the distribution chain and away from the direct control of the primary suppliers and marketers.

3.1.5 The hazards commonly associated with LP Gas are fire and explosion. Since uncontrolled releases of LP Gas can have serious consequences the prime objective of a LP Gas safety programme is to prevent uncontrolled loss of containment. However there are other hazards inherent in handling, distribution and use which are addressed in these Guidelines.

3.1.6 Butane, Propane and Butane/Propane mixtures are handled and/or distributed separately and for safety, one product should not be mistaken for the other.

3.1.7 The consumer receives LP Gas at the end of the distribution chain. In practice this can mean transportation over long distances and probably one or more transhipments. LP Gas safety must take into account hazards associated with the mode and duration of transport including the risk of traffic accidents and delays and their possible consequences.

3.1.8 Most LP Gas is used by combustion in an appliance which is itself part of a consumer installation. Adequate combustion air and ventilation are essential for safety. The products of LP Gas combustion, or product released as a result of leakage,
should be vented to avoid a possible build-up of hazardous secondary products. The installer and the consumer have major roles in this aspect of LP Gas safety.

3.1.9 The vast range of LP Gas uses and of appliances as well as the variable scale of installations adds to the complexity of LP Gas safety.

3.1.10 Introduction of new applications, especially when accompanied by changes in distribution practices present new hazards and may call for the introduction of additional safety practices. The safety procedures in a marketer’s bulk plant may not be adequate at an automotive re-fuelling station. The safety requirements of a household installation with several appliances, e.g. stove, water heater and space heaters will differ from those of a consumer using a single appliance directly attached to a cylinder.

3.2 Physical Properties

3.2.1 LP Gas is produced in oil refining and the processing of natural gas liquids. Commercial, or fuel grade, LP Gas mainly consists of Butane and Propane with small amounts of lighter and heavier fractions, such as Ethane and Pentane.

Table 3.1 Typical Properties of LP Gas

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<tr>
<th>Property</th>
<th>Propane</th>
<th>n-Butane</th>
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<tr>
<td>Chemical Formula</td>
<td>C₃H₈</td>
<td>C₄H₁₀</td>
</tr>
<tr>
<td>Boiling point at 101.3 kPa (°C)</td>
<td>-42.1</td>
<td>-0.5</td>
</tr>
<tr>
<td>Liquid density at 15 °C (kg/m³)</td>
<td>506.0</td>
<td>583.0</td>
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<tr>
<td>Absolute vapour pressure at 40 °C (kPa)</td>
<td>1510</td>
<td>375</td>
</tr>
<tr>
<td>Flash Point (°C)</td>
<td>-104</td>
<td>-60</td>
</tr>
<tr>
<td>Upper flammable limit (% vol. in air)</td>
<td>9.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Lower flammable limit (% vol. in air)</td>
<td>2.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Vol. vapour per vol. liquid</td>
<td>269</td>
<td>235</td>
</tr>
<tr>
<td>Relative vapour density (air - 1)</td>
<td>1.55</td>
<td>2.07</td>
</tr>
<tr>
<td>Coefficient of expansion (liquid) per 1°C</td>
<td>0.0032</td>
<td>0.0023</td>
</tr>
<tr>
<td>Minimum air for combustion (m³/m³)</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>Kinematic Viscosity (centistokes) @ 20°C</td>
<td>0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>Latent Heat of Vapourisation (kJ/kg) @ 20°C</td>
<td>352</td>
<td>368</td>
</tr>
<tr>
<td>Specific Heat (kJ/kg/°C) @ 20°C - liquid</td>
<td>2.554</td>
<td>2.361</td>
</tr>
<tr>
<td>Specific Heat (kJ/kg/°C) @ 20°C - vapour</td>
<td>1.047</td>
<td>1.495</td>
</tr>
<tr>
<td>Minimum ignition temperature (°C ) in oxygen</td>
<td>470 - 575</td>
<td>380 – 550</td>
</tr>
<tr>
<td>Maximum Flame temperature (°C )</td>
<td>1980</td>
<td>1990</td>
</tr>
<tr>
<td>Octane number</td>
<td>&gt;100</td>
<td>92</td>
</tr>
<tr>
<td>Specific Energy (gross) kJ/kg</td>
<td>49.83</td>
<td>49.40</td>
</tr>
</tbody>
</table>

3.2.2 It will be apparent from the above Table that there are significant differences in the physical properties of Butane and Propane. The values for LP Gas mixtures generally lie between these extremes depending on the ratio of Butane and Propane. However, quite small amounts of methane and ethane can have a significant effect on vapour pressure.

3.2.3 The differences in their physical properties mean that Butane and Propane behave differently under everyday conditions and more especially under extreme conditions. Such differences can be turned to advantages in certain applications. However, differences in boiling point, liquid density and vapour pressure between Butane and Propane are particularly important for safety and appliance performance.

3.2.4 Differences in the quantity of air required for complete combustion of Butane and Propane should be taken into account by appliance suppliers and installers. Failure to do so can affect both consumer safety and satisfaction.

3.2.5 Poor quality control in LP Gas refining and production processes can have an indirect bearing on safety as it may lead to hazards further along the distribution chain or at the point of use. Well intentioned but inexpert attempts to solve LP Gas quality problems at the point of use can be risky and are best prevented by appropriate controls during production. Authorities should ensure that relevant product standards are established and observed.
Because Butane and Propane have different physical properties it is important that the composition of LP Gas mixtures being distributed in a market be known to participants and kept within specified limits which are related to product specifications. There are LP Gas standards which have international recognition and one of which could be adopted, in the absence of a suitable national standard. See Appendix Three – List of References.

LP Gas is odourless in its natural state so a distinctive odour is usually added in order to warn of its presence. However, not all LP Gas is odourised in this way and additional hazards exist in the storage and distribution of unodourised LP Gas.

Not all LP Gas is odourised as there are a few applications for LP Gas, like propellants, requiring unstenched product. Additional hazards exist in the storage and distribution of unodourised LP Gas and this requires extra care.

When selecting the type of odourant to use it is important to recognise their particular properties as some are toxic and require careful handling. Attention should also be given to their short life as the odour may fade over time.

### Inherent Hazards/Potential Risks

**3.3.1** The principal potential hazard with LP Gas is fire and explosion. This derives from its inherent quality of high flammability and in extreme cases may combine with another condition, i.e. high pressure, and lead to the BLEVE (Boiling Liquid Expanding Vapour Explosion) phenomenon. This is a type of explosion that can occur when a vessel containing a pressurised liquid is ruptured due to high temperature and pressure. Such explosions can be extremely hazardous. There are also hazards incidental to the various modes of transport for distribution and use.

**3.3.2** An additional potential hazard may arise at the point of use if ventilation is inadequate and the products of combustion are not dispersed into the atmosphere. Carbon monoxide may be produced and reach dangerous levels. LP Gas ‘sniffing’ i.e. the intentional inhalation of LP Gas vapour seeking a narcotic effect can result in injury or in some cases, death.

**3.3.3** The risk associated with such hazards (with the exception of sniffing) can be controlled using available, proven technology, i.e. the safety equipment and procedures normally used by the LP Gas industry.

**3.3.4** Liquid LP Gas will cause cold burns if it comes into contact with the skin. Propane, with its low boiling point is more hazardous in this respect than Butane which, in cold conditions, is slower to vaporise and disperse. The eyes and body must be protected when handling all liquefied products.

**3.3.5** LP Gas vapour, being heavier than air, may, in the event of a leak, accumulate in confined spaces and low-lying areas. The means of ventilation and meteorological conditions will influence the movement and dispersion of the LP Gas vapour.

**3.3.6** Any uncontrolled release of LP Gas is inherently hazardous. A liquid LP Gas leak is considered more hazardous in that it will expand to vapour form with volume in excess of 200 times that of the original liquid volume leak. Being heavier than air, vapour will tend to lie or drift, close to the ground with a risk that it will find a source of ignition while it remains within its flammable limits. The physical properties are given in the table shown earlier in this section.

**3.3.7** Liquid LP Gas has a high coefficient of volumetric expansion and therefore cylinders and tanks should never be completely filled. They should be filled with ullage (the unfilled space in a container of liquid) to allow for liquid expansion caused by an increase in temperature. The degree of ullage necessary will depend on the operating conditions, especially the maximum expected operating temperature. This potential risk is further controlled by a combination of safety devices and procedures and especially by control during product transfer operations. This potential risk explains why cylinders and tanks should only be filled under the supervision of competent persons and why illegal filling is dangerous because of the risk of overfilling.

**3.3.8** Because of its much higher vapour pressure, tanks and cylinders containing Propane need to be stronger than those for Butane, and both should be protected against excessive pressure. This potential risk is controlled by safety devices and by segregating the products or, where LP Gas mixture is handled, ensuring that the Propane content does not exceed a specified upper limit. In cold weather, a tank storing Butane may be subjected to negative pressure and must be capable of withstanding this.

**3.3.9** During the process of distribution, LP Gas will normally be transported in one or more modes. There will be hazards associated with the transport mode and with the consequences of traffic accidents and incidents. The risks will vary from country to country and with the transport mode. The control of transport-related risks is discussed in Chapters 6 and 9.

**3.3.10** The majority of consumers will use LP Gas as a fuel in an appliance. The installation comprising the LP Gas supply and connection to the appliance may be simple or complex, large or small. Hazard scenarios and risk at the point of use are discussed in Chapter 10.
3.3.11 The products of complete LP Gas combustion - mainly water and carbon dioxide - are not inherently hazardous. Good installation practice specifies ventilation to supply the air required for combustion and to vent the products of combustion. This minimises risk by preventing a build-up of carbon monoxide or a development of asphyxiating (i.e. oxygen-deficient) conditions.

3.3.12 LP Gas is a clear odourless liquid and is not readily visible in its gaseous phase. In the event of a leak it may be present, unseen, in hazardous concentrations. To minimize this risk, odorant with a distinctive, persistent and unpleasant smell is added to LP Gas prior to distribution. In special applications requiring odour-free LP Gas, such as aerosol propellant, or the chemical industry, alternative safety measures are adopted such as the use of gas detectors.

3.3.13 Accumulation of LP Gas vapour may result in the development of an oxygen-deficient atmosphere which carries a risk of asphyxiation. The visible cloud might be smaller or bigger than the actual gas cloud, depending on humidity in the air. An explosimeter should be used to approach a gas cloud. No one should enter a gas cloud as the possible introduction of an ignition source creates a hazardous zone and possible fatal area. No one should enter a vessel which has been used for LP Gas storage without supervision and only when all appropriate safety measures are in place and the area has been determined as gas free.

3.4 Basic Safety Principles

3.4.1 While flammability is the major safety concern with LP Gas it is not the only one. Good safety practice addresses the various hazards from production to consumption.

3.4.2 The term LP Gas embraces several products which while related have important physical differences which affect safety. If more than one type or grade of LP Gas is being handled each should be clearly identified and segregated. All should be within specification, especially with respect to maximum permitted vapour pressure.

3.4.3 Large LP Gas installations should not be constructed close to large or sensitive populations. Populations should be restricted close to locations approved for large LP Gas installations. In planning or evaluating proposals for the location of LP Gas facilities due account should be taken of the hazards created and of the risks associated with those hazards within and beyond the facility.

3.4.4 Space and separation distances are fundamental to safety at LP Gas facilities – large and small – and should be assessed for each location and observed.

3.4.5 Participants in the LP Gas industry should actively promote a safety culture within their own businesses and at industry level.

3.4.6 Personnel engaged in LP Gas operations should receive formal training by competent persons for their normal activities and for emergencies. LP Gas facilities should have emergency planning and response programmes appropriate to the hazards and risks which they represent. These include correct handling procedures to avoid injury.

3.4.7 Fuel grade LP Gas should be adequately odourised prior to entering the distribution chain. When LP Gas is required to be odour-free adequate alternative safety measures should be employed. (See Appendix Three - References).

3.4.8 LP Gas cylinders and tanks should never be allowed to become liquid-full. Climatic conditions will influence the degree of ullage required but it is typical practice to fill to around 80% of the water capacity of the vessel. In some circumstances
over fill devices may be required to provide protection. In other cases cylinders and tanks should only be filled under the supervision of competent personnel.

3.4.9 Above a certain quantity LP Gas should be clearly identified during transportation, using classification numbers and appropriate warning signs. (see Appendix One).

3.4.10 Appliances and equipment for the handling, transportation and use of LP Gas should be fit-for-purpose, correctly installed and well-maintained. Sub-standard appliances, equipment and installations should be excluded if necessary by regulation.

3.4.11 Installers of appliances and equipment, and those responsible for service should be formally trained and should have reached a specified level of proficiency.

3.4.12 Cylinders for indoor use should preferably be filled with Butane or Butane-rich LP Gas mixtures although certain countries do permit the use of Propane cylinders indoors. Only those cylinders which are in use should be kept indoors. Whenever Butane and Propane are sold as separate products, cylinders should be readily distinguished and preferably fitted with different outlet valves so that they are not easily interchanged or used for natural gas appliances.

3.4.13 Consumer safety awareness campaigns are an essential part of LP Gas safety principles and they should emphasise:
• The quality/safety linkage for gas, appliances and equipment including safe practices
• The risks associated with inferior installation standards and/or practices
• The need for care and in particular for adequate ventilation
• How to recognise the smell of odourised LP Gas
• The action to take when gas is detected

3.5 Product Classification and Labelling

3.5.1 In practice the products known collectively as LP Gas include n-Butane, iso-Butane, Propane and Propene/Propylene. They may be supplied separately or in varying mixtures and degrees of purity. All come within the designation ‘Hazardous Substances’ and are classified ‘Highly Flammable’.

3.5.2 Transport regulations such as the Agreement for the International Transportation of Dangerous Substances by Road (ADR) and its railway counterpart (RID) include a UN hazard warning and identification system which is useful in emergencies and which should be used. Examples of the system are set out in Appendix One. [also refer: www.unece.org]

3.5.3 LP Gas cylinders, storage tanks and pipelines should be clearly identified by appropriate markings and warning signs, examples of which are to be found in Appendix One. These are recommended for use in the absence of a national system of signs and markings.

3.5.4 Where Butane and Propane are sold as separate products, cylinders and tanks should be marked according to product. Containers of LP Gas which has not been odourised should be clearly marked and labelled.

3.5.5 In the absence of national regulations the minimum safety information on a cylinder should state the product, the supplier’s name or brand, the net fill amount, a flame symbol and the word ‘Flammable’, or its local language equivalent. Information should be of sufficient size to be readily legible and in a colour contrasting with the rest of the cylinder.
Chapter Four

LP Gas Distribution Chain

The distribution chain begins with a small number of large installations and ends with large numbers of consumers, some large but mostly small.

Some consumers receive LP Gas in cylinders others receive it in bulk.

Safety should take account of the distribution system, the different types of consumer and the particular hazards at each stage of the chain.

The exercise of safety becomes more difficult as LP Gas moves through the distribution chain.
4.1 General

4.1.1 The Distribution Chain describes the process by which LP Gas is moved from production or importation to the point of use.

4.1.2 LP Gas purchased ex-ship or ex-pipeline is considered to have entered the distribution chain at the point and time of custody transfer when ownership and responsibility normally passes to the primary marketer. At this early stage of the distribution process, Butane and Propane are often handled separately and the scale of operations tends to be at its largest.

4.1.3 LP Gas is normally stored, handled and transported under pressure and at ambient temperature during distribution. Marketers will seek competitive advantage through distribution efficiency which will include optimising the scale and location of their distribution infrastructure. In practice this will include locating certain of their facilities close to consumption centres. This will necessitate marketers taking care of local interests.

4.1.4 LP Gas distribution may be in bulk or in cylinders depending on many considerations such as application, scale of usage and consumer preference. Automotive LP Gas should always be distributed in bulk. The marketers’ distribution infrastructure will include bulk depots and cylinder filling plants unless solely engaged in Automotive LP Gas.

4.2 Classification and Activities

4.2.1 In its basic form the LP Gas distribution chain starts with a primary marketer purchasing a single grade of LP Gas, probably the producer’s specification, and selling it to consumers within a limited geographical area. The chain becomes more complex as multiple supply sources and possibly choices of grades develop for example as more marketers begin to sell into an expanding geographical area and serve a broader range of LP Gas applications.

4.2.2 Importation of LP Gas may be required to augment indigenous supply on a seasonal and/or year-round basis.

4.2.3 Imports may be made overland but are more commonly made by sea. Sea-fed facilities may be established by specialist terminalling or trading companies by LP Gas marketers or by joint ventures. It is unlikely that a marketer whose experience is limited to purchasing LP Gas ex-refinery or from a gas plant will have the technical and safety skills to handle imports without expert assistance.

4.2.4 Multiple sources will normally enable the marketer to extend his supply options and possibly to shorten the primary transportation lines. The marketer will probably be drawn towards multi-depot operations and should then be prepared to deploy additional supervision in order to maintain safety standards.

4.2.5 Some marketers distribute directly to their consumers, large and small. Oil companies with retail businesses sometimes use their petrol stations as LP Gas outlets. Others distribute through appointed agents, distributors or dealers. All must work to implement LP Gas safety disciplines in distribution networks which may include some unresponsive or disinterested elements.

4.2.6 A developed LP Gas distribution chain will have some (possibly all) of the components shown in the diagram on page 19. In addition it will include traders and transportation companies, shippers, pipeline operators, rail and road transport contractors.

4.3 Implementation of Basic Safety Disciplines

4.3.1 The effective implementation of safety discipline should follow from the regulatory/enforcement system working constructively with industry, both directly and through its representative organisations. For the purpose of this document, ‘industry’ should include manufacturers of LP Gas-based aerosols, refrigeration and air-conditioning appliances’ manufacturers and service providers, equipment vendors and installers, as well as LP Gas marketers.

4.3.2 Elsewhere in the Guidelines, we have noted that:

- LP Gas can be hazardous from production to the point of use
- Safety comes from understanding LP Gas and maintaining control

Understanding and control should be present, and exercised, at every point of the distribution chain.
4.3.3 The logical starting points for the process of implementing safety discipline are knowledge and awareness. We have noted that good technical expertise is to be found in the LP Gas marketing companies and equipment manufacturers. The main burden of implementing knowledge-based safety and safety awareness should be borne by them and they should have recognition when it is done properly.

4.3.4 The majority of LP Gas-related incidents occur at, or close to, the point of use. Safety discipline must include the consumer who, having been made aware of certain hazards, should respond by exercising every reasonable care.
Chapter Five

Trans-Shipement Terminal

LP Gas trans-shipment terminals are always major hazard installations whether by reason of their capacity, the scale of transfer operations and/or proximity to other hazardous installations.

The planning and operation of a trans-shipment terminal requires careful identification and evaluation of the risks and consequences of the operation of the facility. Hazard and operating studies (HAZOP) are often applied to identify and mitigate the consequences against those risks. Environmental impact studies are also sometimes undertaken. In many terminals, Butane and Propane will be handled separately rather than as LP Gas mixtures.

In many terminals, Butane and Propane will be handled separately rather than as LP Gas mixtures. The products may be received and stored at sub-zero temperatures. Safety systems should take account of these factors.

Terminal safety is directly linked to the safety of shipping operations.

5.1 General

5.1.1 Markets in which LP Gas demand exceeds indigenous supply tend sooner or later to have trans-shipment terminals. Through these LP Gas will be imported using special tank ships which may transport different LP Gas products. In these ships LP Gas may be transported under pressure, at ambient temperature, or semi/fully ‘refrigerated’, i.e. at low temperature and reduced pressure. The choice between these modes will be determined by economic considerations which will themselves be strongly influenced by the scale of operation. The compliance of imported LP Gas with local product specifications has to be established and this is usually done in the trans-shipment terminal.

5.1.2 A national market may be served by one or more terminals capable of receiving very large ships with part of the cargo for local use and part being trans-shipped to smaller import terminals, by coastal tanker or barge.

5.1.3 When transported in large ships LP Gas is normally refrigerated with Butane and Propane stored in different cargo tanks. The inland market will require, and the coastal shipping will transport, LP Gas under pressure, i.e. at or close to ambient temperature. The market may require Butane, Propane or an LP Gas mixture. This will prompt consideration of whether the large receiving terminal storage should be refrigerated and if not how the incoming LP Gas should be brought to ambient temperature. These questions all have major safety implications both for the initial design and for subsequent operations.

5.1.4 A LP Gas trans-shipement terminal may be developed as an independent standalone installation with its own ship-handling facilities. More often an LP Gas terminal becomes an additional activity sharing nearby facilities with others.

5.1.5 The planning of an LP Gas trans-shipement terminal should include major hazard and environmental impact studies for both the onshore and offshore aspects using internationally-accepted standards and criteria. The hazard study should take account not only of any compounding of risk associated with neighbouring industrial activities but also of the potential benefits from existing safety/security arrangements, including mutual assistance as part of emergency response programmes.
5.2 Refrigerated/Pressure Shipping and Storage

5.2.1 The choice between shipping and storing LP Gas at ambient or reduced temperature and pressure is largely a matter of logistics and economics. There are costs associated with achieving and maintaining low temperatures but under certain conditions the unit costs of a refrigerated LP Gas containment system will be less than containment at ambient temperature and pressure. Control is essential for safety whatever the choice of storage and the cost of safety systems at such terminals may be significant and needs to be factored into the decision.

5.2.2 The design and engineering of an LP Gas trans-shipment terminal should be in accordance with a reputable standard enjoying international recognition. Volume 1 of The Model Code of Safe Practice No. 9, Liquefied Petroleum Gas by the Institute of Petroleum deals with large bulk storage, both refrigerated and ambient temperature/pressure. Others include SIGTTO – Liquefied Gas Handling Principles on Ships and in Terminals. [refer: www.sigtto.org]

5.2.3 Each terminal will have its own special features and requirements. However, the terminal operations should adopt the safety principles and procedures developed and refined over the years. These can be found in such publications as:

- Safe Transport, Handling and Storage of Dangerous Substances in Port Areas, by The International Maritime Organisation (IMO) [refer: www.imo.org];
- Guidance Notes GS 40 : The Loading and Unloading of Bulk Flammable Liquids and Gases at Harbours and Inland Waterways, by U.K. Health and Safety Executive [refer: www.hse.gov.uk];
- Liquefied Gas Handling Principles on Ships and in Terminals, by The Society of International Gas Tanker and Terminal Operators. [refer: www.sigtto.org]

5.3 Single/Multi-Product Terminal Operation

5.3.1 A single product terminal has the advantage of comparative simplicity, even if several grades of LP Gas are being handled simultaneously.

5.3.2 For the purposes of these Guidelines a multi-product terminal is one in which LP Gas and another product, or products, are being handled. The multi-product aspect may be confined to a shared ship-handling facility or may also apply to the on-shore storage area.

5.3.3 The design, layout and operation of a multi-product terminal should be the subject of the most careful study and evaluation in respect of the compatibility of products and of operations.
Chapter Six

Inland Transportation

LP Gas is moved in bulk in the initial stages of inland transportation by waterway, pipeline, rail or road. Some consumers receive their LP Gas in bulk. Others receive their LP Gas in cylinders. Small sized pressurized canisters are also used to supply LP Gas for the refrigeration and air conditioning appliances. Final delivery is usually by road.

Traffic risks vary from country to country and with the transportation mode. The LP Gas industry should be extra vigilant when the risk of a traffic accident is high. Transport vehicles should be of a suitably high standard and operated by qualified drivers.

6.1 General

6.1.1 Almost invariably LP Gas is moved in bulk in the initial stages of inland transportation. For many applications and especially for automotive and industrial use LP Gas is transported in bulk throughout the distribution process. For others, LP Gas may have started the journey in bulk but is finally delivered or collected in a cylinder.

6.1.2 LP Gas may be transported by inland waterway, by pipeline, rail or road depending on the strengths and weaknesses of the national or local transport infrastructure, or depending on national regulations. There are hazards associated with all these modes of transportation but the risks will vary with local conditions. There will be times when the most economical method must be forgone in the interests of safety.

6.1.3 Tolerability of risk from traffic hazards varies from country to country. The LP Gas industry depends on transport to deliver its products and therefore should employ good safety practice in its inland transport operations. The industry should be extra vigilant where the external risk is known to be high.

6.2 Primary Distribution in Bulk

6.2.1 Primary distribution refers to transportation in the first step of the distribution chain, i.e. from source of supply to major customers, bulk plants and cylinder filling plants. At this stage of distribution the LP Gas is the property and responsibility of the primary marketer who will probably have entrusted the task of transportation to a specialist contractor.

6.2.2 While some primary distribution of LP Gas is by pipeline or barge the principal transportation modes are rail and road. Whether conveyed in marketer owned or contractors’ vehicles, LP Gas transportation should be in accordance with national regulations and in accordance with good international practice. Comprehensive guidance is to be found in codes such as:

- The Agreement concerning the international carriage of dangerous goods by road (ADR) [refer: www.unece.org]
- Regulations concerning the international carriage of dangerous goods by rail (RID) [refer: www.unece.org]

6.2.3 In the absence of transportation contractors capable of providing the required standard of safety the marketer should take direct charge and responsibility for primary distribution.
6.3 Secondary Distribution in Bulk and Cylinders

6.3.1 Secondary distribution refers to the movement of LP Gas onward along the distribution chain from a bulk plant or cylinder filling plant. Ownership of the LP Gas may remain with the marketer or may be passed to others. A change of ownership will affect the exercise of safe practice as each new owner takes responsibility for safety at each stage of the distribution process.

6.3.2 Secondary distribution in bulk is further discussed in Chapter Nine.

6.3.3 Secondary distribution in cylinders usually means transportation by road and exposure to the road traffic hazards. Drivers should be carefully selected and trained both in avoiding and in dealing with the consequences of accidents.

6.3.4 Trucks regularly employed in the transport of LP Gas should be designed, or adapted, to minimise the risks associated with the product and the mode of transportation. They should be inspected before they enter service and be properly maintained.

6.3.5 LP Gas distribution trucks should display product identification plates and be equipped with suitable fire extinguishers.

6.3.6 Filled LP Gas cylinders which are intended to be utilised in the upright position should preferably be transported upright with the valves protected against any impact. Full and empty cylinders should, as far as is practical, be segregated on the truck. Pallets or cylinders must be restrained using straps or ropes (natural hemp not nylon) that are secured to properly designed anchorage points.

6.3.7 Publications giving more detailed safety guidance for secondary distribution of LP Gas in cylinders are referred to in the Appendix Three together with some web links.
Chapter Seven

Bulk Storage and Handling

The location of storage should be considered in conjunction with the nature and scale of the LP Gas operations and of external risks.

Safety systems and procedures should prevent uncontrolled releases of LP Gas and the over-filling of storage tanks.

Passive safety features and fail-safe safety systems should be incorporated into bulk storage and handling facilities.

7.1 General

7.1.1 LP Gas may be stored on a large scale at an import or trans-shipment terminal on an intermediate scale at depots, cylinder filling plants and large industrial consumers, or on a small scale at a household installation. The largest LP Gas terminals may have storage in excess of 100,000 tonnes.

7.1.2 In this section of the Guidelines the principal focus is on large and intermediate storage forming part of the distribution infrastructure. Small-scale bulk storage is discussed further in Chapter 9 of these Guidelines.

7.1.3 From a safety standpoint, LP Gas storage should be considered in conjunction with the nature and scale of the associated on-site LP Gas handling operations. Apart from National Standards and Codes of practices, there are well established International Standards and Codes which, when effectively employed, will substantially reduce both hazard and risk. These include:

- LPGA COP 1 (UK) - The Storage of LP Gas at Fixed Installations, by the UK LP Gas Association (UK) [refer: www.lpga.co.uk]
- Regulations for LP Gas service stations and road tank trucks in the Netherlands (for the special needs of the automotive sector).
- EN 12542 and EN 14075 [refer: www.cen.eu]

7.1.4 A fire or explosion involving LP Gas in bulk storage is potentially a major incident and likely to have an impact beyond the operator’s boundary fence. The development and operation of such facilities should be subject to consultation at official and community level. If national regulations stipulate licensing the criteria should be risk-based.
7.2 Single/Multi-Grade Operation

7.2.1 Some markets work with a single grade of LP Gas and therefore have a simple system for product storage and handling. More often commercial grade Butane, Propane and LP Gas mixtures are stored and handled separately. Some marketers may offer high purity, chemical grade or de-odourised LP Gas requiring dedicated storage and handling systems.

7.2.2 For safety, the important considerations are that:
- stored LP Gas does not develop a vapour pressure in excess of the permitted maximum for any part of its containment system.
- There is no total dependency on the characteristic, unpleasant smell of stenched product to warn of the presence of LP Gas. Other mitigating measures such as gas detectors should be installed. The storage and handling of unstencched product will require these anyway.

7.2.3 Multi-grade facilities should be equipped with the physical means of segregating the various grades of LP Gas and should have procedures to check and validate the effectiveness of such segregation.

7.2.4 Each LP Gas storage tank should be suitable for the grade of product to be stored in it at the expected temperature range and developing the highest vapour pressure.

7.3 Technical Options - Types of Storage

7.3.1 LP Gas is stored in bulk in:
- Salt domes, tunnels or caverns
- Cylindrical or spherical steel tanks which may be above ground, underground or mounded.

The scale, location and method of operation of the storage facility will influence the choice from among these options. Environmental and safety issues must always be given due consideration. The photo below shows a number of above ground horizontal tanks at an installation in South America.

Fig. 7.1 Above-ground cylindrical tanks for storage of LP Gas

7.3.2 Salt domes, tunnels and caverns are typically created deep underground and are most economical for large-scale pressure storage. However they can only be realised if the on-site geological and geophysical conditions are favourable. Steel tanks are preferred for large-scale refrigerated storage.

7.3.3 With growing appreciation of the attractions of passive safety and confidence in modern corrosion protection technology more intermediate and small-scale LP Gas storage is being moundcd or installed underground. In some countries these may be the only permitted technical options for intermediate-scale storage.
7.3.4 The reduced risk with mounded and underground LP Gas storage is reflected in a relaxation of safety/separation distances in certain standards. The distances given in such reputable publications as NFPA 58 [refer: www.nfpa.org] and LPGA COP 1 (UK) [refer: www.lpga.co.uk] are empirical, not scientific. A more scientific approach, based on experimental tests and practical experience and using Hazard and operating studies (HAZOP) are often applied in the LP Gas industry.

7.4 **Technical Options - Product Transfer**

7.4.1 LP Gas transfer is potentially hazardous - an activity where things can and sometimes do go wrong because of equipment or procedural failure.

7.4.2 Pipelines for the transfer of refrigerated LP Gas are insulated to protect the product against unwanted heat gain. Product temperatures should not be below the design and material specifications. When refrigerated LP Gas is to be transferred to non-refrigerated storage, an inline product heater may be employed. At coastal locations in warm or temperate climates, seawater may be used as the heating medium.

7.4.3 The most common bulk transfers are between depot tanks and rail tank cars/road tankers or, in the case of automotive LP Gas, between station and vehicle tanks. Road tankers and rail tank cars may be loaded by weight or by volume, singly or in groups. All such transfers must be monitored to ensure that maximum fill limits are not exceeded. It should be constantly borne in mind that cold LP Gas will expand as its temperature rises.

7.4.4 Articulated loading arms are preferred for in-depot transfers but flexible hoses are currently the only practical option for bulk delivery to consumers and for automotive refueling.

7.5 **Safety Systems for Operation**

7.5.1 The first rule of safety is to avoid any uncontrolled leakage of LP Gas. All systems should be designed with this prime objective of containment in mind.

7.5.2 The traditional approach to safety is based on generous use of space and of water deluge systems for emergency response. Increasingly, this approach is giving way to the concept of passive safety (including the use of passive fire protection [PFP] in the form of coatings) and to fail-safe valving and control systems. The passive safety concept is evident in mounded and underground tanks. Passive fire protection can be used where ground conditions are not suitable for burying or mounding vessels. A modern valve control system will be capable of automatic and/or remote operation. It will ensure that main valves are closed unless they are required to be open and only while that requirement lasts and that they close in case of emergency or alarm.

7.5.3 High and low-level alarms fitted to plant storage tanks can be a useful defence against overfilling but they should not be seen as an alternative to proper supervision.

7.5.4 With the emphasis on safety management systems, risk assessment, training and periodic inspections, regulations derived from the European Directive 96/82/EEC (Seveso II Directive) can be a valuable part of a plant safety programme.

7.5.5 Many plant incidents take place outside normal working hours, often during maintenance operations. After hours security and supervision of maintenance work are crucial for safety. All critical works or works done in critical areas should be subject to a risk assessment and a permit to work.

7.5.6 Static electricity discharge is a cause for concern and so steel structures and pipework should be securely earthed. Road tankers should be bonded to earth before LP Gas transfers commence and remain so until the operation is complete and the hose is disconnected.

7.5.7 Road tankers admitted to the plant should be equipped to the standard specified in national regulations or in a reputable code, such as ADR. Vehicles should be immobilised during transfer operations and equipped to prevent untimely movement. Loading/unloading bays should be protected against impact. Both company-owned and contractors’ vehicles should comply.

7.5.8 Fire-resistant coatings can provide a useful means of improving safety in vessels. They have the advantage that they can be applied to existing tanks to augment an existing safety system. However the selection and application of such coatings should be entrusted to specialists.

7.5.9 Sections of pipework and storage systems that can be isolated with valves or blinds should be equipped with safety valves to protect against possible damage as liquid LP Gas expands with increases in temperature.
Chapter Eight

Cylinder Filling and Handling

Cylinders should be filled with the intended product – Butane, Propane or specific LP Gas mixtures – and should never be over-filled.

Cylinders should be checked before and after filling to ensure that they are fit to fill, have been correctly filled, are gas tight and will be trouble-free in service.

A mishandled cylinder can cause injury and damage, or result in an uncontrolled release of LP Gas.

Handling of LP Gas cylinders should as far as practical be mechanised to prevent injury.

8.1 General

8.1.1 Cylinder filling plants vary in scale and sophistication from simple single-station operations filling small numbers of cylinders on demand, to high-technology plants serving hundreds of thousands of consumers.

8.1.2 LP Gas is sold by weight in cylinders and too often accuracy of filling means ‘not being underweight’ to both consumer and filler. It is not always appreciated that an overfilled cylinder, i.e. one which may become liquid-full, can be highly dangerous with small increases in temperature as liquid LP Gas expands ten times greater than water.

8.1.3 Ownership of cylinders can have an important bearing on safety. They should be manufactured and maintained in accordance with recognised technical standards. Non-compliant cylinders should not be re-filled although this can lead to difficulties when the consumer owns the cylinder and he may suspect a motive in a refusal to fill it. The consumer will have little appreciation of the safety checks which the professional re-filler carries out as a routine part of his work.

8.1.4 Cylinder maintenance and repair are potentially hazardous activities and when undertaken in a filling plant can become disruptive of cylinder filling operations. Maintenance and repair should be carefully planned in order to avoid such disruption.

8.1.5 Filling plants handling more than one grade of LP Gas should be designed and equipped accordingly. They should have the physical and procedural controls to ensure that one is not mistaken for another.

8.2 Cylinder Filling and Checking

8.2.1 Cylinder filling operations should be carried out in accordance with a reputable technical standard or code such as ISO 10691 [refer: www.iso.org]

8.2.2 The initial check is to ensure that the cylinder is fit for refilling, i.e. that when filled it will not create a problem for either the refiller or the consumer. This initial check is also for compliance with any national or industry revalidation rules.

8.2.3 The cylinder valve is normally dual purpose in that it is used both for re-filling and to supply gas to the consumer. The condition and performance of the valve is crucial for safety.

8.2.4 National regulations may determine the permitted filling tolerances. While complying with these the refiller must ensure that the correct grade of LP Gas is filled and that the maximum permitted fill volume for the cylinder is not exceeded, i.e. that there is no risk of the cylinder becoming liquid-full.
8.2.5 Post-filling checks are specified in the Code of Practice referred to in 8.2.1 above. The objective is to provide the consumer with a cylinder which has been correctly filled, will be trouble-free in use and meets all national or industry labelling requirements. The photo below shows LP Gas cylinders on an automatic filling carousel.

8.2.6 Post-fill procedures should include leak-testing, check weighing and, in the absence of fixed protection (e.g. a shroud) the fitting of a suitable form of cylinder valve protection if this is not already provided for in the valve design. Increasingly LP Gas marketers are fixing a tamper-proof seal to the cylinder valve after re-filling to reassure consumers of the integrity.

8.2.7 Both full and empty LP Gas cylinders can cause serious injury during manual handling and, where possible, handling should be mechanised. Manual handling of cylinders should be done with proper personal protective equipment.

8.3 Care and Maintenance of Cylinders

8.3.1 An LP Gas cylinder is a pressure vessel which may, during the process of distribution and end use, be subjected to rough treatment. Nevertheless its integrity is essential for safety and therefore it must be properly maintained.

8.3.2 Where the LP Gas marketer retains ownership of cylinders - and the empties are returned for refilling - the marketer is also responsible for care and maintenance.

8.3.3 The consumer, as the owner of the cylinder, may assume – probably unwittingly – responsibility for maintenance. In this case, compliance with cylinder re-qualification requirements can be very difficult. The cost of re-qualification (to be borne by the owner-consumer) and problems of access to re-qualification facilities are likely to be contributing factors. The owner-consumer system also carries the risk of a do-it-yourself approach to cylinder valve repair/replacement. It is imperative that legislation and regulations are consistent with the standards and codes of practice relating to cylinder re-qualification.

8.3.4 In the absence of national regulations, there are reputable standards, such as ISO 10464 which specify intervals for inspection and re-qualification. Cylinder filling standards such as ISO 10691 codes (e.g. COP 12) [refer: www.iso.org] include acceptance/rejection criteria for damaged cylinders. The LP Gas marketer filling the cylinder must be responsible for checking for compliance with these criteria. Under certain conditions, the ADR allows for the period of inspection and recertification for steel cylinders to be 15 years.

8.4 Technical Options for Cylinder Filling

8.4.1 Although the leading equipment manufacturers also offer volumetric filling machines, most LP Gas cylinders are filled by weight, i.e. by reference to individual tare weights and a specified fill, or weight, of LP Gas. At high volume, the challenge
for the equipment manufacturer is to provide speed and accuracy for both filling and checking together with flexibility to deal with different types of cylinder and different grades of LP Gas. At low volume, accuracy of filling and checking are equally important for safety. Generally, a check weigh scale is needed for ‘weights and measures’ compliance with 100% check weighing becoming the norm.

8.4.2 Essentially, the technical options for cylinder filling are:

- A small number of high volume plants
- A larger number of low volume plants
- High automation/few employees and vice-versa.

8.4.3 Filling large numbers of cylinders manually is heavy, monotonous work and the risk of injury inherent in a labour intensive plant should be evaluated against that of a well-managed, automated plant. In markets where the local regulations permit the manual handling of cylinders, the personnel handling cylinders manually should be trained for minimising the risk of injuries to themselves and others. Management of safety should always be appropriate to the number, size and type of plants.

8.4.4 Advances in electronics, in metering and in data management systems have moved the technology of cylinder filling forward and have helped to make LP Gas operations safer. However, any programme to automate should ensure that safety systems are updated as filling procedures change.

8.5 Storage and Handling

8.5.1 LP Gas cylinders can cause serious injury during manual handling and, wherever possible, handling should be mechanised. Manual handling of cylinders should be done with proper personal protective equipment.

8.5.2 Conveyors and other parts of a mechanical handling system should be earthed to discharge static electricity. As with all rotating machinery they can also lead to incidents and should be designed to avoid employees being trapped and stop when an employee is trapped.

8.5.3 Fork lift trucks are invaluable cylinder handling aids. They should be equipped with spark-suppressing features (flameproof) and observe any hazardous zone restrictions within the filling plant or depot.

8.5.4 Training should be provided for those involved in cylinder handling in order to minimise the risk of injury to employees and of damage to the cylinders.

8.5.5 The storage of cylinders should be systematic with full and empty cylinders segregated and confined to designated areas. Specific guidance can be found in COP 7 – Storage of Full and Empty LP Gas Cylinders and Cartridges, by the LP Gas Association (U.K.) [www.lpga.co.uk].

8.5.6 Cylinders requiring maintenance, repair or fill correction should be dealt with urgently by trained and properly supervised employees. Such cylinders are potentially hazardous and a backlog should never be allowed to accumulate within the cylinder filling area. Should cylinders be unserviceable, then recycling of the different metal components is to be encouraged.

8.6 Safety Systems for Operation

8.6.1 A cylinder filling plant has many potential trouble spots which, in a large plant, may be some distance apart. Plants should incorporate an emergency shutdown system to stop the flow of LP Gas, pumps and filling equipment. An alarm system capable of operation from key locations and of actuating emergency response measures is considered an essential part of the plant safety system.

8.6.2 Clear signage (including road marking) and effective gatehouse control over vehicle and individual access to the hazardous areas are also considered essential.

8.6.3 Many plant incidents take place outside normal working hours, often during maintenance operations. After-hours security and supervision of maintenance work are crucial for safety. All critical work or work done in critical areas should be subject to a risk assessment and a permit to work.

8.6.4 More detailed guidance of safety systems for operation can be found in COP 12 [refer: www.lpga.co.uk].
Bulk LP Gas distribution requires equipment and skills which differ from those required for cylinder distribution.

The consumer's installation and the bulk delivery vehicle should be correctly designed, equipped and maintained.

The driver/operator must be properly trained and equipped to handle both normal operations and emergencies.

9.1 **General**

9.1.1 In the LP Gas industry, ‘bulk distribution’ generally refers to supply by road tanker into a fixed storage tank or tanks. LP Gas is sometimes distributed in bulk using demountable or containerised tanks but this is an exception not the rule. All accepted alternatives will be dealt with in these Guidelines.

9.1.2 Bulk distribution may be ‘full-load’, where the customer has sufficient storage to accept the contents of the supplying road tanker, or ‘part-load’, where the tanker’s LP Gas cargo is shared among a number of customers. Full-load distribution may be by weight or by volume while part-load is often by volume, measured by a tanker-mounted metering system. The system should include a temperature correction feature to take account of changes in volume arising from changes in LP Gas temperature.

9.1.3 The possibility of a release of product during transfer may involve both the delivery tanker and the fixed storage vessel.

9.1.4 Bulk distribution is popular with consumers as it often means a higher level of convenience than cylinders. Sometimes, because of the quantity involved, it is the only practical method of supply.

9.1.5 Bulk distribution and the bulk installation which is a necessary part of the system call for technical, operational and safety expertise which may not be available in a cylinder-only LP Gas market.

9.1.6 Bulk distribution may have the effect of reducing the number of trucks employed in transporting LP Gas (when compared with cylinders) reducing the traffic accident hazard. On the other hand, the amount of LP Gas being carried on each truck will be greater with potentially more serious consequences in the event of a major traffic accident. Technical standards for tanker construction, on-board safety systems and driver skills should be of a suitably high order.

9.2 **Technical Options**

9.2.1 The technical options for bulk distribution of LP Gas are:

- Demountable or containerised tanks
- Road tankers without LP Gas transfer equipment
- Road tankers with on-board LP Gas transfer equipment.

9.2.2 Demountable tanks may be relatively small capacity (i.e. 1 tonne and upwards) and are sometimes used to distribute chemical grade LP Gas or where physical access to the consumer is difficult or where the quantity for distribution does not justify the expense of a road tanker. Containerised tanks are mounted within a standard ISO container frame (see fig. 9.1 on following page). Both demountable and containerised tanks require specialized handling equipment and are probably at highest risk during handling operations.
9.2.3 Road tankers without LP Gas transfer equipment are generally used for full-load deliveries and are unloaded using a fixed pump or compressor at the receiving location. These are rated as low-risk operations because transfers are usually made in controlled environments.

9.2.4 Road tankers with transfer equipment, usually a pump driven by the truck’s engine and an in-line flow meter, are an essential part of bulk LP Gas distribution. Making frequent deliveries through a flexible hose requires more elaborate safety equipment. A comprehensive hose inspection/renewal programme should be implemented. One-man operation is normal but this demands consistent and comprehensive training of the driver/operator but only by a properly trained driver-operator.

9.3 Bulk Supply and Delivery

9.3.1 Tanks used on LP Gas road tankers are specially designed and constructed for this duty as are skid-mounted and containerised tanks. A tank intended for static storage should not be used for deliveries.

9.3.2 Tank nozzles and valves are fitted internally, recessed into the tank shell or positioned so as to minimise the risk of impact damage and to prevent unauthorised access.

9.3.3 Road tankers may be loaded by volume or by weight but should always retain a safety margin, or ullage, to protect against the tank becoming liquid-full of LP Gas.

9.3.4 The time of delivery, i.e. connection, pumping and disconnection, is normally the time of highest risk requiring the full attention of the driver - operator as well as due care on the part of the consumer.

9.4 Safety Systems for Operation

9.4.1 The bulk distribution system requires the driver-operator to spend some time at the tank and some at his tanker during delivery. Ideally, there should be a clear line of sight and unimpeded access between them. Where sight or access are impeded, the driver-operator should be able to shut off the road tanker’s engine and close the liquid outlet valve while stationed at the consumer’s storage tank and monitoring the filling process. The truck should be safely parked and signaled to avoid traffic accidents and allow easy departure in case of emergency. The transfer area should be free from ignition sources.

9.4.2 The vehicle should be equipped with a number of externally-mounted shutdown devices to enable the driver to stop pumping operations quickly and to secure the vehicle in an emergency. It is normal to fit a remote shutdown switch or button on the end of the delivery hose so that the driver can halt pumping without the need to return to the vehicle. Sometimes, a ‘dead man’s handle’ is incorporated so that pumping can continue only in response to a positive action of the driver. In some areas a radio frequency device with a transmitter is used to remotely shut off the engine and the liquid outlet of the road tanker.
9.4.3 The vehicle should be protected against moving, or being driven away, with the hose connected to the stationary tank. Standard systems include wheel chocks, alarms in the driver’s cab and pneumatic interlock devices to immobilise the vehicle while the hose is unhoused. The driver-operator should remain in attendance (see paragraph 9.4.1) while transfer hoses are attached.

9.4.4 The vehicle must be securely ‘earthed’ before the filling/unloading hose is connected and remain so until the hose is disconnected (see also clause 7.5.6). Fire extinguishers should be carried on the vehicle and kept ready for use during delivery operations.

9.4.5 The bulk delivery driver should be carefully selected, properly and comprehensively trained and accorded status in accordance with his responsibilities.
Chapter Ten

Consumer Installation and Usage

Technical and safety standards should be established, maintained and enforced for LP Gas appliances and appliances and for consumer installations, including refrigeration and air conditioning appliances.

Only qualified installers and servicemen should be permitted to undertake LP Gas installation work.

Consumers should be informed about potential hazards in using LP Gas and about the safety features of appliances and their installation.

Consumers should exercise due care in the use of LP Gas.

Consumers should insist that LP Gas installers and servicemen are properly qualified for such work.

10.1 General

10.1.1 The versatility of LP Gas and its range of applications are reflected in the diversity of installation. These include leisure or household applications employing less than a kilogram of LP Gas to industrial installations supported by hundreds of tonnes of LP Gas in on-site storage.

10.1.2 For the purposes of these Guidelines, the installation comprises of a LP Gas supply vessel (cylinder or tank), connected to one or more appliances or to a dispenser. The connection may be direct from vessel to appliance through a flexible hose or through lengths of pipe work to a multiplicity of appliances. Transport applications for LP Gas, including automotive LP Gas and forklift trucks, also fall within this overall classification.

10.1.3 The LP Gas supplier may also be the supplier and/or installer of the appliance. More often however these activities are separate and the LP Gas supplier may not know exactly where and how the product is being used.

10.1.4 Consumer safety depends on the performance of the installer as well as the standard achieved by the supplier of the LP Gas and of the appliance. It also requires an appreciation on the part of the consumer of the importance of such performance and a willingness to demand and pay for it.

10.1.5 Most accidents, including fatalities, occur at or near the point of use. Prompted by this authorities are increasingly regulating the activities of installers and setting appropriate standards for installations.

10.2 Role and Duty of the Installer

10.2.1 It is the role of the installer to bring together the LP Gas supply and the LP Gas consuming appliance and having connected them ensure that the system is working correctly.

10.2.2 The role of the installer is crucial for LP Gas safety and therefore should have achieved and maintained a specified level of proficiency i.e. be qualified by training and experience.

10.2.3 The installer has a duty to ensure that his work conforms to all statutory or code requirements and to draw attention to any defect in the LP Gas supply or in the appliance which he is instructed to install.
10.2.4 The installer should instruct the consumer in the correct use of the LP Gas installation with regard to safety features, including the provision of adequate ventilation, servicing/maintenance needs and any action to be taken by the consumer in the event of difficulty.

10.2.5 Recognising the importance of good installation practice some national authorities regulate the activities of installers. An example may be seen in the Gas Safety (Installation and Use) Regulations of the UK [refer: www.opsi.gov.uk].

10.3 Appliance Installation, Inspection, Servicing

10.3.1 The LP Gas supplier and the appliance manufacturer may not know where the appliance is installed but they nevertheless have a key role in its safety. They should exercise this role by promoting good installation standards and insisting on qualified installers.

10.3.2 A formal system of information exchange between LP Gas producers and marketers, appliance manufacturers and installers can be a highly effective safety measure.

10.3.3 LP Gas delivery personnel should be instructed to inspect the external installation at each visit to their consumers and to report any defects. Marketers must be prepared to follow up such reports promptly.

10.3.4 Delivery personnel responding to ‘out of gas’ calls should additionally check the operation of controls and any pilot lights in the internal installation and if necessary attach a written warning not to turn on the LP Gas supply until a qualified person has tested the system for safety.

10.3.5 Servicing is especially important for appliances which are used seasonally or which may have remained unused for a long time. LP Gas producers and marketers should actively promote an internal inspection and servicing programme for their consumers in association with qualified installers. It may be counter-productive to announce a programme unless it is adequately resourced and managed.

10.3.6 Builders and consumers should be made aware of the need to have LP Gas installations inspected when carrying out construction or alteration work which could affect safe operation, paying particular attention to ventilation and the removal of the products of combustion.

10.3.7 Inspectors should pay special attention to the number of spare LP Gas cylinders at consumers’ installations and the storage arrangements for them. Spare cylinders, full or empty, are potentially hazardous and their numbers should be kept to the minimum required for continuity of supply.

10.3.8 Operating, service and safety instruction literature should be kept up-to-date and widely disseminated usually in a multimedia format.

10.4 Domestic and Commercial Applications

10.4.1 The diversity of LP Gas applications means that sometimes LP Gas is only one of several hazardous substances present. In others, such as aerosols and refrigerant applications, the consumer may be unaware of the presence of LP Gas.

10.4.2 The use of LP Gas cylinders indoors is normal, accepted practice in some countries. LP Gas safety programmes should emphasise the need for care, especially when exchanging LP Gas cylinders indoors.

10.4.3 Water heaters are frequently involved in domestic incidents with LP Gas, notably carbon monoxide poisoning. Because they are high-output appliances and are often installed in small bathrooms adequate ventilation to remove combustion products is especially important for consumer safety. Flues should be checked regularly for obstructions, e.g. snow and nests.

10.4.4 LP Gas is an indispensable part of commercial cooking but there is a tendency to place cylinders in out of the way places where they may constitute an unseen hazard. Cylinders should never be installed or stored in basements, at exits, or in congested or poorly ventilated places.

10.4.5 An efficient delivery service can contribute to safety by removing the need to hoard cylinders in unsafe conditions.

10.4.6 Providing the correct grade of LP Gas and of equipment can be an effective safety measure by deterring dangerous practices. A high-off take application which may be difficult to fuel using Butane is more likely to be trouble-free with Propane, due the latter’s higher vapour pressure over a wide temperature range.
10.5 **Automotive**

10.5.1 The automotive application, i.e. the use of LP Gas as a transportation fuel, has demonstrated very rapid market growth in several countries where market conditions are right.

10.5.2 Specific safety measures apply to automotive LP Gas equipment. For example, the UN/ECE Regulation 67 [refer: www.unep.org] defines the minimum requirements for automotive LP Gas equipment fitted on vehicles. It is extremely hazardous to operate a gasoline engine using a household LP Gas cylinder and hose. LP Gas should never be used in this way on a vehicle.

10.5.3 The opening of an automotive LP Gas market should be accompanied by a determination to set and enforce appropriate safety standards, i.e. to ensure that a motorist is at no greater risk using LP Gas than when using gasoline. For example, CEN, the European Standards Organisation, considered the minimum safety requirements for LP Gas vehicles, the equipment, components and their installation, as well as the distribution of automotive LP Gas.

10.5.4 Some countries insist on separate re-fuelling stations for LP Gas while others allow LP Gas dispensers on gasoline forecourts. Good equipment and procedures will ensure safety for both systems.

![Automotive LP Gas re-fuelling station](image)

10.5.5 More detailed guidance can be found in publications such as the Regulations for LP Gas service stations and road tank trucks in the Netherlands and draft CEN standards on automotive LP Gas re-fuelling stations and in the LP Gas Automotive Retail Outlets Code of Practice for Safe Operation [refer: www.cen.eu].

10.6 **Consumer Safety Awareness**

10.6.1 LP Gas is sold on the basis of benefits, i.e. that it is better than competing fuels for certain applications. It is also hazardous and most LP Gas-related incidents occur at or close to the point of use. In effort to win and retain consumers the marketer seeks to create safety awareness without undermining his product.

10.6.2 The LP Gas industry must address the safety issue directly and enlist the support of national regulatory authorities and consumer organisations to create safety awareness. Together, they should publicise the steps which consumers should take, and those to avoid, in the interest of safety, e.g. by providing Material/Safety Data Sheets.

10.6.3 As consumer safety depends on the appliance and the installation as well as the LP Gas supply, authorities should set standards for all three components and make consumers aware of them. An example is the CE mark which is mandatory on appliances sold in EU member states.

10.6.4 Cylinder labels, marketing letters, point-of-sale notices can all be effective in raising consumer safety awareness. To maintain awareness, messages and presentations should be refreshed from time to time. Brief, timely campaigns are especially useful for seasonal users.

10.6.5 The use of detectors and alarms should not be discouraged but neither should consumers become over-dependent on them. Such devices can be particularly useful in warning against a build-up of CO and for the safety of consumers with an impaired sense of smell.
In any organisation, the most senior management should accept responsibility for safety and should ensure that the resources are available for the safety management programme.

Safety management should be knowledge-based and should operate within a formal structure of policy and action plans.

Safety programmes should be regularly updated on the basis of systematic reviews and advances in technology.

Accident experience can be instructive and should be shared for the benefit of all.

11.1 General

11.1.1 LP Gas is potentially hazardous from the time of production until it has been used and the products of combustion have been safely disposed of. The management of safety is correspondingly wide-ranging.

11.1.2 Management of the hazards associated with LP Gas starts with an understanding of the product and with the exercise of control under all conditions. In the event of a fire affecting LP Gas in storage, particular care is required to prevent the development of conditions which could lead to a BLEVE. If, under abnormal conditions, control is lost then the management task is to regain it with the minimum loss. LP Gas in isolation is not hazardous but even a small leakage must be dealt with immediately.

11.1.3 The safety management programme should also address hazards incidental to the manner in which LP Gas is distributed and used.

11.1.4 At the beginning of the distribution chain LP Gas is usually stored and handled in sufficient quantity to constitute a major industrial hazard and is regulated accordingly. Further along the distribution chain LP Gas will pass through less skilled hands but the safety management task remains.

11.1.5 At the point of use LP Gas may be a culprit or an innocent party to an incident arising from deliberate misuse of the product or through a faulty appliance or installation. Such exposures further complicate the management task.

11.2 Safety Management Programme

11.2.1 The Safety Management Programme (or System) should be aimed at taking an active role to manage the safety within the business.

11.2.2 The Safety Management Programme needs to address issues such as the business and system resources, plant design and layout, the environment, on site and off site risks, recruitment and training of personnel, managing change within the business, dealing with emergencies (including links with emergency services departments), the capacity to deal with events etc.

11.2.3 When properly implemented, a The Safety Management Programme should significantly reduce the incident potential and the number and severity of accidents.
11.3 Management Commitment and Leadership

11.3.1 Effective safety management requires a clear commitment from proprietors, and their appointed top managers, to put safety among their key concerns and priorities.

11.3.2 Top management should demonstrate that commitment through unequivocal leadership, sanctioning and implementing the actions required for a safety programme appropriate to the company's role in the LP Gas industry.

11.4 Policy, Objectives, Action Plans, Resources

11.4.1 Participants in the LP Gas industry should publish a safety policy for their companies, explaining its objectives and action plans to their employees and business partners. The manner and format in which safety policy is promulgated will vary from company to company and may be determined, in part, by national and regional regulations.

11.4.2 Larger organisations should introduce clear, written definitions of the role of managers at all levels. Individual responsibilities and objectives should be specified in respect of the safety programme.

11.4.3 Safety policy lacks credibility without specific action plans and the resources required for implementation. Where licensing of LP Gas operations is required, the responsible authorities should give due consideration to this.

11.5 Laws, Standards and Codes

11.5.1 Laws provide the legal basis for regulations intended to safeguard the safety of the general public and consumers. There may be a law specifically enacted for LP Gas but the product is sometimes brought within the scope of broader legislation.

11.5.2 The public interest requires a measure of safety regulation over hazardous substances, including LP Gas. Participants in the LP Gas industry should co-operate with government authorities by making their expertise available to ensure that safety regulations are soundly based.

11.5.3 LP Gas standards and codes embody the technical expertise of a mature industry which constantly seeks to improve its safety image and performance. There are many such standards and codes listed in Appendix Three together with web site references. Consideration should be given to adopting standards and codes which have achieved international recognition rather than undertake the necessarily laborious work of preparing, or up-dating, national standards.

11.6 Hazard Identification, Evaluation, Quantification, Mitigation

11.6.1 It is recognised that in a modern industrial society certain hazards are present and unavoidable as part of basic wants and needs. This has prompted ideas of hazard evaluation and the tolerability of risk.

11.6.2 The LP Gas industry has taken the initiative in LP Gas related hazard identification, evaluation and quantification, using its expertise to encourage a science-based approach by the authorities responsible for safety regulation.

11.6.3 National Authorities and the LP Gas industry should maintain a dialogue about LP Gas related hazards and technical advances which might be employed in mitigating risks. Where possible, both parties should engage in international, as well as national, dialogue for this purpose.

11.6.4 Contacts between the LP Gas industry and the Authorities should not be confined to times of difficulty. The immediate aftermath of some tragic event or incident is probably not the best time to introduce, or to amend, safety regulations.

11.6.5 Leading participants in the LP Gas industry - marketers, equipment and appliance manufacturers - work constantly and constructively on safety management issues through improvements in technical standards, safety features and procedures. Regulatory authorities should encourage and support hazard mitigation by excluding participants who are not prepared to be part of this process.
11.7 Systematic Review, Corrective Action

11.7.1 Having published their safety policies and set their safety objectives, suppliers and marketers should put in place a system of reviews to monitor progress towards achieving those objectives. The review should be seen as a high-level activity receiving top management’s attention. Operating companies should develop and update a corrective action and safety improvement plan.

11.7.2 The review should monitor all points of the marketer’s distribution chain and provide information feedback to appliance and equipment vendors and installers.

11.7.3 Where a licensing system operates, evidence of systematic safety review process should be a factor in the periodic re-licensing of LP Gas facilities.

11.7.4 There are often useful lessons to be learned from post-incident investigations and such experience should be shared.
Chapter Twelve

Emergency Planning and Response

Planning for emergencies should be an integral part of a safety management programme that also takes into account the national and local emergency requirements that may exist in the particular country, particularly any legal ones.

Planning and response should encompass every stage of the distribution chain as well as LP Gas in storage and in use.

An emergency at an LP Gas plant may have an impact beyond its boundary fence and the APELL (Awareness and Preparedness for Emergencies at a Local Level) process should be employed for preparedness at local level.

APELL is a programme developed by UNEP in conjunction with governments and industry with the purpose of minimising the occurrence and harmful effects of technological accidents and environmental emergencies. [refer: www.unep.fr]

12.1 General

12.1.1 Emergency planning and response is one component of an overall safety management programme. The concept and procedures have been integrated into regulations for the control of major industrial hazards, prompted by such initiatives as the Seveso Directive which specifies ‘planning for emergencies’ as part of the safety management system.

12.1.2 In these Guidelines, emergency planning and response process for LP Gas plants of a size to be classified as ‘major hazards’ and LP Gas in bulk transport will be discussed.

12.2 The APELL Process

12.2.1 APELL is the acronym for Awareness and Preparedness for Emergencies at Local Level, a process developed by the UNEP Industry and Environment Office in co-operation with industry and governments. With its emphasis on preparedness at local level, the APELL process recognises that the extent of an industrial accident’s impact depends heavily on the immediate response to an emergency at the plant site and in its immediate vicinity.

12.2.2 Alongside this emphasis on local preparedness APELL recognises the role of government authorities in formulating regulations and in providing the resources which local communities need. APELL neither replaces nor interferes with established emergency response provisions but seeks to increase awareness of such provisions and activities.

12.2.3 At local level there are three very important partners who must be involved if APELL is to be successful: local authorities, industry and local community/interest groups.

12.2.4 APELL acknowledges the need and the right of the local community to be informed about and to participate at all times in response planning for hazardous installations.

12.2.5 Details of the APELL process can be found in the publication APELL - Awareness and Preparedness for Emergencies at Local Level: A Process for Response to Technological Accidents, published by the United Nations Environment Programme, Industry and Environment. [refer: www.unep.fr]
12.3 Emergency Plan, Procedures

12.3.1 Expert hazard evaluation and quantification should form the basis of the emergency plan by:

- Identifying the on-site and off-site hazards
- Assessing the ability for the emergency plans to mitigate the impact of the accident or incident
- Quantifying the on-site and off-site impact of credible accident scenarios

12.3.2 Whether required to do so by regulation or not, the site owner or project promoter should provide the initial hazard evaluation and quantification. He / she should share this hazard information with the partners described in the APELL process and be prepared to provide independent verification if required.

12.3.3 The development of the emergency response plan should conform to any national or local regulatory requirements and ideally the procedures specified in the APELL process.

12.3.4 The emergency plan should provide for an escalating sequence of events and emergency procedures should be tiered accordingly.

12.3.5 Pipeline and rail operators will have emergency response procedures for the various hazardous product transported by them. LP Gas marketers and suppliers using pipeline and rail transport should ensure that the operators fully understand the emergency procedures for the products being carried and that transport vehicles display the appropriate product identification labels to warn and assist emergency response teams.

12.3.6 For more information on emergency response plan for transport, reference can be made to the publication “TransAPELL: Guidance for dangerous goods transport, Emergency planning in a local community” [refer: www.unep.fr/scp/publications/pdf/2679-TransApellEN.pdf]

12.4 Fire-fighting Principles, Procedures

12.4.1 The most effective way to fight an LP Gas fire is to shut off the LP Gas supply. If this cannot be done, it may be safer to allow the fire to burn itself out, i.e. to burn until the LP Gas supply to it has been exhausted, unless the continuing fire will result in an escalation of the emergency. The photograph below shows an ignited LP Gas flame in controlled conditions.

![An ignited LP Gas Flame in controlled conditions](image)

12.4.2 Dry powder or carbon dioxide fire extinguishers are effective against LP Gas fires.

12.4.3 Water is effective in cooling LP Gas vessels during a fire and in helping to keep the temperature of tanks and their contents below critical levels. Water spray can be useful in protecting fire-fighters attempting to close LP Gas supply valves in heat-effected areas and in dispersing LP Gas vapour.
12.4.4 Emergency response teams drawn from the plant staff should represent the first line of defense and should be trained for quick decisive action to contain emergencies before they develop and be trained to assist emergency personnel as any escalation of the emergency demands.

12.4.5 Emergency response to a fire on or close enough to threaten an LP Gas road tanker depends critically on the driver-operator. Therefore the quality of the equipment and training in its use are crucial to recovering control and mitigating the impact of the emergency situation.

12.5 Internal, External Responses

12.5.1 Most in-plant emergencies begin in a small way or as a result of failure to deal promptly and effectively with a minor incident. Owners and managers should recognise the value of rapid response by trained teams confident in their ability to deal with emergencies. Good equipment, a team spirit and regular training are essential for the commitment and confidence which ensures an effective internal response.

12.5.2 External response may be from local authority emergency services or from a mutual assistance group set up to respond to emergencies.

12.5.3 The effectiveness of both internal and external response depends initially on the seriousness of the event and then on resources, preparedness and timing. Fire drills and rehearsals for emergencies are an essential part of safety management and should be practiced regularly. External response will be most effective when the team is totally familiar with the plant, its hazards and its defenses.

12.5.4 Internal and external communications are important factors in determining the effectiveness of emergency response. The slightest delay in reacting to an emergency can make the difference between success and failure. No one should be criticised for over-reacting to an emergency.

12.6 Investigation, Corrective Action, Follow-up

12.6.1 The purpose of post-incident investigation is to determine the causes, both immediate and underlying, in order that lessons can be learned and corrective action taken. The investigating team should include an independent expert and should report to the owners, or to senior management. The licensing authority may wish to participate or to make an independent investigation.

12.6.2 An investigation may disclose the need for corrective action in respect of plant layout, equipment, systems, procedures or personnel. While the team should guard against developing an unrealistic ‘wish list’ senior management should be prepared to sanction their recommendations.

12.6.3 Senior management should be prepared to discipline anyone who causes or contributes to an incident by disregarding safety rules and procedures. They should also recognise those who respond well in an emergency.

12.6.4 Follow-up should include information feedback to the APELL partners. If relevant information has to be withheld or delayed for legal or other good reason this should be made clear to the partners.

12.6.5 If equipment or system defects contributed to an incident then equipment suppliers, installers and other plants known to be similarly equipped should be alerted.

12.6.6 Authorities responsible for re-licensing should pay particular attention to any LP Gas facility where a reportable incident has occurred or any facility which closely resembles a facility which has suffered a serious accident or incident.

12.6.7 Following a serious incident, plant management should set about maintaining and improving relationships with employees and the community and recognise that this may take time.
Appendix One

Product Classification and Labelling

Hazard Warning Notices and Signs (UN)

Depending on the mixture, there are three UN classification numbers to be considered for LP Gas:

- Butane or Butane mixtures – UN 1011
- Propane or Propane mixtures – UN 1978

Or a common classification:
- Petroleum Gas, Liquefied or Liquefied Petroleum Gas – UN 1965

All these gases fall under the Hazard Classification (Transport): Class 2 Division 1, indicated as 2.1 and have to be marked with the label 2.1 ‘Flammable Gas’.

The colour of the placard or label is red.
Appendix Two

Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Appliance</td>
<td>LP Gas consuming device e.g. stove, water heater, space heater</td>
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<tr>
<td>BLEVE</td>
<td>Boiling Liquid Expanding Vapour Explosion</td>
</tr>
<tr>
<td>Bulk Supply</td>
<td>LP Gas supply to a consumer's tank</td>
</tr>
<tr>
<td>CFCs</td>
<td>Chlorofluorocarbons</td>
</tr>
<tr>
<td>Cylinder</td>
<td>Portable LP Gas container</td>
</tr>
<tr>
<td>Cylinder Supply</td>
<td>LP Gas supply in cylinders</td>
</tr>
<tr>
<td>Equipment</td>
<td>Device(s) connecting and/or controlling LP Gas supply from a tank/cylinder to appliances</td>
</tr>
<tr>
<td>Grade of LP Gas</td>
<td>Type of LP Gas, e.g. chemical, commercial, high purity. Proportion of Butane/Propane in LP Gas mixture, e.g. Butane rich mixture</td>
</tr>
<tr>
<td>Hazard</td>
<td>A threat which could cause an accident. (definition in APELL process)</td>
</tr>
<tr>
<td>Passive Safety</td>
<td>Safety not dependent on active safety systems</td>
</tr>
<tr>
<td>Requalification</td>
<td>Periodic inspection/testing to ensure that LP Gas cylinders and tanks remain fit for service</td>
</tr>
<tr>
<td>Risk</td>
<td>Probability of an accident occurring within a certain time, together with consequences for people, property and the environment. (definition in APELL process)</td>
</tr>
<tr>
<td>Tank</td>
<td>LP Gas container for bulk supply and transportation</td>
</tr>
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</table>
Appendix  Three

List of References

General

European Union

CONCAWE [refer: www.concawe.be]

LPG Safety: Quantified Risk Assessment for LPG Operations  
European LPG Association (AEGPL) [refer: www.aegpl.com]

APELL - Awareness and Preparedness for Emergencies at Local Level: A Process for Response to Technological Accidents  
UNEPI [refer: www.unep.org]

HAZOP (A Hazard and Operability Study (HAZOP) is a systematic method for examining complex facilities or processes to find actual or potentially hazardous procedures and operations so that they may be eliminated or mitigated).  
[refer: www.hse.gov.uk/comah/sragtech/techmeasplantmod.htm]

Technical

ISO 9162: Standard for LPG  
International Standards Organisation [refer: www.iso.org]

K 2644-87: Standard for LPG  
Japanese Institute of Standards [refer: www.jisc.go.jp / www.jsa.or.jp]

Standard 2140: Liquefied Petroleum Gas Specification and Test Methods  

IS 4576: Indian Standard for LPG  
Indian Standards Association [refer: www.bis.org.in]

BS 4250: Standard for Commercial Butane and Propane  
British Standards Institute, UK [refer: www.bsi-global.com]

Standard D-1835 Specification for Liquefied Petroleum (LP) Gases  

Standard 54, National Fuel Gas Code  

UNEPI IE/PAC [refer: www.unep.org]

Liquefied Gas Handling Principles on Ships and in Terminals  
Society of International Gas Tanker and Terminal Operators [refer: www.sigtto.org]
<table>
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<th>Guidance Notes GS 40: The Loading and Unloading of Bulk Flammable Liquids and Gases at Harbours and Inland Waterways</th>
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<td>Health and Safety Executive, UK</td>
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<tr>
<th>Safe Transport, Handling and Storage of Dangerous Substances in Port Areas</th>
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<tr>
<td>International Maritime Organisation</td>
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<tr>
<td>[refer: <a href="http://www.imo.org">www.imo.org</a>]</td>
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<th>Ship-to-Ship Transfer Guide (Liquefied Gases)</th>
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<td>ICS, OCIMF, SIGGTO</td>
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<tr>
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<th>Underground and Mounded Vessels Standards</th>
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<tr>
<td>EEMUA standard 190</td>
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<tr>
<td>[refer: <a href="http://www.eemua.co.uk">www.eemua.co.uk</a> and <a href="http://www.eemua.org">www.eemua.org</a>]</td>
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<tr>
<th>Safety Guide for Terminals Handling Ships Carrying Liquefied Gases in Bulk. OCIMF T14</th>
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<tr>
<td>NFPA 307</td>
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<tr>
<th>Standard for the Construction and Fire Protection of Marine Terminals, Piers and Wharves</th>
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<tr>
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<th>COP 1 The Storage of LPG at Fixed Installations</th>
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<td>UK (LPGA)</td>
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<tr>
<th>ADR - European Agreement concerning the International Transport of Dangerous Goods by Road</th>
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Appendix Four

LP Gas Distribution Chain

Companies around the world provide filling, storage, controlling and safety equipment as well as services to the LP Gas industry and end users.